INSTRUCTIONS TO KCET EXAM

SUBJECT:PHYSICS	**DAY-2**
SESSION MORNING	**TIME: 10.30AM TO 11.50AM**

MAXIMUM MARKS	**TOTAL DURATION**	**MAXIMUM TIME FOR ANSWERING**
60	**80 MINUTES**	**70 MINUTES**

MENTION YOUR CET NUMBER					**QUESTION BOOKLETS DETAILS**	
					VERSION CODE	**SERIAL NUMBER**
					A-1/A-2… D-3/D-4	**548817**

DOs

1. Check whether the CET No. has been entered and shaded in the respective circles on the OMR answer sheet.
2. This question Booklet is issued to you by the invigilator after the 2nd Bell i.e., after 10.30 A.M.
3. The serial number of this question booklet should be entered on the OMR sheet.
4. The Version code of this booklet should be entered on the OMR answer sheet and the respective circles should also be shaded completely.
5. Compulsorily sign at the bottom portion of the OMR answer sheet in the space provide.

DONT"S

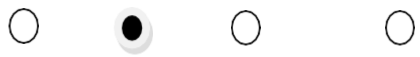
1. **THE TIMING AND MARKS PRINTED ON THE OMR ANWER SHEET SHOULD NOT BE DAMAGED / MUTILATED /SPOILED.**
2. **The 3rd bell rings at 10.40 A.M., till then**
   - Do not remove the paper seal present on the right hand side of this question booklet.
   - Do not look inside this question booklet.
   - Do not start answering on the OMR answer sheet.

IMPORTANT INSTRUCTIONS TO CANDIDATES

1. This question booklet contains 60 questions and each question will have one statement and four distracters (Four different options/choices).
2. After the 3rd bell is rung at 10.40 A.M., remove the paper seal on the side hand side of this question booklet and check that this booklet does not have any unprinted or torn or missing pages or items etc. If so, get it replaced by a complete test booklet. Read each item and start answering on the OMR answer sheet.
3. During the subsequent 70 minutes:
   - Read each question carefully.

- Choose the correct answer from out of the four available distracters (options/choices) given under the each question/statement.

Correct method of shading the circle on the OMR answer sheet is as shown below



4. Please note that even a minute unintended ink dot on the OMR answer sheet will also be recognised and recorded by the scanner. Therefore, avoid multiple markings of any kind on the OMR answer sheet.
5. Use the space provided on each page of the question booklet for rough work. Do not use the OMR answer sheet for the same.
6. After the last bell is rung at 11.50 A.m. stop writing on the OMR answer sheet and affix your **LEFT HAND THUMB IMPRESSION** on the OMR answer sheet as per the instructions.
7. Hand over **OMR ANSWER SHEET** to the room invigilator as it is.
8. After separating the top sheet (Our copy), the invigilator will return the bottom sheet replica (Candidates copy) to you to carry home for self-evaluation.
9. Preserve the replica of the OMR answer sheet for a minimum period of ONE year.

KCET 2023-2013 QUESTIONS WITH SOLUTIONS:

1. **For a point object, which of the following always produces virtual image in air?**
   (A) **Concave mirror** **(B) Plano-convex lens (C) Convex mirror (D) Biconvex**

ANSWER (C) Sol. Conceptual

Solution:

2. **For a given pair of transparent media, the critical angle for which colour is maximum**
   (A) Green (B) Red (C) Blue (D) Violet

ANSWER (B)

Solution:

The relation between critical velocity and refractive index of the material is

$$\sin C = \frac{1}{\mu} = \frac{V}{C} = \frac{V\lambda}{C}$$

Since $\propto \lambda$

$\therefore$ λ is more for red colour

$\therefore$ Critical angle is more for red colour

3. **An equiconvex lens made of glass of refractive index 3/2 has focal length f in air. It is completely immersed in water of refractive index 4/3. The percentage change in the focal length is**
   (A) 400% increase (B) 300% decrease (C) 400% decrease (D) 300% increase

ANSWER (B)

Solution:

In air;

$$\frac{1}{f} = \left[\frac{\mu_g}{\mu_a} - 1\right]\left[\frac{1}{R} - \left(-\frac{1}{R}\right)\right] = \frac{1}{2} \times \frac{2}{R}$$

$$\frac{1}{f} = \frac{1}{R}$$

$$f = R$$

In water;

$$\frac{1}{f_2} = \frac{1}{4\,f}$$

$$f_2 = 4\,f$$

$$\therefore \frac{f_2 - f_1}{f_1} = \frac{4f - f}{f} = 3$$

$$f_2 = 300\%$$

4. A point object is moving at a constant speed of 1 ms^{-1} along the principal axis of a convex lens of focal length 10 cm. The speed of the image is laong 1 ms^{-1} , when the object is at_cm from the optic centre of the lens

(A) 10 (B) 15 (C) 20 (D) 5

ANSWER (C)

Solution:

$$\frac{v_i}{v_o} = m^2$$

$$1 = \left(\frac{V}{u}\right)^2$$

V=u

The lens formula is given by

$$\frac{1}{V} - \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{V} + \frac{1}{V} = \frac{1}{10}$$

$$\frac{2}{V} = \frac{1}{10}$$

V=20

The object is at 20 cm from the optic center of the lens

5. When light propagates through a given homogeneous medium, the velocities of

(A) Primary wavefront are larger than those of secondary wavelets

(B) Primary wavefronts are lesser than those of secondary wavelets

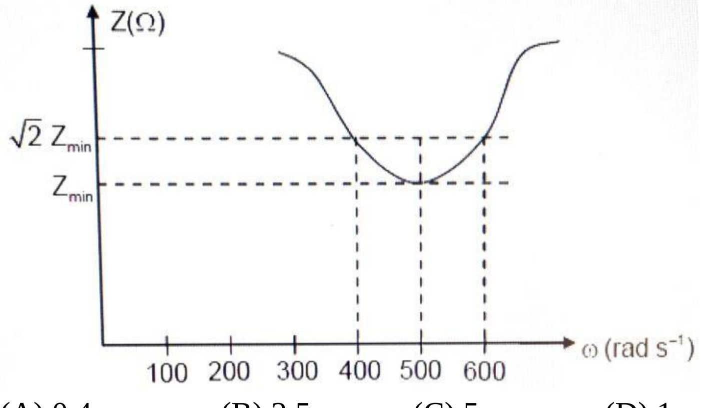
(C) Primary wavefronts are greater than or equal to those of secondary wavelets

(D) Primary wavefront and wavelets are equal

ANSWER (D)

Solution: Conceptual

6. Total impedance of series LCR circuit varies with angular frequency of the AC source connected to it as shown in the graph. The quality factor Q of the series LCR circuit is



(A) 0.4 (B) 2.5 (C) 5 (D) 1

ANSWER (C)

Solution:

$$\text{Quality factor } Q = \frac{fr}{\Delta f} = \frac{\omega r}{\Delta\omega} = \frac{500}{500-400} = \frac{5}{2} = 2.5$$

7. The ratio of the magnitudes of electric field to the magnetic field of an electromagnetic wave is of the order of

(A) 10^{-8} ms^{-1} (B) 10^{5} ms^{-1} (C) 10^{-5} ms^{-1} (D) 10^{8} m

ANSWER (C)

Solution:

$$\frac{E}{B} = C = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$$

$$\frac{E}{B} = C = \frac{1}{\sqrt{4\pi \times 10^{-7}\frac{1}{4\pi \times 10^{9}}}}$$

$$\frac{E}{B} = C = \frac{1}{\sqrt{10^{-7} \times 10^{-9}}}$$

$$\frac{E}{B} = C = \frac{1}{\sqrt{10^{-16}}}$$

$$\frac{E}{B} = C = \frac{1}{10^{-8}}$$

$$\frac{E}{B} = C = 10^{8}$$

$$\frac{E}{B} = C = 10^{8}\ m/s$$

8. A 60 W source emits monochromatic light of wavelength 662.5 nm. The number of photons emitted per second is

(A) 5×10^{17} (B) 2×10^{20} (C) 5×10^{26} (D) 2×10^{29}

ANSWER (C)

Solution:

$$P = \frac{nE}{t} = \frac{n}{t} \times h\gamma = \frac{n}{t} \times \frac{hC}{\lambda}$$

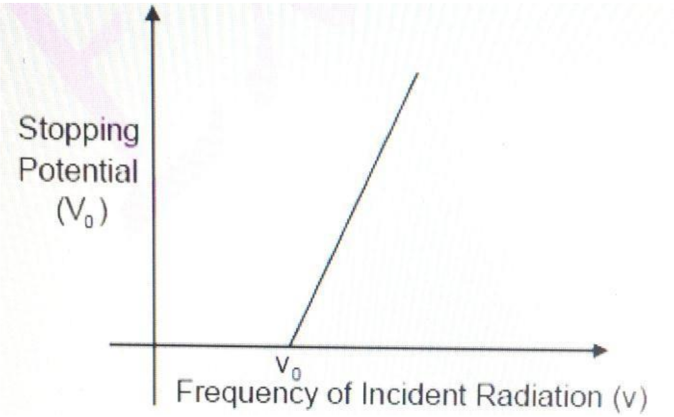
$$\frac{n}{t} = \frac{P\lambda}{hC}$$

$$\frac{n}{t} = \frac{60 \times 662.5 \times 10^{-9}}{6.6 \times 10^{-34} \times 3 \times 10^{8}}$$

$$\frac{n}{t} = 200.75 \times\times 10^{18}$$

$$\frac{n}{t} = 2 \times 10^{20}$$

9. In an experiment to study photo-electric effect that observed variation of stopping potential with frequency of incident radiation is as shown in the figure. The slope and y-intercept are respectively



(A) $\frac{h}{e}, \frac{h\gamma_0}{e}$ (B) $\frac{h\gamma}{e}, \gamma_0$ (c) $\frac{h\gamma}{e}, \frac{h}{e}$ (D) $h\gamma - h\gamma_0$

ANSWER (A)

Solution:

$$\text{Slope} = \frac{\gamma_0}{\gamma} = \frac{h}{e} \qquad \because E = eV_0$$

$$h\gamma = eV_0$$

10. In the Rutherford"s alpha scattering experiment, as the impact parameter increases the scattering angle of the alpha particle

(A) Remains the same (B) Is always 90° (C) Decreases (D) Increases

ANSWER (C) Solution:

$$\text{Scattering angle (q)} \propto \frac{1}{\text{Impact facttor}}$$

11. Three energy levels of hydrogen atom and the corresponding wavelength of the emitted radiation due to different electron transition are as shown. Then

(A) $\lambda_3 = \frac{\lambda_1\lambda_2}{\lambda_1 + \lambda_2}$ (B) $\lambda_3 = \frac{\lambda_2\lambda_3}{\lambda_2 + \lambda_3}$ (C) $\lambda_2 = \lambda_1 + \lambda_3$ (D) $\lambda_2 = \frac{\lambda_1\lambda_3}{\lambda_1 + \lambda_3}$

ANSWER (D)

Solution:

$$E_2 = E_1 + E_3$$

$$\frac{hC}{\lambda_2} = \frac{hC}{\lambda_1} + \frac{hC}{\lambda_3}$$

$$\frac{1}{\lambda_2} = \frac{1}{\lambda_1} + \frac{1}{\lambda_3}$$

$$\lambda_2 = \frac{\lambda_1\lambda_3}{\lambda_1 + \lambda_3}$$

12. An unpolarised light of intensity I is passed through two polaroids kept one after the other with their planes parallel to each other. The intensity of light emerging from second Polaroid is I.

(A) 45°　　(B) 0°　　(C) 60°　　(D) 30°

ANSWER (C)

Solution:

$$I^2 = \frac{1}{2}\cos^{-2}\theta$$

$$\frac{1}{4} = \frac{1}{2}\cos^2\theta$$

$$\frac{1}{2} = \cos^2\theta$$

$$\cos\theta = \frac{1}{\sqrt{2}}$$

$$\theta = 45^0$$

13. The angle between the pass axes of the polaroids is n the Young‟s double slit experiment, the intensity of light passing through each of the two double slits is 2 × 10^{-2} Wm^{-2}. The screen – slit distance is very large in comparison with slit – slit distance. The fringe width is β. The distance between the central maximum and a point P on the screen is x. Then the total light intensity at that point is

(A) 8×10^{-2} Wm^{-2}　　(B) 4×10^{-2} Wm^{-2}　　(C) 2×10^{-2} Wm^{-2}　　(D) 16×10^{-2} Wm^{-2}

ANSWER (C)

Solution:

$$\tan\theta = \frac{\beta/3}{D} = \frac{\lambda D/3d}{D}$$

$$\tan\theta = \lambda/3d$$

$$\text{Path difference} = d\ \tan\theta = d(\lambda/3d) = \frac{\lambda}{3}$$

$$\phi = \frac{2\pi}{\lambda}\left(\frac{\lambda}{3}\right) = \frac{2\pi}{3}$$

$$\phi = 120^0$$

$$I' = 4I_0\cos^2\left(\frac{\phi}{2}\right)$$

$$I' = 4I_0\cos^2(60^0)$$

$$I' = 4I_0\left(\frac{1}{4}\right)$$

$$I' = I_0 = 2\times10^{-2}\ \omega/m^2$$

14. A radioactive sample has half – life of 3 years. The time required for the activity of the sample to reduce to 1 th 5 of its initial value is about

(A) 10 years (B) 7 years (C) 15 years (D) 5 years

ANSWER (B)

Solution:

$$N = N_0 \left(\frac{1}{2}\right)^{t/T}$$

$$\frac{1}{5} N_0 = N_0 \left(\frac{1}{2}\right)^{t/T}$$

$$\log 2^{t/T} = \log^5$$

$$\frac{t}{T} \log^2 = \log^5$$

$$\frac{t}{T} = \left(\frac{\log^5}{\log^2_{10}}\right)$$

$$t = \left(\frac{\log^5}{\log^2_{10}}\right) T$$

$$t = 2.3219 \times 3 \text{ years}$$

$$t = 7 \text{ years}$$

15. When a p – n junction diode is in forward bias, which type of charge carries flow in the
connecting wire?

(A) Free electrons (B) Ions (C) Protons (D) Holes

ANSWER (C)

Solution: Free electrons

16. A full – wave rectifier with diodes D_1 and D_2 is used to rectify 50 Hz alternating voltage. The diode D_1 conducts______times in one second

(A) 100 (B) 25 (C) 75 (D) 50

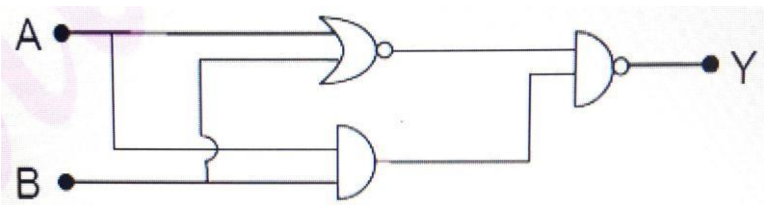
ANSWER (C)

Solution:

Frequency of alternating voltage is equals to current conduction frequency through diode

17. The truth table for the given circuit is

ANSWER (C)



Solution:

(A)

A	B	Y
1	1	1
1	0	1
0	1	0
0	0	1

(B)

A	B	Y
1	1	1
1	0	0
0	1	1
0	0	1

(C)

A	B	Y
1	1	1
1	0	1
0	1	1
0	0	1

(D)

A	B	Y
1	1	1
1	0	1
0	1	1
0	0	0

$$Y = \overline{\overline{(A+B)}.(A.B)}$$

$$Y = (A+B).\overline{(A.B)}$$

$$Y = (A+B) + (\bar{A}+\bar{B})$$

18. The energy gap of an LED is 2.4 eV. When the LED is switched „ON" the momentum of the emitted photons is

(A) 1.28×10^{-27} kg. m.s^{-1} **(B) 2.56×10^{-27} kg. m.s^{-1}**

(C) 1.28×10^{-11} kg.m.s^{-1} **(D) 0.64×10^{-27} kg.m.s^{-1}**

ANSWER (C)

Solution:

$$E = 2.4\ eV = 2.4 \times 1.6 \times 10^{-19}\ J$$

$$P = \frac{E}{C} = \frac{2.4 \times 1.6 \times 10^{-19}}{3 \times 10^{8}}$$

$$P = 1.28 \times 10^{-27}\ \ kg\ ms^{-1}$$

19. In the following equation representing β^- decay, the number of neutrons in the nucleus X is ${}^{210}_{83}Bi \rightarrow X + e^{-1} + \bar{\nu}$

(A) 126 (B) 127 (C) 125 (D) 84

ANSWER (C)

Solution:

No. of neutrons in X(N) = 210 – 84 = 126

$${}^{210}_{83}Bi \rightarrow 84X^{210} + e^{-1} + \bar{\nu}$$

No. of neutrons in X(N) = 210 – 84 = 126

20. A nucleus with mass number 220 initially at rest emits an alpha particle. If the Q value of reaction is 5.5 MeV, calculating the value of kinetic energy of alpha particle

(A) 6.5 MeV **(B) 5.4 MeV** **(C) 7.4 MeV** **(D) 4.5 MeV**

ANSWER (C)

Solution:

$${}_{Z}X^{A} \rightarrow {}_{Z-2}Y^{A-4} + {}_{2}He^{4} + Q$$

Q = 5.5 MeV

$$Q = K.E_{\alpha}\left(1 + \frac{m_{\alpha}}{m_y}\right)$$

$$Q = K.E_{\alpha}\left(\frac{m_y + m_{\alpha}}{m_y}\right)$$

$$Q = K.E_{\alpha}\left(\frac{A_y + A_{\alpha}}{A_y}\right)$$

$$Q = K.E_{\alpha}\left(\frac{A}{A-4}\right)$$

$$K.E_{\alpha} = Q\left(\frac{A-4}{A}\right)$$

$$K.E_{\alpha} = 5.5\left(\frac{216}{220}\right)$$

$$K.E_{\alpha} = 5.4\ \text{MeV}$$

21. A particle is in uniform circular motion. Related to one complete revolution of the particle which among the statements is incorrect?

(A) Average acceleration of the particle is zero

(B) Displacement of the particle is zero

(C) Average speed of the particle is zero

(D) Average velocity of the particle is zero

ANSWER (C)

Solution:

One compete revolution of particle in circular motion average speed of particle never become zero

22. A body of mass 10 kg is kept on a horizontal surface. The coefficient of kinetic friction between the body and the surface is 0.5. A horizontal resulting acceleration of the body is about

(A) 1 ms^{-2} **(B) 5 ms^{-2}** **(C) 6 ms^{-2}** **(D) Zero**

ANSWER (A)

Solution:

Given M= 10kg, μ_k =0.5, F= 60N,

$$\text{Acceleration} = a = \frac{F - \mu_k N}{M}$$

$$a = \frac{60 - 0.5\,(10)(10)}{10}$$

$$a = \frac{10}{10} = 1\,\text{m/s}^2$$

23. A ball of mass 0.2kg is thrown vertically down from a height of 10m. It collides with the floor and loses 50% of its energy and then rises back to the same height. The value of its initial velocity is

(A) zero (B) 14 ms^{-1} (C) 196 ms^{-1} (D) 20 ms^{-1}

ANSWER (D)

Solution:

$$\text{Initial Energy} = \frac{1}{2}mv_0^2$$

$$\text{Final energy} = \text{Potential energy} + \text{Kinetic Energy}$$

$$\text{Final energy} = mgh + \frac{1}{2}mv^2$$

$$\text{Initial Energy} = \text{Final energy}$$

$$\frac{1}{2}mv_0^2 = mgh + \frac{1}{2}mv^2$$

$$\frac{1}{2}mv^2 = mgh + mgh \qquad \because \frac{1}{2}mv^2 = mgh$$

$$\frac{1}{2}mv^2 = 2mgh$$

$$v^2 = 4ghv^2 = 4gh$$

$$v = \sqrt{4gh}$$

$$v = \sqrt{4 \times 10 \times 10}$$

$$v = \sqrt{400} = 20\ m/s^2$$

24. The moment of inertia of a rigid body about an axis

(A) Does not depend on its mass.

(B) Does not depend on its shape.

(C) Depends on the position of axis of rotation

(D) Does not depend on its size

ANSWER (C)

Solution:

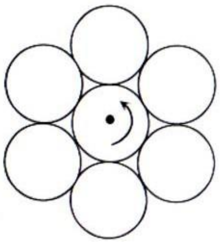
I = mK2

I K

$$\text{Moment of Inertia} = I = mK^2$$

$$I \propto \sqrt{K}$$

25. Seven identical discs are arranged in a planar pattern, so as to touch each other as shown in the figure. Each disc has mass „m‟ radius R. What is the moment of inertia of system of six discs about an axis passing through the centre of central disc and normal to plane of all discs?



(A) $27\ mR^2$ (B) $100\ mR^2$ (c) $55\frac{mR^2}{2}$ (D) $85\frac{mR^2}{2}$

ANSWER (C)

Solution:

Moment of inertia about natural axis = mR^2

Moment of inertia about an axis parallel to natural axis at a distance of 2R

$$I_{axis} = \frac{mR^2}{2} + m(2R)^2$$

$$I_{axis} = \frac{mR^2}{2} + 4mR^2$$

$$I_{axis} = \frac{mR^2 + 8mR^2}{2} \Rightarrow \frac{9\ mR^2}{2}$$

$$\text{Total MI} = \frac{9\ mR^2}{2} \times 6 + \frac{mR^2}{2}$$

$$\text{Total MI} = \frac{54\ mR^2}{2} + \frac{mR^2}{2}$$

$$\text{Total MI} = \frac{55\ mR^2}{2}$$

26. The true length of a wire is 3.678 cm. When the length of this wire is measured using instrument A, the length of the wire is 3.5cm. When the length of the wire is measure using instrument B, it is found to have length 3.38 cm. Then, the

(A) Measurement with A is more accurate and precise.

(B) Measurement with A is more accurate while measurement with B is more precise.

(C) Measurement with B is more accurate and precise.

(D) Measurement with A is more precise while measurement with B is more accurate.

ANSWER (A)

Solution:

True value 3.678

Measured using A = 3.5

Measured using B = 3.38

$3.678 \approx 3.5$

So, option (A) is correct.

27. A body is moving along a straight line with initial velocity v0. Its acceleration a is constant. After t seconds, its velocity becomes v. The average velocity of the body over the given time interval is

(A) $\bar{V} = \frac{V^2 - V_0^2}{at}$ (B) $\bar{V} = \frac{V^2 + V_0^2}{2at}$ (c) $\bar{V} = \frac{V^2 + V_0^2}{at}$ (D) $\bar{V} = \frac{V^2 - V_0^2}{2at}$

ANSWER (D)

Solution:

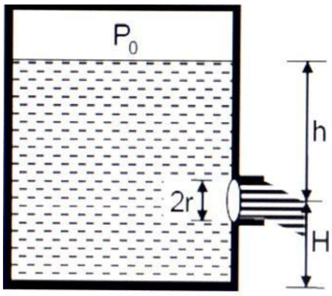
$$\bar{V} = \frac{s}{t} \Rightarrow S = \bar{V} \times t$$

$$V^2 - V_0^2 = 2as \qquad \text{as } S = \bar{V} \times t$$

$$V^2 - V_0^2 = 2a\,\bar{V} \times t$$

$$\bar{V} = \frac{V^2 - V_0^2}{2at}$$

28. A closed water tank has cross-sectional area A. It has a small hole at a depth of h from the free surface of water. The radius of the hole is r so that r << A . If P0 is the pressure inside the tank above the water level, and Pa is the atmospheric pressure, the rate of flow of the water coming over of the hole is [ρ is the density of water]



(A) $\pi r^2\sqrt{2gh}$ (B) $\pi r^2\sqrt{2gH}$ (c) $\pi r^2\sqrt{2gh + \frac{2(P_0 - P_a)}{\rho}}$ (D) $\pi r^2\sqrt{gh + \frac{2(P_0 - P_a)}{\rho}}$

ANSWER (C)

Solution:

$$\frac{1}{2}mv^2 = mgh + \frac{m(P_0 - P_a)}{\rho}$$

$$v^2 = 2gh + \frac{m(P_0 - P_a)}{\rho}$$

$$v = \sqrt{2gh + \frac{m(P_0 - P_a)}{\rho}}$$

29. 100g of ice at 0^0C is mixed with 100g of water at 100^0C. The final temperature of the mixture is [Take $L_f = 3.36 \times 10^5$ J kg^{-1} and $S_w = 4.2 \times 10^3$ J kg^{-1} k^{-1}]

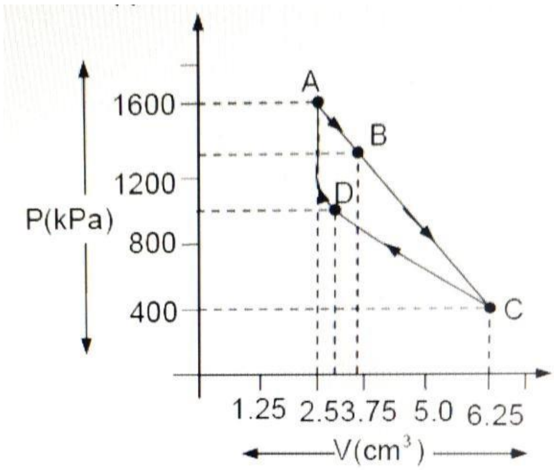
(A) 40°C **(B) 10°C** **(C) 50°C** **(D) 1°C**

ANSWER (B)

Solution:

$$Q_w = m_w S_w (100 - 0)$$
$$Q_w = 100\ (1) 100 = 10000 \times 4.2 \times 10^3$$
$$Q_i = m_i \times L_f \Rightarrow 100 \times 80 \Rightarrow 8000 \times 4.2 \times 10^3$$
$$Q_w > Q_i$$
$$m_{(w+i)} S_w (\Delta t) = Q_w - Q_i$$
$$\Delta t = \frac{Q_w - Q_i}{m_{(w+i)} S_w}$$
$$\Delta t = \frac{10000 - 8000 \times 4.2\ \times 10^3}{200 \times (1) \times 4.2\ \times 10^3}$$
$$\Delta t = \frac{10000 - 8000}{200} = \frac{2000}{200} = 10^0 C$$

30. The P-V diagram of a Carnot"s engine is shown in the graph below. The engine uses 1 mole of an ideal gas as working substance. From the graph, the area enclosed by the P-V diagram is [The heat supplied to the gas is 8000 J]



(A) 1200 J (B) 2000 J (C) 3000 J (D) 1000 J

ANSWER (C)

Solution:

$$1 - \frac{T_2}{T_1} = \frac{W}{Q}$$
$$1 - \frac{P_3 V_3}{P_1 V_1} = \frac{W}{8000}$$
$$1 - \frac{400 \times 6.25}{1600 \times 2.5} = \frac{W}{8000}$$
$$1 - 0.625 = \frac{W}{8000}$$

$$0.375 = \frac{W}{8000}$$
$$W = 0.375 \times 8000 = 3000\,J$$

31. When a planet revolves around the Sun, in general, for the planet
(A) Linear momentum and linear velocity are constant.
(B) Linear momentum and aerial velocity are constant.
(C) Kinetic and potential energy of the planet are constant.
(D) Angular momentum about the Sun and aerial velocity of the planet are constant.

ANSWER (D)

Solution:

$$\frac{L}{2m} = \text{Constant} \Rightarrow L = \text{Constant}$$
$$L = mvr = \text{Constant};\ v = \text{Constant}$$

32. A stretched wire of a material whose Young"s modulus $Y=2x10^{11}$ Nm^{-2} has Poisson"s ratio 0.25. Its lateral strain, $\varepsilon_L = 10^{-3}$. The elastic energy density of the wire is
(A) 16×10^{-5} Jm^{-3} (B) 1×10^{5} Jm^{-3} (C) 4×10^{5} Jm^{-3} (D) 8×10^{5} Jm^{-3}

ANSWER (A)

Solution:

$$\varepsilon_L = 10^{-3}$$
$$\rho = \frac{\varepsilon_L}{\varepsilon_{long}}$$
$$\varepsilon_{long} = \frac{\varepsilon_L}{\rho} \Rightarrow \frac{10^{-3}}{0.25} \Rightarrow 4 \times 10^{-3}$$
$$\text{Elastic energy density} = \frac{1}{2} \times Y \times (\text{Strain})^2$$
$$\text{Elastic energy density} = \frac{1}{2} \times (2 \times 10^{11}) \times (4 \times 10^{-3})^2$$
$$\text{Elastic energy density} = 16 \times 10^{5}\ Jm^{-3}$$

33. The speed of sound in an ideal gas at a given temperature T is V. The rms speed of gas molecules at that temperature is V_{rms}. The ratio of the velocities v and v_{rms} for helium oxygen gases are X and X" respectively. Then X /X' is equal

(A) $\frac{21}{\sqrt{5}}$ (B) $\frac{5}{\sqrt{21}}$ (c) $\sqrt{\frac{5}{21}}$ (D) $\frac{21}{5}$

ANSWER (B)

Solution:

The velocities v and v_{rms} for helium oxygen gases are X and X"

$$X = \frac{V_H}{(V_{rms})_H} = \sqrt{\frac{\gamma_m}{3}} \qquad \gamma_m = \frac{5}{3}\ ;\ \gamma_d = \frac{7}{5}$$

$$X' = \frac{V_0}{(V_{rms})_0} = \sqrt{\frac{\gamma_d}{3}}$$

The ratio of the velocities v and v_{rms} for helium oxygen gases are

$$\frac{X}{X'} = \sqrt{\frac{\gamma_m}{3}} \Big/ \sqrt{\frac{\gamma_d}{3}} = \sqrt{\frac{\gamma_m}{\gamma_d}} = \sqrt{\frac{5/3}{7/5}} = \frac{5}{\sqrt{21}}$$

34. A positively charged glass rod is brought near uncharged metal sphere, which is mounted on an insulated stand. If the glass rod is removed, the net charge on the metal sphere is

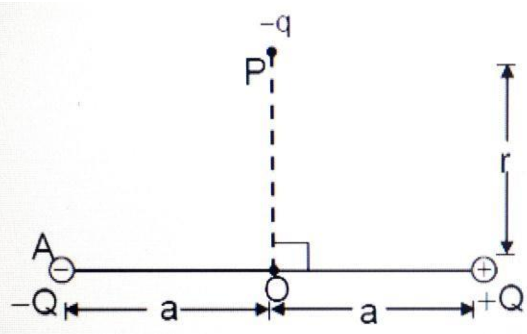
(A) Negative charge (B) Zero (C) 1.6×10^{-19}C (D) Positive charge

ANSWER (B)

Solution:

A positive charge rod induced negative charged on the tide of closed sphere And it glass rod removed and become neutral so that net charge is zero

35. In the situation shown in the diagram, magnitude of q << |Q| and r >> a. The net force on the free charge –q and net torque on it about O at the instant shown are respectively [p = 2aQ is the dipole moment]

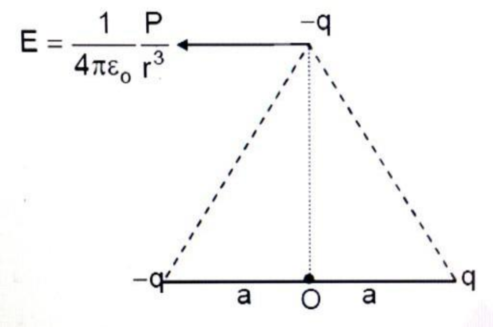


(A) $\frac{1}{4\pi\varepsilon_0}\frac{pq}{r^3}\hat{i}$; $\frac{1}{4\pi\varepsilon_0}\frac{pq}{r^2}\hat{k}$ (B) $\frac{1}{4\pi\varepsilon_0}\frac{pq}{r^2}\hat{k}$; $\frac{1}{4\pi\varepsilon_0}\frac{pq}{r^3}\hat{i}$

(C) $-\frac{1}{4\pi\varepsilon_0}\frac{pq}{r^3}\hat{i}$; $-\frac{1}{4\pi\varepsilon_0}\frac{pq}{r^2}\hat{k}$ (D) $\frac{1}{4\pi\varepsilon_0}\frac{pq}{r^2}\hat{k}$; $+\frac{1}{4\pi\varepsilon_0}\frac{pq}{r^3}\hat{i}$

ANSWER (A)

Solution



$F = (E_q)$

$F = \frac{1}{4\pi\varepsilon_0}\frac{pq}{r^3}\hat{j}$

$\tau = \vec{r} \times \vec{F}$

$\tau = F = \frac{1}{4\pi\varepsilon_0}\frac{p}{r^2}(\hat{j} \times \vec{i})$

$\tau = -\frac{1}{4\pi\varepsilon_0}\frac{p}{r^2}\hat{k}$

$\frac{1}{4\pi\varepsilon_0}\frac{pq}{r^3}\hat{i}$; $\frac{1}{4\pi\varepsilon_0}\frac{pq}{r^2}\hat{k}$

36. Pressure of ideal gas at constant volume is proportional to ______

(A) Force between the molecules

(B) Average potential energy of the molecules

(C) Total energy of the gas

(D) Average kinetic energy of the molecules

ANSWER (C)

Solution:

$P = \frac{1}{3}mn\overline{v}^2$

$P = \frac{2}{3}kE$

Average KE molecules

37. A block of mass m is connected to a light spring of force constant k, the system is placed inside a damping constant b. the instantaneous values of displacement, acceleration and energy of the block are x, a and E respectively. The initial amplitude of oscillation is A and ω' is the angular frequency of oscillations. The incorrect expression related to the damped oscillation is

(A) $X = A\,e^{\frac{b}{m}}\cos(\omega' t + \phi)$ (B) $\omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$

(C) $E = \frac{1}{2}kA^2 e^{\frac{bt}{m}}$ (D) $m\frac{d^2x}{dt^2} + b\frac{dx}{dt} + kx = 0$

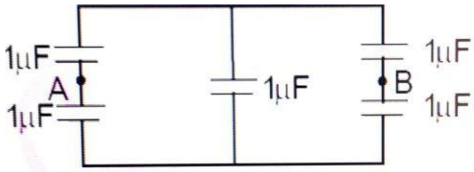
ANSWER (A)

Solution

$X = A e^{\frac{b}{m}} \cos(\omega' t + \phi)$

Displacement of the damped variable time

38. Five capacitors of value 1µF are connected as shown in the figure. The equivalent capacitance between A and B is



(A) 3µF (B) 1µF (C) 2µF (D) 5µF

ANSWER (C)

Solution:

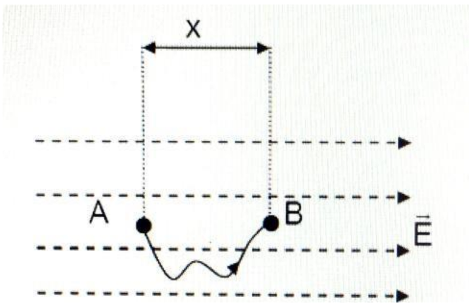
According to Wheatstone bridge

$$\frac{C_1}{C_2} = \frac{C_3}{C_4}$$

$$C_{eq} = \frac{1 \times 1}{1 \times 1} + \frac{1 \times 1}{1 \times 1} = \frac{1}{2} + \frac{1}{2}$$

$$C_{eq} = 1\mu F$$

39. A uniform electric field vector $\overline{E}$ exists along horizontal direction as shown. The electric potential at A is VA. A small point charge q is slowly taken from A to B along the curved path as shown. The potential energy of the charge when it is at point B is



(A) q[VA – Ex] (B) q[VA – Ex] (C) q[Ex – VA] (D) qEx

ANSWER (C)

Solution:

q is slowly moving from A to B

$U = qV^1$

$V_1 = [V_B - V_A]$ $(V_B = E_x)$

$U = q[E_x - V_A]$

40. A parallel plate capacitor of capacitance C1 with a dielectric slab in between its plates is connected across its plates. When the dielectric slab is removed, keeping the capacitor connected to the battery, the new capacitance and potential difference are C2 and V2 respectively. Then,

(A) $V_1 = V_2, C_1 < C_2$ (B) $V_1 > V_2, C_1 > C_2$

(C) $V_1 < V_2, C_1 > C_2$ (D) $V_1 = V_2, C_1 > C_2$

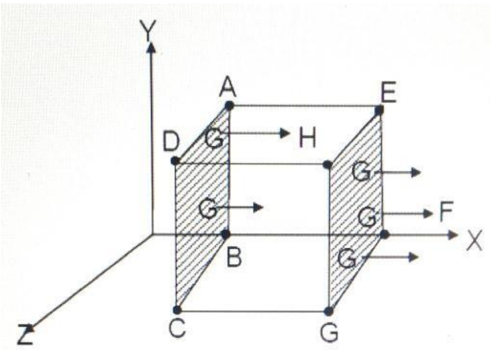
ANSWER (C)

Solution:

C_1 with dielectric medium C_2 without dielectric – C medium

$\therefore C_1 > C_2$ Battery not disconnected So, $V_1 = V_2$

41. A cubical Gaussian surface has side of length a = 10 cm. Electric field lines are parallel to x – axis as shown. The magnitude of electric fields through surfaces ABCD and EFGH are 6kNC–1 and 9kNC–1 respectively. Then the total charge enclosed by the cube is



(A) –0.27nC (B) 1.35 nC (C) –1.35 nC (D) 0.27 nC

ANSWER (C)

Solution:

$q = E_1 A (E_2 – E_1)$

$q = 9 \times 10^{-12} \times 100 \times 10^{-4} \times (9 – 6) \times 103$

$q = 9 \times 3 \times 10 \times 10^{-12}$

$q = 27 \times 10^{-11}$

$q = 0.27$ nC

42. Electric field at a distance „r" from an infinitely long uniformly charged straight conductor, having linear charge density λ is E_1. Another uniformly charged conductor having same linear charge density λ is bent into a semicircle of radius „r". The electric field at its centre is E_2. Then

(A) $E_2 = \pi r E_1$ (B) $E_2 = \frac{E_1}{r}$ (C) $E_1 = E_2$ (D) $E_1 = \pi r E_2$

ANSWER (B)

Solution:

$$E_1 = \frac{1}{2\pi\varepsilon_0}\frac{\lambda}{r}$$

$$E_2 = \frac{2k\lambda}{r}$$

$$E_2 = \frac{2 \times 1}{2\pi\varepsilon_0}\frac{\lambda}{r}$$

$$E_2 = \frac{2 \times 1}{4\pi\varepsilon_0}\frac{\lambda}{r}$$

$$E_2 = \frac{1}{2\pi\varepsilon_0}\frac{\lambda}{r}$$

43. A wire of resistance R is connected across a cell of emf and internal resistance r. The current through the circuit is I. In time t, the work done by the battery to establish the current I is

(A) εIt (B) $\frac{\varepsilon^2 t}{r}$ (C) IRt (D) I^2Rt

ANSWER (D

Solution:

$W = I^2Rt$

Explanation

$W = Vq$

$W = I\,R\,It$

$W = I^2R\,t$

44. For a given electric current the drift velocity of conduction electrons in a copper wire is v_d

(A) v_d increases, μ remains the same (B) v_d remains the same, μ increases

(C) v_d decreases, μ remains the same (D) v_d remains the same, μ decreases

ANSWER (C)

Solution:

I Increase correspond temperature increases KE of electron increases ∴ Vd increases, μ remains the same

45. Ten identical cells each emf 2V and internal resistance 1Ω is connected in series with two cells wrongly connected. A resistor of 10 Ω is connected to the combination. What is the current through the resistor?

(A) 1.8A (B) 2.4A (C) 0.6A (D) 1.2 A

ANSWER (C)

Solution:

$nE - 2mE$

=10 m= 2

Σ = 2

nr +R

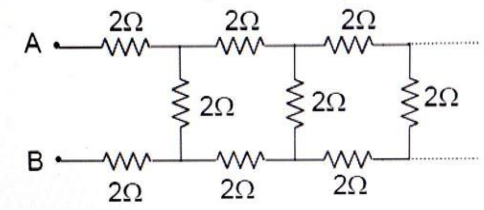
10x 1+10= 20

2 x10-2 x 2 x 2

20-8=12

$$I = \frac{V}{R} = \frac{12}{20} = 0.6$$

46. The equivalent resistance between the points A and B in the following circuit is



(A) 0.5Ω (B) 5.5Ω (C) 0.05Ω (D) 5Ω

ANSWER (C)

Solution:

$$R_S = R_1 + R_2 + R_3$$

$$R_3 = 2 + 2 + 2 = 6$$

The resistance 6Ω is parallel with 2Ω.

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_P} = \frac{1}{6} + \frac{1}{2}$$

$$\frac{1}{R_P} = \frac{2+6}{12} = \frac{8}{12}$$

$$R_P = \frac{12}{8} = \frac{3}{2}$$

3/2 Ω is in parallel with 4Ω.

$$\frac{1}{R_P} = \frac{1}{3/2} + \frac{1}{4} = \frac{2}{3} + \frac{1}{4} = \frac{8+3}{12} = \frac{11}{12}$$

11/2 Ω is in parallel with 2Ω.

$$\frac{1}{R_P} = \frac{1}{11/2} + \frac{1}{2} = \frac{2}{11} + \frac{1}{2} = \frac{4+11}{22} = \frac{15}{22}$$

$$R_P = \frac{22}{15}$$

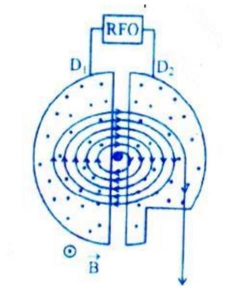
22/15 Ω is in series with 4Ω.

$$R_S = \frac{22}{15} + 4 = \frac{82}{15} = 5.5\ \Omega$$

47. A charged particle is subjected to acceleration in a cyclotron as shown. The charged particle undergoes increase its speed

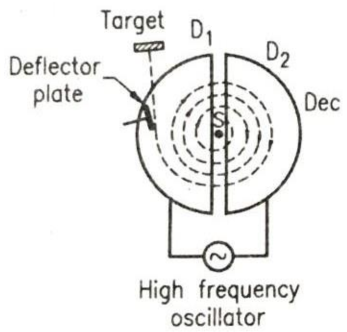
(A) Only in the gap between D_1 and D (B) Only inside D_2

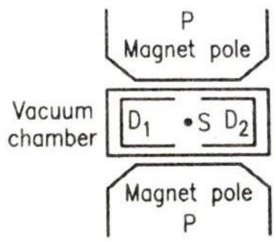
(C) Inside D_1, D_2 and the gaps (D) Only inside D_1

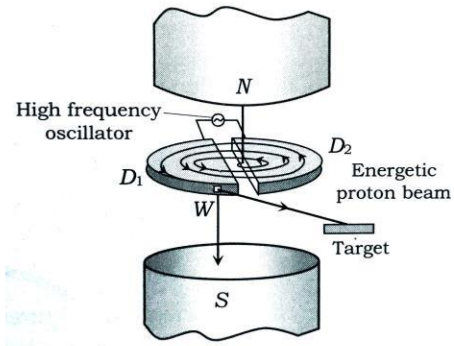


ANSWER (A)

Solution: Between D_1 and D_2 changed particle will accelerate







48. The resistance of a carbon resistor is 4.7 kΩ ± 5%. The colour of the third band is

(A) Gold (B) Red (C) Violet (D) Orange

ANSWER (A)

Solution:.

Letters	**B**	**B**	**R**	**O**	**Y**	**G**	**B**	**V**	**G**	**W**
Colours	Black	Brown	Red	Orange	Yellow	Green	Blue	Violet	Grey	White
Values	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Multiplier	10^0	10^1	10^2	10^3	10^4	10^5	10^6	10^7	10^8	10^9

Red

49. The four bands of a colour coded resistor are of the colours gray, red, gold and gold. The value of the resistance of the

(A) 5.2Ω ± 5% (B) 82Ω ±10% (A) 8.2Ω ± 5% (C) 82Ω ±5%

ANSWER (C)

Solution:.

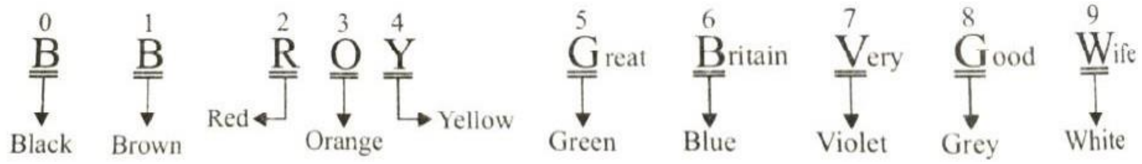
Letters	**B**	**B**	**R**	**O**	**Y**	**G**	**B**	**V**	**G**	**W**
Colours	Black	Brown	Red	Orange	Yellow	Green	Blue	Violet	Grey	White
Values	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Multiplier	10^0	10^1	10^2	10^3	10^4	10^5	10^6	10^7	10^8	10^9

Colour	Gold	Silver	No-Colour
Tolerance	5%	10%	20%

$82 \times 10^{-1} \pm 5\%$

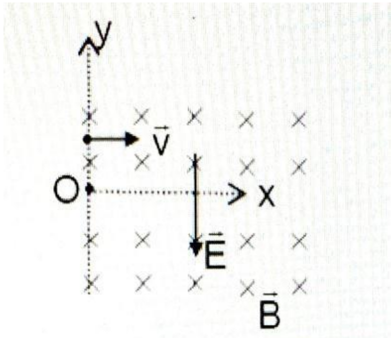
$8.2\Omega \pm 5\%$

This can be easily remembered as "**BB ROY** of **G**reat **B**ritain having **V**ery **G**ood **W**ife wear **G**old, **S**ilver, **N**ecklace (No colour).



50. A positively charged particle of mass m is passed through a velocity selector. It moves horizontally rightward without deviation along the line y = 2mv/qB with speed v. The electric field is vertically downwards and magnetic field is into the plane of the paper. Now, the electric field is switched off at t = 0. The angular momentum of the charged particle about origin O at πm/qB

(A) $\frac{mE^2}{qB^3}$ (B) $\frac{2mE^2}{qB^3}$ (C) Zero (D) $\frac{mE^3}{qB^3}$



ANSWER (A)

Solution:

Angular Momentum = L = mvr

$$L = mv \times \frac{2mV}{qB}$$

$$L = \frac{2m^2V^2}{qB}$$

$$L = \frac{2m^2}{qB}\frac{E^2}{B^2} \quad \because V = \frac{E}{B}$$

$$L = \frac{2m^2E^2}{qB^3}$$

51. The curie temperatures of cobalt and iron are 1400 K and 1000 K respectively. At T =1600 K, the ratio of magnetic susceptibility of cobalt to that of iron is

(A)1/3 (B)3 (C)7/5 (D)5/7

ANSWER (D)

Solution:

$$\chi = \frac{\chi_C}{\chi_{Fe}} = \frac{T_{Fe}}{T_C} = \frac{1000}{1400} = \frac{4}{7}$$

$$\chi = \frac{\chi_C}{\chi_{Fe}} = \frac{T_{Fe}}{T_C} = \frac{1000}{1400} = \frac{5}{7}$$

52. The torque acting on a magnetic diploe placed in uniform magnetic field is zero, when the angle between the diploe axis and the magnetic field is_____.

(A) Zero (B) 45^0 (C) 60^0 (D) 90^0

ANSWER (C)

Solution:

$\tau = MB\ \text{Sin}\theta$

$\theta = 0\ \sin 0^0 = 0$

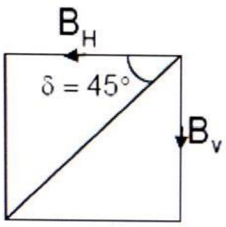
$\tau = 0$

53. The horizontal component of earth‟s magnetic field at a place is $3x10^{-5}$T. If the dip at that place is 45^0, the resultant magnetic field at that place is

ANSWER (D)

Solution:

(A)3×10^{-5} T (B)$\frac{3}{\sqrt{2}} \times 10^{-5}$ T (C)$\frac{3}{2}\sqrt{3} \times 10^{-5}$ T (D)$3\sqrt{2} \times 10^{-5}$ T



$$\tan 45^0 = \frac{B_H}{B_V} = 1$$

$$B = \sqrt{B_H^2 + B_V^2}$$

$$B = 3\sqrt{2} \times 10^{-5}\ T$$

54. A proton and an alpha-particle moving with the same velocity enter a uniform magnetic field with their velocities perpendicular to the magnetic field. The ratio of radii of their circular paths is

(A)2:1 (B) 1:4 (C) 4:1 (D) 1:2

ANSWER (C)

Solution:

$$r = \frac{mv}{qB}$$

$$\frac{r_p}{r_\alpha} = \frac{1}{4} \times \frac{2}{1} = 1:2$$

55. A moving coil galvanometer is converted into an ammeter of range 0 to 5 mA. The galvanometer resistance is 90 Ω and the shunt resistance has a value of 10Ω . If there are 50 divisions in the galvanometer–turned –ammeter on either sides of zero, Its current sensitivity is

(A) $2\text{x}10^4$ div / A (B) $1\text{ x}10^5$ / div (C) $2\text{x}10^4$ /div (D) $1\text{ x}10^5$ div / A

ANSWER (D)

Solution:

$$S = \frac{G}{n-1}$$

$$10 = \frac{90}{\left(\frac{I}{I_g} - 1\right)}$$

$$\frac{I}{I_g} - 1 = \frac{90}{10}$$

$$\frac{I}{I_g} - 1 = 9$$

$$\frac{I}{I_g} = 9 + 1 = 10$$

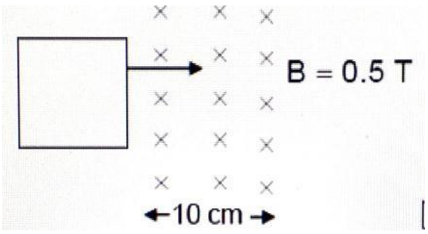
$$I_g = \frac{I}{10}$$

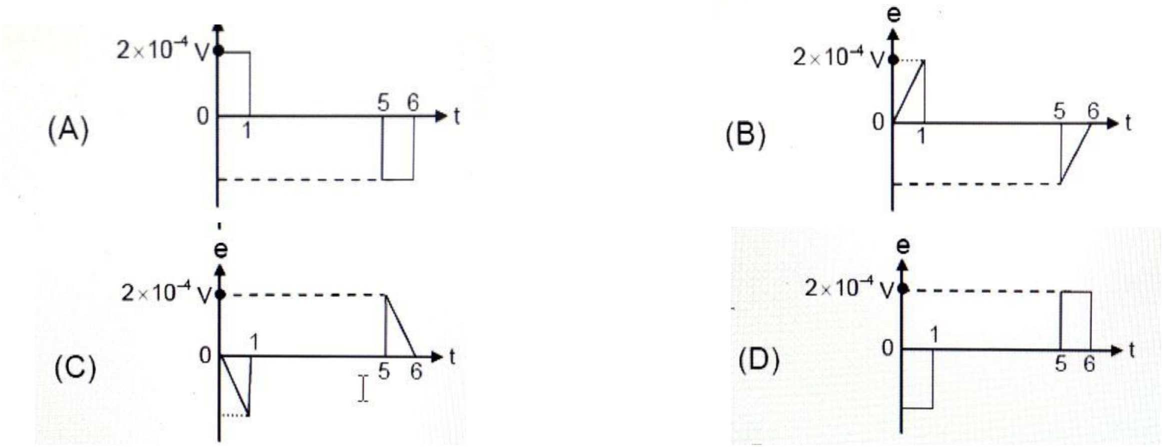
$$I_g = \frac{5}{10} = 0.5 \text{ mA}$$

$$\text{Sensitivity} = \frac{50}{0.5 \text{ mA}}$$

$$\text{Sensitivity} = \frac{50}{5 \times 10^{-1} \times 10^{-3}\text{A}} = \frac{50 \times 10^4}{5 \text{ A}} = 1 \times 10^5 \text{div/A}$$

56. A square loop of side 2 cm enters a magnetic field with a constant speed of 2 cm s-1 as shown. The front edge enters the field at t = 0s. Which of the following graph correctly depicts the induced emf in the loop? (Take clockwise direction positive)





ANSWER (C)

Solution:

According to Faraday‟s laws of electromagnetic induction, the magnitude of induced emf in the coil

$$e = \frac{-d\phi}{dt}$$

$$e = -B\frac{dA}{dt}$$

$$e = -B\frac{(A_2 - A_1)}{t}$$

57. In series LCR circuit resonance, the phase difference between voltage and current is

(A) Zero (B) π (C) $\pi/4$ (D) $\pi/2$

ANSWER (A)

Solution:

In LCR circuit, at resonance, the phase difference is zero,

$$e = -B\frac{(A_2 - A_1)}{t}$$

$$X_L - X_C = 0$$

Therefore, $\phi = 0$

58. An ideal transformer has a turns ratio of 10. When the primary is connected to 220 V, 50 Hz ac source, the power output is

(A) 10 times the power input (B) 1th/10 the power input

(C) Equal to power input (D) Zero

ANSWER (A)

Solution:

$$\eta = \frac{10}{1} = \frac{P_{out}}{P_{in}}$$

$$P_{out} = 10\ P_{in}$$

59. The current in a coil changes from 2A to 5A in 0.3s. The magnitude of emf induced in the coil is 1.0V. The value of self-inductance of the coil is

(A) 1.0 mH (B) 100 mH (C) 0.1 mH (D) 10 mH

ANSWER (C)

Solution:

$$|e| = L\ \frac{dI}{dt}$$

$$0.1 = L\ \frac{3}{0.3}$$

$$L = \frac{0.1 \times 0.3}{3} = \frac{0.003}{3} = 1 \times 10^{-3}H = 1\ mH$$

$$L = \frac{0.1 \times 0.3}{3} = \frac{0.03}{3} = 0.01H = 1 \times 10^{-2} = 0.\times 10^{-3}mH$$

60. A metallic rod of length 1 m held along east – west direction is allowed to fall down freely. Given horizontal component of earth"s magnetic field BH = 3×10^{-5} T. The emf induced in the rod at and instant t = 2s after it is released is (Take g = 10 ms^{-2})

(A) 6×10^{-4} V (B) 3×10^{-3} V (C) 3×10^{-4} V (D) 6×10^{-3} V

ANSWER (C)

Solution:

Motional emf E =Blv

V = u + gt

V = 20m/s

$E = 3 \times 10^{-5} \times 1 \times 20$

$E = 6 \times 10^{-4}$ V

****

KCET 2022 QUESTIONS WITH SOLUTIONS:

Question 1. **The centre of mass of an extended body on the surface of the earth and its centre of gravity**

1) **Can never be at the same point**
2) **Centre of mass coincides with the centre of gravity of a body if the size of the body is negligible as compared to the size (or radius) of the earth**
3) **Are always at the same point for any size of the body**
4) **Are always at the same point only for spherical bodies**

ANSWER. 2

SOLUTION

The center of gravity is based on weight, whereas the center of mass is based on mass. So, when the gravitational field across an object is uniform, the two are identical. However, when the object enters a spatially-varying gravitational field, the COG will move closer to regions of the object in a stronger field, whereas the COM is unmoved.

More practically, the COG is the point over which the object can be perfectly balanced; the net torque due to gravity about that point is zero. In contrast, the COM is the average location of the mass distribution or it is the point where whole mass of the body is supposed to be concentrated. If the object were given some angular momentum, it would spin about the COM.

For small objects, say of sizes less than 100 m placed in uniform gravitational field then centre of mass is very close with the centre of gravity of the body. But when the size of object increases, its weight changes and its CM and CG become far from each other. Like in the case of spherical ball, the CM and the CG are the same, but in case of Mount Everest, its CM lies a bit above its CG.

Question 2. **A metallic rod breaks when strain produced is 0.2%. The Young‟s modulus of the material of the rod is $7\text{x}10^9 N/m^2$. The area of cross section of support a load of 104N is**

1).$7.1\times10^{-4}m^2$ 2).$7.1\times10^{-2}m^2$ 3).$7.1\times10^{-8}m$ 4).$7.1\times10^{-6}m^2$

ANSWER. 1

Sol. Within the elastic limit, the ratio of longitudinal stress to longitudinal strain is known as Young‟ modulus

$$\text{Youngs modulus} = \frac{\text{Stress}}{\text{Strain}}$$

$$Y = \frac{\text{Stress}}{\text{Strain}}$$

$$\text{Stress} = \text{Strain} \times Y$$

Thus,

$$\text{Maximum Stress} = \frac{0.2}{100} \times 7 \times 10^9 = 1.4 \times 10^7$$

$$\text{Stress} = \frac{\text{Force}}{\text{Area}}$$

$$\text{Force} = \text{Stress} \times \text{Area}$$

$$10^4 = 1.4 \times 10^7 \times A$$

$A = 7.14 \times 10^{-4}\, m^2$

Question 3. **A tiny spherical oil drop carrying a net charge q is balanced in still air, with a vertical uniform electric field of strength 81π/ 10^5 V/m. When the field is switched off, the drop is observed to fall with terminal velocity $2x10^{-3}ms^{-1}$. Here g = 9.8 m/s^2, Viscosity of air is 1.8 $x10^{-5}$ Ns/m^2 and the density of oil is 900kgm^{-3}. The magnitude of „q" is.**

1) 1.6×10^{-19}C 2) 3.2×10^{-19}C 3) 0.8×10^{-19}C 4) 8×10^{-19}C

ANSWER. 3

Solution:

Here,

$$E = \frac{81}{7}\pi \times 10^5\ V/m$$

$$v = 2 \times 10^3\ ms^{-1}$$

$$F = mg \quad \text{or} \quad Eq = mg$$

$$F = 6\pi\eta r v_t$$

When the electric field is switched off, let the drop falls with terminal velocity v , then

$$v_t = \frac{2r^2(\rho - \sigma)g}{9\ \eta}$$

$$r = \left[\frac{9v\eta}{2(\rho - \sigma)g}\right]^{\frac{1}{2}}$$

$$\therefore q = \frac{1}{E} \times \frac{4}{3}\pi\rho g\left[\frac{9v\eta}{2(\rho - \sigma)g}\right]$$

On solving

$$q = 8 \times 10^{-19}\ C$$

Question 4. **"Heat cannot be itself flow from a body at lower temperature to a body at higher temperature". This statement corresponds to**

1) Conservation of mass **2) First law of thermodynamics**
3) Second law of Thermodynamics **4) Conservation of momentum**

ANSWER. 3 Second law of Thermodynamics

Sol. According to second law of thermodynamics, Heat cannot flow from the body at lower temperature to the body at higher temperature without performing the external work.

Question 5. **A smooth chain of length 2m is kept on a table such that its length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. The work done in pulling the entire chain on the table is, (Take g=10 m/s^2)**

1) 3.6J **2) 2.0 J** **3) 12.9 J** **4)6.3 J**

Ans. 1

Sol.

$$\text{Mass of the chain lying freely from the Table} = M\frac{1}{L}$$

$$\text{Mass of the chain lying freely from the Table} = 4 \times \frac{0.6}{2} = 1.2 \text{ kg}$$

$$\text{The distance of center of mass of chain from the Table} = \frac{1}{2} \times 0.6 \text{ m} = 0.3 \text{ m}$$

$$\text{Thus the workdone in pulling the chain} = mgh = 1.2 \times 10 \times 0.3 \text{ J} = 3.6 \text{ J}$$

Question 6. The angular speed of a motor wheel is increased from 1200 rpm to 3120 rpm in 16 seconds. The angular acceleration of the motor wheel is

1) 6π rad /s^2 2) 8π rad/s^2 3) 2π rad /s^2 4) 4π rad/s^2

ANSWER. 4

Sol The angular acceleration of the motor wheel is given by

$$\alpha = \frac{W_2 - W_1}{t} = \frac{2\pi n_2 - 2\pi n_1}{t}$$

$$\alpha = \frac{2\pi[n_2 - n_1]}{t}$$

$$\alpha = \frac{2 \times \pi [3120 - 1200]}{16 \times 60} = \frac{2 \times \pi}{960} \times [1920] = 4\pi$$

7. Four charges +a, +2q, +q and -2q are placed at the corners of a square ABCD respectively. The force on a unit positive charge kept at the centre „O" is

1) Along the diagonal AC 2) Perpendicular to AD

3) Zero 4) Along the diagonal BD

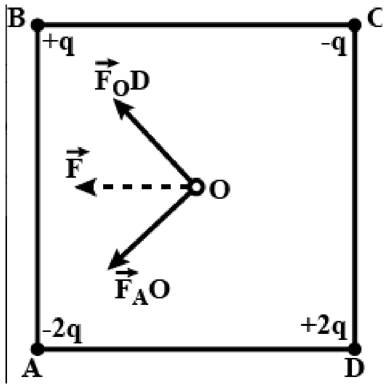
ANSWER. 4

Sol. Conceptual

Force due to charge D and B along $\overrightarrow{F_o}\overrightarrow{D}$ towrds $\vec{B}$

Force due to charge A and C along $\overrightarrow{F_A}\overrightarrow{D}$ towrds $\vec{A}$

Resultant displacement will be along g $\overrightarrow{F_A}$ which is perpendicular AB

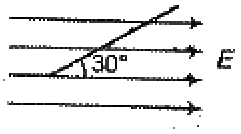


Question 8. An electric dipole with dipole moment $4\text{x}10^{-9}$Cm is aligned at 300 with the direction of a uniform electric field of magnitude $5\text{x}10^4$ NC^{-1} , the magnitude of the torque acting on the dipole is

1) 10^{-5}Nm 2) 10 x10^{-3}Nm 3) 10^{-4}Nm 4) √3 x10^{-4}Nm

ANSWER. 3

Sol.



Electric dipole moment, $E = 4\times10^{-9}$N/C
Angle made by p with a uniform electric field, θ = 30°
Electric field, $E = 5\times10^{4}$ N/C
Torque acting on the dipole:

$$\tau = PE \sin\theta = 4\times10^{-9}\times5\times10^{4}\sin30^0 = 20\times10^{-5}\times\frac{1}{2} = 10^{-4}$$

The direction of torque is perpendicular to both electric field and dipole moment.

Question 9. **A charged particle of mass „m" and charge „q" is released from rest in an uniform electric field E. Neglecting the effect of gravity, the kinetic energy of the charged particle after „t" seconds is**

1) $\frac{Eqm}{t}$ 2) $\frac{E^2q^2t^2}{2m}$ 3) $\frac{2E^2t^2}{mq}$ 4) $\frac{2E^2q^2}{2t^2}$

ANSWER. 2

Force on particle = F = qE
Acceleration ofthe parrticle = a = mF = mqE
Initial speed = u = 0
Hence, final velocity = v = u + at = m qE t

Sol. $K.E = \frac{1}{2}mv^2$

$$K.E = \frac{1}{2}m\left[0+\frac{qE}{m}t\right]^2$$

$$K.E = \frac{E^2q^2t^2}{2m}$$

Question 10. **The electric field and the potential of an electric dipole vary with distance r as**

1) $\frac{1}{r^2}$ and $\frac{1}{r^3}$ 2) $\frac{1}{r^3}$ and $\frac{1}{r^2}$ 3) $\frac{1}{r}$ and $\frac{1}{r^2}$ 4) $\frac{1}{r^2}$ and $\frac{1}{r}$

ANSWER. 2

Sol

Electric field and electric potential at a general point at a distance r from the centre of the dipole is

$$E_g = \frac{1}{4\pi\varepsilon_0}\frac{P}{r^3}\sqrt{3\cos^2\theta+1}$$

and

$$V_g = \frac{1}{4\pi\varepsilon_0}.\frac{P\cos\theta}{r^2}$$

$$E = K\frac{2P}{r^3} \propto \frac{1}{r^3}$$

$$E = K\frac{P\cos\theta}{r^2} \propto \frac{1}{r^2}$$

Question 11. **The displacement of a particle executing SHM is given by** $\mathbf{X = 2\ Sin\left[2\pi t + \frac{\pi}{4}\right]}$

where „x" is in meters and „t" is in seconds. The amplitude and maximum speed of the particle is

1) $3m, 6\pi\ ms^1$ 2) $3m, 8\pi\ ms^1$ 3) $3m, 2\pi\ ms^1$ 4) $3m, 4\pi\ ms^1$

ANSWER. 1

Sol. The given equation of SHM is

$$x = 3\sin\ (2\pi t + 4\pi)$$

Compare the given equation with standard equation of SHM

$$x = A\sin\ (\omega t + \Phi)$$

$$A = 3m,\ \omega = 2\pi s^{-1}$$

Question 12. Electric as well as gravitational affects can be thought to be caused by fields. Which of the following is true for an electrical or gravitational field?

1) Fields are useful for understanding forces acting through a distance

2) There is no way to verify the existence of a force field since it is just a concept

3) The field concept is often used to describe contact forces

4) Gravitational or Electric fields does not exist in the space around an object

ANSWER. 1

Sol.

In physics, concept of field is a model used to explain the influence that a massive body or charged particle extends into the space around itself, producing a force on another massive body or charged body placed in space. Thus, concept of field is used to explain gravitational and electrostatic phenomena.

Question 13. **A charged particle is moving in an electric field of** $\mathbf{3 \times 10^{-10}\ Vm^{-1}}$ **with mobility** $\mathbf{2.5 \times 10^{-6}\ m^2/\ V/S}$**, its drift velocity is**

1) $2.5 \times 10^{-16} m/S$ 2) $1.2 \times 10^{-16} m/S$ 3) $7.5 \times 10^{-16} m/S$ 4) $8.33 \times 10^{-16} m/S$

Ans. 3

Sol. When electrons are subjected to an electric field they do move randomly, but they slowly drift in one direction, in the direction of the electric field applied. The net velocity at which these electrons drift is known as drift velocity.

A drift velocity is the average velocity attained by charged particles, such as electrons, in a material due to an electric field. The magnitude of drift velocity per unit electric field is mobility (m)

The mobility of a particle is given by

$$\mu = \frac{v_d}{E}$$

$$\therefore v_d = \mu E$$

$$\therefore v_d = 3 \times 10^{-10} \times 2.5 \times 10^{-6}$$

$$V_d = 7.5 \times 10^{-16} \text{m/S}$$

Question 14. Wire bound resistors are made by

1) Winding the wires of an alloy of Ge, Au, GA
2) Winding the wires of an alloy of Manganin, constantan, Nichrome
3) Winding the wires of an alloy of Cu, Al, Ag
4) Winding the wires of an alloy of Si, Tu, Fe

ANSWER. 2

Sol.

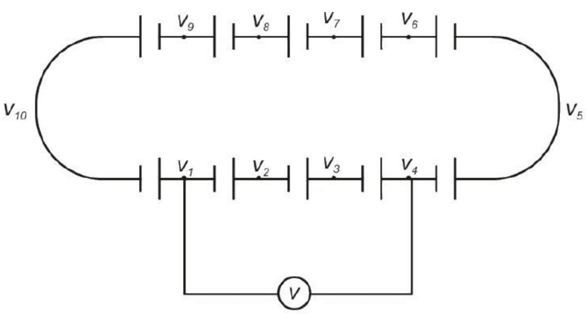
Wire bound resistors are made by winding the wires of an alloys, viz, manganin, constantan, nichrome etc. The choice of these materials is directed mostly by the fact that their resistivity's are relatively insensitive to temperature. These resistances are typically in range of a fraction of an ohm to a few hundred ohms**.**

Question 15. **Ten identical cells each of potential „E" and internal resistance „r", are connected in series to form a closed circuit. An ideal voltmeter connected across three cells, will read**

1) 13E 2) 7E 3) 10E 4) 3E

ANSWER. 4

Sol.



From symmetry we can say $v_1 = v_2 = v_3 = ... = v_{10}$

$\because$ All these points are identical each other reading of ideal voltmeter will be zero.

Ten identical cells are connected in series

Potential of each cell is =E

Internal resistance of each cell is = r

Total voltage of the 10 cells =10E

Total resistance of the 10 cell = 10 r

Current in the circuit $= I = \frac{10\,E}{10\,r} = \frac{E}{r}$

Potential difference across 3 cells , $V = I \times 3r$

$V = \frac{E}{r} \times 3r$

$V = 3E$

Question 16. **In an atom electron revolve around the nucleus along a path of radius 0.72Å making 9.4x10^{18} revolutions per second. The equivalent current is [Given e=1.6x10^{-19}C]**

1) 1.4A 2) 1.8A 3) 1.2A 4) 1.5A

ANSWER. 4

Sol. The distance covered by the body = Circumference of the circle

Angular velocity $= \frac{\text{Distance}}{\text{Time}}$

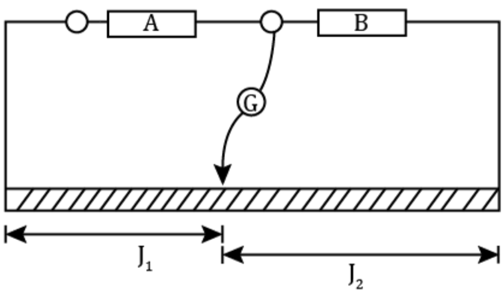
An atom electron revolve around the nucleus, constitute electric current is given by

$I = \frac{e}{T} = ef$

Question 17. When a metal conductor connected to left gap of a meter bridge is heated, the balancing point

1) Remains unchanged 2) Shifts to the center
3) Shifts towards right 4) Shifts towards left

ANSWER. 3



Sol.

$\frac{R}{l} = \frac{S}{100 - l}$

If temperature increases, resistance increases. As R increases, balancing length also increases. It will shift towards Right

----

Question 18. Two tiny spheres carrying charges 1.8 μC and 2.8 μC are located at 40 cm apart. The potential at the mid-point of the line joining the two charges is

1) 4.3×10^4 V 2) 3.6×10^5 V 3) 3.8×10^4 V 4) 2.1×10^5 V

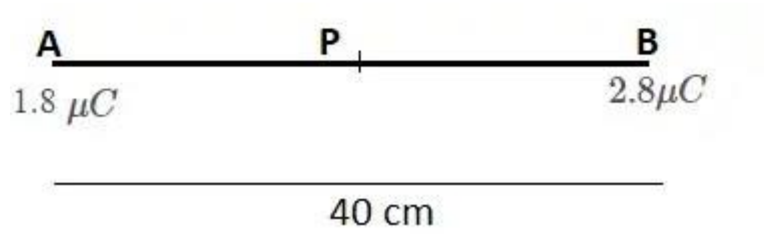
ANSWER 4

Sol. Here $q_1 = 1.8\,\mu C = 1.8\times10^{-6}C$, $q_2 = 2.8\,\mu C = 2.8\times10^{-6}C$

Distance between the two spheres = 40 cm = 0.4 m

For the mid point $r_1 = r_2 = \frac{0.40}{2} = 0.2$ m

Potential at O,



$$V = V_1 + V_2 = \frac{1}{4\pi\varepsilon_0}\left[\frac{q_1}{r_1} + \frac{q_0}{r_2}\right] = \frac{9\times10^9(1.8+2.8)\times10^{-6}}{0.2} = 2.1\times10^5 V$$

Question 19. A parallel plate capacitor is charged by connecting a 2V battery across it. It is then disconnected form the battery and a glass slab is introduced between plates. Which of the following pairs of quantities decrease?

1) Energy stored and capacitance
2) Capacitance and charge
3) Charge and potential difference
4) Potential difference and energy stored.

ANSWER. 4

Sol.

When battery is disconnected, charge remains constant. On introducing glass slab, capacity increases. Potential difference and energy stored decreases. Or

When the battery is disconnected, the charge in the condenser is conserved as it is isolated from the source. Due to insertion of the dielectric, the capacitance increases and hence the potential difference must decrease.

Question 20. A proton moves with a velocity of $5x10^6$ j ms^{-1} through the uniform electric field, $E = 4\times10^6\,[2\hat{i} + 0.2\hat{j} + 0.1\hat{k}]$ Vm^{-1} and the uniform magnetic field B = 0.2 [i+ 0.2j + k]T. The approximate net force acting on the proton is

1) $2.2\ x10^{-13}$N 2) $20x10^{-13}$N 3) $5\ x10^{-13}$N 4) $25x^{10-13}$N

ANSWER. $14.4x10^{-13}$N

Sol.

The speed of the proton is $5\ x10^6$ m/s

Magnetic field B= 0.2 T

Angle $\theta = 30^0$.

Charge on the proton = $1.6\ x10^{-19}$C.

When the proton enters in the magnetic field, it experience a Lorentz field or Force on a charged particle in magnetic field is given by,

$$F = q(v\times B)$$

$|F| = qvB\sin\theta$

$F = 1.6 \times 10^{-19} \times 5 \times 10^{6} \times 2 \times \sin 30^{0}$.

$F = 8.0 \times 10^{-3}$ N.

Question 21. **A solenoid of length 50cm having 100 turns carries a current of 2.5 A. The magnetic field at one end of the solenoid is**

1) 1.57×10^{-4}T 2) 9.42×10^{-4}T 3) 3.14×10^{-4}T 4) 6.28×10^{-4} T

ANSWER. 3

Sol.

Given: $l = 50\text{ cm} = 0.5\text{ m}$ and $i = 2.5\text{ A}$; $N = 100$ turns

The number turns per unit length $= n = \frac{N}{l} = \frac{100}{0.5} = 200$ turns /meter

Magnetic field inside the solenoid $= B = \mu_0 ni = 4\pi \times 10^{-7} \times 25 = 6.28 \times 10^{-4}$ T

Magnetic field at the end of the solenoid $= B = \frac{\mu_0 ni}{2}$

$$B = \frac{\mu_0 ni}{2} = \frac{4\pi \times 10^{-7} \times 25}{2} = \frac{6.28 \times 10^{-4}}{2} = 3.14\text{ T}$$

Question 22. A galvanometer of resistance 50 Ω is connected to a battery of 3 V along with a resistance 2950 Ω in series. A full scale deflection of 30 divisions is obtained in the galvanometer. In order to reduce this deflection to 20 divisions, the resistance in series should be

1) 5050 **Ω** 2) 4450 **Ω** 3) 6050 **Ω** 4) 5550 **Ω**

ANSWER. 2

Sol.

Total initial Resistance= G +R = 50 Ω + 2950 Ω +3000Ω

Resistance to be added = (4500 Ω – 50 Ω) = 4450 Ω

$$\text{Current} = I = \frac{3\text{ V}}{3000\ \Omega} = 1 \times 10^{-3} = 1\text{ mA}$$

If the deflection has to be reduced to 20 divisions, then current

$$I' = \frac{1\text{ mA}}{30} \times 20 = \frac{2}{3}\text{ mA}$$

Let x be the effective resistance of the circuit,

$$3\text{ V} = 3000\ \Omega \times 1\text{ mA} = x\Omega \text{ X } \frac{2}{3}\text{ mA}$$

$$x = 3000 \times 1 \times \frac{2}{3} = 4500\ \Omega$$

Resistance to be added

Resistance to be added = (4500 Ω – 50 Ω) = 4450 Ω

Question 23. **A circular coil of wire of radius „r" has „n" turns and carries a current „I". The magnetic induction „B" at a point on the axis of the coil at a distance √3r from its centre is**

1) $\frac{\mu_0 nI}{16\ r}$ 2) $\frac{\mu_0 nI}{4\ r}$ 3) $\frac{\mu_0 nI}{32\ r}$ 4) $\frac{\mu_0 nI}{8\ r}$

ANSWER. 1

Sol. The magnetic induction „B" at a point on the axis of the coil at a distance √3r from its centre is

$$B = \frac{\mu_0 nI\, r^2}{2\,(x^2 + r^2)^{3/2}}$$

$$B = \frac{\mu_0 nI\ r^2}{2\,(3r^2 + r^2)^{3/2}}$$

$$B = \frac{\mu_0 nI\ r^2}{2\,(4r^2)^{3/2}}$$

$$B = \frac{\mu_0 nI\ r^2}{2\,(2^2\, r^2)^{3/2}}$$

$$B = \frac{\mu_0 nI\ r^2}{2\,[(2r)^2]^{3/2}}$$

$$B = \frac{\mu_0 nI\ r^2}{2\,(2r)^3}$$

$$B = \frac{\mu_0 nI\ r^2}{16\ r^3}$$

$$B = \frac{\mu_0 nI}{16\ r}$$

Question 24. If voltage across a bulb rated 220V, 100 W drops by 2.5 % of its rated value, the percentage of the rated value by which the power would decrease is

1) 5% 2) 10% 3) 20% 4) 2.5%

ANSWER. 1

Sol. The power of the bulb is given by

$$P = \frac{V^2}{R}$$

$$P \propto V^2$$

$$\frac{\Delta P}{P} \times 100 = 2 \times \frac{\Delta V}{V} \times 100 = 2.25 = 5\%$$

Question 25. A wore of certain material is stretched slowly by 10%. Its new resistance and specific resistance becomes respectively

1) 1.21 times, same 2) both remains the same

3) 1.1 times, 1.1 times   4) 1.2 times, 1.1 times

ANSWER. 1

Sol.

Let $I_1 = 100, I_2 = 110$

The resistance of the conductor directly proportional to the current flows through the conductor

$$R \propto I^2$$

$$\frac{R_2}{R_1} \propto \left(\frac{I_2}{I_1}\right)^2$$

$$\frac{R_2}{R_1} \propto \left(\frac{I_2}{I_1}\right)^2 = \left(\frac{110}{100}\right)^2 = (1.1)^2 = 1.21$$

$$R_2 = 1.21R_1$$

Now resistance becomes 1.21 times of initial and specific resistance is the intrinsic property so remains same.

Question 26. **A fully charged capacitor „C" with initial charge „0q" is connected to a coil of self-inductance „L" at t=0. The time at which the energy is stored equally between the electric and the magnetic field is**

1) $\pi\sqrt{LC}$ 2) $\frac{\pi}{4}\sqrt{LC}$ 3) $2\pi\sqrt{LC}$ 4) $\sqrt{LC}$

ANSWER. 2

Sol. In LC oscillation, energy is transferred C to L or L to C

Maximum energy in L is ½ LI^2_{max} .

Maximum energy in C is $q^2_{max}/2C$

Energy will be equal when

$$\frac{1}{2}L\,I_{max}^2 = \frac{q^2}{2C}$$

$$\frac{1}{2}L\,I_{max}^2 = \frac{1}{2}\times\frac{1}{2}L\,I_{max}^2$$

$$I = \frac{I_{max}}{\sqrt{2}}$$

$$I_{max}\sin wt = \frac{I_{max}}{\sqrt{2}}$$

$$wt = \frac{\pi}{4}$$

$$t = \frac{\pi}{4}\sqrt{LC}$$

Question 27. A magnetic field of flux density 1.0 Wb m^2 acts normal to a 80 turn coil of 0.01m^2 area. If this coil is removed from the field in 0.2 second, the emf induced in it is 1) 0.8V   2) 5V   3) 4V   4) 8v

ANSWER. 3

Sol.

The magnetic flux ϕ =B ×A depends on the magnetic field, the area of the loop, and their relative orientation. Where N is the number of turns in the coil. In this case, the magnetic field of flux density 1.0 Wbm^{-2} acts normal to a 80 turns coil of $0.01m^2$ area.

Therefore, the Magnetic flux in 80 turns of coil

$$\Phi_1 = BAN = 1 \times 0.01 \times 80$$

$$\Phi_1 = BAN = 0.80 \text{ wb}$$

$$\Phi_2 = 0$$

The rate of change of e.m.f is given by

$$e = \frac{\Phi_2 - \Phi_1}{t_2 - t_1} = \frac{d\pi}{dt} = \left(\frac{0 - 0.8}{0.2}\right) = 4 \text{ V}$$

Therefore, the e.m.f induced in it, if this coil is removed from the field in 0.1 second is dϕ/dt = 0.8/0.2 = 4 V.

Question 28. **An alternating current is given by** $i = i_1 \sin \omega t + i_2 \cos \omega t$. The r.m.s current is given by

1) $\sqrt{\frac{i_1^2 + i_2^2}{2}}$ 2) $\sqrt{\frac{i_1^2 + i_2^2}{\sqrt{2}}}$ 3) $\frac{i_1 + i_2}{\sqrt{2}}$ 4) $\frac{i_1 - i_2}{\sqrt{2}}$

ANSWER. 1

Sol.

$$I = I_1 \cos \omega t + I_2 \sin \omega t$$

$$I = \sqrt{I_1^2 + I_2^2 + I_1 I_2 \cos 90^0}$$

$$I = \sqrt{I_1^2 + I_2^2 + I_1 I_2}$$

$$I_{max} = \frac{I}{\sqrt{2}}$$

$$I_{rms} = \frac{\sqrt{I_1^2 + I_2^2}}{\sqrt{2}}$$

$$I_{rms} = \sqrt{\frac{I_1^2 + I_2^2}{2}}$$

Question 29. **Which of the following statements proves that Earth has a magnetic field?**

1) Earth is surrounded by ionosphere
2) A large quantity of iron-ore is found in the Earth
3) The intensity of cosmic rays stream of charged particles is more at the poles than at the equator.

4) Earth is a planet rotating about the North south axis

ANSWER. 3

Sol. The intensity of cosmic rays stream of charged particles is more at the poles than at the equator.

Question 30. A long solenoid has 500 turns, When a current of 2A is passed through it, the resulting magnetic flux linked with each turn of the solenoid is $4x10^3$ Wb, then self-induction of the solenoid is

1) 2.0 henry 2) 1.0 henry 3) 4.0 henry 4) 2.5 henry

ANSWER. 2

Sol. Given:

$$\Phi = 500 \times 4 \times 10^3 = 2\ \text{Wb}$$

The self-induction is directly proportional to the flux linked with coil of the solenoid.

$$\text{Li} = \text{N}\Phi$$

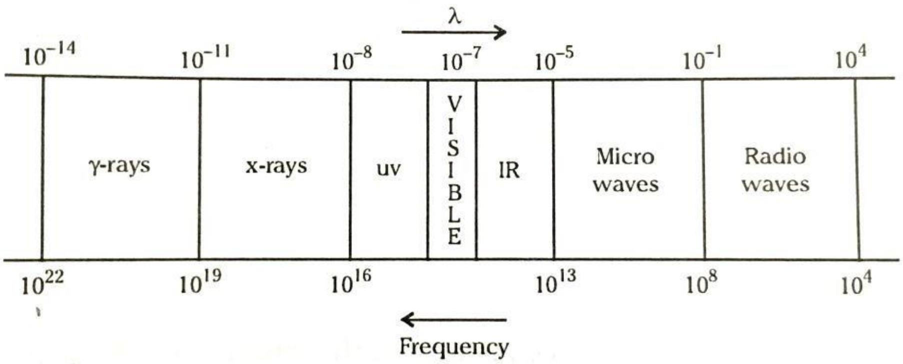
The self-induction of the solenoid is

$$\text{L} = \frac{2}{2} = 1\ \text{H}$$

Question 31. Which of the following radiations of electromagnetic waves has the highest wavelength?

1) IR-rays 2) Microwaves 3) X-rays 4) UV-rays

ANSWER. 2



Sol. Micro waves

Question 32. The power of a equi-concave lens is -4.5 and is made of an material of R.I. 1.6, the radii of curvature of the lens is

1) -2.66 cm 2) 115.44cm 3) -26.6 cm 4) +36.6 cm

ANSWER. 3

Sol. The power of a concave lens is given by

$$P = \frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

The power of equi-convex lens is give by

$$P = \frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$P = \frac{1}{f} = (\mu - 1)\left(\frac{1}{-R} - \frac{1}{R}\right)$$

$$-4.5 = -(1.6 - 1)\left(\frac{1}{R} + \frac{1}{R}\right)$$

$$-4.5 = -(1.6 - 1)\frac{2}{R}$$

$$R = -(1.6 - 1)\frac{2}{-4.5}$$

$$R = -(0.6)\frac{2}{-4.5} = 0.266$$

Question 33. A ray of light passes through an equilateral glass prism in such a manner that the angle of incidence is equal to the angle of emergence and each of these angles is equal to 3/4 of the angle of the prism. The angle of deviation is

1) 20^0 2) 30^0 3) 45^0 4) 39^0

ANSWER. 2

Sol.

The angle of incidence (i) = The angle of emergence (e)

Where A is the angle of the prism A = 60^0.

Since the prism is equilateral triangle = A = 60^0

$$\therefore i = e = 60^0 \times \frac{3}{4} = 45^0$$

From prism formula

Angle of deviation is

$$i_1 + i_2 - A = D$$

$$\frac{3}{4} \times 60 + \frac{3}{4} \times 60 - 60 = D \qquad \because \; A = 60^0$$

$$45 + 45 - 60 = D$$

$$90 - 60 = D$$

$$D = 30^0$$

Question 34. A convex lens of focal length „f" is placed somewhere in between an object and a screen, the distance between the object and the screen is „x". If the numerical value of the magnification produced by the lens is „m", then the focal length of the lens is

1) $\frac{(m+1)^2 x}{m}$ 2) $\frac{(m-1)^2 x}{m}$ 3) $\frac{m\ x}{(m+1)^2}$ 4) $\frac{m\ x}{(m-1)^2}$

ANSWER. 3

Sol. Let us consider the object is placed at a distance u from the lens, then object distance = − u

The distance between the object and the screen is „x"

$$u + v = x$$

The magnification produced by the lens is

$$m = \frac{-v}{-u} = \frac{v}{u}$$

The lens formula

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

By applying sign convention

$$\frac{v}{m} + mu = \frac{1}{f}$$

Question 35. A series resonant ac circuit contains a capacitance 10^{-6}F and an inductor of10^{-4}H. The frequency of electrical oscillations will be

1) $\frac{10^5}{2\pi}$ Hz 2) $\frac{10}{2\pi}$ Hz 3) 10^5 Hz 4) 10 Hz

ANSWER. 1

Sol. In case of AC circuit, the resonant frequency is given by

$$f = \frac{1}{2\pi\sqrt{LC}}$$

$$f = \frac{1}{2 \times \pi\sqrt{10^{-4} \times 10^{-6}}}$$

$$f = \frac{10^5}{2\pi}\ \text{Hz}$$

Question 36. In a series LCR circuit R = 300Ω, L = 0.9H, C = 2 μF and ω = 1000 rad/sec., then impedance of the circuit is

1) 500 Ω 2) 400Ω 3) 1300 Ω 4) 900 Ω

ANSWER. 1

Sol. The impedance of LCR circuit is given by, where X_c is capacitive reactance, X_L is inductive reactance and R is the resistance.

$$Z = \sqrt{R^2 + (X_c - X_L)^2}$$

$$X_c = \frac{1}{\omega C} = \frac{1}{1000 \times 2 \times 10^{-6}} = \frac{1}{2 \times 10^{+3} \times 10^{-6}} = \frac{1}{2 \times 10^{-3}} = 500$$

$$X_L = \omega L = 1000\ \text{rad/sec} \times 0.9\ \text{H} = 900\ \Omega$$

Question 37. For light diverging form a finite point source

1) The wave front is parabolic
2) The intensity at the wave front does not depend on the distance
3) The wave front is cylindrical
4) The intensity decreases in proportion to the distance squared.

ANSWER. 4

Sol. The intensity decreases in proportion to the distance squared.

$$I \propto \frac{1}{d^2}$$

Question 38. The fringe width for red colour as compared to that for violet colour is approximately

1) 4 times 2) 8 times 3) 3 times 4) Double

ANSWER. 4

Sol. The fringe width of interference fringes for red colour is β. The fringe width for the violet colour will be nearly

The expression for fringe width is given by

$$\beta = \frac{\lambda D}{d}$$

B is the fringe width, λ_1 and λ_2 wavelength of red and violet colours respectively. D is the distance between slits and screen

$$\text{For red colour} = \beta_1 = \frac{\lambda_1 D}{d}$$

$$\text{For violet colour} = \beta_2 = \frac{\lambda_2 D}{d}$$

$$\frac{\beta_1}{\beta_2} = \frac{\lambda_1}{\lambda_2}$$

$$\frac{\beta_1}{\beta_2} = \frac{2\,\lambda_2}{\lambda_2}$$

$$\frac{\beta_1}{\beta_2} = 2$$

$$\beta_1 = 2\beta_2$$

Question 39. In case of Fraunhofer"s diffraction at a single slit the diffraction pattern on the screen is correct for which of the following statements?

1) Central dark band having uniform brightness on either side.
2) Central bright band having dark bands on either side.
3) Central dark band having alternate dark and bright bands of decreasing intensity on either side.
4) Central bright band having alternate dark and bright bands of decreasing intensity on either side.

ANSWER. 4

Sol. Central bright band having alternate dark and bright bands of decreasing intensity on either side

---

Question 40. When a Compact Disc (CD) is illuminated by small source of white light coloured bands observed. This due to

1) Interference 2) Reflection 3) Scattering 4) Diffraction

ANSWER. 4

Sol. Diffraction

Question 41. Consider a glass slab which is silvered at one side and the other side is transparent. Given the refractive index of the glass slab to be 1.5. If a ray of light is incident at an angle of 45^0 on the transparent side, the deviation of the ray of light from its initial path, when it comes out of the slab is

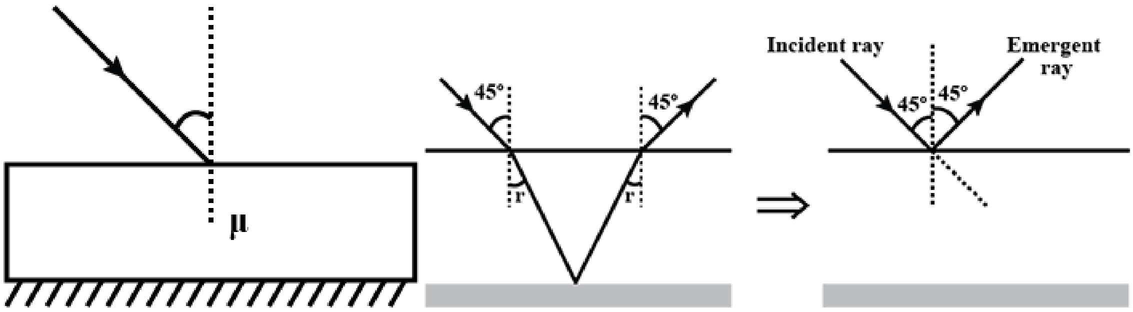
1) 120^0 2) 45^0 3) 90^0 4) 180^0

ANSWER. 3 Sol.

$$\text{From Snells law } \mu = \frac{\text{Sin i}}{\text{Sin r}}$$

$$\text{Sin r} = \frac{\text{Sin i}}{\mu} = \frac{\text{Sin } 45^0}{1.5} = \frac{\sqrt{3}/_2}{1.5} = \frac{0.707}{1.5} = 0.47$$

From the figure it is clear that the angle between incident ray and the emergent ray is 90^o.



Question 42. Focal length of a convex lens will be maximum for

1) Green light 2) Red light

3) Blue light 4) Yellow light

ANSWER. 2

Sol. Red light

The focal length is larger for red colour for both convex and concave lenses. High frequency waves, like blue colour, travel the slowest in any given medium, compared to the low frequency waves like red colour. (Except for in vacuum, in which they all travel with the same speed). Thus, high frequency waves like blue colour, bend more (more refraction or more refractive index) compared to low frequency waves like red. Thus when incident on a convex (or concave) lens, blue colour would bend more and thus converge (or diverge) closer to the lens. Hence, blue colour would have a shorter focal length, compared to red colour. Thus the focal length of a convex (or concave) lens is maximum for red colour.

$$f \propto \frac{1}{(\mu - 1)}$$

Also $\mu \propto \frac{1}{\lambda}$ Thus $f \propto \lambda$

And we know that $\lambda_r > \lambda_v$ $f \propto \frac{1}{(\mu - 1)}$; $\mu_V > \mu_r$

Question 43. The de-Broglie wavelength of a particle of kinetic energy „K" is λ; the wavelength of the particle, if its kinetic energy is K/4 is

1) $\frac{\lambda}{2}$ 2) 4λ 3) λ 4) 2λ

ANSWER. 4

Sol.

$$\lambda \propto \frac{1}{\sqrt{k}}$$

$$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{k_2}{k_1}} = \sqrt{\frac{k}{4k}} = \frac{1}{2}$$

$$\lambda_2 = 2\lambda$$

Question 44. The radius of hydrogen atom in the ground state is 0.53 A. After collision with an electron, it is found to have a radius of 02.12 A, the principle quantum number „n" of the final state of the atom is

1) n = 3 2) n = 4 3) n =1 4) n=2

ANSWER. 4

Sol.

The radius of hydrogen atom in the ground state is directly proportional to the principle quantum number

$$r \propto n^2$$

$$\frac{r_1}{r_2} = \left(\frac{n_1}{n_2}\right)^2$$

$$0.25 = \frac{1}{n_2^2}$$

$$n_2^2 = \frac{1}{0.25} = \frac{100}{25} = 4$$

$$n_2 = 2$$

Question 45. In accordance with the Bohr"s model, the quantum number that characterises the Earth"s revolution around the sun in an orbit of radius $1.5\text{x}10^{11}$m with orbital speed 3 $\text{x}10^{4}$ ms^{-1} is [given mass of Earth $6\text{x}10^{24}$ kg] 1) $8.57\text{x}10^{64}$ 2) $2.57\text{x}10^{74}$ 3) $5.98\text{x}10^{86}$ 4) $2.57\text{x}10^{38}$

ANSWER. 2

Sol. The earth revolving round the sun for which the angular momentum of the sun is equal nh/2π.

$$mv_0 r = n\frac{h}{2\pi}$$

$$6 \times 10^{24} \times 3 \times 10^4 \times 1.5 \times 10^{11} = n\,\frac{6.6 \times 10^{-34}}{2 \times 3.14}$$

$$n = \frac{9.1 \times 10^{-31} \times 3 \times 10^8 \times 1.5 \times 10^{11} \times 2 \times 3.14}{6.6 \times 10^{-34}}$$

$$n = \frac{6 \times 10^{24} \times 3 \times 10^{4} \times 1.5 \times 10^{11} \times 2 \times 3.14}{6.6 \times 10^{-34}}$$

$$n = 25.6909 \times 10^{73}$$

$$n = 2.56909 \times 10^{73}$$

$$n = 2.57 \times 10^{73}$$

Question 46. If an electron is revolving in its Bohr orbit having Bohr radius of 0 0.529 A , then the radius of third orbit is

1) 4.761 Å **2)5125 Å** **3)4324 nm** **4)4496Å**

ANSWER. 1

Sol. The radius of the nth orbit is given by the expression

$$r_n = 0.529 \frac{n^2}{z}; \qquad n = 3$$

$$r_n = 0.529 \times 9 = 4.761Å$$

Question 47. Binding energy of a Nitrogen nucleus [$^{14}_{7}N$], given m [$^{14}_{7}N$] =14.00307u

1) 206.5 MeV **2) 78 MeV** **3) 104.7 MeV** **4) 85 MeV**

ANSWER. 3

Sol. Binding energy is equal to difference of mass of the nucleons and mass of the nucleus.

The difference between the mass of the stable nucleus and the masses of the nucleons (protons and neutrons) is called mass defect.

$$\text{Mass defect} = \Delta m = Zm_p + N\, m_n - M_{nuc}$$

$$\Delta m = [Zm_p + (A - Z)\, m_n] - M_{nuc}$$

m_p – Mass of the proton in free state

m_n – Mass of the neutron in free state

M_{nuc} – Actual mass of the assembled nucleus

$\therefore$ BInding Energy of the nucleus $= (\Delta m)c^2$

$$B.E = \left[Zm_p + (A - Z)m_n - m_X\right] \times 931.5$$

$$B.E = [7.04581 + 7.06069 - 14.0030] \times 931.5$$

$$B.E = 104.7 \text{ MeV}$$

Question 48. In a photo electric experiment, if both the intensity and frequency of the incident light are doubled, then the saturation photo electric current

1) Is doubled **2) Becomes four times** **3) Remains constant** **4)Is halved**

ANSWER. 1

Sol. The photoelectric current is directly proportional to Intensity

---

49. **The kinetic energy of the photoelectrons increases by 0.52 eV when the wavelength of incident light is changed from 500 nm to another wavelength which is approximately**

1) 1250 nm 2) 1000 nm 3) 700 nm 4) 400 nm

ANSWER. 3

Sol.

$$KE_1 - KE_2 = \frac{hc}{\lambda_1} - \frac{hc}{\lambda_2}$$

$$\Delta\ KE = hc\left[\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right]$$

$$\frac{0.52 \times 1.602 \times 10^{-19}}{6.6 \times 10^{-34} \times 3 \times 10^{8}} = \left[\frac{1}{500 \times 10^{-9}} - \frac{1}{\lambda_2}\right]$$

$$\frac{0.52 \times 1.602 \times 10^{7}}{6.6 \times 3} = \left[2 \times 10^{6} - \frac{1}{\lambda_2}\right]$$

$$0.04207 \times 10^{7} = \left[2 \times 10^{6} - \frac{1}{\lambda_2}\right]$$

$$\frac{1}{\lambda_2} = 2 \times 10^{6} - 0.4207 \times 10^{6}$$

$$\frac{1}{\lambda_2} = [2 - 0.4207] \times 10^{6}$$

$$\frac{1}{\lambda_2} = 1.5793 \times 10^{6}$$

$$\lambda_2 = 700\ nm$$

Question 50. The resistivity of a semiconductor at room temperature is in between

1) 10^{6} to 10^{8} Ω cm 2) 10^{10} to 1012 Ω cm

3) 10^{-2} to 10^{-5} Ω cm 4) 10^{-3} to 10^{6} Ω cm

ANSWER. 4

Sol. Resistivity of a semiconductor at room temperature is in between 10^{-5}Ωm to 10^{4} Ωm i.e. 10^{-3} to 10^{6} Ωcm

---

Question 51. The forbidden energy gap for „Ge‟ crystal at „0‟K is

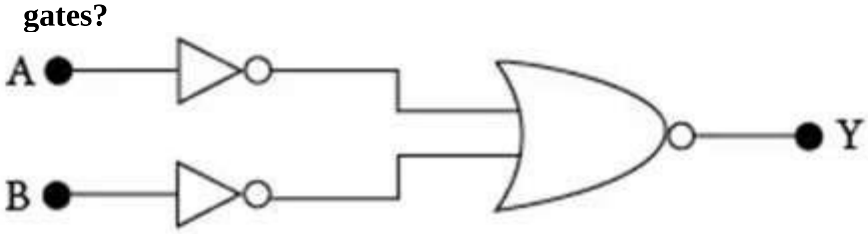
1) 2.57 eV 2) 6.57 eV

3) 0.071 eV 4) 0.71 eV

ANSWER. 4

Sol. The forbidden energy gap for germanium crystal is 0.71eV

Question 52. Which logic gate is represented by the following combination of logic gates?



1) AND 2) NOR 3) OR 4) NAND

Ans. 1

ANSWER.

We know that gate is a digital circuit that follows a logical relationship between input and the output voltages and also, they control the flow of information. Basically we have five common logic gates, namely, NOT, AND, OR, NAND and NOR. Each of them has a function that is defined by a truth table and also has a symbol. Truth tables help us in understanding the behavior of logic gates.

In the question three logic gates are given, namely, two NOT gates and one NOR gate. Before discussing their combination, let us discuss their individual functions.

NOT gate

NOT gate is the most basic gate that has just one input and one output.

If we give 0 as input to this gate we get 1 as output and vice-versa. Clearly, here the output is the inverted version of input and hence it is called inverter. That is, if X was the input then the output is

$$X \Rightarrow \overline{X} \ldots\ldots\ldots (1)$$

NOR gate:

This gate has two inputs and one output.

This gate is the combination of two functions: operation of OR gate followed by NOT gate. We get its output as 1 only when both its inputs are 0. Or we could say that if X and Y were the inputs then, the output of NOR-gate is given by, $\overline{X+Y}$.

$$X, Y \Rightarrow \overline{X+Y} \ldots\ldots\ldots (2)$$

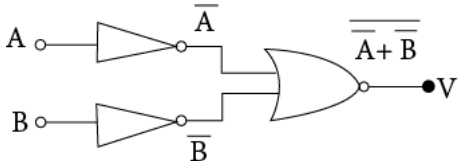
So, for the combination, if $\overline{A \text{ and } B}$ were the inputs then from (1) we have outputs as A and B respectively.

Now, the two inputs of NOR gate are $\overline{A \text{ and } B}$, so from (2) we get the output as, $\overline{\Rightarrow \overline{A} + \overline{B}} = \overline{\overline{A}} . \overline{\overline{B}}$

$$\Rightarrow \overline{\overline{A}}.\overline{\overline{B}} = A.B \ldots\ldots\ldots (3)$$

AND gate if you may recall has two or more inputs with just one output. The inputs have to be both 1 to give the output 1. That is, if X and Y were the inputs then output is given by, ⇒X·Y⇒

Therefore, the combination given in the question results in it operating as an AND gate.



Question 53. A metallic rod of mass unit length 0.5 kgm^{-1}is lying horizontally on a smooth inclined plane which makes an angle of 300 with the horizontal. A magnetic field of strength 0.25 T is acting on it in the vertical direction. When a current „T" is flowing through it, the rod is not allowed to slide down. The quantity of current required to keep the rod stationary is

1) 14.76 A 2) 11.32 A 3) 7.14 A 4) 5.98 A

ANSWER. 2

Sol. Given

$B = 0.25T, l\, m = 0.5mkg, \theta = 30^o$

$F = Bil$

F cos30 balances „mg sin30"

$F = Bil$

$Bil\ \cos\theta = mg\sin\theta$

$\therefore Bil\ \cos 30^0 = mg\sin 30^0$

$$0.25 \times I \times \frac{\sqrt{3}}{2} = 0.5 \times 10 \times \frac{1}{2}$$

$$I = \frac{5 \times 100}{25 \times \sqrt{3}} = \frac{20}{\sqrt{3}} A$$

$I = 11.32\ A$

Question 54. A nuclear reactor delivers a power of 109 W, the amount of fuel consumed by the reactor in one hour is

1) 0.72 g 2) 0.96 g 3) 0.04 g 4) 0.08 g

ANSWER. 3

Sol. The power of the nuclear reactor

$$P = \frac{E}{t} = \frac{mv^2}{t}$$

$$\Rightarrow 10^9 = \frac{m \times 9 \times 10^{16}}{3600}$$

$m = 4 \times 10^{-5}\ kg$

$m = 4 \times 10^{-5}\ \times 10^3 g$

Question 55. Which of the following radiations is deflected by electric field?

1) γ- rays 2) α-particles 3) X -rays 4) Neutrons

ANSWER. 2

Sol. **α-particles**

Alpha particles are positively charged and are therefore attributed to the negative plate in an electric field.

Gamma-rays are a penetrating form of electromagnetic radiation generated from radioactive decay of atomic nuclei. Gamma rays cannot be deflected by an electric field since it is electrically neutral.

Alpha particle or the alpha rays consists of two protons and two neutrons bound together into a particle identical as helium-4 nucleus produced in the process of alpha decay. Alpha particles are positively charged, the beta charge is negatively charged, and gamma-ray is electrically neutral. Hence the alpha particle is deflected by electric fields.

X-ray is the very energetic electromagnetic radiation that is used to take an image of the bones of the human body as the calcium of the bones absorbs the x-rays, so bones look white. X-rays aren"t deflected by any electronic or the magnetic fields as x-rays do not carry any charges.

Neutrons are the neutral subatomic particle found in the atomic nucleus. Neutrons are found with protons in the atomic nucleus. Neutrons have no charge; hence it can"t be reflected in the curved path, and it continues in the straight path.

Question 56. Two objects are projected at an angle θ^0 and $(90^0-\theta)$, to the horizontal with the same speed. The ratio of their maximum vertical heights is

1) 1: tan θ 2) $\tan^2\theta$:1 3) 1:1 4) tanθ:1

Ans. 2

Sol.

$$H_1 = \frac{u^2 \sin^2 \theta}{2g} \dots\dots\dots(1)$$

$$H_2 = \frac{u^2 \sin^2(90-\theta)}{2g} = \frac{u^2 \cos^2 \theta}{2g} \dots\dots\dots(2)$$

$$\frac{H_1}{H_2} = \frac{u^2 \sin^2 \theta}{2g} \times \frac{2g}{u^2 \cos^2\theta}$$

$$\frac{H_1}{H_2} = \frac{\tan^2 \theta}{1}$$

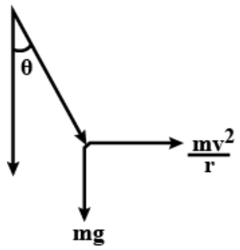
Question 57. A car is moving in a circular horizontal track of radius 10 m with a constant speed of $10ms^{-1}$. A bob is suspended from the roof of the car by a light wire of length 1.0m. The angle made by the wire with the vertical is (in radian)

1) 0 2) $\frac{\pi}{3}$ 3) $\frac{\pi}{6}$ 4) $\frac{\pi}{4}$

ANSWER. 4

Given that, radius =10 m, velocity =10 m/s, g=10m/s^2

Solution:



Hence from the figure, We know that,

$$T \sin\theta = \frac{mv^2}{r} \ldots\ldots\ldots (1)$$

$$T \cos\theta = mg \ldots\ldots\ldots (2)$$

From equations (1) and (2)

$$\frac{T\sin\theta}{T\cos\theta} = \frac{mv^2}{r} \times \frac{1}{mg}$$

$$\tan\theta = \frac{v^2}{2g} = \frac{10\times10}{10\times10} = 1$$

$$\tan\theta = 45^0 \quad \theta = \frac{\pi}{4}$$

Question 58. Two masses of 5 kg and 3 kg are suspended with the help of massless inextensible strings as shown in figure, when whole system is going upwards with acceleration 2m/s2 , the value of 1 T is (use g = 9.8m/s^2)

1) 23.6 N **2) 59 N** **3) 94.4 N** **4) 35.4 N**

ANSWER. 3

Sol.

The free body diagram of 3 kg block is as shown in the fig. (a).

The equation of motion of 3 kg block is T2−3g=3a

T_2 = 3 (a+g) = 3 (2+10) = 36N ....(i)

The free body diagram of 5 kg is as shown in the Fig.(b).

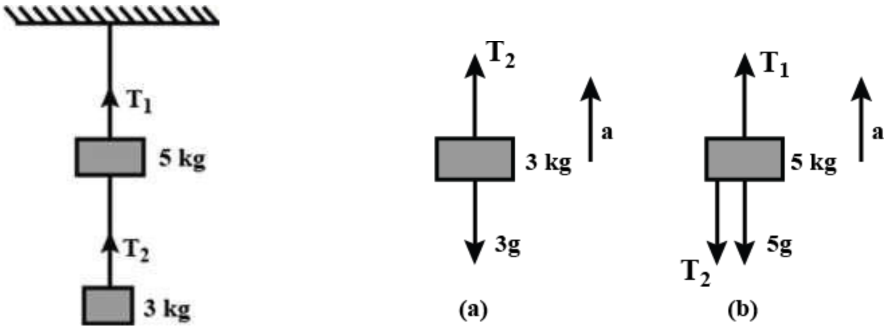
The equation of motion of 5kg block is

$T_1 - T_2 - 5g = 5a$

$T_1 = 5(a+g) + T_2$

= 5 (2+10) + 36 = 96 N

Question $T_1 = (m_1 + m_2)(g + a)$



Question 59. The Vernier scale of a travelling microscope has 50 divisions which coincides with 49 main scale divisions. If each main scale division is 0.5 mm, then the lease count of the microscope is

1) 0.01 mm 2) 0.5 cm 3) 0.01 cm 4) 0.5 mm

ANSWER. 1

Sol.

Least Count = 1 MSD − 1 VSD

Or

$$\text{Least Count} = \frac{\text{One Main Scale Division (1 MSD)}}{\text{Number ofVernier scale Division}} = \frac{0.05}{50} = 0.01\ \text{mm}$$

Question 60. The displacement „x" (in meter) of a particle of mass „m" (in kg) moving in one dimension under the action of a force, is related to time „t" (in sec) by, $t = \sqrt{x} + 3$. The displacement of the particle when its velocity is zero, will be 1) 6m 2) 2m 3) 4m 4) 0m [NEET-2013]

ANSWER. 4

Sol **given**

Time $= t = \sqrt{x} + 3$

$\sqrt{x} = t - 3$

By squaring on both the sides

$x = t^2 - 6t + 9$

The velocity of the particle

$$v = \frac{dx}{dt} = 2t - 6$$

For velocity, v to be equal to zero,

As $v = 0;\quad 2t - 6 = 0$

$t = 3$ sec

At t = 3 s, displacement

$x = (3)^2 - 6(3) + 9 = 0\ m$

KCET 2021 -PHYSICS - VERSION CODE - B2: SOLUTIONS

1. Eight drops of mercury of equal radii combine to form a big drop. The capacitance of a bigger drop as compared to each smaller drop is

(A) 2 times (B) 8 times (C) 4 times (D) 16 times

ANSWER: (A)

Solution

$$C_B = n^{1/3} C_S$$

$$C_B = 8^{1/3} C_S$$

$$C_B = [(2)^3]^{1/3} C_S$$

$$C_B = 2C_S$$

---

2. Which of the statements is false in the case of polar molecules?

(A) Centers of positive and negative charges are separated in the absence of external electric field.

(B) Centers of positive and negative charges are separated in the presence of external electric field.

(C) Do not possess permanent dipole moments.

(D) Ionic molecule HCl is the example of polar molecule.

ANSWER: (C)

Polar molecules have permanent dipole moment.

---

3. An electrician requires a capacitance of 6 μF in a circuit across a potential difference of 1.5 kV. A large number of 2 μF capacitors which can withstand a potential difference of not more than 500 V are available. The minimum number of capacitors required for the purpose is

(A) 3 (B) 9 (C) 6 (D) 27

Ans (B)

Number of capacitors to be connected in each row,

$$m = \frac{1500}{500} = 3$$

Effective capacitance when connected in „n" rows with m capacitors in each row is

$$C_{eff} = n\frac{C}{m}$$

$$C_{eff} = n \times \frac{2}{3}$$

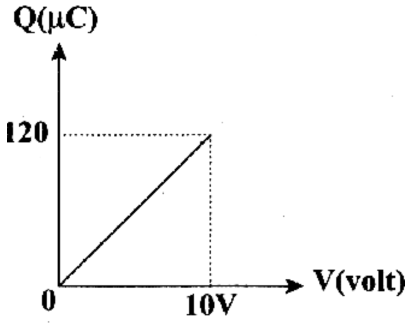
$$n \times \frac{2}{3} = 6$$

$$n = \frac{18}{6}$$

$n = 9$

Total number of capacitors required N = mn = 3 × 9 = 27

4. In figure, charge on the capacitor is plotted against potential difference across the capacitor. The capacitance and energy stored in the capacitor are respectively.



(A) 12 μF, 1200 μJ (B) 12 μF, 600 μJ (C) 24 μF, 600 μJ (D) 24 μF, 1200 μJ

Ans (B)

$q = CV$

$C = \frac{q}{V} = \frac{120 \times 10^{-6}}{10} = 12 \times 10^{-6}\ F$

$C = 12\mu F$

$U = \frac{1}{2}CV^2$

$U = \frac{1}{2} \times 12 \times 10^{-6} \times 10 \times 10$

$U = 600 \times 10^{-6}\ J$

$U = 600\ \mu J$

5. A wire of resistance 3 W is stretched to twice its original length. The resistance of the new wire will be

(A) 1.5 Ω (B) 3 Ω (C) 6 Ω (D) 12 Ω

Ans (D)

$R_2 = n^2 R_1$

$R_2 = 2^2 \times 3$

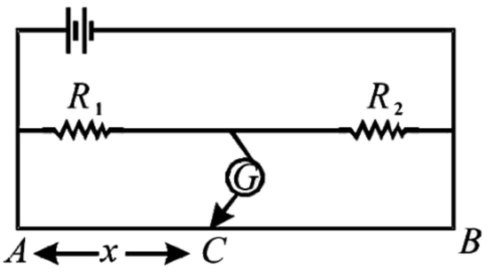
$R_2 = 12\ \Omega$

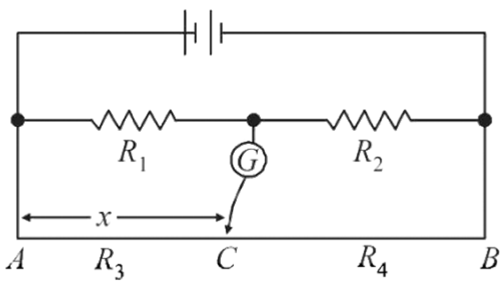
6. In the given arrangement of experiment on Metre Bridge, if AD corresponding to null deflection of the galvanometer is X, what would be its value if the radius of the wire AB is doubled?

(A) X (B) X4 (C) 4 X (D) 2 X

ANSWER (A)

The balancing length is independent of radius of the bridge wire.





At null point, thus, null condition is independent of radius of AB wire

$$\frac{R_1}{R_2}=\frac{R_3}{R_4}=\frac{X}{100-X}$$

But $\frac{R_1}{R_2}$ does not changes so , $\frac{R_1}{R_2}$ should also not change at null point

Therefore the point C does not change.

---

7. A copper wire of length 1 m and uniform cross-sectional area 5 × 10^{-7} m2 carries a current of 1A. Assuming that there are 8×10^{28} free electrons per m^3 in copper, how long will an electron take to drift from one end of the wire to the other?

(A) 0.8 × 10^3 s (B) 1.6 × 10^3 s (C) 3.2 × 10^3 s (D) 6.4 × 10^3 s

ANSWER (D)

Length of the conductor $= l$

Area of cross section of the conductor = A

Volume of the conductor $= A \times l$

Number of electrons per unit Volume of the conductor = n

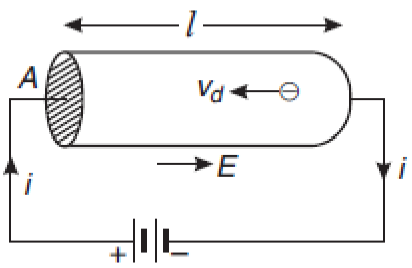
Total number of free electrons in the conductor $= Aln$

The charge on the eacch electron = e

The total charge on all the free electrons in the conductor $= Alne$

The constant potential differrence applied across the ends of the conductor = V

The electric field set up across the conductor is given by $E=\frac{V}{l}$



Given

$i = 1A, \quad A = 5\times 10^{-7} m^2, \quad n = 8\times 10^{28}$ electrons $/m^3$

$$t=\frac{l}{v_d}$$

The current in the conductor is given by

$$I = neAv_d$$

$$\therefore v_d = \frac{I}{neA}$$

$$t = \frac{l}{v_d} = \frac{l}{I/nAe} = \frac{lnAe}{I}$$

$$t = \frac{1 \times (8 \times 10^{28}) \times (5 \times 10^{-7}) \times (1.6 \times 10^{-19})}{1}$$

$$t = 6.4 \times 10^3 s$$

---

8. Consider an electrical conductor connected across a potential difference V. Let Dq be a small charge moving through it in time Dt. If I is the electric current through it,

(i) The kinetic energy of the charge increases by IVDt.

(ii) The electric potential energy of the charge decreases by IVDt.

(iii) The thermal energy of the conductor increases by IVDt.

Then the correct statement/s is/ are

(A) (i) (B) (ii), (ii) (C) (i) and (iii) (D) (ii), (iii)

ANSWER (D)

As the charges flow from higher to lower potential, its potential energy decreases and increase in kinetic energy is transferred to conductor which increases the thermal energy.

- -

9. A strong magnetic field is applied on a stationary electron. Then the electron

(A) Moves in the direction of the field

(B) Moves in an opposite direction of the field

(C) remains stationary

(D) Starts spinning

Ans (C)

A stationary charge in a magnetic field donot experience any force.

$$\text{As } \vec{F} = \vec{q}(\vec{V} \times \vec{B})$$

As the electron is stationary,

$$\therefore \text{ Veleocity: } \vec{V} = 0$$

$$\therefore \vec{F} = 0$$

The electron will remain stationary,

---

10. Two parallel wires in free space are 10 cm apart and each carries a current of 10 A in the same direction. The force exerted by one wire on the other [per unit length] is

(A) 2×10^{-4} N m^{-1} [attractive] (B) 2×10^{-7} N m^{-1} [attractive]

(C) 2×10^{-4} N m^{-1} [repulsive] (D) 2×10^{-7} N m^{-1} [repulsive]

ANSWER (A)

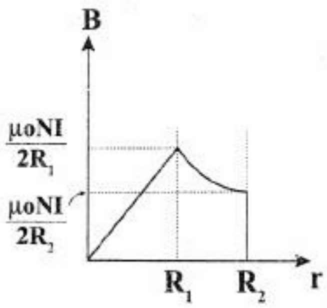
Distance between two parallel wires (x) = 10 cm = 0.1 m; current in each wire $i_1 = i_2$ = 10A and length of wire l is 1 cm

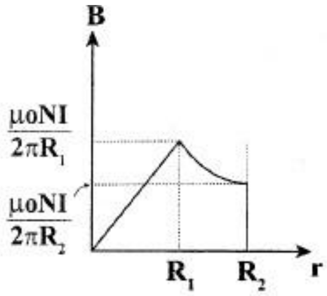
$$\frac{F}{l} = \frac{\mu_0}{4\pi}\frac{2I_1I_2}{d}$$
$$= \frac{10^{-7} \times 2 \times 10 \times 10}{10 \times 10^{-2}}$$
$$\frac{F}{l} = 2 \times 10^{-4}$$
$$\frac{F}{l} = 2 \times 10^{-4}\ Nm^{-1}$$

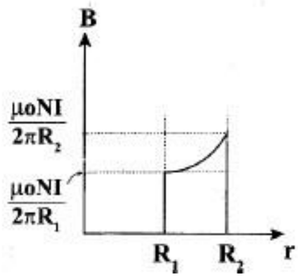
[Attractive since the currents are in the same direction]

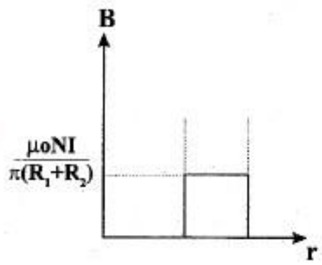
---

11. A toroid with thick windings of N turns has inner and outer radii R_1 and R_2 respectively. If it carries certain steady current I, the variation of the magnetic field due to the toroid with radial distance is correctly graphed in

(A) 

(B) 

(C) 

(D) 

ANSWER (D)

$B = \mu_0 nI$ where $n = \dfrac{N}{2\pi r}$ $B = \dfrac{\mu_0 NI}{\pi\,(R_1 + R_2)}$

$$B = \frac{\mu_0 NI}{2\pi\left(\frac{R_1 + R_2}{2}\right)}$$

12. A tightly wound long solenoid has „n“ turns per unit length, a radius „r“ and carries a current I. A particle having charge „q“ and mass „m“ is projected from a point on the axis in a direction perpendicular to the axis. The maximum speed of the particle for which the particle does not strike the solenoid is

(A) $= \dfrac{\mu_0 nIqr}{m}$ (B) $= \dfrac{\mu_0 nIqr}{2m}$ (C) $= \dfrac{\mu_0 nIqr}{4m}$ (D) $= \dfrac{\mu_0 nIqr}{8m}$

ANSWER (B)

$F_B = qV\,B\,\text{Sin}\theta \qquad \theta = 90^0$

$F_B = qV\,B$

$F_C = \dfrac{mv^2}{r}$

$F_B = F_C$

$F_C = \dfrac{mv^2}{\left(\frac{r}{2}\right)}$

$v = \dfrac{qrB}{2m}$

$B = \mu_0 nI$

$v = \dfrac{qr\mu_0 nI}{2m}$

13. Earth‟s magnetic field always has a horizontal component except at

(A) Equator (B) magnetic poles (C) a latitude of 60° (D) an altitude of 60°

ANSWER (B)

Magnetic dip at poles, $\theta = 90°$

$B_H = B\cos\theta = 0$

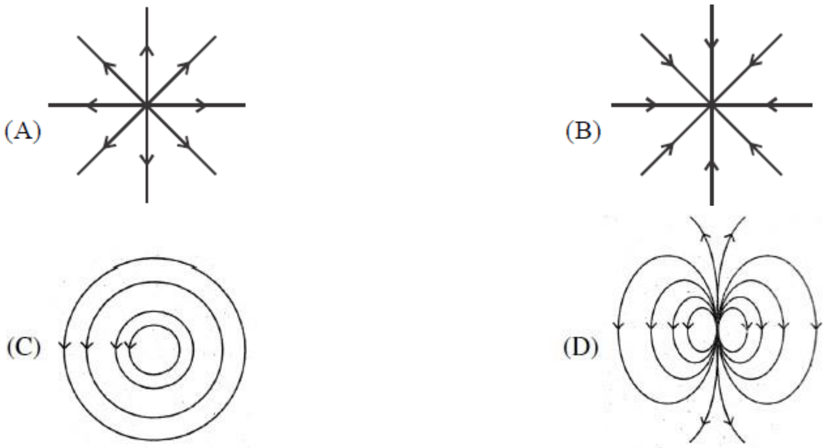
B = Constant

$B_{in} = R_2$

Bout = 0

---

14. Which of the field pattern given below is valid for electric field as well as for magnetic field?



(A) (B) (C) (D)

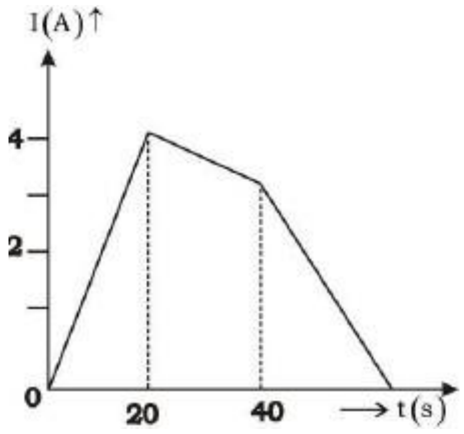
ANSWER (D)

No monopoles exist and electric field lines donot form closed loops.

---

15. The current flowing through an inductance coil of self-inductance 6 mH at different time instants is as shown. The emf induced between t = 20 s and t = 40 s is nearly

(A) 2×10^{-2} V (B) 3×10^{-2} V (C) 4×10^{-3} V (D) 30×10^{2} V



ANSWER: (NIL)

$$e = L\frac{dI}{dt}$$

$$e = 6\times10^3\left[\frac{I_2 - I_1}{t_2 - t_1}\right]$$

$$e = 6\times10^3\left[\frac{1}{40-20}\right]$$

$$e = 6\times10^3\left[\frac{1}{20}\right]$$

$$e = 3\times10^{-4}$$

---

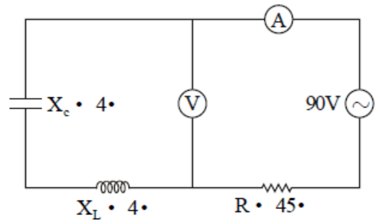
16. The physical quantity which is measured in the unit of wb A^{-1} is (A) Self-inductance (B) Mutual inductance (C) Magnetic flux (D) Both (A) and (B)

ANSWER (D)

$$\phi = LI \quad \text{or} \quad \phi = MI$$

$$L = \frac{\phi}{I} \quad \text{or} \quad M = \frac{\phi}{I}$$

17. What will be the reading in the voltmeter and ammeter of the circuit shown?



(A) 90 V, 2 A **(B) 0 V, 2 A** **(C) 90 V, 1 A** **(D) 0 V, 1 A**

Ans (B)

At resonance condition,

Capacitive reactance = Inductive reactance

$X_L = X_C$

The voltage across L and C is 0.

$Z = R$

$$V = V_L - V_C = 0$$

$$I = \frac{V}{Z} = \frac{V}{R} = \frac{90}{45} = 2A$$

18. LC oscillations are similar and analogous to the mechanical oscillations of a block attached to a spring. The electrical equivalent of the force constant of the spring is

(A) Reciprocal of capacitive reactance (B) capacitive reactance

(C) Reciprocal of capacitance (D) capacitance

Ans (C)

$$K = \frac{1}{LC} \Rightarrow K \propto \frac{1}{LC}$$

---

19. In an oscillating LC circuit, L = 3.00 mH and C = 2.70 μF. At t = 0 the charge on the capacitor is zero and the current is 2.00A. The maximum charge that will appear on the capacitor will be

(A) 1.8×10^{-5} C (B) 18×10^{-5} C (C) 9×10^{-5} C (D) 90×10^{-5} C

Ans (B)

$$\frac{Q^2}{2C} = \frac{1}{2}LI^2$$

$$\frac{Q^2}{2 \times 2.7 \times 10^{-6}} = \frac{3 \times 10^{-3} \times 4^2}{2}$$

$$Q^2 = 12 \times 10^{-3} \times 2.7 \times 10^{-6} = 32.4 \times 10^{-9}$$

$$Q = 18 \times 10^{-5} C$$

---

20. Suppose that the electric field amplitude of electromagnetic wave is E0 = 120 NC^{-1} and its frequency is f = 50 MHz. Then which of the following value is incorrectly computed?

(A) Magnetic field amplitude is 400nT.

(B) Angular frequency of EM wave is p × 108 rad/s

(C) Propagation constant (angular wave number) is 2.1 rad/m

(D) Wavelength of the EM wave is 6 m.

ANSWER (C)

$$C = \frac{E_0}{B_0}$$

$$B_0 = \frac{E_0}{C} = \frac{120}{3 \times 10^8} = 400 \text{ nT}$$

$$K = \frac{2\pi}{\lambda}$$

$$K = 1.05 \neq 2.1 \text{ rad/m}$$

---

21. The source of electromagnetic waves can be a charge.

(A) Moving with a constant velocity (B) Moving in a circular orbit

(C) At rest (D) Moving parallel to the magnetic field

Ans (B)

Charges moving in a circular orbit undergo centripetal acceleration hence emit electromagnetic waves. Or when electron jumps from one higher stationary orbit to another lower stationary orbit emits em radiation.

---

22. In refraction, light waves are bent on passing from one medium to second medium because, in the second medium.

(A) Frequency is different **(B) speed is different**

(C) Coefficient of elasticity is different **(D) amplitude is smaller.**

ANSWER (B)

Refraction takes because of change in speed of light when it moves from one medium to another.

---

23. If the refractive index from air to glass is 3/2 and that from air to water is 4/3 then the ratio of focal lengths of a glass lens in water and in air is

(A) 1: 2 **(B) 2: 1** **(C) 1: 4** **(D) 4: 1.**

ANSWER (D)

$$\mu_w = n_w = \frac{4}{3} \text{ and } \mu_a = n_a = \frac{3}{2}$$

$$f_a(\mu_a - 1) = f_w\left(\frac{\mu_a}{n_w} - 1\right)$$

$$\frac{f_w}{f_a} = \frac{(\mu_a - 1)}{\left(\frac{\mu_a}{n_w} - 1\right)}$$

$$\frac{f_w}{f_a} = \frac{\left({}^3/_2 - 1\right)}{\left(\frac{{}^3/_2}{{}^4/_3} - 1\right)}$$

$$\frac{f_w}{f_a} = \frac{\left(\frac{3-2}{2}\right)}{\left(\frac{9-8}{8}\right)}$$

$$\frac{f_w}{f_a} = \frac{\left({}^1/_2\right)}{\left({}^1/_8\right)}$$

$$\frac{f_w}{f_a} = \frac{8}{2} = \frac{4}{1}$$

---

24. Two thin biconvex lenses have focal lengths f_1 and f_2. A third thin biconcave lens has focal length of f_3. If the two biconvex lenses are in contact, the total power of the lenses is P_1. If the first convex lens is in contact with the third lens, the total power is P_2. If the second lens is in contact with the third lens, the total power is P_3 then

(A) $P_1 = \frac{f_1 f_2}{f_1 - f_2}$, $P_2 = \frac{f_1 f_3}{f_3 - f_1}$ and $P_3 = \frac{f_2 f_3}{f_3 - f_2}$

(B) $P_1 = \frac{f_1 - f_2}{f_1 f_2}$, $P_2 = \frac{f_3 - f_1}{f_3 + f_1}$ and $P_3 = \frac{f_3 - f_2}{f_2 f_3}$

(C) $P_1 = \frac{f_1 - f_2}{f_1 f_2}$, $P_2 = \frac{f_3 - f_1}{f_1 f_3}$ and $P_3 = \frac{f_3 - f_2}{f_2 f_3}$

(D) $P_1 = \frac{f_1 + f_2}{f_1 f_2}$, $P_2 = \frac{f_3 - f_1}{f_1 f_3}$ and $P_3 = \frac{f_3 - f_2}{f_2 f_3}$

ANSWER (D)

$f_1 = +f_1$, $f_2 = +f_2$, $f_3 = -f_3$

$$\frac{1}{F_R} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$P_1 = \frac{1}{f_1} + \frac{1}{f_2} = \frac{f_2 + f_1}{f_1 f_2}$$

$$P_2 = \frac{1}{f_2} + \frac{1}{f_3} = \frac{f_3 - f_1}{f_1 f_3}$$

$$P_3 = \frac{1}{f_2} + \frac{1}{f_3} = \frac{f_3 - f_2}{f_2 f_3}$$

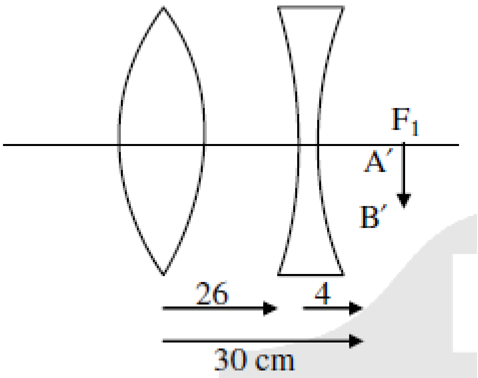
$$P_1 = \frac{f_1 + f_2}{f_1 f_2}, \quad P_2 = \frac{f_3 - f_1}{f_1 f_3}, \quad P_3 = \frac{f_3 - f_2}{f_2 f_3}$$

---

25. The size of the image of an object, which is at infinity, as formed by a convex lens of focal length 30 cm is 2 cm. If a concave lens of focal length 20 cm is placed between the convex lens and the image at a distance of 26 cm from the lens, the new size of the image is

(A) 1.25 cm **(B) 2.5 cm** **(C) 1.05 cm** **(D) 2 cm**

Ans (B)



$$\frac{1}{f} = \frac{1}{u} - \frac{1}{v}$$

$$v = \frac{20}{4}$$

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} \qquad v = 5cm$$

$$\frac{1}{v} = \frac{1}{-20} + \frac{1}{4}$$

$$h_i = \frac{v h_0}{u}$$

$$h_i = \frac{5 \times 2}{4}$$

$$\frac{1}{v} = \frac{-1 + 5}{20} = \frac{4}{20}$$

$$\frac{1}{v} = \frac{-1+5}{-5} = \frac{4}{20}$$
$$m = \frac{h_i}{h_0} = \frac{v}{u}$$

A'B' is the real image due to convex lens and it is at Focus of convex lens. A'B' acts as virtual object for concave lens and object distance is + 4 cm

$$h_{A^1B^1} = 2 \text{ cm}$$

---

26. A slit of width „a" is illuminated by red light of wavelength 6500 Å. If the first diffraction minimum falls at 30°, then the value of „a" is ________

(A) 6.5 × 10^{-4} mm (B) 1.3 micron (C) 3250 Å (D) 2.6 × 10^{-4} cm

ANSWER (B)

For diffraction minima

$a \text{ Sin } \theta = n\lambda$

$$\frac{\lambda}{a \text{ Sin } \theta} = \frac{6.5 \times 10^{-5}}{\sin 30^0} = \frac{6.5 \times 10^{-5}}{0.5} = 13 \times 10^{-7} = 1.3 \times 10^{-6} = 1.3 \text{ micron}$$

---

27. Which of the statements are correct with reference to single slit diffraction pattern?

(i) Fringes are of unequal width **(ii) Fringes are of equal width**

(iii) Light energy is conserved **(iv) Intensities of all bright fringes are equal**

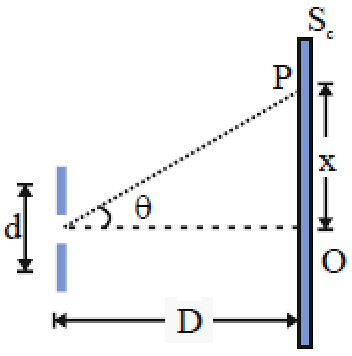
(A) (i) and (iii) (B) (i) and (iv) (C) (ii) and (iv) (D) (ii) and (iii)

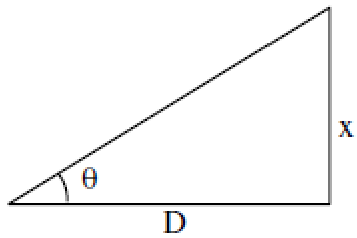
ANSWER (A)

Option (i) and (iii) are correct.

---

28. In the Young"s double slit experiment a monochromatic source of wavelength l is used. The intensity of light passing through each slit is Io. The intensity of light reaching the screen SC at a point P, a distance x from O is given by (Take d<< D).





(A) $= I_0 \cos^2\left(\frac{\pi D}{\lambda d}x\right)$ (B) $= 4I_0 \cos^2\left(\frac{\pi d}{\lambda D}x\right)$

(C) $= I_0 \sin^2\left(\frac{\pi d}{2\lambda D}x\right)$ (D) $= 4I_0 \cos\left(\frac{\pi d}{2\lambda D}x\right)$

ANSWER (B)

$\phi = \left(\frac{2\pi}{\lambda}\right)$ Path difference

Path difference $= d\sin\theta$

Path difference $= d\left(\frac{x}{D}\right)$

$\phi = \left(\frac{2\pi}{\lambda}\right)\left(\frac{dx}{D}\right)$

$I = 4I_0\cos^2\left(\frac{\phi}{2}\right)$

$I = 4I_0\cos^2\left(\frac{\pi d}{\lambda D}\right)x$

---

29. The work function of a metal is 1 eV. Light of wavelength 3000 Å is incident on this metal surface. The velocity of emitted photoelectrons will be

(A) 10 m s^{-1} (B) 1 × 10^3 m s^{-1} (C) 1 × 10^4 m s^{-1} (D) 1 × 10^6 m s^{-1}

ANSWER (D)

$E_{K\,max} = (E_{photon} - W)$ eV

$E_{K\,max} = \left(\frac{12.42 \times 10^{-7}}{3 \times 10^{-7}} - 1\right)$ eV

$E_{K\,max} = (4 - 1)$ eV

$E_{K\,max} = 3 \times 1.6 \times 10^{-19}$ J

$\frac{1}{2}mv^2 = 3 \times 1.6 \times 10^{-19}$ eV

$\frac{1}{2}mv_{max}^2 = \frac{3 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}}$ J

$v_{max}^2 = 10^{12}$

$v_{max} = 10^6\ ms^{-1}$

---

30. A proton moving with a momentum P_1 has a kinetic energy 1/8th of its rest mass energy. Another light photon having energy equal to the kinetic energy of the proton possesses a momentum P_2. Then the ratio

$\frac{P_1 - P_2}{P_1}$ is equal to

(A) 1 (B) $\frac{1}{4}$ (C) $\frac{1}{2}$ (D) $\frac{3}{4}$

ANSWER (D)

For proton: $v^2 = \frac{C^2}{4}$ $\quad v = \frac{C}{4}$

$P = \sqrt{2mE_k}$

$P = \sqrt{2m\frac{1}{8}mC^2}$

$P_1 = \frac{mC}{2}$

For photon

$E_{photon} = KE_{proton}$

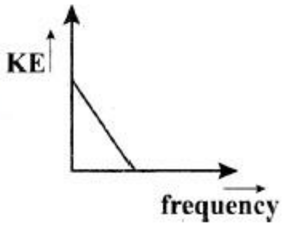
$\frac{hC}{\lambda} = \frac{1}{8}mC^2$

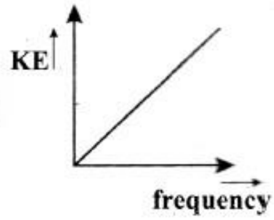
$P_{photon} = \frac{h}{\lambda} = \frac{mC}{8} = P_2$

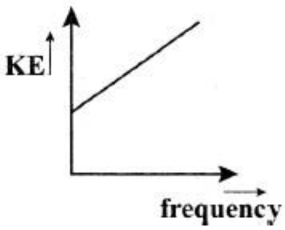
$\frac{P_1 - P_2}{P_1} = \frac{\frac{mC}{2} - \frac{mC}{8}}{\frac{mC}{2}} = \frac{\frac{1}{2} - \frac{1}{8}}{\frac{1}{2}} = \frac{\frac{4-1}{8}}{\frac{1}{2}} = \frac{3 \times 2}{8} = \frac{3}{4}$

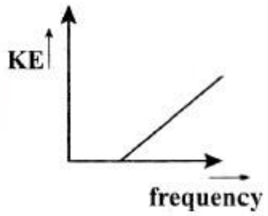
---

31. According to Einstein"s photoelectric equation the graph between kinetic energy of photoelectrons ejected and the frequency of incident radiation is

(A) 

(B) 

(C) 

(D) 

(A) **(B)** **(C)** **(D)**

ANSWER (D)

$K_{max} = h\gamma - \phi_0$

$Y = mx - C$

Graph is a straight line with slope „h"

Till v = vo, no photoelectric emission occurs

---

32. Energy of an electron in the second orbit of hydrogen atom is E2. The energy of electron in the third orbit of He+ will be

(A) $= \frac{9}{16}E_2$ (B) $= \frac{16}{9}E_2$ (C) $= \frac{3}{16}E_2$ (D) $= \frac{16}{3}E_2$

Ans (B)

For 2^{nd} orbit of $H -$ atom

$E_2 = \frac{-13.6}{2^2}$ eV

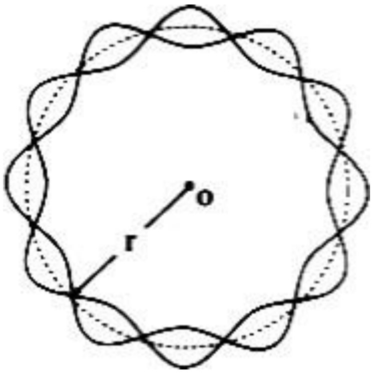
For 3^{rd} orbit of $He -$ atom

$E_2 = \frac{-13.6}{3^2} \times 2^2$

$E_2^{He^+} = \frac{-13.6}{3^2} \times 2^2 = \frac{-13.6}{4} \times \frac{4}{9} \times 2^2$

$$E_2^{He^+} = E_2 \times \frac{16}{9} = \frac{16}{9} E_2$$

33. **The figure shows standing de Broglie waves due to the revolution of electron in a certain orbit of hydrogen atom. Then the expression for the orbit radius is (all notations have their usual meanings)**



(A) $\frac{h^2\varepsilon_0}{\pi me^2}$ (B) $\frac{4h^2\varepsilon_0}{\pi me^2}$ (C) $\frac{9h^2\varepsilon_0}{\pi me^2}$ (D) $\frac{16h^2\varepsilon_0}{\pi me^2}$

AANSWER

Number of stationary waves is 6 i.e., n = 6

$$r^2 = \frac{n^2\varepsilon_0^2 h^2}{\pi me^2} = \frac{36\varepsilon_0^2 h^2}{\pi me^2}$$

34. **An electron in an excited state of Li^{2+} ion has angular momentum 3h/2π The de Broglie wavelength of electron in this state is Ppao (where ao = Bohr radius). The value of Pπa_0 is**

(A) 3 **(B) 2** **(C)1** **(D)4**

ANSWER (B)

$$L = \frac{nh}{2\pi} = \frac{3h}{2\pi}$$

$$n = 3$$

$$\lambda = \frac{h}{P} = \frac{h}{mv} = \frac{h.r}{mvr} = \frac{h.r}{3h/2\pi}$$

$$\lambda = \frac{2}{3} \times \pi r$$

For Li^{2+} atom radius of orbit

$$r = r_0 \times \frac{n^2}{z}$$

$$r = a_0 \times \frac{3^2}{3}$$

$$r = a_0 \times \frac{3^2}{3} \qquad a_0 - \text{Bohr radius}$$

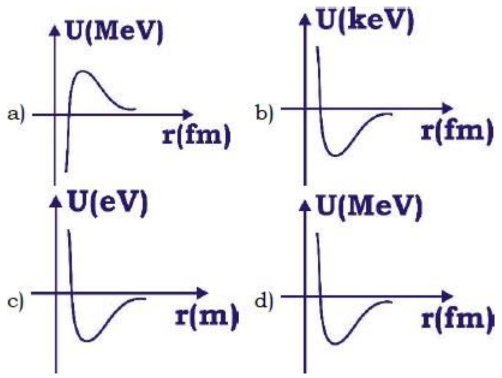
$$\lambda = \frac{2}{3}.\pi \times a_0 \times \frac{3^2}{3}$$

$$\lambda = 2\pi a_0$$

P = 2

---

35. **Which graph in the following diagrams correctly represents the potential energy of a pair of nucleons as a function of their separation?**



(A) **(B)** **(C)** **(D)**

ANSWER (D) Conceptual

---

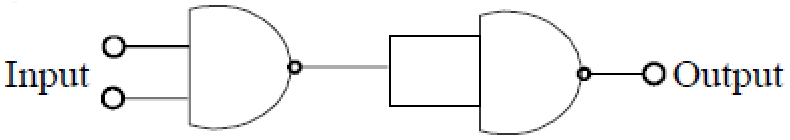
36. **In a nuclear reactor heavy nuclei is not used as moderators because**
   - **(A)** **They will break up**
   - **(B)** **Elastic collision of neutrons with heavy nuclei will not slow them down.**
   - **(C)** **The net weight of the reactor would be unbearably high**
   - **(D)** **Substances with heavy nuclei do not occur in liquid or gaseous state at room temperature.**

ANSWER (B)

Conceptual

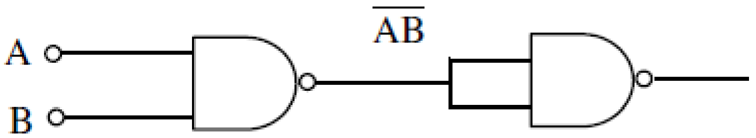
---

37. **The circuit given represents which of the logic operations?**



(A) OR **(B) AND** **(C) NOT** **(D) NOR**

ANSWER (B)



$$Y = \overline{\overline{AB}\cdot\overline{AB}}$$
$$= \overline{\overline{AB}} + \overline{\overline{AB}}$$
$$= AB$$

---

38. **Identify the incorrect statement.**
   - **(A)** **When a P-N junction diode is forward biased, the width of the depletion region decreases.**
   - **(B)** **When a P-N junction diode is reverse biased, the barrier potential increases.**
   - **(C)** **A photo diode is operated in the reverse bias.**

(D) **AN LED is a lightly doped P-N junction diode which emits spontaneous radiation on forward biasing.**

ANSWER (D)

LED is heavily doped PN-junction

---

39. **Three photodiodes D_1, D_2 and D_3 are made of semiconductors having band gaps of 2.5eV, 2eV and 3eV respectively. Which one will be able to detect light of wavelength 600 nm?**

(A) D_1 only (B) Both D_1 and D_3 (C) D_2 only (D) All the three diodes

ANSWER (C)

$E_1 = 2.5 \text{ eV}: \ E_2 = 2 \text{ eV}: E_3 = 3 \text{ eV}: \lambda = 600 \text{ nm}$

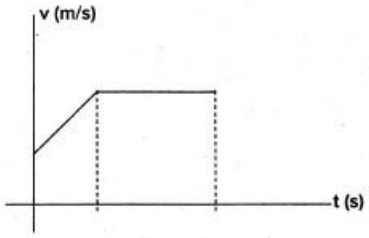
$$E = \frac{1242}{\lambda_m} = \frac{1242}{600} = 2.07 \text{ eV}$$

(E_1 and E_3) is >E3

Only D_2 will detect

---

40. **For a body moving along a straight line, the following v-t graph is obtained. According to the graph, the displacement during**



(A) Uniform acceleration is greater than that during uniform motion.

(B) Uniform acceleration is less than that during uniform motion.

(C) Uniform acceleration is equal to that during uniform motion.

(D) Uniform motion is zero.

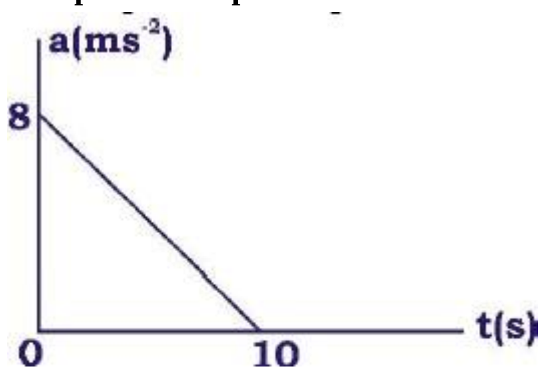
Ans (B)

S = Area under v-t graph

Area under uniform motion > Area under uniform motion triangle

---

41. **A particle starts from rest. Its acceleration „a" versus time „t" is shown in the figure. The maximum speed of the particle will be**



(A) 80 ms^{-1} **(B) 40 ms^{-1}** **(C) 18 ms^{-1}** **(D) 2 ms^{-1}**

ANSWER (B)

Area under a − t graph = v – u

$$\frac{1}{2} \times 8 \times 10 = V$$
$$V = 40 \text{ m s}^{-1}$$

---

42. The maximum range of a gun on horizontal plane is 16 km. If g = 10 m s–2, then muzzle velocity of a shell is

(A) 160 ms^{-1} (B) 200 2ms^{-1} (C) 400 ms^{-1} (D) 800 ms^{-1}

ANSWER (C)

$$\frac{u^2}{g} = 16 \times 10^3 \text{ m}$$
$$u^2 = 16 \times 10^3 \times 10$$
$$u^2 = 16 \times 10^4$$
$$u = 4 \times 10^2$$
$$u = 400 \text{ m}$$

---

43. The trajectory of a projectile is

(A) semicircle (B) an ellipse

(C) a parabola always (D) a parabola in the absence of air resistance

ANSWER (D)

Conceptual

---

44. For a projectile, motion the angle between the velocity and acceleration is minimum and acute at

(A) Only one point (B) two points (C) Three points (D) four points

ANSWER (B)

Conceptual

---

45. A particle starts from the origin at t = 0 s with a velocity of 10 ˆj m s–1 and moves in the x-y plane with a constant acceleration of (8ˆi 2ˆj)ms−2 + . At an instant when the x-coordinate of the particle is 16 m, y-coordinate of the particle is

(A) 16 m (B) 28 m (C) 36 m (D) 24 m

ANSWER (D)

$$\vec{r} = \vec{u}t + \frac{1}{2}\vec{a}t^2$$
$$x\hat{i} + y\hat{j} = 10t\,\hat{j} + \frac{1}{2}(8\,\hat{i} + 2\hat{j}) \times t^2$$
$$x\hat{i} + y\hat{j} = 10t\,\hat{j} + (4\,\hat{i} + \hat{j}) \times t^2$$
$$16\,\hat{i} + y\,\hat{j} = 10t\,\hat{j} + 4t^2\,\hat{i} + t^2\hat{j}$$
$$16\,\hat{i} + y\,\hat{j} = 4t^2\,\hat{i}\,(10t + +t^2)\,\hat{j}$$
$$4t^2 = 16$$
$$t^2 = 4$$
$$t = 2s$$

$y = 10t + t^2$

$y = 20 + 4 = 24\ m$

---

46. A coin placed on a rotating turn table just slips if it is placed at a distance of 4 cm from the centre. If the angular velocity of the turn table is doubled it will just slip at a distance of

(A) 1 cm (B) 2 cm (C) 4 cm (D) 8 cm

ANSWER (A)

$r = 4\ cm$

$f = mr^2 w$

$f = \mu mg$

$\mu mg = mr^2 w$

$\mu g = r^2 w$

$\mu g = r^2 \times 4$

$\mu g = r^2 \times 4 \ldots\ldots\ldots (1)$

$w^1 = 2w$

$\mu g = (2w)^2 r$

$\mu g = 4w^2 r$

$w^2 \times 4 = 4\, w^2 r$

$r = 1\ cm$

---

47. A 1 kg ball moving at 12 ms^{-1} collides with a 2 kg ball moving in opposite direction at 24 m s^{-1}. If the coefficient of restitution is 2/3, then their velocities after the collision are

(A) – 4 m s^{-1}, – 28 m s^{-1} (B) – 28 m s^{-1}, – 4 m s^{-1}

(C) 4 m s^{-}, 28 m s^{-1} (D) 28 m s^{-1}, 4 m s^{-1}

ANSWER (B)

$m_1 = 1kg, \quad u_1 = 12\ ms^{-1}; \quad m_2 = 3\ kg, \quad u_2 = -24\ ms^{-1}$

$$e = \frac{v_2 - v_1}{u_2 - u_1}$$

$$\frac{2}{3} = \frac{v_2 - v_1}{36}$$

$$v_2 - v_1 = \frac{36 \times 2}{3}$$

$v_2 - v_1 = 24$

$v_2 - v_1 = 24 \ldots\ldots\ldots (1)$

$m_1 u_1 + m_2 u_2 = m_1 v_1 + m_2 v_2$

$1 \times 12 + 2 \times (-24) = v_1 + 2\, v_2$

$12 - 48 = v_1 + 2\, v_2$

$v_1 + 2\, v_2 = -36 \ldots\ldots\ldots (2)$

From equations 1 and 2

$v_1 + 2\, v_2 - v_1 + v_2 = -36 + 24$

$$3v_2 = -12$$
$$v_2 = -4 \quad ms^{-1}$$
$$-4 - v_1 = 24$$
$$-4 - 24 = v_1$$
$$v_1 = -28\ ms^{-1}$$

---

48. A ball hits the floor and rebounds after an inelastic collision. In this case

(A) The momentum of the ball is conserved

(B) The mechanical energy of the ball is conserved

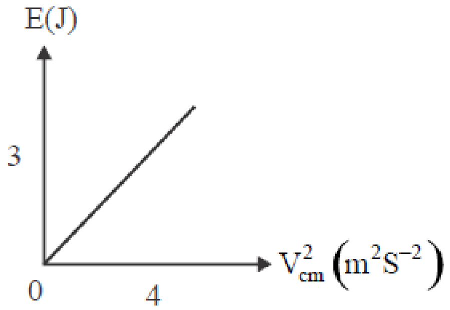
(C) The total momentum of the ball and the earth is conserved

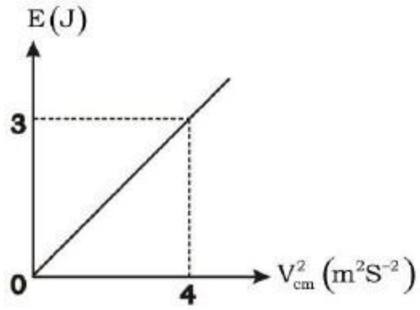
(D) The total mechanical energy of the ball and the earth is conserved

ANSWER (C)

---

49. In figure E and Vcm represent the total energy and speed of centre of mass of an object of mass 1 kg in pure rolling. The object is





(A) Sphere (B) ring (C) disc (D) Hollow Cylinder

ANSWER (C)

$$E = \frac{1}{2}mv_m^2\left[1 + \frac{K^2}{R^2}\right]$$

$$\frac{E}{v_m^2} = \frac{1}{2}\left[1 + \frac{K^2}{R^2}\right]$$

From the graph

$$\frac{E}{v_m^2} = \frac{3}{4}$$

$$\frac{3}{4} = \frac{1}{2}\left[1 + \frac{K^2}{R^2}\right]$$

$$\frac{3}{4} \times \frac{2}{1} = \left[1 + \frac{K^2}{R^2}\right]$$

$$\frac{3}{2} = \left[1 + \frac{K^2}{R^2}\right]$$

$$\frac{3}{2} - 1 = \left[\frac{K^2}{R^2}\right]$$

$$\left[\frac{K^2}{R^2}\right] = \frac{1}{2}$$

For disc

$$I = \frac{mr^2}{2}$$

$$\frac{mr^2}{2} = \frac{mk^2}{2}$$

$$\frac{K^2}{R^2} = \frac{1}{2}$$

---

50. **Two bodies of masses 8 kg are placed at the vertices A and B of an equilateral triangle ABC. A third body of mass 2 kg is placed at the centroid G of the triangle. If AG = BG = CG = 1 m, where should a fourth body of mass 4 kg be placed so that the resultant force on the 2 kg body is zero?**

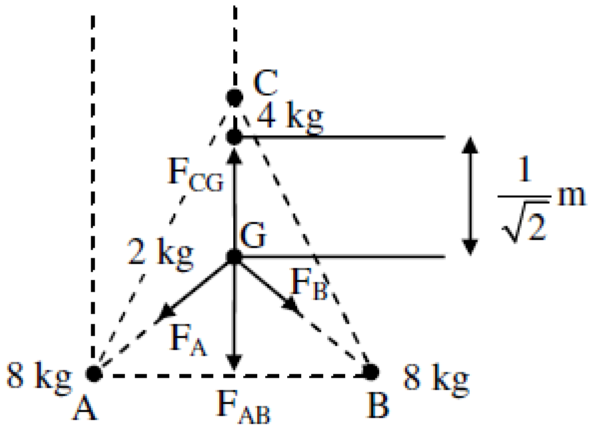
(A) At C

(B) At a point P on the line CG such that

(C) At a point P on the line CG such that PG = 0.5 m

(D) At a point P on the line CG such that PG = 2 m

ANSWER (B)



$$F_A = F_B = \frac{Gm_1m_2}{r^2} = \frac{G \times 8 \times 2}{1^2} = G \times 16$$

$$F_{AB} = \sqrt{F_A^2 + F_B^2 + 2F_AF_B\cos\theta}$$

$$F_{AB} = \sqrt{F_A^2 + F_B^2 + 2F_AF_B\cos 120}$$

$$F_{AB} = \sqrt{F_A^2 + F_B^2 + 2F_AF_B\left(-\frac{1}{2}\right)}$$

$$F_{AB} = F_A = G\,(G16)$$

For resultant force 2 kg be zero

$$\overrightarrow{F_{CG}} = -\overrightarrow{F_{AB}}$$

$$\overrightarrow{F_{CG}} \Rightarrow \frac{G2 \times 4}{X^2} = G(16)$$

$$X^2 = \frac{2 \times 4}{16} = \frac{1}{2}$$

$$X = \frac{1}{\sqrt{2}}$$

---

51. Two capillary tubes P and Q are dipped vertically in water. The height of water level in capillary tube P is (2/3)rd of the height in capillary tube Q. The ratio of their diameter is _

(A) 2 : 3 (B) 3 : 2 (C) 3 : 4 (D) 4 : 3

ANSWER (B)

$$r = \frac{2T\cos\theta}{\rho g h}$$

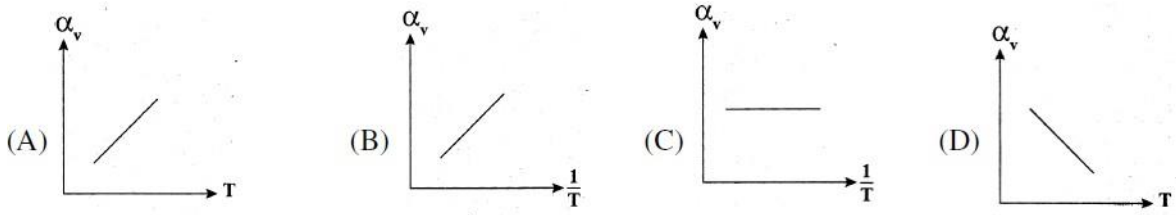
As we know $\propto \frac{1}{h}$

$$\frac{r_P}{r_Q} = \frac{h_Q}{h_P} = \frac{h}{{}^{2}\!/_{3}\,h}$$

$$\frac{r_P}{r_Q} = \frac{h_Q}{h_P} = \frac{h}{{}^{2}\!/_{3}\,h} \Rightarrow \frac{r_P}{r_Q} = \frac{3}{2}$$

---

52. Which of the following curves represent the variation of coefficient of volume expansion of an ideal gas at constant pressure?



ANSWER (B)

We know that $PV = nRT$ or $\frac{1}{T} = \frac{nR}{PV}$

Since, P is constant, $P\,\Delta V = nR\Delta T$

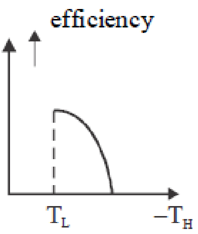
(or) $\frac{\Delta V}{\Delta T} = \frac{nR}{P}$

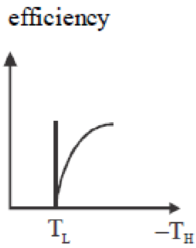
Coefficient of volume expansion: $\alpha_v = \frac{\Delta V}{V \times \Delta T}$

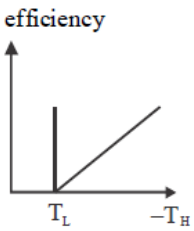
$$\alpha_v = \frac{nR}{PV} = \frac{1}{T}$$

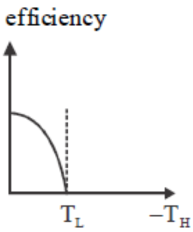
---

53. A number of Carnot engines are operated at identical cold reservoir temperatures (TL). However, their hot reservoir temperatures are kept different. A graph of the efficiency of the engines versus hot reservoir temperature (TH) is plotted. The correct graphical representation is

(A) 

(B) 

(C) 

(D) 

(A) (B) (C) (D)

ANSWER (B)

$n = 1 - \frac{T_L}{T_H}$ At constant T_L, efficiency increases with increase in T_H

54. A gas mixture contains monoatomic and diatomic molecules of 2 moles each. The mixture has a total internal energy of (symbols have usual meanings)

(A) 3 RT (B) 5 RT (C) 8R (D) 9 RT

ANSWER: GRACE

C_V for monoatomic gas is $\frac{3R}{2}$

C_V for diatomic gas is $\frac{5R}{2}$

Total energy for mixture $U = 2 \times \left(\frac{3}{2}\right) RT + 2 \times \left(\frac{5}{2}\right) RT$

$U = 8RT$

---

55. A pendulum oscillates simple harmonically if and only if (I) the size of the bob of pendulum is negligible in comparison with the length of the pendulum (II) the angular amplitude is less than 10°

(A) Both (I) and (II) are correct (B) Both (I) and (II) are incorrect

(C) Only (I) is correct (D) Only (II) is correct

ANSWER: (D)

Concept based

---

56. To propagate both longitudinal and transverse waves, a material must have

(A) Bulk and shear moduli (B) Only bulk modulus

(C) Only shear modulus (D) Young‟s and Bulk modulus

ANSWER: (A)

Conceptual

---

57. A copper rod AB of length l is rotated about end A with a constant angular velocity w. The electric field at a distance x from the axis of rotation is

(A) $\frac{mw^2x}{e}$ (B) $\frac{mwx}{el}$ (C) $\frac{mx}{w^2l}$ (D) $\frac{me}{w^2x}$

ANSWER: (A)

We know in circular motion net force acting on it must be mv2 r

When the rod rotates, electrons in it also rotates which produce electric field E at distance x.

Force on the electron, Fe = eE = mw2x

58. Electric field due to infinite, straight uniformly charged wire varies with distance „r" as

(A) r (B) $\frac{1}{r}$ (C) $\frac{1}{r^2}$ (D) r^2

ANSWER (B)

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{2\lambda}{r} \quad \text{or} \quad \vec{E} = \frac{1}{4\pi\varepsilon_0 r}\hat{r} \quad \Rightarrow |\vec{E}| \propto \frac{1}{r}$$

---

59. A 2 gram object, located in a region of uniform electric field E (300 NC^{-1}) ˆi carries a charge Q. The object released from rest at x = 0, has a kinetic energy of 0.12 J at x = 0.5 m. Then Q is

(A) 400 μC (B) −400 μC (C) 800 μC (D) − 800 μC

ANSWER (C)

Work done (W) = Change in K E

Force × displacement = change in KE

QE × x = 0.12 J

Q (300) × (0.5) = 0.12

$$Q = \frac{0.12}{300 \times 0.5} = 800\ \mu C$$

The charge Q is moving in the direction of electric field, hence it is positive.

---

60. If a slab of insulating material (conceptual) 4× 10^{-3} m thick is introduced between the plates of a parallel plate capacitor, the separation between the plates has to be increased by 3.5 × 10^{-3} m to restore the capacity to original value. The dielectric constant of the material will be

(A) 6 (B) 8 (C) 10 (D) 12

Ans (B)

Where, t- thickness of the dielectric, According to the question,

ANSWER (B)

If k be the dielectric constant, the distance increased due to introduced dielectric is

$$x = t - \frac{t}{k} \Rightarrow x = t\left(1 - \frac{1}{k}\right)$$

Where t-thickness of the dielectric. According to the question,

$$x = 3.5 \times 10^{-3}\ \text{m}$$

$$t\left(1 - \frac{1}{k}\right) = 3.5 \times 10^{-3}$$

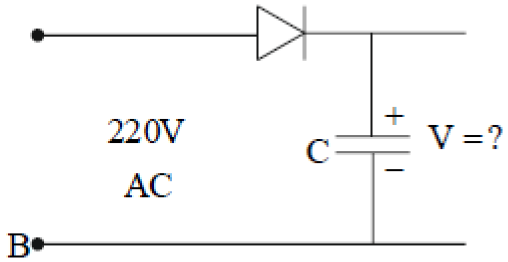
$$\left(1 - \frac{1}{k}\right) = \frac{3.5 \times 10}{4 \times 10} = \frac{3.5}{4}$$

$$\frac{1}{k} = 1 - \frac{35}{4} = \frac{0.5}{4} = 0.125\ k = 8$$

KCET – 2020: PHYSICS

1. **A 220 V A.C supply is connected between points A and B as shown in figure what will be the potential difference V across the capacitor?**

Ans. B



(A) 0 **(B) 220 2V**

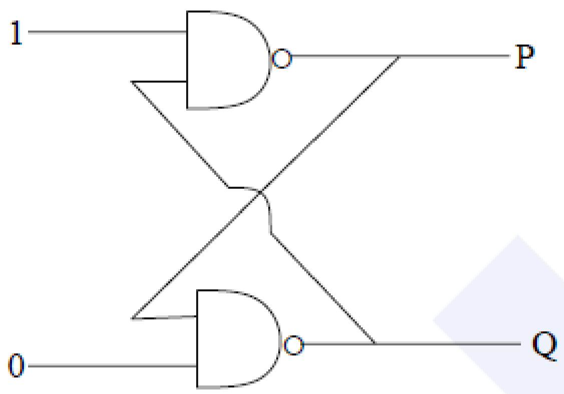
(C) $222\sqrt{2}\,V$ **(D) 110 V**

Sol. The potential difference a cross the capacitor is peak voltage.

$V_{max} = V_{rms} \times \sqrt{2} = 220\sqrt{2}$ volts

---

2. **In the following circuit what are P and Q:**



(A) P = 0, Q = 0 **(B) P = 1, Q = 1**

(C) P = 1 , Q = 0 **(D) P = 0, Q = 1**

Ans. D: Sol. **P = 0, Q = 1**

---

3. **A positive hole in a semiconductor is**

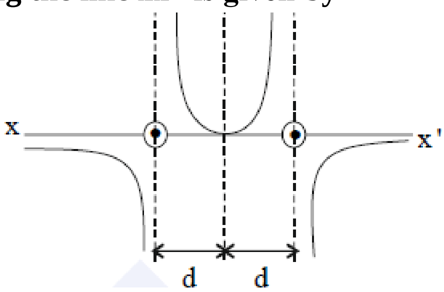
(A) Absence of free electrons. (B) An artificially created particle.

(C) An anti-particle of electron. (D) A vacancy created when an electron leaves a covalent bond.

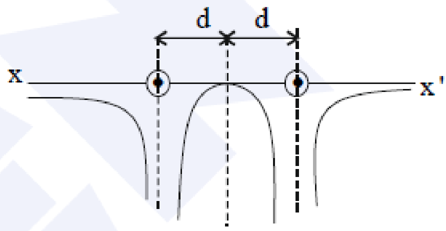
Ans. *D:* A vacancy created when an electron leaves a covalent bond.

4. **Two long straight parallel wires are a distance 2d apart. They carry steady equal currents flowing out of the plane of the paper. The variation of magnetic field B along the line xx" is given by**

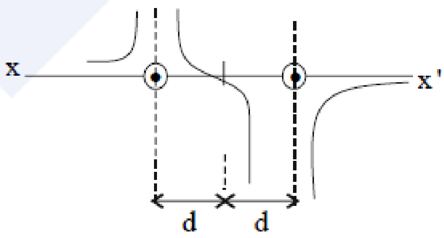
(A)



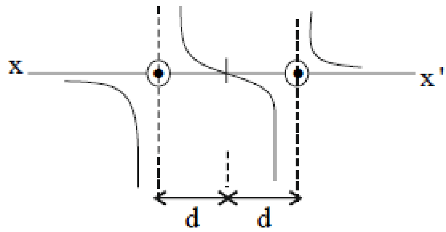
(B)



(C)



(D)



Ans. D

$$B = \frac{\mu_0 i}{2\pi r}$$

$$B \propto \frac{1}{r}$$

5. A cylindrical wire has a mass (0.3 ± 0.003) g, radius (0.5 ± 0.005) mm and length (6 ± 0.06) cm. The maximum percentage error into the measurement of its density is

(A) 3 **(B) 4**

(C) 1 **(D) 2**

Ans. B

$$d = \frac{m}{v} = \frac{m}{\pi r^2 l} \qquad \frac{\Delta d}{d} \times 100\% = \frac{\Delta m}{m} \times 100\% + 2\frac{\Delta r}{r} \times 100\% + \frac{\Delta l}{l} \times 100\% = 4$$

---

6. At a metro station, a girl walks up a stationary escalator in 20sec. If she remains stationary on the escalator, then the escalator takes her up in 30 sec. The time take her up in 30 sec. The time taken by her to walk up on the moving escalator will be

(A) 12 sec **(B) 10 sec**

(C) 25 sec **(D) 60sec**

$$t = \frac{t_1 t_2}{t_1 + t_2} = 12$$

Ans. A

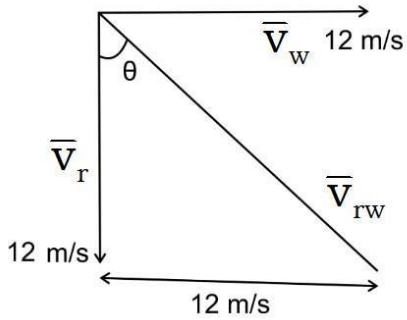
---

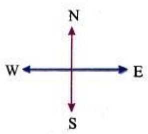
7. Rain is falling vertically with a speed of 12 ms- 1. A woman rides a bicycle with a speed of 12ms-1 in east to west direction. What is the direction in which she should hold her umbrella?

(A) 300 towards West **(B) 450 towards West**

(C) 300 towards East **(D) 450 towards East**

Ans. B





$$\tan\theta = \frac{\lfloor v_r \rfloor}{\lfloor v_m \rfloor} = \frac{12}{12} = 1$$

θ= 45^0 towards east

8. **One end of a string of length „l" is connected to a particle of mass „m" and the other to a small peg on a smooth horizontal table. If the particle moves in a circle with speed „v", the net force on the particle (directed towards the centre is: (T is the tension in the string)**

(A) $= T$

(B) $= T - \frac{mv^2}{l}$

(C) $= T + \frac{mv^2}{l}$

(d) $= 0$

Ans (a)

Sol. The net force on the particle (directed towards the centre) is tension (T) in the string

9. **A body is initially at rest. It undergoes one - dimensional motion with constant acceleration. The power delivered to it at time „t" is proportional to**

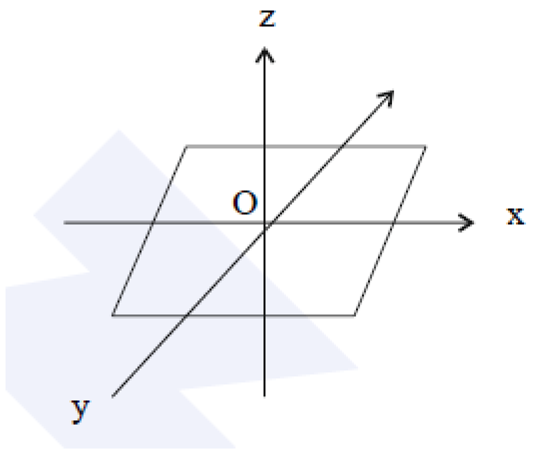
(A) $t^{3/2}$ **(B) t^2** **(C) $t^{1/2}$** **(D) t**

Ans. D

$$P = \frac{1}{2}\frac{mv^2}{t} = \frac{1}{2}\frac{m \times (at)^2}{t}$$

$$P \propto t$$

10. **A thin uniform rectangular plate of mass 2 kg is placed in X - Y plane as shown in figure. The moment of inertia about x - axis is 2 x I = 0.2 kgm and the moment of inertia about y - axis is y I = 0.3 kg m^2. The radius of gyration of the plate about the axis passing through O and perpendicular to the plane of the plate is**



(A) 38.7 cm **(B) 31.6 cm**

(C) 50 cm **(D) 5 cm**

Ans. C

$$I_z = I_x + I_y = 0.5 \text{kg m}^2$$

$$I = mk^2$$

$$K = 0.5 \text{ m} = 5\text{cm}$$

11. The value of acceleration due to gravity at a height of 10 km from the surface of earth is x. At what depth inside the earth is the value of the acceleration due to gravity has the same value x?

(A) 10 km **(B) 15 km**

(C) 5 km **(D) 20 km**

Ans. D

Where g is acceleration due to gravity on the surface of the earth, g_h is the acceleration due to gravity at an height from the surface of the earth and g_d is the acceleration due to depth below the surface of the earth.

The variation of acceleration due to an height $g_h = g\left(1 - \frac{2h}{R}\right)$

The variation of acceleration due to depth is $g_d = g\left(1 - \frac{d}{R}\right)$

According to problem

$$g_h = g_d$$

$$g\left(1 - \frac{2h}{R}\right) = g\left(1 - \frac{d}{R}\right)$$

$$\therefore d = 2R$$

$$d = 2 \times 10$$

$$d = 20 \text{ km}$$

---

12. Young"s modulus of a perfect rigid body is

(A) Infinity **(B) Between zero and unity**

(C) Zero **(D) Unity**

Ans. A *Because the change in length of rigid body is zero*

The Young Modulus is defined as "*within the elastic limit, the ratio of the tensile stress to the tensile strain*".

$$\text{Young's Modulus} = Y = \frac{\text{Longitudinal or Linear or Tensile stress}}{\text{Longitudinal or Linear or Tensile Strain}} = \frac{F/A}{\Delta l/L}$$

Where F is force acting on the body, A is the area of the body, L is the original length of the body and Δl is the change in length of the body. **When $\Delta l = 0$: $Y = \infty$.**

---

13 A wheel starting from rest gains an angular velocity of 10 rad/s after uniformly accelerated for 5 sec. The total angle through which it has turned is

(A) 25 p rad **(B) 50 p about a vertical axis**

(C) 25 rad **(D) 100 rad**

Ans. C

Solution:

$$\omega_1 = 0$$

$$\omega_2 = 10 \text{ rad/sec}$$

$$t = 5 \text{ sec}$$

$$\theta = \left(\frac{\omega_1 + \omega_2}{2}\right) \times t$$
$$\theta = \left(\frac{0 + 10}{2}\right) \times 5$$
$$\theta = 5 \times 5 = 25 \text{ rad}$$

---

14. Iceberg floats in water with part of it submerged. What is the fraction of the volume of iceberg submerged if the density of ice is ri = 0.917 g cm-3 ?

(A) 0.458 **(B) 0**

(C) 0.917 **(D) 1**

Ans. C

$$V_b.\rho_b = V_i.\rho_i$$

$$\frac{V_i}{V_b} = \frac{\rho_b}{\rho_i} = \frac{0.917}{1} = 0.917$$

15. A sphere, a cube and a thin circular plate all of same material and same mass initially heated to same high temperature are allowed to cool down under similar conditions. Then the

(A) Plate will cool the fastest and sphere the slowest.

(B) Cube will cool the fastest and plate the slowest.

(C) Plate will cool the fastest and cube the slowest.

(D) Sphere will cool the fastest and cube the slowest.

Ans. A

Sol. From $E = A\sigma T^4$ $E \propto A$

Surface area is more for plate and less for sphere. Hence plate will cool the fastest and sphere the slowest.

---

16. In an adiabatic expansion of an ideal gas the product of pressure and volume.

(A) Remains constant

(B) At first increases and then decreases

(C) Decreases

(D) Increases

Ans. C

Sol. In an adiabatic expansion as temperature decreases from ideal gas equation PV=nRT the product of pressure and volume decreases

---

17. A certain amount of heat energy is supplied to a monatomic ideal gas which expands at constant pressure. What fraction of the heat energy is converted into work?

(A) 25 **(B)57**

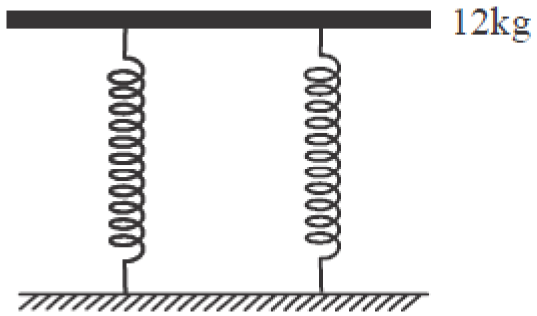
(C) 1 **(D) 23**

Ans.

$$\frac{dQ}{dW} = 1 - \frac{1}{\gamma} = 1 - \frac{1}{\left(5/3\right)} = \frac{2}{5}$$

---

18. **A tray of mass 12 kg is supported by two identical springs as shown in figure. When the tray is pressed down slightly and then released, it executes SHM with a time period of 1.5 s. The spring constant of each spring is** 12kg



(A) 105Nm-1 (B) ¥

(C) 50Nm-1 (D) 0

Ans. A

$$T = 2\pi\sqrt{\frac{m}{K_{eff}}}$$

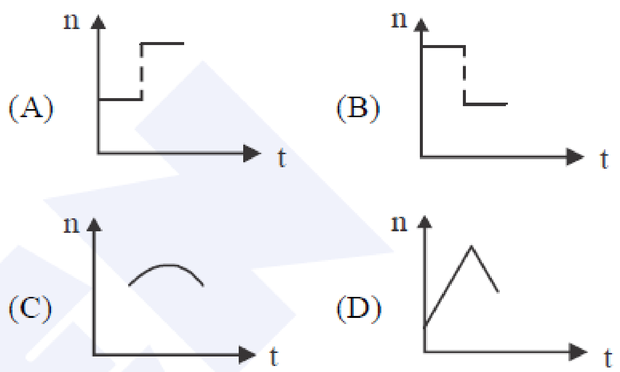
$$\frac{3}{2} = 2\pi\sqrt{\frac{12}{2k}}$$

$$\frac{9}{4} = 4\pi^2 \times \frac{12}{2k}$$

$k \cong 105$ nm

---

19. **A train whistling at constant frequency „n" is moving towards a station at a constant speed V. then train goes past a stationary observer on the station. The frequency „n" of the sound as heard by the observer is plotted as a function of time „t". Identify the correct curve.**



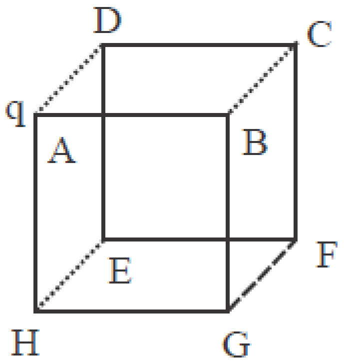
(A) nt (B)n

(C) nt (D) tn

Ans. B

Sol. Conceptual

20. A point charge „q" is placed at the corner of a cube of side „a" as shown in the figure. What is the electric flux through the face ABCD? A BD CE FH Gq



(A) $\frac{q}{6\varepsilon_0}$ (B) $\frac{q}{72\varepsilon_0}$

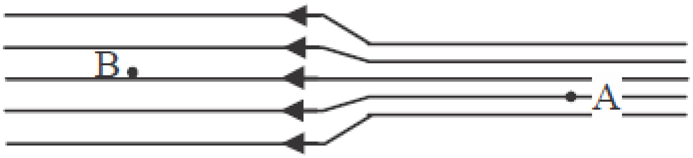
(C) 0 (D) $\frac{q}{24\varepsilon_0}$

Ans. A

Sol.

$$\phi_{ABCD} = \frac{\phi}{6} = \frac{q}{6\varepsilon_0}$$

21. The electric field lines on the left have twice the separation on those on the right as shown in figure. If the magnitude of the field at A is 40 Vm^{-1}, what is the force on 20 C m charge kept at AB



(A) 16 $x10^{-4}Vm^{-1}$ (B) 1 $x10^{-4}Vm^{-1}$

(C) 4 $x10^{-4}Vm^{-1}$ (D) 8 $x10^{-4}Vm^{-1}$

Ans. C

(Most appropriate answer is marked)

$$F = Eq = 20 \times 20 \times 10^{-6}$$

$$F = 4 \times 10^{-4}\, V/_{m}$$

22. An infinitely long thin straight wire has uniform charge density of 2 1 1 10 cm 4What is the magnitude of electric field at a distance 20 cm from the axis of the wire?

(A) $1.12 \times 10^8 NC^{-1}$ (B) $4.5 \times 10^8 NC^{-1}$

(C) $2.25 \times 10^8 NC^{-1}$ (D) $9 \times 10^8 NC^{-1}$

Ans. A

$$E = \frac{\lambda}{2\pi\varepsilon_0 r}$$

$$E = \frac{1}{4} \times \frac{10^{-2}}{10^{-2}} \times 18 \times 10^{19} \times 5$$

$$E = 2.25 \times 10^8 N/C$$

---

23. A dipole of dipole moment „P" and moment of inertia I is placed in a uniform electric field E. If it is displaced slightly from its stable equilibrium position, the period of oscillation of dipole is

(A) $\sqrt{\frac{PE}{I}}$ (B) $2\pi\sqrt{\frac{I}{PE}}$

(C) $\frac{1}{2\pi}\sqrt{\frac{PE}{I}}$ (D) $\pi\sqrt{\frac{I}{PE}}$

Ans. D

---

24. The difference between equivalent capacitances of two identical capacitors connected in parallel to that in series is 6mF. The value of capacitance of each capacitor is

(A) 4μF **(B) 6μF**

(C) 2μF **(D) 3μF**

Ans. A

$$C_p - C_S = 6\ \mu F$$

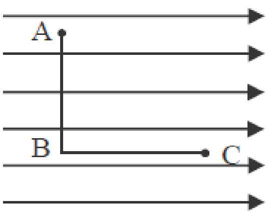
$$2C - \frac{C}{2} = 6\ \mu F$$

$$\frac{3C}{2} = 6\ \mu F$$

$$C = 4\ \mu F$$

---

25. Figure shows three points A, B and C in a region of uniform electric Field Er. The line AB is perpendicular and BC is parallel to the field lines. Then which of the following hold good? (VA, VB and VC represent the electric potential at points A, B and C repulsively) ABC



(A) $V_A = V_B < V_C$ (B) $V_A > V_B = V_C$
(C) $V_A = V_B = V_C$ (D) $V_A = V_B > V_C$

Ans. D

26. When a soap bubble is charged?

(A) The radius remains the same. (B) Its radius may increase or decrease.
(C) Its radius increases. (D) Its radius decreases.

Ans. C Its radius increases

27. A hot filament liberates an electron with zero initial velocity. The anode potential is 1200 V. The speed of the electron when it strikes the anode is

(A) $2.1\text{x}10^7 ms^{-1}$ **(B) $2.5\ \text{x}10^6 ms^{-1}$**
(C) $1.5\ \text{x}10^5\ ms^{-1}$ **(D) $2.5\ \text{x}10^8\ ms^{-1}$**

Ans. A

$$\frac{1}{2}mv^2 = Vq$$

$$v = \sqrt{\frac{2Vq}{m}} = \sqrt{\frac{2 \times 1200 \times 1.6 \times 10^{-16}}{9.1 \times 10^{-31}}} 2.1 \times 10^7 m/s$$

28. A metal rod of length 10 cm and a rectangular cross section of 1cm x 1/2 cm is connected to a battery across opposite faces. The resistance will be

(A) Maximum when the battery is connected across 10cm x 1 cm faces.
(B) Same irrespective of the three faces.
(C) Maximum when the battery is connected across 1cm x ½ cm faces.
(D) Maximum when the battery is connected across 10 cm ½ cm faces.

Ans. C $R \propto \frac{l}{A}$

Maximum when the battery is connected across 1cm x ½ cm faces

29. A car has a fresh storage battery of e.m.f 12 V and internal resistance 2´10-2W . If the starter motor draws current of 80A. Then the terminal voltage when the starter is on is

(A) 10.4V (B) 9.3V
(C) 12V (D) 8.4V

Ans. A **V=E - ir =10.4V**

30. A potentiometer has a uniform wire of length 5 m. A battery of emf 10 V and negligible internal resistance is connected between its ends. A secondary cell connected to the circuit gives balancing length at 200 cm. The emf of the secondary cell is

(A) 2V (B) 8V
(C) 4V (D) 6V

Ans. C

$$\frac{E_1}{E_2} = \frac{l_1}{l_2} = \frac{10}{E_2} = \frac{5}{2} = \Rightarrow E_2 = 4V$$

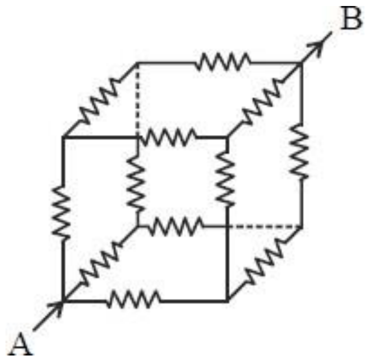
31. The colour code for a carbon resistor of resistance 0.25kW±10% is

(A) Red, Grey, Silver, Silver

(B) Red, Green, Silver
(C) Red, Grey, Brown, Silver
(D) Red, Green, Brown, Silver

Ans.C **Sol. Red, Grey, Brown, Silver**

32. Each resistance in the given cubical network has resistance of 1W and equivalent resistance between A and B is

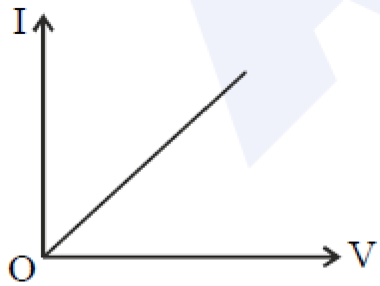


(A) 5/12Ω (B) 12/5 Ω
(C) 5/6 Ω (D) 6/5 Ω

Ans. C

$$R_{eff} = \frac{5}{6}r = \frac{5}{6}r \times 1 = \frac{5}{6}\Omega$$

33. I-V characteristic of a copper wire of length L and rea of cross-section A is shown in figure. The slope of the curve becomes IOV



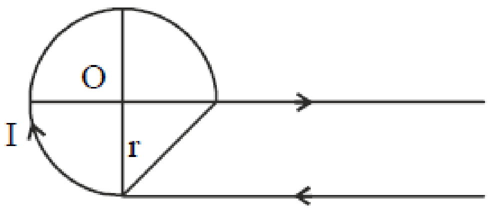
(A) Less if the area of the wire is increased
(B) Less if the length of the wire is increased
(C) More if experiment is performed at higher temperature
(D) More if a wire of steel of same dimension is used

Ans. B

$$\text{Slope} = \frac{1}{R} = \frac{A}{\rho \times l}$$

Less if the length of the wire is increased

34. In the given figure, the magnetic field at „O".



(A) $\frac{3}{8}\frac{\mu_0 I}{r}+\frac{\mu_0 I}{4\pi r}$ (B) $\frac{3}{10}\frac{\mu_0 I}{r}-\frac{\mu_0 I}{4\pi r}$

(C) $\frac{3}{4}\frac{\mu_0 I}{r}+\frac{\mu_0 I}{4\pi r}$ (D) $\frac{3}{8}\frac{\mu_0 I}{r}-\frac{\mu_0 I}{4\pi r}$

Ans. A $B_{nett}=B_1+B_2+B_3$ $B_{nett}=\frac{3}{8}\frac{\mu_0 I}{r}+\frac{\mu_0 I}{4\pi r}+0$

---

35. The magnetic field at the origin due to a current element I dl placed at a point with vector position r is

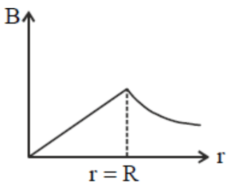
(A) $\frac{\mu_0 i}{4\pi}\frac{\vec{dl}\times\vec{r}}{r^2}$ (B) $\frac{\mu_0 i}{4\pi}\frac{\vec{r}\times\vec{dl}}{r^3}$

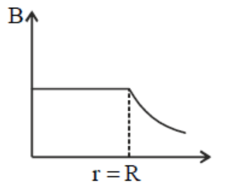
(C) $\frac{\mu_0 i}{4\pi}\frac{\vec{r}\times\vec{dl}}{r^2}$ (D) $\frac{\mu_0 i}{4\pi}\frac{\vec{dl}\times\vec{r}}{r^3}$

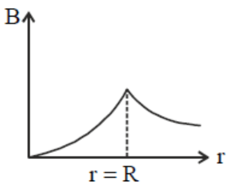
Ans. D

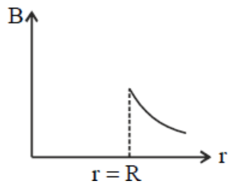
---

36. A long cylindrical wire of radius R carries a uniform current I flowing through it. The variation of magnetic field with distance „r‟ from the axis of the wire is shown by

(A)


(C)


(B)


(D)


Ans. A

---

37. A cyclotron is used to accelerate protons (${}_1H^1$) Deuterons (${}_1H^3$) and α – particles (${}_2He^4$) . While exiting under similar conditions, the minimum K.E. is gained by

(A) Deuteron (B) Same for all

(C) α - particle (D) Proton

Ans. A

$K.E=\frac{q^2B^2i}{2m}$ $K.E=\frac{q^2}{m}$ Minimum K.E is gained by deuteron

---

38. A paramagnetic sample shows a net magnetization of 8Am-1 when placed in an external magnetic field of 0.6T at a temperature of 4 K. When the same sample is placed in an external magnetic field of 0.2T at a temperature of 16K. The magnetization will be

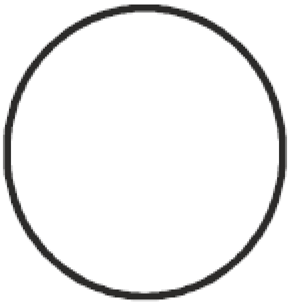
(A) $6\ Am^{-1}$ (B) $2.4\ Am^{-1}$ 1

(C) $\frac{32}{3} Am^{-1}$ (D) $\frac{2}{3} Am^{-1}$

Ans. D

----

39. The ratio of magnetic field at the centre of a current carrying circular coil to magnetic moment is 'x'. If the current and the radius both are doubled. The new ratio will become



(A) x /4 **(B) x/ 8**

(C) 2x **(D) 4x**

Ans.B

$$\frac{B}{M} = \frac{(\mu_0 IN/2r)}{NI\pi r^2}$$

$$\frac{B}{M} = \left(\frac{\mu_0}{2\pi}\right)\frac{1}{r^3}$$

According to the problem,

$$\frac{B}{M} = X$$

$$\frac{B}{M} = \frac{(\mu_0)}{2\pi r^3}$$

$$X = \left(\frac{\mu_0}{2\pi}\right)\frac{1}{r^3} \ldots\ldots\ldots (1)$$

$$\frac{B}{M} \propto \frac{1}{r^3}$$

If the current and the radius both are doubled, the new ratio will become

$$X_2 = \frac{(\mu_0 2IN/4r)}{2IN\ \pi(2r)^2}$$

$$X_2 = \left(\frac{\mu_0}{2\pi}\right)\frac{1}{(2r)^2 r}$$

$$X_2 = \left(\frac{\mu_0}{2\pi}\right)\frac{1}{2r\,(2r)^2}$$

$$X_2 = \left(\frac{\mu_0}{2\pi}\right)\frac{1}{8\,r^3} \dots\dots\dots (2)$$

$$\frac{X_2}{X} = \frac{1}{8}$$

$$X_2 = \frac{X}{8}$$

40. In a permanent magnet at room temperature

(A) Domains are partially aligned

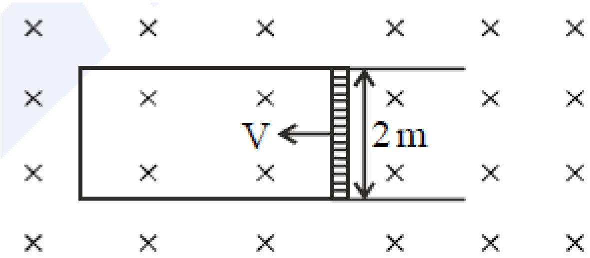
(B) Domains are all perfectly aligned

(C) Magnetic moment of each molecule is zero

(D) The individual molecules have non-zero magnetic moment which are all perfectly aligned.

Ans. A Domains are all perfectly aligned

41. A rod of length 2 m slides with a speed of 5ms-1 on a rectangular conducting frame as shown in figure. There exists a uniform magnetic field of 0.04 t perpendicular to the plane of the figure. If the resistance of the rod is 3W. The current through the rod is V 2m



(A) 0.75 A (B) 1.33 A

(C) 75 mA (D)133 mA

Ans. D

$$i = \frac{Blv}{R} = \frac{0.04 \times 2 \times 5}{3} = 133 \text{ mA}$$

42. The current in a coil of inductance 0.2H changes from 5 A to 2 A in 0.5 sec. The magnitude of the average induced emf in the coil is

(A) 30 V (B) 0.3 V

(C) 0.6 V (D) 1.2 V

Ans. D

According to Faradays second law of electromagnetic induction, the magnitude of the induced e.m.f is given by

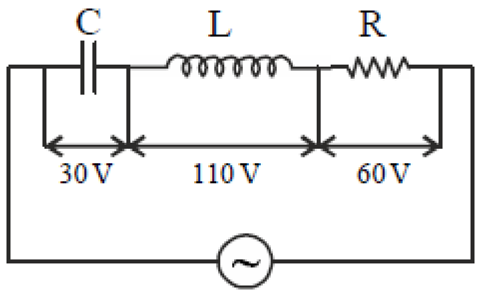
$$e = L\frac{di}{dt}$$

$$e = 0.2\left(\frac{5-2}{0.5}\right)$$

$e = \frac{2}{5} \times 3 = \frac{6}{5}$

$e = 1.2\ V$

43. In the given circuit the peak voltages across C, L and R are 30 V, 110 V and 60 V respectively. The rms value of the applied voltage is C L R 30V 110V 60V



(A) 70.7 V (B) 141 V

(C) 100 V (D)200 V

Ans. A

The net or maximum voltage in the circuit is given by

$$V_0 = \sqrt{V_R{}^2 + (V_L - V_X)^2}$$

$$V_0 = \sqrt{(60)^2 + (110 - 30)^2}$$

$$V_0 = \sqrt{3600 + (80)^2}$$

$$V_0 = \sqrt{3600 + 6400}$$

$$V_0 = \sqrt{10000}$$

$$V_0 = 100\ V$$

$$V_{rms} = \frac{V_0}{\sqrt{2}} = \frac{100}{\sqrt{2}} = \frac{100}{1.414} = 70.7\ V$$

44. The power factor of R-L circuit is $\frac{1}{\sqrt{3}}$ If the inductive reactance is 2Ω. The value of resistance is

(A) 0.5 Ω **(B) $\frac{1}{\sqrt{2}}$ Ω**

(C) 2 Ω **(D) $\sqrt{2}$ Ω**

Ans. D

$$\cos\phi = \frac{1}{\sqrt{3}}$$

$$\tan\phi = \sqrt{2}$$

$$\tan\phi = \frac{X_L}{R}$$

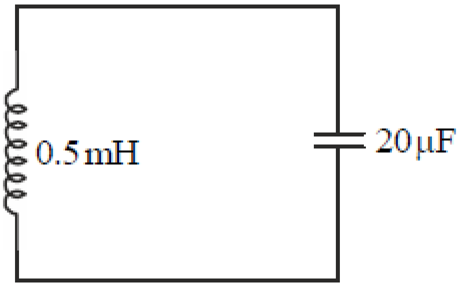
$$\sqrt{2} = \frac{2}{R}$$

$$R = \frac{2}{\sqrt{2}}$$

$$R = \frac{\sqrt{2} \times \sqrt{2}}{\sqrt{2}}$$

$$R = \sqrt{2}\,\Omega$$

45. In the given circuit, the resonant frequency is 0.5mH 20mF



(A) 1592Hz **(B) 15910Hz**
(C) 15.92Hz **(D) 159.2Hz**

Ans. A

$$V = \frac{1}{2\pi\sqrt{LC}}$$

$$V = \frac{1}{2 \times 3.14 \ \sqrt{0.5\ 10^{-3} \times 20 \times 10^{-6}}}$$

$$V = 1592\ V$$

---

46. A light beam of intensity 20W/ cm^2 is incident normally on a perfectly reflecting surface of sides 25cm x 15cm. The momentum imparted to the surface by the light per second is

(A) 5 x10^{-5} kg ms^{-1} **(B) 1.2 x10^{-5} kg ms^{-1}**
(C) 2 x10^{-5} kg ms^{-1} **(D) 1 x10^{-5} kg ms^{-1}**

Ans. A

$$I = \frac{E}{A}$$

$$E = IA$$

$$P = \frac{2E}{C}$$

$$P = \frac{2IA}{C}$$

$$P = \frac{2\ \times 20 \times 25 \times 15}{3 \times 10^{8}}$$

$$P = 5 \times 10^{5}\ kg\ ms^{-1}$$

47. An object approaches a convergent lens from the left of the lens with a uniform speed 5 m/s and stops at the focus, the image

(A) Moves away from the lens with a non-uniform acceleration
(B) Moves towards lens with non-uniform acceleration
(C) Moves away from the lens with an uniform speed 5 m/s.
(D) Moves away from the lens with an uniform acceleration.

Ans. A . Moves away from the lens with a non-uniform acceleration

.

48. The refracting angle of prism is A and refractive index of material of prism is $\cot\left(\frac{A}{2}\right)$**. The angle of minimum derivation is**

(A) 90° - A (B) 180° - 2A

(C) 180° - 3A (D) 180° + 2A

Ans.B

$$n = \frac{\sin\left(\frac{A+d_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

$$\cot\left(\frac{A}{2}\right) = \frac{\sin\left(\frac{A+d_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

$$\frac{\cos\left(\frac{A}{2}\right)}{\sin\left(\frac{A}{2}\right)} = \frac{\sin\left(\frac{A+d_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

$$\sin\left(90 - \frac{A}{2}\right) = \sin\left(\frac{A+d_m}{2}\right)$$

$$\left(90 - \frac{A}{2}\right) = \left(\frac{A+d_m}{2}\right)$$

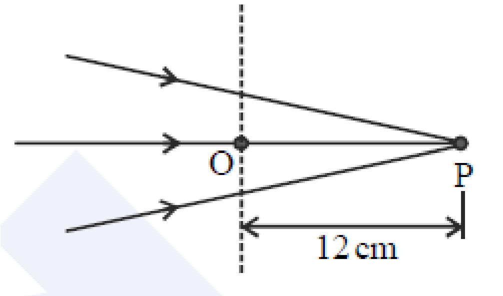
$$\frac{180 - A}{2} = \frac{A+d_m}{2}$$

$$180 - A = A + d_m$$

$$180 - A - A = d_m$$

$$180 - 2A = d_m$$

49. The following figure shows a beam of light converging at point P. When a concave lens of focal length 16 cm is introduced in the path of the beam at a place shown by dotted line such that OP becomes the axis of the lens, the beam converges at a distance x from the lens. The value of x will be equal to O P 12cm



(A) 36 cm (B) 48 cm

(C) 12 cm (D) 24 cm

Ans. B

$f = 16$ cm, $u = 12$cm

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$\frac{1}{16} = \frac{1}{12} + \frac{1}{v}$

$\frac{1}{16} - \frac{1}{12} = \frac{1}{v}$

$\frac{1}{v} = \frac{1}{16} - \frac{1}{12}$

$f = 12$ cm, $u = 12$cm

---

50. Three polaroid sheets 1 2 P ,P and 3 P are kept parallel to each other such that the angle between pass axes of 1 P and 2 P is 45° and that between 2 P and 3 P is 45°. If unpolarised beam of light of intensity 128Wm-2 is incident on 1 P . What is the intensity of light coming out of 3 P ?

(A) 16 Wm^{-2} (B) 64 Wm^{-2}

(C) 128 Wm^{-2} (D) 0

Ans. A

$I = \frac{I_2}{2}$

$I = \frac{I_0 (\cos^2 \theta)^2}{2}$

---

51. Two poles are separated by a distance of 3.14 m. The resolving power of human eye is 1 minute of an arc. The maximum distance from which he can identify the two poles distinctly is

(A) 188 m (B) 376 m

(C) 10.8 km (D)5.4 km

Ans. C

$\theta = \frac{d}{D}$

---

52. In Young"s Double Slit Experiment, the distance between the slits and the screen is 1.2 m and the distance between the two slits is 2.4 mm. If a thin transparent mica sheet of thickness 1 m m and R.I. 1.5 is introduced between one of the interfering beams, the shift in the position of central bright fringe is

(A) 0.125 mm (B) 0.25 mm

(C) 2 mm (D)0.5 mm

Ans. B

---

53. The de-Broglie wavelength associated with electron of hydrogen atom in this ground state is

(A) 6.26Å (B) 10Å

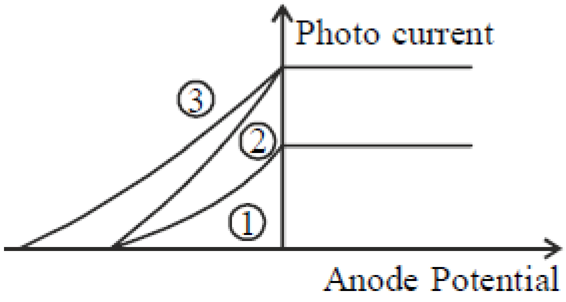
(C) 0.3Å (D) 3.3Å

Ans. D

V= 13.6 V

$$\lambda = \frac{12.27}{\sqrt{V}} = \frac{12.27}{\sqrt{13.6}} = \frac{12.27}{3.68} = 3.33Å$$

54. The following graph represents the variation of photo current with anode potential for a metal surface. Here 1 2 I , I and 3 I represents intensities and g1, g2 , g3 represents frequency for curves 1,2 and 3 respectively, then 123 Photo current Anode Potential



(A) $\gamma_1 = \gamma_2$ and $I_1 = I_2$ (B) $\gamma_2 = \gamma_3$ and $I_1 = I_3$

(C) $\gamma_1 = \gamma_2$ and $I_1 \neq I_2$ (D) $\gamma_2 = \gamma_3$ and $I_1 = I_3$

Ans. C

Sol. Stopping potential same So frequencies same ($\gamma_1 = \gamma_2$) Currents are different ($I_1 \neq I_2$)

So intensity are different

55. The period of revolution of an electron revolving in nth orbit of H-atom is proportional to

(A) n^3 (B) Independent of n

(C) n^2 (D) 1/n

Ans. A $T \propto n^3$

56. Angular momentum of an electron in hydrogen atom is 3h/2π (h is the Planck"s constant). The K.E. of the electron is

(A) 3.4eV **(B) 6.8eV**

(C) 4.35eV **(D) 1.51eV**

ANSWER. D

$$mvr = \frac{nh}{2\pi}$$

n=3

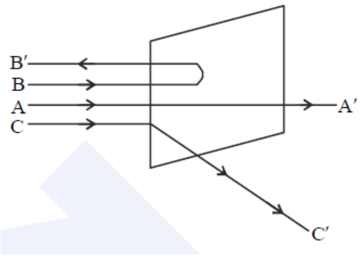
57. A beam of fast moving alpha particles were directed towards a thin film of gold. The parts A, B and C of the transmitted and reflected beams corresponding to the incident parts A, B and C of the beam are shown in the adjoing diagram. The number of alpha particles in A A¢C B B¢ C¢

(A) A" will be minimum and in B" maximum

(B) C" will be minimum and in B" maximum

(C) B" will be minimum and in C" maximum

(D) A" will be maximum and in C" minimum



Ans. Bonus (No options are correct)

---

58. Two protons are kept at separation of 10 nm. Let F_n and F_e be the nuclear force and the electromagnetic force between them

(A) $F_e \ll F_n$ (B) F_e and F_n are differ onl slightly

(C) $F_e = F_n$ (D) $F_e \gg F_n$

Ans. D

59. During a β^- decay

(A) A neutron in the nucleus decays emitting an electron.

(B) A proton in the nucleus decays emitting an electron.

(C) An atomic electron is ejected

(D) An electron which is already present within the nucleus is ejected.

Ans. A A neutron in the nucleus decays emitting an electron

----

60. A radio-active element has half-life of 15 years. What is the fraction that will decay in 30 years?

(A) 0.75 **(B) 0.85**

(C) 0.25 **(D) 0.5**

Ans. A **Sol.** Fraction of remaining element

$$\left(1 - \frac{N}{N_0}\right) \times 100 = \left(\frac{1}{2}\right)^{t/T} = 0.25$$

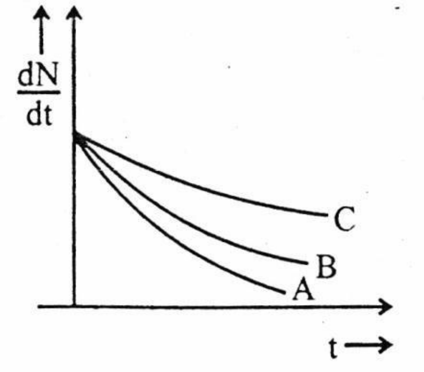
The fraction that will decay in 30 years is 0.75

****

KCET- 2019: PHYSICS

Question 1: Which one of the following nuclei has a shorter mean life?

(A)B (B) same for all (C) A (D) C



ANSWER: (C)

Solution:

Activity dN/dt drops sharply in case of A. Therefore, the disintegration constant λ is high for A. Average life (Mean life) = 1/λ. Thus, average life will be shortest for A.

or

Slope of the graph gives activity. Higher activity shorter the mean life and vice versa

When time t = 0; $\left(\frac{dN}{dt}\right)_A = \left(\frac{dN}{dt}\right)_B = \left(\frac{dN}{dt}\right)_C$

$(N_0)_A = (N_0)_B = (N_0)_C$

At any time t; $\left(\frac{dN}{dt}\right)_A < \left(\frac{dN}{dt}\right)_B < \left(\frac{dN}{dt}\right)_C$

$N_C < N_B < N_A$ Rate of decay of $C < B < A$

$T_C < T_B < T_A$: Mean life of $C < B < A$

$\lambda_A N_A < \lambda_B N_B < \lambda_C N_C$

As $N_A < N_B < N_C$

$\lambda_A < \lambda_B < \lambda_C$

$\tau_A > \tau_B > \tau_C$

That is mean life of B is always lesser than the A and C

Question 2: The conductivity of a semiconductor increases with an increase in temperature because

(A) Relaxation time increases

(B) Number density of current carriers increases, relaxation time decreases but the effect of decrease in relaxation time is much less than the increase in number density

(C) Number density of charge carriers increases

(D) Both number density of charge carriers and relaxation time increase

Solution:

ANSWER:(B)

As temperature increases, the number density of charge carriers increases according to the equation

$$n = CT^{\frac{3}{2}} \exp^{\left(-\frac{E}{2}KT\right)}$$

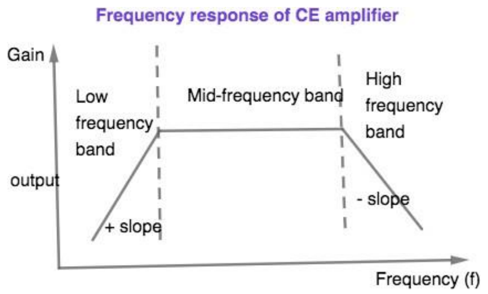
Thus as temperature increases, the number density of charge carriers increases resulting in increased conductivity of semiconductors.
[Due to increase in temperature bonds break which liberates large number of holes and electrons (charge carriers). Relaxation time too decreases but its effect is much less].

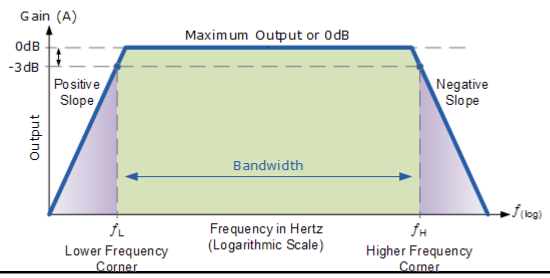
Question 3: For a transistor amplifier, the voltage gain

(A) Is high at high and low frequencies and constant in the middle-frequency range?
(B) Constant at high frequencies and low at low frequencies
(C) remains constant for all frequencies
(D) Is low at high and low frequencies and constant at mid frequencies

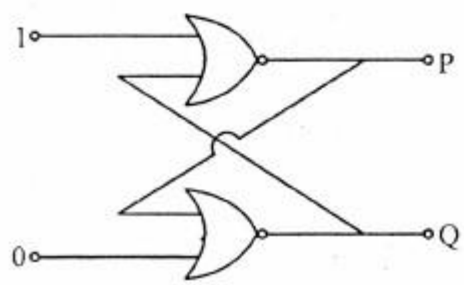
Solution:
ANSWER: (D)

The frequency response curve of the transistor amplifier shows that the voltage gain of a transistor amplifier is constant at mid-frequency range only. It is low at high and low frequencies. [*The voltage gain for a transistor amplifier is low at low and high frequencies and consistently high at middle frequencies*]





Question 4: In the following circuit, what are P and Q?



(A) P = 1, Q = 0 **(B) P = 1, Q =1**
(C) P = 0, Q = 0 **(D) P = 0, Q =1**

Solution:
ANSWER: (D)
For both NOR gates

Output: $\mathbf{y} = \overline{\mathbf{A} + \mathbf{B}}$

For gate 1; A = 1

P = 0

For gate 2; B = 0

Q =1

Or

[A **NAND** gate gives an output 1, if at least one of the inputs is zero. Hence **Q** is **1.** Therefore, the inputs for the upper **NAND** gate are 1, 1. Hence **P = 0].**

Question 5: An antenna uses electromagnetic waves of frequency 5 MHz. For proper working, the size of the antenna should be

(A) 300 m (B) 3 km (C) 15 m (D) 15 km

Solution:

ANSWER: (C)

$$C = \gamma \times \lambda$$

$$\lambda = \frac{C}{\gamma}$$

$$\lambda = \frac{3 \times 10^8}{5 \times 10^6}$$

$$\lambda = \frac{3}{5} \times\times 10^2$$

$$\lambda = 0.6 \times 10^2 = 60\ m$$

$$\text{The Antenna length} = \frac{\lambda}{4} = \frac{60}{4} = 15\ \text{m}$$

Question 6: A magnetic needle has a magnetic moment of 5×10^{-2} Am^2 and moment of inertia 8×10^{-6} kgm^2. It has a period of oscillation of 2s in a magnetic field $\vec{B}$. The magnitude of the magnetic field is approximately;

(A) 0.4×10^{-4}T (B) 0.8×10^{-4}T (C) 1.6×10^{-4}T (D) 3.2×10^{-4}T

Solution:

ANSWER: (C)

$$T = 2\pi\sqrt{\frac{I}{MB}}$$

$$2 = 2\pi\sqrt{\frac{8 \times 10^{-6}}{5 \times 10^{-6}\ B}}$$

$$1 = \pi\sqrt{\frac{8 \times 10^{-6}}{5 \times 10^{-2} B}}$$

On squaring both sides

$$1 = \pi^2 \times \frac{8 \times 10^{-6}}{5 \times 10^{-2}\ B}$$

$$B = (3.14)^2 \times \frac{8 \times 10^{-6}}{5 \times 10^{-2}}$$
$$B = 1.6 \times 10^{-4} T$$

Question 7: A toroid has 500 turns per metre length. If it carries a current of 2A, the magnetic energy density inside the toroid is

(A) 0.314 J/m³ (B) 3.14 J/m³ (C) 0.628 J/m³ (D) 6.28 J/m³

Solution:

ANSWER: (C)

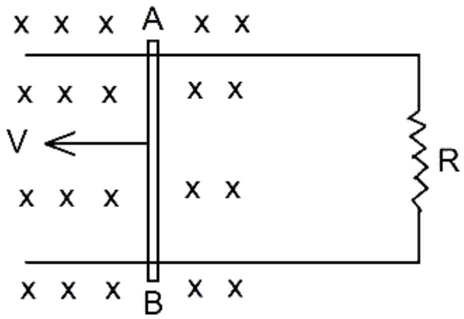
The magnetic field inside a toroid;

$B = \mu_0 NI$

Magnetic energy density inside the toroid = $B^2/2\mu_0$

$$U_0 = \frac{B^2}{2\mu_0} = \frac{\mu_0^2 n^2 I^2}{2\mu_0} = \frac{\mu_0 n^2 I^2}{2}$$
$$U_0 = \frac{4\pi \times 10^{-7} \times (500)^2 \times 2^2}{2}$$
$$U_0 = 0.628\ Jm^{-3}$$

Question 8: Consider the situation given in the figure. The wire AB is slid on the fixed rails with a constant velocity. If the wire AB is replaced by a semi-circular wire, the magnitude of the induced current will



(A) Remain same

(B) Increase or decrease depending on whether the semicircle bulges towards the resistance or away from it

(C) Increase

(D) Decrease

Solution:

ANSWER: (A)

Induced current: $I = \frac{\varepsilon}{R}$

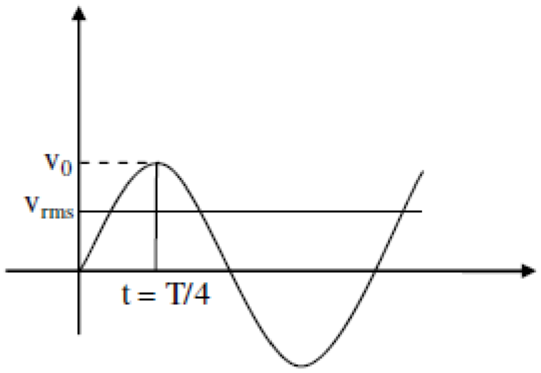
Induced e.m.f: $\varepsilon = l.(\vec{v} \times \vec{B}) = l(v \times B \sin\theta) = Bvl$

If the straight wire is replaced by a semi-circular wire resistance remain the same, therefore, current also remains the same.

Question 9: The frequency of an alternating current is 50 Hz. What is the minimum time taken by current to reach its peak value from rms value?

(A) 2.5×10^{-3}s (B) 10×10^{-3}s (C) 5×10^{-3}s (D) 0.02 s

ANSWER: (B)



We know that

$$V_{rms} = V_0 \sin \omega t$$

$$\frac{V_2}{\sqrt{2}} = V_0 \sin \omega t$$

$$\frac{V_2}{\sqrt{2}} = V_0 \sin \omega t \qquad \therefore \sin \omega t = \frac{1}{\sqrt{2}}$$

$$\omega t = \frac{\pi}{4} = \frac{2\pi}{4}.t = \frac{\pi}{4}$$

$$\therefore t = \frac{T}{8}$$

Time for current to reach from rms value to peak value is i.e., $I_{rms} \to I_0$

$$\frac{T}{4} - \frac{T}{8} = \frac{T}{8} \qquad \left(\frac{I_0}{\sqrt{2}} \to I_0\right)$$

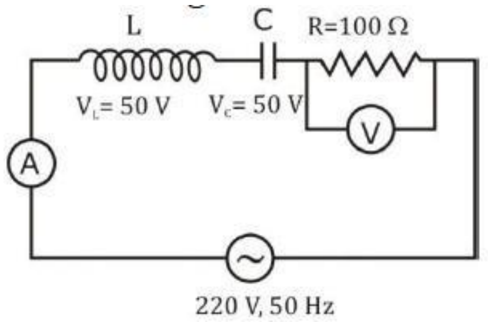
$$f = 50 \qquad \therefore t = \frac{I}{8}$$

$$\omega t = \frac{\pi}{4}$$

$$t = \frac{\pi}{\omega 4} = \frac{\pi}{2\pi f\,4} = \frac{1}{f\,8} = \frac{1}{50 \times 8} = \frac{1}{400} = \frac{1}{4 \times 100} = 0.25 \times 10^{-2} = 2.5 \times 10^{-3} s$$

Question 10: The readings of ammeter and voltmeter in the following circuit are respectively

(A)1.5 A, 100 V **(B)2.2 A, 220 V** **(C)1.2 A, 120 V** **(D)2.7 A, 220 V**



ANSWER: (C)

Solution:

As evident from question

$$V_L = V_C$$

Circuit is purely resistive

V = 220 V

Also;

$$I = \frac{V}{R} = \frac{220}{100} = 2.2 \text{ A}$$

Question 11: Two metal plates are separated by 2 cm. The potentials of the plates are - 10 V, and + 30 V. The electric field between the two plates is

(A) 1000V/m **(B)** 3000V/m **(C)** 500V/m **(D)** 2000V/m

ANSWER: (D)

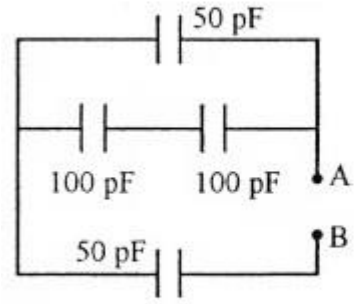
Solution:

Let V is the Potential difference and d is the separation between plates

The relation between Electric field and Elecctric potential $= E = \frac{V}{d}$

$$E = \frac{V}{d} = \frac{30 - (-10)}{2 \times 10^{-2}} = 2000\ V/m$$

Question 12: The equivalent capacitance between A and B is,



(A) **100/3 pF** **(B)300 pF** **(C)50 pF** **(D)150 pF**

ANSWER: (A)

I STEP:

When two capacitors of 100 pF each are connected in parallel, the equivalent capacitance [**Figures (1) and (2)**]

$$\frac{1}{C_S} = \frac{1}{100} + \frac{1}{100} = \frac{2}{100} = \frac{1}{50}$$

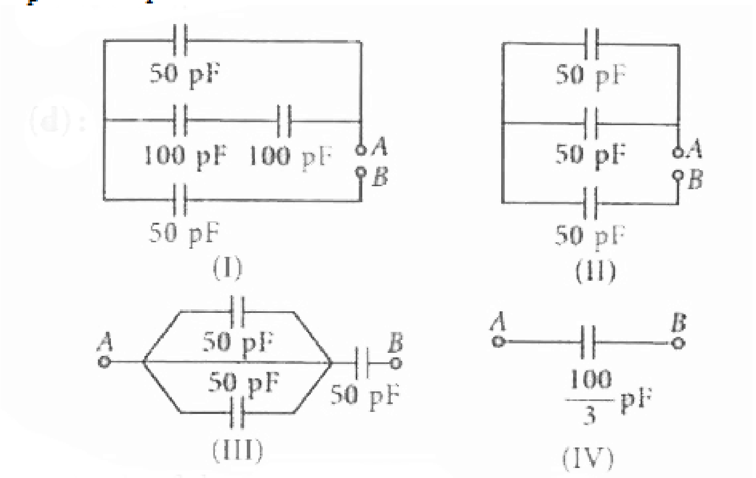
$$C_S = 50\text{ pF}$$

II STEP:

This capacitor C_S is connected in parallel with the capacitor of 50 pF [**Top of II figure**]

$$C_p = 50 + 50 = 100\ \text{pF}$$

$$C_p = 100\text{ pF}$$



III STEP:

This capacitor C_S and C_P are connected in series between the terminals A and B [F**igure-3**]

$$\frac{1}{C_{equvi}} = \frac{1}{100} + \frac{1}{100}$$

$$\frac{1}{C_{equvi}} = \frac{1}{100} + \frac{1}{50}$$
$$\frac{1}{C_{equvi}} = \frac{3}{100}$$
$$C_{equvi} = \frac{100}{3}\ pF$$

Question 13: A capacitor of capacitance C charged by an amount Q is connected in parallel with an uncharged capacitor of capacitance 2C. The final charges on the capacitors are

(A)Q/4, 3Q/4 **(B)**Q/5, 4Q/5 **(C)**Q/2, Q/2 **(D)**Q/3, 2Q/3

Solution:

ANSWER: (D)

The two capacitors attain common potential (V_C) given by the relation.

$$V_C = \frac{\text{Total charge}}{\text{Toatl capacitance}} = \frac{Q + 0}{C + 2C} = \frac{Q}{3C}$$

The final charges on the two capacitors

$$Q_1 = CV_C = \frac{CQ}{3C} = \frac{Q}{3}$$
$$Q_2 = 2CV_C = \frac{2Q}{3}$$

Question 14: Though the electron drift velocity is small and the electron charge is very small, a conductor can carry an appreciably large current because

(A)Drift velocity of the electron is very large (B) Relaxation time is small
(C) Electron number density is very large (D) Electron number density depends on temperature

ANSWER: (C)

Solution:

$$\text{Current}: I = neAV_d$$

The large value of I is due to the number density of free electron in a conductor (n), which is of the order of $n = 10^{28}$ per m^3.

Question 15: Masses of three wires of copper are in the ratio 1:3:5 and their lengths are in the ratio 5:3:1. The ratio of their electrical resistance is

(A)5:3:1 **(B)**125:15:1 **(C)**1:3:5 **(D)**1:15:125

ANSWER: (B)

Solution:

$$\text{Resistance of the wire}: R \propto \frac{L}{A}$$

$$R \propto \frac{L}{A} = \rho\frac{L}{A} \quad ; \text{where } \rho \text{ is the resisitivity of wire}$$

$$\text{Area} = \frac{\text{Volume}}{\text{Length}} \quad \& \quad \text{Mass} = \text{Volume} \times \text{Density}$$

$$\text{Area} = \frac{\text{Mass}}{\text{Density} \times \text{Length}} = \frac{m}{dL}$$

$$R = \rho \frac{L}{\left(\frac{m}{dL}\right)}$$

$$R = \rho \frac{dL^2}{m}$$

$$R = \text{constant} \times \frac{L^2}{m} \quad \text{where } '\rho' \text{ and } 'd' \text{ are constants}$$

$$R \propto \frac{L^2}{m}$$

Thus the ratios of resistances:

$$R_1 : R_2 : R_3 = \frac{L_1^2}{m_1} : \frac{L_2^2}{m_2} : \frac{L_3^2}{m_3}$$

$$R_1 : R_2 : R_3 = \frac{5^2}{1} = \frac{3^2}{3} = \frac{1^2}{5}$$

$$R_1 : R_2 : R_3 = \frac{5^2}{1} : \frac{3^2}{3} : \frac{1^2}{5}$$

$$R_1 : R_2 : R_3 = 25 : 3 : \frac{1}{5}$$

$$R_1 : R_2 : R_3 = 125 : 15 : 1$$

Question 16: If P, Q and R are physical quantities having different dimensions, which of the following combinations can never be a meaningful quantity?

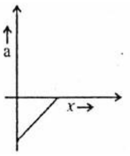
(A) PQ-R **(B)** $(PR-Q^2)/R$ **(C)** (P-Q)/R **(D)**PQ/R

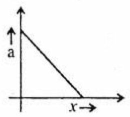
ANSWER: (C)

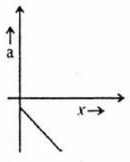
Solution:

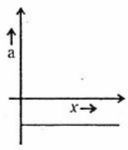
By the principle of Homogeneity; Addition & subtraction of physical quantities having different dimensions is not possible.

Question 17: The given graph shows the variation of velocity (v) with position (x) for a particle moving along a straight line. Which of the following graph shows the variation of acceleration (a) with position (x)?

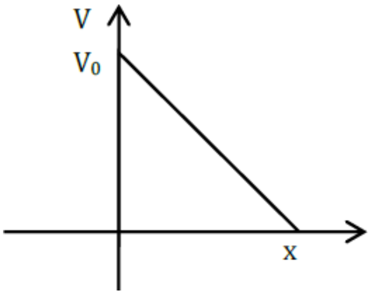
(A)


(B)


(C)


(D)


ANSWER: (B)



Solution:

Given line have positive intercept but negative slope. The equation for the given graph can be written as.

$$v = -mx + v_0 \;\ldots\ldots\ldots\ldots (1)$$

m slope of graph which is –ve. V_0 intercept of line which is +ve and a constant.

$$\text{Acceleration: } a = \frac{dv}{dt} = -m\frac{dx}{dt} = -mv$$

But from eqn (1)

$$a = \frac{dv}{dt} = -m\,(-mx + v_0)$$

$$a = \frac{dv}{dt} = -m\,(-mx + v_0) = m^2x - mv_0$$

$$a = m^2x - mv_0 \;\ldots\ldots\ldots\ldots (2)$$

i.e., the graph between a and x should have positive slope but negative intercept on acceleration axis.

Slope for given eq. (2): +Ve: Intercept for eq. (2):–Ve

Question 18: The trajectory of a projectile projected from the origin is given by the equation y = x-2x^2/5 . The initial velocity of the projectile is?

(A) 5 ms^{-1} **(B)** 5/2 ms^{-1} **(C)** 2/5 ms^{-1} **(D)** 25 ms^{-1}

Solution:

ANSWER: (A)

$$\text{Given: } y = x - \frac{2x^2}{5}$$

Comparing with standard equation of trajectory

$$y = x\tan\theta - \frac{1}{2}\,g\left[\frac{x}{u\cos\theta}\right]^2$$

$$\tan\theta = 1 \;\therefore\; \theta = 45^0$$

Also

$$\frac{g}{2u^2\cos^2\theta} = \frac{2}{5}$$

$$\frac{g}{2u^2\cos^2 45^0} = \frac{2}{5} \qquad \text{Cos } 45^0 = \frac{1}{\sqrt{2}}$$

$$\frac{g}{2u^2 \times \frac{1}{2}} = \frac{2}{5}$$

$$\frac{g}{u^2} = \frac{2}{5}$$

$$u^2 = \frac{10 \times 5}{2} = 25$$

$$u = 5\ m/s$$

Question 19: An object with mass 5 kg is acted upon by a force, F⃗ =−3i^+4j^ N. If it"s initial velocity at t = 0 is v⃗ =6i^−2j^ ms^{-1}, the time at which it will just have a velocity along y-axis is

(A) 10s **(B)** 15s **(C)** 5s **(D)** 2s

ANSWER: (A)

Solution:

Given: $m = 5\ kg;\ \vec{F} = -3\hat{i} + 4\hat{j}\ N$

$\vec{u} = 6\hat{i} - 12\hat{j}\,ms^{-1}$

The acceleration of the body is

$$\vec{a} = \frac{\vec{F}}{m} = \frac{(-3\hat{i} + 4\hat{j})N}{5\ kg} = -\frac{3}{5}\hat{i} + \frac{4}{5}\hat{j}\ ms^{-2}$$

Velocity of the body along x-axis at any time t is

$$v_x = u_x + a_x t = 6 - \frac{3}{5}t$$

As the body will have a velocity along the y-axis its velocity along the y-axis, therefore its velocity along x-axis will be zero.

$$v_x = 0 \text{ or } 6 = \frac{3}{5}t$$

$$t = \frac{30}{3} = 10s$$

Question 20: During inelastic collision between two objects, which of the following quantity always remains conserved?

(A) Total mechanical energy **(B) Speed of each body**

(C) Total kinetic energy **(D) Total linear momentum**

Solution:

ANSWER: (D)

Since no external forces are acting on the colliding bodies during collision, thus total linear momentum is always conserved in all type of collisions but kinetic energy in not conserved in all collections

Kinetic energy is conserved in perfectly elastic collision only but some kinetic energy is lost in inelastic collisions. So, total kinetic energy is not conserved in inelastic collision

Linear momentum always remains conserved for any type of collision.

If in a collision kinetic energy after collision is not equal to kinetic energy before collision, the collision is said to inelastic.

Coefficient of restitution $0 < e < 1$

When we are considering the two bodies as system the total external force on the system will be zero.

Hence, total linear momentum of the system remains conserved. Here kinetic energy appears in other forms, i.e. energy may be lost in the form of heat and sound etc. In some cases

$(KE)_{final} < (KE)_{initial}$ such as when initial KE is converted into intertial energy of the product (as heat, elastic or excitation) while in other cases $(KE)_{final} > (KE)_{initial}$ such as when internal energy stored in the colliding particles is released.

Examples:.

(1) Collision between two billiard balls.

(2) Collision between two automobiles on a road.

In fact all majorities of collisions belong to this category.

Question 21: In Rutherford experiment, for a head-on collision of α -particles with a gold nucleus, the impact parameter is

(A) Of the order of 10^{-14} m **(B)** of the order of 10^{-6} m

(C) Zero **(D)** of the order of 10^{-10} m

Solution:

ANSWER: (C)

For head-on collision, the impact parameter is zero as it retraces its path.

Question 22: Frequency of revolution of an electron revolving in n^{th} orbit of H-atom is proportional to

(A) n **(B)** $1/n^3$ **(C)** $1/n^2$ **(D)** n independent of n

ANSWER: (B)

Solution:

$$\text{Time period of revolution} = T = \frac{2\pi r}{v}$$

$$\text{Freequency of revolution: } f = \frac{1}{T} = \frac{v}{2\pi r}$$

By Bohr atomic model

$$v \propto \frac{1}{n}$$

$$r \propto n^2$$

$$f \propto \frac{1}{n^3}$$

Question 23: A hydrogen atom in ground state absorbs 10.2 eV of energy. The orbital angular momentum of the electron is increased by

(A) 2.11×10^{-34} Js **(B)** 4.22×10^{-34} Js

(C) 1.05×10^{-34} Js **(D)** 3.16×10^{-34} Js

ANSWER: (C)

Solution:

By absorbing 10.2 eV electron goes to 2^{nd} orbit, ie n = 2.

$$E_n = \frac{-13.6}{n^2} eV$$

For first orbit,

$$E_1 = -13.6 \text{ eV}$$

$$E_2 = -3.4 \text{ eV}$$

$$E_2 - E_1 = -10.2 \text{ eV}$$

Angular momentum increased by

$$L_2 - L_1 = \frac{n_2 h}{2\pi} - \frac{n_1 h}{2\pi} = \frac{2h}{2\pi} - \frac{1h}{2\pi} = \frac{h}{2\pi} = \frac{6.62 \times 10^{-34}}{2 \times 3.14}$$

$$L_2 - L_1 = 1.05 \times 10^{-34} \text{ eV}$$

Question 24: The end product of decay of $_{90}Th^{232}$ is $_{82}Pb^{208}$. The number of α and β particles emitted are respectively.

(A) 6, 4 (B) 4, 6 (C) 3, 3 (D) 6, 0

ANSWER: (A)

Solution:

$$_{90}Th^{232} \rightarrow {}_{82}Pb^{208}$$

The mass number decreases by 24 units. This implies [emission of one α particle decreases the mass number by 4 unit]. Then proton number should decrease by 12, but the change in proton number is by 8 only. This implies 4 β particles have been emitted.

Question 25: Two protons are kept at a separation of 10nm. Let F_n and F_e be the nuclear force and the electromagnetic force between them

(A)$F_e >> F_n$ (B) Fe and F_n differ only slightly (C)$F_e = F_n$ (D)$F_e << F_n$

ANSWER: (A)

Solution:

As separation is less than 10nm. Therefore electromagnetic force is greater than nuclear force. Fe >> F_N. [Nuclear force is short range force. [Within few fms].

Question 26: Two particles which are initially at rest move towards each other under the action of their mutual attraction. If their speeds are v and 2v at any instant, then the speed of the centre of mass of the system is,

(A)Zero (B) V (C) 2v (D) 1.5 v

ANSWER: (A)

Solution:

Initially both A and B are at rest, hence initial momentum is zero, Also no external force is acting on the two particles as they are moving under mutual attraction so final momentum should also be zero, by conservation of linear momentum.

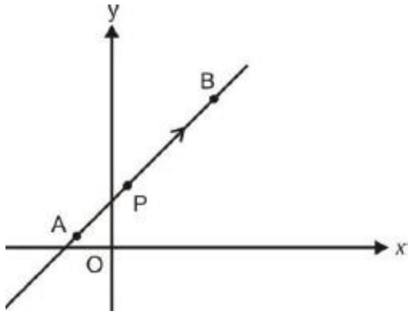
V_{com} = 0, as mass cannot be zero.

Question 27: A particle is moving uniformly along a straight line as shown in the figure. During the motion of the particle from A to B, the angular momentum of the particle about 'O'

(A) Decreases (B) First increases then decreases

(C) Increases **(D)** remains constant

ANSWER: (D)



Angular momentun = L = mvr

Let r is the perpendicular distance of particle from reference point. The parameters m, v, r are constant for position A and B. So angular momentum remains constant.

Question 28: A satellite is orbiting close to the earth and has a kinetic energy K. The minimum extra kinetic energy required by it to just overcome the gravitation pull of the earth is

(A) 2K **(B)** 2√2 **(C)** K **(D)** √3K

ANSWER: (C)

Solution:

The escape velocity: $v_e = \sqrt{2gR} = \sqrt{2v_0} = \sqrt{2 \times \text{Orbital velocity}}$

$$v_e = \sqrt{2v_0}$$

When satellite in orbit : $K_1 = \frac{1}{2}mv_0^2$

The kinetic energy for escape velocity of satellite: $K_2 = \frac{1}{2}mv_e^2$

The kinetic energy for escape velocity of satellite: $K_2 = \frac{1}{2}m \times \left(\sqrt{2}v_0\right)^2 = 2K_1$

Extra kinetic energy required: $= 2K_1 - K_1 = K_1 \therefore K_1 = K$

Question 29: A wire is stretched such that its volume remains constant. The Poisson's ratio of the material of the wire is

(A)-0.50 **(B)**-0.25 **(C)** 0.50 **(D)** 0.25

ANSWER:(C)

Solution:

Let L be the length and r be the radius of wire.

The volume of the wire: $V = \pi r^2 L$

On differentiating both sides of the equation, the volume remains unchanged (constant) , ΔL = 0

$$0 = 2\pi r L\,\Delta r + \pi r^2 \Delta L$$

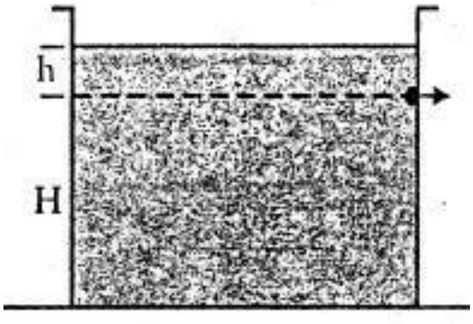
$$2\pi r L\,\Delta r = \pi r^2 \Delta L$$

$$\frac{\Delta r/r}{\Delta L/L} = -\frac{1}{2}$$

$$\text{Poisons ratio} = \frac{\Delta r/r}{\Delta L/L} = \frac{\text{Lateral strain}}{\text{Longidunil starin}} = \frac{\text{Change in radius /original radius}}{\text{Change in length /original lentgh}}$$

$$\text{Poisons ratio} = \frac{\Delta r/r}{\Delta L/L} = 0.5$$

Question 30: A cylindrical container containing water has a small hole at height of H = 8 cm from the bottom and at a depth of 2 cm from the top surface of the liquid. The maximum horizontal distance travelled by the water before it hits the ground (x) is



(A) 4√2 cm **(B)** 6 cm **(C)** 8 cm **(D)** 4 cm

ANSWER: (C)

Solution:

Given: $t = H = 8\text{ cm} = 8 \times 10^{-2}, h = 2\text{ cm} = 8 \times 10^{-2}, g = 9.8\ m/s$

The velocity of water coming out from the hole

$v^2 - u^2 = 2as$ when the body falling down $a = +g, s = H$ and $u = 0$

$v^2 = 2gH$

$v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 2 \times 10^{-2}} = 0.626\text{ m/s}$

We know that

$$S = ut + \frac{1}{2}at^2$$

$$S = ut + \frac{1}{2}at^2; \quad u = 0, S = H,$$

$$t^2 = \frac{2S}{a} = \frac{2H}{g} \quad \text{when the body falling down } a = +g,$$

The time requires for falling of the body.

$$t = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2 \times 8 \times 10^{-2}}{9.8}} = 0.1277\ \text{m/s}$$

Distance covered by the water = velocity × time

Distance covered by the water = 0.626 × 0.1277 = 0.0799m = 7.99cm = 8cm

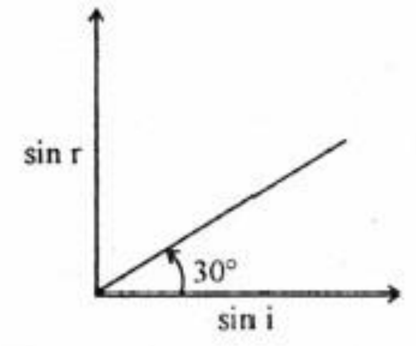
---

Question 31: A transparent medium shows relation between i and r as shown. If the speed of light in vacuum is C, the Brewster angle for the medium is

(A) 45^0 **(B)** 90^0 **(C)** 30^0 **(D)** 60^0

ANSWER: (D)

Solution:



Brewsters law: $\mu = \tan\theta_p$

Snell's law: $\mu = \frac{\sin i}{\sin r}$

From the graph

$$\text{But } \frac{\sin i}{\sin r} = \frac{1}{\text{slope}}$$

$$\frac{\sin i}{\sin r} = \frac{1}{\text{slope}}$$

$$\mu = \frac{\sin i}{\sin r} = \frac{1}{\text{slope}} = \frac{1}{\tan 30^0} = \frac{1}{1/\sqrt{3}} = \sqrt{3}$$

$$\mu = \tan Q_p = \sqrt{3}$$

$$Q_p = \tan^{-1}\sqrt{3}$$

$$Q_p = 60^0$$

Question 32: In Young"s double slit experiment, using monochromatic light of wavelength λ, the intensity of light at a point on the screen where path difference is λ is K units. The intensity of light at a point where path difference is λ/3 is

(A)K/4 **(B)** 2K **(C)**K **(D)** 4K

ANSWER: (A)

Solution:

$$\delta = \frac{2\pi}{\lambda} \times \lambda$$

$$\delta \text{ or } \phi = \frac{2\pi}{\lambda} \times \lambda$$

$$\delta \text{ or } \phi = 2\pi$$

The resultant intensity at P is directly proportional to the square of the amplitude of the wave

$$I = R^2 = 4a_0^2 \cos^2\frac{\delta}{2}$$

When the path difference is $\lambda, I_0 = K$, When the path difference is $\frac{\lambda}{3}, I = ?$

The phase difference δ between the two waves is given by

$$\delta \text{ or } \phi = \frac{2\pi}{\lambda}(\text{Path difference})$$

$$\delta \text{ or } \phi = \frac{2\pi}{\lambda} \times \frac{\lambda}{3}$$

$$\phi = \frac{2\pi}{3} = \frac{2 \times 180^0}{3} = 120^0$$

$$I = I_0 \cos^2\left(\frac{\phi}{2}\right)$$

$$I = K\left(\frac{\cos 120^0}{2}\right)^2$$

$$I = K\,(\cos 60^0)^2$$

$$I = K\left(\frac{1}{2}\right)^2$$

$$I = \frac{K}{4}$$

Question 33: Due to Doppler's effect, the shift in wavelength observed is 0.1 Å for a star producing wavelength 6000 Å. Velocity of recession of the star will be

(A) 10 km/s **(B)** 20 km/s **(C)** 25 km/s **(D)** 5 km/s

ANSWER: (D)

Solution:

$$\text{The Doppler shift} = \frac{\Delta\lambda}{\lambda} = \frac{v}{c}$$

$$v = \left(\frac{\Delta\lambda}{\lambda}\right)c$$

$$v = \frac{0.1}{6000} \times 3 \times 10^8 = 0.5 \times 10^4 = 5 \text{ km/sec}$$

$$v = 5 \text{ km/sec}$$

Question 34: An electron is moving with an initial velocity $\vec{V} = V_0\hat{i}$ and is in a uniform magnetic field $\vec{B} = B_0\hat{i}$. Then, it"s de Broglie wavelength

(A) Increases with time **(B) Increases and decreases periodically**

(C) Remains constant **(D) Decreases with time**

ANSWER: (C)

Solution:

Magnetic force on moving electron:

$$F = -e(V_0\hat{i} \times B_0\hat{j})$$

$$F = -eV_0B_0\hat{k}$$

So, Force is perpendicular to both $\vec{V}_0$ & $\vec{B}_0$ so the magnitude of V will not change it means momentum will not change.

Now; by De- Broglie

$$\lambda = \frac{h}{mv} = \frac{h}{p}$$

Electron is entering perpendicular to magnetic field. It moves in a circular path. But its speed remains same. Momentum remains constant. Therefore, De Broglie wavelength remains constant.

Question 35: Light of certain frequency and intensity incident on a photosensitive material causes the photoelectric effect. If both the frequency and intensity are doubled, the photoelectric saturation current becomes.

(A) **Doubled** **(B)** **Unchanged** **(C)** **Quadrupled** **(D)** **Halved**

ANSWER: (A)

Solution:

We know photoelectric current is directly proportional to the intensity of incident light. The incident frequency is greater than threshold frequency. When intensity is doubled, photoelectric saturation current doubles.

Question 36: A certain charge 2Q is divided at first into two parts q_1 and q_2. Later, the charges are placed at a certain distance. If the force of interaction between two charges is maximum then Q/q_1 =

(A) 2 **(B)** 0.5 **(C)** 4 **(D)** 1

ANSWER: (D)

Solution:

Force of interaction between two charges q_1 and q_2 will be maximum when

$$q_1 = q_2 = \frac{2Q}{2} = Q$$

$$\frac{Q}{q_1} = \frac{Q}{Q} = 1$$

Question 37: A particle of mass m and charge q is placed at rest in uniform electric field E and then released. The kinetic energy attained by the particle after moving a distance y is

(A) qE^2y **(B)** q^2Ey **(C)** qEy^2 **(D)** qEy

ANSWER: (D)

Solution:

Velocity gained after moving a distance y:

$$v^2 = u^2 + 2ay$$

Here; u = 0,

The force experienced by a particle of charge q: $F = qE$

$$F = qE$$

From Newtons seecond law of motion: $F = ma$

$$ma = qE$$

$$a = \frac{qE}{m}$$

$$v^2 = 0 + 2\left(\frac{qE}{m}\right)y$$

$$\text{Kinetic energy} = E = \frac{1}{2}m\,v^2$$

$$\text{Kinetic energy} = E = \frac{1}{2}m \times 2\left(\frac{qE}{m}\right)y$$

$$E = qE\,y$$

Question 38: An electric dipole is kept in a non-uniform electric field. It generally experiences

(A) A force but not a torque **(B)** Neither a force nor a torque

(C) A force and torque **(D)** A torque but not a force

ANSWER: (C)

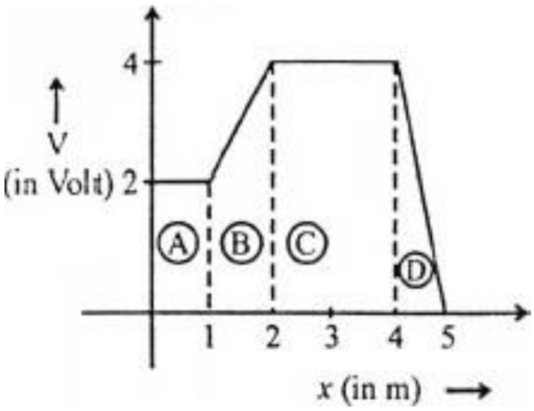
Solution:

An electric dipole in non-uniform electric field generally experiences a force and a torque.

Question 39: The figure gives the electric potential V as a function of distance through four regions on x-axis. Which of the following is true for the magnitude of the electric field E in these regions?

(A)$E_A = E_C$ **and** $E_B < E_D$ **(B)**$E_A < E_B < E_C < E_D$

(C)$E_A > E_B > E_C > E_D$ **(D)**$E_B = E_D$ **and** $E_A < E_C$



ANSWER: (A)

Solution:

In region A, V is constant

$$\text{The relation between Electricfield and potential} = E = -\frac{dV}{dX}$$

$$\text{As V is constant,} \quad E_A = -\frac{dV}{dX} = 0$$

$$\text{In region B, } E_B = \frac{4-2}{2} = 1\ Vm^{-1}$$

$$\text{In region C, V = constant } E_C = 0$$

$$\text{In region D, } E_D = \frac{4-2}{1} = 2\ Vm^{-1}$$

Therefore, $E_A = E_B$ and $E_B < E_D$

Question 40: A system of two charges separated by a certain distance apart stores electrical potential energy. If the distance between them is increased, the potential energy of the system,

(A)Decreases in any case **(B) Remains the same**
(C)Increases in any case **(D) May increase or decrease**

ANSWER: (D)

Solution:

Potential Energy of the sytem: $U = \frac{1}{(4\pi\varepsilon_0)}\frac{q_1q_2}{r}$

Let r is separation between two charges q_1 and q_2.

(i) In case of like charges, (q_1q_2) are positive: Suppose the separation between the two charges increases, the potential energy decreases.

(ii) In case of unlike charges, (q_1q_2) are negative: Suppose the separation between the two charges increases, the potential energy decreases. But because of negative sign, U increases.

Question 41: In a cyclotron, a charged particle

(A) Speeds up between the dees because of the magnetic field
(B) Slows down within a dee and speeds up between dees
(C) Undergoes acceleration all the time
(D) Speeds up in dee

ANSWER: (C)

Solution:

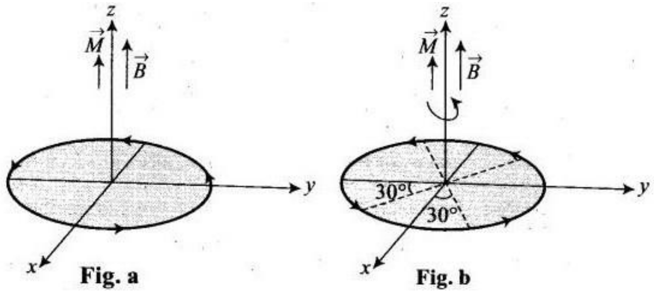
In a cyclotron, a charged particle experiences electric force between the dees and a magnetic force inside the dees while circulating. Therefore it always experiences a force and hence acceleration.

Question 43: A circular current loop of magnetic moment M is in an arbitrary orientation in an external uniform magnetic field $\vec{B}$. The work done to rotate the loop by 30^0 about an axis perpendicular to its plane is

(A) √3MB/2 **(B)** zero **(C)**MB **(D)**MB/2

ANSWER: (C)

Solution:



The rotation of the loop by 30°about an axis perpendicular to its plane make no change in the angle made by axis of the loop with the direction of magnetic field, therefore, the work done to rotate the loop is zero.

Important point: The work done to rotate the loop the loop in magnetic field W = MB($\cos\theta_1$ - $\cos\theta_2$), where signs are as usual.

Even when the coil is rotated, about an axis perpendicular to its plane, the potential energy does not change. Hence, work done is zero

---

Question 44: In a permanent magnet at room temperature

(A) The individual molecules have a nonzero magnetic moment which are all perfectly aligned

(B) Domains are all perfectly aligned

(C) Magnetic moment of each molecule is zero

(D) Domains are partially aligned

ANSWER: (D)

Solution:

Even in case of permanent magnets all the domain are not perfectly aligned due to thermal agitation.

Question 45: Coercivity of a magnet where the ferromagnets gets completely demagnetized is 3 ×10^3 Am^{-1}. The minimum current required to be passed in a solenoid having 1000 turns per metre, so that the magnet gets completely demagnetized when placed inside the solenoid is

(A) 60 mA (B) 6A (C) 30 mA (D) 3A

ANSWER: (D)

Solution:

Coercivity refers to the intensity of magnetic field (B) where the magnets get demagnetized

For Solenoid: $B = \mu_0 nI$

Where n is number of turns per unit length, I is the current through each turn, μ_0 is Absolute permeability, B is magnetic field in solenoid.

Also; $\mu_0 H = \mu_0 nI$

Where H is the intensity of magnetic field

$$I = \frac{H}{n}$$

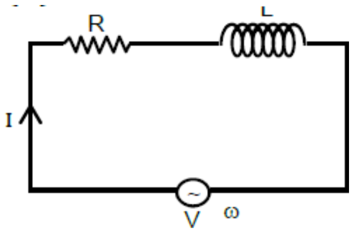
$$n = \frac{N}{l} = \frac{100}{10} = \frac{100}{0.1} \text{ turns/meter}$$

$$I = \frac{3\times10^3}{\left(\frac{100}{0.1}\right)}$$

$$I = \frac{3\times10^3\times0.1}{100}$$

$$I = \frac{3\times10^3\times10^{-1}}{10^2} = 3A$$

Question 46: An inductor of inductance L and resistor R are joined together in series and connected by a source of frequency ω. The power dissipated in the circuit is



(A) $\frac{V^2R}{R^2+\omega^2L^2}$ (B) $\frac{V^2R}{\sqrt{R^2+\omega^2L^2}}$ (C) $\frac{R^2+\omega^2L^2}{V}$ (D) $\frac{V}{R^2+\omega^2L^2}$

ANSWER: (A)

Solution:

In given LR circuit

$$Z=\sqrt{R^2+X_L^2}$$
$$Z=\sqrt{R^2+(\omega L)^2}$$
$$P=I^2R$$
$$I=\frac{V}{\sqrt{R^2+\omega^2L^2}}$$
$$P=\frac{V^2R}{R^2+\omega^2L^2}$$

Question 47: An electromagnetic wave is travelling in x-direction with electric field vector given by $E_y=E_0\sin[kx-\omega t]\hat{j}$. The correct expression for magnetic field vector is

(A) $\overrightarrow{B_z}=E_0C\ \sin\ [kx-\omega t]\ \hat{k}$ (B) $\overrightarrow{B_z}=\frac{E_0}{C}\ \sin\ [kx-\omega t]\ \hat{k}$

(C) $\overrightarrow{B_y}=E_0C\ \sin\ [kx-\omega t]\ \hat{j}$ (D) $\overrightarrow{B_y}=\frac{E_0}{C}\ \sin\ [kx-\omega t]\ \hat{j}$

ANSWER: (B)

Solution:

$$E_y=E_0\sin[kx-\omega t]\hat{j}$$
$$C=\frac{E_0}{B_0}$$
$$B_0=\frac{E_0}{C}$$
$$\overrightarrow{B_z}=\frac{E_0}{C}\ \sin\ [kx-\omega t]\ \hat{k}$$

Question 48: The phenomenon involved in the reflection of radio-waves by ionosphere is similar to

(A) Total internal reflection of light in the air during a mirage

(B) Scattering of light by air particles

(C) Reflection of light by plane mirror

(D) Dispersion of light by water molecules during the formation of a rainbow

ANSWER: (A)

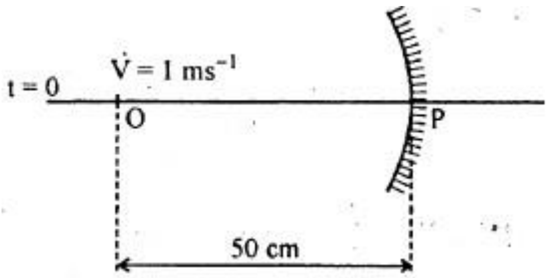
Solution:

The phenomenon involved in the reflection of radio-waves by ionosphere is similar to total internal reflection of light in the air during a mirage.

Question 49: A point object is moving uniformly towards the pole of a concave mirror of focal length 25 cm along its axis as shown below. The speed of the object is $1ms^{-1}$. At t = 0, the distance of the object from the mirror is 50 cm. The average velocity of the image formed by the mirror between time t = 0 and t = 0.25s is: (A) 20 cms^{-1} (B) Infinity (C) 40 cms^{-1} (D) Zero

ANSWER: (B)

Solution:



Focal length = 2.5 cm

$$\text{At } t = 0, \text{Object at a distance of } x_i = 50 \text{ cm}$$

$$\text{At } t = 0.25, \text{Object at a distance of } x_f = \text{Speed} \times \text{Time}$$

$$x_f = 0.1 \times 0.25$$

$$x_f = 0.25 \text{ m}$$

$$x_f = 25 \text{ cm}$$

At t = 0.25 image will beat infinity

$$V_{avg} = \frac{\Delta x}{\Delta t} = \infty$$

Question 50: A certain prism is found to produce a minimum deviation of 38^0. It produces a deviation of 44^0 when the angle of incidence is either 42^0 or 62^0. What is the angle of incidence when it is undergoing minimum deviation?

(A) 40^0 (B) 60^0 (C) 30^0 (D) 49^0

ANSWER: (D)

Solution:

Given: $\delta_{min} = 38^0, \delta = 44^0, i = 42^0$ and $e = 62^0$

$$i = \left(\frac{A + \delta}{2}\right)$$

Where, δ is deviation, i = angle of incidence and A = Angle of prism

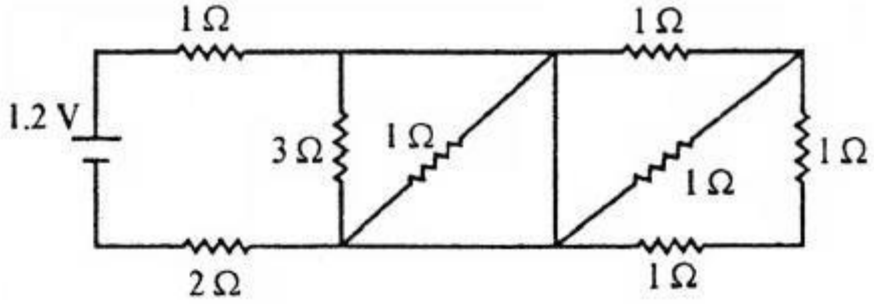
$$\delta = r_1 + r_2 - A$$
$$A = r_1 + r_2 - \delta$$
$$A = i + e - \delta$$

At minimum deviation: $r_1 = r_2$ or $i = e$

$$\delta_{min} = 2i - A$$
$$38 = 2i - 60$$
$$2i = 60 + 38 = 98$$
$$i = 49$$

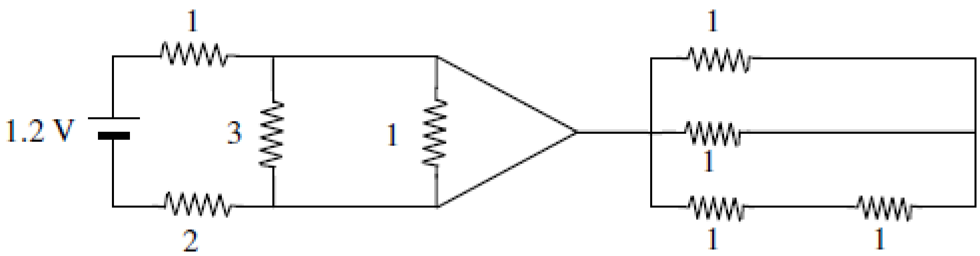
Question 51: In the given circuit, the current through 2 ohm resistor is

(A) 0.3A **(B) 0.1A** **(C) 0.2A** **(D) 0.4A**



ANSWER: (D)

Solution:



The circuit can be redrawn as

$R_{eq} = (1+2) = 3\Omega$

$$I = \frac{V}{R_{eqvi}}$$

$$I = \frac{1.2}{3} = 0.4\ A$$

Question 52: Kirchhoff's junction rule is a reflection of

(A) Conservation of energy **(B) Conservation of charges**

(C) Conservation of current density vector **(D) Conservation of momentum**

ANSWER: (B)

Solution:

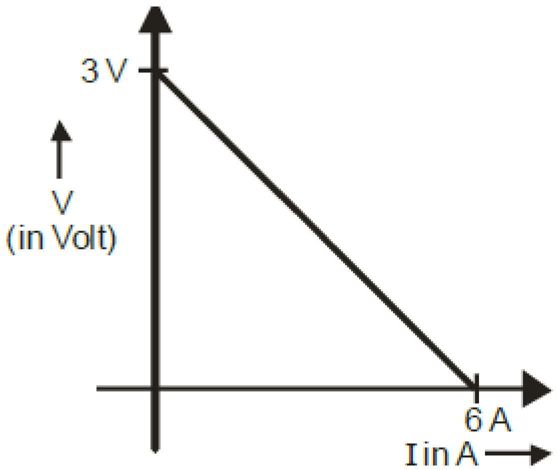
Kirchhoff's junction rule is based on conservation of charges.

Question 53: The variation of terminal potential difference (V) with current flowing through a cell is as shown. The emf and internal resistance of the cell are

(A) 3V, 0.5 ohm (B) 6V, 0.5 ohm (C) 3V, 2 ohm (D) 6V, 2 ohm

ANSWER: (A)

Solution:



From the given graph, we can form the following equation

$V = E - Ir$

When I = 0,

When $V = 0$: $0 = E - Ir$

Question 54: In a potentiometer experiment, the balancing point with a cell is at a length 240 cm. On shunting the cell with a resistance of 2 Ω, the balancing length becomes 120 cm. The internal resistance of the cell is

(A) 2 Ω (B) 0.5 Ω (C) 4 Ω (D) 1 Ω

ANSWER: (A)

Solution:

Internal resistance of a cell is given by:

$$r = R\left(\frac{l_1}{l_2} - 1\right)$$

$$r = 2\left(\frac{240}{120} - 1\right)$$

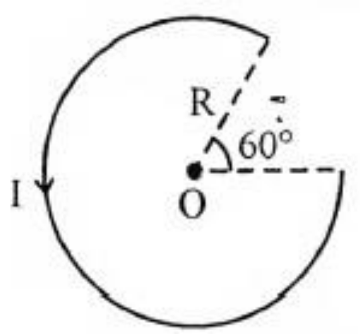
$$r = 2 \times (2 - 1) = 2 \times 1 = 2\Omega$$

Question 55: The magnetic field at the centre 'O' in the given figure is

(A) $\frac{5}{12} \times \frac{\mu_0 I}{R}$ (B) $\frac{7}{14} \times \frac{\mu_0 I}{R}$ (B) $\frac{7}{14} \times \frac{\mu_0 I}{R}$ (D) $\frac{3}{10} \times \frac{\mu_0 I}{R}$

ANSWER: (A)

Solution:



Here $\theta = 300^0$ as can be seen from given diagram

$$\text{Number of turns; } n = \frac{300}{360} = \frac{5}{6}$$

$$B = \frac{\mu_0 nI}{2R}$$

$B = \mu_0 nI/2R$

$$B = \mu_0 \left(\frac{5}{6}\right)\left(\frac{I}{2R}\right)$$

$$B = \frac{5}{12} \times \frac{\mu_0 I}{R}$$

Question 56: An aluminium sphere is dipped into the water. Which of the following is true?

(A) Buoyancy will be more in water at 0^0C than that in water at 4^0C

(B) Buoyancy may be more or less in water at 4^0C depending on the radius of the sphere

(C) Buoyancy will be less in water at 0^0C than that in water at 4^0 C

(D) Buoyancy in water at 0^0C will be same as that in water at 4^0C

ANSWER: (C)

Solution:

Buoyancy at 0^0C: $F_B : V\rho_0 g$

Buoyancy at 4^0C: $F_B' : V\rho_4 g$

$F_B/F_B'' = \rho_0/\rho_4$

$$\frac{F_B}{F_B'} = \frac{\rho_0}{\rho_4}$$

We know that at 4^0C is more than at 0^0C

$\rho_4 > \rho_0$

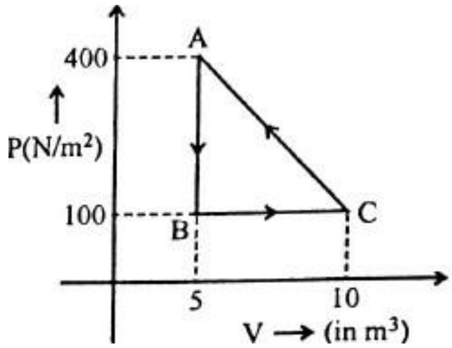
$\rho_4 > \rho_0$ *and* $F_B < F_B'$

Question 57: A thermodynamic system undergoes a cyclic process ABC as shown in the diagram. The work done by the system per cycle is

(A)-1250 J (B) 1250 J (C) 750 J (D) -750 J

ANSWER: (D)

Solution:



Work done $= P \times \Delta V$

Also: Work done = Area of the triangle ABC

$$\text{Work done} = \frac{1}{2} \times \text{Base} \times \text{Height}$$

$$W = \frac{1}{2} \times (10 - 5) \times (100 - 400)$$

$$W = \frac{1}{2} \times 5 \times (-300 - 750)\ \text{J}$$

$$W = \frac{1}{2} \times 5 \times (-300) = -750\ \text{J}$$

Question 58: One mole of O_2 gas is heated at constant pressure starting at 27 ^{0}C. How much energy must be added to the gas as heat to double it"s volume?
(A) 450 R (B) 1050 R (C) Zero (D) 750 R

ANSWER: (B)

Solution:

At constant pressure, the volume is doubled then the temperature also gets doubled. According to Charles law At Constant pressure volume of given mass of gas is directly proportional to its absolute temperature.

Given: $T_1 = 300\text{K}$, $T_2 = 600\text{K}$: Mass m = 1 mole

Change in temperature $\Delta T = T_2 - T_1 = 600 - 300 = 300\ \text{K}$

Quantity of heat supplied to a system = Mass × Specific heat × Change in temperature

$$Q = m \times C_p \times \Delta T$$

$$Q = 1 \times \left(\frac{7}{2}\right) \times 300$$

$$Q = 1 \times \left(\frac{7}{2}\right) R \times 300$$

$$Q = 1050\ R$$

Question 59: A piston is performing S.H.M. in the vertical direction with a frequency of 0.5 Hz. A block of 10 kg is placed on the piston. The maximum amplitude of the system such that the block remains in contact with the piston is

(A) 0.5m **(B)** 0.1m **(C)** 1m **(D)**1.5m

Solution:

ANSWER: (C)

Given: Frequency = f = 0.5 Hz

$$\omega = 2\pi f = 2 \times 3.14 \times 0.5 = 2 \times 3.14 \times \frac{1}{2} = 3.14$$

For block to remain in contact with the piston, at amplitude position of SHM

Weight of block = force due to oscillation

$$mg = ma$$

$$mg = m\,(\omega^2 A)$$

$$\text{Amplitude: } A = \frac{g}{\omega^2}$$

$$\text{Amplitude: } A = \frac{10}{(3.14)^2} = 1\text{m}$$

Question 60: The equation of a stationary wave is y = 2sin(πx/15) cos(48πt). The distance between a node and it‟s next antinode is

(A) 1.5 units **(B)** 30 units **(C)** 7.5 units **(D)** 22.5 units

ANSWER: (C)

$$y = 2\,\sin\left(\frac{2\pi}{15}\right)\cos\,(48\,\pi\,t)$$

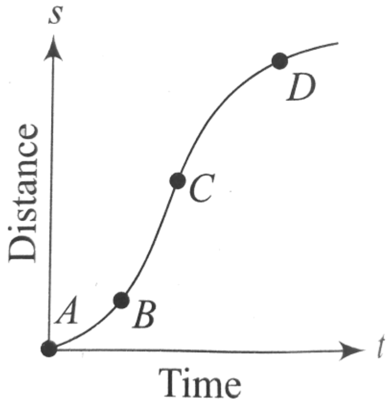
$$\frac{2\pi}{\lambda} = \frac{\pi}{15}$$

$$\lambda = 30$$

So distance between node and next antinodes; $\frac{\lambda}{4} = \frac{30}{4}$ $\quad \frac{\lambda}{4} = 7.5$

KCET-2018: PHYSICS)

1. A particle show distance-time curve as shown in the figure. The maximum instantaneous velocity of the particle is around the point.



(A) P (B) S (C) R (D) Q

ANSWER(C)

Solution

Particle has maximum instantaneous velocity at the point at when the slope is maximum. Therefore,

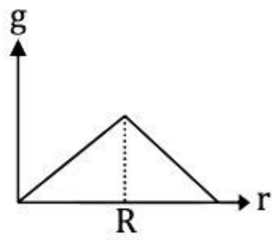
$$v_{max} = \frac{dx}{dt} = \text{Maximum slope}$$

From figure, the point C has maximum slope. Therefore, at this point velocity is maximum.

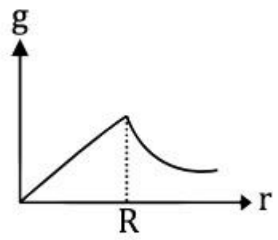
---

2. Which of the following graphs correctly represents the variation of „g" on the Earth?

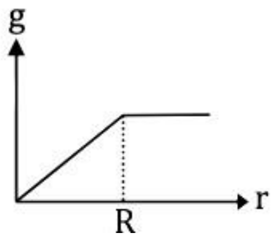
a.



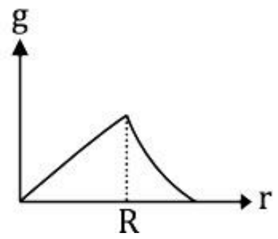
b.



c.

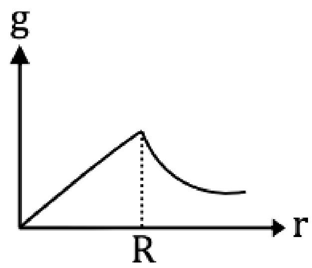


d.



ANSWER: (B)

Solution



The relation between g and G is given by $g = \frac{GM}{R^2}$

Where g is acceleration due to gravity, G is universal gravitational constant and R is the radius of the earth.

(i) Up to the surface of earth $\mathbf{g \propto R}$ (Relation is linear between g and R)

(ii) Outside the surface of earth $\mathbf{g} \propto \frac{1}{\mathbf{R^2}}$ (Relation is parabolic between g and R). Hence, option B is correct.

---

3. A cup of tea cools from 65.5°C to 62.5°C in 1 minute in a room at 22.5°C. How long will it take to cool from 46.5°C to 40.5°C in the same room?

(A) 4 minutes (B) 2 minutes(C) 1 minute (D) 3 minutes

ANSWER: (A)

SOLUTION:

According to the Newton‟s rate of cooling

$$\frac{dT}{dt} = -k(T - T_0)$$

K is rate constant, T is the average temperature, T_0 is the surrounding temperature.

In first case;

$$\frac{65.5 - 62.5}{1} = -k(64 - 22.5) \quad \text{where } T = \frac{65.5 + 62.5}{2} = \frac{128}{2} = 64$$

$$\frac{3}{1} = -k \times 41.5 \ldots\ldots\ldots (1)$$

In second case;

$$\frac{(46.5 - 40.5)}{t} = -k(43.5 - 22.5) \quad \text{where } T = \frac{46.5 + 40.5}{2} = \frac{87}{2} = 43.5$$

$$\frac{6}{t} = -k \times 21 \ldots\ldots\ldots (2)$$

From equations (1) and (2)

$$\frac{3}{1} \times \frac{t}{6} = \frac{41.5}{21}$$

$$\frac{t}{2} = \frac{41.5}{21}$$

$$t = \frac{2 \times 41.5}{21} = \frac{83}{21} = 4 \text{ minutes}$$

---

4. The dimensions of the ratio of magnetic flux (ϕ) and permeability (μ) are

(A) $[M^0L^1A^1T^0]$ **(B)** $[M^0L^{-3}T^0A^1]$ **(C)** $[M^0L^{-1}T^1A^{-1}]$ **(D)** $[M^0L^2T^0A^1]$

ANSWER (A)

Solution:

A= Current, T= Time, L=Length, M= Mass

Magnetic flux: $\phi = B \times A$

Magnetic Flux is dimensionally represented as $[M^1 L^2 T^{-2} A^{-1}]$.

$$\text{Magnetic Permeability: } \mu = \frac{B}{H}$$

Magnetic permeability is dimensionally represented as $[M^1 L^1 T^{-2} A^{-2}]$

$$\frac{\text{Magnetic Flux}}{\text{Magnetic permeability}} = \frac{\phi}{\mu} = \frac{[M^1 L^2 T^{-2} A^{-1}]}{[[M^1 L^1 T^{-2} A^{-2}]}$$

$$\text{The dimension of } \frac{\phi}{\mu} = [M^0 L^1 A^1 T^0]$$

$$\frac{\phi}{\mu} = \frac{B \times A}{B/_H} = B \times A \times \frac{H}{B} = HA$$

$$\frac{\text{Magnetic flux:}}{\text{Magnetic Permeability}} = \frac{\phi}{\mu} = \frac{B \times A}{B/_H} = B \times A \times \frac{H}{B} = HA$$

$$\text{The dimension of } \frac{\phi}{\mu} = [M^0 L^1 A^1 T^0]$$

---

5. A mass „m" on the surface of the Earth is shifted to a target equal to the radius of the Earth. If „R" is the radius and „M" is the mass of the Earth, then work done in this process is

(A) $\frac{mgR}{2}$ (B) mgR (C) 2mgR (D) $\frac{mgR}{4}$

ANSWER (A)

Solution

The gravitational potential energy of a body at a point is the work done in displacing a body from infinity to that point in the gravitational field. The work done is equal to the gravitational potential energy. It is denoted by U.

Case 1:

Given: „R" is the radius and „M" is the mass of the Earth**.**

$$\text{The gravitational potential energy at the surface of the earth: } W = -\frac{GMm}{R}$$

A mass „m" on the surface of the Earth is shifted to a target equal to the radius of the Earth.

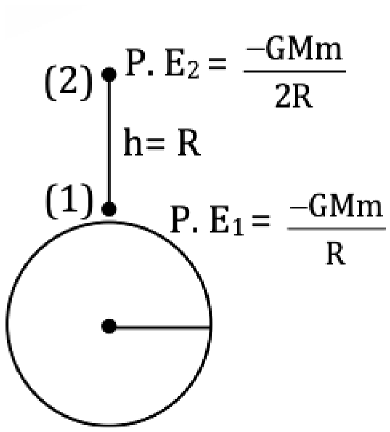
$$\text{Work done} = \text{Change in potetential energy} = -\frac{GMm}{2R} - \left(-\frac{GMm}{2R}\right)$$

$$\text{The gravitational potential energy at the surface of the earth: } W = -\frac{GMm}{R+R} = -\frac{GMm}{2R}$$

$$W = \frac{GMm}{2R}$$

$$\text{The relation between g and G is: } GM = gR^2$$

$$\text{The work done} = W = \frac{gR^2 m}{2R} = \frac{mgR}{2}$$



---

6. **First overtone frequency of a closed pipe of length „l_1" is equal to the 2nd harmonic frequency of an open pipe of length „l_2". The ratio $\frac{l_1}{l_2}$ =?** (A) $\frac{3}{4}$ (B) $\frac{4}{3}$ (C) $\frac{3}{2}$ (D) $\frac{2}{3}$

ANSWER (A)

The frequency of second mode of vibration or first overtone or second harmonic in a closed pipe of length „l_1" is given by

$$n_2 = \frac{3v}{4l_1} \ldots\ldots\ldots (1)$$

The frequency of second mode of vibration or first overtone or second harmonic in an open pipe of length „l_1" is given by

In case of open pipe, the 2nd harmonic frequency of an open pipe of length „l_2" is given by.

$$n_2 = \frac{2\,v}{2l_2} \ldots\ldots\ldots (2)$$

From equations (1) and (2) is given by

$$\frac{3v}{4l_1} = \frac{2\,v}{2l_2}$$

$$\frac{3}{4l_1} = \frac{1}{l_2}$$

$$\frac{l_1}{l_2} = \frac{3}{4}$$

---

7. **The resistance R = VI. Where V= (100 ± 5) V and I = (10 ± 0.2)** A. **The percentage error in R is**

(A) 5.2% **(B) 4.8%** **(C) 7%** **(D) 3%**

ANSWER (A)

Solution

Let I is the current flows through the conductor, R is the resistance of the conductor and V is the potential difference across the conductor.

$$\text{From Ohm's law: } V = IR$$

$$R = \frac{V}{I}$$

The % erroe in R = The % erroe in V + The % erroe in I

$$\frac{\Delta R}{R} \times 100 = \frac{\Delta V}{V} \times 100 + \frac{\Delta I}{I} \times 100$$

$$\frac{\Delta R}{R} \times 100 = 5\% + 2\% = 7\%$$

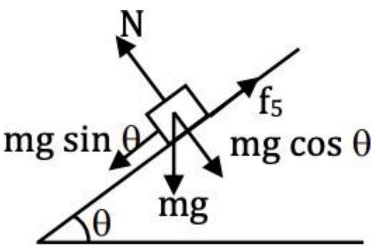
---

8. A block rests on a rough inclined plane making an angle of 30° with the horizontal. The coefficient of static friction between the block and the plane is 0.8. If the frictional force on the block is 10 N, the mass of the block is (g = 10ms–2)

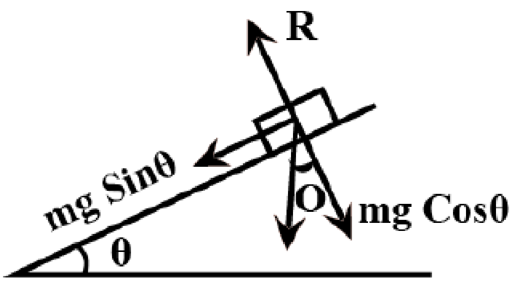
(A) 2.0 kg (B) 4.0 kg (C) 1.6 kg (D) 2.5 kg

ANSWER: (A)

Solution



or



Given: $\theta = 30^0, \mu_S = 0.8$ and $F_C = 10$ N, $g = 10/s^2$

From the figure, the block of mass „m" rests on inclined plane due to frictional force. The weight (mg) of the body is balanced by the normal reaction „R".

$$F_S = mg \sin\theta$$

$$10 = m \times 10 \sin 30^0$$

$$10 = m \times 10 \times \frac{1}{2}$$

Mass of the block is $m = 2$ kg

---

9. Two particles of masses m_1 and m_2 have equal kinetic energies. The ratio of their moments is

(A) $m_1 : m_2$, (B) $m_2 : m_1$, (C) $\sqrt{2m_1} : \sqrt{2m_2}$, (D) $m_1^2 : m_2^2$

ANSWER: (C)

Solution

Mass of the first body $= m_1$, velocity of the first body $= v_1$,

Mass of the second body $= m_2$, velocity of the second body $= v_2$,

Kinetic energy the first body: $\frac{P^2}{2m_1} = \frac{(m_1 v_1)^2}{2}$

Kinetic energy the second body: $\frac{P^2}{2m_2} = \frac{(m_2 v_2)^2}{2}$

$$\frac{(m_1 v_1)^2}{2} = \frac{(m_2 v_2)^2}{2}$$

$$\frac{(m_1 v_1)}{(m_2 v_2)} = \frac{\sqrt{2m_2}}{\sqrt{2m_1}}$$

$$\sqrt{2m_2} = \sqrt{2m_1}$$

---

10. The pressure at the bottom of a liquid tank is not proportional to the

(A) Acceleration due to gravity (B) Density of the liquid

(C) Height of the liquid (D) Area of the liquid surface

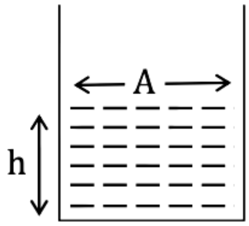
ANSWER (D)

Solution [P=ρgh]

The pressure depends on acceleration (g), the height of the liquid (h) and the density of the liquid (ρ). Pressure does not depend on the area of the liquid surface.

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$P = \rho g h$$



---

11. A Carnot engine takes 300 calories of heat from a source at 500 K and rejects 150 calories of heat to the sink. The temperature of the sink is

(A) 125 K (B) 250K (C) 750 K (D) 1000 K

ANSWER (D)

Solution

$$\text{The effiiciency of Carnots heat engine} = \eta = 1 - \frac{Q_2}{Q_1} = 1 - \frac{T_2}{T_1}$$

$$\frac{Q_2}{Q_1} = \frac{T_2}{T_1}$$

$$\frac{150}{300} = \frac{T_2}{500}$$

$$T_2 = \frac{150}{300} \times 500 = \frac{75000}{300}$$

$$T_2 = 250\ \text{K}$$

---

12. Pressure of an ideal gas is increased by keeping temperature constant. The kinetic energy of molecules

(A) Decreases (B) Increases

(C) Remains same (D) Increases or decreases depending on the nature of gas

ANSWER (D)

Solution

P = ρgh

---

13. **A man weighing 60 kg is in a lift moving down with an acceleration of 1.8 ms–2. The force exerted by the floor on him is**

(A) 588 N (B) 480 N (C) Zero (D) 696 N

ANSWER (B)

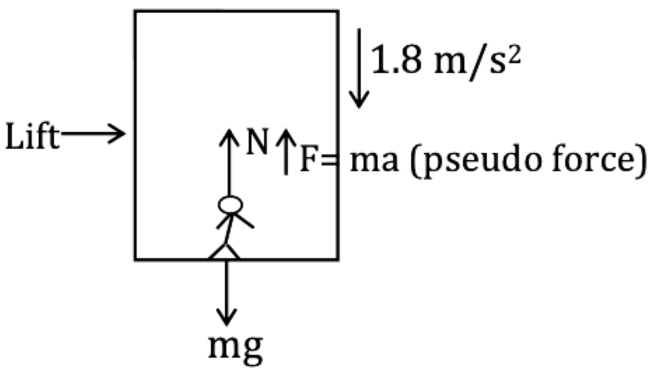
Solution

We know that while moving down in a lift pseudo force acting upwards that is why

$N = m(g - a)$

$N = 60(9.8 - 1.8)$

$N = 60 \times 8 = 480\ N$



14. **Moment of inertia of a body about two perpendicular axes X and Y in the plane of lamina are 20 kg m2 respectively. Its moment of inertia about an axis perpendicular to the plane of the lamina and passing through the point of intersection of X and Y axes is**

(A) 5 kg m^2 (B) 45 kg m^2 (C) 12.5 kg m^2 (D) 500 kg m^2

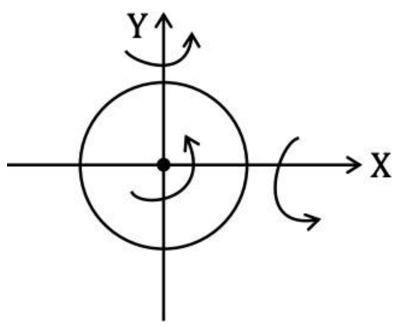
ANSWER (B)

Solution

$I_{33} = I_{XX} + I_{YY}$

$I_{33} = 20 + 25$

$I_{33} = 45\ Kg\ m^2$



15. **Two wires A and B are stretched by the same load. If the area of cross-section of Wire „A" is double that of „B" , then the stress on „B" is**

(A) Equal to that on A (B) Twice that on A

(C) Half that on A (D) Four times that on A

ANSWER (C)

Solution:

$$\text{Stress of A} = \frac{\text{Force}}{\text{Area of A}} = \frac{F}{A}$$

$$\text{Stress of B} = \frac{\text{Force}}{\text{Area of B}} = \frac{F}{2A}$$

If A is doubled the stress is half of that A

$$\frac{\text{Stress of A}}{\text{Stress of B}} = \frac{F/A}{F/2A}$$

$$\frac{\text{Stress of A}}{\text{Stress of B}} = \frac{1}{2}$$

---

16. The magnitude of point charge due to which the electric field 30 cm away has the Magnitude 2 NC^{-1} will be

(A) $2 \times 10^{-11}C$ (B) $3 \times 10^{-11}C$ (C) $5 \times 10^{-11}C$ (D) $9 \times 10^{-11}C$

ANSWER (A)

Solution

$$\text{The Electric field} : E = \frac{1}{4\pi\varepsilon_0} \times \frac{q}{d^2}$$

$$E = 9 \times 10^9 \times \frac{q}{(30 \times 10^{-2})^2}$$

$$2 = 9 \times 10^9 \times \frac{q}{(30 \times 10^{-2})^2}$$

$$q = \frac{2 \times 900 \times 10^{-4}}{9 \times 10^9} =$$

$$q = 2 \times 10^{-11} C$$

---

17. A mass of 1 kg carrying a charge of 2 C is accelerated through a potential of 1 V. The velocity acquired by it is

(A) $\sqrt{2}\,ms^{-1}$ (B) $2ms^{-1}$ (C) $\frac{1}{\sqrt{2}}ms^{-1}$ (D) $\frac{1}{2}ms^{-1}$

ANSWER (B)

Solution

$$qV = \frac{1}{2}mv^2$$

$$v = \sqrt{\frac{2qV}{m}}$$

$$v = \sqrt{\frac{2 \times 2 \times 1}{1}} = \sqrt{4} = 2\,m/s$$

---

18. The force of repulsion between two identical positive charges when kept, with a separation „r" in air is „F". Half the gap between the two charges is filled by a dielectric slab of dielectric constant = 4. Then, the new force of repulsion between those two charges becomes

$(A)\ \frac{F}{3}$ (B) $\frac{F}{2}$ (C) $\frac{F}{4}$ (D) $\frac{4F}{9}$

ANSWER (D)

Solution

According to Coulomb"s law in electrostatics, the force of repulsion between the two charges placed in an air medium is

$$F = \frac{1}{4\pi\varepsilon_0} \times \frac{q^2}{r^2}$$

When half of the gap between the two charges is filled with the dielectric slab dielectric constant K (=4) , the new force of repulsion between them becomes

$$F' = \frac{1}{4\pi\varepsilon_0} \times \frac{q^2}{([r-t] + t\sqrt{K})^2}$$

(Where t is the thickness of the slab, K is dielectric constant)

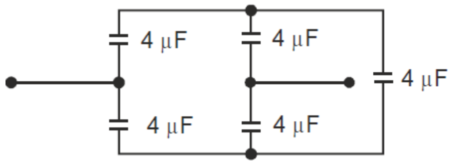
$$F' = \frac{1}{4\pi\varepsilon_0} \times \frac{q^2}{\left[\left(r-\frac{r}{2}\right)+\frac{r}{2}\sqrt{2}\ \right]^2} \quad \text{Because } t = \frac{r}{2}, K = 4$$

$$F' = \frac{1}{4\pi\varepsilon_0} \times \frac{q^2}{\left(\frac{r}{2}+r\right)^2} = \frac{1}{4\pi\varepsilon_0} \times \frac{q^2}{\left(\frac{3}{2}r\right)^2}$$

$$F' = \frac{4}{9}\frac{1}{4\pi\varepsilon_0}\left(\frac{q^2}{r^2}\right) = \frac{4F}{9}$$

---

19. For the arrangement of capacitors as shown in the circuit, the effective capacitance between the point A and B is (capacitance of each capacitor is 4 μF)

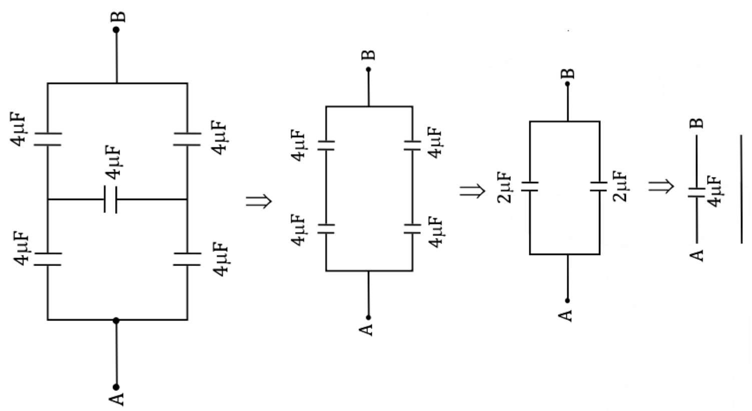


(A) 4 μF (B) 2 μF (C) 1 μF (D) 8 μF

ANSWER (A)

Solution

It resembles Wheatstone"s balanced network



20. The work done to move a charge on an equipotential surface is

(A) Infinity (B) Less than 1 (C) Greater than 1 (D) Zero

The work done equipotential surface is zero $= W = q(V_A - V_B)$ and $(V_A = V_B)$

ANSWER (D)

Solution

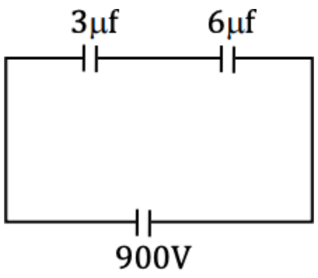
In an equipotential surface, all the points have same electric potential. Therefore, the work done requires to move a charge on an equipotential surface is zero.

21. Two capacitors of 3μF and 6μF are connected in series and a potential difference of 900V is applied across the combination. They are then disconnected and reconnected in parallel. The potential difference across the combination is

(A) Zero (B) 100 V (C) 200 V (D) 400 V

ANSWER (C)

Solution



Let $C_1 = 3\ \mu F, C_2 = 6\mu F$

Let C_1 and C_2 are connected in series with potential difference V= 900 V across the combination.

Thus for the series combination Charge on both capacitor is same

$$C_1V_1 = C_2V_2 = Q \dots\dots\dots (1)$$

$$\frac{V_1}{V_2} = \frac{C_2}{C_1} = 2\mu C \dots\dots\dots (2)$$

Also

$$V_1 + V_2 = 900\ V$$

From (2) and (3)

$$V_2 = 300V, \quad V_1 = 600\ V$$

$$\therefore \text{Charge on each capacitor} = Q = 300 \times 6 = 1800\ \mu C$$

When these capacitors are disconnected and reconnected in parallel the charge is redistributed and the potential difference is same

$$\frac{Q_1}{C_1} = \frac{Q_2}{C_2} = V \dots\dots\dots (4)$$

$$\frac{Q_1}{Q_2} = \frac{C_1}{C_2} = \frac{1}{2} \dots\dots\dots (5)$$

$$Q_1 + Q_2 = Q = 1800\ \mu C \dots\dots\dots (6)$$

From (5) and (6)

$$Q_1 = 600\ \mu C, \quad Q_2 = 1200\ \mu C$$

Therefore, the potential difference across the combination

$$V = \frac{600}{3} = \frac{1200}{6} = 200\ V$$

$$V = 200\ V$$

---

22. Ohm"s Law is applicable to

(A) Diode (B) Transistor (C) Electrolyte (D) Conductor

ANSWER (D)

Solution

Ohms law is applicable only to the conductors.

Resistance of a conductor is directly proportional to its length. That is, when the length of conductor is tripled, its resistance also gets tripled..... Explanation: According to the Ohm's law, it is applicable only to conductors. Hence, Ohm's law is not applicable in case of insulators.

---

23. If the last band on the carbon resistor is absent, then the tolerance is

(A) 5 % (B) 20 % (C) 10 % (D) 15 %

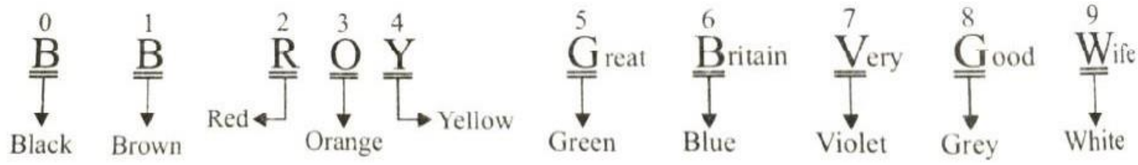
ANSWER (D)

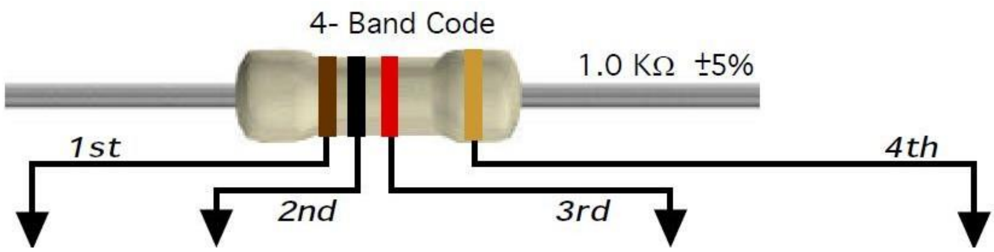
Solution

If the last bond on the carbon resistor is absent, there is no tolerance band, it is 20%.

	B	**B**	**R**	**O**	**Y**	**G**	**B**	**V**	**G**	**W**
Colours	Black	Brown	Red	Orange	Yellow	Green	Blue	Violet	Grey	White
Values	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

This can be easily remembered as **"BB ROY** of **G**reat **B**ritain having **V**ery **G**ood **W**ife.

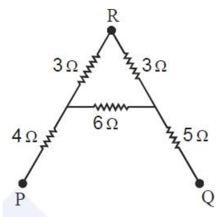




Value is 01 **(One)** Value is O **(Zero)** Value is 00 (**two zeros**)

---

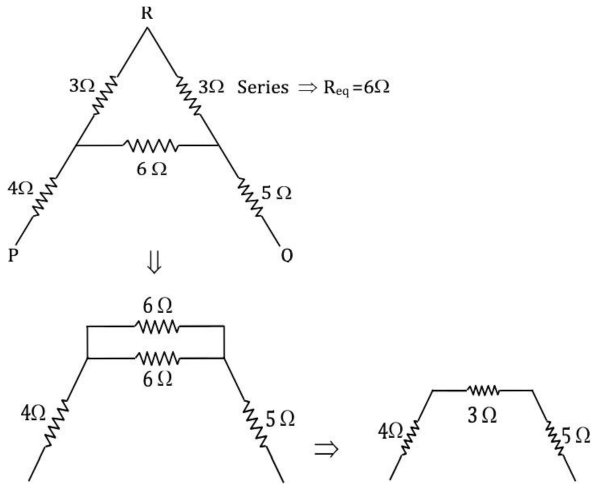
24. The effective resistance between P and Q for the following network is



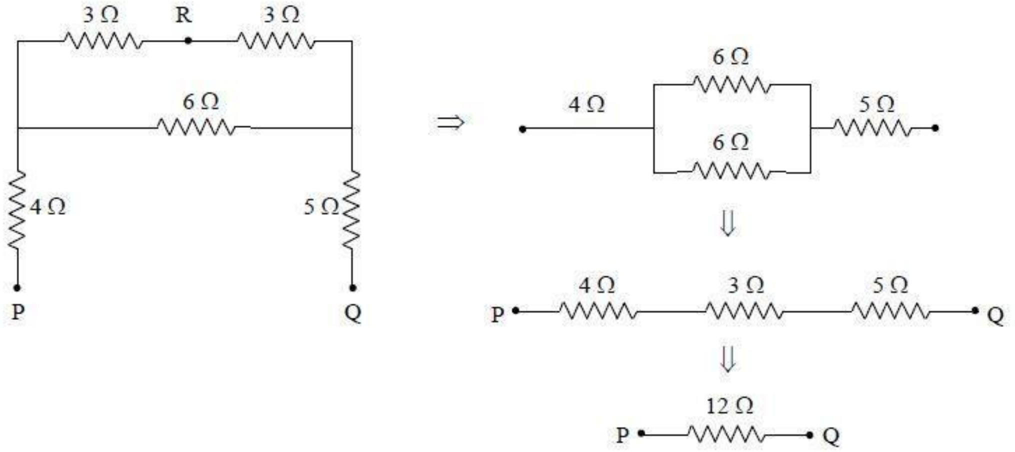
(A) $\frac{1}{12}\Omega$ **(B)** $21\ \Omega$ **(C)** $12\ \Omega$ **(D)** $\frac{1}{21}\Omega$

ANSWER (C)

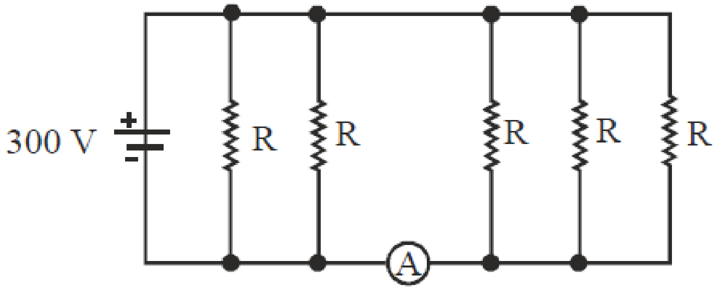
Solution



The circuit can be reduced as now hence $R_1 = 4 + 3 + 5 = 12\Omega$



25. **Five identical resistors each of resistance R = 1500 Ω are connected to a 300 V battery as shown in the circuit. The reading of the ideal ammeter A is**



(A) $\frac{1}{5}$ **A** **(B)** $\frac{3}{5}$ **A** **(C)** $\frac{2}{5}$ **A** **(D)** $\frac{4}{5}$ **A**

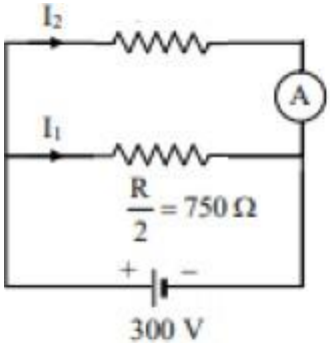
ANSWER (B)

Solution

All the resistances are in parallel.

In a given circuit, all five resistors are connected in parallel to a 300 V battery. Thus, the potential difference across each resistor is V = 300 V.

The given circuit can be redrawn into a simplified form as shown below.



By Ohm's law, current through each resistor

The current through the each resisitor = $I = \frac{V}{R} = \frac{300}{1500} = \frac{1}{5}$ A

The effective resistance to the Right side of the ammeter $= \frac{1}{R_p} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R}$

$$\frac{1}{R_p} = \frac{3}{R} = \frac{3}{1500}$$

$$R_p = \frac{1500}{3} = 500\ \Omega$$

An Ideal Ammeer reading is $= I_2 = \frac{V}{R_2} = \frac{300}{500}$

$$I_2 = \frac{300}{500} = \frac{3}{5}\ A$$

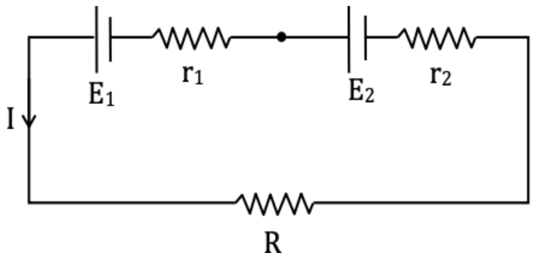
---

26. Two cells of internal resistances r_1 and r_2 and of same emf are connected in series, across a resistor of resistance R. If the terminal potential difference across the cells of internal resistance r_1 is zero, then the value of R is

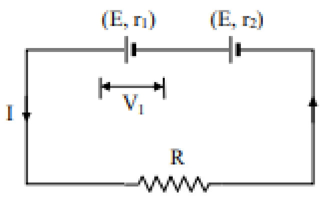
(A) $R = 2(r_1 + r_2)$ (B) $R = r_2 - r_1$ (C) $R = r_1 - r_2$ (D) $R = 2(r_1 - r_2)$

ANSWER (C)

Solution



or



According to Ohm"s law

$V = IR$

The current in the circuit: $I = \frac{V}{R} = \frac{2E}{R + r_1 + r_2}$

Terminal potential difference across First cell is $V_1 = E - Ir_1$

Given: $V_1 = 0$

$E - Ir_1 = 0$

$E - \left(\frac{2E}{R + r_1 + r_2}\right) r_1 = 0$

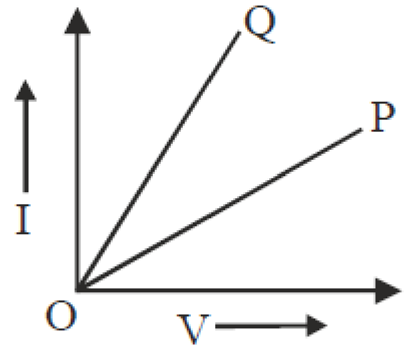
$E = \left(\frac{2Er_1}{R + r_1 + r_2}\right)$

$R + r_1 + r_2 = 2r_1$

$R = 2r_1 - r_1 - r_2$

$R = r_1 - r_2$

27. **The I – V graphs for two different electrical appliances P and Q are shown in thediagram. If RP and RQ be the resistances of the devices, then**



(A) $R_P = R_Q$ **(B)** $R_P > R_Q$ **(C)** $R_P < R_Q$ **(D)** $R_P = \frac{R_Q}{2}$

ANSWER (B)

Solution

$$\text{Slope} = \frac{I}{V} = \frac{I}{IR} = \frac{1}{R}$$

Slope of OQ > Slope of OP

$$\frac{1}{R_{OQ}} > \frac{1}{R_{OP}}$$

$$R_{OQ} < R_{OP}$$

$$R_P > R_Q$$

---

28. **The correct Biot-Savart"s law in vector form is**

(A) $\overrightarrow{dB} = \left(\frac{\mu_0}{4\pi}\right) \frac{\overrightarrow{dl}\,(I \times \vec{r})}{r^3}$ (B) $\overrightarrow{dB} = \left(\frac{\mu_0}{4\pi}\right) \frac{I\,(\overrightarrow{dl} \times \vec{r})}{r^3}$

(C) $\overrightarrow{dB} = \left(\frac{\mu_0}{4\pi}\right) \frac{I\,(\vec{r} \times \overrightarrow{dl})}{r^3}$ (D) $\overrightarrow{dB} = \left(\frac{\mu_0}{4\pi}\right) \frac{I\,(\overrightarrow{dl} \times \vec{r})}{2}$

ANSWER (D)

Solution

The magnetic field „dB" at a point due to current carrying (conductor) element is directly proportional to (i) The length of the element (dl). (ii) Strength of the current (I). (iii) Sine of the angle between elements line joining. (iv) Inversely proportional to the square of the distance between the point and the element (r).

$$dB \propto \frac{I\,dl\,\sin\theta}{r^2}$$

$$dB = \left(\frac{\mu_0}{4\pi}\right)\frac{I\,dl\,\sin\theta}{r^2}\ \ldots\ldots..wb/m^2 \text{ or tesla}$$

Where „I" is in ampere, „dl" and „r" are in metre.
In vector form, Biot and Savart"s law is written as

$$dB = \left(\frac{\mu_0}{4\pi}\right)\frac{I\,dl\,\sin\theta}{r^2}\,\hat{r} \qquad \text{Where } \hat{r} = \frac{\vec{r}}{r}$$

$$\overrightarrow{dB} = \left(\frac{\mu_0}{4\pi}\right)\frac{I\,(\overrightarrow{dl}\times\vec{r})}{r^3}$$

The direction of $\overrightarrow{dB}$ is perpendicular to the plane containing $\overrightarrow{dl}$ and $\vec{r}$

---

29. An electron is moving in a circle of radius r in a uniform magnetic field B. Suddenly, the field is reduced to B

(A) $\frac{r}{2}$ **(B)** $2r$ **(C)** $\frac{r}{4}$ **(D)** $4r$

ANSWER (B)

Solution

The radius of the circuilar path: $r = \frac{mv}{Bq} \Rightarrow r \propto \frac{1}{B}$

When b is reduced to B/2, r is doubled. The new radius of the path is 2r.

---

30. A charge q is accelerated through a potential difference V. It is then passed normally through a uniform magnetic field, where it moves in a circle of radius r. The potential difference required to move it in a circle of radius 2r is

(A) 2V (B) 4V (C) 1V (D) 3V

ANSWER (B)

Solution

If v is the velocity acquired by the charge when accelerated through the potential difference V, then

$$\frac{1}{2}mv^2 = qV$$

$$v = \sqrt{\frac{2qV}{m}}$$

When it passes normally through of uniform magnetic field B, it moves in the circle of radius

$$\frac{mv^2}{r} = qvB$$

$r = \frac{mv}{Bq} = \frac{m}{Bq}\sqrt{\frac{2qV}{m}}$

$r = \frac{\sqrt{2mqV}}{qB}$

$r \propto \sqrt{V}$ or $V \propto r^2$

Let V_2 be the required potential difference in order to move it in the circle of 2r.

$\frac{V_2}{V_1} = \left(\frac{r_2}{r_1}\right)^2$

$\frac{V_2}{V} = \left(\frac{2r_1}{r_1}\right)^2$ $\qquad V_1 = V$

$V_2 = 4V$

---

31. A cyclotron"s oscillator frequency is 10 MHz and the operating magnetic field is 0.66 T. If the radius of its dees is 60 cm, then the kinetic energy of the proton beam produced by the accelerator is

(A) 9 MeV (B) 10 MeV (C) 7 MeV (D) 11 MeV

ANSWER (C)

Solution

Given: Frequency: $\gamma = 10\text{MHz} \Rightarrow 10^7\text{Hz}$, $B = 0.66\text{ T}, R = 60\text{ cm} = 0.60\text{ m}$

Mass of the proton: $m = 1.67 \times 10^{-27}$ Kg; Charge of the proton $= 1.6 \times 10^{-19}$ C

Radius of the circlar path: $R = \frac{mv}{qB}$

The velocity of the proton $= v = \frac{BqR}{m}$

The kinetic energy of the proton $= K.E = \frac{1}{2}mv^2$

The kinetic energy of the proton $= K.E = \frac{1}{2}m\left(\frac{BqR}{m}\right)^2$

The kinetic energy of the proton $= K.E = \frac{B^2q^2R^2}{2m}$

$K.E = \frac{(0.66)^2(1.6 \times 10^{-19})^2(0.6)^2}{2 \times 1.67 \times 10^{-27}} = 1.2 \times 10^{-12}$ joule

$K.E = \frac{1.2 \times 10^{-12}}{1.6 \times 10^{-19}} = 0.75 \times 10^7$

$K.E = 7.5 \times 10^6 = 7.5$ MeV

---

32. Needles N_1, N_2 and N_3 are made of a ferromagnetic, a paramagnetic and a diamagnetic substance respectively. A magnet when brought close to them will

(A) Attract all three of them

(B) Attract N_1 strongly, N_2 weakly and repel N_3 weakly

(C) Attract N_1 strongly but repel N_2 and N_3 weakly

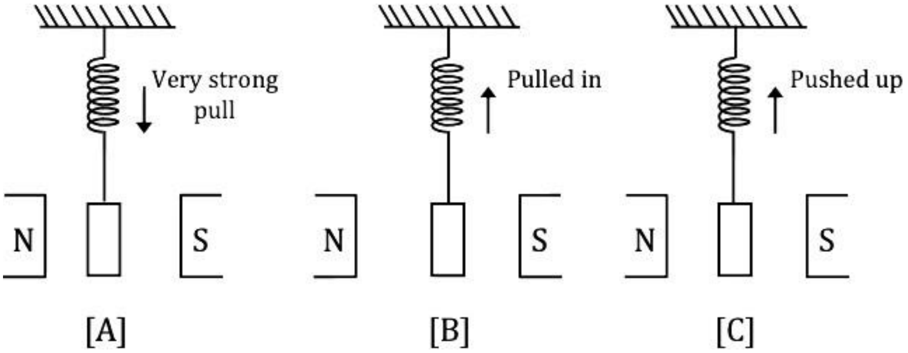
(D) Attract N_1 and N_2 strongly but repel N_3

ANSWER (B)

Solution

Ferromagnetic substances have strong tendency to get magnetised (induced magnetic moment) in the same direction as that of applied magnetic field, so magnet attracts N_1 strongly. Paramagnetic substances get weakly magnetised (magnetic moment induced is small) in the same direction as that of applied magnetic field, so magnet attracts N_2 weakly.

Diamagnetic substances also get weakly magnetised when placed in an external magnetic field but in opposite direction and hence, N_3 is weakly repelled by magnet.



(i) These are strongly attracted in an external magnetic field [In ferromagnetic substance]

(ii) These are feebly attracted in an external magnetic field (in Paramagnetic substance).

(iii) These are repelled in an external magnetic field. (In diamagnetic Substance)

(iv) So, A magnet will attract N_1 strongly, N_2 weakly and repel N_3 weakly.

---

33. The strength of the Earth"s magnetic field is

(A) Constant everywhere (B) Zero everywhere

(C) Having very high value (D)Varying from place to place on the Earth"s surface

ANSWER (D)

Solution

A magnetic field extends infinitely. The strength of the earth"s magnetic field is not constant. It varies from one place to another place on the surface of the earth.

---

34. A jet plane having a wing-span of 25 m is travelling horizontally towards east with a speed of 3600 km/hour. If the Earth"s magnetic field at the location is 4 × 10^{-4}T and the angle of dip is 30° , then, the potential difference between the ends of the wing is

(A) 4 V2 (B) 5 V (C) 2 V (D) 2.5 V

ANSWER (B)

Solution

$$\text{Length } (l) = 25 \text{ m, velocity: } v = 3600 \text{ km/hr} = \frac{3600}{60 \times 60} = 1 \text{ km/sec} = 1000 \text{ m/s}$$

$$\text{Magnetic field} = B = 4 \times 10^{-4} \text{ T}, \theta = 30^0$$

Vertical component of earths magnetic field $= B_V = B \sin\theta$

The potential difference between the two ends: $E = B_v L v = B \sin\theta\, L v$

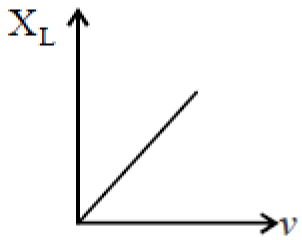
$$E = B_v L v = B \sin\theta\, L v$$

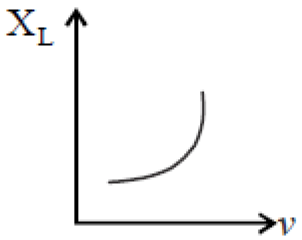
$$E = 4 \times 10^{-4} \times \frac{1}{2} \times 25 \times 1000$$

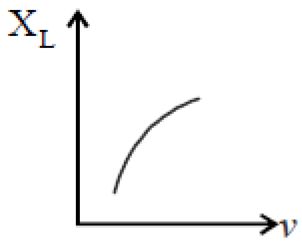
$$E = 5 \text{ volt}$$

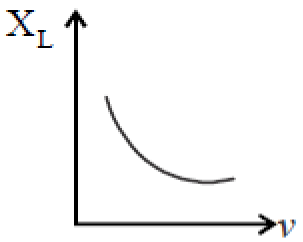
---

35. Which of the following represents the variation of inductive reactance (X_L) with the frequency of voltage source (V)?

(A)


(B)


(C)


(D)


ANSWER (A)

Solution

We know that

Inductive reactance

$$X_L = \omega_L$$

Inductive reactance: $X_L = \omega L = 2\pi\, \gamma\, L = 2\pi L\, \gamma$

This equation is similar to the equation of straight line Y = m × C.

---

36. The magnetic flux linked with a coil varies as $\Phi = 3t^2 + 4t + 9$. The magnitude of the emf induced at t = 2 seconds is

(A) 8 V (B) 16 V (C) 32 V (D) 64 V

ANSWER (B)

Solution

$$\text{e.m.f: } e = \frac{d\phi}{dt}$$

$$e = \frac{d}{dt}[3t^2 + 4t + 9]$$

$$e = 6t + 4$$

$$e = 6 \times 2 + 4 = 16 \text{ V}$$

---

37. A 100 W bulb is connected to an AC source of 220 V, 50 Hz. Then the current flowing through the bulb is

(A) $\frac{5}{11}$ A (B) $\frac{1}{2}$ A (C) 2 A (D) $\frac{3}{4}$ A

ANSWER (A)

Solution

$$\text{Power}: P = VI$$

$$\text{The current}: I = \frac{P}{A}$$

$$\text{The current}: I = \frac{100}{220} = \frac{5}{11}\,A$$

38. In the series LCR circuit, the power dissipation is through

(A) R (B) L (C) C (D) Both L and C

ANSWER (A)

Solution

$$P = V_{rms} I_{rms} \cos\phi$$

---

39. In Karnataka, the normal domestic power supply AC is 220 V, 50 Hz. Here 220 V and 50 Hz refer to

(A) Peak value of voltage and frequency

(B) Rms value of voltage and frequency

(C) Mean value of voltage and frequency

(D) Peak value of voltage and angular frequency

ANSWER (D)

Solution

$$I_{rms} = \frac{V_0}{\sqrt{2}}$$

Rms value of voltage and frequency

---

40. A step-up transformer operates on a 230 V line and l load current of 2 A. The ratio of primary and secondary windings is 1:25. Then the current in the primary is

(A) 25 A (B) 50 A(C) 15 A (D) 12.5 A

ANSWER (B)

Solution

$$\frac{N_P}{N_S} = \frac{I_S}{I_P}$$

$$I_P = \frac{N_S}{N_P} \times I_S$$

$$\frac{N_P}{N_S} = \frac{1}{25}$$

$$\frac{N_S}{N_P} = 25$$

$$I_P = 25 \times 2 = 50\ A$$

41. The number of photons falling per second on a completely darkened plate to produce a force of 6.62 × 10–5 N is „n‟. If the wavelength of the light falling is 5 × 10^{-7} m, then n = _× 10^{22}. (h = 6.62 × 10–34 J–s)

(A) 1 (B) 5 (C) 0.2 (D) 3.3

Given: $\lambda = 5 \times 10^{-7} m, F = 6.62 \times 10^{-5}$ N, Planck'sconstant $= h = 6.62 \times 10^{-34}$ JS

ANSWER (B)

Solution

$$P = \left(\frac{n}{t}\right) \times \frac{hC}{\lambda}$$

$$FC = \left(\frac{n}{t}\right) \times \frac{hC}{\lambda}$$

$$\left(\frac{n}{t}\right) = \frac{\lambda \times F_C}{h}$$

$$\left(\frac{n}{t}\right) = \frac{5 \times 10^{-7} \times 6.62 \times 10^{-5}}{6.62 \times 10^{-34}}$$

$$\left(\frac{n}{t}\right) = 5 \times 10^{22}$$

---

42. An object is placed at the principal focus of a convex mirror. The image will be at

(A) Centre of curvature (B) Principal focus (C) Infinity (D) No image will be formed

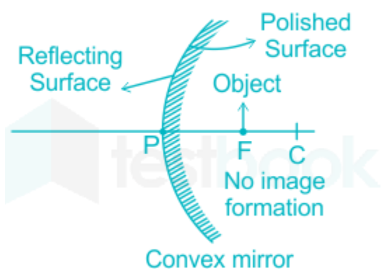
ANSWER (D)

Solution

The principle focus of a convex mirror is in the side which is opposite to the reflecting surface.

Images are formed only when there is a reflection of light by the reflecting surface. If there is no reflection of light then no images will be formed.

Since the object is at the principle focus of a convex mirror which is behind the reflecting surface, so there is no reflection of light by the mirror. So no images will be formed.



---

43. An object is placed at a distance of 20 cm from the pole of a concave mirror of focal length 10 cm. The distance of the image formed is

(A) + 20 cm (B) + 10 cm (C) –20 cm (D) – 10 cm

ANSWER (C)

Solution

Given: $u = -20$ cm, $f = -10$ cm

The lens formula is given by $= \frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$$\frac{-1}{10} = \frac{1}{V} + \frac{1}{-20}$$
$$\frac{1}{V} = \frac{1}{20} - \frac{1}{10}$$
$$\frac{1}{V} = \frac{1-2}{20}$$
$$\frac{1}{V} = \frac{-1}{20}$$
$$V = -20 \text{ cm}$$

---

44. A candle placed 25 cm from a lens forms an image on screen placed 75 cm on the other side of the lens. The focal length and type of the lens should be

(A) + 18.75 cm and convex lens **(B) – 18.75 cm and concave lens**
(C) + 20.25 cm and convex lens **(D) –20.25 cm and concave lens**

ANSWER (A)

Solution

Given: $u = -20$ cm, $v = 75$ cm

The lens formula is given by $= \frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$$\frac{1}{f} = \frac{1}{75} - \frac{1}{-25}$$
$$\frac{1}{f} = \frac{1}{75} + \frac{1}{25}$$
$$\frac{1}{f} = \frac{25+75}{75 \times 25} = \frac{100}{75 \times 25}$$
$$\frac{1}{f} = \frac{4}{75}$$
$$f = \frac{75}{4} \text{ cm}$$
$$f = 18.5 \text{ cm and convex lens}$$

---

45. A plane wavefront of wavelength λ is incident on a single slit of width a. The angular width of principal maximum is

(A) λ/a **(B) 2λ/ a** **(C)a /λ** **(D) a/2λ**

ANSWER (A)

Solution

The seperation between any two dark or bright fringes is called fringe width $\beta = \frac{\lambda D}{a}$

Where λ is the wave length, D is distance between slits and screen and „a" is slit width.

$$\beta = \frac{\lambda D}{a}$$

Angular fringe width is angle subtended by fringe width at slits is given by

$$\theta = \frac{\beta}{D}$$

$$\theta = \frac{\beta}{D} = \frac{\lambda}{a}$$

----

46. In a Fraunhofer"s diffraction at a single slit, if yellow light illuminating the slit is replaced by blue light, then diffraction bands

(A) Remain unchanged (B) Become wider

(C) Disappear (D) Become narrower

ANSWER (D)

Solution

The seperation between any two dark or bright fringes is called fringe width $\beta = \frac{\lambda D}{a}$

When blue light is used instead of yellow, λ decreases and hence diffraction bands become narrower

---

47. In Young"s double slit experiment, two wavelengths λ_1 = 780 nm and λ_2 = 520 nm are used to obtain interference fringes. If the nth bright band due to λ_1 coincides with $(n+1)^{th}$ bright band due to λ_2, then the value of n is

(A) 4 (B)3 (C) 2 (D) 6

ANSWER (C)

Solution

Given: $\lambda_1 = 780\text{ nm} = 780 \times 10^{-9}\text{ m}$, $\lambda_2 = 520\text{ nm} = 520 \times 10^{-9}\text{ m}$;

The fringe width of n^{th} bright band due to λ_1

$$\beta_1 = x_n = n\frac{\lambda_1 D}{d} \dots\dots\dots\dots (1)$$

The fringe width of $(n+1)^{th}$ bright band due to λ_2

$$\beta_2 = x_{n+1} = (n+1)\frac{\lambda_2 D}{d} \dots\dots\dots\dots (2)$$

According to problem, As n^{th} bright band due to $\lambda_1$coincides with $(n+1)^{th}$ bright band due to λ_2

$$\beta_1 = \beta_2$$

$$\frac{n\lambda_1 D}{d} = (n+1)\frac{\lambda_2 D}{d}$$

$$n\lambda_1 = (n+1)\lambda_2$$

$$\frac{n}{(n+1)} = \frac{\lambda_2}{\lambda_1}$$

$$\frac{n}{(n+1)} = \frac{520}{780}$$

$$\frac{n}{(n+1)} = \frac{52}{78}$$

$$78n = 52(n+1)$$

$$78n = 52n + 52$$
$$78n - 52n = 52$$
$$26n = 52$$
$$n = \frac{52}{26} = 2$$

---

48. **In Young"s double slit experiment, slits are separated by 2 mm and the screen is placed at a distance of 1.2 m from the slits. Light consisting of two wavelengths 6500 Å and 5200 Å are used to obtain interference fringes. Then the separation between the fourth bright fringes of two different patterns produced by the two wavelengths is**

(A) 0.312 mm **(B) 0.123 mm** **(C) 0.213 mm** **(D) 0.412 mm**

ANSWER (A)

Solution

Given: $\lambda_1 = 6500 \times 10^{-10}$ m, $\lambda_2 = 5200 \times 10^{-10}$ m; d = 2mm = 2×10^{-3}m; D = 1.2 m

The fringe width of 4th bright band due to λ_1

$$x_1 = n\frac{\lambda_1 D}{d} \ldots\ldots\ldots\ldots (1)$$

The fringe width of 4th bright band due to λ_2

$$x_2 = n\frac{\lambda_2 D}{d} \ldots\ldots\ldots\ldots (2)$$

According to problem, the separation between the fourth bright fringes of two different patterns produced by the two wavelengths is

$$x_1 - x_2 = n\frac{\lambda_1 D}{d} - n\frac{\lambda_2 D}{d}$$
$$x_1 - x_2 = n\frac{D}{d}[\lambda_1 - \lambda_2]$$
$$x_1 - x_2 = 4 \times \frac{1.2}{2 \times 10^{-3}}[6500 - 5200] \times 10^{-10}$$
$$x_1 - x_2 = 3120 \times 10^{-7}$$
$$x_1 - x_2 = 0.312 \times 10^{-3} m$$
$$x_1 - x_2 = 0.312 \text{ mm}$$

---

49. **The maximum kinetic energy of emitted photoelectrons depends on**

(A) Intensity of incident radiation **(B) Frequency of incident radiation**

(C) Speed of incident radiation **(D) Number of photons in the incident radiation**

ANSWER (B)

Solution

By Einstein's photoelectric equation, the kinetic energy of photoelectron is given by

$$\frac{1}{2}mv_{max}^2 = h(\gamma - \gamma_0)$$

(i) Depends on the frequency of incident light

(ii) Independent of intensity of light.

Therefore, there is no effect of intensity of light on the kinetic energy of emitted photoelectrons.

---

50. A proton and an α-particle are accelerated through the same potential difference V. The ratio of their de Broglie wavelengths is

(A) $2\sqrt{2}$ **(B)** $\frac{1}{2\sqrt{2}}$ **(C)** 2 **(D)** $\sqrt{2}$

ANSWER (A)

Solution

The de-Broglie wavelength of a particle of mass m and moving with velocity v is given by

$$\lambda = \frac{h}{P} = \frac{h}{mv}$$

The de-Broglie wavelength of a particle of proton of mass m_1 and kinetic energy is given by

$$\lambda_1 = \frac{h}{\sqrt{2m_1K}} \quad [\text{ Because } P = \sqrt{2mK}]$$

$$\lambda_1 = \frac{h}{\sqrt{2m_1qV}} \quad [\text{ Because K.E} = K = qV]$$

For an α- particle of mass m_2 carrying charge q_0, is accelerated through potential V, then

$$\lambda_2 = \frac{h}{\sqrt{2m_2q_0V}}$$

For an α- particle $({}_2^4He)$: of mass m_2 carrying charge $q_0 = 2q$ and $m_2 = 4m_1$.

$$\lambda_2 = \frac{h}{\sqrt{2 \times 4m_1 \times 2q \times V}} \quad \dots\dots\dots(2)$$

The ratio of their de Broglie wavelengths is

$$\frac{\lambda_1}{\lambda_2} = \frac{h}{\sqrt{2m_1qV}} \times \frac{\sqrt{2 \times 4m_1 \times 2q \times V}}{h} = \frac{4}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}} = 2\sqrt{2}$$

$$\frac{\lambda_1}{\lambda_2} = 2\sqrt{2}$$

---

51. The total energy of an electron revolving in the second orbit of hydrogen atom is

(A) – 13.6 eV **(B) –1.51 eV** **(C) –3.4 eV** **(D) Zero**

ANSWER (C)

Solution

The energy of an electron in the n^{th} orbit of hydrogen atom is : $E_n = -\frac{13.6}{n^2}$ eV

The energy of an electron in the 2^{nd} orbit of hydrogen atom is : $E_n = -\frac{13.6}{2^2}$ eV

$$E_n = -\frac{13.6}{2^2} \text{ eV}$$

$$E_n = -\frac{13.6}{4} = -3.4 \text{ eV}$$

---

52. The period of revolution of an electron in the ground state of hydrogen atom is T. The period of revolution of the electron in the first excited state is

(A) 2T (B) 4T (C) 6T (D) 8T

ANSWER (D)

Solution

The period of revolution of an electron is n^{th} orbit of hydrogen atom is

$$T_n = \frac{2\pi r_n}{v_n} = \frac{4\varepsilon_0^2 h^3 n^3}{me^4} \left(r_n = \frac{n^3 h^3 \varepsilon_0}{\pi m e^4}, v_n = \frac{e^3}{2\pi\varepsilon_0 hn} \right)$$

$$T_n \propto n^3$$

For Ground state $n_1 = 1$ and Excited state $n_2 = 2$

$$\frac{T_2}{T_1} = \frac{2^3}{1^3}$$

$$T_2 = 8T_1$$

But as per question T_1=T

$$T_2 = 8T$$

---

53. The energy equivalent to a substance of mass 1g is

(A) 18 × 10^{13} J (B) 9 × 10^{13} J (C) 18 × 10^{6} J (D) 9 × 10^{6} J

ANSWER (B)

Solution

According to Einstein"s mass energy relation

$$E = mC^2$$

$$E = 1 \times 10^{-3} (3 \times 10^8)^2$$

$$E = 9 \times 10^{13} \text{ J}$$

---

54. The half-life of tritium is 12.5 years. What mass of tritium of initial mass 64 mg will remain undecayed after 50 years?

(A) 32 mg (B) 8 mg (C) 16 mg (D) 4 mg

ANSWER (D)

Solution

Here,

Half - life of tritium , $T_{1/2}$ =12.5=12.5 years

Initial mass of tritium, M_0 = 64 mg

Time, t = 50 years

Mass of tritium remained undecayed after 50 years is ,

$$\frac{N}{N_0} = \frac{1}{2x}$$

55. In a CE amplifier, the input ac signal to be amplified is applied across

(A) Forward biased emitter-base junction

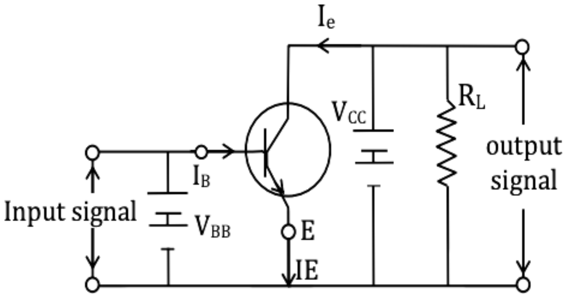
(B) Reverse biased collector-base junction

(C) Reverse biased emitter-base junction

(D) Forward biased collector-base junction

ANSWER (A)

Solution



For a CE amplifier, input is base amplifiers junction. Hence, the input ac signal to be amplified is applied across Forward biased emitter-base junction.

---

56. If A = 1 and B = 0, then in terms of Boolean algebra, A + B =

(A)B (B)B (C)A (D) A

ANSWER (A)

Solution

If A = 1 and B = 0

Hence $\vec{B} = 1$

Therefore, $A + \vec{B} = 1 + 1 = 1 = A$

---

57. The density of an electron-hole pair in a pure germanium is 3×10^{16} m^{-3} at room temperature. On doping with aluminium, the hole density increases to 4.5×10^{22} m^{-3}. Now the electron density (in m^{-3}) in doped germanium will be

(A) 1×10^{10} (B) 2×10^{10} (C) 0.5×10^{10} (D) 4×10^{10}

ANSWER (B)

Solution

At room temp, Denidty of electron – hole pair in pure Ge $= n_1 = 3 \times 10^{16} m^{-3}$

on Doping aluminium, Denidty of holes $= n_2 = 4.5 \times 10^{22}\ m^{-3}$

$$n_1^2 = n_h n_e$$

$$n_e = \frac{n_1^2}{n_h} = \frac{(3 \times 10^{16})^2}{4.5 \times 10^{22}}$$

$$n_e = \frac{n_1^2}{n_h} = \frac{9 \times 10^{32}}{4.5 \times 10^{22}} = 2 \times 10^{10} m^{-3}$$

---

58. The dc common emitter current gain of a n-p-n transistor is 50. The potential difference applied across the collector and emitter of a transistor used in CE

configuration is, VCE = 2 V. If the collector resistance, RC = 4 k , the base current (IB) and the collector current (IC) are

(A) I_B = 10 μA, IC = 0.5 mA **(B) I_B = 0.5 μA, IC = 10 mA**

(C) I_B = 5 μA, IC = 1 mA **(D) I_B = 1 μA,, IC = 0.5 mA**

ANSWER (A)

Solution

$$I_C = \frac{V_{CE}}{R_C} = \frac{2}{4 \times 10^3}$$

$$I_C = \frac{V_{CE}}{R_C} = 0.5 \times 10^{-3}\ A = 0.5\ mA$$

$$\beta = \frac{I_C}{I_B}$$

$$I_C = \frac{V_{CE}}{R_C} = 0.5 \times 10^{-3}\ A = 0.5\ mA$$

$$I_B = \frac{I_C}{\beta} = \frac{0.5 \times 10^{-3}}{50}$$

$$I_B = 10^{-5} A = 10\ \mu A$$

---

59. The radius of the Earth is 6400 km. If the height of an antenna is 500 m, then its range is

(A) 800 km (B) 100 km (C) 80 km (D)10 km

ANSWER (C)

Solution

$$\text{The range} = 2Rh = 2 \times 6400 \times 10^3 \times 500$$

$$\text{The range} = \sqrt{2Rh} = \sqrt{2 \times 6400 \times 10^3 \times 500} = 80 \times 10^3 m = 80\ km$$

---

60. A space station is at a height equal to the radius of the Earth. If „VE" is the escape velocity on the surface of the Earth, the same on the space station is _______times VE.

(A) 12 (B) 14 (C) 12 (D) 13

ANSWER (C)

Solution

$$\text{Th gravitational potential enrgy}: u_s = \frac{GMm}{2R}$$

$$\text{Kinetic Energy} = \text{Potential Energy}$$

$$\frac{1}{2} m v_s^2 = \frac{GMm}{2R}$$

$$v_s^2 = \frac{GM}{R}$$

The relation between „g" and „G" is given by

$$gR^2 = GM$$

$$v_s = \sqrt{gR}$$

The escape velocity $= v_e = \sqrt{2gR} = \sqrt{2}\sqrt{gR}$

$$v_e = \sqrt{2}\, v_s$$

$$v_s = \frac{v_e}{\sqrt{2}}$$

****

KCET – 2017: PHYSICS

Question 1: **A substance of mass 49.53 g occupies 1.5 cm^3 of volume. The density of the substance (in g/cm^3) with the correct number of significant figures is**
(A) 3.302 (B) 3.3 (C) 3.3 (D) 3.30

Answer: (NONE OF THE ABOVE)

Solution:

$$\text{Mass of the substance: } m = 49.535 \text{ g}$$

$$\text{Volume of the substance: } V = 1.5\text{cm}^3$$

$$\text{Mass} = \text{Volume} \times \text{Density}$$

$$\text{Density } = \frac{\text{Mass}}{\text{Volume}}$$

$$\text{Density } = \frac{59.535}{1.5}$$

$$\text{Density} = 39.69 \text{ g/cm}^3$$

Solution: Bonus Mark

Question 2: A car moving with a velocity of 20 ms^{-1} is stopped in a distance of 40 m. If the same car is travelling at double the velocity, the distance travelled by it for the same retardation is
(A) 640 m (B) 320 m (C) 1280 m (D) 160 m

ANSWER: (D)

Solution:

$$\text{Given: Initial velocity of the car} = \ u = 20 \text{ m/s}$$

$$\text{Final velocity of the car} = v = 0 \text{ m/s, Reatardation} = a$$

Case – I

$$V^2 = u^2 + 2as$$

$$0 = (20)^2 + 2 \times a \times 40$$

$$0 = 400 + 2 \times a \times 40$$

$$0 = 400 + 80a$$

$$-400 = 80a$$

$$a = -\frac{400}{80} = -5 \ {}^{m}/_{s^2}$$

$$a = -5 \ {}^{m}/_{s^2}$$

Case – II

$$u = 40 \, {}^{m}/_{s} \ , V = 0 \, {}^{m}/_{s} \ , a = -5 \, {}^{m}/_{s^2}$$

$$u = 40 \, {}^{m}/_{s} \ , V = 0 \, {}^{m}/_{s} \ , a = -5 \, {}^{m}/_{s^2}, \qquad S = ?$$

$$V^2 = u^2 + 2as$$

$$0 = (40)^2 + 2 \times (-5) \times S$$

$$0 = 1600 - 10\,S$$

$$10S = 1600$$

$$S = \frac{1600}{10} = 160\ m$$

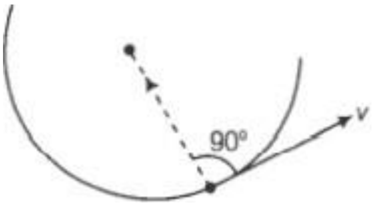
Question 3: The angle between velocity and acceleration of a particle describing uniform circular motion is

(A) 45º (B) 60º (C) 90º (D) 180º

ANSWER: (C)

Solution:

When an object follows a circular path at a constant speed, the motion of object is called uniform circular motion. Although the speed does not vary the particle is accelerating because the velocity changes its direction at every point on circular track.



The acceleration is centripetal, which is perpendicular to motion at every point and acts along the radius and directed towards the centre of the curved circular path **[From internet].**

$$= \frac{90 \times 10^{-3}}{3.14 \times \left(\frac{0.1 \times 10^{-3}}{2}\right)^2}$$

$$= 1200 \times 10^{-3}$$

$$= 1200 \times 10^{3}$$

$$= 12 \times 10^{7}\ A/m^2$$

In a circular motion, the direction of velocity at a point is given by the direction of tangent at that point. In case of uniform circular motion, the acceleration is zero in the direction of motion. Hence, the velocity changes in the direction perpendicular to the direction of motion. Therefore, the acceleration is acting towards the center of the circle..

Question 4: If $A = (2\hat{\imath} + 3\hat{\jmath} + 8\hat{k})$and $B = (4\hat{\imath} + 4\hat{\jmath} + \alpha\hat{k}) = 0$ is perpendicular to $B = (4\hat{\imath} + 4\hat{\jmath} + \alpha\hat{k})$ then the value of „α" is

(A)1/2 (B) -1/ 2 (C) 1 (D) –1

ANSWER: (B)

Solution:

When vectors are perpendicular to each other, then their dot product is zero.

$$\vec{A}.\vec{B} = 0$$

$$(2\hat{\imath} + 3\hat{\jmath} + 8\hat{k}) = (4\hat{\imath} + 4\hat{\jmath} + \alpha\hat{k}) = 0$$

$$-8 + 12 + 8\alpha = 0$$

$$8\alpha = -4$$

$$\alpha = \frac{1}{2}$$

Question 5: **A body of mass 50 kg, is suspended using a spring balance inside a lift at rest. If the lift starts falling freely, the reading of the spring balance is**
(A) = 50 kg (B) > 50 kg (C) < 50 kg (D) = 0

Solution:

As the lift is falling freely, therefore its acceleration = g (downwards). Let, the force acting on body due to spring is "F"

∴ (50g) – F = (50) a

50g – F = 50 g

F = 0

Thus, no force is acting on the body due to spring. So, the reading of spring balance is zero.

Question 6: **A motor pump lifts 6 tons of water from a well of depth 25m to the first floor of height 35 m from the ground floor in 20 minutes. The power of the pump (in kW) is [g = 10 ms^{-2}]**
(A)3 (B)6 (C)1.5 (D)12

ANSWER: (A)

Solution:

Given

$$\text{Height} = 25 + 35 = 60\text{m}$$

$$\text{Power} = \frac{\text{Work done}}{\text{Time taken}}$$

$$P = \frac{\text{Force} \times \text{Distance}}{\text{Time taken}}$$

$$P = \frac{mg \times h}{t}$$

$$P = \left(\frac{m}{t}\right) gh$$

$$\text{Flow rate} = \left(\frac{m}{t}\right) = 6 \text{ tones}/20 \text{ min}$$

$$\text{Flow rate} = \frac{6000}{20 \times 60} = 5\text{kg/s}$$

$$P = 5 \times 10 \times 60 = 300 \text{ W}$$

$$P = 3\text{k W}$$

Question 7: **Two balls are thrown simultaneously in the air. The acceleration of the centre of mass of the two balls when in air**
(A) Depends on the masses of the two balls
(B) Depends on the speeds of the two balls
(C) Is equal to g (Acceleration due to gravity)

(D) Depends on the direction of motion of the two balls

ANSWER: (C)

Solution:

There is no force acting on the two bodies in the horizontal direction. Therefore, no acceleration of COM in horizontal direction. In case of vertical motion, the two balls acted upon by the gravitational force only. Therefore, the acceleration of COM is equal to the acceleration due to gravity (g).

Question 8: The value of acceleration due to gravity at a depth of 1600 km is equal to [Radius of earth = 6400 km]

(A) 9.8 ms^{-2} (B) 19.6 ms^{-2} (C) 4.9 ms^{-2} (D) 7.35 ms^{-2}

ANSWER: (D)

Solution:

$$\text{Given depth: } d = 1600 \text{ km}; \ R_e = 6400 \text{ km}; g = 9.8 \text{ m/s}^2$$

Acceleration due to gravity at a depth "d":

$$g_d = g\left(1 - \frac{d}{R_e}\right)$$

$$g_d = 9.8\left(1 - \frac{1600}{6400}\right)$$

$$g_d = 9.8\left(\frac{6400 - 1600}{6400}\right)$$

$$g_d = 9.8\left(\frac{4800}{6400}\right)$$

$$g_d = 9.8 \times 0.75$$

$$g_d = 7.35\ m/s^2$$

Question 9: „Young"s modulus is defined as the ratio of

(A) Tensile stress and longitudinal strain (B) Hydraulic stress and hydraulic strain

(C) Shearing stress and shearing strain (D) Bulk stress and longitudinal strain

ANSWER: (A)

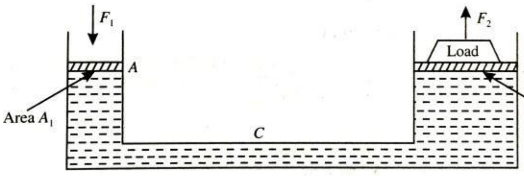
Solution: within the elastic limit

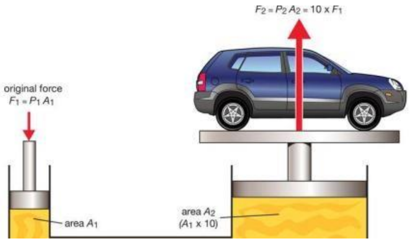
$$\text{Young}'\text{modulus} = \frac{\text{Tensile or Loniudinal or Linear stress}}{\text{Tensile or Loniudinal or Linear strain}}$$

Question 10: „Hydraulic lift" works on the basis of

(A) Stoke"s law (B) Toricelli"s law (C) Pascal"s law (D) Bernoulli"s law

ANSWER: (C) Solution:





Hydraulic lift works on the basis of Pascal's law. Pascal's law states that *If the pressure in a liquid is changed at a particular point, the change is transmitted to all the points of the entire liquid without being diminished in magnitude.*

Question 11: The S.I. unit of specific heat capacity is

(A) J mol^{-1} K^{-1} (B) J kg^{-1} K^{-1} (C) J K^{-1} (D) J kg

ANSWER: (B)

Solution:

Specific heat caapcity $S = \left(\frac{Q}{m\Delta T}\right)$

Q → Amount of heat absorbed

M → Mass of the substance

T → Change in temperature of the substance

SI unit of S → J kg^{-1} K^{-1}

Heat capacity is the amount of heat required to raise the temperature of the entire substance through one degree kelvin (1^0 K). The S.I unit is J/ K.

Question 12: For which combination of working temperatures, the efficiency of „Carnot‟s engine‟ is the least?

(A) 60K, 40 K(B) 40K, 20K (C) 80K, 60K (D) 100K, 80K

ANSWER: (D)

Solution:

For Cornots heat engine, the efficiency $= \eta = 1 - \frac{T_1}{T_2}$

Now, let‟s check options.

$(A)\ \eta_A = 1 - \frac{40}{60} = 0.33$ $(B)\ \eta_B = 1 - \frac{20}{40} = 0.50$

$(C)\ \eta_B = 1 - \frac{60}{80} = 0.25$ $(C)\ \eta_D = 1 - \frac{80}{100} = 0.2$

Thus the efficiency is more if the temperature difference $T_1 - T_2$ is more or T_1 is less. In all the four cases, T_1-T_2 is the same. η is the minimum when T_1 is maximum. T_1 is maximum in option (D) i.e. 100K and 80K.

Question 13: **The mean energy of a molecule of an ideal gas is**

(A) 2 KT **(B) [3 / 2] KT** **(C) KT** **(D)1/2 KT**

ANSWER: (B)

Solution:

Mean energy of a molecule of an ideal gas:

$$E = \frac{1}{2} mV_{rms}^2$$

Root mean square velocity of molecules : $V_{rms} = \sqrt{\frac{3KT}{m}}$

$$E = \frac{1}{2} m \times \frac{3KT}{m}$$

$$E = \frac{3KT}{2}$$

Question 14: **Two simple pendulums A and B are made to oscillate simultaneously and it is found that A completes 10 oscillations in 20 sec and B completes 8 oscillations in 10 sec. The ratio of the lengths of A and B is**

(A) 8/5 **(B) 64/25** **(C) 5/4** **(D) 25/64**

ANSWER: (B)

Solution:

The time period of the simple pendulum: $T = 2\pi\sqrt{\frac{l}{g}}$

$$\frac{l_A}{l_B} = \left[\frac{T_A}{T_B}\right]^2$$

Time period of A: $T_A = \frac{20}{10} = 2$ sec

Time period of A: $T_B = \frac{10}{8} = \frac{5}{4}$ sec

$$\frac{l_A}{l_B} = \frac{64}{25}$$

Question 15: **The waves set up in a closed pipe are**

(A) Transverse and progressive **(B) Longitudinal and stationary**

(C) Transverse and stationary **(D) Longitudinal and progressive**

ANSWER: (B)

Solution:

The waves set up in a closed pipe are longitudinal and stationary because of the superposition of incident wave and reflected wave.

Question 16: Two spheres of electric charges +2 nC and −8 nC are placed at a distance „d" apart. If they are allowed to touch each other, what is the new distance between them to get a repulsive force of the same magnitude as before?

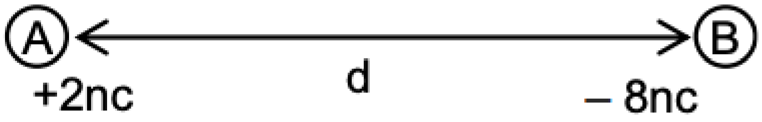
(A) 4d/3 (B) 3d/4 (C) d (D) d/2

ANSWER: (B)

Solution:

Given: $q_A = +2nC = 2 \times 10^{-9}C, q_B = -8nC = -8 \times 10^{-9}C, \quad r = d$

Case – I:



$$\text{The force of attraction: } F_1 = K\frac{q_A q_B}{r^2}$$

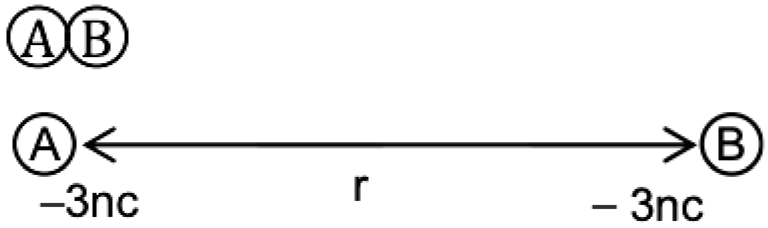
$$\text{The force of attraction: } F_1 = K\frac{2 \times 10^{-9} \times 8 \times 10^{-9}}{d_1^2}$$

$$\text{The force of attraction: } F_1 = K\frac{16 \times 10^{-18}}{d_1^2} \ldots\ldots\ldots\ldots (1)$$

Case – II:

After touching of sphere to each other the total charge = (2−8) nC = −6 nC

$$\text{Charge on each sphere} = 3nC = 3 \times 10^{-9}C$$



$$\text{The force of repulsion: } F_2 = K\frac{3 \times 10^{-9} \times 3 \times 10^{-9}}{d_2^2}$$

$$\text{The force of repulsion:: } F_2 = K\frac{9 \times 10^{-18}}{d_2^2} \ldots\ldots\ldots\ldots (2)$$

$$\text{The force of attraction: } F_1 = \text{ The force of repulsion:: } F_2$$

$$K\frac{16 \times 10^{-18}}{d_1^2} = K\frac{9 \times 10^{-18}}{d_2^2}$$

$$\frac{d_2^2}{d_1^2} = \frac{9}{16}$$

$$d_2^2 = \frac{9}{16}d_1^2$$

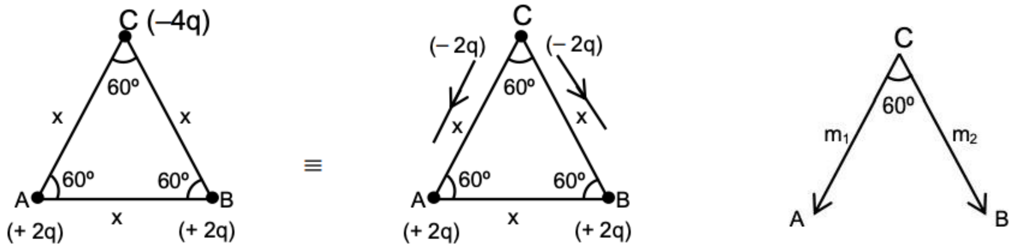
$$d_2 = \frac{3}{4}d_1$$

Question 17: **Three-point charges of +2q, + 2q and –4q are placed at the corner A, B and C of an equilateral triangle ABC of side „x". The magnitude of the electric dipole moment of this system is**

(A)2qx (B)2√3qx (C)3√2qx (D)3qx

ANSWER: (B)

Solution:



From the figure, the two dipoles one is CA and CB.

M_1 = Dipole moment ofdue to charges at C and A (From C to A)

M_2 = Dipole moment ofdue to charges at C and B (From C to B)

M_1: Dipole moment = Magnitud of Charge × Distance between A and C

M_2: Dipole moment = Magnitud of Charge × Distance between B and C

M_1: Dipole moment = $2q \times x$

M_2: Dipole moment = $2q \times x$

The net Electric dipole moment: M or P = $\sqrt{M_1^2 + M_2^2 + 2M_1 M_2 \cos 60^0}$

$$M = \sqrt{M_1^2 + M_2^2 + 2M_1M_2 \times \frac{1}{2}}$$

$$M = \sqrt{M_1^2 + M_2^2 + M_1M_2}$$

$$M = \sqrt{4q^2x^2 + 4q^2x^2 + 4q^2x^2}$$

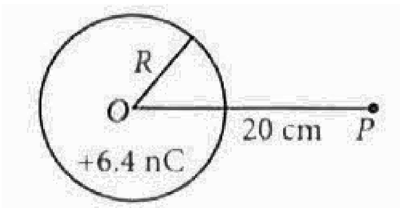
$$M = \sqrt{12q^2x^2} = 2\sqrt{3}\,qx$$

Question 18: **4 × 10^{10} electrons are removed from a neutral metal sphere of diameter 20 cm placed in air. The magnitude of the electric field (in NC^{-1}) at a distance of 20 cm from its centre is**

(A) 5760 (B) 1440 (C) 640 (D) Zero

ANSWER: (B)

Solution:



Total Number of electrons removed (n) = 4×10^{10}

Total Number of charges removed : $q = n \times e = 4 \times 10^{10} \times 1.6 \times 10^{-19}$ C

$$n = 6.4 \times 10^{-9} C$$

Distance of point from centre of sphere = 20 cm = 0.2 m
Radius of the sphere: r = 0.01 m

$$\text{Electric field: } E = \frac{1}{4\pi\varepsilon_0} \times \frac{q_1 q_2}{r^2}$$

$$\text{Electric field: } E = 9 \times 10^9 \times \frac{6.4 \times 10^{-9}}{(0.2)^2}$$

$$\text{Electric field: } E = 1400 \ \text{N/C}$$

Question 19: Two-point charges A = +3nC and B = 1nC are placed 5 cm apart in the air. The work done to move charge B towards A by 1 cm is
(A) 1.35 × 10^{-7} J (B) 2.7 × 10^{-7} J(C) 2.0 × 10^{-7} J (D) 12.1 × 10^{-7} J

ANSWER: (A)

Solution:

$$\text{Given: } A = +3\text{nC} = 3 \times 10^{-9} \text{ C}$$

$$\text{Given: } A = +3\text{nC} = 3 \times 10^{-9}\text{C}, B = +1 \text{ nC} = +1 \times 10^{-9}\text{C}$$

$$\text{Distance } r_1 = 5\text{cm} = 0.05\text{m} = 5 \times 10^{-2}\text{m}$$

$$\text{The Potential energy of the system: } V_1 = \frac{1}{4\pi\varepsilon_0} \times \frac{q_A q_B}{r}$$

$$V_1 = 9 \times 10^9 \times \frac{3 \times 10^{-9} \times +1 \times 10^{-9}}{0.05}$$

$$V_1 = 5.4 \times 10^{-7} \text{ J}$$

$$\text{Suppose the charge} + \text{nC move towrds the charge} + 3\text{nC}$$

$$\text{Distance } r_2 = r_1 - 1 = 0.05\text{m} - 0.01\text{m} = 0.04\text{m}$$

$$\text{The Potential energy of the system: } V_2 = \frac{1}{4\pi\varepsilon_0} \times \frac{q_A q_B}{r}$$

$$V_2 = 9 \times 10^9 \times \frac{3 \times 10^{-9} \times +1 \times 10^{-9}}{0.04}$$

$$V_2 = 6.75 \times 10^{-7} \text{ J}$$

$$\text{The work done: } W = V_2 - V_1 = (6.75 - 5.4) \times 10^{-7} \text{ J}$$

$$W = V_2 - V_1 = 1.35 \times 10^{-7} \text{ J}$$

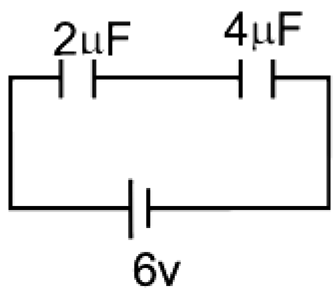
Question 20: A system of 2 capacitors of capacitance 2μF and 4μF is connected in series across a potential difference of 6V. The electric charge and energy stored in the system are

(A)10μC and 30 Mj **(B) 36μC and 108μJ**
(C) 8μC and 24μJ **(D) 1μC and 2μJ**

ANSWER: (C)

Solution:

When the two capacitors are connected in series



The equivlent capacitance connected in series: $\frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2}$

$$C_S = \frac{C_1 \times C_2}{C_1 + C_2}$$
$$C_S = \frac{(2 \times 4) \times 10^{-6}}{(2+4)} = \frac{8}{6} \mu F$$
$$C_S = \frac{8}{6} \times 10^{-6} F$$

Potential difference across the equivalent capacitance: V= 6 volt.

The charge on each capacitor $= Q = C_S\ V$

$$Q = \frac{8}{6} \times 10^{-6} \times 6\ C$$
$$Q = 8 \times 10^{-6}\ C = 8\mu C$$

Energy stored in the sytem: $E = \frac{1}{2} C_S V^2$

$$E = \frac{1}{2} \times \frac{8}{6} \times 10^{-6} \times (6)^2$$
$$E = 24 \times 10^{-6}\ J = 24\ \mu J$$

Question 21: The minimum value of effective capacitance that can be obtained by combining 3 capacitors of capacitances 1pF, 2pF and 4pF are connected in series IS

(A) (4/7) pF (B) 1 pF (C) (7/4) pF (D) 2 pF

Solution:

ANSWER: (A)

The capacitance is minimum when three capacitors are connected in series.

The equivlent capacitance of 3 capacitors connected in series: $\frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

$$\frac{1}{C_S} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$
$$\frac{1}{C_S} = \frac{1}{1} + \frac{1}{2} + \frac{1}{4}$$
$$\frac{1}{C_S} = \frac{8+4+2}{8}$$

$$\frac{1}{C_S} = \frac{14}{8}$$

$$C_S = \frac{8}{14} = \frac{4}{7}\,\text{pF}$$

Question 22: A cylindrical conductor of diameter 0.1 mm carries a current of 90 mA. The current density (in Am^{-2}) is ($\pi \simeq 3$)

(A) 1.2×10^7 (B) 2.4×10^7 (C) 3×10^6 (D) 6×10^6

ANSWER: (A)

Solution:

Given: $I = 90\text{ mA} = 90 \times 10^{-3}\text{A}$, diameter of wire: $d = 0.1\text{mm} = 10^{-4}\text{m}^2$

The area of cross section of wire : $A = \dfrac{\pi d^2}{4}$

$$A = \frac{\pi d^2}{4} = \frac{3.14 \times 10^{-4}}{4}$$

$$A = 0.75 \times 10^{-8}\text{ m}^2$$

The current density: $J = \dfrac{I}{A}$

$$J = \frac{I}{A} = \frac{90 \times 10^{-3}}{0.75 \times 10^{-8}}$$

$$J = 120 \times 10^5 = 1.2 \times 10^7\text{A/m}^2$$

Question 23: A piece of copper is to be shaped into a conducting wire of maximum resistance. The suitable length and diameter are __________ and ____________respectively.

(A) L and d (B) L and d (C) L/2 and 2 d (D) 2L and d/2

Solution:

ANSWER: (D)

The resistace of thecopper wire: $R = \dfrac{\rho L}{A}$

Where: ρ → Resistivity of material and is constant, L → Length of wire, A → Cross-sectional area of conductor

The area of cross section of wire : $A = \dfrac{\pi d^2}{4}$

d → diameter of the wire

$R = \rho L \times \dfrac{4}{\pi d^2}$ Constant: $K = \dfrac{4\rho}{\pi}$

$$R = \text{Constant} \times \frac{L}{d^2}$$

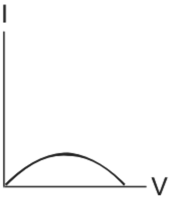
$$R = K \times \frac{L}{d^2}$$

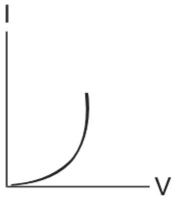
R a L / d^2

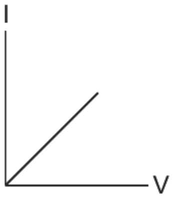
Now, let‟s check the options

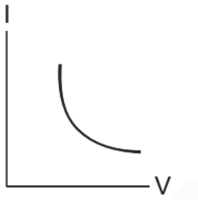
(A) $R_A \propto \left(\frac{L}{d^2}\right)$ (B) $R_B \propto 2\left(\frac{L}{d^2}\right)$ (C) $R_C \propto \left(\frac{1}{8}\right)\left(\frac{L}{d^2}\right)$ (D) $R_D \propto 8\left(\frac{L}{d^2}\right)$

Question 24: Of the following graphs, the one that correctly represents the I –V characteristics of a „Ohmic device‟ is

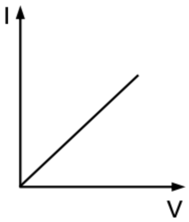
a.


b.


c.


d.


ANSWER: (C) Solution:

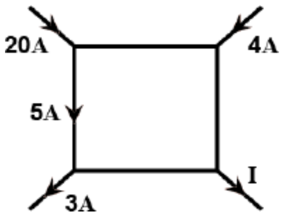


Ohmic device, obey ohm‟s law, i.e. V = IR

V a I (R → constant), I – V characteristic will be a straight line

---

Question 25: The value of I in the figure shown below is

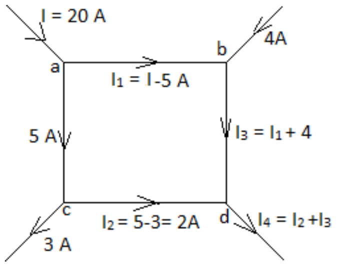


(A) 8A **(B) 21A** **(C) 19A** **(D) 4A**

Solution:

ANSWER: (B)

We will use concepts of KCL i.e. $I_{in} = I_{out}$ at a junction.



At Junction a, using KCL at a

$$I_1 = 20 - 5 = 15\ A$$

At Junction b, Using KCL at b

$$I_3 = 15 + 4 = 19\ A$$

At Junction c, Using KCL at c

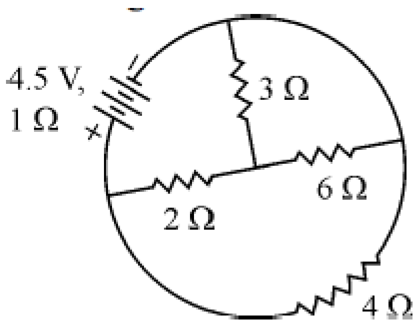
$$I_2 = 5 - 3 = 2A$$

At Junction d, Using KCL at d

$$I_4 = I_2 + I_3$$

$$I_4 = I_2 + I_3 = 2 + 19 = 21\ A$$

$I_4 = 21\ A$



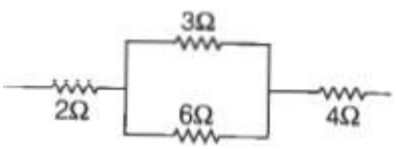
Question 26: The power dissipated in 3Ω resistance in the following circuit is

(A) 0.75 W (B) 0.25W (C) 1 W (D) 0.5 W

Solution:

ANSWER: (A)

The equivalent circuit of the given by



From the circuit

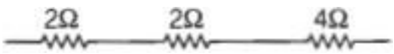
$$\frac{1}{R_1} = \frac{1}{3} + \frac{1}{6}$$

$$\frac{1}{R_1} = \frac{2+1}{6}$$

$$\frac{1}{R_1} = \frac{2+1}{6} = \frac{3}{6} = \frac{1}{2}$$

$$R_1 = 2\Omega$$

The resistance R_1 is connected in series with resistances of 2Ω and 4Ω.



$$R_2 = R_1 + 2 + 4$$
$$R_2 = 2 + 2 + 4$$
$$R_2 = 8\,\Omega$$

The internal resistance of battery: $r = 1\Omega$

So, the equivalent resistance of circuit

$$R = 8\Omega + 1\Omega$$
$$R = 8\Omega + 1\Omega = 9\Omega$$

The current in the circuit

$$I = \frac{V}{R} = \frac{45}{9} = 5\text{ A}$$

The power dissipated in 3Ω3Ω resistance

$$P = I^2 R$$
$$P = \left(\frac{1}{2}\right)^2 \times 3$$
$$P = (0.5)^2 \times 3 = 0.25 \times 3 = 0.75\text{ W}$$

Question 27: In metre bridge experiment, with a standard resistance in the right gap and a resistance coil dipped in water (in a beaker) in the left gap, the balancing length obtained is „I‟. If the temperature of the water is increased, the new balancing length is

(A) > 1 (B) < 1 (C) = 1 (D) = 0

ANSWER: (A)

Solution:

$$\frac{R_{unknown}}{R_{Standard}} = \left(\frac{L}{1 - L}\right)$$

As temperature increases, Resistance is also increases. As Resistance increases balancing length also increases.

$R_{unknown} / R_{standard}$ increases ⇒Ll / (1 - L) increases

(1 – L) should decrease ⇒ (L > 1)

If temperature increases than resistance increases. Hence the new balancing is greater than L.

Question 28: A proton, a deuteron and α - particle is projected perpendicular to the direction of a uniform magnetic field with same kinetic energy. The ratio of the radii of the circular paths described by them is

(A) 1: √2: 1 (B) 1: √2: √2 (C) √2: 1: 1 (D) √2: √2: 1

ANSWER: (A)

Solution:

Radius of the circular path $= r = \frac{mv}{Bq}$

The momentum of the particle $= P = mv = \sqrt{2mE}$,

Where E is the kinetic energy of the particle

Radius of the circular path $= r = \frac{\sqrt{2mE}}{Bq}$ $\quad r \propto \frac{\sqrt{m}}{q}$

Radius of the circular pathfor proton $= R_p = \frac{\sqrt{2mE}}{Bq_p}$

Radius of the circular pathfor deutron $= R_d = \frac{\sqrt{2mE}}{Bq_d}$

Radius of the circular pathfor deutron $= R_\alpha = \frac{\sqrt{2mE}}{Bq_\alpha}$

$q_\alpha = 2q_p$ and $q_d = q_p$ where, q_p is the charge of the proton

q_d is the charge of the deutron and q_α is the charge of the $\alpha -$ particle

M_p is the mass of the proton, M_d is the mass of the deutron.

M_α is the mass of the $\alpha -$ particle

$M_\alpha = 4M_p$ and $M_d = 2M_p$ where M_p is the mass of the proton

$$r_p : r_d : r_\alpha = \frac{\sqrt{M_p}}{q_p} : \frac{\sqrt{M_d}}{q_d} : \frac{\sqrt{M_\alpha}}{q_\alpha}$$

$$r_p : r_d : r_\alpha = \frac{\sqrt{M_p}}{q_p} : \frac{\sqrt{2M_p}}{q_p} : \frac{\sqrt{4M_p}}{2q_p}$$

$$r_p : r_d : r_\alpha = \frac{\sqrt{1}}{1} : \frac{\sqrt{2}}{1} : \frac{\sqrt{4}}{2}$$

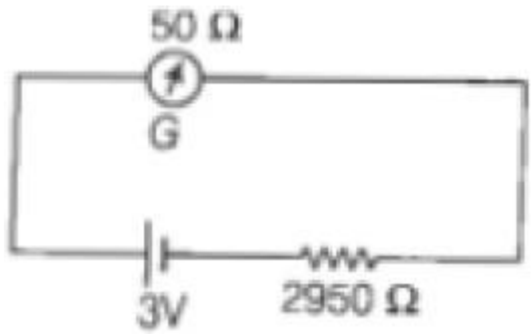
$$r_p : r_d : r_\alpha = 1 : \sqrt{2} : 1$$

Question 29: A galvanometer of resistance 50 Ω is connected to a battery of 3V along with a resistance of 2950 Ω in series shows full-scale deflection of 30 divisions. The additional series resistance required to reduce the deflection to 20 divisions is

(A) 1500 Ω (B) 4450 Ω (C) 7400 Ω (D) 2950 Ω

ANSWER: (B)

Solution:



Given: Galvanometer resistance = G = 50Ω, External resistance R = 2950Ω

Total resistance of the circuit = G + R = 50 + 2950 = 3000 Ω

$$\text{Current} = \frac{V}{R} = \frac{3}{3000} = \frac{1}{1000} = 10^{-3} = 1 \text{ mA}$$

Let the deflection in the galvanometer is reduced to 20 divisions. Then the current

$$I' = \frac{1 \text{ mA}}{30} \times 20 = \frac{2}{3} \text{ mA}$$

Let x be the effective resistance of the circuit.

$$3V = 3000\ \Omega \times 1\text{mA} = X\Omega \times \frac{2}{3}\text{mA}$$

But the Galvanometer resistance = G = 50Ω

$$3000 = X \times \frac{2}{3}$$

$$X = 3000 \times \frac{3}{2} = 4500\ \Omega$$

But the Galvanometer resistance = G = 50Ω

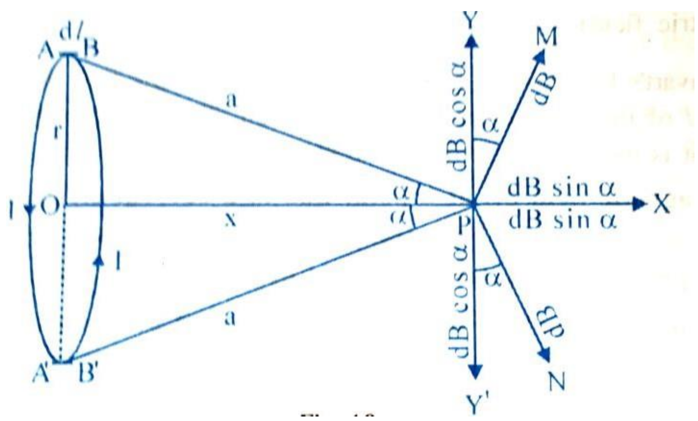
Therefore resistance to be added= 4500-50 = **4450** Ω

Question 30: The magnetic field at the centre of a current-carrying loop of radius 0.1 m is 5√5 times that at a point along its axis. The distance of this point from the centre of the loop is

(A) 0.2 m (B) 0.1m (C) 0.05m (D) 0.25m

ANSWER: (A)

Solution:



For a circular current-carrying loop of radius R. the magnetic field at the point along the axis is given by

$$\therefore \vec{B} = \left(\frac{\mu_0}{4\pi}\right)\frac{2\pi I r^2}{(r^2 + x^2)^{\frac{3}{2}}}$$

$$\therefore \vec{B} = \left(\frac{\mu_0}{2}\right)\frac{I r^2}{(r^2 + x^2)^{\frac{3}{2}}}$$

Where r is the radius of the loop and x is the distance of the point from the Center of the loop When the point P is at the center of the coil then x= o, the magnetic field is given by

$$B = \frac{\mu_0}{2}\frac{I}{r}$$

According to the problem

$$\frac{\mu_0}{2}\frac{I}{r} = 5\sqrt{5}\left(\frac{\mu_0}{2}\right)\frac{I r^2}{(r^2 + x^2)^{\frac{3}{2}}}$$

$$\left(\frac{r^2 + x^2}{r^2}\right)^{3/2} = 5^{3/2}$$

$$\frac{r^2 + x^2}{r^2} = 5$$

$$r^2 + x^2 = 5r^2$$

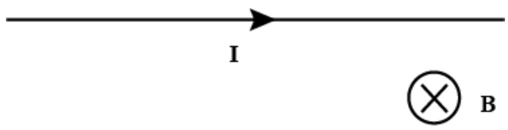
$$x^2 = 5r^2 - r^2 = 4r^2$$

$$x^2 = 4r^2$$

$$x = 2r$$

The distance of the point from center of the loop: $x = 2 \times 0.1 = 0.2\text{m}$

Question 31: A straight wire of length 50 cm carrying a current of 2.5 A is suspended in mid-air by a uniform magnetic field of 0.5 T (as shown in the figure). The mass of the wire is (g = 10 ms^{-2})



(A) 62.5 gm (B) 250 gm (C) 125 gm (D) Cu_2O + FeS

ANSWER: (A)

Solution:

Given: $B = 0.5\ \text{T}, L = 0.5\text{m}$ and $I = 2.5\ \text{A}, g = 10\text{m/s}^2$

The given wire is suspended in air medium. So that weight of the wire is balanced by the force acting on the wire in upward direction.

$$mg = F_g$$

$$mg = BIL$$

$$F_B = mg$$

$$m \times 10 = 0.5 \times 2.5 \times 0.5$$

$m \times 10 = 0.625$

$m = 0.0625 \text{ kg}$

$m = 62.5 \text{ g}$

Question 32: Which of the following properties is „False" for a bar magnet?

(A) Its poles cannot be separated.

(B) It points in North-South direction when suspended

(C) It"s like poles repel and unlike poles attract.

(D) It doesn"t produce a magnetic field

ANSWER: (D)

Solution:

A bar magnet can produce a magnetic field. Option (d) is False.

Question 33: A magnetic dipole of the magnetic moment 6×10^{-2} Am^2 and moment of inertia 12×10^{-6} kgm^2 performs oscillation in a magnetic field of 2×10^{-2} T. The time taken by the dipole to complete 20 oscillations is ($\pi \simeq 3$)

(A) 36 s **(B) 6s** **(C)12 s** **(D)18 s**

ANSWER: (C)

Solution:

Given: Magnetic moment $(M) = 6 \times 10^{-2} \text{ Am}^2$, Moment of inertia $(I) = 12 \times 10^{-6} \text{kgm}^2$

Magnetic field $(B) = 2 \times 10^{-2} \text{ T}$

Time period of oscillation; $T = 2\pi\sqrt{\frac{I}{MB}}$

$$T = 2\pi\sqrt{\frac{12 \times 10^{-6}}{6 \times 10^{-12} \times 2 \times 10^{-2}}}$$

$$T = 2\pi\sqrt{\frac{12 \times 10^{-6}}{12 \times 10^{-4}}} = 2\pi\sqrt{1 \times 10^{-2}} = 2\pi \times 10^{-1} = 2\pi \times 0.1$$

$T = 2 \times 3.14 \times 0.1 = 0.628\, s$

For 20 oscillations

$T = 20 \times 0.628 = 12 \text{ sec}$

Question 34: The susceptibility of a ferromagnetic substance

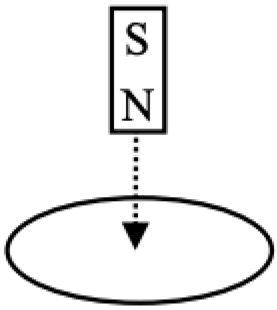
(A) >>1 **(B)** > 1 **(C)** < 1 **(D)** zero

ANSWER: (A)

Solution:

Susceptibility of Ferromagnetic substance is >>>1 because it is strongly attracted to an external magnetic field.

Question 35: A bar magnet is allowed to fall vertically through a copper coil placed in a horizontal plane. The magnet falls with a net acceleration



(A) a. = g (B) b. > g (C) c. < g (D) zero

ANSWER: (C)

Solution:

[If the magnet is falling vertically down with its north pole towards the coil, then the upper face of the coil will become North Pole, So that it can oppose the approaching north pole of the magnet. Here, the acceleration will be less than "g"].

As the magnet will fall the flux through the coil will increase ,according to lenz law, the coil will induce current in order to oppose the flux ,That current will reduce the acceleration of magnet so $a_{magnet} = g - a_{current}$

Question 36: The working of magnetic braking of trains is based on

(A) Alternating current (B) Eddy current

(C) Steady current (D) Pulsating current

ANSWER: (B)

Solution:

Working of magnetic breaking in the train is based on eddy current.

Question 37: A jet plane of wings pan 20 m is travelling towards the west at a speed of 400 ms^{-1}. If the earth"s total magnetic field is 4× 10^{-4} T and the dip angle is 30°, at that place, the voltage difference developed across the ends of the wing is

(A) 1.6 V (B) 3.2 V (C) 0.8 V (D) 6.4 V

ANSWER: (A)

Solution:

Earth's Magnetic field: $B = 4 \times 10^{-4}$ T

Velocity of the Aeroplnane: $v = 400$ m/s

The length of the Jet wing = 20m

The dip angle is 30º

The vertical component of jet velocity $= 400 \sin 30^0$

The e.m.f induced in the rod travelling magnetic field: $e = BvL$

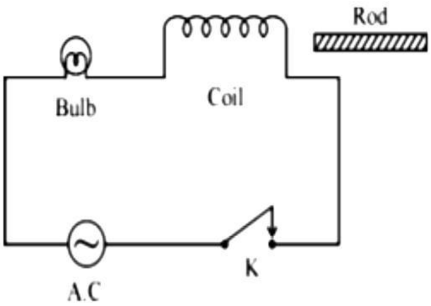
$e = BvL$

Voltage differnce $= e.m.f = BLv \sin 30^0$

$= 4 \times 10^{-4} \times 20 \times 400 \times \sin 30^0$

$e.m.f = 1.6\ V$

Question 38: In the A.C. circuit shown, keeping „K" pressed if an iron rod is inserted into the coil, the bulb in the circuit,



(A) Glows more brightly (B) Glows less brightly

(C) Glows with same brightness (as before the rod is inserted) (D) Gets damaged

ANSWER: (B)

Solution:

When the iron rod is inserted in the coil, then the inductive increases, hence the current flowing through the bulb decreases, therefore brightness decreases.

Question 39: The output of a step-down transformer is measured to be 48 V when connected to a 12w bulb. The value of peak current is

(A) (1 /√2) A (B) (√2) A (C) (1/2√2) A (D) (1/4) A

ANSWER: (C)

Solution:

Root mean sqaure of output voltageof trransformer $V_{rms} = 48\ V$

Power of the bulb: $P = 12W; I = ?$

Power: $P = V \times I$

Power = Voltge × Current

$P = V \times I$

$$I_{rms} = \frac{P}{V_{rms}}$$

$$I_{rms} = \frac{12}{48} = \frac{1}{4}\ A$$

The peak or maximum value of current $= I_0 = \sqrt{2} \times I_{rms}$

$$I_0 = \sqrt{2} \times \frac{1}{4} = \frac{1}{2\sqrt{2}}$$

$$I_0 = \sqrt{2} \times \frac{1}{4} = \sqrt{2}\frac{1}{2 \times 2} = \sqrt{2}\frac{1}{2 \times \sqrt{2} \times \sqrt{2}} = \frac{1}{2 \times \sqrt{2}}$$

$$I_0 = \frac{1}{2 \times \sqrt{2}}$$

Question 40: A coil of inductive reactance (1 / √3) Ω and resistance 1Ω is connected to a 200 V, 50 Hz A.C. supply. The time lag between the maximum voltage and current is

(A) (1/300) s (B) (1/600) s (C) (1/500) s (D) (1/200) s

ANSWER: (B)

Solution:

Given: Inductive reeactance $= X_L = \frac{1}{\sqrt{3}}\Omega; R = 1\Omega; V = 200\text{ V}: 50\text{ Hz}$

Angular frequency: $\omega = 2\pi f = 2 \times 3.14 \times 50 = 314\text{ rad/sec}$

$$\tan\phi = \frac{X_L}{R} = \frac{\omega_L}{R} = \frac{1}{1/\sqrt{3}} = \sqrt{3}$$

$$\phi = \frac{\pi}{6} = \frac{180^0}{6} = 30^0$$

$$\omega t = \frac{\pi}{6}$$

$$t = \frac{\pi}{6} \times \frac{1}{\omega} = \frac{\pi}{6} \times \frac{1}{2\pi f} = \frac{1}{6} \times \frac{1}{2f} = \frac{1}{6} \times \frac{1}{2 \times 50} = \frac{1}{600} S$$

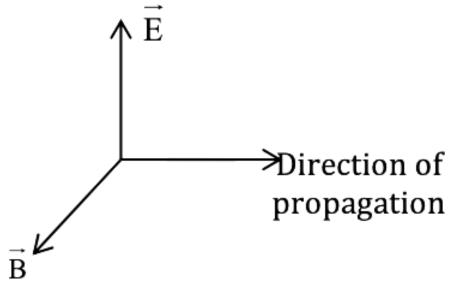
Question 41: If E and B represent electric and magnetic field vectors of an electromagnetic wave, the direction of propagation of the wave is along

(A) E (B) B (C) E × B (D) B × E

ANSWER: (C)

Solution:

As we know, by property of the electromagnetic wave, the electric field, magnetic field & the direction of propagation, all the three are mutually perpendicular. There by right-hand thumb rule using the figure. E × B.



Question 42: According to Cartesian sign convention, in ray optics

(A) All distances are taken positive

(B) All distances are taken negative

(C) All distances in the direction of the incident ray are taken positive

(D) All distances in the direction of the incident ray are taken negative

ANSWER: (C)

Solution:

In ray optics, all the directions in the direction of the incident ray are taken as positive.

Question 43: A linear object of height 10 cm is kept in front of a concave mirror of radius of curvature 15 cm, at a distance of 10 cm. The image formed is

(A) Magnified **(B) Magnified and inverted**

(C) Diminished and erect **(D) Diminished and inverted**

ANSWER: (B)

Solution:

Object distance; $u = -10$ m, radius of curvature of the Concave mirror $= R = -15$ ccm

$$\text{Foacl lentgh } f = \frac{R}{2} = \frac{-15}{2} \text{ cm}$$

Using mirror formula

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{u}$$

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

$$\frac{1}{v} + \frac{1}{-10} = -\frac{2}{15}$$

$$\text{Magnification: } m = \frac{-V}{u}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{2}{15} = \frac{3-2}{30} = \frac{1}{30}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{2}{15} = \frac{3-2}{30} = -\frac{1}{30}$$

$$\frac{1}{v} = -\frac{1}{30}$$

$$v = -30\ cm$$

$$\text{Magnification: } m = \frac{-V}{u}$$

$$\text{Magnification: } m = \frac{-(-30)}{-10} = -3$$

$$\text{Magnification: } m = -3$$

Magnification, m = −v/u = −30 / −10 = −3

Negative sign indicates that the image formed is inverted in nature. Magnitude of magnification is greater than 1 which indicates that magnified image is formed

Therefore, The image formed is real, magnified and inverted.

Question 44: During scattering of light, the amount of scattering is inversely proportional to________of the wavelength of light,

(A) Cube (B) Square (C) Fourth power (D) Half

ANSWER: (C)

Solution:

During scattering of light

Intesity of light: $I \propto \frac{1}{\lambda^4}$

It is inversely proportional to the fourth power of the wavelength of light. It means that the shorter wavelengths in visible white light (violet and blue) are scattered stronger than the longer wavelengths toward the red end of the visible spectrum.

Question 45: In Young‟s double-slit experiment if yellow light is replaced by blue light, the interference fringes become

(A)Wider (B) Narrower (C) Brighter (D) Darker

ANSWER: (B)

Solution:

The fringe width: $\beta = \frac{\lambda D}{d}$

$\lambda_{yellow} > \lambda_{Blue}$

Here the distance between the two slits and screen D and the separation between the two slits „d‟ are constants.

The fringe width: $\beta \propto \lambda$

We know that wavelength of the yellow light is larger than wavelength of the blue light.

$\lambda_{yellow\ light} > \lambda_{Blue\ light}$

$\beta_{yellow\ light} > \beta_{Blue\ light}$

Thus fringe width of the fringes formed by yellow light is more than that formed by blue light. Hence the interference fringes become narrower.

Question 46: According to Huygens‟ Principle, during refraction of light from air to a denser medium

(A) Wavelength and speed decrease

(B) Wavelength and speed increase

(C)Wavelength increases but speed decreases

(D) Wavelength decreases but speed increases

ANSWER: (A)

Solution:

The medium in which the velocity of light is maximum is known as air or rarer medium. The medium in which the velocity of light is minimum is known as denser medium. Frequency of light remains the same for all medium.

The frequency of the light : $\gamma = \frac{C}{\lambda}$

Therefore the wavelength of light (λ) decreased.

Refractive index of the medium

The refractive index: $\mu = \frac{C}{v}$

Where C → velocity of light in vacuum or air, V → velocity of light in the medium

---

Question 47: In a system of two crossed polarizers, it is found that the intensity of light from the second polarizer is half from that of the first polariser. The angle between their pass axes is

(A) 45º (B) 60º (C) 30º (D) 0º

ANSWER: (A)

Solution: Given: $I = \frac{I_0}{2}$

$\frac{I_0}{2} = I_0 Cos^2\theta$

Let the angle between two polarisers be θ and maximum intensity of the light be I_0.

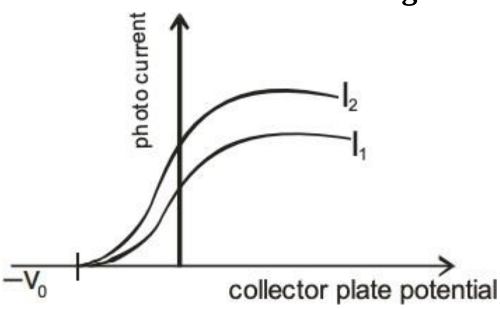
From Malus law, Intensity of light after passing through the polarizers is given by

$Cos^2\theta = \frac{1}{2}$

$\cos\theta = \frac{1}{\sqrt{2}}$

$\theta = 45^0$

Question 48: From the following graph of photocurrent against collector plate potential, for two different intensities of light I_1 and I_2, one can conclude

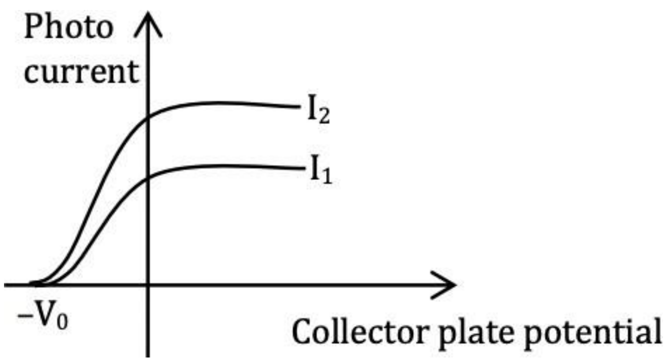


(A) $I_1 = I_2$ (B) $I_1 > I_2$ (C) $I_1 < I_2$ (D) Comparison is not possible

ANSWER: (C)

Solution:

The value of photocurrent depends on the intensity of incident light. So, when the intensity of incident light increases, then the value of photocurrent is increased. The intensity of light a photocurrent.



$I_1 < I_2$

Question 49: A particle is dropped from a height „H‟. The de- Broglie wavelength of the particle depends on height as

(A) H (B) H^0 (C) $H^{1/2}$ (D) $H^{-1/2}$

ANSWER: (D)

Solution:

The velocity gained by the particle while it is falling under the gravity through an height H is given by

$v = \sqrt{2gH}$

From de-Broglie expression

$$\lambda = \frac{h}{mv}$$

$$\lambda = \frac{h}{mv} = \frac{h}{m\sqrt{2gH}}$$

Here, „h‟, „m‟, „ v‟ and „g‟ are constants.

$$\lambda = \text{constant}\ \frac{1}{H}$$

$$\lambda = H^{-1}$$

Question 50: The scientist who is credited with the discovery of „nucleus‟ in an atom is

(A) J.J. Thomson (B) Rutherford (C) Niels Bohr (D) Balmer

ANSWER: (B)

Solution:

Ernest Rutherford discovered the atomic nucleus in the year 1911.

Question 51: The energy (in eV) required to excite an electron from n = 2 to n = 4 state in the hydrogen atom is

(A) + 2.55 (B) – 3.4 (C) – 0.85 (D) + 4.25

Solution:

ANSWER: (A)

The energy required to excite an electron from $n_1 = 2$ to $n_2 = 4$ state in the hydrogen atom is

$$E_2 - E_4 = \Delta E = 13.6\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$E_2 - E_4 = \Delta E = 13.6\left(\frac{1}{2^2} - \frac{1}{4^2}\right) \text{eV}$$

$$\Delta E = +2.55 \text{ eV}$$

Question 52: In a nuclear reactor the function of the Moderator is to decrease

(A) Number of neutrons (B) Speed neutrons

(C) Escape of neutrons (D) Temperature of the reactor

ANSWER: (B)

Solution:

In a nuclear reactor, the function of the moderator is to decrease the speed of neutrons.

Question 53: The particles emitted in the decay of $^{238}{}_{92}U$ to $^{234}{}_{92}U$

(A)1 α and 2 β (B)1 α only (C)1 α and 1 β (D) 2 α and 2 β

ANSWER: (A)

Solution:

$$^{238}_{92}U \xrightarrow{\alpha} {}^{234}_{90}U \xrightarrow{\beta} {}^{234}_{91}U \xrightarrow{\beta} {}^{234}_{92}U$$

∴ 1 α and 2 β particles

Question 54: The mass defect of $^4{}_2He$ is 0.03μ. The binding energy per nucleon of helium (in MeV) is

(A) 27.93 (B) 6.9825 (C) 2.793 (D) 69.825

ANSWER: (B)

Solution:

The mass defect of $^4_2\text{He} = \Delta m = 0.03$ a.m.u

The Binding energy of helium $E = \Delta m \times 931 \text{ MeV} = 0.03 \times 931 = 27.93 \text{ MeV}$

Number of nucleons in helium; n = 4

The Binding energy per nucleon $= \frac{E}{n} = \frac{27.93}{4} = 6.9825$

Question 55: The energy gap in case of which of the following is less than 3 eV?

(A) Copper (B) Iron (C) Zener diode (D) Germanium

ANSWER: (D)

Solution:

In Germanium energy the gap is less than 3eV.

Question 56: Which of the following semiconducting devices is used as a voltage regulator?

(A) Photo diode (B) LASER diode (C) Zener diode (D) Solar cell

ANSWER: (C)

Solution:

Zener diode is used as a voltage regulated as in reverse biased condition it exhibits constant voltage.

Question 57: In the three parts of a transistor, „Emitter is of

(A) Moderate size and heavily doped (B) Large size and lightly doped

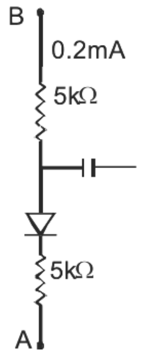
(C) Thin size and heavily doped (D) Large size and moderately doped

ANSWER: (A)

Solution:

In the case of a transistor, the emitter is of moderate size and heavily doped so as to supply a large number of majority charge carriers for current flow.

Question 58: In the figure shown, if the diode forward voltage drop is 0.2 V, the voltage difference between A and B is



(A) 1.3 V (B) 2.2 V (C) 0 (D) 0.5V

ANSWER: (B)

Solution:

The voltage drop across AB by using KVL is as follows:

$V_{AB} = (0.2 \times 10^{-3} \times 5 \times 10^{3}) + 0.2 + (0.2 \times 10^{-3} \times 5 \times 10^{3})$

$= 1 + 0.2 + 1$

$= 2.2V$

Question 59: Which of the following logic gates is considered as „universal"?

ANSWER: (D)

Solution:

NAND and NOR gates are considered as universal gates. Out of the given options, an option **(D)** is NAND gate.

Question 60: basic communication system consists of

(A)Transmitter **(B) Information source**

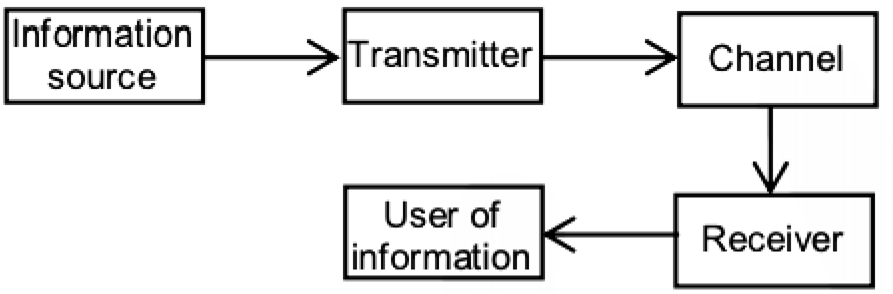
(C) User of information **(D) Channel** **(E) Receive**

(A) a, b, c, d and e **(B)b, a, d, e and c** **(C) b, d, a, c and e** **(D)d. b, e, a, d and c**

ANSWER: (B)

Solution:

The block diagram of the communication system is as follows:



****

KCET – 2016: PHYSICS: VERSION CODE: A-1

Question 1: A body falls freely for 10 sec. Its average velocity during this journey (take g = 10 ms^{-2})

(A) 00 ms^{-1} (B) 10 ms^{-1} (C) 50 ms^{-1} (D) 5 ms^{-1}

ANSWER: (C)

Solution:

Given: Initial velocity $u = 0; t = 10\ sec, g = 10\ ms^{-2}$

$$S = ut + \frac{1}{2}at^2$$

$$S = ut + \frac{1}{2}gt^2 \quad \text{when the body is falling down } a = g$$

$$S = 0 \times 10 + \frac{1}{2} \times 10 \times 10^2$$

$$S = 5 \times 10^2 = 5 \times 100 = 500$$

$$\text{Average velocity} = \frac{\text{Total distance}}{\text{Total time}}$$

$$v = \frac{500}{10} = 50\ ms^{-1}$$

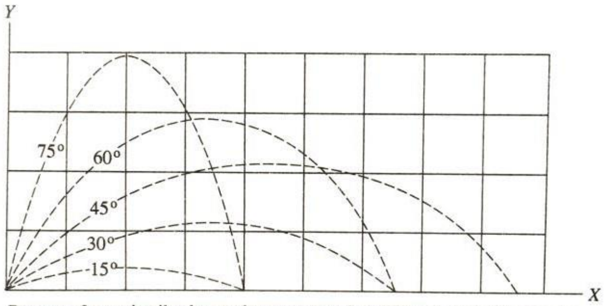
Question 2: Three projectiles A, B and C are projected at an angle of 30°, 45°, 60° respectively. If R_A, R_B, and R_C are ranges of A, B and C respectively, then (velocity of projection is the same for A, B & C).

(A)$R_A = R_B = R_C$ (B)$R_A = R_C > R_B$ (C)$R_A < R_B < R_C$ (D)$R_A = R_C < R_B$

ANSWER: (D)

Solution:

The value of maximum sin2θ =1, or 2θ =1 or θ =45^0. Hence the projectile covers the maximum range when it is projected through angle θ =45^0.



Ranges of a projectile shot at the same speed at different projection angles

$$\text{The horizontal range is given by} = R = \frac{u^2 \sin 2\theta}{g}$$

$$R_A = \frac{u^2 \sin 2 \times 30^0}{g} = \frac{u^2 \sin 60^0}{g} = \frac{\sqrt{3}}{2}\frac{u^2}{g}$$

$$R_B = \frac{u^2 \sin 2 \times 45^0}{g} = \frac{u^2 \sin 90^0}{g} = \frac{u^2}{g}$$

$$R_B = \frac{u^2 \sin 2 \times 60^0}{g} = \frac{u^2 \sin 120^0}{g} = \frac{u^2 \sin(90^0 + 30^0)}{g} = \frac{u^2 \cos 30^0}{g} = \frac{\sqrt{3}}{2}\frac{u^2}{g}$$

$R_A = R_C < R_B$

Question 3: The component of a vector r along x-axis has a maximum value if

(A) $\vec{r}$ is along + ve x-axis (B) $\vec{r}$ is along with + ve y-axis

(C) $\vec{r}$ is along – ve y-axis (D) $\vec{r}$ makes an angle of 45° with the x-axis

ANSWER: (A)

Solution:

The component of r = E cosθ which is maximum when θ = 0^0. So, r will be along positive X -axis for maximum value. $r_x = r\cos\theta$ r_x is maximum if θ = 0.

or

If a vector B forms an angle along the x-axis. Then its components along the x-axis can be written as BCosθ. The maximum value of cosθ = 1, which is when θ = 0. Hence, for the vector r, the maximum value will be when it is along the positive x-axis.

Question 4: Maximum acceleration of the train in which a 50 kg box lying on its floor will remain stationary (Given: Coefficient of static friction between the box and the floor of the train is 0.3 and g = 10 ms^{-2})

(A) 5.0 ms^{-2} (B) 3.0 ms^{-2} (C) 1.5 ms^{-2} (D) 15.0 ms^{-2}

ANSWER: (B)

Given: $\mu = 0.3$ and $m = 30$ kg; $g = 10\ ms^{-2}, f = \mu mg$

$$\text{The frictional force} = f = \mu mg$$

The box kept on the floor of the train remains stationary if the pseudo force acting on the box is balanced by frictional force.

$$ma = \mu mg$$

Where „a" is the maximum acceleration of the train

$$a = \mu g = 0.3 \times 10 = 3.0\ ms^{-2}$$

Question 5: A 12 kg bomb at rest explodes into two pieces of 4 kg and 8 kg piece. If the momentum of the 4kg piece is 20 Ns, the kinetic energy of the 8 kg piece is -(A) 25 J (B) 20 J (C) 50 J (D) 40 J

ANSWER: (A)

Solution:

Given $m = 12$ kg, $u = 0$ (Initial velocity),

Initial momentum $= m \times u = 12 \times 0 = 0$

Momentum of the 4kg weight = 20 Nn

$$m_1 \times v_1 = 20$$

$$m_1 \times v_1 = 4 \times v_1 = 20$$

$$v_1 = \frac{20}{4} = 5m^{-1}$$

So, the final momentum of the system must also be zero.

According to the law of conservation of momentum,

Initial momentum = final momentum

$$m_1v_1 + m_2v_2 = 0$$

$$20 + 8\,v_2 = 0$$

$$v_2 = -\frac{20}{8} = -2.5\ ms^{-1}$$

Negative sign indicates opposite direction.
Kinetic energy of the 8kg piece

$$\frac{1}{2}mv_2{}^2 = \frac{1}{2} \times 8 \times (2.5)^2$$

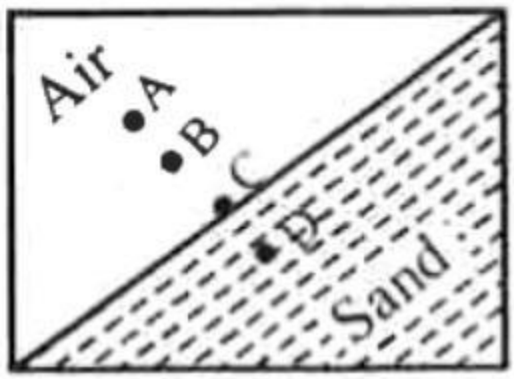
$$\frac{1}{2}mv_2{}^2 = 4 \times (2.5)^2$$

$$\frac{1}{2}mv_2{}^2 = 4 \times 6.25$$

$$\text{K.E} = \frac{1}{2}\text{mv}_2{}^2 = 25\text{ J}$$

Question 6: Which of the points is likely the position of the centre of mass of the system shown in the figure?

(A)A (B) D (C) B (D)C



Solution:

ANSWER: (B)

The centre of mass lies towards the heavier mass, from the above diagram, the mass is more at point D.

Question 7: Three bodies, a ring (R), a solid cylinder (C) and a solid sphere (S) having the same mass and same radius roll down the inclined plane without slipping. They start from rest if V_R, V_C, and V_S are velocities of respective bodies on reaching the bottom of the plane, then -

(A) $V_R = V_C = V_S$ **(B)** $V_R > V_C > V_S$

(C) $V_R < V_C < V_S$ **(D)** $V_R = V_C > V_S$

ANSWER: (C)

Solution:

Let the body start from rest. Using the work-energy equation

"The work done on a body by a force is equal to the change in its energy".

$$W = mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$$v = r\omega \quad \text{(Pure rolling) and } I = kmr^2$$

$$W = mgh = \frac{1}{2}mv^2 + \frac{1}{2}\,kmr^2\omega^2$$

$$W = mgh = \frac{1}{2}mv^2 + kmv^2$$

$$W = mgh = \frac{1}{2}mv^2 + \frac{1}{2}\,kmv^2$$

$$W = mgh = \frac{1}{2}mv^2[1 + k)$$

$$v = \sqrt{\frac{2gh}{1+k}}$$

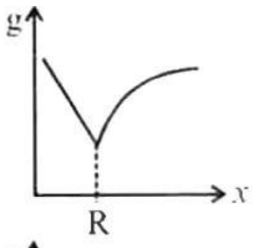
We know that $K_R = 1, K_c = 0.5, K_s = 0.4$

$$K_s < K_c < K_R$$

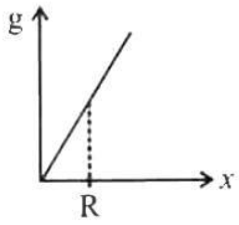
$$V_R < V_C < V_S$$

Question 8: **Variation of acceleration due to gravity (g) with distance x from the centre of the earth is best represented by (R → Radius of the earth)**

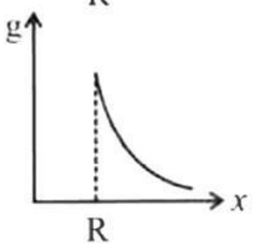
a.



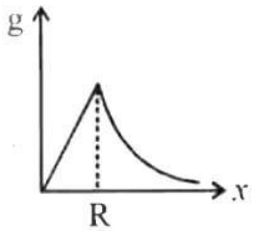
b.



c.



d.



Solution:

ANSWER: (D)

Acceleration due to gravity at a depth d

$$g = g_0\left(1 - \frac{d}{R}\right)$$

Distance from earth centre x = R - d

$$d = R - x$$

$$g = g_0\left(\frac{x}{R}\right)$$

Thus acceleration due to gravity increases linearly with the increase in distance from the centre of the earth.

Acceleration due to gravity at a height h

$$g = g_0\left(\frac{R}{R+h}\right)^2$$

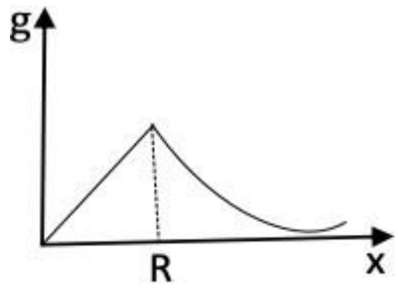
Distance from earth centre x = R + h

$$h = d - R$$

$$h = x - R$$

$$g = g_0\left(\frac{R}{x}\right)^2$$

So acceleration due to gravity decreases as $(1 / x^2)$ with the increase in distance from the centre of earth.



Question 9: A spring is stretched by applying a load to its free end. The strain produced in the spring is –

(A)Volumetric **(B) Shear**

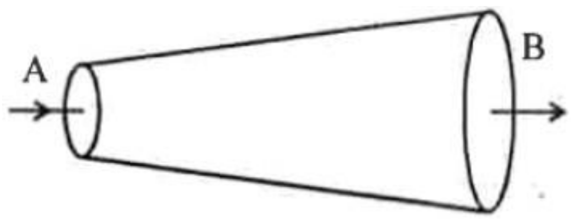
(C)Longitudinal & Shear **(D) Longitudinal**

ANSWER: (C)

Solution:

The length and shape of the spring changes and the weight of the load behave as a deforming force. The change in length corresponds to longitudinal strain and change in shape corresponds to shearing strain.

Question 10: An ideal fluid flow through a pipe of the circular cross-section with diameters 5 cm and 10 cm as shown. The ratio of velocities of fluid at A and B is –

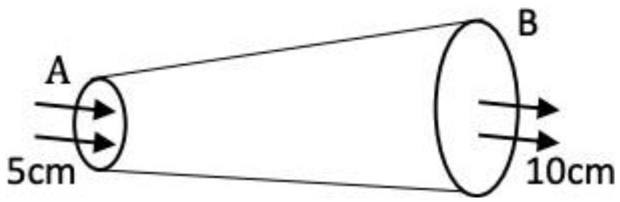


(A) 4: 1 **(B)** 1: 4

(C) 2: 1 **(D)** 1: 2

ANSWER: (A)

Solution:



$D_A = 5cm, D_B = 10cm,$

From continuity equation

$A_1V_1 = A_2V_2$

Where $V_1 = V_A$ and $V_2 = V_B$

$$\left[\frac{\pi D_A^2}{4}\right]V_A = \left[\frac{\pi D_B^2}{4}\right]V_B$$

$$\frac{V_A}{V_B} = D_A^2 = \frac{10^2}{5^2}$$

On solving

$$\frac{V_A}{V_B} = \frac{4}{1}$$

$$V_A : V_B = 4:1$$

Question 11: A pan filled with hot food from 94°C to 86°C in 2 minutes. When the room temperature is 20°C. How long will it cool from 74°C to 66°C?

(A) 2 minutes **(B) 2.8 minutes**

(C) 2.5 minutes **(D) 1.8 minutes**

Solution:

ANSWER: (B)

Using newton"s law of cooling with approximation

$$\frac{dT}{dt} = \frac{-k}{ms(T_{avg} - T_{surrounding})}$$

Casse I; $dt = 2min, T_S = 20^0C$

$$T_{avg} = \frac{[94 + 86]}{2} = 90^0C$$

$$dT = 94 - 86 = 8^0C$$

$$\frac{-k}{ms} = \left[\frac{dT}{dt}\right] \times \left[\frac{1}{T_{av} - T_S}\right]$$

$$\frac{-k}{ms} = \left[\frac{8}{2}\right] \times \left[\frac{1}{70 - 20}\right]$$

$$\frac{-k}{ms} = 0.05714$$

Case II:-

$$T_S = 20^0C, T_{avg} = \left[\frac{74 + 66}{2}\right] = 70^0C$$

$dT = 74 - 66 = 8^0C$

Now value‟s putting in equation (1)

$$\frac{8}{dt} = 0.05714 \times (70 - 20)$$

$$dt = 2.8 \text{ min}$$

Question 12: Four rods with different radii r and length l are used to connect to heat reservoirs at different temperatures. Which one will conduct most heat?

(A) r = 1 cm, l = 2 m (B) r = 1 cm, l = (1/2) m

(C) r = 2 cm, l = 2 m (D) d. r = 2 cm, l = (1/2) m

ANSWER: (D)

Solution:

The quantity of heat Q transferred per unit time across the two faces of the metal rod is directly proportional to (i) the area of cross-section of the metal rod, A (ii) the temperature difference between the faces of the metal rod, (T_1- T_2) and Inversely proportional to the length.

$$\text{The rate of flow of heat} = \frac{dQ}{dt} = K\frac{A(T_1 - T_2)}{l}$$

$$\text{Where Area } A = \pi r^2$$

On considering the above relation

$$r = 2 \text{ cm}; \ l = \frac{1}{2} \text{ cm}$$

Question 13: A Carnot engine working between 300 K and 400 K has 800 J of useful work. The amount of heat energy supplied to the engine from the source is –

(A) 2400 J (B) 3200 J

(C) 1200 J (D) 3600 J

ANSWER: (B)

Solution:

Given: $T_1 = 300$ K and $T_2 = 400$ K; $W = 800$ J

$$\text{Efficiency of Carnots heat engine} = \eta = \frac{\text{Amount heat converted into useful work}}{\text{Heat suppied}} = \frac{W}{Q}$$

$$\text{The efficiency of Carnots heat engine} = \eta = 1 - \frac{T_2}{T_1}$$

$$\text{The efficiency of Carnots heat engine} = \eta = \frac{W}{Q} = 1 - \frac{T_2}{T_1}$$

$$\therefore \frac{W}{Q} = 1 - \frac{T_2}{T_1}$$

$$\frac{800}{Q} = 1 - \frac{300}{400}$$

$$\frac{800}{Q} = \frac{400-300}{400}$$
$$\frac{800}{Q} = \frac{100}{400}$$
$$Q = \frac{800 \times 400}{100}$$
$$Q = 3200\ J$$

Question 14: A particle executing SHM has a maximum speed of 0.5 ms^{-1} and a maximum acceleration of 1.0 ms^{-2}. The angular frequency of oscillation is
(A) 2 rad s^{-1} (B) 0.5 rad s^{-1} (C) 2π rad s^{-1} (D) 0.5π rad s^{-1}

ANSWER: (A)

Solution:

$$\text{Maximu velocity} = V_{max} = \omega A = 0.5\ ms^{-1}$$
$$\text{Maximu Acceleration} = a_{max} = \omega^2 A$$
$$\text{Maximu Acceleration} = a_{max} = \omega^2 A = 1\ m/s^2$$
$$\text{Angular frequency} = \frac{a_{max}}{V_{max}} = \frac{1}{0.5} = 2\ rad/s$$

Question 15: A source of sound is moving with a velocity of 50 ms^{-1} towards the stationary observer. The observer measures the frequency of sound as 500 Hz. The apparent frequency of sound as heard by the observer when the source is moving away from him with the same speed is (Speed of sound at room temperature 350 ms^{-1}) –
(A) 400 Hz (B) 666 Hz (C) 375 Hz (D) 177.5 Hz

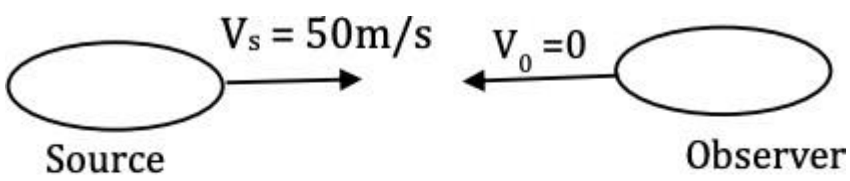
Solution:

ANSWER: (C)

Given: Speed of sound $= v = 350\ ^{m}/_{s}$, Speed of source, $v_s = 50\ ^{m}/_{s}$

Let the original frequency of the source 'n'

When a source moves towardsthe stationary observer



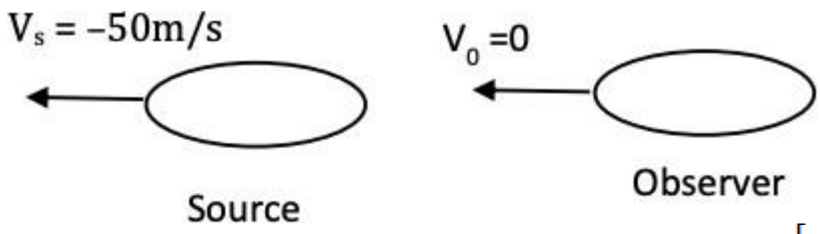
The apparent frequuency of heard by the observer $f^1 = f_0 \left[\frac{v}{v - v_s}\right]$

$$f^1 = f_0 \left[\frac{v}{v - v_s}\right]$$
$$500 = f_0 \left[\frac{350}{350 - 50}\right]$$

$$500 = f_0 \left[\frac{350}{300}\right]$$

$$f_0 = \frac{500 \times 300}{350} = \frac{1500}{35} = 428.6 \text{ Hz}$$

When a source moves away from the stationary observer



The apparent frequuency of heard by the observer $f'' = f_0 \left[\frac{v}{v + v_s}\right]$

$$f'' = 426.8 \left[\frac{350}{350 + 50}\right]$$

$$f'' = 426.8 \left[\frac{350}{400}\right] = 375 \text{ Hz}$$

Question 16: If there is only one type of charge in the universe, then (E → Electric field, ds → Area vector)

(A) $\oint E \cdot ds \neq 0$ on any surface

(B) $\oint E \cdot ds$ could not be defined

(C) $\oint E \cdot ds = \infty$ if the charge is inside

(D) $\oint E \cdot ds = 0$ if charge is outside, inside $= q / \varepsilon_0$ if charge is

ANSWER: (G) BONUS

Solution:

Question 17: An electron of mass m, charge e falls through a distance h meter in a uniform electric field E. Then the time of fall –

(A) $t = \sqrt{\frac{2hm}{eE}}$ (B) $t = \frac{2hm}{eE}$ (C) $t = \sqrt{\frac{2eE}{hm}}$ (D) $t = \frac{2eE}{hm}$

ANSWER: (A)

Solution:

Given $u = 0; s = h$

The electrostatic force acting on the charge, $F = eE$

From Nwewtons second law, $F = ma$

$$\therefore ma = eE$$

Acceleration, $a = \frac{eE}{m}$

$$S = ut + \frac{1}{2}at^2$$

$$h = 0 \times t + \frac{1}{2}at^2$$

$$h = \frac{1}{2}at^2$$

$$h = \frac{1}{2}\left(\frac{eE}{m}\right)t^2$$

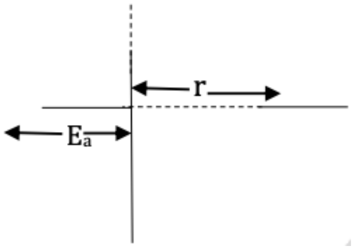
$$t = \sqrt{\frac{2hm}{eE}}$$

Question 18: If E_{ax} and E_{eq} represent an electric field at a point on the axial and equatorial line of a dipole. If points are at a distance r from the centre of the dipole, for r >> a –

(A)$E_{ax} = E_{eq}$ (B)$E_{ax} = -E_{eq}$ (C)$E_{ax} = -2E_{eq}$ D)$E_{eq} = 2E_{ax}$

ANSWER: (C)

Solution:



if $r \gg\gg a$

The electric field on the axial line of the dipole is $E_{axial} = \frac{1}{4\pi\varepsilon_0}\frac{2P}{r^3}$

The electric field on the equitoril line of the dipole is $E_{equitorial} = \frac{1}{4\pi\varepsilon_0}\frac{P}{r^3}$

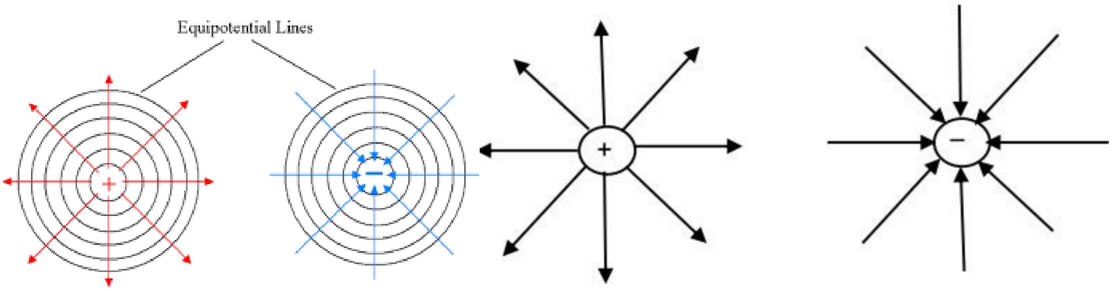
$E_{axial} = 2E_{equitorial}$

Question 19: Nature of equipotential surface for a point charge is –Ellipsoid with the charge at foci.

(A) Ellipsoid with charge at foci.
(B) Sphere with charge at the centre of the sphere.
(C) Sphere with charge on the surface of the sphere.
(D) Plane with charge on the surface.

ANSWER: (B)

Solution:



For a point charge, the equipotential surface is concentric spherical shells with centre at the point charge. **[Equipotential surface for a point charge are concentric spheres with centre at the point charge].**

In case of a point charge, **due to symmetry the electric field at the surface of the sphere** will be same for whole surface. Thus it will be **an equipotential surface where charge is at the centre of the sphere**.

Question 20: A particle of mass 1gm and charge 1μC is held at rest on a frictionless horizontal surface at distance 1m from the fixed charge 2mC. If the particle is released, it will be repelled. The speed of the particle when it is at a distance of 10 m from the fixed charge –

(A) 60 ms^{-1} (B) 100 ms^{-1} (C) 90 ms^{-1} (D) 180ms^{-1}

ANSWER: (D)

Solution:

Given

$r_1 = 1m, r_2 = 10m, q_1 = 1\mu C = 1 \times 10^{-6} C, q_2 = 2mC = 2 \times 10^{-3} C, m = 10^{-3} kg$

$$F = \frac{1}{4\pi\varepsilon_0} \times \frac{q_1 q_2}{r^2}$$

$$U_i = 9 \times 10^9 \times \frac{1 \times 10^{-6} \times 2 \times 10^{-3}}{1}$$

$$U_i = 18 \text{ J}$$

$$K_i = 0$$

$$U_f = 9 \times 10^9 \times \frac{1 \times 10^{-6} \times 2 \times 10^{-3}}{10}$$

$$K_f = 0 + \frac{1}{2} m v^2$$

$$K_f = \frac{1}{2}(0.001) \times v^2$$

$$K_f = 0.0005 \times v^2$$

From the law of conservation of Energy

$$K_f + U_f = K_i + K_i$$
$$0.0005\, v^2 + 1.8 = 0 + 18$$

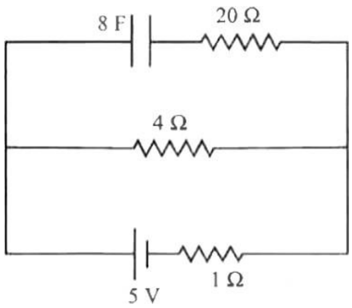
$$0.0005\, v^2 = 18 - 1.8 = 1.62$$

$$v^2 = \frac{1.62}{0.0005}$$

$v^2 = 32400$

$v = 180\ m/s$

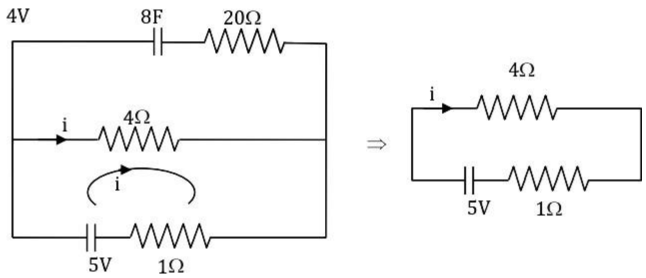
Question 21: A capacitor of 8F is connected as shown. Charge on the plates of the capacitor –



(A) 32 C **(B) 40 C** **(C) 0 C** **(D) 80 C**

ANSWER: (A)

Solution:



A capacitor does not allow a direct current to pass through it, thus no current flows through 8F capacitor and 20 Ω resistors. Hence we can say that 1Ω and 4Ω are connected in series

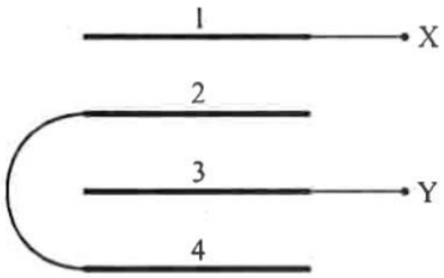
$$\text{Voltage drop across } 4\Omega = V = \frac{4}{1+4} \times 5 = \frac{5}{5} \times 4 = 4 \text{ volt}$$

As no current flows through 20Ω, thus voltage drop across the capacitor is 4 volts.

∴ Charge store the plates of capacitor, Q = CV

⟹ **Q = 8×4 = 32C**

Question 22: Four metal plates are arranged as shown. The capacitance between X and Y (A → area of each plate, d → distance between the plates)

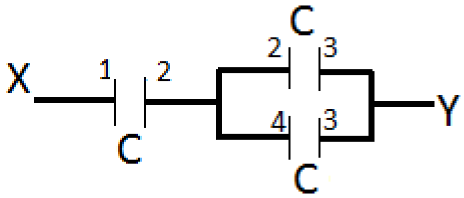


(A) $\frac{3}{2}\frac{\varepsilon_0 A}{d}$ (B) $\frac{2\varepsilon_0 A}{d}$ (C) $\frac{2}{3}\frac{\varepsilon_0 A}{d}$ (D) $\frac{3\varepsilon_0 A}{d}$

ANSWER: (C)

Solution:

Equivalent circuit is shown in the above figure



$$\text{Capaciatnce of the each capacitor,} = C = \frac{\varepsilon_0 A}{d}$$

Equivalent capacitance of capacitors connected in parallel

$$C_S = C_1 + C_2$$
$$C_S = C + C = 2C$$

Equivalent capacitance of capacitors capacitance between x and y

$$\frac{1}{C_p} = \frac{1}{C_1} + \frac{1}{C_2}$$
$$C_p = \frac{C_1 C_2}{C_1 + C_2}$$
$$C_p = \frac{C \times 2C}{C + 2C}$$
$$C_p = \frac{C \times 2C}{C + 2C} = \frac{2C^2}{3C} = \frac{2C}{3}$$
$$C_{equi} = \frac{2}{3}\frac{\varepsilon_0 A}{d}$$

Question 23: Mobility of free electrons in a conductor is –

(A) Directly proportional to electron density. **(B)** Directly proportional to relaxation time.

(C) Inversely proportional to electron density. **(D)** Inversely proportional to relaxation time.

ANSWER: (B)

Solution:

The Electron mobility is directly proportional Drift velocity.

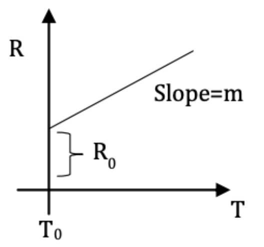
$$\mu_e \propto v_d$$

Mobility of free electrons in a conductor is directly proportional to relaxation time.

$$\mu_e = \frac{e\tau}{m}$$ here „e" and „m" are constants

$$\mu_e \propto \tau$$

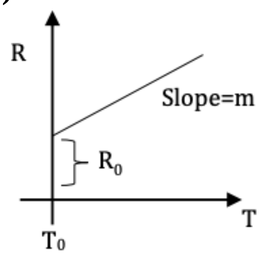
Question 24: Variation of resistance of the conductor with temperature is as shown.
The temperature coefficient (α) of the conductor is –



(A) R_0/m (B) mR_0 (C) m^2R_0 (D) m/R_0

Solution:

ANSWER: (D)



Resistance of conductor, $R = R_0 (1 + \alpha \Delta T)$ where, $\Delta T = T - T_0$

where, α is temperature coefficient of conductor

$$R = R_0 + R_0 \alpha \Delta T \ldots\ldots\ldots(1)$$

From graph slope of the line $m = R_0 \alpha$

$$R = R_0 + m(T - T_0)$$

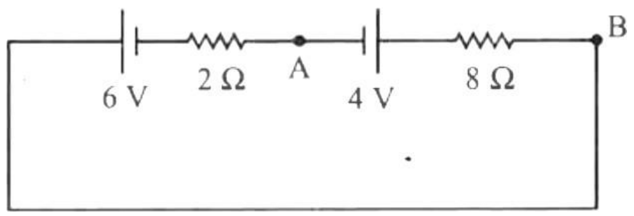
$$R = R_0 + m\,\Delta T \ldots\ldots\ldots(2)$$

From Equations (1) & (2)

$$R_0 + \alpha\Delta T = m\Delta T$$

The temperature coefficient $\alpha = \dfrac{m}{R_0}$

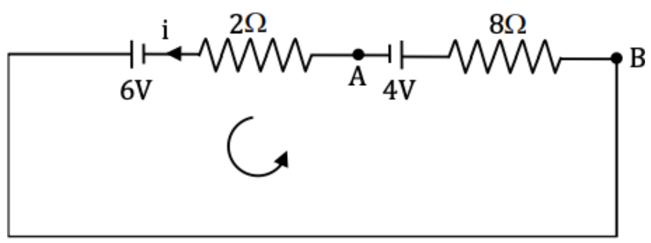
Question 25: Potential difference between A and B in the following circuit –



(A) 4 V (B) 5.6 V (C) 2.8 V (D) 6 V

ANSWER: (B)

Solution:



Using Kirchhoff‟s second law from A to B in direction of anti-clockwise

$$I(2 + 8) = 6 - 4$$

$I \times 10 = 2$

$I = \frac{2}{10} = 0.2\ A$

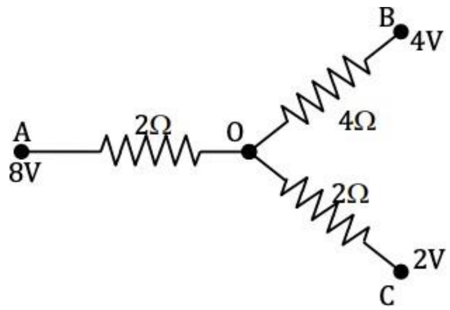
$V_A - I \times 2 + 6 = V_B$

$V_A - V_B = 0.2 \times 2 - 6$

$V_A - V_B = 0.4 - 6 = -5.6\ V$

Hence, $V_A < V_B$ and $V_{BA} = 5.6\ V$

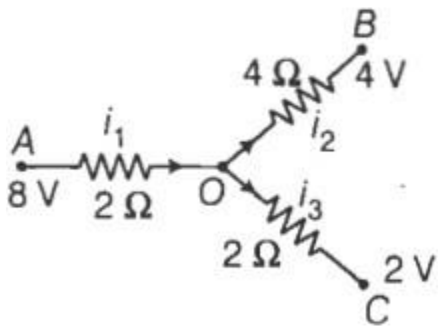
Question 26: In the following network potential at „O“



(A) 6V **(B) 3V** **(C) 6V** **(D) 4.8 V**

ANSWER: (D)

Solution:



Let the potential at O is V_0.

Application of Kirchhoff's first law at junction O gives

$$\frac{8 - V_0}{2} = \frac{V_0 - 4}{2} + \frac{V_0 - 2}{2}$$

$$\frac{V_0 - 4 + 2V_0 - 4}{4}$$

$$\frac{4(8 - V_0)}{2} = V_0 - 4 + 2V_0 - 4$$

$$16 - 2V_0 = 3V_0 - 8$$

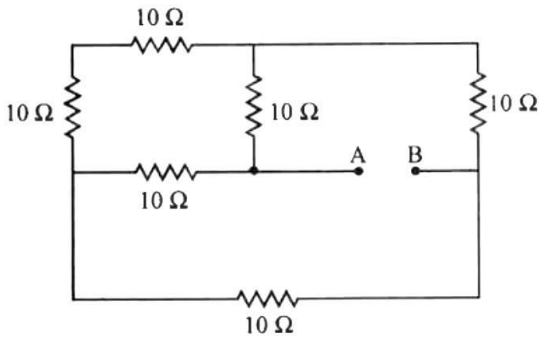
$$16 + 8 = 5V_0$$

$$5V_0 = 24$$

$$V_0 = \frac{24}{5}$$

.

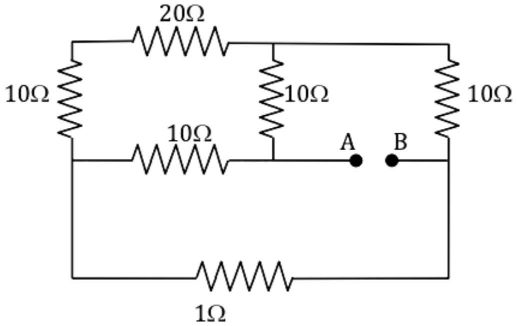
Question 27: Effective resistance between A and B in the following circuit



(A) 10 Ω **(A) 20 Ω** **(A) 5 Ω** **(A) (20/3) Ω**

Solution:

ANSWER: (A)



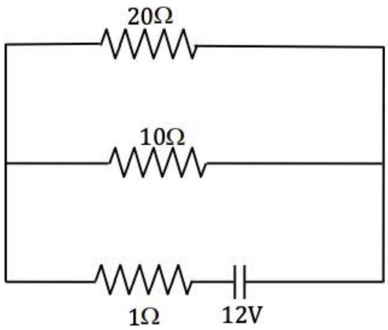
The given circuit represents a balanced wheat stone bridge and each resistance is equal to 10Ω. So, Reg = 10Ω

Question 28: Two heating coils of resistances 10 Ω and 20 Ω are connected in parallel and connected to a battery of emf 12V and internal resistance 1Ω. The power consumed by them is in the ratio –

(A) 1:4 **(B) 1:3** **(C) 2:1** **(D) 4:1**

Solution:

ANSWER: (C)



Let, the potential drop across 10 Ω and 20 Ω resistors is V.

$$\text{Power } P = I^2R = \frac{V^2}{R}$$

$$P_1 = \frac{V^2}{R_1}$$
$$P_2 = \frac{V^2}{R_2}$$
$$\frac{P_1}{P_2} = \frac{R_2}{R_1}$$
$$\frac{P_1}{P_2} = \frac{20}{10} = \frac{2}{1}$$
$$P_1 : P_2 = 2:1$$

Question 29: A portion is projected with a uniform velocity „v" along the axis of a current-carrying solenoid, then –

(A) The proton will be accelerated along the axis

(B) The proton path will be circular about the axis

(C) The proton moves along a helical path.

(D) The proton will continue to move with velocity „v" along the axis.

ANSWER: (D)

Solution:

The force on a charged particle in magnetic field

$$F = q\,(v \times B)$$
$$\therefore v \| B$$
$$F = q\,vB\sin\theta$$
$$\theta = 0 \text{ and } F = 0$$

The magnetic field due to a solenoid at the axis is along the axis. Hence, a proton is moving with a velocity „v" along the axis. Its velocity will be parallel to the magnetic field. There is no component of velocity of a proton ⊥ to the magnetic field. Therefore, the net force on the proton will be zero. The proton will continue to move along the axis with velocity „v".

Question 30: In the cyclotron, as the radius of the circular path of the charged particle increases (ω = angular velocity, v = linear velocity)

(A) Both ω and v increases **(B) ω only increases, v remains constant**

(C) v increases, ω remains constant **(D) v increases, ω decreases**

ANSWER: (C)

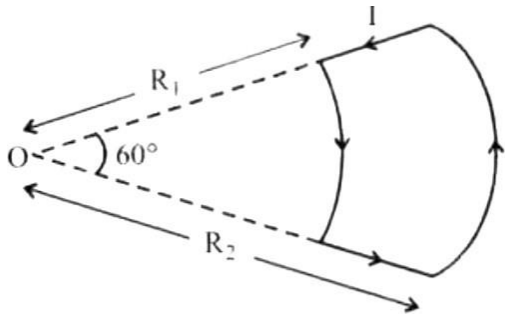
Solution:

$$\text{Linear velocity, } v = \frac{Bqr}{m}$$
$$\therefore v \propto r$$
$$\text{Angular velocity } \omega = \frac{Bq}{m}$$

ω = constant (because B, q and „m" are constants)

Hence, v increases, ω remains constant when the radius of the circular path is increased.

Question 31: A conducting wire carrying current is arranged as shown. The magnetic field at „O"

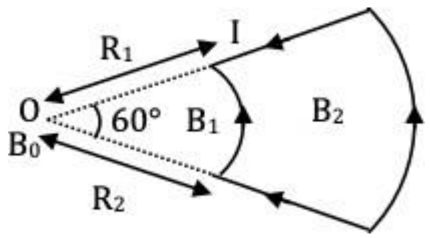


(A) $\frac{\mu_0 i}{12}\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ (B) $\frac{\mu_0 i}{12}\left(\frac{1}{R_1}+\frac{1}{R_2}\right)$

(C) $\frac{\mu_0 i}{6}\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ (D) $\frac{\mu_0 i}{6}\left(\frac{1}{R_1}+\frac{1}{R_2}\right)$

ANSWER: (A)

Solution:



Magnetic field at point „O"

$$B = \frac{\mu_0}{4\pi} \times \frac{i}{R_1}(\alpha) \quad \text{where } \alpha = 60^0 = \frac{\pi}{3}$$

Magnetic induction due to part 1, $B_1 = \frac{\mu_0}{4\pi} \times \frac{i}{R_1}\frac{\pi}{3} = \frac{\mu_0 i}{12R_1}$ (downwards)

Magnetic induction due to part 1, $B_2 = \frac{\mu_0}{4\pi} \times \frac{i}{R_2}\frac{\pi}{3} = \frac{\mu_0 i}{12R_2}$ (upwards)

Magnetic induction at the point O, $B_0 = B_2 - B_1 = \frac{\mu_0 i}{12}\left(\frac{1}{R_2}-\frac{1}{R_1}\right)$

Question 32: The quantity of a charge that will be transferred by a current flow of 20 A over 1 hour 30 minutes period is –

(A) 10.8×10^3 C (B) 10.8×10^4 C (C) 5.4×10^3 C (D) 1.8×10^4 C

ANSWER: (B)

Solution:

Given: Current, $I = 20A$, Time $t_1 = 0,\ t_2 = 1\text{hr } 30 \text{ min} = 1.5 \times 60 \times 60 = 5400$ sec

Electric current $I = \frac{dQ}{dt}$

$dQ = I\,dt$

$$\text{Electric charge} = dQ = \int_{t_1}^{t_2} I\, dt$$

$$\text{Electric charge} = dQ = I\int_{t_1=0}^{t_2=90\text{ min}} dt$$

$$\text{Electric charge} = Q = I \times [t]_0^{5400}$$

$$Q = 20 \times 5400 = 108000\text{ C}$$

$$Q = 10.8 \times 10^4\text{ C}$$

Question 33: A galvanometer coil has a resistance of 50 Ω and the meter shows full-scale deflection for a current of 5 mA. This galvanometer is converted into a voltmeter of range 0 – 20 V by connecting.

(A) 3950 Ω in series with galvanometer (B) 4050 Ω in series with galvanometer

(C) 3950 Ω in parallel with galvanometer (D) 4050 Ω in parallel with galvanometer

ANSWER: (A)

Solution:

$$\text{Given: } R_G = 50\ \Omega, I_g = 5\text{ mA} = 0.005\text{A}, V = 20\text{ volt}$$

A galvanometer is converted into a voltmeter by connecting a resistor in series with resistance of galvanometer. Let the resistor to be connected in series with R_G be R.

$$V = I_g(R_G + R)$$

$$20 = 0.005\ (50 + R)$$

$$\frac{20}{0.005} = (50 + R)$$

$$4000 = (50 + R)$$

$$R = 4000 - 50$$

$$R = 3950\ \Omega$$

In series with the galvanometer

Question 34: x_1 and x_2 are susceptibilities of a paramagnetic material at temperatures T_1K and T_2K respectively, then

(A) $\chi_1 = \chi_2$ (B) $\chi_1 T_1 = \chi_2 T_2$

(C) $\chi_1 T_2 = \chi_2 T_1$ (D) $\chi_1\sqrt{T_1} = \chi_2\sqrt{T_2}$

ANSWER: (B)

Solution:

According to curie‟s law

$$\text{Susceptibility of paramagnetic material} = \chi \propto \frac{1}{T}$$

$$\chi \propto \frac{1}{T} \Rightarrow \frac{\chi_1}{\chi_2} = \frac{T_2}{T_1}$$

$\chi_1 = \text{Constant } \frac{1}{T_1}$

$\chi_2 = \text{Constant } \frac{1}{T_2}$

$\therefore \frac{\chi_1}{\chi_2} = \frac{T_2}{T_1}$

$\chi_1 T_1 = \chi_2 T_2$

Question 35: At a certain place, the horizontal component of earth"s magnetic field is 3.0 G and the angle dip at the place is 30°. The magnetic field of the earth at that location

(A)4.5 G (B)5.1 G (C)3.5 G (D)6.0 G

ANSWER: (C)

Solution:

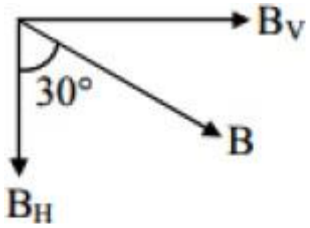
Magnetic field of earth, $B = B_H / \cos\theta$

Given:-

Horizontal component of earths magnetic field $B_H = 3G$ and $\theta = 30^0$

Magnetic field on the earth $= B = \frac{B_H}{\cos\theta}$

Horizontal component of earths magnetic field $B_H = B\cos\theta$



$B\cos 30^0 = 3$

$B\cos 30^0 = 3 \times \frac{1}{\cos 30^0}$

$B\cos 30^0 = 3\sec 30^0$

$B = 3\sec 30^0$

$B = 3 \times \frac{2}{\sqrt{3}}$

$B = 3 \times \frac{2}{\sqrt{3}} = \frac{6}{1.732} = 3.4642$

$B = 3.5\text{ G}$

Question 36: The process of superimposing message signal on the high-frequency carrier wave is called –

(A) Amplification (B) Demodulation (C) Transmission (D) Modulation

Solution:

ANSWER: (D)

The process of superimposing a message signal on a carrier wave is modulation. High-frequency signals on the other hand can be sent over large distances with small dissipation in power.

Question 37: A long solenoid with 40 turns per cm carries a current of 1 A. The magnetic energy stored per unit volume is______________J/m3

(A) 3.2π (B) 32π (C) 1.6π (D) 6.4π

ANSWER: (A)

Solution:

Given; I = 1A, Number of turns ,n = 40 turns per cm = 4000 turns per meter

The energy stored per unit volume of te solenoid, $E = \frac{1}{2\mu_0}B^2$

$$E = \frac{1}{2\mu_0}(\mu_0\, nI)^2$$

$$E = \frac{\mu_0 n^2 I^2}{2}$$

$$E = \frac{4\pi \times 10^{-7}(4 \times 10^3)^2(1)^2}{2}$$

$$E = 32\pi \times 10^{-1} = 3.2\pi\ Jm^3$$

Question 38: A wheel with 10 spokes each of length „L" m is rotated with a uniform angular velocity „ω" in a plane normal to the magnetic field „B". The emf induced between the axle and the rim of the wheel.

(A) $\frac{1}{2}N\omega BL^2$ (B) $\frac{1}{2}\omega BL^2$

(C) ωbL^2 (D) $N\omega bL^2$

ANSWER: (B)

Solution:

The Angular velocity is constant. Therefore, the linear velocity varies from V=0 to V=Lw from the axle to rim of the wheel. L is spokes length. The mea velocity will be

$$V_a = \frac{0 + L_w}{2} = \frac{L_w}{2}$$

According to Faradays law of electromagnetic induction, an e.m.f induced

$$e.m.f = BV_a l = \frac{\omega BL^2}{2}$$

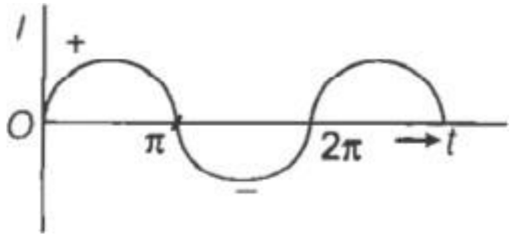
Question 39: The rms value of current in a 50 Hz AC circuit is 6 A. The average value of AC current over a cycle is –

(A) $6\sqrt{2}$ (B) $\frac{3}{\pi\sqrt{2}}$ (C) Zero (D) $\frac{6}{\pi\sqrt{2}}$

ANSWER: (C)

Solution:

Given: $F = 50Hz, I_{rms} = 6A, I_{avg} = ?$



Average value of AC current over a cycle is zero as current is negative for same amount of time that it is positive.

As the current is negative for the same amount of time for which it is positive. So, Average value of AC current over a cycle is zero.

Question 40: A capacitor of capacitance 10 μF is connected to an AC source and an AC ammeter. If the source voltage varies as V = 50√2 sin 100t, the reading of the ammeter is -

(A) 50 mA (B) 70.7 mA (C) 5.0 mA (D) 7.07 mA

Solution:

ANSWER: (A)

Given: $C = 10\ \mu F = 10 \times 10^{-6} F = 10^{-5} F$ and $V = 50\sqrt{2} = \sin 100\ t, \omega = 100$

On comparing withh $V = V_0 \sin \omega t$

$$V_{rms} = \frac{V_0}{\sqrt{2}} = \frac{50\sqrt{2}}{\sqrt{2}} = 50\ V$$

$$X_C = \frac{1}{\omega C} = \frac{1}{100 \times 10 \times 10^{-6}} = 10^3 = 1000\ \Omega$$

$$I_{rms} = \frac{V_{rms}}{X_C} = \frac{50}{1000} = 50 \times 10^3 = 50\ mA$$

Question 41: In a series L.C.R circuit, the potential drop across L, C and R respectively are 40 V, 120 V and 60 V. Then the source voltage is –

(A) 220 V (B) 160 V (C) 180 V (D)100 V

ANSWER: (D)

Solution:

Given: $V_L = 40V, V_C = 120V, V_R = 60V$

The net voltage or source in the LCR circuit $V_S = \sqrt{V_R^2 + (V_C - V_L)^2}$

$$V_S = \sqrt{(60)^2 + (120 - 40)^2}$$

$$V_S = \sqrt{(60)^2 + (80)^2}$$

$$V_S = \sqrt{3600 + 6400}$$

$$V_S = \sqrt{10000}$$

$$V_S = 100\ volt$$

Question 42: In a series, L.C.R. circuit an alternating emf (v) and current (i) are given by the equation $V = V_0 \sin \omega t$ **and** $I = I_0 \sin\left(\omega t + \frac{\pi}{3}\right)$

The average power dissipated in the circuit over a cycle of AC is –

(A) $\frac{V_0 I_0}{2}$ (B) $\frac{V_0 I_0}{4}$ (C) $\frac{\sqrt{3} V_0 I_0}{2}$ (D) Zero

ANSWER (B)

Solution:

$$V = V_0 \sin \omega t$$

$$I = I_0 \sin\left(\omega t + \frac{\pi}{3}\right)$$

The average dissipated power in AC circuit.

$$P = V_{rms} I_{rms} \cos\phi$$

$$V_{rms} = \frac{V_0}{\sqrt{2}} \qquad I_{rms} = \frac{I_0}{\sqrt{2}}$$

$$\phi = \frac{\pi}{3}$$

$$P = \frac{V_0}{\sqrt{2}} \times \frac{I_0}{\sqrt{2}} \times \cos\frac{\pi}{3}$$

$$P = \frac{V_0 I_0}{2} \times \cos 60^0$$

$$P = \frac{V_0 I_0}{2} \times \frac{1}{2}$$

$$P = \frac{V_0 I_0}{4}$$

Question 43: Electromagnetic radiation used to sterilise milk is –

(A) X-ray (B) Y-ray (C) UV ray (D) Radio Waves

ANSWER: (C)

Solution:

The electromagnetic radiation used to sterilise the milk in dairy is ultraviolet.

Question 44: A plane glass plate is placed over various coloured letters (violet, green, yellow, red). The letter which appears to raise more

(A) Red (B) Yellow (C) Green (D) Violet

Solution:

ANSWER: (D)

Normal shift through the plate of thickness t

$$d = t\left[1 - \frac{1}{\mu}\right]$$

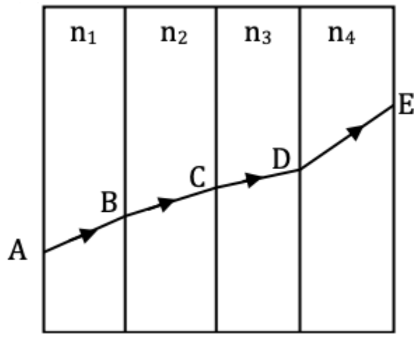
Now, Refractive index (μ) is related to wavelength (λ) of light as

$$\mu = A + \frac{B}{\lambda^2}$$

Violet has least wavelength out of the colored letters and has the greatest shift. So, option D is correct

---

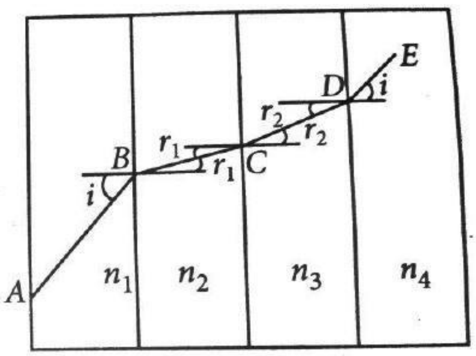
Question 45: A ray of light passes through four transparent media with refractive index n_1, n_2, n_3 and n_4 as shown. The surfaces of all media are parallel. If the emergent ray DE is parallel to incident ray AB, then



(A) $n_1 = n_4$ (B) $n_2 = n_4$ (C) $n_3 = n_4$ (D) $= \frac{n_2 + n_3 + n_4}{3}$

Solution:

ANSWER: (A)



Angle of incidence = Angle of refraction

i = r … (1)

Using snell‟s law of refraction

$n_1 \sin i = n_2 \sin r$

$${}_1n_2 = \frac{\sin i}{\sin r_1} \ldots\ldots\ldots (1)$$

$${}_2n_3 = \frac{\sin r_1}{\sin r_2} \ldots\ldots\ldots (2)$$

$${}_3n_4 = \frac{\sin r_2}{\sin i} \ldots\ldots\ldots (3)$$

$${}_1n_2 \times {}_2n_3 \times {}_3n_4 = \frac{\sin i}{\sin r_1} \times \frac{\sin r_1}{\sin r_2} \times \frac{\sin r_2}{\sin i} = 1$$

$${}_1n_2 \times {}_2n_3 \times {}_3n_4 = \frac{n_2}{n_1} \times \frac{n_3}{n_2} \times \frac{n_4}{n_3} = 1$$

$$\frac{n_4}{n_1} = 1$$

$$n_1 = n_4$$

The emergent ray CD can become parallel to incident ray AB after traveling through different media, only when both of them travel in same medium of same refractive index.

Question 46: Focal length of a convex lens is 20 cm and its RI is 1.5. It produces an erect, enlarged image if the distance of the object from the lens is –

(A) 40 cm (B) 30 cm (C) 15 cm (D) 20 cm

Solution:

ANSWER: (C)

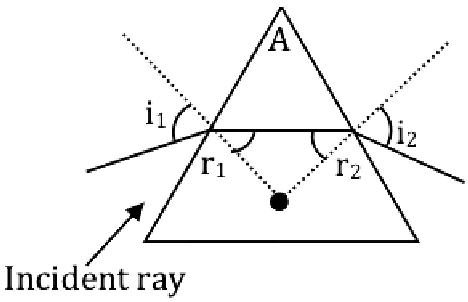
A convex lens forms an erect and enlarged image when the object is placed between focus and the lens. So, object distance must be less than the focal length of the lens. Thus, object distance must be 15cm.

Question 47: A ray of light suffers a minimum deviation when incident on an equilateral prism of refractive index √2. The angle of incidence is –

(A) 30° (B) 45° (C) 60° (D) 50°

Solution:

ANSWER: (B)



Given: Refractive index of air $\mu_1 = 1$

Refractive index of air Prism $\mu_2 = 1$

Refractive index of air Prism $\mu_2 = \sqrt{2}$

Angle of the Prism $A = 60^0$ (Equilaatteral triangle)

By geometry Angle of the prism, $A = r_1 + r_2 \dots\dots\dots (1)$

As ray of light suffers minimum deviation, $r_1 = r_2 = r \dots\dots\dots (2)$

From equation (1) & (2)

$$A = 2r$$

$$r = \frac{A}{2} = \frac{60^0}{2} = 30^0$$

From snell"s law

$$\mu_1 \sin i = \mu_2 \sin r$$

$$1 \times \sin i = \sqrt{2} \times \sin 30^0$$

$$\sin i = \sqrt{2} \times \frac{1}{2}$$

$$\sin i = \sqrt{2} \times \frac{1}{\sqrt{2} \times \sqrt{2}}$$

$$\sin i = \frac{1}{\sqrt{2}}$$

$$i = \sin^{-1}\left(\frac{1}{\sqrt{2}}\right)$$

$$i = 45^0$$

Question 48: In Young"s double-slit experiment the source is white light. One slit is covered with a red filter and the other with a blue filter. There shall be –

(A) Alternate red & blue fringes (B) Alternate dark & pink fringes

(C) Alternate dark & yellow fringes (D) No interference

ANSWER: (D)

Solution:

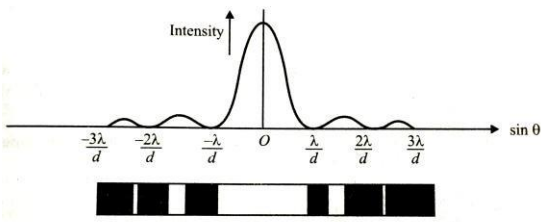
The light from two slits of young"s double-slit experiment is in red and blue colours. They have different wavelengths and frequencies. They produce interference fringes in their own colours. These two patterns are overlapping with each other. Therefore, the net effect is whit light. Hence, there shall be no interference fringes.

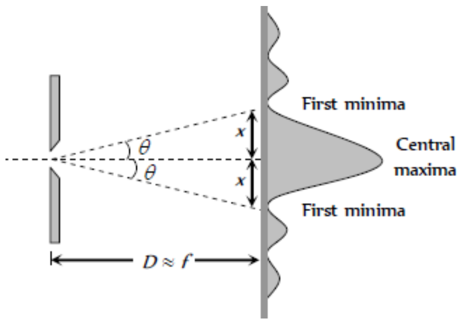
Question 49: Light of wavelength 600 nm is incident normally on a slit of width 0.2 mm. The angular width of central maxima in the diffraction pattern is (measured from minimum to maximum).

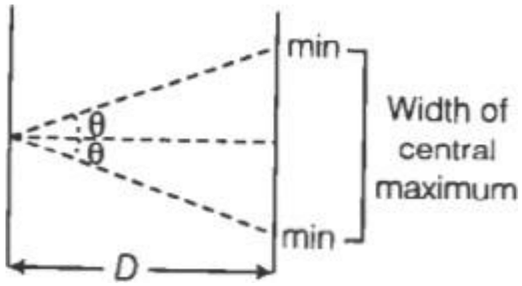
(A) 6 × 10^{-3} rad (B) 4 × 10^{-3} rad (C) 2.4 × 10^{-3} rad (D) 4.5 × 10^{-3} rad

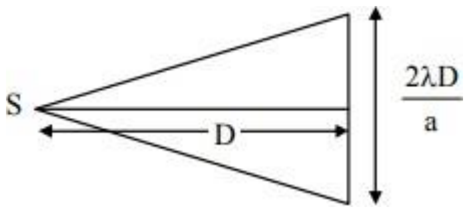
ANSWER: (A)

Solution:









Given $\lambda = 600\ nm = 600 \times 10^{-9} m$, $a = d = 0.2mm = 0.2 \times 10^{-3} m = 2 \times 10^{-4} m$

If a is the distance between the slit and the screen,

The Linear width of the central maximum is

$$2x = \frac{2\lambda D}{a}$$

The angular width of the central maximum $= \frac{2\lambda D/a}{D}$

The angular width of the central maximum $= \frac{2\lambda}{a}$

The angular width $= \frac{2 \times 600 \times 10^{-9}}{2 \times 10^{-4}} = 6 \times 10^{-3}$ rad

---

Question 50: For what distance is ray optics is a good approximation when the aperture is 4 mm and the wavelength of light is 400 nm?

(A) 24 m (B) 40 m (C) 18 m (D) 30 m

Solution:

ANSWER: (ABCD)

Given $\lambda = 400\ nm = 400 \times 10^{-9} m, a = d = 4mm = 4 \times 10^{-3} m$

So, Fresnel distance:-

Fresnel's Diffraction $= D_f = \frac{a^2}{\lambda}$

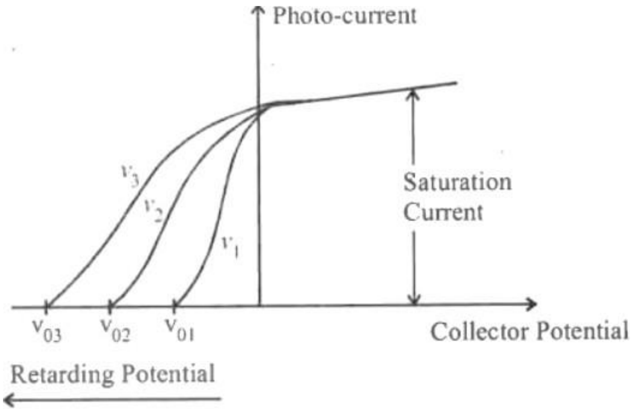
$$D_f = \frac{(4 \times 10^{-3})^2}{400 \times 10^{-9}}$$

$$D_f = \frac{16 \times 10^{-6}}{400 \times 10^{-9}}$$

$$D_f = \frac{16 \times 10^{-6}}{4 \times 10^{-7}}$$

$$D_f = 4 \times 10 = 40\ m$$

Question 51: The variation of photocurrent with collector potential for different frequencies of incident radiation v_1, v_2 and v_3 is as shown in the graph, then

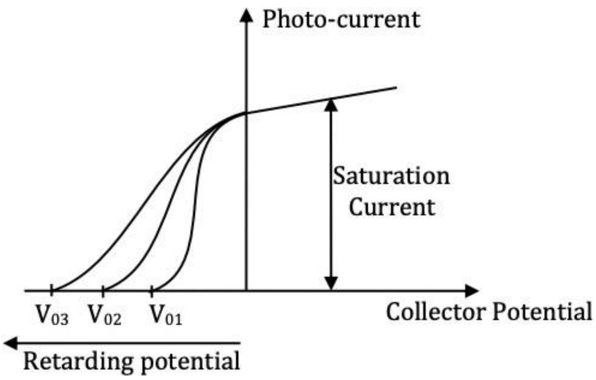


(A) $V_1 = V_2 = V_3$ (B) $V_1 > V_2 > V_3$

(C) $V_1 < V_2 < V_3$ (D) $V_3 = \frac{(V_1 + V_2)}{2}$

ANSWER: (C)

Solution:



$V_{03} > V_{02} > V_{01}$ [Stopping potential]

Minimum Energy of photon required for emission „α" stopping potential

$E_1 > E_2 > E_1$

E = h

So, $V_3 > V_2 > V_1$

Question 52: The de Broglie wavelength of an electron accelerated to a potential of 400 V is approximately –

(A) 0.03 nm (B) 0.04 nm (C) 0.12 nm (D) 0.06 nm

ANSWER: (D)

Solution:

Using de-Broglie wavelength

λ = (123 / √v) Å

Given:-

V = 400v

λ = [12.3 / √400] = (12.3 / 20) Å

= 0.615A°

λ = 0.0615 nm

Question 53: Total energy of an electron in an excited state of a hydrogen atom is – 3.4 eV. The kinetic and potential energy of an electron in this state –

(A) U = -3.4 eV (B) U = - 6.8 eV (C) K = 3.4 eV (D) U = - 6.8 eV

(C) K = -6.8eV U = 3.4Ev (D) K = 10.2eV U = - 13.6eV

ANSWER: (B)

Solution:

Kinetic energy of electron $K.E = \frac{13.6\ Z^2}{n^2}$ eV

For the first excited state of the hydrogen atom, $n = 2$ and $Z = 1$

$$K.E = \frac{13.6}{2^2} = \frac{13.6}{4} = 3.4\ eV$$

$$\text{Total energy} = -3.4\ eV$$

$$T.E = K.E + P.E$$

$$-3.4 = +3.4 + P.E$$

$P.E = 6.8\ eV$

Question 54: When an electron jumps from n = 4 level to n = 1 level, the angular momentum of electron changes by –

(A) h/2π (B) 2h/2π (C) 3h/2π (D) 4h/2π

Solution:

ANSWER: (C)

From Bohr"s postulate, the angular momentum is

$$L = mvr = \frac{nh}{2\pi}$$

$$L_1 = 1 \times \frac{h}{2\pi} \quad \text{when } n = 1$$

$$L_2 = 4 \times \frac{h}{2\pi} \quad \text{when } n = 4$$

$$L_2 - L_1 = 4 \times \frac{h}{2\pi} - 1 \times \frac{h}{2\pi} = (4-1)\frac{h}{2\pi} = 3\frac{h}{2\pi}$$

Question 55: A radioactive sample of half-life 10 days contains 1000 x nuclei. Number of original nuclei present after 5 days is –

(A)707X (B)750 X (C)500X (D) 250X

ANSWER: (A)

Solution:

Given: $N_0 = 1000x, t = 5\text{days}$ and $T_{\frac{1}{2}} = 10$ days

The number of radioactive nuclei left after n -half-lives is

$$N = \frac{N_0}{2}$$

Nuclei present after 5 days, $N = N_0 e^{(-\lambda t)}$

$$\lambda = \frac{0.693}{T}$$

$$N = N_0[\exp]\left(\frac{-0.693 \times 5}{T_{1/2}}\right)$$

$$N = N_0[\exp]\left(\frac{-0.693 \times 5}{10}\right)$$

$$N = 1000\,x \times [\exp]\,(-0.346)$$

$$N = 1000\,x \times 0.707$$

$N = 707\,x$

Question 56: An element X decays into element Z by a two-step process

$$X \rightarrow Y + {}^{4}_{2}He$$

$$Y \rightarrow Z + 2\bar{e} \text{ then}$$

(A) X & Z are isobars. **(B) X & Y are isotopes.**

(C) X & Z are isotones. **(D) X & Z are isotopes.**

ANSWER: (D)

Solution:

Let atomic number and mass number of X be Z and A, respectively.

The first step of the reaction is

$$^{A}_{Z}x \rightarrow {}^{A-4}_{Z-2}y + {}^{4}_{2}He$$

The second step of the reaction is

$$^{A-4}_{Z-2}y \rightarrow {}^{A-4}_{Z}Z \rightarrow +2e^{-}$$

Atoms of elements having same atomic number and different mass number are known as isotopes. Thus X and Z are isotopes.

Question 57: A nucleus of mass 20 u emits a γ photon of energy 6 MeV. If the emission assume to occur when the nucleus is free and rest, then the nucleus will have kinetic energy nearest to (Take 1u = 1.6 × 10^{-27} kg)

(A) 10KeV **(B)1KeV** **(C) 0.1KeV** **(D) 100KeV**

ANSWER: (B)

Solution:

E = 6Mev

= 6 × 1.6 × 10^{-13}J

m = 20u

= 20 × 1.6 × 10^{-27} kg

Momentum of γ photon,

P = E / C

P = P = E / C [momentum of Nucleus]

$K = P^2 / 2m = E^2 / 2mc^2$

$K = [6 \times 1.6 \times 10^{-13}]^2 / [2 \times (20 \times 1.6 \times 10^{-27}) \times (3 \times 10^8)^2]$

After solving

K.E. = 1Kev

Question 58: Constant DC voltage is required from a variable AC voltage. Which of the following is the correct order of operation?

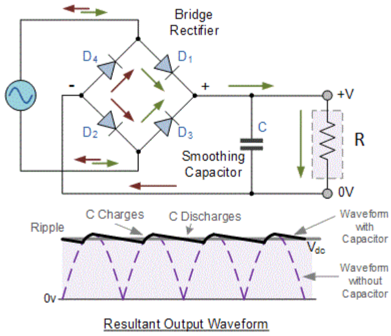
(A) Regulator, filter, rectifier **(B) Rectifier, regulator, filter**

(C) Rectifier, filter, regulator **(D) Filter, regulator, rectifier**

ANSWER: (C)

Solution:

To convert AC to DC, a full wave rectifier is required. The output of the full wave rectifier will be positive cycles of the applied input AC voltage. To convert the positive cycles to ripples, a RC filter will be required. The output of the combination of the two circuits will be ripples as shown in the attached figure. After this, to get a steady value of DC, we will require a voltage regulator (can be built with the help of a Zener diode) so that the output remains constant



Question 59: In a transistor, the collector current varies by 0.49 mA and emitter current varies by 0.50 mA. Current gain β measured is –

(A) 49 **(B) 150** **(C) 99** **(D) 100**

Solution:

ANSWER: (A)

Given: $\Delta I_C = 0.49$ mA, $\Delta I_e = 0.50$ mA,

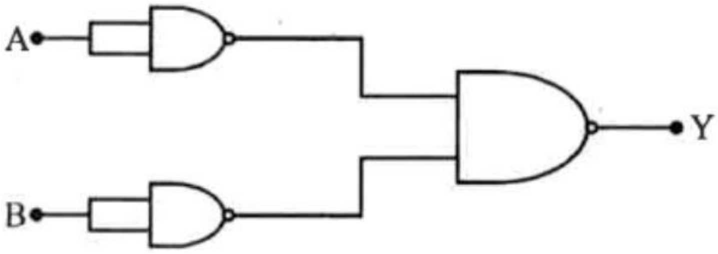
$$\text{Current gain} = \beta = \frac{\Delta I_C}{\Delta I_b} \ldots\ldots\ldots\ldots(1)$$

Change in base current $\Delta I_b = \Delta I_e - \Delta I_C$

Change in base current $\Delta I_b = 0.50 - 0.49 = 0.01$ mA

$$\text{Current gain} = \beta = \frac{\Delta I_C}{\Delta I_b} = \frac{0.49}{0.01} = 49$$

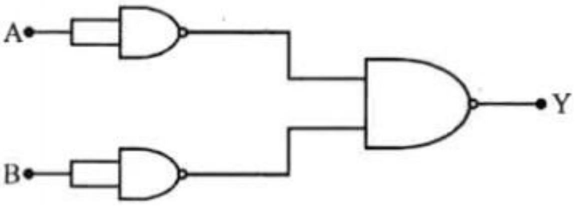
Question 60: Identify the logic operation carried out by the following circuit.



(A) AND **(B) NAND** **(C) NOR** **(D) OR**

ANSWER: (D)

Solution:



$C = \overline{A}\overline{B} = \overline{A}$

$D = \overline{B}$

$Y = \overline{C}\overline{D}$

$= \overline{A} + \overline{B}$

A	B	C	D	Y
0	0	1	1	0
0	1	1	0	1
1	0	0	1	1
1	1	0	0	1

OR Gate

****

KCET – 2015: PHYSICS

Question 1: The ratio of the dimensions of Planck constant and that of moment of inertia has the dimensions of

(A) Time **(B) Frequency**

(C) Angular momentum **(D) Velocity**

ANSWER: (B)

Solution:

The energy of the photon is given by

$E = h\gamma$

Where h is Planck‟s constant and „γ‟ frequency of radiation

$$h = \frac{E}{\gamma} = \frac{[M^1L^2T^{-2}]}{[M^0L^0T^{-1}]} = [M^1L^2T^{-1}] \dots\dots\dots (1)$$

There is no dimensions for constant „γ‟.

Moment of Inertia, $I = mr^2$

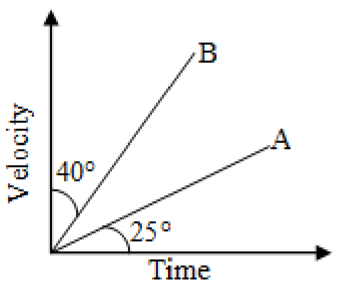
Where „m‟ is mass „r‟ is radius of gyration

$I = [M^1L^2T^0] \dots\dots\dots (2)$

Dividing eq. (1) and (2)

$$\frac{h}{I} = \frac{[M^1L^2T^{-1}]}{[M^1L^2T^0]} = [T^{-1}] = [M^0L^0T^{-1}]. \text{This similar to dimensions for frequency}$$

Question 2: The velocity-time graph for two bodies A and B are shown. Then the acceleration of A and B are in the ratio



(A) tan25° to tan 40° **(B) tan 25° to tan 50°**

(C) sin 25° to sin 50° **(D) cos25° to cos50°**

ANSWER: (B)

Solution:

$$\text{The acceleration of the body} = \text{sloope} = \frac{\text{Change in velocity}}{\text{Change inTime}} = \frac{\Delta v}{\Delta t}$$

The Lines A and B makes an angle of 25^0 and 50° respectively with the horizontal. Therefore, its slope is equal to 25^0 and 50°.

Question 3: A particle is projected with a velocity v so that its horizontal range is twice the greatest height attained. The horizontal range is

(A) $\frac{v^2}{g}$ (B) $\frac{2v^2}{3g}$

(C) $\frac{4v^2}{5g}$ (D) $\frac{v^2}{2g}$

Solution:

ANSWER: (C)

Given R = 2H

$$\frac{v^2 \sin 2\theta}{g} = \frac{2v^2 \sin^2\theta}{2g}$$

$$\sin 2\theta = \sin^2\theta$$

$$2\sin\theta\cos\theta = \sin\theta \times \sin\theta$$

$$2 = \frac{\sin\theta \times \sin\theta}{\sin\theta \times \cos\theta}$$

$$2 = \tan\theta$$

From the triangle we can say that

$$\sin\theta = \frac{v^2 \sin\theta\cos\theta}{g}$$

$$\sin\theta = \frac{2}{\sqrt{5}}, \cos\theta = \frac{1}{\sqrt{5}}$$

$$R = \frac{v^2 \sin\theta\cos\theta}{g} = \frac{2v^2}{g} \times \frac{2}{\sqrt{5}} \times \frac{1}{\sqrt{5}}$$

$$R = \frac{4v^2}{5g}$$

Question 4: A stone of mass 0.05 kg is thrown vertically upwards. What is the direction and magnitude of net force on the stone during its upward motion?

(A) 0.49 N vertically upwards **(B) 0.49 N vertically downwards**

(C) 0.98 N vertically downwards **(D) 9.8 N vertically downwards**

ANSWER: (B)

Solution:

Here Given, m = 0.05 kg

F = mg

F = 0.05 × (–9.8) = – 0.49N

F = 0.49 N vertically downwards

Question 5: The kinetic energy of a body of mass 4 kg and momentum 6 Ns will be

(A) 2.5 J **(B) 3.5 J** **(C) 4.5 J** **(D) 5.5 J**

ANSWER: (C)

Solution:

Given , m = 4kg, P = 6Ns

$$K.E = \frac{P^2}{2m} = \frac{6 \times 6}{2 \times 4} = \frac{36}{8} = 4.5\ J$$

Question 6: The ratio of angular speed of a second-hand to the hour-hand of a watch is

(A) 720:1 (B) 60:1 (C) 3600:1 (D) 72:1

ANSWER: (A)

Solution:

The time taken by a second (needle) hand of the clock takes 60 sec (1 min) to cover an angular distance of 2π radians (360°) or.

The angular speed, $\omega = 2\pi n = \frac{2\pi}{T} = \frac{2\pi}{60}$ radian /sec

$$\omega = \frac{\pi}{30} \text{ radian /sec}$$

$$\omega = \frac{2\pi}{43200} \text{ radian /sec}$$

For an hour (needle) hand to complete 1 rotation i.e 2π radians it takes 12hrs (12×3600 seconds).

The angular speed for an hour hand, $\omega = \frac{2\pi}{43200}$ radian /sec

$$\omega = \frac{2\pi}{43200} \text{ radian /sec}$$

$$\omega = \frac{\pi}{21600} \text{ radian /sec}$$

The ratio angular velocity of the second hand to the hour hand $= \frac{\pi/30}{\pi/21600}$

$$\omega = \frac{21600}{30} \text{ radian /sec}$$

$$\omega = \frac{\omega_1}{\omega_2} = \frac{21600}{30} = \frac{720}{1}$$

$\omega_1 : \omega_2 = 720:1$

Question 7: If the mass of a body is M on the surface of the earth, the mass of the same body on the surface of the moon will be

(A) M/6 (B)M (C)6M (D)Zero

ANSWER: (M)

Solution:

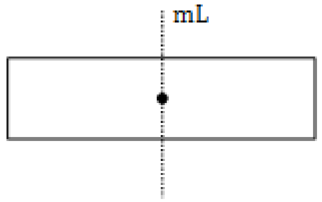
Mass of a body is a constant quantity whereas its weight is a variable quantity. Mass does not depend on the acceleration due to gravity. Hence mass of that body on the surface of moon is also M.

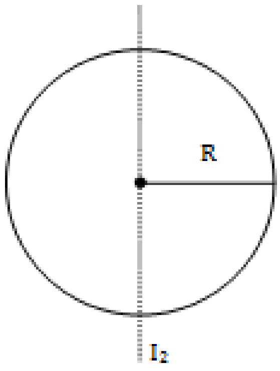
Question 8: Moment of Inertia of a thin uniform rod rotating about the perpendicular axis passing through its centre is 1. If the same rod is bent into a ring and its moment of inertia about its diameter is F. Then the ratio I/I" will be

(A)(3/2) π^2 (B)(8/3) π^2 (C)(2/3) π^2 (D)(5/3) π^2

ANSWER: (C)

Solution:





Moment of Inertia of rectangular body $I_1 = \frac{mL^2}{12}$

$$I_1 = \frac{mL^2}{12}$$

$$L = 2\pi R \Rightarrow R = \frac{L}{2\pi}$$

Moment of Inertia of ring about its diameter is given by $I_2 = \frac{mR^2}{2}$

$$I_2 = \frac{mR^2}{2}$$

$$I_2 = \frac{mR^2}{2} = \frac{1}{2}m\left(\frac{L}{2\pi}\right)^2 = \frac{mL^2}{8\pi^2}$$

$$\frac{I_1}{I_2} = \frac{mL^2}{12} \times \frac{8\pi^2}{mL^2} = \frac{8\pi^2}{12} = \frac{2\pi^2}{3}$$

Question 9: The ratio of hydraulic stress to the corresponding strain is known as

(A)Compressibility **(B) Bulk modulus**

(C)Young's modulus **(D) Rigidity modulus**

ANSWER: (B)

Solution:

Bulk modulus is the ratio of hydraulic stress to the hydraulic strain.

$$\text{Bulk modulus} = \frac{\text{Hydaulic stress}}{\text{Hydaulic strain}}$$

Question 10: The efficiency of a Carnot engine which operates between the two temperatures T_1 = 500 K and T_2 = 300 K is

(A)50% **(B)25%** **(C)75%** **(D)40%**

ANSWER: (D) Solution:

$T_1 = 500K, T_2 = 300K$

Efficiency of Carnots heat engine $= \eta = 1 - \left(\frac{T_2}{T_1}\right)$

$$\eta = 1 - \left(\frac{300}{500}\right)$$

$$\eta = \left(\frac{500 - 300}{500}\right) = \frac{200}{500} = \frac{2}{5} = 0.4$$

Therefore, the efficiency of Carnot"s heat engine is 40%.

Question 11: Water is heated from 0 °C to 10 °C then its volume

(A) Decreases (B) Increases

(C) Does not change (D) First decreases and then increases

ANSWER: (D)

Solution:

When water is heated from 0°C to 4°C, there is a decreasing amount in volume and density increases till it is a 4°C and then volume starts increasing to 10°C.

Question 12: 1 gram of ice is mixed with 1 gram of steam. At thermal equilibrium, the temperature of the mixture is

(A)0 °C (B)100 °C (C)50 °C D)55 °C

Solution:

ANSWER: (B)

According to principle of Calorimetry states that *the total heat given by a hotter body is equal to the total heat received by colder body*

The total heat lost by the hot body = The total heat gained by the cold body

1. The amount of heat required to convert the 1g of ice at **0^0C** into 1 g of water at **0^0C is** given by

$Q_1 = \text{mass} \times \text{Latent heat of fusion of ice}$

$Q_1 = m_1 L$

$Q_1 = 1 \times 80 = 80 \text{ cal}$

2. The amount of heat required to convert the 1g of steam into 1 g of water at 100^0C is given by

$Q_2 = \text{mass} \times \text{Latent heat of vapourisation}$

$Q_2 = m \times L_V$

$Q_2 = 1 \times 540 = 540 \text{ cal}$

3. The amount of heat required to convert the 1g of water at **0^0C** into 1 g of water at 100^0C is

$Q = 1 \times 1 \times 100 \text{ cal}$

So clearly, the whole steam is not condensed. So the temperature of the mixture is 100°C.

Question 13: The ratio of kinetic energy to the potential energy of a particle executing SHM at a distance is equal to half of its amplitude, the distance being measured from its equilibrium position will be

(A)3 : 1 (B) 4 : 1 (C)2 : 1 (D)8 : 1

ANSWER: (A)

Solution:

The potential energyof SHM $= P.E = \frac{1}{2}kx^2$

The distance x is equal to half its amplitude x = A/2

$P.E = \frac{1}{2}k\frac{A^2}{4}$

The Kinetic energy of SHM $= K.E = \frac{1}{2}k\,(A^2 - x^2)$

$$K.E = \frac{1}{2}k\,(A^2 - \frac{A^2}{4})$$

$$K.E = \frac{1}{2}k\left(\frac{4\,A^2 - A^2}{4}\right)$$

$$K.E = \frac{1}{2}k\frac{3A^2}{4}$$

$$\frac{K.E}{P.E} = \frac{1}{2}k\frac{3A^2}{4} \Big/ \frac{1}{2}k\frac{A^2}{4}$$

$$\frac{K.E}{P.E} = \frac{3}{1}$$

Question 14: When two tuning forks A and B are sounded together. 4 beats per second are heard. The frequency of fork B is 384 Hz. When one of the prongs of the fork A is filed and sounded with B. the beat frequency increases, then the frequency of the fork A is

(A) 380 Hz (B) 388 Hz (C) 379 Hz (D)389 Hz

Solution:

ANSWER: (B)

The bat frequency is equal to the difference of the two frequencies.

$$\text{Beat frequency} = \gamma_A - \gamma_B$$

$$4 = (\gamma_A - 384)$$

Suppose one of the prongs of the fork A is loaded with little amount of wax and sounded with B. The beat frequency increases, then the frequency of the fork A is

$$\gamma_A = 384 + 4 = 388\ \text{Hz}$$

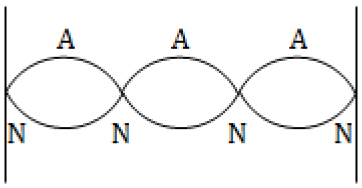
Question 15: A stretched string is vibrating in the second overtone, then the number of nodes and antinodes between the ends of the string are respectively

(A)4 and 3 **(B)**3 and 2 **(C)**3 and 4 **(D)**2 and 3

ANSWER: (A)

Solution: **The second overtone means string vibrating third mode of vibration**

From the figure, number of nodes and antinodes will be 4 and 3



Question 16: Two spheres carrying charges + 6μC and + 9μC separated by a distance d, experiences a force of repulsion F. When a charge of –3μC and - 6μC is given to both the sphere and kept at the same distance as before, the new force of repulsion is

(A)F **(B) 3F** **(C)F/3** **(D)F/9**

ANSWER: (C)

Solution:

The force of repulsion between two positive chrges $= F_1 = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{d^2}$

$$F_1 = \frac{1}{4\pi\varepsilon_0}\frac{6\times10^{-6}\times9\times10^{-6}}{d^2}$$

$$F_1 = \frac{1}{4\pi\varepsilon_0}\frac{54\times10^{-12}}{d^2}$$

The force of repulsion between two negative chrges $= F_2 = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{d^2}$

$$F_2 = \frac{1}{4\pi\varepsilon_0}\frac{-3\times10^{-6}\times-6\times10^{-6}}{d^2}$$

$$F_2 = \frac{1}{4\pi\varepsilon_0}\frac{18\times10^{-12}}{d^2}$$

$$\frac{F_2}{F_1} = 3$$

$$F_2 = 3F_1$$

Question 17: Pick out the statement which is incorrect.

(A) The tangent drawn to a line of force represents the direction of the electric field

(B) The electric field lines form a closed loop

(C) A negative test charge experiences a force opposite to the direction of the field

(D) Field lines never intersect

ANSWER: (B)

Solution:

Electric field lines do not form a closed loop as the line can never start and end on the same change.

Question 18: The angle between the dipole moment and electric field at any point on the equatorial plane is

(A) 0° **(B) 90°** **(C) 180°** **(D) 45°**

Solution:

ANSWER: (C)

The angle between electric dipole moment and electric field in the equatorial line is 180° as both of them are in opposite directions.

Question 19: Three point charges 3nC, 6nC and 9nC are placed at the corners of an equilateral triangle of side 0.1 in. The potential energy of the system is

(A) 8910 J **(B)89100 J** **(C)9910 J** **(D)99100 J**

Answer: Bonus

Question 20: A spherical shell of radius 10 cm is carrying a charge q. If the electric potential at distances 5 cm, 10 cm and 15 cm from the centre of the spherical shell is V_1, V_2 and V_3 respectively, then

(A) $V_1 > V_2 > V_3$ **(B) $V_1 < V_2 < V_3$** **(C) $V_1 = V_2 > V_3$** **(D) $V_1 = V_2 < V_3$**

ANSWER: (C)

Solution:

Inside the spherical shell, potential is same.

$V_1 = V_2$

V a (1/d)

$V_1 = V_2 > V_3$

Question 21: A parallel plate capacitor is charged and then isolated. The effect of increasing the plate separation on charge, potential and capacitance respectively are

(A) Constant, decreases, decreases **(B)** Increases, decreases, decreases

(C) Constant, decreases, increases **(D)** Constant, increases, decreases

ANSWER: (D)

Solution:

From the definition,

$$\text{The capapcitance of the parallel capacitor, } \mathbf{C} = \frac{\boldsymbol{\varepsilon_0 A}}{\mathbf{d}}$$

$$\text{The capapcitance of the capacitor, } \quad \mathbf{C} = \frac{\mathbf{q}}{\mathbf{V}}$$

Suppose the separation between the two plates increases,

(i) The magnitude of the charge is constant,

(ii) Potential increases, and

(iii) Capacitance decreases.

Question 22: Four identical cells of emf E and internal resistance „r" are to be connected in series. Suppose if one of the cells is connected wrongly. The equivalent emf and effective internal resistance of the combination is

(A) 4E and 4r **(B)** 4E and 2r

(C) 2E and 4r **(D)** 2E and 2r

ANSWER: (C)

Solution: Resistance in series connection -

$$r_{equi} = r_1 + r_2 + r_3 + r_4 = r + r + r + r = 4r$$

e.m.f in series connection–

$$E_{equi} = E_1 + E_2 + E_3 - E_4 = E + E + E - E = 2E$$ (When one is connected wrong)

Question 23: Three resistances 2Ω, 3Ω and 4Ω are connected in parallel. The ratio of currents passing through them when a potential difference is applied across its ends will be

(A) 6 : 3 : 2 (B) 6 : 4 : 3 (C) 5 : 4 : 3 (D) 4 : 3 : 2

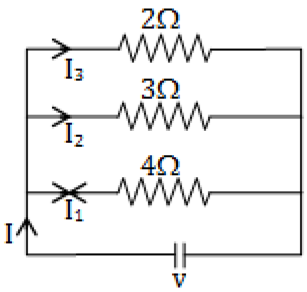
ANSWER: (B)

Solution:

$$\text{Current through } 4\Omega = I_1 = \frac{V}{4}$$

Current through $3\Omega = I_2 = \frac{V}{3}$

Current through $2\Omega = I_3 = \frac{V}{2}$

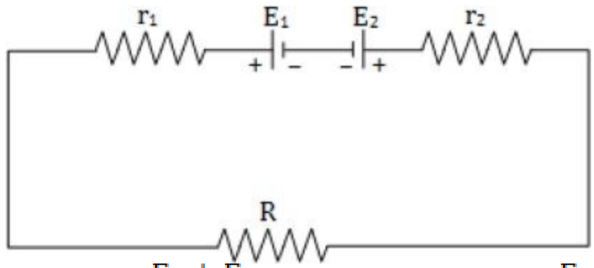


$I_1 : I_2 : I_3 = \frac{1}{2} : \frac{1}{3} : \frac{1}{4}$

On multiplying by 12

$I_1 : I_2 : I_3 = 6 : 4 : 3$

Question 24: Two cells of emf E_1 and E_2 are joined in opposition (such that $E_1 > E_2$). If r_1 and r_2 be the internal resistances and R will be the external resistance, then the terminal potential difference is



(A) $\frac{E_1 + E_2}{r_1 + r_2} \times R$ (B) $\frac{E_1 + E_2}{r_1 + r_2 + R} \times R$

(C) $\frac{E_1 - E_2}{r_1 + r_2} \times R$ (D) $\frac{E_1 - E_2}{r_1 + r_2 + R} \times R$

ANSWER: (D)

Solution:

Two cells of emf E_1 and E_2 are joined in opposite direction. Therefore, $E_1 > E_2$

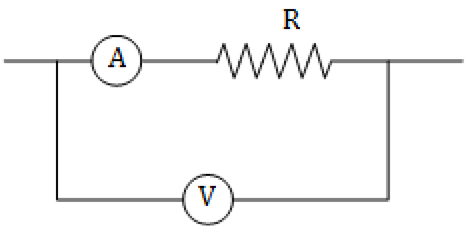
$$I = \frac{E_1 - E_2}{r_1 + r_2 + R}$$

$$V = IR$$

$$V = \left(\frac{E_1 - E_2}{r_1 + r_2 + R}\right)R$$

Question 25: In the circuit shown below, the ammeter and the voltmeter readings are 3 A and 6 V respectively. Then the value of the resistance R is

(A) 2 Ω **(B) > 2 Ω** **(C) < 2 Ω** **(D) ≥ 2 Ω**



ANSWER: (C)

Solution:

$$R = \frac{V}{I} = \frac{6}{3} = 2\Omega \ \text{(For ideal ammeter and voltmeter)}$$

If the ammeter and voltmeter have resistance i.e.

R < 2 Ω when A and V are infinite

3(R + r) = 6V

R + r = 2

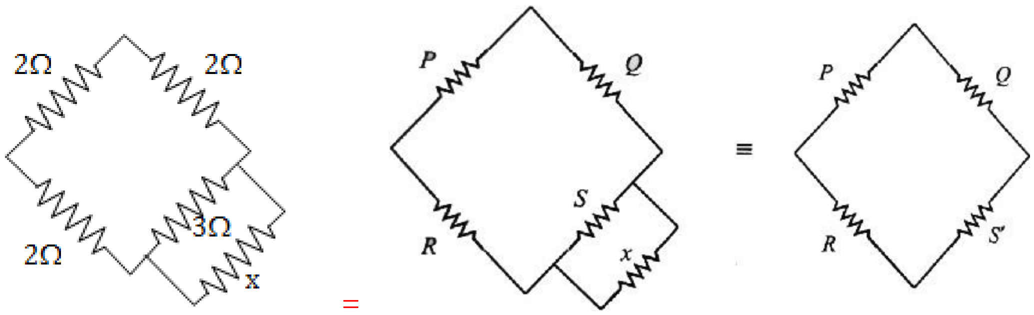
R = 2 – r

Question 26: In Wheatstone's network P = 2Ω, Q = 2Ω, R = 2Ω and S = 3Ω. The resistance with which S is to be shunted in order that the bridge may be balanced is

(A) 1Ω (B) 2Ω (C) 4 Ω (D) 6 Ω

Solution:

ANSWER: (D)



The resistances 3Ω and X are connected in parallel combination.

$$\frac{1}{R_{eff}} = \frac{1}{3} + \frac{1}{x}$$

$$\frac{1}{R_{eff}} = \frac{X+3}{3X}$$

$$R_{eff} = \frac{3X}{X+3}$$

The balancing conditions for Wheatstone bridge is given by

$$\frac{\mathbf{P}}{\mathbf{Q}} = \frac{\mathbf{R}}{\mathbf{S^1}}$$

$$\frac{2}{2} = \frac{2}{\frac{3X}{X+3}}$$

$$\frac{3X}{X+3} = 2$$
$$3x = 2x + 6$$
$$3x - 2x = 6$$
$x = 6\Omega$

Question 27: The resistance of the bulb filament is 100 Ω at a temperature of 100 °C. If its temperature coefficient of resistance be 0.005 per °C, its resistance will become 200 Ω at a temperature

(A) 300°C (B) 400°C (C) 500°C (D) 200°C

ANSWER: (B)

Solution:

$R_1 = 100\ \Omega,\ R_2 = 200\ \Omega, t_1 = 100^0\ C, t_2 = ?\ \alpha = 0.005\ /^0C$

We know that

$$R_2 = R_1\left[1 + \alpha\left(t_2 - t_1\right)\right]$$
$$200 = 100[1 + 0.005\ \ (t_2 - 100)]$$
$$200 = [100 + 0.005 \times 100\ (t_2 - 100)]$$
$$200 = [100 + 0.5\ (t_2 - 100)]$$
$$100 = [0.5\ (t_2 - 100)]$$
$$\frac{100}{0.5} = t_2 - 100$$
$$200 = t_2 - 100$$
$$t_2 = 200 + 100$$
$$t_2 = 300^0C$$

Question 28: Two concentric coils each of radius equal to 2*π* cm are placed right angles to each other. If 3A and 4A are the currents flowing through the two coils respectively. The magnetic induction (in Wb m^{-2}) at the centre of the coils will be

(A) 12×10^{-5} (B) 10^{-5} (C) 5×10^{-5} (D)7×10^{-5}

Solution:

ANSWER: C

$$B_{net} = \sqrt{B_1^2 + B_2^2} = \frac{\mu_0}{4\pi} \times \frac{2\pi}{r} \times \sqrt{i_1^2 + i_2^2}$$
$$B_{net} = 10^{-7} \times \frac{2\pi}{2\pi \times 10^{-2}}\sqrt{3^2 + 4^2}$$
$$B_{net} = 10^{-5} \times \sqrt{9 + 16}$$
$$B_{net} = \sqrt{25} \times 10^{-5}$$
$$B_{net} = 5 \times 10^{-5}\ T$$
$$B_{net} = 5 \times 10^{-5}\ wb/m^2$$

Question 29: A proton beam enters a magnetic field of 10^{-4} Wb m^{-2} normally. If the specific charge of the proton is 10^{11} C kg^{-1} and its velocity is $10^9 ms^{-1}$, then the radius of the circle described will be

(A) 0.1 m (B) 10 m (C) 100 m (D) 1 m

ANSWER: (C)

Solution:

Given; $B = 10^{-4} Wb/m^2, \frac{Q}{m} = 10^{11} C/kg, v = 10^9 m/sec$

$$\text{Radius of the circle described} = r = \frac{mV}{qB}$$

$$r = \frac{10^9}{10^{11} \times 10^{-4}}$$

$$r = 100\ m$$

Question 30: A cyclotron is used to accelerate

(A) Neutron

(B) Only positively charged particles

(C) Only negatively charged particles

(D) Both positively and negatively charged particles

ANSWER: D

Solution:

A cyclotron is used to accelerate both positively and negatively charged particles but a neutral particle cannot be accelerated in a cyclotron.

Question 31: A galvanometer of resistance 50 Ω gives a full-scale deflection for a current 5×10^4 A. The resistance that should be connected in series with the galvanometer to read 3 V is

(A) 595 Ω (B) 5050 Ω (C) 5059 Ω (D) 5950 Ω

ANSWER: (D)

Solution:

Given $= I_g = 5 \times 10^{-4}$ A, $V = 3V$,

$$R = \frac{V}{I_g} - R_G$$

$$R = \frac{3}{5 \times 10^{-4}} - 50$$

$$R = \frac{30000}{5} - 50$$

$$R = 6000 - 50$$

$$R = 59502\ \Omega$$

Question 32: Two parallel wires 1 m apart carry currents of 1 A and 3 A respectively in opposite directions. The force per unit length acting between these two wires is

(A) 6 × 10^{-7} Nm^{-1} repulsive **(B) 6 × 10^{-7} Nm^{-1} attractive**
(C) 6 × 10^{-5} Nm^{-1} repulsive **(D) 6 × 10^{-5} Nm^{-1} attractive**

ANSWER: (A)

Solution:

Given $I_1 = 1A, I_2 = 3A, d = 1m$

The current in the two wires flows in the opposite direction. The force between the two wires is given by

$$F = \left(\frac{\mu_0}{4\pi}\right)\frac{2I_1I_2}{d}$$

$$F = \left(\frac{4\pi \times 10^{-7}}{4\pi}\right)\frac{2 \times 1 \times 3}{1}$$

$$F = 6 \times 10^{-7} N/m$$

Current flowing in opposite direction is repulsive in nature.

Question 33: If there is no torsion in the suspension thread, then the time period of a magnet executing SHM is

(A) $T = \frac{1}{2\pi}\sqrt{\frac{MB}{I}}$ (B) $T = \frac{1}{2\pi}\sqrt{\frac{I}{MB}}$

(C) $T = 2\pi\sqrt{\frac{I}{MB}}$ (D) $T = 2\pi\sqrt{\frac{MB}{l}}$

ANSWER: (C)

Solution:

If there is no torsion in the suspension thread, then the time period of a magnet executing **S.H.M. is (C)**

Question 34: Core of electromagnets are made of ferromagnetic material which has

(A) High permeability and low retentivity

(B) High permeability and high retentivity

(C) Low permeability and high retentivity

(D) Low permeability and low retentivity

Solution:

Answer: (A)

Electromagnetic cores support the formation of a magnetic field because of high permeability and low retentivity so that the magnetic field gets demagnetized easily.

Question 35: The magnetic susceptibility of a paramagnetic material at –73°C is 0.0075 and its value at –173 °C will be

(A) 0.0045 **(B) 0.0030** **(C) 0.015** **(D) 0.0075**

ANSWER: (C)

Solution:

For paramagnetic material $= \chi T = \text{constant}$

$\Rightarrow \chi_1 T_1 = \chi_2 T_2$

$\chi_1 = 0.0075$ at $t_1 = -73^0C$

$\chi_1 = 0.0075$ at $T_1 = 273 + t^0C = 273 - 73 = 200K$

$\chi_2 = ?$ at $T_2 = 273 + t^0C = 273 - 173 = 100K$

$$\chi_2 = \frac{\chi_1 T_1}{T_2}$$

$$\chi_2 = \frac{0.0075 \times 200}{100}$$

$$\chi_2 = 0.015$$

Question 36: Two coils have a mutual inductance 0.005 H. The current changes in the first coil according to the equation i = i_m sin ωt where i_m= 10 A and ω = 100 π rad s^{-1}. The maximum value of the emf induced in the second coil is

(A) 2π (B)5π (C)π (D)4 π

ANSWER: (B)

Solution:

From the faradys II law of electromagnetic Induction $= e = M\frac{dI}{dt}$

$$e = M\frac{dI}{dt} = M\frac{d}{dt}(I_0 \sin \omega t)$$

$$e = M\, I_0 \omega\, \sin \omega t$$

$$e = 0.005 \times 10 \times 100\,\pi = 5\pi$$

Question 37: An aircraft with a wingspan of 40 m flies with a speed of 1080 km/hr in the eastward direction at a constant altitude in the northern hemisphere, where the vertical component of the earth's magnetic field is 1.75 × 10^{-5} T. Then the emf developed between the tips of the wings is

(A) 0.5V (B)0.34V (C)0.21V (D) 2.1V

ANSWER: (C)

Solution:

$$\text{Given } B = 1.75 \times 10^{-5}\ T, l = 40\ m, v = 1080\frac{km}{h} = \frac{1080 \times 1000}{60 \times 60} = 300 m/s$$

$$\text{Induced e.m.f} = E = BvL$$

$$\text{Induced e.m.f} = E = 1.75 \times 10^{-5}(300)(40) = 0.21 \text{ volt}$$

Question 38: In an LCR circuit, at resonance

(A) The current and voltage are in phase (B) The impedance is maximum

(C) The current is minimum (D) The current leads voltage by π/2

ANSWER: (A)

Solution:

At resonance condition, Inductive reactance is equal to capacitive reactance

$X_L = X_C$

At resonance condition, in an L-C-R circuit, the current and voltage are in phase.

Question 39: A transformer is used to light 100 W–110 V lamps from 220 V mains. If the main current is 0.5 A, the efficiency of the transformer is

(A)90% **(B)**95% **(C)**96% **(D)**99%

ANSWER: (A)

Solution:

Given: Out put Power required, $P_0 = 100W$

Input Power given $P_i = V_i I_i = 220 \times 0.5 = 110$ W

$$\text{Efficiency of transformer} = \eta = \frac{\text{Output power}}{\text{Input power}} \times 100$$

$$\eta = \frac{100}{110} \times 100$$

$$\eta = \frac{100}{110} \times 100 = \frac{10000}{110} = 99\%$$

So, the efficiency of the transformer is 90%

Question 40: The average power dissipated in a pure inductor is

(A) (1/2) VI **(B)VI²** **(C) VI²/4** **(D)0**

ANSWER: (D)

Solution:

We know that the in AC circuit consists of pure inductor; the current is lagging behind the voltage by 90^0 or voltage leads the current by 90^0. Therefore, the voltage difference between the current and voltage is 90^0.

$$\text{The average power disipated} = P_{average} = \frac{V_0 I_0}{2} \cos\varphi$$

$$P_{average} = \frac{V_0 I_0}{2} \cos 90^0$$

$$P_{average} = 0; \quad \cos 90^0 = 0$$

Question 41: If ε_0 and μ_0 are the permittivity and permeability of free space and ε and μ are the corresponding quantities for a medium, then refractive index of the medium is

---

(A) $\sqrt{\frac{\mu_0 \varepsilon_0}{\mu \varepsilon}}$ (B) $\sqrt{\frac{\mu \varepsilon}{\mu_0 \varepsilon_0}}$

(C) 1 **(D)** Insufficient information

ANSWER: (D)

Solution:

Let velocity of light in medium and in air is V and C, respectively.

$$\text{Refractive index of the medium}, \mu = \frac{C}{V}$$

$$\text{Therefore,} \quad C = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

$$C = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} \text{ and } V = \frac{1}{\sqrt{\mu\varepsilon}}$$

$$\mu = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} \times \frac{\sqrt{\mu\varepsilon}}{1}$$

$$\mu = \frac{\sqrt{\mu\varepsilon}}{\sqrt{\mu_0 \varepsilon_0}} = \sqrt{\frac{\mu\varepsilon}{\mu_0 \varepsilon_0}}$$

Question 42: A person wants a real image of his own, 3 times enlarged. Where should he stand in front of a concave mirror of radius of curvature 30 cm?

(A) 10 cm (B) 30 cm (C) 90 cm (D) 20 cm

ANSWER: (A)

Solution:

$$\text{Focal length of concave mirror} = f = \frac{-R}{2} = \frac{-30}{2} = -15 \text{ cm}$$

Let the person stands at a distance „x‟ in front of the mirror i.e **u = -x.**

Magnification of image is **m = 3**

$$\mathbf{M} = \frac{-\mathbf{v}}{\mathbf{u}}$$

$$3 = \frac{-v}{-x}$$

$$V = 3x$$

$$\text{Using mirror formula} = \frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

$$\therefore \frac{1}{3x} + \frac{1}{-x} = \frac{1}{-15}$$

$$\therefore \frac{1}{3x} - \frac{1}{x} = -\frac{1}{15}$$

$$\frac{1-3}{3x} = -\frac{1}{15}$$

$$\frac{-2}{3x} = -\frac{1}{15}$$

$$3x = 30$$

$$x = 10 \text{ cm}$$

Question 43: Calculate the focal length of a reading glass of a person if his distance of distinct vision is 75 cm.

(A) 25.6 cm (B) 37.5 cm (C) 75.2 cm (D)100.4 cm

ANSWER: (B)

Solution:

Given: $V = -75$ cm; $u = -D = -25$ cm; D is least distance of distinct vision

$$\text{Using mirror formula,} \quad \frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\frac{1}{f}=\frac{1}{-7.5}-\frac{1}{-25}$$
$$\frac{1}{f}=\frac{1}{25}-\frac{1}{75}$$
$$\frac{1}{f}=\frac{75-25}{1875}$$
$$\frac{1}{f}=\frac{50}{1875}$$
$$f=\frac{1875}{50}=37.5\text{ cm}$$

Question 44: In Young's double-slit experiment, the slit separation is 0.5 m from the slits. For a monochromatic light of wavelength 500 nm, the distance of 3rd maxima from 2nd minima on the other side is

(A) 2.75 mm (B) 2.5 mm (C) 22.5 mm (D) 2.25 mm

ANSWER: BONUS

Question 45: To observe diffraction, the size of the obstacle

(A) Has no relation to the wavelength

(B) Should be λ/2, where λ is the wavelength

(C) Should be much larger than the wavelength

D) Should be of the order of the wavelength

ANSWER: (D)

Solution:

To observe diffraction the size of the obstacle should be of the order of wavelength because of $\lambda \approx d$.

Question 46: The polarizing angle of glass is 57°. A ray of light which is incident at this angle will have an angle of refraction as

(A) 25° (B) 33° (C) 43° (D) 38°

ANSWER: (B)

Solution:

Given $= \theta_p = 57^0$

According to Brewster's law, the reflected and refracted rays are mutually perpendicular to each other.

$$\theta_p + r = 90^0$$
$$r = 90^0 - \theta_p$$

Angle of refraction $r = 90^0 - 57^0 = 33^0$

Question 47: Light of two different frequencies whose photons have energies 1 eV and 2.5 eV respectively, successively illuminate a metallic surface whose work function is 0.5 eV. Ratio of maximum speeds of emitted electrons will be

(A) 1 : 5 (B) 1 : 4 (C) 1 : 2 (D) 1 : 1

ANSWER: (C)

Solution:

Given: $E_1 = h\gamma_1 = 1\text{ eV}$ and $E_2 = h\gamma_2 = 2.5\text{ eV}$, Work function $\phi = W = h\gamma_0 = 0.5\text{ eV}$

Einstein's Photoelctric equation is $\mathbf{h\gamma = h\gamma_0 + K.E}$

$$K.E = h\gamma - h\gamma_0$$

$$K.E = E = h\gamma - W$$

$$E_1 = h\gamma_1 - W \ldots\ldots\ldots (1)$$

$$E_2 = h\gamma_2 - W \ldots\ldots\ldots (2)$$

$$E_1 = 1 - 0.5 = 0.5 \text{ eV}$$

$$E_2 = 2.5 - 0.5 = 2\text{eV}$$

From Einstein"s Photoelectric effect

$$h\gamma = h\gamma_0 + \frac{1}{2}mv^2$$

$$\frac{1}{2}mv^2 = h\gamma - h\gamma_0$$

Let $E = h\gamma$ and $E_2 = h\gamma_0$

$$\frac{1}{2}m{v_1}^2 = h\gamma_1 - h\gamma_0 \ldots\ldots\ldots (1)$$

$$\frac{1}{2}m{v_1}^2 = E_1 - h\gamma_0 \ldots\ldots\ldots (2)$$

$$\frac{1}{2}m{v_1}^2 = 1 - 0.5 = 0.5 \text{ eV}$$

$$\frac{1}{2}m{v_1}^2 = 0.5 \text{ eV} \ldots\ldots\ldots\ldots (3)$$

$$\frac{1}{2}m{v_2}^2 = h\gamma_2 - h\gamma_0 \ldots\ldots\ldots (4)$$

$$\frac{1}{2}m{v_2}^2 = E_2 - h\gamma_0 \ldots\ldots\ldots (5)$$

$$\frac{1}{2}m{v_2}^2 = 2.5 - 0.5 = 2 \text{ eV}$$

$$\frac{1}{2}m{v_2}^2 = 2 \text{ eV} \ldots\ldots\ldots (6)$$

From equations (3) and (6)

$$\frac{{v_1}^2}{{v_2}^2} = \frac{0.5}{2} = \frac{1}{4}$$

$$\frac{v_1}{v_2} = \frac{1}{2}$$

$$v_1 : v_2 = 1 : 2$$

Question 48: Find the de-Broglie wavelength of an electron with a kinetic energy of 120 eV.

(A) 95 pm (B) 102 pm (C) 112 pm (D)124 pm

ANSWER: (C)

Solution:

Given: $E = 120$ eV

We know that de – Broglie wavelengt of an electron, $\lambda = \frac{1.227}{\sqrt{V}}$ nm

We know that de − Broglie wavelengt of an electron, $\lambda = \frac{1.227}{\sqrt{E}}$ nm

$$\lambda = \frac{1.227}{\sqrt{120}} \times 10^{-9} \text{ m}$$
$$\lambda = 0.1120 \times 10^{-9} \text{ m}$$
$$\lambda = 112 \times 10^{-12} \text{ m}$$
$$\lambda = 112 \text{ p m}$$

Question 49: An α-particle of energy 5 MeV is scattered through 180° by gold nucleus. The distance of closest approach is of the order of

(A) 10^{-10}cm (B) 10^{-12}cm (C) 10^{-14}cm (D) 10^{-16}cm

ANSWER: (C)

Solution:

An atomic number of Gold, $Z = 79$

Kinetic energy of the α − particle K. E = 5 MeV

As the α-particle approaches, all the kinetic energy of α-particle has converted into its potential energy, therefore K.E= P.E.

The potential energy at closest approach $P.E = \frac{1}{4\pi\varepsilon_0} \times \frac{Ze\,(2e)}{r}$

$$P.E = \frac{9 \times 10^9 \times 79 \times 2 \times (1.6 \times 10^{-9})^2}{r}$$

$$5 \text{ MeV} = \frac{9 \times 10^9 \times 79 \times 2 \times (1.6 \times 10^{-9})^2}{r}$$

$$5 \times 10^6 \times 1.609 \times 10^{-19} = \frac{9 \times 10^9 \times 79 \times 2 \times (1.6 \times 10^{-9})^2}{r}$$

$$r = 4.55 \times 10^{-14} \text{ m}$$

Hence the closest approach is of the order of 10^{-14} m or 10^{-2} cm.

Question 50: If an electron in a hydrogen atom jumps from an orbit of level n = 3 to an orbit of level n = 2, the emitted radiation has a frequency (R = Rydberg constant, C = velocity of light)

(A) 3RC/27 (B) RC/25 (C) 8RC/9 (D) 5RC/36

ANSWER: (D)

Solution:

$$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$
$$\frac{1}{\lambda} = R\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$$
$$\frac{1}{\lambda} = R\left[\frac{1}{4} - \frac{1}{9}\right]$$
$$\frac{1}{\lambda} = R\left[\frac{9-4}{36}\right]$$

$$\frac{1}{\lambda} = R\left[\frac{5}{36}\right]$$

Question 51: What is the wavelength of light for the least energetic photon emitted in the Lyman series of the hydrogen spectrum? (Take hC = 1240 eV nm)

(A) 82 nm (B)102 nm (C)122 nm (D) 150 nm

Solution:

ANSWER: (C)

Given: $n_1 = 2$ and $n_2 = 1$

Given; $hC = 124\ \text{eV}$; $R = 1.097 \times 10^7$ per meter

Wavelength of light for least – energetic photon emitted in Lyman series of hydrogen atom

$$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{2^2}\right]$$

$$\frac{1}{\lambda} = R\left[\frac{3}{4}\right]$$

$$\frac{1}{\lambda} = 1.097 \times 10^7 \left[\frac{3}{4}\right]$$

$$\lambda = \frac{1}{1.097 \times 10^7}\left[\frac{4}{3}\right]$$

$$\lambda = 1.215 \times 10^{-7} m$$

$$\lambda = 1215 \times 10^{-10} m$$

$$\lambda = 121.5 \times 10^{-9}\ \text{m}$$

$$\lambda = 121.5\ \text{nm}$$

$$\lambda = 122\ \text{nm}$$

Question 52: A nucleus at rest splits into two nuclear parts having radii in the ratio 1: 2. Their velocities are in the ratio

(A) 8: 1 (B) 6: 1 (C) 4: 1 (D) 2: I

ANSWER: (A)

Solution:

Let A_1 and A_2 be the mass number of the two nuclear parts. The radii are given by

$$R_1 = R_0(A_1)^{1/3} \ldots\ldots\ldots (1)$$

$$R_2 = R_0(A_2)^{1/3} \ldots\ldots\ldots (2)$$

From equations (1) and (2)

$$\frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3}$$

$$\left(\frac{R_1}{R_2}\right)^3 = \left(\frac{A_1}{A_2}\right) \qquad \text{Given } \frac{R_1}{R_2} = \frac{1}{2}$$

$$\therefore \left(\frac{A_1}{A_2}\right) = \left(\frac{1}{2}\right)^3$$

$$\left(\frac{A_1}{A_2}\right) = \frac{1}{8}$$

Hence the ratio of masses

$$\frac{m_1}{m_2} = \frac{1}{8}$$

According to the law of conservation of momentum

$$m_1 v_1 = m_2 v_2$$

The magnitude of momentum $P_1 =$ he magnitude of momentum P_2

$$P_1 = P_2$$

$$\frac{v_1}{v_2} = \frac{m_2}{m_1}$$

$$\frac{m_1}{m_2} = \frac{1}{8}$$

Question 53: The half-life of a radioactive substance is 20 minutes. The time taken between 50 % decay and 87.5 % decay of the substance will be
(A) 30 minutes (B) 40 minutes (C) 25 minutes (D) 10 minutes

Solution:

ANSWER: (B)

Given; $T_{1/2} = 20 \text{ min}, N_1 = 50, \ N_2 = 100 - 87.5 = 12.5$

We know that, time taken by a substance to decay,

In time t_1, 50% of the substance decays.

In time t_2, 87.5% of the substance decay.

In time t_1, 50% of the substance left undecayed

In time t_2, 12.5% of the substance left undecayed.

According to the radioactive decay law

$N = N_o e^{-\lambda t}$ where λ is decay constant

$$\frac{N}{N_o} = e^{-\lambda t}$$

$$\frac{50}{100} = e^{-\lambda t_1} \text{ or } \frac{1}{2} = e^{-\lambda t_1} \ \ldots\ldots\ldots (1)$$

$$\frac{12.5}{100} = e^{-\lambda t_2} \text{ or } \frac{1}{8} = e^{-\lambda t_2} \ \ldots\ldots\ldots (2)$$

From equations (1) and (2)

$$\frac{1/8}{1/2} = \frac{e^{-\lambda t_2}}{e^{-\lambda t_1}}$$

$$\frac{1}{4} = e^{-\lambda(t_2 - t_1)}$$

$$e^{\lambda(t_2 - t_1)} = 4$$

$$\lambda(t_2 - t_1) = \ln 4$$

$$\therefore \left(\frac{A_1}{A_2}\right) = \left(\frac{1}{2}\right)^3$$

$$(t_2 - t_1) = \frac{\ln 4}{\lambda} = \frac{2\ln 2}{\lambda} \quad (\ln 4 = 2\ln 2)$$

$$(t_2 - t_1) = \frac{2\ln 2}{\left(\frac{\ln 2}{T_{1/2}}\right)} = 2T_{1/2} \quad \left(\text{Because } \lambda = \frac{\ln 2}{T_{1/2}}\right)$$

$$(t_2 - t_1) = 2T_{1/2}$$

$$(t_2 - t_1) = 2 \times 20 = 40 \text{ min}$$

Question 54: A radioactive decay can form an isotope of the original nucleus with the emission of particles

(A) One α and four β (B) One α and two β (C) One α and one β (D) Four α and one β

Solution:

Answer: (B)

$${}^{A}_{Y}Y(\alpha - \text{particle emiiter}) \rightarrow {}^{A-4}_{Z-2}Y(\beta - \text{particle}) \rightarrow {}^{A-4}_{Z+1}Y(\beta - \text{particle}) \rightarrow {}^{A-4}_{Z}Y$$

Question 55: An LED is constructed from a PN junction based on a certain semi-conducting material whose energy gap is 1.9 eV. Then the wavelength of the emitted light is

(A) 2.9×10^{-9} m (B) 1.6×10^{-8} m (C) 6.5×10^{-7} m (D) 9.1×10^{-5} m

Solution:

Answer: (C)

Given: $h = 6.626 \times 10^{-34}$ Js, $C = 3 \times 10^{8}$ m/s

Energy gap $= 1.9 \text{ eV} = 1.9 \times 1.6 \times 10^{-19}$ V

$$\text{Energy } E_g = \frac{hc}{\lambda}$$

$$\text{Wavelength} = \lambda = \frac{hc}{E_g} = \frac{6.62 \times 10^{-34} \times 3 \times 10^{8}}{1.9 \times 1.6 \times 10^{-19}} \text{m}$$

$$\lambda = 6500 \times 10^{-10} \text{ m}$$

$$\lambda = 6.5 \times 10^{-7} \text{ m}$$

Question 56: Amplitude modulation has

(A) One carrier with two sideband frequencies **(B)** One carrier

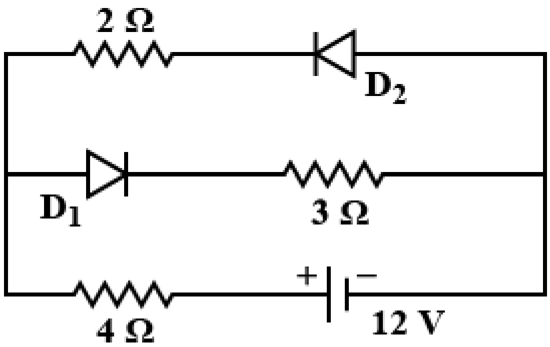
(C) One carrier with infinite frequencies **(D)** One carrier with high frequency

ANSWER: (A)

Solution:

In amplitude modulation modulated signal has a carrier wave with two sideband frequencies one is lower sideband and other is upper side bad.

Question 57: The circuit has two oppositely connected ideal diodes in parallel. What is the current flowing in the circuit?



(A) 1.71 A (B) 2.0 A (C) 2.31 A (D) 1.33 A

ANSWER: (A)

Solution:

Diode D_2 is reversed biased and D_1 is forward biased but. Therefore no current flows through D_2 but current flows through D_1.

$$R_{equi} = 3 + 4 = 7\Omega$$

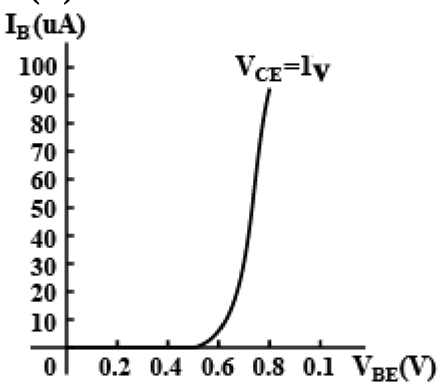
$$\therefore \text{The current in the circuit} = I = \frac{V}{R_q} = \frac{12}{7} = 1.71\text{ A}$$

Question 58: The input characteristics of a transistor in CE mode is the graph obtained by plotting

(A) I_B against V_{BE} at constant V_{CE} (B) I_B against V_{CE} at constant V_{BE}

(C) I_B against I_C at constant V_{CE} (D) I_B against I_C at constant V_{BE}

ANSWER: (A)



Solution:

A NAND gate gives output as 1 when either of the input signals is low i.e. 0 and gives output as 0 only when both the input signals are high i.e. 1. Hence the above truth table is for NAND gate. (Input characteristics circle is drawn between I_B and V_{EB} at constant V_{CE}.)

$$R = \left[\frac{\Delta_{BE}}{\Delta I_B}\right] V_E = \text{constant}$$

Question 59: The given truth table is for Input Output

Input		Output
A	B	Y
0	0	1
0	1	1
1	0	1

1	1	0

(A) AND gate **(B) OR gate** **(C) NAND gate** **D) NOR gate**

Solution:

Answer: (C)

Boolean expression of NAND gate = AB¯. So NAND gate is right.

Question 60: The waves used for line-of-sight (LOS) communication is

(A) Ground waves **(B) Space waves** **(C) Sound waves** **(D) Sky waves**

ANSWER: (B)

Solution:

Space waves are used for the line of sight communication.

****

KCET – 2014: PHYSICS

1. A physical quantity Q is found to depend on observables x, y and z obeying relation $Q = x^3y^2/z$. he percentage error in measurements of x, y and z are 1%, 2% and 4% respectively. What is the percentage error in the quantity „Q".

(A) 4% (B) 3% (C) 11% (D) 1%

ANSWER (C):

SOLUTION

$$Q = \frac{x^3y^2}{z}$$

$$\frac{\Delta Q}{Q} \times 100 = 3 \times \frac{\Delta x}{x} \times 100 + 3 \times \frac{\Delta y}{y} \times 100 + \frac{\Delta z}{z} \times 100$$

$$\Delta Q = 3 \times (1) + 2(2) + \Delta$$

$$\Delta Q = 3 + 4 + 4 = 11\%$$

- -

2. Which of the following is not a vector quantity?

(A) Weight (B) Nuclear spin (C) Momentum (D) Potential energy

ANSWER: (D)

SOLUTION:

Weight, nuclear spin and momentum are vector quantities because they have both magnitude as well as direction. Whereas **potential energy has magnitude only but no direction**, thus it is a scalar quantity.

(A) First, Weight is a vector quantity because it has a direction and it works along the direction of gravitational acceleration. Weight of an object is given by, W = mg, where, m is the mass of the object and „g" is the gravitational acceleration. As acceleration is a vector quantity, weight is also a vector quantity.

(B) Now, the direction of nuclear spin is given by the right-hand rule. When we hold the current carrying conductor, the folded finger gives the direction of the spin. The thumb gives the direction of the vector. As a result, nuclear spin is also a vector quantity.

(C) Thirdly, momentum is a vector quantity. The momentum of an object is p = mv. where, m is the mass of the object and v is the velocity of the object. Therefore, it is a product of a scalar quantity and a vector quantity. Thus, the momentum is also a vector quantity.

(D) Lastly, potential energy is not a vector quantity because it does not have a direction. Energy does not have a direction, and it is a scalar quantity. Hence, potential energy is the correct choice.

----

3. A car moves from A to B with a speed of 30 kmph and from B to A with a speed of 20 kmph. What is average speed of the car?

(A) 25 kmph (B) 24 kmph (C) 50 kmph (D) 10 kmph

ANSWER: (B)

SOLUTION:

The average speed of any moving body is total distance travelled by the body divided by the total time taken to cover that distance.

Let the distance between A to B be x.

Journey from A to B:

$$\text{Time taken } t_1 = \frac{\text{Distance}}{\text{Speed}} = \frac{x}{30} \text{ h}$$

Journey from B to A :

$$\text{Time taken } t_2 = \frac{\text{Distance}}{\text{Speed}} = \frac{x}{20} \text{ h}$$

Total distance covered in whole journey $S' = 2x$

Total time taken $t' = t_1 + t_2$

Average speed

$$v_{av} = \frac{s'}{t'}$$

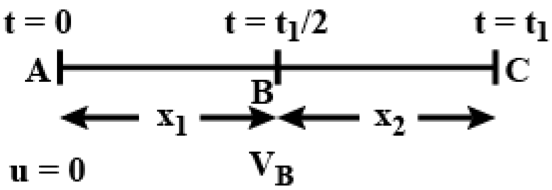
$$v_{av} = \frac{2x}{\frac{x}{30} + \frac{x}{20}} = \frac{2 \times 20 \times 20}{20 + 30} = 24 \text{ kmph}$$

---

4. A body moves starts from rest and moves with constant acceleration for „t" sec. it travels a distance x_1 in first half of time and x_2 in the next half of time, then

(A) $x_2 = x_1$ **(B) $x_2 = 2x_1$** **(C) $x_2 = 3x_1$** **(D) $x_2 = 4x_1$**

$$\textbf{accel}^{\textbf{n}} = \textbf{a(const)}$$



ANSWER: (3)

SOLUTION:

We know that

$$S = ut + \frac{1}{2} at^2$$

$$x_1 = 0 + \frac{1}{2} a\left(\frac{t}{2}\right)^2 = \frac{at^2}{8}$$

We know that

$$V = u + at$$

$$V_B = 0 + a\left(\frac{t}{2}\right) = \frac{at}{2}$$

We know that

$$S = ut + \frac{1}{2}\ at^2$$

C0 10

$$x_2 = \left(\frac{at}{2}\right)\frac{t}{2} + \frac{1}{2}(a)\left(\frac{t}{2}\right)^2$$

$$x_2 = \frac{at^2}{4} + \frac{at^2}{8} = \frac{3at^2}{8}$$

$$x_2 = 3x_1$$

---

5. A person is driving a vehicle at a uniform speed of 5 m^{-1} on a level curved track of radius 5m. The coefficient of static friction between tyre and road is 0.1. Will the person slip while talking the turn with speed? Take g = 10 m/s^2.

(A)A person will slip if $V_2 = 5\ m^{-1}$ (B) A person will slip if $V_2 > 5\ m^{-1}$

(C) A person will slip if $V_2 < 5\ m^{-1}$ (D) A person will slip if $V_2 > 10\ m^{-1}$

ANSWER: (B)

SOLUTION:

Person will slip if centripetal force mv^2/r is greater than frictional force μmg where m is mass off vehicle, v is velocity, r is radius (5m) and μ is coefficient of static friction (0.1), g is acceleration due to gravity (m/s^2).

Therefore condition of slipping

$$\frac{mv^2}{r} > \mu mg$$

$$v^2 > \mu rg$$

II method

$$v_{max} = \sqrt{\mu rg}$$

$$v_{max} = \sqrt{0.5 \times 1 \times 10} = \sqrt{5}$$

$$v_{max}^2 = 5$$

∴ Persons or vehicle will slip if the velocity is more than √5 m/s

---

6. A stone is thrown vertically at speed of 30 ms^{-1} making an angle of 45^0 with the horizontal. What is the maximum height reached by the stone?. Take g = 10 m/s^2.

(A) 30 m (B) 22.5 m (C) 15 m (D) 10 m

ANSWER: (B)

SOLUTION:

Given $u = 30\ m/s\ ;\ \theta = 45^0$

Maximum height reached $H = \frac{u^2 \sin^2\theta}{2g}$ $(\sin^2 45^0 = 0.5)$

$$\therefore H = \frac{30^2 \times 0.5}{2 \times 10} = 22.5\ m$$

---

7. A force $\vec{F} = 5\hat{i} + 2\hat{j} - 5\hat{k}$ act on a particle whose position vector is $\vec{r} = \hat{i} - 2\hat{j} + \hat{k}$. what is the about the origin

(A) $8\hat{i} + 10\hat{j} + 12\hat{k}$ (B) $8\hat{i} + 10\hat{j} - 12\hat{k}$

(C) $8\hat{i} - 10\hat{j} - 8\hat{k}$ (D) $10\hat{i} - 10\hat{j} - 12\hat{k}$

ANSWER: (A)

SOLUTION

Here; $r = \hat{i} - 2\hat{j} + \hat{k}$ and $\vec{F} = 5\hat{i} + 2\hat{j} - 5\hat{k}$

We shall use the determinant rule to find the torque $\tau = r \times F$

$$\tau = \begin{bmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -2 & 1 \\ 5 & 2 & -5 \end{bmatrix} = (10-2)\hat{i} - (-5-5)\hat{j} + [2+10]\hat{k}$$

$$\tau = 8\hat{i} + 10\hat{j} + 12\hat{k}$$

---

8. What is a period of revolution of earth satellite? Ignore the height of the satellite above the surface of the earth.

Given: 1010(1) The value of gravitational acceleration g =10 m/S^{-2}.

(2) The radius of the earth RE= 6400 km. take π = 3.14

(A) 85 minutes (B) 156 minutes (C) 83.73 minutes (D) 90 minutes

ANSWER: (A)

SOLUTION

$R_e = 6400 \text{ km} = 6.4 \times 10^5 \text{ m}, \quad \pi = 3.14, \quad g = 10 \text{ m/s}^2$

We know that the period of revolution of the earth satellite

$$T = 2\pi\sqrt{\frac{(R_e + h)^3}{gR_e^2}} \quad [\text{ if } h << R_e, \quad \text{then } (R_e + h = R_e)$$

$$\text{So}, T = 2\pi\sqrt{\frac{R_e{}^3}{gR_e^2}} = 2\pi\sqrt{\frac{R_e}{g}} = 2 \times 3.14\sqrt{\frac{6.14 \times 10^6}{10}}$$

$$\text{So}, T = 2 \times 3.14 \times 0.8 \times 10^3$$

$$\text{So}, \ T = 5.024 \times 10^3 = 5024 \text{ s} = 83.73 \text{ min}$$

---

9. A period of geostationary satellite is

(A) 24 h (B) 12h (C) 30h (D) 48h

ANSWER: (A)

SOLUTION

A geostationary satellite is an earth-orbiting satellite, placed at an altitude nearly 35,800 kilometres directly above the equator that revolves in the same direction as the earth rotates (from west to east). The time period of revolution of a geostationary satellite around earth is same as that rotation of earth about its own axis i.e. 24 hours.

or

A geostationary orbit can only be achieved at an altitude very close to 35,786 km (22,236mi), and directly above the Equator. This equates to an orbital velocity of 3.07km/s(1.91mi/s) or an orbital period of 1,436 minutes, which equates to almost exactly one sidereal day or 23.934461223 hours, **which is approximately 24 hours.**

Or

Geostationary satellite has an orbital period of exactly 1 day or 24h24h. That is why they can always stay above the same place on the earth, as the earth also makes one turn per day.

---

10. What is the source temperature of the Carnot required to get 70% efficiency? Given: Sink temperature

(A) 1000^0C (B) 90^0C (C) 270^0C (D) 727^0C

ANSWER: (D)

SOLUTION

Given:

Efficiency η =70%

Sink temperature T_1=27^0C+273=300K

Source temperature T_2=?

As we know that efficiency is given by

$$\eta = \left(1 - \frac{T_2}{T_1}\right)$$

$$70\% = \left(1 - \frac{300}{T_1}\right)$$

$$\frac{7}{100} = \left(1 - \frac{300}{T_1}\right)$$

$$0.7 = \left(1 - \frac{300}{T_1}\right)$$

$$\frac{300}{T_1} = 1 - 0.7$$

$$\frac{300}{T_1} = 0.3$$

$$T_1 = \frac{300}{0.3}$$

$$T_1 = 1000\ \text{K}$$

$$T_1 = 1000\ \text{K} = 1000 - 273 = 727^0\text{C}$$

---

11. A 10 Kg metal block is attached to a spring constant $1000Nm^{-1}$. A block is displaced from equilibrium position by 10 cm released. The maximum acceleration of the block is

(A) 10 m/s^{-2} (B) 100 m/s^{-2} (C) 100 m/s^{-2} (D) 0.1 m/s^{-2}

ANSWER: (A)

SOLUTION

Given: $m - 10kg; k = 1000\ N/m$

Amplitude of oscillation A= 10 cm = 0.1 m

We know that spring does SHM. So, the restoring force is proportional to displacement

$$F = -mw^2y \qquad (1)$$
$$F = -ky \qquad (2)$$

Comparing on both sides we get

$$-ky = -mw^2y$$
$$w^2 = \frac{k}{m}$$

Angular frequency of oscillation $= w = \sqrt{\frac{k}{m}} = \sqrt{\frac{1000}{10}} = 10\ rad/s$

Where k is force constant of the spring

Maximum acceleration $= a_{max} = A\,w^2$

$a_{max} = 0.1 \times 10^2 = 10\, m/s^2$

---

12. A metallic wire of 1m length has a mass of 10 x10^{-3} kg. If a tension of 100 N is applied to a wire, what is the speed of transverse wave?

(A) 100 m/s^{-1} (B) 10 m/s^{-1} (C) 200 m/s^{-1} (D) 0.1 m/s^{-1}

ANSWER: (A)

SOLUTION

We know that linear mass density is defined as measure of mass per unit of length

Linear mass density: $m = \frac{\text{Mass}}{\text{Length}} = \frac{10 \times 10^{-3}}{1}$

$$m = 10 \times 10^{-3}\ kg/m$$

$\therefore$ The speed of tansverse wave: $v = \sqrt{\frac{T}{m}} = \sqrt{\frac{100}{10 \times 10^{-3}}}$

$$v = \sqrt{10 \times 10^3}$$

Where m is the volume per x unit density

$v = 1 \times 10^2 = 100\ m/s$

---

13. A train is approaching towards a platform of with a speed of 10 ms^{-1} while blowing a whistle of frequency of 340 Hz. What is the frequency of whistle heard by a stationary observer on the platform?. Given speed of sound = 340 m/s^{-1}.

(A) 330 Hz (B) 350 Hz (C) 340 Hz (D) 360 Hz

ANSWER: (C)

SOLUTION

Speed of train (source); $V_{source} = 10\ m/s$

Original frequency of whistle $f_0 = 340$ Hz
Speed of sound $V = 340$ m/s
Using Doppler's effect when a source moves towards the stationary observer:
Apparent frequency heard by observer: $f = 340\left[\frac{340}{340-10}\right] = 350$ Hz

---

14. A rotating wheel changes angular speed from 1800 rpm to 3000 rpm in 20 sec. what is the angular acceleration assuming to be uniform.
(A) 60 π rad/s^{-2} (B) 90 π rad/s^{-2} (C) 2π rad/s^{-2} (D) 40 π rad/s^{-2}

ANSWER: (C)
SOLUTION

We know that: $w = 2\pi n \Rightarrow w_1 = 2\pi n_1$
$n_1 = 1800$ rpm; $n_2 = 3000$ rpm $\Rightarrow \Delta t = 20$ sec

Here, initial angular speed of the wheel,
$$w_1 = 2\pi \times \frac{1800}{60} = 2\pi \times 30 = 60\ \pi$$
Final angular speed of the wheel,
Similarly, $w_2 = 2\pi n_2 = 2\pi \times \frac{3000}{60} = 2\pi \times 50 = 100\ \pi$

If the angular velocity of a rotating wheel about on axis changes by change in angular velocity in a time interval Δt, then the angular acceleration of rotating wheel about that axis is
$$\alpha = \frac{\text{Change inangular velocity}}{\text{Time interval}}$$
$$\alpha = \frac{w_2 - w_1}{\Delta t}$$
$$\alpha = \frac{100\ \pi - 60\ \pi}{20} = \frac{40\pi}{20} = 2\pi \text{ radians}$$

---

15. A flow of liquid is stream line if the Reynolds number is
(A) Less than 1000 **(B) Greater than 1000**
(C) Between 2000 to 3000 **(D) Between 4000 to 5000**

ANSWER (A)
SOLUTION

If Reynolds number is less than 1000, the flow is streamline.
If Reynolds number is greater than 2000, the flow is turbulent.
If Reynolds number lies between 1000 and 2000, the flow becomes unsteady.

Or

Reynold's number is a pure number and it is equal to the ratio of the inertial force per unit area to the viscous force per unit area for a flowing fluid.
$$\text{Renold's number} = \frac{v_c \rho\, r}{\eta}$$

where ρ = density of the liquid V_c = critical velocity η = coefficient of viscosity of liquid r = radius of capillary tube

Fact

(i) For pure water flowing in a cylindrical pipe, K is about 1000. When 0 < K < 20000 < K < 2000, the flow of liquid is streamlined.

(ii) When 2000 < K < 3000, the flow of liquid is variable between streamlined and turbulent.

(iii) When K > 3000K > 3000, the flow of liquid is turbulent.

Reynold's Number:

The Reynold's number is used to categorize the fluids system in which the effect of viscosity is important in controlling the velocities and the flow pattern of a fluid. It is a pure number and is dimensionless which is equal to the ratio of the inertial force per unit area to the viscous force per unit area for a flowing liquid.

There are three cases for the Reynold's number:

- When 0 < K < 20000, the flow of the liquid through a cylindrical pipe is streamlined. K less than or about 1000
- When 2000 < K < 3000, the flow of liquid is variable between streamlined and turbulent.
- When K>3000K, the flow of liquid is turbulent. As per the problem we need streamlined flow of the liquid. The Reynold's number should be less than 1000.

Therefore the correct option is A.

Note: Remember as the Reynold's number is defined as the ratio of same SI unit terms, it is dimensionless and Unitless. This number is used to determine whether the fluid flows in laminar or turbulent. It is one of the main controlling parameters in all kinds of viscous flow. The best example for this type of flow is blood flowing throughout our body is a streamlined flow.

---

16. A pipe of 30 cm long and open at both the ends produces harmonics. Which harmonic mode of pipe resonates a 1.1 kHz source? Given speed of sound in air = 330 ms^{-1}.

(A) Fifth harmonic **(B) Fourth harmonic**

(C) Third harmonic **(D) Second harmonic**

ANSWER (A)

SOLUTION

Given: $v_n = 1.1$ kHz $= 1100$ Hz: $V = 330\,m/s$

Length of the pipe L= 30 cm= 0.3m

The frequency of n^{th} mode of vibration

$$\text{Frequency of } n^{th} \text{ harmonic in an open pipe} = v_n = \frac{nV}{2L}$$

$$\therefore 1100 = \frac{n \times 330}{2 \times 0.3}$$

$$\therefore n = \frac{1100 \times 2 \times 0.3}{330} = \frac{1100 \times 2 \times 3}{3300} = \frac{6600}{3300} = 2$$

Second harmonic

---

17. In anomalous expansion of water, at what temperature, the density of water is maximum?

(A) 4^0 C **(B) < 4^0 C** **(C) > 4^0 C** **(D) 10^0 C**

ANSWER (A)

SOLUTION

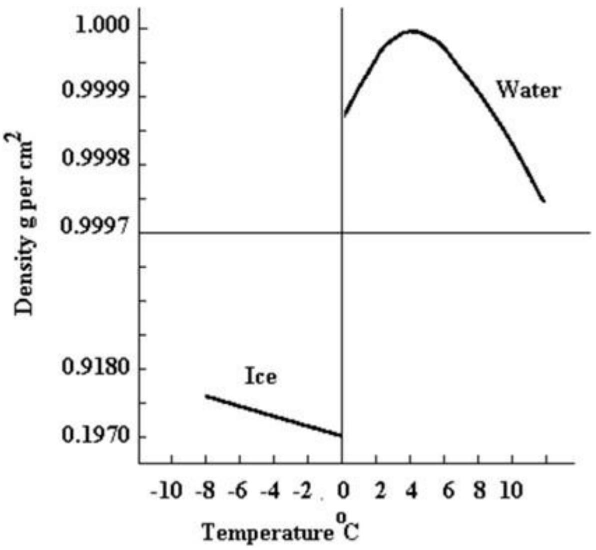
Anomalous expansion of Water

The anomalous expansion of water is an abnormal property of water whereby it expands instead of contracting when the temperature goes from 4^0 C to 0^0 C, and it becomes less dense. The density is maximum at 4 degree centigrade and decreases below that temperature as shown in graph. The density becomes less and less as it freezes because molecules of water normally form open crystal structures when in solid form.

When cooled from room temperature liquid water becomes dense, as with other substances, but at approximately 4^0C (39 F), pure water reaches its maximum density. If it is cooled further, it expands to become less dense.

Water never has a n absolute density because its density varies with temperature. Water has its maximum density of $1 g/cm^3$ at 4^0C. When temperature changes from either greater or less than 4oC, the density becomes less than $1 g/cm^3$.

When cooled from room temperature liquid water becomes dense, as with other substances, but at approximately 4^0C (39F), pure water reaches its maximum density. If it is cooled further, it expands to become less dense.



---

18. An aeroplane executes a horizontal loop at a speed of 720 kmph with its wings banked at 45^0. What is the radius of the loop? Take g = 10 ms^{-2}.

(A) 4 km **(B) 4.5 km** **(A) 7.2 km** **(A) 2 km**

ANSWER (A)

SOLUTION

Given: $V = 720$ kmph; $70 \times \frac{5}{18} = 200$ m/s

Angle of banking $\theta = 45^0$

Let R be the radius of the loop.

Radius of loop $= r = \frac{v^2}{g\,tan\theta}$

$\therefore\ r = \frac{(200)^2}{10 \times 1} = 4000\,m \quad (\tan 45^0 = 1)$

$\Rightarrow$ Radius of loop r = 4km

---

19. A body of moment inertia about its axis of rotation equal to 3 kg-m^2 is rotating with angular velocity of 3 rad s^{-1}. Kinetic energy of this rotating body is same as that of a body of mass 27 kg moving with velocity „v". the value of v is

(A) 1 m/s^{-1} (B) 0.5 m/s^{-1} (C) 2 m/s^{-1} (D) 1.5 m/s^{-1}

ANSWER (A) Solution

Given: I = 3 kg.m^2; w = 3 rad/s; m = 27 kg

Rotational kinetic energy of the body is same as the translational kinetic energy of body of mass 27 kg

$$\frac{1}{2}Iw^2 = \frac{1}{2}mv^2$$

$$\frac{1}{2} \times 3 \times 3^2 = \frac{1}{2} \times 27v^2$$

$$\frac{1}{2} \times 3 \times 3^2 = \frac{1}{2} \times 27v^2 \Rightarrow v = 1\,m/s$$

---

20. A cycle tyre bursts suddenly. What is the type of this process?

(A) Isothermal (B) Adiabatic (C) Isochoric (D) Isobaric

ANSWER (A)

SOLUTION:

Any process is adiabatic is rapid such that there should not be any heat transfer between the system and it's surroundings. When a tyre bursts suddenly, the expansion takes place instantly. This leads to decrease in temperature inside. As such, the higher temperature air outside will transfer heat to it. This heat transfer is not rapid and doesn't take place instantly, unlike the expansion, which is instantaneous. Heat transfer takes place after the bursting, due to which one can consider that there is almost no energy exchange during the actual process. Thus process is adiabatic.

Solution:

In a tyre burst there is too little time for the temperature to be equalized with the surroundings the work done due to the sudden expansion causes the air surrounding the tyre to get cooler. It is adiabatic, because no heat transfer occurs here most of the processes that take very little time is adiabatic.

---

21. An object is placed at 20 cm in front of a concave mirror produces three times magnified real image. What is focal length of the concave mirror?

(A) 15 cm (B) 6.6 cm (C) 10 cm (D) 7. 5cm

ANSWER (A)

Given: Object distance, $u = -20$ cm

A concave mirror forms a real magnified image only when the image to be formed is inverted i.e.

$m = -3$ (∵ all real image are inverted)

Magnification $= \frac{-v}{u}$

$\therefore 3 = \frac{-V}{-20}$

$\Rightarrow V = 60$ cm

Using mirror formula: $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$\therefore \frac{1}{-60} + \frac{1}{-20} = \frac{1}{f}$

$f = \frac{-60}{15} = -15$ cm

Thus focal length of the mirror is 15 cm.

II-Method

Linear magnification: $m = \frac{f}{f-u}$

$\therefore -3 = \frac{f}{f-(-20)}$

$-3 = \frac{f}{f+20}$

$-3f - 60 = f$

$4f = -60$

$\Rightarrow f = \frac{-60}{4} = -15$ cm

---

22. A foal length of a lens is 10 cm. what is a power of a lens in dioptre?

(A) 0.1 D (B) 10 D (C) 15 D (D) 20D

ANSWER (A)

SOLUTION

Focal length of a lens f = 10cm = 0.1 m

Power of lens : $P = \frac{1}{f} = \frac{1}{0.1} = 10$ D

---

23. A microscope is having objective of focal length 1 cm and eye piece of focal length 6 cm. If tube length is 30 cm and image is formed at least distance of distinct vision, what is the magnification produced by the microscope? Take D = 25 cm

(A) 6 (B) 150 (C) 25 (D) 125

ANSWER (D)

SOLUTION

Magnification of objective is given by:

$$m_0 = \frac{L}{f_0}$$

Where: L: tube length of microscope and f_o: focal length of objective

Magnification of eyepiece is given by:

$$m_e = \frac{D}{f_e}$$

Where: D: Distance of least vision and f_e: focal length of eyepiece

Overall magnification is:

$$m = m_0 m_e = \frac{LD}{f_0 f_e}$$

$$|m| = \frac{25 \times 30}{1 \times 6} = 125$$

---

24. A fringe width of a certain interference pattern is β = 0.002 cm. what is the distance of 5^{th} dark fringe from the centre?

(A) $1x\ 10^{-2}$cm (B) $11x\ 10^{-2}$cm (C) $1.1x\ 10^{-2}$cm (D) $3.28\ x\ 10^{-2}$cm

ANSWER (D)

Given: β = 0.002 cm

Distance of 5^{th} dark fringe from center is y

$$y = \left(n + \frac{1}{2}\right)\beta \qquad \text{where } n = 4$$

$$\therefore y = \left(4 + \frac{1}{2}\right) \times 0.002 = 0.009 \text{ cm}$$

$$\therefore y \approx 1 \times 10^{-2} \text{cm}$$

---

25. Diameter of the objective of a telescope is 200 cm. what is the resolving power of a telescope?. Take wavelength of light 5000 Å.

(A) $6.56x\ 10^6$ (B) $3.28\ x\ 10^5$ (C) $1\ x\ 10^6$ (D) $3.28\ x\ 10^6$

ANSWER (D)

SOLUTION:

Given: D = 200 cm = 2 **m**; λ = 5000 Å = 5000 x 10^{-10} m = 5 x 10^{-7} m,

$$\text{Resolving power of the telescope} = R.P = \frac{1}{d\theta} = \frac{D}{1.22\lambda}$$

$$R.P = \frac{2}{1.22 \times 5 \times 10^{-7}} = 3.28 \times 10^6$$

---

26. A polarised light of intensity I_0 is passed through another polarizer whose pass axis makes an angle 60^0 with the pass axis of the former. What is the intensity of emergent polarized light from second polarizer?

(A) $I = I_0$ (B) $I = \frac{I_0}{6}$ (C) $I = \frac{I_0}{5}$ (D) $I = \frac{I_0}{4}$

ANSWER (D)

SOLUTION

Given: $\theta = 60^0$, From Malus's law, intensity of emergent polarised light

$$I = I_0 \cos^2\theta$$
$$I = I_0 \cos^2 60^0$$
$$I = I_0\left(\frac{1}{2}\right)^2 \qquad \cos 60^0 = \frac{1}{2}$$
$$I = \frac{I_0}{4}$$

---

27. What is the de-Broglie wavelength of the electron accelerated through a potential difference of 100 volt?

(A) 12.27 Å (B) 1.227 Å (C) 0.1227 Å (D) 0.001227 Å

ANSWER (B)

SOLUTION

Given: V= 100 volt

$$\text{de} - \text{Bbroglie wavelength ofelectron} = \lambda = \frac{h}{\sqrt{2meV}}$$
$$\therefore \lambda = \frac{6.6 \times 10^{-34}}{\sqrt{2(9.1 \times 10^{-31} \times 1.6 \times 10^{-19}) \times 100}}$$
$$\therefore \lambda = \frac{6.6 \times 10^{-34}}{5.4 \times 10^{-10}} m$$
$$\therefore \lambda = 1227 \times 10^{-7} m$$
$$\therefore \lambda = 1.227 \times 10^{-10}$$
$$\therefore \lambda = 1.227 \text{ Å}$$

---

28. The maximum kinetic energy of the photoelectrons depends only on?

(A) Potential (B) Frequency (C) Incident angle (D) Pressure

ANSWER (B)

SOLUTION: Maximum kinetic energy of photoelectrons $K.E_{max} = h\nu - \phi$

where ν is the frequency of incident photon and ϕ is the work function of metal. Hence maximum kinetic energy of photoelectrons depends only on the frequency of the incident photons. *Or*

Above the threshold frequency, the maximum kinetic energy of the emitted photoelectrons depends on the frequency of the incident light, but is independent of the intensity of the incident light so long as the latter is not too high.

---

29. Which of the following spectral series of hydrogen atom is lying in visible range of electromagnetic wave?

(A) Panchen series **(B) Fund series** **(C) Lyman series** **(D) Balmer series**

ANSWER (D)

SOLUTION: Balmer series lies in the visible region.

When an atom comes down from some higher energy level to the second energy level (n_1=2 and n_2=3, 4, 5,...), then the lines of the spectrum are obtained in the visible part.

These lines were seen and studied for the first time by Balmer in 1885. The longest wavelength of this series (for n=3) is 6563Å and the shortest wavelength (for n=∞) n = ∞) is 3646Å. So, Balmer series is present in visible range of electromagnetic wave.

Or

The spectral line of wavelength 4860 Å lies in the visible region. Since Balmer series lies in the visible region of the spectrum. Therefore, Balmer series give spectral line of 4860 Å.

---

30. What is the energy of the electron revolving in third orbit expressed in eV?

(A) 1.51 eV **(B) 3.4 eV** **(C) 4.53 eV** **(D) 4 eV**

ANSWER (A)

SOLUTION

Energy of the electron in the n^{th} state of the hydrogen atom $= E_n = \frac{-13.6}{n^2}$ eV

The energy of the electron revolving in the 3^{rd} orbit $(n = 3) = E_3 = \frac{-13.6}{n^2}$ eV

$$E_3 = \frac{-13.6}{3^2} = -1.51 \text{ eV}$$

---

31. The relation between half-life (T) and decay constant (λ)?

(A) $\lambda T = 1$ **(B) $\lambda T = \frac{1}{2}$** **(C) $\lambda T = \log_e 2$** **(D) $\lambda = \log 2T$**

ANSWER (C)

SOLUTION

By radioactive decay law, the time in which the final amount becomes half of its initial value is called half-life (T) of that radioactive element. Relation between half-life and disintegration (decay) constant is given

$$T = \frac{0.693}{\lambda}$$

$$\Rightarrow T = \frac{\log_e 2}{\lambda}$$

$$\therefore \lambda T = \log_e 2$$

---

32. A force between the two protons is same as the force between protons and neutron. The nature of the force is?

(A) Weak nuclear force **(B) Strong nuclear force**

(C) Electrical force **(D) gravitational force**

ANSWER (A)

SOLUTION

The strong nuclear force binds protons and neutrons in a nucleus. It acts equally between proton-proton, neutron-neutron and proton-neutron.

Or

The force between two protons is same as the force between proton and neutron and this force is a strong nuclear force- one of the four fundamental forces of nature. It is also the strongest force of the four. However, it also has the shortest range, meaning that particles must be extremely close before its effects are felt. Its main purpose is to hold together the subatomic particles of the nucleus (protons, which carry a positive charge, and neutrons, which carry no charge).

---

33. In N type semiconductor, electrons are majority of charge carriers but it does not show any negative charge. The reason is

(A) Electrons are stationary **(B) Electrons neutralize with holes**

(C) Mobility of electrons is extremely small **(D) Atom is electrically neutral**

ANSWER (D)

SOLUTION:

The n -type semiconductor region has (negative) electrons as majority charge-carriers and an equal number of fixed positively-charged donor ions. Again, the material as a whole is neutral. That is a reason atom is electrically neutral.

or

Semiconductors have both free charge (electrons and holes) and immobile charge. When a donor is ionized, it creates a free electron, but also it creates a positively ionized donor atom. The charge on the free electron and the ionized donor are equal and opposite. So as long as the electron doesn't go anywhere, the net charge remains zero.

or

The n - type semiconductor region has (negative) electrons as majority charge - carriers and an equal number of fixed positively - charged donor ions. Again, the material as a whole is neutral. That is a reason atom is electrically neutral.

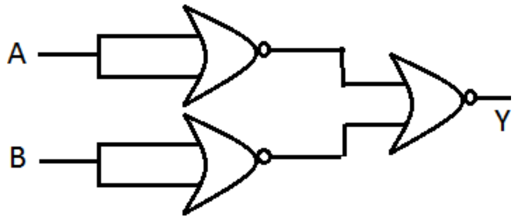
---

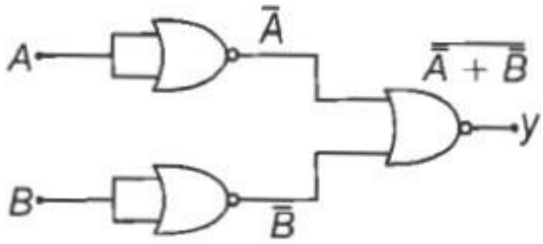
34. For the given digital circuit, write the truth table and identify the logic gate it represents

(A) OR-Gate **(B) NOR-Gate** **(C) NAND Gate** **(D) AND Gate**

ANSWER (D) SOLUTION:

For the given digital circuit, write the truth table and identify the logic gate it represents.





To solve the circuits with truth table only, three truth tables will be required (C,D,Y). Hence, it is useful to solve it with Boolean algebra.

From the attached diagram,

$$C = \overline{A + A} \Rightarrow C = \overline{A}$$

Similarly, $D = \overline{B}$

$$Y = \overline{C + D}$$

$$Y = \overline{\overline{A} + \overline{B}}$$

Using De-Morgan's law, Y=AB which is AND gate.

A	B	C	D	Y
0	0	1	1	0
0	1	1	0	0
1	1	0	0	1
1	0	0	1	0

---

35. If α-particle gain of a transistor is 0.98. What is the value of β- current gain of the transistor?

(A) 0.49 **(B) 49** **(C) 4.9** **(D) 5**

ANSWER (B)

SOLUTION:

By **constants (or parameters) of a transistor where αα and ββ are the AC current gains of a transistor in the common-base configuration and in the common-emitter configuration respectively.**

$$\beta = \frac{\alpha}{1-\alpha} = \frac{0.98}{1-0.98}$$

where $\alpha = 0.98,\quad \beta = ?$

$$\beta = \frac{0.98}{1-0.2}$$

$$\beta = \frac{0.98}{1-0.2} = \frac{98}{2} = 49$$

II method

$$\alpha = \frac{I_C}{I_e} \quad \text{and} \quad \beta = \frac{I_C}{I_b}$$

[Ic, Ib and Ie are collector, base and emitter current].

$$I_e = I_C + I_b$$

On dividing by I_C on both sides

$$\frac{I_e}{I_C} = 1 + \frac{I_b}{I_C}$$

$$\frac{1}{\alpha} = 1 + \frac{1}{\beta} \Rightarrow \beta = \frac{\alpha}{1-\alpha}$$

$$= \frac{0.98}{1-0.98} = \frac{0.98}{0.2} = 49$$

---

36. A tuned amplifier circuit is to use to generate a carrier frequency of 2 MHz for the amplitude modulation. The value of $\sqrt{LC}$ is

(A) $\frac{1}{2\pi \times 10^6}$ (B) $\frac{1}{2 \times 10^6}$ (C) $\frac{1}{3\pi \times 10^6}$ (D) $\frac{1}{4\pi \times 10^6}$

ANSWER (D)

SOLUTION:

Given: $\gamma = 2\text{ MHz} = 2 \times 10^6\text{Hz}$

Using $w = \frac{1}{\sqrt{LC}}$ where $w = 2\pi\gamma$

$$\sqrt{LC} = \frac{1}{2\pi\gamma} = \frac{1}{4\pi \times 10^6}$$

---

37. If a charge on a body is 1nC, then how many electrons are present on the body?

(A) $1.6\text{x}10^{19}$ (B) $6.25\text{x}10^{19}$ (C) $6.25\text{x}10^{27}$ (D) $6.25\text{x}10^{8}$

ANSWER (D)

SOLUTION:

The charge of an electron : $e = 1.6 \times 10^{-19}\,C$

$Q = ne$

No. Of electrons on -1 Coulomb of charge

$$\therefore n = \frac{Q}{e} = \frac{1}{1.6 \times 10^{-19}} = 0.625 \times 10^{19} = 6.25 \times 10^{18}$$

---

38. Two equal and opposite charges of masses m_1 and m_2 are accelerated in an uniform electric field through the same distance. What is the ratio of their accelerations if their ratio of masses $m_1/m_2 = 0.5$?

(A) $\frac{a_1}{a_2} = 0.5$ (B) $\frac{a_1}{a_2} = 1$ (C) $\frac{a_1}{a_2} = 2$ (D) $\frac{a_1}{a_2} = 3$

ANSWER (C)

SOLUTION:

Given $q_1 = q_2$ and $\frac{m_1}{m_2} = 0.5$

According to Newton's third law of motion, both charges apply equal and opposite force on each other

$$I_e = I_C + I_b$$

Let the acceleration of both charges be a_1 and a_2.

$$F_1 = m_1a_1 = q_1E \quad (1)$$

$$F_2 = m_2a_2 = q_2E \quad (2)$$

From equations (1) and (2)

$$F_1 = m_1a_1 \quad \text{and} \quad F_2 = m_2a_2$$

$$m_1a_1 = m_2a_2$$

Thus the ratio of acceleration $= \frac{a_1}{a_2} = \frac{m_2}{m_1} = \frac{1}{0.5} = 2$

---

39. What is the nature of Gaussian surface involved in gauss law of electrostatic?

(A) Scalar (B) Electrical (C) Magnetic (D) Vector

ANSWER (D)

SOLUTION:

Gaussian surface vector is a closed surface in 3-D space through which flux (scalar) of a vector field is calculated.

The Gauss's law in electrostatic given a relation between electric flux through any closed hypothetical surface (called a Gaussian surface) and the charge enclosed by the surface. So, the nature is area vector.

---

40. What is the electric potential at a distance of 9cm from 3nC?

(A) 270V (B) 3 (C) 300V (D) 30V

ANSWER (C)

SOLUTION:

Given: r = 9 cm = 0.09 m

Charge $Q = 3 \text{ nC} = 3 \times 10^{-9}$ C

Potential at a distance at 9cm, $V = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$

$$V = 9 \times 10^9 \frac{3 \times 10^{-9}}{0.09} = 300 \text{ V}$$

---

41. A voltmeter reads 4Vwhen connected to parallel plate capacitor with air as dielectric. When a dielectric slab is introduced between the plates for the same configuration, voltmeter reads 2V. What is the dielectric constant of the material?

(A) 0.5 (B) 2 (C) 8 (D) 10V

ANSWER (D)

SOLUTION:

For a capacitance with dielectric medium is given by C

$$C = \frac{K\varepsilon_0 A}{d}$$

From law of conservation of charge, initial and final charge on the capacitor is same.

$$Q_i = Q_f$$

From definition of capacitance,

$$C_i V_i = C_f V_f$$
$$\frac{\varepsilon_0 A}{d} V_i = \frac{K\varepsilon_0 A}{d} V_f$$
$$4 = 2K$$
$$K = 2$$

---

42. Spherical conductor of radius 2cm is uniformly charged with 3nC. What is the electric field at a distance of 3 cm from the centre of the sphere?

(A) $3 \times 10^6\ Vm^{-1}$ (B) $3\ Vm^{-1}$ (C) $3 \times 10^4\ Vm^{-1}$ (D) $3 \times 10^{-4}\ Vm^{-1}$

ANSWER (C)

SOLUTION:

Given: $r = 9\ cm = 0.09\ m$

Charge $Q = 3\ nC = 3 \times 10^{-9}\ C$

Electric field at a distance of 3cm $= E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{d^2}$

$$E = 9 \times 10^9 \frac{3 \times 10^{-9}}{(0.03)^2} = 3 \times 10^4\ V/m$$

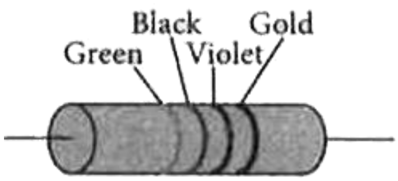
---

43. A carbon film resistor has color code Green Black Violet Gold. The value of the resistor is

(A) $50\ M\Omega$ (B) $500\ M\Omega$ (C) $500 \pm 5\%\ M\Omega$ (D) $500 \pm 10\%\ M\Omega$

ANSWER (C)

SOLUTION:



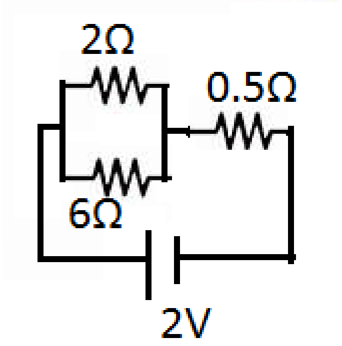
First band (green) indicates the value of first digit (5), Second band (Black) indicates second digit (0), the third band gives the number of zeros (10^7) *and fourth band gives the tolerance limit.* **[BBROY** of **G**reat **B**ritain having **V**ery **G**ood **W**ife]. So, the value of the resistor is written as

$R = 50 \times 10^7 \pm 5\%\ \Omega = 500 \pm 5\%\ M\Omega$

---

44. Two resistors of resistances 2Ω and 6Ω are connected in parallel. This combination is then connected to a battery of emf 2V and internal resistance 0.5Ω. What is the current flowing through the battery?

(A) 4A (B) $\frac{4}{3}$ A (C) $\frac{4}{17}$ A (D) 1A



ANSWER (D)

SOLUTION:

Equivalent resistance of the circuit

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_p} = \frac{1}{2} + \frac{1}{6}$$

$$\frac{1}{R_p} = \frac{6+2}{12} = \frac{8}{12}$$

$$R_p = \frac{12}{8} = 1.5\ \Omega$$

R_P and 0.5 Ω are connected in series

$$R_{eq} = 1.5 + 0.5 = 2\ \Omega$$

Current flowing in the circuit

$$I = \frac{V}{R_{eq}} = \frac{2}{2} = 1\ \text{amp}$$

---

45. The equivalent resistance of two resistors connected in series is 6Ω and their parallel equivalent resistance is 4/3Ω. What are the values of resistances?

(A) 4Ω, 6Ω (B) 8Ω, 1Ω (C) 4Ω, 2Ω (D) 6Ω, 2Ω

ANSWER (C)

SOLUTION:

Let the two resistances be R_1 and R_2.

Equivalent resistance of series connection, $R_s = R_1 + R_2$

$$R_S = R_1 + R_2 = 6$$

$$R_2 = 6 - R_1 \ldots\ldots\ldots (1)$$

Equivalent resistance of parallel connection,

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_p} = \frac{R_1 + R_2}{R_1 \times R_2}$$

$$R_p = \frac{R_1 \times R_2}{R_1 + R_2}$$

$$\frac{4}{3}=\frac{R_1\times(6-R_1)}{R_1+R_2}$$

$$R_1^2-6R_1+8=0$$

$$(R_1-1)\,(R_1-2)=0$$

$$R_1=2\,\Omega\ \text{ or }\ 4\Omega$$

Let us say $R_1=4\,\Omega$

Let us say $R_2=6-4=2\,\Omega$

---

46. In a potentiometer experiment cell of emf 1.25 V gives balancing length of 30 cm. if the cell is replaced by another cell, balancing length is found to be 40 cm. What is emf of second cell?

(A) $\simeq 1.57$ V **(B)** $\simeq 1.67$ V **(C)** $\simeq 1.47$ V **(D)** $\simeq 1.37$ V

ANSWER (C)

SOLUTION:

Given: E1=1.25 V, l_1 = 30 cm, l_2 = 40 cm

Emf of the cell E a l

EMF of the cell E_1= 1.25 V

Balance point of the potentiometer L_1= 30 cm = 0.30 m

The cell is replaced by another cell of emf E_2

The new balancing point of the potentiometer for the new cell L_2 = 40 cm = 0.40 m

$$\frac{E_2}{E_1}=\frac{l_2}{l_1}$$

$$\frac{E_2}{1.25}=\frac{40}{30}$$

$$E_2=1.67\text{ V}$$

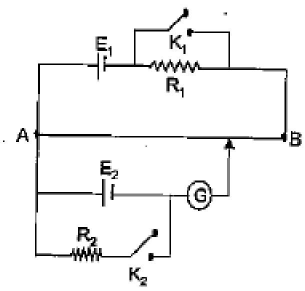
Additional information:

We know that the potentiometer is an instrument that is used to measure an unknown emf by comparison with known emf.

Potentiometer uses the null deflection method.

The fall of potential per unit length of potentiometer wire i.e. the potential gradient of wire is constant. This is the principle of the potentiometer.

The potentiometer is used to measure the emf of a cell, to compare EMFs of two cells, and to determine the internal resistance of a cell.



---

47. A charged particle experiences a magnetic force in the presence of magnetic field. Which of the following statement is correct?

(A) The particle is moving and magnetic field is perpendicular to the velocity.

(B) The particle is moving and magnetic field is perpendicular to the velocity.

(C) The particle is moving and magnetic field is perpendicular to the velocity.

(D) The particle is moving and magnetic field is perpendicular to the velocity.

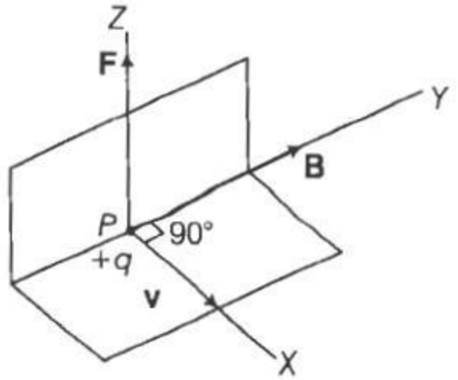
ANSWER (A)

SOLUTION:

When charge is placed in a magnetic field it will experience magnetic force if

1) The charge is moving as no magnetic force acts on static charge.
2) Velocity of moving charge has component perpendicular to the direction of magnetic field.

By Fleming's left-hand rule



So, the particle is moving and magnetic field is perpendicular to the velocity.

---

48. If a velocity has both perpendicular and parallel components while moving through a magnetic field, what is the path followed by a charged article?

(A) Circuilar (B) Elliptical (C) Linear (D) Helical

ANSWER (D)

SOLUTION:

A particle moving in a magnetic field will experience force only if the magnetic field is perpendicular to it. This is because the force on a particle in a magnetic field is the cross product of velocity and direction of the magnetic field.
When a particle is moving in a magnetic field, it experiences force according to the given formula

$$F = q\,(v \times B)$$

$$F = qv\,B \sin\theta$$

where θ is the angle between the velocity and the magnetic field. This force will act perpendicular to the direction of motion of the particle. This centripetal force will be equal to

$$\frac{mv^2}{r} = qvB$$

$$v = \frac{qrB}{m}$$

Thus this force will make the particle move in a circular path. Whereas there will be no external force acting on the particle in the direction of the magnetic field. The resultant of these 2 forces will make the particle move in a helical path.

---

49. A solenoid has length 0.4 cm, radius 1 cm and 400 turns of wire. If a current of 5 A is passed through this solenoid, what is the magnetic field inside the solenoid?

(A) 6.28×10^{-4} T (B) 6.27×10^{-3} T (C) 6.28×10^{-2} T (D) 6.27×10^{-6} T

ANSWER (D)

SOLUTION:

Length of solenoid $l = 0.4$ cm $= 0.004$ m

Number of turn per unit length $= n = \frac{400}{0.004} = 10^5$

Magnetic field inside the solenoid $B = \mu_0 nI$

$\therefore B = 4\pi \times 10^{-7} \times 10^5 \times 5 = 6.28 \times 10^{-3}$ T

---

50. A gyromatric ratio of the electron revolving in a circular orbit of hydrogen atom is 8.8×10^{10} C kg^{-1}. What is the mass of the electron? Given charge of the electron $=1.6 \times 10^{-19}$ C?

(A) 1×10^{-29} Kg (B) 0.1×10^{-29} Kg (C) 1.1×10^{-29} Kg (D) $\frac{1}{11} \times 10^{-29}$ Kg

ANSWER (D)

SOLUTION:

Current in the wire, I = 35 A

Distance of a point from the wire, r = 20 cm = 0.2 m

Magnitude of the magnetic field at this point is given as: B

Where, = Permeability of free space = $4\pi \times 10^{-7}$ T m A^{-1}

Hence, the magnitude of the magnetic field at a point 20 cm from the wire is 3.5×10^{-5} T.

---

51. What is the value of shunt resistance required to convert a galvanometer resistance 100 Ω into an ammeter range of 1A ?. Given full scale division of the Galvanometer is 5 mA.

(A) $\frac{5}{9.95}$ Ω (B) $\frac{9.95}{5}$ Ω (C) 0.5 Ω (D) 0.05 Kg

ANSWER (D) SOLUTION:

Given: Ig = 5 mA = 0.005A G = 100 Ω I = 1A

By conversion of galvanometer into ammeter, Ig= Current through galvanometer

S = Shunt resistance AND G = Galvanometer resistance

$I_g = 5 \times 10^{-3}$ A

I=1A

G=100Ω

$S = \left(\frac{5 \times 10^5}{1 - 5 \times 10^{-3}}\right) \times 100$

$$S = \left(\frac{5 \times 10^5 \times 100 \times 10^3}{1000 - 5}\right)$$

$$S = \frac{500}{995} = \frac{5}{9.95}\,\Omega$$

Let a shunt resistance Rs is connected, as shown in the figure, to convert a galvanometer into an ammeter. From figure, $V_{AB} = V_{CD}$

---

52. A circular of radius 10 cm and 100 turns carries current 1A. What is the magnetic moment of the coil?.

(A) 3.142×10^4 Am^2 (B) 10^4 Am^2 (C) 3.142 Am^2 (D) 3 Am^2

ANSWER (A)

Solution

Correct option is A)

Given; No. of turns N = 100

Radius r = 10 cm = 0.1 m

Current I = 1 A

Solution;

Magnetic moment M = NIA

Now area of the circular coil $A = \pi r^2$

Therefore, $M = N I \pi r^2 = 100 \times 1 \times 3.14 \times 0.1 \times 0.1 = 3.14$

Hence the correct answer is 3.14 Am^2

---

53. A Susceptibility of certain magnetic material is 400. What is the class of the magnetic material?

(A) Diamagnetic (B)Paramgnetic (C) Ferromagnetic (D) Ferroelctric

ANSWER (C)

SOLUTION:

Magnetic susceptibility of a ferromagnetic material is large and positive (very greater than 1) that of diamagnetic material is negative whereas that of a paramagnetic material is small and positive. Hence, the given material is a ferromagnetic material. Ex=Iron, Steel etc

Ferromagnetic material fallows the Curie-Weiss law. When the ferromagnetic substance heated above Curie temperature (T_C)

$$\chi \propto \frac{1}{T - T_C}$$

---

54. A Solenoid of inductance 2H carries current of 1A. What is the magnetic energy stored in the magnetic material?

(A) 2 J (B) 1 J (C) 4 J (D) 5 J

ANSWER (B)

SOLUTION:

Given: $L = 2\,H \qquad I = 1\,A$

Magnetic energy stored $= U_m = \frac{1}{2}LI^2$

$U_m = \frac{1}{2} \times 2 \times 1^2 = 1\,J$

---

55. A multi meter reads a voltage of certain A.C as 100 V. What is the peak value of voltage AC source?

(A) 200 V (B) 100V (C) 141.4V (D) 400V

ANSWER (C)

SOLUTION:

The peak voltage of the alternating current is

$V_0 = \sqrt{2} \times$ rms value of the voltage

$V_0 = \sqrt{2}\,V_{rms}$

$V_0 = \sqrt{2} \times 100 = 100\sqrt{2} = 100 \times 1.414 = 141.4\,V$

---

56. A series LCR circuit contains inductance 5 mH, capacitance 2μF and resistance 10Ω. If a frequency of AC source is varied, what is the frequency at which maximum power is dissipated?

(A) $\frac{10^5}{\pi}$ Hz (B) $\frac{10^{-5}}{\pi}$ Hz (C) $\frac{2}{\pi} \times 10^{-5}$ (D) $\frac{5}{\pi} \times 10^3$

ANSWER (D)

SOLUTION:

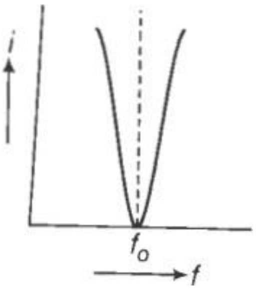
Given: $L = 5\,mH = 5\times10^{-3}H$, $C = 2 \times 10^{-6}\,F$

Maximum power is dissipated at resonant frequency.

Resonant frequency $= W_r = \frac{1}{2\pi\sqrt{LC}}$

$\therefore W_r = \frac{1}{2\pi\sqrt{(5 \times 10^{-3})(2 \times 10^{-10})}}$

$\therefore W_r = \frac{10^4}{2\pi} = \frac{5}{\pi} \times 10^3\,Hz$



---

57. A step down transformer has 50 turns on secondary 1000 on primary winding. If a transformer is connected to 220 V, 1 A, A C source. What is output current of the transformer?

(A) $\frac{1}{20}$ A (B) 20 A (C) 100 A (D) 2A

ANSWER (B)

SOLUTION:

Number of turns on secondary winding Ns = 50

Number of turns on primary winding Np =1000

Current in the primary winding Ip = 1 A

$\therefore$ Current in the second wiring $= I_S = \frac{N_p}{N_S} I_p$

$$\therefore \quad I_S = \frac{1000}{50} \times 1 = 20\ A$$

---

58. The average power dissipated in AC circuit is 2 watt. If a current flowing through a circuit is 2A and impedance is 1Ω, What is the power factor of AC circuit?

(A) 0.5 (B) 1 A (C) 0A (D) $\frac{1}{\sqrt{2}}$

ANSWER (A)

SOLUTION:

Given: $P_{avg} = 2$ Watt, I = 2 A , Z = 1Ω

$P = V_{rms} I_{rms} \cos\phi$

$V_{rms} = I_{rms} \times Z$

Thus the power factor $\cos\phi = \frac{P_{av}}{I^2 Z}$

$\cos\phi = \frac{2}{2^2 \times 1} = 0.5$

---

59. A plane of electromagnetic wave of frequency 20 MHz travels through a space along x-direction. If the electric vector at a certain point in space is 6 Vm-1, what is the magnetic field vector at that point?

(A) 2×10^{-8} T (B) $\frac{1}{2} \times 10^{-8}$ T (C) 2T (D) $\frac{1}{2}$ T

ANSWER (A)

SOLUTION:

Velocity of EM wave $v = 3\times10^8$ m/s

Electric field vector $E = 6$ V/m

Thus magnetic field vector $B = \frac{E}{V}$

$$B = \frac{6}{3 \times 10^8} = 2 \times 10^{-8}\ T$$

---

60. Two capacitors of 10 PF and 20 PF are connected to 200V and 100Vsources respectively. If they are connected by the wire, what is the common potential of the capacitors?

(A) 133.3 volt (B) 150 volt (C) 300 volt (D) 400 volt

ANSWER (A)

SOLUTION:

Total charge on the two capacitors is:

$Q = Q_1 + Q_2 = C_1V_1 + C_2V_2$

$Q = 10 \times 10^{-9} \times 200 + 20 \times 10^{-9} \times 100$

$Q = 4\ \mu C$

Net capacitance of two capacitors in parallel is:

$C = C_1 + C_2$

$C = 30\ pF$

Common potential of the parallel combination of capacitors is:

$$V = \frac{Q}{C} = \frac{4 \times 10^{-6}}{30 \times 10^{-9}} = 133.3\ V$$