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TABLE OF CONTENTS

Physics : Practice Test 01

1. The weight of a body at the centre of the earth is ______.

(a) Infinite
(b) Zero
(c) Same as that on the surface of the earth
(d) Half of that on the surface of the earth

2. If the earth suddenly stops rotating, then the value g at the equator, will _____.

(a) Decrease
(b) Increase
(c) Remain the same
(d) Be zero

3. Work of invertor is:

(a) To change AC into DC
(b) To change DC to AC
(c) To regulate voltage
(d) None of these

4. In a circuit 20Ω resistance and $0.4\mathrm{H}$ inductance are connected with a source of 220 volt of frequency $50\ \mathrm{Hz}$, then the value of phase angle θ is:

(a) $\tan^{-1}(4\pi)$ (b) $\tan^{-1}(2\pi)$
(c) $\tan^{-1}(1\pi)$ (d) $\tan^{-1}(3\pi)$

5. Consider an excited hydrogen atom in state n moving with a velocity v (v<< c). It emits a photon in the direction of its motion and changes its state to a lower state m. Apply momentum and energy conservation principle to calculate the frequency v of the emitted radiation. Compare this with the frequency v 0 emitted if the atom were at rest.

(a) $\nu_0 = \nu\left(1 - \frac{\mathrm{v}}{\mathrm{c}}\right)$
(b) $\nu_0 = \nu\left(1 + \frac{\mathrm{v}}{\mathrm{c}}\right)$
(c) $\nu = \nu_0\left(1 - \frac{\mathrm{v}}{\mathrm{c}}\right)$
(d) $\nu = \nu_0\left(1 + \frac{\mathrm{v}}{\mathrm{c}}\right)$

6. All electrons ejected from a surface by incident light of wavelength $200\ \mathrm{nm}$ can be stopped before traveling $1\ \mathrm{m}$ in the direction of a uniform electric field of $4\mathrm{NC}^{-1}$. The work function of the surface is:

(a) 4eV (b) 6.2eV
(c) 2eV (d) 2.2eV

7. Calculate the velocity of the electron ejected from platinum surface when radiation of 2000A talks omit. The work function of the metal is $5\mathrm{eV}$.

(a) $6.54 \times 10^2\ \mathrm{m/s}$
(b) $0.54 \times 10^2\ \mathrm{m/s}$
(c) $6.5 \times 10^2\ \mathrm{m/s}$
(d) $6.4 \times 10^2\ \mathrm{m/s}$

8. If $v = \frac{A}{t} + Bt^2 + Ct^3$ where v is velocity, t is time and A, B and C are constants, then the dimensional formula of B is:

(a) $[\mathrm{M^0LT^0}]$ (b) $[\mathrm{ML^0\ T^0}]$
(c) $[\mathrm{M^0\ L^0\ T}]$ (d) $[\mathrm{M^0LT^{-3}}]$

9. The expression $[\mathrm{ML^{-1}T^{-2}}]$ does not represent:

(a) Pressure
(b) Power
(c) Stress
(d) Young's modulus

10. Outdoors on the winter, why does a piece of metal feel colder than piece of wood?

(a) Metal is a good conductor of heat than wood
(b) Wood is a good conductor of heat than metal
(c) Wood conducts heat faster than metal
(d) Both the metals and wood are bad conductors of heat

11. 200° Celsius = __________Fahrenheit.

(a) $-73^\circ F$ (b) $-328^\circ F$
(c) $392^\circ F$ (d) $73^\circ F$

12. In Maxwell Boltzmann distribution, the fraction of gas molecules having energy between E and $E + dE$ is proportional to:

(a) $E^{\frac{1}{2}} \exp\left(-\frac{E}{kT}\right)$
(b) $E^{\frac{3}{2}} \exp\left(-\frac{E}{kT}\right)$
(c) $E^{\frac{1}{2}}$
(d) $E^{\frac{3}{2}} \exp\left(\frac{E}{kT}\right)$

13. If temperature of the gas is increased to three times, then its root mean square velocity become:

(a) 3 times (b) 9 times
(c) $\frac{1}{2}$ times (d) $\sqrt{3}$ times

14. Which of the following statement is false for the properties of electromagnetic waves?

(a) These waves do not require any material medium for propagation.
(b) Both electric and magnetic field vectors attains the maxima and minima at the same place and same time.
(c) The energy in electromagnetic wave is divided equally between electric and magnetic vectors.
(d) Both electric and magnetic field vectors are parallel to each other and perpendicular to the direction of propagation of wave.

15. The propagation of electromagnetic waves is along the direction of:

(a) Dot product of electric field and magnetic field.
(b) Axis parallel to electric field.
(c) Cross product of electric field and magnetic field.
(d) Axis parallel to magnetic field.

16. A mass of 5 kg is moving along a circular path of radius 1 m. If the mass moves with 300 revolutions per minute, its kinetic energy would be:

(a) $100\pi^2$ (b) $150\pi^2$
(c) $250\pi^2$ (d) $6\pi^2$

17. A force $F = Py^2 + Qy + R$ acts on a body in the y direction. The change in kinetic energy of the body during a displacement from $y = -a$ to $y = a$ is:

(a) $\frac{2Pa^3}{3} + 2Ra$ (b) $\frac{2Qa^2}{3} + Pa$
(c) $\frac{2Pa^2}{3} + \frac{Ra}{2}$ (d) $\frac{2Pa^2}{3} + \frac{Qa}{2}$

18. A spring balance is attached to the ceiling of a lift. A man hangs his bag on the spring and the spring reads $49\ \mathrm{N}$, when the lift is stationary. If the lift moves downward with an acceleration of $5\ \mathrm{m/s^2}$, the reading of the spring balance will be:

(a) 24 N (b) 74 N
(c) 15 N (d) 49 N

19. A machine gun is mounted on a $2000\ \mathrm{kg}$ car on a horizontal frictionless surface. At some instant the gun fires bullets of mass $10\mathrm{gm}$ with a velocity of $500\ \mathrm{m/sec}$ with respect to the car. The number of bullets fired per second is ten. The average thrust on the system is:

(a) 550 N (b) 50 N
(c) 250 N (d) 250 dyne

20. Atoms having the same number of neutrons, but different number of electrons or protons are called?

(a) Isotones
(b) Isotopes
(c) Isobars

(d) None of these

21. A radioactive nucleus emits a beta particle, then the parent and daughter nuclei are:

(a) Isotones (b) Isotopes

(c) Isomers (d) Isobars

22. An electron emitted in beta radiation originates from:

(a) Free electrons existing in the nuclei

(b) Inner orbits of an atom

(c) Photon escaping from the nucleus

(d) Decay of a neutron in a nuclei

23. A wheel with 10 metallic spokes each 0.5 m long is rotated with a speed of 120 rev/min in a plane normal to the horizontal component of earth's magnetic field H_E at a place. If $H_E = 0.4\text{G}$ at the place, what is the induced emf between the axle and the rim of the wheel? Note that $1\text{G} = 10^{-4}$ T.

(a) 6.28×10^{-5} V

(b) 4.28×10^{-5} V

(c) 4.48×10^{-5} V

(d) 3.28×10^{-5} V

24. Two long straight conductors AOB and COD are perpendicular to each other and carry currents i_1 and i_2. The magnitude of the magnetic induction at a point P at a distance a from the point O in a direction perpendicular to the plane $ABCD$ is :

(a) $\frac{\mu_0}{2\pi a}(i_1 + i_2)$

(b) $\frac{\mu_0}{2\pi a}(i_1 - i_2)$

(c) $\frac{\mu_0}{2\pi a}\sqrt{(i_1^2 + i_2^2)}$

(d) $\frac{\mu_0}{2\pi a}\frac{i_1 i_2}{(i_1+i_2)}$

25. The depletion layer in a $p-n$ junction diode is $10^{-6}\, m$ wide and its knee potential is $0.5\, V$. What is the inner electric field in the depletion region?

(a) $5 \times (10)^6\, V/m$

(b) $5 \times (10)^{-7}\, V/m$

(c) $5 \times (10)^5\, V/m$

(d) None of these

26. The electrical conductivity of a semiconductor increases when electromagnetic radiation of wavelength shorter than 2480 nm is incident on it. The band gap (in eV) for the semiconductor is

(a) 0.9 (b) 0.7

(c) 0.5 (d) 1.1

27. A uniformly charged conducting sphere of 2.4 m diameter has a surface charge density of $80.0\mu C/$m ^{2}. What is the total electric flux leaving the surface of the sphere?

(a) 1.3×10^8 Nm $^2/C$

(b) 1.6×10^5 Nm $^3/C$

(c) 2.5×10^8 Nm $^2/C$

(d) 1.6×10^8 Nm $^2/C$

28. Which of the following is not the property of equipotential surfaces?

(a) The electric field is always perpendicular to an equipotential surface.

(b) The direction of the equipotential surface is from low potential to high potential.

(c) Rate of change of potential with distance on them is zero

(d) In a uniform electric field, any plane normal to the field direction is an equipotential surface.

29. A particle starts S.H.M. from the mean position. Its amplitude is A and time period is T. At the time when its speed is half of the maximum speed, its displacement y is:

(a) $\frac{A}{2}$ (b) $\frac{A}{\sqrt{2}}$

(c) $\frac{A\sqrt{3}}{2}$ (d) $\frac{2A}{\sqrt{3}}$

30. The length of an elastic string is a metre when the longitudinal tension is 4 N and b metre when the longitudinal tension is 5 N. The length of the string in the metre when longitudinal tension is 9 N is:

(a) $l+h$ (b) $l-h$

(c) 5 b − 4a (d) 4 b − 5a

31. C_s is the velocity of sound in air and C is the R.M.S. velocity, then:

(a) $\text{C} = \text{C}_\text{s}\sqrt{\frac{\gamma}{5}}$

(b) $\text{C} = \text{C}_\text{s}\sqrt{\frac{\gamma}{3}}$

(c) $\text{C}_\text{s} = \text{C}\sqrt{\frac{\gamma}{3}}$

(d) None of these

32. The loudness and pitch of a sound depends on:

(a) Intensity and velocity

(b) Frequency and velocity

(c) Intensity and frequency

(d) Frequency and number of harmonic

33. When we rub a glass rod with silk, then the charge on the glass rod will be:

(a) Positive

(b) Negative

(c) Neutral

(d) None of the above

34. In the winter season, a mild spark is often seen when a man touches somebody's else's skin. Why?

(a) Due to lack of humidity and rubbing with clothes, charge accumulate on human body which is discharged via sparking

(b) Due to cold, electrostatic charge on body finds a lower resistance path to the skin of other's body

(c) The static charge on sweaters worn by the two persons is different, hence discharge through sparking occurs

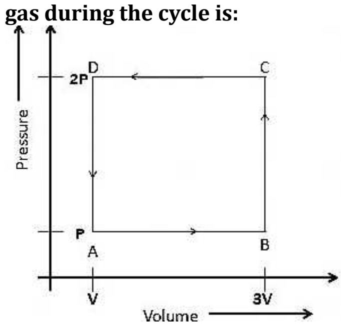
(d) Similar to the lighting, extremely high potential exists on both the bodies and hence they discharge through sparking

35. What is the ratio of $\frac{C_p}{C_v}$ for gas if the pressure of the gas is proportional to the cube of its temperature and the process is an adiabatic process?

(a) $\frac{4}{3}$ (b) $\frac{5}{7}$

(c) $\frac{3}{2}$ (d) $\frac{7}{9}$

36. A thermodynamic system is taken through the cycle $ABCD$ as shown in the figure. Heat rejected by the gas during the cycle is:



(a) PV (b) $2PV$

(c) $4PV$ (d) $\frac{1}{2}\,PV$

37. A closely wound solenoid of 800 turns and area of cross section $2.5 \times 10^{-4}\,\text{m}^2$ carries a current of 3.0 A. What is its associated magnetic moment?

(a) 1.6JT^{-1} (b) 0.6JT^{-1}

(c) 2.6JT^{-1} (d) 0.9JT^{-1}

38. A domain in ferromagnetic iron is in the form of a cube of side length 1μm. Estimate the number of iron atoms in the domain and the maximum possible dipole moment and magnetisation of the domain. The molecular mass of iron is

$55\ \text{g/mole}$ and its density is $7.9\ \text{g/cm}^3$. Assume that each iron atom has a dipole moment of $9.27 \times 10^{-24}\ \text{A m}^2$:

(a) $7.0 \times 10^5 \text{Am}^{-1}$

(b) $7.0 \times 10^3 \text{Am}^{-1}$

(c) $6.0 \times 10^4 \text{Am}^{-1}$

(d) $8.0 \times 10^5 \text{Am}^{-1}$

39. A small hole of area of cross-section 2 mm ^{2} is present near the bottom of a fully filled open tank of height 2 m. Taking g = 10 m/s ^{2}, the rate of flow of water through the open hole would be nearly

(a) $12.6 \times 10^{-6}\ \text{m}^3/\text{s}$

(b) $8.9 \times 10^{-6}\ \text{m}^3/\text{s}$

(c) $2.23 \times 10^{-6}\ \text{m}^3/\text{s}$

(d) $6.4 \times 10^{-6}\ \text{m}^3/\text{s}$

40. A wind-powered generator converts wind energy into electrical energy. Assume that the generator converts a fixed fraction of the wind energy intercepted by its blades into the electric energy. For wind speed V, the electrical power output will be proportional to?

(a) V (b) V^2

(c) V^3 (d) V^4

41. Steel ruptures when a shear of $3.5 \times 10^8 \text{Nm}^{-2}$ is applied. The force needed to punch a $1\ \text{cm}$ diameter hole in a steel sheet $0.3\ \text{cm}$ thick is nearly:

(a) 1.4×10^4 N (b) 2.7×10^4 N

(c) 3.3×10^4 N (d) 1.1×10^4 N

42. The cyclotron frequency of an electron grating in a magnetic field of 1 T is approximately

(a) 28 MHz (b) 280 MHz

(c) 2.8 GHz (d) 28 GHz

43. A magnetising field of 1500Am^{-1} produces flux of 2.4×10^{-5} weber in a iron bar of the cross-sectional area of $0.5\ \text{cm}^2$. The permeability of the iron bar is

(a) 245 (b) 250

(c) 252 (d) 255

44. A freshly prepared radioactive source of half-life 2 hours emits radiation of intensity which is 64 times the permissible safe level. The minimum time after which it would be possible to work safely with this source is:

(a) 6 hours (b) 12 hours

(c) 24 hours (d) 128 hours

45. Two radioactive nuclei P and Q, in a given sample decay into a stable nucleus R. At time $t = 0$, the number of P species are $4N_o$ and that of Q are N_o. Half-life of P (for conversion to R) is $1min$ whereas that of Q is $2min$. Initially there are no nuclei of R present in the sample. When number of nuclei of P and Q are equal, the number of nuclei of R present in the sample would be:

(a) $2N_o$ (b) $3N_o$

(c) $\frac{9N_o}{2}$ (d) $\frac{5N_o}{2}$

46. Radius of gyration is denoted by ————

(a) R (b) G

(c) K (d) I

47. A solid cylinder of mass 2 kg and radius 4 cm rotating about its axis at the rate of 3 rpm. The torque required to stop after 2π revolutions is

(a) 2×10^{-6} N m

(b) 2×10^{-3} N m

(c) 12×10^{-4} N m

(d) 2×10^{6} N m

48. Two thin equiconvex lenses, each of focal length 0.2 m, are placed coaxially with their optic centres 0.5 m apart. What is the focal length of the combination?

(a) -0.4 m (b) 0.4 m

(c) -0.1 m (d) 0.1 m

49. A parallel beam of monochromatic light is incident normally on a narrow slit. A diffraction pattern is formed on a screen placed perpendicular to the direction of the incident beam. At the first minimum of the diffraction pattern, the phase difference between the rays coming from the two edges of the slit is

(a) zero (b) $\frac{\pi}{2}$

(c) π (d) 2π

50. The quantity that does not have mass in its dimension is:

(a) Electrical potential

(b) Electrical resistance

(c) Specific heat

(d) Magnetic flux

51. The unit of which of the following is meter?

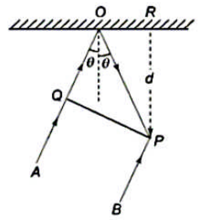
(a) Light year

(b) Wavelength

(c) Displacement

(d) All of the above

52. In the figure given below, PQ represents a plane wavefront and AO and BP represent the corresponding extreme rays of monochromatic light of wavelength λ. The value of angle θ for which the ray BP and the reflected ray OP interfere constructively is given by:



(a) $\cos\theta = \frac{\lambda}{2d}$ (b) $\cos\theta = \frac{\lambda}{4d}$

(c) $\sec\theta = \frac{\lambda}{3d}$ (d) $\sec\theta = \frac{2\lambda}{3d}$

53. A double-slit apparatus is immersed in a liquid of refractive index 1.33. It has slit separation of $1\ mm$ and distance between the plane of slits and the screen is $1.33m$. The slits are illuminated by a parallel beam of light whose wavelength in air is $6300\mathring{A}$. What is the fringe width?

(a) $0.8379\ mm$ (b) $\frac{0.63}{1.33}\ mm$

(c) $\frac{0.63}{(1.33)^2}\ mm$ (d) $0.63\ mm$

54. The displacement of a body from a reference point is given by $\sqrt{x} = 2t + 3$, where x is in metres and t is in seconds. The initial velocity of the body is:

(a) Zero (b) $11m/s$

(c) $13m/s$ (d) $12m/s$

55. The moment of the force, $\vec{F} = 4\hat{i} + 5\hat{j} - 6\hat{k}$ at $(2, 0, -3)$, about the point $(2, -2, -2)$, is given by

(a) $-7\hat{i} - 8\hat{j} - 4\hat{k}$

(b) $-4\hat{i} - \hat{j} - 8\hat{k}$

(c) $-8\hat{i} - 4\hat{j} - 7\hat{k}$

(d) $-7\hat{i} - 4\hat{j} - 8\hat{k}$

56. A body of 5 kg is moving with a velocity of 20 m/s. If a force of 100 N is applied on it for 10 s in the same direction as its velocity, what will now be the velocity of the body?

(a) 200 m/s (b) 220 m/s

(c) 240 m/s (d) 260 m/s

57. A particle when thrown, moves such that it passes from same height at 2 s and 10 s, the height is:

(a) g (b) $2g$

(c) $5g$ (d) $10g$

58. In a series resonant circuit, the AC voltage across resistance R **, inductor** L **and capacitor** C **, are** $5\ \mathrm{V}, 10\ \mathrm{V}$ **and** $10\ \mathrm{V}$ **respectively. The AC voltage applied to the circuit will be:**

(a) $10V$ (b) $25V$

(c) $5V$ (d) $20V$

59. If a current I **given by** $I_0 \sin[\omega t - (\frac{\pi}{2})]$ **flows in an ac circuit across which an ac potential of** $E = \mathrm{E_0} sin\ \omega t$ **has been applied, then the power consumption** P **in the circuit will be,**

(a) $2\mathrm{E_0 I_0}$ (b) $\sqrt{2} E_0 I_0$

(c) $\mathrm{E_0 I_0}$ (d) 0

60. What is Pascal's Law?

(a) For every action, there is an equal and opposite reaction

(b) Force is the time rate of change of momentum

(c) For an ideal gas, the pressure is directly proportional to temperature and constant volume and mass

(d) A pressure change at any point in the fluid is transmitted throughout the fluid such that the same change occurs everywhere

Hints and Solutions

1(B). The weight of a body at the centre of the earth is zero.

The weight of a body at the centre of earth is zero because value of g is zero. As we move a body closer to the centre of the earth, the mass of the earth between the centre of the earth and the body keeps decreasing. This causes the force acting from the centre of the earth on the body to decrease.

2(B). If the earth suddenly stops rotating, then the value g at the equator, will increase.

The effect of rotation of the earth on acceleration due to gravity is to decrease its value. Therefore if the earth stops rotating, the value of g will increase.

$$g = g_e - R\omega^2 \cos^2 \alpha$$

$R \rightarrow$ Radius of earth, $\omega \rightarrow$ Angular velocity of earth.

$\alpha \rightarrow$ lattitude angale.

Where, At equator, $\alpha = 0$

g , increases by a factor of $R\omega^2 \cos^2 \alpha$.

3(B). The inverter converts DC into AC with the help of inductors and capacitors.

The inverter is a static device that can convert one form of electrical power into another form of electrical power. The device can be used for back power supply in homes.

4(B). Given,

$V = 220\ \mathrm{V}$

$\mathrm{f} = 50\ \mathrm{Hz}$

$\omega = 2\pi \mathrm{f} = 2\pi \times 50 = 100\pi\ \mathrm{rad/s}$

$\mathrm{R} = 20\Omega$

$\mathrm{L} = 0.4\mathrm{H}$

$\Rightarrow \mathrm{X_L} = \omega \mathrm{L} = 100\pi \times 0.4 = 40\ \Omega$

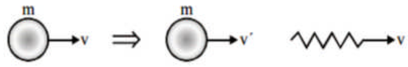
In the given circuit, capacitor is absent.

$\therefore \tan\theta = \frac{X_L - X_C}{R} = \frac{X_L}{R} = \frac{40\pi}{20} = 2\pi$

Therefore, $\theta = \tan^{-1}(2\pi)$

5(A). Let $\mathrm{E_n}$ and $\mathrm{E_m}$ be the energies of electron in n^{th} and m^{th} states.

Then, $\mathrm{E_n - E_m = h\nu_0} \ldots (1)$



In the second case when the atom is moving with a velocity v . Let v′ be the velocity of atom after emitting the photon. Applying conservation of linear momentum,

$\mathrm{mv = mv' + \frac{h\nu}{c}}$ (m = mass of hydrogen atom)

$\Rightarrow \mathrm{v' = \left(v - \frac{h\nu}{mc}\right) \ldots (2)}$

Applying conservation of energy

$\mathrm{E_n + \frac{1}{2}mv^2 = E_m + \frac{1}{2}mv'^2 + h\nu}$

$\Rightarrow \mathrm{h\nu = (E_n - E_m) + \frac{1}{2}\ m\left(v^2 - v'^2\right)}$

From equation (1) and (2)

$\mathrm{= h\nu_0 + \frac{1}{2}\ m\left[v^2 - \left(v - \frac{h\nu}{mc}\right)^2\right]}$

$\mathrm{= h\nu_0 + \frac{1}{2}\ m\left[v^2 - v^2 - \frac{h^2\nu^2}{m^2c^2} + \frac{2h\nu v}{mc}\right]}$

$\mathrm{= h\nu_0 + \frac{h\nu v}{c} - \frac{h^2\nu^2}{2mc^2}}$

Here the term is $\mathrm{\frac{h^2\nu^2}{2mc^2}}$ is very small. So, can be neglected.

$\therefore \mathrm{h\nu = h\nu_0 + \frac{h\nu v}{c}}$

$\Rightarrow \nu = \nu_0 + \frac{\nu \mathrm{v}}{c}$

$\Rightarrow \nu_0 = \nu\left(1 - \frac{\mathrm{v}}{\mathrm{c}}\right)$

6(D). The Einstein's equation for photoelectric effect is,

$\mathrm{eV_0 = \frac{hc}{\lambda} - W}$

where,

$\mathrm{V_0} =$ stopping potential

$\lambda =$ wavelength of incident light

$\mathrm{W} =$ work function of metal.

$E = 4\mathrm{NC}^{-1}$, $d = 1m$

$\mathrm{V_0 = \frac{E}{d} = \frac{4}{1} = 4\ volt}$

$\lambda = 200\ \mathrm{nm} = 200 \times 10^{-9}\ \mathrm{m}$

Thus, $\mathrm{W = \frac{hc}{\lambda} - eV_0}$

$= \frac{(6.62\times10^{-34})(3\times10^8)}{200\times10^{-9}} - (1.6 \times 10^{-19})4$

$= 3.53 \times 10^{-19}\ \mathrm{J}$ (as $1\mathrm{eV} = 1.6 \times 10^{-19}$ J)

$= \frac{3.53\times10^{-19}}{1.6\times10^{-19}}$

$= 2.2\mathrm{eV}$

7(A). Given:

$\mathrm{W} = 5\mathrm{eV} = 5 \times (1.6 \times 10^{-19})\mathrm{J} = 8.0 \times 10^{-19}\ \mathrm{J}$

Using Einstein's photoelectric equation,

$\mathrm{E_1 = KE + W}$

$\mathrm{E_1 = \frac{hc}{\lambda}}$ .....(i)

$h = 6.63\times10^{-34}$, $c = 3\times10^8 m/s$,

$\lambda = 200\times10^{-9}m$

Put the given values in (i).

$= \frac{(6.63\times10^{-34})\times(3\times10^8)}{(200\times10^{-9})}$

$= 9.945 \times 10^{-19}$

$\mathrm{KE = E_1 - W}$ .....(ii)

Put the given values in (ii).

$= 9.945 \times 10^{-19} - 8.0 \times 10^{-19}$

$= 1.945 \times 10^{-19}\ \mathrm{J}$

Kinetic energy of the electron $\mathrm{(KE) = \frac{1}{2mv^2}}$

$\Rightarrow \mathrm{v = [\frac{2KE}{m}]^{\frac{1}{2}}}$ .....(iii)

Put the given values in (iii).

$\mathrm{v} = \left[\frac{2(1.195\times10^{-19})}{9.1\times10^{-31}}\right]^{\frac{1}{2}}$

$= 6.54 \times 10^2\ \mathrm{m/s}$

8(D). Given,

$v = \frac{A}{t} + Bt^2 + Ct^3$

Where,

v = Velocity

t = Time

A, B and C = Constants

As, $v = \frac{\mathrm{A}}{\mathrm{t}} + \mathrm{Bt^2 + Ct^3}$

So, we can write the dimensional equation as:

$\mathrm{dim(v) = dim\ (Bt^2)}$

$\therefore \mathrm{dim(B) = \frac{dim(v)}{dim(t^2)}}$

$= \frac{[\mathrm{LT^{-1}}]}{[\mathrm{T^2}]}$

$= [\mathrm{LT^{-3}}]$

$\Rightarrow \mathrm{dim(B) = [M^0LT^{-3}]}$

9(B). Dimension of pressure, stress & Young's modulus is $[\mathrm{M^1L^{-1}T^{-2}}]$.

While dimension of power $= \frac{\mathrm{Energy}}{\mathrm{Time}}$

$= \frac{\mathrm{ML^2\ T^{-2}}}{\mathrm{T}}$

$= [\mathrm{ML^2\ T^{-3}}]$

10(A). Outdoors on the winter, a piece of metal feels colder than piece of wood because metal is a good conductor of heat than wood.

Concept:

Metal extract more heat from your hand than wood in a given time. Therefore, you perceive the metal as being colder than the wood.

There are three methods of heat transfer between the two systems. They are conduction, convection, and radiation.

- Conduction is a method of heat transfer in solids and heat transfer takes place without the movement of particles.
- Convection is a method of heat transfer in fluids (gases and liquids) and heat

transfer takes place due to the movement of particles.

- Radiation is a method of heat transfer where heat is transferred from one place to another without affecting the medium of heat transfer.

11(C). The various temperature scales commonly used are Celsius (C), Kelvin (K), Fahrenheit (F) and Rankine (Ra).

$^{\circ}F = \frac{9}{5}{}^{\circ}C + 32$

$^{\circ}F = \frac{9}{5} \times 200 + 32$

$= 360 + 32$

$= 392^{\circ}F$

12(A). Maxwell Boltzmann distribution for velocity is given by:

$n(E)dE = \frac{2\pi N}{V(\pi kT)^{\frac{3}{2}}} E^{\frac{1}{2}} e^{-\frac{E}{kT}} dE$

Where, $n =$ number of molecules, $T =$ temperature, $k =$ Boltzmann constant, and $E =$ energy

From the above equation, it is clear that the fraction of gas molecules having an energy between E and $E + dE$ is proportional to $E^{\frac{1}{2}} \exp\left(-\frac{E}{kT}\right)$.

13(D). The rms speed of any homogeneous gas sample is given by:

$V_{rms} = \sqrt{\frac{3RT}{M}} \quad \ldots(1)$

Where, $R =$ universal gas constant, $T =$ temperature and $M =$ Molecular mass

Here, M and R is constant,

On increasing the value of T by 3 in equation (1) we get,

$V_{rms} \propto \sqrt{3T}$

If the temperature is increased to 3 times, then V_{rms} is increased by $\sqrt{3}$ times.

14(D). Both electric and magnetic field vectors are parallel to each other and perpendicular to the direction of propagation of wave- This statement is incorrect.

Electromagnetic waves or EM waves: The waves that are formed as a result of vibrations between an electric field and a magnetic field and are perpendicular to each other and to the direction of the wave is called an electromagnetic wave.

Electromagnetic waves do not require any matter to propagate from one place to another as it consists of photons. They can move in a vacuum.

Properties of electromagnetic waves:

- Not have any charge or we can say that they are neutral.
- Propagate as a transverse wave.
- They move with the velocity the same as that of light i.e., 3×10^8 m/s.
- It contains energy and they also contain momentum.
- They can travel in a vacuum also.

From above, it is clear that, electromagnetic waves do not require any matter to propagate from one place to another as it consists of photons. Therefore, statement in option (A) is correct.

In an electromagnetic wave, the electric field and magnetic field vary continuously with maxima and minima at the same place and same time. Therefore, statement in option (B) is correct.

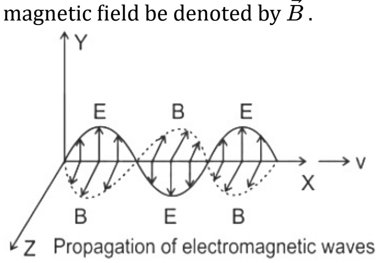
The energy in an electromagnetic wave is divided equally between electric and magnetic fields. Therefore, statement in option (C) is correct.

An electromagnetic wave is a perpendicular variation in both the electric field (E) and Magnetic field (B). Therefore, statement in option (D) is incorrect.

15(C). The direction of EM waves is found from the cross product of the electric field and magnetic field.

Since both electric and magnetic fields are vectors, the direction of propagation of EM waves is obtained from the right-hand rule.

Let the electric field be denoted by $\vec{E}$ and magnetic field be denoted by $\vec{B}$.



Propagation of electromagnetic waves

According to the rule - If the fingers of the right hand are curled so that they follow a rotation from $\vec{E}$ to $\vec{B}$, then the thumb will point in the direction of the vector product i.e., the direction of EM waves.

16(C). Given,

Mass $(m) = 5kg$

Radius $(R) = 1m$

frequency(f) $(v) = 300rpm = \frac{300}{60} = 5rps$

As we know,

The angular speed is given by,

$\omega = 2\pi f$

$\therefore \omega = 2\pi \times 5 = 10\pi rads^{-1}$

$v = \omega R$

$\therefore v = 10\pi \times 1 = 10\pi ms^{-1}$

Kinetic energy, $(KE) = \frac{1}{2}mv^2 = \frac{1}{2}m\omega^2R^2$

$= \frac{1}{2} \times 5 \times (10\pi)^2$

$= 250\pi^2$

17(A). The work-energy theorem states that the net work done by the forces on an object equals the change in its kinetic energy.

Work done, $(W) = \Delta K = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

Where m is the mass of the object, v is the final velocity of the object and u is the initial velocity of the object.

Work-energy theorem for a variable force:

Kinetic energy, $K = \frac{1}{2}mv^2$

$\frac{dK}{dt} = \frac{d\left(\frac{1}{2}mv^2\right)}{dt}$

$\Rightarrow \frac{dK}{dt} = m\frac{dv}{dt}v$

$\Rightarrow \frac{dK}{dt} = mav$

$\Rightarrow \frac{dK}{dt} = Fv$

$\Rightarrow \frac{dK}{dt} = F\frac{dx}{dt}$

$\Rightarrow dK = Fdx$

On integrating, we get

$\int_{K_i}^{K_f} dK = \int_{x_i}^{x_f} Fdx$

$\Rightarrow \Delta K = \int_{x_i}^{x_f} Fdx$

From the work-energy theorem, a change in kinetic energy equals the work done.

$\Delta K = \int_{x_i}^{x_f} Fdx$

$\Rightarrow \Delta K = \int_{-a}^{a} (Py^2 + Qy + R)dy$

$\Rightarrow \Delta K = \left[\frac{Py^3}{3} + \frac{Qy^2}{2} + Ry\right]_{-a}^{a}$

$\Rightarrow \Delta K = \left[\left(\frac{Pa^3}{3} + \frac{Qa^2}{2} + Ra\right) - \left(\frac{-Pa^3}{3} + \frac{Qa^2}{2} - Ra\right)\right]$

$\Rightarrow \Delta K = \frac{2Pa^3}{3} + 2Ra$

18(A). When the lift is stationary spring force balances weight:

$kx = \text{mg} = 49\text{ N}\ldots(1)$

Where,

$k =$ force constant of spring

$x =$ elongation

True weight $= 49$ N

From equation (1), we get

$k = \frac{49}{x}$

$\text{m} = \frac{49}{9.8} = 5\text{ kg}$

when lift moves with acceleration 5 m/s^2 downward we have:

$kx_2 = \text{mg} - 5 \times \text{m}$

Where,

Pseudo force in lift frame $= 5m$ upward

$x_2 =$ new elongation

$\Rightarrow \text{kx}_2 = 49 - 5 \times 5 = 24\text{ N}$

So new reading in spring balance $= 24$ N

19(B). Given,

Mass of car, $M = 2000$ kg

Mass of bullet, $m = 10 \times 10^{-3}$ kg

Velocity of bullet, $u = 500$ m/sec

The number of bullets fired per second is ten. Then,

$\frac{N}{t} = 10$

$F_{\text{avg}} = \frac{\Delta P}{\Delta t}$

$= \frac{Nm(v_2 - v_1)}{t}$

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

$= 50$ N

20(A). Atoms having the same number of neutrons, but different number of electrons or protons are called Isotones.

Nucleoids having the same atomic number, but a different mass number are known as Isotopes.

Atoms of different chemical elements that have the same number of nucleons are called Isobars.

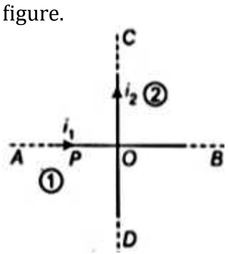
21(D). A radioactive nucleus emits a beta

particle, then the parent and daughter nuclei are Isobars.
The parent and daughter nuclei have the same mass number but different atomic numbers. So they are isobars.

22(C). An electron emitted in beta radiation originates from photons escaping from the nucleus.
The electron emitted in beta radiation may originates from neutron and it increases the atomic number 1. The beta particle, which may be either negatively charged (negatrons) or positively charged (positrons), originates from the nucleus of an atom. A beta particle is emitted from the nucleus of an atom during radioactive decay. The electron, however, occupies regions outside the nucleus of an atom.

23(A). Induced emf $= (\frac{1}{2})\omega BR^2$
$= (\frac{1}{2}) \times 4\pi \times 0.4 \times 10^{-4} \times (0.5)^2$
$= 6.28 \times 10^{-5}$ V
The number of spokes is immaterial because the emf's across the spokes are in parallel.

24(C). Conductors AOB and COD are perpendicular to each other shown in figure.



At distance a above O ,
$B_1 = \frac{\mu_0 i_1}{2\pi a}$
And $B_2 = \frac{\mu_0 i_2}{2\pi a}$
B_1 is perpendicular to B_2 .
Resultant of B_1 and B_2 ,
$B = \sqrt{B_1^2 + B_2^2}$
$= \frac{\mu_0}{2\pi a}\sqrt{i_1^2 + i_2^2}$

25(C). In both forward biasing and reverse biasing, applied potential establishes an internal electric field which acts against or towards the potential barrier. This internal electric field is weakened or stronger at the junction. In forward biasing knee voltage is the forwards voltage at which the current through the junction starts to increase rapidly. Once the applied forward voltage exceeds the knee voltage, the current starts increasing rapidly.
In forward biasing condition, the inner electric field is given by $E = -\frac{\Delta V}{\Delta r}$
or
$|E| = \frac{\Delta V}{\Delta r} = \frac{5\times10^{-1}}{10^{-6}}$
$= 5\times10^5\ V/m$

26(C). Band gap,
$E_g = \frac{hc}{\lambda}$
$= \frac{(6.63\times10^{-34})(3\times10^8)}{2480\times10^{-9}\times1.6\times10^{-19}}\ eV$
$= 0.5\ eV$

27(D). Given,
Diameter of the sphere $= 2.4$
$\therefore$ Radius of sphere, $r = \frac{2.4}{2} = 1.2m$
Surface charge density of conducting sphere, $\sigma = 80 \times 10^{-6} C/m^2$
Therefore,
Charge on sphere will be:
$q = \sigma A = \sigma 4\pi r^2$
$q = 80 \times 10^{-6} \times 4 \times 3.14 \times (1.2)^2$
$q = 1.45 \times 10^{-3} C$
Then, the total electric flux leaving the surface of the sphere will be calculated using the gauss formula, i.e.,
$\phi = \frac{q}{\varepsilon_0}$
$\phi = \frac{1.45\times10^{-3}}{8.854\times10^{-12}}$
$(\because \epsilon_0 = 8.854 \times 10^{-12})$
$\phi = 1.6 \times 10^8 Nm^2/C$

28(B). The direction of the equipotential surface is from low potential to high potential is not the property of equipotential surfaces.
Any surface over which the electric potential is same everywhere is called an equipotential surface. No work is required to move a charge from one point to another on the equipotential surface. Properties of equipotential surface are:

- The electric field is always perpendicular to an equipotential surface.
- Two equipotential surfaces can never intersect.
- For a point charge, the equipotential surfaces are concentric spherical shells.
- For a uniform electric field, the equipotential surfaces are planes normal to the x-axis.
- The direction of the equipotential surface is from high potential to low potential.

29(C). The relation between angular frequency and displacement is given as
$v = \omega\sqrt{A^2 - x^2}$ .....(1)
Suppose
$x = A \sin \omega t$
On differentiating the above equation w.r.t. time we get
$\frac{dx}{dt} = A\omega \cos \omega t$
The maximum value of velocity will be
$v_{max} = A\omega$
The displacement for the time when speed is half the maximum is given as
$v = \frac{A\omega}{2}$
$A^2\omega^2 = 4\omega(A^2 - x^2)$
By substituting the value in (1) we get the displacement as:
$x = \frac{A\sqrt{3}}{2}$

30(C). Let L is the original length of the wire and k is force constant of wire.
Final length = initial length + elongation
$L' = L + \frac{F}{k}$
For first condition $a = L + \frac{4}{k}$ .....(i)
For second condition $b = L + \frac{5}{k}$ ......(ii)
By solving Eqs. (i) and (ii), we get
$L = 5a - 4b$ and $k = \frac{1}{b-a}$
Now, when the longitudinal tension is 9 N . length of the string.
$= L + \frac{9}{k} = 5a - 4b + 9(b - a)$
$= 5b - 4a$

31(C). The velocity of sound in air is given by:
$C_s = \sqrt{\frac{\gamma RT}{M}}$ .....(1)
where γ is the degree of freedom
$T =$ temperature
$M =$ mass
According to the kinetic theory of gases, The rms velocity of sound is given by:
$C = \sqrt{\frac{3RT}{M}}$ .....(2)
Dividing equation (1) and (2) we get:
$\frac{C_s}{C} = \sqrt{\frac{\gamma}{3}}$
$\Rightarrow C_s = C\sqrt{\frac{\gamma}{3}}$

32(C). The loudness and pitch of a sound depends on intensity and frequency.
Loudness is a sensation of how strong a sound wave is at a place. It is always a relative term. It is a dimensionless quantity. Its unit is decibel (dB).
Pitch is the characteristic of sound by which an acute (or shrill) note can be distinguished from a grave or a flat note. The term 'pitch' is often used in music. It depends on the frequency of the sound wave. A note of higher frequency is at a higher pitch than a note of lower frequency. It is a qualitative term and cannot be quantified.

33(A). When we rub a glass rod with silk, then the charge on the glass rod will be positive. When we rub a glass rod with silk, some of the electrons from the rod are transferred to the silk cloth. Thus the rod gets positively charged and the silk gets negatively charged.

34(A). Due to friction between skin and cloths, electrostatic charge is built up on the skin. Hence, electrical discharge may occur when a man touches somebody else. This phenomenon is more significant in winters because due to low humidity, charge has a tendency to stay longer on the body.

35(C). Given,
$p \propto T^3 \quad \ldots(i)$
In an adiabatic process,

$T^{\gamma}p^{1-\gamma} = \text{constant}\left[\text{as } \gamma = \frac{C_p}{C_v}\right]$

$T \propto \frac{1}{p^{\frac{(1-\gamma)}{\gamma}}}$

$T^{\left(\frac{\gamma}{\gamma-1}\right)} \propto p \quad \ldots \text{(ii)}$

Comparing Eqs. (i) and (ii),

Since the pressure is same in both the condition, equating the powers of temperature from both sides we get,

$3\gamma - 3 = \gamma$ or $2\gamma = 3$

$\frac{C_p}{C_v} = \gamma = \frac{3}{2}$

36(B). The following figure shows the cyclic process of gas. If an object returns to its initial position after one or more processes it went through.

$ABCDA$ is the cycle. The pressure at the points both D and C remain the same, which is $2P$. The volume at the point D is V and at the point C is $3V$. So, the work done by the gas from point D to point $C, W_{DC} = 2P(3V - V) = 4PV$

The pressures at the points C and B are $2P$ and P respectively. The volume at the points both C and B remain the same, which is $3V$. So, the work done by the gas from point C to point B,

$W_{CB} = P(3V - 3V) = 0$

The pressure at the points both B and A remain the same, which is P. The volume at the point B is $3V$ and at the point A is V, So, the work done by the gas from point B to point $A, W_{BA} = P(V - 3V) = -2PV$

The pressures at the points A and D are P and $2P$ respectively. The volume at the points both A and D remain the same, which is V.

So, the work done by the gas from point A to the point $D, W_{AD} = P(V - V) = 0$

Hence the total work done in the whole cycle,

$W = 4PV - 2PV = 2PV$

We know the heat rejected from the cycle is equal to the amount of total work done by the gas, so $Q = W$

$Q = 2PV$

37(B). Given,

$n = 800$

$\mathrm{A} = 2.5 \times 10^{-4}\ \mathrm{m}^2$

$\mathrm{I} = 3.0\ \mathrm{A}$

A magnetic field develops along the axis of the solenoid. Therefore current-carrying solenoid acts like a bar magnet.

Associated magnetic moment,

$\mathrm{m} = \mathrm{nIA}$

$= 800 \times 3 \times 2.5 \times 10^{-4}$

$= 0.6\mathrm{JT}^{-1}$

38(D). The volume of the cubic domain is:

$V = \left(10^{-6}\ \mathrm{m}\right)^3$

$= 10^{-18}\ \mathrm{m}^3$

$= 10^{-12}\ \mathrm{cm}^3$

Its mass is volume $\times$ density $= 7.9\ \mathrm{g\ cm}^{-3} \times 10^{-12}\ \mathrm{cm}^3 = 7.9 \times 10^{-12}\ \mathrm{g}$

It is given that Avagadro number (6.023×10^{23}) of iron atoms have a mass of 55 g. Hence, the number of atoms in the domain is

$N = \frac{7.9\times10^{-12}\times6.023\times10^{23}}{55}$

$= 8.65 \times 10^{10}$ atoms

The maximum possible dipole moment $m_{\max}$ is achieved for the (unrealistic) case when all the atomic moments are perfectly aligned.

Thus,

$m_{\max} = \left(8.65 \times 10^{10}\right) \times \left(9.27 \times 10^{-24}\right)$

$= 8.0 \times 10^{-13}\mathrm{Am}^2$

The consequent magnetisation is

$M_{\max} = \frac{m_{\max}}{Domainvolume}$

$= \frac{8.0\times10^{-13}\mathrm{Am}^2}{10^{-18}\ \mathrm{m}^3}$

$= 8.0 \times 10^5\mathrm{Am}^{-1}$

39(A). Rate of flow liquid

$Q = au = a\sqrt{2gh}$

$= 2 \times 10^{-6}m^2 \times \sqrt{2 \times 10 \times 2}\ m/s$

$= 2 \times 2 \times 3.16 \times 10^{-6}m^3/s$

$= 12.64 \times 10^{-6}m^3/s$

$= 12.6 \times 10^{-6}m^3/s$

40(C). Suppose the wind strikes the windmill turbines as a cylindrical-shaped structure of area A and length V, which is the velocity of the wind.

So, the rate of change of volume of this hypothetical cylinder can be written as:

Volume $=$ Area $\times$ Velocity

or $V' = A \times V$

Here, V is the velocity while V' is the volume.

We know from Newton's second law that the force acting on a body is the rate of change of momentum.

We can write it mathematically as,

$\vec{F} = \frac{d\vec{P}}{dt}$

This can be rewritten as,

$\vec{F} = \frac{d(m\vec{V})}{dt} = m\frac{dv}{dt} + V\frac{dm}{dt}$

Here, the velocity of the wind is constant, so the term $\frac{dV}{dt}$ is zero.

So, we can write the force acting on the windmill as,

$\vec{F} = \vec{V}\frac{dm}{dt}$ ......(1)

If the air or the wind has a density of ρ, then the rate of the mass of the wind that hits the turbine can be written as,

$\frac{dm}{dt} = \rho AV$ ....(2)

So, the force acting on the body is, (substituting equation (2) in (1))

$\vec{F} = V\rho AV$

$F = \rho AV^2$

We now have an equation for the force acting on the windmill. So the power of the windmill can be found out by,

Power $=$ Force $\times$ Velocity

Power $= \left(\rho AV^2\right) \times (V)$

Power $= \rho AV^3$

Suppose the kinetic energy of the windmill is converted into electrical energy without any loss. The electrical power output of the windmill will be proportional to V^3.

41(C). The shear is experienced along the surface area of the punch. The surface of the punch is cylindrical with the diameter of 1 cm and a height of 0.3 cm which is the thickness of the sheet.

Therefore force needed to oppose the shear force is = force needed to punch the hole in the steel sheet.

$F =$ Area $\times$ Stress

$F =$ Shear $\times \pi dt$

$F = 3.5 \times 10^8 \times \pi \times 1 \times 10^{-2} \times 0.3 \times 10^{-2}$

$F = 3.29 \times 10^4 N \approx 3.3 \times 10^4 N$

42(D). Cyclotron frequency

$v = \frac{qB}{2\pi m}$

$= \frac{1.6\times10^{-19}\times1}{2\times3.14\times9.1\times10^{-31}}$

$= 28 \times 10^9 Hz = 28GHz$

43(D). Here,

$H = 1500\mathrm{Am}^{-1}, \phi = 2.4 \times 10^{-5}$ weber

$A = 0.5\ \mathrm{cm}^2 = 0.5 \times 10^{-4}\ \mathrm{m}^2$

$\therefore B = \frac{\phi}{A} = \frac{2.4\times10^{-5}}{0.5\times10^{-4}} = 4.8 \times 10^{-1}\ \mathrm{T}$

and $\mu = \frac{B}{H} = \frac{4.8\times10^{-1}}{1500} = 3.2 \times 10^{-4}$

So relative permeability,

$\mu_r = \frac{\mu}{\mu_0} = \frac{3.2\times10^{-4}}{4\pi\times10^{-7}} = 0.255 \times 10^3 = 255$

44(B). According to the law of radioactivity,

$N = N_0e^{-\lambda t} \Rightarrow N = N_0e^{-\frac{\ln(2)}{T_{\frac{1}{2}}}t}$

Where,

$\mathrm{N} =$ intensity of radiation at any time.

$\mathrm{N}_0 =$ intensity of radiation at time $t = 0$ second.

Given that,

$N_0 = 64N_{\text{safe}}$ and $T_{\frac{1}{2}} = 2$ hours.

Therefore, Let after a time t, the intensity of radiation reaches the safe level.

Then,

$N_s = 64N_se^{-\frac{\ln(2)}{2}t}$

$\Rightarrow e^{-\frac{\ln(2)}{2}t} = \frac{1}{64}$

$\Rightarrow e^{\frac{\ln(2)}{2}t} = 64$

$\Rightarrow \frac{\ln(2)}{2}t = \ln\left(2^6\right)$

$\Rightarrow \frac{\ln(2)}{2}t = 6$

$\ln(2)$

$\Rightarrow t = 12$ hours

45(C). Given,

$N_p = 4N_o$

$N_Q = N_o$

Also,

$T_P = 1$ min

$T_Q = 2$ min

Now,

Amount left after time

$N_{P_t} = 4N_O\left(\frac{1}{2}\right)^{\frac{t}{1}}$

And

$N_{Q_t} = N_o\left(\frac{1}{2}\right)^{\frac{t}{2}}$

Now,

According to question,
$N_{P_t} = N_{Q_t}$
Thus,
$4N_o\left(\frac{1}{2}\right)^t = N_o\left(\frac{1}{2}\right)^{\frac{t}{2}}$
Then, we get
$4 = \left(\frac{1}{2}\right)^{\frac{-t}{2}}$
$\Rightarrow 4 = 2^{\frac{t}{2}}$
Further
$\frac{t}{2} = 2$
Thus,
$t = 4$ min
Thus,
For R
$N_R = (N_o - N_{P_t}) + (N_o - N_{Q_t})$
Then,
$N_R = \left(N_o - \frac{N_o}{4}\right) + \left(N_o - \frac{N_o}{4}\right)$
Then, we get
$N_R = \frac{15N_o}{4} + \frac{3N_o}{4}$
Then,
$N_R = \frac{9N_o}{2}$

46(C). The radius of gyration is denoted by the alphabet 'K'.
A radius of gyration in general is the distance from the center of mass of a body at which the whole mass could be concentrated without changing its moment of rotational inertia about an axis through the center of mass.

47(A). Work energy theorem.
$W = \frac{1}{2}I\left(\omega_f^2 - \omega_i^2\right)$
Here, $\theta = 2\pi$ revolution
$= 2\pi \times 2\pi = 4\pi^2 rad$
$W_i = 3 \times \frac{2\pi}{60} rad/s$
$\Rightarrow -\tau\theta = \frac{1}{2} \times \frac{1}{2}mr^2\left(0^2 - \omega_1^2\right)$
$\Rightarrow -\tau = \frac{\frac{1}{2}\times\frac{1}{2}\times2\times\left(4\times10^{-2}\right)\left(-3\times\frac{2\pi}{60}\right)^2}{4\pi^2}$
$\Rightarrow \tau = 2\times10^{-6}Nm$

48(A). Equivalent focal length (F) of two lens separated by distance d is given by
$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$
$= \frac{1}{0.2} + \frac{1}{0.2} - \frac{0.5}{(0.2)(0.2)}$
$= 5 + 5 - 0.5\times5\times5$
$= 10 - 12.5$
$= -2.5$
$\therefore F = -\frac{1}{2.5} = -0.4$ m

49(D). Path difference for the rays coming from the two edges of the slit is
$\Delta = a\sin\theta, a =$ slit width
For the first minimum, $\alpha = \pi$
where $\alpha = \frac{\pi a}{\lambda}\sin\theta = \pi$
or $a\sin\theta = \lambda$
Phase difference $= \frac{2\pi}{\lambda}\Delta = 2\pi$

50(C). Specific heat: $\left[\mathrm{L^2\,T^{-2}\,K^{-1}}\right]$
Electrical potential: $\left[M^1L^2T^{-3}A^{-1}\right]$
Electrical resistance: $\left[\mathrm{M^1\,L^2\,T^{-3}\,A^{-2}}\right]$
Magnetic flux: $\left[\mathrm{M^1\,L^2\,T^{-2}\,A^{-1}}\right]$
From the above information, it is clear that the specific heat does not have mass in its dimension.

51(D). The unit of light year, wavelength and displacement is meter.
The unit of light year is meter. A light year is the distance traveled by light in one year. and wavelength is the distance between two consecutive vertices or descents. The unit of wavelength is also the meter. The minimum distance covered by an object in a certain direction with respect to a reference point is called displacement. The unit of displacement is also the meter.

52(B). In this figure Q and P are at the same phase. Therefore, at P point the path difference between ray BP and reflected ray OP.
We can say, angles of QO and OP are the same.
In triangle $POR, OP = \frac{PR}{cos\theta} = \frac{d}{cos\theta}$
In triangle $QOP, QO = OP\sin(90^\circ - 2\theta) = OP\cos 2\theta$
$\Delta = OP\cos 2\theta + OP$
$= OP(\cos 2\theta + 1)$
$= 2OP\cos^2\theta$
$= 2\times\frac{d}{\cos\theta}\times\cos^2\theta$
$= 2d\cos\theta$
Now, path difference is $\frac{\lambda}{2}$
Due to reflection at point P
$\Delta = \frac{\lambda}{2}, \frac{3\lambda}{2}$ ....
$2d\cos\theta = \frac{\lambda}{2}, \frac{3\lambda}{2}$ ....
$\cos\theta = \frac{\lambda}{4d}, \frac{3\lambda}{4d}$ ....

53(D). Given
$\mu_1 = 1.33, d = 1mm = 10^{-3}m, D = 1.33m,$
$\lambda = 6300\mathring{A}$
$= 6.3\times10^{-7}m$
When the experiment is performed in liquid, λ change to
$\lambda' = \frac{\lambda}{\mu_1}$
Fringe width,
$\beta = \frac{D\lambda}{\mu_l}$
$\frac{1.33\times6.3\times10^{-7}}{1.33\times10^{-3}}$
$= 6.3\times10^{-4}m$
$= 0.63\ mm$

54(D). Equation is given as
$\sqrt{x} = 2t + 3$
Taking square both side
$(\sqrt{x})^2 = (2t+3)^2$
$x = (2t+3)^2$
$x = (2t)^2 + (3)^2 + 2(2t)(3)$
$x = 4t^2 + 12t + 9$
Taking derivative both side relative to $'t'$
$\frac{dx}{dt} = 2(4t) + 12$
$\frac{dx}{dt} = 8t + 12$
We know that,
$v = \frac{dx}{dt}$
Hence, $v = 8t + 12$
at $t = 0$
$v = 8(0) + 12$
$v = 12m/s$
Then, the initial velocity is $12m/s$.

55(D). $\vec{\tau} = (\vec{r} - \vec{r}_0)\times\vec{F}$
$\vec{r} - \vec{r}_0 = (2\hat{i} + 0\hat{j} - 3\hat{k}) - (2\hat{i} - 2\hat{j} - 2\hat{k})$
$= 0\hat{i} + 2\hat{j} - \hat{k}$
$$\vec{\tau} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 2 & -1 \\ 4 & 5 & -6 \end{vmatrix} = -7\hat{i} - 4\hat{j} - 8\hat{k}$$

56(B). Given,
$u = 20$ m/s
$t = 10$ s
$F = 100$ N
$m = 5$ kg
By the first law of motion,
$v = u + at$
$\Rightarrow v = u + \left(\frac{F}{m}\right)t$
$\Rightarrow v = 20 + \left(\frac{100}{5}\right)\times 10$
$\Rightarrow v = 220$ m/s

57(D). Given,
$t_1 = 2$ s
$t_2 = 10$ s
If t_1 and t_2 are the time, when body is at the same height.
Then,
$h = \frac{1}{2}gt_1t_2$
$\Rightarrow h = \frac{1}{2}\times g\times 2\times 10$
$\Rightarrow h = 10g$

58(C). Given, Voltage across resistor, $V_R = 5V$
Voltage across inductor, $V_L = 10V$
Voltage across capacitor, $V_C = 10V$
the AC voltage applied to the circuit is given as
$V = \sqrt{V_R^2 + (V_L - V_C)^2}$
Substituting the given values, we get,
$= \sqrt{(5)^2 + (10-10)^2} = 5V$

59(D). $\mathrm{I = I_O\sin(\omega t - \{\frac{\pi}{2}\})}$
$\mathrm{E = E_0\sin\omega t}$
Now power consumed $\mathrm{= P = EI\cos\theta}$
$\theta =$ angle or phase difference between E and I
Here $\theta = 90^\circ$
$\therefore \mathrm{P = EI\cos 90^\circ}$
$\mathrm{P} = 0$

60(D). A pressure change at any point in the fluid is transmitted throughout the fluid such that the same change occurs everywhere – Pascal's Law.
For every action, there is an equal and opposite reaction – Newton's Third Law
Force is the time rate of change of momentum – Newton's Second Law
For an ideal gas, the pressure is directly proportional to temperature and constant volume and mass – Ideal Gas Law

Physics : Practice Test 02

1. A satellite is orbiting very close to planet.Its time period depends only upon ______.
(a) The density of the planet
(b) Mass of the satellite
(c) The radius of the planet
(d) None of these

2. Satellite going round the earth in a circular orbit loses some energy due to collision. Its speed is v and distance from the earth is d _____.
(a) d will increase, v will increase.
(b) d will increase, v will decrease.
(c) d will decrease, v will decrease.
(d) d will decrease, v will increase.

3. The mean free path of electrons in a metal is 4 x 10^{-8} m. The electric field which can give on an average 2 eV energy to an electron in the metal will be in unit of Vm^{-1}.
(a) 8 x 10^{7} (b) 5 x 10^{-11}
(c) 8 x 10^{-11} (d) 5 x 10^{7}

4. The threshold frequency for a metallic surface corresponds to an energy of 6.2 eV and the stopping potential for a radiation incident on this surface is 5 V. The incident radiation lies in:
(a) X-ray region
(b) Ultra-violet region
(c) Infra-red region
(d) Visible region

5. In stopping potential (V) photo current (I) graph, if $V_2 > V_1$, then compare the wavelengths of incident radiations:
(a) $\lambda_1 = \sqrt{\lambda_2}$ (b) $\lambda_1 < \lambda_2$
(c) $\lambda_1 = \lambda_2$ (d) $\lambda_1 > \lambda_2$

6. A screw gauge has the least count of 0.01 mm and there are 50 divisions in its circular scale. The pitch of the screw gauge is:
(a) 0.01 mm (b) 0.25 mm
(c) 0.5 mm (d) 1.0 mm

7. In the formula $X = 3YZ^2$, X and Z have dimensions of capacitance and magnetic induction respectively. What is the dimension of Y in MKS system?
(a) $[M^{-3} L^{-1} T^3 Q^4]$
(b) $[M^{-3} L^{-2} T^4 Q^4]$
(c) $[M^{-2} L^{-2} T^4 Q^4]$
(d) $[M^{-3} L^{-2} T^3 Q^1]$

8. In gases of monoatomic molecules, find the ratio of the two specific heat of gases $\frac{C_p}{C_v}$.
(a) 1.66 (b) 1.33
(c) 1.4 (d) 1.00

9. The ratio of the root mean square speed, average speed and maximum possible speed for a gas will be:
(a) 1.596:1.414:1.732
(b) 1.732:1.596:1.214
(c) 1.414:1.732:1.596
(d) 1.732:1.596:1.414

10. Which among the following is the incorrect statement regarding displacement current?
(a) The SI unit of displacement current is ampere.
(b) Displacement current associated with the change in electric field through closed conducting loop.
(c) Displacement current is due to flow of electrons in a current.
(d) None of the above

11. The flux of electric field through closed conducting loop changes with time as $\phi_E = (10t^2 - 20t + 5)Vm$ then, the value of displacement current into medium of ϵ_0 at time $t = 1sec$ is:
(a) $20\epsilon_0$ (b) $10\epsilon_0$
(c) $40\epsilon_0$ (d) 0

12. A force (F) acting on a particle is such that F is inversely proportional to the distance covered. The work done by the force in moving the particle from point 'a' to point 'b' is proportional to:
(a) $a^2 - b^2$ (b) a + b
(c) $\frac{a}{b}$ (d) $\ln\left(\frac{b}{a}\right)$

13. A man increases his speed by 2m/s, then his kinetic energy gets doubled. The original speed of the man is:
(a) $\sqrt{2}(\sqrt{2}+1)m/s$
(b) $\sqrt{2}(\sqrt{2}-10)m/s$
(c) $2(\sqrt{2}+1)m/s$
(d) $2(\sqrt{2}-1)m/s$

14. Which among the following is not related to the conservation of charge?
(a) Charge can be created in a body.
(b) Charge can be transferred from one object to another.
(c) Net charge of the system remains constant.
(d) Charge can neither be created nor be destroyed.

15. Which of the following statement is incorrect regarding charge on the body?
(a) Like the gravitational force between two masses, charges always attracts each other.
(b) Unlike charges attract each other
(c) Like charges repel each other
(d) All of these

16. Ionized hydrogen atoms and α-particles with the same momenta enter perpendicular to a constant magnetic field, B. The ratio of their radii of their paths $r_H : r_\alpha$ will be :
(a) 2 : 1 (b) 1 : 2
(c) 4 : 1 (d) 1 : 4

17. The total energy of an electron in an atom in an orbit is –3.4 eV. Its kinetic and potential energies are, respectively :
(a) –3.4 eV, –3.4 eV
(b) –3.4 eV, –6.8 eV
(c) 3.4 eV, –6.8 eV
(d) 3.4 eV, 3.4 eV

18. α-particle consists of :
(a) 2 protons and 2 neutrons only
(b) 2 electrons, 2 protons and 2 neutrons
(c) 2 electrons and 4 protons only
(d) 2 protons only

19. If a transformer of an audio amplifier has an input impedance of 8Ω and output impedance of 8 k Ω, the primary and secondary turns of this transformer connected between the output of the amplifier and to loudspeaker should have the ratio
(a) 1000 :1 (b) 100 : 1
(c) 1 : 32 (d) 32 : 1

20. A conducting circular loop is placed in a uniform magnetic field, B = 0.025 T with its plane perpendicular to the direction of the magnetic field. The radius of the loop is made to shrink at a constant rate of $1\ mm\ s^{-1}$. Find the induced emf in the loop when its radius is 2 cm, is:
(a) $2\pi\mu V$ (b) $\pi\mu V$
(c) $\frac{\pi}{2}\mu V$ (d) $2\mu V$

21. The resistance of a wire at room

temperature $30^\circ C$ is found to be 10Ω. Now, to increase the resistance by 10% the temperature of the wire must be [The temperature coefficient of resistance of the material of wire is $0.002^\circ C$].

(a) $36^\circ C$ (b) $83^\circ C$
(c) $63^\circ C$ (d) $33^\circ C$

22. If a full-wave rectifier circuit is operating from 50 Hz mains, then the fundamental frequency in the ripple will be

(a) 70.7 Hz (b) 100 Hz
(c) 25 Hz (d) 59 Hz

23. The electrostatic force of repulsion between two positively charged ions carrying equal charge is $3.7 \times 10^{-9} N$, when they are separated by a distance of $5\mathring{A}$. How many electrons are missing from each ion?

(a) 2 (b) 4
(c) 6 (d) 8

24. A particle of mass m carrying charge $+q_1$ is revolving around a fixed charge $-q_2$ in a circular path of radius r. Calculate the period of revolution.

(a) $4\pi r\sqrt{\frac{\pi\epsilon_0 m r}{q_1q_2}}$ (b) $\frac{8\pi r}{\sqrt{\frac{\pi^3\epsilon_0 m r^3}{q_1q_2}}}$
(c) $\frac{\sqrt{}}{\frac{q_1q_2}{16\pi^3\epsilon_0 m r^3}}$ (d) Zero

25. If simple harmonic motion is represented by $x = A\cos(\omega t + \varphi)$ then $'\varphi'$ is __________.

(a) Angular frequency
(b) Displacement
(c) Amplitude
(d) Phase constant

26. The length of a second's pendulum is:

(a) 140 cm
(b) 70 cm
(c) 100 cm
(d) None of these

27. Point of maximum positive displacement in a transverse wave is called:

(a) Trough (b) Vertex
(c) Apex (d) Crest

28. Sound waves cannot travel in:

(a) Air (b) Water
(c) Vacuum (d) Steel

29. l One end of a string of length m is tied to a particle of mass and the other end to a peg on a smooth horizontal table. If the particle moves in a circle with a speed v , then the net force on the particle (directed towards the centre) is:

(a) T (b) $T - \frac{mv^2}{l}$
(c) $T + \frac{mv^2}{l^2}$ (d) 0

30. A permanent retarding force of 50 N is applied on a body of mass 20 kg moving with an initial speed of $15\ \text{ms}^{-1}$. How long will it take for the body to stop?

(a) 6 s (b) 10 s
(c) 12 s (d) 14 s

31. The heat transfer in the light bulb takes place due to:

(a) Conduction
(b) Convection
(c) Radiation
(d) None of these

32. Why the surface of a lake is frozen in severe winters, but the water at its bottom is still at liquid state?

(a) The density of water is maximum of $3^\circ C$
(b) Since the surface of the lake is at the same temperature as the air, no heat is lost
(c) Ice is a bad conductor of heat
(d) None of these

33. The magnetic moment of an electron with orbital angular momentum J will be :

(a) $\frac{\text{eJ}}{\text{m}}$ (b) $\frac{\text{eJ}}{2\ \text{m}}$
(c) $\frac{2\ \text{m}}{\text{e}\vec{J}}$ (d) 0

34. A magnetic needle free to rotate in a vertical plane parallel to the magnetic meridian has its north tip pointing down at 22° with the horizontal. The horizontal component of the earth's magnetic field at the place is known to be 0.35G . Determine the magnitude of the earth's magnetic field at the place.

(a) 0.68G (b) 0.36G
(c) 0.83G (d) 0.86G

35. What did Archimedes determine after discovering the Archimedes principle?

(a) Purity of milk
(b) Purity of gold in the king's crown
(c) Design concept of ship
(d) Design concept of submarine

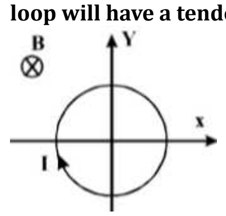
36. Bernoulli's equation is applied to:

(a) Venturimeter
(b) Orifice meter
(c) Pitot tube meter
(d) All of the above

37. A circular coil of radius R carries an electric current. The magnetic field due to the coil at a point on the axis of the coil located at a distance r from the centre of the coil, such that $r >> R$, varies as

(a) $\frac{1}{r}$ (b) $\frac{1}{r^{\frac{3}{2}}}$
(c) $\frac{1}{r^2}$ (d) $\frac{1}{r^3}$

38. A conducting loop carrying a current I is placed in a uniform magnetic field pointing into the plane of the paper as shown. The loop will have a tendency to



(a) Contract
(b) Expand
(c) Move towards $+vex - a\xi s$
(d) Move towards $-vex - a\xi s$

39. After two hours, $\frac{1}{16}$ of the initial amount of a certain radioactive isotope remains undecayed. What is the half-life of the isotope?

(a) 15 minutes (b) 30 minutes
(c) 45 minutes (d) 1 hour

40. An a-particle of energy $5MeV$ is scattered through 180° by a fixed uranium nucleus. The distance of the closest approach is of the order of

(a) $1\dot{A}$ (b) $10^{-10}\ cm$
(c) $10^{-12}\ cm$ (d) $10^{-15}\ cm$

41. The centre of mass of three particle s of masses 1 kg, 2 kg, and 3 kg is at $2, 2, 2$. The position of the fourth mass of 4 kg to be placed in the system so that the new centre of mass is at $0, 0, 0$ is

(a) $-3, -3, -3$ (b) $-3, 3, -3$
(c) $2, 3, -3$ (d) $2, -2, 3$

42. A body is orbiting Earth at a mean radius 9 times as great as the orbit of a geostationary satellite. In how many days will it complete one revolution around Earth and what is its angular velocity?

(a) 20 days; $2.693 \times 10^{-9} \frac{rad}{sec}$

(b) 23 days; $2.693 \times 10^{-6} \frac{rad}{sec}$

(c) 27 days; $2.693 \times 10^{-6} \frac{rad}{sec}$

(d) 29 days; $2.693 \times 10^{-10} \frac{rad}{sec}$

43. In a compound microscope, the objective and the eyepiece have focal lengths of 5 cm and 9.5 cm, respectively, and both are kept at a distance of 20 cm. If the final image is formed at the least distance of 25 cm from the eyepiece, find the total magnification.

(a) 19.6 (b) 89

(c) 6 (d) 1.2

44. The maximum refractive index of a prism which permits the passage of light through it, when the refracting angle of the prism is 90°, is

(a) $\sqrt{3}$ (b) $\sqrt{2}$

(c) $\frac{\sqrt{3}}{2}$ (d) $\frac{3}{2}$

45. Which of the following is not a fundamental unit?

(a) Meter (b) Kilogram

(c) Ampere (d) Volt

46. The distance of the planet from the earth is measured by _______.

(a) Direct method

(b) Directly by metre scale

(c) Spherometer method

(d) Parallax method

47. Two waves having their intensities in the ratio of $9:1$ produce interference. In the interference pattern, the ratio of maximum to minimum intensity is equal to:

(a) $\frac{4}{1}$ (b) $\frac{8}{4}$

(c) $\frac{2}{3}$ (d) $\frac{1}{2}$

48. A beam of light of wavelength $600nm$ from a distant source falls on a single slit $1.0mm$ wide and the resulting diffraction pattern is observed on a screen $2m$ away. The distance between the first dark fringes on either side of the central bright fringe is;

(a) $1.2cm$ (b) $1.2mm$

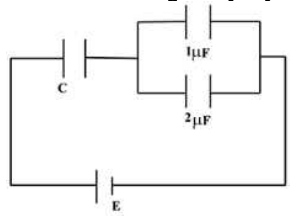
(c) $2.4cm$ (d) $2.4mm$

49. In two single turn circular loop of wire have radius 20 cm and 2 cm. The loops lies in the same plane and are concentric. Find the mutual inductance of the pair is:

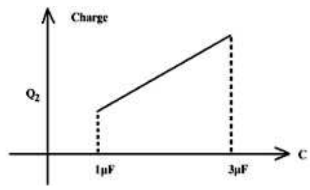
(a) 7.9×10^{-6} (b) 5.2×10^{-7}

(c) 2.4×10^{-6} (d) 4.0×10^{-7}

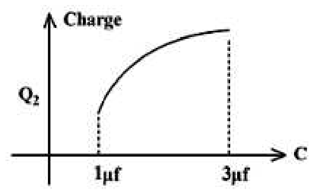
50. In the given circuit, charge Q_2 on the 2μF capacitor changes as C is varied from 1μF to 3μF. Q_2 as a function of C is given properly by:



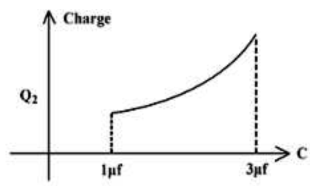
(a)



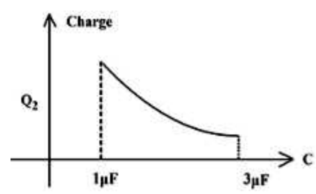
(b)



(c)



(d)



51. A stone dropped from the top of a tower reaches ground in 4 s. Height of the tower is $(g = 10 \text{ m/s}^2)$

(a) 20 m (b) 40 m

(c) 80 m (d) 160 m

52. The magnitude of acceleration of a moving body is equal to the

(a) Gradient of a displacement-time graph

(b) Gradient of a velocity-time graph

(c) Gradient of a displacement-velocity graph

(d) Area of a velocity-time graph

53. Consider a spherical shell of radius R at temperature T. The black body radiation inside it can be considered as an ideal gas of photons with internal energy per unit volume $u = \frac{U}{V} \alpha T^4$ and pressure $P = \frac{1}{3}\left(\frac{U}{V}\right)$. If the shell now undergoes an adiabatic expansion the relation between T and R is:

(a) $T \alpha e^{-R}$ (b) $T \alpha e^{-3R}$

(c) $T \alpha \frac{1}{R}$ (d) $T \alpha \frac{1}{R^3}$

54. The iron blade has a ring in which the wooden handle is fixed. The ring is slightly smaller in size than a wooden handle. The ring is heated. When the ring cools, it ___________ and tightly fits on the handle.

(a) Contracts (b) Expands

(c) Evaporates (d) Condenses

55. $1kWh =$ _____ J

(a) $3.6 \times 10^4 J$ (b) $3.6 \times 10^5 J$

(c) $3.6 \times 10^6 J$ (d) $3.6 \times 10^3 J$

56. The meter bridge is used to:

(a) Measure the electric current in a circuit

(b) Measure the potential difference across a resistance

(c) Measure the resistance of a resistor

(d) Measure the power supplied in the circuit

57. Which theorem states that "If a particle under the simultaneous action of three forces is in equilibrium, then each force has a constant ratio with the sine of the angle between the other two forces"?

(a) Lay's theorem

(b) Lami's Theorem

(c) Newton's law

(d) Faraday's theorem

58. If the time of flight of a projectile is doubled, what happens to the maximum height attained?

(a) Halved

(b) Remains unchanged

(c) Doubled

(d) Becomes four times

59. A body is subjected to strain several times will not obey Hookes law due to

(a) Yeild point

(b) Permanent state

(c) Elastic fatigue

(d) Breaking stress

60. A bar made of material whose Young's modulus is equal to E and Poisson's ratio to μ is subjected to the hydrostatic pressure p. Find the relationship between the compressibility β and the elastic constants E and μ.

(a) $\beta = (1 - 2\mu)\frac{3}{E}$

(b) $\beta = (1 - 3\mu)\frac{2}{E}$

(c) $\beta=(1+2\mu)\frac{E}{3}$

(d) $\mu=(1-2\beta)\frac{3}{E}$

// Hints and Solutions //

1(A). A time period of a satellite is the time taken by the satellite to go once around the earth.

$T=2\pi\sqrt{\frac{r^3}{MG}}$,

Where $r=R+D$,

if D is very small wrt to R so D can be neglected.

So, $T=2\pi\sqrt{\frac{1}{M\sigma}}$,

where σ is density of the planet.

So, here clearly we can see if the orbit of the satellite is very close to the planet then its period depends only on the density of the planet.

2(D). Satellite going round the earth in a circular orbit loses some energy due to collision. Its speed is v and distance from the earth is d will decrease, v will increase.

Given that, the particle lost some energy due to a collision. So, it can no longer continue in that orbit as the earth's gravitational force is more than centripetal force. Due to this, the distance d decreases gradually and the particle moves towards earth at certain accelaration gaining speed. Thus distance d decreases and speed v increases.

3(D). The mean free path of electrons is defined as the distance travelled by the electrons before collision, here mean free path $\lambda=4\times10^{-8}$ m.

And the energy provided by the electric field is 2eV.

$\mathrm{V_0=2eV}$

Now, electric field $\mathrm{E}=\frac{V_0}{\lambda}$

Put the values in above formula.

$\mathrm{E}=\frac{2}{4\times10^{-8}}$

$=0.5\times10^{8}$

$=5\times10^{7}\mathrm{Vm^{-1}}$

4(B). Given that the threshold frequency for metal surface corresponds to an energy $(\nu)=6.2eV$

Stopping potential for the radiation incident on it is, $V_0=5\ V$

We know that in the photoelectric experiment

$E=W+K$

$h\nu=h\nu_o+eV_o$

Put the given values in above equation,

$h\nu=6.2eV+5eV$

$=11.2eV$

We know that,

$h\nu=\frac{hc}{\lambda}$

$\Rightarrow\frac{hc}{\lambda}=11.2eV$

$\Rightarrow c=3\times10^8 m/s$

$\Rightarrow\frac{1242eV\ nm}{\lambda}=11.2eV$

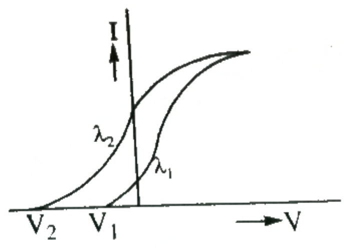
$\Rightarrow\lambda=\frac{1242eV\ nm}{11.2eV}$

$=110.89\ nm$

$\simeq1100A^\circ$

Which is under the ultraviolet region.

5(D).



Case 1: Stopping potential for $\lambda_1=V_1$

$eV_1=h\nu\Rightarrow\frac{hc}{\lambda_1}$

$eV_1=\frac{hc}{\lambda_1}\quad\ldots(1)$

Case 2: Stoping potential for $\lambda_2=V_2$

$eV_2=h\nu$

$eV_2=\frac{hc}{\lambda_2}$

According to the question,

$V_2>V_1$

$\therefore\frac{hc}{\lambda_2}>\frac{hc}{\lambda_1}$

$\Rightarrow\lambda_1>\lambda_2$

6(C). Given,

Least count = 0.01 mm

Number of divisions = 50

The pitch of the screw guage is given as:

p = least count $\times$ number of divisions

Substitute the values, we get

p = 0.01 mm $\times$ 50

p = 0.5 mm

7(B). In the given formula,

$X=3YZ^2$

$[Y]=[\frac{X}{Z^2}]$

$=\left[\frac{\text{Capacitance}}{(\text{Magnetic induction})^2}\right]$

$=\left[\frac{\mathrm{M^{-1}L^{-2}Q^2T^2}}{\mathrm{M^2Q^{-2}T^{-2}}}\right]$

$=[\mathrm{M^{-3}L^{-2}T^4Q^4}]$

8(A). For monoatomic:

Degree of freedom $=3$

For monoatomic molecules,

$\frac{C_p}{C_v}=1+\frac{2}{f}$

Where, C_p is the specific heat at constant pressure, C_v is the specific heat at constant volume and f is the degree of freedom.

$=1+\frac{2}{3}$

$\frac{C_p}{C_v}=\frac{5}{3}\approx1.66$

9(D). Root mean square velocity of Gaseous particles: Root mean square velocity (RMS value) is the square root of the mean of squares of the velocity of individual gas molecules. It is given by,

$V_{rms}=\sqrt{\frac{3RT}{M}}$

Average velocity: It is the arithmetic mean of the velocities of different molecules of a gas at a given temperature. It is given by,

$V_{av}=\sqrt{\frac{8RT}{\pi M}}$

Most probable velocity: It is the velocity possessed by maximum fraction of molecules at the same temperature. It is given by,

$V_p=\sqrt{\frac{2RT}{M}}$

The required ratio between these parameters are,

$\sqrt{\frac{3RT}{M}}:\sqrt{\frac{8RT}{\pi M}}:\sqrt{\frac{2RT}{M}}$

By Canceling all constant terms from the above expression we have,

$\sqrt{3}:\sqrt{\frac{8}{\pi}}:\sqrt{2}$

Or

1.732:1.596:1.414

10(C). Displacement Current:

- The idea of displacement current was firstly developed by famous physicist James Maxwell.
- The displacement current produces due to the change in electric flux (number of electric field lines through a cross-sectional area of a closed-loop) with respect to time.
- The SI unit of displacement current is Ampere.
- The magnitude of displacement current is zero in the case of steady electric fields in conducting wire.
- The idea of displacement current was introduced to the current for making ampere circuital law consistent.

Therefore, out of all the given statements, Only the statement of option (C) is incorrect.

11(D). Given:

$\phi_E=(10t^2-20t+5)Vm$

We know that:

The expression for displacement current is given by,

$i_d=\epsilon_0\frac{d\phi_E}{dt}$

$i_d=\epsilon_0\frac{d(10t^2-20t+5)}{dt}$

$i_d=\epsilon_0(20t-20)$

For t = 1 sec,

$i_d=\epsilon_0(20\times1-20)$

$i_d=\epsilon_0(20-20)=0$

$i_d=0$

12(D). As we know,

Work done by a variable force is given by,

$W=\int_a^b F(x)dx$

Let x be the distance covered.

Given that $F\propto\frac{1}{x}$

Work done, $(W)=\int_a^b F(x)dx$

$\therefore W\propto\int_a^b\frac{1}{x}dx$

$\Rightarrow W\propto[\ln(x)]_a^b$

$\Rightarrow W\propto\ln(b)-\ln(a)$

$\Rightarrow W\propto\ln\left(\frac{b}{a}\right)$

13(C). The energy possessed by a body due to the virtue of its motion is called kinetic energy.

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

Where $KE =$ kinetic energy, $m =$ mass and $v =$ velocity

Given,

$\Delta v = v_2 - v_1 = 2m/s$

$KE_2 = 2KE_1$

Where $\Delta v =$ increase in speed

Initial kinetic energy, $KE_1 = \frac{1}{2}mv_1^2$ ...(1)

Final kinetic energy, $KE_2 = \frac{1}{2}mv_2^2$ ...(2)

By equation (1) and equation (2),

$KE_2 = 2KE_1$

$\Rightarrow \frac{1}{2}mv_2^2 = 2 \times \frac{1}{2}mv_1^2$

$\Rightarrow v_2^2 = 2v_1^2$

$\Rightarrow v_2 = \pm\sqrt{2}v_1$ ...(3)

Since,

$\Delta v = v_2 - v_1 = 2m/s$

By equation (3), we get

$\sqrt{2}v_1 - v_1 = 2$

$\Rightarrow v_1(\sqrt{2} - 1) = 2$

$\Rightarrow v_1 = \frac{2}{\sqrt{2}-1}$ ...(4)

On dividing and multiplying by $\sqrt{2}+1$ in equation (4), we get

$v_1 = \frac{2}{\sqrt{2}-1} \times \frac{\sqrt{2}+1}{\sqrt{2}+1}$

$\Rightarrow v_1 = \frac{2(\sqrt{2}+1)}{(\sqrt{2})^2-1^2}$

$\Rightarrow v_1 = 2(\sqrt{2}+1)m/s$

So, the original speed of man is $2(\sqrt{2}+1)m/s$.

14(A). Law of conservation of charge:

The total charge of an isolated system remains constant. The electric charges can neither be created nor destroyed, they can only be transferred from one body to another. The law of conservation of charge is obeyed both in large-scale and microscopic processes. In fact, charge conservation is a global phenomenon i.e., the total charge of the entire universe remains constant.

From the above, it is clear that charge can neither be created nor be destroyed, but it can be transferred from one object to another by using some methods like induction and conduction. Therefore option (A) is incorrect and options (B) and (D) is correct.

If the charges are distributed in a system, then the net charge of the system remains constant. Therefore option (C) is correct.

15(A). A positive charge attracts a negative charge and repels the positive charge. A negative charge attracts a positive charge and repels a negative charge. It means Like charges repel each other and unlike charges attract each other. All the charges do not attract all the other charges always.

16(A). We know,

$r_H = \frac{P}{e \times B}$

$r_\alpha = \frac{P}{2e \times B}$ (As α has $2e$ of charge on it)

$\frac{r_H}{r_\alpha} = \frac{\frac{P}{eB}}{\frac{P}{2eB}}$

$\Rightarrow \frac{r_H}{r_\alpha} = \frac{2}{1}$

17(C). Total energy $= -3.4$ev

In Bohr's model of H atom

$\therefore$ K.E. $= |TE| = \frac{|U|}{2}$

K.E. $= -(T.E.) = 3.4$eV

$P.E. = 2(T.E) = 2 \times (-3.4\text{eV}) = -6.8$eV

18(A). Alpha particles are composite particles consisting of two protons and two neutrons tightly bound together . They are emitted from the nucleus of some radionuclides during a form of radioactive decay, called alpha-decay.

α - particle is nucleus of Helium which has two protons and two neutrons.

19(C). If a transformer of an audio amplifier has an input impedance of 8Ω output impedance of 8 kΩ, the primary and secondary turns of this transformer connected between the output of the amplifier and to loudspeaker should have the ratio will be 1:32.

20(B). Here, Magnetic field, $B = 0.025$ T , Radius of the loop,r $= 2$ cm $= 2 \times 10^{-2}$ m

Constant rate at which radius of the loop shrinks, $\frac{dr}{dt} = 1 \times 10^{-3} ms^{-1}$

Magnetic flux linked with the loop is $\phi = BA\cos\theta = B\left(\pi r^2\right)\cos 0^\circ = B\pi r^2$

The magnitude of the induced emf is $|\varepsilon| = \frac{d\phi}{dt} = \frac{d}{dt}(B\pi r^2) = B\pi 2r\frac{dr}{dt}$

$= 0.025 \times \pi \times 2 \times 2 \times 10^{-2} \times 1 \times 10^{-3}$

$= \pi \times 10^{-6}V = \pi\mu V$

21(B). $R = R_0(1 + \alpha t)$

$\therefore R_0(1 + 30\alpha) = 10\Omega$

and $R_0(1 + \alpha) = 11\Omega$

Therefore, $\frac{11}{10} = \frac{1+\alpha t}{1+30\alpha}$

$\Rightarrow 11 + 330\alpha = 10 + 10\alpha t$

$\Rightarrow 11 + 330 \times 0.002 = 10 + 10 \times 0.002t$

$\Rightarrow 11.66 = 0.02t + 10$ Or $0.02t = 1.66$

$t = 83^\circ C$

22(B). For full-wave rectifier, ripple frequency $= 2\times$ input frequency

$= 2 \times 50$

$= 100$ Hz

Note: A full-wave rectifier consists of two junction diodes, so, its efficiency is twice that of a half-wave rectifier.

23(A). Given:

Electrostatic force of repulsion, F $= 3.7 \times 10^{-9}$ N

Let charge is $q_1 = q_2 = q$

Distance between two charges, $r = 5\mathring{A} = 5 \times 10^{-10}$ m

We have to find, the number of electrons(n) missing.

Using Coulomb's law,

$F = \frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r^2}$

$\Rightarrow 3.7 \times 10^{-9} = 9 \times 10^9 \times \frac{q \times q}{\left(5 \times 10^{-10}\right)^2}$

$\Rightarrow q^2 = \frac{3.7 \times 10^{-9} \times 25 \times 10^{-20}}{9 \times 10^9}$

$\Rightarrow q^2 = 10.28 \times 10^{-38}$

$\Rightarrow q = 3.2 \times 10^{-19}$ Coulomb

As, we know that:

$q =$ ne

$\therefore n = \frac{q}{e}$

$= \frac{3.2 \times 10^{-19}}{1.6 \times 10^{-19}}$

$= 2$

Therefore, the number of electrons missing is $n = 2$.

24(A). Since the particle carrying positive charge is revolving around another charge, Electrostatic force = Centripetal force

$\Rightarrow \frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r^2} = mr\omega^2$

$\Rightarrow \frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r^2} = \frac{4\pi^2mr}{T^2}$

$\Rightarrow T^2 = \frac{(4\pi\epsilon_0)r^2(4\pi^2mr)}{q_1q_2}$

$\Rightarrow T = 4\pi r\sqrt{\frac{\pi\epsilon_0 mr}{q_1q_2}}$

25(D). Simple harmonic motion is represented by,

$x = A\cos(\omega t + \varphi)$

Where $A =$ amplitude, $\omega =$ Angular frequency, $x =$ Displacement and $\varphi =$ Phase constant

26(C). Given,

T = 2 sec

For a simple pendulum, the time period of swing of a pendulum depends on the length of the string and acceleration due to gravity.

$T = 2\pi\sqrt{\frac{l}{g}}$

The above formula is only valid for small angular displacements.

Where, T = Time period of oscillation, $l =$ length of the pendulum and g = gravitational acceleration

By squaring both side and rearranging we get,

$l = \frac{T^2 \times g}{4\pi^2}$

$l = \frac{4 \times 9.8}{4 \times (3.14)^2} = 0.993$ m ≈ 1 m $= 100$ cm

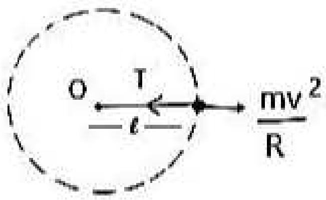
So, the length of second's pendulum is 99.3 cm or nearly 1 meter on earth surface.

27(D). In a transverse waves particle of the medium vibrate up and down in the vertical direction whereas it is propagating along the horizontal direction. So, in a transverse wave, a crest is a part where particle rises from its mean position and has the maximum positive displacement whereas trough is a part where particle dips below mean position and has the maximum negative displacement.

28(C). There are two types of waves Transverse and Longitudinal waves.

Transverse waves: The waves that produce vibrations in the medium in a direction perpendicular to their propagation (eg. Light).
Longitudinal waves: In these waves, the vibrations produced in a medium and their direction of propagation is the same.
The transverse waves can travel in a vacuum but the longitudinal waves require a medium to travel through. Sound waves are longitudinal in nature and therefore cannot travel in a vacuum.
From the above discussion, it is clear that the sound waves cannot travel in a vacuum.

29(A). Given,



Radius, $R = l$
From the figure we can write,
$T = \frac{mv^2}{R}$
$T = \frac{mv^2}{l}$

30(A). Given,
Retarding force, $F = -50$ N
Mass of the body, $m = 20$ kg
Initial velocity, $u = 15\ \text{ms}^{-1}$
Final velocity, $v = 0$
Acceleration of the body, $a = \frac{F}{m}$
$= \frac{-50}{20} = -2.5\ \text{ms}^{-2}$
From the first equation of motion
$v = u + at$
$0 = 15 + (-2.5) \times t$
$t = \left(\frac{15}{2.5}\right)$
$t = 6$ s

31(C). In the presence of oxygen, the filament of the light bulb would burn up as a result of the high temperature. So the vacuum is maintained in the light bulb. Since there is no medium present in the light bulb, so the heat transfer takes place by radiation because the conduction and the convection require a material medium to transfer heat.

32(C). **Concept:**
Good Conductor of heat: The material that allows the heat to transfer through them easily is called a good conductor of heat. Examples: Copper, silver, iron, etc.
The bad conductor of heat or insulator: The material that doesn't allow the heat to transfer through them easily is called an insulator. Example: Wood, ice, glass, plastic, etc.
Heat transfer mainly takes place due to temperature differences.
Air changes temperature faster than water so, in winters, the air cools down before the water. The water on the surface is in direct contact with the air and therefore freezes first, before the water at the bottom.
Now since ice is less dense than water, it continues to float and doesn't sink. This ice sheet keeps getting thicker and acts as an insulator between the cold air and warm water at the bottom. This is why the water at the bottom stays liquid. So we can say that ice is a bad conductor of heat that's why the water at the bottom of the lake remains in the liquid state.

33(B). As we know,
Angular momentum $\text{J} = \text{m}\omega\text{r}^2 \ldots. (1)$
where ω is the angular velocity, r is the radius of the orbit.
As we know,
Magnetic moment $\mu = i$ A
$= \frac{e\omega}{2\pi}\pi r^2 \ldots.. (2)$
By dividing equation (1) and (2), we get
$\therefore \frac{\mu}{\text{J}} = \frac{\frac{e\omega}{2\pi}\pi r^2}{m\omega r^2} = \frac{e}{2m}$
$\Rightarrow \mu = \frac{\text{eJ}}{2\text{ m}}$

34(B). Given,
Dip angle $\theta = 22^\circ$
The horizontal component of the earth's magnetic field
$H_e = 0.35\text{G} = 0.35 \times 10^{-4}\ T$
As we know,
$\text{H}_e = \text{B}_e \cos\theta$
$\text{B}_e = \frac{0.35 \times 10^{-4}}{0.99}$
$= 0.36 \times 10^{-4}$
$= 0.36\text{G}$

35(B). **Archimedes principle:**
- It states that a body when wholly or partially immersed in liquid experiences an upward thrust which is equal to the volume of the liquid.
- Archimedes Principle is also known as the physical law of buoyancy.
- Purity of gold in the king's crown, Archimedes determine after discovering the Archimedes principle.
- Hydrometer, Ships, and Submarines work on the Archimedes Principle.
- A Ship/boat floats on the basis of the Archimedes Principle .

36(D). **Bernoulli's principle:** For a streamlined flow of an ideal liquid in a varying cross-section tube the total energy per unit volume remains constant throughout the fluid.
- From above it is clear that Bernoulli's equation states that the summation of pressure head , kinetic head, and datum/potential head is constant for steady , incompressible , rotational, and non-viscous flow .
- In other words, an increase in the speed of the fluid occurs simultaneously with a decrease in pressure or a decrease in the fluid's potential energy i.e. the total energy of a flowing system remains constant until an external force is applied .
- So Bernoulli's equation refers to the conservation of energy .
- All of the above are the measuring devices like Venturimeter , Orifice meter , and Pitot tube meter works on the Bernoulli's theorem .

37(D). For a circular coil, the component of the field B perpendicular to the axis at P cancel each other while along the axis add up.
The resultant magnetic field at point P will be due to the components along the axis. Hence,
$B = \int dB \sin\beta$
$= \frac{\mu_0}{\mu\pi}\int \frac{idl \sin\theta}{r^2}\sin\beta$
and as here angle θ between the element $\vec{dl}$ and $\vec{r}$ is $\frac{\pi}{2}$ every where and r is same for all elements while $\sin\beta = \frac{R}{r}$
Hence, we have
$B = \frac{\mu_0}{4\pi}\frac{2\pi i R^2}{x^3}$
where $x = \left(R^2 + r^2\right)^{1/2}$
$B = \frac{\mu_0}{4\pi}\frac{2\pi i R^2}{\left(R^2+r^2\right)^{3/2}}$
Given, $r >> R$ then we have, neglecting R_r
$B = \frac{\mu_0}{4\pi}\frac{2\pi i R^2}{r^3}$
Also area $= \pi R^2$
$\therefore B = \frac{\mu_0}{2\pi}\frac{Ai}{r^3}$
$\Rightarrow B \propto \frac{1}{r^3}$

38(B). If we use fleming's left-hand rule. We find that a force is acting in the radially outward direction throughout the circumference of the conducting loop.

39(B). Using formula,
$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$
$N =$ Total Number of nuclei after decay
$N_0 =$ Total number of nuclei at time t = 0
$\frac{1}{16} = \left(\frac{1}{2}\right)^n$
$\left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^n$
$\left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^n$
$n = 4$
Half-life $= \frac{\text{Total time}}{n}$
$\Rightarrow \frac{2}{4} = 0.5$ hour
Half-life $= 30$ minutes.

40(C). At closest approach, all the kinetic energy of the a-particle will converted into the potential energy of the system,
$K.E. = P.E$
i.e., $\frac{1}{2}mv^2 = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r}$
$5MeV = \frac{9\times10^9\times(2e)\times92e}{r}$
$\left(\therefore \frac{1}{2}mv^2 = 5MeV\right)$
$\Rightarrow r = \frac{9\times10^9\times2\times92\times\left(1.6\times10^{-19}\right)^2}{5\times10^6\times1.6\times10^{-19}}$
$r = 5.3 \times 10^{-14}\ m = 10^{-12}\ cm$

41(A). As the c.m. of three particles is at $2, 2, 2$

$\therefore$ The total mass $= 1 + 2 + 3 = 6$ kg
Now consider the 4 kg mass at the position (x, y, z)
Now centre of mass of total system at 0, 0, 0
$\therefore \frac{6\times2+4x}{10} = 0$
$\Rightarrow 12 = -4x$
$\Rightarrow x = -3$
Similarly, $\frac{6\times2+4y}{12} = 0$
$\Rightarrow y = -3$
Similarly, $\frac{6\times2+4z}{12} = 0$
$\Rightarrow z = -3$
From the above we can conclude that
$x = -3, y = -3, z = -3$

42(C). Given: $\left(\frac{T_1^2}{T_2^2}\right) = \left(\frac{R_1^3}{R_2^3}\right)$
$\Rightarrow T_2^2 = \left(\frac{R_2}{R_1}\right) T_1^2$
$\Rightarrow T_2 = \left(\frac{R_2}{R_1}\right)^{\frac{3}{2}} T_1$
For the geostationary satellite, $T_1 = 1$ day (24 hrs.)
$\therefore T_2 = \left(\frac{9R}{R}\right)^{\frac{3}{2}} = 27$ days
So it will complete one revolution in 27 days.
Now, $\omega = \frac{2\pi}{T_2} = \frac{2\pi}{27\times24\times3600} \frac{rad}{s}$
$= 2.693 \times 10^{-6} \frac{rad}{sec}$

43(A). In the case of eye-piece lense
$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$
$\Rightarrow \frac{1}{25} - \frac{1}{u} = \frac{1}{5}$
$\Rightarrow \frac{1}{u} = \frac{1}{25} - \frac{1}{5}$
$\Rightarrow u = \frac{-5}{4}$
$\Rightarrow u = -1.25$ cm
For objective the image distance
$v = 20 - 1.25$
$= 18.75$ cm
Again, by the above formula-
$\frac{1}{18.75} - \frac{1}{u} = \frac{1}{9.5}$
$\Rightarrow \frac{1}{u} = \frac{4}{75} - \frac{2}{19}$
$\Rightarrow \frac{1}{u} = \frac{76-150}{75\times19}$
$\Rightarrow u = \frac{75\times19}{-74}$
$\Rightarrow u = -19.25$ cm
Total magnification $m = m_1 m_2$
Here, $m = \frac{v}{u}$
$\Rightarrow m = \frac{18.75}{19.25} \times \frac{25}{1.25}$
$\Rightarrow m = 19.6$

44(B). Given,
The refracting angle of the prism = 90°
For passing the ray from prism,
$\mu < \text{cosec}\,\frac{A}{2}$
$\Rightarrow \mu < \text{cosec}\left(\frac{90^\circ}{2}\right)$
$\Rightarrow \mu < \sqrt{2}$
$\Rightarrow \mu_{\max} = \sqrt{2}$
Finally, the maximum refractive index of a prism $= \sqrt{2}$

45(D). The fundamental units are the base units defined by International System of Units. These units are not derived from any other unit, therefore they are called fundamental units. The seven base units are:

- Meter (m) for Length
- Second (s) for Time
- Kilogram (kg) for Mass
- Ampere (A) for Electric current
- Kelvin (K) for temperature
- Mole (mol) for Amount of substance
- Candela (cd) for Luminous intensity

Volt is not a fundamental unit, it is a derived unit.

46(D). The distance of the planet from the earth is measured by parallax method. Parallax is a displacement or difference in the apparent position of an object viewed along two different lines of sight, and is measured by the angle or semi-angle of inclination between those two lines. Parallax Method is used for large distances.

47(A). Let the intensities of the two waves be I_1 and I_2 .
Given,
$I_1 : I_2 = 9 : 1$
Ratio of maximum and minimum intensities $\frac{I_{\max}}{I_{\min}} = \left(\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}\right)^2$
or,
$\frac{I_{\max}}{I_{\min}} = \left(\frac{\sqrt{\frac{I_1}{I_2}}+1}{\sqrt{\frac{I_1}{I_2}}-1}\right)^2$
or
$\frac{I_{\max}}{I_{\min}} = \left(\frac{\sqrt{9}+1}{\sqrt{9}-1}\right)^2$
$= \left(\frac{3+1}{3-1}\right)^2$
$\Rightarrow \frac{I_{\max}}{I_{\min}} = \frac{16}{4}$
$= \frac{4}{1}$

48(D). For a dark fringe to form,
$\frac{dy}{D} = \lambda$
$y = \frac{D\lambda}{d}$
$= \frac{2\times600\times10^{-9}}{10^{-3}} = 1.2mm$
Distance between the first dark fringes on either side of central bright fringe is-
$2 \times y = 2.4mm$

49(D). Let the current i in the large loop of radius $\text{R} = 20$ cm produces a magnetic field of magnitude $B = \frac{\mu_o i}{2R}$ at its centre.
Since the radius $r = 2$ cm of the smaller loop is $r << R$, so we may treat the flux through the small loop as being approximately
$\Phi = BA\cos 0^\circ = \frac{\mu i A}{2R} = \frac{\mu\pi r^2 i}{2R}$
So, the mutual inductance of the loop is $M = \frac{\Phi}{i} = \frac{\mu\pi r^2}{2R} = \frac{4\times3.14\times10^{-7}\times3.14\times2\times2}{2\times20}$
$M \approx 4.0 \times 10^{-7}$

50(B). Let the charge on the capacitor C be Q . Charge on the combination of 1 and 2μF is also Q .
$\text{Q}_2 = \frac{2}{1+2}\text{Q} = \frac{2}{3}\text{Q}$ But, $\mathbf{Q} = \text{E}\left(\frac{\mathbf{3C}}{3+\mathbf{C}}\right)$
$\therefore \text{Q}_2 = \frac{2}{3}\text{E}\left(\frac{3\text{C}}{3+\text{C}}\right) = \frac{2\text{EC}}{3+\text{C}}$
As we can see, since C is between 1 and 3, Q_2 will increase until C = 3 .
Slope of curve $\frac{dQ_2}{dC} = \frac{(3+C)2E-2EC}{(3+C)^2} = \frac{6E}{(3+C)^2}$
So, the slope decreases as (C) increases.

51(C). As,
$h = ut + \frac{1}{2}gt^2$
Here, $u = 0, g = 10ms^{-2}, t = 4s$
$\therefore h = 0 \times 4 + \frac{1}{2} \times 10 \times 4^2 = 80$ m

52(B). The magnitude of acceleration of a moving body is equal to the gradient of a velocity-time graph.
$\vec{a} = \frac{d\vec{v}}{dt} \Rightarrow |\vec{a}| = \frac{d\vec{v}}{dt}$

53(C). In a spherical shell, the internal energy per unit volume is given by $\frac{U}{V}\alpha T^4$
$\Rightarrow U = CVT^4$
Here C is a constant
Next the value of P ,
$= \frac{1}{3}\left(\frac{U}{V}\right) = \frac{1}{3}\left(\frac{CVT^4}{V}\right)$
From adiabatic expansion, $dQ = 0$ and $dU = -dW$
$d(CVT)^4 = -PdV$
We get,
$\Rightarrow 4VdT = -\frac{4}{3}TdV$
$\Rightarrow \frac{dT}{T} = \frac{dV}{3V}$
On integrating,
$\Rightarrow TV^{\frac{1}{3}} = C^1$
$\Rightarrow T\left(\frac{4}{3}\pi R^3\right)^{\frac{1}{3}} = C^1$
$TR = \text{Constant}$
$\Rightarrow T\alpha\frac{1}{R}$

54(B). When the metal heated, the length, surface area, volume of the metal also increased. The increase in temperature which results in metal expands and this expansion is termed as the thermal expansion of metal i.e. expansion in metal due to the heating effect.
So, the iron blade has a ring in which the wooden handle is fixed. The ring is slightly smaller in size than a wooden handle. When the ring is heated which is made up of metal expands, after the ring cools, it tightly fits in the wooden handle.

55(C). 1 unit of electric energy: When one-kilowatt load works for 1 hour then the energy consumed is called 1 unit of electricity.
1 Unit of electricity $= 1KWh = 1000$ Watt-hour $= 3.6 \times 10^6 J$
1 Kilo-watt $= 1000$ Watt

1 Watt: The energy consumption rate of 1 joule per second is called 1 watt.
Since $1hr = 3600$ sec
1 Kilo-watt $= 1000$ Watt
$1KWh = 1000$ Watt-hour $= 1000 \times 3600$ W.s $= 3.6 \times 10^6$ J

56(C). Meter Bridge: It is an electrical instruments based on the principle of Wheatstone bridge and is used to measure the resistance of a resistor.
The metre bridge, also known as the slide wire bridge consists of a one metre long wire of uniform cross sectional area, fixed on a wooden block. A scale is attached to the block. Two gaps are formed on it by using thick metal strips in order to make the Wheat stones bridge.
The formula meter bridge is given below:
ρ = Lπr2X
Where, L be the length of the wire and r be its radius.

57(B). Lami's Theorem states that if f a particle under the simultaneous action of three forces is in equilibrium, then each force has a constant ratio with the sine of the angle between the other two forces.

58(D). We know that $\mathrm{H} = \frac{\mathrm{u}^2 \sin^2 \theta}{2\mathrm{~g}}$

and $T = \frac{2\mathrm{u} \sin \theta}{\mathrm{g}}$
From these two equations, we get
So if T is doubled, H becomes four times.

59(C). According to Hookes law stress is directly proportional to strain. But when a material is subjected to strains alternatively there is a loss of strength of the material called Elastic Fatigue. Due to elastic fatigue the behavior of the body shows that of a less elastic body. When fatigue is removed from an elastic body it regains the original degree of elasticity when allowed to rest for a while.

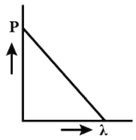
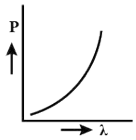
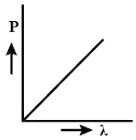
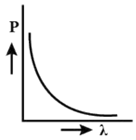
60(A). We know,
$\frac{E}{3K} = 1 - 2\mu$
K = Bulk modulus.
Also, Compressibility $\beta = \frac{1}{\mathrm{K}}$
$\therefore \frac{E\beta}{3} - 1 - 2\mu$
$\therefore \beta = \frac{3}{\mathrm{E}}(1 - 2\mu)$

1. Two spherical bodies of mass M and 5M and radii R and 2R respectively are released in free space with initial separation between their centers equal to 12R. If they attract each other due to gravitational force only, then the distance covered by the smaller body just before collision is:
(a) 2.5R (b) 4.5R
(c) 7.5R (d) 1.5R

2. The mass of spaceship is 1000 kg. It is to be launched from the earth's surface out into free space. The value of 'g' and 'R' (radius of earth) are 10 m/s ^{2} and 6400 km respectively. The required energy for this work will be:
(a) 6.4×10^{11} Joules
(b) 6.4×10^{8} Joules
(c) 6.4×10^{9} Joules
(d) 6.4×10^{10} Joules

3. In an LCR circuit, the pd between the terminals of the inductance is $60V$, between the terminals of the capacitor is $30V$ and that between the terminals of resistance is $40V$. The supply voltage will be equal to:
(a) $50V$ (b) $70V$
(c) $130V$ (d) $10V$

4. Two coils of self-inductance L_1 and L_2 are placed closer to each other so that total flux in one coil is completely linked with others. If M is mutual inductance between them, then:
(a) $M = L_1 L_2$
(b) $\frac{ML_1}{L_2}$
(c) $M = \sqrt{L_1 L_2}$
(d) $M = (L_1 \, L_2)^2$

5. Which of the following figures represents the variation of particle momentum and associated de Broglie wavelength?
(a) 
(b) 
(c) 
(d) 

6. A radio transmitter operates at a frequency 880kHz and a power of 10kW. The number of photons emitted per second is:
(a) 1.71×10^{31} (b) 1.327×10^{25}
(c) 1.327×10^{37} (d) 1.327×10^{45}

7. If K_1 and K_2 are maximum kinetic energies of photoelectrons emitted when lights of wavelength λ_1 and λ_2 respectively incident on a metallic surface. If $\lambda_1 = 3\lambda_2$, then:
(a) $K_1 > (\frac{K_2}{3})$ (b) $K_1 < (\frac{K_2}{3})$
(c) $K_1 = 3K_2$ (d) $K_2 = 3K_1$

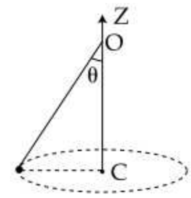
8. The refractive index of a material is given by the equation $n = \frac{A+B}{\lambda^2}$, where A and B are constant. The dimensional formula for B is:
(a) $[\text{M}^0\,\text{L}^2\,\text{T}^{-1}]$ (b) $[\text{M}^0\,\text{L}^{-2}\,\text{T}^0]$
(c) $[\text{M}^0\,\text{L}^2\,\text{T}^{-2}]$ (d) $[\text{M}^0\,\text{L}^2\,\text{T}^0]$

9. The moon is observed from two diametrically opposite points A and B on Earth. The angle θ subtended at the moon by the two directions of observation is $1°54'$. Given the diameter of the Earth to be about 1.276×10^7 m, compute the distance of the moon from the Earth.
(a) 3.84×10^8 m
(b) 3×10^8 m
(c) 3.84×10^{10} m
(d) 5×10^8 m

10. A vessel contains two non-reacting gases Helium and Neon. The ratio of their partial pressure is 5 : 2. Find the ratio of the number of molecules of helium and Neon.
(a) 0.5 (b) 1.6
(c) 2.5 (d) 2.3

11. The ratio of $\frac{C_p}{C_v}$ for a rigid diatomic gas is? (C_p and C_v are molar specific heats at constant pressure and constant volume respectively)
(a) $\frac{5}{3}$ (b) $\frac{7}{5}$
(c) $\frac{3}{5}$ (d) $\frac{5}{7}$

12. A conical pendulum of length 1 m makes an angle $\theta = 45°$ w.r.t. Z-axis and moves in a circle in the XY plane. The radius of the circle is 0.4 m and its center is vertically below O. The speed of the pendulum, in its circular path, will be: (Take $g = 10\ \text{ms}^{-2}$)



(a) 0.4 m/s (b) 4 m/s
(c) 0.2 m/s (d) 2 m/s

13. A block of mass 0.1 kg is connected to an elastic spring of spring constant 640Nm^{-1} and oscillates in a damping medium of damping constant $10^{-2}\ \text{kg s}^{-1}$. The system dissipates its energy gradually. The time taken for its mechanical energy of vibration to drop to half of its initial value is closest to:
(a) 2 s (b) 3.5 s
(c) 5 s (d) 7 s

14. A standing wave is formed by the superposition of two waves travelling in opposite directions. The transverse displacement is given by $y(x,t) = 0.5 \sin\left(\frac{5\pi}{4}x\right)\cos(200\pi t)$. What is the speed of the travelling wave moving in the positive x direction? (x and t are in meter and second, respectively).
(a) 160 m/s (b) 90 m/s
(c) 180 m/s (d) 120 m/s

15. In an experiment to determine the period of a simple pendulum of length 1 m, it is attached to different spherical bobs of radii r_1 and r_2. The two spherical bobs have uniform mass distribution. If the relative difference in the periods, is found to be 5×10^{-4} s, the difference in radii, $|r_1 - r_2|$ is best given by:
(a) 1 cm (b) 0.1 cm
(c) 0.5 cm (d) 0.01 cm

16. The kinetic energy of a body increases from 50 J to 150 J in 10 s. Then the power of the body is:
(a) 10 W (b) 5 W
(c) 100 W (d) 0 W

17. Which of the following is a true representation of the Work-Energy theorem for a variable force?
(a) $\int dK = \int F \cdot dx$
(b) $\Delta K = W$
(c) $K_1 - K_2 = \int_1^2 F \cdot dx$
(d) All of the above

18. **A force acting on a body of 3.0 kg mass changes its speed from 2.0 m/s to 3.5 m/s in 25 seconds. The direction of motion of the body remains unchanged. What is the magnitude of the force?**

(a) 1.18 N (b) 0.18 N

(c) 2.18 N (d) 3.18 N

19. **Two perpendicular forces of 8 Newton and 6 Newton are applied on a body of mass 5.0 kg. Find the magnitude of the acceleration of the body.**

(a) $9m/s^2$ (b) $3m/s^2$

(c) $2m/s^2$ (d) $4m/s^2$

20. **Which of the following molecules have the least number of atoms?**

(a) Methane

(b) Hydrochloric Acid

(c) Water

(d) Sulphuric Acid

21. **A circular disc of radius 0.2 meter is placed in a uniform magnetic field of induction $\frac{1}{\pi}(\frac{Wb}{m^2})$ in such a way that its axis makes an angle of 60° with $\vec{B}$. The magnetic flux linked with the disc is:**

(a) $0.08\ Wb$ (b) $0.01\ Wb$

(c) $0.02\ Wb$ (d) $0.06\ Wb$

22. **Electromagnetic waves of frequencies higher than $9\sqrt{2}MHz$ are found to be reflected by the ionosphere on a particular day at a place. The maximum electron density in the ionosphere is**

(a) $\sqrt{5}\times 10^{23}m^{-3}$

(b) $\sqrt{2}\times 10^{12}m^{-3}$

(c) $2\times 10^{12}m^{-3}$

(d) $5\times 10^{12}m^{-3}$

23. **For transistor action, which of the following statements is correct?**

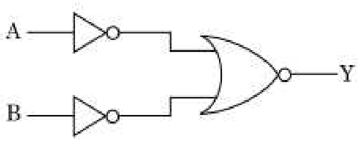
(a) Base, emitter and collector regions should have same doping concentrations

(b) Base, emitter and collector regions should have same size

(c) Both emitter junction as well as the collector junction are forward biased

(d) The base region must be very thin and lightly doped

24. **For the logic circuit shown, the truth table is:**



(a)

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

(b)

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

(c)

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

(d)

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

25. **Find the amount of work done in rotating a dipole of dipole moment 3×10^{-3} cm from its position of stable equilibrium to the position of unstable equilibrium, in a uniform electric field of intensity 10^4NC^{-1}.**

(a) 50 J (b) 60 J

(c) 80 J (d) 70 J

26. **A copper sphere of mass 2 g contains nearly 2×10^{22} atoms. The charge on the nucleus of each atom is 29 e. What fraction of the electrons must be removed from the sphere to give it a charge of $+2\mu C$?**

(a) 2.16×10^{-12} (b) 3.15×10^{-11}

(c) 3.15×10^{-12} (d) 2.16×10^{-11}

27. **The phase difference between the electric field and the magnetic field in the electromagnetic wave is:**

(a) 0 (b) $\frac{\pi}{2}$

(c) π (d) $\frac{\pi}{4}$

28. **Infrared radiation was discovered in 1800 by ____**

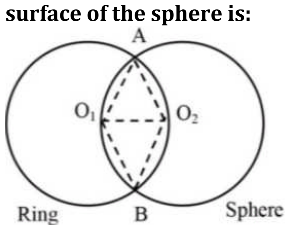
(a) William Wollaston

(b) William Herschel

(c) Wilhelm Roentgen

(d) Thomas Young

29. **A charge q is distributed uniformly on a ring of radius r. A sphere of equal radius r is constructed with its center at the periphery of the ring. The electric flux through the surface of the sphere is:**



(a) $\frac{q}{\varepsilon_0}$ (b) $\frac{2q}{\varepsilon_0}$

(c) $\frac{q}{2\varepsilon_0}$ (d) $\frac{q}{3\varepsilon_0}$

30. **Two bodies are charged by rubbing one against the other. During the process, one becomes positively charged while the other becomes negatively charged. Then mass of each body:**

(a) Remains unchanged

(b) Changes marginally

(c) Changes slightly and hence the total mass

(d) Changes slightly but the total mass remains the same

31. **If a liquid is heated in space under no gravity, the transfer of heat will take place by process of:**

(a) Conduction

(b) Convection

(c) Radiation

(d) None of these

32. **Boyle's law holds for an ideal gas during?**

(a) Isobaric changes

(b) Isothermal changes

(c) Isochoric changes

(d) Adiabatic process

33. **On heating a ferromagnetic substance above Curie temperature __________.**

(a) becomes paramagnetic

(b) becomes diamagnetic

(c) remains ferromagnetic with constant magnetic susceptibility

(d) becomes electromagnetic

34. **Relative permittivity and permeability of a material are ϵ_r and μ_r, respectively. Which of the following values of these quantifies are allowed for a diamagnetic material?**

(a) $\epsilon_r = 0.5, \mu_r = 0.5$

(b) $\epsilon_r = 1.5, \mu_r = 1.5$

(c) $\epsilon_r = 0.5, \mu_r = 1.5$

(d) $\epsilon_r = 1.5, \mu_r = 0.5$

35. **A metal ball immersed in alcohol weighs W_1 at $0\ ^oC$ and W_2 at $59\ ^oC$. The coefficient of cubical expansion of the metal is less than that of alcohol. If the density of the metal is large compared to that of alcohol, then**

(a) $W_1 > W_2$

(b) $W_1 = W_2$

(c) $W_1 < W_2$

(d) None of them

36. **An open U-tube contains mercury. When $11.2\ cm$ of water is poured into one of the arms of the tube, how high does the mercury rise in the other arm from its initial level?**

(a) $0.56\ cm$ (b) $1.35\ cm$

(c) $0.41\ cm$ (d) $2.32\ cm$

37. A particle of charge q and mass m moves in a circular orbit of radius r with an angular speed ω . The ratio of its magnitude of its magnetic moment to that of its angular momentum depends on:

(a) ω and q (b) ω, q and m

(c) q and m (d) ω and m

38. A wire of length L meters carrying a current I amperes is bent in the form of a circle. The magnitude of the magnetic moment is:

(a) $\frac{LI^2}{2\pi}$ (b) $\frac{LI^2}{4\pi}$

(c) $\frac{L^2I}{2\pi}$ (d) $\frac{L^2I}{4\pi}$

39. It is observed that only 6.25% of a given radioactive sample is left undecayed after a period of 16 days. What is the decay constant of this sample in days $^{-1}$?

(a) 4.173 days $^{-1}$

(b) 0.173 days $^{-1}$

(c) 1.173 days $^{-1}$

(d) 2.173 days $^{-1}$

40. Calculate the energy released in the following reaction.

$_3Li^6 + _0n^1 \rightarrow _2He^4 + _1H^3$

Given :

Mass of $_3Li^6$ nucleus $= 6.015126 amu$

Mass of $_1H^3$ nucleus $= 3.016049 amu$

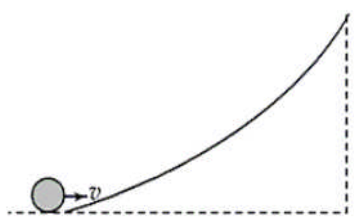
Mass of $_2He^4$ nucleus $= 4.002604 amu$

Mass of $_0n^1 = 1.008665 amu$

(a) $4.78\ MeV$ (b) $5.13\ MeV$

(c) $4.13\ MeV$ (d) $8.15\ MeV$

41. A small object of uniform density rolls up a curved surface with an initial velocity v'. It reaches up to a maximum height of $\frac{3v^2}{4g}$ with respect to the initial position. The object is



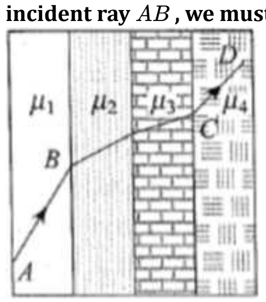
(a) Ring

(b) Solid sphere

(c) H ollow sphere

(d) Disc

42. A ray of light passes through four transparent media with refractive indices μ_1, μ_2, μ_3, and μ_4 as shown in the figure below. The surfaces of all media are parallel. If the emergent ray CD is parallel to the incident ray AB , we must have:



(a) $\mu_1 = \mu_2$ (b) $\mu_2 = \mu_3$

(c) $\mu_3 = \mu_4$ (d) $\mu_4 = \mu_1$

43. A $4.5\ cm$ long needle is placed $12\ cm$ away from a convex mirror of focal length $15\ cm$. Give the location of the image and the magnification.

(a) $6.7\ cm; 0.56$ (b) $7.6\ cm; 0.23$

(c) $8.3\ cm; 0.12$ (d) $9.2\ cm; 0.92$

44. If there is a positive error of 50% in the measurement of velocity of a body, then the error in the measurement of kinetic energy is :

(a) 25% (b) 50%

(c) 100% (d) 125%

45. Accuracy of measurement is determined by __________.

(a) Absolute error

(b) Percentage error

(c) Both (A) and (B)

(d) None of these

46. In Young's experiment, light of wavelength $6000 A^0$ is used to produce fringes of width $0.8\ mm$ at a distance of $2.5 m$. If the whole apparatus is dipped in a liquid of refractive index 1.6 , the fringe width will be

(a) $0.2\ mm$ (b) $0.4\ mm$

(c) $0.6\ mm$ (d) $0.5\ mm$

47. A source emitting wavelengths 480 nm and 600 nm is used in Young's Double Slit Experiment. The separation between the slits is 0.25 mm. The interference is observed 1.5 m away from the slits. The linear separation between first maxima of the two wavelengths is :

(a) 0.72 mm (b) 0.62 mm

(c) 0.76 mm (d) 0.27 mm

48. A car moving with a speed of 50 km/h can be stopped by brakes after at least 6 m. If the same car is moving at a speed of 100 km/h, the minimum stopping distance is:

(a) 12 m (b) 18 m

(c) 24 m (d) 6 m

49. A particle moves for 20 seconds with velocity 3 m/s, then moves with velocity 4 m/s for another 20 seconds, and finally moves with velocity 5 m/s for the next 20 seconds. What is the average velocity of the particle?

(a) 3 m/s (b) 4m/s

(c) 5 m/s (d) 0

50. __________ factor that affects the heat of reaction which is based on Kirchoff's equation.

(a) Molecularity (b) Temperature

(c) Pressure (d) Volume

51. An ideal refrigerator has a freezer at a temperature of $-13°C$ .The coefficient of performance of the engine is 5 . The temperature at which heat is rejected will be:

(a) $30.5°C$ (b) $32.5°C$

(c) $39°C$ (d) $38°C$

52. If two bulbs, one of 200 W and the other of 100 W are connected in series with a 100 V battery, then which bulb will have more brightness:

(a) 100 W bulb will have more brightness

(b) 200 W bulb will have more brightness

(c) Both bulb will have equal brightness

(d) Can't say

53. The heat generated while transferring 96000 coulomb of charge in one hour through a potential difference of 50 V is:

(a) $4.8 \times 10^4 J$ (b) $1.33 \times 10^3 J$

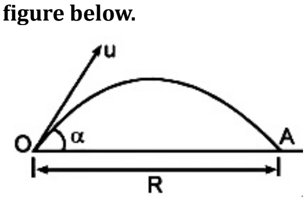
(c) $4.8 \times 10^6 J$ (d) $1.33 \times 10^4 J$

54. Two projectiles are projected with the same velocity. If one is projected at an angle of $30°$ and the other at $60°$ to the horizontal. What will be the ratio of maximum heights?

(a) $1 : 3$ (b) $1 : 2$

(c) $2 : 3$ (d) $3 : 1$

55. A particle projected from O and moving freely under gravity strikes the horizontal plane passing through O at a distance R from the starting point O as shown in the figure below.



Then which one of the following

will be true?

(a) There will be two angles of projection if $Rg > u^2$

(b) The two possible angles of projection are not complementary

(c) The product of the possible times of flight from O to A is $\frac{2R}{g}$

(d) There will be more than two angles of projection if $Rg = u^2$

56. The pressure inside a soap bubble of $10mm$ diameter above the atmosphere is ($\sigma = 0.04N/m$)

(a) 32 Pa (b) 16 Pa
(c) 160 Pa (d) 0.32 Pa

57. A Newtonian fluid fills the clearance between a shaft and a sleeve. When a force of $0.9kN$ is applied to the shaft parallel to the sleeve, the shaft attains a speed of $1.25cm/s$. What will be the speed of the shaft if a force of $3kN$ is applied?

(a) $4.16cm/s$ (b) $5.19cm/s$
(c) $5.26cm/s$ (d) $6.32cm/s$

58. An excited hydrogen atom emits a photon of wavelength λ in returning to the ground state. If R is the Rydberg constant, then the quantum number n of the excited state will be:

(a) $\sqrt{\lambda R}$

(b) $\sqrt{\lambda R - 1}$

(c) $\sqrt{\frac{\lambda R}{\lambda R - 1}}$

(d) $\sqrt{\lambda R(\lambda R - 1)}$

59. What is the wavelength of a photon emitted during a transition from $n = 5$ state to $n = 2$ state in the hydrogen atom?

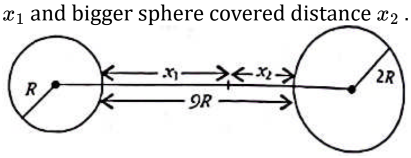
(a) 434 nm (b) 450 nm
(c) 350 nm (d) 525 nm

60. A hydrogen atom emits a photon of wavelength $1027\ \mathring{A}$. Its angular momentum changes by:

(a) $\frac{h}{\pi}$ (b) $\frac{h}{2\pi}$
(c) $\frac{3h}{2\pi}$ (d) $\frac{2h}{\pi}$

// Hints and Solutions //

1(C). Let the spheres collide after time t, when the smaller sphere covered distance x_1 and bigger sphere covered distance x_2.



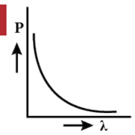
The gravitational force acting between two spheres depends on the distance which is a variable quantity.
Just before the collision, total distance travelled by both $= 9R$
If x is the distance travelled by the block of mass M and $9R - x$ the distance travelled by block of mass 5M.
As the centre of mass of system, not change, then:
$Mx = 5M(9R - x)\ x = 7.5R$

2(D). Given:
Mass of spaceship (m) = 1000 kg
$g = 10\ m/s^2$
R (radius of earth) = 6400 km
The energy needed for the spaceship to out into free space must be equal to gravitational potential energy.
$E = \frac{GMm}{R}$
$= (\frac{GM}{R^2})mR$
$= mgR\ \ [\because g = (\frac{GM}{R^2})]$
$= 1000 \times 10 \times 6400 \times 10^3$
$= 6.4 \times 10^{10}$ J

3(A). Given,
$V_R = 40$ V, $V_L = 60$ V, $V_C = 30$ V
For a series LCR circuit, the total potential difference of the circuit is given by,
$V = \sqrt{V_R^2 + (V_L - V_C)^2}$
$\Rightarrow V = \sqrt{(40)^2 + (60-30)^2} = \sqrt{2500} = 50V$
The supply voltage is 50 V.

4(C). Mutual induction between the two coils of area A, number of turns N_1 and N_2 with the length of secondary or primary l is given by,
$M = -\frac{e_2}{\frac{dI_1}{dt}} = -\frac{e_1}{\frac{dI_2}{dt}}$
Emf induced in coil 1 is given by $e_1 = -L_1\frac{dI_1}{dt}$
Emf induced in coil 2 is given by $e_2 = -L_2\frac{dI_2}{dt}$
If all the flux of coil 2 links coil 1 and vice versa, then
$M^2 = \frac{e_1e_2}{\left(\frac{d_i}{dt}\right)\left(\frac{d_{i_2}}{dt}\right)}$
$M^2 = L_1L_2$
$M = \sqrt{L_1L_2}$

5(D).



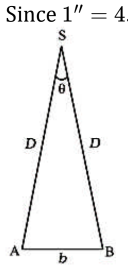
The de-Broglie wavelength is given by
$\lambda = \frac{n}{P}$
$\lambda \propto \frac{1}{P}$,
$\lambda P =$ constant

6(A). Power of transmitter,
$P = 10$kW
$= 10 \times 10^3$W
Frequency of the transmitter,
$v = 880$kHz
$= 880 \times 10^3$ Hz
Number of photons emitted per second
$N = \frac{P}{hv} = \frac{10 \times 10^3}{6.6 \times 10^{-34} \times 880 \times 10^3}$
$N = 1.71 \times 10^{31}$ photons emitted per second.

7(C). Given,
$\lambda_1 = 3\lambda_2$
According to Einsteins photoelectric equation
$\frac{hc}{\lambda} = \phi_0 + KE_{max}$
$\therefore K_1 = \frac{hc}{\lambda_1} - \phi_0$ and $K_2 = \frac{hc}{\lambda_2} - \phi_0$
or,
$K_1 - K_2 = hc\left[\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right]$
$= hc\left[\frac{1}{3\lambda_2} - \frac{1}{\lambda_2}\right] = -\frac{2hc}{3\lambda_2}$
$\Rightarrow K_1 - K_2 = -\frac{2}{3}(K_2 + \phi_0)$
or,
$K_1 = K_2 - \frac{2}{3}\phi_0 = \frac{K_2}{3} - \frac{2}{3}\phi_0$
Or,
$K_1 < \frac{K_2}{3}$
$\Rightarrow K_1 = 3K_2$

8(D). The given equation is,
$n = \frac{A+B}{\lambda^2}$
Where A and B are constants.
$n =$ Refractive index
$\lambda =$ Wavelength
By homogeneity principle the dimensions of all the terms on both sides should be same i.e.,
$[B] = [A] = [n\lambda^2]$
$[B] = [M^0\ L^0\ T^0]\ [L^2]$
$[B] = [M^0L^2T^0]$

9(A). $\theta = 1°54' = 114'$
$= (114 \times 60)'' \times (4.85 \times 10^{-6})$rad
$= 3.32 \times 10^{-2}$rad
Since $1'' = 4.85 \times 10^{-6}$rad



$b = AB = 1.276 \times 10^7$ m
Then by this formula,
$D = \frac{b}{\theta}$
$= \frac{1.276 \times 10^7}{3.32 \times 10^{-2}}$
$= 3.84 \times 10^8$ m

10(C). The volume and temperature are the same for the two gases.
Given the ratio of partial pressure $\frac{n_1}{n_2} = \frac{5}{2}$
We know that:
$P_1V = n_1RT$ and $P_2V = n_2RT$
Where, P is pressure, V is volume, T is

temperature, n is no. of mole and R is the universal gas constant

$\frac{P_1}{P_2} = \frac{n_1}{n_2} = \frac{5}{2} = 2.5$

If N_1 and N_2 are the numbers of molecules of and N is the Avogadro's number, then:

$\frac{n_1}{n_2} = \frac{\frac{N_1}{N}}{\frac{N_2}{N}} = \frac{5}{2} = 2.5$

Thus, the ratio of the number of molecules of helium and Neon is 2.5 .

11(B). We know that:
The relation between the ratio of C_p and C_V with a degree of freedom is given by,

$\gamma = \frac{C_p}{C_v} = 1 + \frac{2}{f}$

Where, $C_v =$ molar specific heat capacity of a gas at constant volume, $C_p =$ molar specific heat of a gas at constant pressure, $f =$ degree of freedom, γ is the adiabatic constant

Diatomic gas has 5 degrees of freedom,

$\gamma = 1 + \frac{2}{5}$

$= \frac{5+2}{5}$

$= \frac{7}{5}$

12(D). A conical pendulum consists of a mass on the end of a string suspended from a point which moves in a circular path.
Let us consider a conical pendulum having the mass m revolving in a circle at a constant velocity v on a string of length l at an angle of θ .
There will be two forces acting on the mass, Tension and centripetal force.
The Tension exerted can be resolved into a horizontal component, $T\sin(\theta)$ and vertical component
Tcos(θ)
The horizontal component of the tension experience centripetal force since the conical pendulum travels in a circular path of radius r with a constant velocity v

$T\sin\theta = \frac{mv^2}{r}$

We can rearrange the above equation as

$T = \frac{mv^2}{r\sin\theta} \to 1$

Since there is no acceleration in the vertical direction, the vertical component is equal and opposite to the weight of the mass so, the vertical component of tension is

$T\cos\theta = mg$

We can rearrange the above equation as

$T = \frac{mg}{\cos\theta} \to 2$

Equating 1 and 2

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

$v^2 = \frac{gr\sin\theta}{\cos\theta}$

$v^2 = gr\tan\theta \to 3$

Given that, The radius of the circular path, $r = 0.4m$

The conical pendulum makes an angle $\theta = 45^\circ$

The acceleration due to gravity, $g = 9.8m/s$

Substitute these given values in the equation 3

$v^2 = gr\tan\theta$

$v^2 = 9.8 \times 0.4 \times \tan 45^\circ$

$v^2 = 9.8 \times 0.4 \times 1$

$v^2 = 3.9 = 4m/s$

$v = \sqrt{4}m/s = 2m/s$

13(D). Amplitude of an damped oscillation is given using the equation, $A = A_0 \cdot e^{\frac{-bt}{2m}}$. It is known that energy of the damped oscillation system is directly related to its amplitude. It is said that since the system dissipates energy gradually with respect to time, the amplitude will decrease with time.
Now, work done is defined as a product of force and displacement. Here, the force acting on the mass is due to spring. Hence, $W = F \times x^2$, which means that work done is directly proportional to square of displacement. In graphical terms, displacement in waveforms is measured as amplitude. Thus energy is proportional to square of amplitude.

When energy is halved, $\frac{E}{2} \propto {a_{\text{new}}}^2$. This implies

When energy is halved, $\frac{E}{2} \propto a_{new}^2$. This implies

$\sqrt{\frac{E}{2}} \propto a_{new}$

$\frac{a_0}{\sqrt{2}} \propto a_{new}$

Substituting the value in the amplitude equation we get,

$A_{new} = A_0 \cdot e^{\frac{-bt}{2m}}$

$\frac{A_0}{\sqrt{2}} = A_0 \cdot e^{\frac{-bt}{2m}}$ (since we know that $A_{new} \frac{A_0}{\sqrt{2}}$ which was derived above)

Cancelling the like term we get

$\frac{1}{\sqrt{2}} = e^{\frac{-bt}{2m}}$

We know that damping constant b is 10^{-2} and mass m as $0.1kgs$. Substituting this we get,

$\frac{1}{\sqrt{2}} = e^{\frac{-10^{-2}t}{2\times 0.1}}$

Removing e by multiplying lnon both sides we get,

$\ln\left(\frac{1}{\sqrt{2}}\right) = \frac{-10^{-2}t}{0.2}$

$-0.35 = \frac{-10^{-2}t}{0.2}$

$0.35 \times 20 = t$

$t = 7s$

14(A). $4\,(x_1 t) = 0.5\sin\left(\frac{5\pi}{4}x\right)\cos(2\omega\pi t)$

$y_1 = A\sin(\kappa x + \omega t)$

$y_2 = A\sin(-\omega t + \kappa x)$

$y_1 + y_2 = A[\sin\kappa x\cos\omega t + \cos\kappa x\sin\omega t\sin \kappa x\cos\omega t - \cos\kappa x\sin\omega t]$

$y_1 + y_2 = 2A\sin\kappa x\cos\omega t$

$v = \frac{\omega}{\kappa}$

$= \frac{2\omega\pi}{5\pi/4}$

$= 160m/s$

15(B). A simple pendulum has a string with a very small mass (sphere ball). It is small but strong enough not to stretch. The mass suspended from the light string that can oscillate when displaced from its rest position.
Pendulums are in common usage such as in clocks, child's swing and some are for fun. For small displacements, a pendulum is a simple harmonic oscillator.
The pendulum's time period is proportional to the square root of the length of string and inversely proportional to the square root of acceleration due to gravity.
The time period of a simple pendulum is given by

$T \propto \sqrt{\frac{l}{g}}$

$T \propto \sqrt{\frac{1}{g}}; T \propto \sqrt{l}$

Where,
T is the time period
l is the length of the pendulum
g is the acceleration due to gravity
Let us take the relation,

$T \propto \sqrt{l}$

$T \propto l\frac{1}{2}$

Given that,
The relative difference in the periods, is $5 \times 10^{-4}s$

$\Delta T = 5 \times 10^{-4}s$

The pendulum is attached to different spherical bobs of radii r_1 and r_2
The change in length is the difference in radii

$\Delta l = |r_1 - r_2|$

Substitute the above in equation 1

$\Delta T = \frac{1}{2}\Delta l \to 1$

$5 \times 10^{-4} = \frac{1}{2}|r_1 - r_2|$

$|r_1 - r_2| = 2 \times 5 \times 10^{-4}$

$|r_1 - r_2| = 10 \times 10^{-4}m$

$|r_1 - r_2| = 0.1 \times 10^{-2}m$

$|r_1 - r_2| = 0.1cm$

The difference in radii, $|r_1 - r_2|$ is $0.1cm$

16(A). Given,

$KE_1 = 50J$

$KE_2 = 150J$

$t = 10s$

As we know,
The work-energy theorem states that the net work done by the forces on an object is equal to the change in its kinetic energy.

$W = \Delta KE$

Where $W =$ work done and $\Delta KE =$ change in kinetic energy
By the work-energy theorem,

$W = \Delta KE$

$\therefore W = KE_2 - KE_1$

$\Rightarrow W = 150 - 50$

$\Rightarrow W = 100J$

So, the power of the body $(P) = \frac{W}{t}$

Where $W =$ work and $t =$ time

$\therefore P = \frac{100}{10}$

$P = 10W$

17(D). The work-energy theorem states that the net work done by the forces on an object equals the change in its kinetic energy.

Work done, $(W) = \Delta K = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$

Where m is the mass of the object, v is the final velocity of the object and u is the initial velocity of the object.

Work-energy theorem for a variable force:

Kinetic energy, $K = \frac{1}{2}mv^2$

$\frac{dK}{dt} = \frac{d\left(\frac{1}{2}mv^2\right)}{dt}$

$\Rightarrow \frac{dK}{dt} = m\frac{dv}{dt}v$

$\Rightarrow \frac{dK}{dt} = mav$

$\Rightarrow \frac{dK}{dt} = Fv$

$\Rightarrow \frac{dK}{dt} = F\frac{dx}{dt}$

$\Rightarrow dK = Fdx$

On integrating, we get

$\int_{K_i}^{K_f} dK = \int_{x_i}^{x_f} Fdx$

$\Rightarrow \Delta K = \int_{x_i}^{x_f} Fdx$

All the given options are correct as they are all different forms of representing the work-energy theorem for a variable force.

18(B). Given,

Mass of the body, $m = 3.0$ kg

$t = 25$ seconds

Initial velocity, $u = 2.0$ m/s

Final velocity, $v = 3.5$ m/s

From the first equation of motion,

$v = u + at$

$a = \frac{(3.5-2.0)}{25}$

$= 0.06$ m/s ^{2}

The magnitude of the force, $F = ma$

$= 3.0 \times 0.06 = 0.18$ N

$= 0.18$ N

19(C). Given,

Mass of the body, $m = 5.0$ kg

Magnitude of forces,

$\vec{F_1} = 8$ Newton

$\vec{F_2} = 6$ Newton

The magnitude of the resultant force of these forces,

$F = \sqrt{\vec{F_1}^2 + \vec{F_2}^2}$

$= \sqrt{[8^2 + 6^2]}$

$= \sqrt{(64 + 36)}$

$= \sqrt{100} = 10$ Newton

Magnitude of acceleration,

$a = \frac{F}{M}$

$= \frac{10}{5.0}$

$= 2m/s^2$

20(B). Among all the given options, hydrochloric acid has the least number of atoms. Every hydrochloric (HCl) acid molecule contains two atoms: one hydrogen and one chlorine.

A molecule of methane (CH_4) contains five atoms: four hydrogen atoms and one carbon atom.

A water (H_2O) molecule consists of three atoms: one oxygen atom and two hydrogen atoms.

Sulphuric acid (H_2SO_4) contains seven atoms: two hydrogen atoms, one sulfur atom and four oxygen atoms.

21(C). Magnetic Flux $\phi = \vec{B} \cdot \vec{A}$

$\Rightarrow$ Magnetic flux $(\phi) =$ B.A.Cos θ

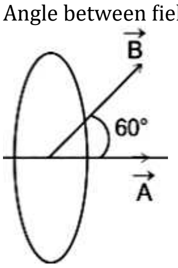
Given Magnetic Field $B = \frac{1}{\pi}\left(\frac{Wb}{m^2}\right)$

Area enclosed (Circular) $= \pi r^2$

$r = 0.2m$

Area $= \pi(0.2)^2$

Angle between field and area $\theta = 60^\circ$



Magnetic Flux $\phi = \text{B.A.Cos}\theta = \frac{1}{\pi}\left(\frac{Wb}{m^2}\right)\left(\pi(0.2)^2\right)\left(\frac{1}{2}\right) = 0.02Wb$

22(C). The frequency of electromagnetic waves

$v = 9\sqrt{\text{maximum electron density}}$

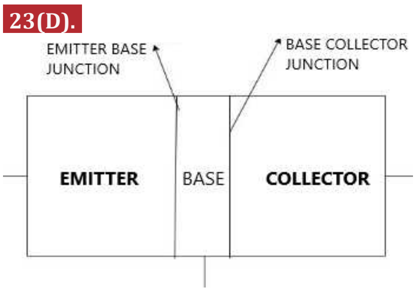
or $v = 9\sqrt{d_{\max}}$

$\Rightarrow 9\sqrt{2} \times 10^6 = 9\sqrt{d_{\max}}$

$\Rightarrow \sqrt{2} \times 10^6 = \sqrt{d_{\max}}$

$d_{\max} = 2 \times 10^{12} m^{-3}$

23(D).



Let us study the validity of each of the four statements with explanations:

Statement – A: Base, emitter, and collector regions have similar size and doping concentrations.

The Emitter, Base and Collector regions have different sizes with varying concentrations. The order of size of these regions are: Base < Emitter < Collector The order of the concentration of the regions are: Base < Collector < Emitter

Hence, these regions are doped in a different way and their sizes are also, unsimilar.

Statement – B: The base region must be very thin and lightly doped.

The base region is the thinnest region of the transistor and the electron concentration of this region, as a result, is the lowest among the three regions.

Statement – C: The emitter-base junction is forward biased and base-collector junction is reverse biased.

The emitter region has a high concentration of electrons. So, connecting them across the base will result in their movement to the base and then, the collector. To facilitate the movement of the charge carriers from emitter, the emitter-base junction is forward biased, and the base-collector junction is reverse biased so as to attract these charge carriers towards the collector region.

Statement – D: Both the emitter-base junction as well as the base-collector junction are forward biased.

If both the emitter-base and collector-base junction are forward biased, the charge carriers will not be able to cross the barrier across the base to move to the collector, thereby, decreasing or hindering the functionality of the transistor.

24(A). The circuit consists of two NOT gates connected to each input of a NOR gate. The correct truth table of the combination will be:

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

25(B). Given that:

Dipole Moment, $P = 3 \times 10^{-3}$ cm

Electric Field Intensity, $E = 10^4 \text{NC}^{-1}$

We know that:

In rotating the dipole from the position of stable equilibrium by an angle θ, the amount of work done is given by,

$W = PE(1 - \cos\theta)$

For unstable equilibrium, $\theta = 180^\circ$

$\therefore W = PE(1 - \cos 180^\circ)$

$[\because \cos 180^\circ = -1]$

$= 2PE$

$= 2 \times 3 \times 10^{-3} \times 10^4$ J

$= 60$ J

26(D). Given a mass of copper slab $= 2$ g contains 2×10^{22} atoms.

We have to find the fraction of electrons that must be removed from sphere to give it $+2\mu$ C charge.

Charge on nucleus of each atom $= 29$ e

$\therefore$ Net charge on 2 gm sphere $= (29)e \times \left(2 \times 10^{22}\right) = 5.8 \times 10^{23}$ ec

$\therefore$ No of electrons on sphere $= 5.8 \times 10^{23}$

$\therefore$ Number of electrons removed to give $2\mu c$ charge $= \frac{q}{e}$

$= \frac{2\times10^{-6}}{1.6\times10^{-19}}$

$= 1.25 \times 10^{13}$

Fraction of electrons removed $= \frac{1.25\times10^{13}}{\text{Total number of electrons in sphere}}$

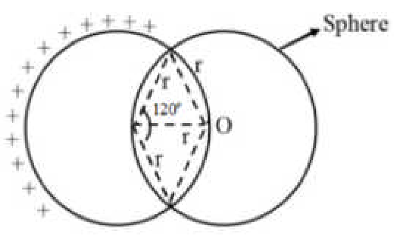
$= \frac{1.25\times10^{13}}{29\times2\times10^{22}}$

$= 2.16 \times 10^{-11}$

27(A). The phase difference between the electric field and the magnetic field in the electromagnetic wave is zero.
The electric field and the magnetic field components of an electromagnetic wave oscillate in such a way that they have their peak at the same time and also become zero at the same time. Since there is no time difference between the peaks of the electric and the magnetic field, so the phase difference between the electric and the magnetic field of the electromagnetic wave is zero.

28(B). Infrared radiation was discovered in 1800 by William Herschel.
He did so with a simple experiment in which he dispersed sunlight through a prism and placed a thermometer at the location of each colour. He noticed that the thermometer temperature increased when he did this, which was not really unexpected since sunlight carries warmth. However when he placed the thermometer past the red end of the spectrum – where there was no visible sunlight – the thermometer's temperature still increased. Herschel had discovered infrared radiation – radiation beyond the red end of the visible spectrum. Wavelength: 700 nanometers to 1 millimeter.

29(D).



If angle at centre is 360° then charge is q .
If angle at centre is 120° then charge $= \frac{q}{360^\circ} \times 120^\circ$
So, $q_{eq} = \frac{q}{3}$
By Gauss's law,
$\phi = \frac{q_{eq}}{\varepsilon_0}$
$\Rightarrow \phi = \frac{q}{3\varepsilon_0}$

30(D). The transfer of electrons from one body to the other results is development of charges. So, no. of electrons given by one body = No. of electrons obtained by the other.
So, mass of negatively charged body slightly increases while mass of positively charged body slightly increases, whereas the total mass of the system remains the same.

31(C). If a liquid is heated in space under no gravity the transfer of heat will take place by process of radiation.
In the case of conduction and convection, the presence of gravity is crucial for these processes to happen.
In the case of radiation, it does not need gravity hence heat transfer can happen only by the process of radiation.

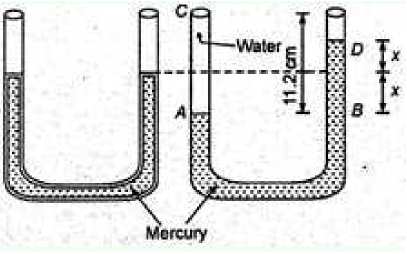
32(B). Boyle's law holds for an ideal gas during isothermal changes.
According to Boyle's law, For a given mass of an ideal gas at a constant temperature, the volume of a gas is inversely proportional to its pressure i.e.
$V \propto \frac{1}{P}$ or $PV =$ constant
$P_1V_1 = P_2V_2$

33(A). When a ferromagnetic material is heated to Curie temperature, it disrupts the arrangements of the molecules and a weak magnetic behavior remains. This weak magnetic behavior is called Paramagnetic. Above this temperature, the paramagnetism property also decreases. Upon cooling, it regains its ferromagnetic behavior.

34(D). For a diamagnetic material, μ_r and ϵ_r should have following bounds $0 < \mu_r < 1$ and for any material $\epsilon_r > 1$. Diamagnetic materials create an induced magnetic field in a direction opposite to an external applied magnetic field and are repelled by applied magnetic field. Magnetic permeability of the diamagnetic materials is little less than unity.

35(C). Since it is given that the coefficient of cubical expansion of alcohol is more than that of the metal.
Upthrust = (volume of the metal ball)× (density of liquid)×g
With the increase in temperature volume of the ball will increase and the density of the liquid will decrease. But the coefficient of cubical expansion of liquid is more. Hence the second effect is more dominating. Therefore upthrust, at higher temperatures will be less, or apparent weight will be more.

36(C). At the same level in the two limbs of a U-tube, the pressure is the same. On pouring water on the left side, mercury rises x cm (say) from its previous level in the right limb of the U-tube creating a difference of levels of mercury by $2x$ cm .
Equating pressures at A and B , we get
$P_A = P_B$
$\therefore 11.2 \times 10^{-2} \times \rho_{\text{water}} \times g = 2x \times \rho_{\text{mercury}} \times g$
$\Rightarrow 11.2 \times 10^{-2} \times 1000\ kg/m^3$
$= 2x \times 13600 \times kg/m^3$
$\Rightarrow x = \frac{11.2 \times 10^{-2} \times 1000\ m}{2 \times 13600} = 0.41\ cm$



37(C). Magnetic moment M = Current × Area $= \frac{\text{Charge} \times \text{Area}}{\text{Time}}$
$= \frac{q \times \pi r^2}{T} = \frac{1}{2} q\omega r^2 \quad (\because \omega = \frac{2\pi}{T})$
Angular momentum $L = m\omega r^2$
$\therefore \frac{M}{L} = \frac{\frac{1}{2} q\omega r^2}{m\omega r^2} = \frac{q}{2m}$
Thus, t he ratio of its magnitude of its magnetic moment to that of its angular momentum depends on q and m
Hence the correct option is (C).

38(D). Magnetic moment $m = AI = \pi r^2 I$
where r is the radius of the circular loop.
Now, the circumference of the circle = length of the wire, i.e.,
$2\pi r = L$
$\pi r^2 = \frac{L^2}{4\pi^2}$
Therefore, $m = \pi r^2 I = \frac{\pi L^2 I}{4\pi^2} = \frac{L^2 I}{4\pi}$
Thus, t he magnitude of the magnetic moment is $\frac{L^2 I}{4\pi}$
Hence the correct option is (D).

39(B). Here,
$\frac{N}{N_0} = \frac{6.25}{100}$
$= \frac{0.25}{4}$
$t = 1$ days, $\lambda = ?$
As,
$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$
$= \frac{0.25}{4}$
$= \frac{1}{16}$
$= \left(\frac{1}{2}\right)^4$
$\therefore n = 4$
As,
$n = \frac{t}{T} = T$
$= \frac{t}{n}$
$= \frac{16}{4}$
$= 4$ days
Decay constant,
$\lambda = \frac{0.693}{T} = \frac{0.693}{4}$
$= 0.173$ days $^{-1}$

40(A). Given data:
Mass of $_3Li^6$ nucleus $= 6.015126 amu$
Mass of $_1H^3$ nucleus $= 3.016049 amu$
Mass of $_2He^4$ nucleus $= 4.002604 amu$
Mass of $_0n^1 = 1.008665 amu$
Solution:
Mass of the reactant = mass of $_3Li^6 +$ mass of neutron
$= (6.015126 + 1.008665) = 7.023791 amu$
Mass of the product = mass of $_2He^4 +$ mass of $_1H^3$
$= (3.016049 + 4.002604) = 7.018653 amu$
Mass difference $\Delta m = (7.023791 - 7.018653)$
$= 0.005138 amu$
Energy released $= (0.005138 \times 931) MeV$
$= 4.783 MeV$

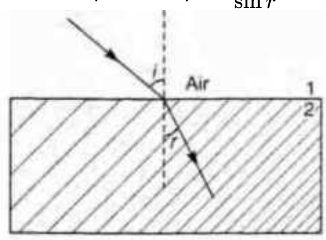
41(D). $v=\sqrt{\frac{2gh}{1+\frac{k^2}{r^2}}}$

$v^2=\sqrt{\frac{2g3v^2}{4g\left(1+\frac{k^2}{r^2}\right)}}$

$\Rightarrow 1+\frac{k^2}{r^2}=\frac{3}{2}$

$k_2=\frac{1}{2}r^2 \rightarrow disc$

42(D). Applying Snell's law at B and C,
$\mu \sin i=$ costant or
$\mu_1 \sin i_B=\mu_4 \sin i_C$
But $AB \| CD$
$\therefore i_B=i_C$
or $\mu_1=\mu_4$
or $\mu_1 \sin i_1=\mu_2 \sin i_2$
Here, $\mu_1=1, \mu_2=\mu$
or $\sin i=\mu \sin r$ or $\mu=\frac{\sin i}{\sin r}$



43(A). Given: Height of the needle, $h_1=4.5\ cm$
Object distance, $u=-12\ cm$
The focal length of the convex mirror, $f=15\ cm$
Image distance, v
The value of v can be obtained using the mirror formula. $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$

$\Rightarrow \frac{1}{v}+\frac{1}{-12}=\frac{1}{15}$

$\Rightarrow \frac{1}{v}=\frac{1}{12}+\frac{1}{15}$

$\Rightarrow \frac{1}{v}=\frac{9}{60}$

$\therefore v \approx 6.7\ cm$
Hence, the image of the needle is 6.7 cm away from the mirror. Also, it is on the other side of the mirror. The image size is given by the magnification formula.

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

$h'=\frac{6.7 \times 4.5}{12}$

$\Rightarrow h'=+2.5\ cm$

So, $m=\frac{2.5}{4.5}$

$\Rightarrow m=0.56$
The height of the image is 2.5 cm. The positive sign indicates that the image is erect, virtual, and diminished. If the needle is moved farther from the mirror, the size of the image will reduce gradually.

44(C). Given,
The percentage error in velocity $=\frac{\Delta \mathrm{v}}{\mathrm{v}} \times 100$

Kinetic energy K. E. $=\frac{1}{2} \mathrm{mv}^2$

Percentage error in the kinetic energy,
$\frac{\Delta \mathrm{K{\cdot}E.}}{\mathrm{K{\cdot}E.}} \times 100=\mathrm{m} \times 2 \frac{\Delta \mathrm{v}}{\mathrm{v}} \times 100$

$\Rightarrow \frac{\Delta \mathrm{K.E.}}{\mathrm{K.E.}} \times 100=2 \times 50\%$

$\Rightarrow \frac{\Delta \mathrm{K.E.}}{\mathrm{K.E.}} \times 100=100\%$

Thus, the error in the measurement of kinetic energy is 100%.

45(A). Accuracy of measurement is determined by the absolute error. Absolute error is the is the difference between the actual and measured value. It is the maximum possible error that needs to be eliminate to get an accurate measurement.

46(D). The Young's double slit experiment belongs to a general class of "double path" experiments, in which a wave is split into two separate waves that later combine into a single wave.
In water λ is reduced to $\frac{\lambda}{\mu}$ so λ' so $\lambda'=\frac{\lambda}{16}$

As $\omega=\frac{D\lambda}{d} \propto \lambda$

$\frac{\omega'}{\omega}=\frac{\lambda'}{\lambda}=\frac{\frac{\lambda}{16}}{\lambda}$

or

$\omega'=\frac{0.8}{1.6}=0.5\ mm$

47(A). First Maxima $=\frac{D\lambda}{d}$

$\beta_1=\frac{1.5 \times 480 \times 10^{-9}}{0.25 \times 10^{-3}}$
$=2.880 \times 10^{-3}$ m

$\beta_2=\frac{1.5 \times 600 \times 10^{-9}}{0.25 \times 10^{-3}}$
$=3.600 \times 10^{-3}$ m

So, $\beta_2-\beta_1=0.72 \times 10^{-3}$ m
$=0.72$ mm

48(C). Given,
$u=50\ km/hr=50 \times \frac{5}{18}=\frac{250}{18}\ m/s$

$v=0$
$s=6\ m$ (at least)
By third equation by motion,
$v^2=u^2+2as$

$0=\left(\frac{250}{18} \times \frac{250}{18}\right)+2(-a)(s)$

$0=192.90-12a$

$a=\frac{192.90}{12}=16.07$

Now applying third equation of motion,
$v^2=u^2+2\mathrm{as}$

$0=\left(100 \times \frac{5^2}{18}\right)+2(-16.07)(s)$

$0=771.60-32.14\ s$

$s=\frac{771.60}{32.14}=24.00$

$\therefore$ The minimum stopping distance is 24 m.

49(B). Given,
Initial velocity $=3$ m/s
Time $=20$ s
Total distance covered by particle,
$d=v_1 t_1+v_2 t_2+v_3 t_3$
$\because t_1=t_2=t_3=20$ s
$T=3 \times 20=60$ s

$v=\frac{d}{t}$

$\Rightarrow \frac{240}{60}=4$ m/s

50(B). Kirchhoff's Law describes the enthalpy of a reaction's variation with temperature changes. In general, enthalpy of any substance increases with temperature, which means both the products and the reactants' enthalpies increase. The overall enthalpy of the reaction will change if the increase in the enthalpy of products and reactants is different.
At constant pressure, the heat capacity is equal to change in enthalpy divided by the change in temperature.

$c_p=\frac{\Delta H}{\Delta T}$

Therefore, if the heat capacities do not vary with temperature then the change in enthalpy is a function of the difference in temperature and heat capacities. The amount that the enthalpy changes by is proportional to the product of temperature change and change in heat capacities of products and reactants.

51(C). Given that, the temperature of freezer,
$T_2=-13^{\circ} C$
$\Rightarrow \quad T_2=-13+273=260K$
Coefficient of performance, $\beta=5$
The coefficient of performance is defined as,

$\beta=\frac{T_2}{T_1-T_2}$

$=5=\frac{260}{T_1-260}$

$=T_1-260=\frac{260}{5}$

$=T_1-260=52$
$\mathrm{T}_1=(52+260)K=312K$
$T_1=(312-273)^{\circ} C$
$T_1=39^{\circ} C$

52(A). Given:
$P_1=200W$
$P_2=100W$
$V=100V$
We know that:
The rate at which the electric energy is dissipated or consumed is termed as electric power.
The electric power is given as,

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

Where, $P=$ electric power, $V=$ voltage, $I=$ current and $R=$ resistance

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

$R \propto \frac{1}{P} \quad \ldots(1)$

For an electric bulb, the resistance of the bulb is inversely proportional to the power of the bulb.
So, the bulb which has more power will have low resistance, therefore the $100W$ bulb will have more resistance compared to the $200W$ bulb.
The heat dissipated by the bulb is given as,
$H=I^2 R$
Both the bulbs are connected in series so the current in both the bulbs will be equal. So the heat dissipated will be more in the bulb which has more resistance.
Since the resistance of the $100W$ bulb is more, so the heat dissipation of the $100W$