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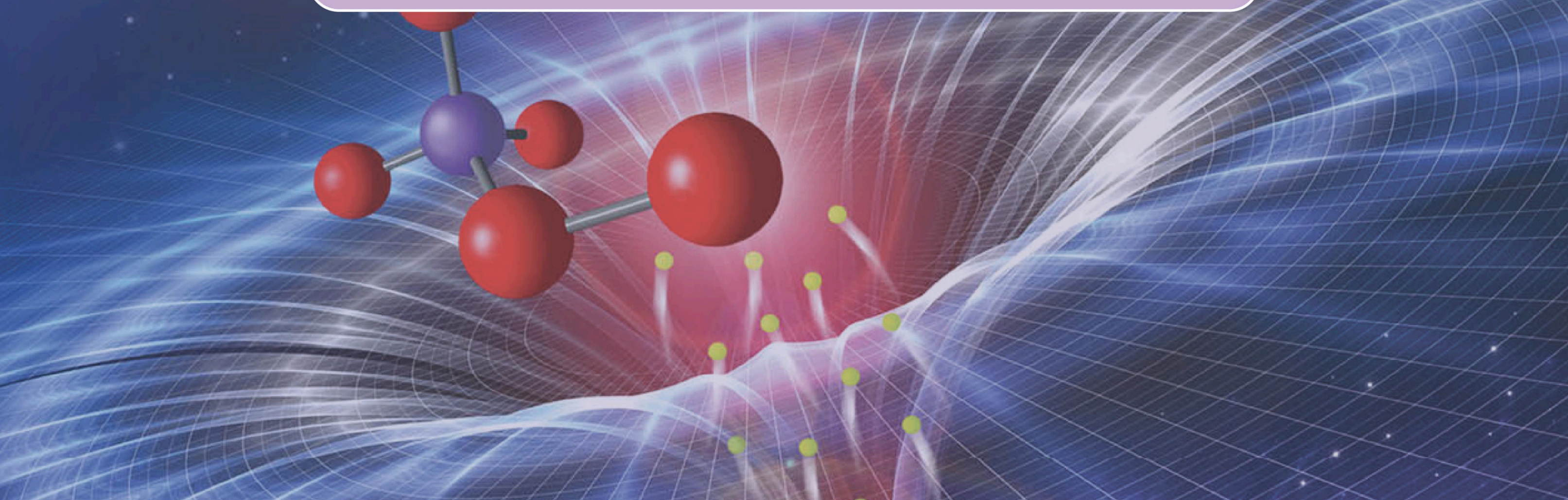
Conducted by Karnataka Examination Authority (KEA)

Karnataka Common Entrance Test

KCET

Physics



10 Practice Tests

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PHYSICS

Karnataka Common Entrance Test - KCET

Latest Edition
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10 Tests

10 Practice Test

Based On Real Exam Pattern

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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 $0.5\,\mathrm{m}$ 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 $H_E=0.4\mathrm{G}$ at the place, what is the induced emf between the axle and the rim of the wheel? Note that $1\mathrm{G}=10^{-4}\,\mathrm{T}$.

(a) $6.28\times10^{-5}\,\mathrm{V}$

(b) $4.28\times10^{-5}\,\mathrm{V}$

(c) $4.48\times10^{-5}\,\mathrm{V}$

(d) $3.28\times10^{-5}\,\mathrm{V}$

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 $80.0\mu C/\mathrm{m}^2$. What is the total electric flux leaving the surface of the sphere?

(a) $1.3\times10^8\,\mathrm{Nm}^2/C$

(b) $1.6\times10^5\,\mathrm{Nm}^3/C$

(c) $2.5\times10^8\,\mathrm{Nm}^2/C$

(d) $1.6\times10^8\,\mathrm{Nm}^2/C$

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) $5\,\mathrm{b}-4\mathrm{a}$ (d) $4\,\mathrm{b}-5\mathrm{a}$

31. $\mathrm{C_s}$ is the velocity of sound in air and C is the R.M.S. velocity, then:

(a) $\mathrm{C}=\mathrm{C_s}\sqrt{\frac{\gamma}{5}}$

(b) $\mathrm{C}=\mathrm{C_s}\sqrt{\frac{\gamma}{3}}$

(c) $\mathrm{C_s}=\mathrm{C}\sqrt{\frac{\gamma}{3}}$

(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

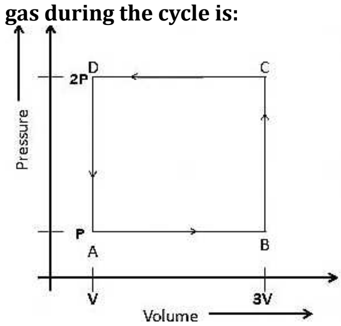
(d) Similar to the lighting, extremely high potential exists on both the bodies and hence they discharge through sparking

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 $2.5\times10^{-4}\,\mathrm{m}^2$ carries a current of $3.0\,\mathrm{A}$. What is its associated magnetic moment?

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

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

38. A domain in ferromagnetic iron is in the form of a cube of side length $1\mu\mathrm{m}$. 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 g/mole and its density is 7.9 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 cm diameter hole in a steel sheet 0.3 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 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 $1 min$ whereas that of Q is $2 min$. 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

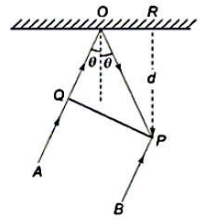
50. The quantity that does not have mass in its dimension is:

(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 $1.33 m$. 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) $11 m/s$
(c) $13 m/s$ (d) $12 m/s$

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) $2\mathrm{E}_0\mathrm{I}_0$ (b) $\sqrt{2}E_0 I_0$

(c) $\mathrm{E}_0\mathrm{I}_0$ (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.

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

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

$\alpha \to$ 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,

$V = 220\ \mathrm{V}$

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

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

$\mathrm{R} = 20\Omega$

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

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

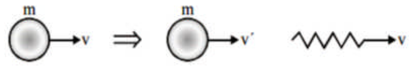
In the given circuit, capacitor is absent.

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

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



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,

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

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

Applying conservation of energy

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

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

From equation (1) and (2)

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

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

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

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

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

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

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

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

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

where,

$\mathrm{V_0} =$ stopping potential

$\lambda =$ wavelength of incident light

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

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

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

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

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

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

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

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

$= 2.2\mathrm{eV}$

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,

$\mathrm{E_1} = \mathrm{KE} + \mathrm{W}$

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

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

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

Put the given values in (i).

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

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

$\mathrm{KE} = \mathrm{E_1} - \mathrm{W}$ .....(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 $(\mathrm{KE}) = \frac{1}{2\mathrm{mv}^2}$

$\Rightarrow \mathrm{v} = \left[\frac{2\mathrm{KE}}{\mathrm{m}}\right]^{\frac{1}{2}}$ .....(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, $v = \frac{\mathrm{A}}{\mathrm{t}} + \mathrm{Bt}^2 + \mathrm{Ct}^3$

So, we can write the dimensional equation as:

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

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

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

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

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

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

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

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

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

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.

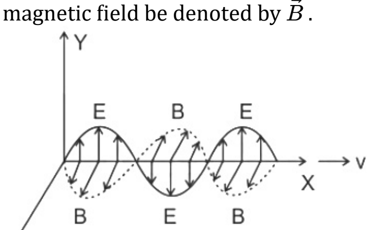
The energy in an electromagnetic wave is divided equally between electric and magnetic fields. Therefore, statement in option (C) is correct.

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

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

$= 250\pi^2$

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:

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

Where,

$k =$ force constant of spring

$x =$ elongation

True weight $= 49$ N

From equation (1), we get

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

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

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

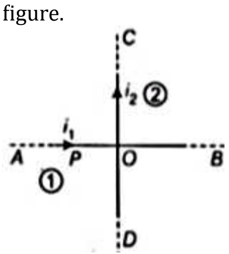
21(D). A radioactive nucleus emits a beta

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
$|E|=\frac{\Delta V}{\Delta r}=\frac{5\times 10^{-1}}{10^{-6}}$
$=5\times 10^5\ V/m$

26(C). Band gap,
$E_g=\frac{hc}{\lambda}$
$=\frac{(6.63\times 10^{-34})(3\times 10^8)}{2480\times 10^{-9}\times 1.6\times 10^{-19}}\ eV$
$=0.5\ eV$

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.,
$\phi=\frac{q}{\varepsilon_0}$
$\phi=\frac{1.45\times 10^{-3}}{8.854\times 10^{-12}}$
$(\because \epsilon_0=8.854\times 10^{-12})$
$\phi=1.6\times 10^8 Nm^2/C$

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
$\mathrm{v}=\omega\sqrt{\mathrm{A}^2-\mathrm{x}^2}$ .....(1)
Suppose
$\mathrm{x}=\mathrm{A}\sin\omega \mathrm{t}$
On differentiating the above equation w.r.t. time we get
$\frac{\mathrm{dx}}{\mathrm{dt}}=\mathrm{A}\omega\cos\omega \mathrm{t}$
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
$\mathrm{v}=\frac{\mathrm{A}\omega}{2}$
$\mathrm{A}^2\omega^2=4\omega(\mathrm{A}^2-\mathrm{x}^2)$
By substituting the value in (1) we get the displacement as:
$\mathrm{x}=\frac{\mathrm{A}\sqrt{3}}{2}$

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

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

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 $\left(6.023 \times 10^{23}\right)$ of iron atoms have a mass of 55 g. Hence, the number of atoms in the domain is

$N = \frac{7.9 \times 10^{-12} \times 6.023 \times 10^{23}}{55}$

$= 8.65 \times 10^{10}$ 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

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

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

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

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,

$\vec{F} = \vec{V}\frac{dm}{dt} \quad$ ......(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,

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

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

$= \frac{1.6 \times 10^{-19} \times 1}{2 \times 3.14 \times 9.1 \times 10^{-31}}$

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

43(D). Here,

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

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

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

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

So relative permeability,

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

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

$N = N_0 e^{-\lambda t} \Rightarrow N = N_0 e^{-\frac{\ln(2)}{T_{\frac{1}{2}}}t}$

Where,

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,

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

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

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

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

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

$\ln(2)$

$\Rightarrow t = 12$ 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
$= 2\pi \times 2\pi = 4\pi^2 rad$
$W_i = 3 \times \frac{2\pi}{60} rad/s$
$\Rightarrow -\tau\theta = \frac{1}{2} \times \frac{1}{2}mr^2\left(0^2 - \omega_1^2\right)$
$\Rightarrow -\tau = \frac{\frac{1}{2}\times\frac{1}{2}\times 2\times\left(4\times10^{-2}\right)\left(-3\times\frac{2\pi}{60}\right)^2}{4\pi^2}$
$\Rightarrow \tau = 2 \times 10^{-6} Nm$

48(A). Equivalent focal length (F) of two lens separated by distance d is given by
$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$
$= \frac{1}{0.2} + \frac{1}{0.2} - \frac{0.5}{(0.2)(0.2)}$
$= 5 + 5 - 0.5 \times 5 \times 5$
$= 10 - 12.5$
$= -2.5$
$\therefore F = -\frac{1}{2.5} = -0.4$ 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: $\left[\mathrm{L}^2\,\mathrm{T}^{-2}\,\mathrm{K}^{-1}\right]$
Electrical potential: $\left[M^1 L^2 T^{-3} A^{-1}\right]$
Electrical resistance: $\left[\mathrm{M}^1\,\mathrm{L}^2\,\mathrm{T}^{-3}\,\mathrm{A}^{-2}\right]$
Magnetic flux: $\left[\mathrm{M}^1\,\mathrm{L}^2\,\mathrm{T}^{-2}\,\mathrm{A}^{-1}\right]$
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 $QOP, QO = OP\sin(90° - 2\theta) = OP\cos 2\theta$
$\Delta = OP\cos 2\theta + OP$
$= OP(\cos 2\theta + 1)$
$= 2OP\cos^2\theta$
$= 2 \times \frac{d}{\cos\theta} \times \cos^2\theta$
$= 2d\cos\theta$
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
$\mu_1 = 1.33, d = 1mm = 10^{-3}m, D = 1.33m,$
$\lambda = 6300\mathring{A}$
$= 6.3 \times 10^{-7}m$
When the experiment is performed in liquid, λ change to
$\lambda' = \frac{\lambda}{\mu_1}$
Fringe width,
$\beta = \frac{D\lambda}{\mu_l}$
$\frac{1.33\times6.3\times10^{-7}}{1.33\times10^{-3}}$
$= 6.3 \times 10^{-4}m$
$= 0.63\ mm$

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

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