QUESTIONS & SOLUTIONS OF AIPMT 2009

CBSE PM/PD 2009

PHYSICS

1. In the nuclear decay given below:

${}^{A}_{Z}X \longrightarrow {}^{A}_{Z+1}Y \longrightarrow {}^{A-4}_{Z-1}B^{*} \longrightarrow {}^{A-4}_{Z-1}B$, the particles emitted in the sequence are:

(1) γ, β, α **(2)** β, γ, α

(3) α, β, γ **(4)** β, α, γ

Sol: ${}^{A}_{Z}X \longrightarrow {}^{A}_{Z+1}Y : \beta,\ {}^{A}_{Z+1}Y \longrightarrow {}^{A-4}_{Z-1}B^{*} : \alpha,\ {}^{A-4}_{Z-1}B^{*} \longrightarrow {}^{A-4}_{Z-1}B : \gamma$

(β, α, γ)

$\therefore$ **Correct choice : (4)**

2. A thin circular ring of mass M and radius R is rotating in a horizontal plane about an axis vertical to its plane with a constant angular velocity ω. If two objects each of mass m be attached gently to the opposite ends of a diameter of the ring, the ring will then rotate with an angular velocity:

(1) $\dfrac{\omega M}{M + 2m}$ **(2)** $\dfrac{\omega(M + 2m)}{M}$

(3) $\dfrac{\omega M}{M + m}$ **(4)** $\dfrac{\omega(M - 2m)}{M + 2m}$

Sol: $I_1 \omega_1 = I_2 \omega_2,\ I_1 = MR^2,\ I_2 = MR^2 + 2\,mR^2$

$\therefore\ \omega_2 = \dfrac{I_1}{I_2}\,\omega = \dfrac{M}{M + 2m}\,\omega.$

$\therefore$ **Correct choice : (1)**

3. In thermodynamic processes which of the following statements is **not** true?

(1) In an isochoric process pressure remains constant

(2) In an isothermal process the temperature remains constant

(3) In an adiabatic process PV^{γ} = constant

(4) In an adiabatic process the system is insulated from the surroundings

Sol: Pressure constant: – isobaric, not isochoric

$\therefore$ **Correct choice : (1)**

4. The number of photo electrons emitted for light of a frequency ν (higher than the threshold frequency ν_0) is proportional to:

(1) Threshold frequency (ν_0) **(2)** Intensity of light

(3) Frequency of light (ν) **(4)** $\nu - \nu_0$

Sol: Saturation current $\propto$ intensity

$\therefore$ **Correct choice : (2)**

5. A simple pendulum performs simple harmonic motion about x = 0 with an amplitude a and time period T. The speed of the pendulum at $x = \frac{a}{2}$ will be:

(1) $\frac{\pi a}{T}$ **(2)** $\frac{3\pi^2 a}{T}$

(3) $\frac{\pi a\sqrt{3}}{T}$ **(4)** $\frac{\pi a\sqrt{3}}{2T}$

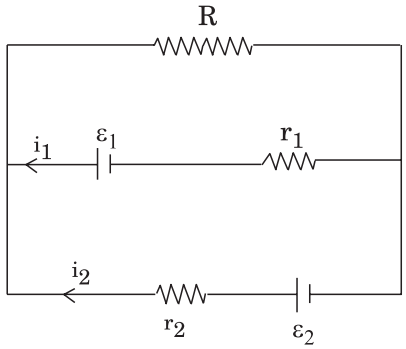
Sol: Speed $v = \omega\sqrt{a^2 - x^2}$, $x = \frac{a}{2}$

$$\therefore v = \omega\sqrt{a^2 - \frac{a^2}{4}} = \omega\sqrt{\frac{3a^2}{4}}$$

$$= \frac{2\pi}{T}\,\frac{a\sqrt{3}}{2} = \frac{\pi a\sqrt{3}}{T}$$

$\therefore$ **Correct choice : (3)**

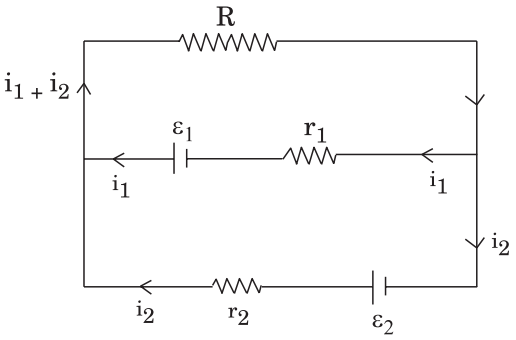
6. See the electric circuit shown in this **Figure**. Which of the following equations is a correct equation for it?



(1) $\varepsilon_2 - i_2 r_2 - \varepsilon_1 - i_1 r_1 = 0$ **(2)** $-\varepsilon_2 - (i_1 + i_2) R + i_2 r_2 = 0$

(3) $\varepsilon_1 - (i_1 + i_2) R + i_1 r_1 = 0$ **(4)** $\varepsilon_1 - (i_1 + i_2) R - i_1 r_1 = 0$

Sol:



$\varepsilon_1 - (i_1 + i_2)R - i_1 r_1 = 0.$

$\therefore$ Correct choice : (4)

7. A body, under the action of a force $\vec{F} = 6\hat{i} - 8\hat{j} + 10\hat{k}$, acquires an acceleration of 1 m/s^2. The mass of this body must be:

(1) 10 kg **(2)** 20 kg **(3)** $10\sqrt{2}$ kg **(4)** $2\sqrt{10}$ kg

Sol: $\vec{F} = 6\hat{i} - 8\hat{j} + 10\hat{k}$,

$|F| = \sqrt{36 + 64 + 100} = 10\sqrt{2}$ N

$a = 1\ ms^{-2}$

$\therefore\ m = \dfrac{10\sqrt{2}}{1} = 10\sqrt{2}$ kg

$\therefore$ Correct choice : (3)

8. The symbolic representation of four logic gates are given below:

(i)

(ii)

(iii)

(iv)

The logic symbols for OR, NOT and NAND gates are respectively:

(1) (iv), (i), (iii) **(2)** (iv), (ii), (i) **(3)** (i), (iii), (iv) **(4)** (iii), (iv), (ii)

$\therefore$ Correct choice : (2)

9. If $\vec{F}$ is the force acting on a particle having position vector $\vec{r}$ and $\vec{\tau}$ be the torque of this force about the origin, then:

(1) $\vec{r} \cdot \vec{\tau} > 0$ and $\vec{F} \cdot \vec{\tau} < 0$

(2) $\vec{r} \cdot \vec{\tau} = 0$ and $\vec{F} \cdot \vec{\tau} = 0$

(3) $\vec{r} \cdot \vec{\tau} = 0$ and $\vec{F} \cdot \vec{\tau} \neq 0$

(4) $\vec{r} \cdot \vec{\tau} \neq 0$ and $\vec{F} \cdot \vec{\tau} = 0$

Sol: $\vec{\tau} = \vec{r} \times \vec{F} \Rightarrow \vec{r} \cdot \vec{\tau} = 0 \qquad \vec{F} \cdot \vec{\tau} = 0$

$\therefore$ **Correct choice : (2)**

10. The two ends of a rod of length L and a uniform cross-sectional area A are kept at two temperatures T_1 and T_2 ($T_1 > T_2$). The rate of heat transfer, $\frac{dQ}{dt}$ through the rod in a steady state is given by:

(1) $\frac{dQ}{dt} = \frac{k(T_1 - T_2)}{LA}$ **(2)** $\frac{dQ}{dt} = k\,L\,A\,(T_1 - T_2)$

(3) $\frac{dQ}{dt} = \frac{k\,A(T_1 - T_2)}{L}$ **(4)** $\frac{dQ}{dt} = \frac{kL(T_1 - T_2)}{A}$

Sol: $\frac{dQ}{dt} = \frac{kA(T_1 - T_2)}{L}$

$\therefore$ **Correct choice : (3)**

11. A p-n photodiode is fabricated from a semiconductor with a band gap of 2.5 eV. It can detect a signal of wavelength:

(1) 4000 nm **(2)** 6000 nm **(3)** 4000 Å **(4)** 6000 Å

Sol: $\lambda_{max} = \frac{hc}{E} = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{2.5 \times 1.6 \times 10^{-19}} \simeq 5000$ Å

$\lambda < \lambda_{max} = 4000$ Å

$\therefore$ **Correct choice : (3)**

12. If the dimensions of a physical quantity are given by $M^a L^b T^c$, then the physical quantity will be:

(1) Velocity if a = 1, b = 0, c = – 1

(2) Acceleration if a = 1, b = 1, c = – 2

(3) Force if a = 0, b = – 1, c = – 2

(4) Pressure if a = 1, b = – 1, c = – 2

Sol: Pressure $= \frac{MLT^{-2}}{L^2} = ML^{-1}T^{-2}$

$\Rightarrow a = 1, b = -1, c = -2.$

$\therefore$ **Correct choice : (4)**

13. A transistor is operated in common-emitter configuration at $V_c = 2$ V such that a change in the base current from 100 μA to 200 μA produces a change in the collector current from 5 mA to 10 mA. The current gain is:

(1) 100 **(2)** 150 **(3)** 50 **(4)** 75

Sol: $\Delta I_E = \Delta I_B + \Delta I_C$

$$\beta = \frac{\Delta I_C}{\Delta I_B}$$

$\Delta I_C = 5 \times 10^{-3}$ A

$\Delta I_B = 100 \times 10^{-6}$ A

$$\beta = \frac{5}{100} \times 1000 = 50$$

$\therefore$ **Correct choice : (3)**

14. The mass of a lift is 2000 kg. When the tension in the supporting cable is 28000 N, then its acceleration is:

(1) 4 ms^{-2} upwards. **(2)** 4 ms^{-2} downwards.

(3) 14 ms^{-2} upwards. **(4)** 30 ms^{-2} downwards.

Sol: 2000 a = 28000 – 20000 = 8000

$$a = \frac{8000}{2000} = 4 \text{ ms}^{-2} \uparrow$$

$\therefore$ **Correct choice : (1)**

15. Four identical thin rods each of mass M and length ℓ, form a square frame. Moment of inertia of this frame about an axis through the centre of the square and perpendicular to its plane is :

(1) $\frac{2}{3}\,M\ell^2$ **(2)** $\frac{13}{3}\,M\ell^2$ **(3)** $\frac{1}{3}\,M\ell^2$ **(4)** $\frac{4}{3}\,M\ell^2$

Sol: $\frac{mL^2}{12} + \frac{mL^2}{4} = \frac{4mL^2}{12} = \frac{mL^2}{3}$

Total M.I. $= 4 \times \frac{mL^2}{3}$

$\therefore$ **Correct choice : (4)**

16. Each of the two strings of length 51.6 cm and 49.1 cm are tensioned separately by 20 N force. Mass per unit length of both the strings is same and equal to 1 g/m. When both the strings vibrate simultaneously the number of beats is:

(1) 7 **(2)** 8 **(3)** 3 **(4)** 5

Sol: $f_1 = \frac{1}{2\ell_1}\sqrt{\frac{T}{m}}$, $f_2 = \frac{1}{2\ell_2}\sqrt{\frac{T}{m}}$, $f_2 - f_1 = \frac{1}{2}\sqrt{\frac{T}{m}}\frac{(\ell_1 - \ell_2)}{\ell_1\,\ell_2}$

$\sqrt{\frac{T}{m}} = \sqrt{\frac{20}{10^{-3}}} = \sqrt{2} \times 10^2 = 1.414 \times 100 = 141.4$

$\frac{\ell_1 - \ell_2}{\ell_1\,\ell_2} = \frac{(51.6 - 49.1) \times 10^2}{51.6 \times 49.1} = \frac{2.5 \times 10^2}{50 \times 50} = \frac{1}{10}$

$\therefore f_2 - f_1 = \frac{1}{2} \times 141.4 \times \frac{1}{10} = 7$ beats

$\therefore$ **Correct choice : (1)**

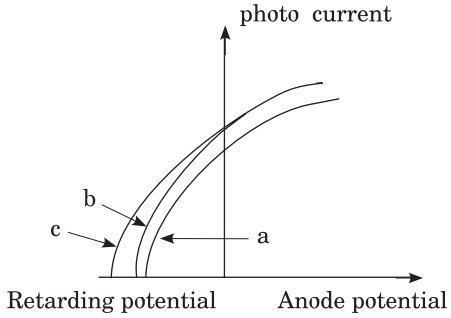
17. The number of beta particles emitted by a radioactive substance is twice the number of alpha particles emitted by it. The resulting daughter is an:

(1) isomer of parent **(2)** isotone of parent

(3) isotope of parent **(4)** isobar of parent

$\therefore$ **Correct choice : (3)**

18. The **Figure** shows a plot of photo current versus anode potential for a photo sensitive surface for three different radiations. Which one of the following is a **correct** statement?



(1) curves (a) and (b) represent incident radiations of same frequency but of different intensities.

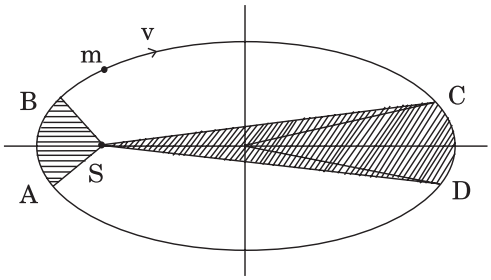
(2) curves (b) and (c) represent incident radiations of different frequencies and different intensities.

(3) curves (b) and (c) represent incident radiations of same frequency having same intensity.

(4) curves (a) and (b) represent incident radiations of different frequencies and different intensities.

∴ Correct choice : (1)

19. The **Figure** shows elliptical orbit of a planet **m** about the sum S. The shaded area SCD is twice the shaded area SAB. If $\mathbf{t_1}$ is the time for the planet of move from C to D and $\mathbf{t_2}$ is the time to move from A to B then:



(1) $t_1 = 4t_2$ **(2)** $t_1 = 2t_2$ **(3)** $t_1 = t_2$ **(4)** $t_1 > t_2$

Sol: SCD : $A_1 - t_1$ (areal velocity constant)

SAB : $A_2 - t_2$

$$\frac{A_1}{t_1} = \frac{A_2}{t_2},\ t_1 = t_2 \cdot \frac{A_1}{A_2},\ A_1 = 2A_2$$

$\therefore\ t_1 = 2t_2$

∴ Correct choice : (2)

20. A black body at 227°C radiates heat at the rate of 7 Cals/cm^{2}s. At a temperature of 727°C, the rate of heat radiated in the same units will be:

(1) 50 **(2)** 112 **(3)** 80 **(4)** 60

Sol: $E = \sigma T^4$,

$$\frac{E_2}{E_1} = \left(\frac{T_2}{T_1}\right)^4 = \left(\frac{1000}{500}\right)^4 = 16$$

$T_1 = 500$ K

$T_2 = 1000$ K

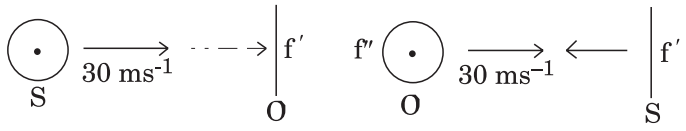
$\therefore E_2 = 16 \times 7 = 112$ cal/cm^2 s.

$\therefore$ **Correct choice : (2)**

21. The driver of a car travelling with speed 30 m/sec towards a hill sounds a horn of frequency 600 Hz. If the velocity of sound in air is 330 m/s, the frequency of reflected sound as heard by driver is:

(1) 555.5 Hz **(2)** 720 Hz **(3)** 500 Hz **(4)** 550 Hz

Sol:

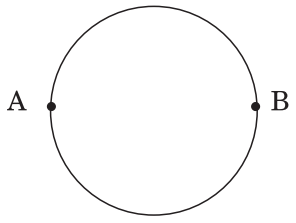


$$f' = \frac{v}{v - 30} f,\ f'' = \frac{v + 30}{v} f' = \frac{v + 30}{v - 30} f = \frac{360}{300} \times 600$$

$= 720$ Hz

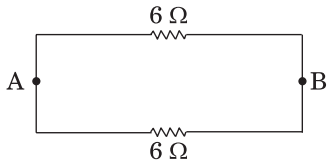
$\therefore$ **Correct choice : (2)**

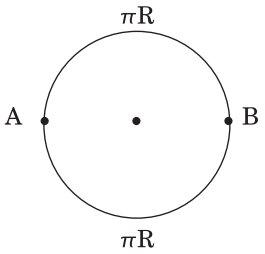
22. A wire of resistance 12 ohms per meter is bent to form a complete circle of radius 10 cm. The resistance between its two diametrically opposite points, A and B as shown in the **Figure**, is:



(1) 3 Ω **(2)** 6 π Ω **(3)** 6 Ω **(4)** 0.6 π Ω

Sol:





$2\pi R \longrightarrow 12\ \Omega$

$\therefore\ R = \dfrac{6 \times 6}{12} = 3\ \Omega$

$\therefore$ Correct choice : (1)

23. A rectangular, a square, a circular and an elliptical loop, all in the (x – y) plane, are moving out of a uniform magnetic field with a constant velocity, $\vec{V} = v\hat{i}$. The magnetic field is directed along the negative z axis direction. The induced **emf**, during the passage of these loops, out of the field region, will not remain constant for:

(1) the circular and the elliptical loops.

(2) only the elliptical loop.

(3) any of the four loops.

(4) the rectangular, circular and elliptical loops.

Sol: As the loop leaves the magnetic field, area in magnetic field decreases for all loops, so induced emf does not remain constant. (Any of four loops)

$\therefore$ Correct choice : (3)

24. A galvanometer having a coil resistance of 60 Ω shows full scale deflection when a current of 1.0 amp passes through it. It can be converted into an ammeter to read currents upto 5.0 amp by:

(1) putting in series a resistance of 15 Ω

(2) putting in series a resistance of 240 Ω

(3) putting in parallel a resistance of 15 Ω

(4) putting in parallel a resistance of 240 Ω

Sol: $G = 60\ \Omega$, $I_g = 1.0$ A, $I = 5$ A.

$I_g G = (I - I_g) S$,

$$S = \frac{I_g G}{I - I_g} = \frac{1}{5 - 1} \times 60 = 15\ \Omega$$

putting 15 Ω in parallel.

$\therefore$ Correct choice : (3)

25. Power dissipated in an LCR series circuit connected to an a.c source of **emf** ε is:

(1) $\dfrac{\varepsilon^2\sqrt{R^2+\left(Lw-\dfrac{1}{Cw}\right)^2}}{R}$ **(2)** $\dfrac{\varepsilon^2\left[R^2+\left(Lw-\dfrac{1}{Cw}\right)^2\right]}{R}$

(3) $\dfrac{\varepsilon^2 R}{\sqrt{R^2+\left(Lw-\dfrac{1}{Cw}\right)^2}}$ **(4)** $\dfrac{\varepsilon^2 R}{\left[R^2+\left(Lw-\dfrac{1}{Cw}\right)^2\right]}$

Sol: Power dissipated in series LCR: $P = I^2R = \dfrac{\varepsilon^2}{|Z|^2}R = \dfrac{\varepsilon^2 R}{\left[R^2+\left(\omega L-\dfrac{1}{\omega C}\right)^2\right]}$

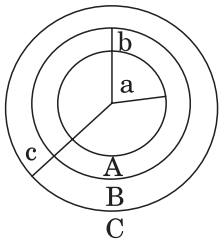
$\therefore$ **Correct choice : (4)**

26. Three concentric spherical shells have radii a, b and c (a < b < c) and have surface charge densities σ, $-\sigma$ and σ respectively. If V_A, V_B and V_C denote the potentials of the three shells, then for c = a + b, we have:

(1) $V_C = V_B \neq V_A$ **(2)** $V_C \neq V_B \neq V_A$

(3) $V_C = V_B = V_A$ **(4)** $V_C = V_A \neq V_B$

Sol: c = a + b.



$$v_A = \frac{\sigma Q}{\varepsilon_0} - \frac{\sigma b}{\varepsilon_0} + \frac{\sigma c}{\varepsilon_0} = \frac{\sigma}{\varepsilon_0}[c-(b-a)]$$

$$V_B = \frac{-\sigma b}{\varepsilon_0} + \frac{1}{4\pi\varepsilon_0}\cdot\frac{\sigma\times 4\pi a^2}{b} + \frac{\sigma c}{\varepsilon_0}$$

$$= \frac{\sigma}{\varepsilon_0}\left[c-\frac{(b^2-a^2)}{b}\right]$$

$$V_C = \frac{\sigma c}{\varepsilon_0} - \frac{1}{4\pi\varepsilon_0}\cdot\frac{\sigma\times 4\pi b^2}{c} + \frac{1}{4\pi\varepsilon_0}\cdot\frac{\sigma\times 4\pi a^2}{c} = \frac{\sigma}{\varepsilon_0}\left[c-\frac{(b^2-a^2)}{c}\right]$$

$$= \frac{\sigma}{\varepsilon_0}\left[c-(b-a)\right]$$

$V_A = V_C \neq V_B$

$\therefore$ **Correct choice : (4)**

27. An engine pumps water continuously through a hose. Water leaves the hose with a velocity **v** and **m** is the mass per unit length of the water jet. What is the rate at which kinetic energy is imparted to water?

(1) mv^2 **(2)** $\frac{1}{2} mv^2$ **(3)** $\frac{1}{2} m^2v^2$ **(4)** $\frac{1}{2} mv^3$

Sol: m : mass per unit length

$\therefore$ rate of mass per sec $= \frac{mx}{t} = mv.$

Rate of K.E. $= \frac{1}{2} (mv)\, v^2 = \frac{1}{2} mv^3$

$\therefore$ **Correct choice : (4)**

28. A bar magnet having a magnetic moment of 2×10^4 JT^{-1} is free to rotate in a horizontal plane. A horizontal magnetic field $B = 6 \times 10^{-4}$ T exists in the space. The work done in taking the magnet slowly from a direction parallel to the field to a direction 60° from the field is:

(1) 12 J **(2)** 6 J **(3)** 2 J **(4)** 0.6 J

Sol: Work done = $MB (\cos \theta_1 - \cos \theta_2)$

$= nB \left(1 - \frac{1}{2}\right) = \frac{2 \times 10^4 \times 6 \times 10^{-4}}{2} = 6$ J

$\therefore$ **Correct choice : (2)**

29. In a Rutherford scattering experiment when a projectile of charge z_1 and mass M_1 approaches a target nucleus of charge z_2 and mass M_2, the distance of closest approach is r_0. The energy of the projectile is:

(1) directly proportional to $z_1 z_2$

(2) inversely proportional to z_1

(3) directly proportional to mass M_1

(4) directly proportional to $M_1 \times M_2$

$\therefore$ **Correct choice : (1)**

30. Monochromatic light of wavelength 667 nm is produced by a helium neon laser. The power emitted is 9 mW. The number of photons arriving per sec. On the average at a target irradiated by this beam is:

(1) 3×10^{16} **(2)** 9×10^{15} **(3)** 3×10^{19} **(4)** 9×10^{17}

Sol: $\lambda = 667 \times 10^{-9}$ m, $P = 9 \times 10^{-3}$ W

$$P = \frac{Nhc}{\lambda}, \text{ N : No. of photons emitted/sec.}$$

$$N = \frac{9 \times 10^{-3} \times 667 \times 10^{-9}}{6.6 \times 10^{-34} \times 3 \times 10^{8}}$$

$$= \frac{9 \times 6.67 \times 10^{-10}}{3 \times 6.6 \times 10^{-26}} \simeq 3 \times 10^{16}/\text{sec}$$

$\therefore$ Correct choice : (1)

31. A wave in a string has an amplitude of 2 cm. The wave travels in the + ve direction of x axis with a speed of 128 m/sec. and it is noted that 5 complete waves fit in 4 m length of the string. The equation describing the wave is:

(1) $y = (0.02)$ m $\sin(15.7x - 2010t)$

(2) $y = (0.02)$ m $\sin(15.7x + 2010t)$

(3) $y = (0.02)$ m $\sin(7.85x - 1005t)$

(4) $y = (0.02)$ m $\sin(7.85x + 1005t)$

Sol: $A = 2$ cm, $\frac{\omega}{k} = 128 \text{ ms}^{-1}$, $5\lambda = 4$, $\lambda = \frac{4}{5}$ m

$y = A \sin(kx - \omega t)$,

$$k = \frac{2\pi}{\lambda} = \frac{2\pi \times 5}{4} = \frac{31.4}{4} = 7.85$$

$y = 0.02$ m $\sin(7.857 - 1005\ t)$

$\omega = 128 \times 7.85 = 1005$

$\therefore$ Correct choice : (3)

32. Which one of the following equations of motion represents simple harmonic motion?

(1) acceleration $= -k(x + a)$

(2) acceleration $= k(x + a)$

(3) acceleration $= kx$

(4) acceleration $= -k_0x + k_1x^2$

Where k, k_0, k_1 and a are all positive.

Sol: $a = -kX$, $X = x + a$.

$\therefore$ Correct choice : (1)

33. A student measures the terminal potential difference (V) of a cell (of **emf** $\in$ and internal resistance r) as a function of the current (I) flowing through it. The slope, and intercept, of the graph between V and I, then, respectively, equal:

(1) $-$ r and $\in$ **(2)** r and $-\in$ **(3)** $-\in$ and r **(4)** $\in$ and $-$ r

Sol: $V + ir = E$

$V = V_A - V_B$

$E - ir$

$$\frac{\partial V}{\partial i} = -r,\ i = 0, v = E$$

$\therefore$ slope = $-$ r, intercept = E

$\therefore$ **Correct choice : (1)**

34. If a diamagnetic substance is brought near the north or the south pole of a bar magnet, it is:

(1) repelled by the north pole and attracted by the south pole

(2) attracted by the north pole and repelled by the south pole

(3) attracted by both the poles

(4) repelled by both the poles

$\therefore$ **Correct choice : (4)**

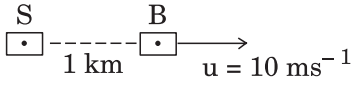
35. A bus is moving with a speed of 10 ms^{-1} on a straight road. A scooterist wishes to overtake the bus in 100 s. If the bus is at a distance of 1 km from the scooterist, with what speed should the scooterist chase the bus?

(1) 40 ms^{-1} **(2)** 25 ms^{-1} **(3)** 10 ms^{-1} **(4)** 20 ms^{-1}

Sol: Let v be the relative velocity of scooter w.r.t b as

$v = v_S - v_B$

$\therefore v_S = v + v_B$, $v = \frac{1000}{100} = 10\ ms^{-1}$



$\therefore$ velocity of scooter = 20 ms^{-1}

$\therefore$ **Correct choice : (4)**

36. Sodium has body centred packing. Distance between two nearest atoms is 3.7 Å. The lattice parameter is:

(1) 4.3 Å **(2)** 3.0 Å **(3)** 8.6 Å **(4)** 6.8 Å

Sol: $3.7 = \frac{\sqrt{3}}{2}\ a$

$$a = \frac{2 \times 3.7}{\sqrt{3}} = 4.3\ \text{Å}$$

∴ Correct choice : (1)

37. The internal energy change in a system that has absorbed 2 Kcals of heat and done 500 J of work is:

(1) 6400 J **(2)** 5400 J **(3)** 7900 J **(4)** 8900 J

Sol: $Q = \Delta U + W$

$\Delta U = Q - W = 2 \times 4.2 \times 1000 - 500 = 8400 - 500$

$= 7900\ J$

∴ Correct choice : (3)

38. Three capacitors each of capacitance C and of breakdown voltage V are joined in series. The capacitance and breakdown voltage of the combination will be:

(1) 3C, $\frac{V}{3}$ **(2)** $\frac{C}{3}$, 3V **(3)** 3C, 3V **(4)** $\frac{C}{3}$, $\frac{V}{3}$

Sol: $Q = CV$

$V_{eff} = V + V + V = 3\ V$

$$\frac{1}{C_{eff}} = \frac{1}{C} + \frac{1}{C} + \frac{1}{C} \Rightarrow C_{eff} = \frac{C}{3}$$

$\left(\frac{C}{3},\ 3V\right)$

∴ Correct choice : (2)

39. An explosion blows a rock into three parts. Two parts go off at right angles to each other. These two are, 1 kg first part moving with a velocity of 12 ms^{-1} and 2 kg second part moving with a velocity of 8 ms^{-1}. If the third part flies off with a velocity of 4 ms^{-1}, its mass would be:

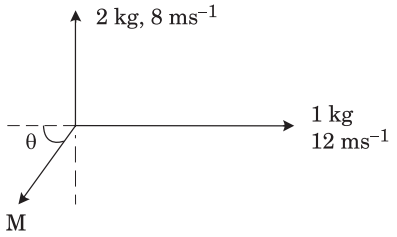
(1) 7 kg **(2)** 17 kg **(3)** 3 kg **(4)** 5 kg

Sol: $Mv \cos\theta = 12$

$Mv \sin\theta = 16$

$$\tan\theta = \frac{16}{12} = \frac{4}{3}$$

$$M = \frac{12 \times 5}{4 \times 3} = \frac{60}{12} = 5 \text{ kg}$$



∴ Correct choice : (4)

40. A particle starts its motion from rest under the action of a constant force. If the distance covered in first 10 seconds is S_1 and that covered in the first 20 seconds is S_2, then:

(1) $S_2 = 3S_1$ **(2)** $S_2 = 4S_1$ **(3)** $S_2 = S_1$ **(4)** $S_2 = 2S_1$

Sol: $s_1 = \frac{1}{2} a \times t_1^2$, $s_2 = \frac{1}{2} a \times t_2^2$

$$\therefore \frac{s_1}{s_2} = \left(\frac{t_1}{t_2}\right)^2 = \left(\frac{10}{20}\right)^2 = \frac{1}{4}$$

$s_2 = 4\, s_1$

∴ Correct choice : (2)

41. A body of mass 1 kg is thrown upwards with a velocity 20 m/s. It momentarily comes to rest after attaining a height of 18 m. How much energy is lost due to air friction? ($g = 10$ m/s^2)

(1) 30 J **(2)** 40 J **(3)** 10 J **(4)** 20 J

Sol: $\frac{1}{2} mv^2 - mgh = \frac{1}{2} \times 1 \times 400 - 1 \times 18 \times 10$

$= 200 - 180 = 20$ J

∴ Correct choice : (4)

42. A conducting circular loop is placed in a uniform magnetic field 0.04 T with its plane perpendicular to the magnetic field. The radius of the loop starts shrinking at 2 mm/s. The induced emf in the loop when the radius is 2 cm is:

(1) $4.8\,\pi\,\mu V$ **(2)** $0.8\,\pi\,\mu V$ **(3)** $1.6\,\pi\,\mu V$ **(4)** $3.2\,\pi\,\mu V$

Sol: $e = -B\frac{d}{dt}(\pi r^2) = -B\,\pi\,2r\,\frac{dr}{dt}$

$r = 2$ cm, $e = -0.04 \times 3.14 \times 2 \times 2 \times 10^{-2} \times 2 \times 10^{-3} = -0.04 \times 25.12 \times 10^{-7}$

$= 100.48 \times 10^{-7}$

$= 32\,\pi \times 10^{-7}$

$= 3.2\,\pi \times 10^{-6}$ V $= 3.2\,\pi\,\mu$ V

$\therefore$ **Correct choice : (4)**

43. The magnetic force acting on a charged particle of charge $-2\ \mu$C in a magnetic field of 2T acting in y direction, when the particle velocity is

$(2\hat{i} + 3\hat{j}) \times 10^6\ ms^{-1}$, is:

(1) 4 N is z direction **(2)** 8 N is y direction

(3) 8 N in z direction **(4)** 8 N in $-$ z direction

Sol: $\vec{F} = q\left(\vec{V} \times \vec{B}\right) = -2 \times 10^{-6}\ C\ [2 \times 2 \times 10^6] = -8$ N z-axis

$\therefore$ **Correct choice : (4)**

44. Two bodies of mass 1 kg and 3 kg have position vectors $\hat{i} + 2\hat{j} + \hat{k}$ and $-3\hat{i} - 2\hat{j} + \hat{k}$, respectively. The centre of mass of this system has a position vector:

(1) $-2\hat{i} - \hat{j} + \hat{k}$ **(2)** $2\hat{i} - \hat{j} - 2\hat{k}$ **(3)** $-\hat{i} + \hat{j} + \hat{k}$ **(4)** $-2\hat{i} + 2\hat{k}$

Sol: $\vec{R} = \frac{m_1\vec{R}_1 + m_2\vec{R}_2}{\left(m_1 + m_2\right)} = \frac{1}{4}\left[-8\hat{i} - 4\hat{j} + 4\hat{k}\right] = -2\,\hat{i} - \hat{j} + \hat{k}$

$\therefore$ **Correct choice : (1)**

45. The electric potential at a point (x, y, z) is given by $V = -x^2y - xz^3 + 4$

The electric field $\vec{E}$ at that point is:

(1) $\vec{E} = \hat{i}\,2xy + \hat{j}\,(x^2 + y^2) + \hat{k}\,(3xz - y^2)$

(2) $\vec{E} = \hat{i}\,z^3 + \hat{j}\,xyz + \hat{k}\,z^2$

(3) $\vec{E} = \hat{i}\,(2xy - z^3) + \hat{j}\,xu^2 + \hat{k}\,3z^2\,x$

(4) $\vec{E} = \hat{i}\,(2xy + z^3) + \hat{j}\,x^2 + \hat{k}\,3xz^2$

Sol: $\vec{E} = -\frac{\partial V}{\partial r} = \left[-\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}\right]$

$$= \left[(2xy + z^3)\hat{i} + \hat{j}\,x^2 + \hat{k}\,3xz^2\right]$$

∴ Correct choice : (4)

46. The mean free path of electrons in a metal is 4×10^{-8} m. The electric field which can given on an average 2 eV energy to an electron in the metal will be in units of V/m:

(1) 5×10^{-11} **(2)** 8×10^{-11} **(3)** 5×10^{7} **(4)** 8×10^{7}

Sol: $E = \frac{V}{d} = \frac{2}{4 \times 10^{-8}} = 0.5 \times 10^{8} = 5 \times 10^{7}\ Vm^{-1}$

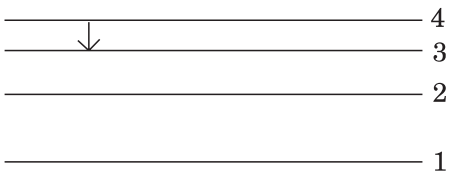
∴ Correct choice : (3)

47. The ionization energy of the electron in the hydrogen atom in its ground state is 13.6 eV. The atoms are excited to higher energy levels to emit radiations of 6 wavelengths. Maximum wavelength of emitted radiation corresponds to the transition between:

(1) n = 3 to n = 1 states **(2)** n = 2 to n = 1 states

(3) n = 4 to n = 3 states **(4)** n = 3 to n = 2 states

Sol: $\frac{n(n-1)}{2} = 6$



$n^2 - n - 12 = 0$

$(n - 4)(n + 3) = 0$ or $n = 4$

∴ Correct choice : (3)

48. Under the influence of a uniform magnetic field, a charged particle moves with constant speed V in a circle of radius R. The time period of rotation of the particle:

(1) depends on R and not on V

(2) is independent of both V and R

(3) depends on both V and R

(4) depends on V and not on R

Sol: $T = \dfrac{2\pi m}{qB}$

$\therefore$ Correct choice : (2)

49. The electric field part of an electromagnetic wave in a medium is represented by $E_x = 0$;

$$E_y = 2.5 \ \frac{N}{C} \cos\left[\left(2\pi \times 10^6 \ \frac{rad}{m}\right) t - \left(\pi \times 10^{-2} \ \frac{rad}{s}\right) x\right];$$

$E_z = 0$. The wave is:

(1) moving along x direction with frequency 10^6 Hz and wave length 100 m.

(2) moving along x direction with frequency 10^6 Hz and wave length 200 m.

(3) moving along – x direction with frequency 10^6 Hz and wave length 200 m.

(4) moving along y direction with frequency $2\pi \times 10^6$ Hz and wave length 200 m.

Sol: $E_y = E_0 \cos(\omega t - kx)$

$\omega = 2\pi f = 2\pi \times 10^6 \quad \therefore f = 10^6$ Hz

$$\frac{2\pi}{\lambda} = k = \pi \times 10^{-2} \ m^{-1}, \ \lambda = 200 \text{ m}$$

$\therefore$ Correct choice : (2)

50. A block of mass M is attached to the lower end of a vertical spring. The spring is hung from a ceiling and has force constant value k. The mass is released from rest with the spring initially unstretched. The maximum extension produced in the length of the spring will be:

(1) 2 Mg/k **(2)** 4 Mg/k **(3)** Mg/2k **(4)** Mg/k

Sol: $ka = mg$

$$a = \frac{mg}{k}$$

$\therefore$ Correct choice : (4)