KCET Board Exam – 2022

Subject: Physics **CODE: ________**

1. A magnetic field of flux density 1.0Wbm^{-2} acts normal to a 80 turn coil of 0.01m^2 area. If this coil is removed from the field in 0.2 second, the emf induced in it is

(A) 5V (B) 4V (C) 8V (D) 0.8V

Sol: $N=80,\ A=0.01\text{ m}^2,\ B=1.0\text{ Wb m}^{-2},\ t=0.2\text{ s}$

$$\varepsilon=\frac{NAB}{\Delta t}=\frac{80\times0.01\times1.0}{0.2}=4\text{ V}$$

Ans: (B)

2. An alternative current is given by $i=i_1\sin\omega t+i_2\cos\omega t$. The r.m.s. current is given by

(A) $\sqrt{\frac{i_1^2+i_2^2}{\sqrt{2}}}$ (B) $\frac{i_1+i_2}{\sqrt{2}}$ (C) $\frac{i_1 i_2}{\sqrt{2}}$ (D) $\sqrt{\frac{i_1^2+i_2^2}{2}}$

Sol: $i=i_1\sin\omega t+i_2\cos\omega t$

$$i=\sqrt{i_1^2+i_2^2+i_1 i_2\cos 90^\circ}$$

$$i=\sqrt{i_1^2+i_2^2}$$

$$I_{\text{RMS}}=\frac{i}{\sqrt{2}}=\sqrt{\frac{i_1^2+i_2^2}{2}}$$

Ans: (D)

3. Which of the following statements proves that Earth has a magnetic field?

(A) A large quantity of iron- ore is found in the Earth

(B) The intensity of cosmic rays stream of charged particles is more at the pole than at the equator.

(C) Earth is planet rotating about the North South axis.

(D) Earth is surrounded by ionosphere.

Sol: The intensity of cosmic rays stream of charged particles is more at the pole than at the equator

Ans: (B)

4. A long solenoid has 500 turns, when a current of 2A is passed through it, the resulting magnetic flux linked with each turn of the solenoid is $4\times10^{-3}\text{Wb}$, then self induction of the solenoid is

(A) 1.0 henry (B) 4.0 henry (C) 2.5 henry (D) 2.0 henry

Sol: $N=500,\ I=2\text{ A},\ B=4\times10^{-3}\text{ Wb}$

$$\phi=N\times B=500\times4\times10^{-3}=2\text{Wb}$$

And $\phi=Li$

$$\therefore\ L=\frac{\phi}{i}=\frac{2}{2}=1\text{ A}$$

Ans: (A)

5. A fully charged capacitor 'C' with initial charge 'q_0' is connected to a coil self inductance 'L' at $t=0$. The time at which the energy is stored equally between the electric and the magnetic field is

(A) $\frac{\pi}{4}\sqrt{LC}$ (B) $2\pi\sqrt{LC}$ (C) $\sqrt{LC}$ (D) $\pi\sqrt{LC}$

Sol: Maximum energy in C is $\frac{Q_0^2}{2C}$

Now, $\frac{1}{2}\frac{Q^2}{C}=\frac{1}{2}\left[\frac{1}{2}\frac{Q_0^2}{C}\right]$

Or $Q^2=\frac{Q_0^2}{2}$

$Q=\frac{Q_0}{\sqrt{2}} \Rightarrow Q_0\cos\omega t=\frac{Q_0}{\sqrt{2}}$

Or $\cos\omega t=\frac{1}{\sqrt{2}} \Rightarrow \omega t=\frac{\pi}{4} \quad t=\frac{\pi}{4\omega}=\frac{\pi}{\frac{4}{\sqrt{LC}}}$

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

Ans: (A)

6. The power of a equi- concave lens is -4.5D and is made od a material of R.I. 1.6, the radii of curvature of the lens is

(A) 115.44 cm (B) -26.6 cm (C) $+36.6$ cm (D) -2.66 cm

Sol: $P=-4.5$ D, $n=1.6$

$\frac{1}{f}=(n-1)\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$

$R_1=-R_2$

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

$-4.5=0.6\left[\frac{1}{-R}-\frac{1}{R}\right]$

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

$R=\frac{0.6\times 2}{4.5}=-26.6$ cm

Ans: (B)

7. A ray of light passes through an equilateral glass prism in such a manner that the angle of incidence is equal to the angle of emergence and each of these angles is equal to $\frac{3}{4}$ of the angle of the prism. The angle of deviation is

(A) $30°$ (B) $45°$ (C) $39°$ (D) $20°$

Sol: $i = e,\ A = 60^\circ$

$i + e = A + \delta$

$i = e = \frac{3}{4} \times A = \frac{3}{4} \times 60^\circ = 45^\circ$

$\Rightarrow\ 45^\circ + 45^\circ = 60^\circ + \delta$

$\therefore\ \delta = 30^\circ$

Ans: (A)

8. A convex lens of focal length $'f'$ is placed somewhere in between an object and a screen. The distance between the object and the screen is $'x'$. If the numerical value of the magnification produced by the lens is $'m'$, then the focal length of the lens is

(A) $\frac{(m-1)^2 x}{m}$ (B) $\frac{mx}{(m+1)^2}$ (C) $\frac{mx}{(m-1)^2}$ (D) $\frac{(m+1)^2 x}{m}$

Sol: $u + v = x$

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

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

$\Rightarrow\ u + mu = x$

$u(1+m) = x$

$u = \frac{x}{1+m}$

$v = x - u = x - \frac{x}{1+m}$

$v = \frac{mx}{1+m}$

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

$= \frac{1+m}{mx} + \frac{1+m}{x}$

$= (1+m)\left[\frac{1}{mx} + \frac{1}{x}\right] = (1+m)\frac{(1+m)}{mx}$

$\frac{1}{f} = \frac{(1+m)^2}{mx}$

$\therefore\ f = \frac{mx}{(m+1)^2}$

Ans: (B)

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

(A) $\frac{10}{2\pi}$Hz (B) 10^5Hz (C) 10Hz (D) $\frac{10^5}{2\pi}$Hz

Sol: $\omega = \frac{1}{\sqrt{LC}}$

$\Rightarrow f = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{10^{-4}\times 10^{-6}}} = \frac{10^5}{2\pi}$ Hz

Ans: (D)

10. In a series LCR circuit $R = 300\Omega$, $\text{L} = 0.9\text{H}$, $C = 2.0\ \mu\text{F}$ and $\omega = 1000\ \text{rad s}^{-1}$, then impedance of the circuit is

(A) 400Ω (B) 1300Ω (C) 900Ω (D) 500Ω

Sol: $Z = \sqrt{R^2 + (X_L - X_C)^2}$

$X_L = \omega L = 1000 \times 0.9 = 900\ \Omega$

$X_C = \frac{1}{\omega C} = \frac{1}{1000 \times 2 \times 10^{-6}} = 500\ \Omega$

$Z = \sqrt{(300)^2 + (900-500)^2}$

$= \sqrt{(300)^2 + (400)^2}$

$Z = 500\ \Omega$

Ans: (D)

11. Which of the following radiations of electromagnetic waves has the highest wave length?

(A) Microwaves (B) X- rays (C) UV- rays (D) IR- rays

Sol: Microwaves has the highest wavelength compared to X rays, UV-rays and IR-rays

Ans: (A)

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

(A) 8 times (B) 3 times (C) Double (D) 4 times

Sol: $\lambda_{\text{Red}} = 650 - 700$ nm $\lambda_{\text{violet}} = 400 - 450$ nm

$\Rightarrow \lambda_{\text{Red}} \approx 2\lambda_{\text{violet}}$

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

$\therefore \beta_{\text{Red}} = 2\beta_{\text{violet}}$

Ans: (C)

13. In case of Fraunhoffer diffraction at a single slit the diffraction pattern on the screen is correct for which of the following statements?

    (A) Central bright band having dark bands on either side.

    (B) Central dark band having alternate dark and bright bands of decreasing intensity on either side.

    (C) Central bright band having alternate dark and bright bands of decreasing intensity on either side

    (D) Central dark band having uniform brightness on either side.

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

    Ans: (C)

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

    (A) Reflection (B) Scattering (C) Diffraction (D) Interference

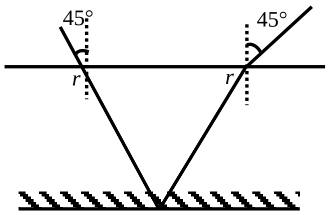
    Sol: Diffraction

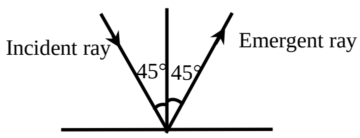
    Ans: (C)

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

    (A) 45° (B) 90° (C) 180° (D) 120°

    Sol: Deviation $= 45^\circ + 45^\circ = 90^\circ$





    Ans: (B)

16. Focal length of a convex lens will be maximum for

    (A) Red light (B) Blue light (C) Yellow light (D) Green light

    Sol: $f \propto \frac{1}{\mu} \propto \lambda$

    λ_{Red} is maximum

    $\therefore$ Focal length is maximum for red light

    Ans: (A)

17. For light diverging from a finite point source

    (A) The intensity at the wave front does not depend on the distance.

    (B) The wave front is cylindrical

    (C) The intensity decreases in proportion to the distance squared.

    (D) The wave front is parabolic.

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

    Ans: (C)

18. The radius of hydrogen atom in the ground state is 0.53 Å. After collision with an electrons, it is found to have a radius of 2.12 Å, the principal quantum number $'n'$ of the final state of the atom is

(A) $n=4$ (B) $n=1$ (C) $n=2$ (D) $n=3$

Sol: $r_n = r_0 n^2$

$2.12\times10^{-10} = 0.53\times10^{-1}\times n^2$

$n^2 = \frac{2.12}{0.53} = 4$

$n=2$

Ans: (C)

19. In accordance with the Bohr's model, the quantum number that characterises the Earth's revolution around the Sun in an orbit of radius 1.5×10^{11} m with orbital speed 3×10^4 m is [given mass of Earth $=6\times10^{24}$ kg]

(A) 2.57×10^{74} (B) 5.98×10^{86} (C) 2.57×10^{38} (D) 8.57×10^{64}

Sol: $mvr = \frac{nh}{2\pi}$

$6\times10^{24}\times3\times10^4\times1.5\times10^{11} = \frac{nh}{2\pi}$

$n = \frac{2\pi}{h}\times6\times3\times1.5\times10^{24}\times10^4\times10^{11} = 2.57\times10^{74}$

Ans: (A)

20. If an electron is revolving in its Bohr orbit having Bohr radius of 0.529 Å, then the radius of third orbit is

(A) 5125 nm (B) 4234 nm (C) 4496 Å (D) 4.761 Å

Sol: $r_n = r_0 n^2$

$=0.529\times10^{-10}\times3^2$

$r = 4.761$ Å

Ans: (D)

21. Binding energy of a Nitrogen nucleus $\left[{}^{14}_{7}N\right]$, given $m\left[{}^{14}_{7}N\right] = 14.00307u$

(A) 78 MeV (B) 104.7 MeV (C) 85 MeV (D) 206.5 MeV

Sol: Mass of 7 neutrons $=7\times1.00866\,u$

Mass of 7 protons $=7\times1.00727\,u$

Mass defect $\Delta = (7m_H + 7m_n) - m_N$

$=(7\times1.00866 + 7\times1.00727) - 14.00307$

$=0.10844u$

$BE = 0.10844\times931.5$ MeV

$=104.7$ MeV

Ans: (B)

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

(A) becomes four times (B) remains constant

(C) is halved (D) is doubled

Sol: Photoelectric current is independent of frequency of incident light. Greater the intensity of light more will be the number of photons. Hence, on doubling the intensity, photo electric current is doubled.

Ans: (D)

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

(A) 1000 nm (B) 700 nm (C) 400 nm (D) 1250 nm

Sol: $K_{\max} = hv\phi_0$

$$K_1 = \frac{hc}{\lambda_1} - \phi_1$$

$$K_2 = \frac{hc}{\lambda_2} - \phi_2$$

$$K_2 - K_1 = \frac{hc}{\lambda_2} - \frac{hc}{\lambda_1}$$

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

$$0.52 \text{ eV} = hc\left[\frac{1}{\lambda_2} - \frac{1}{500\times10^{-9}}\right]$$

$$hc = 1239.97 \text{ eV} - \text{nm}$$

$$\frac{1}{\lambda} - \frac{1}{500\times10^{-9}} = \frac{0.52 \text{ eV}}{hc}$$

$$\frac{1}{\lambda} = \frac{1}{500\times10^{-9}} + \frac{0.52 \text{ eV}}{1239.97 \text{ eV} - \text{nm}}$$

$$\frac{1}{\lambda} = \left[\frac{1}{500} + \frac{0.52}{1239.97}\right]\frac{1}{10^{-9}}$$

$$\Rightarrow \lambda = 413 \text{ nm} \approx 400 \text{ nm}$$

Ans: (C)

24. The de-Broglie wavelength of a particle of kinetic energy 'K' is λ; the wavelength of the particle, if its kinetic energy is $\frac{K}{4}$ is

(A) 4λ (B) λ (C) 2λ (D) $\frac{\lambda}{2}$

Sol: $\lambda = \frac{h}{mv} = \frac{h}{p}$

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

$$\Rightarrow \lambda = \frac{h}{p} = \frac{h}{\sqrt{2mKE}} = \frac{h}{\sqrt{2mK}}$$

$$\lambda_2 = \sqrt{\frac{h}{2m \times (K/4)}} = \frac{2h}{\sqrt{2mK}} = 2\lambda$$

Ans: (C)

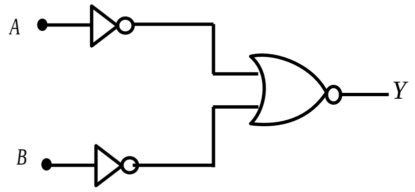
25. The forbidden energy gap of germanium crystal at '0' K is

(A) 6.57 eV (B) 0.071eV (C) 0.71 eV (D) 2.57 eV

Sol: The forbidden energy type of germanium crystal is 0.71 eV

Ans: (C)

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



(A) NOR (B) OR (C) NAND (D) AND

Sol: $Y = \overline{\overline{A} + \overline{B}}$

$= \overline{\overline{A}} + \overline{\overline{B}}$

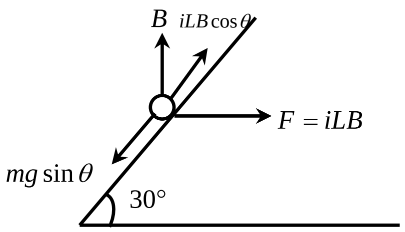
$= A \times B$ (AND gate)

Ans: (D)

27. A metallic rod of mass per unit length $0.5\,\text{kg m}^{-1}$ is lying horizontally on a smooth inclined plane which makes an angle of $30°$ with the horizontal. A magnetic field of strength $0.25\,T$ is acting on it in the vertical direction. When a current $'I'$ is flowing through it, the rod is not allowed to slide down. The quantity of current required to keep the rod stationary is

(A) 11.32 A (B) 7.14 A (C) 5.98 A (D) 14.76 A

Sol:



$iLB\cos\theta = mg\sin\theta$

$iB = \frac{m}{L} g\tan\theta$

$i \times 0.25 = 0.5 \times 9.8 \times \tan 30°$

$i = \frac{0.5 \times 9.8 \times \tan 30°}{0.25}$

$\therefore\ i = 11.32\ \text{A}$

Ans: (A)

28. A nuclear reactor delivers a power of 10^9 W, the amount of fuel consumed by the reactor in one hour is

(A) $0.96\ g$ (B) $0.04\,g$ (C) $0.08\,g$ (D) $0.72\,g$

Sol: $P = 10^9$ W

$\Rightarrow \frac{E}{t} = 10^9$

$\frac{mc^2}{t} = 10^9$

$m \times \frac{\left(3\times10^8\right)^2}{60\times60} = 10^9$

$m = \frac{10^9 \times 36 \times 10^2}{\left(3\times10^8\right)^2}$

$= 4\times10^{-5}$ kg

$\therefore\ m = 0.04$ g

Ans: (B)

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

(A) α - particles (B) X-rays (C) Neutrons (D) $\gamma -$ rays

Sol: α particles is deflected by electric field

Ans: (A)

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

(A) 10^{10} to $10^{12}\,\Omega$ cm (B) 10^{-2} to $10^{-5}\,\Omega$ cm (C) 10^{-3} to $10^{6}\,\Omega$ cm (D) 10^{6} to $10^{8}\,\Omega$ cm

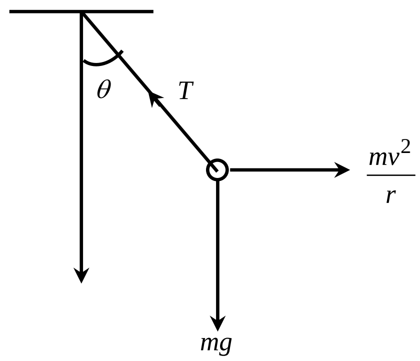
Sol: Resistivity of semiconductor lies in between 10^{-3} to 10^{6} Ωcm

Ans: (C)

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

(A) $\frac{\pi}{3}$ (B) $\frac{\pi}{6}$ (C) $\frac{\pi}{4}$ (D) 0

Sol: From the figure



We know that $T\sin\theta = \frac{mv^2}{r}$ … (1)

$T\cos\theta = mg$ … (2)

Given that

Radius $= 10$ m

Velocity $= 10\ \text{m s}^{-1}$

$g = 10\ \text{m s}^{-2}$

From (1) and (2) $\tan\theta = \frac{v^2}{rg}$

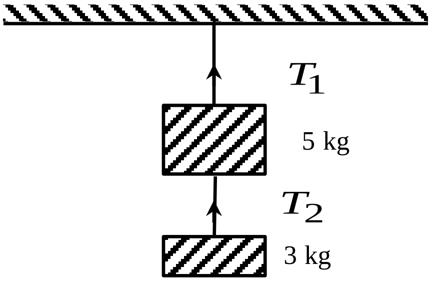
$\tan\theta = \frac{10^2}{10\times10}$

$\tan\theta = 1$

$\theta = \tan^{-1}(1) = 45° = \frac{\pi}{4}$ radian

Ans: (C)

32. Two masses of 5 kg and 3 kg are suspended with the help of massless inextensible strings as shown in figure. When system is going upwards with acceleration 2 ms^{-2}, the value of T_1 is (use $g = 9.8\text{ ms}^{-2}$)



(A) 59 N (B) 94.4 N (C) 35.4 N (D) 23.6 N

Sol: Force on mass m_1

$T_1 - T_2 - m_1 g = m_1 a$

$T_1 - T_2 - 5g = 5a$

$T_1 - T_2 = 59.0\text{ N}$ … (1)

Force on m_2

$T_2 - m_2 g = m_2 a$

$T_2 = m_2(a+g)$

$T_2 = 3(2+9.8)$

$T_2 = 35.4\text{ N}$ … (2)

From eqn (1) and eqn (2)

$T_1 = T_2 = 59$

$T_1 = 35.4 + 59$

$T_1 = 94.4\text{ N}$

Ans: (B)

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

(A) 0.5 cm (B) 0.01 cm (C) 0.5 mm (D) 0.01 mm

Sol: Least count of Vernier scale $= 1\text{ MSD} - 1\text{ VSD}$

$\text{MSD} = 0.5\text{ mm}$

$50\text{ VSD} = 49\text{ MSD}$

$1\text{ VSD} = \frac{49}{50}\text{ MSD}$

$\text{L.C.} = 1\text{ MSD} - 1\text{ VSD}$

$= 1\text{ MSD} - \frac{49}{50}\text{ MSD}$

$= 0.5\text{ mm} - \frac{49}{50} \times (0.5)\text{ mm} = 0.01\text{ mm}$

Ans: (D)

34. The displacement $'x'$ (in metre) of particle of mass $'m'$ (in kg) moving in one dimension under the action of a force, is related to time $'t'$ (in sec.) by, $t = \sqrt{x} + 3$. The displacement of the particle when its velocity is zero, will be

    (A) $2m$ (B) $4m$ (C) $0m$ (D) $6m$

Sol: $t = \sqrt{x} + 3 \Rightarrow x = (t-3)^2$

$v = \frac{dx}{dt} = \frac{d}{dt}\left((t-3)^2\right)$

$= \frac{d}{dt}\left(t^2 + 9 - 6t\right)$

$= 2t + 0 - 6$

$v = 2t - 6$

When $v = 0,\ t = 3$

$x = (t-3)^2$

$x = (3-3)^2$

$x = 0\text{ m}$

Ans: (C)

35. Two objects are projected at an angle $\theta°$ and $(90-\theta)°$, to the horizontal with the same speed. The ratio of their maximum vertical height is

    (A) $\tan^2\theta : 1$ (B) $1:1$ (C) $\tan\theta : 1$ (D) $1 : \tan\theta$

Sol: $H_1 = \frac{u^2 \sin^2\theta}{2g}$

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

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

$\tan^2\theta : 1$

Ans: (A)

36. A metallic rod breaks when strain produced is 0.2%. The Young's modulus the materials of the rod is $7\times10^{9}\ \text{N m}^{-2}$. The area of cross section to support a load of 10^{4} N is

(A) $7.1\times10^{-2}\ \text{m}^2$ (B) $7.1\times10^{-8}\ \text{m}^2$ (C) $7.1\times10^{-6}\ \text{m}^2$ (D) $7.1\times10^{-4}\ \text{m}^2$

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

Then max stress $= \frac{0.2}{100}\times 7\times10^{9} = 1.4\times10^{7}$

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

$10^{4} = 1.4\times10^{7}\times A$

$A = 7.14\times10^{-4}\ \text{m}^2$

Ans: (D)

37. A tiny spherical oil drop carrying a net charge q is balanced in still air, with a vertical uniform electric field of strength $\frac{81}{7}\pi\times10^{5}\ \text{V/m}$. When the field is switched off, the drop is observed to fall with terminal velocity $2\times10^{-3}\ \text{m s}^{-1}$. Here $g = 9.8\ \text{m s}^{-2}$, viscosity of air is $1.8\times10^{-5}\ \text{Ns/m}^2$ and the density of oil is $900\ \text{kg m}^{-3}$. The magnitude of $'q'$ is

(A) $3.2\times10^{-19} C$ (B) $0.8\times10^{-19} C$ (C) $8\times10^{-19} C$ (D) $1.6\times10^{-19} C$

Sol: $qE = mg$ … (i)

$6\pi\eta r v = mg$

$\frac{4}{3}\pi r^3 \rho g = mg$ … (ii)

$r = \left(\frac{3mg}{4\pi\rho g}\right)^{1/3}$ … (iii)

Eq (ii) put in eq. (i)

$$6\pi\eta v\left(\frac{3mg}{4\pi\rho g}\right)^{1/3} = mg$$

or $(6\pi\eta v)^3\left(\frac{3mg}{4\pi\rho g}\right) = (mg)^3$

$\because\ qE = mg$

$$(qE)^2 = \left(\frac{3}{4\pi\rho g}\right)(6\pi\eta v)^3$$

$$qE = \left(\frac{3}{4\pi\rho g}\right)^{1/2}(6\pi\eta v)^{3/2}$$

$$q = \frac{7}{81\pi\times10^{5}}\sqrt{\frac{3}{4\pi\times900\times9.8}\times216\pi^3}\times\sqrt{\left(1.8\times10^{-5}\times2\times10^{-3}\right)^3}$$

$q = 8.0\times10^{-19}$ C

Ans: (C)

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

(A) First law of thermodynamics (B) Second law of Thermodynamics

(C) Conservation of momentum (D) Conservation of mass

Sol: Heat cannot flow itself from a body of lower temperature to a body of higher temperature. This statement from Kelvin Planck" statement it corresponds to second law of thermodynamics.

Ans: (B)

39. A smooth chain of length 2 m is kept on a table such that its length of 60 cm hangs freely from the edge of the table. The total mass of the chain is 4 kg. The work done in pulling the entire chain on the table is, (Take $g = 10\text{ms}^{-2}$)

(A) 2.0 J (B) 12.9 J (C) 6.3 J (D) 3.6 J

Sol: Mass of the chain lying freely from the table $= \frac{M}{L}(\Delta x)$ (Δx – hanging part of chain)

$= \frac{4}{2}(0.6)$

$= 1.2\text{ kg}$

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

Thus the work done in pulling the chain $= 1.2 \times 10 \times 0.3$ $(\because W = mgx)$

$= 3.6\text{ J}$

Ans: (D)

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

(A) $8\pi\text{ rads}^{-2}$ (B) $2\pi\text{ rads}^{-2}$ (C) $4\pi\text{ rads}^{-2}$ (D) $6\pi\text{ rads}^{-2}$

Sol: $\omega_1 = 1200\text{ rpm} = 1200 \times \frac{2\pi}{60} = 40\pi\text{ rads}^{-1}$

$\omega_2 = 312\not{0} \times \frac{2\pi}{6\not{0}} = 104\pi\text{ rads}^{-1}$

$t = 16\text{ s}$

Angular acceleration of the motor wheel

$a = \frac{\omega_2 - \omega_1}{16} = \frac{64\pi}{16}$

$= 4\pi\text{ rads}^{-2}$

Ans: (C)

41. The centre of mass of an extended body on the surface of the earth and its centre of gravity

(A) centre of mass coincides with the centre of gravity of a body if the size of the body is negligible as compared to the size (or radius) of the earth

(B) are always at the same point for any size of the body.

(C) Are always at the same point only for spherical bodies.

(D) Can never be at the same point.

Sol: $x_{cg} = \frac{m_1 g_1 n_1 + m_2 g_2 n_2 + ...}{m_1 g_1 + m_2 g_2 + ...}$

$x_{cm} = \frac{m_1 n_1 + m_2 n_2 + ...}{m_1 + m_2 + ...}$

if $g_1 = g_2 = g...$ (true for small bodies)

$x_{cm} = x_{cg}$

Ans: (A)

42. An electric dipole with dipole moment $4\times10^{-9}\,\text{C m}$ is aligned at $30°$ with the direction of a uniform electric field of magnitude $5\times10^{4}\,\text{NC}^{-1}$, the magnitude of the torque acting on the dipole is

(A) $10\times10^{-3}\,\text{N m}$ (B) $10^{-4}\,\text{N m}$ (C) $\sqrt{3}\times10^{-4}\,\text{N m}$ (D) $10^{-5}\,\text{N m}$

Sol: $\tau = pE\ sin\theta$

$= 4\times10^{-9}\times5\times10^{4}\sin(30°)$

$= 20\times10^{-5}\left(\frac{1}{2}\right)$

$= 10^{-4}\,\text{N m}$

Ans: (B)

43. A charged particle of mass $'m'$ and charge $'q'$ is released from rest in an uniform electric field $\vec{E}$. Neglecting the effect of gravity, the kinetic energy of the charged particle after $'t'$ second is

(A) $\frac{E^2q^2t^2}{2m}$ (B) $\frac{2E^2t^2}{mq}$ (C) $\frac{Eq^2m}{2t^2}$ (D) $\frac{Eqm}{t}$

Sol: Force $F = qE$

$ma = qE$

$a = \frac{qE}{m}$

Initial speed $u = 0$

$v = u + \text{at} = \left(\frac{qE}{m}\right)t$

$K.E = \frac{1}{2}m\left(\frac{qE}{m}t\right)^2 = \frac{E^2q^2t^2}{2m}$

Ans: (A)

44. The electric field and the potential of an electric dipole vary with distance r as

(A) $\frac{1}{r^3}$ and $\frac{1}{r^2}$ (B) $\frac{1}{r}$ and $\frac{1}{r^2}$ (C) $\frac{1}{r^2}$ and $\frac{1}{r}$ (D) $\frac{1}{r^2}$ and $\frac{1}{r^3}$

Sol: Electric field $E = \frac{1}{4\pi\varepsilon_0}\frac{p}{r^3}\sqrt{1+3\cos^2\theta}$

$E \propto \frac{1}{r^3}$

Electric potential $V = \frac{1}{4\pi\varepsilon_0}\frac{p\cos\theta}{r^2}$

$V \propto \frac{1}{r^2}$

Ans: (A)

45. The displacement of a particle executing SHM is given by $X = 3\sin\left[2\pi t + \frac{\pi}{4}\right]$ where $'x'$ is in metres and $'t'$ is in seconds. The amplitude and maximum speed of the particle is

(A) $3\text{ m}, 8\pi\text{ ms}^{-1}$ (B) $3\text{ m}, 2\pi\text{ ms}^{-1}$ (C) $3\text{ m}, 4\pi\text{ ms}^{-1}$ (D) $3\text{ m}, 6\pi\text{ ms}^{-1}$

Sol: $x = 3\sin\left(2\pi t + \frac{\pi}{4}\right) = A\sin(\omega t + \phi)$

Here, amplitude $= 3\text{ m}$

$v_{\max} = A\,\omega = 3\times 2\pi = 6\pi\,\text{ms}^{-1}$

Ans: (D)

46. Electrical as well as gravitational effects can be thought to be caused by fields. Which of the following is true for an electrical or gravitational field?

(A) There is no way to verify the existence of force filed since it is just a concept

(B) The field concept is often used to describe contact forces.

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

(D) Fields are useful for understanding forces acting through a distance.

Sol: Fields are useful for understanding forces acting through a distance.

Ans: (D)

47. Four charges $+q, +2q, +q$ and $-2q$ are placed at the corners of a square $ABCD$ respectively.

The force on a unit positive charge kept at the centre $'O'$ is

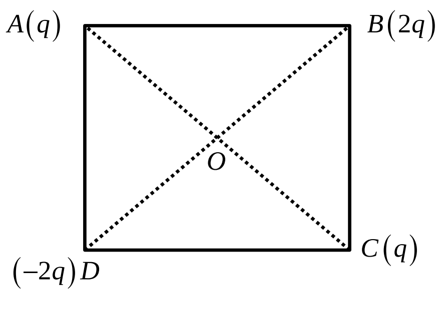
(A) perpendicular to AD

(B) zero

(C) along the diagonal BD

(D) along the diagonal AC

Sol: Forces on a unit charges kept at O, due to A and C cancel out. Due to charges kept at B and D the net force is along BD



Ans: (C)

48. Wire bound resistors are made by

(A) winding the wires of an alloy of manganin, constantan, nichrome

(B) winding the wires of an alloy of Cu, Al, Ag

(C) winding the wires of an alloy of Si, Tu, Fe

(D) winding the wires of an alloy of Ge, Au, Ga

Sol: Fact - based

Ans: (A)

49. Ten identical cells each of potential $'E'$ and internal resistance $'r'$ are connected in series to form a closed circuit. An ideal voltammeter connected across three cells, will read

(A) $7E$ (B) $10E$ (C) $3E$ (D) $13E$

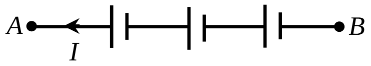
Sol: Current, $I = \frac{10E}{10r} = \frac{E}{r}$

Applying KVL,

$V_A + 3Ir - 3E = V_B$

$\Rightarrow V_A - V_B = 3E - 3Ir$

$= 3E - \frac{3E \times r}{r} = 0$



Ans: (No Key)

50. In an atom electrons revolve around the nucleus along a path of radius 0.72 Å making 9.4×10^{18} revolutions per second. The equivalent current is $-\left[\text{given } e = 1.6 \times 10^{-19} C\right]$

(A) 1.8 A (B) 1.2 A (C) 1.5 A (D) 1.4 A

Sol: $I = \frac{ne}{t} = 9.4 \times 10^{18} \times \left(1.6 \times 10^{-19}\right)$

$= 1.504 \times 10^{-1} = 1.5$ A

Ans: (C)

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

(A) shifts to the centre

(B) shifts towards right

(C) shifts towards left

(D) remains unchanged

Sol: When the conductor is heated its resistance increases

$\frac{R_1}{R_2} = \frac{L}{(100 - L)}$

So, If R, increases, length L also increases

Balance point shift towards right

Ans: (B)

52. Two tiny spheres carrying charges $1.8\ \mu C$ and $2.8\mu C$ are located at 40 cm apart. The potential at the mid-point of the line joining the two charges is

(A) 3.6×10^5 V (B) 3.8×10^4 V (C) 21×10^5 V (D) 4.3×10^4 V

Sol: $V=\frac{Kq_1}{r_1}+\frac{Kq_2}{r_2}=9\times10^9\left[\frac{1.8\times10^{-6}}{20\times10^{-2}}+\frac{2.8\times10^{-6}}{20\times10^{-12}}\right]=\frac{9\times10^9\times4.6\times10^{-6}}{20\times10^{-2}}=2.07\times10^5\ \text{V}$

Ans: (C)

53. A parallel plate capacitor is charged by connecting a $2\ \text{V}$ battery across it. It is then disconnected from the battery and a glass slab is introduced between plates. Which of the following pairs of quantities decrease?

(A) Capacitance and charge
(B) Charge and potential difference
(C) Potential difference and energy stored
(D) Energy stores and capacitance.

Sol: $q_0=C_0V_0$ (in air)

$U=\frac{1}{2}C_0V_0^2$

When the glass slab is inserted (after removal of battery)

Charge remains same

$C=KC_0$ (Capacitance increases)

$U=\frac{q_0^2}{2C}=\frac{q_0^2}{2KC}$ (U decreases)

$V=\frac{q_0}{C}=\frac{q_0}{KC_0}$ (V decreases)

Ans: (C)

54. A charged particle is moving in an electric field of $3\times10^{-10}\ \text{V m}^{-1}$ with mobility $2.5\times10^6\ \text{m}^2/\text{V/s}$, its drift velocity is

(A) $1.2\times10^{-4}\ \text{ms}^{-1}$ (B) $7.5\times10^{-4}\text{ms}^{-1}$ (C) $8.33\times10^{-4}\text{ms}^{-1}$ (D) $2.5\times10^4\text{ms}^{-1}$

Sol: $\mu=\frac{V_d}{E}\Rightarrow V_d=\mu E$

$=2.5\times10^6\times3\times10^{-10}=7.5\times10^{-4}\ \text{ms}^{-1}$

Ans: (B)

55. A solenoid of length 50cm having 100 turns carries a current of $2.5\ \text{A}$. The magnetic field at one end of the solenoid is

(A) 9.42×10^{-4} T (B) 3.14×10^{-4} T (C) 6.285×10^{-4} T (D) 1.57×10^{-4} T

Sol: $B_{\text{end}}=\frac{\mu_0 nI}{2}$

$=4\pi\times10^{-7}\times\frac{100}{50\times10^{-2}}\frac{2.5}{2}$

$\therefore\ B=10\pi\times10^{-5}\ \text{T}=3.14\times10^{-4}\ \text{T}$

Ans: (B)

56. A galvanometer of resistance 50Ω is connected to a battery of $3\,\text{V}$ along with a resistance $2950\,\Omega$ in series. A full scale deflection of 30 divisions is obtained in the galvanometer. In order to reduce this deflection to 20 divisions, the resistance in series should be

(A) 4450Ω (B) 6050Ω (C) 5550Ω (D) 5050Ω

Sol: 30 divisions $\propto I_g$

20 divisions $\propto I$

$$\frac{I}{I_g}=\frac{2}{3}$$

Also $I=\frac{V}{(G+R)}$

$$I_g=\frac{V}{(G+2950)}$$

$$\Rightarrow \frac{I}{I_g}=\frac{G+2950}{G+R}$$

$$\frac{2}{3}=\frac{50+2950}{50+R}$$

$$\frac{2}{3}=\frac{3000}{50+R}$$

$$\Rightarrow 9000=100+2R$$

$$R=\frac{8900}{2}=4450\ \Omega$$

Ans: (A)

57. A circular coil of wire of radius $'r'$ has $'n'$ turns and carries a current $'I'$. The magnetic induction $'B'$ at a point on the axis of the coil at a distance $\sqrt{3}\,r$ from its centre is

(A) $\frac{\mu_0 nI}{4r}$ (B) $\frac{\mu_0 nI}{32r}$ (C) $\frac{\mu_0 nI}{8r}$ (D) $\frac{\mu_0 nI}{16r}$

Sol: $B_{\text{axis}}=\frac{\mu_0 nIr^2}{2\left(r^2+x^2\right)^{3/2}}$; $x=r\sqrt{3}$

$$\Rightarrow B_{\text{axis}}=\frac{\mu_0 nIr^2}{2\left(r^2+3r^2\right)^{3/2}}=\frac{\mu_0 nIr^2}{2\times 8^3}=\frac{\mu_0 nI}{16\ r}$$

Ans: (D)

58. If voltage across a bulb rated $220\,\text{V}, 100\,\text{W}$ drops by 2.5% of its rated value, the percentage of the rated value by which the power would decrease is

(A) 10% (B) 20% (C) 2.5% (D) 5%

Sol: $P=\frac{V^2}{R}\Rightarrow\frac{dP}{P}=2\frac{dV}{V}$

$$\Rightarrow\frac{dP}{P}=2\times 2.5\%=5\%$$

Ans: (D)

59. A wire of a certain material is stretched slowly by 10%. Its new resistance and specific resistance becomes respectively

(A) both remain the same
(B) 1.1 times, 1.1 times
(C) 1.2 times, 1.1 times
(D) 1.21 times, same

Sol: $R = \frac{\rho l}{A} = \frac{\rho l^2}{AV} = \frac{\rho l^2}{V}$

$\rho, V = \text{constant} \Rightarrow R \propto l^2$

$\frac{R_1}{R_2} = \frac{1}{1.21} \Rightarrow R_2 = 1.21\,R,$

Specific resistance remains same

Ans: (D)

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

(A) 20×10^{-13} N
(B) 5×10^{-13} N
(C) 25×10^{-13} N
(D) 2.2×10^{-13} N

Sol: $\vec{F} = q\left(\vec{E} + \vec{v}\times\vec{B}\right)$

$= 1.6\times10^{-19}\left[4\times10^6\left(2\hat{i} + 0.2\hat{j} + 0.1\hat{k}\right) + \left(5\times10^6\,\hat{j}\right)\times(0.2)\left(\hat{i} + 0.2\hat{j} + \hat{k}\right)\right]$

$= 1.6\times10^{-19}\times10^6\left[8\hat{i} + 0.8\hat{j} + 0.4\hat{k} + -\hat{k} + 5\hat{i}\right]$

$= 1.6\times10^{-13}\left[13\hat{i} + 0.8\hat{j} - 0.6\hat{k}\right]$

$\left|\vec{F}\right| = 1.6\times10^{-13}\times\sqrt{13^2 + (0.8)^2 + (0.6)^2}$

$= 1.6\times10^{-13}\times\sqrt{169+1}$

$= 1.6\times10^{-13}\times13$

$= 20.8\times10^{-13}$ N

Ans: (A)

Key Answers:

1. B	2. D	3. B	4. A	5. A	6. B	7. A	8. B	9. D	10. D
11. A	12. C	13. C	14. C	15. B	16. A	17. C	18. C	19. A	20. D
21. B	22. D	23. C	24. C	25. C	26. D	27. A	28. B	29. A	30. C
31. C	32. B	33. D	34. C	35. A	36. D	37. C	38. B	39. D	40. C
41. A	42. B	43. A	44. A	45. D	46. D	47. C	48. A	49.	50. C
51. B	52. C	53. C	54. B	55. B	56. A	57. D	58. D	59. D	60. A