PHYSICS - CET 2021 - VERSION CODE - B2
SOLUTIONS

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

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

   Ans (A)

   $C_B = n^{\frac{1}{3}} C_S$

   $C_B = 8^{\frac{1}{3}} C_S$

   $C_B = 2C_S$

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

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

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

   (C) Do not possess permanent dipole moments.

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

   Ans (C)

   Polar molecules have permanent dipole moment.

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

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

   Ans (B)

   Number of capacitors to be connected in each row, $m = \frac{1500}{500} = 3$

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

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

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

   $n = \frac{18}{2} = 9 \Rightarrow n = 9$

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

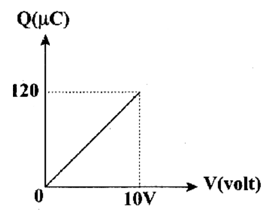
4. In figure, charge on the capacitor is plotted against potential difference across the capacitor. The capacitance and energy stored in the capacitor are respectively.

   (A) 12 μF, 1200 μJ

   (B) 12 μF, 600 μJ

   (C) 24 μF, 600 μJ

   (D) 24 μF, 1200 μJ



Ans (B)

$q = CV$

$$C = \frac{q}{V} = \frac{120\times10^{-6}}{10} = 12\times10^{-6}\,F$$

$C = 12\ \mu F$

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

$$= \frac{1}{2}\times12\times10^{-6}\times10\times10$$

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

$U = 600\ \mu J$

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

(A) 1.5 Ω (B) 3 Ω (C) 6 Ω (D) 12 Ω

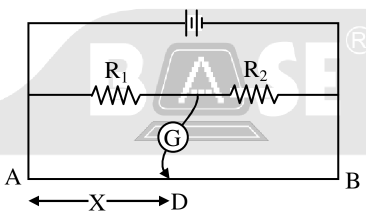
Ans (D)

$R_2 = n^2 R_1$

$R_2 = 2^2 \times 3$

$R_2 = 12\ \Omega$

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



(A) X

(B) $\frac{X}{4}$

(C) 4 X

(D) 2 X

Ans (A)

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

7. A copper wire of length 1 m and uniform cross-sectional area 5×10^{-7} m^2 carries a current of 1 A. Assuming that there are 8×10^{28} free electrons per m^3 in copper, how long will an electron take to drift from one end of the wire to the other?

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

Ans (D)

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

$I = neAv_d$

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

$$t = \frac{l\,neA}{I}$$

$$t = \frac{1\times8\times10^{28}\times1.6\times10^{-19}\times5\times10^{-7}}{1}$$

$t = 6.4 \times 10^3$ s

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

(I) the kinetic energy of the charge increases by $IV\Delta t$.

(II) the electric potential energy of the charge decreases by $IV\Delta t$.

(III) the thermal energy of the conductor increases by $IV\Delta t$.

Then the correct statement/s is/ are

(A) (I) (B) (I), (II) (C) (I) and (III) (D) (II), (III)

Ans (D)

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

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

(A) Moves in the direction of the field (B) Moves in an opposite direction of the field

(C) Remains stationary (D) Starts spinning

Ans (C)

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

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

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

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

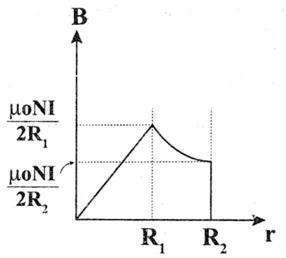
Ans (A)

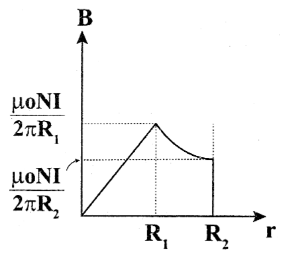
$$\frac{F}{l} = \left(\frac{\mu_0}{4\pi}\right)\frac{2I_1I_2}{d}$$

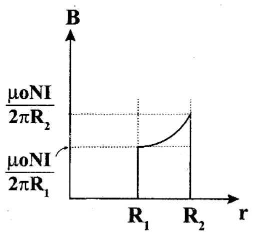
$$= \frac{10^{-7} \times 2 \times 10 \times 10}{10 \times 10^{-2}}$$

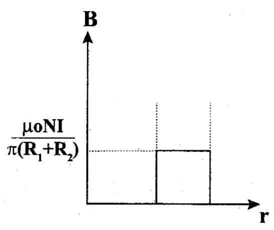
$$\frac{F}{l} = 2 \times 10^{-4}\ \text{N m}^{-1}\ \text{[attractive since the currents are in the same direction]}$$

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

(A) 

(B) 

(C) 

(D) 

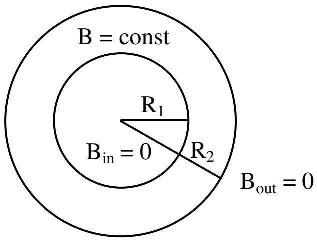
Ans (D)

$B = \mu_0 n I$

where $n = \dfrac{N}{2\pi r}$

$B = \dfrac{\mu_0 N I}{2\pi\left(\dfrac{R_1 + R_2}{2}\right)}$

$B = \dfrac{\mu_0 N I}{\pi\left(R_1 + R_2\right)}$



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

(A) $\dfrac{\mu_0 n I q r}{m}$ (B) $\dfrac{\mu_0 n I q r}{2m}$ (C) $\dfrac{\mu_o n I q r}{4m}$ (D) $\dfrac{\mu_o n I q r}{8m}$

Ans (B)

$F_B = qvB \sin\theta$ $\theta = 90°$

$F_B = qvB$

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

$F_B = F_C$

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

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

$B = \mu_0 n I$

$v = \dfrac{qr\mu_0 n I}{2m}$

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

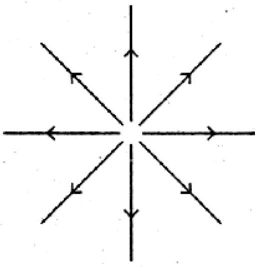
(A) equator (B) magnetic poles (C) a latitude of 60° (D) an altitude of 60°

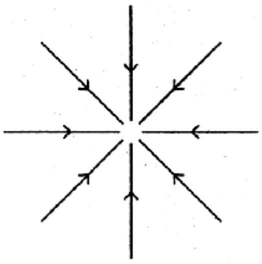
Ans (B)

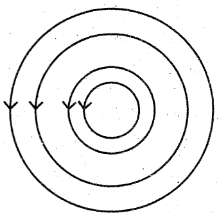
Magnetic dip at poles, $\theta = 90°$

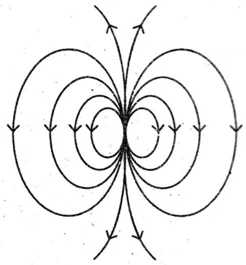
$B_H = B \cos\theta = 0$

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

(A) 

(B) 

(C) 

(D) 

Ans (D)

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

But induced electric field form closed loops.

If they consider induced electric field, then option (C) they may consider as correct option.

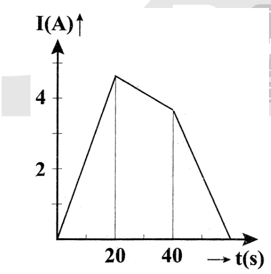
15. The current flowing through an inductance coil of self inductance 6 mH at different time instants is as shown. The emf induced between t = 20 s and t = 40 s is nearly

(A) 2×10^{-2} V

(B) 3×10^{-2} V

(C) 4×10^{-3} V

(D) 30×10^{2} V



Ans GRACE

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

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

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

$e = 3 \times 10^{-4}$ V.

16. The physical quantity which is measured in the unit of wb A^{-1} is

(A) Self inductance (B) Mutual inductance (C) Magnetic flux (D) Both (A) and (B)

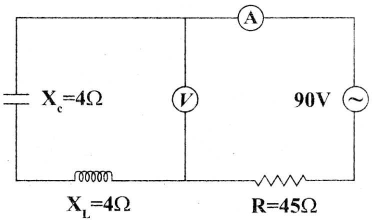
Ans (D)

$\phi = LI$ or $\phi = MI$

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

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

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



Ans (B)

$X_L = X_C$ Hence, the resultant voltage across L and C is 0.

$Z = R$

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

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

(A) reciprocal of capacitive reactance
(B) capacitive reactance
(C) reciprocal of capacitance
(D) capacitance

Ans (C)

$$k \to \frac{1}{C}$$

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

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

Ans (B)

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

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

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

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

20. Suppose that the electric field amplitude of electromagnetic wave is $E_0 = 120\ NC^{-1}$ and its frequency is f = 50 MHz. Then which of the following value is incorrectly computed?

(A) Magnetic field amplitude is 400nT.
(B) Angular frequency of EM wave is $\pi \times 10^8$ rad/s
(C) Propagation constant (angular wave number) is 2.1 rad/m
(D) Wavelength of the EM wave is 6 m.

Ans (C)

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

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

$$k = \frac{2\pi}{\lambda} = \frac{2 \times 3.14}{6}$$

$$k \neq 2.1\ \ rad\,m^{-1}$$

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

(A) Moving with a constant velocity
(B) Moving in a circular orbit
(C) At rest
(D) Moving parallel to the magnetic field

Ans (B)

Charges moving in a circular orbit undergo centripetal acceleration hence emit em waves.

Or when electron jumps from one higher stationary orbit to another lower stationary orbit emits em radiation.

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

(A) frequency is different
(B) speed is different
(C) coefficient of elasticity is different
(D) amplitude is smaller.

Ans (B)

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

23. If the refractive index from air to glass is $\frac{3}{2}$ and that from air to water is $\frac{4}{3}$, then the ratio of focal lengths of a glass lens in water and in air is

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

Ans (D)

$n_w = \frac{4}{3}$ $\qquad$ $n_g = \frac{3}{2}$

$f_a\left(n_g - 1\right) = f_w\left(\frac{n_g}{n_w} - 1\right)$

$$\frac{f_w}{f_a} = \frac{n_g - 1}{\frac{n_g}{n_w} - 1} = \frac{\frac{3}{2} - 1}{\frac{\frac{3}{2}}{\frac{4}{3}} - 1}$$

$$= \frac{\frac{3-2}{2}}{\frac{9}{8} - 1} = \frac{\frac{1}{2}}{\frac{9-8}{8}} = \frac{\frac{1}{2}}{\frac{1}{8}} = \frac{8}{2} \qquad \therefore \frac{f_w}{f_a} = \frac{4}{1}$$

24. Two thin biconvex lenses have focal lengths f_1 and f_2. A third thin biconcave lens has focal length of f_3. If the two biconvex lenses are in contact, the total power of the lenses is P_1. If the first convex lens is in contact with the third lens, the total power is P_2. If the second lens is in contact with the third lens, the total power is P_3 then

(A) $P_1 = \frac{f_1 f_2}{f_1 - f_2}$, $P_2 = \frac{f_1 f_3}{f_3 - f_1}$ and $P_3 = \frac{f_2 f_3}{f_3 - f_2}$
(B) $P_1 = \frac{f_1 - f_2}{f_1 f_2}$, $P_2 = \frac{f_3 - f_1}{f_3 + f_1}$ and $P_3 = \frac{f_3 - f_2}{f_2 f_3}$
(C) $P_1 = \frac{f_1 - f_2}{f_1 f_2}$, $P_2 = \frac{f_3 - f_1}{f_1 f_3}$ and $P_3 = \frac{f_3 - f_2}{f_2 f_3}$
(D) $P_1 = \frac{f_1 + f_2}{f_1 f_2}$, $P_2 = \frac{f_3 - f_1}{f_1 f_3}$ and $P_3 = \frac{f_3 - f_2}{f_2 f_3}$

Ans (D)

$$\begin{array}{l|l} f_1 = +f_1 & \frac{1}{F_R} = \frac{1}{f_1} + \frac{1}{f_2} \\ f_2 = +f_2 & \\ f_3 = -f_3 & P_R = \frac{1}{f_1} + \frac{1}{f_2} \end{array}$$

$$P_1 = \frac{1}{f_1} + \frac{1}{f_2} = \frac{f_2 + f_1}{f_1 f_2}$$

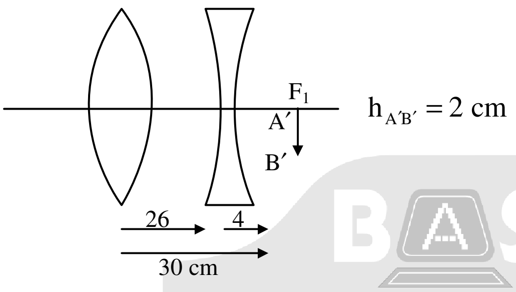
$$P_2 = \frac{1}{f_1} + \frac{1}{f_3} = \frac{f_3 - f_1}{f_1 f_3}$$

$$P_2 = \frac{1}{f_2} + \frac{1}{f_3} = \frac{f_3 - f_2}{f_2 f_3}$$

25. The size of the image of an object, which is at infinity, as formed by a convex lens of focal length 30 cm is 2 cm. If a concave lens of focal length 20 cm is placed between the convex lens and the image at a distance of 26 cm from the lens, the new size of the image is

(A) 1.25 cm (B) 2.5 cm (C) 1.05 cm (D) 2 cm

Ans (B)



$A'B'$ is the real image due to convex lens and it is at Focus of convex lens.

$A'B'$ acts as virtual object for concave lens and object distance is + 4 cm

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \qquad v = \frac{20}{4}$$

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} \qquad v = 5\text{ cm}$$

$$\frac{1}{v} = \frac{1}{-20} + \frac{1}{4}$$

$$\frac{1}{v} = \frac{-1+5}{20} = \frac{4}{20}$$

$$m = \frac{h_i}{h_o} = \frac{v}{u}$$

$$h_i = \frac{v h_o}{u}$$

$$= \frac{5 \times 2}{4} = \frac{10}{4} = 2.5\text{ cm}$$

26. A slit of width ‘a’ is illuminated by red light of wavelength 6500 Å. If the first diffraction minimum falls at 30°, then the value of ‘a’ is _______

(A) 6.5×10^{-4} mm (B) 1.3 micron (C) 3250 Å (D) 2.6×10^{-4} cm

Ans (B)

For diffraction minima

a sin θ = nλ

n = 1 for I minimum

$$a = \frac{\lambda}{\sin\theta} = \frac{6.5\times10^{-7}}{\sin 30}$$

$$= \frac{6.5\times10^{-7}}{0.5}$$

$= 13 \times 10^{-7}$

$= 1.3 \times 10^{-6}$ m

= 1.3 micron

27. Which of the statements are correct with reference to single slit diffraction pattern?

(i) Fringes are of unequal width

(ii) Fringes are of equal width

(iii) Light energy is conserved

(iv) Intensities of all bright fringes are equal

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

Ans (A)

Option (i) and (iii) are correct.

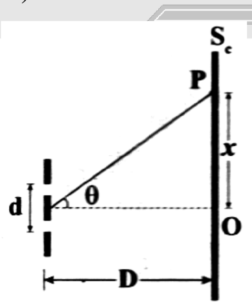
28. In the Young's double slit experiment a monochromatic source of wavelength λ is used. The intensity of light passing through each slit is I_o. The intensity of light reaching the screen S_C at a point P, a distance x from O is given by (Take d < < D).

(A) $I_o \cos^2\left(\frac{\pi D}{\lambda d}x\right)$

(B) $4I_o \cos^2\left(\frac{\pi d}{\lambda D}x\right)$

(C) $I_o \sin^2\left(\frac{\pi d}{2\lambda D}x\right)$

(D) $4I_o \cos\left(\frac{\pi d}{2\lambda D}x\right)$

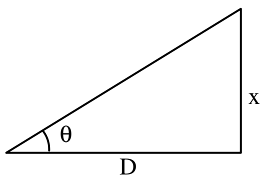


Ans (B)

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

Path difference = d sin θ

$$= d\left[\frac{x}{D}\right]$$



$$\phi = \frac{2\pi}{\lambda}\left[\frac{dx}{D}\right]$$

$$I = 4I_o \cos^2\frac{\phi}{2}$$

$$= 4I_o \cos^2\frac{\pi d}{\lambda D}\cdot x$$

29. The work function of a metal is 1 eV. Light of wavelength 3000 Å is incident on this metal surface. The velocity of emitted photoelectrons will be

(A) 10 m s^{-1} (B) $1 \times 10^3 \text{ m s}^{-1}$ (C) $1 \times 10^4 \text{ m s}^{-1}$ (D) $1 \times 10^6 \text{ m s}^{-1}$

Ans (D)

$$E_{k\,max} = (E_{photon} - W) \text{ eV}$$

$$= \left(\frac{12.42\times10^{-7}}{3\times10^{-7}} - 1\right) \text{eV}$$

$$= (4 - 1) \text{ eV}$$

$$E_{k\,max} = 3 \text{ eV} = 3 \times 1.6 \times 10^{-19} \text{ J}$$

$$\frac{1}{2}mv^2_{max} = 3\times1.6\times10^{-19}$$

$$v^2_{max} = \frac{3\times2\times1.6\times10^{-19}}{9.1\times10^{-31}}$$

$$v^2_{max} = 10^{12}$$

$$v_{max} = 10^6 \text{ m s}^{-1}$$

30. A proton moving with a momentum P_1 has a kinetic energy $\frac{1}{8}$th of its rest mass energy. Another light photon having energy equal to the kinetic energy of the proton possesses a momentum P_2. Then the ratio $\frac{P_1 - P_2}{P_1}$ is equal to

(A) 1 (B) $\frac{1}{4}$ (C) $\frac{1}{2}$ (D) $\frac{3}{4}$

Ans (D)

For proton $v^2 = \frac{c^2}{4}$ $\quad v = \frac{c}{2}$

$$P = \sqrt{2mE_k}$$

$$= \sqrt{\cancel{2}m\frac{1}{\cancel{8}_4}mc^2}$$

$$P_1 = \frac{mc}{2}$$

For photon

$$E_{photon} = KE_{proton}$$

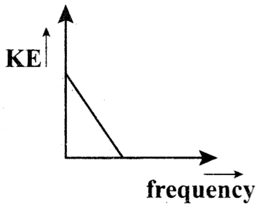
$$\frac{h\cancel{c}}{\lambda} = \frac{1}{8}mc^{\cancel{2}}$$

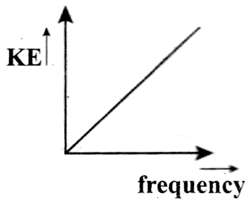
$$P_{photon} = \frac{h}{\lambda} = \frac{mc}{8} = P_2$$

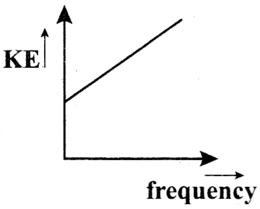
$$\frac{P_1 - P_2}{P_1} = \frac{\frac{\cancel{mc}}{2} - \frac{\cancel{mc}}{8}}{\frac{\cancel{mc}}{2}} = \frac{\frac{1}{2} - \frac{1}{8}}{\frac{1}{2}} = \frac{\frac{4-1}{8}}{\frac{1}{2}}$$

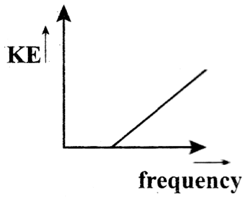
$$= \frac{3\times2}{8} = \frac{3}{4}$$

31. According to Einstein's photoelectric equation the graph between kinetic energy of photoelectrons ejected and the frequency of incident radiation is

(A) 

(B) 

(C) 

(D) 

Ans (D)

$K_{max} = h\nu - \phi_o$

$y = m\,x - C$

Graph is a straight line with slope 'h'

Till $\nu = \nu_o$, no photoelectric emission occurs

32. Energy of an electron in the second orbit of hydrogen atom is E_2. The energy of electron in the third orbit of He^+ will be

(A) $\frac{9}{16}E_2$ (B) $\frac{16}{9}E_2$ (C) $\frac{3}{16}E_2$ (D) $\frac{16}{3}E_2$

Ans (B)

For 2nd orbit of H-atom

$$E_2 = \frac{-13\cdot 6}{2^2}\,\text{eV}$$

For 3rd orbit of He^+

$$E_3^{He^+} = \frac{-13\cdot 6}{3^2}2^2 = \frac{-13\cdot 6}{4}\times\frac{4}{9}\times 2^2$$

$$= E_2\times\frac{16}{9} = \frac{16}{9}E_2$$

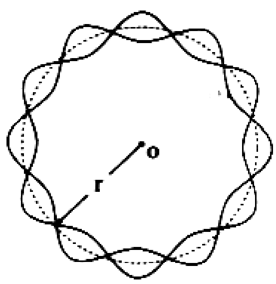
33. The figure shows standing de Broglie waves due to the revolution of electron in a certain orbit of hydrogen atom. Then the expression for the orbit radius is (all notations have their usual meanings)

(A) $\frac{h^2\varepsilon_0}{\pi me^2}$

(B) $\frac{4h^2\varepsilon_0}{\pi me^2}$

(C) $\frac{9h^2\varepsilon_0}{\pi me^2}$

(D) $\frac{16h^2\varepsilon_0}{\pi me^2}$



Ans GRACE

Number of stationary waves is 6 i.e., $n = 6$

$$r = \frac{n^2\varepsilon_0^2 h^2}{\pi m e^2} = \frac{36\,\varepsilon_0^2 h^2}{\pi m e^2}$$

34. An electron in an excited state of Li^{2+} ion has angular momentum $\frac{3h}{2\pi}$. The de Broglie wavelength of electron in this state is $P\pi a_o$ (where a_o = Bohr radius). The value of P is

(A) 3 (B) 2 (C) 1 (D) 4

Ans (B)

$$L = \frac{nh}{2\pi} = \frac{3h}{2\pi}$$

$n = 3$

$$\lambda = \frac{h}{mv} = \frac{h.r}{mvr} = \frac{hr}{\frac{3h}{2\pi}}$$

$$= \frac{2}{3}\pi r$$

For Li^{2+} atom radius of orbit.

$$r = r_0 \frac{n^2}{z}$$

$$r = a_0 \times \frac{3^2}{3}$$ (a_0 = Bohr radius)

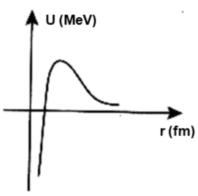
$$\therefore \ \lambda = \frac{2}{3}.\ \pi \times a_0 \times \frac{3^2}{3}$$

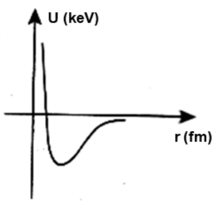
$$= 2\pi a_0$$

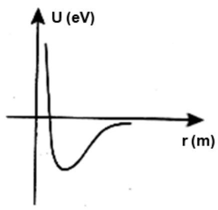
Comparing

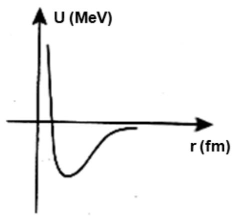
$\therefore\ P = 2$

35. Which graph in the following diagrams correctly represents the potential energy of a pair of nucleons as a function of their separation?

(A) 

(B) 

(C) 

(D) 

Ans (D)

Conceptual

36. In a nuclear reactor heavy nuclei is not used as moderators because

(A) They will break up

(B) Elastic collision of neutrons with heavy nuclei will not slow them down.

(C) The net weight of the reactor would be unbearably high

(D) Substances with heavy nuclei do not occur in liquid or gaseous state at room temperature.

Ans (B)

Conceptual

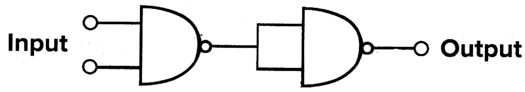
37. The circuit given represents which of the logic operations?

(A) OR

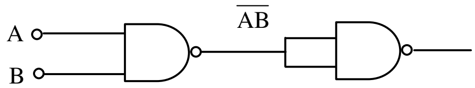
(B) AND

(C) NOT

(D) NOR



Ans (B)



$$Y = \overline{\overline{AB} \cdot \overline{AB}}$$
$$= \overline{\overline{AB}} + \overline{\overline{AB}}$$
$$= AB$$

38. Identify the incorrect statement.

(A) when a P-N junction diode is forward biased, the width of the depletion region decreases.

(B) when a P-N junction diode is reverse biased, the barrier potential increases.

(C) a photo diode is operated in the reverse bias.

(D) an LED is a lightly doped P-N junction diode which emits spontaneous radiation on forward biasing.

Ans (D)

LED is heavily doped PN-junction

39. Three photodiodes D_1, D_2 and D_3 are made of semiconductors having band gaps of 2.5 eV, 2 eV and 3 eV respectively. Which one will be able to detect light of wavelength 600 nm?

(A) D_1 only (B) Both D_1 and D_3 (C) D_2 only (D) All the three diodes

Ans (C)

$E_1 = 2.5$ eV

$E_2 = 2$ eV

$E_3 = 3$ eV

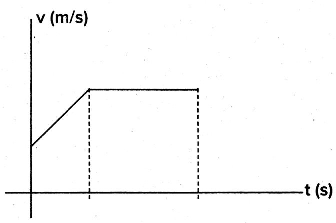
$\lambda = 600$nm $\quad \therefore \quad E = \dfrac{1242}{\lambda_{nm}} = \dfrac{1242}{600}$ eV

$= 2.07$ eV

(E_1 and E_3) is > E

Only D_2 will detect

40. For a body moving along a straight line, the following v-t graph is obtained.



According to the graph, the displacement during

(A) Uniform acceleration is greater than that during uniform motion.

(B) Uniform acceleration is less than that during uniform motion.

(C) Uniform acceleration is equal to that during uniform motion.

(D) Uniform motion is zero.

Ans (B)

S = Area under v-t graph

$$\left.\begin{array}{l}\text{Area under}\\ \text{uniform motion}\end{array}\right\} > \begin{array}{c}\text{Area under}\\ \text{triangle}\end{array}$$

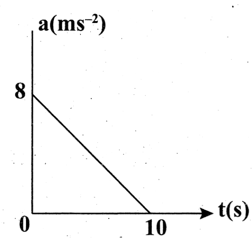
41. A particle starts from rest. Its acceleration 'a' versus time 't' is shown in the figure. The maximum speed of the particle will be

(A) 80 m s^{-1}

(B) 40 m s^{-1}

(C) 18 m s^{-1}

(D) 2 m s^{-1}



Ans (B)

Area under a – t graph = v – u

$$\frac{1}{2}\times 8\times 10 = v$$

v = 40 m s^{-1}

42. The maximum range of a gun on horizontal plane is 16 km. If g = 10 m s^{-2}, then muzzle velocity of a shell is

(A) 160 m s^{-1} (B) $200\sqrt{2}$ m s^{-1} (C) 400 m s^{-1} (D) 800 m s^{-1}

Ans (C)

$$\frac{u^2}{g} = 16\times 10^3 \text{ m}$$

$u^2 = 16 \times 10^3 \times 10$

$u^2 = 16 \times 10^4$

u = 400 m s^{-1}

43. The trajectory of a projectile is

(A) semicircle (B) an ellipse

(C) a parabola always (D) a parabola in the absence of air resistance

Ans (D)

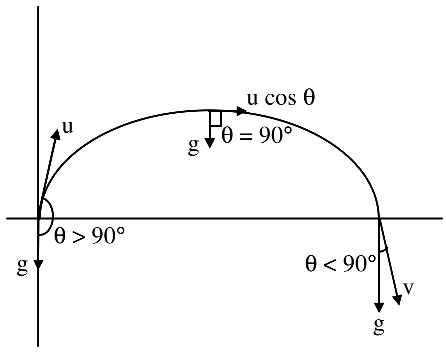
Conceptual

44. For a projectile, motion the angle between the velocity and acceleration is minimum and acute at

(A) only one point (B) two points (C) three points (D) four points

Ans (A)

Conceptual



45. A particle starts from the origin at t = 0 s with a velocity of $10\,\hat{j}$ m s^{-1} and moves in the x-y plane with a constant acceleration of $(8\hat{i}+2\hat{j})\,ms^{-2}$. At an instant when the x-coordinate of the particle is 16 m, y-coordinate of the particle is

(A) 16 m (B) 28 m (C) 36 m (D) 24 m

Ans (D)

$\vec{r}=\vec{u}t+\frac{1}{2}\vec{a}\,t^2$

$x\hat{i}+y\hat{j}=10t\,\hat{j}+\frac{1}{2}(8\hat{i}+2\hat{j})t^2$

$x\hat{i}+y\hat{j}=10t\,\hat{j}+(4\hat{i}+\hat{j})t^2$

$16\hat{i}+y\hat{j}=10t\,\hat{j}+4t^2\hat{i}+t^2\hat{j}$

$16\hat{i}+y\hat{j}=4t^2\,\hat{i}+(10t+t^2)\hat{j}$

$4t^2 = 16$

$t = 4s$

$y = 10t + t^2$

$= 20 + 4 = 24$ m.

46. A coin placed on a rotating turn table just slips if it is placed at a distance of 4 cm from the centre. If the angular velocity of the turn table is doubled it will just slip at a distance of

(A) 1 cm (B) 2 cm (C) 4 cm (D) 8 cm

Ans (A)

$r = 4$ cm

$f = mr\omega^2$

$f = \mu mg$

$\mu mg = m\omega^2 r$

$\mu g = \omega^2 r$

$\mu g = \omega^2 \times 4$ …(1)

$\omega^1 = 2\omega$

$\mu g = (2\omega)^2 r$

$\mu g = 4\omega^2 r$ …(2)

$\omega^2 \times 4 = 4\omega^2 r$

$r = 1$ cm

47. A 1 kg ball moving at 12 m s^{-1} collides with a 2 kg ball moving in opposite direction at 24 m s^{-1}. If the coefficient of restitution is $\frac{2}{3}$, then their velocities after the collision are

(A) – 4 m s^{-1}, – 28 m s^{-1} (B) – 28 m s^{-1}, – 4 m s^{-1}

(C) 4 m s^{-1}, 28 m s^{-1} (D) 28 m s^{-1}, 4 m s^{-1}

Ans (B)

$m_1 = 1$ kg, $u_1 = 12$ m s^{-1}

$m_2 = 3$ kg, $u_2 = -24$ m s^{-1}

$e=\frac{v_2-v_1}{u_1-u_2}$

$$\frac{2}{3}=\frac{v_2-v_1}{36}$$

$$v_2-v_1=\frac{36\times2}{3}$$

$v_2 - v_1 = 24$ ...(1)

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$1 \times 12 + 2 \times (-24) = v_1 + 2v_2$

$12 - 48 = v_1 + 2v_2$

$$\begin{array}{r} v_1+2v_2=-36 \\ -v_1+v_2=24 \\ \hline 3v_2=-12 \end{array}$$

$v_2=-4\ \text{m s}^{-1}$

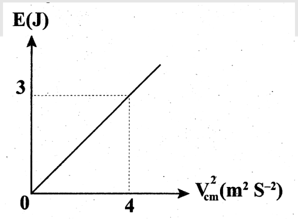
$-4 - v_1 = 24$ [from equation (1)]

$-4 - 24 = v_1$

$v_1 = -28\ \text{m s}^{-1}$

48. A ball hits the floor and rebounds after an inelastic collision. In this case
(A) the momentum of the ball is conserved
(B) the mechanical energy of the ball is conserved
(C) the total momentum of the ball and the earth is conserved
(D) the total mechanical energy of the ball and the earth is conserved
Ans (C)

49. In figure E and V_{cm} represent the total energy and speed of centre of mass of an object of mass 1 kg in pure rolling. The object is
(A) sphere
(B) ring
(C) disc
(D) Hollow Cylinder



Ans (C)

$$E=\frac{1}{2}mv_{cm}^2\left[1+\frac{K^2}{R^2}\right]$$

$$\frac{E}{v_{cm}^2}=\frac{1}{2}\left[1+\frac{K^2}{R^2}\right]$$

From graph, $\frac{E}{v_{cm}^2}=\frac{3}{4}$

$$\frac{3}{4}=\frac{1}{2}\left[1+\frac{K^2}{R^2}\right]$$

$$\frac{3}{2}-1=\frac{K^2}{R^2}$$

$$\frac{K^2}{R^2}=\frac{1}{2}$$

For disc, $I=\frac{mR^2}{2}$

$$\frac{mR^2}{2} = mK^2$$

$$\frac{K^2}{R^2} = \frac{1}{2}$$

50. Two bodies of masses 8 kg are placed at the vertices A and B of an equilateral triangle ABC. A third body of mass 2 kg is placed at the centroid G of the triangle. If AG = BG = CG = 1 m, where should a fourth body of mass 4 kg be placed so that the resultant force on the 2 kg body is zero?
(A) at C
(B) at a point P on the line CG such that $PG = \frac{1}{\sqrt{2}}$ m
(C) at a point P on the line CG such that PG = 0.5 m
(D) at a point P on the line CG such that PG = 2 m
Ans (B)

$$F_A = F_B = \frac{G m_1 m_2}{r^2} = \frac{G 8\times 2}{1^2} = G(16)$$

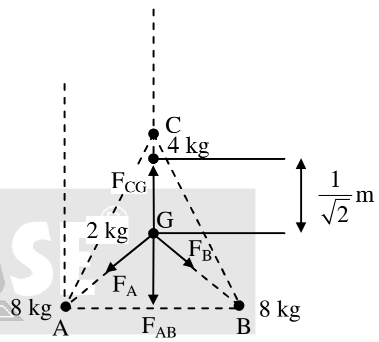
$$F_{AB} = \sqrt{F_A^2 + F_B^2 + 2F_A F_B \cos\theta}$$

$$= \sqrt{F_A^2 + F_B^2 + 2F_A F_B \cos 120}$$

$$= \sqrt{F_A^2 + F_B^2 + 2F_A F_B \left(-\frac{1}{2}\right)}$$

$$F_{AB} = F_A = G(16)$$

For resultant force on 2 kg to be zero



$$\vec{F}_{CG} = -\vec{F}_{AB}$$

$$\Rightarrow \frac{G\ 2\times 4}{X^2} = G(16)$$

$$X^2 = \frac{2\times 4}{16} = \frac{1}{2}$$

$$X = \frac{1}{\sqrt{2}}$$

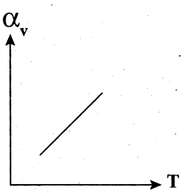
51. Two capillary tubes P and Q are dipped vertically in water. The height of water level in capillary tube P is $\frac{2}{3}^{rd}$ of the height in capillary tube Q. The ratio of their diameter is ____.
(A) 2 : 3 (B) 3 : 2 (C) 3 : 4 (D) 4 : 3
Ans (B)

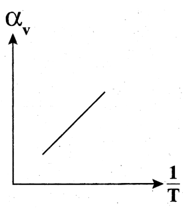
$$r = \frac{2T\cos\theta}{\rho g h}$$

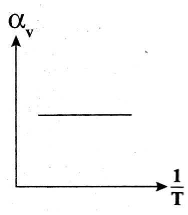
As we know $r \propto \frac{1}{h}$

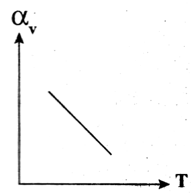
$$\frac{r_P}{r_Q} = \frac{h_Q}{h_P} = \frac{h}{\frac{2}{3}h} \Rightarrow \frac{r_P}{r_Q} = \frac{3}{2}$$

52. Which of the following curves represent the variation of coefficient of volume expansion of an ideal gas at constant pressure?

(A) 

(B) 

(C) 

(D) 

Ans (B)

We know $PV = nRT$ or $\frac{1}{T} = \frac{nR}{PV}$

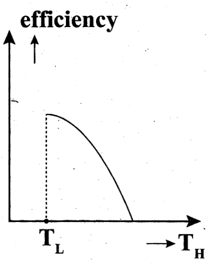
Since, P is constant, $P\Delta V = nR\Delta T$

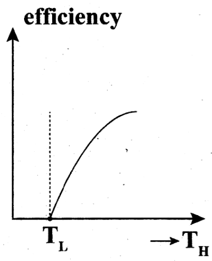
(or) $\frac{\Delta V}{\Delta T} = \frac{nR}{P}$

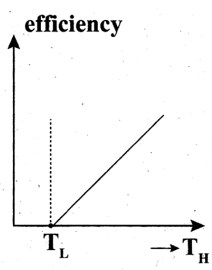
Coefficient of volume expansion $\alpha_v = \frac{\Delta V}{V\Delta T}$

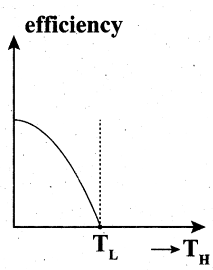
$\alpha_v = \frac{nR}{PV} = \frac{1}{T}$

53. A number of Carnot engines are operated at identical cold reservoir temperatures (T_L). However, their hot reservoir temperatures are kept different. A graph of the efficiency of the engines versus hot reservoir temperature (T_H) is plotted. The correct graphical representation is

(A) 

(B) 

(C) 

(D) 

Ans (B)

$n = 1 - \frac{T_L}{T_H}$ At constant T_L, efficiency increases with the increase in T_H.

54. A gas mixture contains monoatomic and diatomic molecules of 2 moles each. The mixture has a total internal energy of (symbols have usual meanings)

(A) 3 RT (B) 5 RT (C) 8 R (D) 9 RT

Ans GRACE

C_v for monoatomic gas is $\frac{3R}{2}$

C_v for diatomic gas is $\frac{5R}{2}$

Total internal energy for mixture

$$U = 2\times\left(\frac{3}{2}\right)RT + 2\left(\frac{5}{2}\right)RT$$

U = 8 RT

55. A pendulum oscillates simple harmonically if and only if

(I) the size of the bob of pendulum is negligible in comparison with the length of the pendulum

(II) the angular amplitude is less than 10°

(A) Both (I) and (II) are correct (B) Both (I) and (II) are incorrect

(C) Only (I) is correct (D) Only (II) is correct

Ans (D)

Concept based

56. To propagate both longitudinal and transverse waves, a material must have

(A) Bulk and shear moduli (B) Only bulk modulus

(C) Only shear modulus (D) Young's and Bulk modulus

Ans (A)

Conceptual

57. A copper rod AB of length l is rotated about end A with a constant angular velocity ω. The electric field at a distance x from the axis of rotation is

(A) $\frac{m\omega^2 x}{e}$ (B) $\frac{m\omega x}{el}$ (C) $\frac{mx}{\omega^2 l}$ (D) $\frac{me}{\omega^2 x}$

Ans (A)

We know in circular motion net force acting on it must be $\frac{mv^2}{r}$

When the rod rotates, electrons in it also rotates which produce electric field E at distance x.

Force on the electron, Fe = eE = $m\omega^2 x$

$$\therefore\ Ee = \frac{mv^2}{x} \qquad (v = x\omega)$$

$$Ee = \frac{m(x\omega)^2}{x} \Rightarrow E = \frac{m\omega^2 x}{e}$$

58. Electric field due to infinite, straight uniformly charged wire varies with distance 'r' as

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

Ans (B)

$$\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{2\lambda}{r} \text{ (or) } \vec{E} = \frac{\lambda}{2\pi\varepsilon_0 r}\hat{r} \Rightarrow |\vec{E}| \propto \frac{1}{r}$$

59. A 2 gram object, located in a region of uniform electric field $\vec{E} = (300\ NC^{-1})\hat{i}$ carries a charge Q. The object released from rest at x = 0, has a kinetic energy of 0.12 J at x = 0.5 m. Then Q is

(A) 400 μC (B) –400 μC (C) 800 μC (D) – 800 μC

Ans (C)

Work done (W) = Change in K E

Force × displacement = change in KE

$QE \times x = 0.12$ J

$Q(300) \times (0.5) = 0.12$

$$Q = \frac{0.12}{300 \times 0.5} = 800\ \mu C$$

The charge Q is moving in the direction of electric field, hence it is positive.

60. If a slab of insulating material (conceptual) 4×10^{-3} m thick is introduced between the plates of a parallel plate capacitor, the separation between the plates has to be increased by 3.5×10^{-3} m to restore the capacity to original value. The dielectric constant of the material will be

(A) 6 (B) 8 (C) 10 (D) 12

Ans (B)

If k be the dielectric constant, the distance increased due to introduced dielectric is

$$x = t - \frac{t}{k} \Rightarrow x = t\left(1 - \frac{1}{k}\right)$$

Where, t → thickness of the dielectric.

According to the question,

$x = 3.5 \times 10^{-3}$ m

$$t\left(1 - \frac{1}{k}\right) = 3.5 \times 10^{-3}$$

$$1 - \frac{1}{k} = \frac{3.5 \times 10}{4 \times 10} = \frac{3.5}{4}$$

$$\frac{1}{k} = 1 - \frac{35}{4} = \frac{0.5}{4} = 0.125$$

k = 8

* * *