

DATE : 04/05/2025

Test Booklet Code



47

NARMADA

Corporate Office : 3rd Floor, Incuspaze Campus-2, Plot No. 13,  
Sector-18, Udyog Vihar, Gurugram, Haryana - 122015

## Answers & Solutions

Time : 3 hrs.

for

M.M.: 720

## NEET (UG)-2025

### Important Instructions:

1. The test is of **3 hours** duration and the Test Booklet contains **180** multiple choice questions (Four options with a single correct answer) from **Physics, Chemistry and Biology (Botany and Zoology)**.
2. Each question carries **4 marks**. For each correct response, the candidate will get **4 marks**. For every wrong response **1 mark** shall be deducted from the total scores. The maximum marks are **720**.
3. Use **Blue / Black Ball Point Pen only** for writing particulars on this page / marking responses on Answer Sheet.
4. Rough work is to be done in the space provided for this purpose in the Test Booklet only.
5. On completion of the test, the candidate **must hand over the Answer Sheet (ORIGINAL and OFFICE Copy)** to the Invigilator before leaving the Room / Hall. The candidates are allowed to take away this Test Booklet with them.
6. The CODE for this Booklet is **47**.
7. The candidates should ensure that the Answer Sheet is not folded. Do not make any stray marks on the Answer Sheet. Do not write your Roll No. anywhere else except in the specified space in the Test Booklet/Answer Sheet. Use of white fluid for correction is **NOT** permissible on the Answer Sheet.
8. Each candidate must show on-demand his/her Admit Card to the Invigilator.
9. No candidate, without special permission of the Centre Superintendent or Invigilator, would leave his/her seat.
10. Use of Electronic/Manual Calculator is prohibited.
11. The candidates are governed by all Rules and Regulations of the examination with regard to their conduct in the Examination Room/Hall. All cases of unfair means will be dealt with as per Rules and Regulations of this examination along with Public Examinations (Prevention of unfair means act 2024).
12. **No part of the Test Booklet and Answer Sheet shall be detached under any circumstances.**
13. The candidates will write the Correct Test Booklet Code as given in the Test Booklet / Answer Sheet in the Attendance Sheet.



**Sol.** In electromagnetic wave,  $E$  and  $B$  are in same phase and  $B_0 = \frac{E_0}{c}$ ; their planes are perpendicular to each other.

$$\therefore B_y = \frac{60}{c} \cos(5x + 1.5 \times 10^9 t) \text{ T}$$

$$= \frac{60}{3 \times 10^8} \cos(5x + 1.5 \times 10^9 t) \text{ T}$$

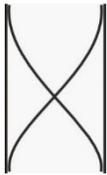
$$B_y = 2 \times 10^{-7} \cos(5x + 1.5 \times 10^9 t) \text{ T}$$

3. A pipe open at both ends has a fundamental frequency  $f$  in air. The pipe is now dipped vertically in a water drum to half of its length. The fundamental frequency of the air column is now equal to:

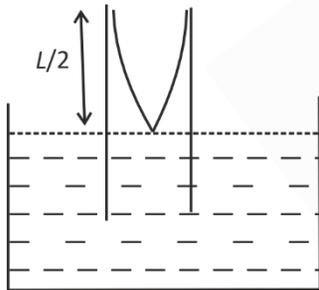
- |          |                    |
|----------|--------------------|
| (1) $2f$ | (2) $\frac{f}{2}$  |
| (3) $f$  | (4) $\frac{3f}{2}$ |

**Answer (3)**

**Sol.** Fundamental frequency of open pipe (at both ends)  $f = \frac{v}{2L}$  ... (i)



Now immersed in water open pipe behaves as closed pipe.



$$f' = \frac{v}{4 \left( \frac{L}{2} \right)} = \frac{v}{2L} \quad \dots \text{(ii)}$$

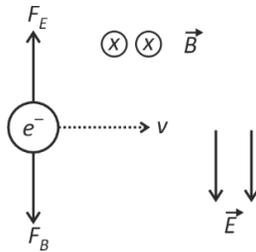
$$f = f'$$

4. An electron (mass  $9 \times 10^{-31}$  kg and charge  $1.6 \times 10^{-19}$  C) moving with speed  $c/100$  ( $c$  = speed of light) is injected into a magnetic field  $\vec{B}$  of magnitude  $9 \times 10^{-4}$  T perpendicular to its direction of motion. We wish to apply a uniform electric field  $\vec{E}$  together with the magnetic field so that the electron does not deflect from its path. Then (speed of light  $c = 3 \times 10^8$  ms $^{-1}$ )

- (1)  $\vec{E}$  is parallel to  $\vec{B}$  and its magnitude is  $27 \times 10^4$  V m $^{-1}$
- (2)  $\vec{E}$  is perpendicular to  $\vec{B}$  and its magnitude is  $27 \times 10^4$  V m $^{-1}$
- (3)  $\vec{E}$  is perpendicular to  $\vec{B}$  and its magnitude is  $27 \times 10^2$  V m $^{-1}$
- (4)  $\vec{E}$  is parallel to  $\vec{B}$  and its magnitude is  $27 \times 10^2$  V m $^{-1}$

**Answer (3)**

**Sol.** For no deflection of electron,  $\vec{F}_B = \vec{F}_E$



$$-e(\vec{v} \times \vec{B}) = -e\vec{E}$$

$$\Rightarrow \vec{E} = \vec{v} \times \vec{B} \Rightarrow \vec{E} \perp \vec{B}$$

$$E = vB = \frac{c}{100} \times 9 \times 10^{-4}$$

$$= \frac{3 \times 10^8}{100} \times 9 \times 10^{-4}$$

$$= 27 \times 10^2 \text{ V m}^{-1}$$

5. In a certain camera, a combination of four similar thin convex lenses are arranged axially in contact. Then the power of the combination and the total magnification in comparison to the power ( $p$ ) and magnification ( $m$ ) for each lens will be, respectively

- (1)  $p^4$  and  $m^4$  (2)  $4p$  and  $4m$   
 (3)  $p^4$  and  $4m$  (4)  $4p$  and  $m^4$

**Answer (4)**

**Sol.** For series combination of lens

$$p_{\text{eff}} = p_1 + p_2 + p_3 + p_4 = 4p$$

$$m_{\text{eff}} = m_1 \times m_2 \times m_3 \times m_4 = m^4$$

6. A 2 amp current is flowing through two different small circular copper coils having radii ratio 1 : 2. The ratio of their respective magnetic moments will be

- (1) 4 : 1 (2) 1 : 4  
 (3) 1 : 2 (4) 2 : 1

**Answer (2)**

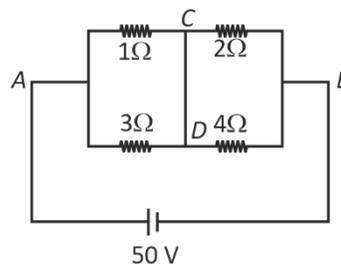
**Sol.** Magnetic moment of current carrying circular loop =  $IA$

$$M = IA$$

$$M \propto A \quad [I\text{-Same}]$$

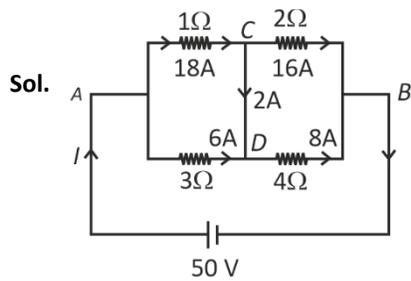
$$\frac{M_1}{M_2} = \frac{A_1}{A_2} = \frac{\pi r_1^2}{\pi r_2^2} = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$$

7. A constant voltage of 50 V is maintained between the points A and B of the circuit shown in the figure. The current through the branch CD of the circuit is:



- (1) 3.0 A (2) 1.5 A  
 (3) 2.0 A (4) 2.5 A

**Answer (3)**



$R_{AB} = (1\Omega/3\Omega)$  in series with  $(2\Omega/4\Omega)$

$$= \frac{3 \times 1}{3+1} + \frac{2 \times 4}{2+4}$$

$$= \frac{3}{4} + \frac{8}{6} = \frac{9+16}{12} = \frac{25}{12} \Omega$$

Now total current through cell

$$I = \frac{50}{\frac{25}{12}} = 24A$$

$$I_{1\Omega} = \frac{3}{4} \times 24 = 18A, I_{3\Omega} = \frac{1}{4} \times 24 = 6A$$

$$I_{2\Omega} = \frac{4}{6} \times 24 = 16A, I_{4\Omega} = \frac{2}{6} \times 24 = 8A$$

Using junction rule at C,  $I_{CD} = 18 - 16 = 2A$  (From C to D)

8. Two gases A and B are filled at the same pressure in separate cylinders with movable pistons of radius  $r_A$  and  $r_B$ , respectively. On supplying an equal amount of heat to both the systems reversibly under constant pressure, the pistons of gas A and B are displaced by 16 cm and 9 cm, respectively. If the change in their internal energy is the same, then the ratio  $\frac{r_A}{r_B}$  is equal to

- (1)  $\frac{\sqrt{3}}{2}$  (2)  $\frac{4}{3}$   
 (3)  $\frac{3}{4}$  (4)  $\frac{2}{\sqrt{3}}$

**Answer (3)**

Sol. Using first law of thermodynamics

$$\Delta Q = \Delta U + P\Delta V$$

$\Delta Q$  is same

$\Delta U$  is also same

$$W_A = W_B$$

$$\therefore (P\Delta V)_A = (P\Delta V)_B$$

P is also same

$$\therefore A_A d_A = A_B d_B$$

$$\pi r_A^2 d_A = \pi r_B^2 d_B$$

$$\frac{r_A}{r_B} = \left( \frac{d_B}{d_A} \right)^{\frac{1}{2}} = \left( \frac{9}{16} \right)^{\frac{1}{2}}$$

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

9. A container has two chambers of volumes  $V_1 = 2$  litres and  $V_2 = 3$  litres separated by a partition made of a thermal insulator. The chambers contain  $n_1 = 5$  and  $n_2 = 4$  moles of ideal gas at pressures  $p_1 = 1$  atm and  $p_2 = 2$  atm, respectively. When the partition is removed, the mixture attains an equilibrium pressure of
- (1) 1.8 atm (2) 1.3 atm  
(3) 1.6 atm (4) 1.4 atm

**Answer (3)**

**Sol.**  $P_1V_1 + P_2V_2 = P(V_1 + V_2)$

$$1(2) + 2(3) = P(2 + 3)$$

$$\frac{8}{5} = P$$

$$\Rightarrow 1.6 \text{ atm}$$

10. The radius of Martian orbit around the Sun is about 4 times the radius of the orbit of Mercury. The Martian year is 687 Earth days. Then which of the following is the length of 1 year on Mercury?
- (1) 124 earth days (2) 88 earth days  
(3) 225 earth days (4) 172 earth days

**Answer (2)**

**Sol.** Applying Kepler's 3<sup>rd</sup> law :  $T^2 \propto R^3$

Radius of Martian orbit,  $R' = 4R$

$$\left(\frac{T'}{T}\right)^2 = \left(\frac{R'}{R}\right)^3 = \left(\frac{4R}{R}\right)^3 = 4^3 = 64 \Rightarrow \frac{T'}{T} = 8$$

$$\therefore \text{Length of 1 year on Mercury} = T = \frac{T'}{8} = \frac{687}{8} = 85.88 \text{ days}$$

11. To an ac power supply of 220 V at 50 Hz, a resistor of  $20 \Omega$ , a capacitor of reactance  $25 \Omega$  and an inductor of reactance  $45 \Omega$  are connected in series. The corresponding current in the circuit and the phase angle between the current and the voltage is, respectively
- (1) 15.6 A and  $45^\circ$  (2) 7.8 A and  $30^\circ$   
(3) 7.8 A and  $45^\circ$  (4) 15.6 A and  $30^\circ$

**Answer (3)**

**Sol.**  $X_L = 45 \Omega$ ,  $X_C = 25 \Omega$ ,  $R = 20 \Omega$

$$I = \frac{220}{\sqrt{(X_L - X_C)^2 + R^2}} = \frac{220}{\sqrt{(45 - 25)^2 + 20^2}}$$

$$= \frac{220}{2\sqrt{2}} = \frac{11}{\sqrt{2}} = 7.779 \text{ A}$$

$$\tan \phi = \frac{X_L - X_C}{R} = \frac{45 - 25}{20} = 1$$

$$\phi = 45^\circ$$

12. A wire of resistance  $R$  is cut into 8 equal pieces. From these pieces two equivalent resistances are made by adding four of these together in parallel. Then these two sets are added in series. The net effective resistance of the combination is:

- (1)  $\frac{R}{8}$  (2)  $\frac{R}{64}$   
(3)  $\frac{R}{32}$  (4)  $\frac{R}{16}$

**Answer (4)**

**Sol.** After being cut into 8 equal pieces,

$$\Rightarrow \text{Resistance of each piece} = R' = \frac{R}{8}$$

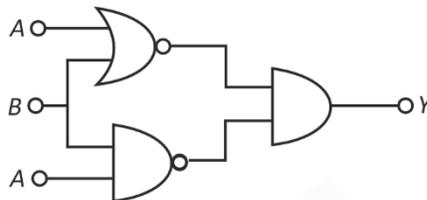
Each set has 4 pieces in parallel combination

$$\Rightarrow \text{Resistance of each set} = R'' = \frac{R'}{4} = \frac{R}{32}$$

Both sets are connected in series

$$\therefore R_{\text{eq}} = R'' + R'' = 2 \times \frac{R}{32} = \frac{R}{16}$$

13. The output (Y) of the given logic implementation is similar to the output of an/a \_\_\_\_\_ gate.



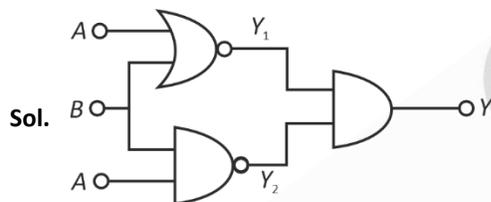
(1) NOR

(2) AND

(3) NAND

(4) OR

**Answer (1)**



$$Y_1 = \overline{A+B}$$

$$Y_2 = \overline{A \cdot B}$$

$$Y = Y_1 \cdot Y_2$$

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

$$= \overline{(A+B) + A \cdot B}$$

$$= \overline{A+B(1+A)}$$

$$= \overline{A+B} \text{ NOR gate}$$

14. Two identical charged conducting spheres A and B have their centres separated by a certain distance. Charge on each sphere is  $q$  and the force of repulsion between them is  $F$ . A third identical uncharged conducting sphere is brought in contact with sphere A first and then with B and finally removed from both. New force of repulsion between spheres A and B (Radii of A and B are negligible compared to the distance of separation so that for calculating force between them they can be considered as point charges) is best given as:

(1)  $\frac{3F}{8}$

(2)  $\frac{3F}{5}$

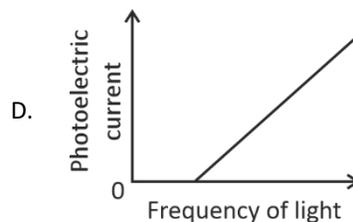
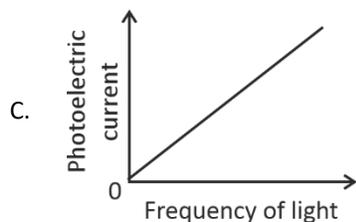
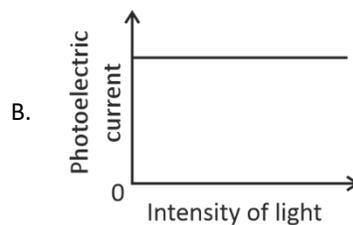
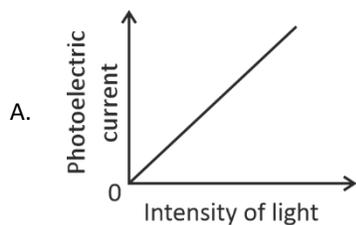
(3)  $\frac{2F}{3}$

(4)  $\frac{F}{2}$

**Answer (1)**



17. Which of the following options represent the variation of photoelectric current with property of light shown on the x-axis?



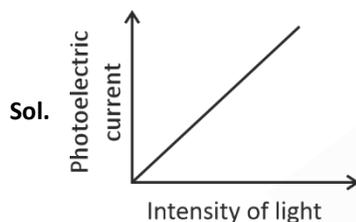
(1) B and D

(2) A only

(3) A and C

(4) A and D

**Answer (2)**



Photoelectric current is directly proportional to intensity of light.

18. A particle of mass  $m$  is moving around the origin with a constant force  $F$  pulling it towards the origin. If Bohr model is used to describe its motion, the radius of the  $n^{\text{th}}$  orbit and the particle's speed  $v$  in the orbit depend on  $n$  as

(1)  $r \propto n^{4/3}$ ;  $v \propto n^{-1/3}$

(2)  $r \propto n^{1/3}$ ;  $v \propto n^{1/3}$

(3)  $r \propto n^{1/3}$ ;  $v \propto n^{2/3}$

(4)  $r \propto n^{2/3}$ ;  $v \propto n^{1/3}$

**Answer (4)**

Sol. Given, force is constant

$$F = \frac{mv^2}{r}$$

$$\Rightarrow \frac{v^2}{r} = \text{constant}$$

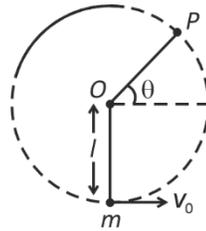
$$\Rightarrow r \propto v^2 \quad \dots(1)$$

$$\& \quad L = mvr = \frac{nh}{2\pi} \quad \dots(2)$$

$\Rightarrow$  on solving equation (1) and equation (2)

$$v \propto n^{1/3} \text{ and } r \propto n^{2/3}$$

19. A bob of heavy mass  $m$  is suspended by a light string of length  $l$ . The bob is given a horizontal velocity  $v_0$  as shown in figure. If the string gets slack at some point  $P$  making an angle  $\theta$  from the horizontal, the ratio of the speed  $v$  of the bob at point  $P$  to its initial speed  $v_0$  is:



(1)  $\left(\frac{\sin\theta}{2+3\sin\theta}\right)^{\frac{1}{2}}$

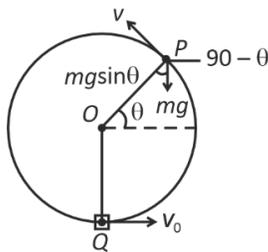
(2)  $(\sin\theta)^{\frac{1}{2}}$

(3)  $\left(\frac{1}{2+3\sin\theta}\right)^{\frac{1}{2}}$

(4)  $\left(\frac{\cos\theta}{2+3\sin\theta}\right)^{\frac{1}{2}}$

**Answer (1)**

**Sol.**



At Point  $P$ ,  $mg\sin\theta = \frac{mv^2}{l}$  ... (1)

By conservation of mechanical energy at point  $P \in Q$

$$\frac{1}{2}mv_0^2 = \frac{1}{2}mv^2 + mg(l + l\sin\theta)$$

$$\frac{v_0^2}{2} = \frac{v^2}{2} + gl(1 + \sin\theta)$$

Put  $gl = \frac{v^2}{\sin\theta}$  using (1)

$$\frac{v_0^2}{2} = \frac{v^2}{2} + \frac{v^2}{\sin\theta}(1 + \sin\theta)$$

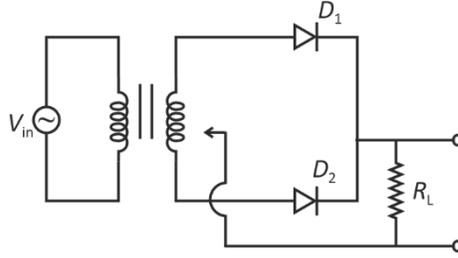
$$\frac{v_0^2}{2} = \frac{v^2}{2} + \frac{v^2}{\sin\theta} + v^2$$

$$\frac{v_0^2}{2} = \frac{3}{2}v^2 + \frac{2v^2}{2\sin\theta}$$

$$v_0^2 = v^2 \left[ 3 + \frac{2}{\sin\theta} \right]$$

$$\frac{v}{v_0} = \left( \frac{\sin\theta}{3\sin\theta + 2} \right)^{\frac{1}{2}}$$

20. A full wave rectifier circuit with diodes ( $D_1$ ) and ( $D_2$ ) is shown in the figure. If input supply voltage  $V_{in} = 220\sin(100\pi t)$  volt, then at  $t = 15$  msec



- (1)  $D_1$  and  $D_2$  both are reverse biased  
 (2)  $D_1$  is forward biased,  $D_2$  is reverse biased  
 (3)  $D_1$  is reverse biased,  $D_2$  is forward biased.  
 (4)  $D_1$  and  $D_2$  both are forward biased

**Answer (3)**

**Sol.**  $V_{in} = 220\sin(100\pi t)$  volt

$$t = 15 \text{ ms}$$

$$t = 0.015 \text{ s}$$

$$\omega = 100\pi$$

$$\frac{2\pi}{T} = 100\pi$$

$$T = \frac{1}{50} \text{ s}$$

$$T = 0.02 \text{ s}$$

$$\therefore t = \frac{3T}{4}$$

i.e. negative half cycle.

So now negative half cycle is fed to circuit making  $D_1$  as reverse biased and  $D_2$  as forward biased.

21. A balloon is made of a material of surface tension  $S$  and its inflation outlet (from where gas is filled in it) has small area  $A$ . It is filled with a gas of density  $\rho$  and takes a spherical shape of radius  $R$ . When the gas is allowed to flow freely out of it, its radius  $r$  changes from  $R$  to 0 (zero) in time  $T$ . If the speed  $v(r)$  of gas coming out of the balloon depends on  $r$  as  $r^a$  and  $T \propto S^\alpha A^\beta \rho^\gamma R^\delta$  then

(1)  $a = \frac{1}{2}, \alpha = \frac{1}{2}, \beta = -\frac{1}{2}, \gamma = \frac{1}{2}, \delta = \frac{7}{2}$

(2)  $a = \frac{1}{2}, \alpha = \frac{1}{2}, \beta = -1, \gamma = +1, \delta = \frac{3}{2}$

(3)  $a = -\frac{1}{2}, \alpha = -\frac{1}{2}, \beta = -1, \gamma = -\frac{1}{2}, \delta = \frac{5}{2}$

(4)  $a = -\frac{1}{2}, \alpha = -\frac{1}{2}, \beta = -1, \gamma = \frac{1}{2}, \delta = \frac{7}{2}$

**Answer (4)**

**Sol.**  $T \propto S^\alpha A^\beta \rho^\gamma R^\delta$

$$M^0 L^0 T^1 = K(MT^{-2})^\alpha (L^2)^\beta (ML^{-3})^\gamma L^\delta$$

$$M^0 L^0 T^1 = K[M^{\alpha+\gamma} L^{2\beta-3\gamma+\delta} T^{-2\alpha}]$$

$$-2\alpha = 1 \quad \alpha = -\frac{1}{2}$$

$$\alpha + \gamma = 0 \quad \gamma = \frac{1}{2}$$

$$2\beta - 3\gamma + \delta = 0$$

$$2\beta - 3\left(\frac{1}{2}\right) + \delta = 0$$

By hit and trial (using option (1))

$$\text{Put } \beta = -1$$

$$2(-1) - \frac{3}{2} + \delta = 0 \quad \therefore \delta = \frac{7}{2}$$

22. A microscope has an objective of focal length 2 cm, eyepiece of focal length 4 cm and the tube length of 40 cm. If the distance of distinct vision of eye is 25 cm, the magnification in the microscope is
- (1) 250 (2) 100  
(3) 125 (4) 150

**Answer (3)**

**Sol.** 
$$m = \frac{L}{f_o} \times \frac{D}{f_e}$$

$$= \frac{40}{2} \times \frac{25}{4}$$

$$m = 125$$

23. Two identical point masses  $P$  and  $Q$ , suspended from two separate massless springs of spring constants  $k_1$  and  $k_2$ , respectively, oscillate vertically. If their maximum speeds are the same, the ratio ( $A_Q/A_P$ ) of the amplitude  $A_Q$  of mass  $Q$  to the amplitude  $A_P$  of mass  $P$  is

- (1)  $\sqrt{\frac{k_1}{k_2}}$  (2)  $\frac{k_2}{k_1}$   
(3)  $\frac{k_1}{k_2}$  (4)  $\sqrt{\frac{k_2}{k_1}}$

**Answer (1)**

**Sol.** Maximum velocity  $V = A\omega$

$$v_P = v_Q$$

$$A_P\omega_P = A_Q\omega_Q$$

$$\frac{A_Q}{A_P} = \frac{\omega_P}{\omega_Q}$$

$$= \sqrt{\frac{k_P m_Q}{m_P k_Q}}$$

$$= \sqrt{\frac{k_1}{k_2}}$$

$$\left( \omega = \sqrt{\frac{k}{m}} \right)$$

24. A parallel plate capacitor made of circular plates is being charged such that the surface charge density on its plates is increasing at a constant rate with time. The magnetic field arising due to displacement current is:

- (1) Zero between the plates and non-zero outside  
(2) Zero at all places  
(3) Constant between the plates and zero outside the plates  
(4) Non-zero everywhere with maximum at the imaginary cylindrical surface connecting peripheries of the plates

**Answer (4)**

**Sol.** Let the surface charge density be  $\sigma = \frac{q}{A}$

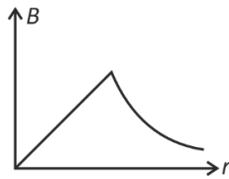
Given  $\frac{d\sigma}{dt} = \text{constant}$

$$\therefore \frac{d}{dt} \left( \frac{q}{A} \right) = \text{constant} \Rightarrow \frac{I}{A} = \text{constant}$$

It means displacement current is constant.

This system will act like a cylindrical wire.

The graph of magnetic field ( $B$ ) vs  $r$  is



25. An electric dipole with dipole moment  $5 \times 10^{-6}$  C m is aligned with the direction of a uniform electric field of magnitude  $4 \times 10^5$  N/C. The dipole is then rotated through an angle of  $60^\circ$  with respect to the electric field. The change in the potential energy of the dipole is:

- (1) 1.5 J (2) 0.8 J  
 (3) 1.0 J (4) 1.2 J

**Answer (3)**

**Sol.** Given

$$|\vec{p}| = 5 \times 10^{-6} \text{ C m}$$

$$|\vec{E}| = 4 \times 10^5 \text{ N/C}$$

$$\theta_i = 0^\circ \text{ and } \theta_f = 60^\circ$$

$$\Delta U = U_f - U_i$$

$$= -PE \cos \theta_f + PE \cos \theta_i$$

$$= PE [\cos \theta_i - \cos \theta_f]$$

$$= 5 \times 10^{-6} \times 4 \times 10^5 \left[ 1 - \frac{1}{2} \right]$$

$$= 10 \times 10^{-6} \times 10^5 = 1 \text{ J}$$

26. There are two inclined surfaces of equal length ( $L$ ) and same angle of inclination  $45^\circ$  with the horizontal. One of them is rough and the other is perfectly smooth. A given body takes 2 times as much time to slide down on rough surface than on the smooth surface. The coefficient of kinetic friction ( $\mu_k$ ) between the object and the rough surface is close to

- (1) 0.75 (2) 0.25  
 (3) 0.40 (4) 0.5

**Answer (1)**

**Sol.**  $t_{\text{rough}} = 2t_{\text{smooth}}$

$$a_{\text{smooth}} = g \sin \theta$$

$$t \propto \frac{1}{\sqrt{a}} \Rightarrow t_{\text{smooth}} \propto \frac{1}{\sqrt{g \sin \theta}}$$

$$a_{\text{rough}} = g \sin \theta - \mu_k g \cos \theta$$

$$\frac{t_{\text{rough}}}{t_{\text{smooth}}} = \frac{\sqrt{\sin \theta}}{\sqrt{\sin \theta - \mu_k \cos \theta}} = 2$$

Squaring both sides

$$\frac{\sin \theta}{\sin \theta - \mu_k \cos \theta} = 4 \Rightarrow \frac{\frac{1}{\sqrt{2}}}{\frac{1}{\sqrt{2}} - \mu_k \times \frac{1}{\sqrt{2}}} = 4$$

$$\Rightarrow 1 - \mu_k = \frac{1}{4}$$

$$\mu_k = \frac{3}{4}$$

$$= 0.75$$

27. De-Broglie wavelength of an electron orbiting in the  $n = 2$  state of hydrogen atom is close to  
(Given Bohr radius = 0.052 nm)
- (1) 2.67 nm (2) 0.067 nm  
(3) 0.67 nm (4) 1.67 nm

**Answer (3)**

**Sol.**  $r = 0.052 n^2$

For  $n = 2$

$r = 0.052 \times 4$

$= 0.208 \text{ nm}$

$Mvr = \frac{nh}{2\pi}$

$\lambda = \frac{h}{Mv} = \pi r$

$= 3.14 \times 0.208 \text{ nm}$

$= 0.65317 \text{ nm}$

$\approx 0.67 \text{ nm}$

28. The Sun rotates around its centre once in 27 days. What will be the period of revolution if the Sun were to expand to twice its present radius without any external influence? Assume the Sun to be a sphere of uniform density.
- (1) 108 days (2) 100 days  
(3) 105 days (4) 115 days

**Answer (1)**

**Sol.** Assuming the Sun to be a solid sphere,  $I = \frac{2}{5}mR^2$

Using conservation of angular momentum,  $I'\omega' = I\omega$

$\Rightarrow \frac{2}{5}m(2R)^2 \times \frac{2\pi}{T'} = \frac{2}{5}mR^2 \times \frac{2\pi}{T}$

$\Rightarrow T' = 4T = 4 \times 27 = 108 \text{ days}$

29. A physical quantity  $P$  is related to four observations  $a$ ,  $b$ ,  $c$  and  $d$  as follows:

$P = a^3 b^2 / c \sqrt{d}$

The percentage errors of measurement in  $a$ ,  $b$ ,  $c$  and  $d$  are 1%, 3%, 2%, and 4% respectively. The percentage error in the quantity  $P$  is

- (1) 15% (2) 10%  
(3) 2% (4) 13%

**Answer (4)**

**Sol.** Maximum % error in  $P = \frac{\Delta P}{P} \times 100 = 3\left(\frac{\Delta a}{a} \times 100\right) + 2\left(\frac{\Delta b}{b} \times 100\right) + \left(\frac{\Delta c}{c} \times 100\right) + \frac{1}{2}\left(\frac{\Delta d}{d} \times 100\right)$

$= 3 \times (1) + 2 \times (3) + (2) + \frac{1}{2} \times (4)$

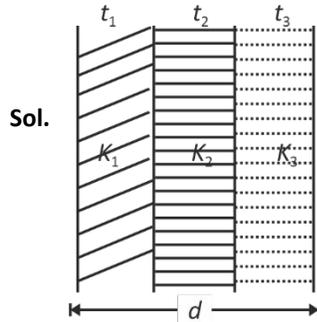
$= 13\%$

30. The plates of a parallel plate capacitor are separated by  $d$ . Two slabs of different dielectric constant  $K_1$  and  $K_2$  with thickness  $\frac{3}{8}d$  and  $\frac{d}{2}$ , respectively are inserted in the capacitor. Due to this, the capacitance becomes two times larger than when there is nothing between the plates.

If  $K_1 = 1.25 K_2$ , the value of  $K_1$  is:

- (1) 1.33 (2) 2.66  
 (3) 2.33 (4) 1.60

**Answer (2)**



$$\text{Using } C_{eq} = \frac{\epsilon_0 A}{\frac{t_1}{K_1} + \frac{t_2}{K_2} + \frac{t_3}{K_3}}$$

$$\text{here } C_0 = \frac{\epsilon_0 A}{d}, t_1 = \frac{3d}{8}, t_2 = \frac{d}{2}, t_3 = \frac{d}{8}$$

$$K_1 = K_1, K_2 = \frac{K_1}{1.25} \text{ and } K_3 = 1$$

$$\text{Given } C_{eq} = 2C_0$$

$$\Rightarrow 2C_0 = \frac{\epsilon_0 A}{\frac{3d}{8K_1} + \frac{d \times 1.25}{2K_1} + \frac{d}{8}}$$

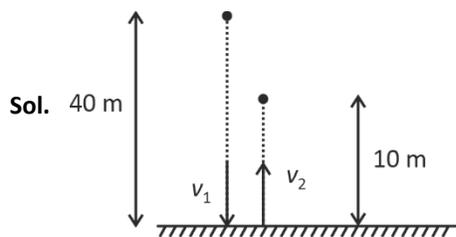
$$\Rightarrow \frac{2\epsilon_0 A}{d} = \frac{\epsilon_0 A}{\frac{3d}{8K_1} + \frac{d}{2K_1} \times \frac{5}{4} + \frac{d}{8}}$$

$$\Rightarrow 2 = \frac{1}{\frac{3}{8K_1} + \frac{5}{8K_1} + \frac{1}{8}} \Rightarrow K_1 = \frac{8}{3} = 2.66$$

31. A ball of mass 0.5 kg is dropped from a height of 40 m. The ball hits the ground and rises to a height of 10 m. The impulse imparted to the ball during its collision with the ground is (Take  $g = 9.8 \text{ m/s}^2$ )

- (1) 84 NS (2) 21 NS  
 (3) 7 NS (4) 0

**Answer (2)**



$$v_1 = \sqrt{2gh_1}$$

$$= \sqrt{2 \times 9.8 \times 40}$$

$$v_1 = \sqrt{784} = 28 \text{ m s}^{-1}$$

$$\text{and } v_2 = \sqrt{2gh_2} = \sqrt{2 \times 9.8 \times 10}$$

$$= \sqrt{196} = 14 \text{ m s}^{-1}$$

$$\text{Impulse} = \Delta \vec{p} = m(\vec{v}_f - \vec{v}_i) = m(\vec{v}_2 - \vec{v}_1)$$

$$= \frac{1}{2}(14 - (-28))$$

$$= 21 \text{ NS}$$

32. Two cities  $X$  and  $Y$  are connected by a regular bus service with a bus leaving in either direction every  $T$  min. A girl is driving scooty with a speed of 60 km/h in the direction  $X$  to  $Y$  notices that a bus goes past her every 30 minutes in the direction of her motion, and every 10 minutes in the opposite direction. Choose the correct option for the period  $T$  of the bus service and the speed (assumed constant) of the buses.

(1) 15 min, 120 km/h

(2) 9 min, 40 km/h

(3) 25 min, 100 km/h

(4) 10 min, 90 km/h

**Answer (1)**



$X \rightarrow Y$

Let velocity of bus =  $v$  km/hr

Relative velocity of bus w.r.t. scooty =  $(v - 60)$

Distance between 2 consecutive buses =  $vT$

$$(v - 60)30 = vT \quad \dots(i)$$

$Y \rightarrow X$

$$(v + 60)10 = vT \quad \dots(ii)$$

Equating (1) and (2)

$$(v - 60)30 = (v + 60)10$$

$$\therefore v = 120 \text{ km/hr}$$

$$T = 15 \text{ min}$$

33. An oxygen cylinder of volume 30 litre has 18.20 moles of oxygen. After some oxygen is withdrawn from the cylinder, its gauge pressure drops to 11 atmospheric pressures at temperature  $27^\circ\text{C}$ . The mass of the oxygen withdrawn from the cylinder is nearly equal to:

[Given,  $R = \frac{100}{12} \text{ J mol}^{-1} \text{ K}^{-1}$ , and molecular mass of  $\text{O}_2 = 32$ , 1 atm pressure =  $1.01 \times 10^5 \text{ N/m}^2$ ]

(1) 0.156 kg

(2) 0.125 kg

(3) 0.144 kg

(4) 0.116 kg

**Answer (4)**



Since  $\omega = \frac{2\pi}{T}$

Hence as mass leaks,  $\omega$  will increase

Now, at any instant

$$mg = kx_0$$

So, equilibrium length  $x_0 = \frac{mg}{k}$ , where  $m$  is decreasing

So, equilibrium length will decrease.

So, amplitude also go on decreasing.

36. A model for quantized motion of an electron in a uniform magnetic field  $B$  states that the flux passing through the orbit of the electron is  $n(h/e)$  where  $n$  is an integer,  $h$  is Planck's constant and  $e$  is the magnitude of electron's charge. According to the model, the magnetic moment of an electron in its lowest energy state will be ( $m$  is the mass of the electron)

(1)  $\frac{heB}{2\pi m}$

(2)  $\frac{he}{\pi m}$

(3)  $\frac{he}{2\pi m}$

(4)  $\frac{heB}{\pi m}$

**Answer (3)**

**Sol.** Magnetic force =  $\frac{mv^2}{r}$

$$evB = \frac{mv^2}{r}$$

$$v = \frac{eBr}{m}$$

$$\phi = BA$$

$$\frac{nh}{e} = B\pi r^2$$

$$Br^2 = \frac{nh}{e\pi}$$

$$\mu = IA$$

$$= \frac{e}{T} \pi r^2$$

$$= \frac{e \times v}{2\pi r} \pi r^2$$

$$\mu = \frac{evr}{2}$$

$$= \frac{1}{2} e \times \frac{eBr}{m} r$$

$$\mu = \frac{1}{2} e^2 \frac{Br^2}{m}$$

$$\mu = \frac{1}{2} e^2 \frac{nh}{e\pi m}$$

$$\mu = \frac{neh}{2\pi m}$$

for  $n = 1$

$$\mu = \frac{eh}{2\pi m}$$

37. A body weighs 48 N on the surface of the earth. The gravitational force experienced by the body due to the earth at a height equal to one-third the radius of the earth from its surface is :

- (1) 36 N (2) 16 N  
(3) 27 N (4) 32 N

**Answer (3)**

**Sol.**  $W = mg$  and  $g = \frac{GM}{R^2}$ ,  $g_h = \frac{GM}{(R+h)^2}$

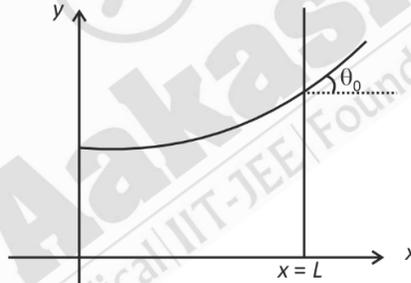
$$\Rightarrow \frac{W_h}{W} = \frac{mg_h}{mg} = \frac{g_h}{g} = \frac{R^2}{(R+h)^2} \left( h = \frac{R}{3} \right)$$

$$\Rightarrow \frac{W_h}{W} = \frac{R^2}{\left(R + \frac{R}{3}\right)^2} = \frac{R^2}{\left(\frac{4R}{3}\right)^2} = \frac{9}{16}$$

$$\Rightarrow W_h = \frac{9}{16}W = \frac{9}{16} \times 48 \text{ [} W = 48 \text{ N]}$$

$$= 27 \text{ N}$$

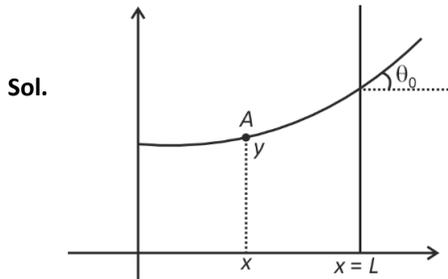
38. Consider a water tank shown in the figure. It has one wall at  $x = L$  and can be taken to be very wide in the  $z$  direction. When filled with a liquid of surface tension  $S$  and density  $\rho$ , the liquid surface makes angle  $\theta_0$  ( $\theta_0 \ll 1$ ) with the  $x$ -axis at  $x = L$ . If  $y(x)$  is the height of the surface then the equation for  $y(x)$  is:



(take  $\theta(x) = \sin\theta(x) = \tan\theta(x) = \frac{dy}{dx}$ ,  $g$  is the acceleration due to gravity)

- (1)  $\frac{dy}{dx} = \sqrt{\frac{\rho g}{S}}x$  (2)  $\frac{d^2y}{dx^2} = \frac{\rho g}{S}x$   
(3)  $\frac{d^2y}{dx^2} = \frac{\rho g}{S}y$  (4)  $\frac{d^2y}{dx^2} = \sqrt{\frac{\rho g}{S}}$

**Answer (3)**



ROC = Radius of curvature at point A

$$\text{Curvature} = \frac{1}{ROC} = \frac{\left| \frac{d^2y}{dx^2} \right|}{\left( 1 + \left( \frac{dy}{dx} \right)^2 \right)^{\frac{3}{2}}} = \frac{\left| \frac{d^2y}{dx^2} \right|}{(1+0)^{\frac{3}{2}}} = \frac{d^2y}{dx^2} \quad \left[ \because \frac{dy}{dx} = \tan\theta \approx 0 \right]$$

$$\Delta P = S \times \text{curvature}$$

$$\Rightarrow \rho g y = S \frac{d^2y}{dx^2}$$

$$\therefore \frac{d^2y}{dx^2} = \frac{\rho g y}{S}$$

39. The intensity of transmitted light when a polaroid sheet, placed between two crossed polaroids at  $22.5^\circ$  from the polarization axis of one of the polaroids, is ( $I_0$  is the intensity of polarised light after passing through the first polaroid):

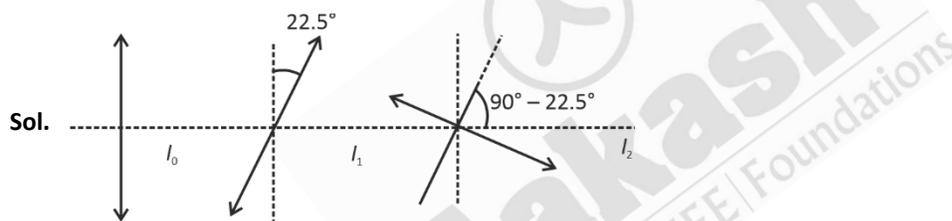
(1)  $\frac{I_0}{16}$

(2)  $\frac{I_0}{2}$

(3)  $\frac{I_0}{4}$

(4)  $\frac{I_0}{8}$

**Answer (4)**



$$I_1 = I_0 \cos^2\left(\frac{45}{2}\right)$$

$$I_2 = I_1 \cos^2\left(90 - \frac{45}{2}\right)$$

$$= I_0 \cos^2\left(\frac{45}{2}\right) \sin^2\left(\frac{45}{2}\right)$$

$$= \frac{I_0}{4} \left( 4 \cos^2\left(\frac{45}{2}\right) \sin^2\left(\frac{45}{2}\right) \right)$$

$$= \frac{I_0}{4} \sin^2 45^\circ = \frac{I_0}{8}$$

40. A photon and an electron (mass  $m$ ) have the same energy  $E$ . The ratio ( $\lambda_{\text{photon}}/\lambda_{\text{electron}}$ ) of their de Broglie wavelengths is: ( $c$  is the speed of light)

(1)  $\frac{1}{c} \sqrt{\frac{E}{2m}}$

(2)  $\sqrt{\frac{E}{2m}}$

(3)  $c\sqrt{2mE}$

(4)  $c\sqrt{\frac{2m}{E}}$

**Answer (4)**

**Sol.** For photon,  $E = \frac{hc}{\lambda_{ph}} \Rightarrow \lambda_{ph} = \frac{hc}{E}$

For electron,  $p =$  momentum and  $E = \frac{p^2}{2m} = \left(\frac{h}{\lambda_e}\right)^2 \times \frac{1}{2m}$

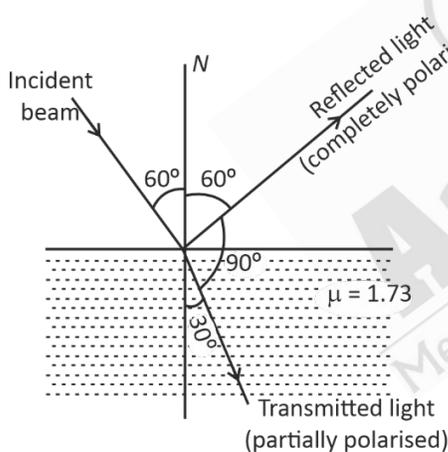
$$\Rightarrow \lambda_e = \frac{h}{\sqrt{2mE}}$$

$$\therefore \frac{\lambda_{ph}}{\lambda_e} = \frac{\frac{hc}{E}}{\frac{h}{\sqrt{2mE}}} = c\sqrt{\frac{2m}{E}}$$

41. An unpolarized light beam travelling in air is incident on a medium of refractive index 1.73 at Brewster's angle. Then
- (1) Transmitted light is completely polarized with angle of refraction close to  $30^\circ$
  - (2) Reflected light is completely polarized and the angle of reflection is close to  $60^\circ$
  - (3) Reflected light is partially polarized and the angle of reflection is close to  $30^\circ$
  - (4) Both reflected and transmitted light are perfectly polarized with angles of reflection and refraction close to  $60^\circ$  and  $30^\circ$ , respectively

**Answer (2)**

**Sol.** Using Brewster law



$$\mu = \tan\theta_p$$

$$\Rightarrow 1.73 = \tan\theta_p$$

$$\Rightarrow \sqrt{3} = \tan\theta_p$$

$$\Rightarrow \theta_p = 60^\circ$$

At this polarising angle, reflected light is perfectly polarized and transmitted light is partially polarised.

42. A uniform rod of mass 20 kg and length 5 m leans against a smooth vertical wall making an angle of  $60^\circ$  with it. The other end rests on a rough horizontal floor. The friction force that the floor exerts on the rod is (Take  $g = 10 \text{ m/s}^2$ )
- (1)  $200\sqrt{3} \text{ N}$
  - (2) 100 N
  - (3)  $100\sqrt{3} \text{ N}$
  - (4) 200 N

**Answer (3)**



In series rate of heat flow is same

$$\therefore \frac{3T - T_1}{R_1} = \frac{3T - T}{R_{eq}}$$

$$\frac{(3T - T_1)2KA}{l} = \frac{(2T)KA}{2l}$$

$$\Rightarrow 6T - 2T_1 = T$$

$$\Rightarrow 2T_1 = 5T$$

$$\Rightarrow T_1 = \frac{5T}{2} \dots(1)$$

Now, equate heat flow rate in 3<sup>rd</sup> section & total section

$$\frac{T_2 - T}{R_3} = \frac{3T - T}{R_{eq}}$$

$$\Rightarrow \frac{(T_2 - T)(2KA)}{l} = \frac{2T(KA)}{2l}$$

$$\Rightarrow 2T_2 - 2T = T$$

$$\Rightarrow T_2 = \frac{3T}{2} \dots(2)$$

By equation (1) and equation (2)

$$\frac{T_1}{T_2} = \frac{5T \times 2}{2 \times 3T} = \frac{5}{3}$$

44. The kinetic energies of two similar cars A and B are 100 J and 225 J respectively. On applying breaks, car A stops after 1000 m and car B stops after 1500 m. If  $F_A$  and  $F_B$  are the forces applied by the breaks on cars A and B respectively, then the ratio of  $\frac{F_A}{F_B}$  is

(1)  $\frac{1}{2}$

(2)  $\frac{3}{2}$

(3)  $\frac{2}{3}$

(4)  $\frac{1}{3}$

**Answer (3)**

**Sol.** By work-energy theorem,

$$FS = \Delta K \cdot E$$

$$\Rightarrow -FS = k_f - k_i$$

$$\Rightarrow FS = k_i - k_f$$

$$\Rightarrow \frac{F_A}{F_B} = \frac{k_A}{k_B} \times \frac{S_B}{S_A}$$

$$= \frac{100}{225} \times \frac{1500}{1000}$$

$$= \frac{150}{225} = \frac{2}{3}$$

