DATE : 04/05/2025

Test Booklet Code

46

NARMADA

Aakash

Medical | IIT-JEE | Foundations

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

Answers & Solutions for NEET (UG)-2025

Time : 3 hrs.

M.M.: 720

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 **46**.
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.

PHYSICS

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

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

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) 2% (2) 13%

(3) 15% (4) 10%

Answer (2)

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%

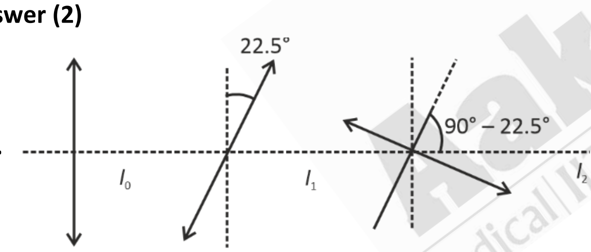
2. The intensity of transmitted light when a polaroid sheet, placed between two crossed polaroids at 22.5° from the polarization axis of one of the polaroids, is (I_0 is the intensity of polarised light after passing through the first polaroid):

(1) $\frac{I_0}{4}$ (2) $\frac{I_0}{8}$

(3) $\frac{I_0}{16}$ (4) $\frac{I_0}{2}$

Answer (2)

Sol.



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

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

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

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

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

3. 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) 1 : 2 (2) 2 : 1

(3) 4 : 1 (4) 1 : 4

Answer (4)

Sol. Magnetic moment of current carrying circular loop = IA

$M = IA$

$M \propto A$ [I–Same]

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

4. Consider the diameter of a spherical object being measured with the help of a Vernier callipers. Suppose its 10 Vernier Scale Divisions (V.S.D.) are equal to its 9 Main Scale Divisions (M.S.D.). The least division in the M.S. is 0.1 cm and the zero of V.S. is at x = 0.1 cm when the jaws of Vernier callipers are closed.

If the main scale reading for the diameter is M = 5 cm and the number of coinciding vernier division is 8, the measured diameter after zero error correction, is

(1) 5.08 cm
(2) 4.98 cm
(3) 5.00 cm
(4) 5.18 cm

Answer (2)

Sol. Least count **=** 1MSD – 1VSD

$$= 1\text{ MSD} - \frac{9}{10}\text{MSD}$$

$$= \frac{1}{10}\text{MSD}$$

$$= \frac{1}{10} \times 0.1\text{ cm} = 0.01\text{ cm}$$

Zero error = +0.1 cm

Main scale reading = 5 cm

Vernier scale reading = 8 × 0.01 = 0.08 cm

Final measurement of diameter

= 5 + 0.08 – 0.1 = 4.98 cm

5. 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) $c\sqrt{2mE}$
(2) $c\sqrt{\frac{2m}{E}}$
(3) $\frac{1}{c}\sqrt{E/2m}$
(4) $\sqrt{E/2m}$

Answer (2)

Sol. For photon, $E = \frac{hc}{\lambda_{\text{Ph}}} \Rightarrow \lambda_{\text{Ph}} = \frac{hc}{E}$

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

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

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

6. 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) 0.67 nm

(2) 1.67 nm

(3) 2.67 nm

(4) 0.067 nm

Answer (1)

Sol. $r = 0.052\ n^2$

For $n = 2$

$r = 0.052 \times 4$

= 0.208 nm

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

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

= 3.14 × 0.208 nm

= 0.65317 nm

≈ 0.67 nm

7. An unpolarized light beam travelling in air is incident on a medium of refractive index 1.73 at Brewster's angle. Then

(1) Reflected light is partially polarized and the angle of reflection is close to 30°

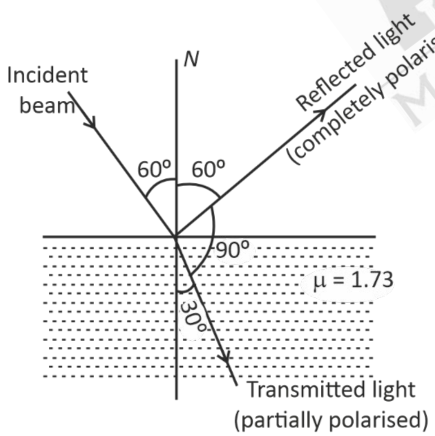
(2) Both reflected and transmitted light are perfectly polarized with angles of reflection and refraction close to 60° and 30°, respectively

(3) Transmitted light is completely polarized with angle of refraction close to 30°

(4) Reflected light is completely polarized and the angle of reflection is close to 60°

Answer (4)

Sol. Using Brewster law



$\mu = \tan\theta_P$

$\Rightarrow$ $1.73 = \tan\theta_P$

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

$\Rightarrow$ $\theta_P = 60°$

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

8. 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) $\frac{2}{3}$ (2) $\frac{1}{3}$

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

Answer (1)

Sol. By work-energy theorem,

$FS = \Delta K \cdot E$

$\Rightarrow -FS = k_f - k_i$

$\Rightarrow FS = k_i - k_f$

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

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

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

9. 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) $\frac{R}{32}$ (2) $\frac{R}{16}$

(3) $\frac{R}{8}$ (4) $\frac{R}{64}$

Answer (2)

Sol. After being cut into 8 equal pieces,

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

Each set has 4 pieces in parallel combination

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

Both sets are connected in series

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

10. 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 pressure at temperature 27°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 O_2 = 32, 1 atm pressure = 1.01×10^5 N/m]

(1) 0.144 kg (2) 0.116 kg

(3) 0.156 kg (4) 0.125 kg

Answer (2)

Sol. Number of moles left

$$n = \frac{PV}{RT} = \frac{12 \times 1.01 \times 10^5 \text{N/m}^2 \times 30 \times 10^{-3} \text{m}^3}{\frac{100}{12} \times 300}$$

$$n = \frac{12 \times 1.01 \times 12}{10} = 14.54 \text{ moles}$$

Moles removed = 18.2 – 14.54

= 3.656 moles

Mass removed = 3.656 × 32 = 116.99 g = 0.116 kg

11. 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 $4m$
(2) $4p$ and m^4
(3) p^4 and m^4
(4) $4p$ and $4m$

Answer (2)

Sol. For series combination of lens

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

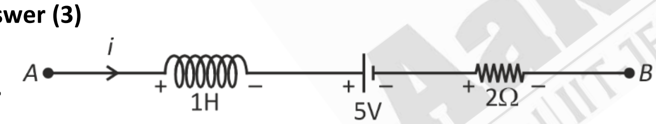
$m_{eff} = m_1 \times m_2 \times m_3 \times m_4 = m^4$

12. AB is a part of an electrical circuit (see figure). The potential difference "$V_A - V_B$", at the instant when current i = 2 A and is increasing at a rate of 1 amp/second is:

(1) 6 volt
(2) 9 volt
(3) 10 volt
(4) 5 volt

Answer (3)

Sol.



Given, I = 2A and $\frac{di}{dt} = +1\text{A/s}$

$$V_A - L\frac{di}{dt} - 5 - i \times 2 = V_B$$

$\Rightarrow$ $V_A - 1 \times 1 - 5 - 2 \times 2 = V_B$

$\Rightarrow$ $V_A - V_B = 10$ volt

13. 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) 27 N
(2) 32 N
(3) 36 N
(4) 16 N

Answer (1)

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

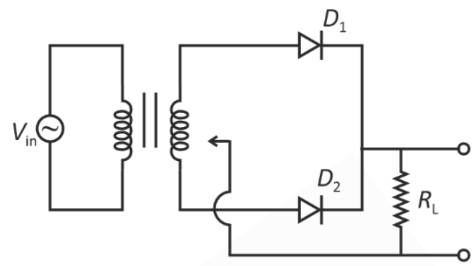
$$\Rightarrow \frac{W_h}{W} = \frac{mg_h}{mg} = \frac{g_h}{g} = \frac{R^2}{(R+h)^2} \quad \left(h = \frac{R}{3}\right)$$

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

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

$$= 27 \text{ N}$$

14. 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 is reverse biased, D_2 is forward biased.

(2) D_1 and D_2 both are forward biased

(3) D_1 and D_2 both are reverse biased

(4) D_1 is forward biased, D_2 is reverse biased

Answer (1)

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

t = 15 ms

t = 0.015 s

$\omega = 100\pi$

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

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

T = 0.02 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.

15. 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) 25 min, 100 km/h

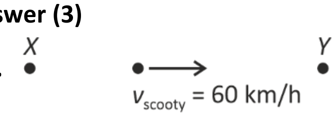
(2) 10 min, 90 km/h

(3) 15 min, 120 km/h

(4) 9 min, 40 km/h

Answer (3)

Sol.



$X \rightarrow Y$

Let velocity of bus = v km/hr

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

Distance between 2 consecutive buses = vT

$(v - 60)30 = vT$ ...(i)

$Y \rightarrow X$

$(v + 60)10 = vT$ ...(ii)

Equating (1) and (2)

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

$\therefore \quad v = 120$ km/hr

$T = 15$ min

16. 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) 105 days
(2) 115 days
(3) 108 days
(4) 100 days

Answer (3)

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

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

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

$\Rightarrow T' = 4T = 4 \times 27 = 108$ days

17. The electric field in a plane electromagnetic wave is given by

$E_z = 60 \cos(5x + 1.5 \times 10^9 t)$ V/m.

Then expression for the corresponding magnetic field is (here subscripts denote the direction of the field) :

(1) $B_x = 2 \times 10^{-7} \cos(5x + 1.5 \times 10^9 t)T$
(2) $B_z = 60\cos(5x + 1.5 \times 10^9 t)T$
(3) $B_y = 60 \sin(5x + 1.5 \times 10^9 t)T$
(4) $B_y = 2 \times 10^{-7} \cos(5x + 1.5 \times 10^9 t)T$

Answer (4)

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.

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

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

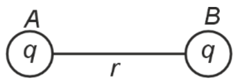
$B_y = 2 \times 10^{-7}\cos(5x + 1.5 \times 10^9 t)$ T

18. 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:

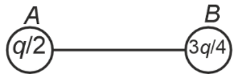
(1) $\frac{2F}{3}$
(2) $\frac{F}{2}$
(3) $\frac{3F}{8}$
(4) $\frac{3F}{5}$

Answer (3)

Sol.



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



$F' = \frac{K\frac{q}{2}\frac{3q}{4}}{r^2}$

$F' = \frac{3F}{8}$

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

(1) 1.0 J (2) 1.2 J

(3) 1.5 J (4) 0.8 J

Answer (1)

Sol. Given

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

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

$\theta_i = 0°$ and $\theta_f = 60°$

$\Delta U = U_f - U_i$

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

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

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

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

20. 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) 125 (2) 150

(3) 250 (4) 100

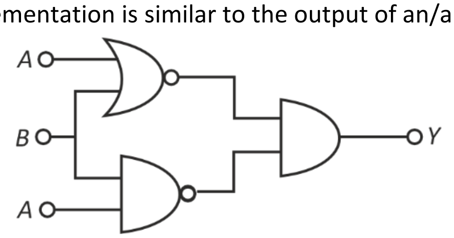
Answer (1)

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

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

$m = 125$

21. The output (Y) of the given logic implementation is similar to the output of an/a ______ gate.

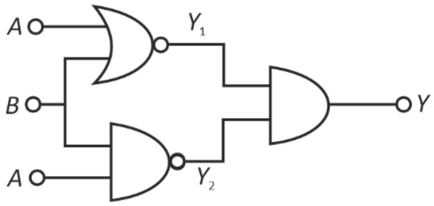


(1) NAND (2) OR

(3) NOR (4) AND

Answer (3)

Sol.



$Y_1 = \overline{A+B}$

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

$Y = Y_1 \cdot Y_2$

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

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

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

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

22. A uniform rod of mass 20 kg and length 5 m leans against a smooth vertical wall making an angle of 60° 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 m/s^2)

(1) $100\sqrt{3}$ N

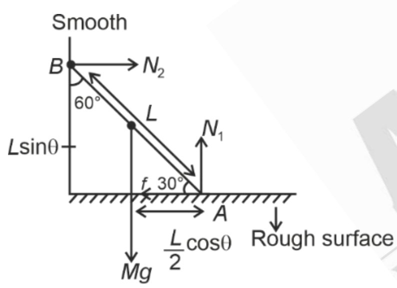
(2) 200 N

(3) $200\sqrt{3}$ N

(4) 100 N

Answer (1)

Sol.



For translational equilibrium

$N_1 = Mg$

$N_2 = f$

For rotational equilibrium

Torque about A, $Mg\frac{L}{2}\cos\theta = N_2 L\sin\theta$

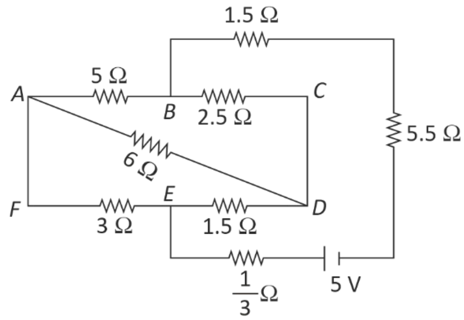
$\frac{Mg}{2}\cot\theta = N_2 = f$

$\frac{Mg}{2}\cot 30^\circ = f$

$\frac{Mg}{2}\sqrt{3} = N_2$

$100\sqrt{3} = f$

23. The current passing through the battery in the given circuit, is:

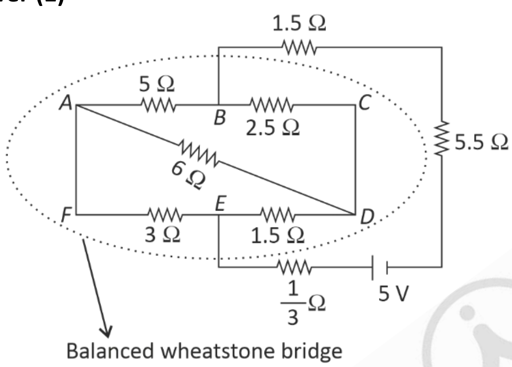


(1) 0.5 A (2) 2.5 A

(3) 1.5 A (4) 2.0 A

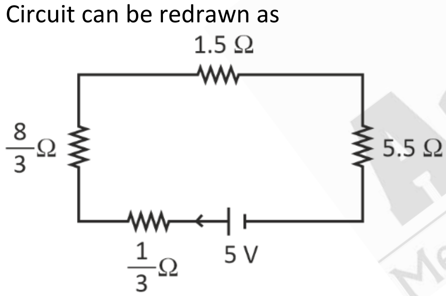
Answer (1)

Sol.



$\therefore$ its equivalent $R' = \frac{4\times 8}{12} = \frac{8}{3}\Omega$

Circuit can be redrawn as



$R_{eq} = \frac{8}{3} + \frac{1}{3} + 1.5 + 5.5$

$= 10\ \Omega$

$i = \frac{V}{R_{eq}} = \frac{5}{10} = 0.5\text{A}$

24. 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) $\frac{he}{2\pi m}$ (2) $\frac{heB}{\pi m}$

(3) $\frac{heB}{2\pi m}$ (4) $\frac{he}{\pi m}$

Answer (1)

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

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

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

$$\phi = BA$$

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

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

$$\mu = IA$$

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

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

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

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

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

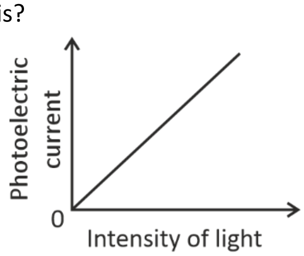
$$\mu = \frac{1}{2}e^2 \frac{nh}{e\pi m}$$

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

for $n = 1$

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

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

A.


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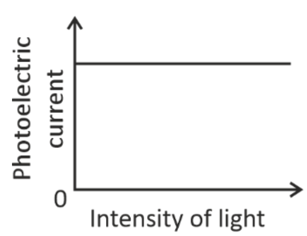

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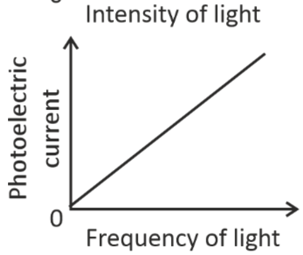
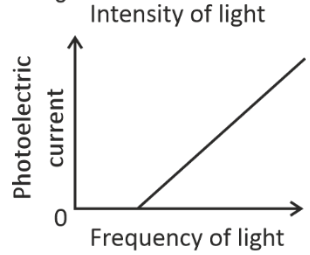
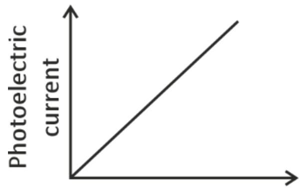


D.


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

Answer (4)

Sol.



Photoelectric current is directly proportional to intensity of light.

26. An electron (mass 9×10^{-31} kg and charge 1.6×10^{-19} C) moving with speed $c/100$ (c = speed of light) is injected into a magnetic field $\vec{B}$ of magnitude 9×10^{-4} T perpendicular to its direction of motion. We wish to apply an 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 perpendicular to $\vec{B}$ and its magnitude is 27×10^2 V m^{-1}

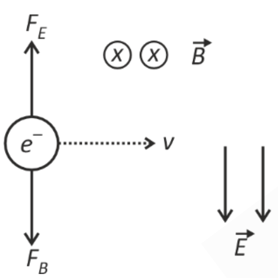
(2) $\vec{E}$ is parallel to $\vec{B}$ and its magnitude is 27×10^2 V m^{-1}

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

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

Answer (1)

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



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

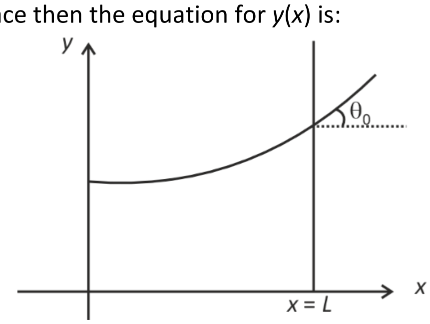
$$\Rightarrow \vec{E} = \vec{v} \times \vec{B} \quad \Rightarrow \vec{E} \perp \vec{B}$$

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

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

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

27. 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 ρ, the liquid surface makes angle θ_0 ($\theta_0 << 1$) 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) $\dfrac{d^2y}{dx^2} = \dfrac{\rho g}{S} y$

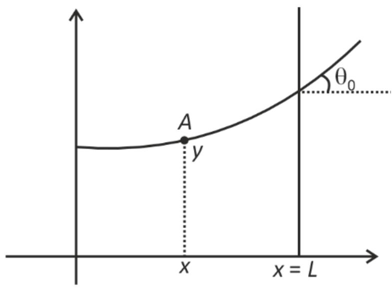
(2) $\dfrac{d^2y}{dx^2} = \sqrt{\dfrac{\rho g}{S}}$

(3) $\dfrac{dy}{dx} = \sqrt{\dfrac{\rho g}{S}} x$

(4) $\dfrac{d^2y}{dx^2} = \dfrac{\rho g}{S} x$

Answer (1)

Sol.



ROC = Radius of curvature at point *A*

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

$\Delta P = S \times$ curvature

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

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

28. 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) f

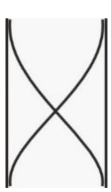
(2) $\dfrac{3f}{2}$

(3) $2f$

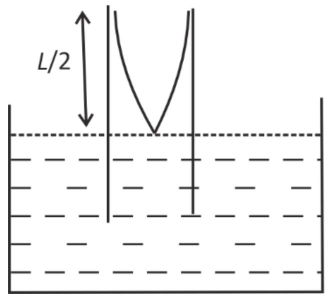
(4) $\dfrac{f}{2}$

Answer (1)

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



Now immersed in water open pipe behaves as closed pipe.



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

$f = f'$

29. 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) Constant between the plates and zero outside the plates

(2) Non-zero everywhere with maximum at the imaginary cylindrical surface connecting peripheries of the plates

(3) Zero between the plates and non-zero outside

(4) Zero at all places

Answer (2)

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

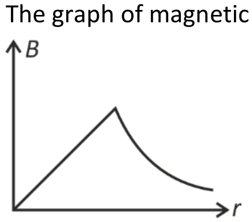
Given $\frac{d\sigma}{dt}$ = constant

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

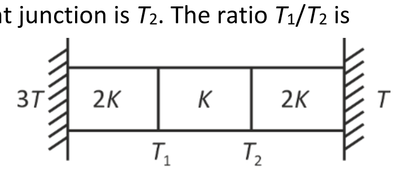
It means displacement current is constant.

This system will act like a cylindrical wire.

The graph of magnetic field (B) vs r is



30. Three identical heat conducting rods are connected in series as shown in the figure. The rods on the sides have thermal conductivity $2K$ while that in the middle has thermal conductivity K. The left end of the combination is maintained at temperature $3T$ and the right end at T. The rods are thermally insulated from outside. In steady state, temperature at the left junction is T_1 and that at the right junction is T_2. The ratio T_1/T_2 is



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

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

(3) $\frac{5}{4}$

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

Answer (2)

Sol. In series, $R_{eq.} = R_1 + R_2 + R_3$

$$= \frac{l}{2KA} + \frac{l}{KA} + \frac{l}{2KA}$$

$$= \frac{4l}{2KA}$$

$$R_{eq.} = \frac{2l}{KA}$$

In series rate of heat flow is same

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

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

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

$\Rightarrow \quad 2T_1 = 5T$

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

Now, equate heat flow rate in 3rd section & total section

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

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

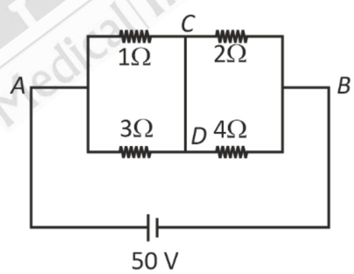
$\Rightarrow \quad 2T_2 - 2T = T$

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

By equation (1) and equation (2)

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

31. 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:

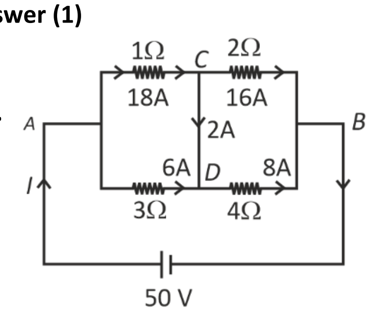


(1) 2.0 A (2) 2.5 A

(3) 3.0 A (4) 1.5 A

Answer (1)

Sol.



R_{AB} = (1Ω/3Ω) in series with (2Ω/4Ω)

$$= \frac{3\times1}{3+1} + \frac{2\times4}{2+4}$$

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

Now total current through cell

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

$$I_{1\Omega} = \frac{3}{4}\times24 = 18\text{A},\ I_{3\Omega} = \frac{1}{4}\times24 = 6\text{A}$$

$$I_{2\Omega} = \frac{4}{6}\times24 = 16\text{A},\ I_{4\Omega} = \frac{2}{6}\times24 = 8\text{A}$$

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

32. In some appropriate units, time (*t*) and position (*x*) relation of a moving particle is given by $t = x^2 + x$. The acceleration of the particle is

(1) $-\frac{2}{(2x+1)^3}$

(2) $+\frac{2}{(x+1)^3}$

(3) $+\frac{2}{2x+1}$

(4) $-\frac{2}{(x+2)^3}$

Answer (1)

Sol. $t = x^2 + x$

$$\frac{dt}{dx} = 2x+1$$

$$v = \frac{dx}{dt} = \frac{1}{(2x+1)}$$

$$\frac{dv}{dx} = \frac{-2}{(2x+1)^2}$$

$$a = v\frac{dv}{dx} = \frac{1}{(2x+1)}\left[\frac{-2}{(2x+1)^2}\right]$$

$$= -\frac{2}{(2x+1)^3}$$

33. 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) $\frac{3}{4}$

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

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

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

Answer (1)

Sol. Using first law of thermodynamics

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

ΔQ is same

ΔU is also same

$W_A = W_B$

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

P is also same

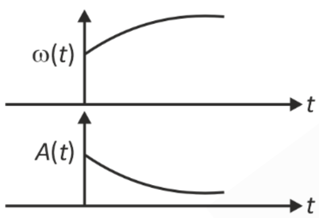
$\therefore\ A_A d_A = A_B d_B$

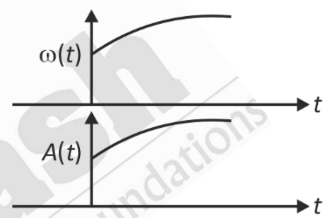
$\pi r_A^2 d_A = \pi r_B^2 d_B$

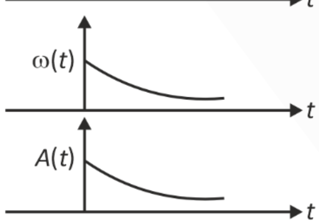
$\frac{r_A}{r_B} = \left(\frac{dB}{dA}\right)^{\frac{1}{2}} = \left(\frac{9}{16}\right)^{\frac{1}{2}}$

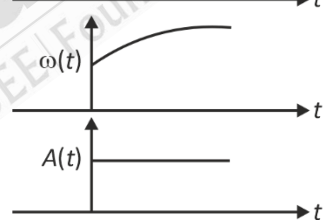
$= \frac{3}{4}$

34. In an oscillating spring mass system, a spring is connected to a box filled with sand. As the box oscillates, sand leaks slowly out of the box vertically so that the average frequency $\omega(t)$ and average amplitude $A(t)$ of the system change with time t. Which one of the following options schematically depicts these changes correctly?

(1)


(2)


(3)


(4)


Answer (1)

Sol. At any point of time, time period is given by

$T = 2\pi\sqrt{\frac{m}{k}}$

Here m is decreasing, so time period T will be decreasing

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

Hence as mass leaks, ω will increase

Now, at any instant

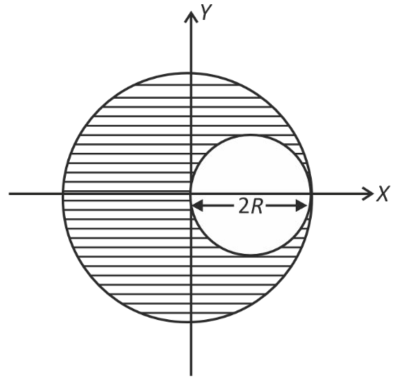
$mg = kx_0$

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

So, equilibrium length will decrease.

So, amplitude also go on decreasing.

35. A sphere of radius R is cut from a larger solid sphere of radius $2R$ as shown in the figure. The ratio of the moment of inertia of the smaller sphere to that of the rest part of the sphere about the Y-axis is:



(1) $\frac{7}{40}$

(2) $\frac{7}{57}$

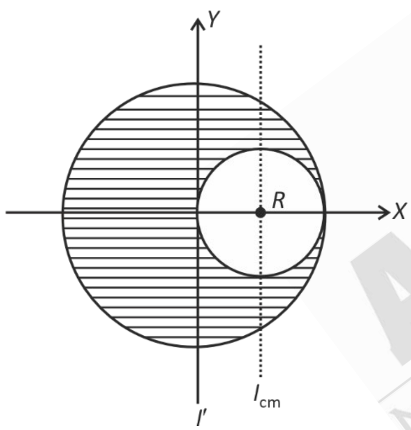
(3) $\frac{7}{64}$

(4) $\frac{7}{8}$

Answer (2)

Sol. For larger solid sphere about diameter Y-axis,

$$I_{\text{whole}} = \frac{2}{5}M(2R)^2 = \frac{8}{5}MR^2$$



Density of sphere is uniform

$$\Rightarrow \frac{M}{V_{\text{whole}}} = \frac{M_{\text{smaller}}}{V_{\text{smaller}}} \Rightarrow \frac{M}{\frac{4}{3}\pi(2R)^3} = \frac{M'}{\frac{4}{3}\pi R^3}$$

$$\Rightarrow M' = \frac{M}{8}$$

Using parallel axis theorem for smaller sphere,

$$I' = I_{\text{cm}} + M'R^2 = \frac{2}{5}\frac{MR^2}{8} + \frac{MR^2}{8} = \frac{7}{40}MR^2$$

$$\therefore \text{ Ratio} = \frac{I_{\text{smaller}}}{I_{\text{remaining}}} = \frac{I'}{I_{\text{whole}} - I'} = \frac{\frac{7}{40}MR^2}{\left(\frac{8}{5} - \frac{7}{40}\right)MR^2} = \frac{7}{64-7} = \frac{7}{57}$$

36. 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) 2.33

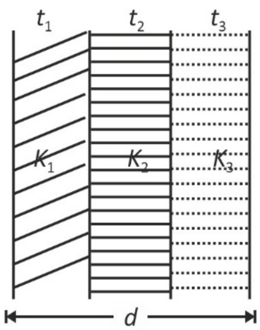
(2) 1.60

(3) 1.33

(4) 2.66

Answer (4)

Sol.



Using $C_{eq} = \dfrac{\varepsilon_0 A}{\dfrac{t_1}{K_1} + \dfrac{t_2}{K_2} + \dfrac{t_3}{K_3}}$

here $C_0 = \dfrac{\varepsilon_0 A}{d}, t_1 = \dfrac{3d}{8}, t_2 = \dfrac{d}{2}, t_3 = \dfrac{d}{8}$

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

Given $C_{eq} = 2C_0$

$$\Rightarrow 2C_0 = \frac{\varepsilon_0 A}{\dfrac{3d}{8K_1} + \dfrac{d \times 1.25}{2K_1} + \dfrac{d}{8}}$$

$$\Rightarrow \frac{2\varepsilon_0 A}{d} = \frac{\varepsilon_0 A}{\dfrac{3d}{8K_1} + \dfrac{d}{2K_1} \times \dfrac{5}{4} + \dfrac{d}{8}}$$

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

37. There are two inclined surfaces of equal length (L) and same angle of inclination 45° 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 (μ_k) between the object and the rough surface is close to

(1) 0.40

(2) 0.5

(3) 0.75

(4) 0.25

Answer (3)

Sol. $t_{rough} = 2t_{smooth}$

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

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

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

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

Squaring both sides

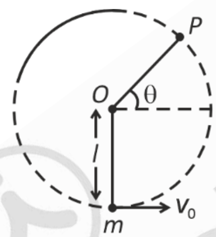
$$\frac{\sin\theta}{\sin\theta - \mu_k \cos\theta} = 4 \Rightarrow \frac{\frac{1}{\sqrt{2}}}{\frac{1}{\sqrt{2}} - \mu_k \times \frac{1}{\sqrt{2}}} = 4$$

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

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

= 0.75

38. 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 θ from the horizontal, the ratio of the speed v of the bob at point P to its initial speed v_0 is:



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

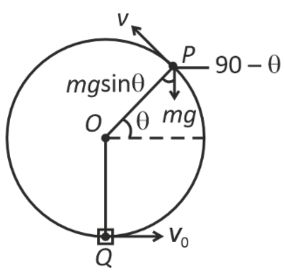
(2) $\left(\frac{\cos\theta}{2+3\sin\theta}\right)^{\frac{1}{2}}$

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

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

Answer (3)

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)

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

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

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

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

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

39. 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) 1.6 atm (2) 1.4 atm

(3) 1.8 atm (4) 1.3 atm

Answer (1)

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 atm

40. To an ac power supply of 220 V at 50 Hz, a resistor of 20 Ω, a capacitor of reactance 25 Ω and an inductor of reactance 45 Ω are connected in series. The corresponding current in the circuit and the phase angle between the current and the voltage is, respectively

(1) 7.8 A and 45° (2) 15.6 A and 30°

(3) 15.6 A and 45° (4) 7.8 A and 30°

Answer (1)

Sol. X_L = 45 W , X_C = 25 W, R = 20 W

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

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

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

f = 45°

41. 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) 225 earth days

(2) 172 earth days

(3) 124 earth days

(4) 88 earth days

Answer (4)

Sol. Applying Kepler's 3rd law : $T^2 \propto R^3$

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

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

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

42. 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 ρ 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) $a = -\frac{1}{2}, \alpha = -\frac{1}{2}, \beta = -1, \gamma = -\frac{1}{2}, \delta = \frac{5}{2}$

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

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

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

Answer (2)

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

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

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

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

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

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

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

By hit and trial (using option (1))

Put $\beta = -1$

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

43. 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^{th} orbit and the particle's speed v in the orbit depend on n as

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

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

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

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

Answer (2)

Sol. Given, force is constant

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

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

$\Rightarrow r \propto v^2$ ...(1)

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

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

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

44. 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) $\frac{k_1}{k_2}$

(2) $\sqrt{\frac{k_2}{k_1}}$

(3) $\sqrt{\frac{k_1}{k_2}}$

(4) $\frac{k_2}{k_1}$

Answer (3)

Sol. Maximum velocity $V = A\omega$

$v_P = v_Q$

$A_P\omega_P = A_Q\omega_Q$

$$\frac{A_Q}{A_P} = \frac{\omega_P}{\omega_Q} \qquad \left(\omega = \sqrt{\frac{k}{m}}\right)$$

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

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

45. 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 $g = 9.8$ m/s^2)

(1) 7 NS

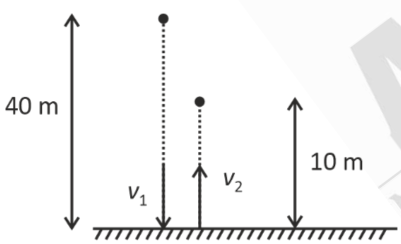
(2) 0

(3) 84 NS

(4) 21 NS

Answer (4)

Sol.



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

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

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

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

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

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

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

= 21 NS