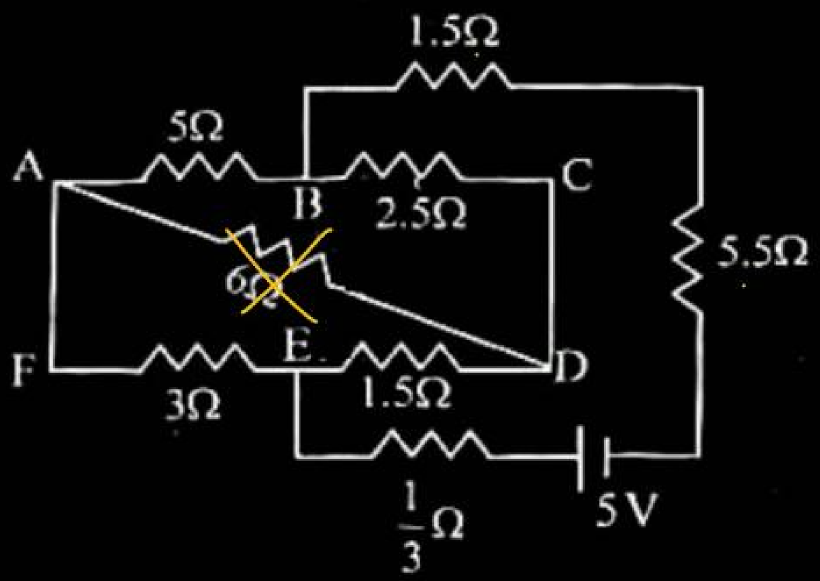
Question no. 1

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



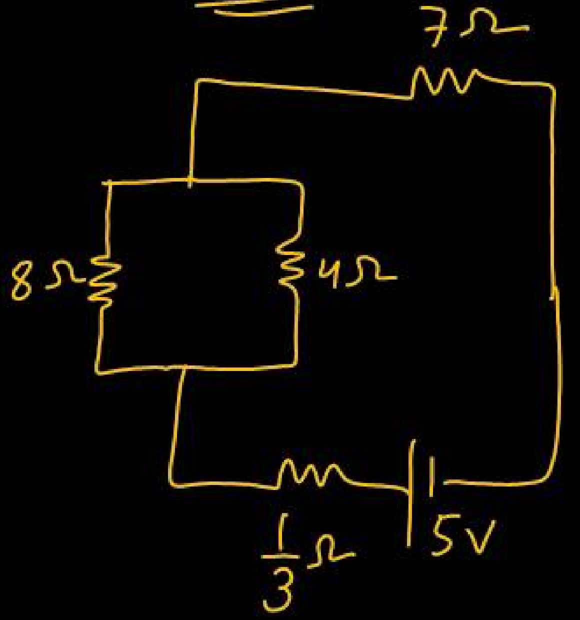
(1) 1.5 A (2) 2.0 A

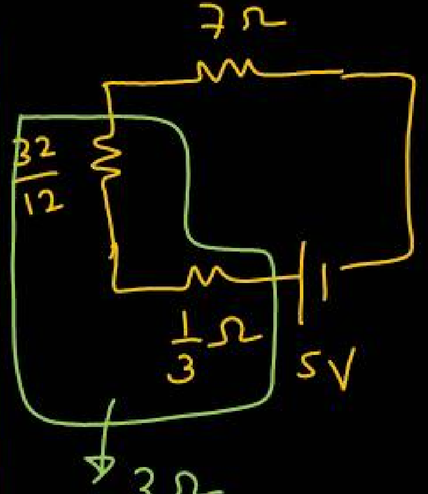
(3) 0.5 A (4) 2.5 A

$5 \times 1.5 = 3 \times 2.5$

$7.5 = 7.5$

BWLB





$i = \frac{5}{10}$

$= 0.5A$

Question no. 2

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) $B_y = 60 \sin(5x + 1.5 \times 10^9 t)$ T

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

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

(4) $B_z = 60 \cos(5x + 1.5 \times 10^9 t)$ T

(2)

EM waves

$E_0 = 60$ V/m

$\text{speed} = \frac{1.5 \times 10^9}{5} = 3 \times 10^8$ m/s

vacuum

$E_0 = B_0 \times c$

$B_0 = \frac{E_0}{c} = \frac{60}{3 \times 10^8} = 20 \times 10^{-8} = 2 \times 10^{-7}$ T

wave vel : → −x

EF → z

B → y

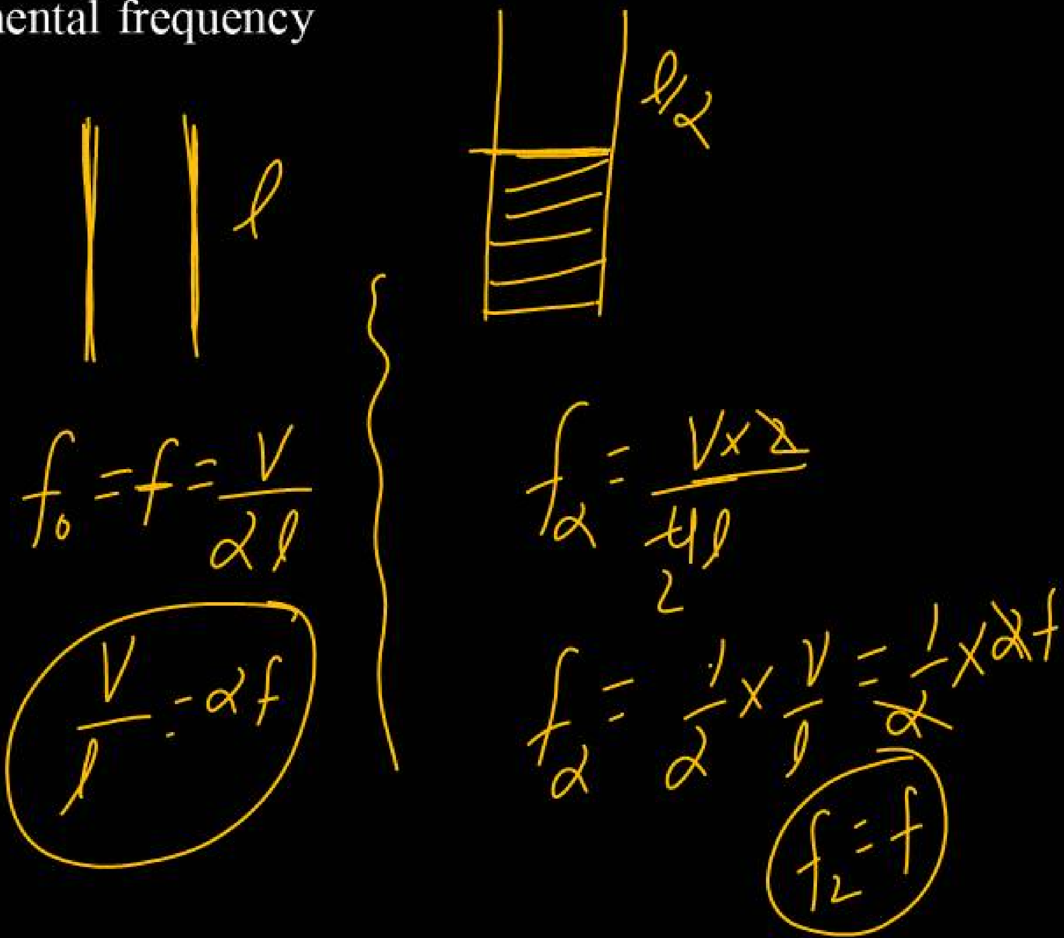
$B_y = 2 \times 10^{-7} \cos(5x + 1.5 \times 10^9)$

Question no. 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) $\frac{3f}{2}$



Question no. 4

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

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

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

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

(3)

$e^- \longrightarrow$

$F_{net} = 0$

electric & mag. force must be equal & opposite.

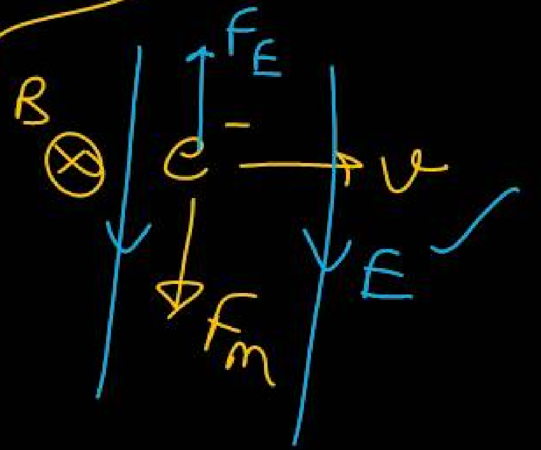
$qE = qvB\sin\theta$ ($\sin\theta = 1$)

$E = vB$

$E = \frac{c}{100} B$

$E = \frac{3\times10^8}{100} \times 9\times10^{-4}$

$E = 27 \times 10^2$ V/m



Question no. 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

$$P_{net} = \sum P = P_1 + P_2 + P_3 + P_4$$
$$= P + P + P + P$$
$$= 4P$$

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

(4)

Question no. 6

A 2 amp current in 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

$M = NiA$

$M = iA$

$M \propto A$

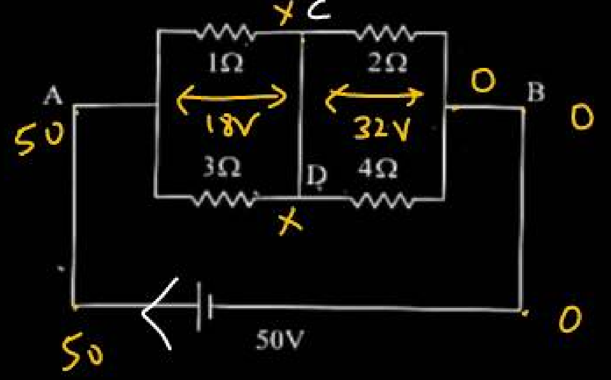
$M \propto r^2$

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

(2)

Question no. 7

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



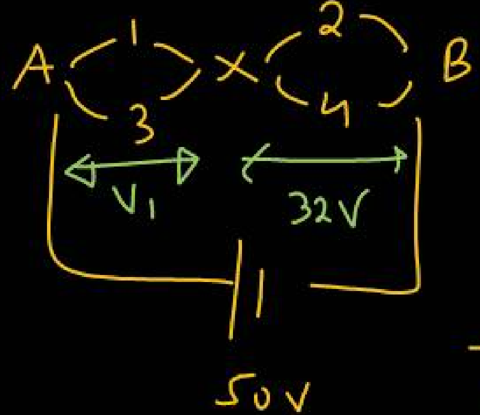
(1) 3.0 A 24A (2) 1.5 A

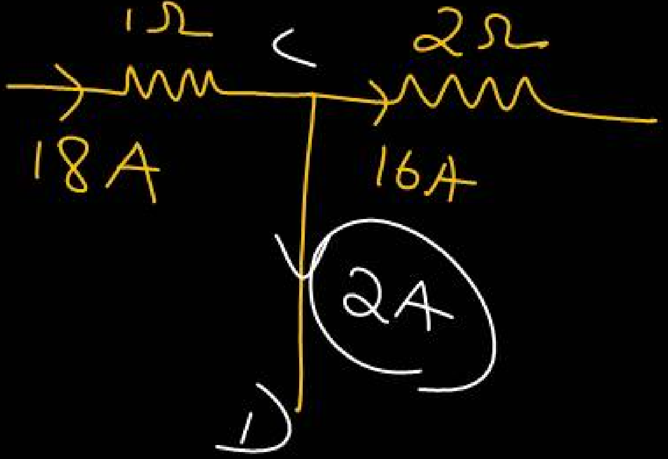
(3) 2.0 A (4) 2.5 A

$R_{eq} = \frac{3}{4} + \frac{4}{3} = \frac{25}{12}$

$i = \frac{50}{25/12} = 24\,A$

$V_1 = 24 \times \frac{3}{4} = 18\,V$





Question no. 8

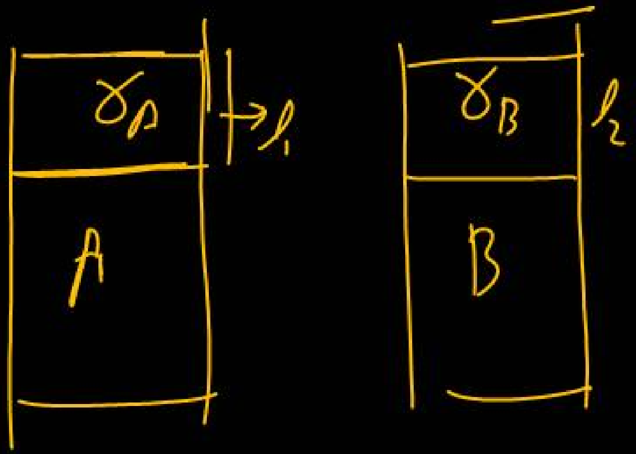
Two gases A and B are filled at the same pressure in separate cylinders with movable pistons of radisu r_A and r_B, respectively. On supplying an equal amount of heat to both the system reversibly under constant pressure, the pistons of gas A and B are displaced by 16 cm and 9 cm, respectively. If the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

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

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

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

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

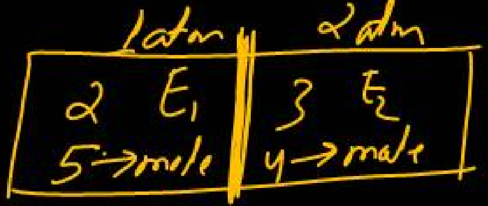


Question no. 9

A container has two chambers of volumes $V_1 = 2$ liters and $V_2 = 3$ liters separated by a partition made of a thermal insulator. The chambers contains $n_1 = 5$ and $n_2 = 4$ moles of ideal gas at pressure $p_1 = 1$ 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



$E_1 + E_2 = E_m$

$$\frac{n_1 f R T_1}{2} + \frac{n_2 \times f R T_2}{2} = \frac{(n_1 + n_2) R f T_m}{2}$$

$PV = nRT$

$$\frac{P_1 V_1 \times f}{2} + \frac{P_2 V_2 f}{2} = \frac{P_m (V_1 + V_2) f}{2}$$

$P_1 V_1 + P_2 V_2 = P_m \times (V_1 + V_2)$

$$P_m = \frac{1 \times 2 + 2 \times 3}{5}$$

$$P_m = \frac{8}{5} \rightarrow 1.6 \text{ atm}$$

Question no. 10

The radius of Martion orbit around the Sun is about 4 times the radius of the orbit of Mercury. The Martain 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

Mars → $4r$

$T^2 \propto r^3$

$\left(\frac{T_1}{T_2}\right)^2 = \left(\frac{4r}{r}\right)^3$

$\left(\frac{687}{T_2}\right)^2 = 4 \times 4 \times 4$

$T_2 = \frac{687}{8} \to 85 \simeq 88$

Question no. 11

To an ac power supply of 220V 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) 15.6 A and 45° (2) 7.8 A and 30°

(3) 7.8 A and 45° (4) 15.6 A and 30°

③

$R = 20\,\Omega$

$X_C = 25\,\Omega$, $X_L = 45\,\Omega$ } $X_L > X_C$ ✓

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

$\phi = 45^\circ$

$i = \frac{V}{Z} = \frac{220}{\sqrt{(45-20)^2+20^2}} = \frac{220}{\sqrt{625+400}} = \frac{220}{\sqrt{1025}}$

$\approx 7.8\,A$

Question no. 12

A wire of ressitance R is cut into 8 equal pieces. From thess 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 :

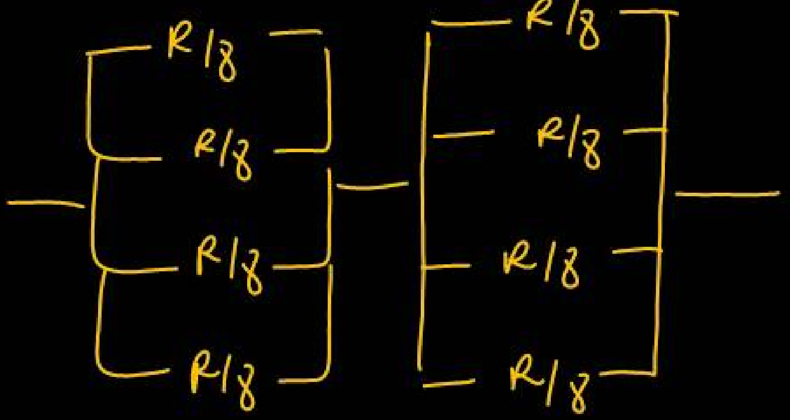
(1) $\frac{R}{8}$ (2) $\frac{R}{64}$

(3) $\frac{R}{32}$ (4) $\frac{R}{16}$

4

CE

each part → R/8



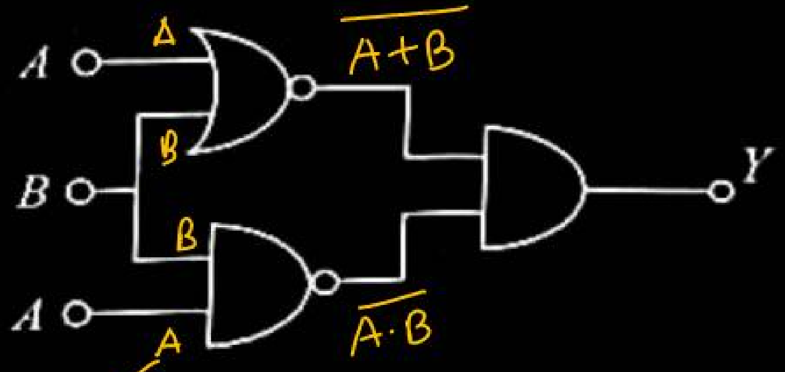
A — $\frac{R}{32}$ — $\frac{R}{32}$ — B

$R_{eq} = \frac{R}{32} \times 2$

$= \frac{R}{16}$

Question no. 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

1

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

$Y = (\bar{A}\cdot\bar{B}) \cdot (\bar{A}+\bar{B})$

$Y = \bar{A}\bar{B}\bar{A} + \bar{A}\bar{B}\bar{B}$

$Y = \bar{A}\bar{B} + \bar{A}\bar{B}$

$Y = \bar{A}\bar{B}$

$Y = \overline{A+B}$

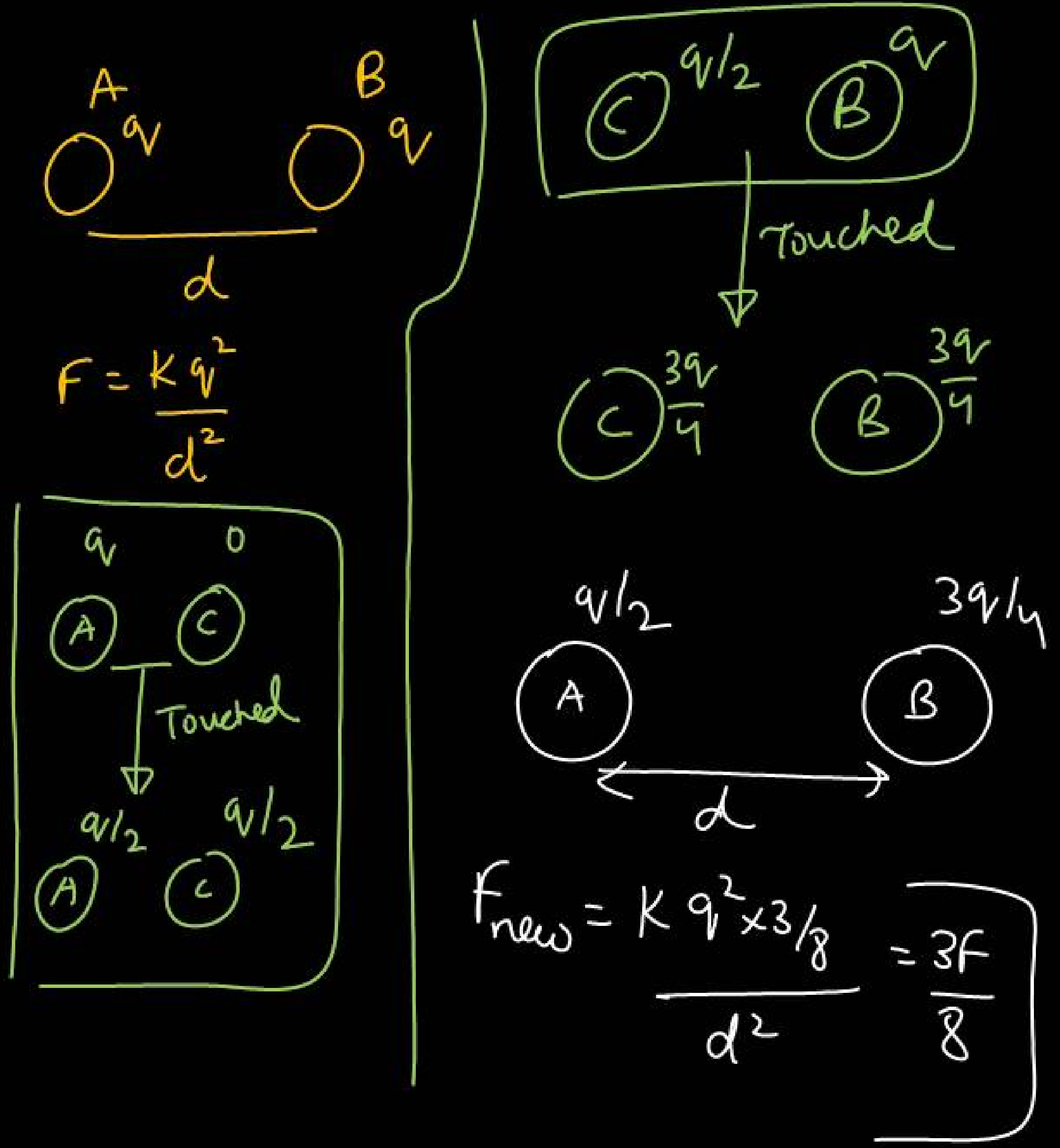
NOR

Question no. 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 sepration 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) $\frac{F}{2}$



Question no. 15

Consider the diameter of a spherical object being measured with the help of a Vernier calipers. 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 ther zero of V.S. is at x = 0.1 cm when the jaws of Vernier calipers 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) 5.00 cm

(2) 5.18 cm

(3) 5.08 cm

(4) 4.98 cm ✓

10 VSD = 9 MSD

$1\ VSD = \frac{9}{10}(MSD) = \frac{9}{10} \times 0.1 = \frac{0.9}{10} = 0.09$

LC = 1 MSD − 1 VSD = 0.10 − 0.09 = 0.01 cm

Reading = MSD + (LC × VS matching)

= 5 + (0.01 × 8)

= 5.08

final = 5.08 − (+ve error)

= 5.08 − 0.10

= 4.98

Question no. 16

In some appropriate units, time (t) and position 9x) relation of a moving particle is given by $t = x^2 + x$. The acceleration of the particle is

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

(3) $-\frac{2}{(2x+1)^3}$ (4) $+\frac{2}{(x+1)^3}$

$t = x^2 + x$

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

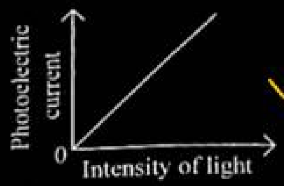
$v = \frac{dx}{dt} = (2x+1)^{-1}$

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

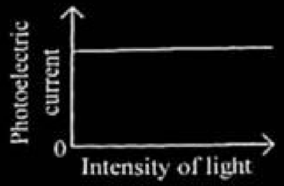
$= \frac{-2}{(2x+1)^3}$

Question no. 17

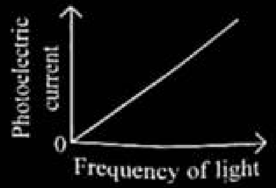
Which of the following options represent the variation of photoelectric current with property of light shown on the x-axis?



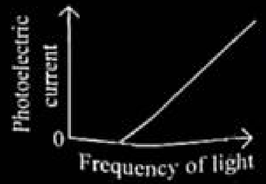
A.



B.



C.



D.

(1) B and D (2) A only

(3) A and C (4) A and D

Question no. 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 r of the n^{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) $r \propto n^{2/3}; v \propto n^{1/3}$

$F = \frac{mv^2}{r}$ — (1)

$mvr = n\frac{h}{2\pi}$ — (2)

$vr = nK'$ $\left(K' = \frac{h}{2\pi m}\right)$

$v^2 = K''r$ $\left(K'' = F/m\right)$

$v \cdot \frac{v^2}{K''} = nK'$

$\frac{v^3}{K''} = nK'$

$v \propto n^{1/3}$

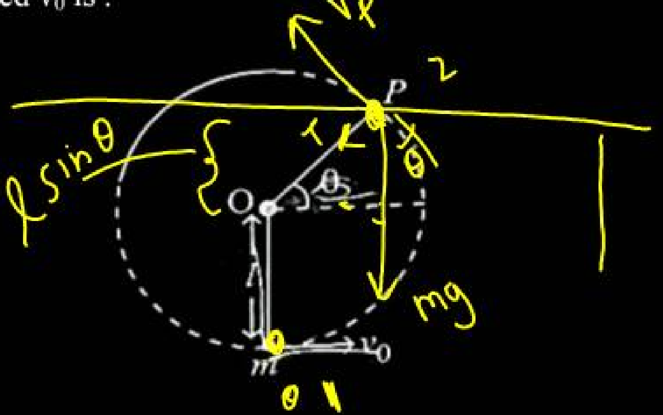
$r \propto v^2$

$r \propto n^{2/3}$

4

Question no. 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 θ from the horizontal, the ratio of the speed v of the bob at point P to its initial speed v_0 is :



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

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

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

$$T + mg\sin\theta = \frac{mv_p^2}{l} \quad (2)$$

$$mv_p^2 = mg\sin\theta \cdot l$$

$$v_p = \sqrt{gl\sin\theta}$$

$$\frac{1}{2}mv_0^2 = mgl(1+\sin\theta) + \frac{1}{2}m\,gl\sin\theta$$

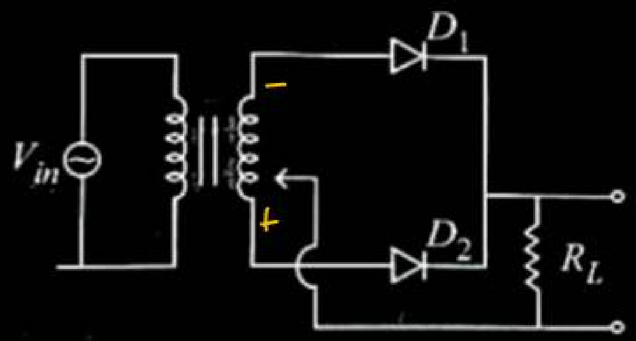
$$v_0^2 = 2gl + 2gl\sin\theta + gl\sin\theta$$

$$v_0 = \sqrt{2gl + 3gl\sin\theta}$$

$$\frac{v_p}{v_0} = \sqrt{\frac{gl\sin\theta}{2gl+3gl\sin\theta}} = \sqrt{\frac{\sin\theta}{2+3\sin\theta}} = \left(\frac{\sin\theta}{2+3\sin\theta}\right)^{1/2}$$

Question no. 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 π t) volt, then at t = 15 m sec



(1) D_1 and D_2 both are reverse biased

(2) D_1 si forward baised, 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

$V_{in} = 220\left(\sin\left[100\pi \times \frac{15}{1000}\right]\right)$

$\sin 3\pi/2$

V_{in} -ve

Question no. 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 dentisty 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) $a = \frac{1}{2}, \alpha = \frac{1}{2}, \beta = -\frac{1}{2}, \gamma = \frac{1}{2}, \delta = \frac{7}{2}$

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

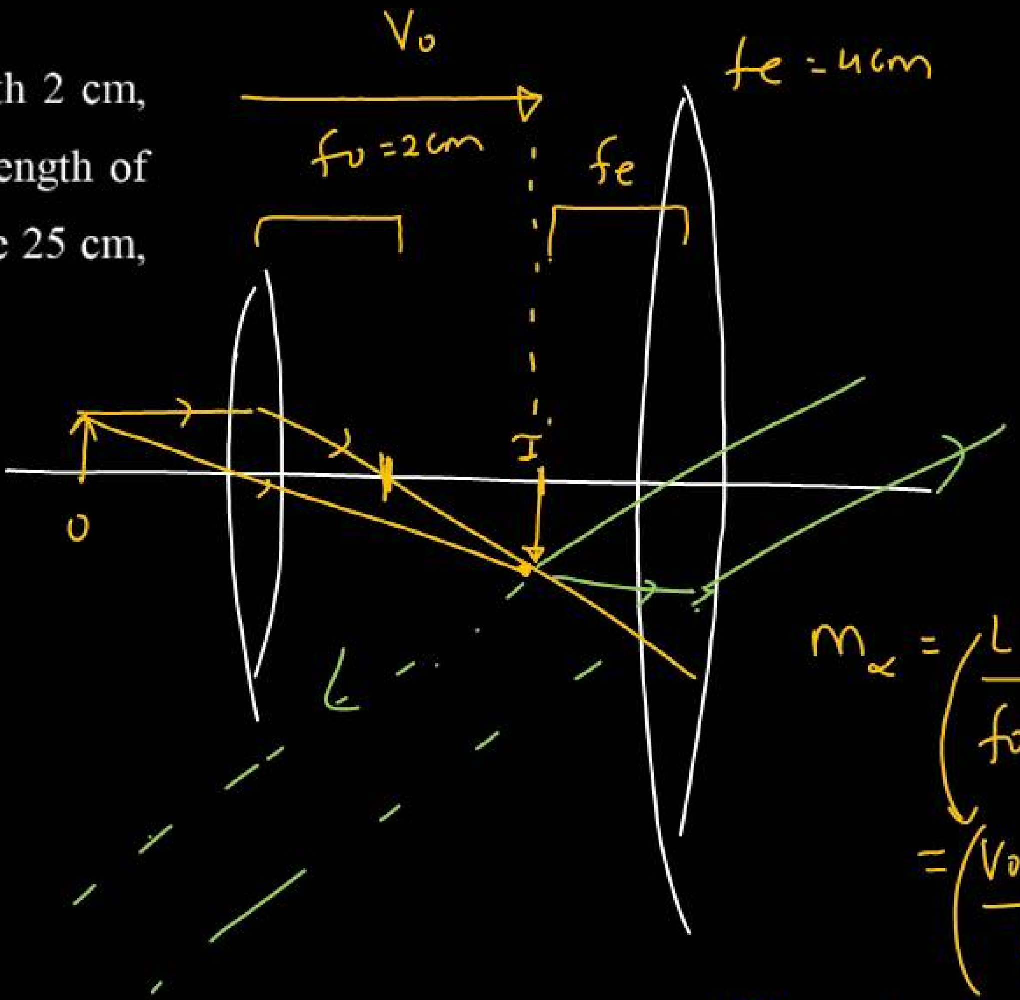
Question no. 22

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 25 cm, the mangnification in the microsope is

(1) 250 (2) 100

(3) 125 ✓ (4) 150

(3)



$$m_\alpha = \frac{LD}{f_0 f_e}$$

$$= \left(\frac{V_0 - f_0}{f_0}\right)\left(\frac{D}{f_e}\right)$$

$$m_\alpha = \frac{40 \times 25}{2 \times 4} = 125$$

Question no. 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) $\sqrt{\frac{k_2}{k_1}}$

Question no. 24

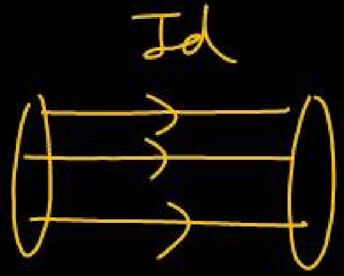
A parallel plate capacitor made of circular plates is being charged such that the surface charge density on its plates is increasing at a constant rate with time. The magnitude field arising due to displacement current is : → mag.

(1) zero between the plates and non-zero outside

(2) zero at all places

(3) constant between the plates and zero outside the plates

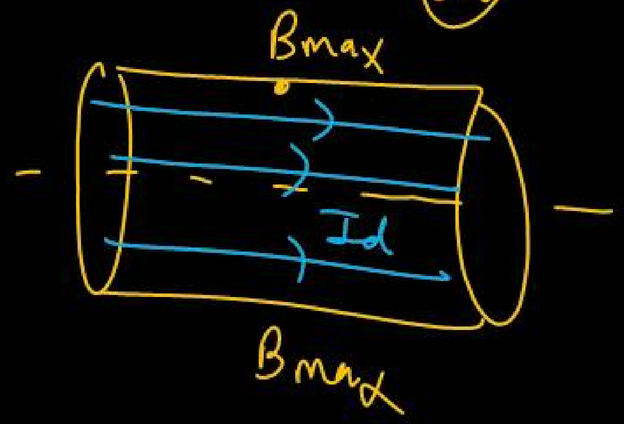
(4) non-zero everywhere with maximum at the imaginary cylindrical surface connecting peripheries of the plates.



$$\frac{d\sigma}{dt} = K$$

$$I_d = \varepsilon_0 \frac{d\phi}{dt} = \varepsilon_0 \frac{d}{dt}\left(\frac{\sigma}{\varepsilon_0} A\right)$$

$$I_d = A\frac{d\sigma}{dt} = AK$$



Question no. 25

10^{-6}

An electric dipole with dipole moment 5×10^{06} Cm is aligned with the direction of a uniform electric field of magnitude 4×10^5 N/C. The dipole is then rotated thorugh an angle of 60° 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

$U_i = -PE\cos 0 = -PE$

$U_f = -PE\cos 60^\circ = -\frac{PE}{2}$

$\text{Diff} = \frac{PE}{2} = \frac{5 \times 10^{-6} \times 4 \times 10^{5}}{2}$

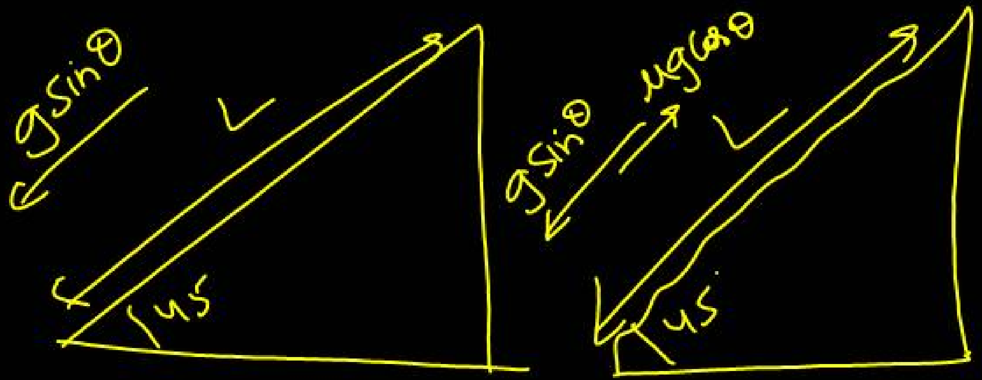
$= 10 \times 10^{-1} = 1\text{ J}$

Question no. 26

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) 0.75 (2) 0.25

(3) 0.40 (4) 0.5



$$L = \frac{1}{2} a_s t_s^2 = \frac{1}{2} a_r t_r^2$$

$$\left(\frac{t_r}{t_s}\right)^2 = \frac{a_s}{a_r}$$

$$(2)^2 = \frac{g/\sqrt{2}}{\frac{g}{\sqrt{2}} - \frac{\mu g}{\sqrt{2}}} = \frac{1}{1-\mu}$$

$$4 = \frac{1}{1-\mu}$$

$$1-\mu = \frac{1}{4}$$

$$\mu = 1 - \frac{1}{4} = 3/4$$

Question no. 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

$r_n = \frac{n^2}{Z} \times 0.052\,nm$

$\lambda = \frac{2\pi r_n}{n} = \frac{2\pi \times 2^2 \times 0.052\,nm}{2}$

$\lambda = 3.14 \times 4 \times 0.052\,nm$

(3)

Question no. 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

$I_I \omega_I = I_F \omega_F$

$\frac{1}{T_1} = \frac{4}{T_2}$

$T_2 = 4T_1$

$T_2 = 4 \times 27$

$T_2 = 108$

Question no. 29

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

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

The percentage erros of measurement in a, b, c and d are 1%, 3%, 2% and 4% respectively. The percentage erro in the quanity P is

(1) 15% (2) 10%

(3) 2% (4) 13% ✓

$$P = a^3 b^2 c^{-1} d^{-1/2}$$

$$\frac{\Delta P}{P} \times 100 = 3\frac{\Delta a}{a} + 2\frac{\Delta b}{b} + \frac{\Delta c}{c} + \frac{1}{2}\frac{\Delta d}{d}$$

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

$$= 3 + 6 + 2 + 2$$

$$= 13\%$$

Question no. 30

The plates of a parallel plate capacitor are separated by d. Two slabs of different dielectric constat K_1 and K_2 with thickness $\frac{3d}{8}$ 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

2

$$K_1 = \frac{125}{100} K_2 = \frac{5}{4} K_2$$

$$C_{new} = \frac{\varepsilon_0 A}{d - \left(\frac{3d}{8} + \frac{4d}{8}\right) + \frac{3d}{8K_1} + \frac{d}{2K_2}} = \frac{\varepsilon_0 A}{\frac{d}{8} + \frac{3d}{8K_1} + \frac{4d}{8K_2}}$$

$$C_{new} = \frac{Cd}{\frac{d}{8}\left(1 + \frac{3}{K_1} + \frac{4}{K_2}\right)}$$

$$2C = \frac{C d\, 8}{d\left(1 + \frac{3}{K_1} + \frac{4 \cdot 5}{4K_1}\right)}$$

$$2 = \frac{8}{1 + \frac{8}{K_1}}$$

$$2 + \frac{16}{K_1} = 8$$

$$\frac{16}{K_1} = 6$$

$$K_1 = \frac{16}{6} = \frac{8}{3}$$

$$= 2.66$$

Question no. 31

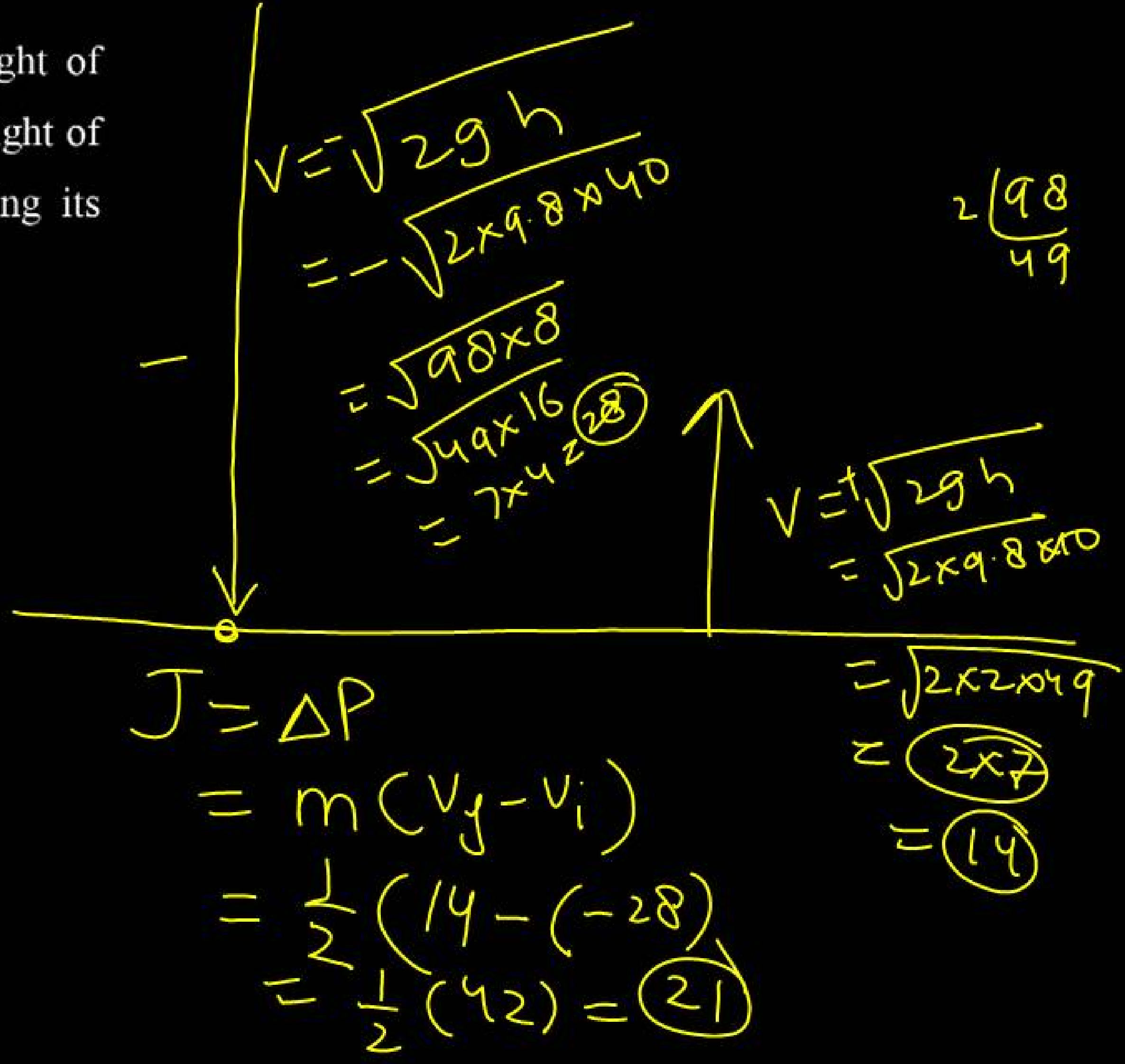
A ball of mass 0.5 kg is dropped form a height of 40 m. The ball hits the ground and rises to a height of 10 m. The impulse imparted to the ball during its collision with the ground is (Take $g = 9.8\ m/s^2$)

(1) 84 NS

(2) 21 NS

(3) 7 NS

(4) 0

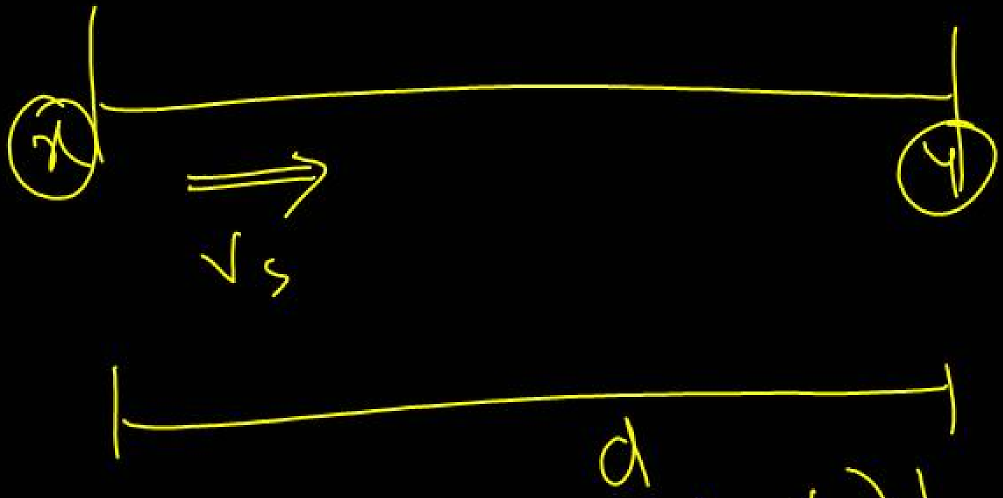


Question no. 32

Two cities X and Y 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 fo 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



$d = (v_B - v_s)\frac{1}{2} = (v_B + v_s)\frac{1}{6}$

$3v_B - 3v_s = v_B + v_s$

$2v_B = 3(60) + 60$

$2v_B = 240$

$v_B = 120$

$d = (120 - 60)\frac{1}{2} = 30\text{ km}$

$t = \frac{30}{120} = \frac{1}{4} = 15\text{ min}$

Question no. 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 11atmospheric pressure at temperature 27°C. The mass of the oxygen withdrawn from the cylinder is nearly equal to :

[Given, $R = \frac{100}{12}$ J mol^{-1} K^{-1}, and molecular mass of $O_2 = 32$, 1 atm pressure $= 1.01 \times 10^5$ N/m]

(1) 0.156 kg (2) 0.125 kg

(3) 0.144 kg (4) 0.116 kg

Question no. 34

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

(1) 10 volt (2) 5 volt

(3) 6 volt (4) 9 volt

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

$$V_A - 1 \times (+1) - 5 - 2 \times 2 = V_B$$

$$V_A - 1 - 5 - 4 = V_B$$

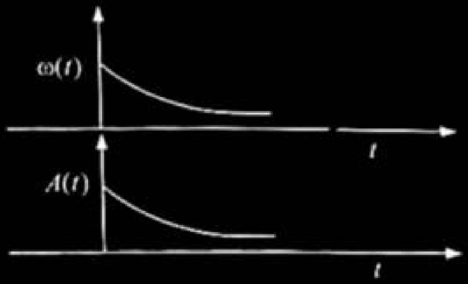
$$V_A - 10 = V_B$$

$$V_A - V_B = 10\,V$$

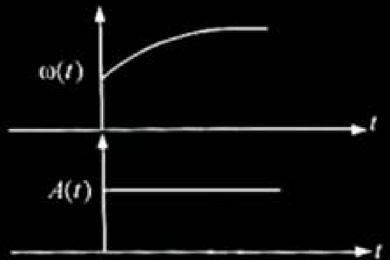
Question no. 35

In an oscillating spering mass system, a spring is connectd 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?

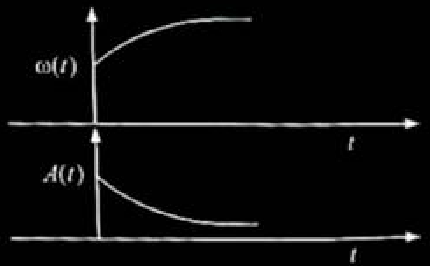
(1)



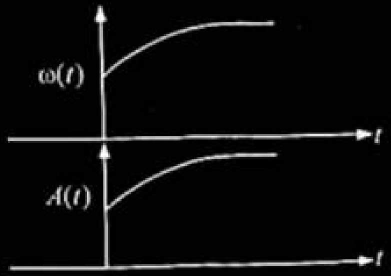
(2)



(3)



(4)



Question no. 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. Accroding to the model, the magnetic moment of an electron in its lowest energy state will be (m is the masses of the electron)

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

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

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

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

Question no. 37

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

(1) 36 N

(2) 16 N

(3) 27 N

(4) 32 N

$W = mg$

$h = R/3$

$g_h = \frac{GM}{(R+h)^2}$

$g_h = \frac{g}{\left(1+\frac{h}{R}\right)^2}$

$g_h = \frac{g}{\left(1+\frac{1}{3}\right)^2}$

$g_h = \frac{9g}{16}$

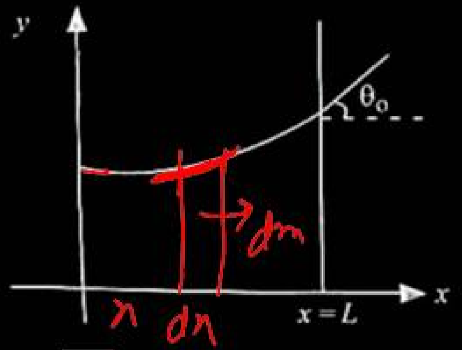
$W_2 = 48 \times \frac{9}{16}$

$W_2 = 27 N$

Question no. 38

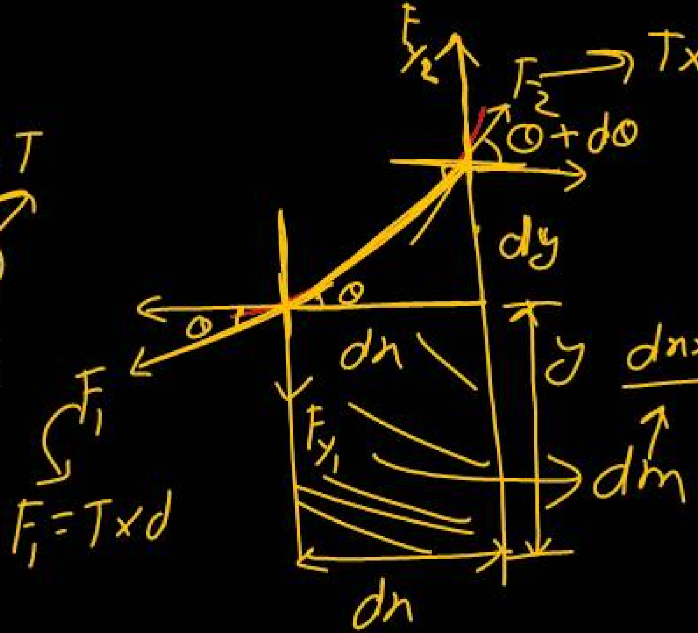
Consider a water tank shown in the figure. It has one wall at $x = L$ and can be taken to be very wide in the z direction. When filled with a liquid of surface thension S and density ρ, the liquid surface makes angle θ_0 ($\theta_0 << 1$) with the x-axis at $x = L$. If $y(x)$ is the height of the surface then the euation 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) $\frac{d^2y}{dx^2} = \sqrt{\frac{\rho g}{S}}$



$\tan\alpha = \frac{dy}{dn}$

$\sec^2\theta \frac{d\theta}{dn} = \frac{d^2y}{dn^2}$

$\frac{d\theta}{dn} = \frac{d^2y}{dn^2}$

$dn \times dx \times y \times \rho$

$T d \sin(\theta + d\theta) - T d \sin\theta = dm \times g$

$T \times d \times d\theta = dn \times [illegible] \times y \times \rho \times g$

$\frac{d\theta}{dn} = \frac{\rho g y}{T}$

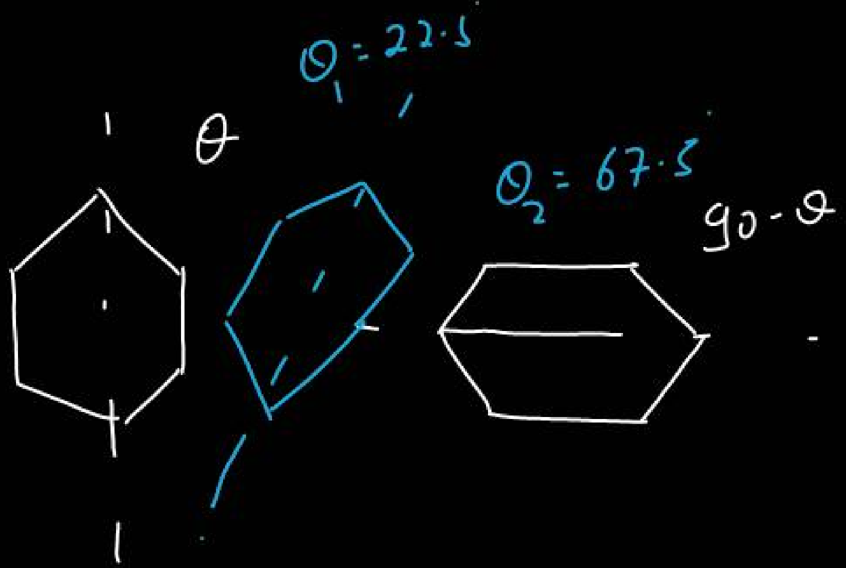
$\frac{d^2y}{dn^2} = \frac{\rho g y}{S}$

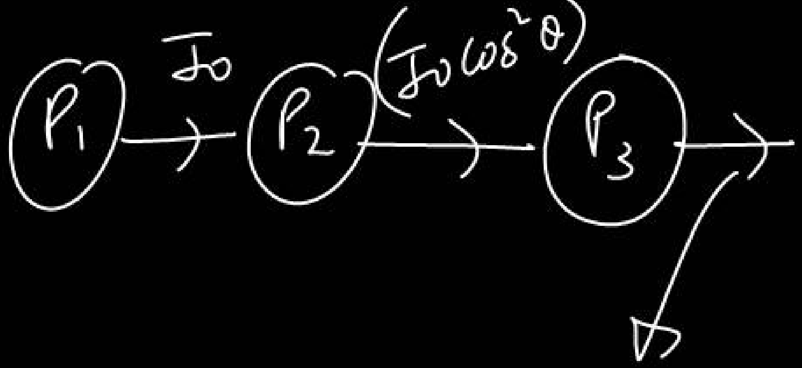
Question no. 39

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

(1) $\frac{I_0}{16}$ (2) $\frac{I_0}{2}$

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





$$I_{out} = I_0 \cos^2\theta \sin^2\theta$$

$$= I_0 \frac{4\cos^2\theta \sin^2\theta}{4}$$

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

$$I_{out} = (I_0 \cos^2\theta)\cos^2(90-\theta)$$

Question no. 40

A photon and an electron (mass m) have the same energy E. The ratio (λ_{photon} / $\lambda_{electron}$) 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) $c\sqrt{\frac{2m}{E}}$

$\lambda_p = \frac{hc}{E}$

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

$\frac{\lambda_p}{\lambda_e} = \frac{hc}{E} \times \frac{\sqrt{2mE}}{h}$

$= c\sqrt{\frac{2m}{E}}$

(4)

Question no. 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°.

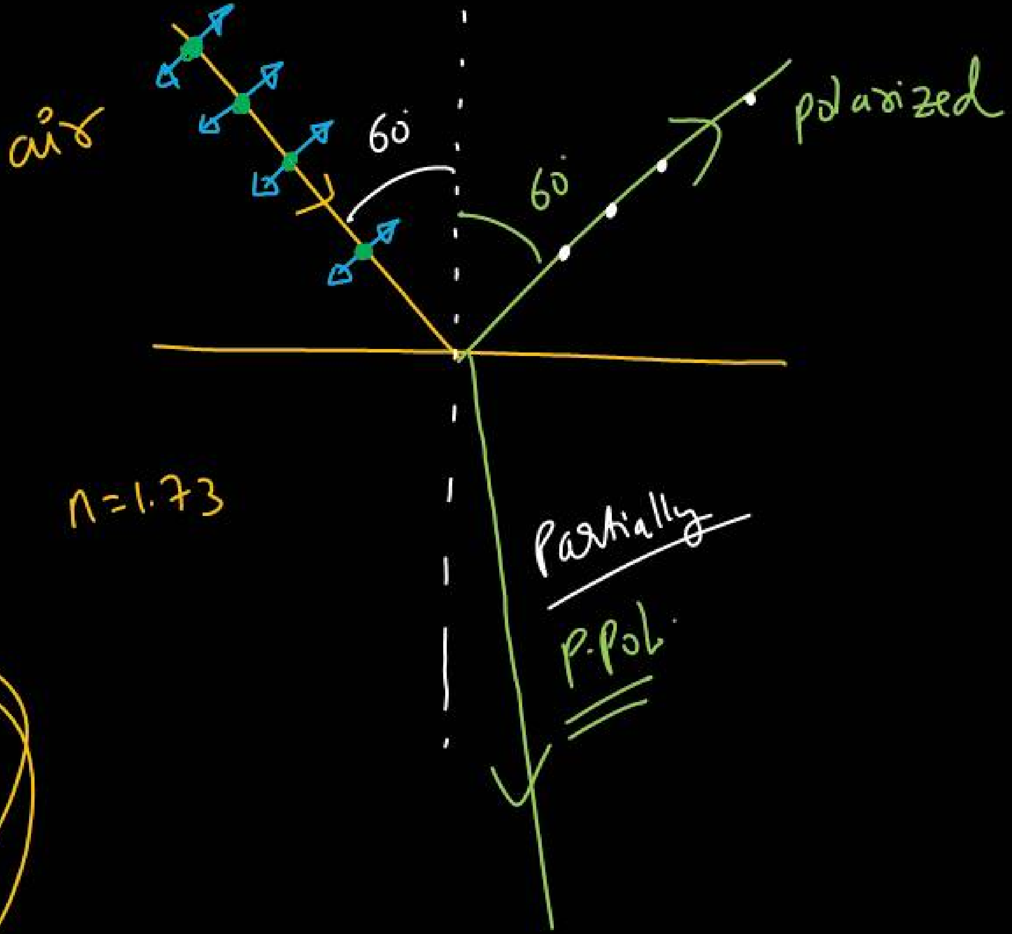
(2) reflected light is completely polarized and the angle of relfection is close to 60°.

(3) reflected light is partially polarized and the angle of reflection is close to 30°.

(4) both reflected and transmitted light are perfectly and refraction close to 60° and 30°, respectively.

$i = \tan^{-1}(\mu)$

$i = \tan^{-1}(\sqrt{3}) = 60°$

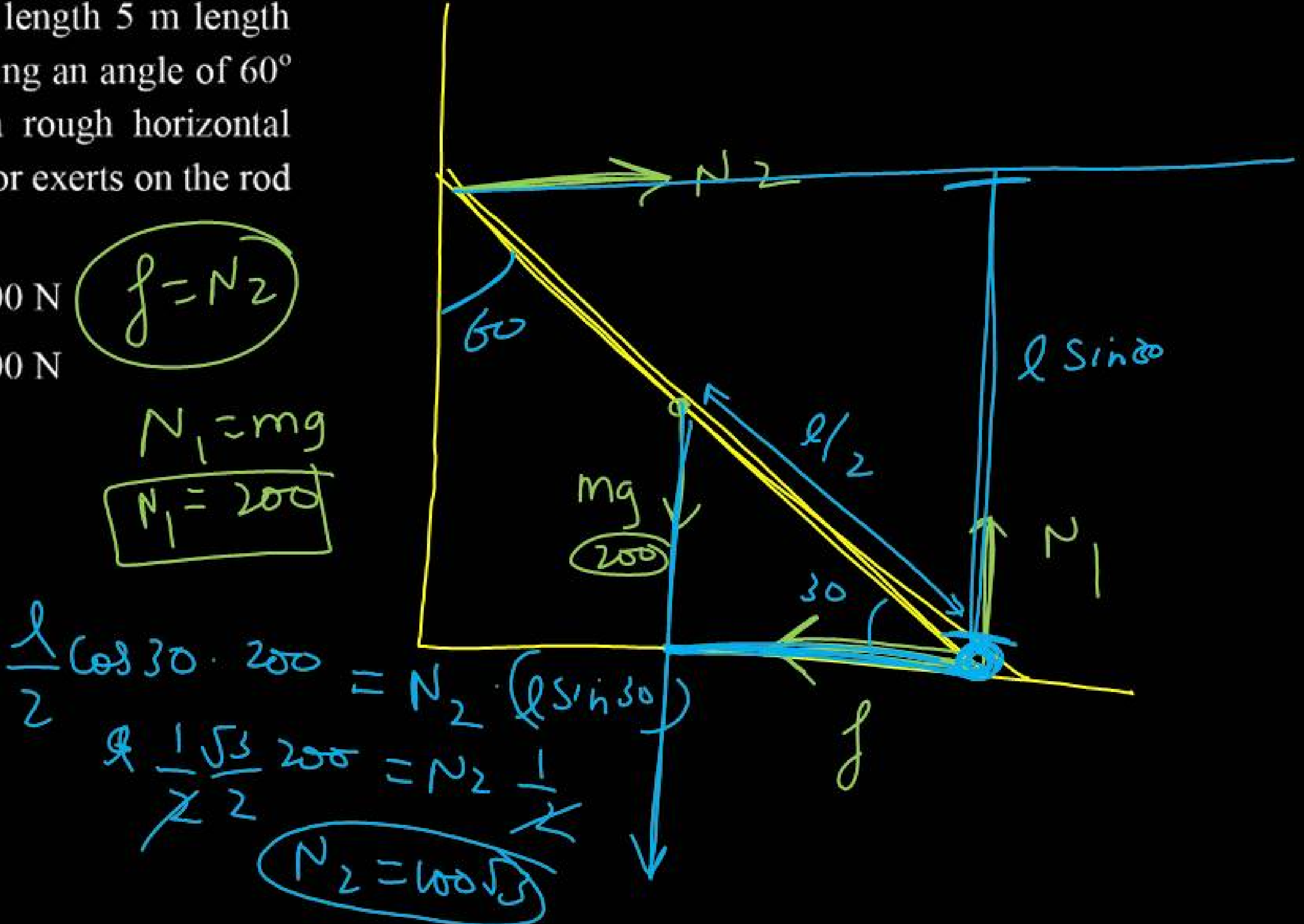


Question no. 42

A uniform rod of mass 20 kg and length 5 m length 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 $g = 10\ m/s^2$)

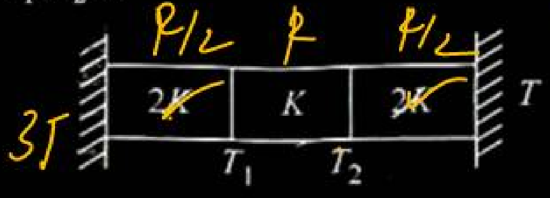
(1) $200\sqrt{3}$ N (2) 100 N

(3) $100\sqrt{3}$ N (4) 200 N



Question no. 43

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. 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) $\frac{5}{4}$ (2) $\frac{3}{2}$

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

$R = \frac{1}{KA}$

$I = \frac{\Delta T}{R_T}$

$I = \frac{2T}{2R}$

$I = \frac{T}{R}$

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

$\frac{T}{2} = 3T - T_1$

$T_1 = \frac{5T}{2}$

$\frac{T}{R} = \frac{(T_2 - T)2}{R}$

$\frac{T}{2} = T_2 - T$

$T_2 = \frac{3T}{2}$

$\frac{T_1}{T_2} = \frac{5}{3}$

Question no. 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 F_A/F_B is

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

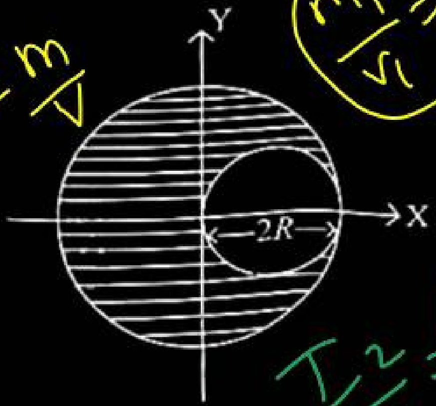
(2) $\frac{3}{2}$

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

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

Question no. 45

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 aobut the Y-axis is :



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

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

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

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