PHYSICS
JEE-MAIN (August-Attempt) 1 SEPTEMBER
(Shift-2) Paper

SECTION - A

Q.1 The temperature of an ideal gas in 3-dimension is 300k. The corresponding de-Broglie wavelength of the electron approximately at 300 K, is
[m_e = mass of electron = 9×10^{-31} kg
h = Planck constant = 6.6×10^{-34} Js
k_B = Boltzmann constant = 1.38×10^{-23} Jk^{-1}]
(1) 6.26 nm (2) 8.46 nm (3) 2.26 nm (4) 3.25 nm

Sol 1
De- Broglie wavelength

$$\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2mE}}$$

Where E is kinetic energy

$$E = \frac{3kT}{2} \text{ for gas}$$

$$\lambda = \frac{h}{\sqrt{3mKT}} = \frac{6.63 \times 10^{-34}}{\sqrt{3 \times 9 \times 10^{-31} \times 1.38 \times 10^{-23} \times 300}}$$

L =6.26×10^{-9} m = 6.26 nm

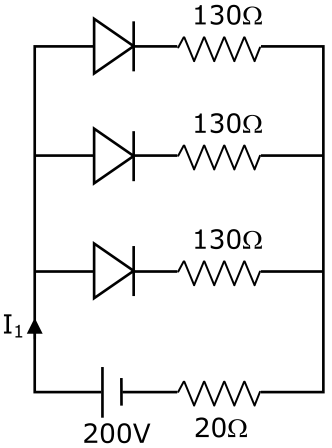
Q.2 A body of mass 'm' dropped from a height 'h' reaches the ground with a speed of $0.8\sqrt{gh}$ .The value of workdone by the air friction is .
(1) −0.68 mgh (2) 0.64 mgh (3) 1.64 mgh (4) mgh

Sol 1
Work done = Change in kinetic energy

$$W_{mg} + W_{ari\text{-}friction} = \frac{1}{2}m\left(.8\sqrt{gh}\right)^2 - \frac{1}{2}m(0)^2$$

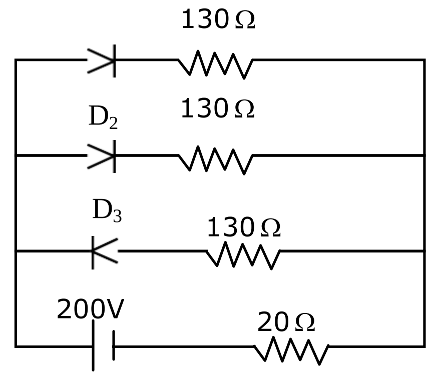
$$W_{air-friction} = \frac{.64}{2}mgh - mgh = -0.68mgh$$

Q.3 In the given figure, each diode has a forward bias resistance of $30\,\Omega$ and infinite resistance in reverse bias. The current I_1 will be

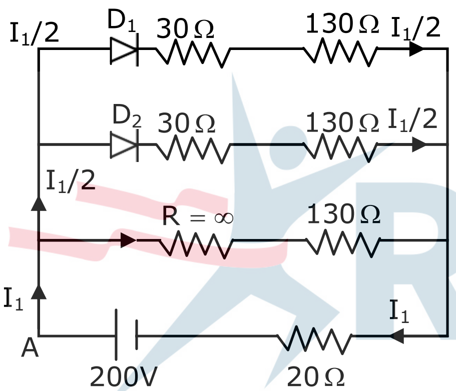


(1) 3.75 A (2) 2 A (3) 2.73 A (4) 2.35 A

Sol 2



As per diagram
Diode D_1& D_2 are in forward bias i.e R = 30Ω
Whereas diode D_3 is in reverse bias i.e. R = infinite
⇒ Equivalent cirucit will be
Applying KVL starting from point A



$$-\left(\frac{I_1}{2}\right)\times 30-\left(\frac{I_1}{2}\right)\times 130-I_1\times 20+200=0$$

$$\Rightarrow -100I_1+200=0$$

$$I_1=2$$

Q. 4 A student determined Young's Modulus of elasticity using the formula $Y=\frac{MgL^3}{4bd^3\delta}$. The value of g is taken to be 9.8 m/s^2, without any significant error, his observation are as following.

Physical Quantity	**Least count of Equipment Used for measurement**	**Observed Value**
Mass (M)	1g	2kg
Length of bar (L)	1mm	1m
Breadth of bar (b)	0.1 mm	4 cm
Thickness of bar (d)	0.01 mm	0.4 cm
Depression (δ)	0.01 mm	5 mm

Then the fractional error in the measurement of Y is :

(1) 0.155 (2) 0.083 (3) 0.0155 (4) 0.0083

Sol 3

Given $y = \dfrac{mgL^3}{4bd^3\rho}$, (No error in g)

The fractional error in measurement of y

$$= \frac{\Delta M}{M} + \frac{3\Delta L}{L} + \frac{\Delta b}{b} + 3\frac{\Delta d}{d} + \frac{\Delta \rho}{\rho}$$

$$\Rightarrow \frac{1\times10^{-3}}{2} + \frac{3\times1\times10^{-3}}{1} + \frac{0.1\times10^{-3}}{4\times10^{-2}} + \frac{3\times0.01\times10^{-3}}{0.4\times10^{-2}} + \frac{0.01\times10^{-3}}{5\times10^{-3}}$$

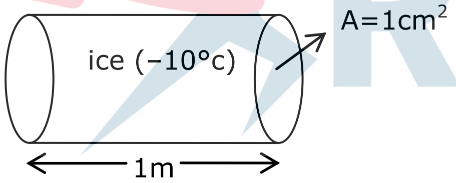
$$\Rightarrow 0.0005 + 0.003 + \left(\frac{0.25}{100}\right) + 0.0075 + 0.002$$

$\Rightarrow$ 0.0155

Q.5 Due to cold weather a 1 m water pipe of cross-sectional area 1 cm^2 is filled with ice at –10°C. Resistive heating is used to melt the ice. Current of 0.5 A is passed throuth 4 kΩ resistance. Assuming that all the heat produced is used for melting, what is the minimum time required ?
(Given latent heat of fusion for water/ice = 3.33 × 10^5 J $kg^{-1,}$
Specific heat of ice = 2× 10^3 j kg^{-1} and density of ice = 10^3 kg/ m^3)

(1) 3.53 s (2) 0.353 s (3) 70.6 s (4) 35.3 s

Sol 4



Heat required to melt ice

Q = msDT + mL

$$\Rightarrow \left(\frac{1}{10}\right)2\times10^3\times10 + \frac{1}{10}\times3.3\times10^5$$

$\Rightarrow$ 2000 + 3.3 × 10^4

$\Rightarrow$ 2000 + 33000

$\Rightarrow$ 3500 joole

H = i^2Rt = 35000 = $(0.5)^2$ × 4× 10^3 × t

$$t = \frac{35000}{4000\times0.5\times0.5} \Rightarrow \frac{3500}{100}$$

$\Rightarrow$ 35 sec

Q.6 The half life period of a radioactive element x is same as the mean life time of another radioactive element y. Initially they have the same number of atoms. Then :

(1) y- will dacay faster than x.
(2) x and y have same decay rate initially and later on different decay rate.
(3) x and y decay at the same rate always.
(4) x – will decay faster than y.

Sol (1)

$\left(t_{1/2}\right)_x = (\tau)_y$

$\Rightarrow \dfrac{\ell n2}{\lambda_x} = \dfrac{1}{\lambda_y} \Rightarrow \lambda_x = 0.693\lambda_y$

Also initially $N_x = N_y = N_0$

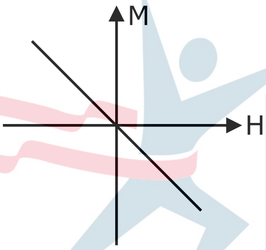
Activity $A = \lambda N$

As $\lambda_x < \lambda_y \Rightarrow A_x < A_y$

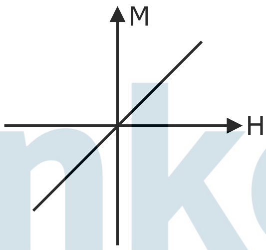
$\Rightarrow$ y will decay faster than x.

Q.7 Following plots show magnetization (M) vs Magnetising field (H) and magnetic susceptibility (X) vs temperature (T) graph :

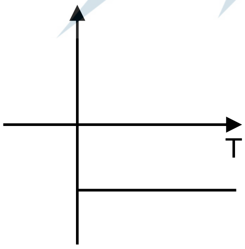
(a)



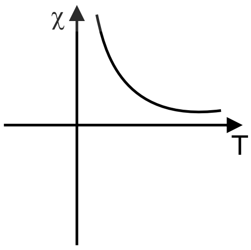
(b)



(c)



(d)



Which of the following combination will be represented by a diamagnectic material

(1) (a), (c) (2) (b), (d) (3) (a), (d) (4) (b), (c)

Sol **(1)**

Conceptual question

Q.8 Electric field of a plane electromagnetic wave propagating through a non-magnetic medium is given by E = 20cos (2 × 10^{10} t −200x) V/m. the dielectric constant of the medium is equal to : (take $\mu_r = 1$)

(1) 9 (2) 3 (3) $\frac{1}{3}$ (4) 2

Sol 1

Speed of wave = $\frac{2\times10^{10}}{200} = 10^8 m/s$

Refractive index = $\frac{3\times10^8}{10^8} = 3$

Now refractive index = $\sqrt{\varepsilon_r \mu_r}$

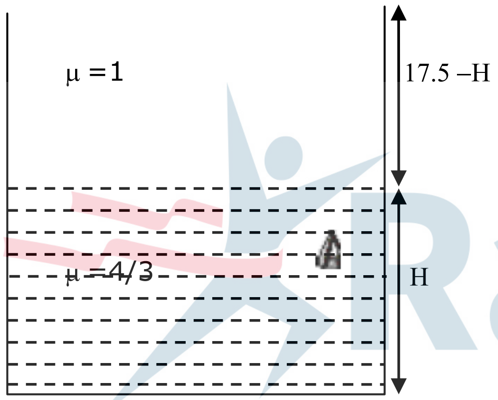
3 = $\sqrt{\varepsilon_r (1)}$

$\Rightarrow \varepsilon_r = 9$

Q.9 A glass tumbler having inner depth of 17.5 cm is kept on a table. A student starts pouring water (μ = 4/3) into it while looking at the surface of water from the above. When he feels that the tumbler is half filled, he stops pouring water. Up to what height, the tumbler is actuallly filled ?

(1) 11.7 cm (2) 7.5 cm (3) 8.75 cm (4) 10 cm

Sol 4



Height of water observed by observer

$= \frac{H}{\mu_w} = \frac{H}{(4/3)} = \frac{3H}{4}$

Height of air observed by obsrever = 17.5 – H

According to question, both height observed by observer is same

$\frac{3H}{4} = 17.5 - H$

$\Rightarrow$ H = 10 cm

Q.10 The ranges and height for two projectiles projected with same initial velocity at angles 42° and 48° with the horizontal are R_1, R_2 and H_1, H_2 respectively. Choose the correct option :

(1) $R_1 = R_2$ and $H_1 < H_2$

(2) $R_1 < R_2$ and $H_1 < H_2$

(3) $R_1 = R_2$ and $H_1 = H_2$

(4) $R_1 > R_2$ and $H_1 = H_2$

Sol 1

Range R = $\frac{u^2 \sin 2\theta}{g}$ and same for θ and $90 - \theta$

So same for 42° and 48°

Maximum height H = $\frac{u^2 \sin^2 \theta}{2g}$

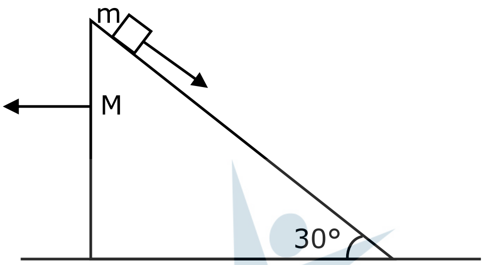
H is high for higher θ

So H for 48° is higher than H for 42°

Q.11 A block of mass m slide on the wooden wedge, which in turn slides backward on the horizontal surface. The acceleration of the block with respect to the wedge is :

Given m = 8 kg, M = 16 kg

Assume all the surface shown in the figure to be frictionless.

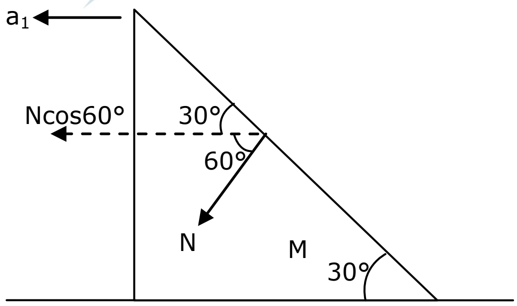


(1) $\frac{4}{3}g$ (2) $\frac{2}{3}g$ (3) $\frac{3}{5}g$ (4) $\frac{6}{5}g$

Sol. 2

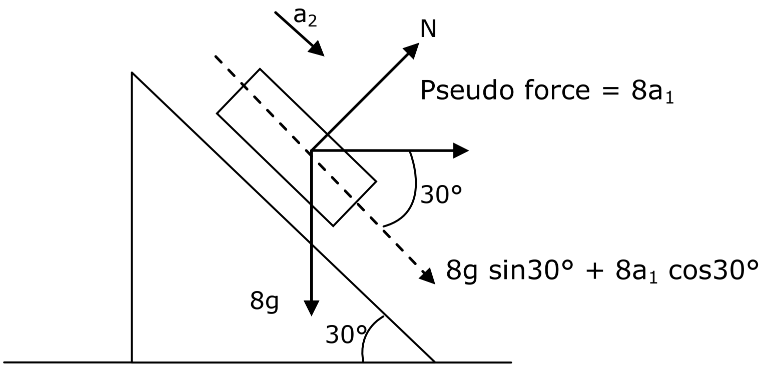
Let acceleration of wedge is a_1 and acceleration of block w.r.t. wedge is a_2

block w.r.t wedge is a_2



N cos 60° = Ma_1 = $16a_1$

F.B.D of block w.r.t wedge



⊥ to incline

$N = 8g \cos 30° - 8a_1 \sin 30° \Rightarrow 32a_1 = 4\sqrt{3g} - 4a_1$

$\Rightarrow a_1 = \frac{\sqrt{3}}{9} g$

Along incline

$8g\sin 30° + 8a_1\cos 30° = ma_2 = 8a_2$

$a_2 = g \times \frac{1}{2} + \frac{\sqrt{3}}{9} g.\frac{\sqrt{3}}{2} = \frac{2g}{3}$

Q.12 Two resistors $R_1 = (4 \pm 0.8)\ \Omega$ and $R_2 = (4 \pm 0.4)\ \Omega$ are connected in parallel. The equivalent resistance of their parallel combination will be :

(1) $(4 \pm 0.3)\ \Omega$ (2) $(2 \pm 0.4)\ \Omega$ (3) $(2 \pm 0.3)\ \Omega$ (4) $(4 \pm 0.4)\ \Omega$

Sol. **3**

$$\frac{1}{R_{eq.}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_{eq}} = \frac{1}{4} + \frac{1}{4} \Rightarrow R_{eq} = 2\Omega$$

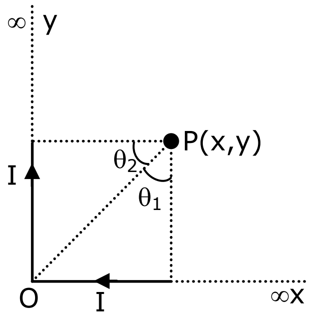
Also $\frac{\Delta R_{eq}}{R_{eq}^2} = \frac{\Delta R_1}{R_1^2} + \frac{\Delta R_2}{R_2^2}$

$$\frac{\Delta R_{eq.}}{4} = \frac{0.8}{16} + \frac{0.4}{16} = \frac{1.2}{16}$$

$\triangleq R_{eq} = 0.3\Omega$

$R_{eq} = (2 \pm 0.3)\Omega$

Q.13 There are two infinitely long staight current carryin conductors and they are held at right angles to each other so that their common ends meet at the origin as shown in the figure given below. The ratio of current in both conductors is 1 :1. The magnetic field at point P is ________.



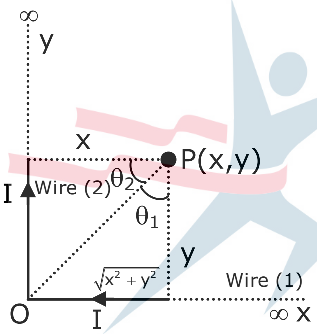
(1) $\frac{\mu_0 Ixy}{4\pi}\left[\sqrt{x^2+y^2}-(x+y)\right]$

(2) $\frac{\mu_0 I}{4\pi xy}\left[\sqrt{x^2+y^2}+(x+y)\right]$

(3) $\frac{\mu_0 I}{4\pi xy}\left[\sqrt{x^2+y^2}-(x+y)\right]$

(4) $\frac{\mu_0 Ixy}{4\pi}\left[\sqrt{x^2+y^2}+(x+y)\right]$

Sol 2



$$B_{\text{due to wire (1)}} = \frac{\mu_o I}{4\pi y}[\sin 90 + \sin \theta_1]$$

$$= \frac{\mu_0}{4\pi}\frac{I}{y}\left(1+\frac{x}{\sqrt{x^2+y^2}}\right) \quad .....(1)$$

$$B_{\text{due to wire (1)}} = \frac{\mu_o}{4\pi}\frac{I}{x}(\sin 90 + \sin \theta_2)$$

$$= \frac{\mu_0}{4\pi}\frac{I}{x}\left(1+\frac{y}{\sqrt{x^2+y^2}}\right) \quad .....(2)$$

Total magnetic field

$B = B_1 + B_2$

$$B = \frac{\mu_0 I}{4\pi}\left[\frac{1}{y}+\frac{x}{y\sqrt{x^2+y^2}}+\frac{1}{x}+\frac{y}{x\sqrt{x^2+y^2}}\right]$$

$$B = \frac{\mu_0 I}{4\pi}\left[\frac{x+y}{xy} + \frac{x^2+y^2}{xy\sqrt{x^2+y^2}}\right]$$

$$B = \frac{\mu_0 I}{4\pi}\left[\frac{x+y}{xy} + \frac{\sqrt{x^2+y^2}}{xy}\right]$$

$$B = \frac{\mu_0 I}{4\pi}\left[\sqrt{x^2+y^2} + (x+y)\right]$$

Q.14 A capacitor is connected to a 20 b batter through a resistance of 10 Ω. It is found that the potential difference across the capacitor rises to 2 V in 1 μs. the capacitance of the capacitor is _____μ F

Given $\ln\left(\frac{10}{9}\right) = 0.105$

(1) 0.105 (2) 1.85 (3) 9.52 (4) 0.95

Sol 4

$V = V_0(1-e^{-t/RC})$

$2 = 20(1-e^{-t/RC})$

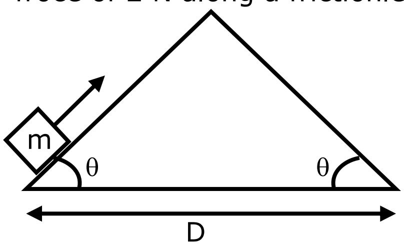
$\frac{1}{10} = 1 - e^{-t/RC}$

$e^{-t/RC} = \frac{9}{10}$

$\frac{t}{RC} = \ell n\left(\frac{10}{9}\right) \Rightarrow C = \frac{t}{R\ell n\left(\frac{10}{9}\right)}$

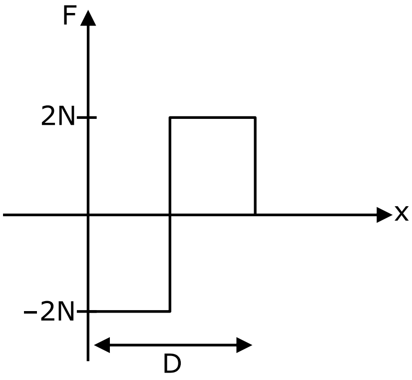
$C = \frac{10^{-6}}{10 \times .105} = .95\mu F$

Q.15 An object of mass 'm' is being moved with a constant velocity undr the action of an applied froce of 2 N along a frictionless surface with following surface profile.

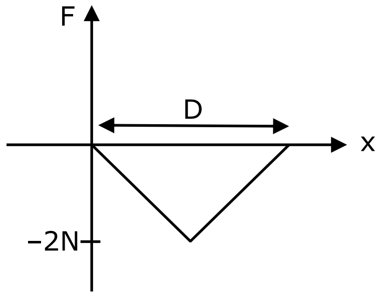


The correct applied force vs distance graph will be :

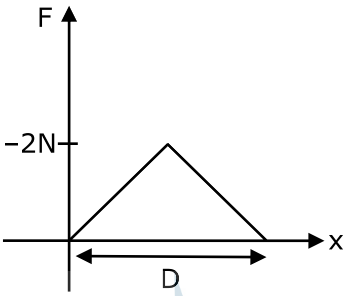
(1)



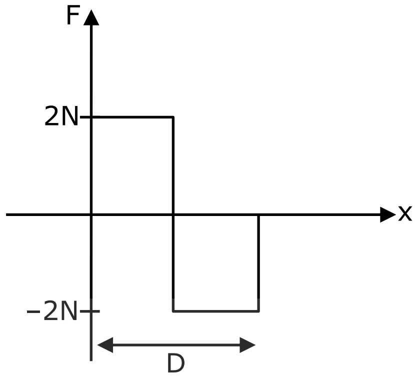
(2)



(3)

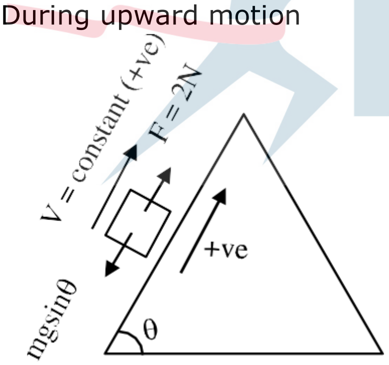


(4)



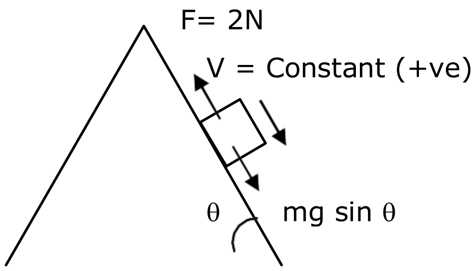
Sol. 4

During upward motion



F= 2 N = (+ve) constant

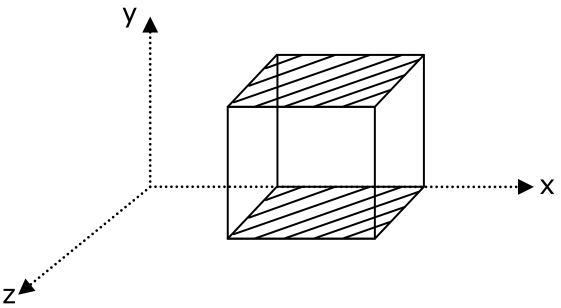
During downward motion



⇒ F= 2N = (-ve) constant

⇒ Best possible answer is option (2)

Q.16 A cube is placed inside an electric field, $\vec{E} = 150y^2\hat{j}$. The side of the cube is 0.5 m and is placed in the field as shown in the given figure. The charge inside the cube is :



(1) 3.8×10^{-12} C (2) 3.8×10^{-11} C (3) 8.3×10^{-12} C (4) 8.3×10^{-11}C

Sol 4

As electric field is in y-direction so electric flux is only due to top and bottom surface

Bottom surface y = 0

$\Rightarrow E = 0 \Rightarrow \phi = 0$

Top surface y = 0

$\Rightarrow E = 0 \Rightarrow \phi = 0$

Top surface y = 0.5 m

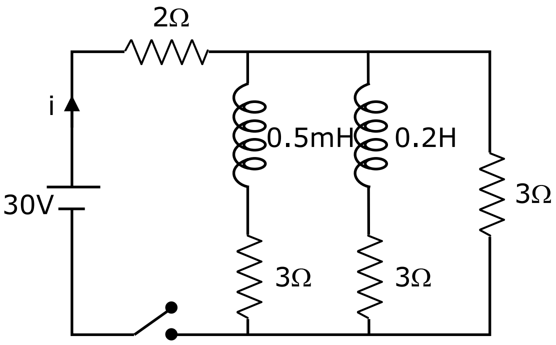
$\Rightarrow E = 150(5)^2 = \frac{150}{4}$

Now flux $\phi = EA = \frac{150}{4}(.5)^2 = \frac{150}{16}$

By Gauss's law $\phi = \frac{Q_{in}}{\epsilon_0}$

$Q_{in} = \frac{150}{16} \times 8.85 \times 10^{-12} = 8.3 \times 10^{-11}C$

Q.17 For the given circuit the current I throuht the battery when the key in closed and the steady state has been reached is _______.

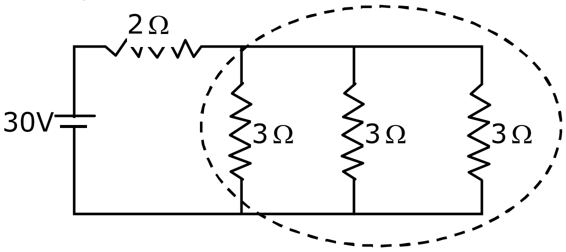


(1) 0 A (2) 6 A (3) 10 A (4) 25 A

Sol. **3**

In steady state, inductor behaves as a conducting wire.

So, equivalent circuit becomes

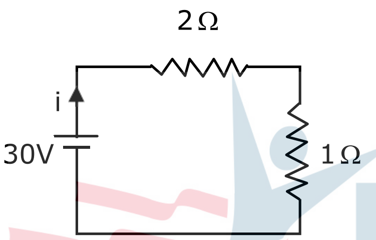


Parallel ($R_{eq.}$)

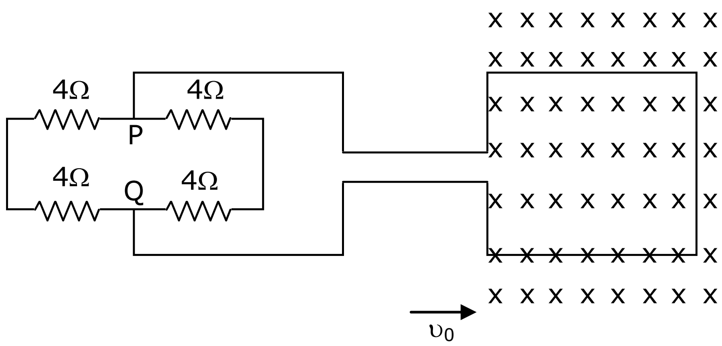
$$\frac{1}{R_{eq}} = \frac{1}{3} + \frac{1}{3} + \frac{1}{3} = 1$$

$$\Rightarrow R_{eq.} = 1\Omega$$

$\Rightarrow$ Circuit becomes



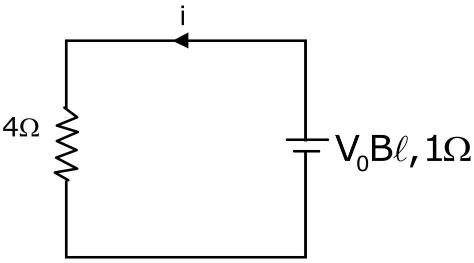
Q.18 A Square loop of side 20 cm and resistance 1 Ω is moved toward right with a constant speed υ_0. The right arm of the loop is in a uniform magnietic field of 5T. the field is perpendicular to the plane of the plane of the loop and is going into it. The loop is connected to a network of resistors each of value 4 Ω. What should be the value of υ_0 so that a steady current of 2 mA flows in the loop ?



(1) 10^2 m/s (2) 1 cm/s (3) 1 m/s (4) 10^{-2} cm/s

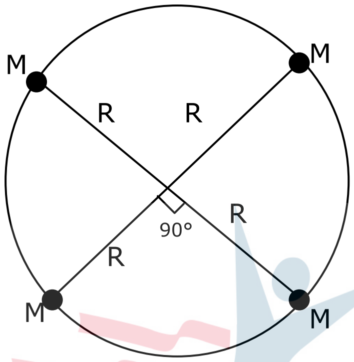
Sol 2

Equivalent circuit



$i = \frac{V_0 B\ell}{4+1} \Rightarrow V_0 \frac{5(2mA)}{5\times .2} = 10^{-2} m/s = 1cm/s$

Q.19 Four particles each of mass M, move along a circle of radius R under the action of their mutual gravitational atraction as shown in figure. The speed of each particle is :



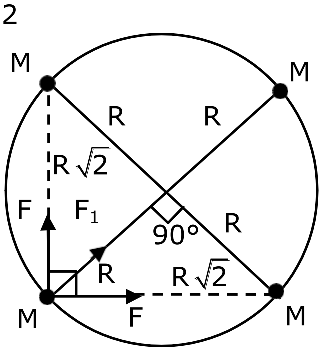
(1) $\frac{1}{2}\sqrt{\frac{GM}{R}\left(2\sqrt{2}-1\right)}$

(2) (2) $\frac{1}{2}\sqrt{\frac{GM}{R}\left(2\sqrt{2}+1\right)}$

(3) $\sqrt{\frac{GM}{R}}$

(4) $\frac{1}{2}\sqrt{\frac{GM}{R\left(2\sqrt{2}+1\right)}}$

Sol 2



$F_{net} = \frac{MV^2}{R}$

$$\sqrt{2}F + F_1 = \frac{MV^2}{R}$$

$$\sqrt{2}\frac{GMM}{\left(\sqrt{2}R\right)^2} + \frac{GMM}{(2R)^2} = \frac{MV^2}{R}$$

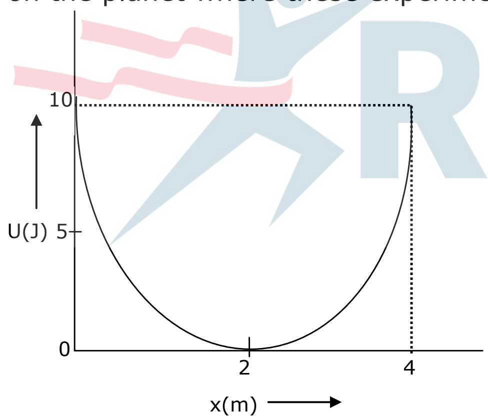
$$\frac{GM}{R}\left(\frac{1}{\sqrt{2}} + \frac{1}{4}\right) = V^2$$

$$\frac{GM}{R}\left(\frac{4+\sqrt{2}}{4\sqrt{2}}\right) = V^2$$

$$V = \sqrt{\frac{GM\left(4+\sqrt{2}\right)}{R4\sqrt{2}}}$$

$$V = \frac{1}{2}\sqrt{\frac{GM\left(2\sqrt{2}+1\right)}{R}}$$

Q.20 A mass of 5 kg connected to a spring. The potential energy curve of the simple harmonic motion executed by the system is shown in the figure. A simple pendulum of length 4 m has the same period of oscillation as the spring system. What is the value of acceleration due to gravity on the planet where these experiments as performed ?



(1) 5 m/s^2 (2) 4 m/s^2 (3) 9.8 m/s^2 (4) 10 m/s^2

Sol 2

From potential energy curve

$$U_{max} = \frac{1}{2}kA^2 \Rightarrow 10 = \frac{1}{2}k(2)^2$$

$$\Rightarrow k = 5$$

Now $T_{spring} = T_{pendulum}$

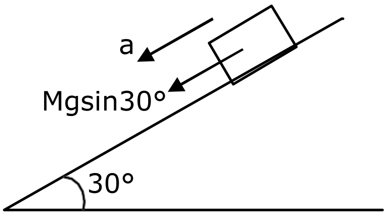
$$2\pi\sqrt{\frac{5}{5}} = 2\pi\sqrt{\frac{4}{g}}$$

$$\Rightarrow 1 = \sqrt{\frac{4}{g}} \Rightarrow g = 4 \text{ on planet}$$

Section B

Q.1 When a body slides down from rest along a smooth inclined plane making an angle of 30° with the horizontal, it takes time T. When the same body slides down form the rest along a rough inclined plane making the same angle and through the same distance, it takes time αT, where α is a constant greater than 1 the co-efficient of friction between the body and the rough plane is $\frac{1}{\sqrt{x}}\left(\frac{\alpha^2-1}{\alpha^2}\right)$ where x = ________.

Sol 3

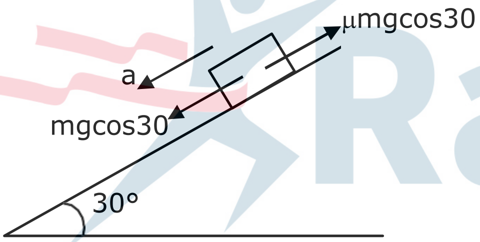


On smooth incline

A = g sin30°

By $S = ut + \frac{1}{2}at^2$

$$S = \frac{1}{2}\frac{g}{2}T^2 = \frac{g}{4}T^2 \text{ ....(i)}$$



On rough incline

A= g sing30° – μg cos30°

By $S = ut + \frac{1}{2}at^2$

$$S = \frac{1}{4}g\left(1-\sqrt{3}\mu\right)(\alpha T)^2 \text{ .....(ii)}$$

By (i) and (ii)

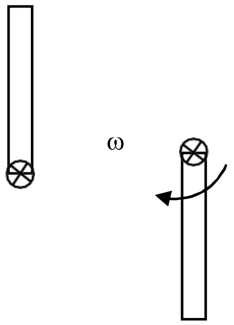
$$\frac{1}{4}gT^2 = \frac{1}{4}g\left(1-\sqrt{3}\mu\right)\alpha^2T^2$$

$$\Rightarrow 1-\sqrt{3}g = \frac{1}{\alpha^2} \Rightarrow g = \left(\frac{\alpha^2-1}{\alpha^2}\right).\frac{1}{\sqrt{3}} \Rightarrow x = 3.00$$

Q.2 A 2 kg steel rod of length 0.6 m is clamped on a table vertically at its lower end and is free to rotate in vertical plane. The upper end is pushed so that the rod falls under gravity. Ignoring the friction due to clamping at its lower end, the speed of the free end of rod when it passes through its lowest position is ___________ms^{-1}.

(Take $g = 10\ ms^{-2}$)

Sol 6



By energy conservation $mg\ell = \frac{1}{2}I\omega^2 = \frac{1}{2}\frac{m\ell\omega^2}{3}$

$\Rightarrow \omega = \sqrt{\frac{6g}{\ell}}$

Speed $v = \underline{\omega}r = \omega\ell = \sqrt{6g\ell}$

$v = \sqrt{6 \times 10 \times .6} = 6m/s$

Q.3 A steel rod with y = 2.0 × 10^{11} Nm^{-2} and a = 10^{-5} °C^{-1} of length 4m and area of cross section 10cm^2 is heated from 0°C to 400°C without being allowed to extend. The tension produced in the rod is x × 10^5N where the value of x is __________.

Sol 8

Thermal force $F = Ay \propto \Delta T$

F= (10 × 10^{-4})(2×10^{11})(10^{-5})(400)

F = 8 × 10^5N

$\Rightarrow$ x= 8

Q.4 An engine is attached to a wagon through a shock absorber of length 1.5 m. The system with a total mass of 40,000 kg is moving with a speed of 72 kmh^{-1} when the brakes are applied to bring it to rest. In the process of the system being brought to rest, the spring of the shock absorber gets compressed by 1.0m. If 90% of energy of the wagon is lost due to friction, the spring constant______× 10^5 N/m.

Sol 16

Work = ΔK.E.

$W_{friction} + W_{spring} = 0 - \frac{1}{2}mv^2$

$-\frac{90}{100}\left(\frac{1}{2}mv^2\right) + W_{spring} = -\frac{1}{2}mv^2$

$W_{spring} = -\frac{10}{100} \times \frac{1}{2}mv^2$

$-\frac{1}{2}kx^2 = -\frac{1}{20}mv^2$

$\Rightarrow k = \frac{40000 \times (20)^2}{10 \times (1)^2} = 16 \times 10^5$

Q.5 The temperature of 3.00 mol of an ideal diatomic gas is increased by 40.0°C without changing the pressure of the gas. The molecules in the gas rotate but do not oscillate. If the ratio of change in initernal energy of the gas to the amount of workdone by the gas is $\frac{x}{10}$. Then the value of x (round off to the nearest integer) is________.
(Given R = 8.31 J mol^{-1} K^{-1})

Sol 25

Pressure is not changeing $\Rightarrow$ isobaric process

$\Rightarrow \Delta U = nC_V\Delta T = \frac{5nR\Delta T}{2}$

and W = $nR\Delta T$

$\frac{\Delta U}{W} = \frac{5}{2} = \frac{x}{10} \Rightarrow x = 25.00$

Q.6 The average translational kinetic energy of N_2 gas molecules at ____°C becomes equal to the K.E. of an electron accelerated from rest through a potential difference of 0.1 volt. (Given k_B = 1.38 × 10^{-23} J/K) (fill the nearest integer).

Sol 500

Given

Translation K.E. of N_2 = K.E. of electron

$\frac{3}{2}kT = eV$

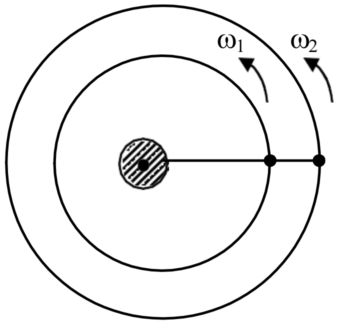
$\frac{3}{2} \times 1.38 \times 10^{-23} T = 1.6 \times 10^{-19} \times 0.1$

$\Rightarrow T = 773k$

T = 773 – 273 = 500°C

Q.7 Two satellite revolve around a planed in coplanar circular orbits in anticlockwise direction. Their period of revolutions are 1 hour and 8 hour respectively. The radius of the orbit of nearer satellite is 2 × 10^3 km. The angular speed of the farther satellite as observed from the nearer satellite at the instant when both the satellites are closest is $\frac{\pi}{x}$ rad h^{-1} where x is ________.

Sol 3



T_1 = 1 hour

$\Rightarrow \omega_1 = 2\pi$ rad / hour

$T_2 = 8$ hours

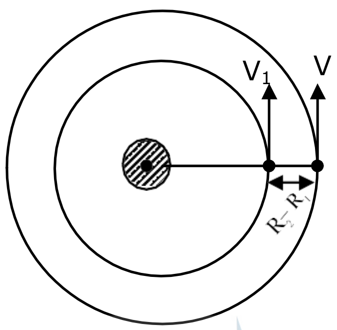
$\Rightarrow \omega_2 = \frac{\pi}{4}\text{rad / hour}$

$R_1 = 2 \times 10^3 \text{km}$

As $T^2 \propto R^3$

$\Rightarrow \left(\frac{R_2}{R_1}\right)^3 = \left(\frac{T_2}{T_1}\right)^2$

$\Rightarrow \frac{R_2}{R_1} = \left(\frac{8}{1}\right)^{2/3} = 4 \Rightarrow R_2 = 8 \times 10^3 \text{km}$



$V_2 = \omega_2 R_2 = 2\pi \times 10^3 \text{km / h}$

Relative $\omega = \frac{V_1 - V_2}{R_2 - R_1} = \frac{2\pi \times 10^3}{6 \times 10^3}$

$= \frac{\pi}{3}\text{rad / hour}$

x = 3.

Q.8 The width of one of the two slits in a Young's double slit experiment is three times the other slit. If the amplitude of the light coming from a slit is propotional to the slit-width, the ratio of minimum to maximum intensity in the interference patternis x:4 where x is ______.

Sol 1

Given amplitude $\propto (\text{Amplitude})^2 \propto (\text{Slit width})^2$

$\frac{I_1}{I_2} = \left(\frac{3}{1}\right)^2 = 9 \Rightarrow I_1 = 9I_2$

$\frac{I_{min}}{I_{max}} = \left(\frac{\sqrt{I_1} - \sqrt{I_2}}{\sqrt{I_1} + \sqrt{I_2}}\right)^2 = \left(\frac{3-1}{3+1}\right)^2 = \frac{1}{4} = \frac{x}{4}$

$\Rightarrow x = 1.00$

Q.9 A carrier wave with amplitude of 250 V is amplitude modulated by a sinusoidal base band signal of amplitude 150 V. the ratio of minimum amplitude to maximum amplitude for the amplitude modulated wave is 50 : x, then value of x is ___________.

Sol 200

$A_{max} = A_C + A_m = 250 + 150 = 400$

$A_{min} = A_C - A_m = 250 - 150 = 100$

$\frac{A_{min}}{A_{max}} = \frac{100}{400} = \frac{1}{4} = \frac{50}{200}$

x = 200

Q.10 A uniform heating wire of resistance 36 Ω is connected across a potential difference of 240 V. The wire is then cut into half and a potential difference of 240 V is applied across each half separately. The ratio of power dissipation in first case to the total power dissipation in the second case would be 1 : x, where x is ________.

Sol 4

First case $P_1 = \frac{V^2}{R} = \frac{(240)^2}{36}$

Second case Resistance of each half $= 18\Omega$

$P_2 = \frac{(240)^2}{18} + \frac{(240)^2}{18} = \frac{(240)^2}{9}$

$\frac{P_1}{P_2} = \frac{1}{4}$

x = 4.00