# FINAL JEE–MAIN EXAMINATION – APRIL, 2023
Held On Monday 10th April, 2023
TIME : 03:00 PM to 06:00 PM

## SECTION - A

**31.** Given below are two statements:

**Statement I :** Rotation of the earth shows effect on the value of acceleration due to gravity (g)

**Statement II :** The effect of rotation of the earth on the value of 'g' at the equator is minimum and that at the pole is maximum.

In the light of the above statements, choose the correct answer from the options given below.

(1) Both Statement I and Statement II are true
(2) Both Statement I and Statement II are false
(3) Statement I is false but statement II is true
(4) Statement I is true but statement II is false

**Sol.** **(4)**

Due to rotation of earth, $g_{eff} = g - \omega^2 R \cos^2 \theta$

Where 'θ' is angle made with equator

Also, At poles, $\theta = 90°$

$\Delta g = \omega^2 R \cos^2\theta$

$= \omega^2 R \cos^2 90 = 0$

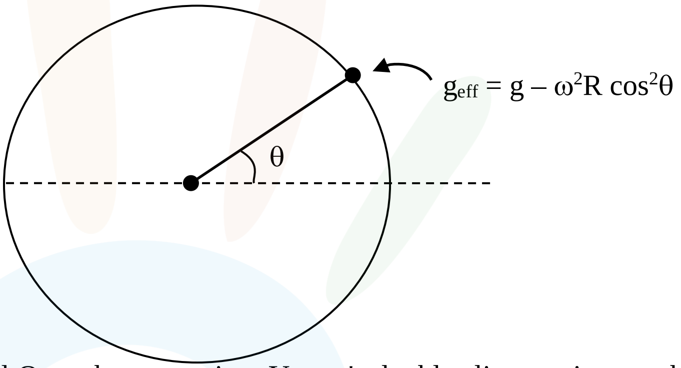
[no effect on poles]

$g_{eff} = g - \omega^2 R \cos^2\theta$

for equator $\theta = 0°$

So, $g_{eff} = g - w^2 R$

& $\Delta g = \omega^2 R$ (Which is maximum change)




**32.** The ratio of intensities at two points P and Q on the screen in a Young's double slit experiment where phase difference between two waves of same amplitude are π/3 and π/2, respectively are

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

**Sol.** **(1)**

$I_{res} = 4I_o \cos^2\left(\frac{\theta}{2}\right)$

If $\theta = \frac{\pi}{3}$, $I_{res} = 4I_o \cdot \cos^2\left[\frac{\pi}{6}\right]$

$= 4I_o \cdot \left(\frac{\sqrt{3}}{2}\right)^2$

$I_1 = (4I_o)\left(\frac{3}{4}\right) = 3I_o$

If $\theta = \frac{\pi}{2}$, $I_{res} = 4I_o \cdot \cos^2\left(\frac{\pi}{2}\right)$

$= 4I_o \left(\frac{1}{\sqrt{2}}\right)^2$

$= (4I_o)\left(\frac{1}{2}\right)$

$I_2 = 2I_o$

$\frac{I_1}{I_2} = \frac{3}{2}$

**33.** The time period of a satellite, revolving above earth's surface at a height equal to R will be
(Given g = $\pi^2$ m/s$^2$, R = radius of earth)

(1) $\sqrt{32R}$ (2) $\sqrt{4R}$ (3) $\sqrt{2R}$ (4) $\sqrt{8R}$

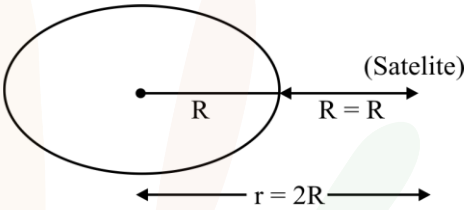
**Sol.** **(1)**

$$T^2 = \frac{4\pi^2 r^3}{GM}$$

$$T^2 = \frac{4\pi^2 (2R)^3}{GM}$$

$$= 4\times 8\times \frac{\pi 2\times R^3}{GM}$$

$$= 4\times 8\times \frac{(g)(R^3)}{GR^2}$$




At surface of earth $\Rightarrow$ $g = \frac{GM}{R^2}$

So, GM = g. $R^2$

Also $\pi^2 = g$

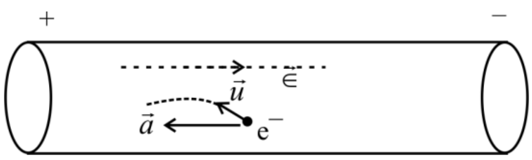
$T^2 = 32R$

$\Rightarrow$ $T = \sqrt{32R}$

**34.** In a metallic conductor, under the effect of applied electric field, the free electrons of the conductor
(1) Move with the uniform velocity throughout from lower potential to higher potential
(2) Move in the curved paths from lower potential to higher potential
(3) Move in the straight line paths in the same direction
(4) Drift from higher potential to lower potential.

**Sol.** **(2)**

Electrons moves in curved path because there velocity $\vec{u}$ may make any angle $\theta$ with acceleration $\vec{a}$ between time interval of two successive collisions.




Also electron moves from lower potential to higher potential.

**35.** A message signal of frequency 3kHz is used to modulate a carrier signal of frequency 1.5 MHz. The bandwidth of the amplitude modulated wave is

(1) 6 kHz (2) 3 kHz (3) 6 MHz (4) 3 MHz

**Sol.** **(1)**

Bond width of Amplitude modulated signal (AM) = $2 \times f_{(\text{message signal})}$

$= 2 \times 3$ KHz

$= 6$ KHz

**36.** In an experiment with vernier calipers of least count 0.1 mm, when two jaws are joined together the zero of vernier scale lies right to the zero of the main scale and $6^{th}$ division of vernier scale coincides with the main scale division. While measuring the diameter of a spherical bob, the zero of vernier scale lies in between 3.2 cm and 3.3 cm marks, and $4^{th}$ division of vernier scale coincides with the main scale division. The diameter of bob is measured as

(1) 3.25 cm (2) 3.22 cm (3) 3.18 cm (4) 3.26 cm

**Sol.** **(3)**

The zero error in verniel scale is = 6 × 0.1mm = 0.6 mm (+ve zero error)

Note: +ve zero error will have to be subtracted

From the reading of the object.

Now, the diameter measured with the help of Vernier scale is

Given by → M.S.D + V.S.D × L.S

$\Rightarrow 3.2 \text{ cm} + 0.1 \text{ mm} \times 4$

$= 3.24 \text{ cm}$

The actual diameter is ⇒ 3.24 mm – (zero error) = 3.24 – 0.6 = 3.18 cm

**37.** Two projectiles are projected at 30° and 60° with the horizontal the same speed. The ratio of the maximum height attained by the two projectiles respectively is:

(1) $2 : \sqrt{3}$ (2) $1 : \sqrt{3}$ (3) $\sqrt{3} : 1$ (4) 1 : 3

**Sol.** **(4)**

In projectile motion, $H_{many} = \dfrac{u^2 \sin^2\theta}{2g}$

at θ = 30°, $H_1 = \dfrac{u^2 \sin^2 30°}{2g}$

at θ = 60°, $H_2 = \dfrac{u^2 \sin^2 60°}{2g}$

$$\frac{H_1}{H_2} = \frac{\sin^2 30°}{\sin^2 60°} = \frac{\left(\frac{1}{2}\right)}{\left(\frac{\sqrt{3}}{2}\right)^2} = \frac{1}{3}$$

**38.** Given below are two statements : one is labelled as **Assertion A** and then other is labelled as **Reason R**

**Assertion A :** An electric fan continues to rotate for some time after the current is switched off.

**Reason R :** Fan continues to rotate due to inertia of motion.

In the light of above statements, choose the **most appropriate** answer from the options given below.

(1) A is not correct but **R** is correct

(2) Both **A** and **R** are correct and **R** is the correct explanation of **A**

(3) Both **A** and **R** are correct but **R** is **NOT** the correct explanation of **A**

(4) A is correct but **R** is not correct

**Sol.** **(2)**

Inertia is the property of mass due to which the object continues to move until any external force do not stops it. In the case of rotation of fan, if we switch off then also it moves for some time as air resistance takes time to stop it and due to inertia of fan it moves for some time.

**39.** The distance between two plates of a capacitor is d and its capacitance is $C_1$, when air is the medium between the plates. If a metal sheet of thickness $\frac{2d}{3}$ and of the same area as plate is introduced between the plates, the capacitance of the capacitor becomes $C_2$. The ratio $\frac{C_2}{C_1}$ is

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

**Sol.** **(2)**


$t = \frac{2d}{3}$

$K = \infty$ for metals

$C_1 = \frac{\varepsilon_0 A}{d}$

$C_2 = \frac{\varepsilon_0 A}{d - t + \frac{t}{k}} = \frac{\varepsilon_0 A}{d - \frac{2d}{3} + 0} = \frac{3\varepsilon_0 A}{d}$

$= \frac{C_2}{C_1} = \frac{\frac{3\varepsilon_0 A}{d}}{\frac{\varepsilon_0 A}{d}} = \frac{3}{1}$

**40.** The amplitude of magnetic field in an electromagnetic wave propagating along y-axis is $6.0 \times 10^{-7}$ T. The maximum value of electric field in the electromagnetic wave is

(1) $2 \times 10^{15}$ Vm$^{-1}$ (2) $2 \times 10^{14}$ Vm$^{-1}$ (3) $6.0 \times 10^{-7}$ Vm$^{-1}$ (4) 180 Vm$^{-1}$

**Sol.** **(4)**

In electromagnetic wave, $E_0 = B_0 C$

$E_0 = 6 \times 10^{-7} \times 3 \times 10^8$

$= 18 \times 10^1$

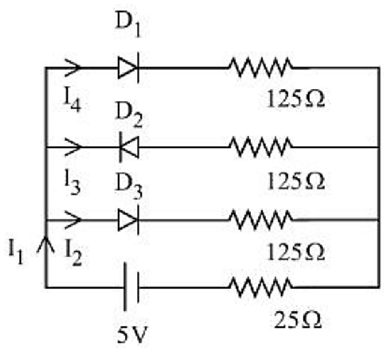
$= 180\ {}^{V}\!/_{m}$

$E_0 \rightarrow$ Amplitude of electric field

$B_0 \rightarrow$ Amplitude of magnetic field

$C \rightarrow$ Speed of light

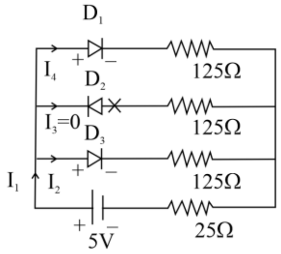
**41.** If each diode has a forward bias resistance of 25 Ω in the below circuit,




Which of the following options is correct:

(1) $\frac{I_1}{I_2} = 2$ (2) $\frac{I_2}{I_3} = 1$ (3) $\frac{I_3}{I_4} = 1$ (4) $\frac{I_1}{I_2} = 1$

**Sol.** **(1)**




Here we can see that $D_1$ and $D_3$ conducts but $D_2$ is reversed biased.

Current $I_1$ will be equally distributed among $I_3$ and $I_4$ and $I_3 = 0$

$I_1 = I_2 + I_4 + I_3$

$I_1 = 2I_2$

$\frac{I_1}{I_2} = 2$

**42.** A gas mixture consists of 2 moles of oxygen and 4 moles of neon at temperature T. Neglecting all vibrational modes, the total internal energy of the system will be,

(1) 4RT (2) 11RT (3) 8RT (4) 16RT

**Sol.** **(2)**

Internal energy of $O_2 = \frac{5}{2}nRT = \frac{5}{2} \times 2RT = 5RT$

Internal energy of Ne $= nRT = \frac{3}{2} \times nRT = \frac{3}{2} \times 4RT = 6RT$

Total energy of mixture (system) = 5RT + 6RT = 11RT

**43.** For a periodic motion represented by the equation $y = \sin \omega t + \cos \omega t$ the amplitude of the motion is

(1) 0.5 (2) 1 (3) 2 (4) $\sqrt{2}$

**Sol.** **(4)**

If equation of SHM is in the form $y = a \sin(\omega t) + B\cos(\omega t)$

**Then** its amplitude is = $\sqrt{A^2 + B^2}$

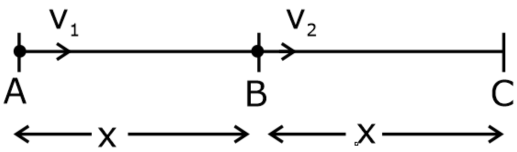
Here A = B = 1 in equation $y = \sin(\omega t) + (\cos t)$

Therefore, Amplitude = $\sqrt{(1)^2 + (1)^2} = \sqrt{2}$

**44.** A person travels x distance with velocity $v_1$ and then x distance with velocity $v_2$ in the same direction. The average velocity of the person is v, then the relation between v, $v_1$ and $v_2$ will be.

(1) $v = v_1 + v_2$ (2) $\frac{1}{v} = \frac{1}{v_1} + \frac{1}{v_2}$ (3) $\frac{2}{v} = \frac{1}{v_1} + \frac{1}{v_2}$ (4) $v = \frac{v_1 + v_2}{2}$

**Sol.** **(3)**




Time taken b/w A & B $\Rightarrow t_1 = \frac{x}{v_1}$

Time between b/w B & C $\Rightarrow t_2 = \frac{x}{v_2}$

Average velocity (v) = $\frac{\text{Total displacement}}{\text{Total time}} = \frac{x+x}{t_1+t_2} = \frac{2x}{\frac{x}{v_1}+\frac{x}{v_2}}$

(v) = $\frac{2v_1v_2}{v_1+v_2}$ or $\frac{2}{v} = \frac{1}{v_1} + \frac{1}{v_2}$

**45.** The half life of a radioactive substance is T. The time taken, for disintegrating $\frac{7}{8}$th part of its original mass will be:

(1) T (2) 2T (3) 3T (4) 8T

**Sol.** **(3)**

If $\frac{7}{8}$th is disintegrated it means only $\frac{1}{8}$th part is radioactive active no. of nuclears after 'n' half lives

$\Rightarrow \frac{N_o}{2^n} = \frac{N_o}{8}$

$2^n = 8 = n = 3$

So, the elapsed is 3 half lives = 3T

**46.** A gas is compressed adiabatically, which one of the following statement is NOT true.

(1) There is no change in the internal energy

(2) The temperature of the gas increases.

(3) The change in the internal energy is equal to the work done on the gas

(4) There is no heat supplied to the system

**Sol.** (1)

In Adiabatic process, $\Delta Q = 0$

If gas is compressed, then w (by gas) $\neq 0$

Therefore by 1st law $\Delta Q = \Delta u + w$

$0 = \Delta u + w$

$\Delta u = -w \neq 0$

It implies in adiabatic compression, internal energy of gas changes.

**47.** Given below are two statements:

**Statement I :** For diamagnetic substance, $-1 \le X < 0$, where $X$ is the magnetic susceptibility.

**Statement II :** Diamagnetic substances when placed in an external magnetic field, tend to move from stronger to weaker part of the field.

In the light of the above statements, choose the correct answer from the options given below

(1) Both Statement I and Statement II are false

(2) Statement I is incorrect but Statement II is true

(3) Both Statement I and Statement II are true

(4) Statement I is correct but Statement II is false

**Sol.** **(3)**

Diamagnetic substances have the property due to which they tends to move away from stronger magnetic field to weaker magnetic field, as their magnetic susceptibility is negative.

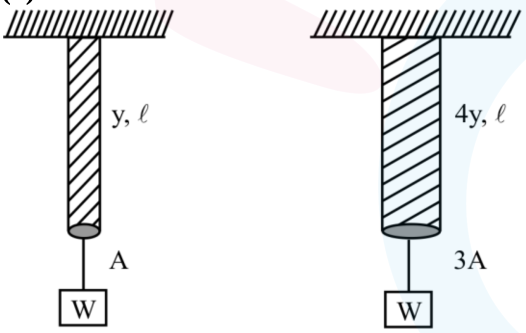
Therefore both statements are correct.

**48.** Young's moduli of the material of wires A and B are in the ratio of 1:4, while its area of cross sections are in the ratio of 1:3. If the same amount of load is applied to both the wires, the amount of elongation produced in the wires A and B will be in the ratio of

[Assume length of wires A and B are same]

(1) 12 : 1 (2) 1 : 36 (3) 1 : 12 (4) 36 : 1

**Sol.** **(1)**

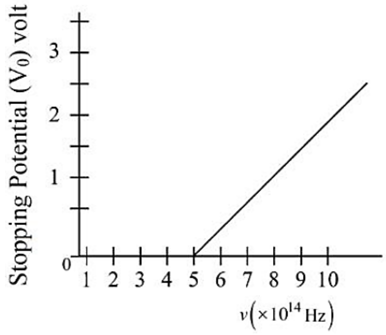



$$\frac{W}{A} = Y.\frac{\Delta\ell_1}{\ell} \qquad \frac{W}{3A} = 4Y.\frac{\Delta\ell_2}{\ell}$$

$$\Delta l_1 = \frac{W\ell}{AY} \qquad \Delta l_2 = \frac{W\ell}{12AY}$$

$$\frac{\Delta\ell_1}{\Delta\ell_2} = \frac{12}{1}$$

**49.** The variation of stopping potential ($V_0$) as a function of the frequency ($\nu$) of the incident light for a metal is shown in figure. The work function of the surface is




(1) 2.07 eV (2) 18.6 eV (3) 2.98 eV (4) 1.36 eV

**Sol.** **(1)**

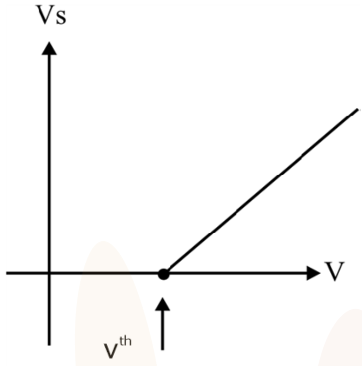
Work function ($\phi$) = $hv^{th}$

$= 6.6 \times 10^{-34} \times 5 \times 10^{14}$

$= 33 \times 10^{-20}$

$\phi = 3.3 \times 10^{-19}$ J

$= \dfrac{3.3\times10^{-19}}{1.6\times10^{-19}} \text{ev} \Rightarrow 2.07$




**50.** A bar magnet is released from rest along the axis of a very long vertical copper tube. After some time the magnet will

(1) Oscillate inside the tube

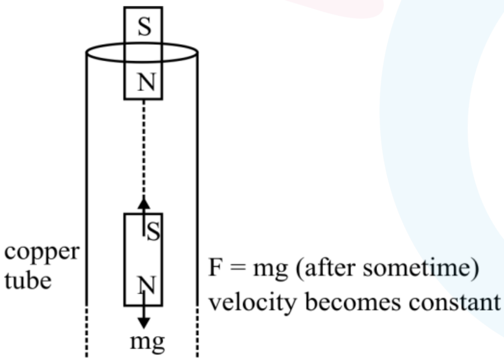
(2) Move down with an acceleration greater than g

(3) Move down with almost constant speed

(4) Move down with an acceleration equal to g

**Sol.** **(3)**

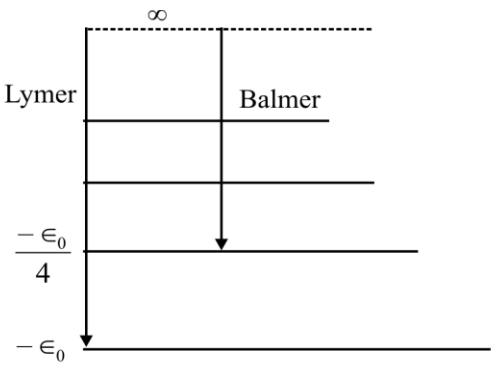
According to lenz's law, the rate of charge of flum produced by bar magnet will be approused by the conducting loops.




**SECTION – B**

**51.** If 917 Å be the lowest wavelength of Lyman series then the lowest wavelength of Balmer series will be __________ Å.

**Sol.** (3668)




Lowest wavelength of by may sense will be obtained for trasition $n = \infty \longrightarrow n = 1$

and for balmer series, Lyman Series n = ∞ ⟶ n = 2

for Lyman, $E_0 = \frac{hC}{917\text{Å}}$

for balmer, $\frac{E_0}{4} = \frac{hC}{\lambda(\text{Å})}$

using this

$\lambda = 917 \times 4 = 3668$

**52.** A square loop of side 2.0 cm is placed inside a long solenoid that has 50 turns per centimeter and carries a sinusoidally varying current of amplitude 2.5 A and angular frequency 700 rad $s^{-1}$. The central axes of the loop and solenoid coincide. The amplitude of the emf induced in the loop is x × $10^{-4}$ V. The value of x is ________ .

(Take, $\pi = \frac{22}{7}$)

**Sol.** **(44)**

emf induced in solenoid ⇒ BAWN sin(ωt), w = 700 rad/s

Amplitude ⇒ BAWN

Area (A) = 2cm × 2 cm

= 4 $cm^2$

= 4 × $10^{-4}$ $m^2$

$(B)_{solenoid} = \mu_0 ni$

= 4π × $10^{-7}$ × 5000 × 2.5

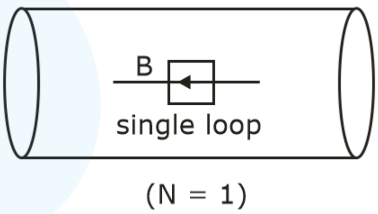
= 5π × $10^{-3}$

$n = \frac{50 \text{ turns}}{\text{cm}} = \frac{5000}{\text{m}}$

i = 2.5

Amplitude of emf = (5p × $10^{-3}$) (4 × $10^{-4}$) (700) (1)

$= 5 \times \frac{22}{7} \times 4 \times 700 \times 10^{-7} = 44 \times 10^{-4}$



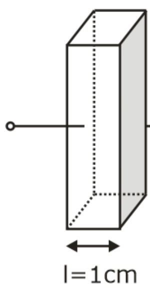

**53.** A rectangular parallelepiped is measured as 1 cm × 1 cm × 100 cm. If its specific resistance is 3 × $10^{-7}$ Ω m, then the resistance between its tow opposite rectangular faces will be __________ × $10^{-7}$ Ω.

**Sol.** **(3)**

ρ = 3 × $10^{-7}$ Ω-cm

$R = \rho . \frac{l}{A}$

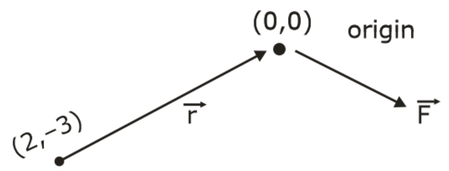
$= \frac{3\times10^{-7}\times(10^{-2}\text{m})}{(100\times10^{-4}\text{m}^2)} = 3 \times 10^{-7}$




**54.** A force of –P $\hat{k}$ acts on the origin of the coordinate system. The torque about the point (2, –3) is $P(a\hat{i} + b\hat{j})$, The ratio of $\frac{a}{b}$ is $\frac{x}{2}$. The value of x is -

**Sol.** **(3)**

$\vec{\tau} = \vec{r} \times \vec{F}$




$\vec{\tau} = \text{head} - \text{tail}$

$= (0-2)\hat{i} + (0(-3))\hat{j}$

$= -2\hat{i} + 3\hat{j}$

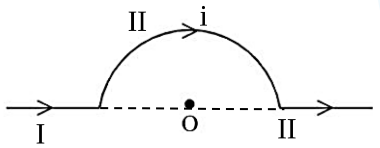
$\tau = (-2\hat{i} + 3\hat{j}) \times (-p\hat{k})$

$= -2p\hat{j} - 3p\hat{i}$

$= -p(3p\hat{i} + 2p\hat{j})$ $\frac{a}{b} = \frac{3}{2} = \frac{x}{2}$ $x = 3$

**55.** A straight wire carrying a current of 14 A is bent into a semicircular arc of radius 2.2 cm as shown in the figure. The magnetic field produced by the current at the centre (O) of the arc. is __________ $\times 10^{-4}$T


**Sol.** **(2)**




$B_{total} = B_I + B_{II} + B_{III}$

$B_I = 0$

$B_{III} = 0$

Because $\vec{dl} \times \vec{r} = 0$

Now, magnetic field due to semicirclaur ring at its center is given by

$B_{II} = \frac{\mu_0 i}{4R}$

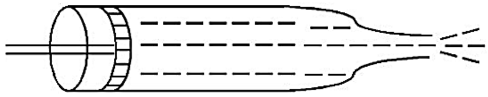
$= \frac{4\pi \times 10^{-7} \times 14}{4 \times 2.2 \times 10^{-2}}$

$= \frac{22}{7} \times \frac{10^{-7} \times 14}{22 \times 10^{-3}}$

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

$= 2$

**56.** Figure below shows a liquid being pushed out of the tube by a piston having area of cross section 2.0 $cm^2$. The area of cross section at the outlet is 10 $mm^2$. If the piston is pushed at a speed of 4 cm $s^{-1}$, the speed of outgoing fluid is _________ cm $s^{-1}$



**Sol.** **(80)**

By equation of continuity

$A_1V_1 = A_2V_2$

$(2\ cm^2)\ (4\ cm/s) = (10 \times 10^{-2}\ cm^2)\ (v)$

$\frac{8cm^3}{s} = 10^{-1} cm^2 (v)$

V = 80 cm/s

**57.** A rectangular block of mass 5 kg attached to a horizontal spiral spring executes simple harmonic motion of amplitude 1 m and time period 3.14 s. The maximum force exerted by spring on block is __________N.

**Sol.** **(20)**

When an object executes S.H.M, its morning acceleration is given by $a_{max} = \omega^2 A$

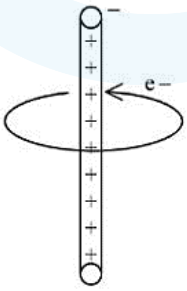
Where $\omega = \frac{2\pi}{T}$

Therefore, $a_{max} = \frac{4\pi^2 A}{T^2}$

(Max force) $F_{max} = ma_{max} = 5 \times \frac{4 \times 3.14 \times 3.14}{3.14 \times 3.14} \times (1)$

= 20 N

**58.** An electron revolves around an infinite cylindrical wire having uniform linear charge density $2 \times 10^{-8}$ C $m^{-1}$ in circular path under the influence of attractive electrostatic field as shown in the figure. The velocity of electron with which it is revolving is ________ $\times 10^6$ m $s^{-1}$. Given mass of electron = $9 \times 10^{-31}$ kg




**Sol.** **(8)**

In uniform circular motion

$F_c = ma_c$

$(q)(E) = \frac{mv^2}{r}$

$(e)\left(\frac{2k\lambda}{r}\right) = \frac{mv^2}{r}$

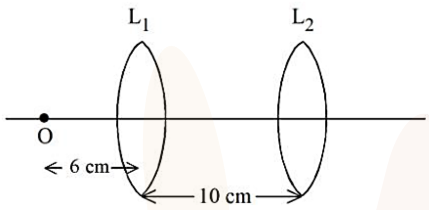
$v^2 = \frac{(e)(2k\lambda)}{m} = \frac{(1.6 \times 10^{-19}) \times 2 \times (9 \times 10^9) \times (2 \times 10^{-8})}{9 \times 10^{-31}}$

$= 1.6 \times 4 \times 10^{13}$

$V^2 = 16 \times 4 \times 10^{12} \Rightarrow v = 8 \times 10^6$ m/s

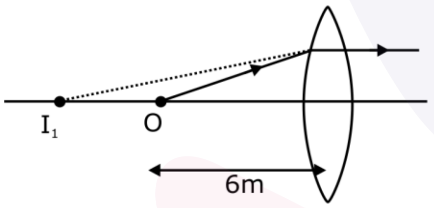
Ans. 8

**59.** A point object, 'O' is placed in front of two thin symmetrical coaxial convex lenses $L_1$ and $L_2$ with focal length 24 cm and 9 cm respectively. The distance between two lenses is 10 cm and the object is placed 6 cm away from lens $L_1$ as shown in the figure. The distance between the object and the image formed by the system of two lenses is __________ cm.




**Sol.** **(34)**

Due to lens $L_1$



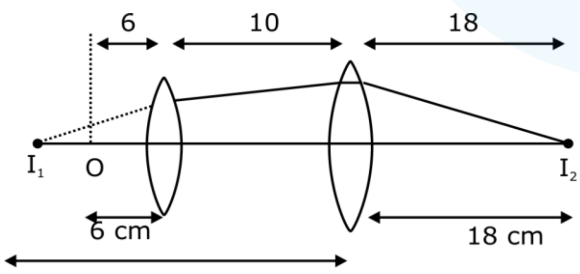

u = –6m

f = +24m

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$$

$$\frac{1}{v}=\frac{1}{24}-\frac{1}{6}=\frac{1-4}{24} \Rightarrow v=-8m$$

Due to lens $L_2$




U = –18m

F = +9m

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}\ \text{x}$$

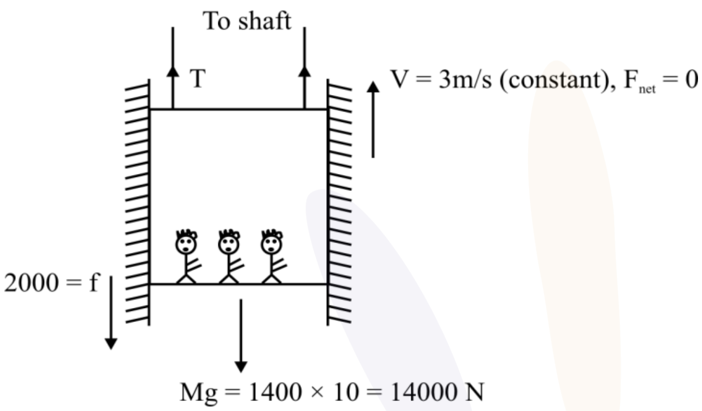
$$\frac{1}{v}-\frac{1}{9}=\frac{1}{18}$$

$$V = \frac{1}{v}=\frac{2-1}{18}$$

V = 18m

**60.** If the maximum load carried by an elevator is 1400 kg (600 kg – Passengers + 800 kg - elevator), which is moving up with a uniform speed of 3 m $s^{-1}$ and the frictional force acting on it is 2000 N, then the maximum power used by the motor is ___________ kW (g = 10 m/$s^2$)

**Sol.** **(48)**




Tension in the string ⇒ 16000 N

Maximum power = (F)(V)

= 16000 × 3

= 48000

= 48 kw

Ans. 48