JEE Main 2025 (April)
Chapter-wise Qs Bank

Physics

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Questions

Solutions

Q1. A physical quantity C is related to four other quantities $\mathrm{p}, \mathrm{q}, \mathrm{r}$ and s as follows $\mathrm{C}=\frac{\mathrm{pq}^2}{\mathrm{r}^3 \sqrt{\mathrm{s}}}$
The percentage errors in the measurement of $\mathrm{p}, \mathrm{q}, \mathrm{r}$ and s are $1\%, 2\% 3\%$ and 2% respectively.
The percentage error in the measurement of C will be _____%.

Q2. A quantity Q is formulated as $\mathrm{X}^{-2} \mathrm{Y}^{+\frac{3}{2}} \mathrm{Z}^{-\frac{2}{5}} \cdot \mathrm{X}, \mathrm{Y}$ and Z are independent parameters which have fractional errors of $0.1, 0.2$ and 0.5 , respectively in measurement. The maximum fractional error of Q is

(1) 0.1

(2) 0.8

(3) 0.7

(4) 0.6

Q1. If μ_0 and ε_0 are the permeability and permittivity of free space, respectively, then the dimension of $\left(\frac{1}{\mu_0 \varepsilon_0}\right)$ is :

(1) L/T^2

(2) L^2/T^2

(3) T^2/L

(4) $\mathrm{T}^2/\mathrm{L}^2$

Q2. A person measures mass of 3 different particles as 435.42 g, 226.3 g and 0.125 g. According to the rules for arithmetic operations with significant figures, the additions of the masses of 3 particles will be.

(1) 661.845 g

(2) 662 g

(3) 661.8 g

(4) 661.84 g

Q3. If ϵ_0 denotes the permittivity of free space and Φ_{E} is the flux of the electric field through the area bounded by the closed surface, then dimension of $\left(\epsilon_0 \frac{\mathrm{d}\phi_{\mathrm{E}}}{\mathrm{dt}}\right)$ are that of :

(1) Electric field

(2) Electric potential

(3) Electric charge

(4) Electric current

Q4. Match List-I with List-II.

List-I	List-II
(A) Heat capacity of body	(I) Jkg^{-1}
(B) Specific heat capacity of body	(II) JK^{-1}
(C) Latent heat	(III) $\mathrm{Jkg}^{-1}\ \mathrm{K}^{-1}$
(D) Thermal conductivity	(IV) $\mathrm{Jm}^{-1}\ \mathrm{K}^{-1}\ \mathrm{s}^{-1}$

Choose the correct answer from the options given below :

(1) (A)-(III), (B)-(I), (C)-(II), (D)-(IV)

(2) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(3) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

(4) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)

Q5. The equation for real gas is given by $\left(P+\frac{a}{V^2}\right)(V-b)=RT$, where P, V, T and R are the pressure, volume, temperature and gas constant, respectively. The dimension of ab^{-2} is equivalent to that of :

(1) Planck's constant

(2) Compressibility

(3) Strain

(4) Energy density

Q6. Match List-I with List-II.

List-I	List-II
(A) Coefficient of viscosity	(I) $\left[ML^0 T^{-3}\right]$
(B) Intensity of wave	(II) $\left[ML^{-2} T^{-2}\right]$
(C) Pressure gradient	(III) $\left[M^{-1}LT^2\right]$
(D) Compressibility	(IV) $\left[ML^{-1} T^{-1}\right]$

Choose the correct answer from the options given below :

(1) $(A)-(I), (B)-(IV), (C)-(III), (D)-(II)$

(2) (A)-(IV), (B)-(I), (C)-(II), (D)-(III)

(3) $(A)-(IV), (B)-(II), (C)-(I), (D)-(III)$

(4) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)

Q7. Given a charge q, current I and permeability of vacuum μ_0. Which of the following quantity has the dimension of momentum?

(1) qI/μ_0

(2) $q\mu_0 I$

(3) $q^2\mu_0 I$

(4) $q\mu_0/I$

Q8. Match the LIST-I with LIST-II

	LIST-I		LIST-II
A.	Gravitational constant	I.	$[LT^{-2}]$
B.	Gravitational potential energy	II.	$[L^2 T^{-2}]$
C.	Gravitational potential	III.	$[ML^2 T^{-2}]$
D.	Acceleration due to gravity	IV.	$[M^{-1} L^3 T^{-2}]$

Choose the correct answer from the options given below :

(1) A-IV, B-III, C-II, D-I

(2) A-III, B-II, C-I, D-IV

(3) A-II, B-IV, C-III, D-I

(4) A-I, B-III, C-IV, D-II

Q9. Match the **LIST-I** with**LIST-II**

LIST-I		LIST-II	
A.	Boltzmann constant	I.	ML^2T^{-1}
B.	Coefficient of viscosity	II.	$MLT^{-3}K^{-1}$
C.	Planck's constant	III.	$ML^2T^{-2}K^{-1}$
D.	Thermal conductivity	IV.	$ML^{-1}T^{-1}$

Choose the ***correct*** answer from the options given below :

(1) A-III, B-IV, C-I, D-II

(2) A-II, B-III, C-IV, D-I

(3) A-III, B-II, C-I, D-IV

(4) A-III, B-IV, C-II, D-I

Q10. In an electromagnetic system, the quantity representing the ratio of electric flux and magnetic flux has dimension of $M^P L^Q T^R A^S$, where value of ' Q ' and ' R ' are

(1) $(3,-5)$

(2) $(-2,2)$

(3) $(-2,1)$

(4) $(1,-1)$

Q11. Given below are two statements :

Statement (I) : The dimensions of Planck's constant and angular momentum are same.

Statement (II) : In Bohr's model electron revolve around the nucleus only in those orbits for which angular momentum is integral multiple of Planck's constant.

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

(1) Both Statement I and Statement II are correct

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

(3) Statement I is correct but Statement II is incorrect

(4) Both Statement I and Statement II are incorrect

Q12. In an electromagnetic system, a quantity defined as the ratio of electric dipole moment and magnetic dipole moment has dimension of $\left[M^P L^{\circ} \mathrm{T}^{\mathrm{R}} \mathrm{A}^{\mathrm{S}}\right]$. The value of P and Q are :

(1) $-1,0$

(2) $-1,1$

(3) $1,-1$

(4) $0,-1$

Q13. The dimension of $\sqrt{\frac{\mu_0}{\epsilon_0}}$ is equal to that of :

($\mu_0=$ Vacuum permeability and $\epsilon_0=$ Vacuum permittivity)

(1) Voltage

(2) Capacitance

(3) Inductance

(4) Resistance

Q14. Match List-I with List-II.

	List-I		List-II
(A)	Mass density	(I)	$\left[ML^2 T^{-3}\right]$
(B)	Impulse	(II)	$\left[MLT^{-1}\right]$
(C)	Power	(III)	$\left[ML^2 T^0\right]$
(D)	Moment of inertia	(IV)	$\left[ML^{-3} T^0\right]$

Choose the correct answer from the options given below :

(1) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

(2) (A)-(I), (B)-(III), (C)-(IV), (D)-(II)

(3) (A)-(IV), (B)-(II), (C)-(I), (D)-(III)

(4) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)

Q1. A body of mass 2 kg moving with velocity of $\overrightarrow{\mathrm{v}}_{\text{in}}=3\hat{\mathrm{i}}+4\hat{\mathrm{j}}\,\mathrm{ms}^{-1}$ enters into a constant force field of 6 N directed along positive z -axis. If the body remains in the field for a period of $\frac{5}{3}$ seconds, then velocity of the body when it emerges from force field is

(1) $4\hat{\mathrm{i}}+3\hat{\mathrm{j}}+5\hat{\mathrm{k}}$

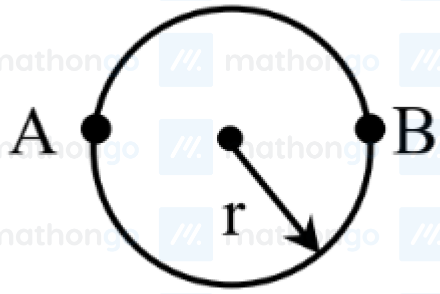
(2) $3\hat{\mathrm{i}}+4\hat{\mathrm{j}}+5\hat{\mathrm{k}}$

(3) $3\hat{i}+4\hat{j}-5\hat{k}$

(4) $3\hat{\mathrm{i}}+4\hat{\mathrm{j}}+\sqrt{5}\hat{\mathrm{k}}$

Q2. A person travelling on a straight line moves with a uniform velocity v_1 for a distance x and with a uniform velocity v_2 for the next $\frac{3}{2}$x distance. The average velocity in this motion is $\frac{50}{7}$ m/s. If v_1 is 5 m/s then $\mathrm{v}_2=$ ________ m/s.

Q3. A sportsman runs around a circular track of radius r such that he traverses the path $ABAB$. The distance travelled and displacement, respectively, are



(1) $2\mathrm{r}, 3\pi\mathrm{r}$

(2) $3\pi r, \pi r$

(3) $\pi r, 3r$

(4) $3\pi r, 2r$

Q4. A helicopter flying horizontally with a speed of 360 km/h at an altitude of 2 km , drops an object at an instant. The object hits the ground at a point O , 20 s after it is dropped. Displacement of ' O ' from the position of helicopter where the object was released is :
(use acceleration due to gravity $\mathrm{g}=10\ \mathrm{m/s^2}$ and neglect air resistance)

(1) $2\sqrt{5}$ km

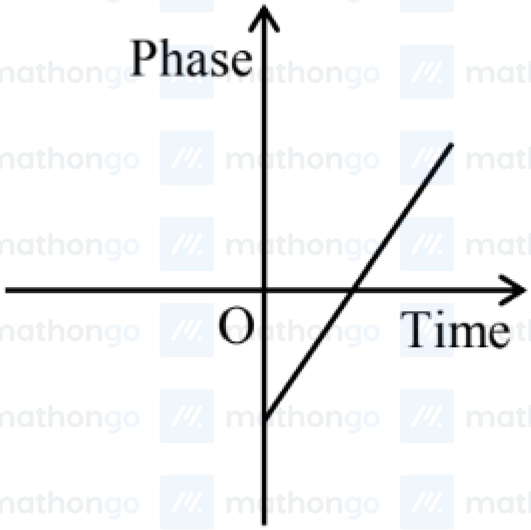
(2) 4 km

(3) 7.2 km

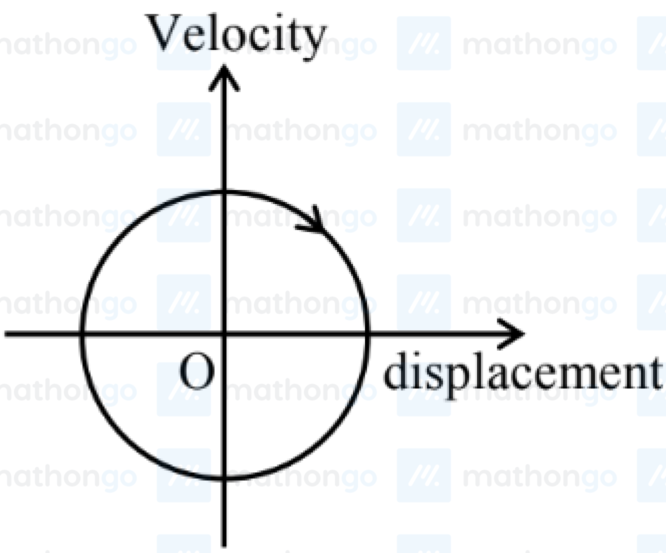
(4) $2\sqrt{2}$ km

Q5. Which of the following curves possibly represent one-dimensional motion of a particle?

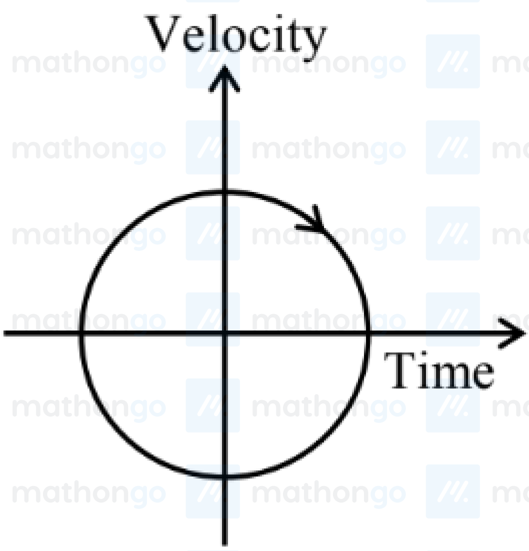
(A)



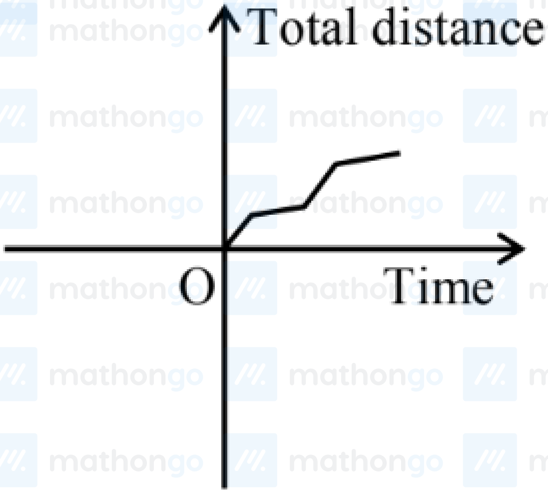
(B)



(C)



(D)



Choose the correct answer from the options given below :

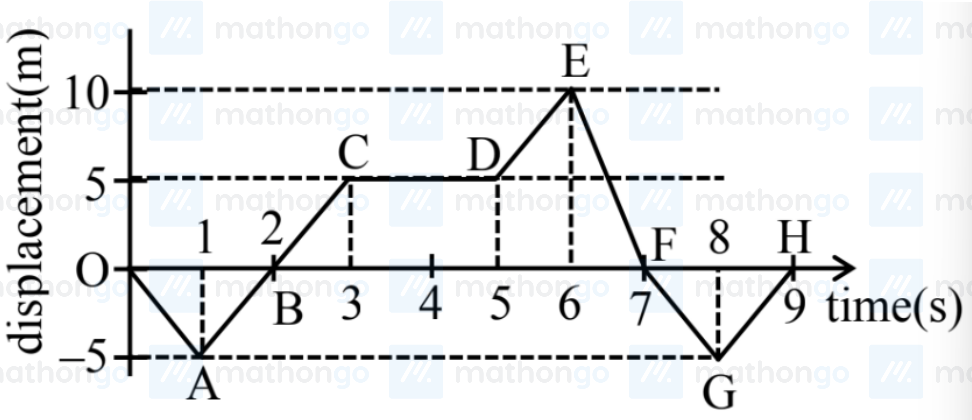
(1) A, B and D only

(2) A, B and C only

(3) A and B only

(4) A, C and D only

Q6. The displacement x versus time graph is shown below.



(A) The average velocity during 0 to 3 s is 10 m/s
(B) The average velocity during 3 to 5 s is 0 m/s
(C) The instantaneous velocity at $t = 2$ s is 5 m/s
(D) The average velocity during 5 to 7 s and instantaneous velocity at $t = 6.5$ s are equal
(E) The average velocity from $t = 0$ to $t = 9$ s is zero
Choose the correct answer from the options given below:

(1) (A), (D), (E) only

(2) (B), (C), (D) only

(3) (B), (D), (E) only

(4) (B), (C), (E) only

Q7. A particle moves along the x-axis and has its displacement x varying with time t according to the equation $\mathrm{x}=\mathrm{c}_0\left(\mathrm{t}^2-2\right)+\mathrm{c}(\mathrm{t}-2)^2$ where c_0 and c are constants of appropriate dimensions. Then, which of the following statements is correct?

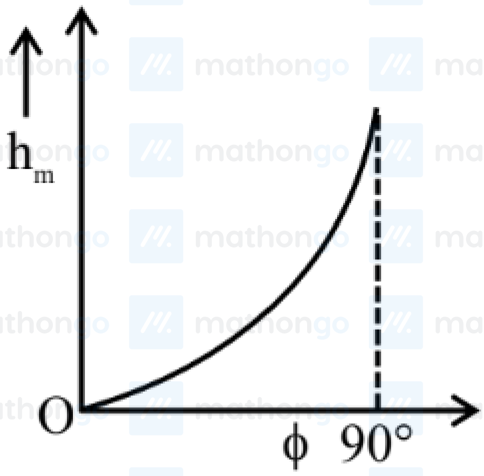
(1) the acceleration of the particle is $2\mathrm{c}_0$

(2) the acceleration of the particle is $2\ \mathrm{c}$

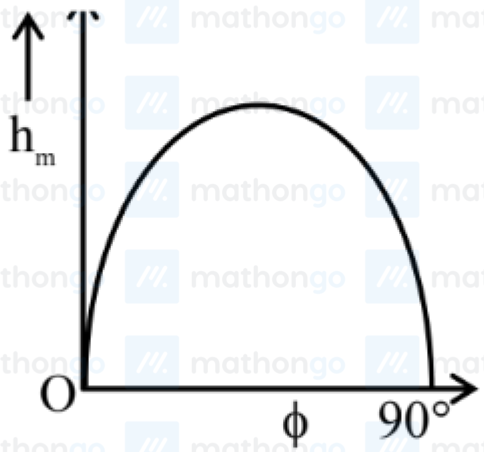
(3) the initial velocity of the particle is $4\ \mathrm{c}$

(4) the acceleration of the particle is $2\left(c+c_0\right)$

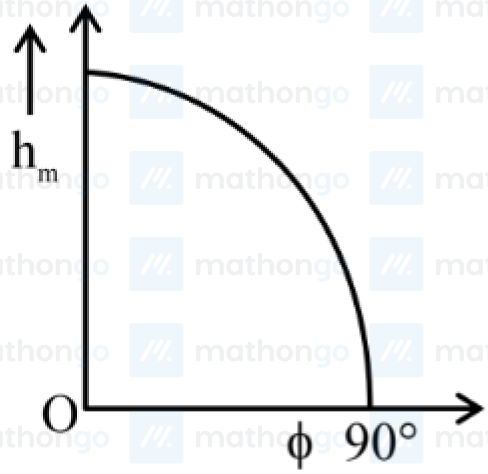
Q1. The angle of projection of a particle is measured from the vertical axis as ϕ and the maximum height reached by the particle is h_m. Here h_m as function of ϕ can be presented as



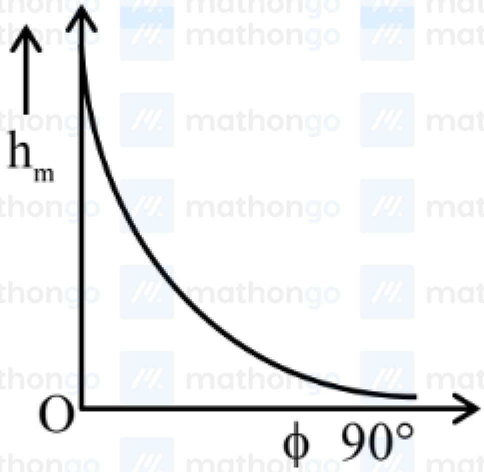
(1)



(2)



(3)



(4)

Q2. A particle is projected with velocity u so that its horizontal range is three times the maximum height attained by it. The horizontal range of the projectile is given as $\frac{nu^2}{25g}$, where value of n is : (Given ' g ' is the acceleration due to gravity).

(1) 6

(2) 18

(3) 12

(4) 24

Q3. Two projectiles are fired from ground with same initial speeds from same point at angles $(45^\circ + \alpha)$ and $(45^\circ - \alpha)$ with horizontal direction. The ratio of their times of flights is

(1) 1

(2) $\frac{1-\tan\alpha}{1+\tan\alpha}$

(3) $\frac{1+\sin 2\alpha}{1-\sin 2\alpha}$

(4) $\frac{1+\tan\alpha}{1-\tan\alpha}$

Q4. Two balls with same mass and initial velocity, are projected at different angles in such a way that maximum height reached by first ball is 8 times higher than that of the second ball. T_1 and T_2 are the total flying times of first and second ball, respectively, then the ratio of T_1 and T_2 is :

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

(2) $2 : 1$

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

(4) $4 : 1$

Q5. A river is flowing from west to east direction with speed of 9 km h^{-1}. If a boat capable of moving at a maximum speed of 27 km h^{-1} in still water, crosses the river in half a minute, while moving with maximum speed at an angle of 150° to direction of river flow, then the width of the river is :

(1) 300 m

(2) 112.5 m

(3) 75 m

(4) $112.5 \times \sqrt{3}$ m

Q1. An object with mass 500 g moves along x -axis with speed $v=4\sqrt{x}$ m/s. The force acting on the object is :

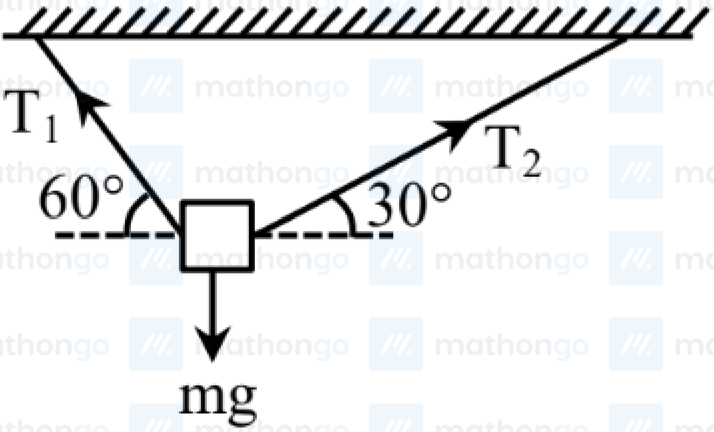
(1) 8 N

(2) 5 N

(3) 6 N

(4) 4 N

Q2.



A body of mass 1 kg is suspended with the help of two strings making angles as shown in figure. Magnitude of tensions T_1 and T_2, respectively, are (in N) :

(1) $5, 5\sqrt{3}$

(2) $5\sqrt{3}, 5$

(3) $5\sqrt{3}, 5\sqrt{3}$

(4) 5,5

Q3. A body of mass m is suspended by two strings making angles θ_1 and θ_2 with the horizontal ceiling with tensions T_1 and T_2 simultaneously. T_1 and T_2 are related by $T_1=\sqrt{3}T_2$. the angles θ_1 and θ_2 are

(1) $\theta_1=30^{\circ}\theta_2=60^{\circ}$ with $\mathrm{T}_2=\frac{3\mathrm{mg}}{4}$

(2) $\theta_1=60^{\circ}\theta_2=30^{\circ}$ with $\mathrm{T}_2=\frac{\mathrm{mg}}{2}$

(3) $\theta_1=45^{\circ}\theta_2=45^{\circ}$ with $\mathrm{T}_2=\frac{3\mathrm{mg}}{4}$

(4) $\theta_1=30^{\circ}\theta_2=60^{\circ}$ with $\mathrm{T}_2=\frac{4\mathrm{mg}}{5}$

Q4. The length of a light string is 1.4 m when the tension on it is 5 N. If the tension increases to 7 N , the length of the string is 1.56 m. The original length of the string is ______ m.

Q5. A cubic block of mass m is sliding down on an inclined plane at 60° with an acceleration of $\frac{g}{2}$, the value of coefficient of kinetic friction is

(1) $\sqrt{3}-1$

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

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

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

Q1. Which one of the following forces cannot be expressed in terms of potential energy?

(1) Coulomb's force

(2) Gravitational force

(3) Frictional force

(4) Restoring force

Q2. A particle is released from height S above the surface of the earth. At certain height its kinetic energy is three times its potential energy. The height from the surface of the earth and the speed of the particle at that instant are respectively.

(1) $\frac{S}{2}, \sqrt{\frac{3gS}{2}}$

(2) $\frac{S}{2}, \frac{3gS}{2}$

(3) $\frac{S}{4}, \frac{3gS}{2}$

(4) $\frac{S}{4}, \sqrt{\frac{3gS}{2}}$

Q3. A block of mass 1 kg , moving along x with speed $v_i = 10 \mathrm{~m/s}$ enters a rough region ranging from $x = 0.1 \mathrm{~m}$ to $x = 1.9 \mathrm{~m}$. The retarding force acting on the block in this range is $F_r = -kx\mathrm{N}$, with $k = 10 \mathrm{~N/m}$. Then the final speed of the block as it crosses rough region is

(1) $10 \mathrm{~m/s}$

(2) $4 \mathrm{~m/s}$

(3) $6 \mathrm{~m/s}$

(4) $8 \mathrm{~m/s}$

Q4. An object of mass 1000 g experiences a time dependent force $\vec{F} = \left(2t\hat{i} + 3t^2\hat{j}\right) N$. The power generated by the force at time t is :

(1) $\left(2t^2 + 3t^3\right) W$

(2) $\left(2t^2 + 18t^3\right) W$

(3) $\left(3t^3 + 5t^5\right) W$

(4) $\left(2t^3 + 3t^5\right) W$

Q5. A block of mass 25 kg is pulled along a horizontal surface by a force at an angle 45° with the horizontal. The friction coefficient between the block and the surface is 0.25. The displacement of 5 m of the block is:

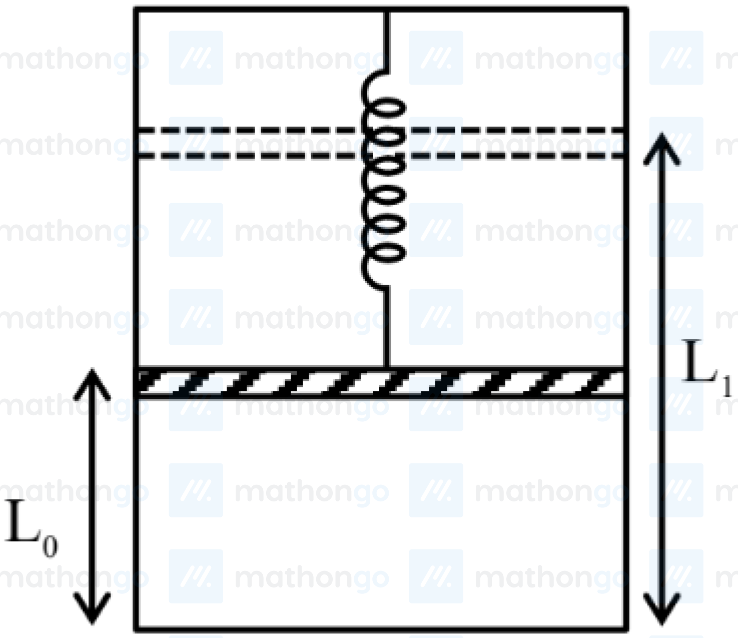
(1) 970 J

(2) 735 J

(3) 245 J

(4) 490 J

Q6. A piston of mass M is hung from a massless spring whose restoring force law goes as $\mathrm{F}=-\mathrm{kx}^3$, where k is the spring constant of appropriate dimension. The piston separates the vertical chamber into two parts, where the bottom part is filled with ' n ' moles of an ideal gas. An external work is done on the gas isothermally (at a constant temperature T) with the help of a heating filament (with negligible volume) mounted in lower part of the chamber, so that the piston goes up from a height L_0 to L_1, the total energy delivered by the filament is (Assume spring to be in its natural length before heating)



(1) $3nRT\ln\left(\frac{L_1}{L_0}\right)+2\mathrm{Mg}\left(L_1-L_0\right)+\frac{k}{3}\left(L_1^3-L_0^3\right)$

(2) $nRT\ln\left(\frac{L_1^2}{L_0^2}\right)+\frac{Mg}{2}\left(L_1-L_0\right)+\frac{k}{4}\left(L_1^4-L_0^4\right)$

(3) $nRT\ln\left(\frac{L_1}{L_0}\right)+Mg\left(L_1-L_0\right)+\frac{k}{4}\left(L_1^4-L_0^4\right)$

(4) $nRT\ln\left(\frac{L_1}{L_0}\right)+Mg\left(L_1-L_0\right)+\frac{3k}{4}\left(L_1^4-L_0^4\right)$

Q7. A block of mass 2 kg is attached to one end of a massless spring whose other end is fixed at a wall. The spring-mass system moves on a frictionless horizontal table. The spring's natural length is 2 m and spring constant is $200\ \mathrm{N/m}$. The block is pushed such that the length of the spring becomes 1 m and then released. At distance $\mathrm{xm}(\mathrm{x}<2)$ from the wall. the speed of the block will be :

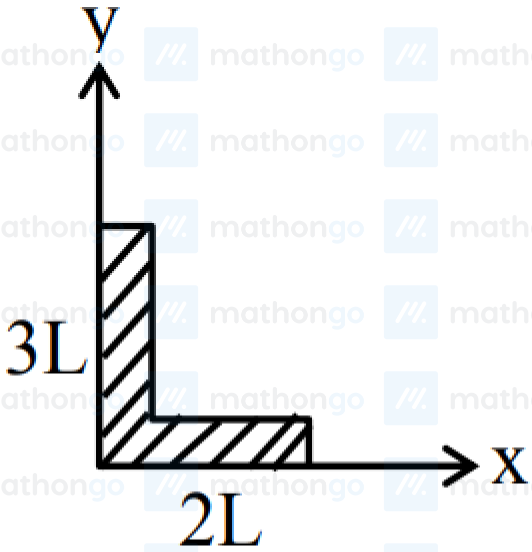
(1) $10[1-(2-x)]^{3/2}$ m/s

(2) $10\left[1-(2-x)^2\right]^{1/2}$ m/s

(3) $10\left[1-(2-\mathrm{x})^2\right]$ m/s

(4) $10\left[1-(2-\mathrm{x})^2\right]^2$ m/s

Q1. A rod of length 5 L is bent right angle keeping one side length as 2 L.



The position of the centre of mass of the system: (Consider $\mathrm{L} = 10$ cm)

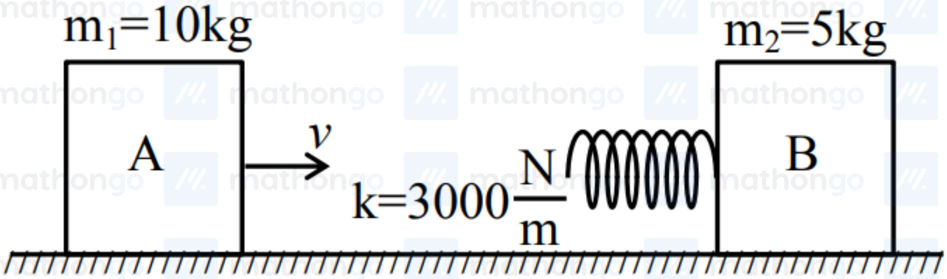
(1) $2\hat{i} + 3\hat{j}$

(2) $3\hat{i} + 7\hat{\mathrm{j}}$

(3) $5\hat{\mathrm{i}} + 8\hat{\mathrm{j}}$

(4) $4\hat{i} + 9\hat{j}$

Q2.



Consider two blocks A and B of masses $m_1 = 10$ kg and $m_2 = 5$ kg that are placed on a frictionless table. The block A moves with a constant speed $v = 3$ m/s towards the block B kept at rest. A spring with spring constant $\mathrm{k} = 3000$ N/m is attached with the block B as shown in the figure. After the collision, suppose that the blocks A and B, along with the spring in constant compression state, move together, then the compression in the spring is, (Neglect the mass of the spring)

(1) 0.2 m

(2) 0.4 m

(3) 0.1 m

(4) 0.3 m

Q1. The moment of inertia of a circular ring of mass M and diameter r about a tangential axis lying in the plane of the ring is :

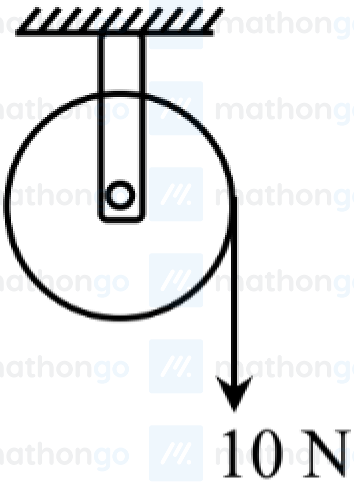
(1) $\frac{1}{2}\mathrm{Mr}^2$

(2) $\frac{3}{8}\mathrm{Mr}^2$

(3) $\frac{3}{2}\mathrm{Mr}^2$

(4) $2\mathrm{Mr}^2$

Q2.



A wheel of radius 0.2 m rotates freely about its center when a string that is wrapped over its rim is pulled by force of 10 N as shown in figure. The established torque produces an angular acceleration of $2\ \mathrm{rad/s^2}$. Moment of inertia of the wheel is ______ kgm^2.
(Acceleration due to gravity $= 10\ \mathrm{m/s^2}$)

Q3. Which of the following are correct expression for torque acting on a body?
B. $\vec{\tau} = \frac{\mathrm{d}}{\mathrm{dt}}(\overrightarrow{\mathrm{r}} \times \overrightarrow{\mathrm{p}})$
C. $\vec{\tau} = \overrightarrow{\mathrm{r}} \times \frac{\mathrm{dp}}{\mathrm{dt}}$
D. $\vec{\tau} = \mathrm{I}\vec{\alpha}$
E. $\vec{\tau} = \overrightarrow{\mathrm{r}} \times \overrightarrow{\mathrm{F}}$
($\overrightarrow{\mathrm{r}}$ = position vector; $\overrightarrow{\mathrm{p}}$ = linear momentum;
$\overrightarrow{\mathrm{L}}$ = angular momentum; $\vec{\alpha}$ = angular acceleration;
I = moment of inertia; $\vec{F}$ = force; t = time)
Choose the correct answer from the options given below :

(1) B, D and E Only

(2) C and D Only

(3) B, C, D and E Only

(4) A, B, D and E Only

Q4. Moment of inertia of a rod of mass ' M ' and length 'L' about an axis passing through its center and normal to its length is ' α '. Now the rod is cut into two equal parts and these parts are joined symmetrically to form a cross shape. Moment of inertia of cross about an axis passing through its center and normal to plane containing cross is :

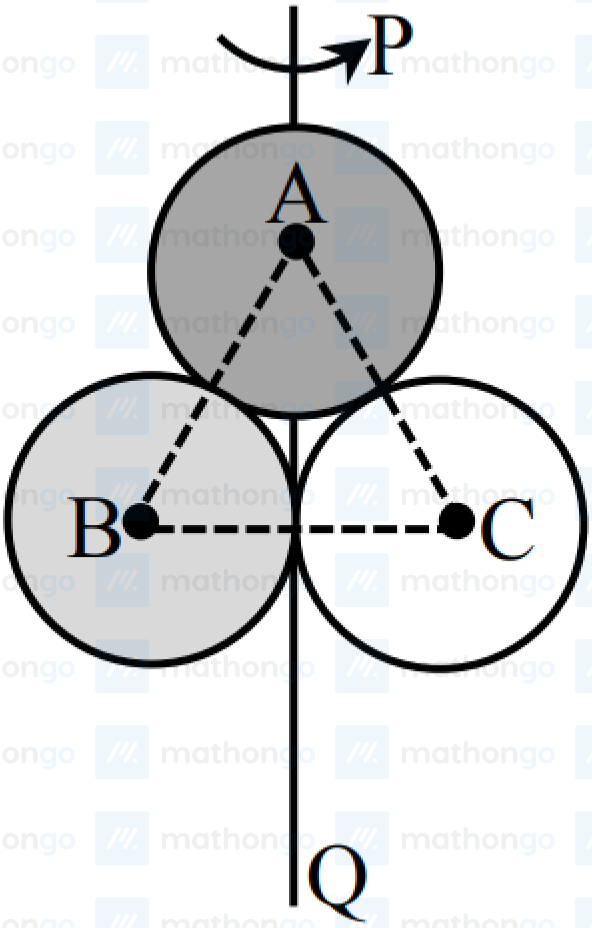
(1) α

(2) $\alpha/4$

(3) $\alpha/8$

(4) $\alpha/2$

Q5. A, B and C are disc, solid sphere and spherical shell respectively with same radii and masses. These masses are placed as shown in figure.



The moment of inertia of the given system about PQ is $\frac{X}{15}I$, where I is the moment of inertia of the disc about its diameter. The value of x is ________.

Q6. A rod of linear mass density ' λ ' and length ' L ' is bent to form a ring of radius 'R'. Moment of inertia of ring about any of its diameter is :

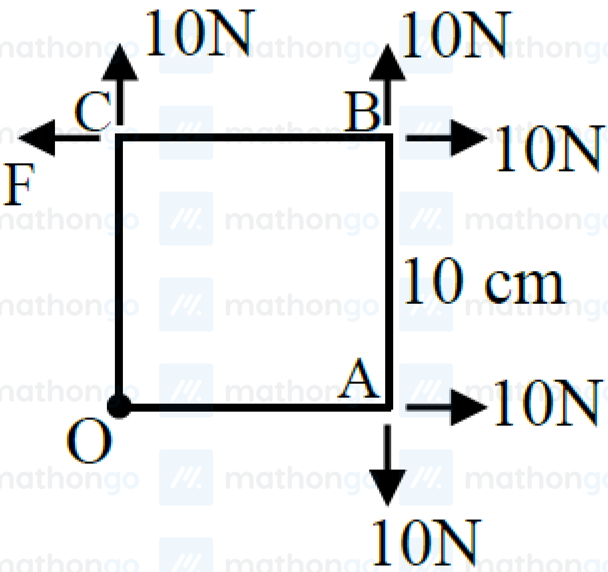
(1) $\frac{\lambda L^3}{16\pi^2}$

(2) $\frac{\lambda L^3}{12}$

(3) $\frac{\lambda L^3}{4\pi^2}$

(4) $\frac{\lambda L^3}{8\pi^2}$

Q7. A square Lamina OABC of length 10 cm is pivoted at 'O'. Forces act at Lamina as shown in figure. If Lamina remains stationary, then the magnitude of F is :



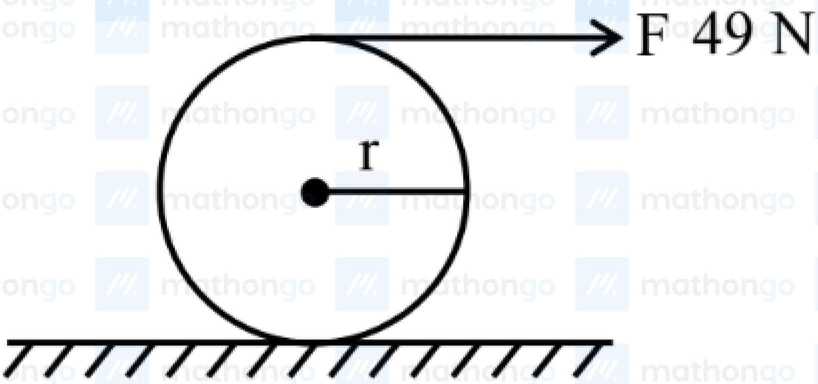
(1) 20 N

(2) 0 (zero)

(3) 10 N

(4) $10\sqrt{2}$ N

Q8. A force of 49 N acts tangentially at the highest point of a sphere (solid) of mass 20 kg , kept on a rough horizontal plane. If the sphere rolls without slipping, then the acceleration of the center of the sphere is



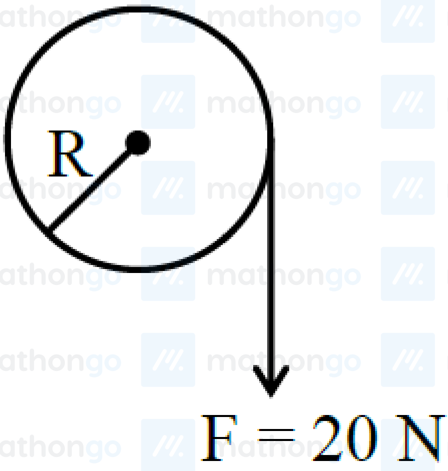
(1) $3.5 \mathrm{~m/s^2}$

(2) $0.35 \mathrm{~m/s^2}$

(3) $2.5 \mathrm{~m/s^2}$

(4) $0.25 \mathrm{~m/s^2}$

Q9. A cord of negligible mass is wound around the rim of a wheel supported by spokes with negligible mass. The mass of wheel is 10 kg and radius is 10 cm and it can freely rotate without any friction. Initially the wheel is at rest. If a steady pull of 20 N is applied on the cord, the angular velocity of the wheel, after the cord is unwound by 1 m , would be :



(1) $20 \mathrm{rad/s}$

(2) $30 \mathrm{rad/s}$

(3) $10 \mathrm{rad/s}$

(4) $0 \mathrm{rad/s}$

Q10. A thin solid disk of 1 kg is rotating along its diameter axis at the speed of 1800 rpm. By applying an external torque of 25π Nm for 40 s, the speed increases to 2100 rpm. The diameter of the disk is ________ m.

Q11. If $\overrightarrow{\mathrm{L}}$ and $\overrightarrow{\mathrm{P}}$ represent the angular momentum and linear momentum respectively of a particle of mass ' m ' having position vector $\overrightarrow{\mathrm{r}}=\mathrm{a}(\hat{\mathrm{i}} \cos \omega \mathrm{t}+\hat{\mathrm{j}} \sin \omega \mathrm{t})$. The direction of force is

(1) Opposite to the direction of $\vec{r}$

(2) Opposite to the direction of $\overrightarrow{\mathrm{L}}$

(3) Opposite to the direction of $\vec{P}$

(4) Opposite to the direction of $\overrightarrow{\mathrm{L}} \times \overrightarrow{\mathrm{P}}$

Q12. A solid sphere with uniform density and radius R is rotating initially with constant angular velocity (ω_1) about its diameter. After some time during the rotation its starts loosing mass at a uniform rate, with no change in its shape. The angular velocity of the sphere when its radius become $R/2$ is $x\omega_1$. The value of x is ________

Q13. A circular ring and a solid sphere having same radius roll down on an inclined plane from rest without slipping. The ratio of their velocities when reached at the bottom of the plane is $\sqrt{\frac{x}{5}}$ where $\mathrm{x}=$ _____

Q14. A wheel is rolling on a plane surface. The speed of a particle on the highest point of the rim is $8 \mathrm{~m/s}$. The speed of the particle on the rim of the wheel at the same level as the centre of wheel, will be :

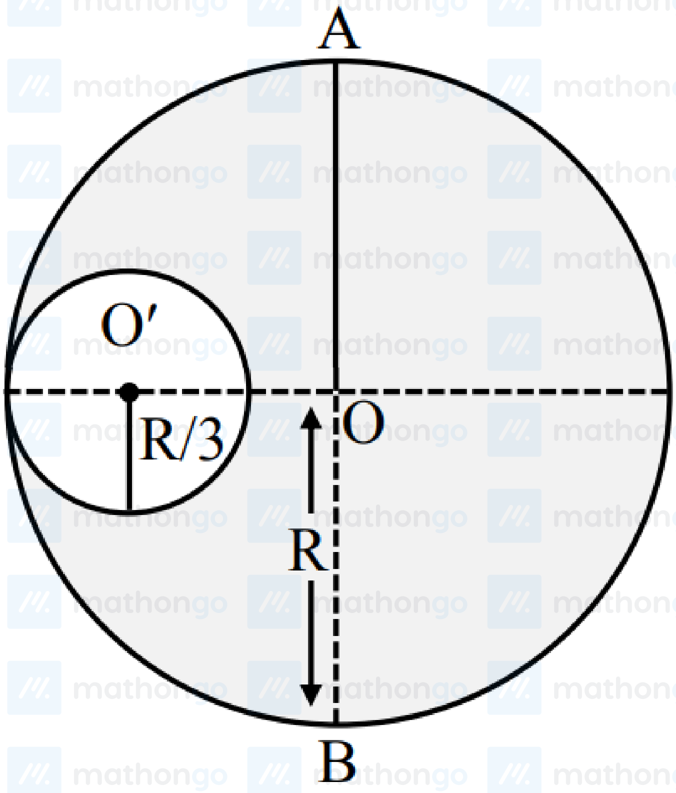
(1) $4\sqrt{2} \mathrm{~m/s}$

(2) $8 \mathrm{~m/s}$

(3) $4 \mathrm{~m/s}$

(4) $8\sqrt{2} \mathrm{~m/s}$

Q15. M and R be the mass and radius of a disc. A small disc of radius $R/3$ is removed from the bigger disc as shown in figure. The moment of inertia of remaining part of bigger disc about an axis AB passing through the centre O and perpendicular to the plane of disc is $\frac{4}{x} M R^2$. The value of x is ________.



Q16. A cube having a side of 10 cm with unknown mass and 200 gm mass were hung at two ends of an uniform rigid rod of 27 cm long. The rod along with masses was placed on a wedge keeping the distance between wedge point and 200 gm weight as 25 cm. Initially the masses were not at balance. A beaker is placed beneath the unknown mass and water is added slowly to it. At given point the masses were in balance and half volume of the unknown mass was inside the water.

(Take the density of unknown mass is more than that of the water, the mass did not absorb water and water density is $1 \mathrm{gm}/\mathrm{cm}^3$.) The unknown mass is ________ kg.

Q1. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The radius vector from the Sun to a planet sweeps out equal areas in equal intervals of time and thus areal velocity of planet is constant.
Reason (R) : For a central force field the angular momentum is a constant.
In the light of the above statements, choose the most appropriate answer from the options given below :

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

(2) Both (A) and (R) are correct but (R) is not the correct explanation of (A)

(3) (A) is correct but (R) is not correct

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

Q2. Three identical spheres of mass m , are placed at the vertices of an equilateral triangle of length a. When released, they interact only through gravitational force and collide after a time $T = 4$ seconds. If the sides of the triangle are increased to length 2 a and also the masses of the spheres are made 2 m , then they will collide after _____ seconds.

Q3. A satellite of mass 1000 kg is launched to revolve around the earth in an orbit at a height of 270 km from the earth's surface. Kinetic energy of the satellite in this orbit is ______ $\times 10^{10}$ J.
(Mass of earth $= 6 \times 10^{24}$ kg, Radius of earth $= 6.4 \times 10^{6}$ m, Gravitational constant $= 6.67 \times 10^{-11} \mathrm{Nm}^2 \mathrm{~kg}^{-2}$)

Q4. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R Assertion A : The kinetic energy needed to project a body of mass m from earth surface to infinity is $\frac{1}{2}$mgR, where R is the radius of earth.
Reason R : The maximum potential energy of a body is zero when it is projected to infinity from earth surface.
In the light of the above statements, choose the correct answer from the option given below

(1) A False but R is true

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

(3) A is true but R is false

(4) (4) Both A and R are true but R is NOT the correct explanation of A

Q5. An object is kept at rest at a distance of 3 R above the earth's surface where R is earth's radius. The minimum speed with which it must be projected so that it does not return to earth is :
(Assume M = mass of earth, G = Universal gravitational constant)

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

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

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

(4) $\sqrt{\frac{2GM}{R}}$

Q1. Two wires A and B are made of same material having ratio of lengths $\frac{L_A}{L_B} = \frac{1}{3}$ and their diameters ratio $\frac{d_A}{d_B} = 2$. If both the wires are stretched using same force, what would be the ratio of their respective elongations?

(1) 1 : 6

(2) 1 : 12

(3) 3 : 4

(4) 1 : 3

Q2. A 3 m long wire of radius 3 mm shows an extension of 0.1 mm when loaded vertically by a mass of 50 kg in an experiment to determine Young's modulus. The value of Young's modulus of the wire as per this experiment is $\mathrm{P} \times 10^{11} \mathrm{Nm}^{-2}$, where the value of P is: (Take $\mathrm{g} = 3\pi \mathrm{~m/s^2}$)

(1) 5

(2) 10

(3) 25

(4) 2.5

Q3. A sample of a liquid is kept at 1 atm. It is compressed to 5 atm which leads to change of volume of 0.8 cm^3. If the bulk modulus of the liquid is 2 GPa , the initial volume of the liquid was _______ litre. (Take $1 \mathrm{~atm} = 10^5 \mathrm{~Pa}$)

Q4. Two slabs with square cross section of different materials $(1, 2)$ with equal sides (l) and thickness d_1 and d_2 such that $\mathrm{d}_2 = 2 \mathrm{~d}_1$ and $l > \mathrm{d}_2$. Considering lower edges of these slabs are fixed to the floor, we apply equal shearing force on the narrow faces. The angle of deformation is $\theta_2 = 2\theta_1$. If the shear moduli of material 1 is $4 \times 10^9 \mathrm{~N/m^2}$, then shear moduli of material 2 is $\mathrm{x} \times 10^9 \mathrm{~N/m^2}$, where value of x is ________.

Q5. A cylindrical rod of length 1 m and radius 4 cm is mounted vertically. It is subjected to a shear force of 10^5 N at the top. Considering infinitesimally small displacement in the upper edge, the angular displacement θ of the rod axis from its original position would be : (shear moduli, $\mathrm{G} = 10^{10} \mathrm{~N/m^2}$)

(1) $1/160\pi$

(2) $1/4\pi$

(3) $1/40\pi$

(4) $1/2\pi$

Q6. A steel wire of length 2 m and Young's modulus $2.0 \times 10^{11} \mathrm{Nm}^{-2}$ is stretched by a force. If Poisson ratio and transverse strain for the wire are 0.2 and 10^{-3} respectively, then the elastic potential energy density of the wire is _______ $\times 10^5$ (in SI units)

Q1. Two liquids A and B have θ_{A} and θ_{B} as contact angles in a capillary tube. If $K=\cos \theta_A / \cos \theta_B$. then identify the correct statement:

(1) K is negative, then liquid A and liquid B have convex meniscus.

(2) K is negative, then liquid A and liquid B have concave meniscus.

(3) K is negative, then liquid A has concave meniscus and liquid B has convex meniscus

(4) K is zero, then liquid A has convex meniscus and liquid B has concave meniscus.

Q2. Two cylindrical vessels of equal cross sectional area of $2 \mathrm{~m}^2$ contain water up to height 10 m and 6 m , respectively. If the vessels are connected at their bottom then the work done by the force of gravity is : (Density of water is $10^3 \mathrm{~kg} / \mathrm{m}^3$ and $\mathrm{g}=10 \mathrm{~m} / \mathrm{s}^2$)

(1) $1 \times 10^5 \mathrm{~J}$

(2) $4 \times 10^4 \mathrm{~J}$

(3) $6 \times 10^4 \mathrm{~J}$

(4) $8 \times 10^4 \mathrm{~J}$

Q3. A vessel with square cross-section and height of 6 m is vertically partitioned. A small window of $100 \mathrm{~cm}^2$ with hinged door is fitted at a depth of 3 m in the partition wall. One part of the vessel is filled completely with water and the other side is filled with the liquid having density $1.5 \times 10^3 \mathrm{~kg} / \mathrm{m}^3$. What force one needs to apply on the hinged door so that it does not get opened ?
(Acceleration due to gravity $=10 \mathrm{~m} / \mathrm{s}^2$)

Q4. Consider a completely full cylindrical water tank of height 1.6 m and cross-sectional area $0.5 \mathrm{~m}^2$. It has a small hole in its side at a height 90 cm from the bottom. Assume, the cross-sectional area of the hole to be negligibly small as compared to that of the water tank. If a load 50 kg is applied at the top surface of the water in the tank then the velocity of the water coming out at the instant when the hole is opened is : $\left(\mathrm{g}=10 \mathrm{~m} / \mathrm{s}^2\right)$

(1) $3 \mathrm{~m} / \mathrm{s}$

(2) $5 \mathrm{~m} / \mathrm{s}$

(3) $2 \mathrm{~m} / \mathrm{s}$

(4) $4 \mathrm{~m} / \mathrm{s}$

Q5. Two water drops each of radius 'r' coalesce to from a bigger drop. If ' T ' is the surface tension, the surface energy released in this process is :

(1) $4 \pi \mathrm{r}^2 \mathrm{~T}\left[2-2^{\frac{2}{3}}\right]$

(2) $4\pi r^2\ \mathrm{T}\left[2-2^{\frac{1}{3}}\right]$

(3) $4\pi r^2\ \mathrm{T}[1+\sqrt{2}]$

(4) $4\pi r^2 T[\sqrt{2}-1]$

Q6. The excess pressure inside a soap bubble A in air is half the excess pressure inside another soap bubble B in air. If the volume of the bubble A is n times the volume of the bubble B, then, the value of n is ___.

Q7. A capillary tube of radius 0.1 mm is partly dipped in water (surface tension $70\mathrm{dyn/cm}$ and glass water contact angle $\simeq 0^\circ$) with 30° inclined with vertical. The length of water risen in the capillary is ________ cm.
(Take $\mathrm{g}=9.8\ \mathrm{m/s^2}$)

(1) $\frac{82}{5}$

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

(3) $\frac{71}{5}$

(4) $\frac{68}{5}$

Q8. A solid steel ball of diameter 3.6 mm acquired terminal velocity $2.45\times10^{-2}\ \mathrm{m/s}$ while falling under gravity through an oil of density $925\ \mathrm{kg\ m^{-3}}$. Take density of steel as $7825\ \mathrm{kg\ m^{-3}}$ and g as $9.8\ \mathrm{m/s^2}$. The viscosity of the oil in SI unit is

(1) 2.18

(2) 2.38

(3) 1.68

(4) 1.99

Q1. A particle is subjected two simple harmonic motions as :
$\mathrm{x}_1 = \sqrt{7}\sin 5\mathrm{tcm}$
and $x_2 = 2\sqrt{7}\sin\left(5t + \frac{\pi}{3}\right)\mathrm{cm}$
where x is displacement and t is time in seconds. The maximum acceleration of the particle is $\mathrm{x} \times 10^{-2}\ \mathrm{ms}^{-2}$. The value of x is :

(1) 175

(2) $25\sqrt{7}$

(3) $5\sqrt{7}$

(4) 125

Q2. Two simple pendulums having lengths l_1 and l_2 with negligible string mass undergo angular displacements θ_1 and θ_2, from their mean positions, respectively. If the angular accelerations of both pendulums are same, then which expression is correct?

(1) $\theta_1 l_2^2 = \theta_2 l_1^2$

(2) $\theta_1 l_1 = \theta_2 l_2$

(3) $\theta_1 l_1^2 = \theta_2 l_2^2$

(4) $\theta_1 l_2 = \theta_2 l_1$

Q3. The amplitude and phase of a wave that is formed by the superposition of two harmonic travelling waves,
$\mathrm{y}_1(\mathrm{x}, \mathrm{t}) = 4\sin(\mathrm{kx} - \omega\mathrm{t})$ and $\mathrm{y}_2(\mathrm{x}, \mathrm{t}) = 2\sin\left(\mathrm{kx} - \omega\mathrm{t} + \frac{2\pi}{3}\right)$, are :
(Take the angular frequency of initial waves same as ω)

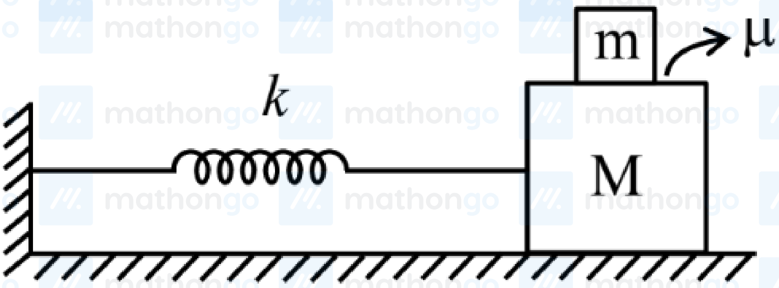
(1) $\left[6, \frac{2\pi}{3}\right]$

(2) $\left[6, \frac{\pi}{3}\right]$

(3) $\left[\sqrt{3}, \frac{\pi}{6}\right]$

(4) $\left[2\sqrt{3}, \frac{\pi}{6}\right]$

Q4. Two blocks of masses m and M, $(M > m)$, are placed on a frictionless table as shown in figure. A massless spring with spring constant k is attached with the lower block. If the system is slightly displaced and released then ($\mu =$ coefficient of friction between the two blocks)



(A) The time period of small oscillation of the two blocks is $\mathrm{T}=2 \pi \sqrt{\frac{(\mathrm{~m}+\mathrm{M})}{\mathrm{k}}}$
(B) The acceleration of the blocks is $\mathrm{a}=\frac{\mathrm{kx}}{\mathrm{M}+\mathrm{m}}$ ($\mathrm{x}=$ displacement of the blocks from the mean position)
(C) The magnitude of the frictional force on the upper block is $\frac{m \mu|x|}{M+m}$
(D) The maximum amplitude of the upper block, if it does not slip, is $\frac{\mu(M+m) g}{k}$
(E) Maximum frictional force can be $\mu(\mathrm{M}+\mathrm{m}) \mathrm{g}$.
Choose the correct answer from the options given below:

(1) A, B, D Only

(2) B, C, D Only

(3) C, D, E Only

(4) A, B, C Only

Q1. The equation of a wave travelling on a string is $y = \sin[20\pi x + 10\pi t]$, where x and t are distance and time in SI units. The minimum distance between two points having the same oscillating speed is :

(1) 5.0 cm

(2) 20 cm

(3) 10 cm

(4) 2.5 cm

Q2. Two strings with circular cross section and made of same material, are stretched to have same amount of tension. A transverse wave is then made to pass through both the strings. The velocity of the wave in the first string having the radius of cross section R is v_1, and that in the other string having radius of cross section $R/2$ is v_2. Then $\frac{v_2}{v_1} =$

(1) $\sqrt{2}$

(2) 2

(3) 8

(4) 4

Q3. A sinusoidal wave of wavelength 7.5 cm travels a distance of 1.2 cm along the x -direction in 0.3 sec. The crest P is at $x = 0$ at $t = 0$sec and maximum displacement of the wave is 2 cm. Which equation correctly represents this wave ?

(1) $y = 2\cos(0.83x - 3.35t)$cm

(2) $y = 2\sin(0.83x - 3.5t)$cm

(3) $y = 2\cos(3.35x - 0.83t)$cm

(4) $y = 2\cos(0.13x - 0.5t)$cm

Q4. Displacement of a wave is expressed as $x(t) = 5\cos\left(628t + \frac{\pi}{2}\right)m$. The wavelength of the wave when its velocity is 300 m/s is :

(1) 5 m

(2) 3 m

(3) 0.5 m

(4) 0.33 m

Q5. In the resonance experiment, two air columns (closed at one end) of 100 cm and 120 cm long, give 15 beats per second when each one is sounding in the respective fundamental modes. The velocity of sound in the air column is :

(1) $335 \mathrm{~m/s}$

(2) $370 \mathrm{~m/s}$

(3) $340 \mathrm{~m/s}$

(4) $360 \mathrm{~m/s}$

Q6. In an experiment with a closed organ pipe, it is filled with water by $\left(\frac{1}{5}\right)$ th of its volume. The frequency of the fundamental note will change by

(1) 25%

(2) 20%

(3) -20%

(4) -25%

Q7. Consider the sound wave travelling in ideal gases of He, CH_4, and CO_2. All the gases have the same ratio $\frac{P}{\rho}$, where P is the pressure and ρ is the density. The ratio of the speed of sound through the gases $v_{He} : v_{CH_4} : v_{CO_2}$ is given by

(1) $\sqrt{\frac{7}{5}} : \sqrt{\frac{5}{3}} : \sqrt{\frac{4}{3}}$

(2) $\sqrt{\frac{5}{3}} : \sqrt{\frac{4}{3}} : \sqrt{\frac{7}{5}}$

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

(4) $\sqrt{\frac{4}{3}} : \sqrt{\frac{5}{3}} : \sqrt{\frac{7}{5}}$

Q8. Two harmonic waves moving in the same direction superimpose to form a wave $\mathrm{x} = \mathrm{a} \cos(1.5\mathrm{t}) \cos(50.5\mathrm{t})$ where t is in seconds. Find the period with which they beat (close to nearest integer)

(1) 6 s

(2) 4 s

(3) 1 s

(4) 2 s

Q1. Consider a rectangular sheet of solid material of length $\ell = 9$ cm and width $\mathrm{d} = 4$ cm. The coefficient of linear expansion is $\alpha = 3.1 \times 10^{-5}\ \mathrm{K}^{-1}$ at room temperature and one atmospheric pressure. The mass of sheet $\mathrm{m} = 0.1$ kg and the specific heat capacity $\mathrm{C_v} = 900\ \mathrm{J\ kg^{-1}\ K^{-1}}$. If the amount of heat supplied to the material is 8.1×10^2 J then change in area of the rectangular sheet is :-

(1) $2.0 \times 10^{-6}\ \mathrm{m}^2$

(2) $3.0 \times 10^{-7}\ \mathrm{m}^2$

(3) $6.0 \times 10^{-7}\ \mathrm{m}^2$

(4) $4.0 \times 10^{-7}\ \mathrm{m}^2$

Q2. Water falls from a height of 200 m into a pool. Calculate the rise in temperature of the water assuming no heat dissipation from the water in the pool.
(Take $g = 10\ \mathrm{m/s^2}$, specific heat of water $= 4200\ \mathrm{J/(kgK)}$)

(1) 0.23 K

(2) 0.36 K

(3) 0.14 K

(4) 0.48 K

Q3. A wire of length 10 cm and diameter 0.5 mm is used in a bulb. The temperature of the wire is $1727^{\circ}\mathrm{C}$ and power radiated by the wire is 94.2 W. Its emissivity is $\frac{x}{8}$ where $x =$_______
(Given $\sigma = 6.0 \times 10^{-8}\ \mathrm{W\ m^{-2}\ K^{-4}}, \pi = 3.14$ and assume that the emissivity of wire material is same at all wavelength.)

Q4. Two cylindrical rods A and B made of different materials, are joined in a straight line. The ratio of lengths, radii and thermal conductivities of these rods are :
$\frac{\mathrm{L_A}}{\mathrm{L_B}} = \frac{1}{2}, \frac{\mathrm{r_A}}{\mathrm{r_B}} = 2$ and $\frac{\mathrm{K_A}}{\mathrm{K_B}} = \frac{1}{2}$. The free ends of rods A and B are maintained at 400 K, 200 K, respectively. The temperature of rods interface is ________ K, when equilibrium is established.

Q1. Match List-I with List-II.

	List - I		List - II
(A)	Isobaric	(I)	$\Delta Q=\Delta W$
(B)	Isochoric	(II)	$\Delta Q=\Delta U$
(C)	Adiabatic	(III)	$\Delta Q=$ zero
(D)	Isothermal	(IV)	$\Delta Q=\Delta U+P\Delta V$

ΔQ = Heat supplied
ΔW = Work done by the system
ΔU = Change in internal energy
P = Pressure of the system
ΔV = Change in volume of the system
Choose the correct answer from the options given below:

(1) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

(2) (A)-(IV), (B)-(I), (C)-(III), (D)-(II)

(3) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

(4) (A)-(II), (B)-(IV), (C)-(III), (D)-(I)

Q2. There are two vessels filled with an ideal gas where volume of one is double the volume of other. The large vessel contains the gas at 8 kPa at 1000 K while the smaller vessel contains the gas at 7 kPa at 500 K. If the vessels are connected to each other by a thin tube allowing the gas to flow and the temperature of both vessels is maintained at 600 K , at steady state the pressure in the vessels will be (in kPa).

(1) 4.4

(2) 6

(3) 24

(4) 18

Q3. The internal energy of air in $4\text{ m}\times 4\text{ m}\times 3\text{ m}$ sized room at 1 atmospheric pressure will be ________ $\times 10^6$ J. (Consider air as diatomic molecule)

Q4. During the melting of a slab of ice at 273 K at atmospheric pressure :

(1) Internal energy of ice-water system remains unchanged.

(2) Positive work is done by the ice-water system on the atmosphere.

(3) Internal energy of the ice-water system decreases.

(4) Positive work is done on the ice-water system by the atmosphere.

Q5. In an adiabatic process, which of the following statements is true?

(1) The molar heat capacity is infinite

(2) Work done by the gas equals the increase in internal energy

(3) The molar heat capacity is zero

(4) The internal energy of the gas decreases as the temperature increases

Q6. Identify the characteristics of an adiabatic process in a monoatomic gas.
(A) Internal energy is constant.
(B) Work done in the process is equal to the charge in internal energy.
(C) The product of temperature and volume is a constant.
(D) The product of pressure and volume is a constant.
(E) The work done to change the temperature from T_1 to T_2 is proportional to $(T_2 - T_1)$
Choose the correct answer from the options given below :

(1) (A), (C), (D) only

(2) (A), (C), (E) only

(3) (B), (E) only

(4) (B), (D) only

Q7. A gas is kept in a container having walls which are thermally non-conducting. Initially the gas has a volume of 800 cm^3 and temperature 27°C. The change in temperature when the gas is adiabatically compressed to 200 cm^3 is :
(Take $\gamma = 1.5$: γ is the ratio of specific heats at constant pressure and at constant volume)

(1) 327 K

(2) 600 K

(3) 522 K

(4) 300 K

Q8. Pressure of an ideal gas, contained in a closed vessel, is increased by 0.4% when heated by 1°C. Its initial temperature must be :

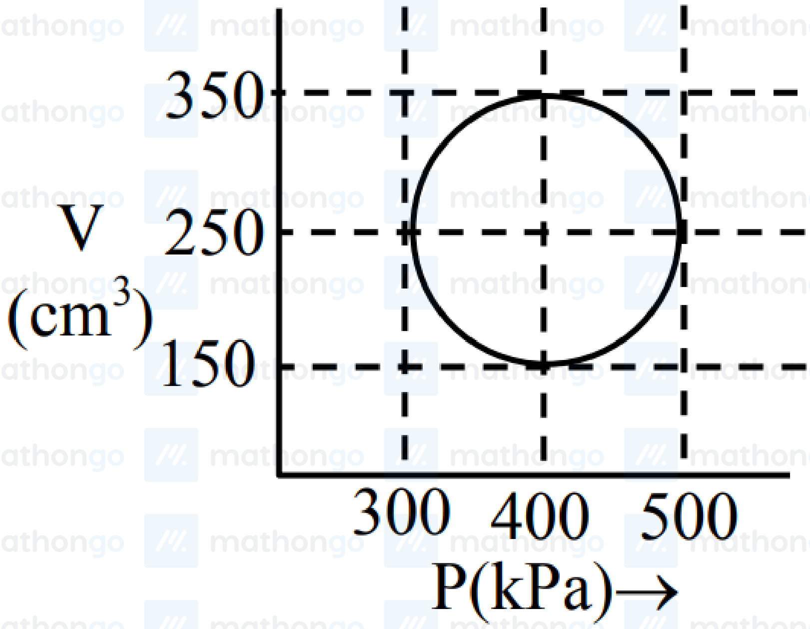
(1) $25^\circ C$

(2) 2500 K

(3) 250 K

(4) $250^\circ C$

Q9. An ideal gas has undergone through the cyclic process as shown in the figure. Work done by the gas in the entire cycle is ______ $\times 10^{-1}$ J.
(Take $\pi = 3.14$)



Q10. Match List-I with List-II.

	List-I		List-II
(A)	Isothermal	(I)	ΔW(work done) $= 0$
(B)	Adiabatic	(II)	ΔQ(supplied heat) $= 0$
(C)	Isobaric	(III)	ΔU(change in internal energy $\neq 0$
(D)	Isochoric	(IV)	$\Delta U = 0$

Choose the correct answer from the options given below :

(1) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

(2) (A)-(IV), (B)-(I), (C)-(III), (D)-(II)

(3) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)

(4) (A)-(II), (B)-(IV), (C)-(I), (D)-(III)

Q11. A monoatomic gas having $\gamma = \frac{5}{3}$ is stored in a thermally insulated container and the gas is suddenly compressed to $\left(\frac{1}{8}\right)^{\text{th}}$ of its initial volume. The ratio of final pressure and initial pressure is: (γ is the ratio of specific heats of the gas at constant pressure and at constant volume)

(1) 16

(2) 40

(3) 32

(4) 28

Q12. An ideal gas exists in a state with pressure P_0 volume V_0.It is isothermally expanded to 4 times of its initial volume $\left(\mathrm{V}_0\right)$, then isobarically compressed to its original volume. Finally the system is heated isochorically to bring it to its initial state. The amount of heat exchanged in this process is :

(1) $\mathrm{P}_0 \mathrm{~V}_0(2 \ln 2-0.75)$

(2) $\mathrm{P}_0 \mathrm{~V}_0(\ln 2-0.75)$

(3) $\mathrm{P}_0 \mathrm{~V}_0(\ln 2-0.25)$

(4) $P_0 V_0(2 \ln 2-0.25)$

Q1. The mean free path and the average speed of oxygen molecules at 300 K and 1 atm are 3×10^{-7} m and $600 \mathrm{~m/s}$ respectively. Find the frequency of its collisions.

(1) $2 \times 10^{10}/\mathrm{s}$

(2) $9 \times 10^{5}/\mathrm{s}$

(3) $2 \times 10^{9}/\mathrm{s}$

(4) $5 \times 10^{8}/\mathrm{s}$

Q2. The helium and argon are put in the flask at the same room temperature (300 K). The ratio of average kinetic energies (per molecule) of helium and argon is :
(Give : Molar mass of helium $= 4 \mathrm{~g/mol}$, Molar mass of argon $= 40 \mathrm{~g/mol}$)

(1) 1 : 10

(2) 10 : 1

(3) $1 : \sqrt{10}$

(4) 1 : 1

Q3. γ_{A} is the specific heat ratio of monoatomic gas A having 3 translational degrees of freedom. γ_B is the specific heat ratio of polyatomic gas B having 3 translational, 3 rotational degrees of freedom and 1 vibrational mode. If $\frac{\gamma_{\mathrm{A}}}{\gamma_{\mathrm{B}}} = \left(1 + \frac{1}{\mathrm{n}}\right)$, then the value of n is ________.

Q4. Match the List – I with List – II

	List-I		List-II
A.	Triatomic rigid gas	I.	$\frac{C_P}{C_V} = \frac{5}{3}$
B.	Diatomic non-rigid gas	II.	$\frac{C_P}{C_V} = \frac{7}{5}$
C.	Monoatomic gas	III.	$\frac{C_P}{C_V} = \frac{4}{3}$
D.	Diatomic rigid gas	IV	$\frac{C_P}{C_V} = \frac{9}{7}$

Choose the correct answer from the options given below :

(1) A-III, B-IV, C-I, D-II

(2) A-III, B-II, C-IV, D-I

(3) A-II, B-IV, C-I, D-III

(4) A-IV, B-II, C-III, D-I

Q1. Two metal spheres of radius R and $3R$ have same surface charge density σ. If they are brought in contact and then separated, the surface charge density on smaller and bigger sphere becomes σ_1 and σ_2, respectively. The ratio $\frac{\sigma_1}{\sigma_2}$ is.

(1) $\frac{1}{9}$

(2) 9

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

(4) 3

Q2. A point charge +q is placed at the origin. A second point charge +9 q is placed at $(\mathrm{d}, 0, 0)$ in Cartesian coordinate system. The point in between them where the electric field vanishes is :

(1) $(4\ \mathrm{d}/3, 0, 0)$

(2) $(\mathrm{d}/4, 0, 0)$

(3) $(3\ \mathrm{d}/4, 0, 0)$

(4) $(\mathrm{d}/3, 0, 0)$

Q3. The electrostatic potential on the surface of uniformly charged spherical shell of radius $\mathrm{R} = 10$ cm is 120 V. The potential at the centre of shell, at a distance $\mathrm{r} = 5$ cm from centre, and at a distance $\mathrm{r} = 15$ cm from the centre of the shell respectively, are :

(1) 120 V, 120 V, 80 V

(2) 40 V, 40 V, 80 V

(3) 0 V, 0 V, 80 V

(4) 0 V, 120 V, 40 V

Q4. Two small spherical balls of mass 10 g each with charges $-2\mu\mathrm{C}$ and $2\mu\mathrm{C}$, are attached to two ends of very light rigid rod of length 20 cm. The arrangement is now placed near an infinite nonconducting charge sheet with uniform charge density of $100\mu\mathrm{C}/\mathrm{m}^2$ such that length of rod makes an angle of 30° with electric field generated by charge sheet. Net torque acting on the rod is:
(Take $\varepsilon_0 : 8.85 \times 10^{-12}\mathrm{C}^2/\mathrm{Nm}^2$)

(1) 112 Nm

(2) 1.12 Nm

(3) 2.24 Nm

(4) 11.2 Nm

Q5. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Net dipole moment of a polar linear isotropic dielectric substance is not zero even in the absence of an external electric field.
Reason (R) : In absence of an external electric field, the different permanent dipoles of a polar dielectric substance are oriented in random directions.
In the light of the above statements, choose the most appropriate answer from the options given below :

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

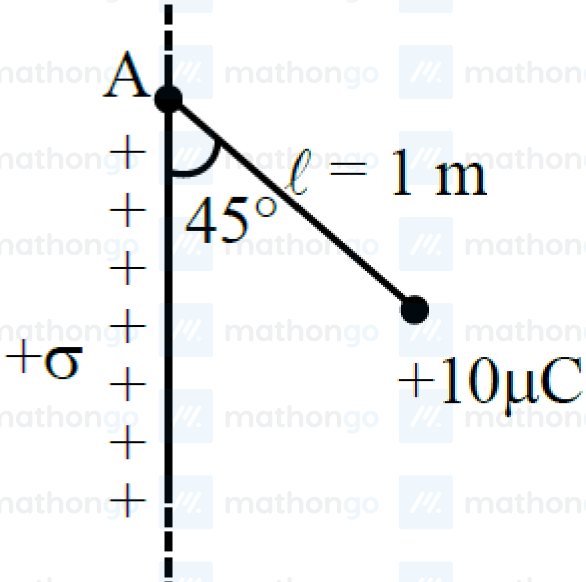
(2) Both (A) and (R) are correct but (R) is not the correct explanation of (A)

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

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

Q6. The electric field in a region is given by $\overrightarrow{\mathrm{E}} = (2\hat{\mathrm{i}} + 4\hat{\mathrm{j}} + 6\hat{\mathrm{k}}) \times 10^3\ \mathrm{N/C}$. The flux of the field through a rectangular surface parallel to $x - z$ plane is $6.0\mathrm{Nm}^2\mathrm{C}^{-1}$. The area of the surface is ________ cm^2.

Q7. A small bob of mass 100 mg and charge $+10\mu\mathrm{C}$ is connected to an insulating string of length 1 m. It is brought near to an infinitely long nonconducting sheet of charge density ' σ ' as shown in figure. If string subtends an angle of 45° with the sheet at equilibrium the charge density of sheet will be :
(Given, $\varepsilon_0 = 8.85 \times 10^{-12} \frac{\mathrm{F}}{\mathrm{m}}$ and acceleration due to gravity, $g = 10\ \mathrm{m/s^2}$)



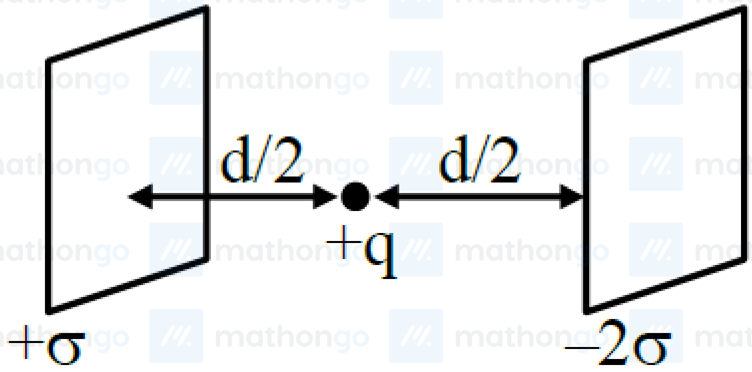
(1) $0.885\mathrm{nC/m^2}$

(2) $17.7\mathrm{nC/m^2}$

(3) $885\mathrm{nC/m^2}$

(4) $1.77\mathrm{nC/m^2}$

Q8. Consider two infinitely large plane parallel conducting plates as shown below. The plates are uniformly charged with a surface charge density $+\sigma$ and -2σ. The force experienced by a point charge +q placed at the mid point between two plates will be :



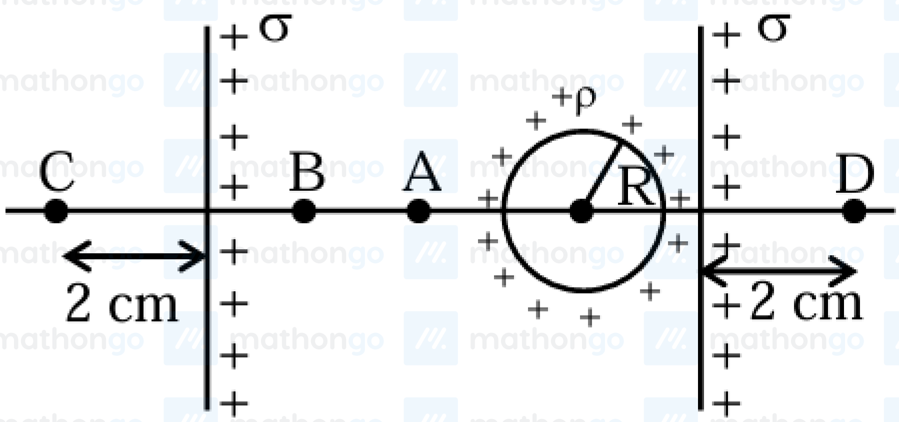
(1) $\frac{\sigma q}{4\epsilon_0}$

(2) $\frac{3\sigma q}{2\epsilon_0}$

(3) $\frac{3\sigma q}{4\in_0}$

(4) $\frac{\sigma q}{2\epsilon_0}$

Q9. Two infinite identical charged sheets and a charged spherical body of charge density ' ρ ' are arranged as shown in figure. Then the correct relation between the electrical fields at A, B, C and D points is :



(1) $\vec{E}_A = \vec{E}_B; \vec{E}_C = \vec{E}_D$

(2) $\vec{E}_A > \vec{E}_B; \vec{E}_C = \vec{E}_D$

(3) $\vec{E}_C \neq \vec{E}_D; \vec{E}_A > \vec{E}_B$

(4) $\left|\vec{E}_A\right| = \left|\vec{E}_B\right|; \vec{E}_C > \vec{E}_D$

Q10. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The outer body of an air craft is made of metal which protects persons sitting inside from lightning-strikes.
Reason (R) : The electric field inside the cavity enclosed by a conductor is zero.
In the light of the above statements, chose the most appropriate answer from the options given below :

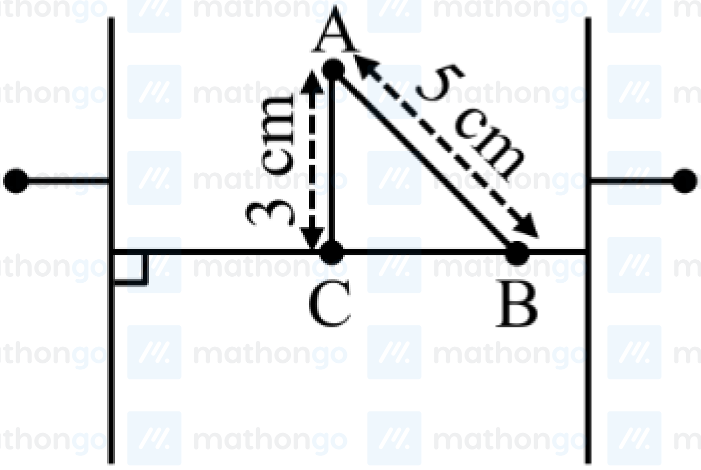
(1) Both (A) and (R) are correct and (R) is the correct explanation of (A)

(2) (A) is correct but (R) is not correct

(3) Both (A) and (R) are correct but (R) is not correct explanation of (A)

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

Q11. Two large plane parallel conducting plates are kept 10 cm apart as shown in figure. The potential difference between them is V. The potential difference between the points A and B (shown in the figure) is :



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

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

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

(4) 1 V

Q12. Consider a circular loop that is uniformly charged and has a radius $a\sqrt{2}$. Find the position along the positive z - axis of the cartesian coordinate system where the electric field is maximum if the ring was assumed to be placed in xy-plane at the origin :

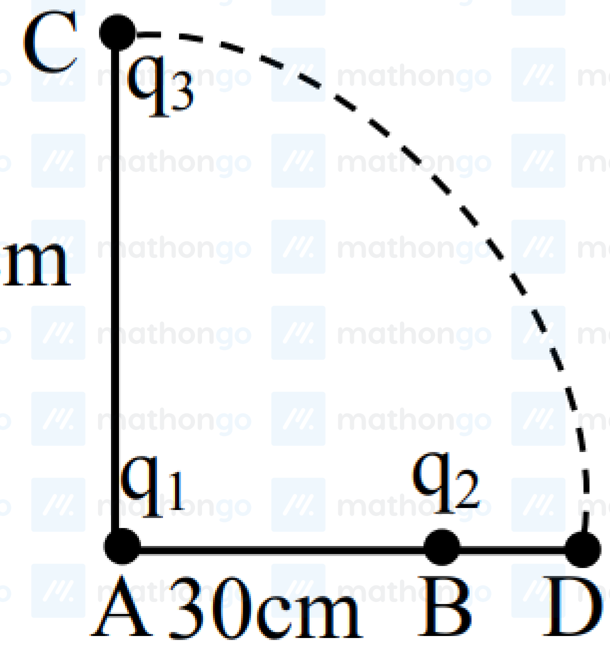
(1) $\frac{a}{\sqrt{2}}$

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

(3) a

(4) 0

Q13. Two charges q_1 and q_2 are separated by a distance of 30 cm. A third charge q_3 initially at ' C ' as shown in the figure, is moved along the circular path of radius 40 cm from C to D. If the difference in potential energy due to movement of q_3 from C to D is given by $\frac{q_3 K}{4\pi\epsilon_0}$, the value of K is :



(1) $8q_2$

(2) $6q_2$

(3) $8q_1$

(4) $6q_1$

Q14. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R Assertion A : Work done in moving a test charge between two points inside a uniformly charged spherical shell is zero, no matter which path is chosen.

Reason R : Electrostatic potential inside a uniformly charged spherical shell is constant and is same as that on the surface of the shell. In the light of the above statements, choose the correct answer from the options given below

(1) A is true but R is false

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

(3) A is false but R is true

(4) Both A and R are true but R is NOT the correct explanation of A

Q15. A dipole with two electric charges of $2\mu\mathrm{C}$ magnitude each, with separation distance 0.5μ m, is placed between the plates of a capacitor such that its axis is parallel to an electric field established between the plates when a potential difference of 5 V is applied. Separation between the plates is 0.5 mm. If the dipole is rotated by 30° from the axis, it tends to realign in the direction due to a torque. The value of torque is :

(1) $5 \times 10^{-9}\mathrm{Nm}$

(2) $5 \times 10^{-3}\mathrm{Nm}$

(3) $2.5 \times 10^{-12}\mathrm{Nm}$

(4) $2.5 \times 10^{-9}\mathrm{Nm}$

Q16. An infinitely long wire has uniform linear charge density $\lambda = 2\mathrm{nC/m}$. The net flux through a Gaussian cube of side length $\sqrt{3}$ cm, if the wire passes through any two corners of the cube, that are maximally displaced from each other, would be $\mathrm{xNm^2C^{-1}}$, where x is :
[Neglect any edge effects and use $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ SI units]

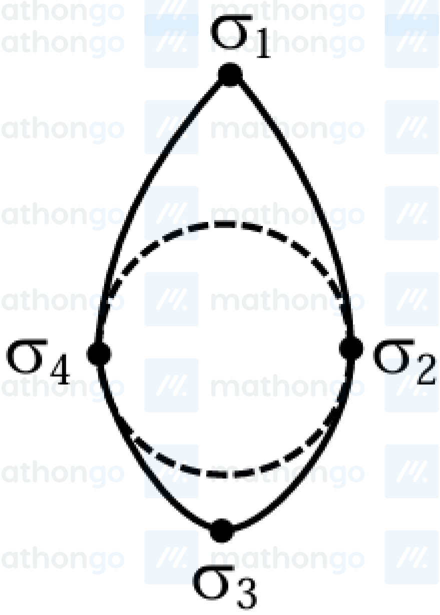
(1) 0.72π

(2) 1.44π

(3) 6.48π

(4) 2.16π

Q17. Electric charge is transferred to an irregular metallic disk as shown in figure. If $\sigma_1, \sigma_2, \sigma_3$ and σ_4 are charge densities at given points then, choose the correct answer from the options given below:



(A) $\sigma_1 > \sigma_3$; $\sigma_2 = \sigma_4$ (B) $\sigma_1 > \sigma_2$; $\sigma_3 > \sigma_4$
(C) $\sigma_1 > \sigma_3 > \sigma_2 = \sigma_4$ (D) $\sigma_1 < \sigma_3 < \sigma_2 = \sigma_4$
(E) $\sigma_1 = \sigma_2 = \sigma_3 = \sigma_4$

(1) A, B and C Only

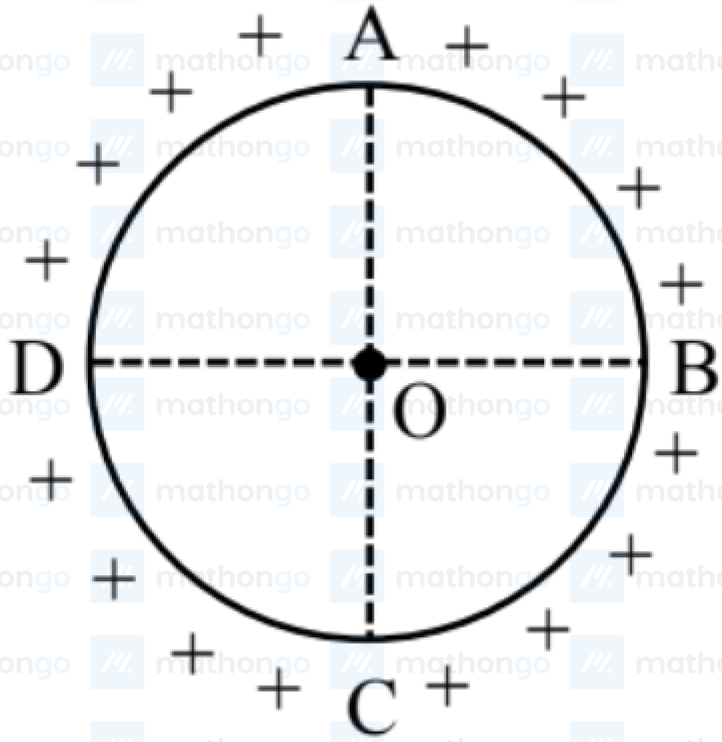
(2) A and C Only

(3) D and E Only

(4) B and C Only

Q18. An electron is released from rest near an infinite non-conducting sheet of uniform charge density ' $-\sigma$ '. The rate of change of de-Broglie wave length associated with the electron varies inversely as n^{th} power of time. The numerical value of n is ________.

Q19. A metallic ring is uniformly charged as shown in figure. AC and BD are two mutually perpendicular diameters. Electric field due to arc AB to ' O ' is ' E ' is magnitude. What would be the magnitude of electric field at ' O ' due to arc ABC ?



(1) 2 E

(2) $\sqrt{2}$E

(3) E/2

(4) Zero

Q1. Using a battery, a 100 pF capacitor is charged to 60 V and then the battery is removed. After that, a second uncharged capacitor is connected to the first capacitor in parallel. If the final voltage across the second capacitor is 20 V, its capacitance is : (in pF)

(1) 600

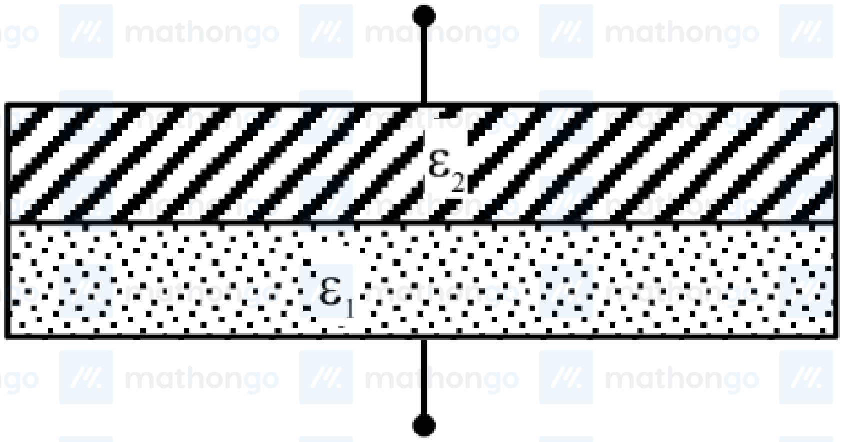
(2) 200

(3) 400

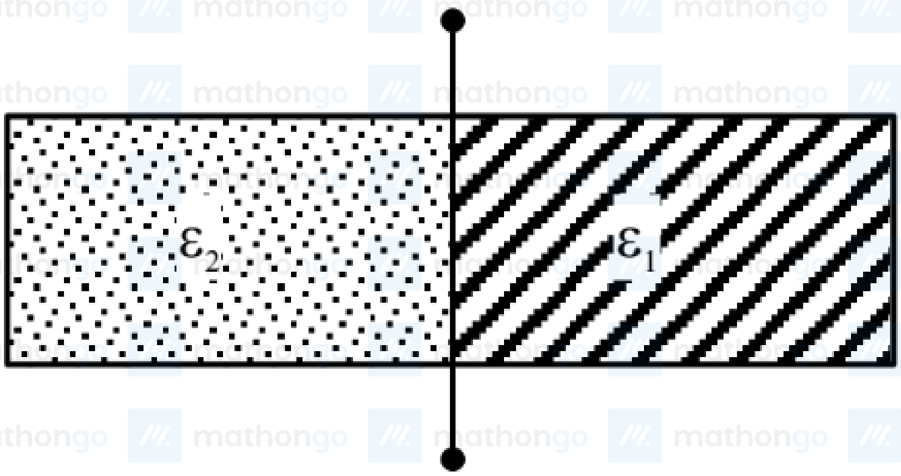
(4) 100

Q2. A parallel plate capacitor is filled equally (half) with two dielectrics of dielectric constant ε_1 and ε_2, as shown in figures. The distance between the plates is d and area of each plate is A. If capacitance in first configuration and second configuration are C_1 and C_2 respectively, then $\frac{C_1}{C_2}$ is :

First Configuration



Second Configuration



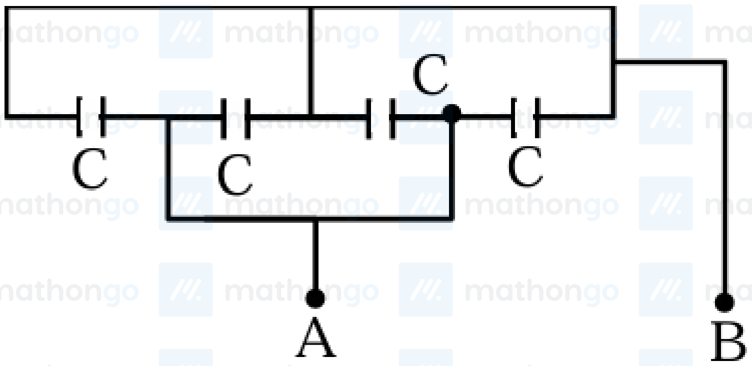
(1) $\frac{\varepsilon_1\varepsilon_2^2}{(\varepsilon_1+\varepsilon_2)^2}$

(2) $\frac{4\varepsilon_1\varepsilon_2}{(\varepsilon_1+\varepsilon_2)^2}$

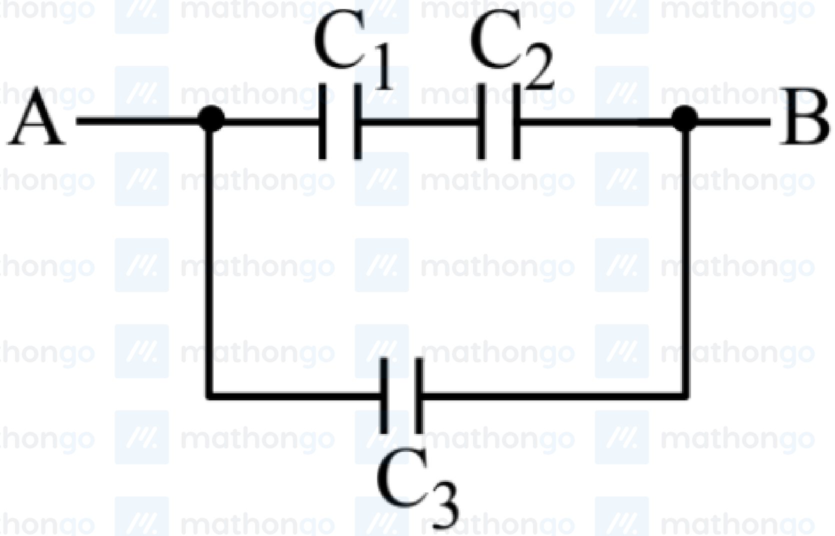
(3) $\frac{\varepsilon_1\varepsilon_2}{\varepsilon_1+\varepsilon_2}$

(4) $\frac{\varepsilon_0(\varepsilon_1+\varepsilon_2)}{2}$

Q3. Four capacitor each of capacitance 16μ F are connected as shown in the figure. The capacitance between points A and B is : ______ (in μF).



Q4. Three parallel plate capacitors C_1, C_2 and C_3 each of capacitance 5μ F are connected as shown in figure. The effective capacitance between points A and B, when the space between the parallel plates of C_1 capacitor is filled with a dielectric medium having dielectric constant of 4, is :



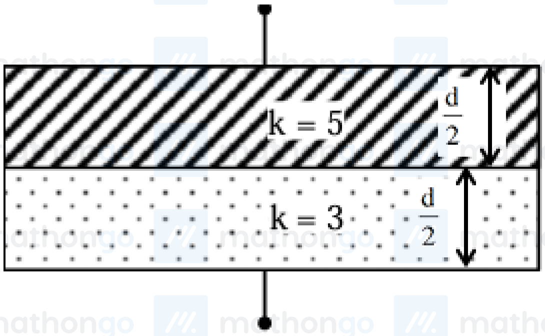
(1) 22.5μ F

(2) 7.5μ F

(3) 9μ F

(4) $30 \mu \mathrm{~F}$

Q5.



Space between the plates of a parallel plate capacitor of plate area $4 \mathrm{~cm}^2$ and separation of (d) 1.77 mm, is filled with uniform dielectric materials with dielectric constants (3 and 5) as shown in figure. Another capacitor of capacitance 7.5 pF is connected in parallel with it. The effective capacitance of this combination is ________ pF. $\left(\text{ Given } \varepsilon_0=8.85 \times 10^{-12} \mathrm{~F} / \mathrm{m}\right)$

Q6. A parallel plate capacitor has charge $5 \times 10^{-6} \mathrm{C}$. A dielectric slab is inserted between the plates and almost fills the space between the plates. If the induced charge on one face of the slab is $4 \times 10^{-6} \mathrm{C}$ then the dielectric constant of the slab is ________.

Q1. Current passing through a wire as function of time is given as $\mathrm{I(t)} = 0.02\mathrm{t} + 0.01\ \mathrm{A}$. The charge that will flow through the wire from $t = 1s$ to $t = 2s$ is :

(1) 0.06 C

(2) 0.02 C

(3) 0.07 C

(4) 0.04 C

Q2. A motor operating on 100 V draws a current of 1 A. If the efficiency of the motor is 91.6%, then the loss of power in units of cal/s is

(1) 4

(2) 8.4

(3) 2

(4) 6.2

Q3. A wire of length 25 m and cross-sectional area 5 mm^2 having resistivity of $2 \times 10^{-6} \Omega\ \mathrm{m}$ is bent into a complete circle. The resistance between diametrically opposite points will be

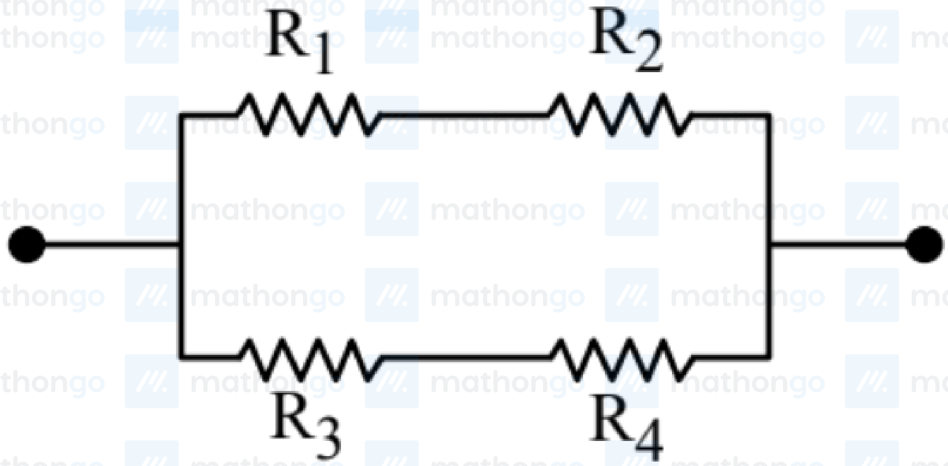
(1) 12.5Ω

(2) 50Ω

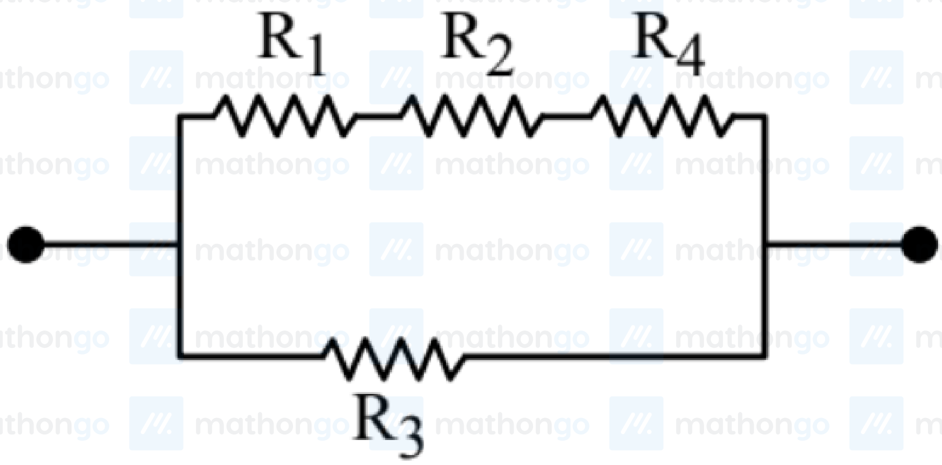
(3) 100Ω

(4) 25Ω

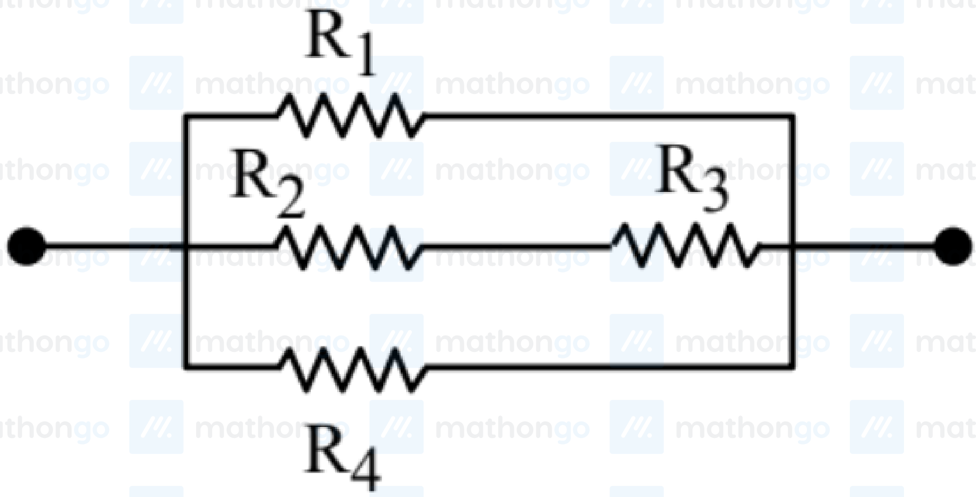
Q4. From the combination of resistors with resistance values $R_1 = R_2 = R_3 = 5\Omega$ and $R_4 = 10\Omega$, which of the following combination is the best circuit to get an equivalent resistance of 6Ω ?



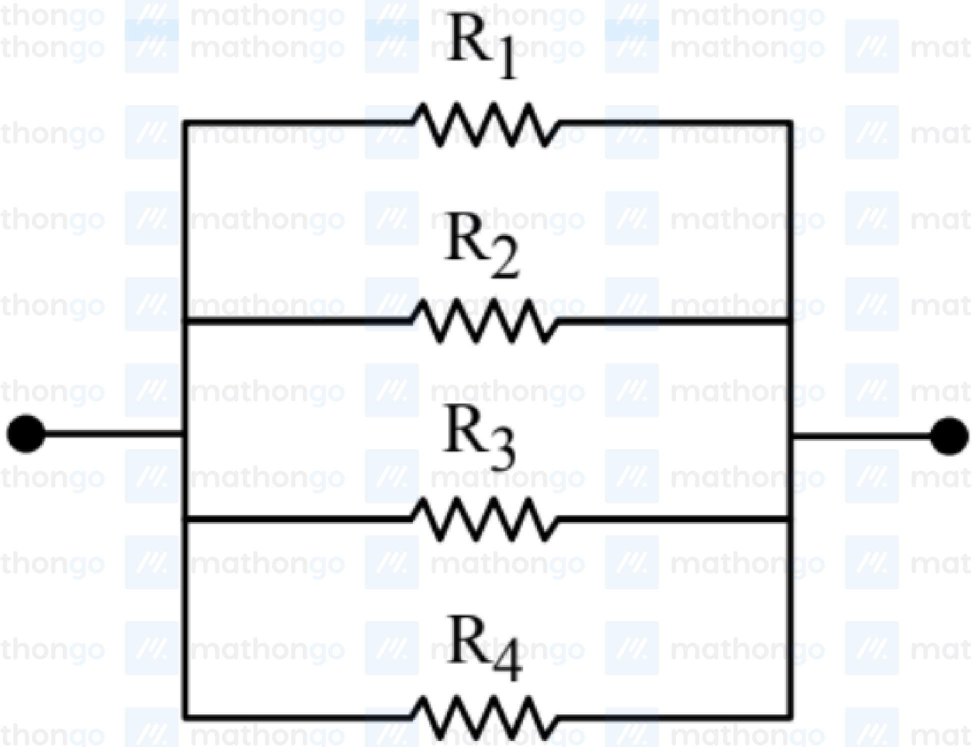
(1)



(2)



(3)



(4)

Q5. Two cells of emf 1 V and 2 V and internal resistance 2Ω and 1Ω, respectively, are connected in series with an external resistance of 6Ω. The total current in the circuit is I_1. Now the same two cells in parallel configuration are connected to same external resistance. In this case, the total current drawn is I_2. The value of $\left(\frac{I_1}{I_2}\right)$ is $\frac{x}{3}$. The value of x is _____.

Q6. The battery of a mobile phone is rated as 4.2 V , 5800 mAh. How much energy is stored in it when fully charged ?

(1) 43.8 kJ

(2) 48.7 kJ

(3) 87.7 kJ

(4) 24.4 kJ

Q7. There are ' n ' number of identical electric bulbs, each is designed to draw a power p independently from the mains supply. They are now joined in series across the main supply. The total power drawn by the combination is :

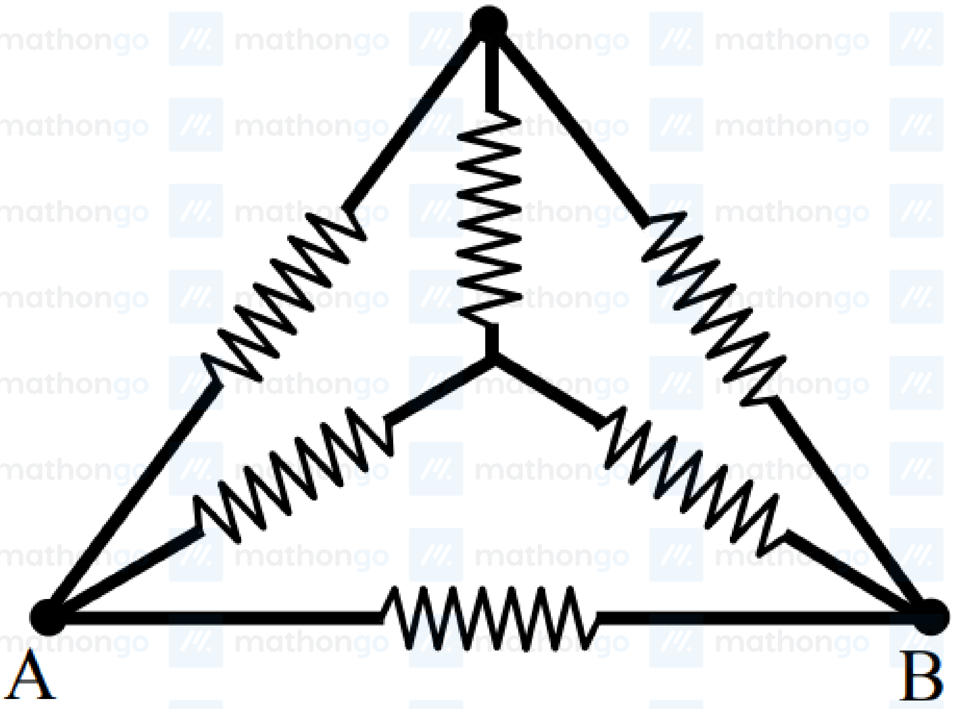
(1) np

(2) $\frac{\mathrm{p}}{\mathrm{n}^2}$

(3) $\frac{\mathrm{p}}{\mathrm{n}}$

(4) p

Q8. A wire of resistance R is bent into a triangular pyramid as shown in figure with each segment having same length. The resistance between points A and B is R/n. The value of n is :



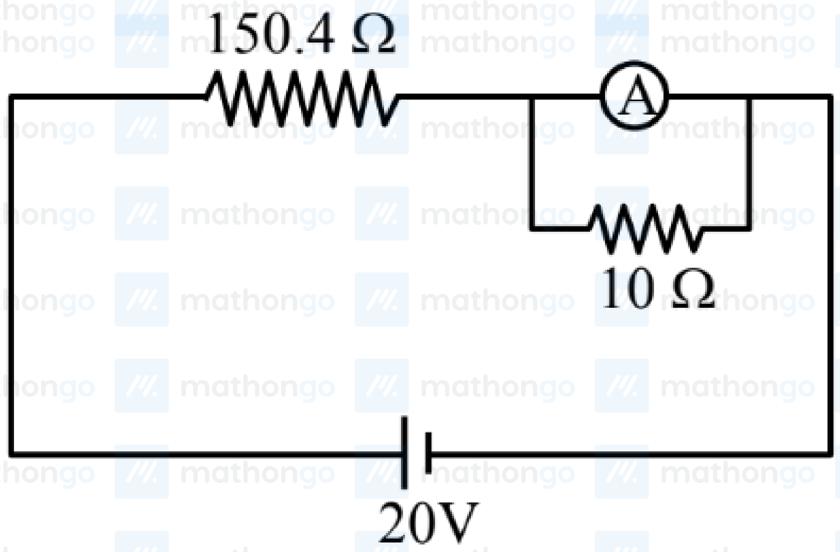
(1) 16

(2) 14

(3) 10

(4) 12

Q9. In the figure shown below, a resistance of 150.4Ω is connected in series to an ammeter A of resistance 240Ω. A shunt resistance of 10Ω is connected in parallel with the ammeter. The reading of the ammeter is ______ mA.


150.4 Ω
A
10 Ω
20V

Q1. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason(R).
Assertion (A) : Magnetic monopoles do not exist.
Reason (R) : Magnetic field lines are continuous and form closed loops.
In the light of the above statements, choose the most appropriate answer from the options given below :

(1) Both (A) and (R) are correct but (R) is not the correct explanation of (A)

(2) (A) is correct but (R) is not correct

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

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

Q2. The relationship between the magnetic susceptibility (χ) and the magnetic permeability (μ) is given by :
(μ_0 is the permeability of free space and μ_{r} is relative permeability)

(1) $\chi=\frac{\mu}{\mu_0}-1$

(2) $\chi=\frac{\mu_{\mathrm{r}}}{\mu_0}+1$

(3) $\chi=\mu_{\mathrm{r}}+1$

(4) $\chi=1-\frac{\mu}{\mu_0}$

Q3. A solenoid having area A and length ' l ' is filled with a material having relative permeability 2. The magnetic energy stored in the solenoid is :

(1) $\frac{\mathrm{B}^2 \mathrm{~A} l}{\mu_0}$

(2) $\frac{\mathrm{B}^2 \mathrm{~A} l}{2 \mu_0}$

(3) $\mathrm{B}^2 \mathrm{Al}$

(4) $\frac{\mathrm{B}^2 \mathrm{~A} l}{4 \mu_0}$

Q4. The percentage increase in magnetic field (B) when space within a current carrying solenoid is filled with magnesium (magnetic susceptibility $\left.\chi_{\mathrm{mg}}=1.2 \times 10^{-5}\right)$ is :

(1) $\frac{6}{5} \times 10^{-3} \%$

(2) $\frac{5}{6} \times 10^{-5} \%$

(3) $\frac{5}{6} \times 10^{-4} \%$

(4) $\frac{5}{3} \times 10^{-5} \%$

Q1. A 4.0 cm long straight wire carrying a current of 8A is placed perpendicular to an uniform magnetic field of strength 0.15 T. The magnetic force on the wire is ______ mN.

Q2. Let B_1 be the magnitude of magnetic field at center of a circular coil of radius R carrying current I. Let B_2 be the magnitude of magnetic field at an axial distance ' x ' from the center. For $x : R = 3 : 4$, $\frac{B_2}{B_1}$ is :

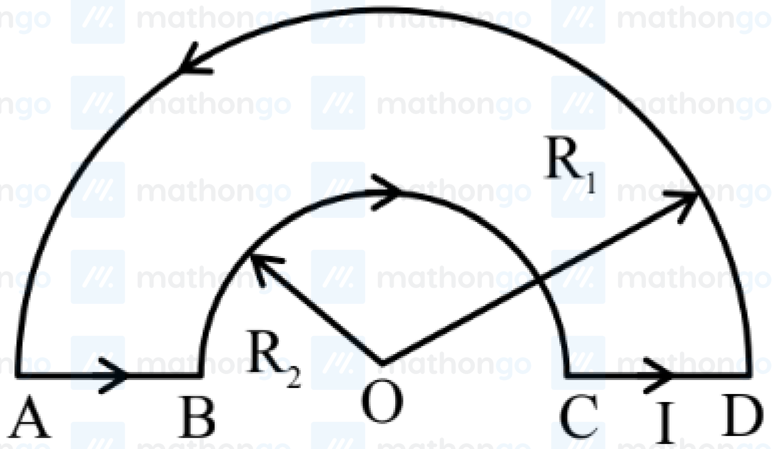
(1) 4 : 5

(2) 16 : 25

(3) 64 : 125

(4) 25 : 16

Q3. A loop ABCDA , carrying current $\mathrm{I} = 12$ A, is placed in a plane, consists of two semi-circular segments of radius $R_1 = 6\pi$ m and $\mathrm{R}_2 = 4\pi$ m. The magnitude of the resultant magnetic field at center O is $\mathrm{k} \times 10^{-7}$ T. The value of k is ______ (Given $\mu_0 = 4\pi \times 10^{-7} \mathrm{TmA}^{-1}$)



Q4. Given below are two statements: one is labelled as **Assertion A** and the other is labelled as**Reason R**.
Assertion A:. If oxygen ion $\left(\mathrm{O}^{-2}\right)$ and Hydrogen ion $\left(\mathrm{H}^{+}\right)$enter normal to the magnetic field with equal momentum, then the path of O^{-2} ion has a smaller curvature than that of H^{+}.
Reason R : A proton with same linear momentum as an electron will form a path of smaller radius of curvature on entering a uniform magnetic field perpendicularly.
In the light of the above statements, choose the ***correct*** answer from the options given below :

(1) A is true but R is false.

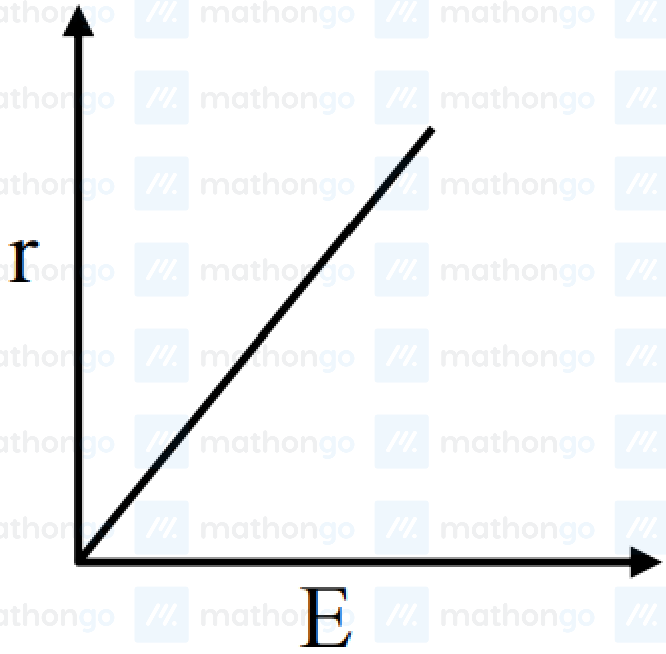
(2) Both A and R are true but R is NOT the correct explanation of A.

(3) A is false but R is true.

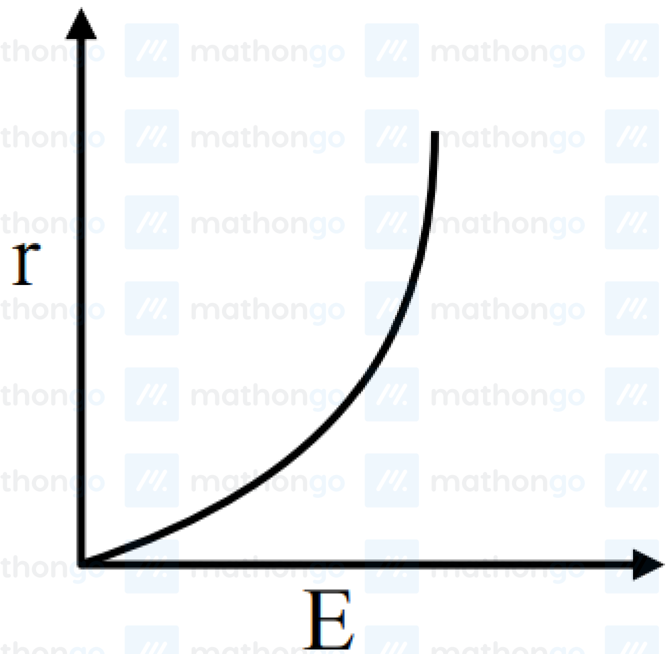
(4) Both A and R are true and R is the correct explanation of A.

Q5. A particle of charge $1.6 \mu \mathrm{C}$ and mass 16μ g is present in a strong magnetic field of 6.28 T. The particle is then fired perpendicular to magnetic field. The time required for the particle to return to original location for the first time is ________ S. $(\pi=3.14)$

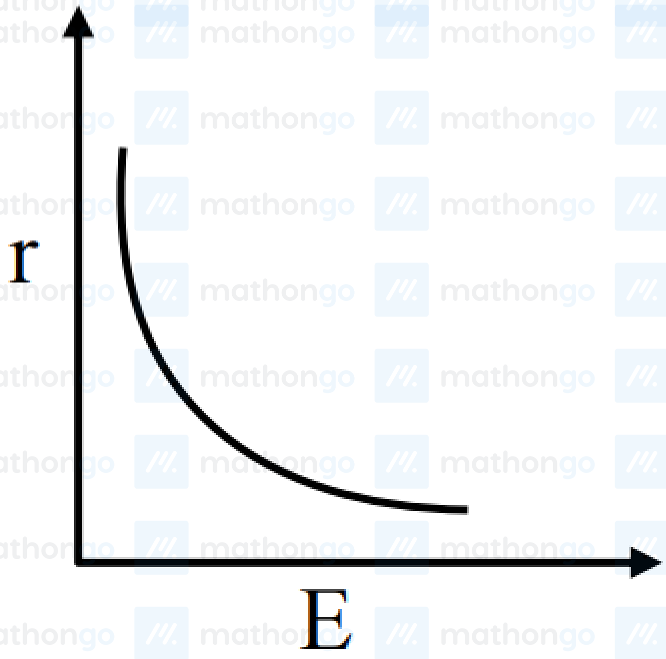
Q6. A particle of charge q, mass m and kinetic energy E enters in magnetic field perpendicular to its velocity and undergoes a circular arc of radius(r). Which of the following curves represents the variation of r with E ?



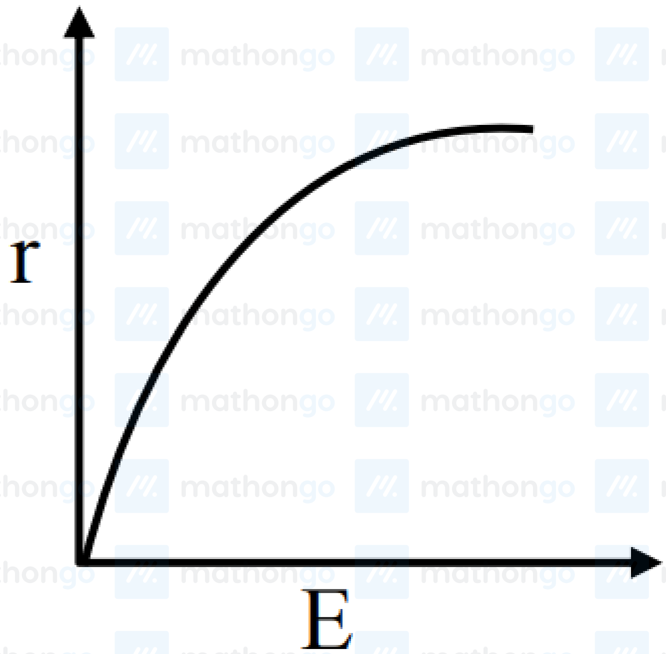
(1)



(2)



(3)



(4)

Q7. In a moving coil galvanometer, two moving coils M_1 and M_2 have the following particulars :

$\mathrm{R}_1 = 5\Omega,\ \mathrm{N}_1 = 15,\ \mathrm{A}_1 = 3.6 \times 10^{-3}\ \mathrm{m}^2,\ \mathrm{B}_1 = 0.25\ \mathrm{T}$

$\mathrm{R}_2 = 7\Omega,\ \mathrm{N}_2 = 21,\ \mathrm{A}_2 = 1.8 \times 10^{-3}\ \mathrm{m}^2,\ \mathrm{B}_2 = 0.50\ \mathrm{T}$

Assuming that torsional constant of the springs are same for both coils, what will be the ratio of voltage sensitivity of M_1 and M_2 ?

(1) 1 : 1

(2) 1 : 4

(3) $1:3$

(4) $1:2$

Q8. A magnetic dipole experiences a torque of $80\sqrt{3}$ N m when placed in uniform magnetic field in such a way that dipole moment makes angle of 60° with magnetic field. The potential energy of the dipole is :

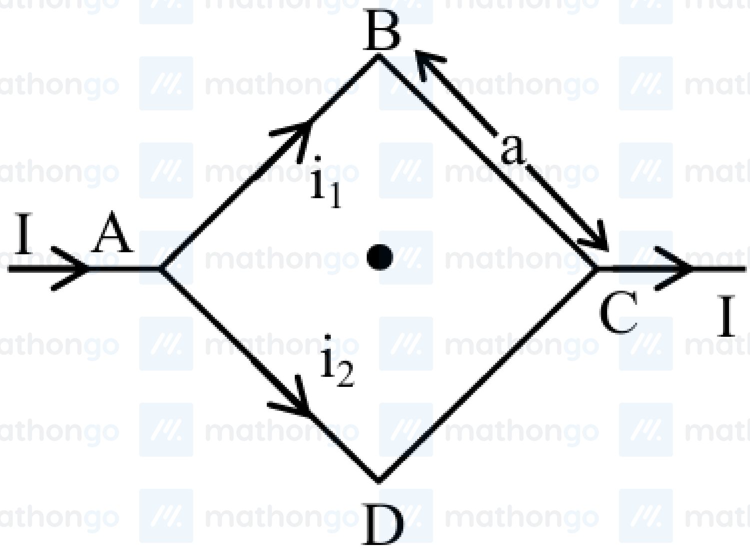
(1) 80 J

(2) $-40\sqrt{3}$ J

(3) -60 J

(4) -80 J

Q9. Figure shows a current carrying square loop ABCD of edge length is ' a ' lying in a plane. If the resistance of the ABC part is r and that of ADC part is 2 r , then the magnitude of the resultant magnetic field at centre of the square loop is



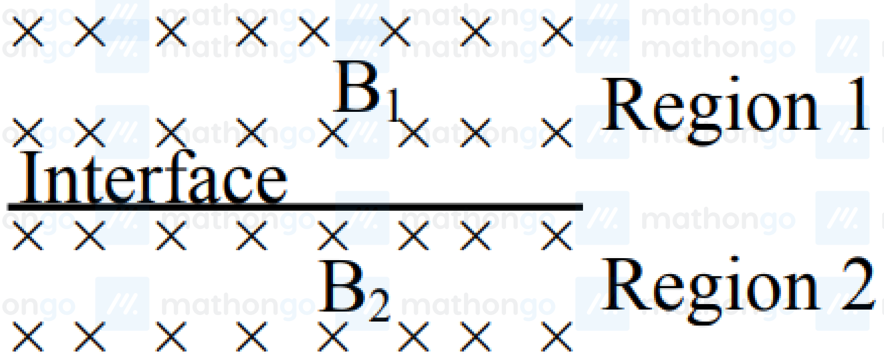
(1) $\frac{3\pi\mu_0 I}{\sqrt{2}a}$

(2) $\frac{\mu_0 I}{2\pi a}$

(3) $\frac{\sqrt{2}\mu_0 I}{3\pi a}$

(4) $\frac{2\mu_0 I}{3\pi a}$

Q10. Uniform magnetic fields of different strengths (B_1 and B_2), both normal to the plane of the paper exist as shown in the figure. A charged particle of mass m and charge q , at the interface at an instant, moves into the region 2 with velocity v and returns to the interface. It continues to move into region 1 and finally reaches the interface. What is the displacement of the particle during this movement along the interface?



(Consider the velocity of the particle to be normal to the magnetic field and $B_2 > B_1$)

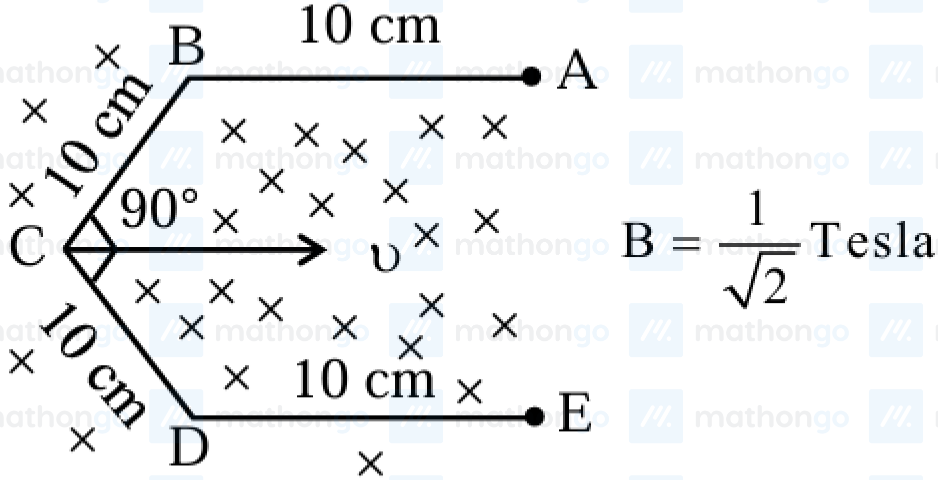
(1) $\frac{mv}{qB_1}\left(1-\frac{B_2}{B_1}\right)\times 2$

(2) $\frac{mv}{qB_1}\left(1-\frac{B_1}{B_2}\right)$

(3) $\frac{mv}{qB_1}\left(1-\frac{B_2}{B_1}\right)$

(4) $\frac{mv}{qB_1}\left(1-\frac{B_1}{B_2}\right)\times 2$

Q1. Conductor wire ABCDE with each arm 10 cm in length is placed in magnetic field of $\frac{1}{\sqrt{2}}$ Tesla, perpendicular to its plane. When conductor is pulled towards right with constant velocity of 10 cm/s, induced emf between points A and E is _____ mV.



Q1. An electric bulb rated as $100 \mathrm{~W}-220 \mathrm{~V}$ is connected to an ac source of rms voltage 220 V. The peak value of current through the bulb is :

(1) $0.64 \mathrm{~A}$

(2) $0.45 \mathrm{~A}$

(3) $2.2 \mathrm{~A}$

(4) $0.32 \mathrm{~A}$

Q2. An alternating current is represented by the equation, $i=100 \sqrt{2} \sin (100 \pi t)$ ampere. The RMS value of current and the frequency of the given alternating current are

(1) $100 \sqrt{2} \mathrm{~A}, 100 \mathrm{~Hz}$

(2) $\frac{100}{\sqrt{2}} \mathrm{~A}, 100 \mathrm{~Hz}$

(3) $100 \mathrm{~A}, 50 \mathrm{~Hz}$

(4) $50 \sqrt{2} \mathrm{~A}, 50 \mathrm{~Hz}$

Q3. An ac current is represented as
$\mathrm{i}=5 \sqrt{2}+10 \cos \left(650 \pi \mathrm{t}+\frac{\pi}{6}\right) \mathrm{Amp}$
The r.m.s value of the current is

(1) 50 Amp

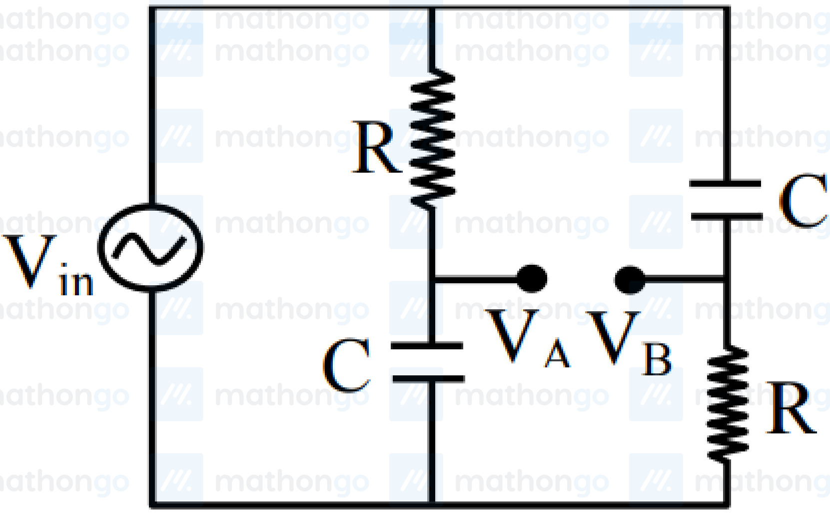
(2) 100 Amp

(3) 10 Amp

(4) $5 \sqrt{2} \mathrm{Amp}$

Q4. An inductor of reactance 100Ω, a capacitor of reactance 50Ω, and a resistor of resistance 50Ω are connected in series with an AC source of 10 V , 50 Hz. Average power dissipated by the circuit is ________ W.

Q5. For ac circuit shown in figure, $\mathrm{R}=100 \mathrm{k} \Omega$ and $\mathrm{C}=100 \mathrm{pF}$ and the phase difference between $\mathrm{V}_{\text {in }}$ and $\left(V_B-V_A\right)$ is 90°. The input signal frequency is $10^x \mathrm{rad} / \mathrm{sec}$, where ' x ' is ______



Q6. An inductor of self inductance 1 H connected in series with a resistor of 100π ohm and an ac supply of 100π volt, 50 Hz. Maximum current flowing in the circuit is ________ A.

Q1. The radii of curvature for a thin convex lens are 10 cm and 15 cm respectively. The focal length of the lens is 12 cm. The refractive index of the lens material is

(1) 1.2

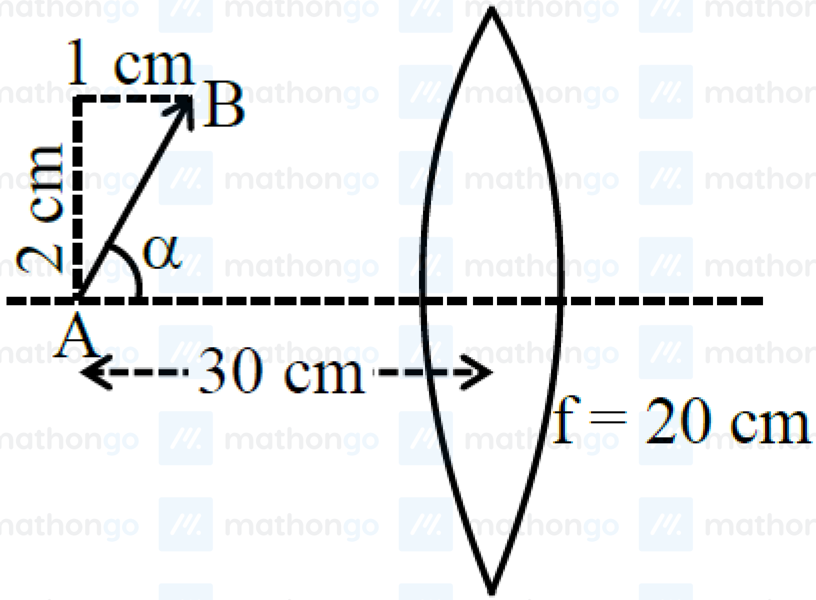
(2) 1.4

(3) 1.5

(4) 1.8

Q2. A ray of light suffers minimum deviation when incident on a prism having angle of the prism equal to 60°. The refractive index of the prism material is $\sqrt{2}$. The angle of incidence (in degrees) is ______.

Q3. A slanted object AB is placed on one side of convex lens as shown in the diagram. The image is formed on the opposite side. Angle made by the image with principal axis is:



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

(2) -45°

(3) $+45^{\circ}$

(4) $-\alpha$

Q4. Two identical objects are placed in front of convex mirror and concave mirror having same radii of curvature of 12 cm , at same distance of 18 cm from the respective mirrors. The ratio of sizes of the images formed by convex mirror and by concave mirror is :

(1) 1/2

(2) 2

(3) 3

(4) $1/3$

Q5. When an object is placed 40 cm away from a spherical mirror an image of magnification $\frac{1}{2}$ is produced. To obtain an image with magnification of $\frac{1}{3}$, the object is to be moved :

(1) 40 cm away from the mirror.

(2) 80 cm away from the mirror.

(3) 20 cm towards the mirror.

(4) 20 cm away from the mirror.

Q6. Distance between object and its image $\left(\text{magnified by } -\frac{1}{3}\right)$ is 30 cm. The focal length of the mirror used is $\left(\frac{x}{4}\right)$ cm,
where magnitude of value of x is ________.

Q7. A finite size object is placed normal to the principal axis at a distance of 30 cm from a convex mirror of focal length 30 cm. A plane mirror is now placed in such a way that the image produced by both the mirrors coincide with each other. The distance between the two mirrors is :

(1) 45 cm

(2) 7.5 cm

(3) 22.5 cm

(4) 15 cm

Q8. A mirror is used to produce an image with magnification of $\frac{1}{4}$. If the distance between object and its image is 40 cm , then the focal length of the mirror is ________

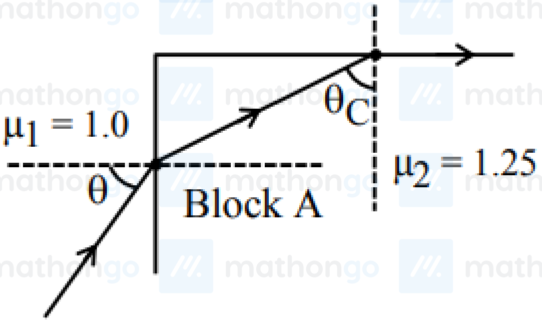
(1) 10 cm

(2) 12.7 cm

(3) 10.7 cm

(4) 15 cm

Q9. A transparent block A having refractive index $\mu = 1.25$ is surrounded by another medium of refractive index $\mu = 1.0$ as shown in figure. A light ray is incident on the flat face of the block with incident angle θ as shown in figure. What is the maximum value of θ for which light suffers total internal reflection at the top surface of the block?



(1) $\tan^{-1}(4/3)$

(2) $\tan^{-1}(3/4)$

(3) $\sin^{-1}(3/4)$

(4) $\cos^{-1}(3/4)$

Q10. A container contains a liquid with refractive index of 1.2 up to a height of 60 cm and another liquid having refractive index 1.6 is added to height H above first liquid. If viewed from above, the apparent shift in the position of bottom of container is 40 cm. The value of H is _______ cm.
(Consider liquids are immisible)

Q11. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R)
Assertion (A) : Refractive index of glass is higher than that of air.
Reason (R) : Optical density of a medium is directly proportionate to its mass density which results in a proportionate refractive index.
In the light of the above statements, choose the most appropriate answer from the options given below :

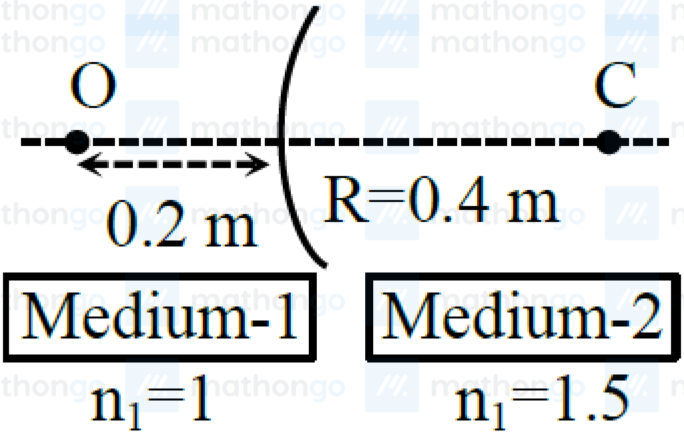
(1) (A) is not correct but (R) is correct

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

(3) (A) is correct but (R) is not correct

(4) Both (A) and (R) are correct but (R) is not the correct explanation of (A)

Q12.



A spherical surface separates two media of refractive indices 1 and 1.5 as shown in figure. Distance of the image of an object ' O ', is :

(C is the center of curvature of the spherical surface and R is the radius of curvature)

(1) 0.24 m right to the spherical surface

(2) 0.4 m left to the spherical surface

(3) 0.24 m left to the spherical surface

(4) 0.4 m right to the spherical surface

Q13. A bi-convex lens has radius of curvature of both the surfaces same as $1/6$ cm. If this lens is required to be replaced by another convex lens having different radii of curvatures on both sides $(R_1 \neq R_2)$, without any change in lens power then possible combination of R_1 and R_2 is :

(1) $\frac{1}{3}$ cm and $\frac{1}{3}$ cm

(2) $\frac{1}{5}$ cm and $\frac{1}{7}$ cm

(3) $\frac{1}{3}$ cm and $\frac{1}{7}$ cm

(4) $\frac{1}{6}$ cm and $\frac{1}{9}$ cm

Q14. Light from a point source in air falls on a spherical glass surface (refractive index, $\mu = 1.5$ and radius of curvature $= 50$ cm). The image is formed at a distance of 200 cm from the glass surface inside the glass. The magnitude of distance of the light source from the glass surface is ____ m.

Q15. A lens having refractive index 1.6 has focal length of 12 cm , when it is in air. Find the focal length of the lens when it is placed in water.

(Take refractive index of water as 1.28)

(1) 355 mm

(2) 288 mm

(3) 555 mm

(4) 655 mm

Q16. Two thin convex lenses of focal length 30 cm and 10 cm are placed coaxially, 10 cm apart. The power of this combination is :

(1) 5 D

(2) 1 D

(3) 20 D

(4) 10 D

Q17. A concave-convex lens of refractive index 1.5 and the radii of curvature of its surfaces are 30 cm and 20 cm , respectively. The concave surface is upwards and is filled with a liquid of refractive index 1.3. The focal length of the liquid-glass combination will be

(1) $\frac{500}{11}$ cm

(2) $\frac{800}{11}$ cm

(3) $\frac{700}{11}$ cm

(4) $\frac{600}{11}$ cm

Q18. A convex lens of focal length 30 cm is placed in contact with a concave lens of focal length 20 cm. An object is placed at 20 cm to the left of this lens system. The distance of the image from the lens in cm is ________

(1) 30

(2) 45

(3) $\frac{60}{7}$

(4) 15

Q19. Consider following statements for refraction of light through prism, when angle of deviation is minimum.
(A) The refracted ray inside prism becomes parallel to the base.
(B) Larger angle prisms provide smaller angle of minimum deviation.
(C) Angle of incidence and angle of emergence becomes equal.
(D) There are always two sets of angle of incidence for which deviation will be same except at minimum deviation setting.
(E) Angle of refraction becomes double of prism angle.
Choose the correct answer from the options given below.

(1) A, C and D Only

(2) B, C and D Only

(3) A, B and E Only

(4) B, D and E Only

Q1. A monochromatic light of frequency 5×10^{14} Hz travelling through air, is incident on a medium of refractive index ' 2 '. Wavelength of the refracted light will be :

(1) 300 nm

(2) 600 nm

(3) 400 nm

(4) 500 nm

Q2. Two monochromatic light beams have intensities in the ratio 1:9. An interference pattern is obtained by these beams. The ratio of the intensities of maximum to minimum is

(1) 8 : 1

(2) 9 : 1

(3) 3 : 1

(4) 4 : 1

Q3. In a Young's double slit experiment, the source is white light. One of the slits is covered by red filter and another by a green filter. In this case

(1) There shall be an interference pattern for red distinct from that for green.

(2) There shall be no interference fringes.

(3) There shall be alternate interference fringes of red and green.

(4) There shall be an interference pattern, where each fringe's pattern center is green and outer edges is red.

Q4. A light wave is propagating with plane wave fronts of the type $x + y + z =$ constant. The angle made by the direction of wave propagation with the x-axis is:

(1) $\cos^{-1}\left(\frac{1}{\sqrt{3}}\right)$

(2) $\cos^{-1}\left(\frac{2}{3}\right)$

(3) $\cos^{-1}\left(\frac{1}{3}\right)$

(4) $\cos^{-1}\left(\sqrt{\frac{2}{3}}\right)$

Q5. Two coherent monochromatic light beams of intensities 4I and 9I are superimposed. The difference between the maximum and minimum intensities in the resulting interference pattern is xI. The value of x is ______.

Q6. If the measured angular separation between the second minimum to the left of the central maximum and the third minimum to the right of the central maximum is 30° in a single slit diffraction pattern recorded using 628 nm light, then the width of the slit is _______ μm.

Q7. Width of one of the two slits in a Young's double slit interference experiment is half of the other slit. The ratio of the maximum to the minimum intensity in the interference pattern is :

(1) $(2\sqrt{2}+1):(2\sqrt{2}-1)$

(2) $(3+2\sqrt{2}):(3-2\sqrt{2})$

(3) $9:1$

(4) $3:1$

Q8. In a Young's double slit experiment, the slits are separated by 0.2 mm. If the slits separation is increased to 0.4 mm , the percentage change of the fringe width is:

(1) 0%

(2) 100%

(3) 50%

(4) 25%

Q9. In a Young's double slit experiment, two slits are located 1.5 mm apart. The distance of screen from slits is 2 m and the wavelength of the source is 400 nm. If the 20 maxima of the double slit pattern are contained within the centre maximum of the single slit diffraction pattern, then the width of each slit is x $\times 10^{-3}$ cm, where x -value is _______

Q10. Two polarisers P_1 and P_2 are placed in such a way that the intensity of the transmitted light will be zero. A third polariser P_3 is inserted in between P_1 and P_2, at the particular angle between P_2 and P_3. The transmitted intensity of the light passing the through all three polarisers is maximum. The angle between the polarisers P_2 and P_3 is :

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

(2) $\frac{\pi}{6}$

(3) $\frac{\pi}{8}$

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

Q1. An electron with mass ' m ' with an initial velocity $(\mathrm{t}=0) \overrightarrow{\mathrm{v}}=\mathrm{v}_0 \hat{\mathrm{i}} \quad (\mathrm{v}_0>0)$ enters a magnetic field $\vec{B}=B_0 \hat{j}$. If the initial de-Broglie wavelength at $\mathrm{t}=0$ is λ_0 then its value after time ' t ' would be :

(1) $\frac{\lambda_0}{\sqrt{1-\frac{\mathrm{e}^2 \mathrm{~B}_0^2 \mathrm{t}^2}{\mathrm{~m}^2}}}$

(2) $\frac{\lambda_0}{\sqrt{1+\frac{\mathrm{e}^2 \mathrm{~B}_0^2 \mathrm{t}^2}{\mathrm{~m}^2}}}$

(3) $\lambda_0 \sqrt{1+\frac{\mathrm{e}^2 \mathrm{~B}_0^2 \mathrm{t}^2}{\mathrm{~m}^2}}$

(4) λ_0

Q2. A photo-emissive substance is illuminated with a radiation of wavelength λ_i so that it releases electrons with de-Broglie wavelength λ_e. The longest wavelength of radiation that can emit photoelectron is λ_0. Expression for de-Broglie wavelength is given by :
(m : mass of the electron, h : Planck's constant and c : speed of light)

(1) $\lambda_{\mathrm{e}}=\sqrt{\frac{\mathrm{h}}{2 \mathrm{mc}\left(\frac{1}{\lambda_{\mathrm{i}}}-\frac{1}{\lambda_0}\right)}}$

(2) $\lambda_{\mathrm{e}}=\sqrt{\frac{\mathrm{h} \lambda_0}{2 \mathrm{mc}}}$

(3) $\lambda_{\mathrm{e}}=\frac{\mathrm{h}}{\sqrt{2 \mathrm{mc}\left(\frac{1}{\lambda_{\mathrm{i}}}-\frac{1}{\lambda_0}\right)}}$

(4) $\lambda_{\mathrm{e}}=\sqrt{\frac{\mathrm{h} \lambda_{\mathrm{i}}}{2 \mathrm{mc}}}$

Q3. A monochromatic light is incident on a metallic plate having work function ϕ. An electron, emitted normally to the plate from a point A with maximum kinetic energy, enters a constant magnetic field, perpendicular to the initial velocity of electron. The electron passes through a curve and hits back the plate at a point B. The distance between A and B is :
(Given : The magnitude of charge of an electron is e and mass is m, h is Planck's constant and c is velocity of light. Take the magnetic field exists throughout the path of electron)

(1) $\sqrt{2 \mathrm{~m}\left(\frac{\mathrm{hc}}{\lambda}-\phi\right)} / \mathrm{eB}$

(2) $\sqrt{\mathrm{m}\left(\frac{\mathrm{hc}}{\lambda}-\phi\right)} / \mathrm{eB}$

(3) $\sqrt{8 \mathrm{~m}\left(\frac{\mathrm{hc}}{\lambda}-\phi\right)} / \mathrm{eB}$

(4) $2\sqrt{\mathrm{m}\left(\frac{\mathrm{hc}}{\lambda}-\phi\right)}/\mathrm{eB}$

Q4. The radiation pressure exerted by a 450 W light source on a perfectly reflecting surface placed at 2 m away from it, is :

(1) 1.5×10^{-8} Pascals

(2) 0

(3) 6×10^{-8} Pascals

(4) 3×10^{-8} Pascals

Q5. The work function of a metal is 3 eV. The color of the visible light that is required to cause emission of photoelectrons is

(1) Green

(2) Blue

(3) Red

(4) Yellow

Q6. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R
Assertion A: In photoelectric effect, on increasing the intensity of incident light the stopping potential increases.
Reason R : Increase in intensity of light increases the rate of photoelectrons emitted, provided the frequency of incident light is greater than threshold frequency.
In the light of the above statements, choose the correct answer from the options given below

(1) Both A and R are true but R is NOT the correct explanation of A

(2) A is false but R is true

(3) A is true but R is false

(4) Both A and R are true and R is the correct explanation of A

Q7. A small mirror of mass m is suspended by a massless thread of length l. Then the small angle through which the thread will be deflected when a short pulse of laser of energy E falls normal on the mirror ($\mathrm{c}=$ speed of light in vacuum and $\mathrm{g}=$ acceleration due to gravity)

(1) $\theta=\frac{3\mathrm{E}}{4\mathrm{mc}\sqrt{\mathrm{g}l}}$

(2) $\theta=\frac{\mathrm{E}}{\mathrm{mc}\sqrt{\mathrm{g}l}}$

(3) $\theta=\frac{\mathrm{E}}{2\mathrm{mc}\sqrt{\mathrm{gl}}}$

(4) $\theta=\frac{2E}{mc\sqrt{gl}}$

Q1. Given below are two statements: one is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A: The Bohr model is applicable to hydrogen and hydrogen-like atoms only.
Reason R : The formulation of Bohr model does not include repulsive force between electrons.

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

(1) Both A and R are true but R is NOT the correct explanation of A.

(2) A is false but R is true.

(3) Both A and R are true and R is the correct explanation of A.

(4) A is true but R is false.

Q2. Considering the Bohr model of hydrogen like atoms, the ratio of the ratio of the radius 5^{th} orbit of the electron in Li^{2+} and He^{+} is

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

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

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

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

Q3. Considering Bohr's atomic model for hydrogen atom :

(A) the energy of H atom in ground state is same as energy of He^{+}ion in its first excited state.
(B) the energy of H atom in ground state is same as that for Li^{++}ion in its second excited state.
(C) the energy of H atom in its ground state is same as that of He^{+}ion for its ground state.
(D) the energy of He^{+}ion in its first excited state is same as that for Li^{++}ion in its ground state

Choose the correct answer from the options given below :

(1) (B), (D) only

(2) (A), (B) only

(3) (A), (D) only

(4) (A), (C) only

Q4. Assuming the validity of Bohr's atomic model for hydrogen like ions the radius of Li^{++}ion in its ground state is given by $\frac{1}{X}a_0$, where $X =$ _______. (Where a_0 is the first Bohr's radius.)

(1) 2

(2) 1

(3) 3

(4) 9

Q5. An electron in the hydrogen atom initially in the fourth excited state makes a transition to n^{th} energy state by emitting a photon of energy 2.86 eV. The integer value of n will be ____.

Q6. In a hydrogen like ion, the energy difference between the 2^{nd} excitation energy state and ground is 108.8 eV. The atomic number of the ion is

(1) 4

(2) 2

(3) 1

(4) 3

Q7. For a hydrogen atom, the ratio of the largest wavelength of Lyman series to that of the Balmer series is.

(1) 5 : 36

(2) 5 : 27

(3) 3 : 4

(4) 27 : 5

Q1. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The density of the copper $\left({}_{29}^{64}\mathrm{Cu}\right)$ nucleus is greater than that of the carbon $\left({}_{6}^{12}\mathrm{C}\right)$ nucleus.
Reason (R): The nucleus of mass number A has a radius proportional to $\mathrm{A}^{1/3}$.
In the light of the above statements, choose the most appropriate answer from the options given below :

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

(2) (A) is not correct but (R) is correct

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

(4) Both (A) and (R) are correct but (R) is not the correct explanation of (A)

Q2. For a nucleus of mass number A and radius R, the mass density of nucleus can be represented as

(1) A^3

(2) $\mathrm{A}^{\frac{1}{3}}$

(3) $\mathrm{A}^{\frac{2}{3}}$

(4) Independent of A

Q3. Energy released when two deuterons $\left({}_1\mathrm{H}^2\right)$ fuse to form a helium nucleus $\left({}_2\mathrm{He}^4\right)$ is :

(Given : Binding energy per nucleon of ${}_1\mathrm{H}^2 = 1.1\mathrm{MeV}$ and binding energy per nucleon of ${}_2\mathrm{He}^4 = 7.0\mathrm{MeV}$)

(1) 8.1 MeV

(2) 5.9 MeV

(3) 23.6 MeV

(4) 26.8 MeV

Q4. Match the LIST-I with LIST-II

	LIST-I		LIST-II
A.	${}_0^1\mathrm{n} + {}_{92}^{235}\mathrm{U} \rightarrow {}_{54}^{140}\mathrm{Xe} + {}_{38}^{94}\mathrm{Sr} + 2{}_0^1\mathrm{n}$	I.	Chemical reaction
B.	$2\mathrm{H}_2 + \mathrm{O}_2 \rightarrow 2\mathrm{H}_2\mathrm{O}$	II.	Fusion with +ve Q value
C.	${}_1^2\mathrm{H} + {}_1^2\mathrm{H} \rightarrow {}_2^3\mathrm{He} + {}_0^1\mathrm{n}$	III.	Fission
D.	${}_1^1\mathrm{H} + {}_1^3\mathrm{H} \rightarrow {}_1^2\mathrm{H} + {}_1^2\mathrm{H}$	IV.	Fusion with -ve Q value

Choose the correct answer from the options given below :

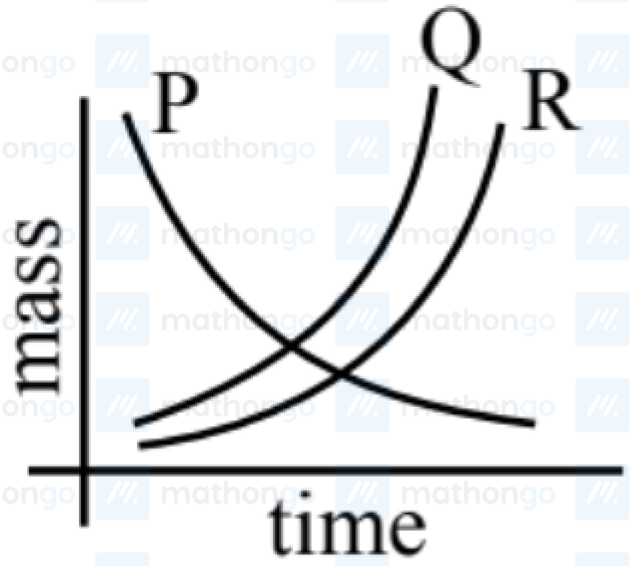
(1) A-II, B-I, C-III, D-IV

(2) A-III, B-I, C-II, D-IV

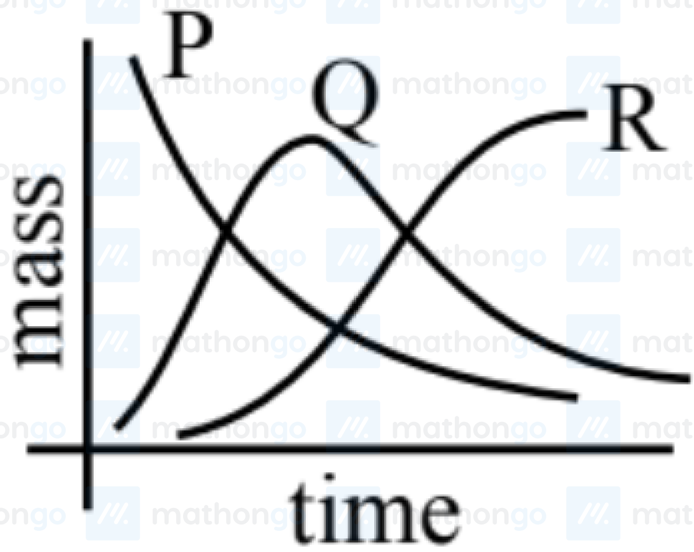
(3) A-II, B-I, C-IV, D-III

(4) A-III, B-I, C-IV, D-II

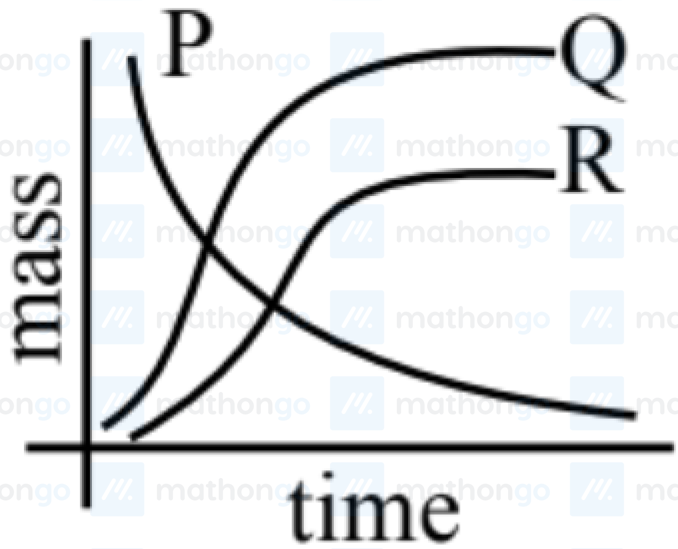
Q5. A radioactive material P first decays into Q and then Q decays to non-radioactive material R. Which of the following figure represents time dependent mass of P, Q and R ?



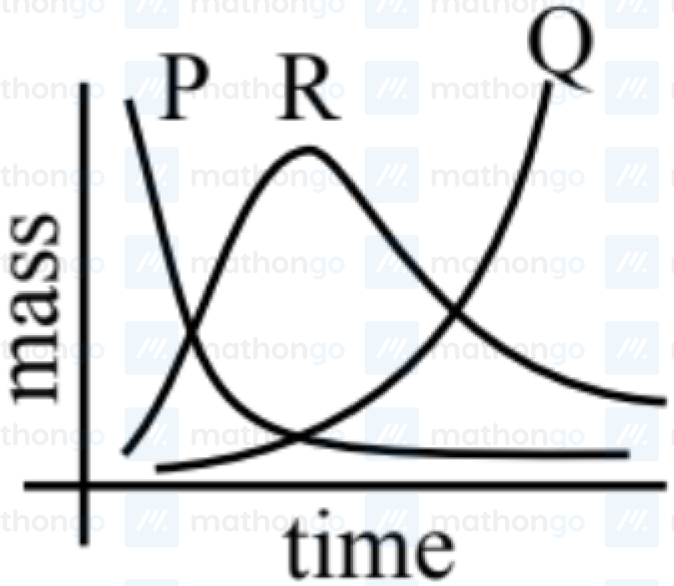
(1)



(2)



(3)



(4)

Q1. If an optical medium possesses a relative permeability of $\frac{10}{\pi}$ and relative permittivity of $\frac{1}{0.0885}$, then the velocity of light is greater in vacuum than that in this medium by ________ times.
$\left(\mu_0 = 4\pi \times 10^{-7} \mathrm{H/m}, \epsilon_0 = 8.85 \times 10^{-12}\ \mathrm{F/m}\right.$
$\left.\mathrm{c} = 3 \times 10^8\ \mathrm{m/s}\right)$

Q2. Two plane polarized light waves combine at a certain point whose electric field components are
$\mathrm{E}_1 = \mathrm{E}_0 \sin \omega t$
$\mathrm{E}_2 = \mathrm{E}_0 \sin\left(\omega t + \frac{\pi}{3}\right)$
Find the amplitude of the resultant wave.

(1) 0.9 E

(2) E_0

(3) $1.7\mathrm{E}_0$

(4) $3.4\mathrm{E}_0$

Q3. The unit of $\sqrt{\frac{2\mathrm{I}}{\epsilon_0 c}}$ is :
(I = intensity of an electromagnetic wave, c : speed of light)

(1) Vm

(2) NC

(3) Nm

(4) NC^{-1}

Q1. Consider a n-type semiconductor in which n_e and n_h are number of electrons and holes, respectively.

(A) Holes are minority carriers

(B) The dopant is a pentavalent atom

(C) $n_e n_h \neq n_i^2$

(where n_i is number of electrons or holes in semiconductor when it is intrinsic form)

(D) $n_e n_h \geq n_i^2$

(E) The holes are not generated due to the donors Choose the correct answer from the options given below :

(1) (A), (C), (D) only

(2) (A), (C), (E) only

(3) (A), (B), (E) only

(4) (A), (B), (C) only

Q2. A zener diode with 5 V zener voltage is used to regulate an unregulated dc voltage input of 25 V. For a 400Ω resistor connected in series, the zener current is found to be 4 times load current. The load current (I_L) and load resistance (R_L) are :

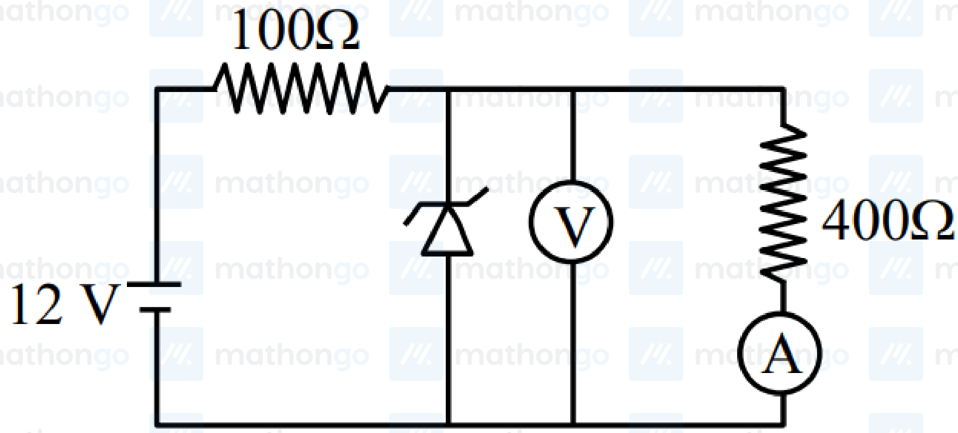
(1) $I_L = 20\ mA; R_L = 250\Omega$

(2) $I_L = 10\ A; R_L = 0.5\Omega$

(3) $I_L = 0.02\ mA; R_L = 250\Omega$

(4) $I_L = 10\ mA; R_L = 500\Omega$

Q3. In the following circuit, the reading of the ammeter will be (Take Zener breakdown voltage $= 4$ V)



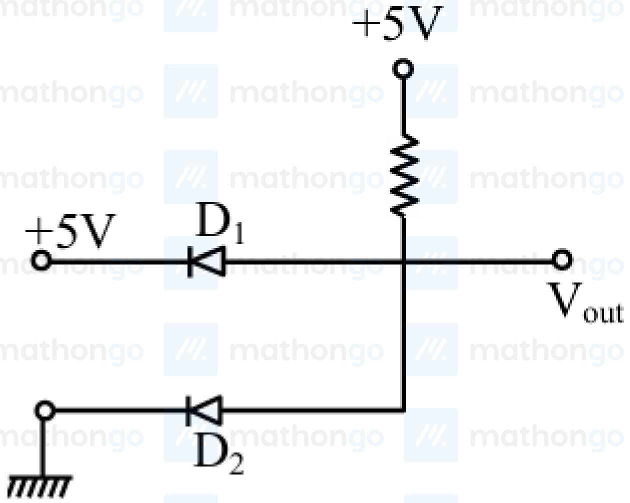
(1) 24 mA

(2) 80 mA

(3) 10 mA

(4) 60 mA

Q4. The output voltage in the following circuit is (Consider ideal diode case)



(1) 10 V

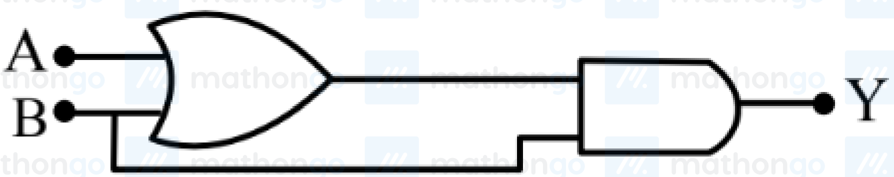
(2) 0 V

(3) +5 V

(4) −5 V

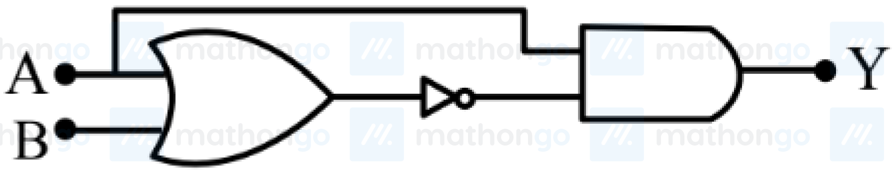
Q5. Choose the correct logic circuit for the given truth table having inputs A and B.

Inputs		Output
A	B	Y
0	0	0
0	1	0
1	0	1
1	1	1

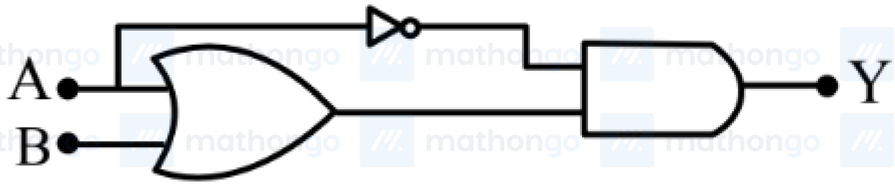


(1)

(2)



(3)



(4)

Q6. The truth table corresponding to the circuit given below is

A	B	C
0	0	0
1	0	0
0	1	0
1	1	1

(1)

A	B	C
0	0	0
0	1	0
1	0	1
1	1	1

(2)

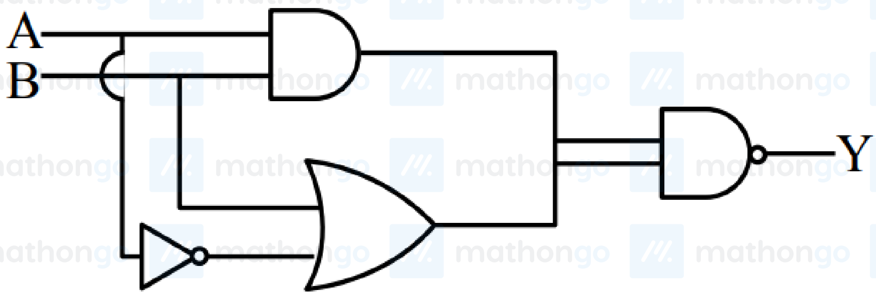
A	B	C
0	0	1
1	0	0
0	1	0
1	1	0

(3)

A	B	C
0	0	1
0	1	0
1	0	0
1	1	0

(4)

Q7. Consider the following logic circuit.



The output is $\mathrm{Y}=0$ when :

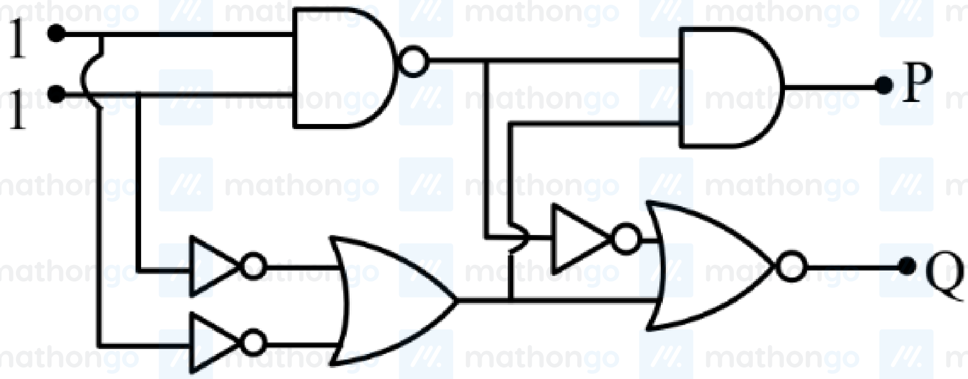
(1) $\mathrm{A}=1$ and $\mathrm{B}=1$

(2) $\mathrm{A}=0$ and $\mathrm{B}=1$

(3) $\mathrm{A}=1$ and $\mathrm{B}=0$

(4) $\mathrm{A}=0$ and $\mathrm{B}=0$

Q8. In the digital circuit shown in the figure, for the given inputs the P and Q values are :



(1) $P=1, Q=1$

(2) $P=0, Q=0$

(3) $P=0, Q=1$

(4) $P=1, Q=0$

Q9. The Boolean expression $\mathrm{Y}=\mathrm{A}\overline{\mathrm{B}}\mathrm{C}+\overline{\mathrm{AC}}$ can be realised with which of the following gate configurations.

A. One 3-input AND gate, 3 NOT gates and one 2input OR gate, One 2-input AND gate,

B. One 3-input AND gate, 1 NOT gate, One 2input NOR gate and one 2-input OR gate

C. 3-input OR gate, 3 NOT gates and one 2-input AND gate

Choose the correct answer from the options given below

(1) B, C Only

(2) A,B Only

(3) A, B, C Only

(4) A, C Only

Q1. For the determination of refractive index of glass slab, a travelling microscope is used whose main scale contains 300 equal divisions equals to 15 cm. The vernier scale attached to the microscope has 25 divisions equals to 24 divisions of main scale. The least count (LC) of the travelling microscope is (in cm) :

(1) 0.001

(2) 0.002

(3) 0.0005

(4) 0.0025

Mathematics in Physics

1. (15) **2.** (3)

Units and Dimensions

1. (2) **2.** (3) **3.** (4) **4.** (4) **5.** (4) **6.** (2) **7.** (2) **8.** (1)
9. (1) **10.** (4) **11.** (3) **12.** (4) **13.** (4) **14.** (3)

Motion In One Dimension

1. (2) **2.** (10) **3.** (4) **4.** (4) **5.** (1) **6.** (4) **7.** (4)

Motion In Two Dimensions

1. (3) **2.** (4) **3.** (4) **4.** (1) **5.** (2)

Laws of Motion

1. (4) **2.** (2) **3.** (2) **4.** (1) **5.** (1)

Work Power Energy

1. (3) **2.** (4) **3.** (4) **4.** (4) **5.** (3) **6.** (3) **7.** (2)

Center of Mass Momentum and Collision

1. (4) **2.** (3)

Rotational Motion

1. (2) **2.** (1) **3.** (3) **4.** (2) **5.** (199) **6.** (4) **7.** (3) **8.** (1)
9. (1) **10.** (40) **11.** (1) **12.** (32) **13.** (4) **14.** (1) **15.** (9) **16.** (3)

Gravitation

1. (1) **2.** (8) **3.** (3) **4.** (1) **5.** (1)

Mechanical Properties of Solids

1. (2) **2.** (1) **3.** (4) **4.** (1) **5.** (1) **6.** (25)

Mechanical Properties of Fluids

1. (3) **2.** (4) **3.** (150) **4.** (4) **5.** (1) **6.** (8) **7.** (1) **8.** (4)

Oscillations

1. (1) **2.** (4) **3.** (4) **4.** (1)

Waves and Sound

1. (1) **2.** (2) **3.** (1) **4.** (2) **5.** (4) **6.** (1) **7.** (3) **8.** (4)

Thermal Properties of Matter

1. (1) **2.** (4) **3.** (5) **4.** (360)

Thermodynamics

1. (3) **2.** (2) **3.** (12) **4.** (4) **5.** (3) **6.** (3) **7.** (4) **8.** (3)
9. (314) **10.** (3) **11.** (3) **12.** (1)

Kinetic Theory of Gases

1. (3) **2.** (4) **3.** (3) **4.** (1)

Electrostatics

1. (4) **2.** (2) **3.** (1) **4.** (2) **5.** (4) **6.** (15) **7.** (4) **8.** (2)
9. (3) **10.** (1) **11.** (2) **12.** (3) **13.** (1) **14.** (2) **15.** (1) **16.** (4)
17. (1) **18.** (2) **19.** (2)

Capacitance

1. (2) **2.** (2) **3.** (64) **4.** (3) **5.** (15) **6.** (5)

Current Electricity

1. (4) **2.** (3) **3.** (4) **4.** (1) **5.** (4) **6.** (3) **7.** (3) **8.** (4)
9. (5)

Magnetic Properties of Matter

1. (3) **2.** (1) **3.** (4) **4.** (1)

Magnetic Effects of Current

1. (48) **2.** (3) **3.** (1) **4.** (1) **5.** (0) **6.** (4) **7.** (1) **8.** (4)
9. (3) **10.** (4)

Electromagnetic Induction

1. (10)

Alternating Current

1. (1) **2.** (3) **3.** (3) **4.** (1) **5.** (5) **6.** (1)

Ray Optics

1. (3) **2.** (45) **3.** (2) **4.** (1) **5.** (1) **6.** (45) **7.** (2) **8.** (3)
9. (3) **10.** (80) **11.** (3) **12.** (2) **13.** (2) **14.** (4) **15.** (2) **16.** (4)
17. (4) **18.** (4) **19.** (1)

Wave Optics

1. (1) **2.** (4) **3.** (2) **4.** (1) **5.** (24) **6.** (6) **7.** (2) **8.** (3)
9. (15) **10.** (1)

Dual Nature of Matter

1. (4) **2.** (1) **3.** (3) **4.** (3) **5.** (2) **6.** (2) **7.** (4)

Atomic Physics

1. (3) **2.** (4) **3.** (2) **4.** (3) **5.** (2) **6.** (4) **7.** (2)

Nuclear Physics

1. (2) **2.** (4) **3.** (3) **4.** (2) **5.** (2)

Electromagnetic Waves

1. (6) **2.** (3) **3.** (4)

Semiconductors

1. (3) **2.** (4) **3.** (3) **4.** (2) **5.** (2) **6.** (2) **7.** (1) **8.** (2)
9. (2)

Experimental Physics

1. (2)

Q1. $\mathrm{C}=\mathrm{P}^1 \mathrm{q}^2 \mathrm{r}^{-3} \mathrm{~s}^{1/2}$

(15) $\left(\frac{\mathrm{dC}}{\mathrm{C}}\right)_{\max }=\frac{\mathrm{dP}}{\mathrm{P}}+\frac{2 \mathrm{dq}}{\mathrm{q}}+\frac{3 \mathrm{dr}}{\mathrm{r}}+\frac{1}{2} \frac{\mathrm{ds}}{\mathrm{s}}$

$=\left(1+2 \times 2+3 \times 3+\frac{1}{2} \times 2\right) \%$

$=15 \%$

Ans. 15

Q2. Fractional error $=2 \frac{\Delta X}{X}+\frac{3}{2} \frac{\Delta Y}{Y}+\frac{2}{5} \frac{\Delta Z}{Z}$

(3) $=2(0.1)+\frac{3}{2}(0.2)+\frac{2}{5}(0.5)$

$=0.2+0.3+0.2=0.7$

Q1. $C=\frac{1}{\sqrt{\mu_0\varepsilon_0}} \Rightarrow \frac{1}{\mu_0\varepsilon_0}=C^2=L^2T^{-2}$
(2)

Q2. $m_1+m_2+m_3=435.42+226.3+0.125$
(3) According to least significant digits $m=661.8$ g

Q3. We know that formula for displacement current is given by
(4) $id=\varepsilon_0\frac{d\phi_\varepsilon}{dt}$

Q4. $C'=\frac{\Delta Q}{\Delta T}=JK^{-1}$
(4)
$S=\frac{\Delta Q}{m\Delta T}=Jkg^{-1}K^{-1}$
$L=\frac{\Delta Q}{m}=Jkg^{-1}$
$\Delta Q=\frac{KA\Delta T}{L}\Rightarrow K=\frac{\Delta Q(L)}{A\Delta T}=Jm^{-1}K^{-1}s^{-1}$

Q5. $\left[P+\frac{a}{V^2}\right](V-b)=RT$
(4)
$\therefore[a]=[P]\left[V^2\right]=ML^{-1}T^{-2}L^6=ML^5T^{-2}$
$[b]=[V]=L^3$
$\left[ab^{-2}\right]=ML^5T^{-2}L^{-6}=ML^{-1}T^{-2}$
Dimension of energy density.

Q6. (A) Coefficient of viscosity
(2) $[\eta]=\left[M^1L^{-1}T^{-1}\right]$
(B) Intensity $[I]=\left[M^1L^0T^{-3}\right]$
(C) Pressure gradient $=\left[ML^{-2}T^{-2}\right]$
(D) Compressibility $[K]=\left[M^{-1}L^1T^2\right]$

Q7. $Q=AT$
(2) $I=A$
$\mu_0=MLT^{-2}A^{-2}$
$P=Q^x\mu_0^yI^z=[AT]^x\left[MLT^{-2}A^{-2}\right]^y[A]^z$
$MLT^{-1}=M^yL^yT^{x-2y}A^{-2y+z+x}$
Now; $y=1$
$x-2y=-1$
$-2y+z=0$
$\therefore x=y=z=1$

Q8.
(1)
(A) $G = \frac{Fr^2}{m^2}$

$[G] = \frac{[MLT^{-2}][L^2]}{[M^2]} = [M^{-1} L^3 T^{-2}]$ (IV)

(B)

$P.E. = mgh = [MLT^{-2} L]$

$= [ML^2 T^{-2}]$ (III)

(C) Gravitational Potential $= \frac{GM}{r}$

$= \frac{[M^{-1} L^3 T^{-2}][M]}{[L]} = [M^0 L^2 T^{-2}] = [L^2 T^{-2}]$ (II)

(D) Acceleration due to gravity $= [g] = [LT^{-2}]$ (I)

Q9.
(1)
(A) $[k] = \frac{PV}{NT} = \frac{ML^2 T^{-2}}{K} = ML^2 T^{-2} K^{-1}$

(B) $[\eta] = \frac{F}{6\pi rv} = \frac{MLT^{-2}}{L^2 T^{-1}} = ML^{-1} T^{-1}$

(C) $[h] = \frac{E}{f} = \frac{ML^2 T^{-2}}{T^{-1}} = ML^2 T^{-1}$

(D) $\frac{dQ}{dt} = k\frac{AdT}{dx}$

$k = \frac{(ML^2 T^{-3})L}{L^2 \cdot K} = MLT^{-3} K^{-1}$

Q10.
(4)
$\frac{\phi_E}{\phi_M} = \frac{EA}{BA} = \frac{E}{B}$

$B = \frac{M\ell T^{-2}}{ATLT^{-1}}$

So $\left[\frac{E}{B}\right] = \frac{ML^{-3} A^{-1}}{MT^{-2} A^{-1}} = LT^{-1}$

Or

$E = c \cdot B$

$\left[\frac{E}{B}\right] = LT^{-1}$

Q11.
(3)
$E = hf$

$ML^2 T^{-2} = [h] \times [T^{-1}]$

$[h] = [ML^2 T^{-1}]$

$L = [MVR] = [ML^2 T^{-1}]$

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

L is integral multiple of $\frac{h}{2\pi}$

Q12.
(4)
Electric dipole moment $(\overrightarrow{P}) = q \times 2\ell$

Magnetic dipole moment $(\overrightarrow{M}) = IA$

$\left[\frac{P}{M}\right] = \left[\frac{LTA}{L^2 A}\right] = L^{-1} T = M^0 L^{-1} T^1 A^0$

After compering values of P&Q are $0, -1$ Correct Answer : Option 4

Q13.
(4)

$$L = \frac{\mu_0 N A}{\ell}$$

$$C = \frac{A\epsilon_0}{d}$$

$$\frac{L}{C} \propto \frac{\mu_0}{\epsilon_0}$$

$$\sqrt{\frac{\mu_0}{\epsilon_0}} \propto \sqrt{\frac{L}{C}}$$

$$\frac{L}{C} = \frac{\tau R}{(\tau/R)} = R^2$$

$$\sqrt{\frac{\mu_0}{\epsilon_0}} = R$$

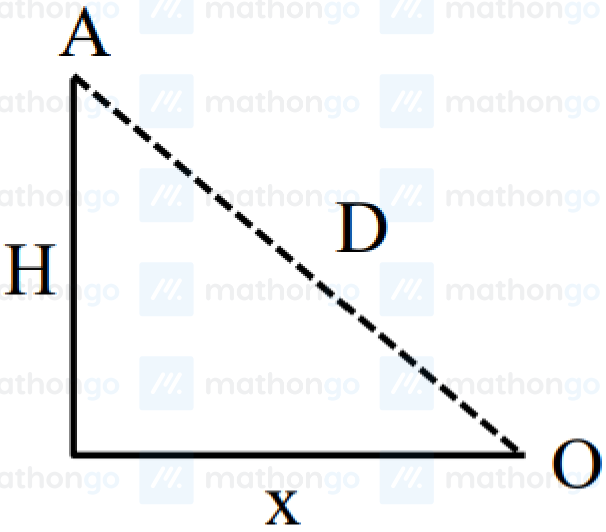
Q14. (A) Mass density $= \frac{M}{V} = M^1 L^{-3}$...(iv)
(3) (B) Impulse $= \mathrm{M} \times \mathrm{u} = \mathrm{M}^1\ \mathrm{L}^1\ \mathrm{T}^{-1}$....(ii)
(C) Power $= \mathrm{F.\ V} = \mathrm{M}^1\ \mathrm{L}^2\ \mathrm{T}^{-3}$....(i)
(D) Moment of inertia $= \mathrm{Mr}^2 = \mathrm{M}^1\ \mathrm{L}^2$...(iii)

Q1. $\vec{a} = \frac{B}{2}\hat{k} = 3\hat{k}, t = \frac{5}{3}$ s
(2)
$\vec{u} = 3\hat{i} + 4\hat{j}$
$\vec{v} = \vec{u} + \vec{a}t = 3\hat{i} + 4\hat{j} + 5\hat{k}$

Q2. $v_{avg} = \frac{x_1 + x_2}{t_1 + t_2}$
(10)
$\Rightarrow \frac{50}{7} = \frac{x + \frac{3x}{2}}{\frac{x}{5} + \frac{3x}{2v_2}}$
$\Rightarrow \frac{50}{7} = \frac{5/2}{\frac{1}{5} + \frac{3}{2v_2}}$
$\Rightarrow \frac{1}{5} + \frac{3}{2v_2} = \frac{7}{20}$
$\Rightarrow \frac{3}{2v_2} = \frac{7}{20} - \frac{1}{5} = \frac{7-4}{20}$
$\Rightarrow \frac{3}{2v_2} = \frac{3}{20}$
$\Rightarrow v_2 = 10$ m/s

Q3. Displacement $= 2r$
(4) Distance $= 2\pi r + \pi r = 3\pi r$

Q4.
(4)



$$u = 360 \times \frac{5}{18} = 100 \text{ m/s}$$
$$x = u \times t = 2 \times 10^3 \text{ m}$$
$$t = \sqrt{\frac{2H}{g}} \Rightarrow H = \frac{t^2 g}{2}$$
$$H = \frac{400 \times 10}{2}$$
$$H = 2000 \text{ m}$$
$$D = \sqrt{x^2 + H^2}$$
$$D = 2\sqrt{2} \text{ km}$$

Q5. For option (A)
(1) $\phi = kt + C$ it can be 1D motion
eg $\rightarrow x = A \sin \phi(\text{SHM})$
For option (B)
$v^2 + x^2 =$ constant yes 1D
For option (C)
time can't be negative Not possible
For option (D)
Possible
A, B \& D only

Q6.
(4)
$$\langle \vec{v} \rangle = \frac{\Delta \vec{s}}{\Delta t} = \frac{S_f - S_i}{t_f - t_i}$$
$$\vec{v} = \frac{ds}{dt} = \text{ slope}$$
(A) 0 to 3sec; $\langle \vec{v} \rangle = \frac{5-0}{3} = 5/3 \text{ m/s}$
(B) 0 to 5sec; $\langle \vec{v} \rangle = \frac{5-5}{2} = 0$
(C) $t = 2$; slope $= \vec{v} = 5 \text{ m/s}$

(D) $\mathrm{t}=5$ to $7\mathrm{sec}; \langle\overrightarrow{\mathrm{v}}\rangle=\frac{0-5}{2}=-2.5\ \mathrm{m/s}$

At $t=6.5\mathrm{sec}; \vec{v}=10$

(E) $\mathrm{t}=0$ to $\mathrm{t}=9; \langle\overrightarrow{\mathrm{v}}\rangle=0$

Q7. (4)

$$\mathrm{v}=\frac{\mathrm{dx}}{\mathrm{dt}}=2\mathrm{tC}_0+2\mathrm{C}(\mathrm{t}-2)$$

$$\mathrm{a}=\frac{\mathrm{dv}}{\mathrm{dt}}=2\mathrm{C}_0+2\mathrm{C}$$

Q1.
(3)

$H_{max} = \frac{u^2 \cos^2 \phi}{2\,g}$

Q2. Range $= 3H_{max}$
(4) $\frac{u^2 \sin 2\theta}{g} = \frac{3u^2 \sin^2 \theta}{2\,g}$

$2 \sin\theta \cos\theta = \frac{3}{2} \sin^2\theta$

$\tan\theta = \frac{4}{3} \Rightarrow \theta = 53^\circ$

$R = \frac{u^2\left(2 \times \frac{3}{5} \times \frac{4}{5}\right)}{g} \Rightarrow \frac{24u^2}{25\,g}$

Q3. $\theta_1 = 45 + \alpha; \theta_2 = 45 - \alpha$
(4) Time of flight, $T = \frac{2v \sin\theta}{g}$

$\frac{T_1}{T_2} = \frac{\sin(45+\alpha)}{\sin(45-\alpha)}$

$\frac{T_1}{T_2} = \frac{\frac{1}{\sqrt{2}} \cos\alpha + \frac{1}{\sqrt{2}} \sin\alpha}{\frac{1}{\sqrt{2}} \cos\alpha - \frac{1}{\sqrt{2}} \sin\alpha}$

$\frac{T_1}{T_2} = \frac{\cos\alpha + \sin\alpha}{\cos\alpha - \sin\alpha} = \frac{1 + \tan\alpha}{1 - \tan\alpha}$

Q4. Given, $(H_{max})_1 = 8 \times (H_{max})_2$
(1) $\frac{u^2 \sin^2 \theta_1}{2\,g} = 8 \times \frac{u^2 \sin^2 \theta_2}{2\,g}$

$\Rightarrow \sin\theta_1 = 2\sqrt{2} \sin\theta_2$

$\frac{T_1}{T_2} = \frac{2u \sin\theta_1 / g}{2u \sin\theta_2 / g} = \frac{\sin\theta_1}{\sin\theta_2} = 2\sqrt{2}$

Q5.

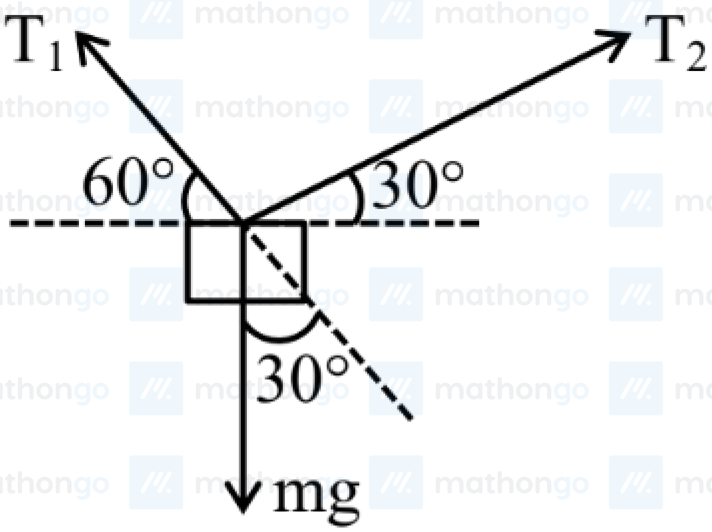
(2)

$\therefore \mathrm{V}_{\perp}=$ river flow $=27 \times \cos 60^{\circ}=\frac{27}{2} \mathrm{~km} / \mathrm{hr}$.

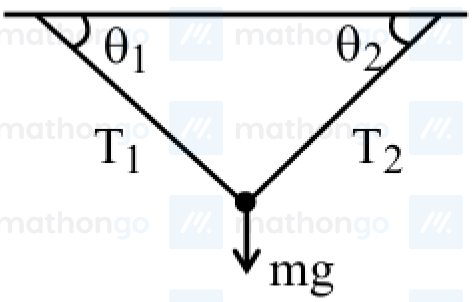
Time taken $=30$sec.

$\therefore \mathrm{S}=\mathrm{Vt}=\frac{27}{2} \times \frac{5}{18} \times 30 \mathrm{~m}=112.5 \mathrm{~m}$

Q1.
(4)
$F = M \times a$
$v = 4\sqrt{x}$
$v^2 = 16x$
$2v\frac{dv}{dx} = 16$
$\frac{vdv}{dx} = \frac{16}{2} = 8$
$F = 0.5 \times 8 = 4N$

Q2.
(2)


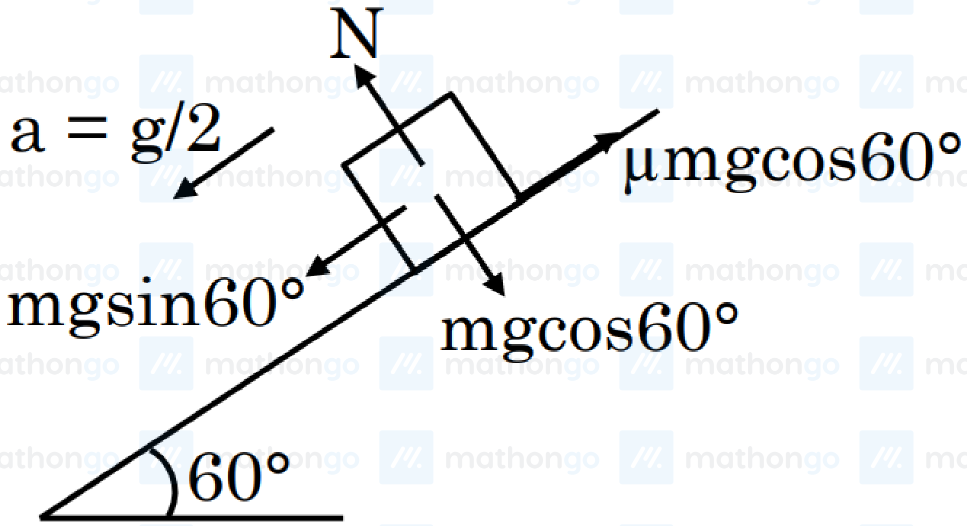
$T_1 = mg\cos 30^\circ$
$T_2 = mg\sin 30^\circ$

Q3.
(2)


$T_1\sin\theta_1 + T_2\sin\theta_2 = mg \& \ T_1 = \sqrt{3}\,T_2$
$\Rightarrow \ T_2\left[\sqrt{3}\sin\theta_1 + \sin\theta_2\right] = mg$
for $\theta_1 = 60^\circ \& \theta_2 = 30^\circ$
$T_2 = \frac{mg}{2}$

Q4.
(1)
$T = K(\ell - \ell_0)$
$\Rightarrow 5 = K(1.4 - \ell_0)$
$\Rightarrow 7 = K(1.56 - \ell_0)$
$\Rightarrow \frac{5}{1.4 - \ell_0} = \frac{7}{1.56 - \ell_0}$
$\therefore \ell_0 = 1\text{ m}$

Q5.
(1)



$\mathrm{mg}\sin 60^{\circ} - \mu \mathrm{mg}\cos 60^{\circ} = \mathrm{ma}$

$g\sin 60 - \mu g\cos 60 = \frac{g}{2}$

$\frac{\sqrt{3}}{2} - \frac{\mu}{2} = \frac{1}{2}$

$\mu = \sqrt{3} - 1$

Q1. Potential energy is defined for conservative force only. It is not defined for non-conservative force i.e. frictional
(3) force.

Q2. $V^2 = 0 + 2\,g(S - x)$
(4) $V^2 = 2\,g(S - x)$

At B, Potential energy $= mgx$

$$mgx = 3 \times \frac{1}{2} mv^2$$

$$gx = \frac{3}{2} \times 2\,g(S - x)$$

$$4x = S$$

$$x = \frac{S}{4}$$

$$\Rightarrow V = \sqrt{2\,g \times \frac{3\,S}{4}} = \sqrt{\frac{3gS}{2}}$$

Q3. $a = \dfrac{F}{m} = -10x$
(4)

$$v\frac{dv}{dx} = -10x$$

$$\int_{10}^{v} vdv = -10 \int_{0.1}^{1.9} xdx$$

$$\frac{v^2 - 100}{2} = -10\left(\frac{1.9^2 - 0.1}{2}\right)^2$$

$$v = 8\ \mathrm{m/s}$$

Q4. $\vec{F} = (2t\hat{i} + 3t\hat{j})N$
(4) $m = 1000gm = 1\ kg$

$$\vec{F} = m\vec{a},\ \vec{a} = 2t\hat{i} + 3t^2\hat{j}$$

$$\frac{d\vec{v}}{dt} = 2t\hat{i} + 3t^2\hat{j}$$

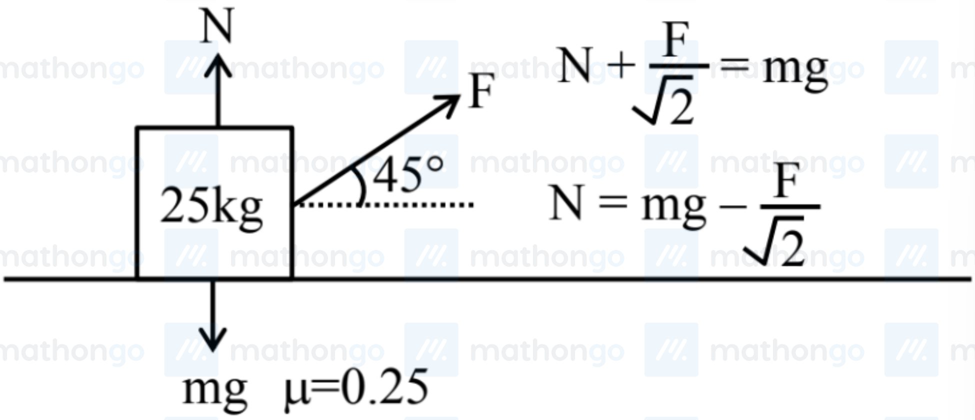
$$\vec{v} = t^2\hat{i} + t^3\hat{j}$$

Power, $P = \vec{F} \cdot \vec{v}$

$$P = \left(2t\hat{i} + 3t^2\hat{j}\right) \cdot \left(t^2\hat{i} + t^3\hat{j}\right)$$

$$P = \left(2t^3 + 3t^5\right) W$$

Q5.
(3)



Block travels with uniform velocity

So $\quad a=0 \Rightarrow \mathrm{F} \cos 45^{\circ}=$ friction

$$\frac{\mathrm{F}}{\sqrt{2}}=\mu\left[\mathrm{mg}-\frac{\mathrm{F}}{\sqrt{2}}\right]$$

$$\frac{\mathrm{F}}{\sqrt{2}}=0.25\left[25 \times 9.8-\frac{\mathrm{F}}{\sqrt{2}}\right]$$

$$\Rightarrow \quad 1.25 \frac{\mathrm{F}}{\sqrt{2}}=61.25$$

$$\mathrm{F}=\frac{61.25 \times \sqrt{2}}{1.25}=49 \sqrt{2}$$

$$\mathrm{W}_{\text {ext }}=\mathrm{FS} \cos 45^{\circ}$$

$$=49 \sqrt{2} \times 5 \times \frac{1}{\sqrt{2}}=245 \mathrm{~J}$$

Q6. Using WET
(3) Total energy supplied = gravitational potential energy + spring potential energy + work done by gas

$$\mathrm{Mg} \quad\left(L_1-L_0\right)+\int_{L_0}^{L_1} k^3 d x+n R T \ell n$$

$$\left[\frac{L_1 \mathrm{~A}}{\mathrm{~L}_0 \mathrm{~A}}\right]+\mathrm{W}_{\text {ext }}=0$$

$$\frac{\mathrm{K}}{4}\left[\mathrm{x}^4\right]_{\mathrm{L}_0}^{\mathrm{L}_1}+\mathrm{Mg}\left(\mathrm{L}_1-\mathrm{L}_0\right)+\int_{\mathrm{L}_0}^{\mathrm{L}_1} k x^3 d x+n R T \ell n$$

$$\left[\frac{L_1}{L_0}\right]+\mathrm{W}_{\text {ext }}=0$$

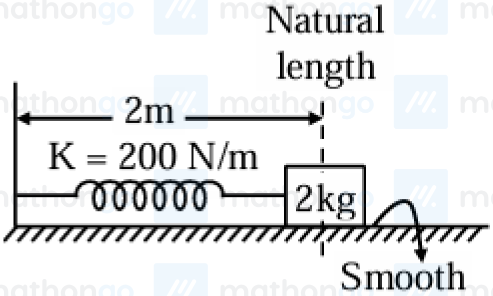
$$\frac{\mathrm{k}}{4}\left(\mathrm{~L}_1^4-\mathrm{L}_0^4\right)+\mathrm{Mg} \quad\left(\mathrm{L}_1-\mathrm{L}_0\right)+\mathrm{nRT} \ell \mathrm{n}$$

$$\left[\frac{\mathrm{L}_1}{\mathrm{~L}_0}\right]+\mathrm{W}_{\text {ext }}=0$$

$$\mathrm{W}_{\text {ext }}=\frac{\mathrm{k}}{4}\left(\mathrm{~L}_1^4-\mathrm{L}_0^4\right)+\mathrm{Mg}\left(\mathrm{L}_1-\mathrm{L}_0\right)+\mathrm{nRT} \ell \mathrm{n}\left[\frac{\mathrm{L}_1}{\mathrm{~L}_0}\right]$$

Q7.

(2)



Given, Natural length of spring $= 2$ m

Initial compression in spring $(x_i) = 1$ m

Final compression in spring $(x_f) = (2 - x)$m

Using energy conservation

$K_i + U_i = K_f + U_f$

$0 + \frac{1}{2}Kx_i^2 = \frac{1}{2}mv^2 + \frac{1}{2}Kx_f^2$

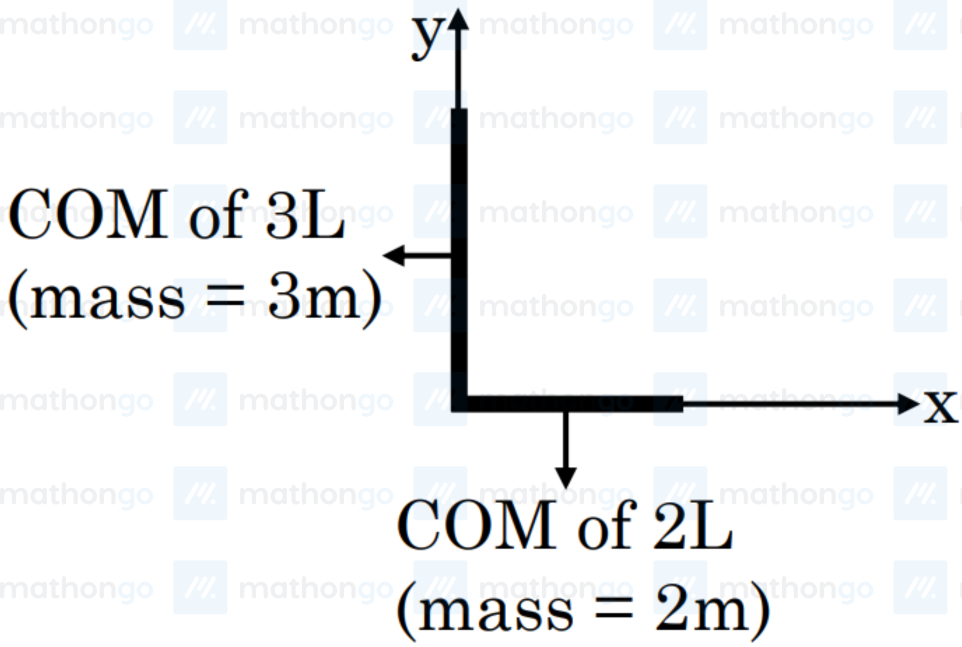
$\frac{1}{2}mv^2 = \frac{1}{2}K\left(x_i^2 - x_f^2\right)$

$\frac{1}{2} \times 2 \times v^2 = \frac{1}{2} \times 200 \times \left(1^2 - (2 - x)^2\right)$

$v^2 = 100\left[1 - (2 - x)^2\right]$

$v = 10\left[1 - (2 - x)^2\right]^{1/2}$

Q1.
(4)



$x_{com} = \frac{2\,m(10)+3\,m(0)}{5\,m} = 4\text{ cm}$

$y_{com} = \frac{2\,m(0)+3\,m(15)}{5\,m} = 9\text{ cm}$

$\vec{r}_{com} = 4\hat{i} + 9\hat{j}$

Q2. $m_1v_1 + m_2v_2 = (m_1 + m_2)\,v_{cm}$

(3) $v_{cm} \Rightarrow \frac{10 \times 3}{10+5} \Rightarrow \frac{30}{15} = 2\text{ m/s}$

$\frac{1}{2}kx^2 = \frac{1}{2}(10)(3)^2 - \left[\frac{1}{2}(15)(2)^2\right]$

$\Rightarrow 90 - 60 = 30 = 3000x^2$

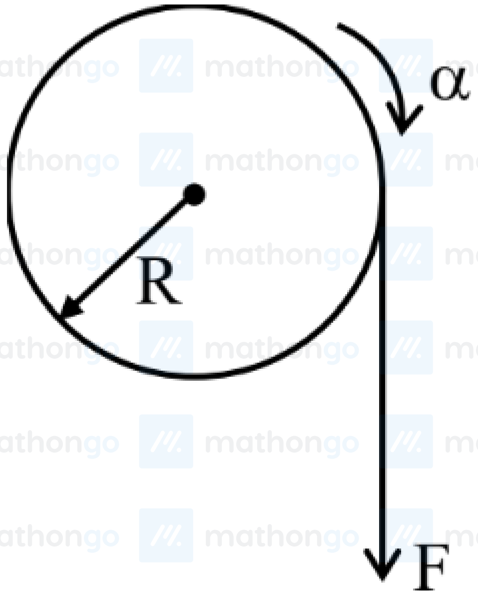
$x^2 \Rightarrow \frac{30}{3000} = \frac{1}{100}$

$x \Rightarrow \frac{1}{10}\text{ m.}$

Q1. Diameter is given as R.
(2) $\therefore$ Radius $= R/2$

$$I_{\tan\text{ gent}} = \frac{3}{2} m\left(\frac{R}{2}\right)^2 = \frac{3}{8} mR^2$$

Q2.
(1)

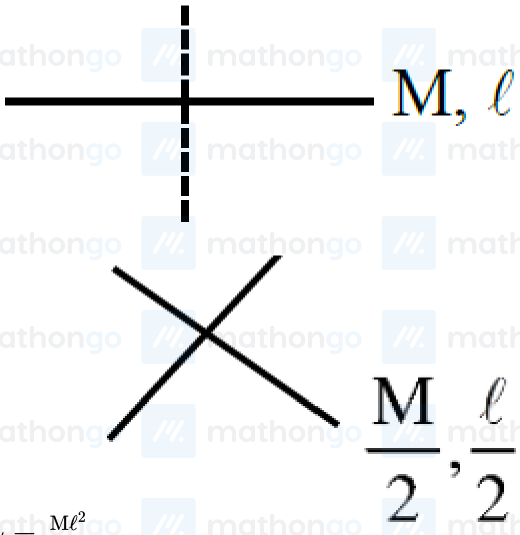


$$FR = I\alpha$$

$$\Rightarrow I = \frac{FR}{\alpha} = \frac{10 \times 0.2}{2} = 1\ \mathrm{kg-m^2}$$

Q3. Conceptual
(3)

Q4.
(2)



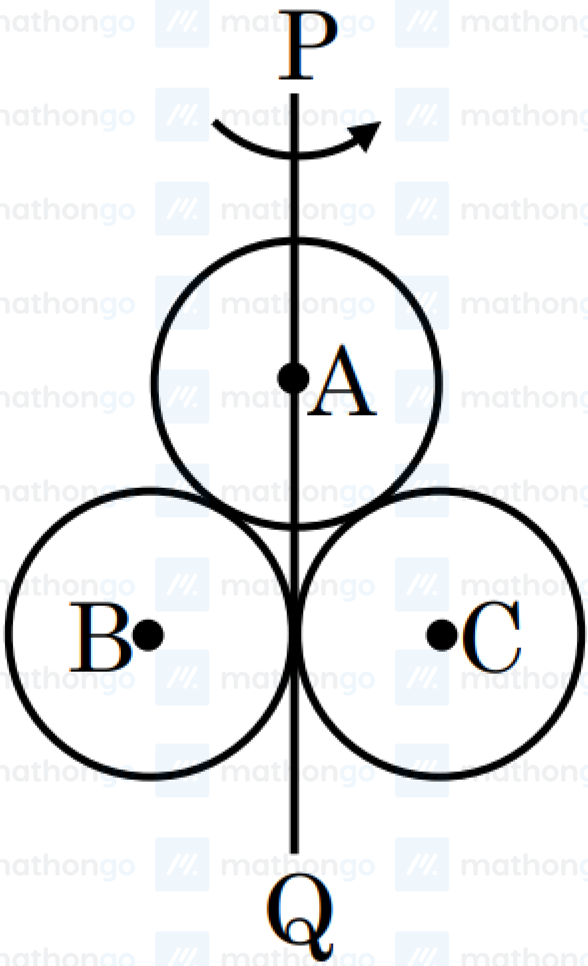
$\alpha = \frac{M\ell^2}{12}$

$$\alpha' = 2\left[\frac{\frac{M}{2}\left(\frac{\ell}{2}\right)^2}{12}\right]$$

$$\alpha' = \frac{M\ell^2}{48} = \frac{\alpha}{4}$$

Correct option is (2)

Q5.
(199)



All bodies have same mass and same radius.

$A \rightarrow$ Disc

$B \rightarrow$ Solid sphere

$C \rightarrow$ Spherical shell

and, $I = \frac{MR^2}{4}$

$I_{PQ} = \frac{MR^2}{4} + \left(\frac{2}{5}MR^2 + MR^2\right) + \left(\frac{2}{3}MR^2 + MR^2\right)$

$I_{PQ} = \frac{15MR^2 + 24MR^2 + 60MR^2 + 40MR^2 + 60MR^2}{60}$

$I_{PQ} = \frac{199}{60}MR^2 = \frac{199}{15}\left(\frac{MR^2}{4}\right)$

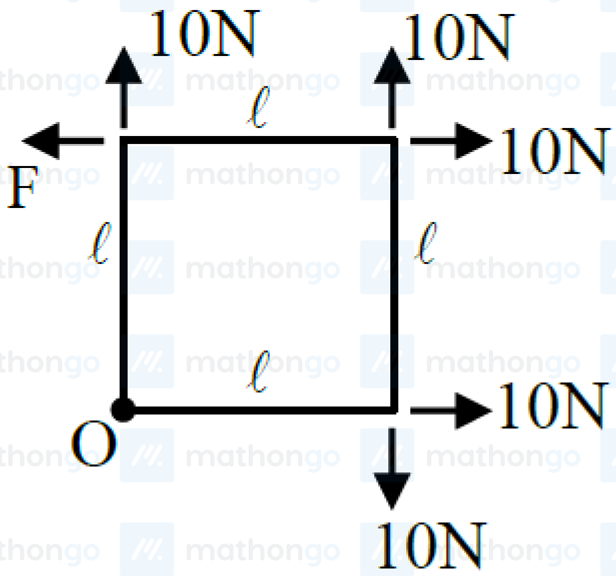
$= \frac{199}{15}I$

Q6. $L = 2\pi R$

(4) $\mathrm{I} = \frac{\mathrm{MR}^2}{2} = \frac{\lambda \times \mathrm{L}}{2} \times \left(\frac{\mathrm{L}}{2\pi}\right)^2 = \frac{\lambda \mathrm{L}^3}{8\pi^2}$

Q7. Since the lamina is equilibrium.

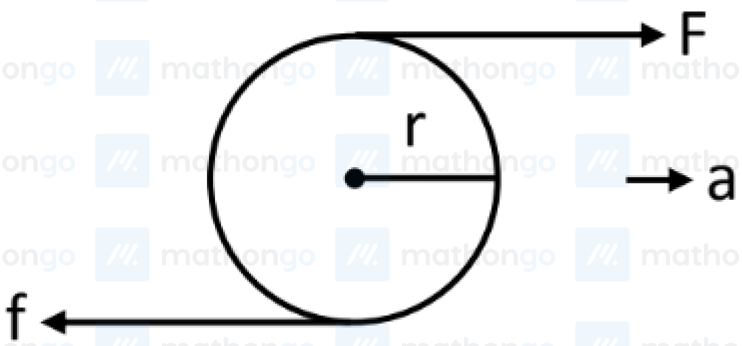
(3) $\therefore \mathrm{F}_{\text{net}} = 0 \& \tau_{\text{net}} = 0$



$\mathrm{T}_{\mathrm{o}} = 10\ell - \mathrm{F}\ell \Rightarrow \mathrm{F} = 10\ \mathrm{N}$

Q8.

(1)



Torque about bottom point

$\mathrm{F} \times 2\mathrm{r} = \mathrm{I}\alpha$

$49 \times 2\mathrm{r} = \frac{7}{5}\mathrm{mr}^2\alpha$

$14 = 4\mathrm{r}\alpha$

As sphere rolls without slipping

$\mathrm{a} = \mathrm{r}\alpha$

$\mathrm{a} = \frac{14}{4} = \frac{7}{2} = 3.5\ \mathrm{m/s}^2$

Q9. $W_F = 20 \times 1 = 20\text{ J}$
(1) $\therefore \quad \Delta KE = 20\text{ J} = \frac{1}{2} I\omega^2$

$I = MR^2 = 10 \times 0.1^2 = 0.1\text{ kg m}^2$

$\therefore \quad 20 = \frac{1}{2} \times 0.1 \times \omega^2$

$\Rightarrow \omega = 20\text{rad/sec}$

Q10. Given, $m = 1\text{ kg}$
(40) $\omega_i = 1800\text{rpm} = 1800 \times \frac{2\pi}{60} = 60\pi \frac{\text{rad}}{\text{sec}}$

$\omega_f = 2100\text{rpm} = 2100 \times \frac{2\pi}{60} = 70\pi \frac{\text{rad}}{\text{sec}}$

$\tau_{ext} = 25\pi\text{Nm}$
$t = 40\text{sec}$
Using equation of motion
$\omega_f = \omega_i + \alpha t$
$70\pi = 60\pi + \alpha(40)$
$\alpha = \frac{\pi}{4}\text{rad/sec}^2$
Also, $\tau = I\alpha$
$\tau = \frac{mR^2}{4}\alpha$
$25\pi = \frac{1 \times R^2}{4} \times \frac{\pi}{4}$
$R = 20\text{ m}$
Hence, diameter of disk $= 2R = 2 \times 20 = 40\text{ m}$

Q11. $\vec{a} = -\omega^2 \vec{r}$
(1) $\therefore \vec{F}$ opposite to $\vec{r}$ –

Q12. When sphere is of radius R, its mass is M, when radius is reduced to $\frac{R}{2}$, mass will reduced to $\frac{M}{8}$ Now by
(32) conservation of angular momentum
$(\tau_{ext} = 0)$
$L_1 = L_2$
$I_1\omega_1 = I_2\omega_2$

$$\left(\frac{2}{5}MR^2\right)\omega_1 = \left(\frac{2}{5}\left(\frac{M}{8}\right)\left(\frac{R}{2}\right)^2\right)\omega_2$$

$\omega_2 = 32\omega_1$ value of x is 32
Answer is 32

Q13. Applying Mechanical Energy conservation :
(4) $k_i + U_i = k_f + U_f$

$$\Rightarrow 0 + Mgh = \frac{1}{2}mv^2\left(1 + \frac{k^2}{R^2}\right) + 0$$

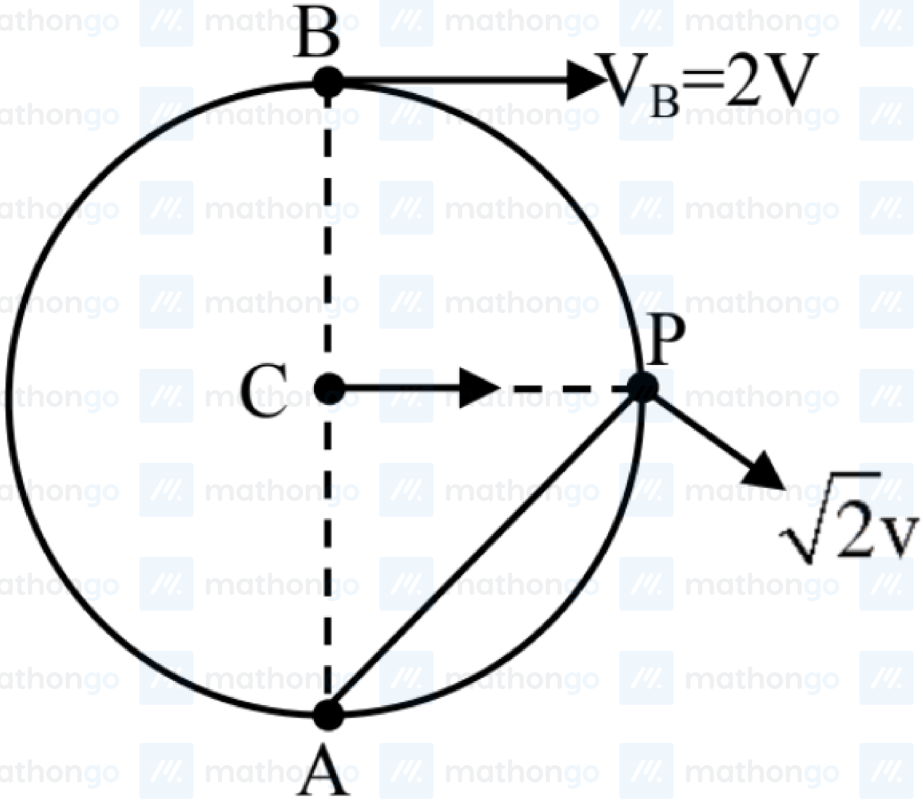
$$\Rightarrow V = \sqrt{\frac{2gh}{1 + \frac{k^2}{R^2}}}$$

So Ratio of velocities

$\frac{V_{\text{Ring}}}{V_{\text{solids sphere}}} = \sqrt{\frac{1+\frac{2}{5}}{1+1}} = \sqrt{\frac{7}{10}}$

$x = 3.5$ Rounding off $x = 4$

Q14.
(1)



If $V_B = 2V$

Point A is instantaneous center of rotation

Given $V_B = 8$ m/s

$V = 4$ m/s

$V_p = \sqrt{2}v \Rightarrow V_p = 4\sqrt{2}$ m/s

correct(1)

Q15. Without cavity $I_1 = \frac{MR^2}{2}$
(9)

Mass of removed disc $= \frac{M}{\pi R^2} \times \left(\frac{R}{3}\right)^2 \pi$

$= \left(\frac{M}{9}\right)$

M.I. of removed disc $I_2 = \frac{\frac{M}{9}\left(\frac{R}{3}\right)^2}{2} + \frac{M}{9} \times \left(\frac{2R}{3}\right)^2$

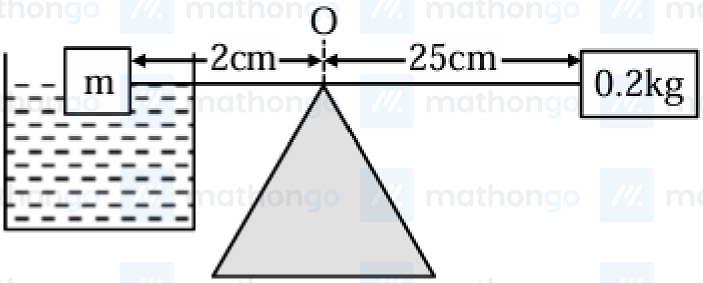
$= \frac{MR^2}{18}$

$I = I_1 - I_2 = \frac{MR^2}{2} - \frac{MR^2}{18} = \frac{4MR^2}{9}$

$(n = 9)$

Q16.

(3)

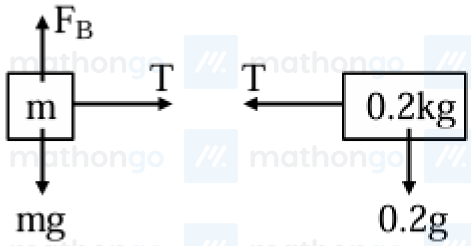


Given, volume of block $= \left(10 \times 10^{-2}\right)^3 = 10^{-3}\ \mathrm{m}^3$

Let density of block $= \rho \mathrm{kg/m}^3$

mass of block $= \rho \times 10^{-3}$ kg

Buoyant Force $(\mathrm{F_B}) = 1000 \times \frac{10^{-3}}{2} \times 10 = 5\ \mathrm{N}$



F.B.D. of blocks

Balancing torque about point O , we get

$\mathrm{mg}\left(2 \times 10^{-2}\right) - \mathrm{F_B}\left(2 \times 10^{-2}\right) = 0.2\ \mathrm{g}\left(25 \times 10^{-2}\right)$

$\rho \times 10^{-3} \times 10 \times 2 - 10 = 50$

$\rho = 3000\ \mathrm{kg/m}^3$

Hence, mass of block $= \rho \times 10^{-3}$

$= 3000 \times 10^{-3} = 3$ kg

Q1. $\frac{dA}{dt} = \frac{L}{2\,m}$

(1) Due to central force torque is zero & angular momentum is constant.

Q2. $T \propto m^x G^y a^z$

(8) $T \propto M^x \left[M^{-1} L^3 T^{-2}\right]^y [L]^z$

$T \propto M^{x-y} L^{3y+z} T^{-2y}$

$x - y = 0 \Rightarrow x = y$

$-2y = 1 \Rightarrow y = -\frac{1}{2}, x = -\frac{1}{2}$

$\Rightarrow 3y + z = 0$

$z = -3y = \frac{3}{2}$

Hence

$T \propto m^{-1/2} G^{-1/2} a^{3/2}$

$T \propto \left(\frac{a^3}{m}\right)^{1/2}$

$T = 4 \times \left(\frac{2^3}{2}\right)^{1/2} = 8\text{ s}$

Q3. $KE = \frac{1}{2}mv^2 = \frac{1}{2}m\frac{GM_e}{r} = \frac{GM_e m}{2r} = \frac{GM_e m}{2(R_E + h)}$

(3) $= \frac{6.67 \times 10^{-11} \times 6 \times 10^{24} \times 6.4 \times 10^6}{2\left(6.4 \times 10^6 + 2.7 \times 10^5\right)} = 3 \times 10^{10}\text{ J}$

Q4. $KE = \frac{1}{2}m\left(\frac{2Gm}{R}\right) = mgR$

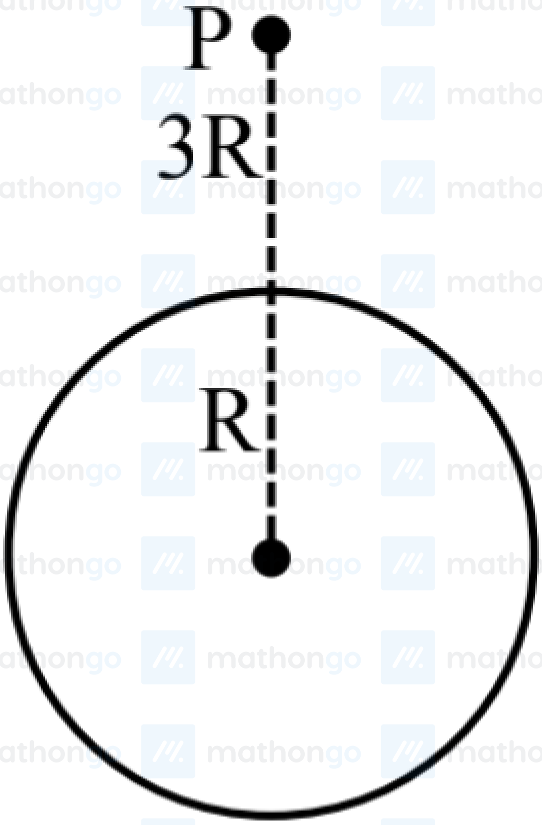
(1) Assertion wrong

at ∞

$U = 0$

$\therefore$ Reason correct.

Q5.
(1)



$P_P + k_P = P_o + k_0$

$-\frac{GMm}{4R} + \frac{1}{2}mV_P^2 = 0$

$V_P = \sqrt{\frac{GM}{2R}}$

Choice 1

Q1. $\frac{L_A}{L_B} = \frac{1}{3}$ and $\frac{d_A}{d_B} = 2$

(2) $\Delta L_A = \frac{F_A L_A}{A_A Y_A}$ and $\Delta L_B = \frac{F_B L_B}{A_B Y_B}$

Given, $F_A = F_B$ and $Y_A = Y_B$

$$\frac{\Delta L_A}{\Delta L_B} = \frac{\frac{F_A L_A}{A_A Y_A}}{\frac{F_B L_B}{A_B Y_B}} = \left(\frac{L_A}{L_B}\right)\left(\frac{A_B}{A_A}\right)$$

$$\frac{\Delta L_A}{\Delta L_B} = \left(\frac{L_A}{L_B}\right)\left(\frac{\frac{\pi}{4} d_B^2}{\frac{\pi}{4} d_A^2}\right) = \left(\frac{L_A}{L_B}\right)\left(\frac{d_B}{d_A}\right)^2$$

$$\frac{\Delta L_A}{\Delta L_B} = \left(\frac{1}{3}\right)\left(\frac{1}{2}\right)^2 = \frac{1}{12}$$

Q2. $\frac{50\ \mathrm{g}}{\pi r^2} = y \cdot \frac{\Delta \ell}{\ell}$

(1)

$$\frac{50 \times 3\pi}{\pi \times \left(3 \times 10^{-3}\right)^2} = P \times 10^{11} \times \frac{0.1 \times 10^{-3}}{3}$$

$$\Rightarrow P = \frac{50 \times 3 \times 3}{3^2 \times 10^{-6} \times 10^{11} \times 0.1 \times 10^{-3}}$$

$P = 5$

Q3. Given, Initial pressure of liquid $(P_i) = 1$ atm

(4) Final pressure of liquid $(P_f) = 5$ atm

Change in pressure $(dP) = P_f - P_i = 4$ atm

$= 4 \times 10^5$ Pa

Change in volume $(dV) = -0.8\ \mathrm{cm}^3$

Bulk modulus $(B) = 2 \times 10^9$ Pa

Now, $B = \frac{-dP}{(dV/V)} \Rightarrow V = -B\left(\frac{dV}{dP}\right)$

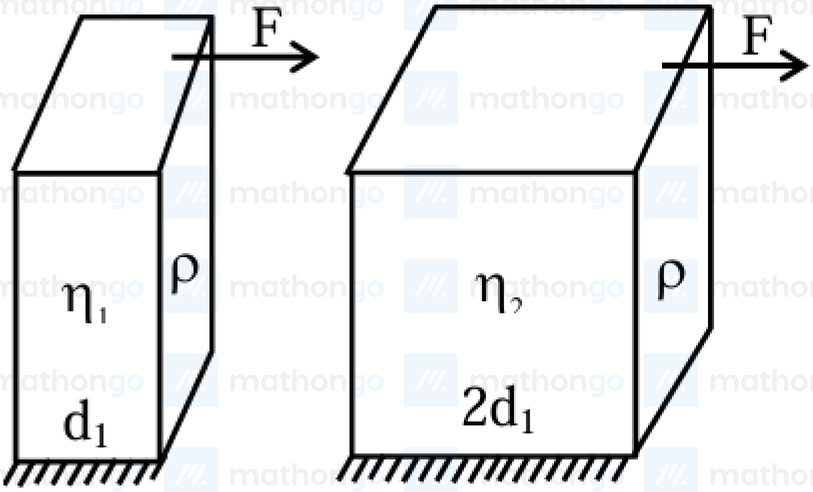
$$\Rightarrow V = -2 \times 10^9 \times \frac{\left(-0.8 \times 10^{-6}\right)}{4 \times 10^5}$$

$$= 4 \times 10^{-3}\ \mathrm{m}^3 = 4 \text{ litre}$$

Q4. Deformation angle

(1) $2\theta_1 = \theta_2$

$$\Rightarrow 2\frac{\sigma_1}{\eta_1} = \frac{\sigma_2}{\eta_2}$$

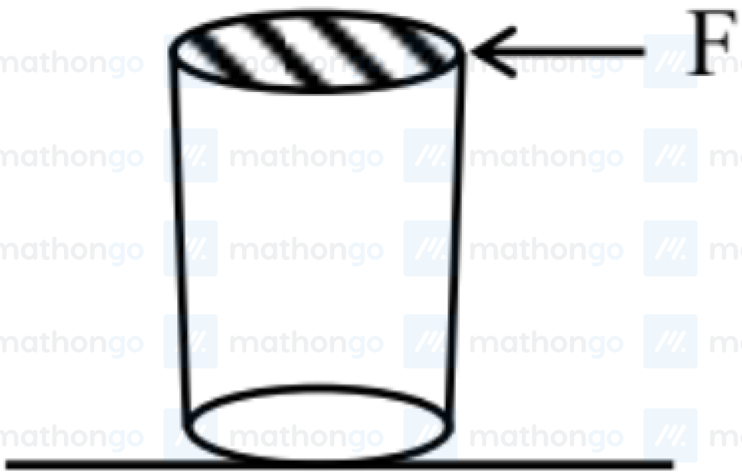


$$\Rightarrow 2\left(\frac{F}{\ell\ d_1\eta_1}\right) = \frac{F}{\ell d_2\eta_2}$$

$$\Rightarrow \eta_2 = \frac{\eta_1}{4} = 1\times10^9 \Rightarrow x = 1$$

Q5.

(1)



$$\text{Shear moduli } = \frac{\sigma_{\text{shear}}}{\theta}$$

$$10^{10} = \frac{10^5}{\pi\times16\times10^{-4}}\times\frac{1}{\theta}$$

$$\theta = \frac{1}{160\pi}\text{ Radian}$$

Q6. $\ell = 2\text{ m}; \mathrm{Y} = 2 \times 10^{11} \dfrac{\mathrm{N}}{\mathrm{m}^2}$

(25)

$$\mu = -\frac{\left(\frac{\Delta \mathrm{r}}{\mathrm{r}}\right)}{\left(\frac{\Delta \ell}{\ell}\right)} \Rightarrow \frac{\Delta \ell}{\ell} = \frac{1}{\mu} \times \left(\frac{\Delta \mathrm{r}}{\mathrm{r}}\right)$$

$$= \frac{1}{0.2} \times \left(10^{-3}\right)$$

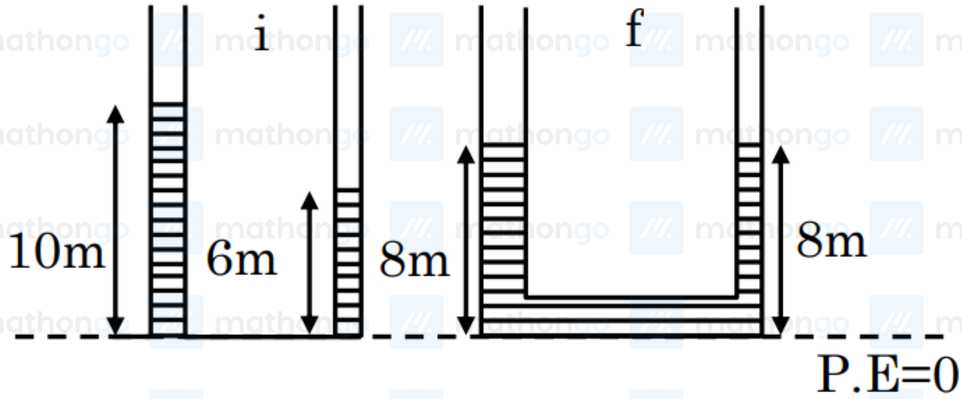
$$\Rightarrow \frac{\Delta \ell}{\ell} = 5 \times 10^{-3}$$

$$\mathrm{u} = \frac{1}{2} \mathrm{y} \varepsilon_\ell^2 = \frac{1}{2} \times 2 \times 10^{11} \times \left[5 \times 10^{-3}\right]^2$$

$$= 25$$

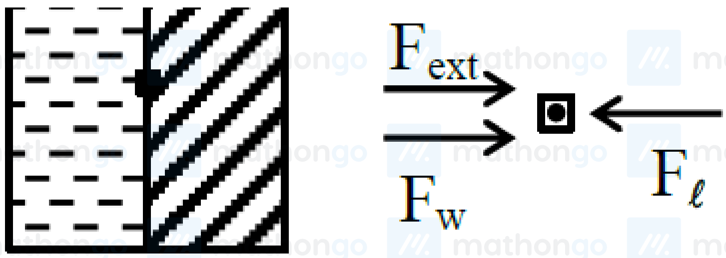
Q1. $k=\frac{\cos\theta_A}{\cos\theta_B}$
(3) It is negative when $\cos\theta_A \& \cos\theta_B$ are of opposite sign. so option (3)

Q2.
(4)



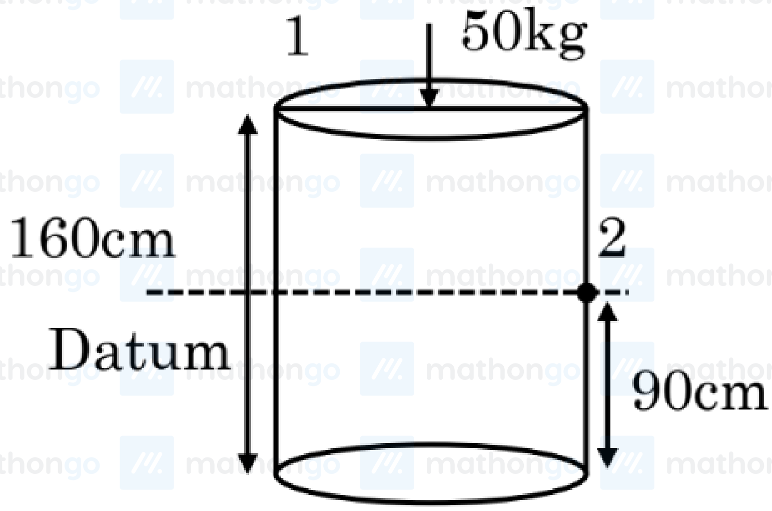
$U_1=(\rho A\times 10)g\times 5+(\rho A6)g\times 3$
$U_i=\rho Ag(50+18)$
$U_i=68\rho Ag$
$U_f=(\rho A\times 16)g\times 4$
$=(\rho Ag)\times 64$
$\omega=\Delta U=4\times\rho Ag$
$=4\times 1000\times 2\times 10=8\times 10^4$ J

Q3.
(150)



in equilibrium
$F_{ext}+F_w=F_\ell$
$\Rightarrow F_{ext}=F_\ell-F_w$
$=(P_0+\rho_\ell gh)A-(P_0+\rho_w gh)A$
$=(\rho_\ell-\rho_w)ghA$
$=(1500-1000)\times 10\times 3\times\left(100\times 10^{-4}\right)$
$=150$ m

Q4.
(4)



Apply Bernouli equation between points 1&2

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h = P_2 + \frac{1}{2}\rho v_2^2 + 0$$

$$P_0 + \frac{\mathrm{mg}}{\mathrm{A}} + \rho g \frac{70}{100} = P_0 + \frac{1}{2}\rho v_2^2$$

$$\frac{5000}{0.5} + 10^3 \times 10 \frac{70}{100} = \frac{1}{2} \times 10^3 v_2^2$$

$$10^3 + 10^3 \times 7 = \frac{10^3}{2} \mathrm{v}_2^2$$

$$\mathrm{v}_2^2 = 16$$

$$\mathrm{v}_2 = 4 \mathrm{~m/s}$$

As the tank area is large v_1 is negligible compared to v_2

Q5.
(1)

$$2 \times \frac{4}{3}\pi \mathrm{R}^3 = \frac{4}{3}\pi \mathrm{r}^3 \Rightarrow \mathrm{r} = 2^{1/3}\mathrm{R}$$

$$\mathrm{U_i} = 2 \times 4\pi \mathrm{R}^2 \mathrm{~T}$$

$$\mathrm{U_f} = 4\pi \mathrm{r}^2 \mathrm{~T} = 4\pi \mathrm{R}^2 \mathrm{~T} 2^{2/3}$$

$$\therefore \text{ Heat lost } = \mathrm{u_i} - \mathrm{u_f} = 4\pi \mathrm{R}^2 \mathrm{~T}\left[2 - 2^{2/3}\right]$$

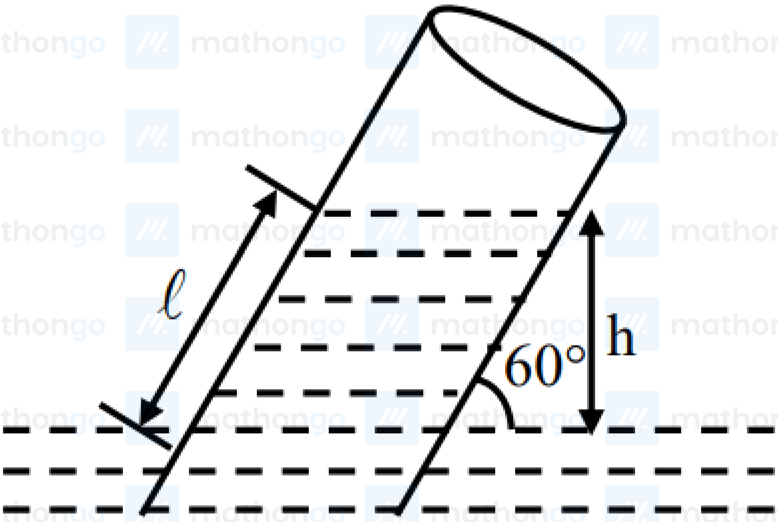
Q6.
(8)

$$\Delta \mathrm{P} = \frac{4 \mathrm{~T}}{\mathrm{R}}$$

$$\frac{\mathrm{R_A}}{\mathrm{R_B}} = \frac{\Delta \mathrm{P_B}}{\Delta \mathrm{P_A}} = 2$$

$$\frac{\mathrm{V_A}}{\mathrm{V_B}} = \left(\frac{\mathrm{R_A}}{\mathrm{R_B}}\right)^3 = 8$$

Q7.
(1)



$$h = \frac{2\,T\cos\theta}{\rho g r} = \frac{2 \times 70 \times 1}{1 \times 980 \times 10^{-2}}$$

$$h = \frac{100}{7}\ \text{cm}$$

$$\sin 60^\circ = \frac{h}{\ell}$$

$$\ell = \frac{h \times 2}{\sqrt{3}}$$

$$\ell = \frac{100}{7} \times \frac{2}{\sqrt{3}}$$

$$= \frac{200}{7 \times \sqrt{3}}$$

$$= 16.49\ \text{cm}$$

Q8.
(4)

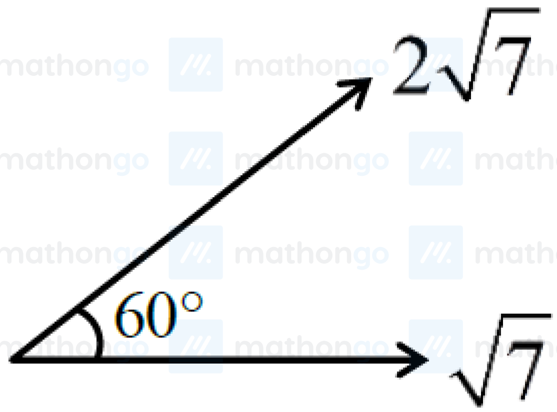
$$v_T \Rightarrow \frac{2}{9}\frac{(\rho_0-\rho_\ell)r^2\,g}{\eta}$$

$$\eta = \frac{2}{9}\left(\frac{7825 - 925}{2.45 \times 10^{-2}}\right) \times (1.8)^2 \times 10^{-6} \times 9.8$$

$$\eta \approx 1.99$$

Q1.
(1)
$x_1 = \sqrt{7}\sin 5t$
$x_2 = 2\sqrt{7}\sin\left(5t + \frac{\pi}{3}\right)$

From phasor,



$\therefore$ Amplitude of resultant SHM $= 7$

$$\phi = \tan^{-1}\frac{2\sqrt{7}\times\sqrt{3}/2}{\sqrt{7}+2\sqrt{7}\times\frac{1}{2}} = \tan^{-1}\frac{\sqrt{21}}{2\sqrt{7}} = \tan^{-1}\frac{\sqrt{3}}{2}$$

$\therefore \quad X_R = 7\sin(5t+\phi)$

$a_R = -7\times 25\sin(5t+\phi)$

$\therefore a_{max} = 175\ \text{cm/sec} = 175\times 10^{-2}\ \text{m/sec}$

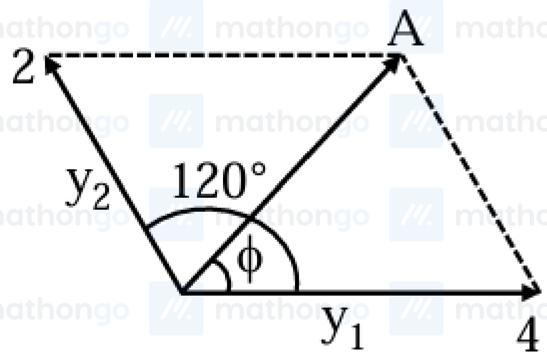
Q2.
(4)
$\omega = \sqrt{\frac{g}{\ell}}$

$\alpha = -\omega^2\theta$

$\therefore \frac{g}{\ell_1}\theta_1 = \frac{g}{\ell_2}\theta_2$

$\Rightarrow \theta_1\ell_2 = \theta_2\ell_2$

Q3.
(4)



$A = \sqrt{2^2+4^2+2\times 2\times 4\times\cos 120^\circ}$

$= \sqrt{12} = 2\sqrt{3}$

$\tan\phi = \frac{2\sin 120^\circ}{4+2\cos 120^\circ} = \frac{\sqrt{3}}{3} = \frac{1}{\sqrt{3}}$

$\phi = \frac{\pi}{6}$

Q4. (1) (A) As both blocks moving together so Time period $= 2\pi\sqrt{\frac{m}{K}}$; where $m = M + m$

$T = 2\pi\sqrt{\frac{M+m}{K}}$

(B) Let block is displaced by x in (+ve) direction so force on block will be in(-ve) direction

$F = -Kx$

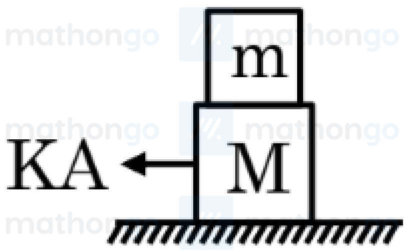
$(M+m)a = -Kx$

$a = -\dfrac{Kx}{(M+m)}$

(C) As upper block is moving due to friction thus

$f = ma = \frac{mKx}{(M+m)}$

(D) This option is like two block problem in friction for maximum amplitude, force on block is also maximum, for which both blocks are moving together.



$KA = (M+m)a$

$a = \dfrac{KA}{(M+m)}$

$f = ma = \dfrac{mKA}{(M+m)}$

$f_{\max} = f_L = \mu \mathrm{mg}$

$f = \mu mg$

$\dfrac{mKA}{(M+m)} = \mu mg$

$A = \dfrac{\mu(M+m)g}{K}$

(E) Maximum friction can be μmg as force is acting between blocks \& normal force here is mg.

Q1. Minimum distance between 2 points having same speed is $\frac{\lambda}{2}$.

(1) $\lambda=\frac{2\pi}{\mathrm{k}}=\frac{1}{10}\ \mathrm{m}=10\ \mathrm{cm}$

Distance $=\frac{\lambda}{2}=5\ \mathrm{cm}$

Q2.

(2) $v=\sqrt{\dfrac{T}{\mu}}=\sqrt{\dfrac{T}{f\pi R^2}}$

$\dfrac{v_2}{v_1}=\dfrac{R_1}{R_2}=2$

Q3.

(1) $\mathrm{v}=\dfrac{\text{distance}}{\text{time}}$

$\mathrm{v}=\dfrac{12}{0.3}=4\ \mathrm{cm/s}$

$\mathrm{k}=\dfrac{2\pi}{\lambda}=\dfrac{2\pi}{7.5}=\dfrac{4\pi}{15}=0.83$

$\mathrm{v}=\dfrac{\omega}{\mathrm{k}}\Rightarrow\omega=\mathrm{vk}=4\times\dfrac{4\pi}{15}=3.35$

So $y=A\cos(kx-\omega t)$

Q4.

(2) $\mathrm{x(t)}=5\cos\left[628\mathrm{t}+\dfrac{\pi}{2}\right]\mathrm{m}$

velocity $(\mathrm{v}_\omega)=300\ \mathrm{m/s}$

$\mathrm{v_w}=\dfrac{\omega}{\mathrm{K}}$

$300=\dfrac{628}{\mathrm{K}}\Rightarrow\ \mathrm{K}=\dfrac{628}{300}$

$\dfrac{2\pi}{\lambda}=\dfrac{628}{300}\Rightarrow\lambda=\dfrac{2\times3.14\times300}{628}$

$\lambda=2\ \mathrm{m}$

Q5. Fundamental frequency in close/organ pipe

(4) $(\mathrm{f})=\dfrac{\mathrm{v}}{4\ell}$

$\mathrm{f_1}=\dfrac{\mathrm{v}}{4\ell_1}\&\mathrm{f_2}=\dfrac{\mathrm{v}}{4\ell_2}$

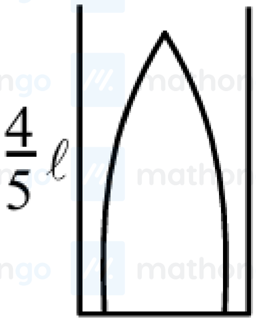
Beat $=(\mathrm{f_1}-\mathrm{f_2})=\frac{\mathrm{v}}{4}\left(\frac{1}{\ell_1}-\frac{1}{\ell_2}\right)$

$15=\dfrac{\mathrm{v}}{4}\left(\dfrac{1}{1}-\dfrac{1}{1.2}\right)$

$\mathrm{v}=\left(\dfrac{15\times4\times1.2}{0.2}\right)=60\times6=360\ \mathrm{m/s}$

Q6.
(1)

$\lambda_1 = 4\ell$



$f_1 = \frac{v}{4\ell}$

$\lambda_2 = \frac{16\ell}{5}$

$f_2 = \frac{5\ V}{16\ell}$

$\frac{\Delta f}{f} = \frac{\frac{V}{\ell}\left(\frac{1}{16}\right)}{\frac{V}{4\ell}} \times 100 = 25\%$

Q7.
(3)

$v_{\text{sound}} = \sqrt{\frac{\gamma p}{\rho}}$

$\gamma = 1 + \frac{2}{f}$

$\gamma_{He} = \frac{5}{3}$

$\gamma_{CH_4} = \gamma_{CO_2} \approx 1.33 = \frac{4}{3} \quad \text{(Experimental data}\Big)$

Q8. The given equation can be written as
(4) $x = \frac{a}{2}\cos[1.5 + 50.5]t + \frac{a}{2}\cos[50.5 - 1.5]$

$x = \frac{a}{2}\cos[52t] + \frac{a}{2}\cos[49t]$

Here, $2\pi f_1 \& 2\pi f_2 = 49$

$f_1 = \frac{52}{2\pi}, f_2 = \frac{49}{2\pi}$

$\therefore f_{Bat} = f_1 - f_2 = \frac{3}{2\pi}$ Hz

$\therefore T_{Beat} = \frac{1}{f_{Beat}} = \frac{2\pi}{3}$sec

$= 2.09\text{sec} \approx 2\text{sec}$

Q1.
(1)

$\Delta Q = ms\Delta T$

$8.1 \times 10^2 = 0.1 \times 900 \times \Delta T$

$\Delta A = A_0 2\alpha\Delta\, T = 2.0 \times 10^{-6}\ m^2$

Q2.
(4)

$mgh = ms\Delta T$

$\Delta T = \dfrac{gh}{s} = \dfrac{10 \times 200}{4200}\ K = \dfrac{10}{21}\ K$

Q3.
(5)

$L = 10\ cm,\ d = 0.5\ mm,\ T = 1727^\circ C = 2000\ K$

Power, $P = 94.2\ W$

$P = \varepsilon\sigma AT^4$

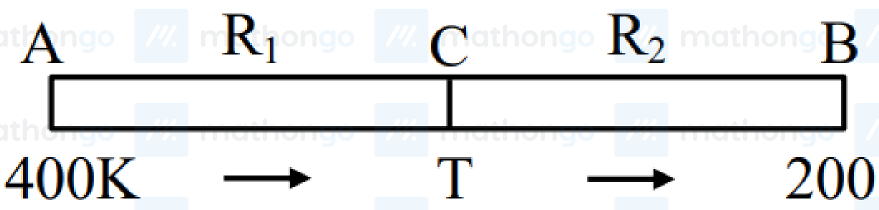
$94.2 = \varepsilon \times \left(6 \times 10^{-8}\right)(\pi dL)(2000)^4$

$94.2 = \varepsilon \times \left(6 \times 10^{-8}\right)(3.14)(0.5)\left(10^{-3}\right)$

$\left(10 \times 10^{-2}\right)(2000)^4$

$\varepsilon = \frac{94.2}{(94.2)(16)} = \frac{5}{8}$

Q4.
(360)



$R_1 = \dfrac{\ell_1}{K_1\, A_1}, R_2 = \dfrac{\ell_2}{K_2\, A_2}$

$\dfrac{dQ}{dt} = \dfrac{\Delta T}{R}$

$\left(\dfrac{dQ}{dt}\right)_1 = \left(\dfrac{dQ}{\mu}\right)_2$

$\dfrac{400 - T}{R_1} = \dfrac{T - 200}{R_2}$

$\dfrac{400 - T}{T - 200} = \dfrac{R_1}{R_2} = \left(\dfrac{\ell_1}{\ell_2}\right)\left(\dfrac{r_2}{r_1}\right)^2 \times \dfrac{K_2}{K_1}$

$= \dfrac{1}{2} \times \left(\dfrac{1}{2}\right)^2 \times 2$

$= \left(\dfrac{1}{4}\right)$

$\dfrac{400 - T}{T - 200} = \dfrac{1}{4}$

$1600 - 4\,T = T - 200$

$5\,T = 1800$

$T = 360\ K$

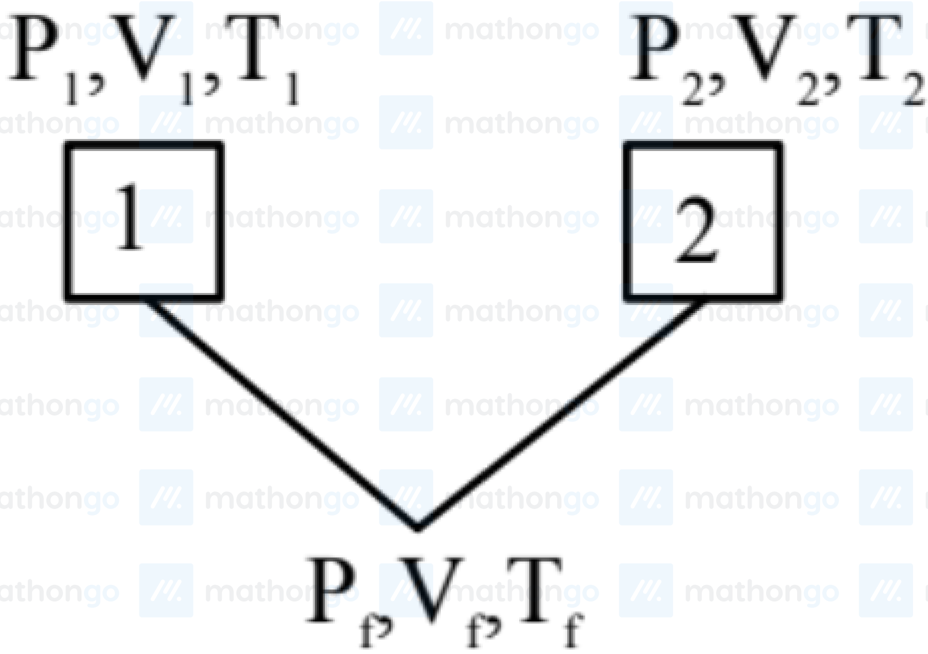
Q1. (A) Isobaric $(P = C)$
(3) $\Delta Q = \Delta U + P\Delta V$

(B) Isochoric $(V = C)$
$\Delta Q = \Delta U$

(C) Adiabatic $(\Delta Q = 0)$
$\Delta Q = 0$

(D) Isothermal $(\Delta U = 0)$
$\Delta Q = \Delta W$

Q2.
(2)



Number of masses will remain constant

$n_1 + n_2 = n_f$

$$\frac{P_1 V_1}{RT_1} + \frac{P_2 V_2}{RT_2} = \frac{P_f V_f}{RT_f}$$

$$\frac{8 \times 2V}{R \times 1000} + \frac{7 \times V}{R \times 500} = \frac{P_f(3V)}{R \times 600}$$

$$\frac{16}{1000} + \frac{14}{1000} = \frac{P_f}{R \times 600}$$

$$\frac{30}{1000} = \frac{P_f}{200}$$

$P_f = 6 \text{kPa}$

Q3. To find the internal energy of gas in the room.
(12) $U = nC_v T = n\frac{5RT}{2}$

$$= \frac{5}{2}PV = \frac{5}{2} \times 10^5 \times 48 = 12 \times 10^6 \text{ J}$$

Q4. Volume decreases during melting of ice so positive work is done on ice water system by atmosphere
(4) Heat absorbed by ice water so ΔQ is positive, work done by ice water system is negative

Hence by first law of thermodynamics

$\Delta U=\Delta Q+\Delta W=$ Positive

So internal energy increases

Q5. For adiabatic process, $dQ=0$
(3) $\therefore$ Molar heat capacity $=0$

$\because dQ=0 \Rightarrow dU=-dW$

Also $dU=\frac{f}{2} nRdT$

$\therefore$ Only option (3) is correct.

Q6. $Q=\Delta U+W=0 \Rightarrow-\Delta U=W$
(3) $WD=-nC_v \Delta T \Rightarrow|WD|=nC_v \Delta T \propto T_2-T_1$

$\therefore$ B&E [Only possibility]

Q7. $V_1=800 \mathrm{~cm}^3 \quad V_2=200 \mathrm{~cm}^3$
(4) $T_1=300 \mathrm{~K}$

for adiabatic

$TV^{\gamma-1}=$ const.

$(300)(800)^{1.5-1}=T_2(200)^{1.5-1}$

$T_2=300\left[\frac{800}{200}\right]^{0.5}=300 \times\left(2^2\right)^{1/2}$

$T_2=600 \mathrm{~K}$

$\Delta T=600-300=300 \mathrm{~K}$

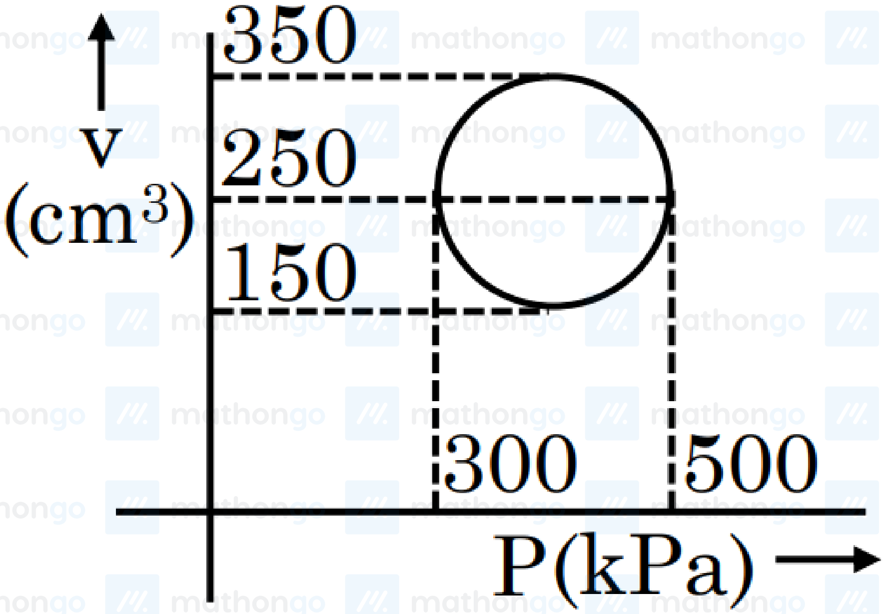
Q8. Isochoric process
(3) $P \propto T$

$\frac{\Delta P}{P}=\frac{\Delta T}{T}$

$\frac{0.4}{100}=\frac{1}{T}$

$T=250 \mathrm{~K}$

Q9.
(314)



Area of circle, $W = \frac{\pi}{4} d_1 d_2$

$W = \frac{\pi}{4}(500 - 300) \times 10^3 (350 - 150) \times 10^{-6}$

W = 31.4 Joule

$W = 314 \times 10^{-1}$ Joule

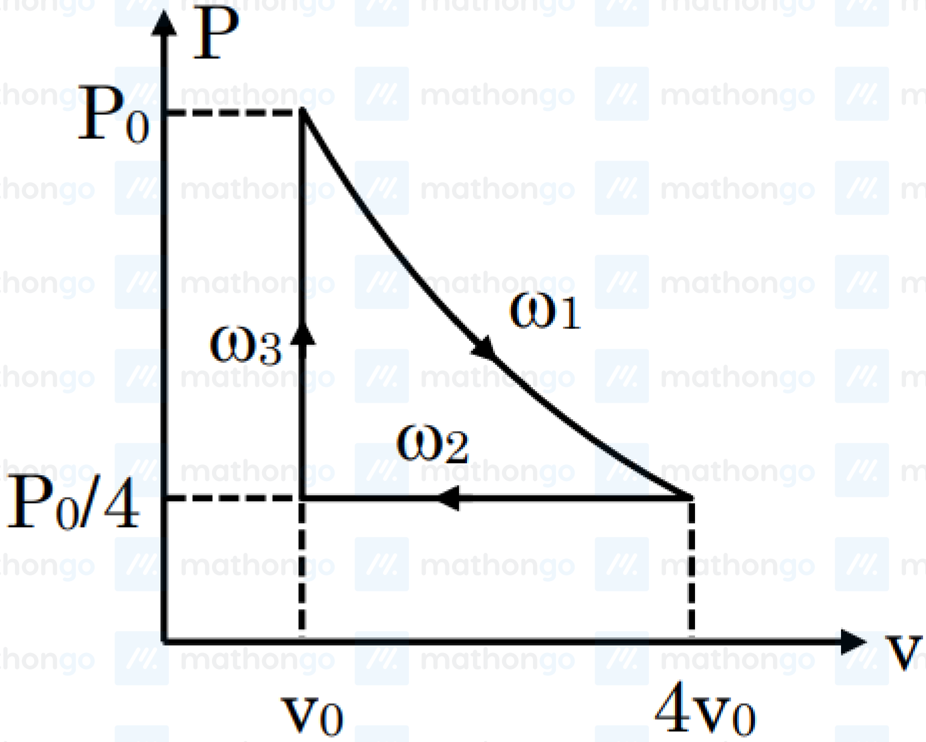
Q10. (A) Isothermal $\rightarrow \Delta T = 0 \rightarrow \Delta U = 0$ (IV)
(3) (B) Adiabatic $\rightarrow \Delta Q = 0$ (II)
(C) Isobaric $\rightarrow \Delta P = 0 \rightarrow \Delta U \neq 0$ (III)
(D) Isochoric $\rightarrow \Delta V = 0 \rightarrow \Delta W = 0$(I)

Q11. $P_i V_i^\gamma = P_f V_f^\gamma$
(3) $\frac{P_f}{P_i} = \left(\frac{V_i}{V_f}\right)^\gamma = (8)^{5/3}$

$\frac{P_f}{P_i} = 32$

Q12.

(1)



$$\omega_1 = P_0 v_0 \ln 4$$

$$\omega_2 = \frac{P_0}{4}(-3v_0) = -\frac{3P_0 v_0}{4}$$

$$\omega_3 = 0$$

$$\mathrm{Q_T} = \Delta \mathrm{U_{cyclic}} + \omega$$

$$\mathrm{Q_T} = \omega \quad (\Delta \mathrm{U_{cyclic}} = 0)$$

$$\mathrm{Q_T} = \mathrm{P_0 v_0}\left(\ln 4 - \frac{3}{4}\right)$$

$$= \mathrm{P_0 v_0}(2 \ln 2 - 0.75)$$

Q1. Frequency $= \frac{1}{T} = \frac{V_{\text{avg}}}{\lambda}$
(3)
$= \frac{600}{3 \times 157} = 2 \times 10^9 \mathrm{sec}^{-1}$

Q2. $K.E = \frac{f}{2} KT$
(4) For He and Arf $= 3$
$\frac{\mathrm{K \cdot E_{He}}}{\mathrm{K \cdot E_{Ar}}} = \frac{1}{1}$

Q3. $\frac{\gamma_A}{\gamma_B} = \frac{\mathrm{f_A} + 2}{\mathrm{f_A}} \times \frac{\mathrm{f_B}}{\mathrm{f_B} + 2}$
(3)
$= \frac{3+2}{3} \times \frac{(6+2)}{(6+2)+2}$
$= \frac{5}{3} \times \frac{8}{10} = \frac{40}{30}$
$\because \frac{40}{30} = 1 + \frac{1}{\mathrm{n}}$
$\Rightarrow \frac{40}{30} - 1 = \frac{1}{\mathrm{n}}$
$\Rightarrow \mathrm{n} = 3$

Q4. $\gamma = 1 + \frac{2}{\mathrm{f}}$
(1) $f = 6$, Triatomic rigid gas
f $= 7$, Diatomic non-rigid gas
$f = 5$, Diatomic rigid gas
f $= 3$, monoatomic rigid gas
$\gamma = 1 + \frac{2}{6} = \frac{4}{3}$ (Triatomic)
$\gamma = 1 + \frac{2}{7} = \frac{9}{7}$(Diatomic, non-rigid)
$\gamma = 1 + \frac{2}{5} = \frac{7}{5}$(Diatomic, rigid)
$\gamma = 1 + \frac{2}{3} = \frac{5}{3}$(Monoatomic, rigid)
A-III, B-IV, C-I, D-II

Q1. For conducting sphere, $V = \frac{\sigma r}{\varepsilon_0}$

(4) After contact, $V_1 = V_2$

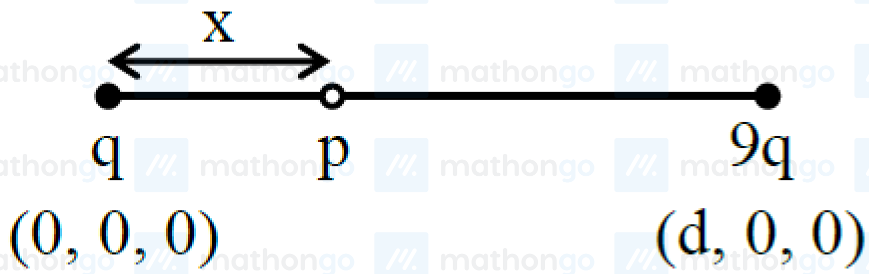
$\sigma_1 r_1 = \sigma_2 r_2$

$\frac{\sigma_1}{\sigma_2} = \frac{r_2}{r_1}$

$\frac{\sigma_1}{\sigma_2} = 3$

Q2.

(2)



Let $E_p = 0$

$\therefore \frac{kq}{x^2} = \frac{k9q}{(d-x)^2}$

$\Rightarrow \frac{d-x}{x} = 3 \Rightarrow x = \frac{d}{4}$

$\therefore$ co-ordinate of P is $\left(\frac{d}{4}, 0, 0\right)$

Q3. Potential inside shell is equal to potential on surface

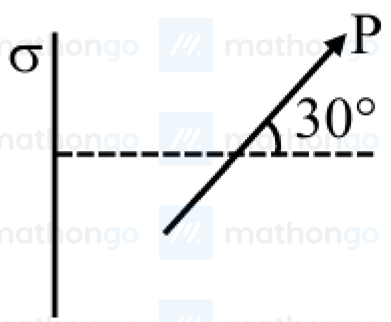
(1) $V_{in} = V_{surface} = \frac{kQ}{R} = 120\ V$

at $r = 15$ cm

$V = \frac{kQ}{r} = \frac{120 \times 10}{15} = 80\ V$

Q4.

(2)



$E = \frac{\sigma}{2\varepsilon_0}$

$\tau = PE \sin\theta$

$= \left[\left(2 \times 10^{-6}\right)\left(\frac{2}{10}\right)\right]\left[\frac{100 \times 10^{-6}}{2 \times 8.85 \times 10^{-12}}\right]\left(\frac{1}{2}\right)$

$= \frac{10}{8.85} = 1.12 Nm$

Q5. A : Since polar dielectrics are randomly oriental $\vec{P}_{net} = \vec{0}$.

(4) R : If $\vec{E}$ is absent, polar dielectric remain polar \& are randomly oriented.

Q6. $\phi=\overrightarrow{\mathrm{E}}\cdot\overrightarrow{\mathrm{A}}=(2\hat{\mathrm{i}}+4\hat{\mathrm{j}}+6\hat{\mathrm{k}})\times10^{3}\cdot\ \mathrm{A}\hat{\mathrm{j}}$

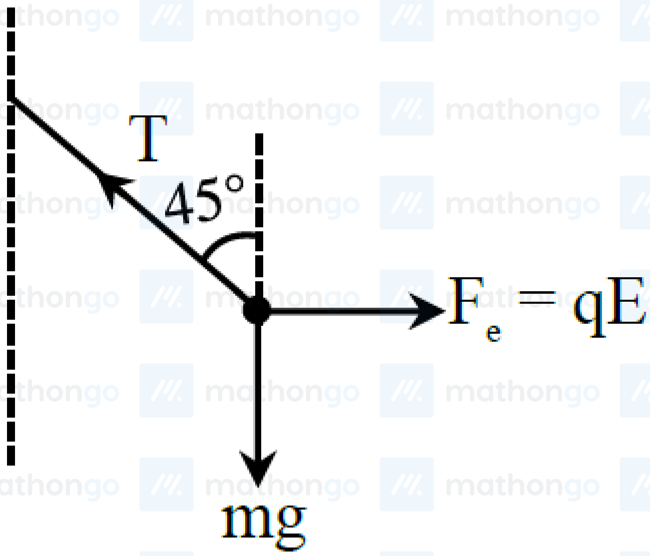
(15) $6=4\times10^{3}\ \mathrm{A}$

$\mathrm{A}=1.5\times10^{-3}\ \mathrm{m}^{2}$

$=15\ \mathrm{cm}^{2}$

Q7.

(4)



$\mathrm{qE}=\mathrm{mg}$

$\mathrm{q}\left[\frac{\sigma}{2\varepsilon_0}\right]=\mathrm{mg}$

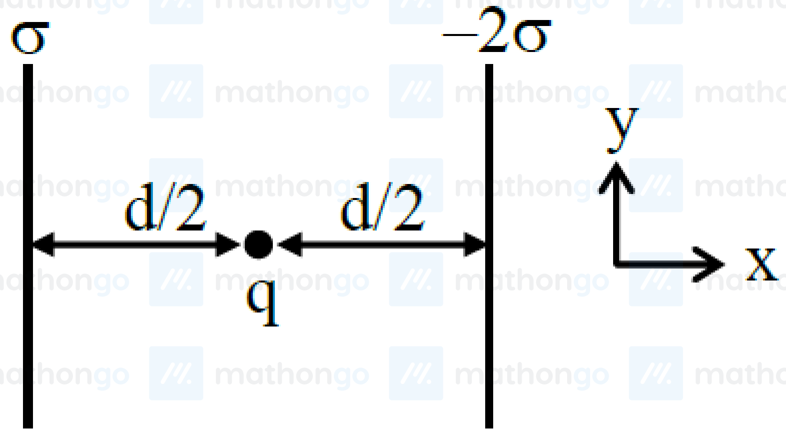
$\sigma=\frac{2\varepsilon_0\mathrm{mg}}{\mathrm{q}}$

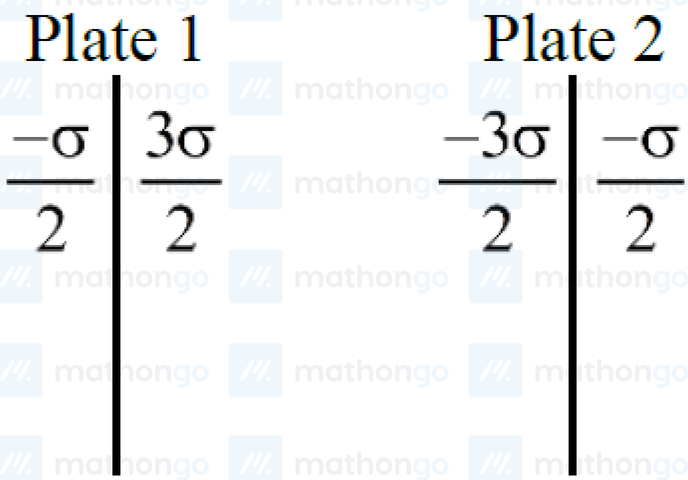
$\sigma=\frac{2\times8.85\times10^{-12}\times100\times10^{-6}\times10}{10\times10^{-6}}$

$\sigma=17.7\times10^{-10}\mathrm{C}/\mathrm{m}^{2}$

$\sigma=1.77\mathrm{nC}/\mathrm{m}^{2}$

Q8.
(2)





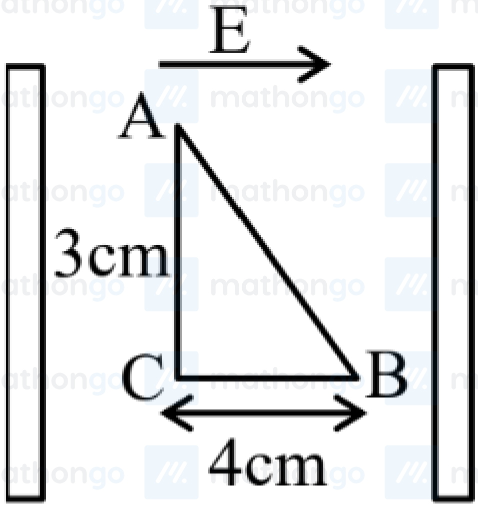
Final charge distribution will be

$\therefore F_{net} = \frac{3\sigma}{2\epsilon_0} q$

Q9. Conceptual
(3) $E_C \neq E_D$
$E_A > E_B$

Q10. Electric field of outside charge is zero inside conductor
(1)

Q11.
(2)



Using $\Delta V = E(\Delta d)$

$V = E(10)$

$V_{AB} = E \cdot 4 = \frac{V}{10} \times 4 = \frac{2V}{5}$

Q12.
(3)

$E = \frac{KQr}{\left(x^2 + R^2\right)^{3/2}}$

$\frac{dE}{dx} = 0$

$\therefore x = \frac{R}{\sqrt{2}} = \frac{\sqrt{2}a}{\sqrt{2}} = a$

Q13. Potential at C
(1)

$V_C = \frac{kq_1}{0.4} + \frac{kq_2}{0.5}$

Potential at D

$V_D = \frac{kq_1}{0.4} + \frac{kq_2}{0.1}$

$\Delta U = (V_D - V_c)(q_3) = \left(\frac{kq_2}{0.1} - \frac{kq_2}{0.5}\right)(q_3)$

$\Delta U = 8kq_2q_3 = \frac{8q_2q_3}{4\pi\varepsilon_0}$

Q14. For a uniformly charged spherical shell:
(2)

- The electric field inside the shell is zero everywhere (from Gauss's law)

* When the electric field is zero, no work is done in moving a charge

- Since work - force × displacement, and force - qE (where E - 0), work - 0

- The potential inside is constant and equal to the value at the surface

Assertion A is correct: Since the electric field is zero everywhere inside the shell, no work is done moving a charge between any two points, regardless of path.

Reason R is correct: The potential inside a uniformly charged spherical shell is indeed constant and equal to the value at the surface.

Does R explain A ? Yes, because:

- Constant potential means zero electric field (since $E = -FW$)

- Zero electric field means no force on a test charge

- No force means no work done in moving the charge

Therefore, opxion (2) is correct: Both A and R are true and R is the correct explanation of A.

Q15. $E=\frac{v}{d}=\frac{5}{5\times10^{-4}}=10^4\ V/m$

(1) $\tau=PE\sin\theta$

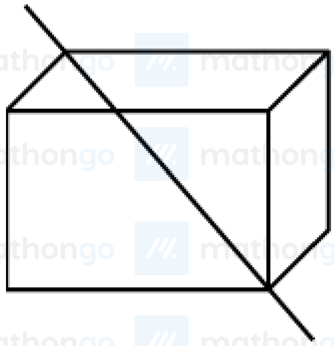
Where $P=qa=2\times10^{-6}\times5\times10^{-7}$

$=1\times10^{-12}C-m$

$\tau=1\times10^{-12}\times10^4\times\frac{1}{2}=5\times10^{-9}\ N-m$

Q16.

(4)



$\phi=\frac{q_{enc}}{\varepsilon_0}=\frac{\lambda\cdot\sqrt{3}a}{\varepsilon_0}$

$=2\times10^{-9}\times\sqrt{3}\times\sqrt{3}\times10^{-2}\times36\pi\times10^9Nm^2C^{-1}$

$=2.16\pi Nm^2C^{-1}$

Q17. $\sigma\propto\frac{1}{ROC}$

(1) $(ROC)_1<(ROC)_3<(ROC)_2=(ROC)_4$

$\sigma_1>\sigma_3>\sigma_2=\sigma_4$

Q18. Let the momentum of e^- at any time t is p and its de-broglie wavelength is λ.

(2) Then, $p=\frac{h}{\lambda}$

$\frac{dp}{dt}=\frac{-h}{\lambda^2}\frac{d\lambda}{dt}$

$ma=F=-\frac{h}{\lambda}\frac{d\lambda}{dt}$ [m = mass of e]

Where, -ve sign represents decrease in λ with time

$ma=\frac{-h}{(h/p)^2}\frac{d\lambda}{dt}$

$a=-\frac{p^2}{mh}\frac{d\lambda}{dt}$

$a=-\frac{mv^2}{h}\frac{d\lambda}{dt}$

$\frac{d\lambda}{dt}=-\frac{ah}{mv^2}\ldots(1)$

here, $a=\frac{qE}{m}=\frac{e}{m}\frac{\sigma}{2\varepsilon_0}$

$a=\frac{\sigma e}{2m\varepsilon_0}$

and $v = u + at$

$v = at$

Substituting values of a \& v in equation (1)

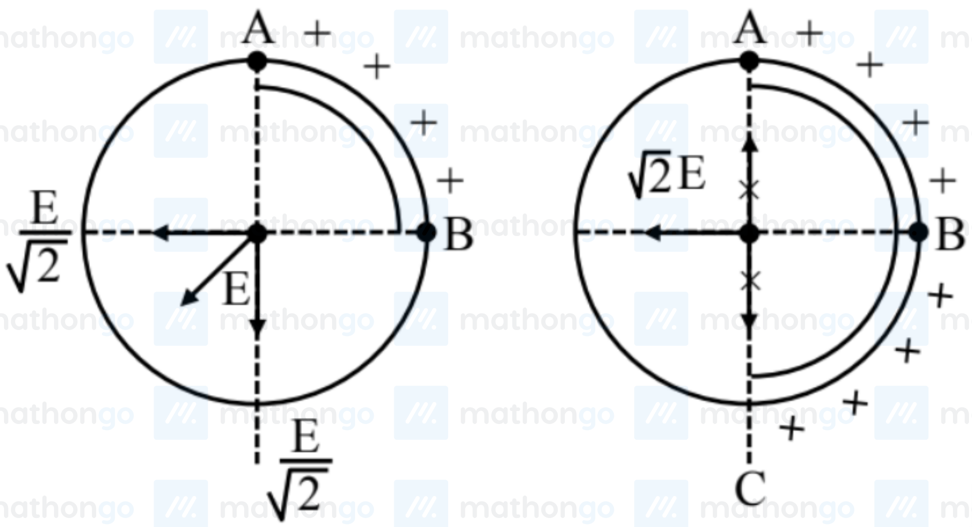
$\frac{d\lambda}{dt} = -\frac{2\,h\varepsilon_0}{\sigma e t^2}$

$\Rightarrow \frac{d\lambda}{dt} \propto \frac{1}{t^2}$

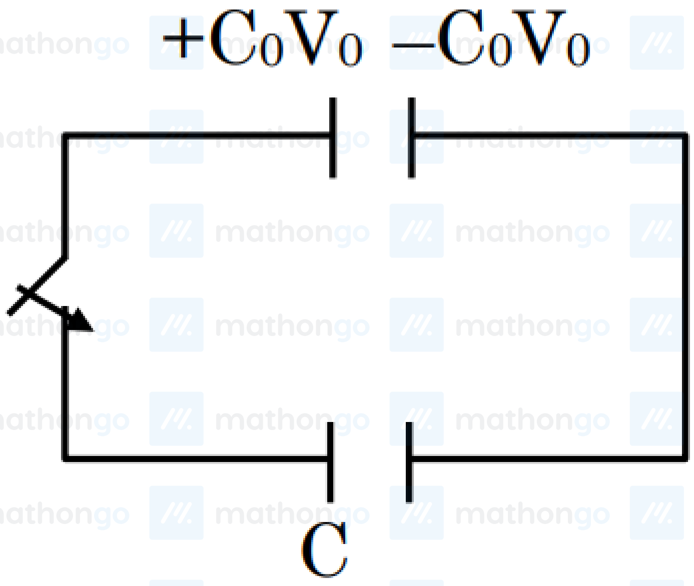
$\Rightarrow n = 2$

Q19.

(2)



Q1.
(2)



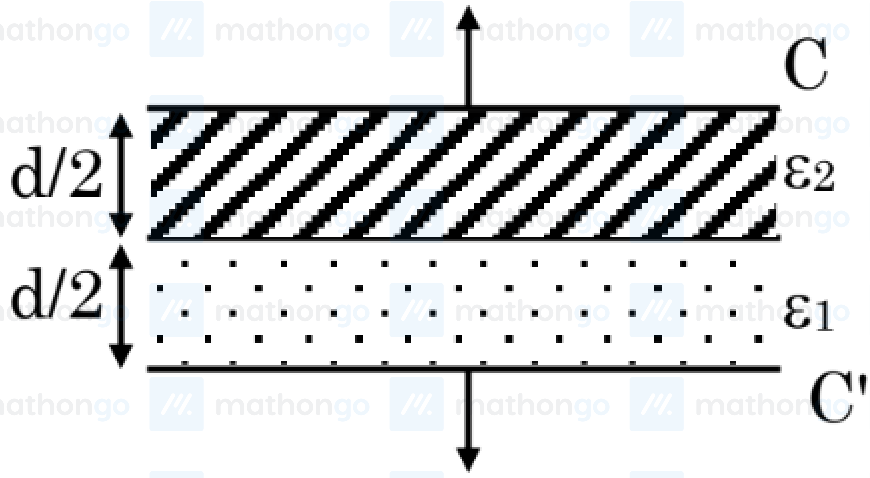
New potential $= \frac{C_0 V_0}{C_0+C} = \frac{V_0}{3}$

$3C_0 V_0 = C_0 V_0 + CV_0$

$2C_0 V_0 = CV_0$

$C \Rightarrow 2C_0$

Q2.
(2)



First configuration

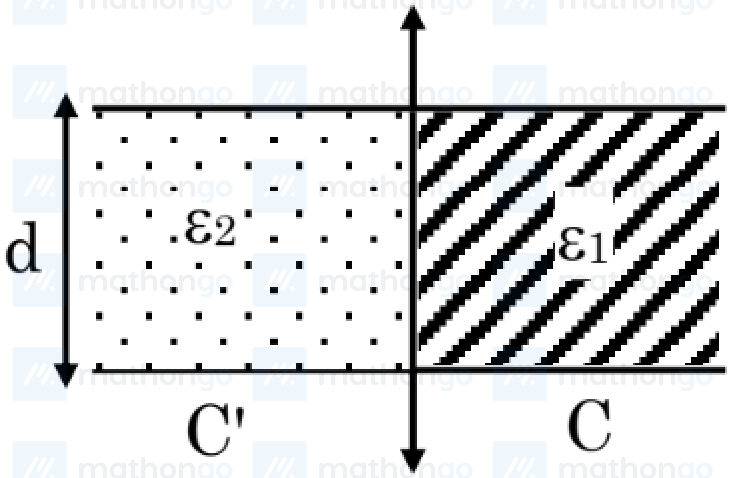
Area of plate is A. then

$C = \frac{\varepsilon_2 \varepsilon_0 A}{d/2} = \frac{2\varepsilon_2 \varepsilon_0 A}{d}$

$C' = \frac{\varepsilon_1 \varepsilon_0 A}{d/2} = \frac{2\varepsilon_1 \varepsilon_0 A}{d}$

Let $C_0 = \frac{\varepsilon_0 A}{d}$

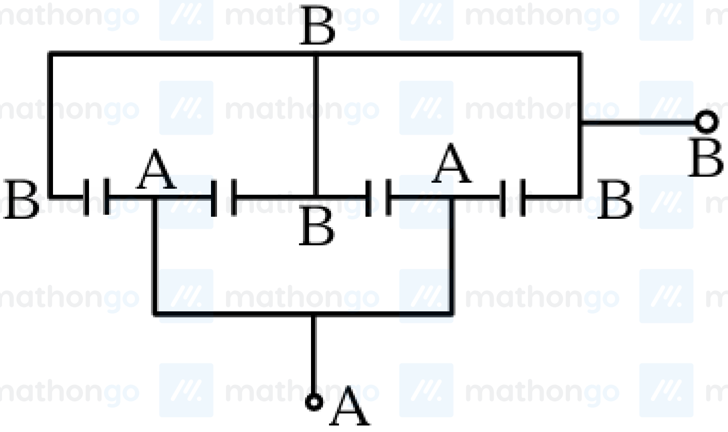
$\mathrm{C}=2\varepsilon_2\mathrm{C}_0$
$\mathrm{C}'=2\varepsilon_1\mathrm{C}_0$
$\mathrm{C}\&\mathrm{C}'$ are in series
$\mathrm{C}_1=\frac{\mathrm{CC}'}{\mathrm{C}+\mathrm{C}'}=\frac{4\varepsilon_2\varepsilon_1\mathrm{C}_0^2}{2\mathrm{C}_0(\varepsilon_2+\varepsilon_1)}$

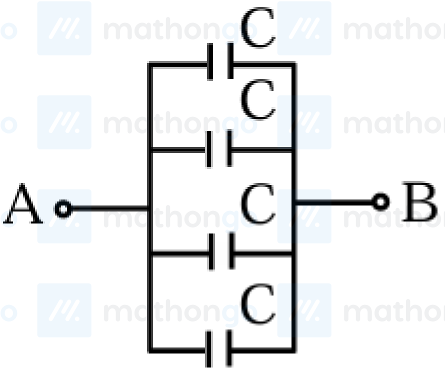


Second configuration

$=\frac{2\varepsilon_2\varepsilon_1\mathrm{C}_0}{(\varepsilon_2+\varepsilon_1)}$
Here $\mathrm{C}=\frac{\varepsilon_1\varepsilon_0\mathrm{~A}}{2\mathrm{~d}}=\frac{\varepsilon_1\mathrm{C}_0}{2}$
$\mathrm{C}'=\frac{\varepsilon_2\mathrm{C}_0}{2}$
$\mathrm{C}\&\mathrm{C}'$ are inparallel
$\mathrm{C}_2=\mathrm{C}'+\mathrm{C}=(\varepsilon_1+\varepsilon_2)\frac{\mathrm{C}_0}{2}$
Thus $\frac{\mathrm{C}_1}{\mathrm{C}_2}=\frac{2\varepsilon_2\varepsilon_1\mathrm{C}_0}{(\varepsilon_2+\varepsilon_1)}\times\frac{2}{(\varepsilon_1+\varepsilon_2)\mathrm{C}_0}$
$=\frac{4\varepsilon_2\varepsilon_1}{(\varepsilon_2+\varepsilon_1)^2}$

Q3.
(64)





Redrawing

$C_{eq} = 4C = 64$

Q4. After dielectric
(3)

$C_1 = 4C$

$C_1 = 4 \times 5 = 20\mu\,F$

$C_2 = C_3 = 5\mu\,F$

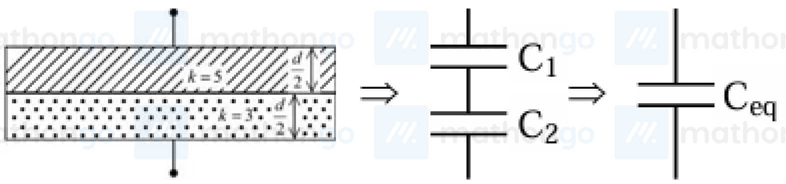
$C_1 \& C_2$ are in series which is parallel to C_3 So

$C_{cq} = \dfrac{C_1 C_2}{C_1 + C_2} + C_3 \Rightarrow \dfrac{20 \times 5}{20 + 5} + 5$

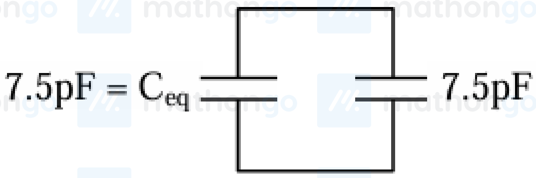
$= 4 + 5 = 9\mu\,F$

Correct Option (3)

Q5.
(15)



$C_1 = \dfrac{5 \times 4 \times 10^{-4} \times 8.85 \times 10^{-12}}{\frac{1.77}{2} \times 10^{-3}} = 20\text{pF}$



$C_2 = \dfrac{3 \times 4 \times 10^{-4} \times 8.85 \times 10^{-12}}{\frac{1.77}{2} \times 10^{-3}} = 12\text{pF}$

$C_{eq} = \dfrac{C_1 C_2}{C_1 + C_2} = \dfrac{12 \times 20}{12 + 20} = 7.5\text{pF}$

Finally equivalent capacitance

$\left(C_{eq}\right)_{final} = 7.5 + 7.5 = 15pF$

Q6. **(5)**

$Q_{in} = Q\left(1 - \frac{1}{K}\right)$

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

$1 - \frac{1}{K} = \frac{4}{5}$

$K = 5$

Q1.
(4)

$q=\int idt$

$\int_0^2(0.02t+0.01)dt$

$q=\left[0.02\frac{t^2}{2}+0.01t\right]_1^2$

$=0.01(3)+0.01(1)$

$=0.04C$

Q2.
(3)

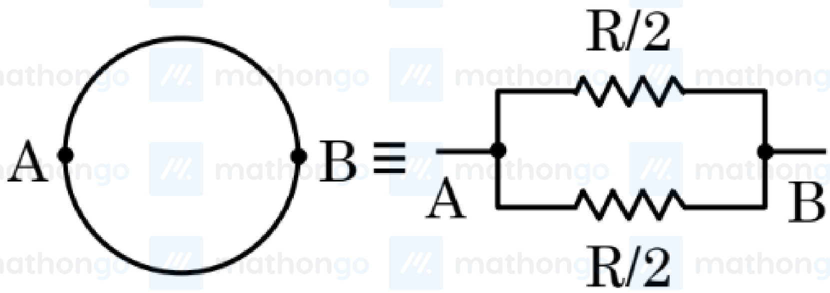
$P_{\text{input}}=Vi=100\text{ W}$

$\eta=\frac{P_{\text{out}}}{P_{\text{input}}}=0.916$

$P_{\text{out}}=91.6\text{ W}$

$\text{Loss}=100-91.6=8.4\text{ J/s}=2\text{cal/s}$

Q3.
(4)



$L=25\text{ m},\ A=5\text{ mm}^2=5\times10^{-6}\text{ m}^2$

$\rho=2\times10^{-6}\Omega\text{ m}$

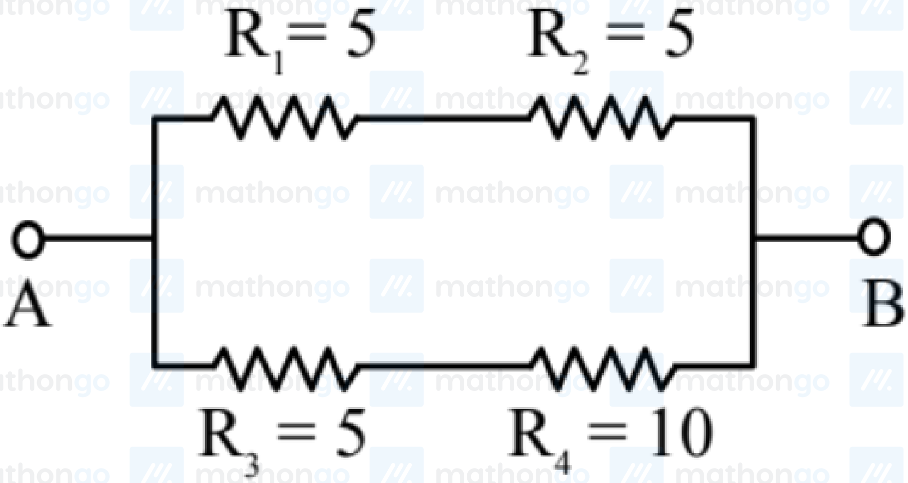
$R_{\text{wire}}=\frac{\rho L}{A}=\frac{2\times10^{-6}\times25}{5\times10^{-6}}=10$

$R_{eq}=\frac{R}{4}=\frac{10}{4}=2.5\Omega$

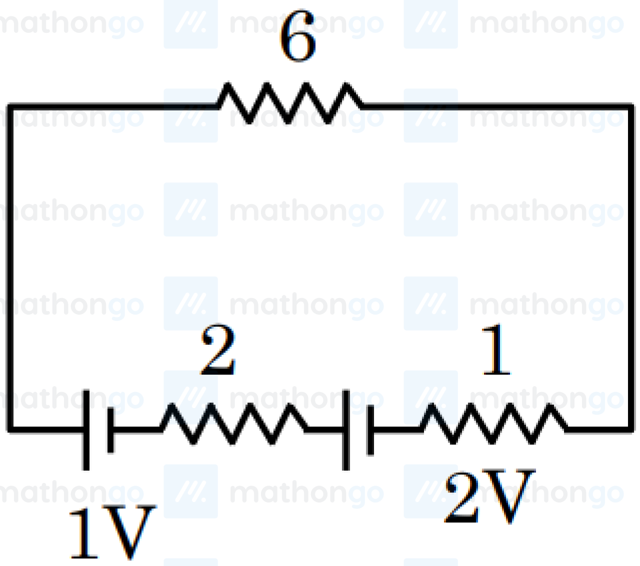
Answer does not match with NTA option.

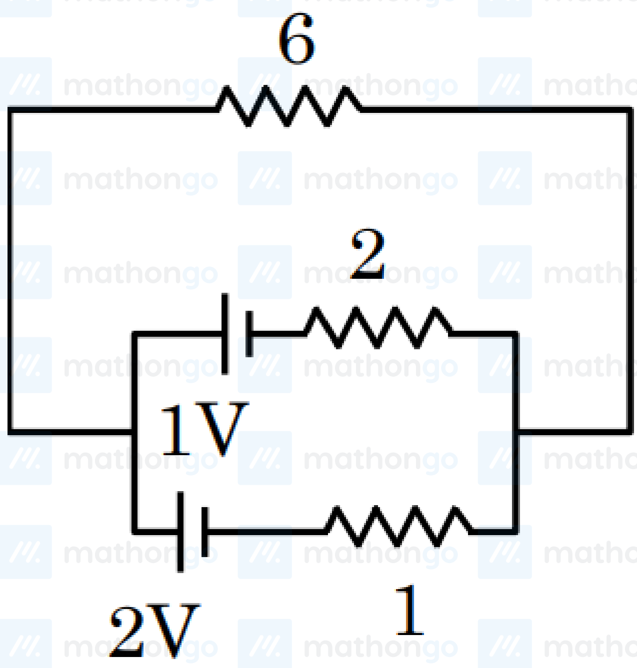
Q4. $\frac{1}{R_P}=\frac{1}{10}+\frac{1}{15}=\frac{3+2}{30}=\frac{1}{6}$

(1)



Q5.
(4)





$\varepsilon_{eq} = 3$
$R_{eq} = 9$
$i_1 = \frac{3}{9} = \frac{1}{3}$
$\varepsilon_{eq} = \frac{\frac{\varepsilon_1}{r_1} + \frac{\varepsilon_2}{r_2}}{\frac{1}{r_1} + \frac{1}{r_2}}$
$\varepsilon_{eq} = \frac{\frac{1}{2} + \frac{2}{1}}{\frac{1}{2} + \frac{1}{1}} = \frac{5}{3}$
$r_{equ} = \frac{2 \times 1}{3} + 6 = \frac{20}{3}$
$i_2 = \frac{1}{4} \Rightarrow \frac{i_1}{i_2} = \frac{4}{3}$

Q6. Given $V = 4.2$ volt
(3) $\therefore$ Energy supplied by battery
$= vq = 4.2 \times 5800 \times 3600 \times 10^{-3}\ J = 87.696\ kJ$

$\therefore$ Energy stored in the battery when fully charged
$= 87.696 \text{ kJ} \approx 87.7 \text{ kJ}$

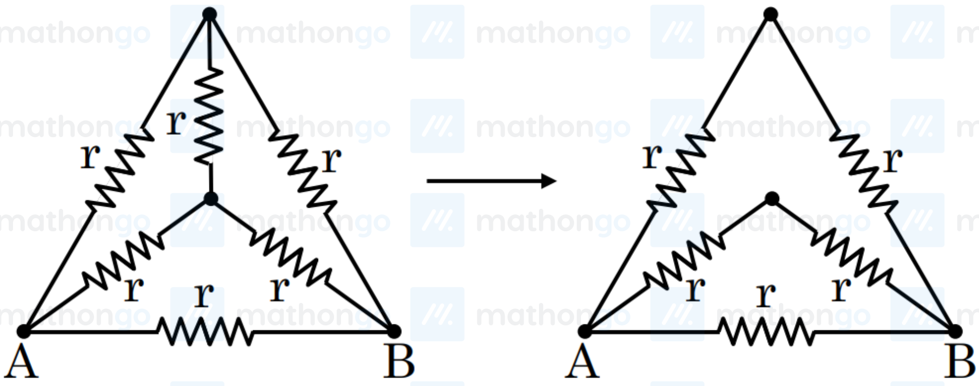
Q7. $R_s = R_1 + R_2 + R_3 + \ldots\ldots + R_n$

(3) $\dfrac{V^2}{P_s} = \dfrac{V^2}{P} + \dfrac{V^2}{P} + \ldots\ldots + \dfrac{V^2}{P_n}$

$P_s = \dfrac{P}{n}$

Q8. As $r = \frac{R}{6}$

(4)



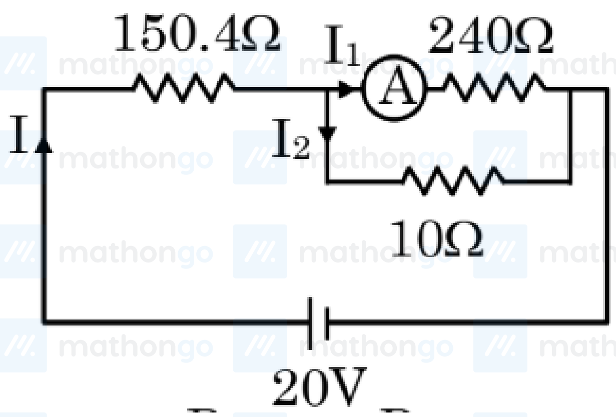
(As balanced wheat stone bridge is formed) Now, Equivalent resistance between A and B can be written as

$\frac{1}{R_{AB}} = \frac{1}{2r} + \frac{1}{2r} + \frac{1}{r} = \frac{2}{r}$

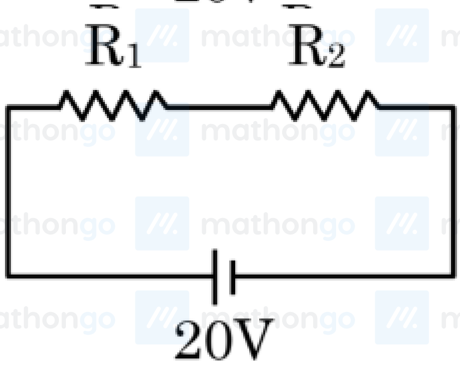
$R_{AB} = \frac{R}{12}$

Q9.

(5)



Sol.



$R_{eq} = R_1 + R_2$

$R_{eq} = 150.4 + \frac{240 \times 10}{250}$

$= 150.4 + 9.6 = 160\Omega$

$I_1 = \frac{IR_2}{240}$

$I_1 = \frac{I \times 9.6}{240}$

$= \frac{20}{160} \times \frac{9.6}{2400} = \frac{1}{200} = 5 \times 10^{-3}\ A = 5\ mA$

Q1. Both statements are correct and reason is also the correct explanation of assertion.
(3)

Q2. We have
(1) $\mu_{\mathrm{r}}=(1+\chi) \Rightarrow \chi=(\mu_{\mathrm{r}}-1)$

$\mu=\mu_0 \mu_{\mathrm{r}} \Rightarrow \mu_{\mathrm{r}}=\dfrac{\mu}{\mu_0}$

$\therefore \chi=\left(\dfrac{\mu}{\mu_0}-1\right)$

Q3. $\frac{\mathrm{U}}{\mathrm{V}}=\frac{\mathrm{B}^2}{2 \mu_{\mathrm{r}} \mathrm{u}_0} \Rightarrow \mathrm{U}=\frac{\mathrm{B}^2}{4 \mu_0} \mathrm{~V}=\frac{\mathrm{B}^2}{4 \mu_0} \mathrm{~A} \ell$
(4)

Q4. $\%$ change in $B=\dfrac{B_{\text{new}}-B_{\text{old}}}{B_{\text{old}}} \times 100 \%$
(1)

$=\dfrac{\mu \mathrm{ni}-\mu_0 \mathrm{ni}}{\mu_0 \mathrm{ni}} \times 100 \%=\dfrac{(\mu-\mu_0)}{\mu_0} \times 100 \%$

$=\dfrac{(\mu_0 \mu_{\mathrm{r}}-\mu_0)}{\mu_0} \times 100 \%$

$=(\mu_{\mathrm{r}}-1) \times 100 \%$

$=\chi_{\mathrm{n}} \times 100 \%$

$=1.2 \times 10^{-3} \%$

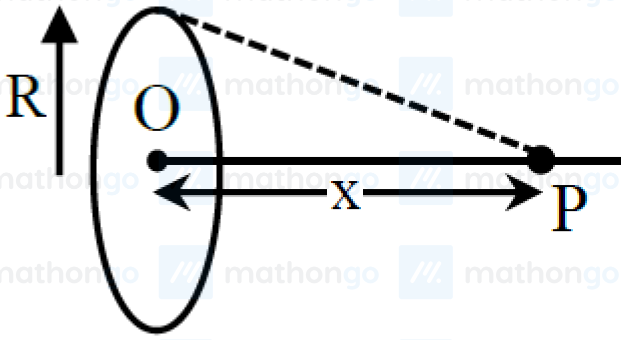
Q1. $F = I\ell B$

(48) $= 8 \times \frac{4}{100} \times 0.15$

$= 48 \times 10^{-3}\ \mathrm{N} = 48\mathrm{mN}$

Q2.

(3)



$B_1 = \frac{\mu_0 i}{2R} \qquad B_2 = B_1 \sin^3 \theta$

$\therefore \frac{B_2}{B_1} = \sin^3 \theta = \left(\frac{4}{5}\right)^3 = \frac{64}{125}$

Q3. Magnetic field due to AB&CD $= 0$

(1) $B_0 = |B_{R_1} - B_{R_2}|$

$= \frac{\mu_0 I}{4R_2} - \frac{\mu_0 I}{4R_1}$

$= \frac{4\pi \times 10^{-7} \times 12}{4}\left(\frac{1}{4\pi} - \frac{1}{6\pi}\right)$

$= 12\pi \times 10^{-7}\left(\frac{1}{12\pi}\right)$

$= 1 \times 10^{-7}$

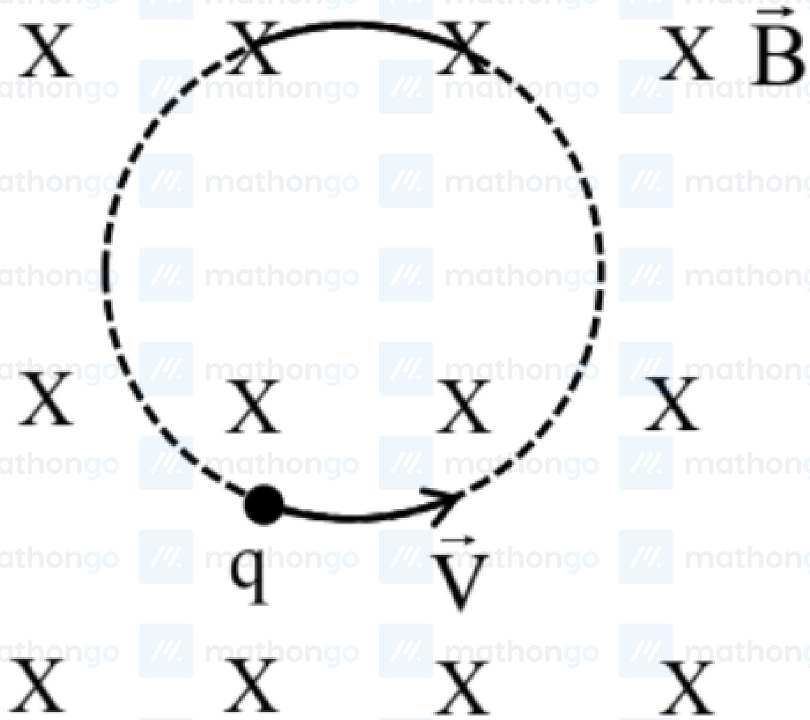
$K = 1$

Q4. $r = \frac{mv}{qB} = \frac{p}{qB}$

(1) $r \propto \frac{1}{q}$

Assertion is true reason is false

Q5.
(0)



Angle between $\vec{V}$ of charge & $\vec{B}$ is 90° motion will be uniform circular motion time period is given by

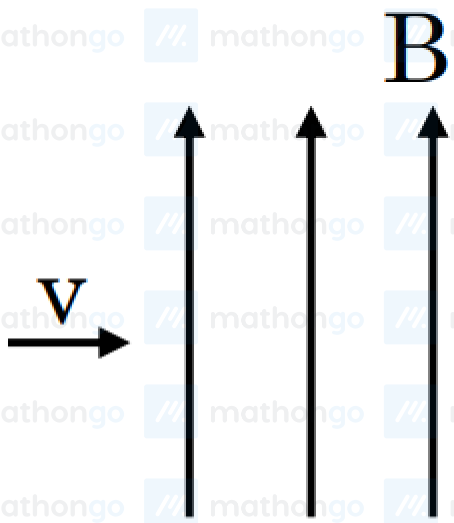
$T = \frac{2\pi m}{qB} = \frac{2\pi \times 16 \times 10^{-9} \text{ kg}}{1.6 \times 10^{-6} \times 6.28}$

$T = 0.01$ seconds

NTA Answer is 10

Correct Answer is 0 (nearest integer)

Q6.
(4)



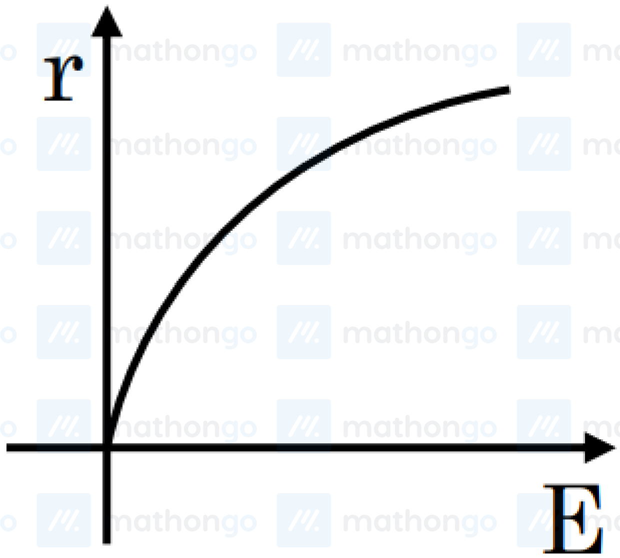
$\frac{mv^2}{r} = qvB$

$mv = qBr$

$E = \frac{1}{2}mv^2$

$$E=\frac{1}{2}m\left(\frac{q^2B^2r^2}{m^2}\right)=\frac{q^2B^2r^2}{2m}$$

$$E=\left(\frac{q^2B^2}{2m}\right)r^2$$



$r^2 \propto E$

Q7.
(1)

$$\text{Voltage sensitivity } =\frac{\theta}{V}=\frac{NAB}{cR}$$

$$\text{Ratio }==\left(\frac{N_1A_1B_1}{N_2A_2B_2}\right)\frac{R_2}{R_1}=\frac{15\times3.6\times0.25}{21\times1.8\times0.5}\times\frac{7}{5}=\frac{1}{1}$$

Q8.
(4)

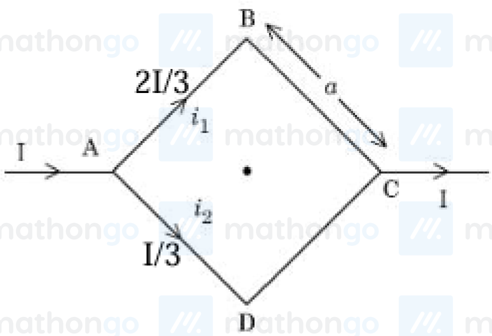
$\tau=M\times B=MB\sin 60=\frac{\sqrt{3}}{2}MB=80\sqrt{3}$

$MB=160$

$U=-M\cdot B=-MB\cos 60$

$U=-160\times1/2=-80\text{ J}$

Q9.
(3)



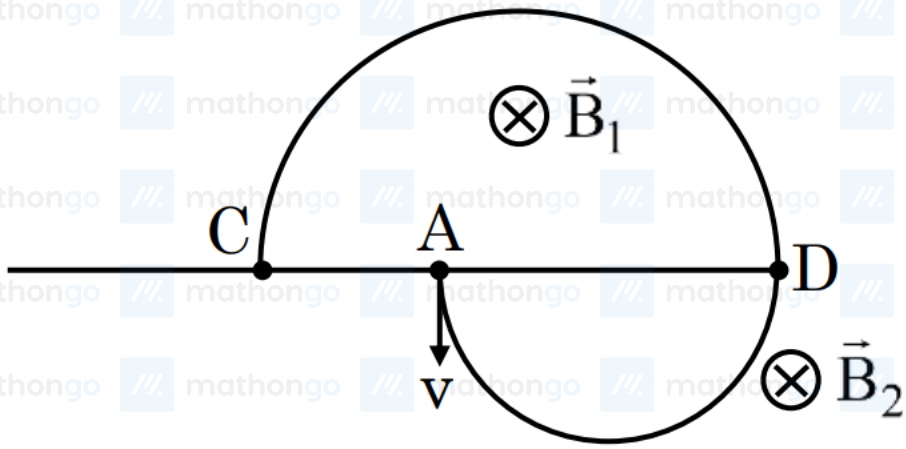
$$\vec{B}=\vec{B}_{AB}+\vec{B}_{BC}+\vec{B}_{CD}+\vec{B}_{DA}$$

$$\vec{B}=\left[\frac{-\mu_0(2I/3)}{4\pi(a/2)}\sqrt{2}-\frac{\mu_0(2I/3)}{4\pi(a/2)}\sqrt{2}+\frac{\mu_0(I/3)}{4\pi(a/2)}\sqrt{2}+\frac{\mu_0(I/3)}{4\pi(a/2)}\sqrt{2}\right]\hat{k}$$

$$\vec{B}=\left[\frac{-2\sqrt{2}\mu_0 I}{3\pi a}+\frac{\sqrt{2}\mu_0 I}{3\pi a}\right]\hat{k}$$

$$\vec{B}=\frac{-\sqrt{2}\mu_0 I}{3\pi a}\hat{k}$$

Q10. (4) As $\vec{v}$ is $\perp$ to $\vec{B}$, so charge particle will move in circular path, whose radius is given by $R=\frac{mv}{qB}$



Starting point $\rightarrow$ A

Ending point $\rightarrow$ C

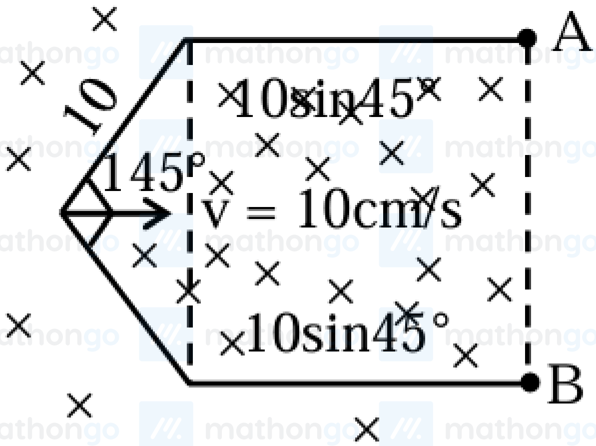
$\therefore$ Net displacement $=$ AC

$$AC = CD - AD$$

$$AC=\frac{2mv}{qB_1}-\frac{2mv}{qB_2}$$

$$AC=\frac{2mv}{qB_1}\left[1-\frac{B_1}{B_2}\right]$$

Q1.
(10)



As field is uniform we can replace the bent wire with straight wire from A to B.
So EMF :

$$\varepsilon = \mathrm{Bv}\ell_{\mathrm{AB}}$$
$$= \frac{1}{\sqrt{2}} \times \frac{10\ \mathrm{cm}}{5} \times 2\,(10 \sin 45^\circ)\ \mathrm{cm}$$
$$\varepsilon = 10\mathrm{mV}$$

Q1. $P = v_{rms} i_{rms}$

(1) $i_{rms} = \frac{100}{220}$

$i_0 = \sqrt{2} i_{rms} = 0.64 \text{ A}$

Q2. $i_r = \frac{i_0}{\sqrt{2}} = 100 \text{ A}$

(3)

$f = \frac{w}{2\pi} = \frac{100\pi}{2\pi} = 50 \text{ Hz}$

Q3. $i = 5\sqrt{2} + 10\cos\left(650\pi t + \frac{\pi}{6}\right)$

(3) $i^2 = 50 + 100\cos^2\left(650\pi t + \frac{\pi}{6}\right)$

$+(2)(5\sqrt{2})(10)\cos\left(650\pi t + \frac{\pi}{6}\right)$

$\langle i^2 \rangle = 50 + \frac{100}{2} + 0$

$< i^2 \rangle = 100$

$< i >= 10\text{Amp}$

Q4. $P = V_{rms} I_{rms} \cos\phi$

(1) $P = V_{rms} \times \frac{V_{rms}}{z} \times \frac{R}{z}$

$P = V_{rms}^2 \times \frac{R}{z^2}$

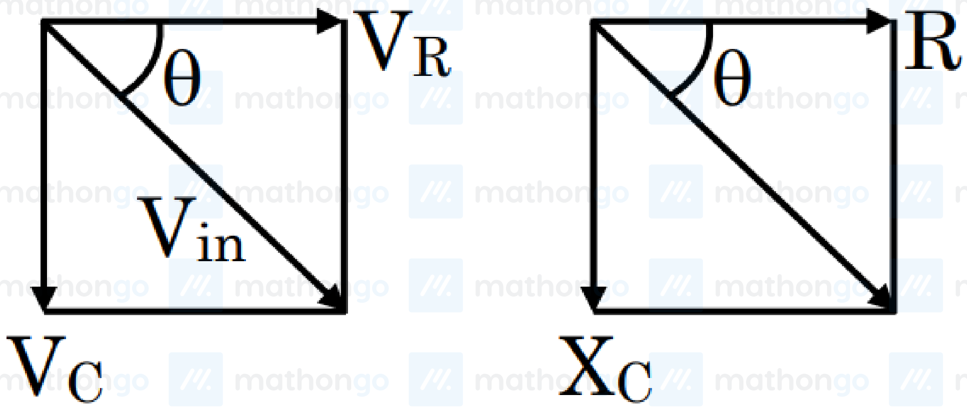
$z = \sqrt{R^2 + (x_L - x_C)^2}$

$Z = 50\sqrt{2}\Omega$

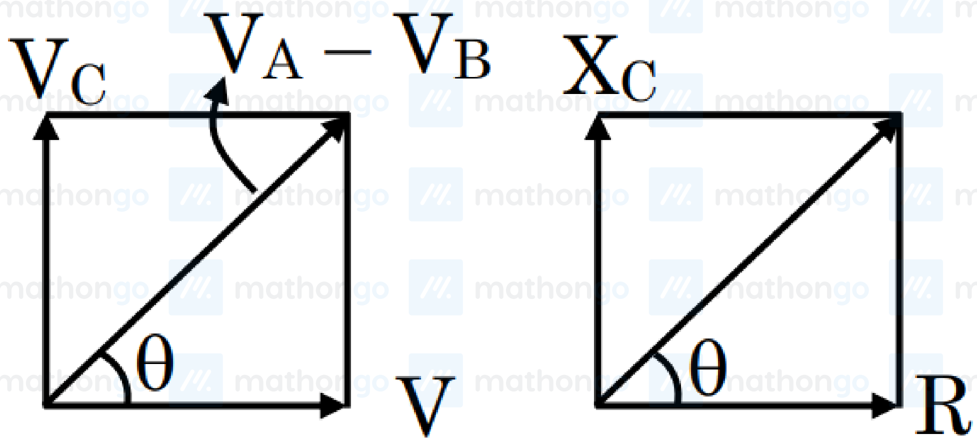
$P = 100 \times \frac{50}{2500 \times 2} = 1 \text{ W}$

Q5.
(5)

Input voltage



$\mathbf{V_A - V_B}$:



$\theta + \theta = 90^\circ; \theta = 45^\circ$

$\tan\theta = \frac{X_C}{R}$

$X_C = R \Rightarrow \frac{1}{W_C} = R$

$W = \frac{1}{R_C} = \frac{1}{100\times10^3\times100\times10^{-12}}$

$= \frac{10^{12}}{10^7} = 10^5$

Q6. Impedance of circuit

(1) $Z = \sqrt{R^2 + (X_L)^2} = \sqrt{R^2 + (\omega_L)^2}$

$= \sqrt{(100\pi)^2 + (2\pi \times 50 \times 1)^2}$

$= \sqrt{(100\pi)^2 + (100\pi)^2}$

$= \sqrt{2} \times 100\pi$

$I_{rms} = \frac{V}{2} = \frac{100\pi}{\sqrt{2} \times 100\pi} = \frac{1}{\sqrt{2}}$

$I_{max} = \sqrt{2} I_{rms} = \sqrt{2} \times \frac{1}{\sqrt{2}} = 1$ Ampere

Correct Answer : 1

Q1.
(3)
$\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

$\frac{1}{12}=(\mu-1)\left(\frac{1}{10}-\frac{1}{-15}\right)$

$\frac{1}{12}=(\mu-1)\left(\frac{3+2}{30}\right)$

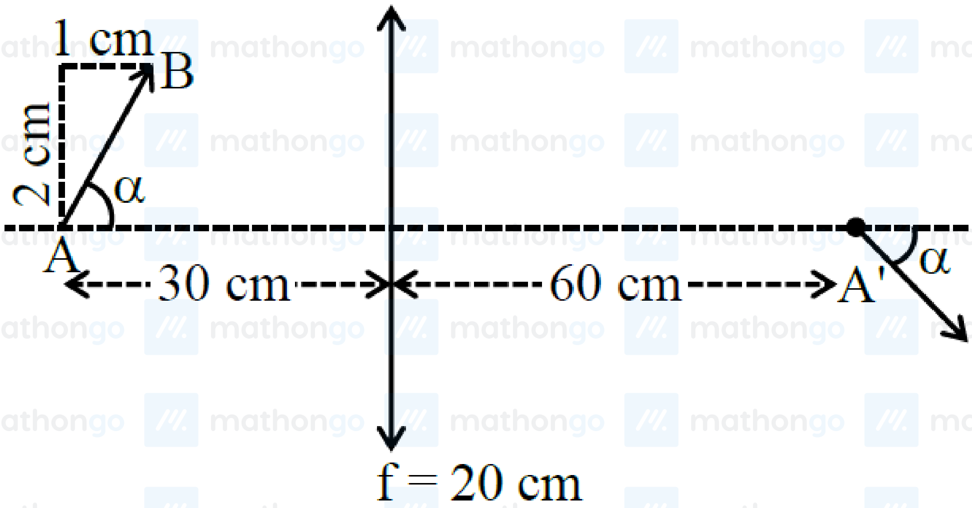
$\mu=\frac{3}{2}$

Q2.
(45)
$\mu=\frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$, since $A=60^\circ \quad \therefore \delta m=30^\circ$

$\delta_m=2i-A[\text{ as } i=e]$

$\Rightarrow i=45^\circ$

Q3.
(2)



Location of image of A : –

$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}\Rightarrow\frac{1}{v}-\frac{1}{-30}=\frac{1}{20}\Rightarrow\frac{1}{v}=\frac{1}{60}\Rightarrow v=60\text{ cm}$

$\therefore\ m=2$

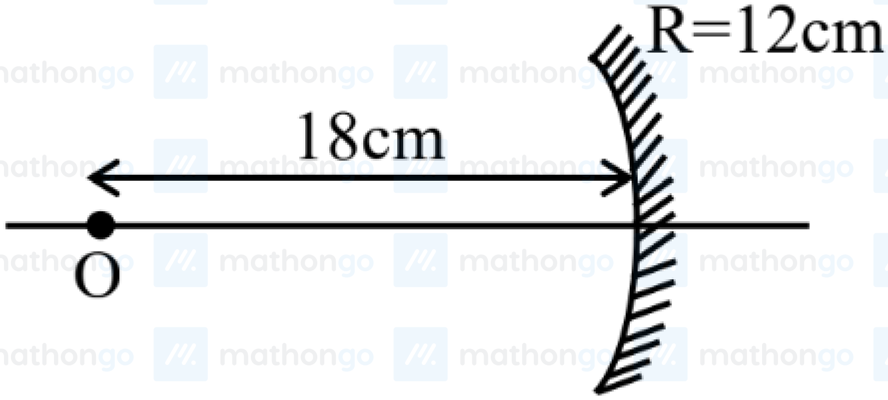
Since size of object is small wrt the location hence

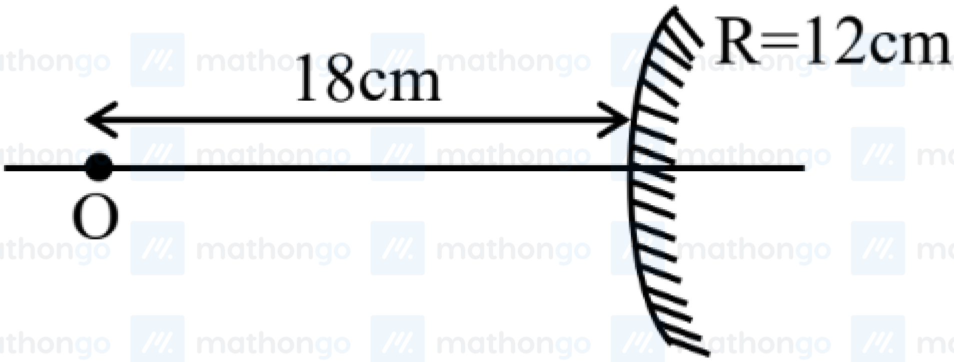
$dv=m^2du\Rightarrow dv=4\times1=4\text{ cm}$

$h_i=mh_0\Rightarrow h_i(dy)=2\times2=4\text{ cm}$

$\therefore$ Angle made with principle axis $=-45^\circ$

Q4.
(1)





Using $m = \frac{f}{u-f}$

$m_1 = \frac{6}{18-6} = \frac{1}{2}$

$m_2 = \frac{6}{18+6} = \frac{1}{4} \quad \therefore \frac{m_2}{m_1} = \frac{1}{2}$

Q5.
(1)

$m = \frac{1}{2} = \frac{f}{f-u}$

$\frac{1}{2} = \frac{f}{f-(-40)}$

$f + 40 = 2f \Rightarrow f = 40 \text{ cm}$

now $m = \frac{1}{3} = \frac{40}{40-u}$

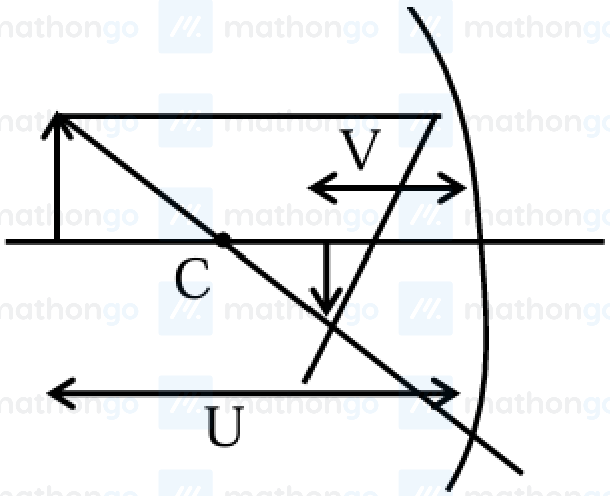
$40 - u = 120 \Rightarrow u = -80$

Q6.
(45)

$M = -\frac{1}{3}$

$-\frac{-V}{-U} = \frac{-1}{3} \Rightarrow V = \frac{U}{3}$

Distance b/w object and image :



$U - V = 30$

$U - \frac{\mu}{3} = 30$

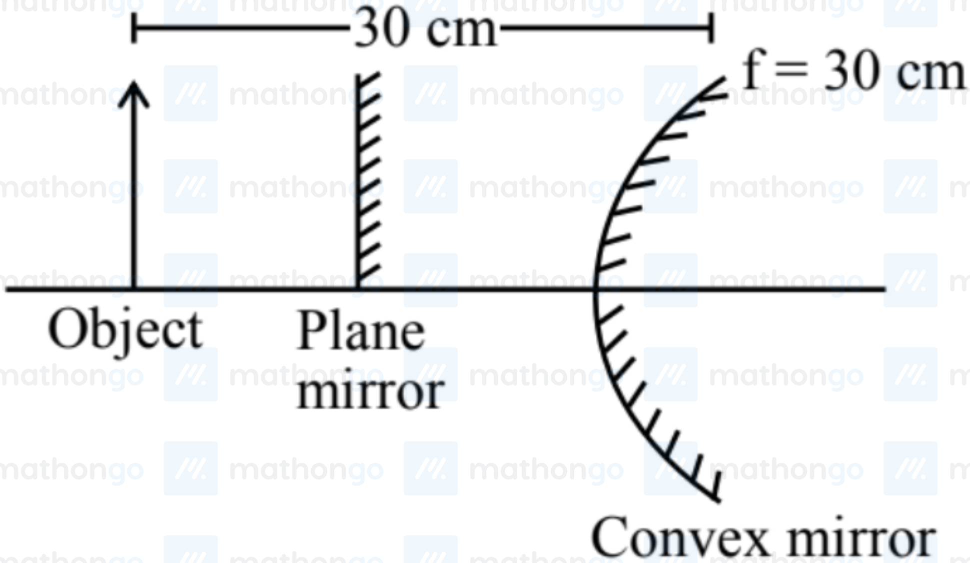
$\Rightarrow U = 45 \quad V = 15$

$\frac{1}{f} = \frac{1}{V} + \frac{1}{U} = -\frac{1}{15} - \frac{1}{45}$

$\Rightarrow F = \frac{45}{4}$

$x = 45$

Q7.
(2)



For Convex mirror

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

$\frac{1}{v} - \frac{1}{30} = \frac{1}{30}$

$\frac{1}{v} = \frac{2}{30} = \frac{1}{15} \Rightarrow v = 15$ cm

Image formed by convex mirror is at 45 cm from object so plane mirror should be placed midway at 22.5 cm from object so that both of their images may coinside, Therefore distance between both mirrors

$= 30 - 22.5 = 7.5$ cm

Correct Answer : Option 2

Q8.
(3)

$m = -\frac{v}{u} = -\left(\frac{v}{-u}\right) = \frac{v}{u}$

$\frac{1}{4} = \frac{v}{u} \Rightarrow u = 4v$

$v + u = 40$

$5v = 40$

$v = 8$ cm

$u = 32$ cm

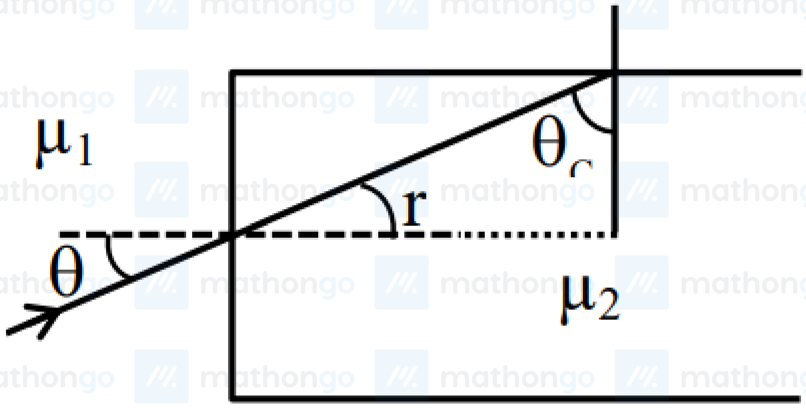
$\frac{1}{v} + \frac{v}{u} = \frac{1}{f}$

$\frac{1}{8} - \frac{1}{32} = \frac{1}{f}$

$\frac{4-1}{32} = \frac{1}{f}$

$f = \frac{32}{3} = 10.7$ cm

Q9.
(3)



$r + \theta_C = 90^\circ$

$\mu_1 \sin\theta = \mu_2 \sin r$

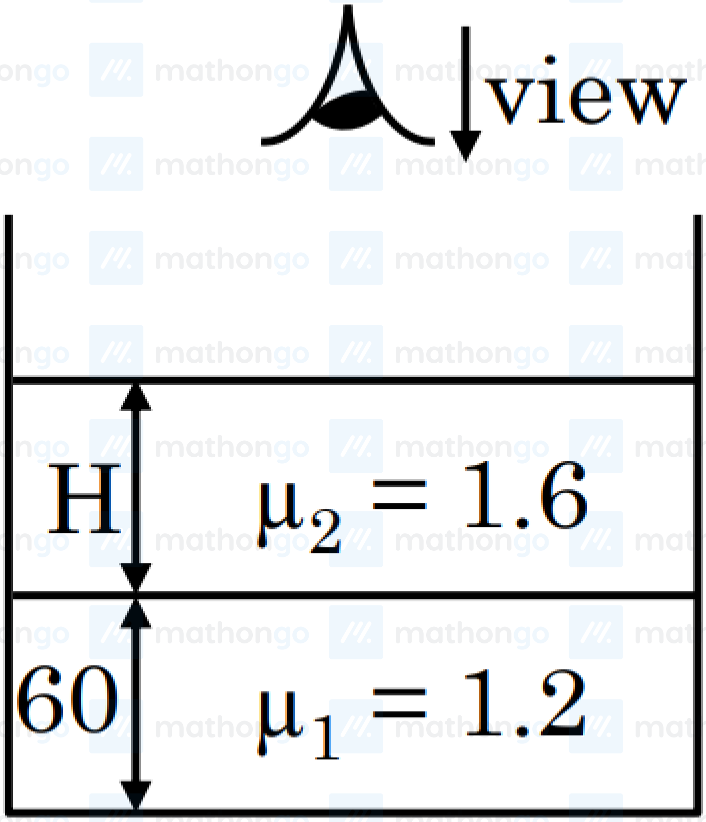
$\sin\theta = \frac{\mu_2}{\mu_1}\sin(90 - \theta_C)$

$\sin\theta = \frac{\mu_2}{\mu_1}\cos\theta_C$

$\sin\theta_C = \frac{\mu_1}{\mu_2}$

$$\sin\theta = \frac{\mu_2}{\mu_1}\sqrt{1-\frac{\mu_1^2}{\mu_2^2}}$$
$$\sin\theta = \sqrt{\frac{\mu_2^2-\mu_1^2}{\mu_1^2}} = \sqrt{\frac{\frac{25}{16}-1}{1}}$$
$$\sin\theta = \frac{3}{4}$$
$$\theta = \sin^{-1}\left(\frac{3}{4}\right)$$

Q10.
(80)



$y =$ apparent depth of bottom
$\frac{y}{1} = \frac{H}{1.6} + \frac{60}{1.2}$
Shift $= 40$
$H + 60 - y = 40$
$H + 60 - \frac{H}{1.6} - \frac{60}{1.2} = 40$
$\frac{6}{16}H = 30$
$H = 80$ cm

Q11. Refractive index has no relation with mass density because both have different meaning. Hence reason is
(3) incorrect.
So (A) is correct but (R) is not correct.

Q12. $\frac{\mu_2}{v}-\frac{\mu_1}{u}=\frac{\mu_2-\mu_1}{R}$

(2) $\frac{1.5}{v}-\frac{1}{(-0.2)}=\frac{1.5-1}{0.4}$

$\frac{1.5}{v}=\frac{0.5}{0.4}-\frac{1}{0.2}$

$\frac{1.5}{v}=-\frac{1.5}{0.4}$

$v=-0.4\text{ m}$

Q13. This will happen when

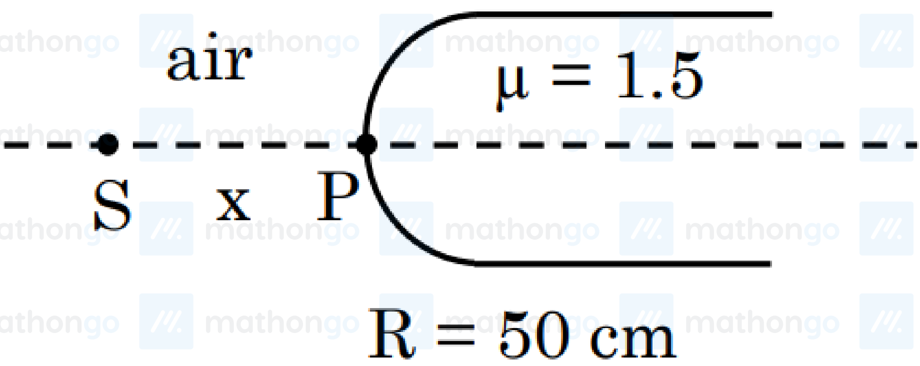
(2) $\frac{1}{f_1}=\frac{1}{f_2}$

$(\mu-1)\left(\frac{1}{R_1}-\frac{1}{-R_2}\right)=(\mu-1)\left(\frac{2}{R}\right)$

$\frac{1}{R_1}+\frac{1}{R_2}=\frac{2}{R}$

Q14.

(4)



$\frac{\mu_2}{v}-\frac{\mu_1}{u}=\frac{\mu_2-\mu_1}{R}$

$\frac{1.5}{200}-\frac{1}{-x}=\frac{1.5-1}{50}$

$\frac{1}{x}=\frac{1}{100}-\frac{3}{400}$

$x=400\text{ cm}$

$x=4m$

Q15. As we know,

(2) $\frac{1}{f}=\left[\frac{\mu_L}{\mu_m}-1\right]\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$

For air $\mu_m=1$

$\frac{1}{12}=[1.6-1]\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$

$\frac{1}{12}=\frac{6}{10}\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$

$\left[\frac{1}{R_1}-\frac{1}{R_2}\right]=\frac{10}{72}$

For water

$\frac{1}{f}=\left[\frac{1.6}{1.28}-1\right]\left[\frac{10}{72}\right]=\frac{32}{128}\times\frac{10}{72}$

$\frac{1}{f}=\frac{1}{4}\times\frac{10}{72}$

$f=28.8 \text{ cm}$

$f=288 \text{ mm}$

Q16. $f_1=30 \text{ cm}, f_2=10 \text{ cm}$

(4) $\frac{1}{f_{eq}}=\frac{1}{f_1}+\frac{1}{f_2}-\frac{d}{f_1 f_2}$, $d=$ distance between lens

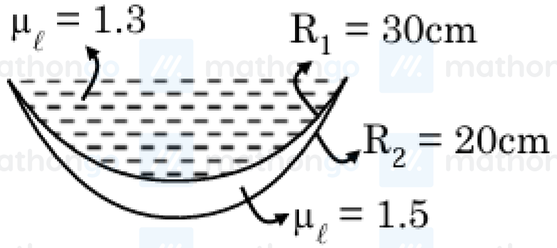
$\frac{1}{f_{eq}}=\frac{1}{0.3}+\frac{1}{0.1}-\frac{0.1}{(0.3)(0.1)}$

$\frac{1}{f_{eq}}=\frac{1}{0.1}$

Power $=\frac{1}{f_{eq}}=10D$

Q17.

(4)



$$\frac{1}{f}=\left(\frac{1.3-1}{1}\right)\left(\frac{1}{\infty}-\frac{1}{-30}\right)$$

$$=\left(\frac{1.5-1}{1}\right)\left(\frac{1}{-30}-\frac{1}{-30}\right)$$

$$=\frac{0.3}{30}+\frac{0.5}{60}=\frac{1}{100}+\frac{1}{120}$$

$$=\frac{6+5}{600}=\frac{11}{600}$$

$$f=\frac{600}{11}\text{ cm}$$

Q18. Equivalent focal length

(4) $\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}$

$$=\frac{1}{30}+\frac{1}{-20}=\frac{2-3}{60}=-\frac{1}{60}$$

$f=-60$ cm

Lens formula

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

$\frac{1}{v}-\frac{1}{-20}=\frac{1}{-60}$

$v=-15$ cm

Q19. $\delta=I+e-A$

(1) For $\delta_{\min}\Rightarrow I=e$ and refracted ray is parallel to base A, C, D are correct

Q1. $f\lambda = v \quad \lambda_{\text{medium}} = \frac{\lambda_{\text{vacuum}}}{\mu}$
(1) $\lambda_{\text{medium}} \Rightarrow \frac{3\times10^8}{2\times5\times10^{14}} \Rightarrow 0.3\times10^{-6} \Rightarrow 300\text{ nm}$

Q2. $\frac{I_{\max}}{I_{\min}} = \frac{(\sqrt{I_1}+\sqrt{I_2})^2}{(\sqrt{I_1}-\sqrt{I_2})^2} \Rightarrow \frac{(4)^2}{(2)^2} \Rightarrow \frac{16}{4} = 4$
(4)

Q3. Different colours will have different fringe width. Within a few fringes of red, there will be several fringes of
(2) violet.

Also, there will be overlapping of colours.

Q4. The direction of propagation of light is perpendicular to the wave front and is symmetric about x, y and z axis.
(1) $\therefore$ Angle made by the light with x, y&z axis is same.

$\therefore \quad \cos\alpha = \cos\beta = \cos\gamma (\alpha, \beta \& \gamma$ are angle made by light with x, y&z axis respectively)

Also $\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$ [Sum of direction cosines]

$\therefore \alpha = \cos^{-1}\frac{1}{\sqrt{3}}$

Q5. $I_{\max} = \left(\sqrt{I_1}+\sqrt{I_2}\right)^2$
(24) $= (\sqrt{4I}+\sqrt{9I})^2 = 25I$

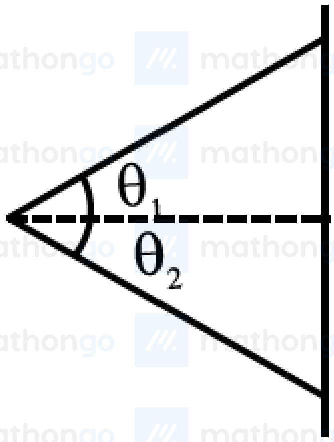
$I_{\min} = \left(\sqrt{I_1}-\sqrt{I_2}\right)^2$

$= (\sqrt{4I}-\sqrt{9I})^2 = I$

$I_{\max} - I_{\min} = 24I$

$x = 24$

Q6.
(6)



$\theta_1 = \sin^{-1}\left(\frac{2\lambda}{a}\right)$

$\theta_2 = \sin^{-1}\left(\frac{3\lambda}{a}\right)$

$\because \quad \theta_1 + \theta_2 = 30^\circ$

$\Rightarrow \sin^{-1}\left(\frac{2\lambda}{a}\right) + \sin^{-1}\left(\frac{3\lambda}{a}\right) = \frac{\pi}{6}$

$\Rightarrow \frac{2\lambda}{a}\sqrt{1-\left(\frac{3\lambda}{a}\right)^2} + \frac{3\lambda}{a}\sqrt{1+\left(\frac{2\lambda}{a}\right)^2} = \sin\frac{\pi}{6}$

Here $\lambda = 628$ nm

After solving

$A = 6.07\mu$ m

Approximate Method :

$\theta = \theta_1 + \theta_2$

$\Rightarrow \frac{\pi}{6} = \frac{2\lambda}{a} + \frac{3\lambda}{a}$

$\Rightarrow \frac{\pi}{6} = \frac{5}{a}(628 \text{ nm})$

$\Rightarrow a = 6\mu$ m

Q7. I $\propto$ width $\quad I_{\max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$

(2) $\therefore I_1 = I_0, I_2 = 2I_0 \quad I_{\min} = \left(\sqrt{I_1} - \sqrt{I_2}\right)^2$

$\frac{I_{\max}}{I_{\min}} = \frac{(\sqrt{2}+1)^2}{(\sqrt{2}-1)^2} \Rightarrow \frac{3+2\sqrt{2}}{3-2\sqrt{2}}$

Q8. $\beta = \frac{D\lambda}{d} \propto \frac{1}{d}$

(3) If d is doubled then β is half so 50% decrement.

Q9. Width of 20 maxima of double slit = width of central maxima of single slit

(15) $\frac{20\lambda D}{d} = \frac{2\lambda D}{a}$

$\frac{10}{d} = \frac{1}{a}$

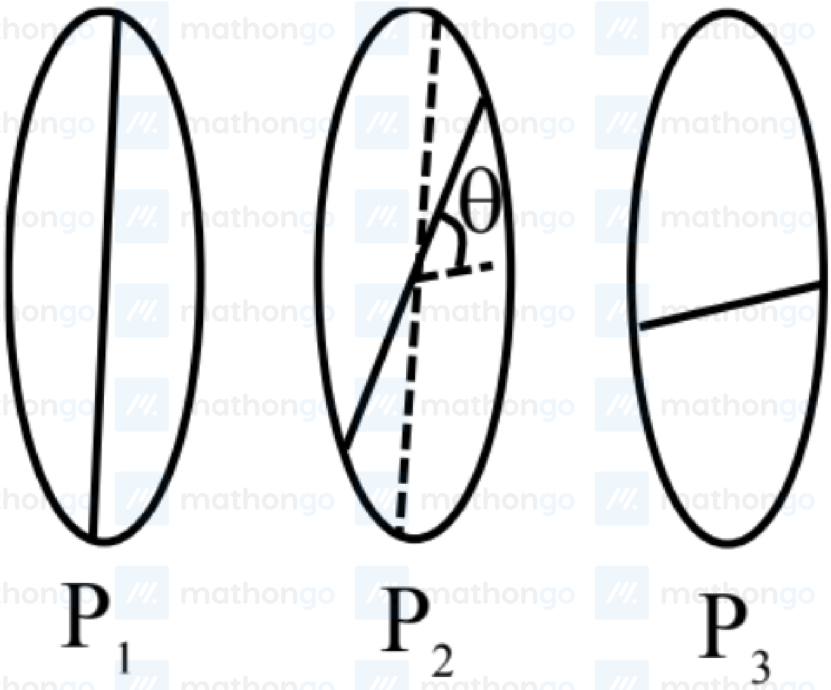
$a = \frac{d}{10} = \frac{1.5 \times 10^{-1}}{10}$ cm $= 15 \times 10^{-3}$ cm

Value of x is 15

Answer is 15

Q10. Through $P_2 I_1 = I_0 \sin^2\left(\frac{\pi}{2} - \theta\right)$

(1)



$I_1 = I_0 \cos^2 \theta$

Through $P_3 I_{\text{net}} = \left(I_0 \cos^2 \theta\right) \sin^2 \theta$

$I_{nct} = \frac{I_0}{4}[\sin(2\theta)]^2$ for max I_{net} $\theta = 45^\circ$

So angle between P_2 and $P_3 = \frac{\pi}{4}$

Correct Ans. (1)

Q1. Magnetic field does not work
(4) $\therefore$ Speed will not charge, so De-Broglie wavelength remains same.

Q2. $\mathrm{K.E}=\mathrm{E}-\mathrm{W}$
(1) $\lambda_{\mathrm{e}}=\frac{\mathrm{h}}{\sqrt{2\mathrm{mK}\cdot\mathrm{E}}}, \mathrm{E}=\frac{\mathrm{hc}}{\lambda_{\mathrm{i}}}, \mathrm{W}=\frac{\mathrm{hc}}{\lambda_0}$

$$\frac{\mathrm{h}^2}{2\,\mathrm{m}\lambda_{\mathrm{e}}^2}=\frac{\mathrm{hc}}{\lambda_{\mathrm{i}}}-\frac{\mathrm{hc}}{\lambda_0}$$

$$\lambda_{\mathrm{e}}=\sqrt{\frac{\mathrm{h}}{2\mathrm{mc}\left(\frac{1}{\lambda_{\mathrm{i}}}-\frac{1}{\lambda_0}\right)}}$$

Q3. $\mathrm{KE}_{\max}=\frac{\mathrm{hc}}{\lambda}-\phi$
(3) $\mathrm{p}=\sqrt{2\mathrm{mK}_{\max}}$

$$\mathrm{p}=\sqrt{2\,\mathrm{m}\left(\frac{\mathrm{hc}}{\lambda}-\phi\right)}$$

$$\mathrm{d}_{\mathrm{A-B}}=2\mathrm{R}$$

$$=2\left[\frac{\mathrm{p}}{\mathrm{qB}}\right]$$

$$\mathrm{d}_{\mathrm{AB}}=\frac{2\sqrt{2\,\mathrm{m}\left(\frac{\mathrm{hc}}{\lambda}-\phi\right)}}{\mathrm{eB}}=\frac{\sqrt{8\,\mathrm{m}\left(\frac{\mathrm{hc}}{\lambda}-\phi\right)}}{\mathrm{eB}}$$

Q4. $P_{\text{rad}}=\frac{2I}{\mathrm{C}}$
(3) Where I = intensity at surface

C = Speed of light

$$I=\frac{\text{Power}}{\text{Area}}=\frac{450}{4\pi\mathrm{r}^2}$$

$$=\frac{450}{4\pi\times4}=\frac{450}{16\pi}$$

$$P_{\text{rad}}=\frac{2\times450}{16\pi\times3\times10^8}=\frac{150}{8\pi\times10^8}$$

$=5.97\times10^{-8}\approx6\times10^{-8}$ Pascals

Q5. $(\mathrm{KE})_{\max}=\frac{\mathrm{hc}}{\lambda}-\phi$
(2) $\frac{\mathrm{hc}}{\lambda}>\phi$[for emission]

$$\lambda<\frac{\mathrm{hc}}{\phi}\Rightarrow\lambda<\frac{1242}{3}\,\mathrm{nm}$$

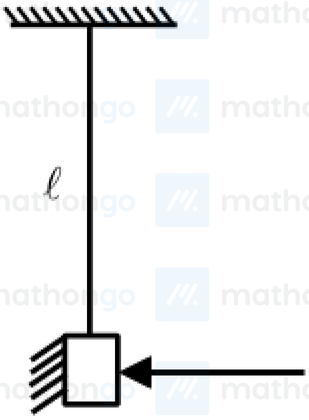
So blue light option (B)

Q6. $\mathrm{V}_{\mathrm{S}}=\frac{\mathrm{hv}-\phi}{\mathrm{e}}$
(2) so stopping potential doesn't depend on Intensity

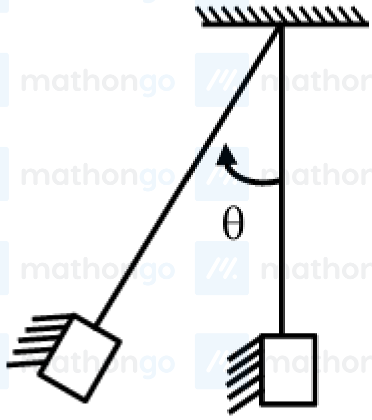
$\mathrm{I}=\frac{\eta\mathrm{hv}}{\mathrm{A}}$

On increasing intensity no. of photons per sec. n increases so the no. of electrons.

Q7.
(4)



Force due to beam assuming complete reflection $F = \frac{2P}{C} = \frac{2}{C}\frac{dE}{dt}$; P is power
So change in momentum of mirror.
$m(V - 0) = \int F dt = \frac{2}{C}\int dE = \frac{2E}{C}$



Now using work energy theorem ...(1)
$W_g = \Delta k$

$-mg\ell(1-\cos\theta) = 0 - \frac{1}{2}mv^2$

$g\ell\left(2\sin^2\frac{\theta}{2}\right) = \frac{v^2}{2}$

as θ is small

$g\ell 2\left(\frac{\theta}{2}\right)^2 = \frac{1}{2}\frac{4E^2}{m^2c^2}$

$g\ell\theta^2 = \frac{4E^2}{m^2c^2}$

$\theta = \frac{2E}{mc\sqrt{g\ell}}$

Q1. Conceptual
(3)

Q2. $r = r \cdot \frac{n^2}{2}$
(4) for Li^{2+}

$r_5 = r \cdot \frac{25}{3}$

for He^{+}

$r_5 = r \cdot \dfrac{25}{2}$

$\therefore \dfrac{r_{Li^{2+}}}{r_{He^{+}}} = \dfrac{2}{3}$

Q3. $E \propto \dfrac{Z}{n^2}$
(2)

$Z_H = 1 \quad Z_{He^+} = 2 \quad Z_{Li^{+2}} = 3$

1^{st} excited state $\Rightarrow n = 2$

2^{nd} excited state $\Rightarrow n = 3$

From the given statements only A \& B are correct.

Q4. $r = r_0 \frac{n^2}{z} \& z = 3$ for Li^{+2} and $n = 1$
(3) $\therefore r = r_0 \frac{1^2}{3} = \frac{r_0}{3} \quad \therefore x = 3$

Q5. $E = 13.6\left(\frac{1}{n_1^2} - \frac{1}{n_1^2}\right)$
(2)

$2.86 = 13.6\left(\frac{1}{n^2} - \frac{1}{5^2}\right)$

$\dfrac{1}{n^2} = 0.21 + \dfrac{1}{2.5}$

$n^2 = 4$

$n = 2$

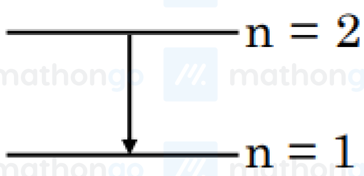
Q6. $\Delta E = 13.6z^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$
(4)

$(13.6)z^2\left[\frac{1}{1} - \frac{1}{9}\right] = 108.8$

$\frac{(13.6)(8)}{9}\left(z^2\right) = 108.8$

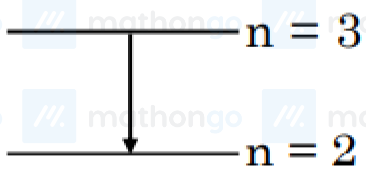
$z = 3$

Q7. Lyman
(2)



$\frac{1}{\lambda_1} = R\left[\frac{1}{1} - \frac{1}{4}\right] = \frac{3R}{4}$

$\lambda_1 = \frac{4}{3R}$ ____________...(1)



and Balmer

$\frac{1}{\lambda_2} = \mathrm{R}\left[\frac{1}{4} - \frac{1}{9}\right] = \frac{5\mathrm{R}}{36}$

$\lambda_2 = \frac{36}{5R}$

Then, $\frac{\lambda_1}{\lambda_2} = \frac{5}{27}$

Q1. $\rho=\frac{M}{V}=\frac{m_n \times A}{\frac{4}{3} \pi R^3}=\frac{m_n \times A}{\frac{4}{3} \pi A R_0^3}$
(2)
So ρ is almost is constant
$R=R_0 A^{1/3}$
$R \propto A^{1/3}$

Q2. The mass density (ρ) of a nucleus is defined as the ratio of its mass to its volume:
(4) $\rho=$ Mass of nucleus / Volume of nucleus

For a spherical nucleus with radius R , the volume is:
$\text{Volume } =(4/3) \pi R^3$

The mass of the nucleus is related to the mass number A :
$\text{Mass } - A \times m\_u$

(where m_u is the atomic mass unit, approximately 1.66×10^{-27} kg)
Therefore:

$\rho=(A \times m\_u) / \left[(4/3) \pi R^3\right]$

Now, there's an important relationship between the mass number A and nuclear radius R. Empirically, it has been found that:

$R=Ro * A^{\wedge}(1/3)$

Where Ro is a constant approximately equal to 1.2×10^{-15} m(1.2 fermi).
Substituting this into the density equation:

$\rho=(A \times m\_u) / \left[(4/3) \pi\left(Ro \times A^{\wedge}(1/3)\right)^3\right]$

$\rho=(A \times m\_u) / \left[(4/3) \pi Ro^3 \times A\right]$

$\rho=m\_u / \left[(4/3) \pi Ro^3\right]$

This shows that the nuclear density is approximately constant for all nuclei, regardless of their mass number. This is a fundamental property of nuclear matter known as nuclear saturation density.

The numerical value is:
$\rho=2.3 \times 10^{17} \mathrm{~kg}/\mathrm{m}^3$

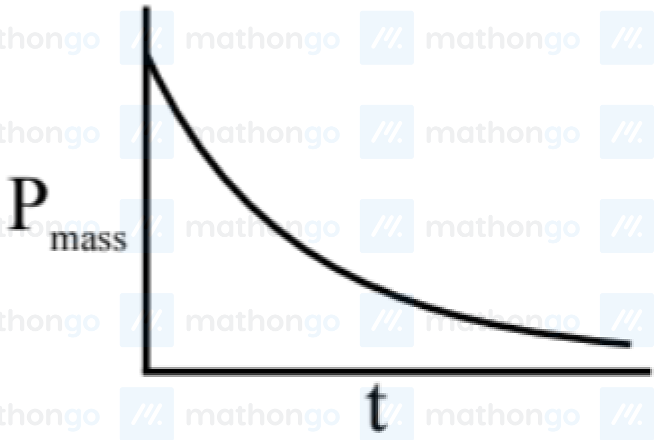
Q3.
(3)
$$\underset{1.1\,\mathrm{MeV}}{{}_1H^2}+{}_1H^2 \rightarrow \underset{7.0\,\mathrm{MeV}}{{}_1He^4}$$

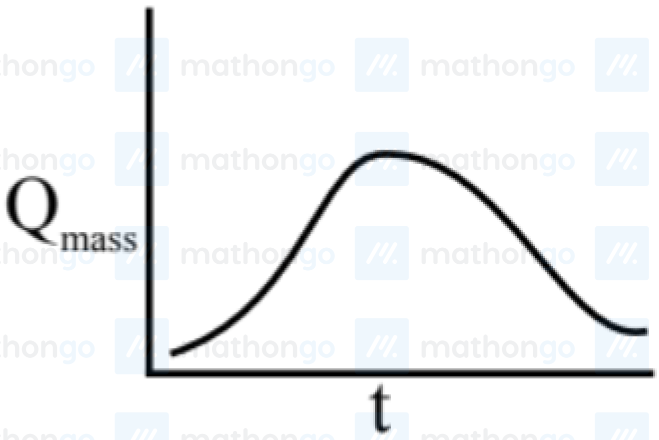
$E_B=BE_{\text{reactant }}-BE_{\text{product}}$
$=1.1 \times 2+1.1 \times 2-7 \times 4=-23.6 \mathrm{MeV}$
$=Q=23.6 \mathrm{MeV}$

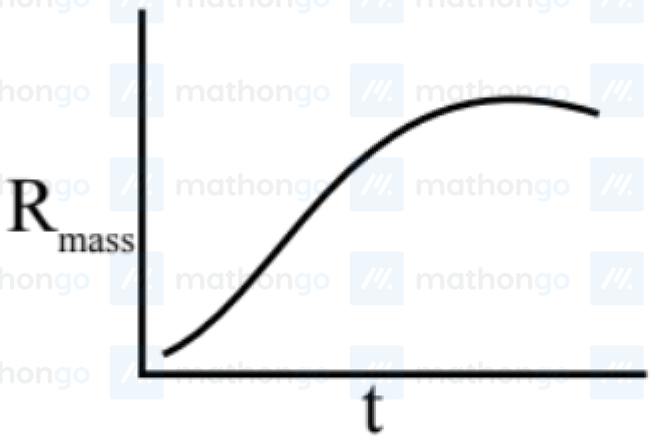
Q4. Conceptual
(2)

Q5. $P \rightarrow Q \rightarrow R$

(2)







Q1. Since velocity of light in terms of $\mu \& E$ is
(6)
$$V=\frac{1}{\sqrt{\mu \epsilon}}=\frac{1}{\sqrt{\mu_0 \mu_r}} \times \frac{1}{\sqrt{\epsilon_0 \epsilon_r}}$$
$$=\frac{1}{\sqrt{\mu_{\mathrm{r}} \epsilon_{\mathrm{r}}}} \times \frac{1}{\sqrt{\mu_0 \epsilon_0}}$$
$$=\frac{C}{\sqrt{\mu_{\mathrm{r}} \epsilon_{\mathrm{r}}}}=\frac{C}{\sqrt{\frac{10}{\pi} \times \frac{1}{0.0885}}}$$
$$=\frac{C}{\sqrt{36}}=\frac{C}{6}$$
$$\mathrm{V}=\frac{\mathrm{C}}{6}$$
$$\mathrm{C}=6 \mathrm{~V}$$
Velocity of light in vacuum is greater by 6 times the velocity of light in medium

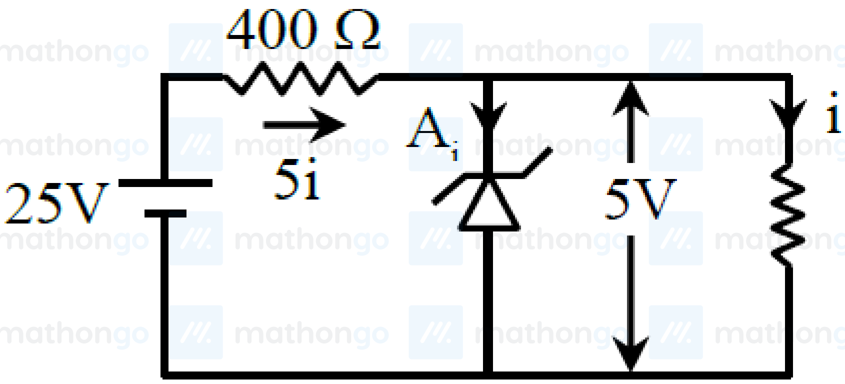
Answer is 6

Q2.
(3)
$$\mathrm{E}=\sqrt{\left(\mathrm{E}_0\right)^2+\left(\mathrm{E}_0\right)^2+2\left(\mathrm{E}_0\right)\left(\mathrm{E}_0\right) \cos \frac{\pi}{3}}$$
$$\mathrm{E}=\sqrt{2 \mathrm{E}_0^2+\mathrm{E}_0^2}=\sqrt{3} \mathrm{E}_0=1.73 \mathrm{E}_0$$

Q3.
(4)
$$\mathrm{I}=\frac{1}{2} \epsilon_0 \mathrm{E}_0^2 \times \mathrm{C}$$
$$\mathrm{E}_0=\sqrt{\frac{2 \mathrm{I}}{\epsilon_0 \mathrm{C}}}$$
E_0 : electric field N/C

Q1. (A) n type semiconductor holes are minority carriers and e^- are majority carriers
(3) (B) Dopant are pentavalent atom.
(C) $n_e \cdot n_h = n_i^2$ for intrinsic semiconductor
(E) In n type semiconductor primary source of holes generation are thermal excitation.

Q2.
(4)



From the circuit diagram,

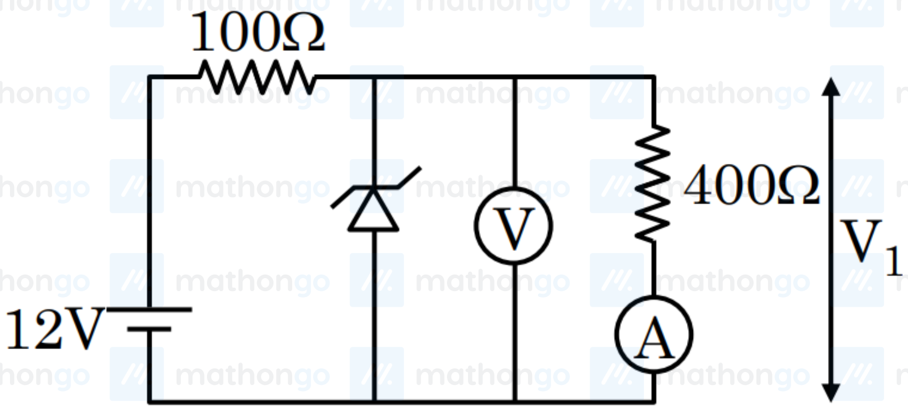
$5i = \frac{20}{400} = \frac{1}{20}$ A

$\therefore i = \frac{1}{100}$ A $= 10$ mA $=$ Load current

Also, $V_L = 5$ V

$\therefore R_L = \frac{5}{10 \times 10^{-3}} \Omega = 500 \Omega$

Q3.
(3)



$V_1 = \frac{400}{100+400} \times 12\ V = \frac{4}{5} \times 12 = \frac{48}{5}$ V

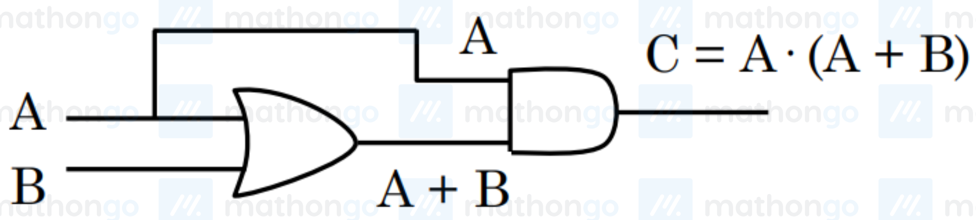
here, $V_1 > V_z$, ($V_z =$ Zener Voltage) So, Zener breakdown will be take place So, voltage across 400Ω will be 4 V

$I = \frac{4}{400}$ A $= \frac{1}{100\ A} = 10$ mA

Q4. Here D_1 is reverse biased and D_2 is forward biased. Therefore current flow through D_Q and 5 V drop on resistor.
(2) So, $V_{out} = 0$

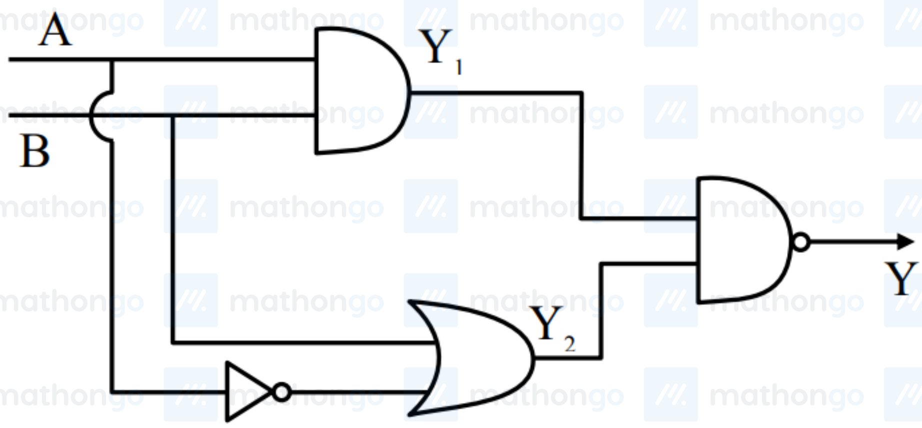
Q5. Only option (2) matches with the truth table
(2)

Q6.
(2)



A	B	A + B	C
0	0	0	0
1	0	1	1
0	1	1	0
1	1	1	1

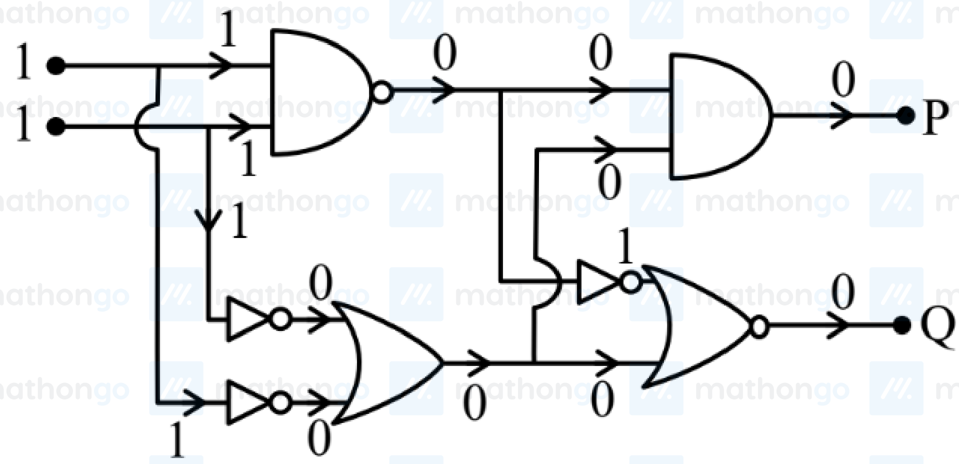
Q7.
(1)



$Y_1 = A \cdot B, Y_2 = \overline{A} + B$
$Y = \overline{Y_1 \cdot Y_2} = \overline{Y}_1 + \overline{Y}_2$
$Y = \overline{A \cdot B} + \overline{A + B}$
$Y = \overline{A} + \overline{B} + A \cdot \overline{B}$

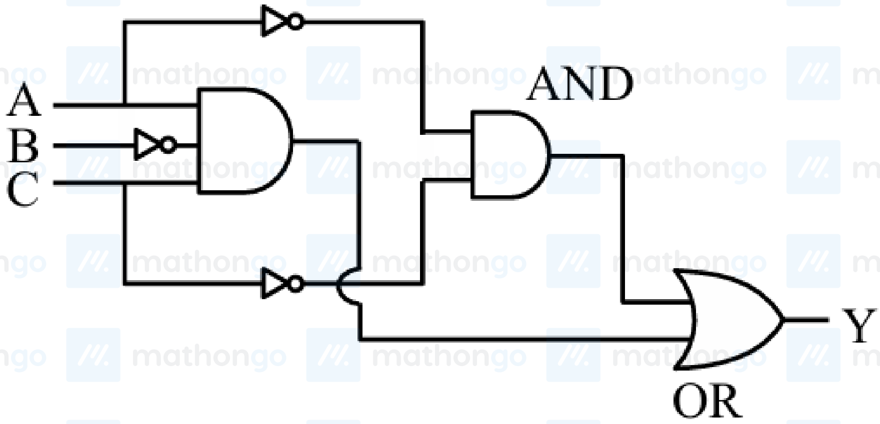
A	B	Y
0	0	1
1	0	1
0	1	1
1	1	0

Q8.
(2)

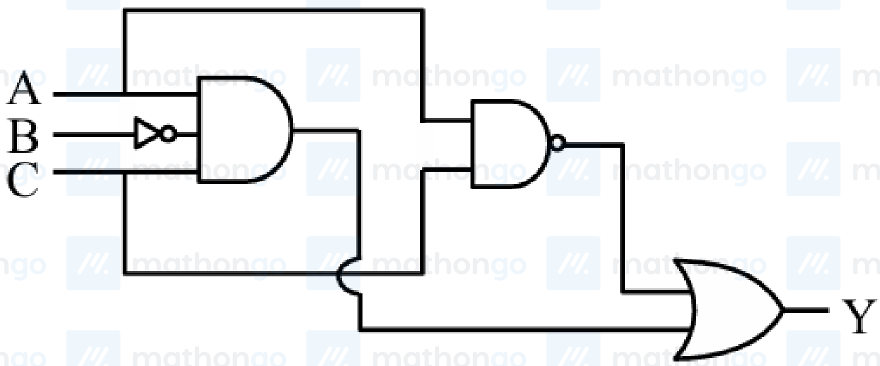


Q9.
(2)

(A)



(B)



$\because \overline{A}\cdot\overline{C} + \overline{A+C} \equiv \text{NOR gate}$

Q1. $300\text{msd} = 15 \text{ cm}$

(2) $1\text{msd} = \frac{15}{300} \text{ cm} = 0.05 \text{ cm}$

$25\text{vsd} = 24\text{msd}$

$1\text{vsd} = \frac{24}{25}\text{msd}$

$\text{LC} = 1\text{msd} - 1\text{vsd}$

$\text{LC} = 1\text{msd} - \frac{24}{25}\text{msd} = \frac{1}{25}\text{msd}$

$\text{LC} = \frac{1}{25} \times 0.05 = 0.002 \text{ cm}$

correct option (2)