PHYSICS

DPP
DAILY PRACTICE PROBLEMS

DPP No. 72

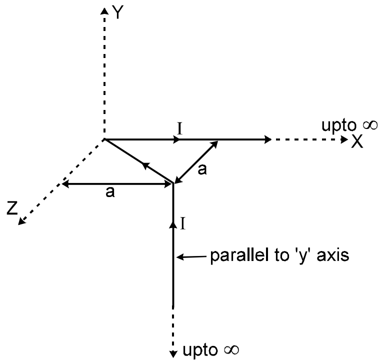
Total Marks : 28

Max. Time : 29 min.

Topics : Magnetic Effect of Current and Magnetic Force on Charge/current, Electromagnet Induction, Rotation, Current Electricity, Fluid, Center of Mass

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.5	(3 marks, 3 min.)	[15, 15]
Subjective Questions ('–1' negative marking) Q.6	(4 marks, 5 min.)	[4, 5]
Comprehension ('–1' negative marking) Q.7 to Q.9	(3 marks, 3 min.)	[9, 9]

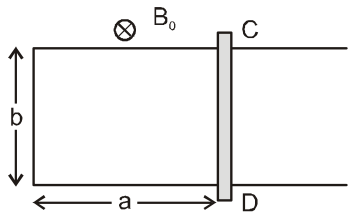
1. The magnetic field at the origin due to the current flowing in the wire is



(A) $-\frac{\mu_0 I}{8\pi a}(\hat{i}+\hat{k})$ (B) $\frac{\mu_0 I}{2\pi a}(\hat{i}+\hat{k})$

(C) $\frac{\mu_0 I}{8\pi a}(-\hat{i}+\hat{k})$ (D) $\frac{\mu_0 I}{4\pi a\sqrt{2}}(\hat{i}-\hat{k})$

2. A U-shaped conducting frame is fixed in space. A conducting rod CD lies at rest on the smooth frame as shown. The frame is in uniform magnetic field B_0, which is perpendicular to the plane of frame. At time t = 0, the magnitude of magnetic field begins to change with time t as, $B = \frac{B_0}{1+kt}$, where k is a positive constant. For no current to be ever induced in frame, the speed with which rod should be pulled starting from time t = 0 is (the rod CD should be moved such that its velocity must lie in the plane of frame and perpendicular to rod CD)



Frame in magnetic field
before time t = 0

(A) ak (B) bk
(C) a(1 + kt) (D) b(1 + kt)

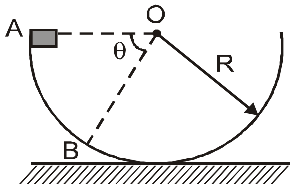
3. A uniform smooth rod is placed on a smooth horizontal floor is hit by a particle moving on the floor, at a distance $\frac{\ell}{4}$ from one end. Then the distance travelled by the centre of the rod after the collision when it has completed three revolution will be:
[$e \neq 0$ & ' ℓ ' is the length of the rod]

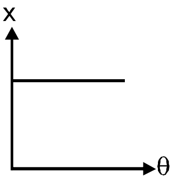
(A) $2\pi\ell$ (B) can't be determined
(C) $\pi\ell$ (D) none of these

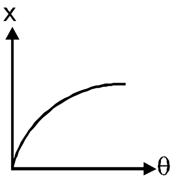
4. The convex lens is used in-

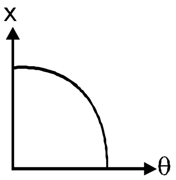
(A) Microscope (B) Telescope (C) Projector (D) All of the above

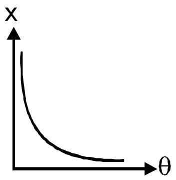
5. A small block of mass m is released from rest from point A inside a smooth hemisphere bowl of radius R, which is fixed on ground such that OA is horizontal. The ratio (x) of magnitude of centripetal force and normal reaction on the block at any point B varies with θ as :



(A) 

(B) 

(C) 

(D) 

6. A solid ice block (of any shape) is floating remaining in equilibrium in water. Some part of it is outside water because its density is less than the density of water. Prove that the level of water does not ascend or descend if the ice melts completely. Neglect the changes in volume due to temperature changes.

COMPREHENSION

Two small spheres of mass m_1 and m_2 are moving towards each other with constant velocities $\vec{u}_1$ and $\vec{u}_2$ respectively and undergo head on inelastic collision. If the coefficient of restitution is e and $m_1\vec{u}_1 + m_2\vec{u}_2 = 0$,

7. The velocity of sphere of mass m_1 after collision is :

(A) $-e\vec{u}_2$ (B) $-e\vec{u}_1$ (C) $e\vec{u}_1$ (D) None of these

8. The velocity of sphere of mass m_2 after collision is :

(A) $-e\vec{u}_1$ (B) $-e\vec{u}_2$ (C) $e\vec{u}_2$ (D) None of these

9. For the given situation, pick up the ***incorrect statement*** :

(A) During the collision, least kinetic energy of system of both spheres is non-zero.

(B) During the collision, least kinetic energy of system of both spheres is zero.

(C) Velocity of separation of both spheres after collision has magnitude = $e|\vec{u}_1 - \vec{u}_2|$

(D) At the instant of maximum deformation during collision, speed of each sphere is zero.

Answers Key

1.	(C)	**2.**	(A)	**3.**	(A)	**4.**	(D)
5.	(A)	**7.**	(B)	**8.**	(B)	**9.**	(A)

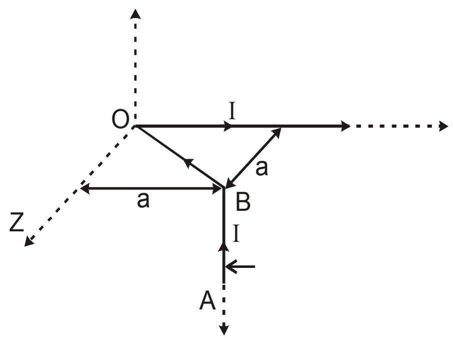
Hints & Solutions

1. $B_{OD} = 0$

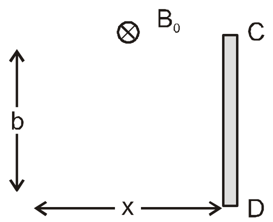
$B_{OB} = 0$

$$B_{AB} = \frac{\mu_0 I}{4\pi a\sqrt{2}}[\cos 45°(-\hat{i}) + \cos 45°\hat{k}]$$

$$= \frac{\mu_0 I}{8\pi a}(-\hat{i} + \hat{k})$$



2.



The magnetic flux must remain constant

$\therefore \phi_m = B_0 ab = \frac{B_0}{1+kt} bx$

where x is as shown

$\therefore \ x = a(1 + kt)$

or $v = \text{——} = ak$ **Ans.**

3. **(A)** Let 'F' be the magnitude of force exerted on the rod due to the collision.

Then : F = ma

and F. $= \ m\ell \ .\alpha$

(about 'O')

$\Rightarrow a = \quad \alpha$ .... (1)

Using ; $S = ut + \quad at^2$ and $\theta = \omega_0 t + \quad \alpha t^2$

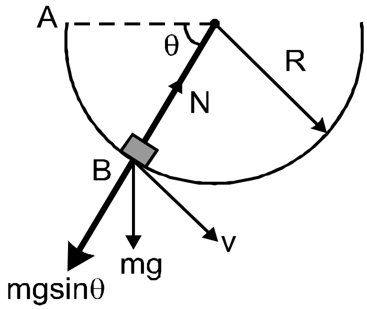
$S = ut + \quad at^2 \quad \theta = \omega_0 t + \quad \alpha t^2$

$S = \quad at^2$ and $6\pi = \quad \alpha t^2$

$\Rightarrow \frac{6\pi}{s} = \frac{\alpha}{a} = \frac{3}{\ell}$ (from (1)))

$\Rightarrow S = 2\ \ell$ Ans.

5. $\frac{mv^2}{R} = N - mg\sin\theta$



$N = \frac{mv^2}{R} + mg\sin\theta$

By energy conservation,

$mgR\sin\theta = \frac{1}{2}mv^2$

$\frac{mv^2}{R} = 2mg\sin\theta$

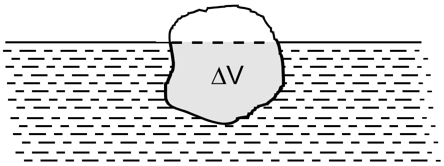
$N = 3mg\sin\theta$

Ratio $= \frac{mv^2}{RN} = \frac{2}{3}$ (constant)

$x = \frac{2}{3}$.

6. Consider a block of ice having volume V and density ρ_i.

Let the volume of ice submerged in water (of density ρ_w) be ΔV



Since the ice block is in equilibrium

$\rho_i V g = \rho_w \Delta V g$ or $\Delta V = \frac{\rho_i V}{\rho_w}$ ... (1)

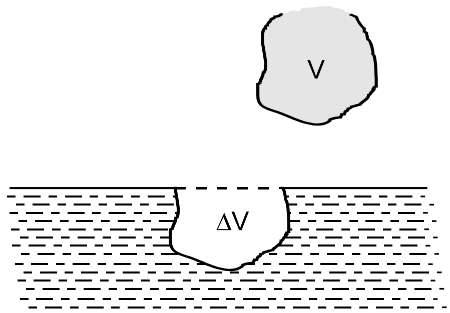
Let V volume of ice melt in to V′ of water. Then

$\therefore \quad \rho_i V = \rho_w V'$

or $V' = \frac{\rho_i V}{\rho_w}$ ... (2)

from (1) and (2) $\Rightarrow \Delta V = V'$

Hence when V volume of ice melts it occupies $V' = \Delta V$ volume of water.



Hence the level of water does not change on melting of ice.

9. The velocity of centre of mass is always zero. At maximum deformation during head on collision, velocity of each sphere is equal to velocity of centre of mass and hence zero. Therefore at maximum deformation K.E. of system is also zero.

Velocity of separation after collision = e (velocity of approach before collision).

From centre of mass frame in a head-on collision, if u and v be velocity of a ball before and after collision . Since, $v_{cm} = 0$ from ground frame, ground frame and centre of mass frame carry same meaning.