PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 71

Total Marks : 29

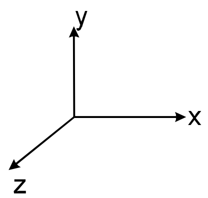
Max. Time : 31 min.

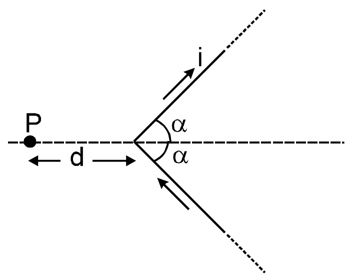
Topics : Magnetic Effect of Current and Magnetic Force on Charge/current, Electromagnet Induction, Rotation, Center of Mass, Geometrical Optics, Current Electricity

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.4	(3 marks, 3 min.)	[12, 12]
Subjective Questions ('–1' negative marking) Q.5 to Q.6	(4 marks, 5 min.)	[8, 10]
Comprehension ('–1' negative marking) Q.7 to Q.9	(3 marks, 3 min.)	[9, 9]

1. The direction of the field B at P is :

The V shaped wire is in x-y plane.





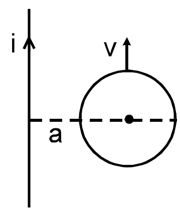
(A) along + x-axis
(B) along + z-axis
(C) along (–x)–axis
(D) along + y-axis

2. If the magnetic field at 'P' can be written as K tan $\left(\frac{\alpha}{2}\right)$ then K is :

[Refer to the figure of above question]

(A) $\frac{\mu_0 I}{4\pi d}$ (B) $\frac{\mu_0 I}{2\pi d}$ (C) $\frac{\mu_0 I}{\pi d}$ (D) $\frac{2\mu_0 I}{\pi d}$

3. A circular loop of radius r is moved with a velocity v as shown in the diagram. The work needed to maintain its velocity constant is :

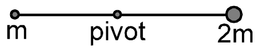


(A) $\frac{\mu_0 i v r}{2\pi a}$ (B) $\frac{\mu_0 i v r}{2\pi(a+r)}$ (C) $\frac{\mu_0 i v r}{2\pi}\ell n\left(\frac{2r+a}{a}\right)$ (D) zero

4. The magnifying power of a simple microscope can be increased if an eyepiece of :

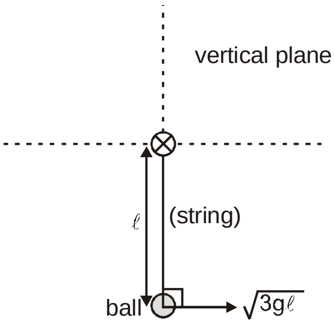
(A) shorter focal length is used (B) longer focal length is used
(C) shorter diameter is used (D) longer diameter is used

5. A rod of negligible mass and length ℓ is pivoted at its centre. A particle of mass m is fixed to its left end & another particle of mass 2 m is fixed to the right end. If the system is released from rest,



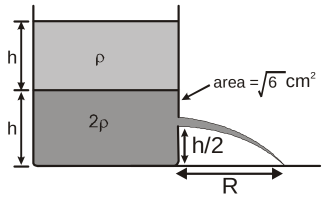
(a) what is the speed v of the two masses when the rod is vertical.
(b) what is the angular speed ω of the system at that instant.

6. A ball is given velocity $\sqrt{3g\ell}$ as shown. If the ratio of centripital acceleration to tangential acceleration is $1 : y\sqrt{2}$ at the point where the ball leaves circular path then write the value of y. [Neglect the size of ball]



COMPREHENSION

A fixed cylindrical tank having large cross-section area is filled with two liquids of densities ρ and 2ρ and in equal volumes as shown in the figure. A small hole of area of cross–section $a = \sqrt{6}\,cm^2$ is made at height h/2 from the bottom.



7. Velocity of efflux will be :

(A) $\sqrt{2gh}$ (B) $\sqrt{3gh}$ (C) $\sqrt{gh}$ (D) $2\sqrt{gh}$

8. Distance (R) of the point at which the liquid will strike from container is :

(A) 2h (B) h (C) $\frac{h}{2}$ (D) $\sqrt{2}h$

9. Area of cross section of stream of liquid just before it hits the ground.

(A) 2 cm^2 (B) $\sqrt{3}$ cm^2 (C) 1 cm^2 (D) $\sqrt{5}$ cm^2

Answers Key

1. (B) **2.** (B) **3.** (D) **4.** (A)

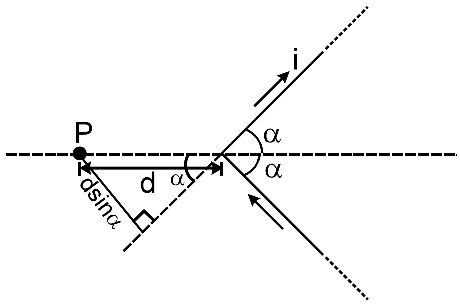
5. **(a)** $V = \sqrt{g\ell/3}$, $\omega = \sqrt{4g/3\ell}$]

6. y = 2 **7.** (A) **8.** (D) **9.** (A)

Hints & Solutions

1. By right hand thumb rule, the field by both the segments are out of the plane i.e.along **+ve z-axis**.

2. Let us compute the magnetic field due to any one segment :



$$B = \frac{\mu_0 i}{4\pi(d\sin\alpha)}(\cos 0^0 + \cos(180-\alpha))$$

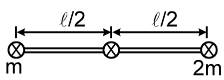
$$= \frac{\mu_0 i}{4\pi(d\sin\alpha)}(1-\cos\alpha) = \frac{\mu_0 i}{4\pi d}\tan\frac{\alpha}{2}$$

Resultant field will be :

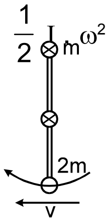
$$B_{net} = 2B = \frac{\mu_0 i}{2\pi d}\tan\frac{\alpha}{2} \quad \Rightarrow k = \frac{\mu_0 i}{2\pi d}$$

3. Due to the motion of the loop, there will be an induced current flowing in the circuit, resulting in a force acting on each element of the loop equally & radially. Therefore the net force on the loop is zero.

Hence (D).

5. Decrease in PE = 

Increase in rotation K.E



$$\Rightarrow 2mg.\frac{\ell}{2} - mg.\frac{\ell}{2} = \frac{1}{2}I\omega^2$$

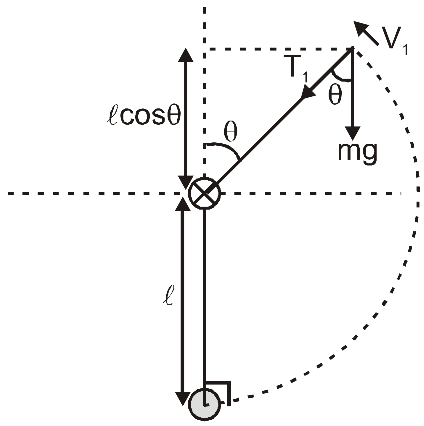
$$= \frac{1}{2}\left(2m\frac{\ell^2}{4} + m.\frac{\ell}{4}\right)\omega^2$$

$$\frac{mg\ell}{2} = \frac{1}{2}.\frac{3m\ell^2}{4}.\omega = \frac{3m\ell^2}{8}\omega^2$$

$$\omega = \sqrt{\frac{4g}{3\ell}} \quad \text{and } v = r\omega = \frac{\ell}{2}\sqrt{\frac{4g}{3\ell}} = \sqrt{\frac{g\ell}{3\ell}}$$

[**Ans.: (a)** $V = \sqrt{g\ell/3}$, $\omega = \sqrt{4g/3\ell}$]

6.



$$mg\cos\theta + T_1 = \frac{mv_1^2}{\ell}$$

for leaving circle $T_1 = 0$

$mv_1^2 = mg\,\ell\cos\theta$ ...(i)

and by energy conservation

$$0 + \frac{1}{2}m\left(\sqrt{3g\ell}\right)^2 = \frac{1}{2}mv_1^2 + mg(\ell + \ell\cos\theta)$$

$$\frac{1}{2}m(3g\ell) = \frac{1}{2}mv_1^2 + mg\ell(1+\cos\theta)$$

$$\frac{3mg\ell}{2} = \frac{mg\ell\cos\theta}{2} + mg\ell + mg\ell\cos\theta$$

(by eqation (i))

$$\frac{mg\ell}{2} = \frac{3}{2}mg\ell\cos\theta$$

$$\cos\theta = \frac{1}{3}$$

$$\sin\theta = \sqrt{1-\frac{1}{9}} = \frac{\sqrt{8}}{3}$$

$$a_c = \frac{v_1^2}{\ell} = \frac{g\ell\cos\theta}{\ell} = g\cos\theta$$

$a_t = g\sin\theta$

then $\dfrac{a_c}{a_t}$

$$= \frac{g\cos\theta}{g\sin\theta} = \frac{1/3}{\sqrt{8}/3} = \frac{1}{\sqrt{8}} = \frac{1}{2\sqrt{2}} = \frac{1}{y\sqrt{2}}$$

so y = 2

Sol. **(7 to 9)**

Applying bernoulli's equation

$$P_0 + \frac{1}{2} \times 2\rho \times V^2 = P_0 + 2\rho g \times \frac{h}{2} + \rho gh$$

$$v = \sqrt{2gh}$$

$$\frac{1}{2} \times g \times t^2 = \frac{h}{2}$$

$$\Rightarrow \quad t = \sqrt{\frac{h}{g}}$$

$$R = v \times t$$

$$\Rightarrow \quad \sqrt{2}h$$

Applying continuity equation

$$\sqrt{6} \times \sqrt{2gh} = \sqrt{3gh} \times A$$

$$A = 2cm^2$$