PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 73

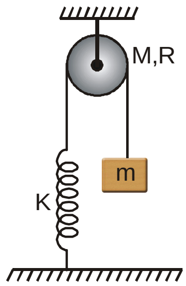
Total Marks : 36

Max. Time : 42 min.

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

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	(4 marks, 5 min.)	[4, 5]
Comprehension ('–1' negative marking) Q.6 to Q.8	(3 marks, 3 min.)	[9, 9]

1. A uniform disc of mass m and radius R is free to rotate about its fixed horizontal axis without friction. There is sufficient friction between the inextensible light string and disc to prevent slipping of string over disc. At the shown instant extension in light spring is $\frac{3mg}{K}$, where m is mass of block, g is acceleration due to gravity and K is spring constant. Then at the shown moment, magnitude of acceleration of block is :

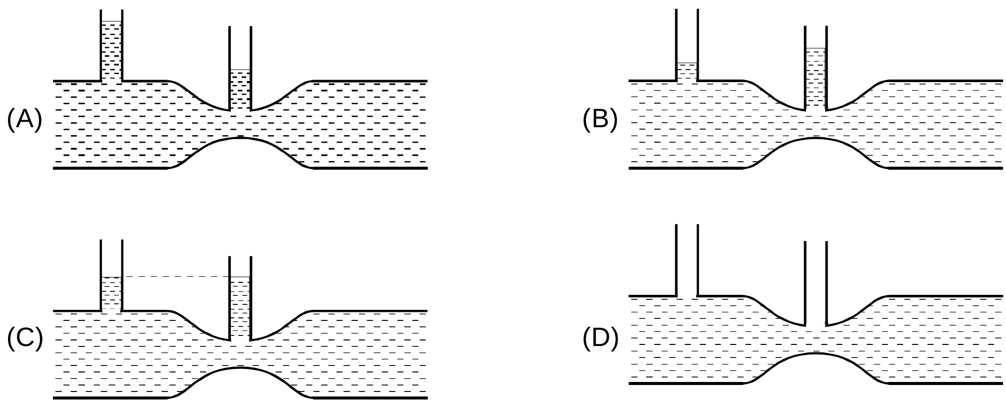


(A) $\frac{2g}{3}$ (B) $\frac{4g}{3}$ (C) $\frac{g}{3}$ (D) $\frac{g}{4}$

2. The focal length of the objective of a microscope is

(A) arbitrary
(B) less than the focal length of eyepiece
(C) equal to the focal length of eyepiece
(D) greater than the focal length of eyepiece

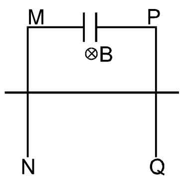
3. For a fluid which is flowing steadily, the level in the vertical tubes is best represented by



4. In the motorcycle stunt called "the well of death" the track is a vertical cylindrical surface of 18 m radius. Take the motorcycle to be a point mass and μ = 0.8. The minimum angular speed of the motorcycle to prevent him from sliding down should be:

(A) 6/5 rad/s (B) 5/6 rad/s (C) 25/3 rad/s (D) none of these

5. In the figure shown a conducting rod of length ℓ, resistance R & mass m can move vertically downward due to gravity. Other parts are kept fixed. B = constant = B_0. MN and PQ are vertical, smooth, conducting rails. The capacitance of the capacitor is C. The rod is released from rest. Find the maximum current in the circuit



COMPREHENSION

Tangent Galvanometer : In case of tangent galvanometer (Figure) a magnetic compass needle is placed horizontally at the centre of a vertical fixed current-carrying coil whose plane is in the magnetic meridian (the plane in which the earth's magnetic field is present in vertical and horizontal directions). So if the needle in equilibrium subtends an angle ϕ with the earth's horizontal magnetic field, then for equilibrium we have

$$|\vec{M} \times \vec{B}_H| = |\vec{M} \times \vec{B}_C| \quad \ldots (1)$$

(direction of the torque on the needle due to field of the earth (B_H) and due to field of the coil (B_C) must be opposite)

Here $\vec{M}$ is the magnetic moment of the needle

$\vec{B}_H$ is the earth's horizontal magnetic field

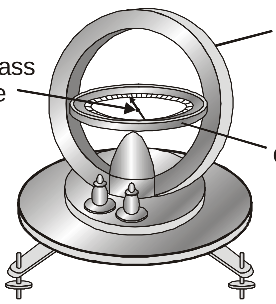
$\vec{B}_C$ is the magnetic field at centre due to coil

Now from equation-(1), we have

or, $MB_H \sin\phi = MB_C \sin(90 - \phi)$ or, $B_C = B_H \tan\phi$

or, $\dfrac{\mu_0 NI}{2R} = B_H \tan\phi$ here R is the radius of the coil and N is the number of turns.

i.e., $I = K \tan\phi$ with $K = \dfrac{2RB_H}{\mu_0 N}$ → Reduction factor of the tangent galvanometer, i.e., in case of a tangent galvanometer when the plane of coil is in magnetic meridian, current in the coil is directly proportional to the tangent of deflection of magnetic needle.



Tangent Galvanometer

6. If at a place horizontal component of Earth's magnetic field is $B_H = 2 \times 10^{-5}$ T, No. of turns in the coil N = 100, current I = 10 mA, coil radius = π cm. The angle of dip at this position will be :

(A) $\frac{\pi}{6}$ (B) $\frac{\pi}{4}$ (C) $\frac{\pi}{3}$ (D) Data insufficient

7. If no. of turns in coil are doubled, the reduction factor of tangent galvanometer will be :

(A) 0.001 (B) 0.002 (C) 0.005 (D) None of these

8. If at an instant in equilibrium after doubling the number of turns compass needle points in the direction 30° north of east then current in coil is :

(A) $\frac{\sqrt{3}}{200}$ (B) $\frac{\sqrt{3}}{500}$ (C) $\frac{1}{200\sqrt{3}}$ (D) $\frac{1}{500\sqrt{3}}$

Answers Key

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

5. $i_{max} = \dfrac{mgB\ell c}{m + B^2\ell^2 c}$ **6.** (D) **7.** (C)

8. (A)

Hints & Solutions

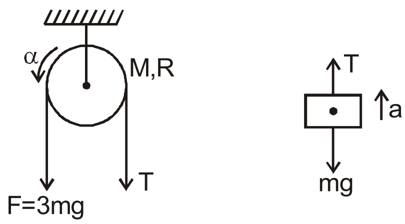
1. For disc, from torque equation

$$3\,mg\,R - TR = \frac{mR^2}{2}\alpha \quad .... (1)$$

By application of Newton's second law on block we get,

$T - mg = ma$ .... (2)

where $a = R\alpha$ ..... (3)



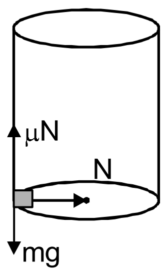
solving $a = \dfrac{4g}{3}$

3. (A) From continuity equation, velocity at cross-section (1) is more than that at cross-section (2).

Hence ; $P_1 < P_2$

Hence (A)

4.



$N = mr\omega^2$ ....(i)

$\mu N = mg$ ....(ii)

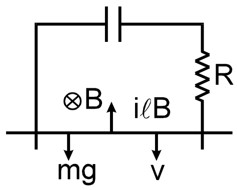
From (i) & (ii),

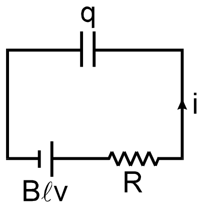
$\mu(mr\omega^2) = mg$

$$\omega^2 = \frac{g}{\mu r} = \frac{10}{0.8 \times 18}$$

5. By newton's law :

$$mg - i\,l\,B = m\frac{dv}{dt} \qquad \text{..........} \quad (1)$$





By kvl $\quad B\,l\,v = i\,R + \frac{q}{c} \qquad \text{..........} \quad (2)$

differentiate (2) w.r.t. time

$$B\,l\frac{dv}{dt} = R\frac{di}{dt} + \frac{i}{c} \qquad \text{..........} \quad (3)$$

Eliminate $\frac{dv}{dt}$ by (1) & (3)

$$mg - i\,l\,B = \frac{m}{B\ell}\left[R\frac{di}{dt} + \frac{i}{c}\right]$$

$$\Rightarrow \; m\,g\,B\,l - i\,B^2 l^2 = m\,R\frac{di}{dt} + \frac{m\,i}{c} \qquad \text{..........} \quad (4)$$

i will be maximum when $\frac{di}{dt} = 0$.

Use this in (4)

$\Rightarrow \; m\,g\,B\,l\,c = i\,(B^2 l^2 c + m)$

$\Rightarrow \; i_{max} = \frac{mgB\ell c}{m + B^2\ell^2 c}$ **Ans.**

6. Angle of dip can not be calculated by tangent galvanometer.

7. $K = \frac{2\times\pi\times10^{-2}\times2\times10^{-5}}{4\pi\times10^{-7}\times200} = 0.005$

8. $i = K\tan\phi$

using values ($\phi = 60°$)

$i = 0.005 \times \sqrt{3} \quad = \frac{\sqrt{3}}{200}$