PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 32

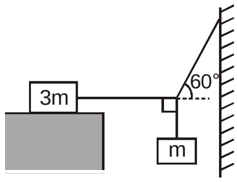
Total Marks : 30

Max. Time : 33 min.

Topics : Newton's Law of Motion, Fluid, Surface Tension, Gravitation, Electrostatics

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.3	(3 marks, 3 min.)	[9, 9]
Subjective Questions ('–1' negative marking) Q.4 to Q.6	(4 marks, 5 min.)	[12, 15]
Comprehension ('–1' negative marking) Q.7 to Q.9	(3 marks, 3 min.)	[9, 9]

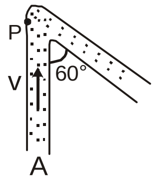
1. A mass *m* is supported as shown in the figure by ideal strings connected to a rigid wall and to a mass 3*m* at rest on a fixed horizontal surface. The string connected to larger mass is horizontal, that connected to smaller mass is vertical and the one connected to wall makes an angle 60° with horizontal.Then the minimum coefficient of static friction between the larger mass and the horizontal surface that permits the system to remain in equilibrium in the situation shown is:



(A) $\frac{1}{\sqrt{3}}$ (B) $\frac{1}{3\sqrt{3}}$

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

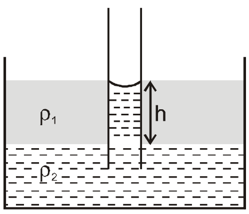
2. Water (density ρ) is flowing through the uniform tube of cross-sectional area A with a constant speed v as shown in the figure. The magnitude of force exerted by the water on the curved corner of the tube is(neglect viscous forces)



(A) $\sqrt{3}\,\rho Av^2$ (B) $2\rho Av^2$

(C) $\sqrt{2}\rho Av^2$ (D) $\frac{\rho Av^2}{\sqrt{2}}$

3. A container is partially filled with a liquid of density ρ_2. A capillary tube of radius r is vertically inserted in this liquid. Now another liquid of density ρ_1 ($\rho_1 < \rho_2$) is slowly poured in the container to a height h as shown. There is only denser liquid in the capillary tube. The rise of denser liquid in the capillary tube is also h. Assuming zero contact angle, the surface tension of heavier liquid is



(A) $r\rho_2 gh$ (B) $2\pi r\,\rho_2 gh$

(C) $\frac{r}{2}(\rho_2 - \rho_1)gh$ (D) $2\pi r(\rho_2 - \rho_1)gh$

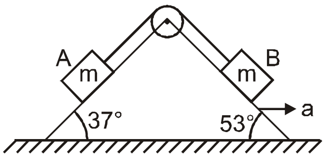
4. A point P lies on the axis of a fixed ring of mass M and radius a, at a distance a from its centre C. A small particle starts from P and reaches C under gravitational attraction only. Its speed at C will be ________.

5. Three conducting concentric spherical shells of radius R, 2R and 3R have charges Q, $\frac{Q}{3}$ and $-2Q$ respectively. $Q = 1.6 \times 10^{-6}$C. The intermediate shell is grounded. Find the number of electrons that will flow through the connecting wire. Also tell whether, the electrons flow into the earth or into the shell.

6. A non–uniform string of mass 45 kg and length 1.5 m has a variable linear mass density given by $\mu = kx$, where x is the distance from one end of the string and k is a constant. Tension in the string is 15 N which is uniform. Find the time (in second) required for a pulse generated at one end of the string to travel to the other end.

COMPREHENSION

Two blocks A and B of equal masses m kg each are connected by a light thread, which passes over a massless pulley as shown. Both the blocks lie on wedge of mass m kg. Assume friction to be absent everywhere and both the blocks to be always in contact with the wedge. The wedge lying over smooth horizontal surface is pulled towards right with constant acceleration a (m/s²). (g is acceleration due to gravity).



7. Normal reaction (in N) acting on block B is

(A) $\frac{m}{5}(3g + 4a)$ (B) $\frac{m}{5}(3g - 4a)$ (C) $\frac{m}{5}(4g + 3a)$ (D) $\frac{m}{5}(4g - 3a)$

8. Normal reaction (in N) acting on block A.

(A) $\frac{m}{5}(3g + 4a)$ (B) $\frac{m}{5}(3g - 4a)$ (C) $\frac{m}{5}(4g + 3a)$ (D) $\frac{m}{5}(4g - 3a)$

9. The maximum value of acceleration a (in m/s²) for which normal reactions acting on the block A and block B are nonzero.

(A) $\frac{3}{4}g$ (B) $\frac{4}{3}g$ (C) $\frac{3}{5}g$ (D) $\frac{5}{3}g$

Answers Key

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

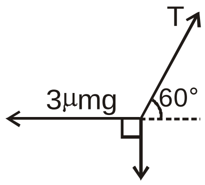
4. $\sqrt{\frac{2GM}{a}\left(1-\frac{1}{\sqrt{2}}\right)}$

5. $\frac{Q}{3}$,which is same as that before earthing

6. 2 **7.** (A) **8.** (D) **9.** (B)

Hints & Solutions

1. At the instant 3m is about to slip, tension in all the strings are as shown



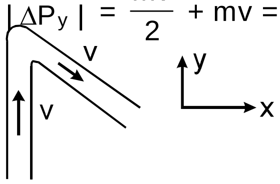
$\therefore$ 3 μmg = T cos 60° .... (1)

and mg = T sin 60° .... (2)

$$\therefore \quad \mu = \frac{1}{3\sqrt{3}}$$

2. $|\overrightarrow{\Delta P_x}| = mv \sin 60° = \frac{\sqrt{3}}{2} mv$

$|\overrightarrow{\Delta P_y}| = \frac{mv}{2} + mv = \frac{3}{2} mv$



$$\Rightarrow |\overrightarrow{\Delta P_{net}}| = \sqrt{\Delta P_x^2 + \Delta P_y^2} = \sqrt{\left(\frac{9}{4} + \frac{3}{4}\right)} mv$$

$$|\overrightarrow{\Delta P_{net}}| = \sqrt{3}\, mv$$

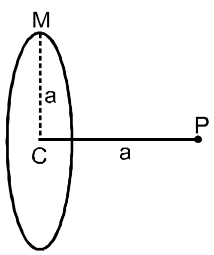
$$\left(\begin{array}{l}\text{Since, } dm = A(v\,dt)\rho \\ \Rightarrow \frac{dm}{dt} = A\rho v\end{array}\right)$$

$$\Rightarrow |\overrightarrow{\Delta F_{net}}| = \sqrt{3}\left(\frac{dm}{dt}\right).v = \sqrt{3}\,\rho A v^2 \quad \textbf{Ans.}$$

3. $P_0 + \rho_1 gh - \rho_2 gh + \frac{2T}{r} = P_0$

$$\Rightarrow T = \frac{r}{2}(\rho_2 - \rho_1)\, gh$$

4.



KE = $V_1 - V_2$ $\quad \frac{1}{2} m\upsilon^2 = \frac{GMm}{\sqrt{2}a} - \left(\frac{-GMm}{a}\right)$

$$\upsilon = \sqrt{\frac{2GM}{a}\left(1 - \frac{1}{\sqrt{2}}\right)}$$

5. Let the charge on intermediate shell be q (after earthing)

Potential of the intermediate shell $= 0$

$$\Rightarrow \frac{KQ}{2R} + \frac{Kq}{2R} - \frac{K2Q}{3R} = 0$$

$$\frac{Q}{2} + \frac{q}{2} - \frac{2Q}{3} = 0$$

$$q = \left(\frac{2Q}{3} - \frac{Q}{2}\right)2 = \left(\frac{4Q - 3Q}{6}\right)2$$

$= \frac{Q}{3}$, which is same as that before earthing

$\therefore$ **No charge will flow.**

6. 2

$$\mu = Kx = \frac{dM}{dx}$$

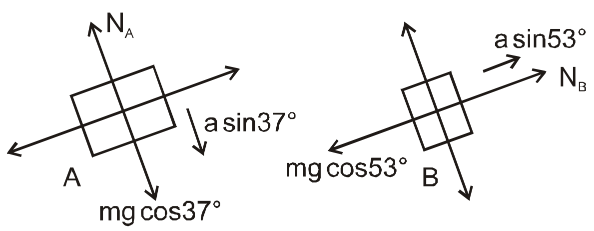
$$\int_O^M dM = \int_O^{\ell} Kx\,dx \text{ and } K = \frac{2M}{\ell^2}$$

$$V = \sqrt{\frac{F}{\mu}} = \sqrt{\frac{F}{Kx}} = \frac{dx}{dt} \qquad \int_O^{\ell} \sqrt{x}\,dx = \sqrt{\frac{F}{K}} \int_o^t dt$$

$$\therefore \quad t = \sqrt{\frac{4\ell^3}{9} . \frac{K}{f}} = \sqrt{\frac{4\ell^3}{9F} . \frac{2m}{\ell^2}}$$

$$= \sqrt{\frac{8M\ell}{9F}} = \sqrt{\frac{8 \times 45 \times 1.5}{9 \times 15}} = 2.$$

Sol. 7 to 9.



The FBD of A and B are

Applying Newton's second law to block A and B along normal to inclined surface

$N_B - mg\cos 53° = ma\sin 53°$

$mg\cos 37° - N_A = ma\sin 37°$

Solving $N_A = \frac{m}{5}(4g - 3a)$ and $N_B = \frac{m}{5}(3g + 4a)$

For N_A to be non zero

$4g - 3a \geq 0$

or $\quad a \leq \frac{4g}{3}$