PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 65

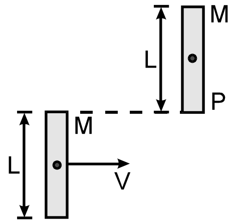
Total Marks : 26

Max. Time : 27 min.

Topic : Rigid Body Dynamics

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.3	(3 marks, 3 min.)	[9, 9]
Multiple choice objective ('–1' negative marking) Q.4	(4 marks, 4 min.)	[4, 4]
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 bar of mass M and length L is in pure translatory motion with its centre of mass velocity V. It collides with and sticks to a second identical bar which is initially at rest. (Assume that it becomes one composite bar of length 2L). The angular velocity of the composite bar will be



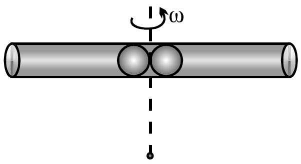
(A) $\frac{3}{4}\frac{V}{L}$ clockwise

(B) $\frac{4}{3}\frac{V}{L}$ clockwise

(C) $\frac{3}{4}\frac{V}{L}$ counterclockwise

(D) $\frac{V}{L}$ counterclockwise

2. A smooth tube of certain mass is rotated in gravity free space. The two balls shown in the figure move towards ends of the tube. For the whole system which of the following quantity is not conserved.



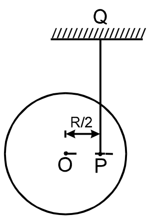
(A) Angular momentum

(B) Linear momentum

(C) Kinetic energy

(D) Angular speed

3. A uniform disc of mass M and radius R is released from the shown position. PQ is a string, OP is a horizontal line, O is the centre of the disc and distance OP is R/2. Then tension in the string just after the disc is released will be:



(A) $\frac{Mg}{2}$

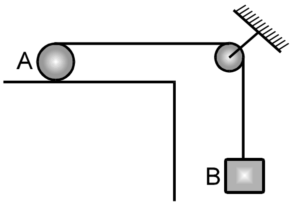
(B) $\frac{Mg}{3}$

(C) $\frac{2Mg}{3}$

(D) none of these

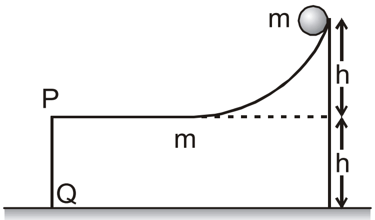
4. Which of the following statements is/are true
(A) work done by kinetic friction on an object may be positive.
(B) A rigid body rolls up an inclined plane without sliding. The friction force on it will be upwards. (only contact force and gravitational force is acting)
(C) A rigid body rolls down an inclined plane without sliding. The friction force on it will be upwards. (only contact force and gravitational force is acting)
(D) A rigid body is left from rest and having no angular velocity from the top of a rough inclined plane. It moves down the plane with slipping. The friction force on it will be upwards.

5. Find the acceleration of solid right circular roller A, weighing 12 kg when it is being pulled by another weight B (6 kg) along the horizontal plane as in figure (pulley is massless). The weight B is attached to the end of a string wound around the circumference of roller. Assume there is no slipping of the roller and the string is inextensible.



COMPREHENSION

A small ball (uniform solid sphere) of mass m is released from the top of a wedge of the same mass m. The wedge is free to move on a smooth horizontal surface. The ball rolls without sliding on the wedge. The required height of the wedge are mentioned in the figure.



6. The speed of the wedge when the ball is just going to leave the wedge at point 'P' of the wedge is

(A) $\sqrt{\frac{5gh}{9}}$ (B) $\sqrt{gh}$ (C) $\sqrt{\frac{5gh}{6}}$ (D) None of these

7. The total kinetic energy of the ball just before it falls on the ground

(A) 2 mgh (B) mgh (C) $\frac{13}{18}$mgh (D) None of these

8. The horizontal separation between the ball and the edge 'PQ' of wedge just before the ball falls on the ground is

(A) $\frac{3\sqrt{10}}{2}$h (B) $\frac{2\sqrt{10}}{3}$h (C) 2 h (D) None of these

Answers Key

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

5. a = $\frac{20}{7}$ or $\frac{2g}{7}$ **6.** (A) **7.** (D) **8.** (B)

Hint & Solutions

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1. Cons. of ang. momentum about P gives

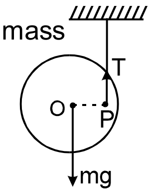
$$MV\frac{L}{2} = \frac{(2M)(2L)^2}{12}\,\omega$$

$$\frac{V}{2} = \frac{2L\omega}{3}$$

$\omega = \dfrac{3V}{4L}$, counterclockwise **Ans. (C)**

2. **(D)** As $\Sigma\tau = 0$; Angular momentum, linear momentum remains conserved.
As the two balls will move radially out, I changes.In order to keep the angular momentum $(L = I\omega)$ conserved, angular speed (ω) should change Hence (D).

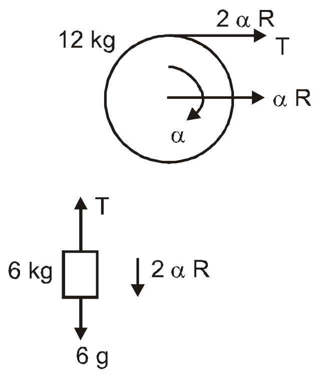
3. **[C]**
Applying Newton's law on centre of mass O
Mg – T = ma {a = acceleration of centre of mass}
$\tau = I\alpha$, about centre of mass



$$T\frac{R}{2} = \frac{MR^2}{2}\cdot\alpha$$

Also $a = \dfrac{R}{2}\alpha$ from above equations $T = \dfrac{2mg}{3}$

5.



$$T\,2R = \left[\frac{12R^2}{2} + 12R^2\right]\alpha$$

$T\,2R = 18R^2\alpha$
$6g – T = 6 \times 2\alpha R$
$T = 60 – 12\alpha R$
$T = 9\alpha R$
$9\alpha R = 60 – 12\alpha R$

$$\alpha R = \frac{60}{21} = \frac{20}{7}$$

$$a = \frac{20}{7} \quad \text{or} \quad \frac{2g}{7}$$

6. to 8

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}mv^2 + \frac{1}{2}\cdot\frac{2}{5}mr^2\left(\frac{2v}{r}\right)^2$$

$$= \frac{1}{2}mv^2\left[1 + 1 + \frac{8}{5}\right] = \frac{1}{2}mv^2\frac{18}{5} = \frac{9mv^2}{5}$$

$$\Rightarrow v = \sqrt{\frac{5}{9}gh}$$

7. KE of the ball = mg 2h

$$-\frac{1}{2}m\left(\sqrt{\frac{5gh}{9}}\right)^2 = \frac{31}{18}mgh$$

$$= mg\,2h - \frac{1}{2}m\left(\sqrt{\frac{5gh}{9}}\right)^2 = \frac{31}{18}mgh$$

8. $X = 2vt = 2v\sqrt{\dfrac{2h}{g}} = 2.\sqrt{\dfrac{5}{9}gh}\sqrt{\dfrac{2h}{g}}$

$$= \frac{2\sqrt{10}}{3}h$$