PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 62

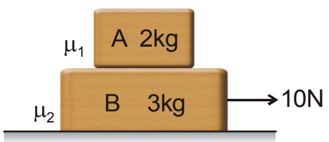
Total Marks : 30

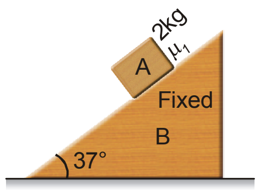
Max. Time : 33 min.

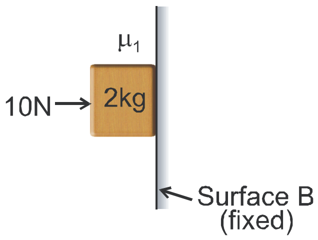
Topics : Friction, Rigid Body Dynamics, Center of Mass

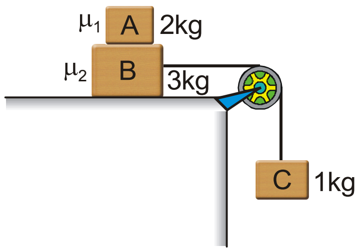
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.3	(3 marks, 3 min.)	[9, 9]
Subjective Questions ('–1' negative marking) Q.4	(4 marks, 5 min.)	[4, 5]
Comprehension ('–1' negative marking) Q.5 to Q.7	(3 marks, 3 min.)	[9, 9]
Match the Following (no negative marking) (2 × 4) Q.8	(8 marks, 10 min.)	[8, 10]

1. In which of the following cases the friction force between'A' and 'B' is maximum. In all cases μ_1=0.5,μ_2 = 0.

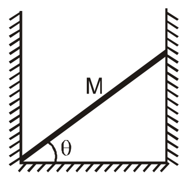
(A) 

(B) 

(C) 

(D) 

2. A uniform stick of mass M is placed in a frictionless well as shown. The stick makes an angle θ with the horizontal. Then the force which the vertical wall exerts on right end of stick is :



(A) $\frac{Mg}{2\cot\theta}$ (B) $\frac{Mg}{2\tan\theta}$

(C) $\frac{Mg}{2\cos\theta}$ (D) $\frac{Mg}{2\sin\theta}$

3. Two small spheres of equal mass, and heading towards each other with equal speeds, undergo a head-on collision (no external force acts on system of two spheres). Then which of the following statement is correct?

(A) Their final velocities must be zero.

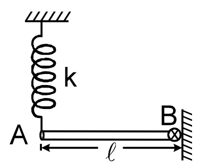
(B) Their final velocities may be zero.

(C) Each must have a final velocity equal to the other's initial velocity.

(D) Their velocities must be reduced in magnitude

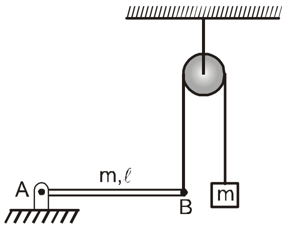
4. In the figure shown a uniform rod of mass 'm' and length 'ℓ' is hinged at one end and the other end is connected to a light vertical spring of spring constant 'k' as shown in figure. The spring has extension such that rod is in equilibrium when it is horizontal. The rod can rotate about horizontal axis passing through end 'B'. Neglecting friction at the hinge find

a) extension in the spring (b) the force on the rod due to hinge.



COMPREHENSION

Uniform rod AB is hinged at the end A in a horizontal position as shown in the figure (the hinge is frictionless, that is, it does not exert any friction force on the rod). The other end of the rod is connected to a block through a massless string as shown. The pulley is smooth and massless. Masses of the block and the rod are same and are equal to 'm'.



5. Then just after release of block from this position, the tension in the thread is

(A) $\frac{mg}{8}$ (B) $\frac{5mg}{8}$ (C) $\frac{11mg}{8}$ (D) $\frac{3mg}{8}$

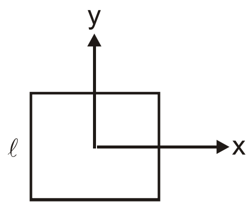
6. Then just after release of block from this position, the angular acceleration of the rod is

(A) $\frac{g}{8\ell}$ (B) $\frac{5g}{8\ell}$ (C) $\frac{11g}{8\ell}$ (D) $\frac{3g}{8\ell}$

7. Then just after release of block from this position, the magnitude of reaction exerted by hinge on the rod is

(A) $\frac{3mg}{16}$ (B) $\frac{5mg}{16}$ (C) $\frac{9mg}{16}$ (D) $\frac{7mg}{16}$

8. Four identical rods, each of mass m and length l are joined to form a rigid square frame. The frame lies in the X-Y plane, with its centre at the origin and the sides parallel to the x and y axis. it's moment of inertia about



Column I	Column II
(A) An axis parallel to z-axis and passing through a corner	(p) 5/3 $m\ell^2$
(B) One side	(q) 2/3 $m\ell^2$
(C) The x-axis	(r) 4/3 $m\ell^2$
(D) The z-axis	(s) 10/3 $m\ell^2$

Answers Key

1. (B) **2.** (B) **3.** (B) **4.(a)** $\frac{mg}{2k}$ **(b)** $\frac{mg}{2}$

5. (B) **6.** (D) **7.** (C)

8. A – s , B – p, C – q , D – r

Hint & Solutions

1. (d) (i) If both moves together a = 2m/s^2

Force required for A = 4N

Max. frictionforce = 10 N

Hence there will be no slipping and friction force willbe 4 N.

(ii) Max. Friction force = μmg cosθ = 8 N

Force along incline = mg sinθ = 12 N

Hence block will move and friction force will be 8 N.

(iii) Max. friction force = μN = 5N

Downward force = 20 N

Block will slip and friction force will be 5 N

(iv) Acceleration of the system = $\frac{10}{6}$m/s^2

Force required for A = $\frac{20}{6}$N

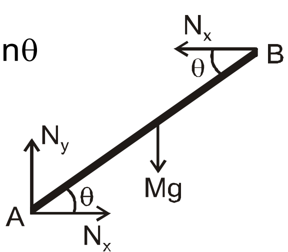
Max. friction force = 10 N

Hence A and B will move together and friction force will be $\frac{20}{6}$N.

2. The free body diagram of rod is Where N_x and N_y are horizontal and vertical components of reaction exerted by wall on rod. Net torque on rod about left end A is zero

$$\therefore \ Mg\frac{\ell}{2}\cos\theta = N_x \ell \sin\theta$$

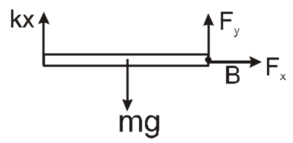
$$\Rightarrow N_x = \frac{Mg}{2\tan\theta}.$$



3. **(Easy)** Nothing is mentioned about coefficient of restitution. Hence the only true statement is 'their final velcities may be zero.'

4. (a) net torque about B = 0

$\Rightarrow$ mg . $\frac{\ell}{2}$ = kx.ℓ or x = $\frac{mg}{2k}$.



(b) For the rod to be in equilibrium net force on it = 0

$\Rightarrow$ $F_x = 0$

$kx + F_y = mg$

$\Rightarrow$ $F_y = \frac{mg}{2}$

Ans. **(a)** $\frac{mg}{2k}$ **(b)** $\frac{mg}{2}$

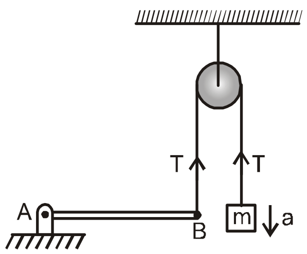
5, 6 & 7.

Let α be the angular acceleration of rod and a be acceleration of block just after its release.

$\therefore$ mg – T = ma ..... (1)

$T\ell - mg\frac{\ell}{2} = \frac{m\ell^2}{3}\alpha$ .... (2)

and $a = \ell\alpha$ .... (3)

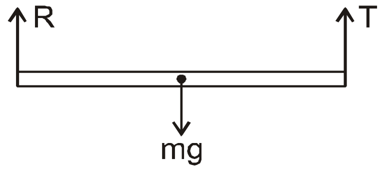


Solving we get

$T = \frac{5mg}{8}$ and $\alpha = \frac{3g}{8\ell}$

Now from free body diagram of rod, let R be the reaction by hinge on rod

$R + T - mg = m\,a_{cm} = m\,\frac{1}{2}\alpha$



Solving we get R = $\frac{9mg}{16}$

8. Ans. A – s , B – p, C – q , D – r