PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 26

Total Marks : 27

Max. Time : 29 min.

Topics : Newtons's Law of Motion, Relative Motion, Projectile Motion, Rectilinear Motion

Type of Questions		**M.M., Min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.5	**(3 marks, 3 min.)**	**[15, 15]**
Multiple choice objective ('–1' negative marking) Q.6	**(4 marks, 4 min.)**	**[4, 4]**
Subjective Questions ('–1' negative marking) Q.7 to Q.8	**(4 marks, 5 min.)**	**[8, 10]**

1. Two men of masses m and m/2 starts climbing up on two massless strings fixed at the ceiling with acceleration g and g/2 respectively. The ratio of tensions in the two strings will be :

(A) 2 : 1
(B) 4 : 1
(C) 4 : 3
(D) 8 : 3

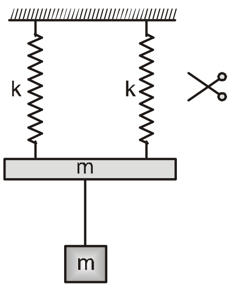
2. Two particles at a distance 5m apart, are thrown towards each other on an inclined smooth plane with equal speeds 'v' . It is known that both particle move along the same straight line. Find the value of v if they collide at the point from where the lower particle is thrown. Inclined plane is inclined at an angle of 30^0 with the horizontal. [take g = 10m/s^2]

(A) 2.5 m/sec
(B) 5 m/sec
(C) 7.5 m/sec
(D) 10 m/sec

3. A particle is projected from a point (0, 1) on Y-axis (assume + Y direction vertically upwards) aiming towards a point (4, 9). It fell on ground along x axis in 1 sec. Taking g = 10 m/s^2 and all coordinate in metres. Find the X-coordinate where it fell.

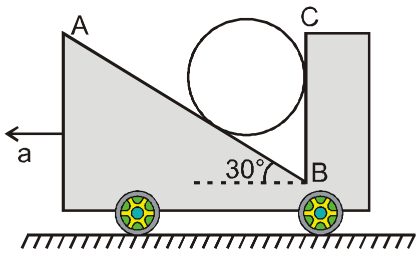
(A) (3, 0)
(B) (4, 0)
(C) (2, 0)
(D) $(2\sqrt{5}, 0)$

4. System shown in figure is in equilibrium. The magnitude of change in tension in the string just before and just after, when one of the spring is cut. Mass of both the blocks is same and equal to m and spring constant of both springs is k. (Neglect any effect of rotation)



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

5. A cylinder rests in a supporting carriage as shown. The side AB of carriage makes an angle 30° with the horizontal and side BC is vertical. The carriage lies on a fixed horizontal surface and is being pulled towards left with an horizontal acceleration '*a*'. The magnitude of normal reactions exerted by sides AB and BC of carriage on the cylinder be N_{AB} and N_{BC} respectively. Neglect friction everywhere. Then as the magnitude of acceleration '*a*' of the carriage is increased, pick up the correct statement:



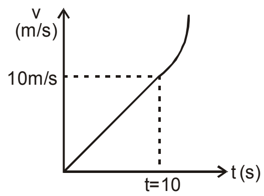
(A) N_{AB} increases and N_{BC} decreases.
(B) Both N_{AB} and N_{BC} increase.
(C) N_{AB} remains constant and N_{BC} increases.
(D) N_{AB} increases and N_{BC} remains constant.

6. A particle is moving in a straight line as :

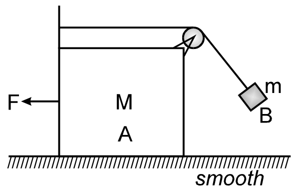
$$a = 1 \text{ m/s}^2 \qquad 0 \le t \le 10$$
$$a = 2t \qquad t > 10$$

where t is the time and a is the acceleration. If initial velocity of the particle is zero then :

(A) velocity of the particle at t = 20 sec is 310 m/s
(B) displacement of the particle in t = 20 s is 1483.33 m.
(C) acceleration the particle at t = 15 s is 32 m/s².
(D) v-t graph is



7. A force F is applied on block A of mass M so that the tension in light string also becomes F when block B of mass m acquires an equilibrium state with respect to block A. Find the force F. Give your answer in terms of m, M and g.



8. During a rainy day, rain is falling vertically with a velocity 2m/s. A boy at rest starts his motion with a constant acceleration of 2m/s² along a straight road. Find the rate at which the angle of the axis of umbrella with vertical should be changed so that the rain always falls parallel to the axis of the umbrella.

Answers Key

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1. (D) **2.** (A) **3.** (C) **4.** (A) **5.** (C)

6. (A) (B) (D) **7.** $F = \dfrac{mg}{\sqrt{1-\left(\dfrac{m}{m+M}\right)^2}}$

8. $\dfrac{d\theta}{dt} = \dfrac{1}{1+t^2}$

Hint & Solutions

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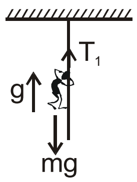
1. FBD of man of mass (m)

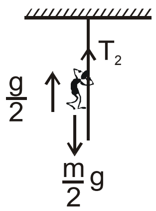


$T_1 = mg + mg$

$T_1 = 2\,mg$

$\Rightarrow\ T_1 : T_2 :: 8 : 3$

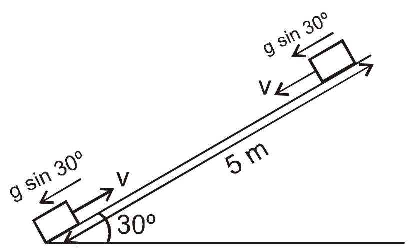
FBD of man of mass (m/2)



$T_2 = \dfrac{m}{2}g + \dfrac{m}{2}\cdot\dfrac{g}{2}$

$T_2 = \dfrac{mg}{2}\left[\dfrac{3}{2}\right] = \dfrac{3mg}{4}$

2.



Down the plane $5 = v\,.\,t + \dfrac{1}{2}(g\sin\theta)\,t^2$ ....(1)

at the plane $0 = v - g\sin\theta\, t' \Rightarrow t' = \frac{v}{g\sin\theta}$ 1

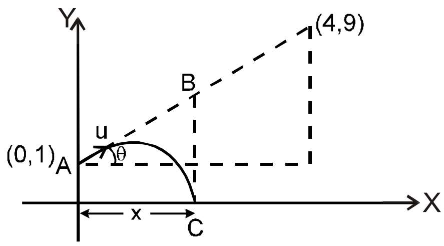
$t = 2t' = \frac{2v}{g\sin\theta}$ [time taken by B in coming back to initial position]

$$5 = \frac{2.v^2}{g\sin\theta} + \frac{1}{2}\,\frac{g\sin\theta.4v^2}{g^2\sin^2\theta}$$

$10\,g\sin\theta = 8v^2$

$$v = \sqrt{\frac{10\times10\times\left(\frac{1}{2}\right)}{8}} = \sqrt{\frac{100}{16}} = \frac{10}{4} = 2.5 \text{ m/sec}$$

3.



$\tan\theta = \frac{9-1}{4-0} = 2$,

$y = u_y t + \frac{1}{2}a_y t^2$

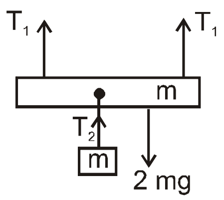
now , $-1 = u\sin\theta\,(1) - \frac{1}{2}g\,(1)^2$

$u\sin\theta = 4$ and $\sin\theta = \frac{2}{\sqrt{5}}$

$\Rightarrow u = 2\sqrt{5}$

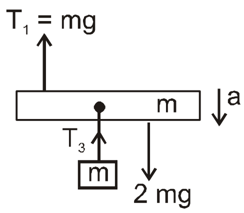
now, $x = u\cos\theta\,(1) = (2\sqrt{5}) \times \frac{1}{\sqrt{5}} = 2\text{m}$

4. Before cutting the spring



$T_2 = mg$

After cutting the spring



$2mg - mg = 2\,ma$

$a = g/2$

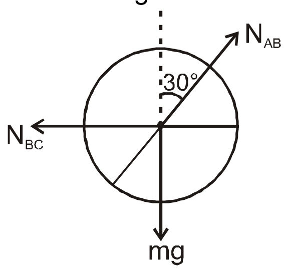
$T_3 = mg/2$

$$T_2 - T_3 = mg - \frac{mg}{2} = \frac{mg}{2}$$

5. The free body diagram of cylinder is as shown.

Since net acceleration of cylinder is horizontal,

$N_{AB}\cos 30° = mg$



or $\quad N_{AB} = \frac{2}{\sqrt{3}}\,mg \qquad \text{.... (1)}$

and $N_{BC} - N_{AB}\sin 30° = ma$

or $\quad N_{BC} = ma + N_{AB}\sin 30° \qquad \text{.... (2)}$

Hence N_{AB} remains constant and N_{BC} increases with increase in a.

6. For t = 0 to t = 10.

V = u + at

V = 0 + (1) (10) = 10 m/s.

a = 2t

$$\int_{10}^{v} dv = 2\int_{10}^{20} t\,dt \qquad \text{.... (1)}$$

$$v - 10 = 2\left|\frac{t^2}{2}\right|_{10}^{20}$$

$v - 10 = (20)^2 - (10)^2 = 300$

v = 310 m/s.

(b) For t = 0 to t = 10 s.

$$S = ut + \frac{1}{2}at^2$$

$$\Rightarrow \quad S = (0)(10) + \frac{1}{2} \times 1 \times (10)^2 = 50 \text{ m}$$

From (1)

$v - 10 = t^2 - (10)^2$

$v = t^2 - 90$

$$\int_{50}^{s} ds = \int_{10}^{20} (t^2 - 90)\,dt$$

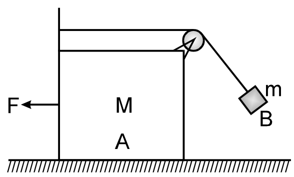
$$S - 50 = \left[\frac{(20)^3}{3} - 90 \times 20\right] - \left[\frac{(10)^3}{3} - 90 \times 10\right]$$

$$S = 50 + \frac{8000}{3} - 1800 - \frac{1000}{3} + 900$$

$$S = 50 + \frac{7000}{3} - 900$$

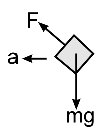
$$\Rightarrow \quad S = 1483.33 \text{ m}$$

7. A force F is applied on block A of mass M so that the tension in light string also becomes F when block B

of mass 

Applying Newton's law on the system in horizontal direction F = (M + m) a.

Now consider the equilibrium of block B w.r.t. block M

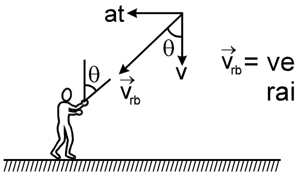


$$F^2 = (mg)^2 + (ma)^2 = (mg)^2 + \left(m\frac{F}{m+M}\right)^2$$

$$\therefore \quad F^2 = \frac{m^2g^2}{1 - \frac{m^2}{(m+M)^2}} \;;$$

$$F = \frac{mg}{\sqrt{1 - \left(\frac{m}{m+M}\right)^2}}$$

8. At any time t, rain will appear to the boy as shown in picture.



$\tan\theta = \frac{at}{v}$

Boy should hold his unbrella at an angle θ from the vertical

$\therefore \quad \tan\theta = \frac{at}{v} \qquad \sec^2\theta \frac{d\theta}{dt} = \frac{a}{v}$

$$\Rightarrow \frac{d\theta}{dt} = \frac{a}{v\sec^2\theta} = \frac{a}{v[1+\tan^2\theta]}$$

$$= \frac{a}{v\left[1+\frac{a^2t^2}{v^2}\right]} = \frac{av}{v^2+a^2t^2} = \frac{2\times 2}{4+4t^2} = \frac{1}{1+t^2}$$

$\frac{d\theta}{dt} = \frac{1}{1+t^2}$ **Ans.** $\frac{d\theta}{dt} = \frac{1}{1+t^2}$