PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 35

Total Marks : 26

Max. Time : 28 min.

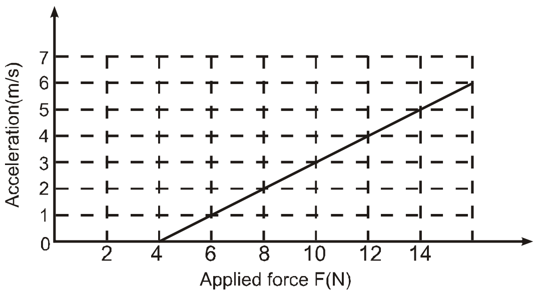
Topics : Friction, Work, Power and Energy, Newton's Law of Motion

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.5	(4 marks, 5 min.)	[8, 10]
Comprehension ('–1' negative marking) Q.6 to Q.8	(3 marks, 3 min.)	[9, 9]

1. Work done by static friction on an object:

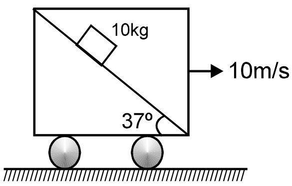
(A) may be positive
(B) must be negative
(C) must be zero
(D) none of these

2. A block of unknown mass is at rest on a rough, horizontal surface. A horizontal force F is applied to the block. The graph in the figure shows the acceleration of the block with respect to the applied force. The mass of the block is



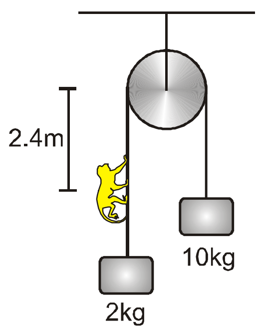
(A) 1.0 kg
(B) 0.1 kg
(C) 2.0 kg
(D) 0.2 kg

3. A block of mass 10 kg is released on a fixed wedge inside a cart which is moved with constant velocity 10 m/s towards right. Take initial velocity of block with respect to cart zero. Then work done by normal reaction (with respect to ground) on block in two second will be: ($g = 10\ m/s^2$).



(A) zero
(B) 960 J
(C) 1200 J
(D) none of these

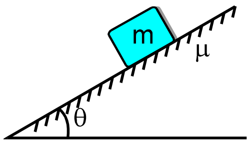
4. Two blocks of mass 10 kg and 2 kg respectively are connected by an ideal string passing over a fixed smooth pulley as shown in figure. A monkey of mass 8 kg started climbing the string with a constant acceleration of $2\ m/s^2$ with respect to string at $t = 0$. Initially the system is in equilibrium and monkey is at a distance 2.4 from the pulley. Find the time taken by monkey to reach the pulley in sec.



5. The work done by a force $\vec{F} = -5\hat{k}$ as its point of application moves from the point (1, 1, 1) to the origin is equal to _______ .

COMPREHENSION

A block of mass m is placed on a rough inclined plane. The coefficient of friction between the block and the plane is μ and the inclination of the plane is θ. Initially $\theta = 0$ and the block will remain stationary on the plane. Now the inclination θ is gradually increased. The block presses the inclined plane with a force $mg\cos\theta$. So welding strength between the block and inclined is $\mu\, mg\cos\theta$, and the pulling forces is $mg\sin\theta$. As soon as the pulling force is greater than the welding strength, the welding breaks and the block starts sliding, the angle θ for which the block starts sliding is called angle of repose (λ). During the contact, two contact forces are acting between the block and the inclined plane. The pressing reaction (Normal reaction) and the shear reaction (frictional force). The net contact force will be resultant of both.



Answer the following questions based on above comprehension :

6. If the entire system, were accelerated upward with acceleration 'a', the angle of repose, would :
(A) increase (B) decrease (C) remain same (D) increase of a > g

7. For what value of θ will the block slide on the inclined plane :
(A) $\theta > \tan^{-1}\mu$ (B) $\theta < \tan^{-1}\mu$ (C) $\theta > \cot^{-1}\mu$ (D) $\theta < \cot^{-1}\mu$

8. If $\mu = 3/4$ then what will be frictional force (shear force) acting between the block and inclined plane when $\theta = 30^0$:

(A) $\frac{3\sqrt{3}}{8}mg$ (B) $\frac{mg}{2}$ (C) $\frac{\sqrt{3}}{2}mg$ (D) zero

Answers Key

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1.	(A)	**2.**	(C)	**3.**	(B)	**4.**	2 sec.
5.	5	**6.**	(C)	**7.**	(A)	**8.**	(B)

Hint & Solutions

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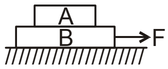
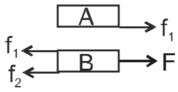
1. 

Consider the blocks shown in the figure to be moving together due to friction between them.

The free body diagrams of both the blocks is shown below.



Work done by static friction on A is positive and on B is negative.

2. From graph ; Let m be mass of block

when $a = 0$, $F = 4 = f_{max}$

when $a = 1$, $F = 6$

$\Rightarrow$ $F - f_{max} = ma$

$\Rightarrow$ $6 - 4 = m(1)$

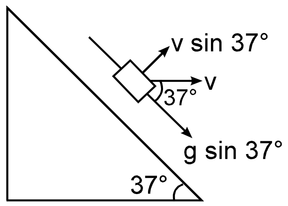
$\Rightarrow$ $m = 2kg$

3. Because the acceleration of wedge is zero, the normal reaction exerted by wedge on block is

$N = mg\cos 37°$.

The acceleration of the block is $g \sin 37°$ along the incline and initial velocity of the block is

$v = 10$ m/s horizontally towards right as shown in figure.



The component of velocity of the block normal to the incline is $v \sin 37°$. Hence the displacement of the block normal to the incline in $t = 2$ second is

$$S = v \sin 37° \times 2 = 10 \times \frac{3}{5} \times 2 = 12 \text{ m}.$$

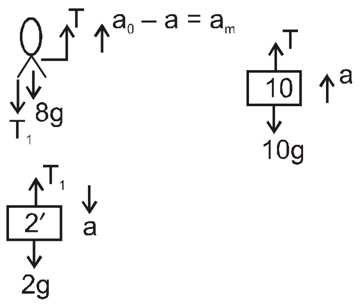
$\therefore$ The work done by normal reaction

$$W = mg\cos 37° \;\; S = 100 \times \frac{4}{5} \times 12 = 960 \text{ J}$$

4. $a_{(cm)\ left} = a_{cm\ right}$

$$\frac{8(a_0 - a) - 2a}{8 + 2} = \frac{10a}{10}$$

$$a = \frac{2}{5}a_0$$



$$a_m = a_0 - a = \frac{3}{5}a_0 = 1.2\ m/s^2$$

$$t = \sqrt{\frac{2 \times S}{a_m}} = 2\ Sec.$$

5. $W = \int_1^0 -5dz = 5J$.

6. to 8 Angle (θ')of repose ;

$m(g + a)\sin\theta' = F$

$m(g + a)\cos\theta' = R$

$\therefore \frac{F}{R} = \tan\theta'$

$\theta' = \tan^{-1}\left(\frac{F}{R}\right) = \alpha$

Hence angle of repose does not change.

7. To slide $mg\sin\theta > \mu\ mg\cos\theta$

$\sin\theta > \mu\cos\theta$

$\tan\theta > \mu$

$\theta > \tan^{-1}\mu$

8. Shear force = $\mu\ mg\cos\theta$

$$= \frac{3}{4} \times mg \times \frac{\sqrt{3}}{2} = \frac{3\sqrt{3}}{8}mg = 00.6\ mg$$

But, pulling force = $mg\sin\theta = mg\sin 30^0 = 0.5\ mg$ $< f_{smax}$. $\therefore$ block does not slide.

Hence frictional force (shear force) between the block of the plane at this situation will be

$$= mg\sin 30^0 = \frac{mg}{2}\ \left(\text{not } \frac{3\sqrt{3}}{8}mg\right)$$

Alternate Sol.

$$\tan\theta = \frac{1}{\sqrt{3}} = \frac{\sqrt{3}}{3} = \frac{1.73}{3} = 0.58 < \mu$$

$\therefore$ block does not slide. $\therefore$ $f_s = mg\sin 30^0$