PHYSICS

DPP
DAILY PRACTICE PROBLEMS

DPP No. 46

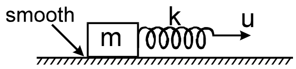
Total Marks : 28

Max. Time : 32 min.

Topics : Center of Mass, Work, Power and Energy, Friction

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.4	(3 marks, 3 min.)	[12, 12]
Subjective Questions ('–1' negative marking) Q.5 to Q.6	(4 marks, 5 min.)	[8, 10]
Match the Following (no negative marking) (2 × 4)Q.7	(8 marks, 10 min.)	[8, 10]

1. A block attached with an ideal spring is kept on a smooth horizontal surface. Now the free end of the spring is pulled with a constant velocity u horizontally. Then the maximum energy stored in the spring and block system during subsequent motion is :

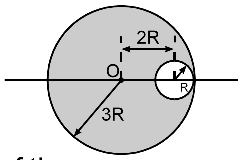


(A) $\frac{1}{2}$ mu^2 (B) mu^2 (C) 2mu^2 (D) 4 mu^2

2. A block of mass 1kg is pushed on a movable wedge of mass 2kg and height h = 30 cm with a velocity u = 6m/sec. Before striking the wedge it travels 2 m on a rough horizontal portion. Velocity is just sufficient for the block to reach the top of the wedge. Assuming all surfaces are smooth except the given horizontal part and collision of block and wedge is jerkless, the friction coefficient of the rough horizontal part is **:**

(A) 0.125 (B) 0.377 (C) 0.675 (D) 0.45

3. In the figure shown find out the distance of centre of mass of a system of a uniform circular plate of radius 3 R from O in which a hole of radius R is cut whose centre is at 2R distance from centre of large circular plate.



(A) R/4 (B) R/5 (C) R/2 (D) none of these

4. Which of the following statement is not true?

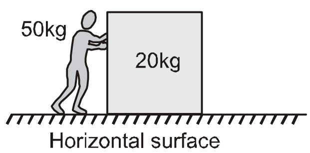
(A) Work done by conservative force on an object depends only on the initial and final states and not on thepath taken.

(B) The change in the potential energy of a system corresponding to conservative internal forces is equalto negative of the work done by these forces.

(C) If some of the internal forces within a system are non-conservative, then the mechanical energy of the system is not constant.

(D) If the internal forces are conservative, the work done by the internal forces is equal to the change in mechanical energy.

5. A boy of mass 50 kg produces an acceleration of 2m/s^2 in a block of mass 20kg by pushing it in horizontal direction. The boy moves with the block such that boy and the block have same acceleration. There is no friction between the block and fixed horizontal surface but there is friction between foot of the boy and horizontal surface. Find friction force (in Newton) exerted by the horizontal surface on the boy.



6. Four particles of mass 5, 3, 2, 4 kg are at the points (1, 6), (–1, 5), (2, –3), (–1, –4). Find the coordinates of their centre of mass.

7. Motion of particle is described in column-I. In column-II, some statements about work done by forces on the particle from ground frame is given. Match the particle's motion given in column-I with corresponding possible work done on the particle in certain time interval given in column-II.

Column-I	Column-II
(A) A particle is moving in horizontal circle	(p) work done by all the forces may be positive
(B) A particle is moving in vertical circle with uniform speed	(q) work done by all the forces may be negative
(C) A particle is moving in air (projectile motion without any air resistance) under gravity	(r) work done by all the forces must be zero
(D) A particle is attached to roof of moving train on inclined surface.	(s) work done by gravity may be positive.

Answers Key

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1. (C) **2.** (C) **3.** (A)
4. (D) **5.** 140 N. **6.** (1/7, 23/14)
7. (A) p,q (B) r, s (C) p,q,s (D) p,q,s

Hint & Solutions

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1. As ; $W_{ext} = \Delta(ME)$; ME = Mechanical energy.
Mechanical energy will keep on increasing upto the instant the W_{ext} is positive, which will happen till there is no compression in the spring. First the spring gets extended to a maximum and after which the extension decreases upto the natural length. After that there is a compression in the spring, results in a –ve external work (so as to move the end of spring at constant speed u).

Hence maximum energy stored is at the natural length.

& $ME_{max} = \frac{1}{2}mv^2$

At the natural length v = 2u, since the block is moving at this instant at a speed u with respect to the other end of the spring.

Hence $ME_{max} = \frac{1}{2}m(2u)^2 = 2mu^2$.

2. Apply work energy theorem
$\mu mg\,(2) + mgh = KE_i - KE_f$ ....(1)
at the highest point
$V_{block} = V_{wedge}$
velocity of the block after passing through the rough surface is $v = \sqrt{36 - 2\mu g(2)}$
so applying momentum conservation
$1\,(v) = (1 + 2)\,v_f$
$\Rightarrow \quad v_f = v/3$
$\Rightarrow \quad \mu = 0.675$

3. $\bar{x} = \dfrac{m_1 x_1 + (-m_2)x_2}{m_1 + (-m_2)}$

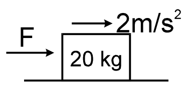
$= \dfrac{A_1 x_1 + (-A_2)x_2}{A_1 + (-A_2)}$

$A_1 = \pi\,(3R)^2$, $A_2 = \pi R^2$

$x_1 = O$, $x_2 = 2R$

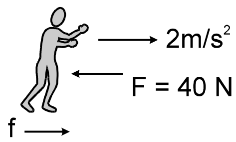
$\therefore\ \bar{x} = -R/4$

5. For Block F = 20.2 = 40 N



As boy exerts 40 N force on block, block exerts 40 N force on the boy, in opposite direction. As boy is also moving with same acceleration

$f - 40 = 50.2$



f = 140 N.

Aliter : Consider the boy + block system. The

only external force is friction acting on boy 'f'

$\therefore\ f = (M_{boy} + M_{block})a = 140$ N.

$\therefore\ f = (M_{man} + M_{block})a = 140$ N.

6. $X_{cm} = \dfrac{m_1x_1 + m_2x_2 + m_3x_3 + m_4x_4}{m_1 + m_2 + m_3 + m_4}$

$= \dfrac{5\times1 + 3\times(-1) + 2\times(2) + 4\times(-1)}{5+3+2+4} = \dfrac{2}{14} = \dfrac{1}{7}$

$Y_{cm} = \dfrac{m_1y_1 + m_2y_2 + m_3y_3 + m_4y_4}{m_1 + m_2 + m_3 + m_4}$

$= \dfrac{5\times(6) + 3\times5 + 2\times(-3) + 4\times(-4)}{5+3+2+4}$

$= \dfrac{23}{14}$

7. (A) If motion is uniform circular motion (constant speed), change in kinetic energy of particle is zero

$W_{all} = KE_2 - KE_1$

$W_{all} = 0$

If motion is non uniform circular motion then kinetic energy of particle may decrease or increase. So work done by all the forces may be positive or negative.

(B) The particle's speed is constant, so work done by all the force is zero. For vertical downward displacement, work done by gravity is positive.

(C) In projectile motion, for upward vertical displacement, speed particle decreases, so work done by all the forces will be negative. For vertical downward displacement, speed of particle increases, so work done by all the force will be positive.

(D) If the speed of train is increasing, then work done by all the forces is positive and vice versa. If train is moving downward the incline, work done by gravity on the particle is positive.