PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 43

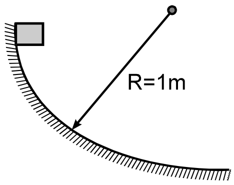
Total Marks : 35

Max. Time : 37 min.

Topic : Work, Power and Energy

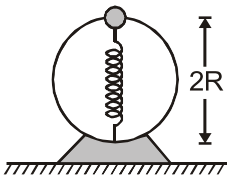
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.4	(3 marks, 3 min.)	[12, 12]
Subjective Questions ('–1' negative marking) Q.5 to Q.6	(4 marks, 5 min.)	[8, 10]
Comprehension ('–1' negative marking) Q.7 to Q.11	(3 marks, 3 min.)	[15, 15]

1. A block of mass 1 kg slides down a vertical curved track that is one quadrant of a circle of radius 1m. Its speed at the bottom is 2 m/s. The work done by frictional force is :



(A) 8 J (B) – 8 J (C) 4 J (D) – 4 J

2. A bead of mass m slides without friction on a vertical hoop of radius R. The bead moves under the combined influence of gravity and a spring of spring constant k attached to the bottom of the hoop. For simplicity assume, the equilibrium length of the spring to be zero. The bead is released at the top of the hoop with negligible speed as shown. The bead, on passing the bottom point will have a velocity of :

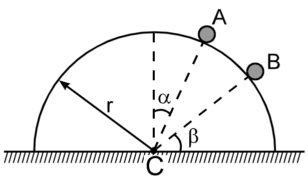


(A) $2\sqrt{gR}$ (B) $2\sqrt{gR + \frac{2kR^2}{m}}$ (C) $2\sqrt{gR + \frac{kR^2}{m}}$ (D) $\sqrt{2gR + \frac{kR^2}{m}}$

3. In a simple pendulum, the breaking strength of the string is double the weight of the bob. The bob is released from rest when the string is horizontal. The string breaks when it makes an angle θ with the vertical.

(A) $\theta = \cos^{-1}\frac{1}{3}$ (B) $\theta = 60^\circ$ (C) $\theta = \cos^{-1}\frac{2}{3}$ (D) $\theta = 0$

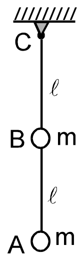
4. A particle initially at rest starts moving from point A on the surface of a fixed smooth hemisphere of radius r as shown. The particle looses its contact with hemisphere at point B. C is centre of the hemisphere. The equation relating α and β is



(A) $3\sin\alpha = 2\cos\beta$ (B) $2\sin\alpha = 3\cos\beta$
(C) $3\sin\beta = 2\cos\alpha$ (D) $2\sin\beta = 3\cos\alpha$

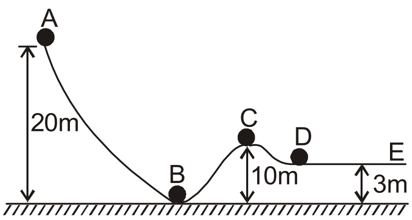
5. A heavy particle is projected from a point on the horizontal at an angle 60^0 with the horizontal with a speed of 10m/s. Then the radius of the curvature of its path at the instant of crossing the same horizontal is ________.

6. A weightless rod of length 2ℓ carries two equal masses 'm', one secured at lower end A and the other at the middle of the rod at B. The rod can rotate in vertical plane about a fixed horizontal axis passing through C. What horizontal velocity must be imparted to the mass at A so that it just completes the vertical circle.



COMPREHENSION

A smooth sphere (mass 10 kg, negligible radius) rolls on a smooth curved surface from the point A with a speed of 10 m/s as shown in figure . The sphere reaches the point D passing through point B . If the ground is taken as reference, Then [Take $g = 10\ m/s^2$]



7. The total energy of the sphere at the point A ,
(A) 2500 J (B) zero (C) 1500 J (D) 2000 J

8. The kinetic energy & the potential energy at point B ,
(A) 2500 J, 0 J (B) 0 J, 2500 J (C) 2500 J, 1500 J (D) 1500 J, 2500 J

9. The kinetic energy at C
(A) 2500 J (B) zero (C) 1500 J (D) 2000 J

10. The kinetic energy at D ,
(A) 2200 J (B) zero (C) 1500 J (D) 2000 J

11. Will the sphere go beyond D ?
(A) Yes (B) No
(C) More information is required (D) None of these

Answers Key

DPP NO. - 43

1. (B) **2.** (C) **3.** (C)

4. (C) **5.** 20 m **6.** $u = \sqrt{\frac{48}{5}g\ell}$

7. (A) **8.** (A) **9.** (C)
10. (A) **11.** (A)

Hint & Solutions

DPP NO. - 43

1. $mg1 + w_{fk} = \frac{1}{2}(1)2^2 - 0$

$w_{fk} = 2 - 10$

2. From mechanical energy conservation :

$$mg(2R) + \frac{1}{2}k(2R)^2 = \frac{1}{2}mv^2$$

$$v = 2\sqrt{gR + \frac{kR^2}{m}}.$$

3. $T = mg\cos\theta + \frac{mv^2}{r}$ ....(i)

$T = 2mg$ ....(ii)

M.E. conservation

$mgr = mgr(1 - \cos\theta) + \frac{1}{2}mv^2$ ....(iii)

From (i), (ii) & (iii) $\theta = \cos^{-1}\frac{2}{3}$ **Ans.**

4. **(C)** Let v be the speed of particle at B, just when it is about to loose contact.

From application of Newton's second law to the particle normal to the spherical surface.

$\frac{mv^2}{r} = mg\sin\beta$ .... (1)

Applying conservation of energy as the block moves from A to B..

$\frac{1}{2}mv^2 = mg(r\cos\alpha - r\sin\beta)$ .... (2)

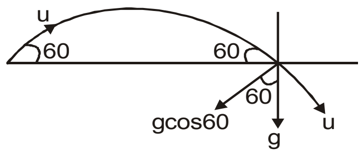
Solving 1 and 2 we get

$3\sin\beta = 2\cos\alpha$

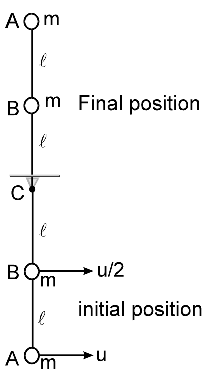
5. radial acceleration at the point of landing

$$a_n = g\cos 60 = \frac{u^2}{r}$$

$$\Rightarrow \quad r = \frac{u^2}{g\cos 60} = \frac{(10)^2}{10 \times 1/2} = 20 \text{ m}$$



6.



Let the initial velocity given to the mass at A be u.
Then the velocity of mass at B is u/2

As the system moves from initial the final position
Increase in potential energy is $= 4\,mg\ell + 2mg\ell$
Decrease in kinetic energy

$$= \frac{1}{2}mu^2 + \frac{1}{2}m\left(\frac{u}{2}\right)^2 = \frac{5}{8}mu^2$$

From conservation of energy

$$\frac{5}{8}mu^2 = 6\,mg\ell \quad \text{or} \quad u = \sqrt{\frac{48}{5}g\ell}$$

7. ME_A

$$= \frac{1}{2}Mv^2 + Mg \times 20 = \frac{1}{2} \times 10^2 \times 10 + 10 \times 20 \times 10$$

= 2500 J.

8. $ME_B = KE_B + PE_B = ME_A$
$PE_B = 0 \quad KE_B = ME_A = 2500$ J.

9. $KE_C = (ME)_A - (PE)_C = 2500 - 10 \times 10 \times 10$
= 1500 J.

10. $KE_D = (ME)_A - (PE)_D = 2500 - 10 \times 10 \times 3$
= 2200 J.