PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 74

Total Marks : 26

Max. Time : 29 min.

Topics : Newton's law of Motion, Simple Harmonic Motion, Rigid Body Dynamics, Work Power and Energy, Projectile Motion

Type of Questions		**M.M., Min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.2	**(3 marks, 3 min.)**	**[6, 6]**
Multiple choice objective ('–1' negative marking) Q.3 to Q.4	**(4 marks, 4 min.)**	**[8, 8]**
Subjective Questions ('–1' negative marking) Q.5 to Q.7	**(4 marks, 5 min.)**	**[12, 15]**

1. A man stands on a weighing machine kept inside a lift. Initially the lift is ascending with the acceleration 'a' due to which the reading is W. Now the lift decends with the same accleration and reading is 10 % of initial. Find the acceleration of lift ?

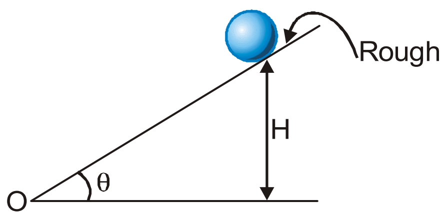
(A) $\frac{g}{19}$ m/sec^2 (B) $\frac{9g}{11}$ m/sec^2

(C) 0 m/sec^2 (D) g m/sec^2

2. A horizontal spring–block system of mass 2kg executes S.H.M. When the block is passing through its equilibrium position, an object of mass 1kg is put gently on it and the two move together. The new amplitude of vibration is (A being its initial amplitude):

(A) $\sqrt{\frac{2}{3}}A$ (B) $\sqrt{\frac{3}{2}}A$ (C) $\sqrt{2}\,A$ (D) $\frac{A}{\sqrt{2}}$

3. A solid ball of mass 'm' is released on a rough fixed inclined plane from height H. The ball will perform pure rolling on the inclined plane. Then



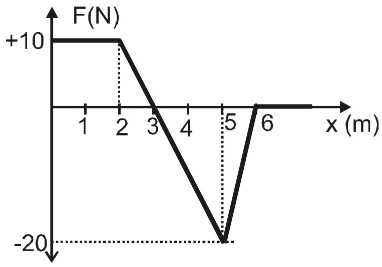
(A) Kinetic energy of the ball at O will be less than mgH.

(B) Translational kinetic energy of the ball at O will be $\frac{5mgH}{7}$

(C) Rotational kinetic energy of the ball at O will be $\frac{2mgH}{7}$

(D) Angular momentum of the ball will be conserved about a point on the inclined plane.

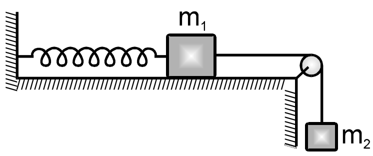
4. A particle of mass 1 kg moves from rest along a straight line due to action of a force F which varies with the displacement x as shown in graph - (Use $\frac{1}{\sqrt{2}}$ = 0.7 if needed)



(A) maximum K.E. of particle is 25 J
(B) Total work done by force on particle up to x = 6m is – 5J
(C) There will be no power delivered by the particle at x = 3, 5.3 and 6 m
(D) None of these

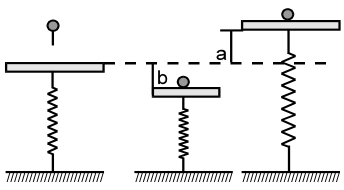
5. A particle is projected from ground with an initial velocity 20 m/sec making an angle 60° with horizontal. If R_1 and R_2 are radius of curvatures of the particle at point of projection and highest point respectively, then find the value of $\frac{R_1}{R_2}$

6. A block of mass m_1 = 1 kg is attached to a spring of force constant k = 24 N/cm at one end and attached to a string tensioned by mass m_2 = 5 kg. Deduce the frequency of oscillations of the system. If m_2 is initially supported in hand and then suddenly released, find



(a) instantaneous tension just after m_2 is released.
(b) the maximum displacement of m_1.
(c) the maximum and minimum tensions in the string during oscillations.

7. A mass M is in static equilibrium on a massless vertical spring as shown in the figure. A ball of mass m dropped from certain height sticks to the mass m after colliding with it. The oscillations they perform reach to height 'a' above the original level of spring & depth 'b' below it.



(a) Find the force constant of the spring.
(b) Find the oscillation frequency.
(c) What is the height above the initial level from which the mass m was dropped ?

Answers Key

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1. (B) **2.** (A) **3.** (B) (C) **4.** (A) (B) (C)

5. 8 **6.** (a) $\frac{10}{\pi}$ Hz (b) $\frac{25}{6}$ cm (c) $\frac{25}{3}$ N , 91.7 N.

7. **(a)** $K = \frac{2mg}{b-a}$ **; (b)** $\frac{1}{2\pi}\sqrt{\frac{k}{M+m}}$ **(c)** $\left(\frac{M+m}{b-a}\right)\frac{ab}{m}$

Hint & Solutions

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1. N = m (g + a) N′ = m (g - a)

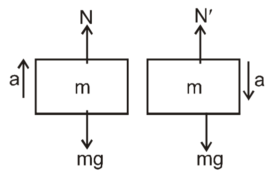
$N' = \frac{10}{100} \times N$

$m(g - a) = \frac{m(g+a)}{10}$

10g – 10a = g + a

9g = 11a

$\Rightarrow$ $a = \frac{9g}{11}$



2. Conserving momentum : 2V = 3V′

$\Rightarrow V' = \frac{2}{3}V.$

$E_i = \frac{1}{2}m_1V_1^2 = \frac{1}{2}.2.V^2 = V^2$

$\Rightarrow \frac{1}{2}KA^2 = V^2.$

$E_f = \frac{1}{2}.m_2V_2^2 = \frac{1}{2}.3.\frac{2}{3}.\frac{2}{3}V^2 = \frac{2}{3}V^2$

$\Rightarrow \frac{1}{2}KA'^2 = \frac{2}{3}V^2 = \frac{2}{3}E_i$

($\because$ $E_i = V^2$ from above)

$\Rightarrow \frac{1}{2}KA'^2 = \frac{2}{3}\left(\frac{1}{2}KA^2\right)$

$\Rightarrow A' = \sqrt{\frac{2}{3}}A$ **Ans.**

3. In pure rolling static friction acts so energy remain conserved. So kinetic energy of ball at O = mgh

$mgh = \frac{1}{2}mv^2 + \frac{1}{2} \times \frac{2}{5}mr^2\frac{v^2}{r^2}$

translational kinetic energy Rotational kinetic

$$mgh = \frac{1}{2}mv^2 + \frac{1}{5}mv^2$$

Translational kinetic energy = $\dfrac{mgh \times \frac{1}{2}}{\frac{1}{2}+\frac{1}{5}}$

$$= \frac{mgh \times \frac{1}{2}}{\frac{7}{10}} = \frac{5mgh}{7}$$

Rotational kinetic energy = $\dfrac{2mgh}{7}$

4. (A) Maximum kinetic energy at x = 3m.
(B) KE = work done = area under the curve

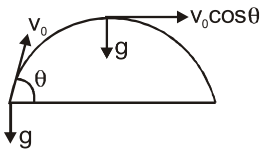
$$= 10 \times 2 + \frac{1}{2} \times 1 \times 10 = 25 \text{ J}$$

(C) w_{ret} = area under the curve

$$= 25 - \frac{1}{2} \times 3 \times 20 = -5\text{J}$$

(D) Power $P = \vec{F}.\vec{v}$

5. $R_1 = \dfrac{v_0^2}{g\cos\theta}$



$R_2 = \dfrac{(v_0 \cos\theta)^2}{g}$

$$\therefore \quad \frac{R_1}{R_2} = \frac{1}{(\cos\theta)^3} = 8$$

Ans. 8

6. $T = 2\pi\sqrt{\dfrac{m_1 + m_2}{K}}$

$$= 2\pi\sqrt{\frac{6}{2400}} = \frac{\pi}{10}$$

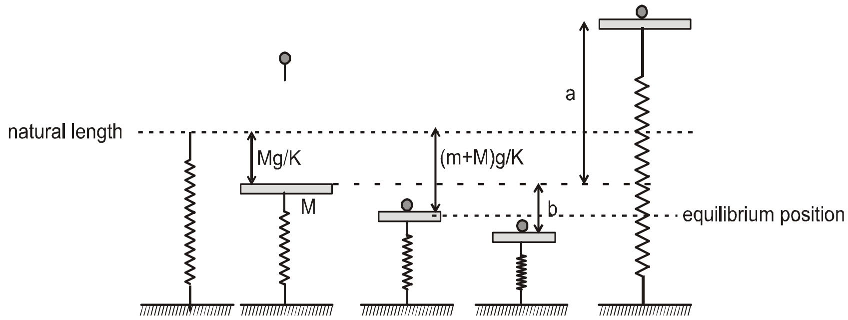
$$\Rightarrow \quad f = \frac{10}{\pi}$$

Instantaneous tension just after m_2 is released will be zero as the spring is unstressed.
Amplitude of $m_1 = m_2g/K = 25/12$ cm, hence maximum dispalcement of m_1 will be 25/6 cm.

7. **[Ans:** **(a)** $K = \dfrac{2mg}{b-a}$

(b) $\dfrac{1}{2\pi}\sqrt{\dfrac{k}{M+m}}$

(c) $\left(\frac{M+m}{b-a}\right)\frac{ab}{m}$



Amplitude = $b - \frac{mg}{K} = a + \frac{mg}{K}$ (by diagram)

$\Rightarrow$ $K = \frac{2mg}{b-a}$

(b) $f = \frac{1}{T} = \frac{1}{2\pi}\sqrt{\frac{K}{M+m}}$.

(c) If the ball was dropped from 'h'.

$\Rightarrow$ $V_{\text{before collision}} = \sqrt{2gh}$

conserving momentum :

$m\sqrt{2gh} = (m+M)V'$ Where V′

$= \omega\sqrt{A^2 - x^2} = \sqrt{\frac{K}{M+m}}.\sqrt{\left(b-\frac{mg}{K}\right)^2 - \left(\frac{mg}{K}\right)^2}$

Squaring both sides and putting

$K = \frac{2mg}{b-a}$, get $h = \left(\frac{M+m}{b-a}\right)\frac{ab}{m}$.