PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 35

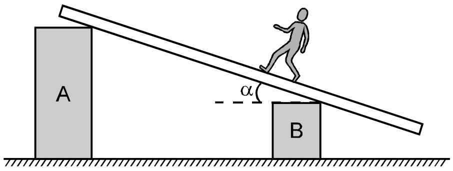
Total Marks : 30

Max. Time : 33 min.

Topics : Friction, Electrostatics, Geometrical Optics, Relative Motion, Rigid Body Dynamics, 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	(4 marks, 5 min.)	[4, 5]
Comprehension ('–1' negative marking) Q.5 to Q.7	(3 marks, 3 min.)	[9, 9]
Match the Following (no negative marking) (2 × 4) Q.8	(8 marks, 10 min.)	[8, 10]

1. A plank is held at an angle α to the horizontal (Fig.) on two fixed supports A and B. The plank can slide against the supports (without friction) because of its weight Mg. With what acceleration and in what direction, a man of mass m should move so that the plank does not move.



(A) $g \sin\alpha \left(1+\frac{m}{M}\right)$ down the incline (B) $g \sin\alpha \left(1+\frac{M}{m}\right)$ down the incline

(C) $g \sin\alpha \left(1+\frac{m}{M}\right)$ up the incline (D) $g \sin\alpha \left(1+\frac{M}{m}\right)$ up the incline

2. Two small electric dipoles each of dipole moment $p\hat{i}$ are situated at (0, 0, 0) and (r, 0, 0). The electric potential at a point $\left(\frac{r}{2}, \frac{\sqrt{3}r}{2}, 0\right)$ is :

(A) $\frac{p}{4\pi \in_0 r^2}$ (B) 0 (C) $\frac{p}{2\pi \in_0 r^2}$ (D) $\frac{p}{8\pi \in_0 r^2}$

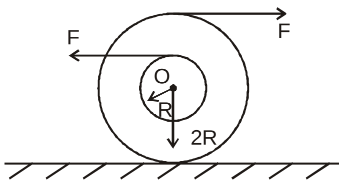
3. A mango tree is at the bank of a river and one of the branch of tree extends over the river. A tortoise lives in river. A mango falls just above the tortoise. The acceleration of the mango falling from tree appearing to the tortoise is (Refractive index of water is 4/3 and the tortoise is stationary)

(A) g (B) $\frac{3g}{4}$ (C) $\frac{4g}{3}$ (D) None of these

4. A balloon is ascending vertically with an acceleration of 0.4 m/s^{-2}. Two stones are dropped from it at an interval of 2 sec. Find the distance between them 1.5 sec. after the second stone is released. (g = 10 m/sec^2)

COMPREHENSION

In the given figure F=10N, R=1m mass of the body is 2kg and moment of inertia of the body about an axis passing through O and perpendicular to plane of body is $4 kgm^2$. O is the centre of mass of the body.



5. Find the frictional force acting on the body if it performs pure rolling.

(A) $\frac{20}{3}$ (B) $\frac{10}{3}$ (C) $\frac{5}{3}$ (D) None of these

6. The kinetic energy of the body in the above question after 3 seconds will be.
(A) 75J (B) 80J (C) 82J (D) 85J

7. If ground is smooth, then the total kinetic energy after 3 seconds will be :
(A) 105.5J (B) 112.5J (C) 115.5J (D) None of these

8. In the column-I, a system is described in each option and corresponding time period is given in the column-II. Suitably match them.

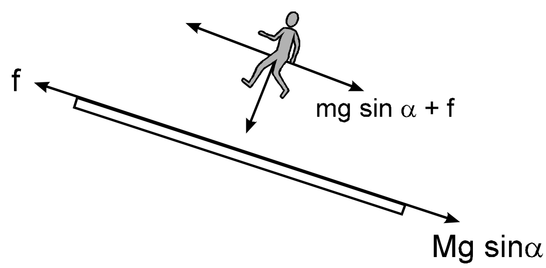
Column-I	**Column-II**
(A) A simple pendulum of length 'ℓ' oscillating with small amplitude in a lift moving down with retardation g/2.	(p) $T = 2\pi\sqrt{\frac{2\ell}{3g}}$
(B) A block attached to an end of a vertical spring, whose other end is fixed to the ceiling of a lift, stretches the spring by length 'ℓ' in equilibrium. It's time period when lift moves up with an acceleration g/2 is	(q) $T = 2\pi\sqrt{\frac{\ell}{g}}$
(C) The time period of small oscillation of a uniform rod of length 'ℓ' smoothly hinged at one end. The rod oscillates in vertical plane.	(r) $T = 2\pi\sqrt{\frac{2\ell}{g}}$
(D) A cubical block of edge 'ℓ' and specific gravity 1/2 is in equilibrium with some volume inside water filled in a large fixed container. Neglect viscous forces and surface tension. The time period of small oscillations of the block in vertical direction is	(s) $T = 2\pi\sqrt{\frac{\ell}{2g}}$

Answers Key

1. (B) **2.** (B) **3.** (C) **4.** 52 m
5. (B) **6.** (A) **7.** (B)
8. (A) p (B) q (C) p (D) s

Hints & Solutions

1. F.B.D. of man and plank are -



For plank be at rest, applying Newtons second law to plank along the incline

$Mg \sin \alpha = f$ ....(1)

and applying Newton's second law to man along the incline.

$mg \sin \alpha + f = ma$ ....(2)

$a = g \sin \alpha \left(1 + \frac{M}{m}\right)$ down the incline

Alternate Solution :

If the friction force is taken up the incline on man, then application of Newton's second law to man and plank along incline yields.

$f + Mg \sin \alpha = 0$ ....(1)

$mg \sin \alpha - f = ma$ ....(2)

Solving (1) and (2)

$a = g \sin \alpha \left(1 + \frac{M}{m}\right)$ down the incline

Alternate Solution :

Application of Newton's seconds law to system of man + plank along the incline yields

$mg \sin \alpha + Mg \sin \alpha = ma$

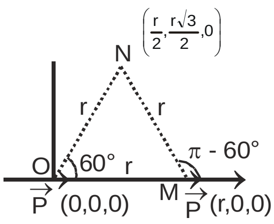
$a = g \sin \alpha \left(1 + \frac{M}{m}\right)$ down the incline

2. As ON = MN = OM = r

So it is equilateral triangle :

$\therefore$ Potential at N due to two dipoles ;

$V = V_1 + V_2$



$$= \frac{Kp\cos 60^\circ}{r^2} + \frac{Kp\cos(\pi - 60^\circ)}{r^2} = 0$$

3. $\frac{x}{1} = \frac{x_{rel}}{\mu}$ $\quad x_{rel} = \mu x$

$$\frac{d^2x_{rel}}{dt^2} = \mu\frac{d^2x}{dt^2}$$

$a_{rel} = \mu g$

4. At position A balloon drops first particle

So, $u_A = 0$, $a_A = -g$, $t = 3.5$ sec.

$S_A = \left(\frac{1}{2}gt^2\right)$ ....(i)

Balloon is going upward from A to B in 2 sec.so distance travelled by balloon in 2 second.

$\left(S_B = \frac{1}{2}a_Bt^2\right)$ ....(ii)

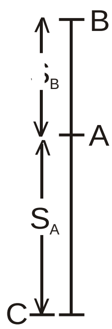
$a_B = 0.4\ m/s^2$, $t = 2$ sec.

$S_1 = BC = (SB + SA)$ ....(iii)

Distance travell by second stone which is droped from balloon at B

$u_2 = u_B = a_Bt = 0.4 \times 2 = 0.8$ m/s

t = 1.5 sec.

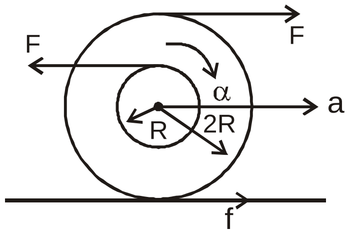


$\left(S_2 = u_2t - \frac{1}{2}gt^2\right)$ ....(iv)

Distance between two stone

$\Delta S = S_1 - S_2$.

5.



$f = ma$ ...(i)

$F2R - FR - fR = I\alpha$ ...(ii)

$a = Ra$ ...(iii)

$$FR - fR = I.\frac{a}{R}$$

$$F - ma = \frac{Ia}{R^2}$$

$$F = \left(m + \frac{I}{R^2}\right)a.$$

$$a = \frac{F}{m + I/R^2}$$

$$f = ma = \frac{mF}{m + \frac{I}{R^2}}$$

$$f = \frac{mF}{m + \frac{I}{R^2}}$$

$$f = \frac{10}{3}\text{ N}$$

6. $a = \dfrac{F}{m + \frac{I}{R^2}} = \dfrac{5}{3}$

$$\alpha = \frac{a}{2} = \frac{5}{6}$$

$$v = 0 + \frac{5}{6} \times 3 = \frac{5}{2}$$

$$\omega = \omega_o + \alpha\, t = 0 + \frac{5}{3} \times 3 = 5$$

$$KE = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$$= \frac{1}{2} \times 2 \times 5 \times 5 + \frac{1}{2} \times 4 \times \frac{5}{2} \times \frac{5}{2}$$

$$= 25 + \frac{25}{2} = \frac{75}{2}\text{ J}$$

7. $F2R - FR = I\alpha$

$$\alpha = \frac{FR}{I}$$

$$\omega = 0 + \left(\frac{FR}{I}\right)t$$

$$KE = \frac{1}{2}Iw^2$$

$$= \frac{1}{2}\times I\left(\frac{F^2R^2}{I^2}\right)t^2$$

$$= \frac{F^2R^2}{2I} = \frac{100\times1\times3\times3}{2\times4} = \frac{25\times9}{2} = 112.5\text{ J.}$$

8. (A) p (B) q (C) p (D) s

(A) In frame of lift effective acceleration due to gravity is $g + \frac{g}{2} = \frac{3g}{2}$ downwards

$$\therefore T = 2\pi\sqrt{\frac{2\ell}{3g}}$$

(B) $K\ell = mg$ $\quad \therefore \frac{k}{m} = \frac{g}{L}$

constant acceleration of lift has no effect in time period of oscillation.

$$\therefore T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{\ell}{g}}$$

(C) $T = 2\pi\sqrt{\frac{I}{mgd}} = 2\pi\sqrt{\frac{\frac{m\ell^2}{3}}{mg\frac{\ell}{2}}} = 2\pi\sqrt{\frac{2\ell}{3g}}$

(D) $T = 2\pi\sqrt{\frac{m}{\rho Ag}} = 2\pi\sqrt{\frac{\rho/2A\ell}{\rho Ag}} = 2\pi\sqrt{\frac{\ell}{2g}}$