PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 15

Total Marks : 34

Max. Time : 36 min.

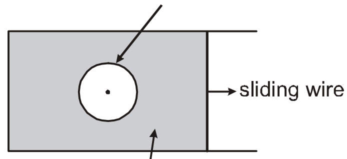
Topics : Electrostatics, Surface Tension, Friction, Simple Harmonic Motino, Thermal Expansion, Work, Power and Energy , Rigid Body Dynamics , Geometrical Optics

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.3	(3 marks, 3 min.)	[9, 9]
Multiple choice objective ('–1' negative marking) Q.4 to Q.5	(4 marks, 4 min.)	[8, 8]
Subjective Questions ('–1' negative marking) Q.6 to Q.7	(4 marks, 5 min.)	[8, 10]
Comprehension ('–1' negative marking) Q.8 to Q.10	(3 marks, 3 min.)	[9, 9]

1. A point charge + Q is placed at the centroid of an equilateral triangle. When a second charge + Q is placed at a vertex of the triangle, the magnitude of the electrostatic force on the central charge is 8 N. The magnitude of the net force on the central charge when a third charge + Q is placed at another vertex of the triangle is:

(A) zero (B) 4 N (C) $4\sqrt{2}$ N (D) 8 N

2. The figure shows a soap film in which a closed elastic thread is lying. The film inside the thread is pricked. Now the sliding wire is moved out so that the surface area increases. The radius of the circle formed by elastic thread will



(A) increase (B) decrease
(C) remain same (D) data insufficient

3. A block of mass M rests on a rough horizontal surface. The co-efficient of friction between the block and the surface is μ. A force F = M g acting at angle θ with the vertical side of the block pulls it. In which of the following cases, the block can be pulled along the surface?

(A) $\tan\theta \geq \mu$ (B) $\cot\theta \geq \mu$ (C) $\cot(\theta/2) \geq \mu$ (D) none

4. A particle is executing SHM between points $-X_m$ and X_m, as shown in figure-I. The velocity V(t) of the particle is partially graphed and shown in figure-II. Two points A and B corresponding to time t_1 and time t_2 respectively are marked on the V(t) curve.

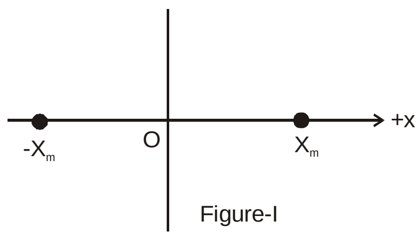


Figure-I

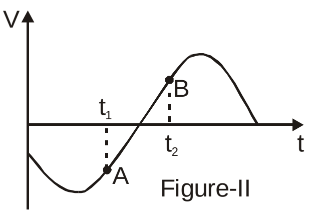
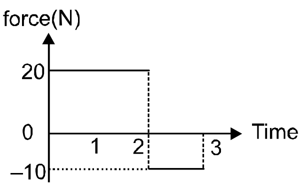


Figure-II

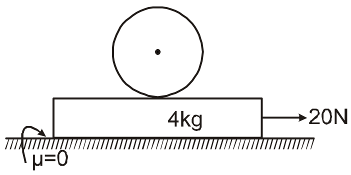
(A) At time t_1 , it is going towards X_m.
(B) At time t_1, its speed is decreasing.
(C) At time t_2, its position lies in between $-X_m$ and O.
(D) The phase difference $\Delta\phi$ between points A and B must be expressed as $90° < \Delta\phi < 180°$.

5. When the temperature of a copper coin is raised by 80 °C, its diameter increases by 0.2%,
(A) percentage rise in the area of a face is 0.4%
(B) percentage rise in the thickness is 0.4%
(C) percentage rise in the volume is 0.6%
(D) coefficient of linear expansion of copper is 0.25×10^{-4} / °C.

6. Starting at rest, a 5 kg object is acted upon by only one force as indicated in figure. Find the total work done by the force.

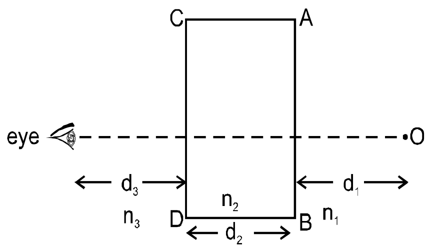


7. A 2 kg uniform cylinder is placed on a plank of mass 4 kg which in turn rests on a smooth horizontal plane. A constant horizontal force of 20 N is applied on the plank. If no slipping occurs between cylinder and plank obtain the acceleration of the cylinder and the plank.



COMPREHENSION

There is a slab of refractive index n_2 placed as shown. Medium on two side are n_1 and n_3. Width of slab is d_2. An object is placed at distance d_1 from surface AB and observer is at distance d_3 from surface CD. Given n_1 = air [ref. index = 1] and n_2 is glass
[ref. index = 3/2], d_1 = 12 cm and d_2 = 9cm, d_3 = 4cm.



8. If object starts to move with speed of 12cm/sec towards the slab then find the speed of image as seen by observer [given n_3 = air = (ref. index = 1)]

(A) 8 cm/sec (B) 180 cm/sec (C) 12 cm/sec (D) none of these

9. If $n_3 = \frac{4}{3}$ then distance of image of object seen by observer is :

(A) 25 cm (B) 30 cm (C) 28 cm (D) none of these

10. If $n_3 = \frac{4}{3}$ and object start to move towards the slab with speed of 12 cm/sec then speed of image is :

(A) 16 cm/sec (B) 9 cm/sec (C) 12 cm/sec (D) none of these

Answers Key

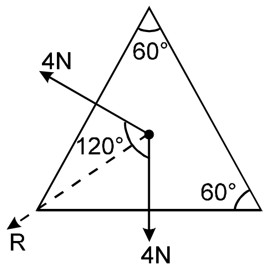
1.	(D)	**2.**	(C)	**3.**	(C)
4.	(B), (C)	**5.**	(A), (C), (D)	**6.**	90 J

7. $a_1 = \frac{10}{7}$ m/s^2, $a_2 = \frac{30}{7}$ m/s^2

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

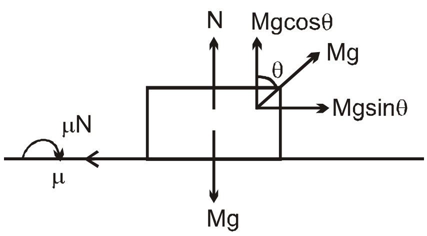
Hints & Solutions

1. $R = \sqrt{4^2 + 4^2 + 2.44\cos 120^\circ} = 4N$



2. The force exerted by film on wire or thread depends only on the nature of material of the film and not on its surface area. Hence the radius of circle formed by elastic thread does not change.

3. $N = Mg(1 - \cos\theta)$



$Mg\sin\theta > \mu Mg(1 - \cos\theta)$

4. At time t_1, velocity of the particle is negative i.e. going towards $-X_m$. From the graph, at time t_1, its speed is decreasing. Therefore particle lies in between $-X_m$ and 0.
At time t_2, velocity is positive and its magnitude is less than maximum i.e. it has yet not crossed O. It lies in between $-X_m$ and 0.
Phase of particle at time t_1 is $(180 + \theta_1)$.
Phase of particle at time t_2 is $(270 + \theta_2)$
Phase difference is $90 + (\theta_2 - \theta_1)$
$\theta_2 - \theta_1$ can be negative making $\Delta\phi < 90^\circ$ but can not be more than 90°.

5. $\frac{\Delta A}{A} \times 100$

$= \quad 2\left(\frac{\Delta \ell}{A}\right) \times 100$

$\Rightarrow$ % increase in Area
$= 2 \times 0.2 = 0.4$

$\frac{\Delta V}{V} \times 100 = 3 \times 0.2 = 0.6$ %

Since $\Delta\ell = \ell\ \alpha\ \Delta T$

$\frac{\Delta \ell}{\ell} \times 100$

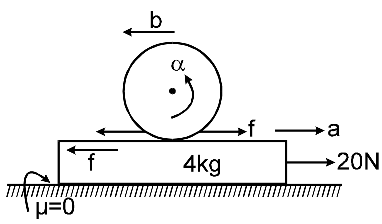
$= \alpha\, \Delta T \times 100$
$= 0.2$
$\Rightarrow \alpha = 0.25 \times 10^{-4}$ / ºC

6. Change in velocity = $\frac{\text{area under F} - \text{T graph}}{\text{mass}}$

$= \frac{40 + (-10)}{5} = 6$ m/s

$W_F = \Delta K.E. = \frac{1}{2}(5)\ 6^2 = 90$ J

7. Suppose acceleration of cylinder wrt plank is 'b' wrt plank.



As there's no slipping b = Rα ....(1)
Equation of Rotation motion f. R = Iα.

$\Rightarrow f = \frac{M_C R^2}{2.R} \cdot \frac{b}{R} = \frac{M_C b}{2}$ ....(2)

Linear motion of cylinder

$f = M_C\,(a - b)$ ....(3)

for plank

$20 - f = 4.a$ ......(4)

putting $M_C = 2kg$

$f = b \quad 2f = 2\,(a - b)$

$$\Rightarrow \quad f = \frac{2a}{3}$$

using in (4) $20 - \dfrac{2a}{3} = 4a$

$$\Rightarrow \quad a = \frac{30}{7}\ m/s^2$$

and $b = \dfrac{20}{7}\ m/s^2$

Acceleration of cylinder $= a - b = \dfrac{10}{7}\ m/s^2$

[Ans.: $a_1 = \dfrac{10}{7}$ m/s², $a_2 = \dfrac{30}{7}$ m/s²]

8. Apperent distance

$$(t) = \frac{d_1}{n_1/n_3} + \frac{d_2}{n_2/n_3} + d_3$$

but $n_1 = n_3 = 1$ & $n_2 = 3/2$

$$d = \frac{d_1}{1} + \frac{d_2}{3/2} + d_3$$

but d_2 and d_3 are constant when only object is moving.

So $d' = d'_1 + 0 + 0 \Rightarrow v_I = v_0 = 12$ cm/sec.

9. $$d' = \frac{d_1}{n_1/n_3} + \frac{d_2}{n_2/n_3} + d_3$$

$$= \frac{12}{1/4/3} + \frac{9}{3/2/4/3} + \frac{4}{1}$$

$$= 12 \times \frac{4}{3} + \frac{8}{1} + 4$$

$= 16 + 8 + 4$

$= 28$ cm.

10. $$d' = \frac{d_1}{1/4/3} + \frac{d_2}{9/8} + d_3$$

$$v' = \frac{4v_1}{3} + 0 + 0$$

$$v' = \frac{4}{3} \times 12 = 16 \text{ cm/sec.}$$