PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 14

Total Marks : 34

Max. Time : 36 min.

Topics : Rigid Body Dynamics, Geometrical Optics, Simple Harmonic Motion, Work, Power and Energy , Electrostatics, Fluid

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.4	(3 marks, 3 min.)	[12, 12]
Multiple choice objective ('–1' negative marking) Q.5 to Q.6	(4 marks, 4 min.)	[8, 8]
Subjective Questions ('–1' negative marking) Q.7 to Q.8	(4 marks, 5 min.)	[8, 10]
Comprehension ('–1' negative marking) Q.9 to Q.10	(3 marks, 3 min.)	[6, 6]

1. A circular platform is mounted on a frictionless vertical axle. Its radius R = 2m and its moment of inertia about the axle is 200 kgm^2. it is initially at rest. A 50 kg man stands on the edge of the platform and begins to walk along the edge at the speed of $1ms^{-1}$ relative to the ground. Time taken by the man to complete one revolution with respect to disc is :

(A) πs (B) $\frac{3\pi}{2}$s (C) 2πs (D) $\frac{\pi}{2}$s

2. For the angle of minimum deviation of a prism to be equal to its refracting angle, the prism must be made of a material whose refractive index :

(A) lies between $\sqrt{2}$ and 1 (B) lies between 2 and $\sqrt{2}$

(C) is less than 1 (D) is greater than 2

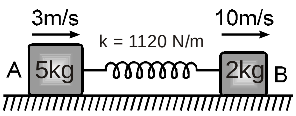
3. The potential energy of a particle executing SHM changes from maximum to minimum in 5 s. Then the time period of SHM is :

(A) 5 s (B) 10 s (C) 15 s (D) 20 s

4. A force $\vec{F} = (3\hat{i} + 4\hat{j})N$ acts on a 2 kg movable object that moves from an initial position $\vec{d}_i = (-3\hat{i} - 2\hat{j})m$ to a final position $\vec{d}_f = (5\hat{i} + 4\hat{j})m$ in 6 s. The average power delivered by the force during the interval is equal to :

(A) 8 watt (B) $\frac{50}{6}$ watt (C) 15 watt (D) $\frac{50}{3}$watt.

5. Two blocks A (5kg) and B(2kg) attached to the ends of a spring constant 1120N/m are placed on a smooth horizontal plane with the spring undeformed. Simultaneously velocities of 3m/s and 10m/s along the line of the spring in the same direction are imparted to A and B then



(A) when the extension of the spring is maximum the velocities of A and B are zero.

(B) the maximum extension of the spring is 25cm.

(C) the first maximum compression occurs $3\pi/56$ seconds after start.

(D) maximum extension and maximum compression occur alternately.

6. Two free point charges +q and +4q are placed a distance x apart. A third charge is so placed that all the three charges are in equilibrium. Then

(A) unknown charge is -4q/9

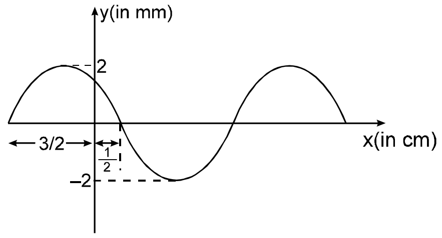
(B) unknown charge is -9q/4

(C) It should be at (x/3) from smaller charge between them

(D) It should be placed at (2x/3) from smaller charge between them.

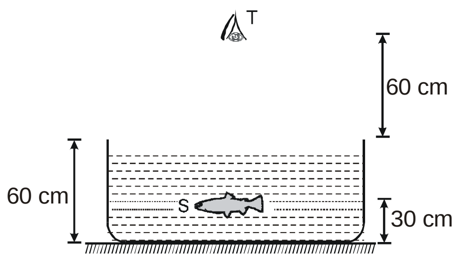
7. A fixed container of height 'H' with large cross-sectional area 'A' is completely filled with water. Two small orifice of cross-sectional area 'a' are made, one at the bottom and the other on the vertical side of the container at a distance H/2 from the top of the container. Find the time taken by the water level to reach a height of H/2 from the bottom of the container.

8. A standing wave pattern of maximum amplitude 2mm is obtained in a string whose shape at t = 0 is represented in the graph. If the speed of the travelling wave in the string is 5 cm/s then find the component waves.



COMPREHENSION

Consider the situation in figure. The bottom of the pot is a reflecting plane mirror, S is a small fish and T is a human eye. Refractive index of water is 4/3.



9. At what distance from itself will the fish see the image of the eye in upward direction?
(A) 35 cm (B) 45 cm (C) 55 cm (D) 110 cm

10. At what distance from itself will the fish see the image of the eye in downward direction?
(A) 90 cm (B) 110 cm (C) 170 cm (D) 180 cm

Answers Key

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

5. (B), (C), (D) **6.** (A), (C)

7. $t = \frac{2A}{3a}\left(\sqrt{2}-1\right)\sqrt{\frac{H}{g}}$

8. $\sin\left(\frac{\pi}{2}x + \frac{3\pi}{4} + \frac{5\pi}{2}t\right) + \sin\left(\frac{\pi}{2}x + \frac{3\pi}{4} - \frac{5\pi}{2}t\right)$

9. (D) **10.** (C)

Hints & Solutions

1. using angular momentum conservation

$L_i = 0$

$L_t = mvR - I\omega$

$mvR = I.\omega$

$\omega = \left(\frac{1}{2}\right)$ $(v + \omega R)t = 2\pi R$

$\left(1+\frac{1}{2}\times 2\right) = 2\pi\times 2$ $t = 2\pi$ sec.

2. $\delta_{min} = i + e - A$

$\delta_{min} =$ A then

$2A = i + e$ in case of δ_{min} $i = e$

$2A = 2i$ $r_1 = r_2 = \frac{A}{2}$

$i = A = 90°$

then $1 \sin i = n \sin r_1$

$\sin A = n \sin \frac{A}{2}$

$2 \sin\frac{A}{2} \cos\frac{A}{2} = n \sin\frac{A}{2}$

$2\cos\frac{A}{2} = n$

when $A = 90° = i_{max}$

then $n_{min} = \sqrt{2}$

$i = A = 0$ $n_{max} = 2$

3. P.E. is maximum at extreme position and minimum at mean position.
Time to go from extreme position to mean position

is, $t = \frac{T}{4}$; where T is time period of SHM

$5\text{ s} = \frac{T}{4}$

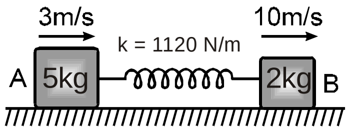
$\Rightarrow$ T = 20 s.

4. $\vec{d} = \vec{d}_f - \vec{d}_i = 8\hat{i} + 6\hat{j}$

$W = \vec{F}.\vec{d} = 24 + 24 = 48\text{ J}$

$P_{av} = \frac{W}{t} = 8\text{ Watt}$

5. At max. extension both should move with equal velocity.



$\therefore$ By momentum conservation,
(5 × 3) + (2 × 10) = (5 + 2)V
V = 5 m/sec.
Now, by energy conservation

$$\frac{1}{2}5 \times 3^2 + \frac{1}{2} \times 2 \times 10^2 = \frac{1}{2}(5+2)V^2 + \frac{1}{2}kx^2$$

Put V and k

$\therefore\ x_{max} = \frac{1}{4}\text{m} = 25\text{ cm.}$

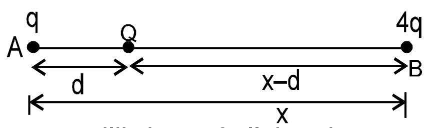
Also first maximum compression occurs at ;

$$t = \frac{3T}{4} = \frac{3}{4}2\pi\sqrt{\frac{\mu}{k}}$$

$$= \frac{3}{4}2\pi\sqrt{\frac{10}{7 \times 1120}} = \frac{3\pi}{56}\text{ sec.}$$

(where $\mu \Rightarrow$ reduced mass, $\mu = \frac{m_1 m_2}{m_1 + m_2}$)

6.



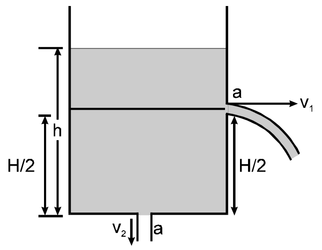
For equilibrium of all the changes net force on each charge should be zero.

$\Rightarrow \frac{KqQ}{d^2} - \frac{4KqQ}{(x-d)^2} = 0$ (Net force on Q)

$\Rightarrow$ d = x/3

& $\frac{KqQ}{d^2} + \frac{4Kq^2}{x^2} = 0$ (Net force on A)

7.



$$v_1 = \sqrt{2g\,(h - H/2)}$$

$$v_2 = \sqrt{2gh}$$

$\therefore$ By continuity equation

$$A\left(-\frac{dh}{dt}\right) = a\,(v_1 + v_2)$$

$$\Rightarrow A\left(-\frac{dh}{dt}\right) = a\,\left\{\sqrt{2g\,(h - H/2)} + \sqrt{2gh}\right\}$$

$$\text{or } -\frac{A}{a\sqrt{2g}}\int_{H}^{H/2}\frac{dh}{\sqrt{h} + \sqrt{h - H/2}} = \int_0^t dt$$

$$\Rightarrow\ t = \frac{2A}{3a}\left(\sqrt{2} - 1\right)\sqrt{\frac{H}{g}}$$ **Ans.**

8. Equation of standing wave can be written as
$Y = 2\sin(kx + \theta)\cos\omega t$
because the particles at $t = 0$ are at extreme position.

$$k = \frac{2\pi}{\lambda} = \frac{2\pi}{4} = \frac{\pi}{2}$$

From the graph it is clear that $x = \frac{1}{2}$,

Amplitude $= 0$

$$\therefore\ 2\sin\left[\frac{\pi}{2}\cdot\frac{1}{2} + \theta\right] = 0 \Rightarrow \frac{\pi}{4} + \theta = 0 \text{ or } \pi.$$

we will select $\frac{\pi}{4} + \theta = \pi$ to suit the initial condition

$$\therefore\ \theta = \frac{3\pi}{4}$$

$$\therefore\ y = 2\sin\left(\frac{\pi}{2}x + \frac{3\pi}{4}\right)\cos\frac{5\pi}{2}t$$

$$= \sin\left(\frac{\pi}{2}x + \frac{3\pi}{4} + \frac{5\pi}{2}t\right)$$

$$+ \sin\left(\frac{\pi}{2}x + \frac{3\pi}{4} - \frac{5\pi}{2}t\right)$$

9. Distance of image of eye from fish in upward direction

$$d = \frac{d}{n_{rel}} + 30 = \frac{60}{\left(\frac{1}{4/3}\right)} = 60 \times \frac{4}{3} + 30$$

= 110 cm

10. Distance of first image of eye from the refraction at water surface

$$v = \frac{60}{\left(\frac{1}{4/3}\right)} = 80$$

Distance of image of eye from mirror due to refraction = 80 + 60 = 140

Distance of second image in downward direction from mirror = 140 cm

Distance of second image from fish in downward direction = 140 + 30 = 170 cm