PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 13

Total Marks : 35

Max. Time : 36 min.

Topics : Rigid Body Dynamics, Geometrical Optics, Simple Harmonic Motion, Center of Mass

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.6	(3 marks, 3 min.)	[18, 18]
Multiple choice objective ('–1' negative marking) Q.7	(4 marks, 4 min.)	[4, 4]
Subjective Questions ('–1' negative marking) Q.8	(4 marks, 5 min.)	[4, 5]
Comprehension ('–1' negative marking) Q.9 to Q.11	(3 marks, 3 min.)	[9, 9]

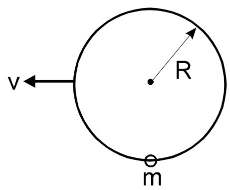
1. A car is initially at rest, 330 m away from a stationary observer. It begins to move towards the observer with an acceleration of 1.1 m/s^2, sounding its horn continuously. 20 second later, the driver stops sounding the horn. The velocity of sound in air is 330 m/s. The observer will hear the sound of the horn for a duration of:

(A) 20 sec (B) 21 sec (C) 62/3 sec (D) 58/3 sec

2. A point moves in a straight line under the retardation a v^2 , where 'a' is a positive constant and v is speed. If the initial speed is u , the distance covered in ' t ' seconds is :

(A) a u t (B) $\frac{1}{a}$ ln (a u t) (C) $\frac{1}{a}$ ln (1 + a u t) (D) a ln (a u t)

3. A ring of radius R lies in vertical plane. A bead of mass 'm' can move along the ring without friction. Initially the bead is at rest at the bottom most point on ring. The minimum constant horizontal speed v with which the ring must be pulled such that the bead completes the vertical circle

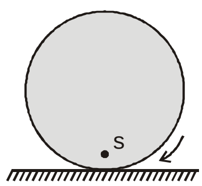


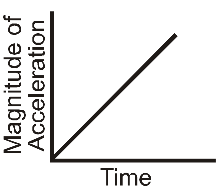
(A) $\sqrt{3gR}$ (B) $\sqrt{4gR}$ (C) $\sqrt{5gR}$ (D) $\sqrt{5.5\,gR}$

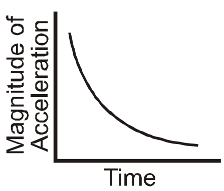
4. Minimum number of prisms required to make a combination which is 'Achromatic' as well as 'Direct Vision' is:

(A) 2 (B) 3 (C) 4 (D) 11

5. As shown in figure, S is a point on a uniform disc rolling with uniform angular velocity on a fixed rough horizontal surface. The only forces acting on the disc are its weight and contact forces exerted by horizontal surface. Which graph best represents the magnitude of the acceleration of point S as a function of time



(A)


(B)


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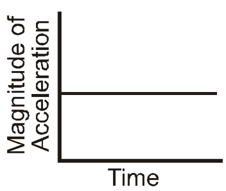
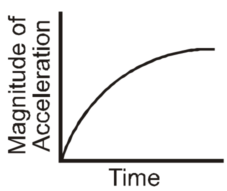


(D)


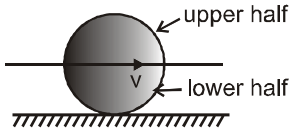
6. Consider a uniform disc of mass 'm' performing pure rolling with velocity 'v' on a fixed rough surface

(A) Kinetic energy of upper half will be $\frac{3}{8}$ mv^2

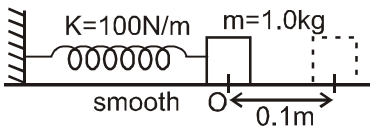
(B) Kinetic energy of upper half will be less than $\frac{3}{8}$ mv^2

(C) Kinetic energy of upper half will be more than $\frac{3}{8}$ mv^2

(D) Kinetic energy of upper half will be more than $\frac{3}{4}$ mv^2



7. A block of mass m = 1 kg is placed on a smooth surface and is connected with a spring of spring constant k = 100 N/m and another end of spring is connected to a fixed wall as shown. The block is pulled by a distance A = 0.10 m from its natural length and released at t = 0.



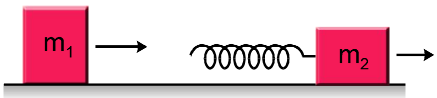
(A) The maximum speed is after t = $\frac{\pi}{20}$s.

(B) Time taken to cover first 0.10 m, t = $\frac{\pi}{20}$s.

(C) Time taken to cover first 0.05 m, t = $\frac{\pi}{40}$s.

(D) Time taken to cover first 0.05 m, t = $\frac{\pi}{30}$s.

8. A block of mass m_1 = 2 kg slides on a frictionless table with speed of 10 m/s. In front of it, another block of mass m_2 = 5 kg is moving with speed 3 m/s in the same direction. A massless spring of spring constant k = 1120 N/m is attached on the backside of m_2 as shown. Find the maximum compression of the spring in cm when the block of mass m_1 in contect with spring. (Take g = 10 m/s^2)



COMPREHENSION

Magnification (by a lens) of an object at distance 10 cm from it is – 2. Now a second lens is placed exactly at the same position where first was kept and first lens is removed. The magnification by this lens is – 3.

9. Find position of image formed by combination of both in contact. (relative to combination) :

(A) $\frac{60}{9}$ cm (B) $\frac{60}{11}$ cm (C) $\frac{60}{13}$ cm (D) $\frac{60}{17}$ cm

10. What is the focal length of the combination when both lenses are in contact :

(A) $\frac{60}{17}$ cm (B) $\frac{5}{17}$ cm (C) $\frac{12}{7}$ (D) $\frac{13}{9}$ cm

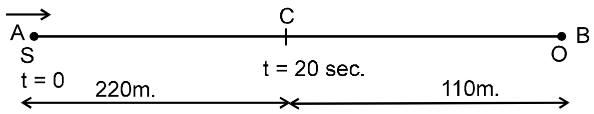
11. When both the lenses are kept in contact at the same place, what will be the new magnification :

(A) $\frac{-13}{5}$ (B) $\frac{-12}{7}$ (C) $\frac{-6}{11}$ (D) $\frac{-5}{7}$

Answers Key

1.	(D)	**2.**	(C)	**3.**	(B)	**4.**	(A)
5.	(C)	**6.**	(C)	**7.**	(A), (B), (D)		
8.	25 cm.	**9.**	(B)	**10.**	(A)	**11.**	(C)

Hints & Solutions

1. 

In 20 seconds , distance travelled by the Source is :

$S = \frac{1}{2}(1.1)(20)^2 = 220$ m.

Let, t = 0 be the starting time.

The sound wave started at t = 0 from 'A' reaches the observer at 'B' after $\left(\frac{330}{330}\right)$ = 1sec. ie. observer started hearing the sound at t = 1 sec. At t = 20 sec. the source reaches at 'C' 220 m from 'A'.

The last sound wave starting from 'C' reaches 'B' afrer $\left(\frac{110}{330}\right) = \frac{1}{3}$ sec < 1 sec.

Hence , the observer do not hear the sound for whole 20 sec.

but for:

$T = \left(19 + \frac{1}{3}\right)$ sec $= \frac{58}{3}$ sec.

2. The retardation is given by

$$\frac{dv}{dt} = -av^2$$

integrating between proper limits

$$\Rightarrow \; -\int_u^v \frac{dv}{v^2} = \int_0^t a\,dt$$

or $\frac{1}{v} = at + \frac{1}{u}$

$\Rightarrow \quad \frac{dt}{dx} = at + \frac{1}{u}$

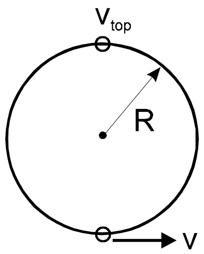
$\Rightarrow \quad dx = \frac{u\ dt}{1+aut}$

integrating between proper limits

$$\Rightarrow \quad \int_0^s dx = \int_0^t \frac{u\,dt}{1+aut}$$

$$\Rightarrow \quad S = \frac{1}{a}\ \ell n\ (1 + aut)$$

3. In the frame of ring (inertial w.r.t. earth), the initial velocity of the bead is v at the lowest position.



The condition for bead to complete the vertical circle is, its speed at top position

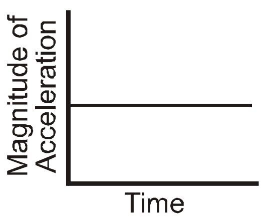
$v_{top} \geq 0$

From conservation of energy

$$\frac{1}{2}\ m\ \ v_{top}^2\ + mg\ (2R) = \frac{1}{2}\, mv^2$$

or $\quad v = \sqrt{4gR}$

5. Since angular velocity is constant, acceleration of centre of mass of disc is zero. Hence the magnitude of acceleration of point S is $\omega^2 x$ where ω is angular speed of disc and x is the distance of S from centre. Therefore the graph is



6. T.K.E. of disc **[M.Bank_Rotation_7.120]**

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

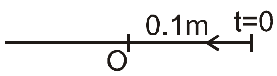
$$= \frac{1}{2}mv^2 + \frac{1}{2} \times \frac{mr^2}{2} \times \left(\frac{v}{r}\right)^2$$

$$= \frac{3}{4}mv^2$$

Velocity of particles of upper half is more than that of lower half hence kinetic energy of upper half will be more than $\frac{3}{8}$ mv^2.

7. $\omega = \sqrt{\frac{K}{m}} = 10$ rad/s

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{10} s$$



Maximum speed will be at the natural length of the spring at T/4 = $\frac{2\pi}{10 \times 4}$ = $\frac{\pi}{20}$s.

Time taken to cover 0.1 m is $\frac{T}{4} = \frac{\pi}{20}$ s

Time taken to cover $\frac{1}{2}$ × 0.1m is

$$\frac{T}{4} \times \frac{2}{3} = \frac{2\pi}{10 \times 4} \times \frac{2}{3} = \frac{\pi}{30} s$$

8. Compression is maximum when both blocks move with same velocity V.

By cons. of momentum

$$V = \frac{m_1v_1 + m_2v_2}{m_1 + m_2} = 5 \text{ m/s}$$

The change in K.E. = $k_f - k_i$ = – 35 J

This is stored as spring PE

Therefore $\frac{1}{2}kx^2 = \Delta K \Rightarrow x = \sqrt{\frac{2\Delta K}{k}}$

on solving x = 0.25 m = 25 cm.

9 to 11

Magnification is negative, therefore lens is convex. v = m.u

u is negative and v is positive u

$$\frac{1}{20}+\frac{1}{10} = \frac{1}{f_1} \qquad \dots (i)$$

$$\frac{1}{30}+\frac{1}{10} = \frac{1}{f_2} \qquad \dots (ii)$$

$$\frac{1}{v}+\frac{1}{10} = \frac{1}{f_1}+\frac{1}{f_2} = \frac{1}{f} \qquad \dots (iii)$$

For combination

$$m = \frac{v}{u} = \frac{60/11}{-10} = \frac{-6}{11}$$