PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 4

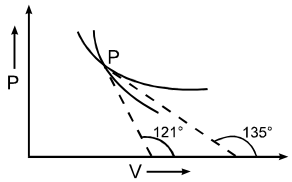
Total Marks : 36

Max. Time : 39 min.

Topics : Kinetic Theory of Gases ,Thermodynamics, Projectile Motion, Friction, Geometrical Optics, String Waves

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	(4 marks 4 min.)	[4, 4]
Subjective Question ('–1' negative marking) Q.5	(4 marks 5 min.)	[4, 5]
Comprehension ('–1' negative marking) Q.6 to Q.8	(3 marks 3 min.)	[9, 9]

1. A gas undergoes an adiabatic process and an isothermal process. The two processes are plotted on a P-V diagram. The resulting curves intersect at a point P. Tangents are drawn to the two curves at P. These make angles of 135° & 121° with the positive V-axis. If tan 59° = 5/3, the gas is likely to be:

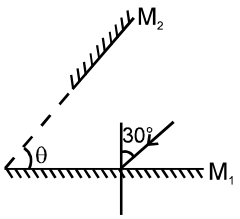


(A) monoatomic (B) diatomic
(C) triatomic (D) a mixture of monoatomic & diatomic gases

2. A particle is projected from a point P (2, 0, 0)m with a velocity 10 m/s making an angle 45° with the horizontal. The plane of projectile motion passes through a horizontal line PQ which makes an angle of 37° with positive x-axis, xy plane is horizontal. The coordinates of the point where the particle will strike the line PQ is: (Take g = 10 m/s^2)

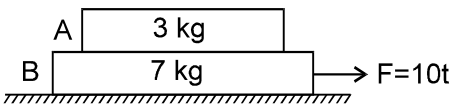
(A) (10, 6, 0)m (B) (8, 6, 0)m (C) (10, 8, 0)m (D) (6, 10, 0)m

3. A ray of light is incident at an $\angle$ of 30° on a plane mirror M_1. Another plane mirror M_2 is inclined at angle θ to M_1. What is the value of angle θ so that light reflected from M_2 is parallel to M_1.



(A) 60° (B) 75° (C) 67.5° (D) none of these

4. A variable force F = 10 t is applied to block B placed on a smooth surface. The coefficient of friction between A & B is 0.5. (t is time in seconds. Initial velocities are zero, A is always on B)



(A) block A starts sliding on B at t = 5 seconds
(B) the heat produced due to friction in first 5 seconds is 312.5J
(C) the heat produced due to friction in first 5 seconds is (625/8) J
(D) acceleration of A at 10 seconds is 5 m/s^2.

5. A point source S is centered in front of a 70 cm wide plane mirror. A man starts walking from the source along a line parallel to the mirror in a single direction. Maximum distance that can be walked by man without losing sight of the image of the source is _____.

COMPREHENSION

A sinusoidal wave is propagating in negative x–direction in a string stretched along x-axis. A particle of string at $x = 2m$ is found at its mean position and it is moving in positive y direction at $t = 1$ sec. If the amplitude of the wave, the wavelength and the angular frequency of the wave are 0.1meter, $\pi/4$ meter and 4π rad/sec respectively.

6. The equation of the wave is

(A) $y = 0.1 \sin (4\pi(t - 1) + 8(x - 2))$ (B) $y = 0.1 \sin ((t - 1) - (x - 2))$

(C) $y = 0.1 \sin (4\pi(t - 1) - 8(x - 2))$ (D) none of these

7. The speed of particle at $x = 2$ m and $t = 1$sec is

(A) 0.2π m/s (B) 0.6π m/s

(C) 0.4π m/s (D) 0

8. The instantaneous power transfer through x=2 m and t= 1.125 sec, is

(A) 10 J/s (B) $\frac{4\pi}{3}$ J/s (C) $\frac{2\pi}{3}$ J/s (D) zero

Answers Key

1. (A)
2. (A)
3. (A)
4. (A,D)
5. 70 cm
6. (A)
7. (C)
8. (D)

Hints & Solutions

1. (A)

The slope of isothermal curve at point of intersection

is $\frac{dP}{dV} = -\frac{P}{V} = \tan 135°$ ...(1)

The slope of adiabatic curve at point of intersection is

$\frac{dP}{dV} = -\frac{\gamma P}{V} = \tan 121°$ ....(2)

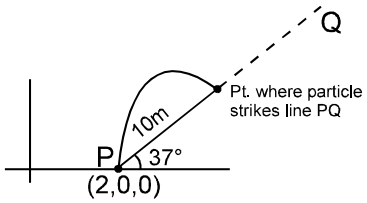
from (1) and (2)

$\gamma = \tan 59° = 1.66 = 5/3$

$\therefore$ gas is monoatomic

2. Range = 10 m.

For point where particle strikes line PQ

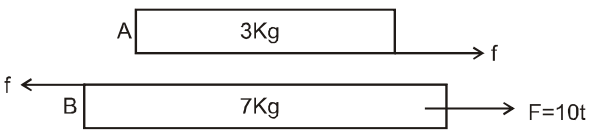


$\therefore$ x coordinate = 10 cos 37° + 2 = 10m

y coordinate = 10 sin 37° = 6m

z coordinate = 0m

4.

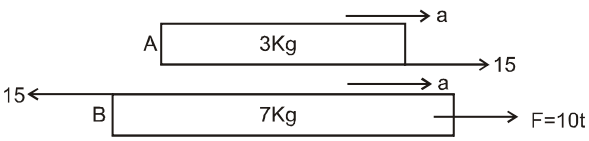


$f_{max} = \mu \times 3g$

$= 0.5 \times 30 = 15$ N

block A starts sliding when friction force becomes max. i.e. $f_{max} = 15$

at that instant (F.B. D.)



both will move with same acceleration

So $15 = 3a \Rightarrow a = 5 m/s^2$

$F - 15 = 7a$

$10t - 15 = 7 \times 5$

$10t = 50$

$\Rightarrow$ t = 5 sec

Work done by friction in 5 seconds

$W = \int F.ds$

$\int$ F 10t

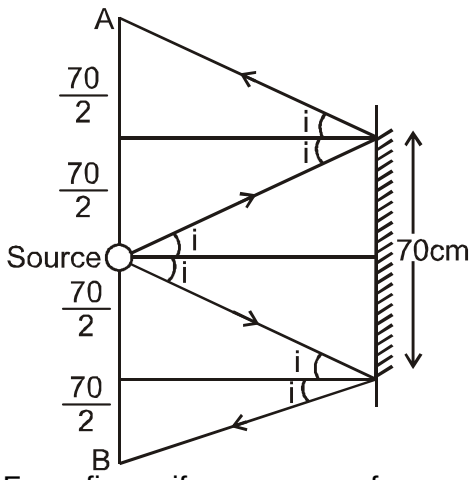
$$= \int_0^5 10t.Vdt \quad (ds = vdt)$$

$$= \int_0^5 10t.\frac{t^2}{2}dt \qquad \left(V = \int adt = \int tdt = \frac{t^2}{2}\right)$$

$$= \int_0^5 5t^3 dt$$

$$= 5\left[\frac{t^4}{4}\right]_0^5 = \frac{5}{4}[625-0] = \frac{625\times 5}{4}$$

5.



From figure if man moves from source to point A $\left(\frac{70}{2}+\frac{70}{2}=70\text{cm}\right)$. Then he can see image

If man moves from source to point B $\left(\frac{70}{2}+\frac{70}{2}=70\text{cm}\right)$. then he can not loose sight of image.

6. The equation of wave moving in negative x-direction, assuming origin of position at x = 2 and origin of time (i.e. initial time) at t = 1 sec.
$y = 0.1 \sin (4\pi t + 8x)$
Shifting the origin of position to left by 2m, that is, to x = 0. Also shifting the origin of time backwards by 1 sec, that is to t = 0 sec.
$y = 0.1 \sin [(4\pi t + 8(x - 2)]$

7. As given the particle at x = 2 is at mean position at t = 1 sec.
$\therefore$ its velocity $v = \omega A = 4\pi \times 0.1 = 0.4\ \pi$ m/s.

8. Time period of oscillation $T = \frac{2\pi}{\omega} = \frac{2\pi}{4\pi} = \frac{1}{2}$ sec.

Hence at t = 1.125 sec, that is, at $\frac{T}{4}$ seconds after t = 1 second, the particle is at rest at extreme position.