PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 12

Total Marks : 33

Max. Time : 36 min.

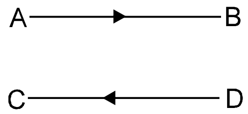
Topics : Geometrical Optics., Rectilinear Motion, String Wave, Projectile Motion, Rigid Body Dynamics, Heat and Thermodynamics

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.4	(3 marks, 3 min.)	[12, 12]
Subjective Questions ('–1' negative marking) Q.5 to Q.7	(4 marks, 5 min.)	[12, 15]
Comprehension ('–1' negative marking) Q.8 to Q.10	(3 marks, 3 min.)	[9, 9]

1. Two plane mirrors are inclined to each other at 90º. A ray of light is incident on one mirror and the reflected light goes to the other mirror. The ray will undergo a total deviation of :

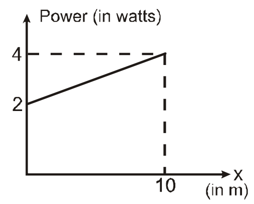
(A) 180º
(B) 90º
(C) 45º
(D) cannot be found because angle of incidence is not given.

2. AB is an incident beam of light and CD is a reflected beam (the number of reflections for this may be 1 or more than 1) of light. AB & CD are separated by some distance (may be large). It is possible by placing what type of mirror on the right side.



(A) one plane mirror
(B) one concave mirror
(C) one convex mirror
(D) none of these

3. A particle A of mass $\frac{10}{7}$ kg is moving in the positive direction of x. Its initial position is x = 0 & initial velocity is 1 m/s. The velocity at x = 10 is: (use the graph given)



(A) 4 m/s
(B) 2 m/s
(C) $3\sqrt{2}$ m/s
(D) 100/3 m/s

4. Two wave functions in a medium along x direction are given by -

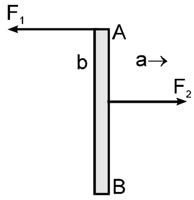
$$y_1 = \frac{1}{2+(2x-3t)^2}\,m \qquad y_2 = -\frac{1}{2+(2x+3t-6)^2}\,m$$

where x is in metres and t is in seconds

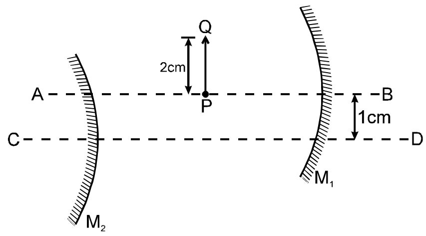
(A) There is no position at which resultant displacement will be zero at all times.
(B) There is no time at which resultant displacement will be zero everywhere.
(C) Both waves travel along the same direction.
(D) Both waves travel in opposite directions.

5. A bullet is fired with speed 50 m/s at 45° angle find the height of the bullet when its direction of motion makes angle 30° with the horizontal.

6. A thin uniform rod AB of mass 'm' translates with an acceleration 'a', when two anti parallel forces F_1 and F_2 act on it as shown in figure. If the distance between F_1 and F_2 is 'b', the length of the bar is _______.

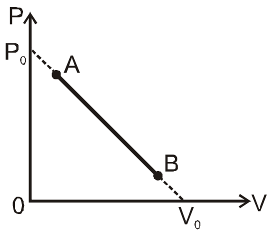


7. In the figure shown M_1 and M_2 are two spherical mirrors of focal length 20 cm each. AB and CD are their principal axes respectively which are separated by 1 cm. PQ is an object of height 2 cm and kept at distance 30 cm from M_1. The separation between the mirrors is 50 cm. Consider two successive reflections first on M_1 then on M_2. Find the size of the 2^{nd} image. Also find distances of end points P″ and Q″ of that image from the line AB.

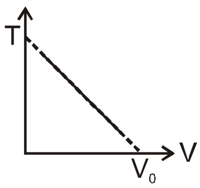


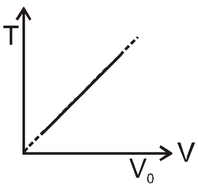
COMPREHENSION

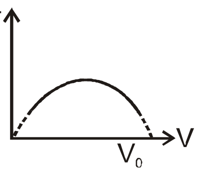
One mole of an ideal monatomic gas undergoes a linear process from A to B, in which is pressure P and its volume V change as shown in figure

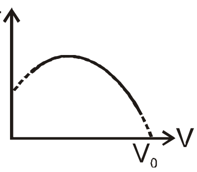


8. The absolute temperature T versus volume V for the given process is

(A) 

(B) 

(C) 

(D) 

9. The maximum temperature of the gas during this process is

(A) $\frac{P_0V_0}{2R}$ (B) $\frac{P_0V_0}{4R}$ (C) $\frac{3P_0V_0}{4R}$ (D) $\frac{3P_0V_0}{2R}$

10. As the volume of the gas is increased, in some range of volume the gas expands with absorbing the heat (the endothermic process) ; in the other range the gas emits the heat (the exothermic process). Then the volume after which if the volume of gas is further increased the given process switches from endothermic to exothermic is

(A) $\frac{2V_0}{8}$ (B) $\frac{3V_0}{8}$ (C) $\frac{5V_0}{8}$ (D) none of these

Answers Key

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

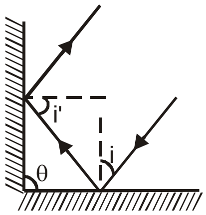
5. $h = \frac{125}{3}$ m above point of projection

6. $2F_2b/ma$ **7.** 8 cm **8.** (C)

9. (B) **10.** (C)

Hints & Solutions

1.



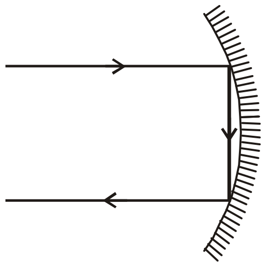
$\delta = \delta_1 + \delta_2 = (180 - 2i) + (180 - 2i')$

$= 360 - 2(i + i')$

$\delta = 360° - 2\theta$

$\delta = 360° - 2(90°) = 180°$.

2. The only possibility is by reflection from concave mirror as shown.



3. **(A)** Area under P–x graph = $\int p\,dx = \int \left(m\frac{dv}{dt}\right) v\,dx$

$= \int_1^V mv^2\,dV = \left[\frac{mv^3}{3}\right]_1^V = \frac{10}{7 \times 3}(v^3 - 1)$

from graph ; area = $\frac{1}{2}(2 + 4) \times 10 = 30$

$\therefore \frac{10}{7 \times 3}(v^3 - 1) = 30$

$\therefore v = 4$ m/s

ALITER :

from graph

$P = 0.2x + 2$

or $mv\frac{dv}{dx} v = 0.2x + 2$

or $mv^2 dv = (0.2x + 2) dx$

Now integrate both sides,

$$\int_1^v mv^2 dv = \int_1^{10} (0.2x + 2) dx$$

$\Rightarrow v = 4$ m/s.

4. Resultant Displacement

$y = y_1 + y_2$

for y to be zero

$y = 0$

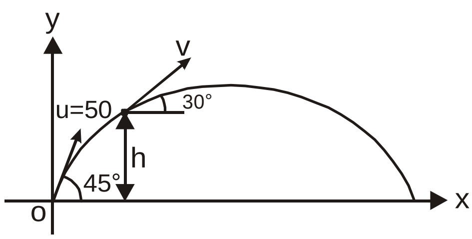
$(2x - 3t)^2 = (2x + 3t - 6)^2$

on solving $(x - \frac{3}{2})(t - 1) = 0$

Therefore,

at $x = \frac{3}{2}$, resultant displacement is zero for all values of t.

5.



h = height of the point where velocity makes 30° with horizontal.

As the horizontal component of velocity remain same

$50 \cos 45° = v \cos 30°$

$v = 50\sqrt{\frac{2}{3}}$

Now by equation

$v^2 = u^2 + 2a_y y$

$$\left(50 \times \sqrt{\frac{2}{3}}\right)^2 = 50^2 - 2gxh$$

$\Rightarrow 2gh = 50^2 - 50^2 \times \frac{2}{3}$

$\Rightarrow 2gh = \frac{1}{3} \times 50^2$

$\Rightarrow h = \frac{2500}{60} = \frac{125}{3}$

$h = \frac{125}{3}$ m above point of projection

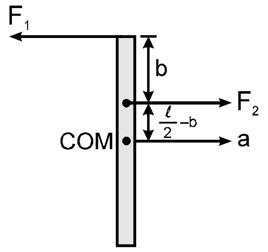
6. As Rod is in linear motion only (there's no rotation of the rod), Net torque about COM must be zero. Hence

$$F_1 . \frac{\ell}{2} - F_2\left(\frac{\ell}{2} - b\right) = 0 \qquad ....(1)$$

also for linear motion.

$F_2 - F_1 = ma$ ....(2)

solving (1) and (2)

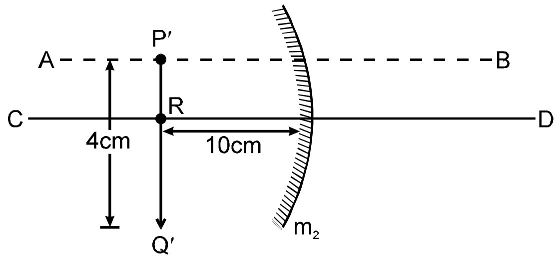


$$\ell = \frac{2F_2b}{ma}$$ **Ans.**

7. for $M_1 : \rightarrow$ u = – 30, f = – 20

$$\therefore \frac{1}{v} + \frac{1}{-30} = \frac{1}{-20} \Rightarrow v = -60 \text{ cm}$$

$$m_1 = -\frac{v}{u} = -\frac{-60}{-30} = -2.$$



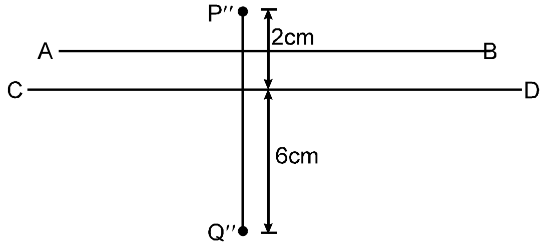
The image By M_1 is P′Q′

for M_2 : u = + 10 , f = + 20

$$\therefore \frac{1}{v} + \frac{1}{10} = \frac{1}{20} \Rightarrow v = -20 \text{ cm}$$

$$m_2 = -\frac{-20}{10} = +2$$

now the size of final image is = **8 cm. Ans.**



distance of P″ from AB = 1 cm. Ans.

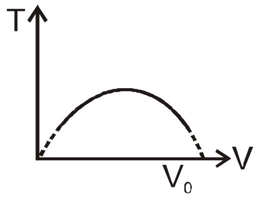
distance of Q″ from AB = 7 cm. Ans.

8, 9, 10. From The P–V graph, the relation between P and V is $P = -\frac{P_o}{V_o}V + P_0$ .... (1)

Also the ideal gas state equation for one mole is PV =RT .... (2)

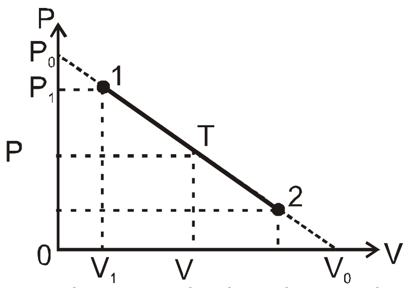
From equation (1) and (2) is $T = \frac{P_o}{R}V\left(1 - \frac{V}{V_o}\right)$

Hence the graph of T vs. V is a parabola given by



Obviously T is maximum at $V = \frac{V_o}{2}$. There maximum value of T is $\frac{P_0V_0}{4R}$

$Q = \Delta U + W$



where ΔU is the change in the internal energy of the gas; and W is work, done by the gas. For one mole of the monatomic ideal gas $\Delta U = 3/2R\ \Delta T$. Work equals the area under the graph P vs. V Therefore, for the process from the initial state with $P_1V_1 = 3/2\ RT_1$ to the state with P,V,T the heat given to system is

$Q = (3/2)\ R\ (T - T_1) + (1/2)\ (P + P_1\ (V - V_1)$

$= \frac{3}{2}\ (PV - P_1V_1) + \frac{1}{2}(PV + P_1V + PV_1 - P_1V_1)$ .... (3)

$= 2PV + \frac{1}{2}P_1V - \frac{1}{2}PV_1 - 2P_1V_1$

from equation 1 and 3 we get

$Q = 2\frac{P_0}{V_0}V^2 + \frac{5}{2}P_0V - 2P_0V_1\left(\frac{5}{4} - \frac{V_1}{V_0}\right)$

The process switches from endothermic to exothermic as $\frac{dQ}{dV}$ changes from positive to negative, that is

dQ