PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 5

Total Marks : 39

Max. Time : 44 min.

Topics : Rigid Body Dynamics, Geometical Optics., Calorimetry, Work, Power and Energy , Fluid Mechanics, Kinetic Theory of Gases and thermodynamics

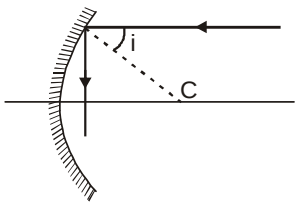
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.2	(3 marks, 3 min.)	[6, 6]
Multiple choice objective ('–1' negative marking) Q.3	(4 marks, 4 min.)	[4, 4]
Subjective Questions ('–1' negative marking) Q.4 to Q.6	(4 marks, 5 min.)	[12, 15]
Comprehension ('–1' negative marking) Q.7 to Q.9	(3 marks, 3 min.)	[9, 9]
Match the Following (no negative marking) (2 × 4) Q.10	(8 marks, 10 min.)	[8, 10]

1. Moment of inertia of a uniform quarter disc of radius R and mass M about an axis through its centre of mass and perpendicular to its plane is :

(A) $\frac{MR^2}{2} - M\left(\frac{4R}{3\pi}\right)^2$ (B) $\frac{MR^2}{2} - M\left(\sqrt{2}\,\frac{4R}{3\pi}\right)^2$

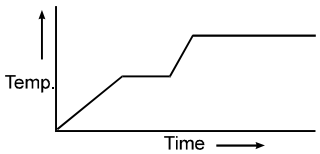
(C) $\frac{MR^2}{2} + M\left(\frac{4R}{3\pi}\right)^2$ (D) $\frac{MR^2}{2} + M\left(\sqrt{2}\,\frac{4R}{3\pi}\right)^2$

2. Angle of incidence of the incident ray for which reflected ray intersect perpendiculaly the principal axis.



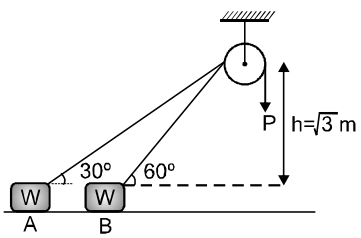
(A) 0° (B) 30° (C) 45° (D) 60°

3. Heat is supplied to a certain homogeneous sample of matter at a uniform rate. Its temperature is plotted against time as shown in the figure. Which of the following conclusions can be drawn?

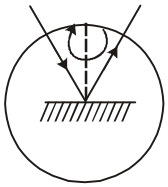


(A) its specific heat capacity is greater in the solid state than in the liquid state.
(B) its specific heat capacity is greater in the liquid state than in the solid state.
(C) its latent heat of vaporization is greater than its latent heat of fusion.
(D) its latent heat of vaporization is smaller than its latent heat of fusion.

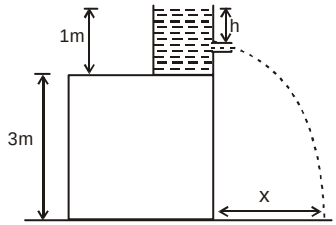
4. A block of weight W is dragged across the horizontal floor from A to B by the constant vertical force P acting at the end of the rope. Calculate the work done on the block by the force P = $(\sqrt{3}+1)$N.Assume that block does not lift off the floor. (g = 10 m/s^2)



5. A Plane mirror revolves as shown at constant angular velocity making 2 rps about its normal. With what velocity will the light spot move along a spherical screen of radius of 10 m if the mirror is at the centre of curvature of the screen and the light is incident from a fixed direction.



6. A water tank stands on the roof of a building as shown. Find the value of h (in m) for which the horizontal distance 'x' covered by the water is greatest.



COMPREHENSION

A quantity of an ideal monoatomic gas consists of n moles initially at temperature T_1. The pressure and volume are then slowly doubled in such a manner so as to trace out a straight line on a P-V diagram.

7. For this process, the ratio $\frac{W}{nRT_1}$ is equal to (where W is work done by the gas) :

(A) 1.5 (B) 3 (C) 4.5 (D) 6

8. For the same process, the ratio $\frac{Q}{nRT_1}$ is equal to (where Q is heat supplied to the gas) :

(A) 1.5 (B) 3 (C) 4.5 (D) 6

9. If C is defined as the average molar specific heat for the process then $\frac{C}{R}$ has value

(A) 1.5 (B) 2 (C) 3 (D) 6

10. Consider a system of particles (it may be rigid or non rigid). In the column-I some condition on force and torque is given. Column-II contains the effects on the system. (Letters have usual meaning)

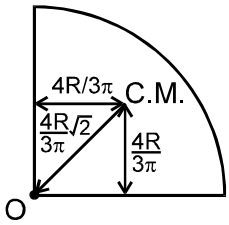
Column-I	**Column-II**
(A) $\vec{F}_{res} = 0$	(p) $\vec{P}_{system}$ will be constant
(B) $\vec{\tau}_{res} = 0$	(q) $\vec{L}_{system}$ will be constant
(C) External force is absent	(r) total work done by all forces will be zero
(D) No nonconservative force acts.	(s) total mechanical energy will be constant.

Answers Key

1. (B)
2. (C)
3. (AC)
4. 4
5. zero
6. 1
7. (A)
8. (D)
9. (B)
10. (A) p (B) q (C) p,q (D) s

Hints & Solutions

1.



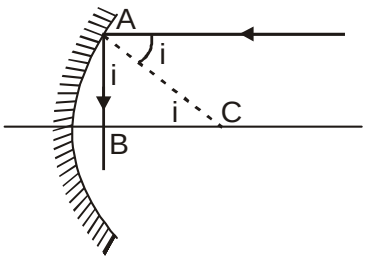
M.I. about 'O' is $\frac{MR^2}{2}$

By parallel-axis theorem : $\frac{MR^2}{2}$

$= I_{cm} + M\left(\frac{4R}{3\pi}.\sqrt{2}\right)^2$

$\Rightarrow I_{cm} = \frac{MR^2}{2} - M\left(\sqrt{2}.\frac{4R}{3\pi}\right)^2$ 1

2.



In the figure i + i = 90°
$\therefore$ i = 45°

3. Slope of graph is greater in the solid state i.e., temperature is rising faster, hence lower heat capacity.
The transition from solid to liquid state takes lesser time, hence latent heat is smaller.

4. $W = Px$

$$= P\left[\frac{h}{\sin 30^\circ} - \frac{h}{\sin 60^\circ}\right]$$

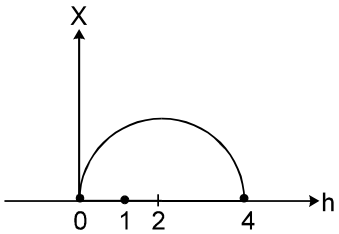
$$= 2Ph\left[1 - \frac{1}{\sqrt{3}}\right] = \frac{2[\sqrt{3}-1]}{\sqrt{3}}Ph$$

$$= \frac{2(\sqrt{3}-1)(\sqrt{3}+1)(\sqrt{3})}{\sqrt{3}}$$

$= 4\ J$ **Ans.**

5. Angular speed of reflected light = 0 rps
There is no change in angular of incidence due to rotation of mirror. **Ans.** zero

6.



$V_{efflux} = \sqrt{2gh}$

time of fall $t = \sqrt{\frac{(4-h)2}{g}}$

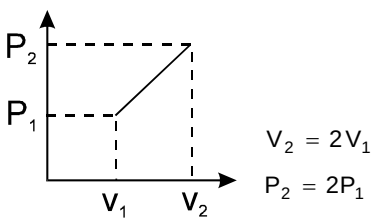
$x = V_{efflux}\, t = 2\sqrt{h(4-h)}$

the roots of x are (0,4) and the maximum of x is at h = 2.
The permitted value of h is 0 to 1 clearly h = 1 will give the
maximum value of x in this interval.

Aliter Solution:

If the column of water itself were from ground upto a height of 4m, h = 2m would give the maximum range x. Farther the hole is from this midpoint, lower the range. Here the nearest point possible to this midpoint is the base of the container. Hence h = 1m.

7. W = Area under the curve = $\frac{3}{2}\ P_1V_1$



and $P_1V_1 = nRT_1$

Therefore $\frac{w}{nRT_1} = \frac{\frac{3}{2}\cdot P_1V_1}{P_1V_1}$

8. $Q = dU + W$

$dU = nC_v\,dT$

For final state $P_2V_2 = 2P_1\ 2V_1$

$= 4P_1V_1 = nR(4T_1)$

Hence final temp. is $4T_1$

$$dU = n \cdot \frac{3}{2} R \cdot 3T_1 = \frac{9}{2} nRT_1$$

$$Q = \frac{3}{2} \cdot nRT_1 + \frac{9}{2} nRT_1 \quad = 6nRT_1$$

$$\frac{Q}{nRT_1} = 6$$

9. $nC\,\Delta T = Q \Rightarrow nC\Delta T = 6n\,RT_1$

$dT = 4T_1 - T_1 = 3T_1$

$n \cdot C \cdot 3T_1 = 6nRT_1$

$$\frac{C}{R} = 2$$

10. (A) p (B) q (C) p,q (D) s

(A) If resultant force is zero,

$\vec{P}_{system}$ will be constant.

(B) If resultant torque is zero,

$\vec{L}_{system}$ will be constant.

(C) If external forces are absent, both $\vec{P}_{system}$ and $\vec{L}_{system}$ will be constant.

(D) If no non conservative force acts, total mechanical energy of system will be constant.