PHYSICS

DPP
DAILY PRACTICE PROBLEMS

DPP No. 26

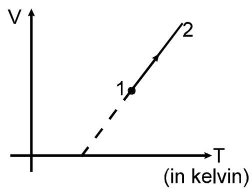
Total Marks : 31

Max. Time : 31 min.

Topics : Kinetic Theory of Gases, Surface Tension, Rigid Body Dynamics, Center of Mass, Electrostatics, Sound Wave, Work, Power and Energy

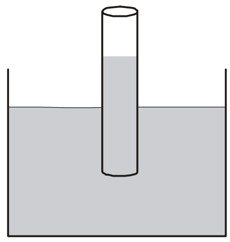
Type of Questions		**M.M., Min.**
Single choice Objective ('–1' negative marking) Q.1 to Q.6	**(3 marks, 3 min.)**	**[18, 18]**
Multiple choice objective ('–1' negative marking) Q.7	**(4 marks, 4 min.)**	**[4, 4]**
Comprehension ('–1' negative marking) Q.8 to Q.10	**(3 marks, 3 min.)**	**[9, 9]**

1. V–T diagram for a process of a given mass of ideal gas is as shown in the figure. During the process pressure of gas.



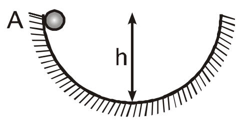
(A) first increases then decreases
(B) continuously decreases
(C) continuously increases
(D) first decreases then increases.

2. A long capillary tube of mass 'π' gm, radius 2mm and negligible thickness, is partially immersed in a liquid of surface tension 0.1 N/m. Take angle of contact zero and neglect buoyant force of liquid. The force required to hold the tube vertically, will be - (g = 10 m/s^2)



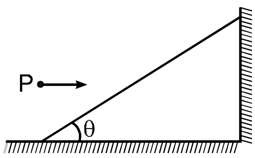
(A) 10.4 π mN (B) 10.8 π mN
(C) 0.8 π mN (D) 4.8 π mN

3. A small solid sphere of mass m is released from a point A at a height h above the bottom of a rough track as shown in the figure. If the sphere rolls down the track without slipping, its rotational kinetic energy when it comes to the bottom of track is



(A) mgh (B) $\frac{10}{7}$ mgh (C) $\frac{5}{7}$ mgh (D) $\frac{2}{7}$ mgh

4. In the figure shown a particle P strikes the inclined smooth plane horizontally and rebounds vertically. If the angle θ is 60°, then the coefficient of restitution is:



(A) $\frac{1}{3}$ (B) $\frac{1}{\sqrt{3}}$ (C) $\frac{1}{2}$ (D) 1

5. A point charge ' q ' is placed at the corner of an equilateral prism. Then the electric flux through the surface of the prism is:

(A) $\frac{q}{8\,\varepsilon_0}$ (B) $\frac{q}{6\,\varepsilon_0}$ (C) $\frac{q}{12\,\varepsilon_0}$ (D) $\frac{q}{24\,\varepsilon_0}$

6. There is a set of four tuning forks, one with the lowest frequency vibrating at 550 Hz. By using any two tuning forks at a time, the following beat frequencies are heard: 1, 2, 3, 5, 7, 8. The possible frequencies of the other three forks are:

(A) 552, 553, 560 (B) 557, 558, 560 (C) 552, 553, 558 (D) 551, 553, 558

7. Which of the following statements is/are true

(A) work done by kinetic friction on an object may be positive.

(B) A rigid body rolls up an inclined plane without sliding. The friction force on it will be up the incline. (only contact force and gravitational force is acting)

(C) A rigid body rolls down an inclined plane without sliding. The friction force on it will be up the incline. (only contact force and gravitational force is acting)

(D) A rigid body is release from rest and having no angular velocity from the top of a rough inclined plane. It moves down the plane with slipping. The friction force on it will be up the incline.

COMPREHENSION

A stone is projected from level ground with speed u and at an angle θ with horizontal. Some how the acceleration due to gravity (g) becomes double (that is 2g) immediately after the stone reaches the maximum height and remains same thereafter. Assume direction of acceleration due to gravity always vertically downwards.

8. The total time of flight of particle is :

(A) $\frac{3}{2}\frac{u\sin\theta}{g}$ (B) $\frac{u\sin\theta}{g}\left(1+\frac{1}{\sqrt{2}}\right)$ (C) $\frac{2u\sin\theta}{g}$ (D) $\frac{u\sin\theta}{g}\left(2+\frac{1}{\sqrt{2}}\right)$

9. The horizontal range of particle is

(A) $\frac{3}{4}\frac{u^2\sin 2\theta}{g}$ (B) $\frac{u^2\sin 2\theta}{2g}\left(1+\frac{1}{\sqrt{2}}\right)$ (C) $\frac{u^2}{g}\sin 2\theta$ (D) $\frac{u^2\sin 2\theta}{2g}\left(2+\frac{1}{\sqrt{2}}\right)$

10. The angle ϕ which the velocity vector of stone makes with horizontal just before hitting the ground is given by:

(A) $\tan\phi = 2\tan\theta$ (B) $\tan\phi = 2\cot\theta$ (C) $\tan\phi = \sqrt{2}\tan\theta$ (D) $\tan\phi = \sqrt{2}\cot\theta$

Answers Key

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

Hints & Solutions

1. $V = KT + C$

$$P = \frac{nRT}{V}$$

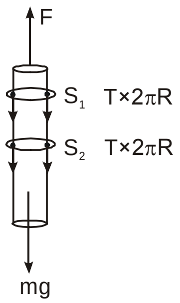
$$\Rightarrow \quad P = \frac{nRT}{KT + C} \qquad \Rightarrow \quad \frac{dP}{dT} = \frac{nRC}{(KT + C)^2}$$

As $C < 0$ by diagram

$$\Rightarrow \quad \frac{dP}{dT} < 0 \text{ for all T}$$

$\Rightarrow$ P continuously decreases.

2. The free body diagram of the capillary tube is as shown in the figure. Net force F required to hold tube is
F = force due to surface tension at cross-section $(S_1 + S_2)$ + weight of tube.



Free body daigram
of capillary tube

$= (2\pi RT + 2\pi RT) + mg = 4\pi RT + mg$
$= 4\pi \times 2 \times 10^{-3} \times 0.1 + \pi \times 10^{-3} \times 10 = 10.8\ \pi mN$

3. From conservation of energy

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}\,Iw^2$$

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{2}{5}mr^2\right)\omega^2$$

$$gh = \frac{7}{10}(\omega^2 r^2) \qquad \because \ = wr$$

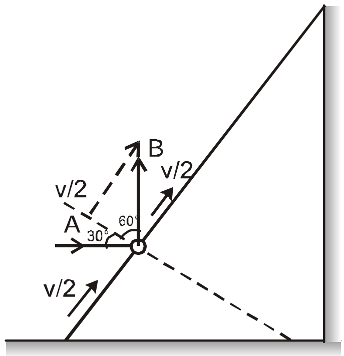
$$\frac{10gh}{7} = \omega^2 r^2$$

$$KE = \frac{1}{2}\left(\frac{2}{5}mr^2\right)\omega^2 = \frac{2mgh}{7}$$

4. Let 'v' be the initial velocity. Tangential velocity remains same during collision and equal to v cos60° = v/2

Let v′ be the normal component of velocity after impact.

In Δ OAB : $\tan 60° = \dfrac{v/2}{v'} \Rightarrow v' = \dfrac{v}{2\sqrt{3}}$



Then : $e = \dfrac{v'}{v\cos 30°} = \dfrac{(v/2\sqrt{3})}{(\sqrt{3}v/2)} = \dfrac{1}{3}$

6. As no. of beats = $\Delta\upsilon$

For option (A) : The frequencies are :

υ_1 = 550 Hz, υ_2 = 552 Hz, υ_3 = 553 Hz, υ_4 = 560 Hz.

The beats produced will be :

$\Delta\upsilon_1 = \upsilon_2 - \upsilon_1 = 2$,

$\Delta\upsilon_2 = \upsilon_3 - \upsilon_1 = 3$,

$\Delta\upsilon_3 = \upsilon_4 - \upsilon_1 = 10$,

$\Delta\upsilon_4 = \upsilon_3 - \upsilon_2 = 1$

$\Delta\upsilon_5 = \upsilon_4 - \upsilon_2 = 8$,

$\Delta\upsilon_6 = \upsilon_4 - \upsilon_3 = 7$

Which doesnot matches with the given set of beat frequencies. Hence (A) is not possible.

Similarly (B) and (C) are also not possible.

For option (D); frequencies were;

υ_1 = 550, υ_2 = 551, υ_3 = 553, υ_4 = 558

$\Delta\upsilon_1 = \upsilon_2 - \upsilon_1 = 1$,

$\Delta\upsilon_2 = \upsilon_3 - \upsilon_1 = 3$,

$\Delta\upsilon_3 = \upsilon_4 - \upsilon_1 = 8$,

$\Delta\upsilon_4 = \upsilon_3 - \upsilon_2 = 2$

$\Delta\upsilon_5 = \upsilon_4 - \upsilon_2 = 7$,

$\Delta\upsilon_6 = \upsilon_4 - \upsilon_3 = 5$

which matches with the given set of beat frequencies.

Hence (D).

7. Work done by kinetic friction may be positive when it acts along motion of the body.
Friction on rigid body rolling on inclined plane is along upward because tendency of slipping is downwards.

Sol. 8 to 10

The time taken to reach maximum height and maximum height are

$$t = \frac{u\sin\theta}{g} \quad \text{and } H = \frac{u^2\sin^2\theta}{2g}$$

For remaining half, the time of flight is

$$t' = \sqrt{\frac{2H}{(2g)}} = \sqrt{\frac{u^2\sin^2\theta}{2g^2}} = \frac{t}{\sqrt{2}}$$

$\therefore$ Total time of flight is $t + t' = t\left(1+\frac{1}{\sqrt{2}}\right)$

$$T = \frac{u\sin\theta}{g}\left(1+\frac{1}{\sqrt{2}}\right)$$

Also horizontal range is = $u\cos\theta \times T$

$$= \frac{u^2\sin 2\theta}{2g}\left(1+\frac{1}{\sqrt{2}}\right)$$

Let u_y and v_y be initial and final vertical components of velocity.

$\therefore \quad u_y^2 = 2gH \quad$ and $v_y^2 = 4gH$

$\therefore \quad v_y = \sqrt{2}u_y$

Angle (ϕ) final velocity makes with horizontal is

$$\tan\phi = \frac{v_y}{u_x} = \sqrt{2}\frac{u_y}{u_x} = \sqrt{2}\tan\theta$$