PHYSICS

DPP
DAILY PRACTICE PROBLEMS

DPP No. 21

Total Marks : 38

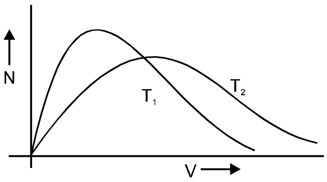
Max. Time : 40 min.

Topics : Calorimetry & Thermal Expansion, Kinetic Theory of Gases, Center of Mass, Geometrical Optics, Circular Motion.

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 to Q.6	(4 marks, 4 min.)	[12, 12]
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]

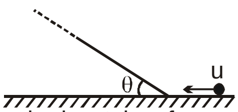
1. A cubical block of copper of side 10 cm is floating in a vessel containing mercury. Water is poured into the vessel so that the copper block just gets submerged. The height of water column is
(ρ_{Hg} = 13.6 g/cc , ρ_{Cu}= 7.3 g/cc, ρ_{water} =1 gm/cc)
(A) 1.25 cm (B) 2.5 cm (C) 5 cm (D) 7.5 cm

2. Maxwell's velocity distribution curve is given for the same quantity two different temperatures. For the given curves.



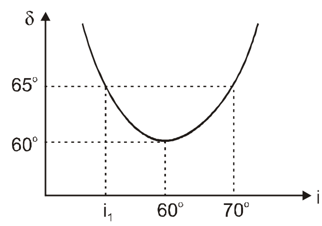
(A) $T_1 > T_2$ (B) $T_1 < T_2$
(C) $T_1 \le T_2$ (D) $T_1 = T_2$

3. A particle of mass m is given initial horizontal velocity of magnitude u as shown in the figure. It transfers to the fixed inclined plane without a jump, that is, its trajectory changes sharply from the horizontal line to the inclined line. All the surfaces are smooth and 90° ≥ θ > 0°. Then the height to which the particle shall rise on the inclined plane (assume the length of the inclined plane to be very large)



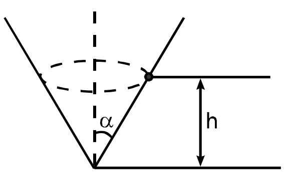
(A) increases with increase in θ (B) decreases with increase in θ
(C) is independent of θ (D) data insufficient

4. The angle of deviation (δ) vs angle of incidence (i) is plotted for a prism. Pick up the correct statements.



(A) The angle of prism is 60°
(B) The refractive index of the prism is n = $\sqrt{3}$
(C) For deviation to be 65° the angle of incidence i_1 = 55°
(D) The curve of 'δ' vs 'i' is parabolic

5. A particle is describing circular motion in a horizontal plane in contact with the smooth inside surface of a fixed right circular cone with its axis vertical and vertex down. The height of the plane of motion above the vertex is h and the semivertical angle of the cone is α. The period of revolution of the particle:



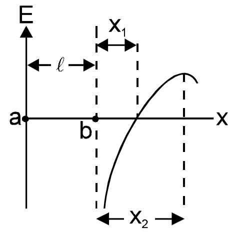
(A) increases as h increases (B) decreases as h increases
(C) increases as α increases (D) decreases as α increases

6. Two identical straight wires are stretched so as to produce 6 beats/sec. when vibrating simultaneously. On changing the tension slightly in one of them the beat frequency remains unchanged. Denoting by T_1, T_2, the higher & the lower initial tensions in the strings, then it could be said that while making the above changes in tension:

(A) T_2 was decreased (B) T_2 was increased (C) T_1 was increased (D) T_1 was decreased

COMPREHENSION

Two point charges are placed at point a and b. The field strength to the right of the charge Q_b on the line that passes through the two charges varies according to a law that is represented graphically in the figure. The electric field is taken positive if its direction is towards right and negative if its direction is towards left.



7. Choose the correct statement regarding the signs of the charges.

(A) Charge at point a is positive and charge at point b is negative.

(B) Charge at point a is negative and charge at point b is positive.

(C) Both charges are positive

(D) Both charges are negative

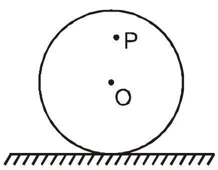
8. Ratio of magnitudes of charges $\left|\frac{Q_a}{Q_b}\right|$ will be equal to

(A) $\left(1+\frac{\ell}{x_1}\right)$ (B) $\left(1+\frac{\ell}{x}\right)^2$ (C) $1+\left(\frac{\ell}{x}\right)^2$ (D) $\left(1+\frac{\ell}{x}\right)^4$

9. The distance x_2 from point b where the field is maximum, will be

(A) $\frac{\ell}{\left(\frac{\ell+x_1}{x_1}\right)^{\frac{2}{3}}-1}$ (B) $\frac{\ell}{\left(\frac{\ell+x_1}{x_1}\right)^{\frac{1}{3}}-1}$ (C) $\frac{\ell}{\left(\frac{\ell+2x_1}{x_1}\right)^{\frac{2}{3}}-1}$ (D) $\frac{\ell}{\left(\frac{\ell+2x_1}{x_1}\right)^{\frac{1}{3}}-1}$

10. A uniform disc rolls without slipping on a rough horizontal surface with uniform angular velocity. Point O is the centre of disc and P is a point on disc as shown. In each situation of column I a statement is given and the corresponding results are given in column-II. Match the statements in column-I with the results in column-II.



Column I	**Column II**
(A) The velocity of point P on disc	(p) Changes in magnitude with time
(B) The acceleration of point P on disc	(q) Is always directed from that point (the point on disc given in column-I) towards centre of disc.
(C) The tangential acceleration of point P on disc	(r) is always zero
(D) The acceleration of point on disc which is in contact with rough horizontal surface	(s) is non-zero and remains constant in magnitude

Answers Key

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

Hints & Solutions

1. Let h = height to of water column

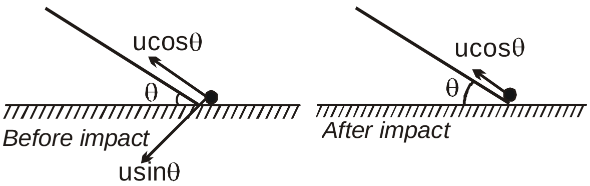
then $\rho_w gh + \rho_{Hg} g(10–h) = \rho_{Cu} g10$

$\Rightarrow$ h + 13.6 (10 – h) = 73

$\Rightarrow$ 63 = 12.6 h $\Rightarrow$ h = 5 cm

2. Higher is the temperature greater is the most probable velocity.

3. Just before the particle transfers to inclined surface, we resolve its velocity along and normal to the plane.



For the trajectory of the particle to sharply change from the horizontal line to the inclined line, the impact of the particle with inclined plane should reduce the usinθ component of velocity to zero. Hence the particle moves up the incline with speed u cosθ.

Hence as θ increases, the height to which the particle rises shall decrease.

4. **[Moderate]** $\delta = i + e - A$ (for minimum derivation i = e)

$\therefore$ minimum deviation = 2i – A

60 = 2 × 60 – A $\Rightarrow \because$ A = 60°

$$n = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)} = \frac{\sin\left(\frac{60+60}{2}\right)}{\sin\left(\frac{60}{2}\right)} = \sqrt{3}$$

$\delta_1 = i_1 + e - A$

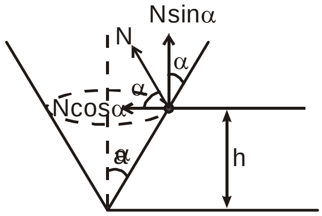
$65° = i_1 + 70° - 60°$ or $i_1 = 55°$

the δ versus i curve is not parabolic

5. As N sin α = mg

N cos α = mω^2 r

tan α = $\dfrac{g}{\omega^2 r}$ $\quad\therefore$ $T^2 \propto \tan\alpha$



$\therefore$ when α increases T also increases

Also $T^2 \propto r \tan\alpha$

but r = h tan α

$\therefore$ $T^2 \propto h \tan^2\alpha$

for constant α

$T^2 \propto h$

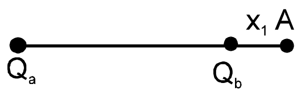
Thus when h increases T also increases

9. $\because$ Electric field near point b is $-\infty$

$\therefore$ 'b' should be negative electric field at x_1 is O which possible only if 'a' and 'b' are of opposite sign.

$\therefore$ 'a' is positive

Charge b is negative and charge a is positive



E at A = 0

$$\Rightarrow \frac{|Q_a|}{(\ell + x_1)^2} = \frac{|Q_b|}{(x_1)^2}$$

$$\therefore \left|\frac{Q_a}{Q_b}\right| = \left(\frac{\ell + x_1}{x_1}\right)^2 = \left(1 + \frac{\ell}{x_1}\right)^2$$

E at a general X

$$\frac{K|Q_a|}{(\ell + x^2)} - \frac{K|Q_b|}{(x^2)}$$

$$= K|Q_a|\left\{\frac{1}{(\ell + x)^2} - \left|\frac{Q_b}{Q_a}\right|\frac{1}{x^2}\right\}$$

If E is a maximum , $\dfrac{dE}{dx} = 0$

$$\Rightarrow \frac{-2}{(\ell + x\ )^3} + \left(\frac{x_1}{\ell + x_1}\right)^2 \frac{2}{x^3} = 0$$

$$(\ell + x)^3 = x^3\left(\frac{\ell + x_1}{x_1}\right)^2 \quad ; \quad \ell + x = x\left(\frac{\ell + x_1}{x_1}\right)^{\frac{2}{3}}$$

$$\therefore \quad x_2 = \frac{\ell}{\left(\frac{\ell + x_1}{x_1}\right)^{\frac{2}{3}} - 1}$$

Ans: $$x_2 = \frac{\ell}{\left(\frac{\ell + x_1}{x_1}\right)^{\frac{2}{3}} - 1}, \quad \left|\frac{Q_a}{Q_b}\right| = \left(1 + \frac{\ell}{x_1}\right)^2,$$

Charge b is negative and charge a is positive

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

(A) Speed of point P changes with time

(B) Acceleration of point P is equal to $\omega^2 x$ (ω = angular speed of disc and x = OP). The acceleration is directed from P towards O.

(C) The angle between acceleration of P (constant in magnitude) and velocity of P changes with time. Therefore, tangential acceleration of P changes with time.

(D) The acceleration of lowest point is directed towards centre of disc and remains constant with time