PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 22

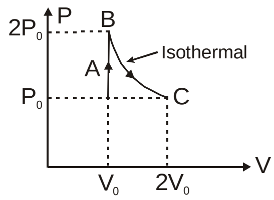
Total Marks : 33

Max. Time : 33 min.

Topics : String Wave, Circular Motion, Projectile Motion, Center of Mass, Rectilinear Motion, Sound Wave, Geometrical Optics, Rigid Body Dynamics

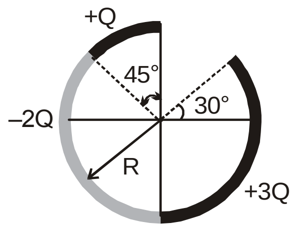
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.7	(3 marks, 3 min.)	[21, 21]
Multiple choice objective ('–1' negative marking) Q.8 to Q.10	(4 marks, 4 min.)	[12, 12]

1. A diatomic ideal gas undergoes a thermodynamic change according to the P–V diagram shown in the figure. The total heat given to the gas is nearly (use $\ell n2 = 0.7$) :



(A) $2.5\ P_0V_0$ (B) $1.4\ P_0V_0$
(C) $3.9\ P_0V_0$ (D) $1.1\ P_0V_0$

2. Figure shows three circular arcs, each of radius R and total charge as indicated.
The net elecric potential at the centre of curvature is :



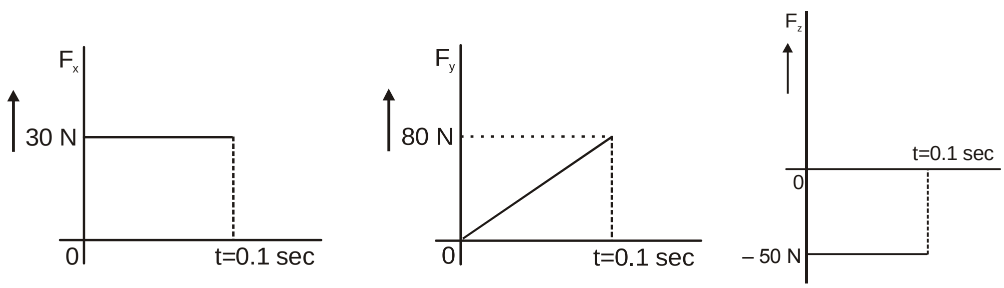
(A) $\frac{Q}{2\pi\varepsilon_0 R}$ (B) $\frac{Q}{4\pi\varepsilon_0 R}$

(C) $\frac{2Q}{\pi\varepsilon_0 R}$ (D) $\frac{Q}{\pi\varepsilon_0 R}$

3. A heavy body of mass 25 kg is to be dragged along a horizontal plane ($\mu = 1/\sqrt{3}$). The least force required is

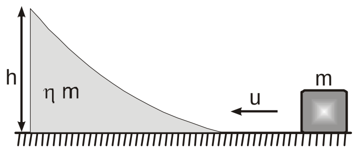
(A) 25 kg f (B) 2.5 kg f (C) 12.5 kg f (D) $25/\sqrt{3}$ kg f

4. A particle is acted upon by a force whose component's variations with time are shown in diagrams. Then the magnitude of change in momentum of the particle in 0.1 sec will be



(A) $2\ kg\ \frac{m}{sec}$ (B) $10\ kg\ \frac{m}{sec}$ (C) $12\ kg\ \frac{m}{sec}$ (D) $5\sqrt{2}\ kg\ \frac{m}{sec}$

5. A small block of mass m is pushed towards a movable wedge of mass ηm and height h with initial velocity u. All surfaces are smooth. The minimum value of u for which the block will reach the top of the wedge



(A) $\sqrt{2gh}$ (B) $\eta\sqrt{2gh}$ (C) $\sqrt{2gh\left(1+\frac{1}{\eta}\right)}$ (D) $\sqrt{2gh\left(1-\frac{1}{\eta}\right)}$

6. A bird flies for 4 seconds with a velocity of $|t - 2|$ m/sec. in a straight line, where t = time in seconds. It covers a distance of

(A) 4 m (B) 6 m (C) 8m (D) none of these

7. A violin string oscillating in its fundamental mode, generates a sound wave with wavelength λ. To generate a sound wave with wavelength $\lambda/2$ by the string, still oscillating in its fundamental mode, tension must be changed by the multiple :

(A) 2 (B) 1/2 (C) 4 (D) 1/4

8. In displacement method, the distance between object and screen is 96 cm. The ratio of length of two images formed by a convex lens placed between them is 4.84.

(A) Ratio of the length of object to the length of shorter image is 11/5.

(B) Distance between the two positions of the lens is 36 cm.

(C) Focal length of the lens is 22.5 cm.

(D) Distance of the lens from the shorter image is 30 cm.

9. A source emit sound waves of frequency 1000 Hz. The source moves to the right with a speed of 32 m/s relative to ground. On the right a reflecting surface moves towards left with a speed of 64 m/s relative to ground. The speed of sound in air is 332 m/s :

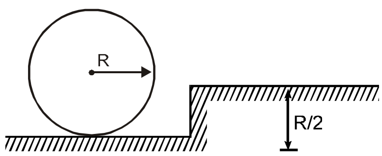
(A) wavelength of sound infront of source is 0.3 m

(B) number of waves arriving per second which meets the reflected surface is 1320

(C) speed of reflected wave is 268 m/s

(D) wavelength of reflected waves is nearly 0.2 m

10. A wheel (to be considered as a ring) of mass m and radius R rolls without sliding on a horizontal surface with constant velocity v. It encounters a step of height R/2 at which it ascends without sliding.



(A) the angular velocity of the ring just after it comes in contact with the step is 3v/4R

(B) the normal reaction due to the step on the wheel just after the impact is $\frac{mg}{2} + \frac{9\,mv^2}{16\,R}$

(C) the normal reaction due to the step on the wheel increases as the wheel ascends

(D) the friction will be absent during the ascent.

Answers Key

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

Hints & Solutions

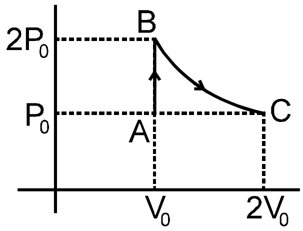
1. $Q_{AB} = \Delta U_{AB} + W_{AB}$

$W_{AB} = 0$

$\Delta U_{AB} = \frac{f}{2} nR\Delta T$

$\Rightarrow \frac{f}{2}(\Delta PV)$

$\Delta U_{AB} = \frac{5}{2}(\Delta PV)$



$Q_{AB} = 2.5\, P_0 V_0$

Process BC

$Q_{BC} = \Delta U_{BC} + W_{BC}$

$Q_{BC} = 0 + 2P_0 V_0 \ell n 2$

$= 1.4\, P_0 V_0$

$Q_{net} = Q_{AB} + Q_{BC} = 3.9\, P_0 V_0$

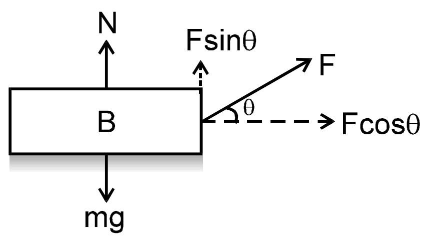
2. $V = V_1 + V_2 + V_3$

$= \frac{1}{4\pi\varepsilon_0} \cdot \frac{Q}{R} + \frac{1}{4\pi\varepsilon_0}\left(\frac{-2Q}{R}\right) + \frac{1}{4\pi\varepsilon_0}\left(\frac{3Q}{R}\right)$

$= \frac{1}{4\pi\varepsilon_0} \cdot \left(\frac{2Q}{R}\right)$

3. Let the body is acted upon by a force at an angle θ with horizontal.

FBD :



$F \cos \theta = \mu (mg - F \sin\theta)$

$\Rightarrow F = \dfrac{\mu mg}{\cos\theta + \mu \sin\theta}$. For min. force ;

$(\cos\theta + \mu \sin\theta)$ should be max.

$\Rightarrow -\sin\theta + \mu \cos \theta = 0$

$\Rightarrow \tan\theta = \mu$. or $\theta = \tan^{-1} (1/\sqrt{3}) = 30°$ Substituting

; F_{min} = **12.5 kg f**

4. Change in momentum = Impulse

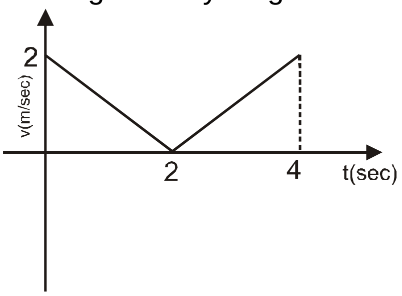
$\Delta\vec{P} = J_x\hat{i} + J_y\hat{j} + J_z\hat{k}$

$= 30(0.1)\,\hat{i} + \dfrac{1}{2}(80)\,(0.1)\,\hat{j} + (-50) \times (0.1)\,\hat{k}$

$= 3\hat{i} + 4\hat{j} - 5\hat{k}$

$|\Delta\vec{P}| = 5\sqrt{2}\ \text{kg}\dfrac{\text{m}}{\text{sec.}}$

6. Plotting velocity v against time t, we get



Area under the v–t curve gives distance.

$\text{Distance} = \dfrac{1}{2} \times 2 \times 2 + \dfrac{1}{2} \times 2 \times 2 = 4\text{m}$

7. (C) $v \,\alpha \sqrt{T}$; and as there is no change in length

$\Rightarrow \lambda \,\alpha \frac{1}{\sqrt{T}}$

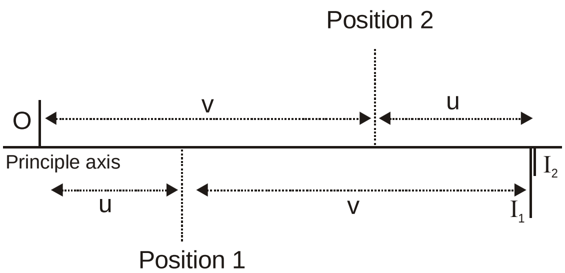
$\frac{\lambda'}{\lambda} = \frac{\sqrt{T}}{\sqrt{T'}}$

$\Rightarrow \sqrt{T'} = \frac{\lambda}{\lambda'}\sqrt{T}$

$\Rightarrow$ T' = $(2)^2$ T = 4T.

Hence (C).

8.



For first & second position $\frac{v}{u} = \frac{I_1}{O}$, $\frac{u}{v} = \frac{I_2}{O}$

$\Rightarrow \frac{v^2}{u^2} = \frac{I_1}{I_2} = 4.84$

$\Rightarrow \frac{v}{u} = 2.2$ and v + u = 96 $\Rightarrow$ v = 66 , u = 30

$\frac{O}{I_2} = \frac{v}{u} = 2.2 = \frac{11}{5}$ $\Rightarrow$ A is True

Distance between two position of lens = v - u

= 36 cm

$\Rightarrow$ B is True

Focal length of lens f = $\frac{uv}{u+v} = \frac{66 \times 30}{66+30}$ = 20.63

$\Rightarrow$ C is False

Distance of lens from shorter image = u = 30 cm

$\Rightarrow$ D is True

<u>9.</u> $\lambda' = \frac{V - V_s}{f} = \frac{332-32}{1000}$ = 0.3 m

$f' = f\frac{(V+V_0)}{V-V_s}$ = 1000 × $\frac{332+64}{332-32}$ = 1320 Hz

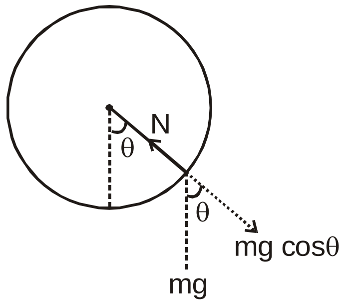
$\lambda'' = \frac{V-V_0}{f'}$ = 0.2 m.

10. By angular momentum conservation ;

$$L = I\omega \Rightarrow mv\frac{R}{2} + mvR = 2mR^2\omega$$

$$\frac{3}{2}mvR = 2mR^2\omega$$

$$\omega = \frac{3v}{4R}$$



Also at the time of contact ;

$$mg\cos\theta - N = \frac{mv^2}{R}$$

$$\therefore\ N = mg\cos\theta - \frac{mv^2}{R}$$

when it ascends θ decreases so $\cos\theta$ increases and v decreases.

$\therefore$ $mg\cos\theta$ is increasing and $\frac{mv^2}{R}$ is decreasing

$\therefore$ we can say N increases as wheel ascends.