PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 3

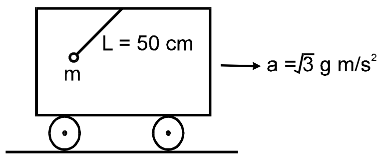
Total Marks : 36

Max. Time : 39 min.

Topics : Simple Harmonic Motion, Circular Motion, Work, Power and Energy, Newton's Law of Motion, Kinetic Theory of Gases and Thermodynamics, Sound Waves, Geometrical Optics

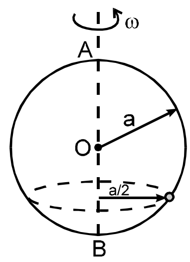
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.4	(3 marks, 3 min.)	[12, 12]
Multiple choice Objective ('–1' negative marking) Q.5 to Q.7	(4 marks, 4 min.)	[12, 12]
Subjective Question ('–1' negative marking) Q.8	(4 marks, 5 min.)	[4, 5]
Mathch the following (no negative marking) Q.9	(8 marks, 10 min.)	[8, 10]

1. A simple pendulum 50 cm long is suspended from the roof of a cart accelerating in the horizontal direction with constant acceleration $\sqrt{3}$ g m/s^2. The period of small oscillations of the pendulum about its equilibrium position is (g = π^2 m/s^2) :



(A) 1.0 sec (B) $\sqrt{2}$ sec (C) 1.53 sec (D) 1.68 sec

2. A smooth wire is bent into a vertical circle of radius ***a***. A bead P can slide smoothly on the wire. The circle is rotated about vertical diameter AB as axis with a constant speed ω as shown in figure. The bead P is at rest w.r.t. the wire in the position shown. Then ω^2 is equal to :



(A) $\frac{2g}{a}$ (B) $\frac{2g}{a\sqrt{3}}$

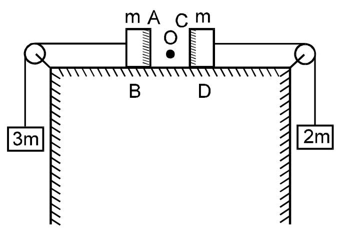
(C) $\frac{g\sqrt{3}}{a}$ (D) $\frac{2a}{g\sqrt{3}}$

3. The potential energy of a particle varies with x according to the relation U(x) = $x^2 - 4x$. The point x = 2 is a point of :

(A) stable equilibrium (B) unstable equilibrium

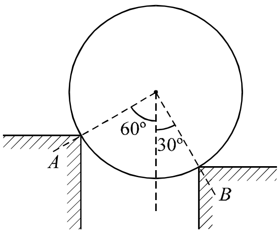
(C) neutral equilibrium (D) none of above

4. Two blocks each of mass m lie on a smooth table. They are attached to two other masses as shown in the figure. The pulleys and strings are light. An object O is kept at rest on the table. The sides AB and CD of the two blocks are made reflecting. The acceleration of two images formed in those two reflecting surfaces w.r.t. each other is :



(A) 5g/6 (B) 5g/3 (C) g/3 (D) 17 g/6

5. A cylinder of mass M and radius R is resting on two corner edges A and B as shown in figure. The normal reaction at the edges A and B are : (Neglect friction)



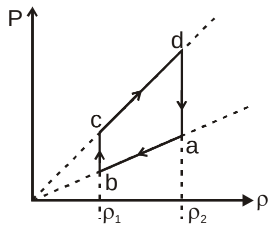
(A) $N_A = \sqrt{2}N_B$

(B) $N_B = \sqrt{3}N_A$

(C) $N_A = \frac{Mg}{2}$

(D) $N_B = \frac{2\sqrt{3}Mg}{5}$

6. An ideal gas undergoes a cyclic process abcda which is shown by pressuredensity curve.



(A) Work done by the gas in the process 'bc' is zero

(B) Work done by the gas in the process 'cd' is negative

(C) Internal energy of the gas at point 'a' is greater than at state 'c'

(D) Net work done by the gas in the cycle is negative.

7. A car moves towards a hill with speed v_c. It blows a horn of frequency f which is heard by an observer following the car with speed v_0. The speed of sound in air is v.

(A) the wavelength of sound reaching the hill is $\frac{v}{f}$

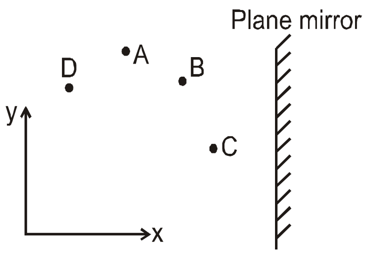
(B) the wavelength of sound reaching the hill is $\frac{v - v_c}{f}$

(C) The wavelength of sound of horn directly reaching the observer is $\frac{v + v_c}{f}$

(D) the beat frequency observed by the observer is $\frac{2v_c(v + v_o)f}{v^2 - v_c^2}$

8. Power delivered to a body varies as $P = 3t^2$. Find out the change in kinetic energy of the body from t = 2 to t = 4 sec.

9. Four particles are moving with different velocities in front of stationary plane mirror (lying in y-z plane). At t = 0, velocity of A is $\vec{v}_A = \hat{i}$, velocity of B is $\vec{v}_B = -\hat{i} + 3\hat{j}$, velocity of C is $\vec{v}_C = 5\hat{i} + 6\hat{j}$, velocity of D is $\vec{v}_D = 3\hat{i} - \hat{j}$. Acceleration of particle A is $\vec{a}_A = 2\hat{i} + \hat{j}$ and acceleration of particle C is $\vec{a}_C = 2t\hat{j}$. The particle B and D move with uniform velocity (Assume no collision to take place till t = 2 seconds). All quantities are in S.I. Units. Relative velocity of image of object A with respect to object A is denoted by $\vec{V}_{A',A}$. Velocity of images relative to corresponding objects are given in column I and their values are given in column II at t = 2 second. Match column I with corresponding values in column II and indicate your answer by darkening appropriate bubbles in the 4 × 4 matrix given in OMR.



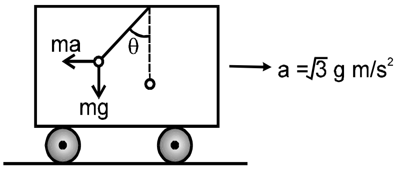
Column I	Column II
(A) $\vec{V}_{A',A}$	(p) $2\hat{i}$
(B) $\vec{V}_{B',B}$	(q) $-6\hat{i}$
(C) $\vec{V}_{C',C}$	(r) $-12\hat{i} + 4\hat{j}$
(D) $\vec{V}_{D',D}$	(s) $-10\hat{i}$

Answers Key

1. (A)
2. (B)
3. (A)
4. (D)
5. (BC
6. (ABD)
7. (BC)
8. 56 J
9. (A) s, (B) p, (C) s, (D) q

Hints & Solutions

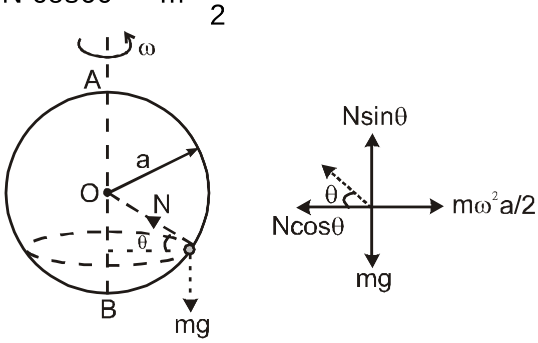
1. With respect to the cart, equilibrium position of the pendulum is shown.
If displaced by small angle θ from this position, then it will execute SHM about this equilibrium position, time period of which is given by :



$$T = 2\pi\sqrt{\frac{L}{g_{eff}}} \; ; \; g_{eff} = \sqrt{g^2 + (\sqrt{3}g)^2}$$

$\Rightarrow \; g_{eff} = 2g \qquad \Rightarrow \; T = 1.0$ second

2. As ; $\cos\theta = \frac{a}{2a}$
$\theta = 60^\circ$
$\therefore \; N\sin60^\circ = mg$
$N\cos60^\circ = m\frac{\omega^2 a}{2}$



w.r.t. wire

$\therefore \; \tan60^\circ = \frac{2g}{\omega^2 a}$

$\omega^2 = \frac{2g}{\ldots}$

3. $U(x) = x^2 - 4x$

F = 0

$$\frac{dU(x)}{dx} = 0$$

2x – 4 = 0 x = 2

$$\frac{d^2U}{dx^2} = 2 > 0$$

i.e. U is minimum hence x = 2 is a point of stable equilibrium.

4. Acceleration of block AB = $\frac{3mg}{3m+m} = \frac{3}{4}g$;

acceleration of block CD = $\frac{2mg}{2m+m} = \frac{2g}{3}$

Acceleration of image in mirror AB

= 2 acceleration of mirror

$$= 2.\left(\frac{-3g}{4}\right) = \frac{-3}{2}g$$

Acceleration of image in mirror CD = $2.\left(\frac{2g}{3}\right)$

$$= \frac{4g}{3}$$

∴ Acceleration of the two image w.r.t. each other

$$= \frac{4g}{3} - \left(\frac{-3g}{2}\right) = \frac{17g}{6}.$$

5. For equilibrium $N_A \cos 60° + N_B \cos 30° = Mg$

and $N_a \sin 60° = N_B \sin 30°$

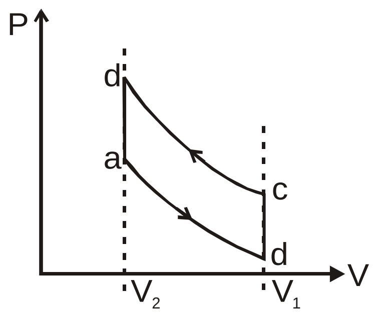
On solving $N_B = \sqrt{3}\ N_A$; $N_A = \frac{Mg}{2}$

6. $r = \frac{\rho}{M_0}RT \Rightarrow \frac{P}{\rho} = \frac{R}{M_0}T$

Slope of the curve α Temperature

Hence cd and ab are isothermal processes.

$$\rho \propto \frac{1}{V}$$



Equivalent PV diagram.

i.e. bc and da are constant volume process
(A) and (B) are true.
Temp. in cd process is greater than ab.
Net work done by the gas in the cycle is negative, as is clear by the PV-diagram.

$$\rho = \frac{\rho}{M_0}RT$$

$$\Rightarrow \frac{P}{\rho} = \frac{R}{M_0}T$$

7. Frequency of horn directly heard by observer

$$\frac{v+v_0}{v+v_c}f$$

Frequency of echo = $\frac{v}{v+v_c}f$

Frequency of echo of horn as heard by observer.

$$\frac{v}{v-v_c}f.\left(\frac{v+v_0}{v}\right)$$

Frquency of Beats :

$$= (v+v_0)\, f \left\{\frac{1}{v-v_c} - \frac{1}{v+v_c}\right\}$$

$$= \frac{2v_c(v+v_0)}{(v^2-v_c^2)}f$$

8. Applying work energy theorem to body
ΔKE = work done by forces delivering power P

$$= \int_{t=2}^{4} P dt = \int_{2}^{4} 3t^2\, dt = 56 \text{ J}$$

Ans. 56 J

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

$$\vec{v}_A = \hat{i} + \vec{a}t = \hat{i} + (2\hat{i}+\hat{j})(2)$$

$$= 5\hat{i} + 2\hat{j}$$

$$\vec{v}_{A'} = -5\hat{i} + 2\hat{j}$$

$$\vec{v}_{A',A} = \vec{v}_{A'} - \vec{v}_A = -10\hat{i}$$

$\vec{v}_B = (-\hat{i} + 3\hat{j})$, $\vec{v}_{B'} = \hat{i} + 3\hat{j}$ so $\vec{v}_{B',B} = 2\hat{i}$

For particle C (कण C के लिए)

$$\frac{dv_y}{dt} = 2t$$

$\Rightarrow v_y - 6 = t^2$ $\Rightarrow v_y = 6 + 4 = 10$

$\vec{v}_C = 5\hat{i} + 10\hat{j}$, $\vec{v}_{C'} = -5\hat{i} + 10\hat{j}$

so $\vec{v}_{C',C} = -10\hat{i}$