PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 2

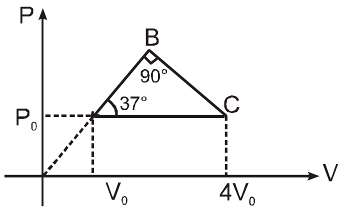
Total Marks : 35

Max. Time : 37 min.

Topics : Kinetic Theory of Gases and Thermodynamics, Simple Harmonic Motion, Circular Motion, Friction, Work, Power and Energy, String Wave

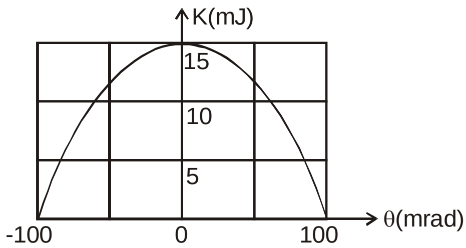
Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.6	(3 marks, 3 min.)	[18, 18]
Multiple choice Objective ('–1' negative marking) Q.7 to Q.9	(3 marks, 3 min.)	[9, 9]
Comprehension ('–1' negative marking) Q.10	(8 marks, 10 min.)	[8, 10]

1. In the figure shown the pressure of the gas in state B is:



(A) $\frac{63}{25}P_0$ (B) $\frac{73}{25}P_0$ (C) $\frac{48}{25}P_0$ (D) none of these

2. Figure shows the kinetic energy K of a simple pendulum versus its angle θ from the vertical. The pendulum bob has mass 0.2 kg. The length of the pendulum is equal to (g = 10 m/s^2).



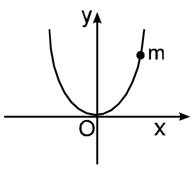
(A) 2.0 m (B) 1.8 m (C) 1.5 m (D) 1.2 m

3. A particle is revolving in a circle increasing its speed uniformly. Which of the following is constant?

(A) centripetal acceleration (B) tangential acceleration

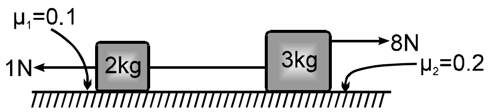
(C) angular acceleration (D) none of these

4. A bead of mass m is located on a parabolic wire with its axis vertical and vertex at the origin as shown in figure and whose equation is $x^2 = 4ay$. The wire frame is fixed in vertical plane and the bead can slide on it without friction. The bead is released from the point y = 4a on the wire frame from rest. The tangential acceleration of the bead when it reaches the position given by y = a is :



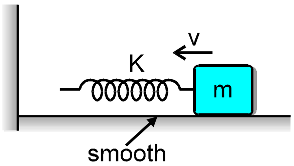
(A) $\frac{g}{2}$ (B) $\frac{\sqrt{3}g}{2}$ (C) $\frac{g}{\sqrt{2}}$ (D) $\frac{g}{\sqrt{5}}$

5. In the shown arrangement if f_1, f_2 and T be the frictional forces on 2 kg block, 3kg block and tension in the string respectively, then their values are:



(A) 2 N, 6 N, 3.2 N
(B) 2 N, 6 N, 0 N
(C) 1 N, 6 N, 2 N
(D) data insufficient to calculate the required values.

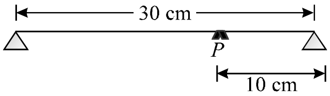
6. A block is attached with a spring and is moving towards a fixed wall with speed v as shown in figure. As the spring reaches the wall, it starts compressing. The work done by the spring on the wall during the process of compression is :



(A) $1/2\ mv^2$ (B) mv^2 (C) Kmv (D) zero

COMPREHENSION

Figure shows a clamped metal string of length 30 cm and linear mass density 0.1 kg/m. which is taut at a tension of 40 N. A small rider (piece of paper) is placed on string at point *P* as shown. An external vibrating tuning fork is brought near this string and oscillations of rider are carefully observed.



7. At which of the following frequencies of turning fork, rider will not vibrate at all :

(A) $\frac{100}{3}$ Hz (B) 50 Hz (C) 200 Hz (D) None of these

8. At which of the following frequencies the point *P* on string will have maximum oscillation amplitude among all points on string :

(A) $\frac{200}{3}$ Hz (B) 100 Hz (C) 200 Hz (D) None of these

9. Now if the tension in the string is made 160 N, at which of the following frequencies of turning fork, rider will not vibrate at all

(A) $\frac{100}{3}$ Hz (B) 50 Hz (C) 200 Hz (D) None of these

10. In each situation of column-I, the x-coordinate of a particle moving along x-axis is given in terms of time t. (ω is a positive constant). Match the equation of motion given in column-I with the type of motion given in column-II.

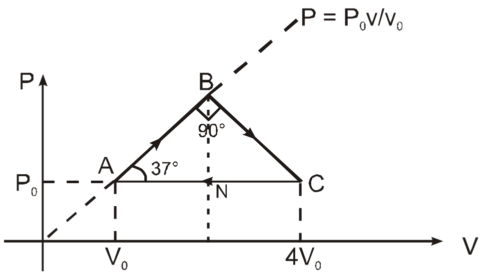
Column-I	Column-II
(A) $\sin \omega t - \cos \omega t$	(p) SHM
(B) $\sin^3 \omega t$	(q) Periodic
(C) $\sin \omega t + \sin 3\omega t + \sin 5\omega t$	(r) Periodic but not SHM
(D) $\exp(-\omega^2 t^2)$	(s) Non periodic

Answers Key

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

Hints & Solutions

1.



$AN = 3v_0 \cos^2 37^o$

$P_B = \frac{P_0}{v_0}\left(v_0 + 3v_0 \times \frac{16}{25}\right)$

$= \left(1 + \frac{48}{25}\right) = P_0(73/25)$ **Ans.** (B)

2. $\frac{1}{2}mV_m^2 = 15 \times 10^{-3}$

$V_m = \sqrt{0.150}\ m/s$

$A\omega = \sqrt{0.150}\ m/s$

$L\ q_m.\ \sqrt{\frac{g}{L}} = \sqrt{0.150}\ m/s$

$\sqrt{gL} = \frac{\sqrt{0.150}}{100 \times 10^{-3}} \Rightarrow L = \frac{0.150}{0.1} = 1.5\ m$

3. Angular acceleration $(\alpha) = \frac{a_t}{r}$

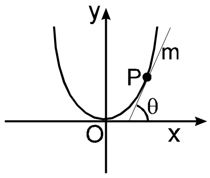
Since, $\left|\vec{a}_t\right| = \frac{d\left|\vec{v}\right|}{dt}$ = constant

$\therefore$ magnitude of α is constant
Also its direction is always constant (perpendicular to the plane of circular motion).

whereas, direction of a_t changes continuously $\vec{a}_t$ is not constant.

4. $x^2 = 4ay$

Differentiating w.r.t. y, we get



$$\frac{dy}{dx} = \frac{x}{2a}$$

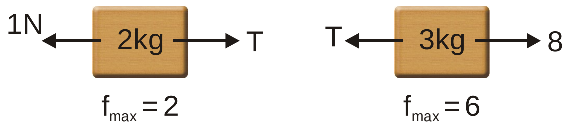
$\therefore$ At (2a, a), $\frac{dy}{dx} = 1$

$\Rightarrow$ hence $\theta = 45°$

the component of weight along tangential direction is mg sin θ.

hence tangential acceleration is g sin $\theta = \frac{g}{\sqrt{2}}$

5. **(C)** FBD



Net force without friction on system is '7N' in right side so first maximum friction will come on 3 kg block.

So $f_2 = 1$ N, $f_3 = 6$ N, T = 2N

6. As *point of application of force is not moving, therefore work done by the force is zero.*

9. Wave velocity in string is

$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{40}{0.1}} = 20 \text{ m/s}$$

Fundamental frequency of string oscillations is

$$n_0 = \frac{v}{2e} = \frac{20}{0.6} = \frac{100}{3} \text{ Hz}$$

Thus string will be in resonance with a turning fork of frequency.

$$n_f = \frac{100}{3} \text{ Hz}, \frac{200}{3} \text{ Hz}, 100 \text{ Hz}, \frac{400}{3} \text{ Hz}, \dots .$$

Here rider will not oscillate at all only if it is at a node of stationary wave in all other cases of resonance and non-resonance it will vibrate at the frequency of tuning fork. At a distance $\frac{l}{3}$ from one end node will appear at 3^{rd}, 6^{th}, 9^{th} or similar higher Harmonics i.e. at frequencies 100 Hz, 200 Hz, ... If string is divided in odd no. of segments, these segments can never resonate simultaneously hence at the location of rider, antinode is never obtained at any frequency.

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

(A) $x = \sqrt{2}\left(\frac{1}{\sqrt{2}}\sin\omega t - \frac{1}{\sqrt{2}}\cos\omega t\right)$

$\Rightarrow x = \sqrt{2}\sin(\omega t - \frac{\pi}{4})$ is periodic with SHM.

(B) $x = \sin^3 \omega t$ can not be written
as $x = A\sin(\omega' t + \phi)$ so it is not SHM
but periodic motion.
(C) Linear combination of different periodic function
is also periodic function.

$\frac{d^2x}{dt^2}$ is not directly proportional to x i.e. this motion
is not SHM
(D) x continuously decreases with time. So x is not
periodic function.