

Topic : Rectilinear Motion

Type of Questions

Single choice Objective ('-1' negative marking) Q.1 to Q.6

(3 marks, 3 min.)

M.M., Min.

[18, 18]

Multiple choice objective ('-1' negative marking) Q.7 to Q9

(4 marks, 4 min.)

[12, 12]

Subjective Questions ('-1' negative marking) Q.10

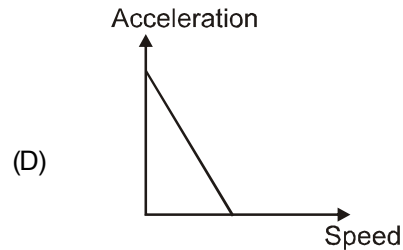
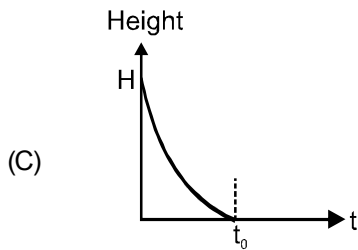
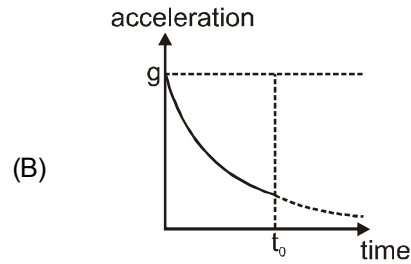
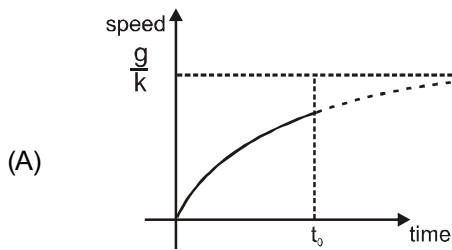
(4 marks, 5 min.)

[4, 5]

- A particle of mass 2 kg moves in the xy plane under the action of a constant force where $F = \hat{i} - \hat{j}$. Initially the velocity of the particle is $2\hat{i}$. The velocity of the particle at time t is
 (A) $\frac{1}{2}(t+4)\hat{i} - \frac{1}{2}t\hat{j}$ (B) $t(\hat{i} - \hat{j})$ (C) $\frac{1}{2}t(\hat{i} - \hat{j})$ (D) $\frac{1}{2}t\hat{i} + \frac{1}{2}(t+4)\hat{j}$
- A point moves rectilinearly. Its position x at time t is given by $x^2 = t^2 + 1$. Its acceleration at time t is:
 (A) $\frac{1}{3}$ (B) $\frac{1}{t} - \frac{1}{2}$ (C) $-\frac{t}{2}$ (D) none of these
- A man moves on his motorbike with speed 54 km/h and then takes a U turn (180°) and continues to move with same speed. The time of U turn is 10 s. Find the magnitude of average acceleration during U turn .
 (A) 0 (B) 3 ms^{-2} (C) $1.5\sqrt{2} \text{ ms}^{-2}$ (D) none of these
- Distance between a frog and an insect on a horizontal plane is 10 m. Frog can jump with a maximum speed of $\sqrt{10}$ m/s. $g = 10 \text{ m/s}^2$. Minimum number of jumps required by the frog to catch the insect is :
 (A) 5 (B) 10 (C) 100 (D) 50
- A clock has a minute-hand 10 cm long. Find the average velocity between 6.00 AM to 6.30 AM for the tip of minute-hand.
 (A) $\frac{22}{21} \text{ cm min}^{-1}$ (B) $\frac{2}{21} \text{ cm min}^{-1}$ (C) $\frac{12}{21} \text{ cm min}^{-1}$ (D) $\frac{2}{3} \text{ cm min}^{-1}$
- A stone is dropped from the top of a tower. When it has fallen by 5m from the top, another stone is dropped from a point 25m below the top. If both stones reach the ground at the same moment, then height of the tower from ground is : (take $g = 10 \text{ m/s}^2$)
 (A) 45 m (B) 50m (C) 60m (D) 65m
- Angle made by vector $\sqrt{3}\hat{i} + \sqrt{2}\hat{j} - 2\hat{k}$ with -ve y-axis is :
 (A) $\cos^{-1}\left(\frac{\sqrt{2}}{3}\right)$ (B) $\cos^{-1}\left(-\frac{\sqrt{2}}{3}\right)$ (C) $\pi - \cos^{-1}\left(\frac{\sqrt{2}}{3}\right)$ (D) $\pi - \cos^{-1}\left(-\frac{\sqrt{2}}{3}\right)$



8. A particle is dropped from a finite height H above the ground level under gravity. Due to air resistance acceleration of particle become $a = g - kv$ in the direction of velocity. Where $k =$ positive constant & $v =$ speed of particle. Then which of the following graph(s) is/are possible ($t_0 =$ time when particle touches the ground):



9. A particle moves with an initial velocity v_0 along straight line and retardation βv , where v is its velocity at any time t (β is a positive constant).
- (A) the particle will cover a total distance of v_0/β
 (B) the particle will continue to move for a very long time
 (C) the particle will stop shortly
 (D) the velocity of particle will become $v_0/2$ after time $1/\beta$.
10. A particle moving along a straight line with a constant acceleration of -4 m/s^2 passes through a point A on the line with a velocity of $+8 \text{ m/s}$ at some moment. Find the distance travelled by the particle in 5 seconds after that moment.

Answers Key

DPP NO. - 14

1. (A) 2. (A) 3. (B) 4. (B) 5. (D)
 6. (A) 7. (B)(C) 8. (A,B,D) 9. (A,B)
 10. 26 m.

Hint & Solutions

DPP NO. - 14

1. $m = 2\text{kg}$, $F = \hat{i} - \hat{j}$.

$$\Rightarrow a = \frac{F}{m} = \frac{1}{2} (\hat{i} - \hat{j})$$

Now $v = u + a t$.

$$\Rightarrow v = 2\hat{i} + \frac{1}{2} (\hat{i} - \hat{j}) t$$

$$= \left(2 + \frac{t}{2}\right) \hat{i} - \frac{t}{2} \hat{j} = \frac{1}{2} (t+4) \hat{i} - \frac{t}{2} \hat{j}$$

Alter: Substitute $t = 0$ in option and get answer

2. $x^2 = t^2 + 1$

$$2x \frac{dx}{dt} = 2t$$

$$\Rightarrow xV = t$$

$$xa + V^2 = 1$$

$$a = \frac{1-V^2}{x} = \frac{1-t^2}{x^2}$$

$$\Rightarrow a = \frac{x^2 - t^2}{x^3} = \frac{1}{x^3}$$

3. $54 \text{ km/h} = 54 \times \frac{5}{18} = 15 \text{ m/s}$

$$\langle a \rangle = \frac{15 - (-15)}{10} = 3 \text{ m/s}^2$$

4. For minimum number of jumps, range must be maximum.

$$\text{maximum range} = \frac{u^2}{g} = \frac{(\sqrt{10})^2}{10} = 1 \text{ meter.}$$

Total distance to be covered = 10 meter

So total step = 10

5. From 6:00 AM to 6:30 AM
displacement of tip of minute hand
 $= 2 \times 10\text{cm} = 20 \text{ cm}$

$$\text{Hence, average velocity} = \frac{20 \text{ cm}}{30 \text{ min}} = \frac{2}{3} \text{ cm min}^{-1}$$

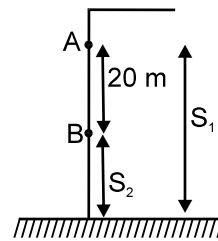
6. Vel. of 1st stone when passing at A \rightarrow

$$V^2 = 0 + 2 \cdot 10 \cdot 5$$

$$V = 10 \text{ m/s}$$

$$S_1 - S_2 = 20 \text{ m.}$$

$$\Rightarrow \left(10t + \frac{1}{2} 10t^2\right) - \left(\frac{1}{2} \cdot 10t^2\right) = 20$$



$$t = 2\text{s}$$

$$S_2 = \frac{1}{2} \cdot 10 \cdot 4 = 20 \text{ m}$$

$$Ht = 25 + 20 = 45 \text{ m.}$$

7. $\cos \theta = \frac{(\sqrt{3}\hat{i} + \sqrt{2}\hat{j} - 2\hat{k})(-\hat{j})}{\sqrt{3+2+4}(1)} = \frac{-\sqrt{2}}{3}$

$$\theta = \cos^{-1}\left(\frac{-\sqrt{2}}{3}\right) \text{ or } \pi - \cos^{-1}\left(\frac{\sqrt{2}}{3}\right)$$

8. $\frac{dv}{dt} = g - kv \quad \int_0^v \frac{dv}{g - kv} = \int_0^t dt$

$$-\frac{1}{k} \ln\left(\frac{g - kv}{g}\right) = t$$

$$g - kv = ge^{-kt} \quad v = \frac{g}{k} [1 - e^{-kt}]$$

$$a = \frac{g}{k} [0 - e^{-kt} (-k)]$$

$$= g e^{-kt}$$

$$V = \frac{g}{k} - \frac{a}{k} = -\frac{a}{k} + \frac{g}{k}$$

$$V - \frac{g}{k} = -\frac{a}{k}$$

$$kv - g = -a$$

$$a = g - kv$$

$$= -kv + g$$

9. (i) $V \frac{dv}{dx} = -\beta V$ (ii) $a = -\beta V$

$$dv = -\beta dx \quad \frac{dv}{dt} = -\beta V$$

$$\int_{v_0}^0 dv = -\beta \int_0^x dx \quad \int_{v_0}^v \frac{dv}{v} = -\beta \int_0^t dt$$

$$-v_0 = -\beta x \quad \ln\left(\frac{V}{V_0}\right) = -\beta t$$

$$x = \frac{v_0}{\beta} \quad V = V_0 e^{-\beta t}$$

$$V = \frac{V_0}{e^{\beta t}} \quad \text{at } t \rightarrow \infty V = 0.$$

\therefore A & B are correct answer

10. $u = + 8 \text{ m/s}$

$$a = - 4 \text{ m/s}^2$$

$$v = 0$$

$$\Rightarrow 0 = 8 - 4t \quad \text{or } t = 2 \text{ sec.}$$

displacement in first 2 sec.

$$S_1 = 8 \times 2 + \frac{1}{2} \cdot (-4) \cdot 2^2 = 8 \text{ m}$$

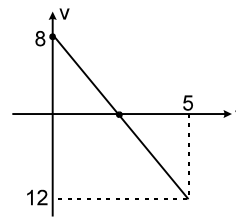
displacement in next 3 sec.

$$S_2 = 0 \times 3 + \frac{1}{2} (-4)3^2 = - 18 \text{ m.}$$

$$\text{distance travelled} = |S_1| + |S_2| = 26 \text{ m.}$$

Ans. 26 m.

ALITER :



$$\begin{aligned} \text{total distance} &= \frac{1}{2} \times 2 \times 8 + \frac{1}{2} \times 3 \times 12 \\ &= 8 + 18 = 26 \text{ m} \end{aligned}$$