PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 14

Total Marks : 34

Max. Time : 35 min.

Topic : Rectilinear Motion

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 Q9	(4 marks, 4 min.)	[12, 12]
Subjective Questions ('–1' negative marking) Q.10	(4 marks, 5 min.)	[4, 5]

1. A particle of mass 2 kg moves in the xy plane under the action of a constant force $\vec{F}$ where $\vec{F} = \hat{i} - \hat{j}$. 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) $\frac{1}{2}t\hat{i} + \frac{1}{2}(t+4)\hat{j}$

2. 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) $\frac{1}{x^3}$ (B) $\frac{1}{x} - \frac{1}{x^2}$ (C) $-\frac{t}{x^2}$ (D) none of these

3. 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) $1.5\sqrt{2}$ ms^{-2} (D) none of these

4. 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 m/s^2. Minimum number of jumps required by the frog to catch the insect is :

(A) 5 (B) 10 (C) 100 (D) 50

5. 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) $\frac{22}{21}$ cm min^{-1} (B) $\frac{2}{21}$ cm min^{-1} (C) $\frac{12}{21}$ cm min^{-1} (D) $\frac{2}{3}$ cm min^{-1}

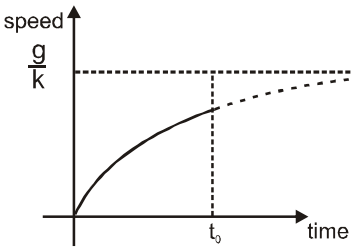
6. A stone is dropped from the top of a tower. When it has fallen by 5m from the top, another stone is dropped from a point 25m below the top. If both stones reach the ground at the same moment, then height of the tower from ground is : (take g = 10m/s^2)

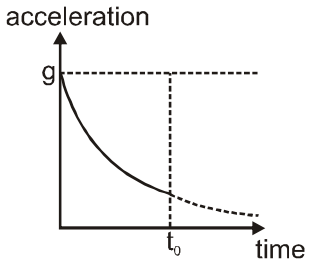
(A) 45 m (B) 50m (C) 60m (D) 65m

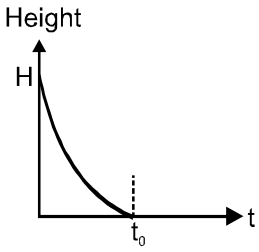
7. Angle made by vector $\sqrt{3}\hat{i} + \sqrt{2}\hat{j} - 2\hat{k}$ with –ve y-axis is :

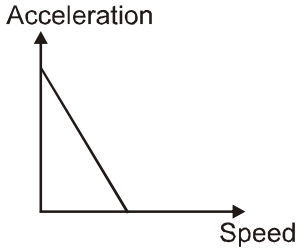
(A) $\cos^{-1}\left(\frac{\sqrt{2}}{3}\right)$ (B) $\cos^{-1}\left(-\frac{\sqrt{2}}{3}\right)$ (C) $\pi - \cos^{-1}\left(\frac{\sqrt{2}}{3}\right)$ (D) $\pi - \cos^{-1}\left(-\frac{\sqrt{2}}{3}\right)$

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):

(A) 

(B) 

(C) 

(D) 

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 m/s at some moment. Find the distance travelled by the particle in 5 seconds after that moment.

Answers Key

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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

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

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

Now $\vec{V} = \vec{u} + \vec{a}\,t$.

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

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

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

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

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

$\Rightarrow xV = t$

$xa + V^2 = 1$

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

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

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

$< a > = \frac{15 - (-15)}{10} = 3\ m/s^2$.

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

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

$= 2 \times 10cm = 20\ cm$

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

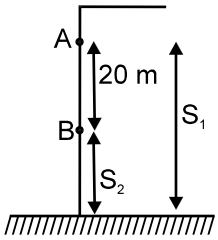
6. Vel. of Ist stone when passing at A $\rightarrow$

$V^2 = 0 + 2.10.5$

$V = 10\ m/s$

$S_1 - S_2 = 20\ m$.

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



$t = 2s$

$S_2 = \frac{1}{2}.10.4 = 20\ m$

$Ht = 25 + 20 = 45\ m$.

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

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

8. $\frac{dv}{dt} = g - kv$ $\int_0^v \frac{dv}{g - kv} = \int_{t=0}^{t} dt$

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

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

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

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

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

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

$kv - g = -a$

$a = g - kv$

$= -kv + g$

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

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

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

$-v_0 = -\beta x$ $\qquad \ell n\left(\frac{V}{V_0}\right) = -\beta t$

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

$V = \frac{V_0}{e^{\beta t}}$ $\qquad$ at $t \to \infty$ $V = 0$.

$\therefore$ A & B are correct answer

10. $u = +8$ m/s

$a = -4$ m/s^2

$v = 0$

$\Rightarrow$ $0 = 8 - 4t$ or $t = 2$ sec.

displacement in first 2 sec.

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

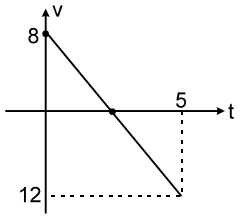
displacement in next 3 sec.

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

distance travelled $= |S_1| + |S_2| = 26$ m.

Ans. 26 m.

ALITER :



total distance $= \frac{1}{2} \times 2 \times 8 + \frac{1}{2} \times 3 \times 12$

$= 8 + 18 = 26$ m