Distance, Displacement and Position Vector DPP-01

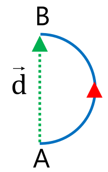
1. **A particle moves on a circular path of radius 'r'. It completes one revolution in 40 s. Calculate distance and displacement respectively in 2 min 20 s.**

(1) $2\pi r, 7r$ (2) $7\pi r, 2r$ (3) $7r, 2\pi r$ (4) $2r, 7\pi r$

2. **A man moves 4 m along east direction, then 3 m along north direction, after that he climbs up a pole to a height 12 m. Find the distance covered by him and his displacement respectively.**

(1) 19 m, 13 m (2) 13 m, 19 m (3) 17 m, 13 m (4) 13 m, 17 m

3. **A person moves on a semi-circular track of radius 40 m. If he starts at one end of the track and reaches the other end, find the magnitude of displacement of the person.**



(1) 40 m from A to B (2) 40 m from B to A (3) 80 m from B to A (4) 80 m from A to B

4. **A man has to go 50 m due north, 40 m due east and 20 m due south to reach a cafe from his home. What is his displacement from his home to the cafe?**

(1) 50 m, 37° N of E (2) 50 m, 37° S of E (3) 100 m, 37° N of E (4) 100 m, 37° S of E

5. **If the distance covered is zero, the displacement :**

(1) must be zero (2) may or may not be zero

(3) cannot be zero (4) depends upon the particle

6. **The numerical ratio of distance to the displacement covered is always :–**

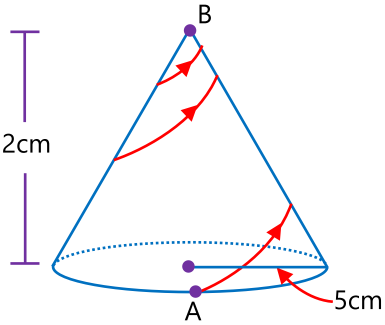
(1) less than one (2) equal to one

(3) equal to or less than one (4) equal to or greater than one

7. **A hall has the dimensions 10 m × 10 m × 10 m. A fly starting at one corner ends up at diagonally opposite corner. The magnitude of its displacement is**

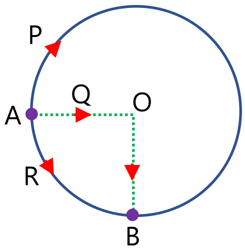
(1) $5\sqrt{3}$ m (2) $10\sqrt{3}$ m (3) $20\sqrt{3}$ m (4) $30\sqrt{3}$ m

8. **An insect starts climbing a conical birthday hat of radius 5 cm at base. It starts from point A and reaches point B, taking spiral path on the hat. Find out its displacement if height is 12 cm :-**



(1) 12 cm (2) 8 cm (3) 13 cm (4) 25 cm

9. **Three particles P, Q and R are initially situated at point A on the circular path of radius 10 m. All three particles move along different paths and reach point B as shown in figure. Then the ratio of distance traversed by particles P and R is :**



(1) $\frac{3}{4}$ (2) $\frac{3}{1}$ (3) $\frac{3\pi}{4}$ (4) $\frac{\pi}{4}$

10. **Distance travelled by the tip of minute hand of length 10 cm in 100 sec is**

(1) $\frac{\pi}{180}$m (2) $\frac{\pi}{360}$m (3) $\frac{\pi}{1200}$m (4) $\frac{3\pi}{2160}$m

11. **A man walks 30 m towards north, then 20 m towards east and the last 30 $\sqrt{2}$ m towards south - east. The displacement from origin is :**

(1) 10 m towards west (2) 50 m towards east

(3) 60 $\sqrt{2}$ m towards north west (4) 60 $\sqrt{2}$ m towards east north

12. **A person walks 80 m east, then turns right through angle 143° walks further 50 m and stops. His position relative to the starting point is**

(1) 50 m, 53° east of south (2) 50 m, 53° south of east

(3) 30 m, 37° south of east (4) 30 m, 53° south of east

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11	12
Answer	2	1	4	1	1	4	2	3	2	1	2	1

SOLUTIONS

1. **(2)**

t = 2 min 20 sec = 120 + 20 = 140 sec

Number of rotation = $\frac{140}{40} = 3\frac{1}{2}$ i.e. 3 complete rotation and 1 half rotation.

$\therefore$ Displacement in $\frac{1}{2}$ rotation = 2r

and displacement for 3 rotation = 0 ($\because$ After each complete rotation, displacement becomes zero)

Distance in $3\frac{1}{2}$ rotation = 3 × (2πr+ πr) = 7πr ($\because$ After each complete rotation, distance = 2πr)

2. **(1)**

Distance = 4 + 3 + 12 = 19 m

Displacement = $\sqrt{4^2+3^2+12^2}$ = 13 m

3. **(4)**

Displacement = 2r = 80m

4. **(1)**

Let east direction is $\hat{i}$ and north direction is $\hat{j}$ then

$\overrightarrow{AB} = 50\hat{j},\ \overrightarrow{BC} = 40\hat{i},\ \overrightarrow{CD} = -20\hat{j}$

According to law of polygon $\overrightarrow{AD} = \overrightarrow{AB} + \overrightarrow{BC} + \overrightarrow{CD}$

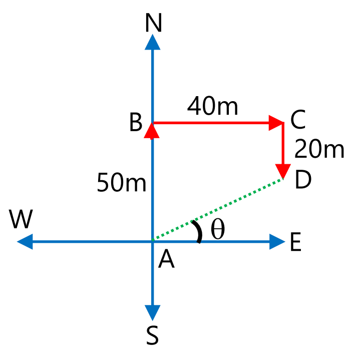
Or $\overrightarrow{AD} = 50\hat{j} + 40\hat{i} - 20\hat{j} = 40\hat{i} + 30\hat{j}$

$|\overrightarrow{AD}| = \sqrt{40^2+30^2} = 50\text{m}$

Now, if angle of $\overrightarrow{AD}$ with east towards north is θ, then

$\tan\theta = \frac{30}{40} = \frac{3}{4}$, so $\theta = \tan^{-1}\left(\frac{3}{4}\right) = 37^\circ$

So, direction of displacement is E 37° N (37° N of E).



5. **(1)**

Displacement $\leq$ Distance

6. **(4)**

Equal to or greater than 1

7. **(2)**

Displacement = Length of diagonal of cube

$$= \sqrt{(10)^2 + (10)^2 + (10)^2} = 10\sqrt{3}\ \text{m}$$

8. **(3)**

Displacement = Length of curved part of the cone.

$$= \sqrt{(12)^2 + (5)^2} = 13\,\text{cm}$$

9. **(2)**

Ratio = $\dfrac{s_P}{s_Q} = \dfrac{\frac{3}{2}\pi r}{\frac{\pi R}{2}} = \dfrac{3}{1}$

10. **(1)**

Distance = $\dfrac{2\pi R}{3600} \times 100$

$$= \frac{2\pi \times 10}{3600 \times 100} \times 100 = \frac{\pi}{180}\,\text{m}$$

11. **(2)**

$\vec{d} = \vec{d}_1 + \vec{d}_2 + \vec{d}_3$

$\vec{d} = 30\hat{j} + 20\hat{i} + 30\sqrt{2}\left(\dfrac{+\hat{i} - \hat{j}}{\sqrt{2}}\right)$

$\vec{d} = 30\hat{j} + 20\hat{i} + 30\hat{i} - 30\hat{j}$

$\vec{d} = +50\hat{i}$

$\vec{d} = 50\,\text{m}$ towards east

12. **(1)**

$\vec{d}_1 = 80\hat{i}$

$\vec{d}_2 = -30\hat{j} - 40\hat{i}$

Position from starting point

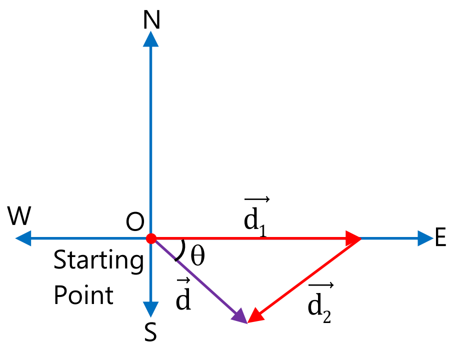
$\vec{d} = \vec{d}_1 + \vec{d}_2$

$\vec{d} = 40\hat{i} - 30\hat{j}$

$|\vec{d}| = \sqrt{40^2 + 30^2} = 50\,\text{m}$

$\tan\theta = -\left(\dfrac{40}{30}\right) = \left(-\dfrac{4}{3}\right)$

θ = 53° east of south



DAILY PRACTICE PROBLEM

Speed DPP-02

1. A train covers the first half of the distance between two stations with a speed of 30 km/h and the other half with 70 km/h. Then its average speed is :-

(1) 50 km/h (2) 48 km/h (3) 42 km/h (4) 100 km/h

2. A man walks for some time 't' with velocity (v) due east. Then he walks for same time 't' with velocity (v) due north. The average speed of the man is :-

(1) 2v (2) $\sqrt{2}v$ (3) v (4) $\frac{v}{\sqrt{2}}$

3. An object travels 10 km at a speed of 100 m/s and another 10 km at 50 m/s. The average speed over the whole distance is :-

(1) 75 m/s (2) 55 m/s (3) 66.7 m/s (4) 33.3 m/s

4. A body has speed v, 2v and 3v in first 1/3 part of total travelled distance S, second 1/3 part of S and third 1/3 part of S respectively. Its average speed will be :-

(1) v (2) 2v (3) $\frac{18}{11}v$ (4) $\frac{11}{18}v$

**5. If a car covers 2/5th of total distance with v_1 speed and 3/5th distance with v_2 speed then the average
speed is :-**

(1) $\frac{1}{2}\sqrt{v_1v_2}$ (2) $\frac{v_1+v_2}{2}$ (3) $\frac{2v_1+v_2}{v_1+v_2}$ (4) $\frac{5v_1v_2}{3v_1+2v_2}$

6. A particle moves on a straight line in such way that it covers 1st half distance with speed 3 m/s and next half distance in 2 equal time intervals with speeds 4.5 m/s and 7.5 m/s respectively. Find average speed of the particle.

(1) 3 m/s (2) 4 m/s (3) 5 m/s (4) 6 m/s

7. A car travels from A to B at a speed of 20 km/hr and returns at a speed of 30 km/hr. The average speed of the car for the whole journey is

(1) 25 km/hr (2) 24 km/hr (3) 50 km/hr (4) 5 km/hr

8. A boy walks to his school at a distance of 6 km with constant speed of 2.5 km/hour and walks back with a constant speed of 4 km/hr. His average speed for round trip expressed in km/hour, is

(1) 24/13 (2) 40/13 (3) 3 (4) 1/2

Answer Key

Question	1	2	3	4	5	6	7	8
Answer	3	3	3	3	4	2	2	2

SOLUTIONS

1. **(3)**

$$v_{avg} = \frac{2v_1v_2}{v_1+v_1} = \frac{2\times30\times70}{30+70} = 42\text{km/h}$$

2. **(3)**

$$v_{avg} = \frac{d_1+d_2}{2t} = \frac{vt+vt}{2t} = v$$

3. **(3)**

$t_1 = \frac{10\times1000}{100}$ = 100 sec.

$t_2 = \frac{10\times1000}{50}$ = 200 sec.

Avg. speed = $\frac{\text{Total distance}}{\text{Total time}} = \frac{10000+10000}{300}$

= 66.66 $\simeq$ 66.7 m/s

4. **(3)**

Average speed $= \frac{3v_1v_2v_3}{v_1v_2+v_2v_3+v_1v_3}$

$$= \frac{3\times v\times2v\times3v}{2v^2+6v^2+3v^2} = \frac{18}{11}v$$

5. **(4)**

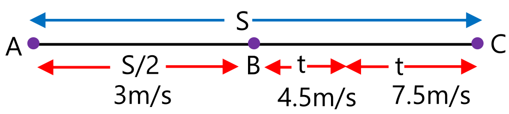
Average speed $= \frac{S}{\frac{\frac{2S}{5}}{v_1}+\frac{\frac{3S}{5}}{v_2}} = \frac{5}{\frac{2}{v_1}+\frac{3}{v_2}} = \frac{5v_1v_2}{3v_1+2v_2}$

6. **(2)**

Average speed from B to C

$$(v_{Avg})_{B\to C} = \frac{4.5\times t+7.5\times t}{2t}$$

$$(v_{Avg})_{B\to C} = 6\text{ m/s}$$



Average speed from A to C

$$(v_{Avg})_{A\to C} = \frac{\frac{S}{2}+\frac{S}{2}}{\frac{S}{2\times3}+\frac{S}{2\times6}}$$

$$(v_{Avg})_{A\to C} = 4\text{ m/s}$$

7. **(2)**

Average speed $= \dfrac{2v_1v_2}{v_1 + v_2}$

$$= \frac{2 \times 20 \times 30}{20 + 30}$$

$$= \frac{120}{5} = 24 \text{ km / hr}$$

8. **(2)**

Average speed $= \dfrac{2v_1v_2}{v_1 + v_2}$

$$= \frac{2 \times 2.5 \times 4}{2.5 + 4}$$

$$= \frac{200}{65} = \frac{40}{13} \text{km / hr}$$

Velocity DPP-03

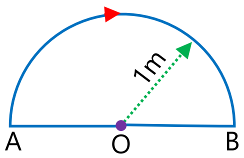
1. Length of a minute hand of a clock is 4.5 cm. Find the average velocity of the tip of minute's hand between 6 A.M. to 6:30 A.M.

(1) 5×10^{-3} cm/s (2) 5×10^{-4} cm/s (3) 5×10^{-5} cm/s (4) 5×10^{-6} cm/s

2. A particle of mass 2 kg moves on a circular path with constant speed 10 m/s. Find change in speed and magnitude of change in velocity when particle completes half revolution.

(1) 0 m/s, 20 m/s (2) 10 m/s, 20 m/s (3) 20 m/s, 0 m/s (4) 20 m/s, 10 m/s

3. A particle goes from point A to point B, moving in a semicircle of radius 1m in 1 second. Find the magnitude of its average velocity.

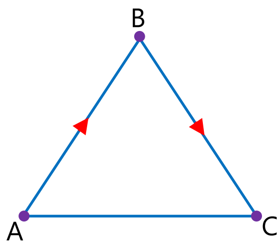


(1) 1 m/s (2) 2 m/s (3) 3 m/s (4) 4 m/s

4. A particle moves in the east direction with 15 m/sec for 2 sec then northwards with 5 m/s for 8 sec. Average velocity of the particle is :–

(1) 1 m/s (2) 5 m/s (3) 7 m/s (4) 10 m/s

5. A man walks on an equilateral triangle (of side length a) along path ABC with constant speed then the ratio of average speed and magnitude of average velocity for A to C :-



(1) 1 (2) 2 (3) $\frac{1}{2}$ (4) None

6. A car runs at constant speed on a circular track of radius 10 m taking 6.28s on each lap (i.e. round). The average speed and average velocity for half lap is :

(1) Velocity $20/\pi$ m/s, speed 10 m/s (2) Velocity zero, speed 10 m/s

(3) Velocity zero, speed zero (4) Velocity 10 m/s, speed zero

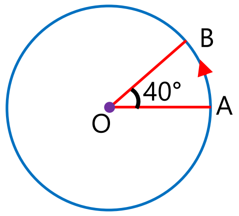
7. A body covers one-third of the time with a velocity v_1 the second one-third of the time with a velocity v_2, and the last one-third of the time with a velocity v_3. The average velocity is :

(1) $\frac{v_1+v_2+v_3}{3}$ (2) $\frac{3v_1v_2v_3}{v_1v_2+v_2v_3+v_3v_1}$ (3) $\frac{v_1v_2+v_2v_3+v_3v_1}{3}$ (4) $\frac{v_1v_2v_3}{3}$

8. **A scooter going due east at 10 ms^{-1} turns to right side through an angle of 90°. If the speed of the scooter remains unchanged in taking this turn, the change in the velocity of the scooter is :-**

(1) 20.0 ms^{-1} in south-west direction
(2) Zero
(3) 10.0 ms^{-1} in south-east direction
(4) 14.14 ms^{-1} in south-west direction

9. **A person is moving in a circle of radius r with constant speed v. The change in velocity in moving from A to B is :-**



(1) 2v cos 40°
(2) 2v sin 40°
(3) 2v cos 20°
(4) 2v sin 20°

10. **An insect crawls a distance of 4 m along north in 10 s and then a distance of 3 m along east in 5 s. The average velocity of the insect is :-**

(1) $\frac{7}{15}m/s$
(2) $\frac{1}{5}m/s$
(3) $\frac{1}{3}m/s$
(4) $\frac{4}{5}m/s$

11. **A particle located at x = 0 at time t = 0, starts moving along the positive x–direction with a velocity 'v' which varies as $v = \alpha\sqrt{x}$, then velocity of particle varies with time as : (α is a constant)**

(1) $v \propto t$
(2) $v \propto t^2$
(3) $v \propto \sqrt{t}$
(4) v = constant

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11
Answer	1	1	2	2	2	1	1	4	4	3	1

SOLUTIONS

1. **(1)**

Between 6:00 A.M. to 6:30 A.M., the tip of minute hand moves from (12) mark to (6) mark.

$\therefore$ Displacement (S) = 2 × (length of minute hand)

= 2 × 4.5 cm = 9 cm

and time taken (t) = 30 min = 30 × 60 = 1800s

$\therefore$ Average velocity $=\frac{S}{t}$

$=\frac{9}{1800}=5\times10^{-3}\,\text{cm/s}$

Direction of average velocity is from 12 mark to 6 mark on the clock panel.

2. **(1)**

Change in speed

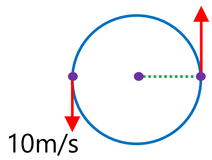
Δv = 10 – 10 = 0

Change in velocity

$\Delta\vec{v}=\vec{v}_f-\vec{v}_i$

$=10\hat{j}-(-10\hat{j})=20\hat{j}$

Magnitude $|\Delta\vec{v}|=20\,\text{m/s}$



3. **(2)**

Average velocity

$=\frac{\text{Net displacement}}{\text{total time}}=\frac{AO+OB}{\text{time}}$

$=\frac{1+1}{1}$ = 2 m/s

4. **(2)**

Average velocity = $\frac{15\times2\hat{i}+5\times8\hat{j}}{2+8}=3\hat{i}+4\hat{j}$

$|\vec{v}|$ = 5 m/s

5. **(2)**

Let the constant speed is v, then

Average speed = v

Average velocity = $\frac{a}{\frac{2a}{v}}=\frac{v}{2}$

Ratio$=\frac{\text{average speed}}{\text{average velocity}}=\frac{v}{v/2}=\frac{2}{1}$

6. **(1)**

Average speed $= \dfrac{\text{Total distance}}{\text{Total time}}$

$$= \frac{\pi r}{3.14} = 10\,\text{m/s}$$

Average velocity $= \dfrac{\text{Total displacement}}{\text{Total time}}$

$$= \frac{2}{3.14} = \frac{20}{\pi}\,\text{m/s}$$

7. **(1)**

$$v_{avg} = \frac{v_1 t + v_2 t + v_3 t}{3t}$$

$$v_{avg} = \frac{v_1 + v_2 + v_3}{3}$$

8. **(4)**

$$\vec{V}_i = 10\hat{i}$$

$$\vec{V}_f = -10\hat{j}$$

$$\Delta\vec{V} = \vec{V}_f - \vec{V}_i$$

$$\Delta\vec{V} = (-10\hat{j} - 10\hat{i})\,\text{m/s}$$

$$\Delta\vec{V} = (-10\hat{i} - 10\hat{j})\,\text{m/s}$$

$\left|\Delta\vec{V}\right| = 10\sqrt{2}\,\text{m/s} = 14.14\,\text{m/s}$, in south-west direction

9. **(4)**

$$\Delta v = 2v\sin\frac{\theta}{2}$$

$$\Delta v = 2v\sin\frac{40^\circ}{2}$$

Δv = 2v sin20°

10. **(3)**

$$\vec{V}_{avg} = \frac{4\hat{j} + 3\hat{i}}{10+5}\,\text{m/s}$$

$$\vec{V}_{avg} = \left(\frac{4}{15}\hat{j} + \frac{3}{15}\hat{i}\right)\text{m/s}$$

$$V_{avg} = \frac{1}{3}\ \text{m/s}$$

11. **(1)**

$$v = \alpha\sqrt{x} \ \Rightarrow\ \frac{dx}{dt} = \alpha\sqrt{x} \ \Rightarrow\ \frac{dx}{\sqrt{x}} = \alpha\,dt$$

Integrating, $\int\limits_{x=0}^{x} x^{-1/2}dx = \int\limits_{t=0}^{t} \alpha\,dt$

$$\Rightarrow 2\sqrt{x} = \alpha t \ \Rightarrow\ \sqrt{x} = \frac{\alpha t}{2}$$

Put this value of $\sqrt{x}$ in the original given eqn.

$$v = \alpha\sqrt{x} = \alpha\left(\frac{\alpha t}{2}\right) = \frac{\alpha^2 t}{2}$$

$$\therefore\ v \propto t$$

DPP
DAILY PRACTICE PROBLEM

Acceleration DPP-04

1. A particle moves on a circular path of radius 5 m with constant speed 5 m/s. Find the magnitude of its average acceleration when it completes half revolution.

(1) $\frac{1}{\pi} m/s^2$ (2) $\frac{10}{\pi} m/s^2$ (3) $\frac{2}{\pi} m/s^2$ (4) $\frac{20}{\pi} m/s^2$

2. If x denotes displacement in time t and x = a sin t, then acceleration is :

(1) a cos t (2) –a cos t (3) a sin t (4) –a sin t

3. The motion of a particle is described by the equation $x = a + bt^2$ where a = 15 cm and b = 3 cm/sec^2. Its acceleration at time 3 sec will be :-

(1) 36 cm/sec^2 (2) 18 cm/sec^2 (3) 6 cm/sec^2 (4) 32 cm/sec^2

4. Equation of displacement for a particle is $s = 3t^3 + 7t^2 + 14t + 8$ m. Its acceleration at time t = 2 sec is :-

(1) 10 m/s^2 (2) 16 m/s^2 (3) 25 m/s^2 (4) 50 m/s^2

5. The relation $t = \sqrt{x} + 3$ describes the position of a particle where x is in meters and t is in seconds. The acceleration of particle is :–

(1) 2 m/s^2 (2) 4 m/s^2 (3) 5 m/s^2 (4) zero

6. Equation of a particle moving along the x axis is $x = u(t - 2) + a(t - 2)^2$

(1) the initial velocity of the particle is u
(2) the acceleration of the particle is a
(3) the acceleration of the particle is 2a
(4) at t = 2 particle is not at origin

7. If for a particle position $x \propto t$ then :–

(1) velocity is constant
(2) acceleration is non-zero
(3) acceleration is variable
(4) none of these

8. The velocity of a body depends on time according to the equation v = 20 + 0.1t. The body has :

(1) uniform acceleration
(2) uniform retardation
(3) non-uniform acceleration
(4) zero acceleration

9. Which of the following relations representing velocity of a particle describes motion with constant acceleration?

(1) $v = 6 - 7t$ (2) $v = 3t^2 + 5t^3 + 7$ (3) $v = 9t^2 + 8$ (4) $v = 4t^{-2} + 3t - 1$

10. The displacement of a particle starting from rest (at t = 0) is given by $s = 6t^2 - t^3$. The time when the particle will attain zero acceleration is :

(1) 2s (2) 8s (3) 12s (4) 16s

11. **A particle moves along a straight line such that its displacement at any time t is given by $s = t^3 - 6t^2 + 3t + 4$ metres. The displacement when the acceleration is zero is :-**

(1) 3 m (2) –12 (3) 42 m (4) –6 m

12. **Displacement x of a particle is related to time t as $x = at + bt^2 - ct^3$ where a, b and c are constants. The velocity of the particle when its acceleration is zero is given by :-**

(1) $a+\frac{b^2}{c}$ (2) $a+\frac{b^2}{2c}$ (3) $a+\frac{b^2}{3c}$ (4) $a+\frac{b^2}{4c}$

13. **A particle is moving with a velocity of 10 m/s towards east. After 20 s its velocity changes to 10m/s towards north. Its average acceleration is :-**

(1) zero

(2) $\sqrt{2}$ m/s^2 towards N-W

(3) $\frac{1}{\sqrt{2}}$ m/s^2 towards N-E

(4) $\frac{1}{\sqrt{2}}$ m/s^2 towards N-W

14. **If the velocity of a particle is given by $v = (180 - 16x)^{1/2}$ m/s, then its acceleration will be:-**

(1) Zero (2) 8 m/s^2 (3) –8 m/s^2 (4) 4 m/s^2

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Answer	2	4	3	4	1	3	1	1	1	1	4	3	4	3

SOLUTIONS

1. **(2)**

$$t = \frac{\pi R}{v} = \frac{\pi \times 5}{5} = \pi \text{ sec}$$

$$\Delta \vec{v} = (-5\hat{i}) - (5\hat{i}) = -10\hat{i}$$

$$\vec{a}_{avg} = \frac{\Delta \vec{v}}{t} = \frac{-10\hat{i}}{\pi}$$

$$\left|\vec{a}_{avg}\right| = \frac{10}{\pi} m/s^2$$

2. **(4)**

$x = a \sin t$

$v = \dfrac{dx}{dt} = a \cos t$

$a = \dfrac{dv}{dt} = -a \sin t$

3. **(3)**

$x = a + bt^2,\ v = \dfrac{dx}{dt} = 2bt$

$a = \dfrac{dv}{dt} = 2b = 2 \times 3\ cm/s^2 = 6\ cm/s^2$

4. **(4)**

$s = 3t^3 + 7t^2 + 14t + 8$

$v = \dfrac{ds}{dt} = 9t^2 + 14t + 14$

$a = \dfrac{dv}{dt} = 18t + 14$

At $t = 2$, $a = 50\ m/s^2$

5. **(1)**

$t = \sqrt{x} + 3$

$\Rightarrow \sqrt{x} = t - 3$

$\Rightarrow x = (t-3)^2 = t^2 - 6t + 9$

$v = \dfrac{dx}{dt} = 2t - 6$

$a = \dfrac{dv}{dt} = 2\ m/s^2$

6. **(3)**

$x = u(t-2) + a(t-2)^2$

$v = \frac{dx}{dt} = u + 2a\,(t-2)$

acceleration $= \frac{dv}{dt} = 2a$

Initial velocity, v at t = 0

$= u - 4a$

At $t = 2$, $x = 0$

Hence, particle is at origin at t = 2

7. **(1)**

$x = kt$

$v = \frac{dx}{dt} = k$

$a = \frac{dv}{dt} = 0$

8. **(1)**

$v = 20 + 0.1\,t$

$a = \frac{dv}{dt} = 0.1\ \text{m/s}^2$

Acceleration is uniform.

9. **(1)**

Acceleration $= \frac{dv}{dt}$

For constant acceleration, expression of v should contain terms with coefficient t only.

Hence, correct answer is $v = 6 - 7t$

10. **(1)**

$s = 6t^2 - t^3$

$v = 12t - 3t^2$

$a = 12 - 6t$

$a = 0$ at $t = 2$ sec.

11. **(4)**

$s = t^3 - 6t^2 + 3t + 4$

$v = \frac{ds}{dt} = 3t^2 - 12t + 3$

$a = \frac{dv}{dt} = 6t - 12$

$a = 0$ at $t = 2$

$s = 2^3 - 6(2)^2 + 3(2) + 4$

$s = 8 - 24 + 6 + 4 = -6\text{m}$

12. **(3)**

$x = at + bt^2 - ct^3$

$v = \frac{dx}{dt} = a + 2bt - 3ct^2$

acceleration a' = 2b − 6ct

if a' = 0 then $t = \frac{b}{3c}$

So at $t = \frac{b}{3c}$

$v = a + 2b \times \frac{b}{3c} - 3c \times \frac{b^2}{9c^2}$

$\Rightarrow v = a + \frac{2b^2}{3c} - \frac{b^2}{3c}$

$\Rightarrow v = a + \frac{b^2}{3c}$

13. **(4)**

Acceleration $\vec{a} = \frac{\Delta \vec{v}}{\Delta t} = \frac{10\hat{j} - 10\hat{i}}{20}\ m/s^2$

$= \frac{-\hat{i} + \hat{j}}{2}$ (west-north)

$|\vec{a}| = \sqrt{\frac{1}{4} + \frac{1}{4}} = \frac{1}{\sqrt{2}}\ m/s^2$ (north-west)

14. **(3)**

$v = (180 - 16x)^{1/2}$

$\because\ a = \frac{vdv}{dx}$

$a = (180 - 16x)^{1/2} \cdot \frac{d}{dx}(180 - 16x)^{1/2}$

$a = \frac{1}{2}\left[\frac{(180 - 16x)^{1/2}}{(180 - 16x)^{1/2}}\right][0 - 16]$

$a = -8\ m/s^2$

DPP
DAILY PRACTICE PROBLEM

Problems based on Uniformly Accelerated Motion DPP-05

1. **A particle starts from rest, moves with constant acceleration for 15 s. If it covers S_1 distance in first 5 s then distance S_2 in next 10 s, then find the relation between S_1 & S_2.**

(1) $S_2 = 2S_1$ (2) $S_2 = 4S_1$ (3) $S_2 = 6S_1$ (4) $S_2 = 8S_1$

2. **A car moving along a straight highway with speed 126 kmh^{-1} is brought to a halt within a distance of 200m. What is the retardation of the car (assume uniform) and how long does it take for the car to stop?**

(1) 3.06 ms^{-2} ; 11.4 s (2) 3.06 ms^{-2} ; 1.14 s (3) 30.6 ms^{-2} ; 11.4 s (4) 30.6 ms^{-2} ; 1.14 s

3. **A car is moving with speed u. Driver of the car sees red traffic light. His reaction time is t, then find out the distance travelled by the car after the instant when the driver decided to apply brakes. Assume uniform retardation 'a' after applying brakes.**

(1) $ut + \frac{u^2}{a}$ (2) $ut + \frac{u^2}{2a}$ (3) $2ut + \frac{u^2}{a}$ (4) $2ut + \frac{u^2}{2a}$

4. **If a body starts from rest and travels 120cm in the 6^{th} second then what is the acceleration?**

(1) 0.218 m/s^2 (2) 0.318 m/s^2 (3) 0.418 m/s^2 (4) 0.518 m/s^2

5. **If a car at rest accelerates uniformly and attains a speed of 54 km/h in 10s, then it covers a distance of**

(1) 75 m (2) 100 m (3) 200 m (4) 400 m

6. **Initially a body is at rest. If its acceleration is 5 ms^{-2} then the distance travelled in the 5^{th} second is**

(1) 86.6 m (2) 87.5 m (3) 88 m (4) 22.5 m

7. **A car moving with a velocity of 10 m/s can be stopped by the application of a constant force F in a distance of 20m. If the velocity of the car is 40 m/s. It can be stopped by this force in :**

(1) $\frac{20}{3}m$ (2) 320 m (3) 60 m (4) 180 m

8. **A body starts from rest and with a uniform acceleration of 5 ms^{-2} for 5 seconds. During the next 10 seconds it moves with uniform velocity, the total distance travelled by the body is :–**

(1) 100 m (2) 312.5 m (3) 500 m (4) 625 m

9. **Three different objects of masses m_1, m_2 and m_3 are allowed to fall from rest and from the same point 'O' along three different frictionless paths. The speeds of the three objects on reaching the ground, will be in the ratio of :–**

(1) $m_1 : m_2 : m_3$ (2) $m_1 : 2m_2 : 3m_3$ (3) 1 : 1 : 1 (4) $\frac{1}{m_1} : \frac{1}{m_2} : \frac{1}{m_3}$

10. **A body is released from the top of a tower of height H m. After 2 sec it is stopped and then instantaneously released. What will be its height from ground after next 2 sec :-**

(1) (H–5) m (2) (H–10) m (3) (H–20) m (4) (H-40) m

11. **Four marbles are dropped from the top of a tower one after the other with an interval of one second. The first one reaches the ground after 4 seconds. When the first one reaches the ground, the distances between the first and second, the second and third and the third and fourth will be respectively :-**

(1) 35 m, 25 m and 15 m (2) 30 m, 20 m and 10 m

(3) 20 m, 10 m and 5 m (4) 40 m, 30 m and 20 m

12. **If a ball is thrown vertically upwards with speed u, the distance covered during the last 't' seconds of its ascent is :–**

(1) ut (2) $\frac{1}{2}gt^2$ (3) $ut-\frac{1}{2}gt^2$ (4) (u + gt)t

13. **A ball is thrown vertically upwards. The ball was observed at a height h twice with a time interval Δt. The initial velocity of the ball is**

(1) $\sqrt{8gh+(g\Delta t)^2}$ (2) $\sqrt{2gh+\left(\frac{g\Delta t}{2}\right)^2}$ (3) $\sqrt{8gh+(2g\Delta t)^2}$ (4) $\sqrt{2gh}$

14. **A stone is thrown straight upward with a speed of 20 m/sec from a tower 200 m high. The speed with which it strikes the ground is approximately (g = 9.8 m/s^2)**

(1) 60 m/sec (2) 65 m/sec (3) 70 m/sec (4) 75 m/sec

15. **A stone falls from a balloon that is descending at a uniform rate of 10 ms^{-1}. The displacement of the stone from the point of release after 10 seconds is : (g = 10 m/s^2)**

(1) 490 m (2) 510 m (3) 600 m (4) 725 m

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Answer	4	1	2	1	1	4	2	2	3	4	1	2	2	2	3

SOLUTIONS

1. **(4)**

Let a = a_0

u = 0 (given)

So $S_1 = 0 + \frac{1}{2}a_0(5)^2 = \frac{25}{2}a_0$

& S_1 + S_2 (distance covered in 15 sec)

$$= \frac{1}{2}a_0(15)^2 = \frac{225}{2}a_0$$

So $S_2 = \frac{225}{2}a_0 - \frac{25}{2}a_0 = 100a_0$

$\therefore \quad \frac{S_1}{S_2} = \frac{\frac{25}{2}a_0}{100a_0} = \frac{1}{8}$

$\Rightarrow \quad S_1 = \frac{S_2}{8}$

2. **(1)**

Initial velocity u = 126 × $\frac{5}{18}$ = 35 m/s,

s = 200 m

From equation of motion

$v^2 = u^2 + 2as$

$\Rightarrow$ 0 = $(35)^2$ + 2a × 200

$\Rightarrow$ a = –3.06 m/s^2

$\therefore$ retardation is 3.06 m/s^2

v = u + at

$\Rightarrow$ 0 = 35 – 3.06 t

$\Rightarrow$ t = 11.4 sec.

3. **(2)**

During the reaction time, the car will move with constant speed.

So, S_1 = ut

The distance covered by the car after brakes are applied, $S_2 = \frac{0^2 - u^2}{-2a} = \frac{u^2}{2a}$

So Total distance travelled = $S_1 + S_2 = ut + \frac{u^2}{2a}$

4. **(1)**

$$S_{n^{th}} = u + \frac{1}{2}a(2n-1)$$

$$\Rightarrow 1.2 = 0 + \frac{1}{2} \times a \times 11$$

$$\Rightarrow a = \frac{2.4}{11} \quad \Rightarrow a = 0.218 \text{ m/s}^2$$

5. **(1)**

$$s = \left(\frac{u+v}{2}\right) \times t = \left(\frac{0+15}{2}\right) \times 10 = 75 \text{ m}$$

6. **(4)**

$$S = 0 + \frac{5}{2}(2 \times 5 - 1) = \frac{45}{2} = 22.5 \text{ m}$$

7. **(2)**

$$\because S \propto u^2$$

$$\therefore \frac{S_1}{S_2} = \frac{u_1^2}{u_2^2}$$

$$\Rightarrow \frac{20}{S_2} = \frac{10^2}{40^2}$$

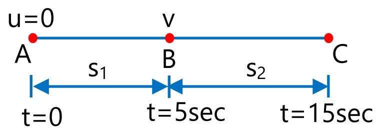
$$\Rightarrow S_2 = 320 \text{ m}$$

8. **(2)**

$$s_1 = \frac{1}{2} \times 5 \times (5)^2 = \frac{125}{2} \text{ m}$$

$v = 0 + 5(5) = 25$ m/s

$s_2 = 25 \times 10 = 250$ m



Total distance travelled = $s_1 + s_2 = 312.5$ m

9. **(3)**

$v^2 = 2as$

$v = \sqrt{2gh}$ [does not depend upon mass]

10. **(4)**

In first 2 sec the distance travelled is

$h_1 = 0 + \frac{1}{2}(10)(2)^2 = 20$ m

After stopped & released the distance travelled in next 2 sec

$h_2 = 0 + \frac{1}{2} 10 (2)^2 = 20$ m

So height from ground = (H – 40)

11. **(1)**

$$S_1 = \frac{1}{2}g(4)^2 = 80 \text{ m}$$

$$S_2 = \frac{1}{2}g(3)^2 = 45 \text{ m}$$

$$S_3 = \frac{1}{2}g(2)^2 = 20 \text{ m}$$

$$S_4 = \frac{1}{2}g(1)^2 = 5 \text{ m}$$

$S_1 - S_2 = 80 - 45 = 35$ m

$S_2 - S_3 = 45 - 20 = 25$ m

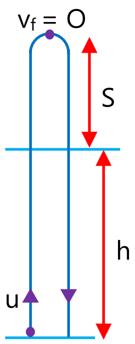
$S_3 - S_4 = 20 - 5 = 15$ m

12. **(2)**

Distance covered in last t second of ascent = Distance covered in first t second of descent $= \frac{1}{2}gt^2$

13. **(2)**

For distance 'S', time should be $\frac{\Delta t}{2}$



$$S = \frac{1}{2}g\left(\frac{\Delta t}{2}\right)^2$$

For total height

$$(h+S) = \frac{u^2}{2g}$$

$$\Rightarrow u = \sqrt{2g(h+S)} = \sqrt{2g\left(h + \frac{1}{2}g\left(\frac{\Delta t}{2}\right)^2\right)}$$

$$\Rightarrow u == \sqrt{2gh + \left(\frac{g\Delta t}{2}\right)^2}$$

14. **(2)**

$\because$ $v^2 = u^2 + 2g(H)$

$v^2 = (20)^2 + 2(9.8)(200)$

$\Rightarrow v = \sqrt{4320}$

$\Rightarrow v \simeq 65 \text{ m/s}$

15. **(3)**

Initial velocity of stone u = 10 m/sec downwards

$\therefore$ Displacement $h = ut + \frac{1}{2}gt^2$

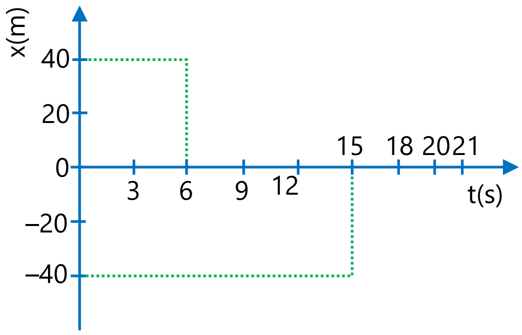
$= 10 \times 10 + \frac{1}{2} \times 10 \times (10)^2$

$= 100 + 500 = 600$ m

DAILY PRACTICE PROBLEM

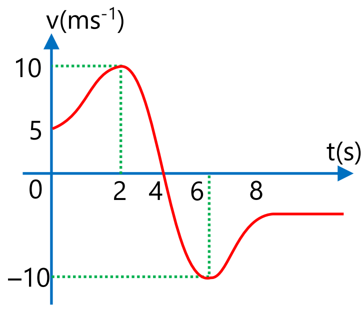
Graphical Problems in Horizontal Motion DPP-06

1. A person walks along an east-west street and a graph of his displacement from home is shown in figure. His average speed for the whole-time interval is



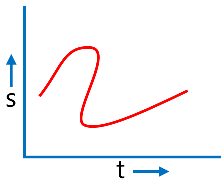
(1) 0 (2) 23 m/s (3) 8 m/s (4) None of above

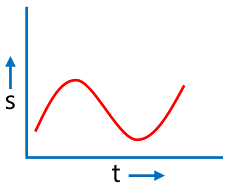
2. A particle is moving in a straight line. Its velocity time graph is shown in figure. Its speed is minimum at t =............

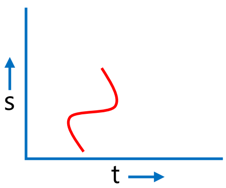


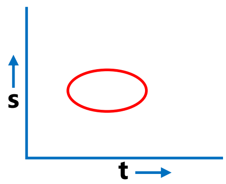
(1) 2s (2) 4s (3) 6s (4) 8s

3. Which of the following displacement–time graphs shows a realistic situation for a body in motion?

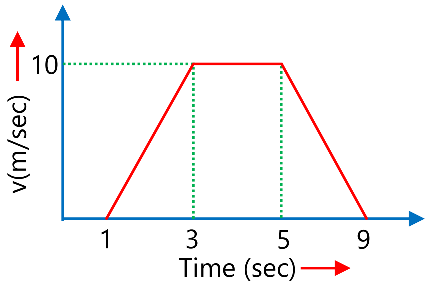
(1) 

(2) 

(3) 

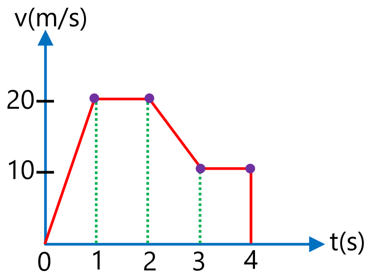
(4) 

4. **A particle moves according to given velocity–time graph. Then the ratio of distance travelled in last 4 seconds and 9 seconds is :-**



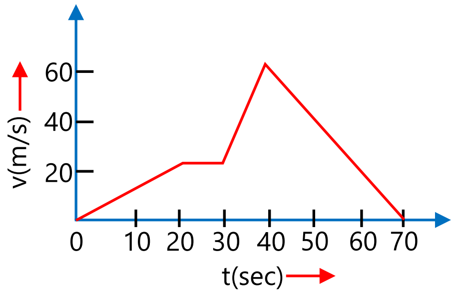
(1) $\frac{1}{4}$ (2) $\frac{2}{5}$ (3) $\frac{1}{8}$ (4) $\frac{4}{11}$

5. **The variation of velocity of a particle moving along a straight line is illustrated in the figure. The distance traversed by the particle in 3 seconds is**



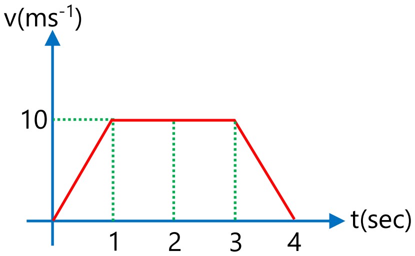
(1) 60 m (2) 45 m (3) 55 m (4) 30 m

6. **The velocity versus time curve of a moving particle is as shown in the following figure. The maximum acceleration is**



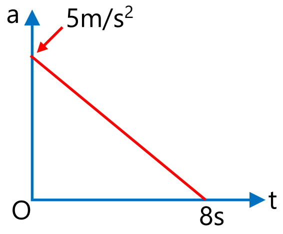
(1) $1\ m\ sec^{-2}$ (2) $2\ m\ sec^{-2}$ (3) $3\ m\ sec^{-2}$ (4) $4\ m\ sec^{-2}$

7. **Find the average acceleration of the block from time t=2 sec to t=4 sec.**



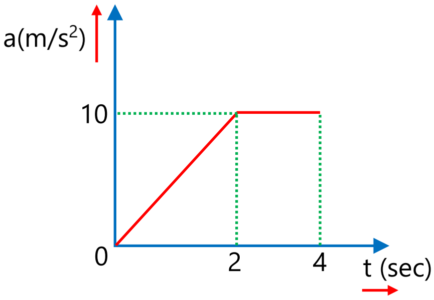
(1) $5\ m/s^2$ (2) $10\ m/s^2$ (3) $-5\ m/s^2$ (4) $-10\ m/s^2$

8. A particle starts from rest. Its acceleration at time t = 0 is 5 m/s^2 which varies with time as shown in the figure. The maximum speed of the particle will be :



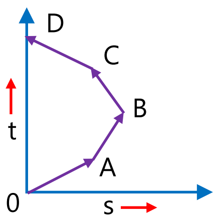
(1) 7.5 m/s (2) 15 m/s (3) 20 m/s (4) 37.5 m/s

9. A particle starts from rest, its acceleration-time graph is shown in figure. Find out velocity at t = 4 sec



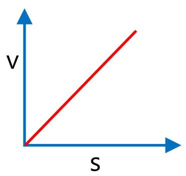
(1) 20 m/s (2) 30 m/s (3) 40 m/s (4) None of these

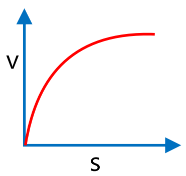
10. Which of the following options is correct for the object having a straight-line motion represented by the following graph: -

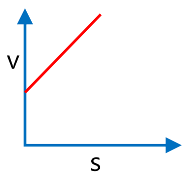


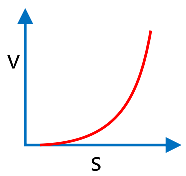
(1) The object moves with constantly increasing velocity from O to A and then it moves with constant velocity
(2) Velocity of the object increases uniformly
(3) Average velocity is zero
(4) The graph shown is impossible

11. A particle starts from rest and moves with constant acceleration. Its velocity-displacement curve is :

(1) 

(2) 

(3) 

(4) 

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11
Answer	3	2	2	2	2	4	3	3	2	3	2

SOLUTIONS

1. **(3)**

Avg. speed = $\frac{\text{Total distance}}{\text{Total time}} = \frac{120+120+60+160}{20} = 23\text{m}/\text{s}$

2. **(2)**

Speed at t = 4 s is zero and it is the minimum value.

3. **(2)**

Particle cannot have different displacements at same time.

4. **(2)**

$$\frac{\text{Distance in last 4 sec.}}{\text{Distance in 9 sec.}} = \frac{\frac{1}{2}\times 4\times 10}{\frac{1}{2}(8+2)\times 10} = \frac{2}{5}$$

5. **(2)**

Distance travelled in 3 sec

= area under the curve for 3 sec

$= \frac{20\times 1}{2} + 20\times 1 + \frac{10\times 1}{2} + 10\times 1 = 45\text{m}$

6. **(4)**

Acceleration will be maximum when slope will be maximum and that is between the duration 30s to 40s.

$a_{max} = \frac{60-20}{40-30} = \frac{40}{10} = 4\ \text{m}/\text{s}^2$

7. **(3)**

$a_{avg} = \frac{V_2 - V_1}{t_2 - t_1} = \frac{0-10}{4-2} = -5\ \text{m}/\text{s}^2$

8. **(3)**

Area under a-t graph gives the change in velocity during given time interval.

$\therefore \Delta v = \frac{1}{2} \times 5 \times 8 = 20$ m/s

Since initial velocity = 0

$\therefore$ Maximum speed of the particle = 20 m/s

9. **(2)**

Area under the acceleration-time graph = change in velocity

$\Rightarrow \frac{1}{2}(4 + 2) \times 10 = v - 0$

$\Rightarrow v = 30$ m/s

10. **(3)**

Because the displacement is zero, hence the average velocity is also zero.

11. **(2)**

For constant accelerated motion, we have $v^2 = 2as$

Hence, velocity - displacement graph will be parabola with decreasing slope.

so correct option is (2).

DAILY PRACTICE PROBLEM

Motion under Gravity-Vertical Projection from Ground DPP-07

1. A body is thrown vertically upwards. If air resistance is to be taken into account, then the time during which the body rises is

(1) Equal to the time of fall
(2) Less than the time of fall
(3) Greater than the time of fall
(4) Twice the time of fall

2. A player throws a ball upwards that reaches in his hands in 4 s. If the height of player is 1.5 m, the maximum height attained by the ball from the ground level is :

(1) 19.6 m (2) 21.1 m (3) 23.6 m (4) 25.1 m

3. A rocket is fired vertically up from the ground with a resultant vertical acceleration of 10 m/s^2. The fuel is finished in 1 minute and it continues to move up. What is the maximum height reached?

(1) 18 km (2) 36 km (3) 54 km (4) 72 km

4. A body is projected vertically up with a velocity v and after some time it returns to the point from which it was projected. The average velocity and average speed of the body for the total time of flight are -

(1) $\vec{v}/2$ and v/2 (2) 0 and v/2 (3) 0 and 0 (4) $\vec{v}/2$ and 0

5. A particle is projected upwards. The times corresponding to height h while ascending and while descending are t_1 and t_2 respectively. The velocity of projection will be :

(1) gt_1 (2) gt_2 (3) $g(t_1 + t_2)$ (4) $\frac{g(t_1+t_2)}{2}$

6. An object is projected upwards with a velocity of 100 m/s. It will strike the ground after (approximately)

(1) 10 sec (2) 20 sec (3) 15 sec (4) 5 sec

7. A rocket is fired upward from the earth's surface such that it creates an acceleration of 19.6 m/sec^2. If after 5 sec its engine is switched off, then the maximum height achieved by the rocket from earth's surface would be

(1) 245 m (2) 490 m (3) 980 m (4) 735 m

Answer Key

Question	1	2	3	4	5	6	7
Answer	2	2	2	2	4	2	4

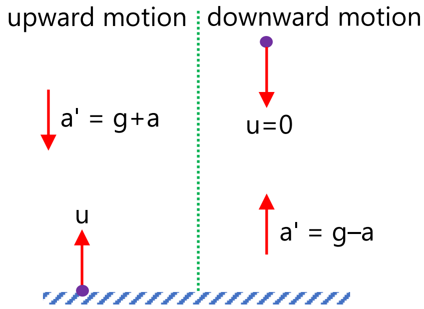
SOLUTIONS

1. **(2)**

Let the initial velocity of ball be u

Time of rise $t_1 = \frac{u}{g+a}$ and height reached $= \frac{u^2}{2(g+a)}$

Time of fall t_2 is given by



$$\frac{1}{2}(g-a)t_2^2 = \frac{u^2}{2(g+a)}$$

$$\Rightarrow t_2 = \frac{u}{\sqrt{(g+a)(g-a)}} = \frac{u}{(g+a)}\sqrt{\frac{g+a}{g-a}}$$

$\therefore t_2 > t_1$ because $\frac{1}{g+a} < \frac{1}{g-a}$

2. **(2)**

$$\frac{2u}{g} = 4$$

$\Rightarrow$ u = 2g

$$H = \frac{u^2}{2g} = 2g = 19.6\text{ m}$$

Height of the ball from ground = 19.6 + 1.5 = 21.1 m

3. **(2)**

The distance travelled by the rocket during burning interval i.e. 1 minute (= 60 sec) in which resultant acceleration is vertically upwards and 10 m/s^2 h_1 = 0× 60+(1/2)×10×602 = 18000 m=18 km

and velocity acquired by it v = 0 + 10 × 60 = 600 m/s

Now after 1 minute the rocket moves vertically up with initial velocity of 600 m/s and acceleration due to gravity opposes its motion. So, it will go to a height h_2 from this point, till its velocity becomes zero.

Hence, 0 = $(600)^2 - 2gh_2$

$\Rightarrow$ h_2 = 18000 m = 18 km [g = 10 m/s^2]

So, the maximum height reached by the rocket from the ground, H = $h_1 + h_2$ = 18 + 18 = 36 km

4. **(2)**

Here, displacement = 0

Distance = $\frac{v^2}{2g} + \frac{v^2}{2g} = \frac{v^2}{g}$

Time taken = $\frac{2v}{g}$

So, average velocity = $\frac{\text{displacement}}{\text{time}} = 0$

Average speed = $\frac{\text{distance}}{\text{time}} = \frac{v^2}{g} \times \frac{g}{2v} = \frac{v}{2}$

5. **(4)**

Time of flight = $(t_1 + t_2) = \dfrac{2v}{g}$ (v = velocity of projection)

$\Rightarrow v = \dfrac{g(t_1 + t_2)}{2}$

6. **(2)**

It will strike the ground after time of flight and

Time of flight T $= \dfrac{2u}{g} = \dfrac{2 \times 100}{10} = 20\,sec$

7. **(4)**

Given a = 19.6 m/s^2 = 2g

Resultant velocity of the rocket after 5 sec

v = 2g×5 = 10g m/s

Height achieved after 5 sec, $h_1 = \dfrac{1}{2} \times 2g \times 25 = 245m$

On switching off the engine it goes up to height h_2 where its velocity becomes zero.

$0 = (10g)^2 - 2gh_2$

$\Rightarrow h_2 = 490m$

$\therefore$ Total height achieved by rocket = $h_1 + h_2$ = 735m

DPP
DAILY PRACTICE PROBLEM

Motion under Gravity-Vertical Projection from Height DPP-08

1. **A particle is dropped from the top of a tower. During its motion, it covers $\frac{9}{25}$ part of height of tower in the last 1 second. Find the height of tower.**

(1) 120m (2) 125m (3) 130m (4) 135m

2. **A particle is dropped from the top of a tower. It covers 40 m in last 2s. Find the height of the tower.**

(1) 42m (2) 44m (3) 45m (4) 47m

3. **A particle is dropped from the top of a tower. The distance covered by it in the last one second is equal to that covered by it in the first three seconds. Find the height of the tower.**

(1) 115 m (2) 125 m (3) 135 m (4) 145 m

4. **Water drops are falling in regular intervals of time from top of a tower of height 9 m. If 4^{th} drop begins to fall when 1^{st} drop reaches the ground, find the positions of 3^{rd} drops from the top of the tower.**

(1) 1m (2) 2m (3) 3m (4) 4m

5. **An elevator is accelerating upward at a rate of 6 ft/sec^2 when a bolt from its ceiling falls to the floor of the lift (Distance = 19 feet). The time (in seconds) taken by the falling bolt to hit the floor is (take g = 32 ft/ sec^2)**

(1) $\sqrt{2}$ (2) 1 (3) $2\sqrt{2}$ (4) $\frac{1}{2\sqrt{2}}$

6. **A body is released from the top of a tower of height h. It takes t sec to reach the ground. Where will be the ball after time t/2 sec**

(1) At h/2from the ground (2) At h/4 from the ground
(3) Depends upon mass and volume of the body (4) At 3h/4 from the ground

7. **A stone thrown upward with a speed u from the top of the tower reaches the ground with a velocity 3u. The height of the tower is**

(1) $3u^2/g$ (2) $4u^2/g$ (3) $6u^2/g$ (4) $9u^2/g$

8. **A ball is thrown vertically upwards from the top of a tower at 4.9 ms^{-1}. It strikes the pond near the base of the tower after 3 seconds. The height of the tower is**

(1) 73.5 m (2) 44.1 m (3) 29.4 m (4) None of these

Answer Key

Question	1	2	3	4	5	6	7	8
Answer	2	3	2	1	2	4	2	3

SOLUTIONS

1. **(2)**

Let it takes n seconds to fall from the tower.

Height of tower H = $\frac{1}{2}g(n)^2$

Distance travelled in n^{th} second

$$S_{n^{th}} = 0 + \frac{g}{2}(2n-1)$$

$$\Rightarrow S_{n^{th}} = \frac{9}{25}H$$

$$\frac{9}{25}H = \frac{g}{2}(2n-1)$$

$$\Rightarrow \frac{9}{25}\left(\frac{1}{2}g(n^2)\right) = \frac{g}{2}(2n-1)$$

$$\Rightarrow 9n^2 = 50n - 25$$

$$\Rightarrow n = \frac{50 + \sqrt{50^2 - 4\times 9\times(+25)}}{2\times 9} = 5$$

$$H = \frac{1}{2}g(5)^2 = 125m$$

2. **(3)**

Let the particle covers its total journey in n seconds then

$$\frac{1}{2}g(n)^2 - \frac{1}{2}g(n-2)^2 = 40$$

$$\Rightarrow (4n-4) = 8 \Rightarrow n = 3$$

Height of tower $= \frac{1}{2}g(3)^2 = 45m$

3. **(2)**

Let time of fall be 'n'

$$\frac{1}{2}g(2n-1) = \frac{1}{2}g(3)^2$$

$$\Rightarrow n = 5sec$$

Height of tower $= \frac{1}{2}g(5)^2 = 125m$

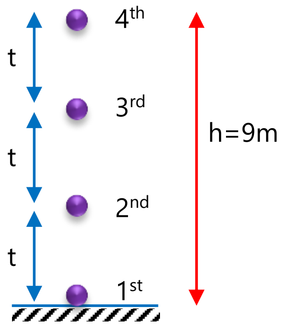
4. **(1)**

$$3t = \sqrt{\frac{2\times 9}{10}}$$

$$\Rightarrow t = \sqrt{\frac{1}{5}}$$

Position of 3^{rd} drop

$$\Rightarrow S_3 = \frac{1}{2}\times 10\times\left(\sqrt{\frac{1}{5}}\right)^2 = 1m$$



5. **(2)**

Effective acceleration in ascending lift = (g + a)

$$t=\sqrt{\frac{2h}{g+a}}=\sqrt{\frac{2\times 19}{32+6}}$$

$$t=\sqrt{\frac{2\times 19}{38}}=1\,\text{sec}$$

6. **(4)**

Let the body after time t/2 be at x from the top, then

$$x=\frac{1}{2}g\frac{t^2}{4}=\frac{gt^2}{8} \qquad \text{...(i)}$$

$$h=\frac{1}{2}gt^2 \qquad \text{...(ii)}$$

Eliminate t from (i) and (ii), we get $x=\frac{h}{4}$

$\therefore$ Height of the body from the ground $=h-\frac{h}{4}=\frac{3h}{4}$

7. **(2)**

$$v^2=u^2+2gh$$

$$\Rightarrow (3u)^2=(-u)^2+2gh$$

$$\Rightarrow h=\frac{4u^2}{g}$$

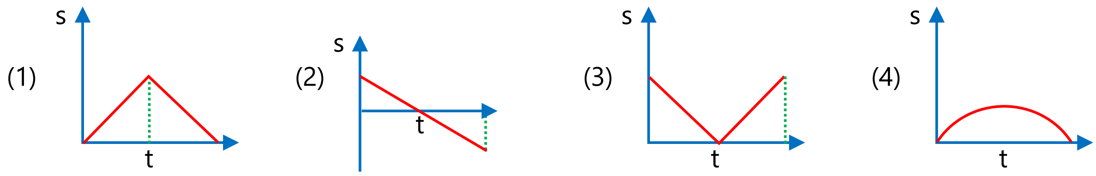
8. **(3)**

$h=ut+\frac{1}{2}gt^2$ (Given $t=3\,\text{sec}, u=-4.9\,\text{m/s}$)

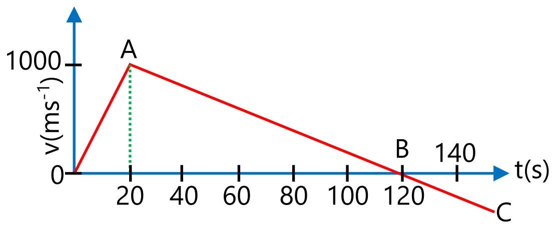
$$\Rightarrow h=-4.9\times 3+4.9\times 9=29.4\,\text{m}$$

Graphical Problems in Vertical Motion DPP-09

1. A body is projected vertically upward from the surface of the earth, its displacement-time graph is:

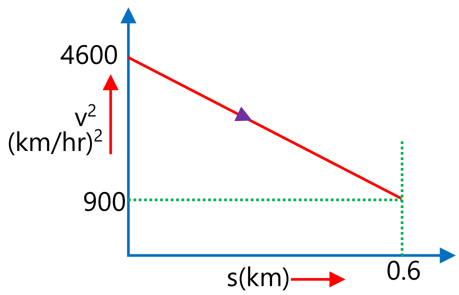


2. A rocket is launched upward from the earth's surface whose velocity time graphs shown in figure. Then maximum height attained by the rocket is :



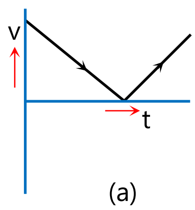
(1) 1 km (2) 10 km (3) 100 km (4) 60 km

3. Graph between the square of the velocity (v) of a particle and the distance (s) moved is shown in figure. The acceleration of the particle in kilometers per hour square is :

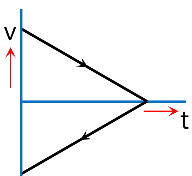


(1) 2250 (2) 3084 (3) –2250 (4) –3084

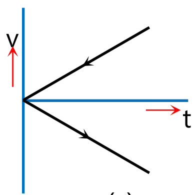
4. A ball is thrown vertically upwards. Which of the following graph represents velocity-time graph of the ball during its flight (air resistance is neglected).



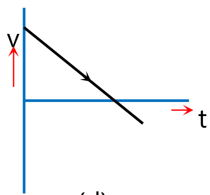
(a)



(b)



(c)



(d)

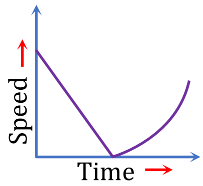
(1) A (2) B (3) C (4) D

5. **Velocity-time curve for a body projected vertically upwards is**

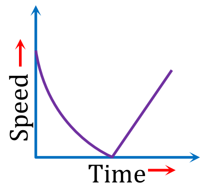
(1) Parabola (2) Ellipse (3) Hyperbola (4) Straight line

6. **A ball is thrown vertically upwards. Which of the following plots represents the speed-time graph of the ball during its height if the air resistance is not ignored**

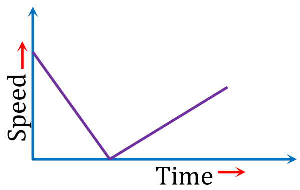
(1)



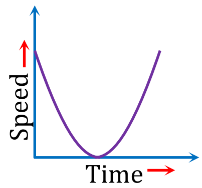
(2)



(3)

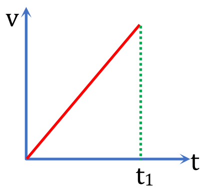


(4)

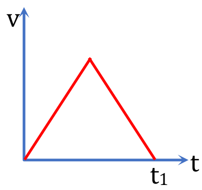


7. **A ball is thrown straight up with velocity at t = 0 and returns to earth at $t = t_1$. Which graph shows the correct motion?**

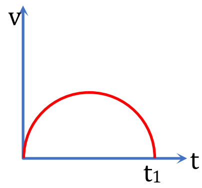
(1)



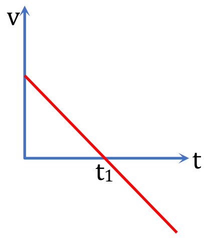
(2)



(3)



(4)



Answer Key

Question	1	2	3	4	5	6	7
Answer	4	4	4	4	4	3	4

SOLUTIONS

1. **(4)**

The slope of S-t curve gives velocity.

2. **(4)**

Area of v–t curve = displacement (here height)

$$= \frac{1}{2} \times 120 \times 1000 = 60{,}000\text{m} = 60 \text{ km}$$

3. **(4)**

$v^2 = u^2 + 2as$

$$\Rightarrow a = \frac{v^2 - u^2}{2s} = \frac{(900) - (4600)}{2 \times 0.6} = -\frac{3700}{1.2} = -3084 \text{ km/hr}^2$$

4. **(4)**

During free fall, acceleration of the ball will remain constant i.e. slope of velocity-time curve will be constant.

Hence, option (4) is correct answer.

5. **(4)**

During free fall, acceleration of the ball will remain constant and slope of velocity-time curve gives acceleration. Hence, curve will be a straight line.

6. **(3)**

For ascending and descending motion, acceleration of the ball is constant but acceleration for descending motion is greater than acceleration for ascending motion. Hence magnitude of slope for descending motion will be greater.

7. **(4)**

Acceleration during the motion of the ball is constant.

Hence, v-t curve is a straight line with negative slope (-g) and positive intercept.