

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.

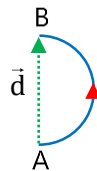
- (1) $2\pi r, 7r$
- (2) $7\pi r, 2r$
- (3) $7r, 2\pi r$
- (4) $2r, 7\pi r$

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

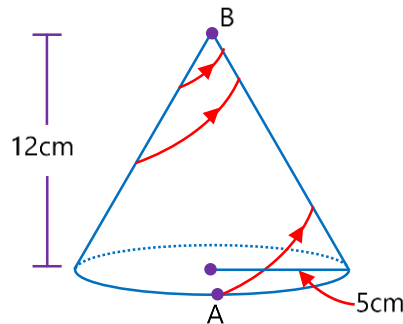
6. The numerical ratio of distance to the displacement covered is always :-

- (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

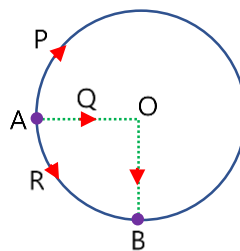
- (1) $5\sqrt{3}$ m
- (2) $10\sqrt{3}$ m
- (3) $20\sqrt{3}$ m
- (4) $30\sqrt{3}$ m

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 DPP-01

1. (2)

$$t = 2 \text{ min } 20 \text{ sec} = 120 + 20 = 140 \text{ sec}$$

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

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

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

$$\text{Distance in } 3\frac{1}{2} \text{ rotation} = 3 \times (2\pi r + \pi r) = 7\pi r \quad (\because \text{After each complete rotation, distance} = 2\pi r)$$

2. (1)

$$\text{Distance} = 4 + 3 + 12 = 19 \text{ m}$$

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

3. (4)

$$\text{Displacement} = 2r = 80 \text{ m}$$

4. (1)

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

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

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

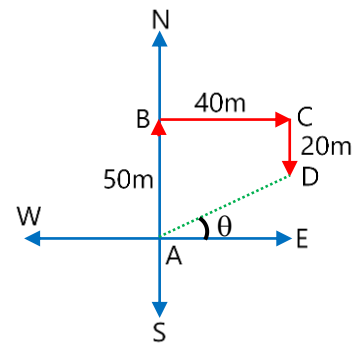
$$\text{or } \overline{AD} = 50\hat{j} + 40\hat{i} - 20\hat{j} = 40\hat{i} + 30\hat{j}$$

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

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

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

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



5. (1)

$$\text{Displacement} \leq \text{Distance}$$

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)

$$\text{Ratio} = \frac{s_p}{s_q} = \frac{\frac{3}{2}\pi r}{\frac{\pi R}{2}} = \frac{3}{1}$$

10. (1)

$$\begin{aligned} \text{Distance} &= \frac{2\pi R}{3600} \times 100 \\ &= \frac{2\pi \times 10}{3600 \times 100} \times 100 = \frac{\pi}{180} \text{ m} \end{aligned}$$

11. (2)

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

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

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

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

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

12. (1)

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

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

Position from starting point

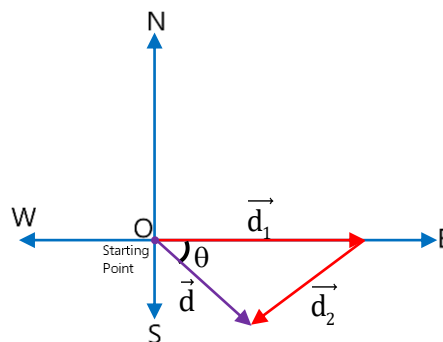
$$\vec{d} = \vec{d}_1 + \vec{d}_2$$

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

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

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

$$\theta = 53^\circ \text{ east of south}$$



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 $\frac{2}{5}$ th of total distance with v_1 speed and $\frac{3}{5}$ th distance with v_2 speed then the average speed is :-

(1) $\frac{1}{2}\sqrt{v_1 v_2}$

(2) $\frac{v_1 + v_2}{2}$

(3) $\frac{2v_1 + v_2}{v_1 + v_2}$

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

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) $\frac{24}{13}$

(2) $\frac{40}{13}$

(3) 3

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

Answer key

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

SOLUTIONS DPP-02

1. (3)

$$v_{\text{avg}} = \frac{2v_1v_2}{v_1+v_2} = \frac{2 \times 30 \times 70}{30+70} = 42 \text{ km/h}$$

2. (3)

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

3. (3)

$$t_1 = \frac{10 \times 1000}{100} = 100 \text{ sec.}$$

$$t_2 = \frac{10 \times 1000}{50} = 200 \text{ sec.}$$

$$\begin{aligned} \text{Avg. speed} &= \frac{\text{Total distance}}{\text{Total time}} = \frac{10000+10000}{300} \\ &= 66.66 \approx 66.7 \text{ m/s} \end{aligned}$$

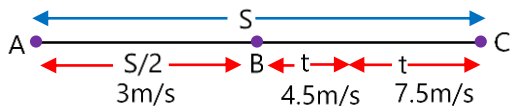
4. (3)

$$\begin{aligned} \text{Average speed} &= \frac{3v_1v_2v_3}{v_1v_2 + v_2v_3 + v_1v_3} \\ &= \frac{3 \times v \times 2v \times 3v}{2v^2 + 6v^2 + 3v^2} = \frac{18}{11}v \end{aligned}$$

5. (4)

$$\begin{aligned} \text{Average speed} &= \frac{S}{\frac{2S}{v_1} + \frac{3S}{v_2}} = \frac{5}{\frac{2}{v_1} + \frac{3}{v_2}} = \frac{5v_1v_2}{3v_1 + 2v_2} \end{aligned}$$

6. (2)



Average speed from B to C

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

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

Average speed from A to C

$$(v_{\text{Avg}})_{A \rightarrow C} = \frac{\frac{S}{2} + \frac{S}{2}}{\frac{S}{2 \times 3} + \frac{S}{2 \times 6}}$$

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

7. (2)

$$\begin{aligned} \text{Average speed} &= \frac{2v_1v_2}{v_1 + v_2} \\ &= \frac{2 \times 20 \times 30}{20 + 30} \\ &= \frac{120}{5} = 24 \text{ km/hr} \end{aligned}$$

8. (2)

$$\begin{aligned} \text{Average speed} &= \frac{2v_1v_2}{v_1 + v_2} \\ &= \frac{2 \times 2.5 \times 4}{2.5 + 4} \\ &= \frac{200}{65} = \frac{40}{13} \text{ km/hr} \end{aligned}$$

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.

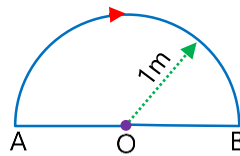
- (1) 5×10^{-3} cm/s
- (2) 5×10^{-4} cm/s
- (3) 5×10^{-5} cm/s
- (4) 5×10^{-6} cm/s

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.

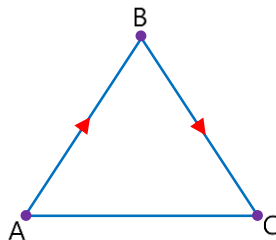
- (1) 1 m/s
- (2) 2 m/s
- (3) 3 m/s
- (4) 4 m/s



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 :

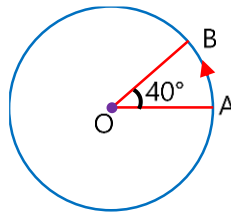
- (1) $\frac{v_1 + v_2 + v_3}{3}$
- (2) $\frac{3v_1v_2v_3}{v_1v_2 + v_2v_3 + v_3v_1}$
- (3) $\frac{v_1v_2 + v_2v_3 + v_3v_1}{3}$
- (4) $\frac{v_1v_2v_3}{3}$

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) $2v \cos 40^\circ$
- (2) $2v \sin 40^\circ$
- (3) $2v \cos 20^\circ$
- (4) $2v \sin 20^\circ$



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

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) $v = \text{constant}$

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 DPP-03

1. (1)

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

∴ Displacement (S) = 2 × (length of minute hand)

$$= 2 \times 4.5 \text{ cm} = 9 \text{ cm}$$

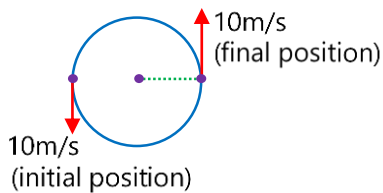
and time taken (t) = 30 min = 30 × 60 = 1800s

∴ Average velocity = $\frac{S}{t}$

$$= \frac{9}{1800} = 5 \times 10^{-3} \text{ cm/s}$$

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

2. (1)



Change in speed

$$\Delta v = 10 - 10 = 0$$

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

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

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

4. (2)

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

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

5. (2)

Let the constant speed is v , then

Average speed = v

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

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

6. (1)

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

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

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

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

7. (1)

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

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

8. (4)

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

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

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

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

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

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

9. (4)

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

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

$$\Delta v = 2v \sin 20^\circ$$

10. (3)

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

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

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

11. (1)

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

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

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

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

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

$$\therefore v \propto t$$

Acceleration DPP-04

- 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.**
 - $\frac{1}{\pi} \text{ m/s}^2$
 - $\frac{10}{\pi} \text{ m/s}^2$
 - $\frac{2}{\pi} \text{ m/s}^2$
 - $\frac{20}{\pi} \text{ m/s}^2$
- If x denotes displacement in time t and $x = a \sin t$, then acceleration is :**
 - $a \cos t$
 - $-a \cos t$
 - $a \sin t$
 - $-a \sin t$
- The motion of a particle is described by the equation $x = a + bt^2$ where $a = 15 \text{ cm}$ and $b = 3 \text{ cm/sec}^2$. Its acceleration at time 3 sec will be :-**
 - 36 cm/sec^2
 - 18 cm/sec^2
 - 6 cm/sec^2
 - 32 cm/sec^2
- Equation of displacement for a particle is $s = 3t^3 + 7t^2 + 14t + 8 \text{ m}$. Its acceleration at time $t = 2 \text{ sec}$ is :-**
 - 10 m/s^2
 - 16 m/s^2
 - 25 m/s^2
 - 50 m/s^2
- 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 :-**
 - 2 m/s^2
 - 4 m/s^2
 - 5 m/s^2
 - zero
- Equation of a particle moving along the x axis is $x = u(t - 2) + a(t - 2)^2$**
 - the initial velocity of the particle is u
 - the acceleration of the particle is a
 - the acceleration of the particle is $2a$
 - 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/s² towards N-W
- (3) $\frac{1}{\sqrt{2}}$ m/s² towards N-E
- (4) $\frac{1}{\sqrt{2}}$ m/s² 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/s²
- (3) -8 m/s²
- (4) 4 m/s²

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 DPP-04

1. (2)

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

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

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

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

2. (4)

$$x = a \sin t$$

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

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

3. (3)

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

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

4. (4)

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

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

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

$$\text{At } t = 2, \quad a = 50 \text{ m/s}^2$$

5. (1)

$$t = \sqrt{x} + 3$$

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

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

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

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

6. (3)

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

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

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

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)

$$v = 20 + 0.1t$$

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

Acceleration is uniform.

9. (1)

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

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

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

10. (1)

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

$$v = 12t - 3t^2$$

$$a = 12 - 6t$$

$$a = 0 \text{ at } t = 2 \text{ sec.}$$

11. (4)

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

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

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

$$a = 0 \text{ at } t = 2$$

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

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

12. (3)

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

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

$$\text{acceleration } a' = 2b - 6ct$$

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

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

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

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

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

13. (4)

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

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

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

14. (3)

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

$$\therefore a = \frac{v dv}{dx}$$

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

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

$$a = -8 \text{ m/s}^2$$

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 6th 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 5th 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 ($g = 9.8 \text{ m/s}^2$)
- (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 : ($g = 10 \text{ m/s}^2$)
- (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 DPP-05

1. (4)

Let $a = a_0$

$u = 0$ (given)

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

& $S_1 + S_2$ (distance covered in 15 sec)

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

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

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

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

2. (1)

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

$$s = 200 \text{ m}$$

From equation of motion

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

$$\Rightarrow 0 = (35)^2 + 2a \times 200$$

$$\Rightarrow a = -3.06 \text{ m/s}^2$$

\therefore retardation is 3.06 m/s^2

$$v = u + at$$

$$\Rightarrow 0 = 35 - 3.06 t$$

$$\Rightarrow t = 11.4 \text{ sec.}$$

3. (2)

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

$$\text{So, } S_1 = ut$$

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

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

4. (1)

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

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

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

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)

$$\therefore S \propto u^2$$

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

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

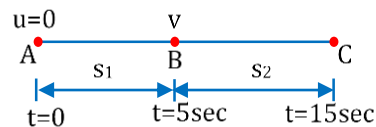
$$\Rightarrow S_2 = 320 \text{ m}$$

8. (2)

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

$$v = 0 + 5(5) = 25 \text{ m/s}$$

$$s_2 = 25 \times 10 = 250 \text{ m}$$



$$\text{Total distance travelled} = s_1 + s_2 = 312.5 \text{ m}$$

9. (3)

$$v^2 = 2as$$

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

10. (4)

In first 2 sec the distance travelled is

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

After stopped & released the distance travelled in next 2 sec

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

$$\text{So height from ground} = (H - 40)$$

11. (1)

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

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

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

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

$$S_1 - S_2 = 80 - 45 = 35 \text{ m}$$

$$S_2 - S_3 = 45 - 20 = 25 \text{ m}$$

$$S_3 - S_4 = 20 - 5 = 15 \text{ m}$$

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 $\frac{\Delta t}{2}$

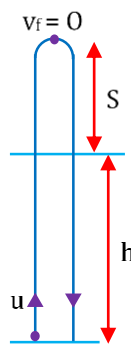
$$S = \frac{1}{2}g\left(\frac{\Delta t}{2}\right)^2$$

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)

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

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

$$\Rightarrow v = \sqrt{4320}$$

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

15. (3)

Initial velocity of stone $u = 10 \text{ m/sec}$ downwards

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

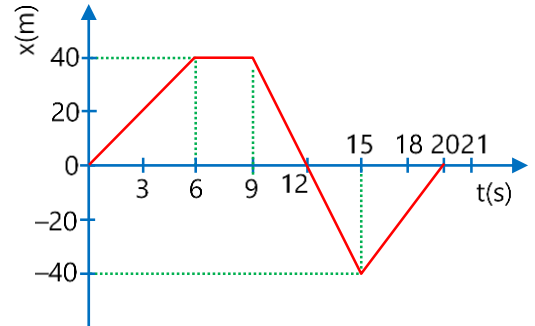
$$= 10 \times 10 + \frac{1}{2} \times 10 \times (10)^2$$

$$= 100 + 500 = 600 \text{ m}$$

Graphical Problems in Horizontal Motion DPP-06

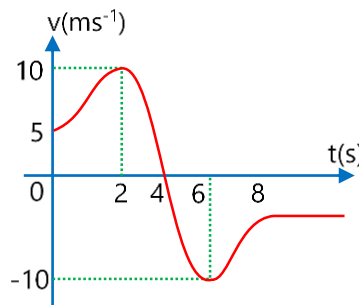
1. A person walks along an east-west street and a graph of his displacement from home is shown in figure. His average speed for the whole-time interval is

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

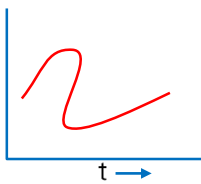
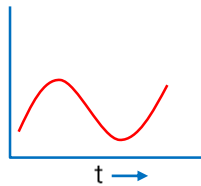
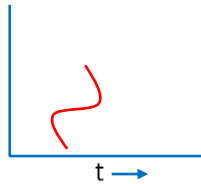
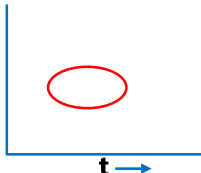


2. A particle is moving in a straight line. Its velocity time graph is shown in figure. Its speed is minimum at $t = \dots\dots\dots$

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

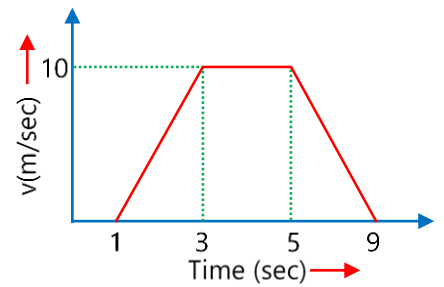


3. Which of the following displacement–time graphs shows a realistic situation for a body in motion ?

- (1) 
- (2) 
- (3) 
- (4) 

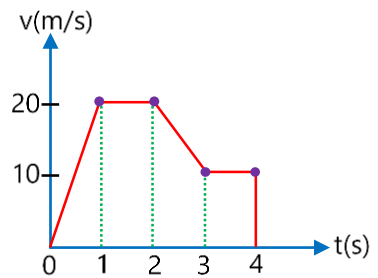
4. A particle moves according to given velocity–time graph. Then the ratio of distance travelled in last 4 seconds and 9 seconds is :-

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



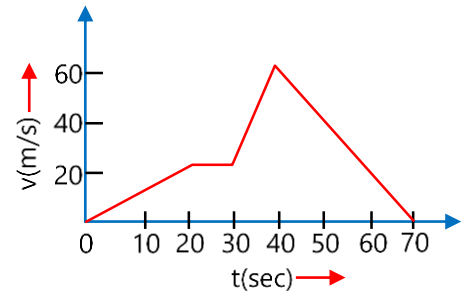
5. The variation of velocity of a particle moving along a straight line is illustrated in the figure. The distance traversed by the particle in 3 seconds is

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



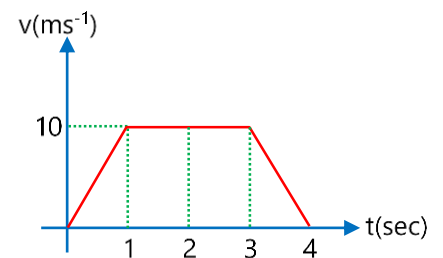
6. The velocity versus time curve of a moving particle is as shown in the following figure. The maximum acceleration is

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



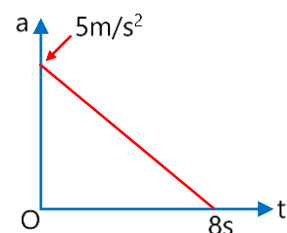
7. Find the average acceleration of the block from time $t=2 \text{ sec}$ to $t=4 \text{ sec}$.

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



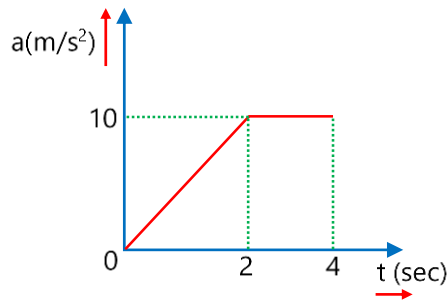
8. A particle starts from rest. Its acceleration at time $t = 0$ is 5 m/s^2 which varies with time as shown in the figure. The maximum speed of the particle will be :

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

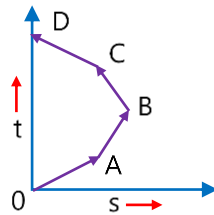


9. A particle starts from rest, its acceleration-time graph is shown in figure. Find out velocity at $t = 4$ sec

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

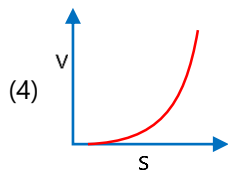
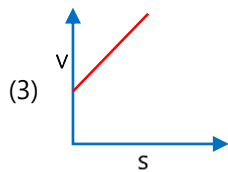
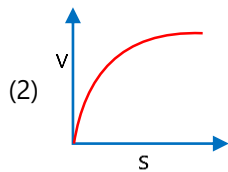
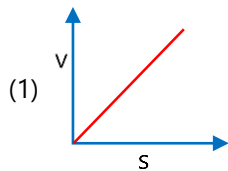


10. Which of the following options is correct for the object having a straight line motion represented by the following graph :-



- (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 :



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 DPP-06

1. (3)

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

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.

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

7. (3)

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

8. (3)

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

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

Since initial velocity = 0

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

9. (2)

Area under the acceleration-time graph = change in velocity

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

$$\Rightarrow v = 30 \text{ m/s}$$

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).

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) $\bar{v}/2$ and $v/2$
 - (2) 0 and $v/2$
 - (3) 0 and 0
 - (4) $\bar{v}/2$ 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 DPP-07

1. (2)

Let the initial velocity of ball be u

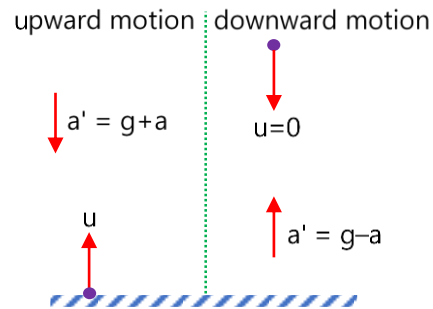
$$\text{Time of rise } t_1 = \frac{u}{g+a} \text{ and height reached} = \frac{u^2}{2(g+a)}$$

Time of fall t_2 is given by

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

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

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



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 = $19.6 + 1.5 = 21.1 \text{ m}$

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 $h_1 = 0 \times 60 + (1/2) \times 10 \times 60^2 = 18000 \text{ m} = 18 \text{ km}$ and velocity acquired by it $v = 0 + 10 \times 60 = 600 \text{ m/s}$

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.

$$\text{Hence, } 0 = (600)^2 - 2gh_2$$

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

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

4. (2)

Here, displacement = 0

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

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

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

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

5. (4)

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

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

6. (2)

It will strike the ground after time of flight and

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

7. (4)

$$\text{Given } a = 19.6 \text{ m/s}^2 = 2g$$

Resultant velocity of the rocket after 5 sec

$$v = 2g \times 5 = 10g \text{ m/s}$$

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

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

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

$$\Rightarrow h_2 = 490\text{m}$$

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

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 4th drop begins to fall when 1st drop reaches the ground, find the positions of 3rd 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/sec² 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/ sec²)**

 - (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 $h/2$ from 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 DPP-08

1. (2)

Let it takes n seconds to fall from the tower.

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

Distance travelled in n^{th} second

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

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

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

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

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

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

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

2. (3)

Let the particle covers its total journey in n seconds then

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

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

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

3. (2)

Let time of fall be ' n '

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

$$\Rightarrow n = 5\text{sec}$$

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

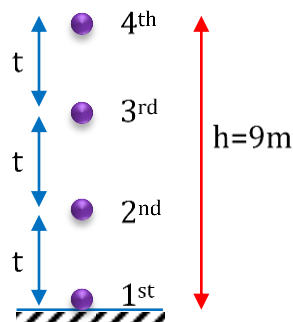
4. (1)

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

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

Position of 3rd drop

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



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

$$x = \frac{1}{2}g \frac{t^2}{4} = \frac{gt^2}{8} \quad \dots(i)$$

$$h = \frac{1}{2}gt^2 \quad \dots(ii)$$

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

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

7. (2)

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

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

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

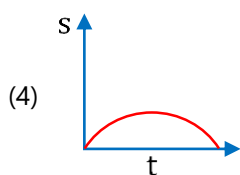
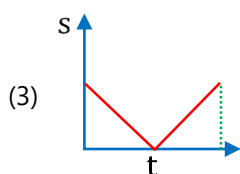
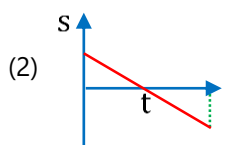
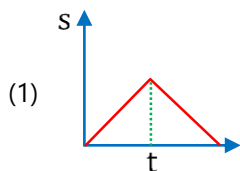
8. (3)

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

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

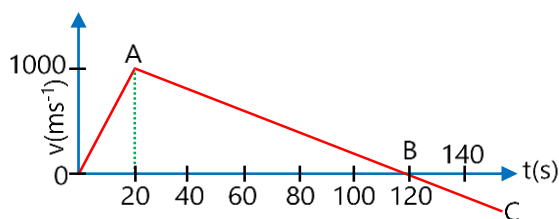
Graphical Problems in Vertical Motion DPP-09

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



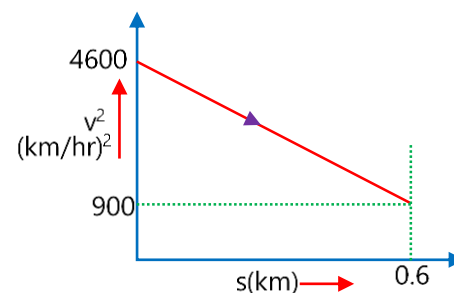
2. A rocket is launched upward from the earth's surface whose velocity time graphs shown in figure. Then maximum height attained by the rocket is :

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

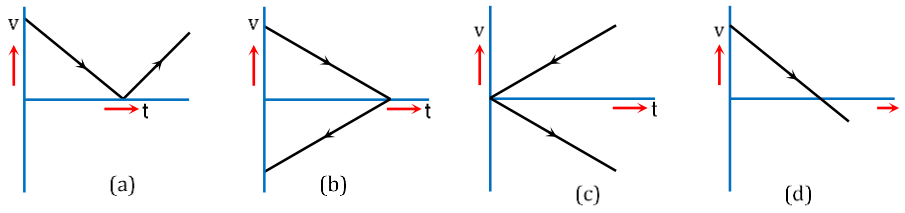


3. Graph between the square of the velocity (v) of a particle and the distance (s) moved is shown in figure. The acceleration of the particle in kilometers per hour square is :

- (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).

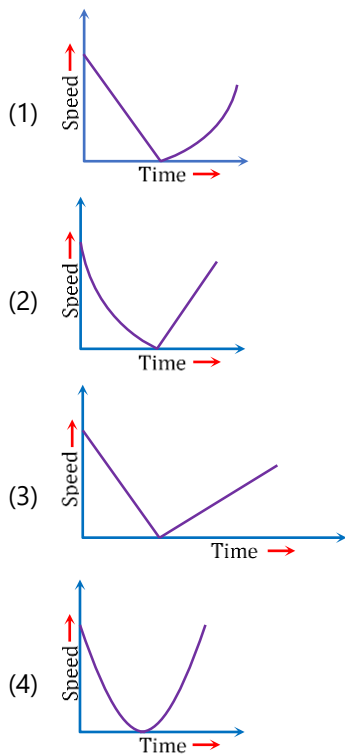


- (1) A
- (2) B
- (3) C
- (4) D

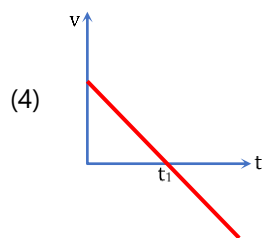
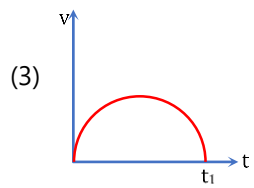
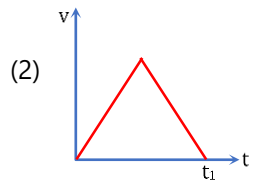
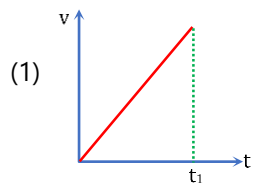
5. Velocity-time curve for a body projected vertically upwards is

- (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



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?



Answer key

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

SOLUTIONS DPP-09

- (4)**
The slope of S-t curve gives velocity.
- (4)**
Area of v-t curve = displacement (here height)

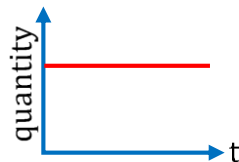
$$= \frac{1}{2} \times 120 \times 1000 = 60,000\text{m} = 60 \text{ km}$$
- (4)**

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

$$\Rightarrow a = \frac{v^2 - u^2}{2s} = \frac{(900) - (4600)}{2 \times 0.6} = -\frac{3700}{1.2} = -3084 \text{ km/hr}^2$$
- (4)**
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.
- (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.
- (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.
- (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.

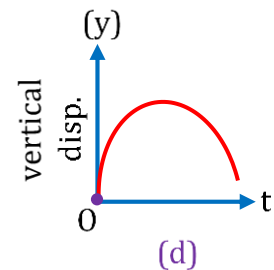
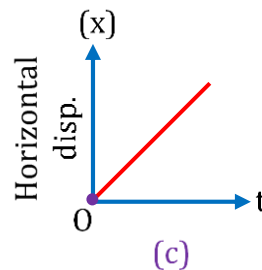
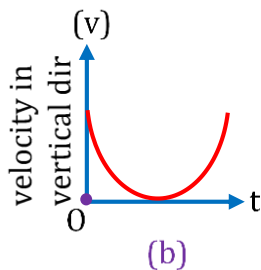
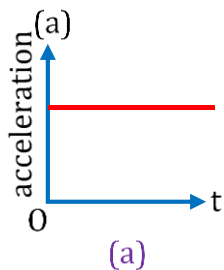
Ground to Ground Projectile Motion DPP-10

1. In the graph shown in fig. time is plotted along x-axis. Which quantity associated with a projectile motion is plotted along the y - axis?



- (1) kinetic energy
- (2) momentum
- (3) horizontal velocity
- (4) none of the above

2. For ground to ground projection following curves are given :-



Find incorrect one.

- (1) a
 - (2) b
 - (3) c
 - (4) d
3. Which of the following quantities remains constant during projectile motion?

(A) Average velocity between two points.

(B) Average speed between two points

(C) $\frac{d\vec{v}}{dt}$

(D) $\frac{d^2}{dt^2}(\vec{v})$

- (1) only A
- (2) only C
- (3) A and C
- (4) C and D

4. In a projectile motion, the velocity :-

- (1) is always perpendicular to the acceleration
- (2) is never perpendicular to the acceleration
- (3) is perpendicular to the acceleration for one instant only
- (4) is perpendicular to the acceleration for two instants

5. A body of mass m is thrown upwards at an angle θ with the horizontal with speed v . While rising up the magnitude of the velocity after t seconds will be:

- (1) $\sqrt{(v\cos\theta)^2 + (v\sin\theta)^2}$
- (2) $\sqrt{(v\cos\theta - v\sin\theta)^2 - gt}$
- (3) $\sqrt{v^2 + g^2t^2 - (2v\sin\theta)gt}$
- (4) $\sqrt{v^2 + g^2t^2 - (2v\cos\theta)gt}$

6. A particle is fired with velocity u making θ angle with the horizontal. What is the magnitude of change in velocity when it returns to the ground.

- (1) $u \cos \theta$
- (2) u
- (3) $2u \sin \theta$
- (4) $(u \cos \theta - u)$

7. In the above, the change in speed is :

- (1) $u \cos \theta$
- (2) 0
- (3) $u \sin \theta$
- (4) $(u \cos \theta - u)$

8. The angle which the velocity vector of a projectile, will make with the vertical after time t of its being thrown with a velocity v at an angle θ to the horizontal, is :

- (1) θ
- (2) $\tan^{-1}\left(\frac{\theta}{t}\right)$
- (3) $\tan^{-1}\left(\frac{v\cos\theta}{v\sin\theta - gt}\right)$
- (4) $\tan^{-1}\left(\frac{v\sin\theta - gt}{v\cos\theta}\right)$

9. At a height 0.4 m from the ground, the velocity of a projectile in vector form is : $\vec{v} = (6\hat{i} + 2\hat{j})$ m/s . The angle of projection from horizontal is

($g = 10$ m/s²) :-

- (1) 45°
- (2) 60°
- (3) 30°
- (4) $\tan^{-1}(3/4)$

Answer key

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

SOLUTIONS DPP-10

1. (3)
Horizontal component of velocity remain same.

2. (2)

3. (4)
For projectile motion acceleration is constant

$$\frac{d\vec{v}}{dt} = \text{constant} \quad \& \quad \frac{d^2\vec{v}}{dt^2} = 0$$

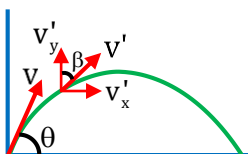
4. (3)
At highest point only velocity is horizontal & acceleration (g) is vertically downwards.

5. (3)
After time 't'
velocity $\vec{v} = (v_x)\hat{i} + (v_y)\hat{j}$
 $\vec{v} = (v \cos\theta)\hat{i} + (v \sin\theta - gt)\hat{j}$
 $|\vec{v}| = \sqrt{(v \cos\theta)^2 + (v \sin\theta - gt)^2}$
 $= \sqrt{v^2 + g^2t^2 - (2v \sin\theta)gt}$

6. (3)
 $\Delta v_x = 0$ (as $\vec{v}_x = \text{const}$)
 $\Delta v_y = -u \sin \theta - (+ u \sin \theta)$
So change in velocity = $-2u \sin \theta$

7. (2)
Change in speed = speed_{Top} - speed_{bottom}
change in speed = $u - u = 0$

8. (3)
 $\tan\beta = \frac{v_x}{v_y} = \frac{v \cos\theta}{v \sin\theta - gt}$



9. (3)

For vertical motion

$$v_y^2 = u_y^2 - 2g(h)$$

$$(2)^2 = u_y^2 - 2(10) \quad (0.4)$$

$$u_y = 2\sqrt{3}$$

$$\therefore \vec{u} = (u_x)\hat{i} + (u_y)\hat{j}$$

$$\therefore \vec{u} = 6\hat{i} + 2\sqrt{3}\hat{j}$$

$$\tan\theta = \frac{2\sqrt{3}}{6} = \frac{1}{\sqrt{3}} \Rightarrow \boxed{\theta = 30^\circ}$$

Problems Based on Ground to Ground Projectile Motion DPP-11

1. **A bomb is fired from a cannon with a velocity of 1000 m/s making an angle of 30° with the horizontal. What is the time taken by the bomb to reach at the highest point-**
 - (1) 11 sec
 - (2) 23 sec
 - (3) 38 sec
 - (4) 50 sec
2. **If time of flight of a projectile is 10 seconds. Range is 500 meters. The maximum height attained by it will be :-**
 - (1) 125 m
 - (2) 50 m
 - (3) 100 m
 - (4) 150 m
3. **A body is thrown with a velocity of 19.6 m/s making an angle of 30° with the horizontal. It will hit the ground after a time :-**
 - (1) 3s
 - (2) 2s
 - (3) 1.5s
 - (4) 1s
4. **A projectile is projected with initial velocity $(5\hat{i} + 12\hat{j})$ m/s. If $g = 10 \text{ ms}^{-2}$, then horizontal range is :**
 - (1) 4.8 metre
 - (2) 9.6 metre
 - (3) 19.2 metre
 - (4) 12 metre
5. **The range of a projectile when fired at 60° to the horizontal is 0.5 km. What will be its range when fired at 45° with the same speed?**
 - (1) 0.5 km
 - (2) $\frac{1}{\sqrt{3}}$ km
 - (3) 1.5 km
 - (4) 2 km
6. **The speed of a projectile at its maximum height is $\frac{1}{2}$ times of its initial speed 'u' of projection. Its range on the horizontal plane is :**
 - (1) $\frac{\sqrt{3}u^2}{2g}$
 - (2) $\frac{u^2}{2g}$
 - (3) $\frac{3u^2}{2g}$
 - (4) $\frac{3u^2}{g}$

7. For a given angle of projection if the initial velocity is tripled the range of the projectile becomes :-
- (1) 9 times
 - (2) one-fourth
 - (3) two times
 - (4) four times
8. A ball is thrown at an angle θ to the vertical and the range is maximum. The value of $\tan \theta$ is :
- (1) 1
 - (2) $\sqrt{3}$
 - (3) $\frac{1}{\sqrt{3}}$
 - (4) 2
9. A grasshopper can jump maximum distance 1.6 m. It spends negligible time on the ground. How far can it go in 10 seconds :-
- (1) $5\sqrt{2}m$
 - (2) $10\sqrt{2}m$
 - (3) $20\sqrt{2}m$
 - (4) $40\sqrt{2}m$
10. The equation of a projectile is $y = x - \frac{gx^2}{2}$. The angle of projection is :
- (1) 30°
 - (2) 60°
 - (3) 45°
 - (4) none
11. The equation of a projectile is $y = 4x - \frac{x^2}{4}$. The horizontal range is :
- (1) 16 m
 - (2) 8 m
 - (3) 64 m
 - (4) 12.8 m
12. A particle is projected at an angle of 45° , 6m away from the foot of a wall, just touches the top of the wall and falls on the ground on the opposite side at a distance 3m from it. The height of wall is :
- (1) 2m
 - (2) $\frac{4}{3}m$
 - (3) $\frac{8}{3}m$
 - (4) $\frac{3}{4}m$
13. A stone is projected from the ground with velocity 50 m/s at an angle of 30° from horizontal. It crosses a wall after 3 sec. How far beyond the wall, the stone will strike the ground ($g = 10m/sec^2$)
- (1) 90.2 m
 - (2) 89.6 m
 - (3) 86.6 m
 - (4) 70.2 m

Answer key

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

SOLUTIONS DPP-11

1. (4)

$$t = \frac{u \sin \theta}{g} = \frac{1000 \sin 30^\circ}{10}$$

$$t = 50 \text{ sec}$$

2. (1)

$$\therefore \frac{2u \sin \theta}{g} = 10$$

$$\therefore u \sin \theta = 50$$

$$\therefore H = \frac{u^2 \sin^2 \theta}{2g} = \frac{(50)^2}{2 \times 10}$$

$$\therefore H = 125 \text{ m}$$

3. (2)

$$T = \frac{2u \sin \theta}{g} = \frac{2 \times 19.6 \sin 30^\circ}{9.8} = 2 \text{ sec}$$

4. (4)

$$\vec{v} = 5\hat{i} + 12\hat{j}$$

$$\Rightarrow u \cos \theta = 5 \text{ and } u \sin \theta = 12$$

$$R = \frac{2(u \sin \theta)(u \cos \theta)}{g} = \frac{2 \times 5 \times 12}{10} = 12 \text{ m}$$

5. (2)

$$0.5 = \frac{u^2 \sin(2 \times 60^\circ)}{g} \Rightarrow 0.5 = \frac{u^2}{g} \times \frac{\sqrt{3}}{2}$$

$$\frac{u^2}{g} = \frac{1}{\sqrt{3}} \Rightarrow R = \frac{u^2 \sin(2 \times 45^\circ)}{g} = \frac{u^2}{g} = \frac{1}{\sqrt{3}} \text{ km}$$

6. (1)

$$u \cos \theta = \frac{1}{2}u \Rightarrow \theta = 60^\circ$$

$$\Rightarrow R = \frac{u^2 \sin(2 \times 60^\circ)}{g} = \frac{u^2 \sin 120^\circ}{g} = \frac{\sqrt{3}u^2}{2g}$$

7. (1)

$$\text{Range of projectile} = \frac{u^2 \sin 2\theta}{g}$$

$$\therefore \text{Range} \propto u^2$$

\(\therefore\) When u is tripled, range becomes 9 times.

8. (1)

For maximum range $\theta = 45^\circ$
So $\tan \theta = 1$

9. (3)

For maximum range

$$R_{\max} = \frac{u^2}{g} = 1.6$$

$$u = 4 \text{ m/s}$$

So horizontal distance in 10 sec. will be

$$d = (u_x)(t)$$

$$d = (4) \cos(45^\circ) (10)$$

$$= 20\sqrt{2} \text{ m}$$

10. (3)

$$y = x \tan \theta - \frac{1}{2} \frac{gx^2}{u^2 \cos^2 \theta} \text{ (standard equation)}$$

$$y = x - \frac{1}{2} gx^2 \Rightarrow \tan \theta = 1 \Rightarrow \theta = 45^\circ$$

11. (1)

$$y = 4x - \frac{x^2}{4}; y = 4x \left(1 - \frac{x}{16}\right)$$

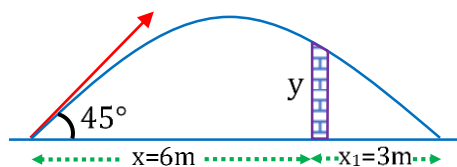
$$\text{Comparing with } y = x \tan \theta \left(1 - \frac{x}{R}\right)$$

$$R = 16 \text{ m}$$

12. (1)

$$R = 6 + 3 = 9 \text{ m}$$

$$y = (x \tan \theta) \left[1 - \frac{x}{R}\right] = 6 \times 1 \times \left[1 - \frac{6}{9}\right] = 2 \text{ m}$$



13. (3)

$$\text{Total time of flight } T = \frac{2u \sin \theta}{g}$$

$$T = \frac{(2)(50) \sin(30^\circ)}{10} = 5 \text{ sec}$$

$$\text{Horizontal range } R = \frac{u^2 \sin 2\theta}{g}$$

$$R = \frac{(50)^2 \sin(60^\circ)}{10} = 216.25 \text{ m}$$

While crossing the wall at $t = 3$ sec. The distance travelled is $d = u_x \times 3$

$$= 50 \cos(30^\circ) (3) = 129.71$$

So remaining horizontal distance beyond the wall is

$$R - d = (216.25) - (129.71)$$

$$\approx 86.6 \text{ m}$$

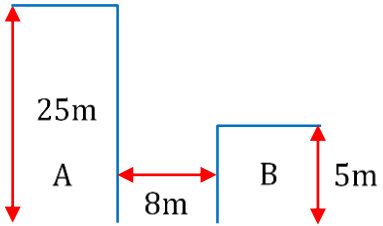
Horizontal Projection from Height DPP-12

- A stone is projected horizontally with a speed 10 m/s from a 80 m high building. The distance of the target on the ground from the foot of the building is :- ($g = 10 \text{ m/s}^2$)**

 - 80 m
 - 40 m
 - 20 m
 - 10 m
- Two stones are projected horizontally from the same height with speeds 100 m/s and 40 m/s. The ratio of their horizontal range is :-**

 - 1 : 1
 - 5 : 2
 - 2 : 5
 - 3 : 4
- A bomber is flying horizontally with a constant speed of 150 m/s at a height of 19.6 m. The pilot has to drop a bomb at the enemy target. At what horizontal distance from the target should he release the bomb?**

 - 0 m
 - 300 m
 - 600 m
 - 1000 m
- A boy wants to jump from building A to building B. Height of building A is 25 m and that of building B is 5m. Distance between buildings is 8m. Assume that the boy jumps horizontally, then calculate minimum velocity with which he has to jump to land safely on building B.**


 - 6 m/s
 - 8 m/s
 - 4 m/s
 - 2 m/s
- Two bodies of masses 100 kg and 50 kg are projected horizontally from same height with speeds 40 m/s and 20 m/s, simultaneously. The ratio of time taken by both the bodies to reach the ground is :-**

 - 1 : 1
 - 1 : 2
 - 2 : 1
 - 1 : 4

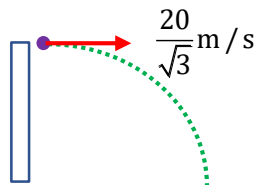
6. A ball is thrown horizontally from a height of 90 m with a speed of 4.5 m/s then find the time when it is at the height of 45 m from the ground:

- (1) $3\sqrt{2}$ sec
- (2) 10 sec
- (3) 9 sec
- (4) 3 sec

7. When a particle is thrown horizontally, the displacement of the projectile at any time t is given by :

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

8. A particle is projected horizontally with a speed of $\frac{20}{\sqrt{3}}$ m/s, from some height at $t = 0$. At what time will its velocity make 30° angle with the initial velocity



- (1) 1 sec
- (2) 2 sec
- (3) 1.5 sec
- (4) 2/3 sec

9. A body is dropped from a plane moving with constant horizontal velocity. The path of the body as seen by a person on the plane will be :-

- (1) Straight line
- (2) Parabolic
- (3) Hyperbolic
- (4) None of these

10. Two tall buildings are 30 m apart. The speed with which a ball must be thrown horizontally from a window 150m above the ground in one building so that it enters a window 27.5 m from the ground in the other building is

- (1) 2 ms^{-1}
- (2) 6 ms^{-1}
- (3) 4 ms^{-1}
- (4) 8 ms^{-1}

Answer key

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

SOLUTIONS DPP-12

1. (2)

Time taken

$$T = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \times 80}{10}} = 4 \text{ sec.}$$

$$\text{distance 'd'} = (u_x)(T) = (10)(4) = 40 \text{ m}$$

2. (2)

Horizontal range

$$R = (u_x)(T)$$

If projected horizontal from same height then time of flight will be same

$$R \propto u_x$$

$$\frac{R_1}{R_2} = \frac{100}{40} = \frac{5}{2}$$

3. (2)

$$R = v_x t = v_x \sqrt{\frac{2h}{g}} = 150 \times \sqrt{\frac{2 \times 19.6}{9.8}} = 300 \text{ m}$$

4. (3)

$$t = \sqrt{\frac{2 \times 20}{g}} = 2 \text{ sec}$$

$$x = v_x t \Rightarrow v_x = \frac{8}{2} = 4 \text{ m/s}$$

5. (1)

For vertical motion

$$H = (u_y T) + \frac{1}{2} g (T)^2$$

Here 'H' & 'u_y' same for both bodies so time will be same.

$$\boxed{\frac{T_1}{T_2} = \frac{1}{1}}$$

6. (4)

$$\therefore h = u_y(t) + \frac{1}{2} g t^2$$

$$45 = 0 + \frac{1}{2} (g) t^2$$

$$t = 3 \text{ sec}$$

7. (2)

$$x=ut, \quad y = \frac{1}{2}gt^2$$

$$\text{Displacement} = \sqrt{x^2 + y^2} = \sqrt{u^2t^2 + \frac{g^2t^4}{4}}$$

8. (4)

$$\tan 30^\circ = \frac{v_y}{v_x} \Rightarrow v_y = \frac{v_x}{\sqrt{3}} = \frac{20}{3} \text{ m/s}$$

$$v_y = 0 + gt$$

$$t = \frac{20/3}{g} = \frac{2}{3} \text{ sec}$$

9. (1)

10. (2)

$$h = 150 - 27.5 = 122.5 \text{ m}$$

$$\text{Time taken, } T = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \times 122.5}{9.8}} = 5 \text{ s}$$

$$\text{Now } R = uT \text{ or } 30 = 5u \text{ or } u = 6 \text{ ms}^{-1}$$

Oblique Projection from Height DPP-13

- 1. A ball is projected upwards from the top of a tower with a velocity of 50 m/s making an angle of 30° with the horizontal. The height of the tower is 70m. After how much time from the instant of throwing, will the ball reach the ground?**

 - (1) 2 s
 - (2) 5 s
 - (3) 7 s
 - (4) 9 s
- 2. A ball is projected from the top of a tower at an angle 60° with the vertical. What happens to the vertical component of its velocity?**

 - (1) Increases continuously
 - (2) Decreases continuously
 - (3) Remains unchanged
 - (4) First decreases and then increases
- 3. From the top of a tower of height 40 m, a ball is projected upwards with a speed of 20 ms^{-1} at an angle of elevation of 30° . Then the ratio of the total time taken by the ball to hit the ground to the time taken by ball to come at same level as top of tower.**

 - (1) 2 : 1
 - (2) 3 : 1
 - (3) 3 : 2
 - (4) 4 : 1
- 4. A particle is projected under gravity with velocity $\sqrt{2ag}$ from a point at a height h above the level plane at an angle θ to it. The maximum range R on the ground is :**

 - (1) $\sqrt{(a^2 + 1)h}$
 - (2) $\sqrt{a^2h}$
 - (3) \sqrt{ah}
 - (4) $2\sqrt{a(a+h)}$
- 5. A ball is thrown from the tower with an initial velocity of 10 ms^{-1} at an angle of 30° with the horizontal. If it hits the ground at a distance of 17.3 meter from the back of the tower, the height of the tower is (Take $g = 10 \text{ m/s}^2$)**

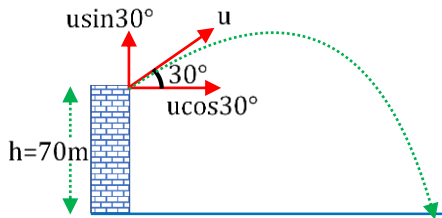
 - (1) 5 m
 - (2) 10 m
 - (3) 15 m
 - (4) 20 m

Answer key

Question	1	2	3	4	5
Answer	3	4	1	4	2

SOLUTIONS DPP-13

1. (3)



$$\text{by } S_y = u_y t + \frac{1}{2} a_y t^2$$

$$\Rightarrow h = -u \sin 30^\circ t + \frac{1}{2} g t^2$$

$$\Rightarrow 70 = -50 \times \frac{1}{2} t + \frac{1}{2} \times 10 t^2 \Rightarrow t = 7 \text{ sec}$$

2. (4)

As acceleration due to gravity acts against the motion up to the highest point, hence vertical component of the velocity first decrease. But during downward motion, acceleration due to gravity acts in the direction of motion; hence vertical component of velocity then starts increasing.

3. (1)

If t is the total time taken, then

$$40 = -20 \sin 30^\circ t + \frac{1}{2} \times 10 \times t^2$$

$$\text{or } 40 = -10t + 5t^2$$

$$\text{or } 5t^2 - 10t - 40 = 0$$

$$\text{or } t^2 - 2t - 8 = 0$$

$$\text{or } t^2 - 4t + 2t - 8 = 0$$

$$\text{or } t(t-4) + 2(t-4) = 0$$

$$\text{or } (t+2)(t-4) = 0$$

$$t = 4 \text{ s [Negative time is not allowed]}$$

$$T = \frac{2v \sin \theta}{g} = \frac{2 \times 20 \sin 30^\circ}{10} \text{ s} = 2 \text{ s}$$

$$\therefore \frac{t}{T} = \frac{4}{2} = \frac{2}{1}$$

4. (4)

Coordinate of point P are (R, -h)

$$\text{Hence } -h = R \tan \theta - \frac{gR^2}{2(2ga)}(1 + \tan^2 \theta)$$

$$\text{or } R^2 \tan^2 \theta - 4aR \tan \theta + (R^2 - 4ah) = 0$$

For θ to be real.

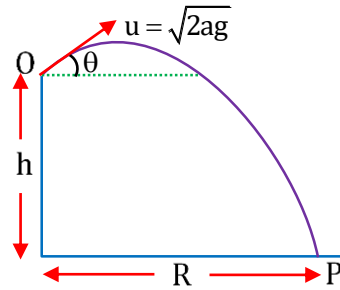
$$(4aR)^2 \geq 4R^2(R^2 - 4ah)$$

$$\text{or } 4a^2 \geq (R^2 - 4ah)$$

$$\text{or } R^2 \leq 4a(a+h)$$

$$\text{or } R \leq 2\sqrt{a(a+h)}$$

$$R_{\max} = 2\sqrt{a(a+h)}$$



5. (2)

Here, $\theta = 30^\circ$, $u = 10 \text{ms}^{-1}$

$R = 17.3 \text{ m}$, $g = 10 \text{ms}^{-2}$

For horizontal motion, $R = (u \cos \theta) t$

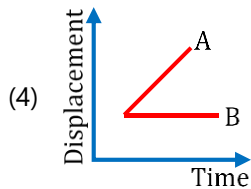
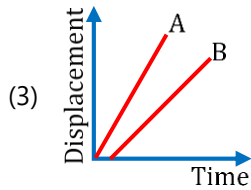
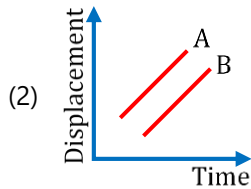
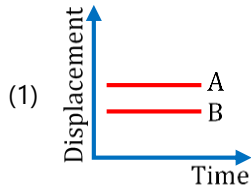
$$t = \frac{R}{u \cos \theta} = \frac{17.3}{10 \cos 30^\circ} = \frac{17.3 \times 2}{10 \times \sqrt{3}} = \frac{17.3 \times 2}{10 \times 1.73} = 2 \text{ s}$$

For vertical motion, $h = (-u \sin \theta) t + \frac{1}{2}gt^2$

$$= -10 \sin 30^\circ \times 2 + \frac{1}{2} \times 10 \times 2^2$$

Concept of Relative Motion DPP-14

1. Which one of the following represents the displacement-time graph of two objects A and B moving with zero relative speed :-



2. A monkey is climbing up a tree at a speed of 3 m/s. A dog runs towards the tree with a speed of 4 m/s. What is the relative speed of the dog as seen by the monkey ?

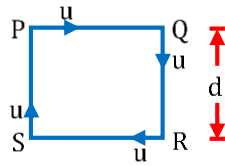
- (1) 7 m/s
- (2) Between 5 m/s and 7 m/s
- (3) 5 m/s
- (4) < 5 m/s

3. A train is moving towards east and a car is along north, both with same speed. The observed direction of car to the passenger in the train is:-

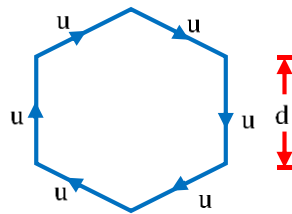
- (1) North-east direction
- (2) North-west direction
- (3) South-east direction
- (4) None of these

4. **Two car A & B start from rest (from the same point) in same direction with acceleration 8 m/s^2 & 4 m/s^2 respectively then acceleration of car B in frame of A (Take direction of motion of car to be positive) :-**
- (1) 4 m/s^2
 - (2) -4 m/s^2
 - (3) 12 m/s^2
 - (4) None of these
5. **Two cars A and B start moving from the same point with same speed $v = 5 \text{ km/minute}$. Car A moves towards south and car B is moving towards west. What is the relative velocity of B with respect to A ?**
- (1) $5\sqrt{2} \text{ km/min}$ towards South-East
 - (2) $5\sqrt{2} \text{ km/min}$ towards North-West
 - (3) $5\sqrt{2} \text{ km/min}$ towards South-West
 - (4) $5\sqrt{2} \text{ km/min}$ towards North-East
6. **A train is moving towards East with a speed 20 m/s . A person is running on the roof of the train with a speed 3 m/s in the direction of motion of train. Velocity of the person as seen by an observer on ground will be :**
- (1) 23 m/s towards East
 - (2) 17 m/s towards East
 - (3) 23 m/s towards West
 - (4) 17 m/s towards West
7. **A jet air plane travelling with a speed of 500 km/h ejects its products of combustion with a speed of 1600 km/h relative to the jet plane. The speed of the latter with respect to an observer on the ground is :-**
- (1) 1600 km/h
 - (2) 2100 km/h
 - (3) 1100 km/h
 - (4) 500 km/h
8. **A train moves in north direction with a speed of 54 km/h . A monkey is running on the roof of the train, against its motion with a velocity of 36 km/h . with respect to train. The velocity of monkey as observed by a man standing on the ground is:**
- (1) 5 m/s due north
 - (2) 25 m/s due south
 - (3) 10 m/s due south
 - (4) 10 m/s due north
9. **A lift is moving upwards with acceleration a . A man in the lift drops a ball within the lift. The acceleration of the ball as observed by the man in the lift and a man standing stationary on the ground are respectively:**
- (1) g, g
 - (2) $g - a, g - a$
 - (3) $g + a, g$
 - (4) a, g

10. Four persons P, Q, R and S of same mass travel with same speed u along a square of side ' d ' such that each one always faces the other. After what time will they meet each other?



- (1) $\frac{d}{u}$
 (2) $\frac{2d}{3u}$
 (3) $\frac{2d}{u}$
 (4) $d\sqrt{3}u$
11. Six persons of same mass travel with same speed u along a regular hexagon of side ' d ' such that each one always faces the other. After how long will they meet each other ?



- (1) $\frac{d}{u}$
 (2) $\frac{2d}{3u}$
 (3) $\frac{2d}{u}$
 (4) $d\sqrt{3}u$
12. A stone is thrown upwards and it rises to a height of 100 m. The relative velocity of the stone with respect to earth will be maximum at height :-
 (1) 100 m
 (2) 50 m
 (3) Ground
 (4) 25 m
13. Two cars are traveling in the same direction with a velocity of 60 kmph. They are separated by a distance of 5 km. A truck moving in opposite direction meets the two cars in a time interval of 3 min. The velocity of the truck is (in kmph) :-
 (1) 20
 (2) 30
 (3) 40
 (4) 60

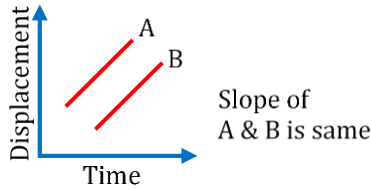
Answer key

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

SOLUTIONS DPP-14

1. (2)

Slope of displacement-time graph gives velocity



2. (3)

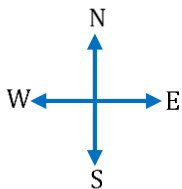
∴ Both velocities are perpendicular

$$\therefore |\vec{v}_{rel}| = \sqrt{4^2 + 3^2} = 5 \text{ m/s}$$

3. (2)

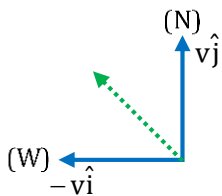
$$\vec{v}_{Train} = v\hat{i}$$

$$\vec{v}_{Car} = v\hat{j}$$



Velocity of car relative to train

$$\vec{v}_{rel} = v\hat{j} - v\hat{i}$$



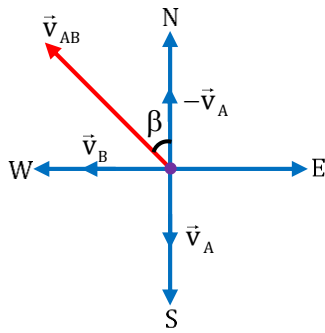
North-West direction

4. (2)

$$a_A = 8 \text{ m/s}^2 \text{ \& } a_B = 4 \text{ m/s}^2$$

$$a_{BA} = a_B - a_A = 4 - 8 = -4 \text{ m/s}^2$$

5. (2)



The velocity of car A and car B are represented by the vectors in the direction as given in the question as shown in the figure.

Given : $v_A = v_B = v = 5 \text{ km/min}$

The relative velocity of car B w.r. t car A is given by : $\vec{v}_{BA} = \vec{v}_B - \vec{v}_A$

$$\vec{v}_{BA} = -5\hat{i} + 5\hat{j}$$

$$|\vec{v}_{BA}| = \sqrt{5^2 + 5^2} = 5\sqrt{2} \text{ km / min}$$

$$\tan\beta = \frac{5}{5} = 1$$

$\beta = 45^\circ$ in north-west.

6. (1)

$$\vec{v}_{MT} = \vec{v}_M - \vec{v}_T$$

$$\vec{v}_M = \vec{v}_{MT} + \vec{v}_T$$

$$\vec{v}_M = +3\hat{i} + 20\hat{i} = 23\hat{i}$$

23 m/s towards east

7. (3)

$$v_{\text{gas, plane}} = v_{\text{gas}} + v_{\text{plane}}$$

$$v_{\text{gas}} = v_{\text{gas, plane}} - v_{\text{plane}}$$

$$= 1600 - 500 = 1100 \text{ km/hr}$$

8. (1)

$$\vec{v}_{TG} = 54 \times \frac{5}{18} \hat{j} = 15\hat{j} \text{ m/s}$$

$$\vec{v}_{MT} = -36 \times \frac{5}{18} \hat{j} = -10\hat{j} \text{ m/s}$$

$$\vec{v}_{MT} = \vec{v}_{MG} - \vec{v}_{TG}$$

$$\vec{v}_{MG} = \vec{v}_{MT} + \vec{v}_{TG} = -10\hat{j} + 15\hat{j} = 5\hat{j} \text{ m/s}$$

= 5 m/s along north

9. (3)

$g + a, g$

10. (1)

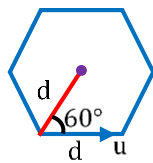
$$t = \frac{d}{u + u \cos 90^\circ} = \frac{d}{u}$$

11. (3)

$$t = \frac{d}{u - u \cos 60^\circ}$$

$$\frac{d}{u - \frac{u}{2}} = \frac{d}{\frac{u}{2}} = \frac{2d}{u}$$

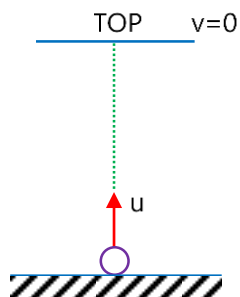
Alternative method



$$t = \frac{d}{u \cos 60^\circ}$$

$$t = \frac{2d}{u}$$

12. (3)



at TOP $V = 0$

$\therefore V_{\text{stone}}$ w.r.t earth is max. at ground

13. (3)

Let velocity of truck w.r.t ground is u , then

$$5 \text{ km} = (u + 60) \times \frac{3}{60} \Rightarrow u = 40 \text{ km/hr}$$

Standard Questions of Relative Motion DPP-15

- 1. A person walks up a stalled escalator in 45 sec. He is carried in 60s, when standing on the same escalator which is now moving. The time he would take to walk up the moving escalator will be :-**

 - (1) 16.23 s
 - (2) 72 s
 - (3) 18 s
 - (4) 25.71 s
- 2. A bus starts from rest moving with an acceleration of 2m/s^2 . A cyclist, 96 m behind the bus starts simultaneously towards the bus at 20 m/s. After what time will he be able to overtake the bus :-**

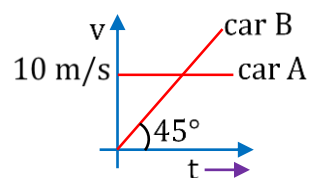
 - (1) 8 s
 - (2) 10 s
 - (3) 12 s
 - (4) 1 s
- 3. An elevator is accelerating upward at a rate of 6 ft/sec^2 when a bolt from its ceiling falls to the floor of the lift (Distance = 19 feet). The time (in seconds) taken by the falling bolt to hit the floor is (take $g = 32\text{ ft/sec}^2$)**

 - (1) $\sqrt{2}$
 - (2) 1
 - (3) $2\sqrt{2}$
 - (4) $\frac{1}{2\sqrt{2}}$
- 4. A train of 150 metre length is going towards north direction at a speed of 10 m/s. A parrot flies at the speed of 5 m/s towards south direction parallel to the railways track. The time taken by the parrot to cross the train is :-**

 - (1) 12 sec
 - (2) 8 sec
 - (3) 15 sec
 - (4) 10 sec
- 5. A train is moving eastwards with a velocity of 10 ms^{-1} . On a parallel track another train passes with a velocity of 15 ms^{-1} eastwards. To the passengers in the second train, the first train will appear to be moving with a velocity :-**

 - (1) 5 ms^{-1} westwards
 - (2) 5 ms^{-1} eastwards
 - (3) 20 ms^{-1} westwards
 - (4) 25 ms^{-1} eastwards

6. A train is moving with uniform velocity on a straight track. A boy moving at 4 km/h due east observes that the train is moving due north. Another boy moving at 1 km/h due south claims that the train is moving towards north-east. What is the true velocity of the train ?
- (1) 5 km/h 37° north of east
 - (2) 7 km/h 53° , north of east
 - (3) 8 km/h 37° , north of east
 - (4) 5 km/h 37° east of north
7. A person walked up a stalled escalator in 90 s. When standing on the same escalator, now moving, he is carried up in 60 s. How much time would it take him to walk up the moving escalator?
- (1) 36 s
 - (2) 30 s
 - (3) 60 s
 - (4) 26 s
8. Two trains one of length 100 m and another of length 125 m, are moving in mutually opposite directions along parallel lines, meet each other, each with speed 10 m/s. If their acceleration are 0.3 m/s^2 and 0.2 m/s^2 respectively, then the time they take to pass each other will be :-
- (1) 5 s
 - (2) 10 s
 - (3) 15 s
 - (4) 20 s
9. Initially car A is 10.5 m ahead of car B. Both start moving at time $t = 0$ in the same direction along a straight line. The velocity time graph of two cars is shown in figure. The time when the car B will catch the car A, will be :-



- (1) $t = 21 \text{ sec}$
- (2) $t = 2\sqrt{5} \text{ sec}$
- (3) 20 sec
- (4) None of these

Answer key

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

SOLUTIONS DPP-15

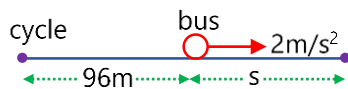
1. (4)

$$\text{speed of man } (v_m) = \frac{d}{45}$$

$$\text{speed of escalator } (v_s) = \frac{d}{60}$$

$$t = \frac{d}{v_m + v_s} = \frac{d}{\frac{d}{45} + \frac{d}{60}} = \frac{60 \times 45}{105} = 25.71 \text{ sec}$$

2. (1)



$$\text{For cycle } 96 + s = 20 \times t$$

$$\text{for bus } s = \frac{1}{2}at^2 = \frac{1}{2} \times 2 \times t^2 = t^2$$

$$\therefore 96 + t^2 = 20t \Rightarrow t^2 - 20t + 96 = 0$$

$$(t - 8)(t - 12) = 0 \therefore t = 8 \text{ s or } 12 \text{ s}$$

cyclist overtakes bus in 8 s

Note : At $t = 12$ s, bus overtakes cyclist.

3. (2)

Effective acceleration in ascending lift = $(g + a)$

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

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

4. (4)

$$150 = (10+5)t \Rightarrow t = 10 \text{ sec}$$

5. (1)

$$\vec{V}_A = 10\hat{i}, \vec{V}_B = 15\hat{i},$$

$$\vec{V}_{A/B} = \vec{V}_A - \vec{V}_B = 10\hat{i} - 15\hat{i}$$

$$\vec{V}_{A/B} = -5\hat{i}, \vec{V}_{A/B} = -5\text{m/s} = 5\text{m/s west wards}$$

6. (1)

Let the velocity of train be $v_x \hat{i} + v_y \hat{j}$

According to 1st condition

$$v_x = 4$$

According to 2nd condition

$$v_y + 1 = v_x$$

$$v_y = 3$$

$$\text{velocity of train} = 4\hat{i} + 3\hat{j}$$

$$\Rightarrow |\vec{v}| = \sqrt{4^2 + 3^2} = 5$$

7. (1)

$$t = \frac{t_1 t_2}{t_1 + t_2} = 36 \text{ sec}$$

8. (2)

Relative velocity of one train w.r.t other = $10 + 10 = 20 \text{ m/s}$

Relative acceleration = $0.3 + 0.2 = 0.5 \text{ m/s}^2$

It trains cross each other then from $s = ut + \frac{1}{2}at^2$

$$\text{As, } S = S_1 + S_2 = 100 + 125 = 225$$

$$\Rightarrow 225 = 20t + \frac{1}{2} \times 0.5 \times t^2$$

$$\Rightarrow 0.5t^2 + 40t - 450 = 0$$

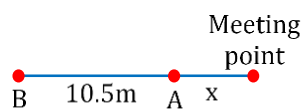
$$\Rightarrow t = \frac{-40 \pm \sqrt{1600 + 4 \cdot (0.05) \times 450}}{1} = -40 \pm 50$$

$\therefore t = 10 \text{ sec}$ (Taking + ve value)

9. (1)

Suppose both cars meet after time t

For car A, $x = 10t$



$$\text{For car B, } 10.5 + x = \frac{1}{2}(1)t^2$$

$$\Rightarrow t^2 - 20t - 21 = 0$$

$$\Rightarrow t = 21 \text{ sec}$$

Problems Based on Relative Motion - Under Gravity DPP-16

- 1. A stone is thrown upwards and it rises to a height of 200 m. The relative velocity of the stone with respect to the earth will be minimum at :-**

 - (1) Height of 100 m
 - (2) Height of 150 m
 - (3) Highest point
 - (4) The ground
- 2. Two bodies are held separated by 9.8 m vertically one above the other. They are released simultaneously to fall freely under gravity. After 2 s the relative distance between them is :-**

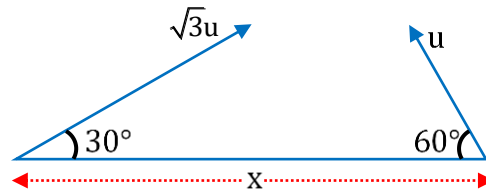
 - (1) 4.9 m
 - (2) 19.6 m
 - (3) 9.8 m
 - (4) 39.2m
- 3. Two balls are thrown simultaneously, (A) vertically upwards with a speed of 20 m/s from the ground and (B) vertically downwards from a height of 80 m with the same speed and along the same line of motion. At which point will the balls collide? (take $g = 10 \text{ m/s}^2$)**

 - (1) 15 m above from the ground
 - (2) 15 m below from the top of the tower
 - (3) 20 m above from the ground
 - (4) 20 m below from the top of the tower
- 4. While sitting on a tree branch 20 m above the ground, you drop a walnut. When the walnut has fallen 5m, you throw a second walnut straight down. What initial speed must you give the second walnut if they are both to reach the ground at the same time? ($g=10 \text{ ms}^{-2}$)**

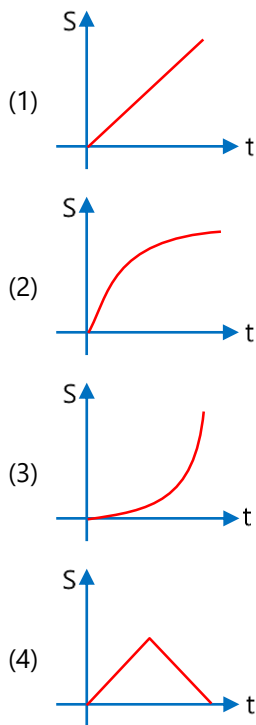
 - (1) 5 ms^{-1}
 - (2) 10 ms^{-1}
 - (3) 15 ms^{-1}
 - (4) None of these
- 5. A body A is thrown up vertically from the ground with velocity v_0 and another body B is simultaneously dropped from a height H. They meet at a height $\frac{H}{2}$ if v_0 is equal to**

 - (1) $\sqrt{2gH}$
 - (2) \sqrt{gH}
 - (3) $\frac{1}{2}\sqrt{gH}$
 - (4) $\sqrt{\frac{2g}{H}}$

6. Two particles are separated by a horizontal distance x as shown in figure. They are projected as shown in figure with different initial speeds. The time after which the horizontal distance between them becomes zero is :



- (1) $\frac{x}{u}$
 (2) $\frac{u}{2x}$
 (3) $\frac{x}{2u}$
 (4) None
7. One stone is dropped from a tower from rest and simultaneously another stone is projected vertically upwards from the tower with some initial velocity. The graph of the distance (s) between the two stones varies with time (t) as (before either stone hits the ground) :-



8. Motion of a projectile as observed from other projectile is :-
- (1) parabolic
 (2) may be parabolic or straight line
 (3) straight line
 (4) None

Answer key

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

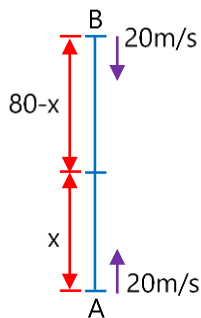
SOLUTIONS DPP-16

1. (3)

2. (3)

Distance will remain the same as before because relative acceleration of both the bodies is same and initial velocity is zero.

3. (3)



Let us assume they are meeting at x distance from ground

$$80 - x = 20t + \frac{1}{2}gt^2 \quad \dots(i)$$

$$x = 20t - \frac{1}{2}gt^2 \quad \dots(ii)$$

From eq. (i) and (ii)

$$80 = 40t$$

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

$$x = 20 \text{ m from ground.}$$

4. (3)

Total time taken by the first walnut to reach at ground :-

$$h = \frac{1}{2}gt^2$$

$$20 = \frac{1}{2} \times 10 \times t^2$$

$$t = 2 \text{ sec.}$$

time taken by it to cover a distance of 5 m :

$$5 = \frac{1}{2}gt^2 \Rightarrow t = 1 \text{ sec}$$

So, For 2nd walnut :

$$S = ut + \frac{1}{2}at^2$$

$$20 = u \times 1 + \frac{1}{2} \times 10 \times (1)^2$$

$$u = 15 \text{ m/s}$$

5. (2)

Let the two bodies A and B respectively meet at a time t , at a height $\frac{H}{2}$ from the ground.

Alternate solution is shorter with relative velocity concept.

Using $S = ut + \frac{1}{2}at^2$

For a body A, $u = v_0$, $a = -g$, $S = \frac{H}{2}$

$$\therefore \frac{H}{2} = v_0 t - \frac{1}{2}gt^2 \quad \dots(i)$$

For a body B, $u = 0$, $a = +g$, $S = \frac{H}{2}$

$$\therefore \frac{H}{2} = \frac{1}{2}gt^2 \quad \dots(ii)$$

Equating equations (i) and (ii), we get

$$v_0 t - \frac{1}{2}gt^2 = \frac{1}{2}gt^2$$

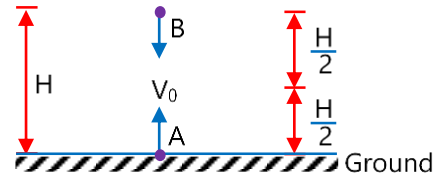
$$v_0 t = gt^2 \quad \text{or} \quad t = \frac{v_0}{g}$$

Substituting the value of t in equation (i), we get

$$\frac{H}{2} = v_0 \times \left(\frac{v_0}{g}\right) - \frac{1}{2}g\left(\frac{v_0}{g}\right)^2 = \frac{v_0^2}{g} - \frac{1}{2}\frac{v_0^2}{g}$$

$$\frac{H}{2} = \frac{1}{2}\frac{v_0^2}{g} \quad \text{or} \quad v_0^2 = gh$$

$$v_0 = \sqrt{gH}$$



6. (3)

$$u_{x_1} t + u_{x_2} t = x$$

$$\left[\sqrt{3}u \cos 30^\circ + u \cos 60^\circ \right] t = x$$

$$\left[\sqrt{3}u \times \frac{\sqrt{3}}{2} + \frac{u}{2} \right] t = x \Rightarrow t = \frac{x}{2u}$$

7. (1)

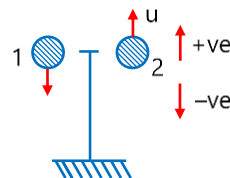
$$s_1(t) = \frac{1}{2}gt^2 \quad (\text{downwards})$$

$$\text{and } s(t) = ut - \frac{1}{2}gt^2 \quad (\text{upwards})$$

\therefore Distance between the two stones will be

$$s = s_1(t) + s_2(t) = ut$$

Therefore, s - t graph will be a straight line passing origin.



8. (3)

straight line

Rain-Man Concept DPP-17

- Rain is falling vertically with a speed of 3 m/s. If a man is running with the same speed then the velocity of rain w.r.t. man is :-**

 - 3 m/s
 - 6 m/s
 - 4.2 m/s
 - 0 m/s
- A man is walking on a road with a velocity of 5km/h. When suddenly it starts raining, velocity of rain is 10km/h in vertically downward direction, relative velocity of the rain with respect to man is :**

 - $\sqrt{13}$ km / hr
 - $\sqrt{7}$ km / hr
 - $\sqrt{109}$ km / hr
 - $5\sqrt{5}$ km / hr
- If the rain is falling vertically downwards with velocity 20 m/s and a bike is going with velocity 30 m/s. Calculate at what angle from the vertical a man on the bike must incline his umbrella so that he can save himself from rain :-**

 - $\tan^{-1}\left(\frac{2}{3}\right)$
 - $\tan^{-1}\left(\frac{3}{2}\right)$
 - $\tan^{-1}(1)$
 - $\tan^{-1}\left(\frac{6}{5}\right)$
- If rain is falling at some angle from vertical and has horizontal velocity 2 m/s in east direction. With what velocity a man must move on the horizontal surface so that rain will appear vertical to him :-**

 - 4 m/s in east direction
 - 2 m/s in east direction
 - 2 m/s in west direction
 - 2 m/s in a circular path
- A boy is running on a levelled road with velocity (u) with a long hollow tube in his hand. Water is falling vertically downwards with velocity (v). At what angle to the vertical, should he incline the tube so that the water drops enters without touching its side :**

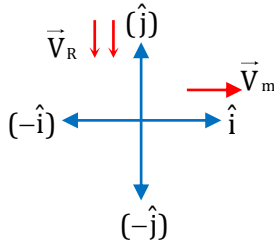
 - $\tan^{-1}\left(\frac{v}{u}\right)$
 - $\sin^{-1}\left(\frac{v}{u}\right)$
 - $\tan^{-1}\left(\frac{u}{v}\right)$
 - $\cos^{-1}\left(\frac{v}{u}\right)$

Answer key

Question	1	2	3	4	5
Answer	3	4	2	2	3

SOLUTIONS DPP-17

1. (3)



$$\vec{v}_{RM} = \vec{v}_R - \vec{v}_M = -3\hat{j} - 3\hat{i}$$

$$|\vec{v}_{RM}| = \sqrt{3^2 + 3^2} = 4.2 \text{ m/s}$$

2. (4)

$$\vec{V}_M = 5\hat{i}$$

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

$$\vec{V}_{R/M} = \vec{V}_R - \vec{V}_M = -10\hat{j} - 5\hat{i}$$

$$|\vec{V}_{R/M}| = \sqrt{100 + 25} = 5\sqrt{5} \text{ km/hr}$$

3. (2)

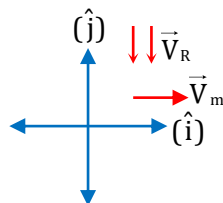
$$\vec{v}_{RM} = \vec{v}_R - \vec{v}_M$$

$$= -20\hat{j} - 30\hat{i}$$

Angle with vertical

$$\tan \theta = \left(\frac{30}{20} \right)$$

$$\theta = \tan^{-1} \left(\frac{3}{2} \right)$$



4. (2)

If man has horizontal velocity equal to horizontal component of rain velocity, then relative velocity in horizontal direction becomes zero, so rain will appear vertically.

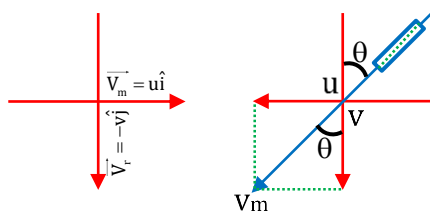
5. (3)

$$\vec{v}_{rm} = \vec{v}_r - \vec{v}_m$$

$$\Rightarrow \vec{v}_{rm} = -v\hat{j} - u\hat{i}$$

$$\Rightarrow \tan \theta = \frac{u}{v}$$

$$\Rightarrow \theta = \tan^{-1} \left(\frac{u}{v} \right)$$



River-Crossing Concept DPP-18

- 1. A boat is sailing at a velocity $(3\hat{i}+4\hat{j})$ with respect to ground and water in river is flowing with a velocity $(-3\hat{i}-4\hat{j})$. Relative velocity of the boat with respect to water is :**

 - (1) $8\hat{j}$
 - (2) $5\sqrt{2}$
 - (3) $6\hat{i}+8\hat{j}$
 - (4) $-6\hat{i}-8\hat{j}$
- 2. A river is flowing at the rate of 8 km/h. A swimmer swims across the river with a velocity of 10 km/h w.r.t. water. The resultant velocity of the man will be in (km/h):-**

 - (1) $\sqrt{117}$
 - (2) $\sqrt{340}$
 - (3) $\sqrt{164}$
 - (4) $3\sqrt{40}$
- 3. A river is flowing from W to E with a speed of 5 m/min. A man can swim in still water with a velocity 10 m/min. In which direction should the man swim so as to take the shortest possible path to go to the opposite bank towards his north :-**

 - (1) 30° with downstream
 - (2) 60° with downstream
 - (3) 120° with downstream
 - (4) South
- 4. A river 4.0 miles wide is flowing at the rate of 2 miles/hr. The minimum time taken by a boat to cross the river with a speed $v = 2$ miles/hr (in still water) is approximately**

 - (1) 1 hr and 0 minute
 - (2) 2 hr
 - (3) 1 hr and 12 minutes
 - (4) 2 hr and 25 minutes
- 5. A river flows from east to west with a speed of 5 m/min. A man on south bank of river, capable of swimming at the rate of 10 m/min in still water, wants to swim across the river in shortest time; he should swim :**

 - (1) due north
 - (2) due north-east
 - (3) due north-east with double the speed of river
 - (4) none of the above

6. A boat-man can row a boat to make it move with a speed of 10 km/h in still water. River flows steadily at the rate of 6 km/h and the width of the river is 4 km. If the boat man crosses the river along the minimum distance of approach, then time elapsed in rowing the boat will be :

(1) $\frac{2\sqrt{3}}{5}$ h

(2) $\frac{2}{5\sqrt{3}}$ h

(3) $\frac{3\sqrt{2}}{5}$ h

(4) $\frac{1}{2}$ h

7. A man wishes to swim across a river 0.5 km wide. If he can swim at the rate of $\sqrt{2}$ km/h in still water and the river flows at the rate of 1 km/h. The angle made by the direction (w.r.t. the flow of the river) along which he should swim so as to reach a point exactly opposite his starting point, should be :

(1) 60°

(2) 120°

(3) 135°

(4) 90°

8. A boat takes 2 hours to go 10 km and come back in still water lake. The time taken for going 10 km upstream and coming back with water velocity of 5 km/h is :

(1) 140 min

(2) 150 min

(3) 160 min

(4) 170 min

9. A river 2 km wide flows at the rate of 2km/h. A boatman who can row a boat at a speed of 6 km/h in still water, goes a distance of 2 km upstream and then comes back. The time taken by him to complete his journey is

(1) 60 min

(2) 45 min

(3) 80 min

(4) 90 min

Answer key

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

SOLUTIONS DPP-18

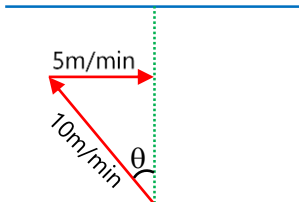
1. (3)

$$\vec{V}_{BW} = \vec{V}_{BG} - \vec{V}_{RG} = 6\hat{i} + 8\hat{j}$$

2. (3)

$$\vec{v}_{res} = \sqrt{v_p^2 + v_r^2} = \sqrt{164} \text{ km/hr}$$

3. (3)



$$\sin \theta = \frac{5}{10} = \frac{1}{2}$$

$$\theta = 30^\circ$$

$$\text{Angle with downstream} = 90^\circ + 30^\circ = 120^\circ$$

4. (2)

Minimum time is taken when the boat crosses the river at right angles to its flow. The velocity of boat w.r.t. river should be at right angles to flow of river.

$$t_{\min} = \frac{D}{v} = \frac{4}{2} = 2 \text{ hr}$$

5. (1)

For shortest time he has to cross the river by swimming perpendicular to flow i.e. due north.

6. (4)

$$t = \frac{d}{\sqrt{v^2 - v_R^2}} = \frac{4}{\sqrt{10^2 - 6^2}} = \frac{4}{8} = \frac{1}{2} \text{ hr}$$

7. (3)

$$\sin \theta = \frac{v_R}{v} = \frac{1}{\sqrt{2}} \Rightarrow \theta = 45^\circ$$

$$\text{Angle with river flow} = 90 + 45 = 135^\circ$$

8. (3)

$$\frac{10}{v_{mr}} + \frac{10}{v_{mr}} = 2 \Rightarrow v_{mr} = 10 \text{ km/hr}$$

$$\Rightarrow t = \frac{10}{v_{mr} + v_r} + \frac{10}{v_{mr} - v_r}$$

$$= \frac{10}{10+5} + \frac{10}{10-5} = \frac{10}{15} + \frac{10}{5} = \frac{8}{3} \text{ hr}$$

$$\Rightarrow t = \frac{8}{3} \times 60 = 160 \text{ min.}$$

9. (2)

The velocity in upstream is $(4 - 2)$ km/hr and downstream is $(4 + 2)$ km/hr.

$$\therefore \text{Total time taken} = \frac{2}{4} + \frac{2}{8} = \frac{6}{8} = \frac{3}{4} \text{ hr} = 45 \text{ minutes}$$