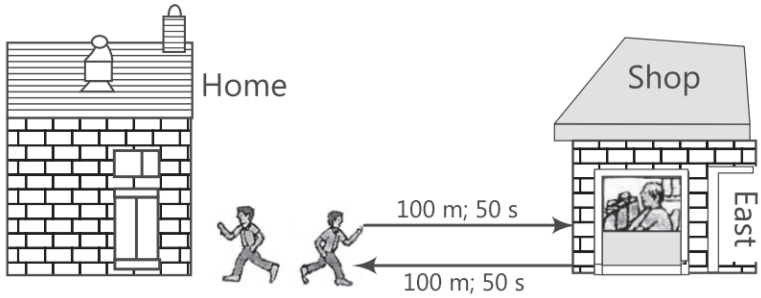
Motion

Case Study Based Questions

Case Study 1

Suppose the boy first runs a distance of 100 m in 50 seconds in going from his home to the shop in the East direction and then runs a distance of 100 m again in 50 seconds in the reverse direction from the shop to reach back home from where he started.



Read the given passage carefully and give the answer of the following questions:

Q1. Find the speed of the boy.

a. 1 m/s

b. 2 m/s

c. 3 m/s

d. None of these

Q2. Find the velocity of the boy.

a. 1 m/s

b. 2 m/s

c. 3 m/s

d. 0 m/s

Q3. If the initial velocity of an object is equal to final velocity, then the acceleration is equal to:

a. negative

b. positive

c. zero

d. infinite

Q4. If the boy is running from West to East at an average speed of 120 km/h, then how far does this boy run in 6 s?

a. 20 m

b. 200 m

c. 900 m

d. 500 m

Q5. A boy walks on a straight road from his home to a shop 2.5 km away with a speed of 5 km/h. Finding the shop closed, he instantly turns and walks back home with a speed of 7.5 km/h. The average speed of the boy over the interval of time 0 to 40 min is equal to:

a. 5 km/h

b. 25/4 km/h

c. 30/4 km/h

d. 45/8 km/h

Solutions

1. (b) 2 m/s

Total distance travelled is 100 m + 100 m = 200 m and the total time taken in 50 s + 50 s = 100 s

$$\text{Speed of boy} = \frac{\text{Distance travelled}}{\text{Time taken}} = \frac{200\,\text{m}}{100\,\text{s}} = 2\,\text{m/s}$$

2. (d) 0 m/s

The boy runs 100 m towards East and then 100m towards West and reaches at the starting point. So, the displacement will be 100 m - 100 m = 0 m

The total time taken is 50 s + 50 s = 100 s

$$\text{Velocity of boy} = \frac{\text{Displacement}}{\text{Time taken}} = \frac{0\,\text{m}}{100\,\text{s}} = 0\,\text{m/s}$$

3. (c) zero

Given that $v = u$

$$\therefore \quad a = \frac{v-u}{t} = \frac{u-u}{t} = 0$$

4. (b) 200 m

Given, $v = 120$ km/h $= 120 \times \frac{5}{18}$ m/s $= 33.33$ m/s

$\therefore$ Displacement $= 33.33 \times 6 = 200$ m

5. (d) $\frac{45}{8}$ km/h

Speed of boy from his home to shop is 5 km/h.

Distance = 2.5 km and time $= \frac{d}{v} = \frac{2.5}{5} = \frac{1}{2}$h

Case Study 2

One day Radhika decided to go her office by her car. She is enjoying the driving along with listening the old songs. Her car is moving along a straight road at a steady speed. On a particular moment, she notices that the car travels 150 m in 5 s.

Read the given passage carefully and give the answer of the following questions:

Q1. What is its average speed?

a. 20 m/s

b. 30 m/s

c. 10 m/s

d. 40 m/s

Q2. How far does it travel in 1 s?

a. 20 m

b. 30 m

c. 10 m

d. 40 m

Q3. How far does it travel in 6 s?

a. 120 m

b. 130 m

c. 180 m

d. 140 m

Q4. How long does it take to travel 240 m?

a. 2 s

b. 4 s

c. 6 s

d. 8 s

Q5. Which of the following statement is correct regarding velocity and speed of a moving body?

a. Velocity of a moving body is always higher than its speed

b. Speed of a moving body is always higher than its velocity

c. Speed of a moving body is its velocity in a given direction

d. Velocity of a moving body is its speed in a given direction

Solutions

1. (b) 30 m/s

Average speed = total distance travelled/total time taken

= 150/530 m/s

2. (b) 30 m

Time = 1s

Distance = average speed × time

= 30 m/s x 1s = 30 m

3. (c) 180 m Time = 6 s

Distance = average speed x time

= 30 m/s x 65

= 180 m

4. (d) 8 s

Distance = 240 m

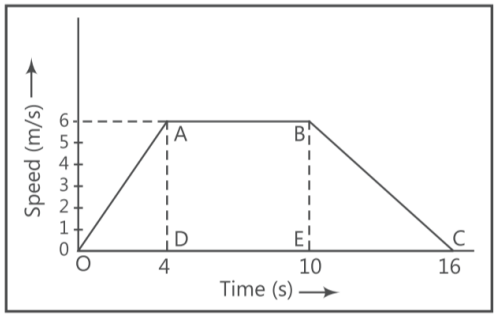
Time Distance/Average speed

= 240/30 = 8 s

5. (d) Velocity of a moving body is its speed in a given direction.

Case Study 3

Amir started driving his car. He increases the speed till 4 seconds and then he kept his car in constant speed for 6 seconds. Then after he decreased the speed of the car up to another 6 seconds. After reaching at the starting place, he draws the speed-time graph of his 16 seconds driving as shown below:



Read the given passage carefully and give the answer of the following questions:

Q1. What type of motion is represented by OA?

a. Uniform velocity

b. Uniform acceleration

c. Negative acceleration

d. No acceleration

Q2. What type of motion is represented by BC?

a. Uniform velocity

b. Uniform acceleration

c. Negative acceleration

d. No acceleration

Q3. Find out the acceleration of the body.

a. 1.5 m/s^2 b. 2 m/s^2

c. 3 m/s^2 d. 1 m/s^2

Q4. Calculate the retardation of the body.

a. 1.5 m/s^2 b. 2 m/s^2

c. 3 m/s^2 d. 1 m/s^2

Q5. Find out the distance travelled by the body from A to B.

a. 15 m b. 30 m

c. 36 m d. 60 m

Solutions

1. (b) Uniform acceleration

OA is a straight line graph between speed and time and it is sloping upwards from 0 to A.

Therefore, the graph line OA represents uniform acceleration.

2. (c) Negative acceleration

BC is a straight line graph between speed and time which is sloping downwards from B to C.

Therefore, BC represents uniform retardation (or negative acceleration).

3. (a) 1.5 m/s^2

The slope of speed-time graph OA will give us the acceleration of the body.

Thus, acceleration Slope of line OA = AD/OD

From the graph AD = 6 m/s and OD = 4 s.

∴ Acceleration 6 m/s/4s = 1.5 m/s^2

4. (d) 1 m/s^2

The slope of speed-time graph BC will be equal to the retardation of the body.

So, retardation = Slope of line BC= BE/EC

From the graph BE = 6 m/s

and EC 16 - 10 = 6 seconds.

∴ Retardation 6m/s/6s = 1 m/s^2

5. (c) 36 m

Distance travelled from A to B

= Area under the line AB and the time axis

= Area of rectangle DABE

= DA × DE

Now, from the given graph, we find that

DA = 6 m/s and DE = 10 - 4 = 6 s.

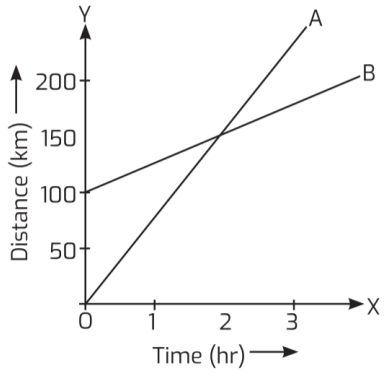
Therefore, Distance travelled from A to B = 6 x 6

= 36 m

Case Study 4

The change in the position of an object with time can be represented on the distance-time graph adopting a convenient scale of choice. In this graph, time is taken along the X-axis and distance is taken along the Y-axis. This graph shows that the distance travelled by the trains is directly proportional to time taken.

Study the graph related to distance-time graph of two trains and answer the questions that follow:



Read the given passage carefully and give the answer of the following questions:

Q1. How much ahead of A is B when the motion starts?

Q2. What is the speed of B?

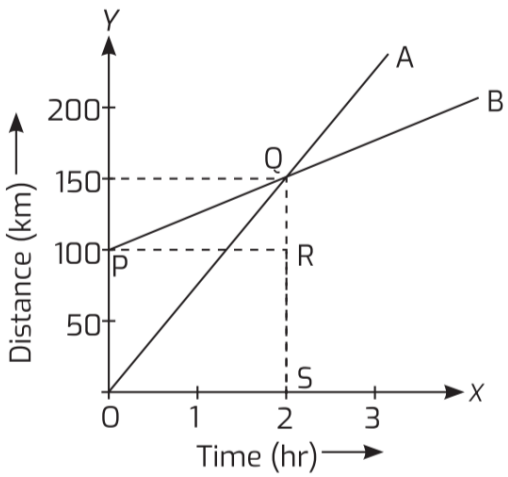
Q3. When and where will A catch B?

Q4. What is the difference between the speeds of A and B?

Q5. Is the speed of both the trains uniform? Justify your answer.

Solutions

1. B is 100 km ahead of *A*.



2. Speed of $B = \frac{QR}{PR} = \frac{150 - 100}{2 - 0} = \frac{50}{2}$

$= 25$ km/hr

3. A will catch B after 2 hours at a distance of 150 km.

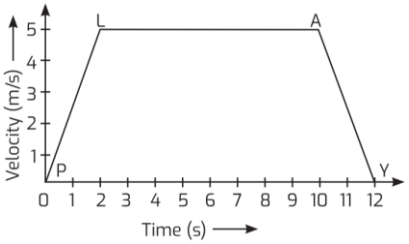
4. Speed of $A = \frac{QS}{OS} = \frac{150 - 0}{2 - 0} = \frac{150}{2} = 75$ km/hr

Difference = 75 – 25 = 50 km/hr

5. Yes, because both are straight line graphs.

Case Study 5

The variation in velocity with time for an object moving in a straight line can be represented by a velocity-time graph. In this graph, time is represented along the x-axis and velocity is represented along the y-axis.



Study the above graph carefully and give the answer of the following questions:

Q1. Identify the type of motion represented by lines PL and AY.

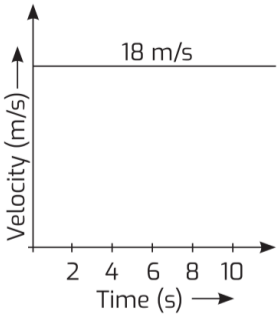
Q2. What is the velocity of object at t = 3.7 s?

Q3. Calculate acceleration:

(i) between 4th and 9th second.

(ii) during last 2 seconds.

Q4. Based on the data represented in the graph below, find the displacement of body in first 8 seconds.



Q5. In Q. 4, what is the acceleration of the body?

Solutions

1. PL represents uniformly accelerated motion.

AY represents uniformly retarded motion.

2. At t = 3.7 s, velocity of object is 5 m/s.

3. (i) Between 4th and 9th second, a = 0

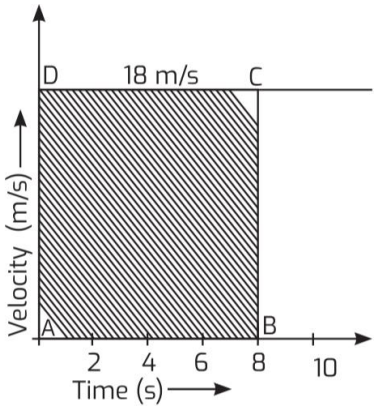
(ii) During last 2 s,

$$\text{acceleration } (a) = \frac{0-5}{12-10} = \frac{-5}{2} = -2.5 \text{ m/s}^2$$

4. Displacement = Area under v-t graph

= Area of rectangle ABCD

= DC × AB = 18 m/s x 8 s = 144 m



5. From the graph as shown in Q.4, it is clear that the velocity is not changing with time, i.e., acceleration is zero.