Motion: Exercise Question

Q.1 An athlete completes one round of a circular track of diameter 200 m in 40s. What will be the distance and displacement at the end of 2 minutes 20 s?

Sol.

(i) Given: Diameter = 200m, so radius r = 200/2 =100 m

Time = 40 s

Distance travelled in 40 s =2× π× 100

Distance travelled in 1 s = 200π / 40

Distance travelled in 2 min 20s or 140 s = $\frac{200x\Pi}{40} x140 = 5\Pi x140$

=700π

=700× 3.14

=2198m

(ii) Displacement = 0 m (since, initial and final position is the same).

Q.2 Joseph jogs from one end A to the other end B of a straight 300 m road in 2 minutes 50 seconds and then turns around and jogs 100 m back to point C in another 1 minute. What are joseph's average speeds and velocities in jogging?

(a) from A to B and

(b) From A to C?

Sol:

(a) From A to B:

Travelled Distance = 300 m

Time = 2 min 50 s = 170 s

Average speed = Total distance / Total time

=300m / 170s=1.76ms^{-1}

Average velocity = Total Displacement / Total time

Since Joseph moves in a straight line from A to B, so displacement = 300 m

=300m / 170s =1.76ms^{-1}

(b) From A to C:

Now Travelled distance = (300 + 100) m = 400 m

Total Time = (170 + 60)s = 230 s

So, Average speed = Total distance / Total time

=400m / 230s=1.73ms^{-1}

Now, Average velocity = Total Displacement / Total time

Since, Joseph turns back and moves 100m back. So, displacement =200 m

Average velocity =200m/230s

=0.86ms^{-1}

Q.3 Abdul, while driving to school computes the average speed for his trip to be 20 kmh^{-1}. On his return trip along the same route, there is less traffic and the average speed is 40 kmh^{-1}. What is the average speed for Abdul's trip?

Sol: Let the distance between home and school be x km.
Average speed from the starting point to school = 20 kmh^{-1}

Time taken for this journey $T_1 = \frac{x}{20}$

Average speed from the school to home point = 40 kmh^{-1}

Time for this return journey $T_2 = \frac{x}{40}$

Average speed for total journey = Total distance / Total time

$$= \frac{2x}{T_1 + T_2}$$

$$= \frac{2x}{\frac{x}{20} + \frac{x}{40}}$$

$$= 80/21$$

$$= 3.8 \text{ km/h}$$

Q.4 A motor boat starting form rest on a lake accelerates in a straight line at a constant rate of 3.0 ms^{-2} for 8.0 s. How far does the boat travel during this time?

Sol: Given: Initial velocity u = 0

Acceleration a= 3ms^{-2}

T = 8s

According to second equation of motion,

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

$$s = 0x8 + \frac{1}{2}3(8)^2$$

S= 96 m

Q.5 A driver of a car travelling at 52 km h^{-1} applies the brakes and accelerates uniformly in the opposite direction. The car stops in 5 s. Another driver going at 3 km h^{-1} in another car applies his brakes slowly and stops in 10 s. On the same graph paper, plot the speed versus time graphs for the two cars. Which of the two cars travelled farther after the brakes were applied?

Sol: Case -1

Initial speed of car = 52 kmh^{-1} = 52 x 5/18 = 14.4 m/s

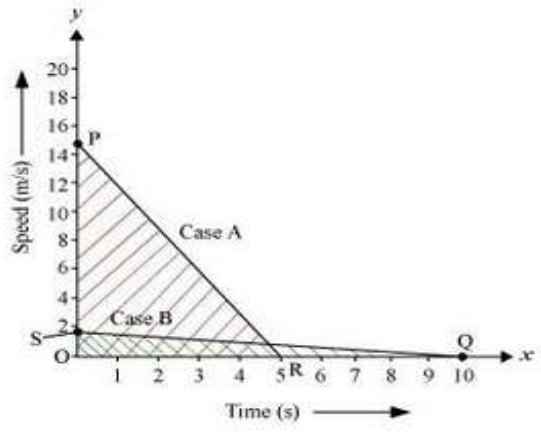
Time taken = 5s

Case-2

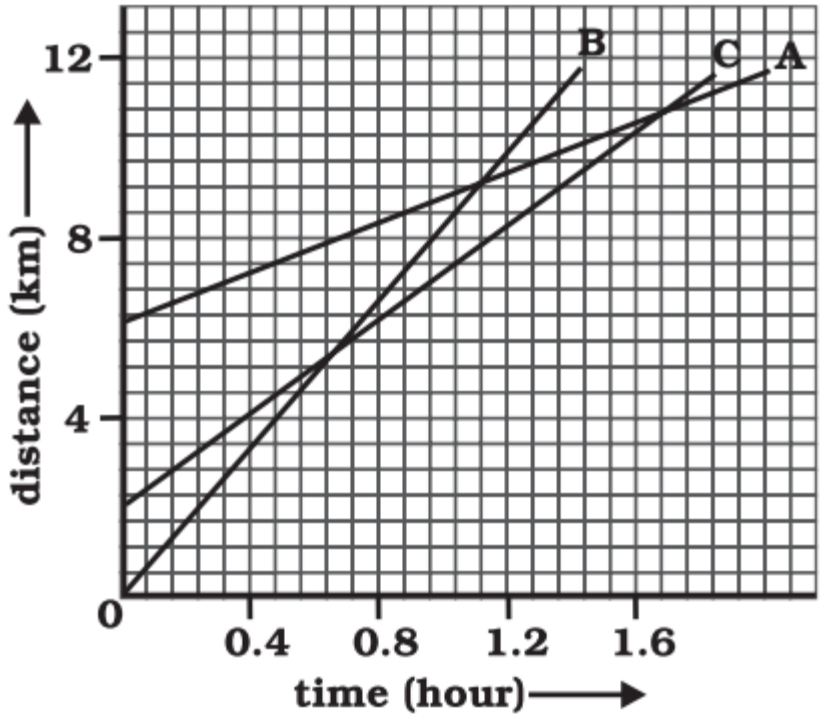
Initial speed of car = 3 kmh^{-1} = 3 x 5/18 = 0.83 m/s

Time taken = 10s

Graph:



Q.6 Fig. shows the distance-time graph of three objects A,B and C. Study the graph and answer the following questions:



(a) Which of the three is travelling the fastest?

(b) Are all three ever at the same point on the road?

(c) How far has C travelled when B passes A?

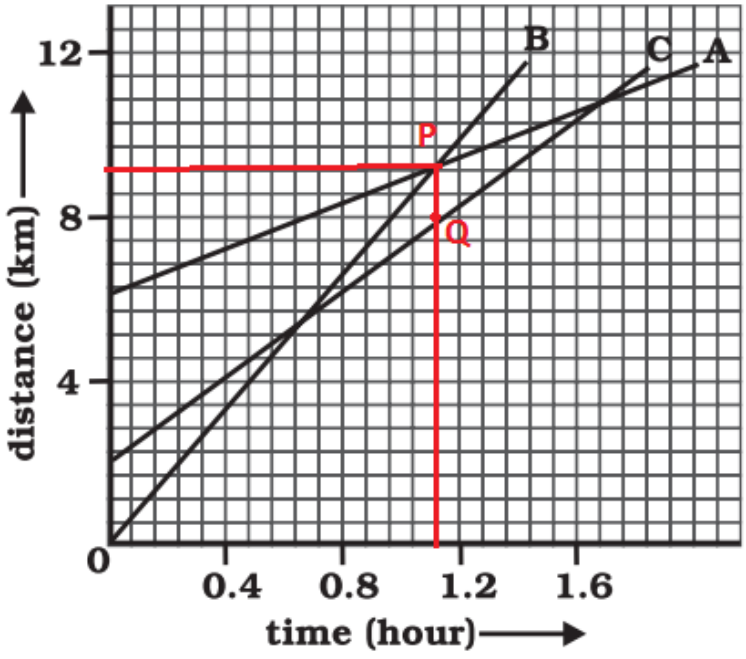
(d) How far has B travelled by the time it passes C?

Sol:

(a) If we see he graph, the slope of object B is greater than slope of object A and C. So, object B is travelling fastest.

(b) All three objects A, B and C never meet at a single point because all the three lines do not intersect at a single point.

(c) From the graph, we can that object B passes the object A at P point



On the distance axis:
7 box = 4km
So, 1 box = 4/7 km
Since, initial position of C is at 4 box away from the origin. So, its initial position:
4 x (4/7) = 16/7 km
Now the final position of object C is at Q point which is 8 km from the origin. (Final position of object C at Q when Object B passes the object A)

So, Distance travelled by Object C = 8-(16/7) = 5.71 km

(d) Object B travelled 9 box of graph by the time it passes C.
So, total distance traveled by B when it cross C = 9x (4/7) = 5.14 km

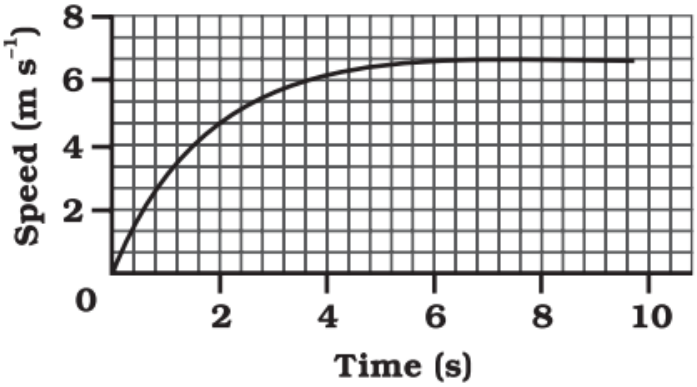
Q.7 A ball is gently dropped from a height of 20 m. If its velocity increases uniformly at the rate of 10 m s-2, with what velocity will it strike the ground? After what time will it strike the ground?

Sol: Given: Height s = 20 m
Initial velocity u = 0
Acceleration a = 10 ms^{-2}
By second equation of motion

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

$20=0+ ½ \times 10 \times t^2$
$\Rightarrow 20=5t^2$
Or $t = \sqrt{4} = 2s$
So, time when ball strike the ground = 2s
By first equation of motion,
v = u + at
$\Rightarrow v = 0 + 10 \times 2$
$\Rightarrow v = 20\ ms^{-1}$
Velocity of ball the strike the ground = 20m/s

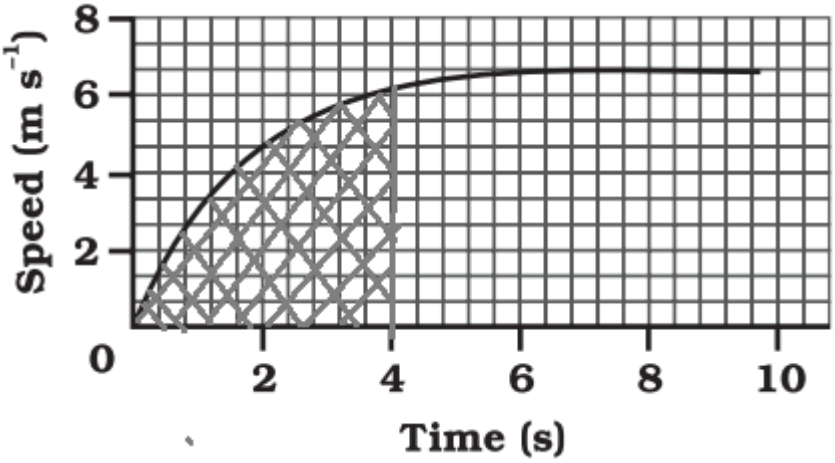
Q.8 The speed-time graph for a car is shown is Fig.



(a) Find how far the car travels in the first 4 seconds. Shade the area on the graph that represents the distance travelled by the car during the period.
(b) Which part of the graph represents uniform motion of the car?

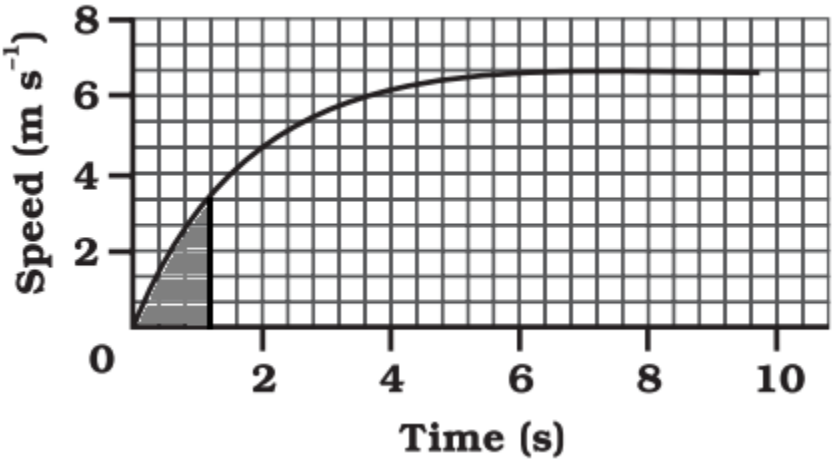
Sol:

(a)



Shaded area shows the distance travelled by the car in 4 second

(b)



This shaded are shows the uniform motion of the car.

Q.9 State which of the following situations are possible and give an example for each of these:

(a) An object with a constant acceleration but with zero velocity

(b) An object moving in a certain direction with an acceleration in the perpendicular direction.

Sol:

(a) Yes, this situation is possible. When an object is thrown upward direction, at maximum height it has final velocity is zero and gravitational acceleration g =9.8 m/s^2, which is constant.

(b) Yes, this situation is also possible. When an object moves in circular path. Its acceleration is perpendicular to the direction of motion.

Q.10An artificial satellite is moving in a circular orbit of radius 42250 km. Calculate its speed if it takes 24 hours to revolve around the earth.

Sol:

Given: Radius of circular orbit = 42250 km

Time taken = 24 hours

Circumference of the orbit= 2 x π x (42250) = 265571.42 km

So, speed of satellite = 265571.42/24 = 11065.4 kmh^{-1}