Motion – a change in position measured by distance and time. **Speed** – the rate at which an object moves. **Velocity** – the speed and direction of a moving object. **Acceleration** – a change in velocity and/or direction. **Scalar Quantity** – a quantity with magnitude but no direction. **Vector Quantity** – a quantity with magnitude and direction.

Position (distance) Vs. Time Graphs

Plotting position (distance) against time can tell you a lot about motion. Time is always plotted on the X-axis (independent). The further to the right on the axis, the longer the time from the start. Position (distance) is plotted on the Y-axis (dependent). The higher up the graph, the further from the start.

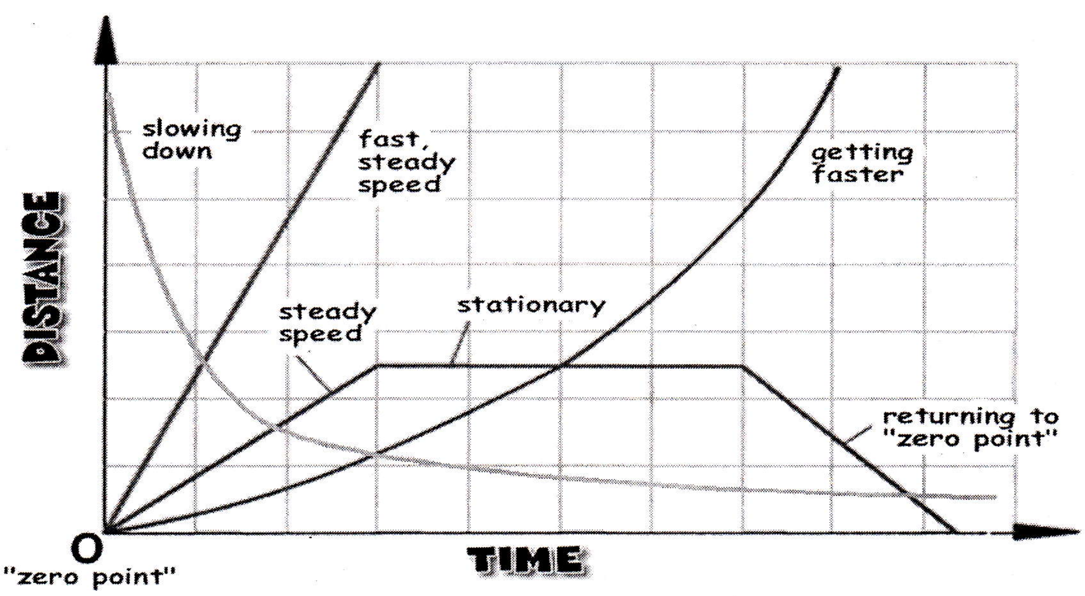
If an object is not moving, a horizontal line is shown on a position (distance) v. time graph. Time is increasing to the right, but distance does not change. It is not moving. We say it is **at rest**.

If an object is moving at a constant speed, it means it has the same increase in distance in a given time. Time is increasing to the right and Position (distance) is increasing constantly with time. The object moves at a **constant speed**. **Constant speed/velocity is shown by straight lines on a graph.**

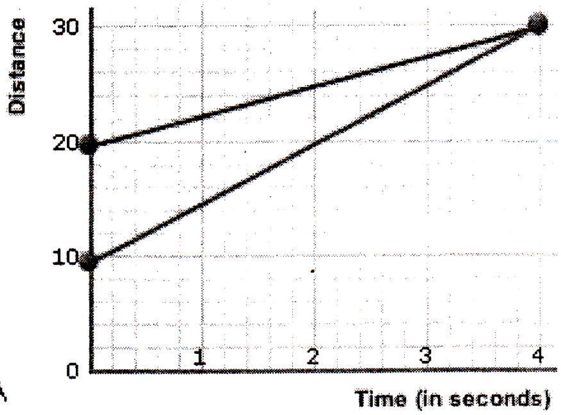
Consider two moving objects. Both of the lines in the graph show that each object moved the same distance, but the steeper dashed line traveled the distance in a shorter period of time. A **steeper line indicates** a larger distance moved in a given amount of time, **higher speed/velocity**. Both lines are **straight** so both speeds are **constant**.

Distance (position) vs. Time graphs that show acceleration look different from those that show constant speed. The line on this graph is **curving** upwards. This **shows an increase in speed/velocity** since the line is getting steeper. In a given time the distance the object moves is changing (getting larger) therefore the object is **accelerating**.

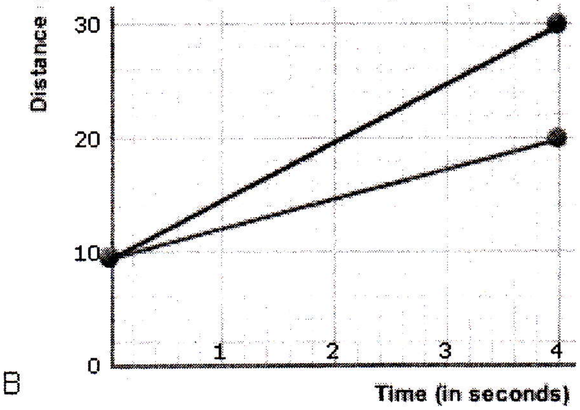
Summary – A Position (distance) Vs. Time graph tells us how far an object has moved with time. The steeper the graph, the faster the motion. A horizontal line means the object is not changing its position, it is not moving, it is at rest. A downward sloping line means the object is returning to the start.



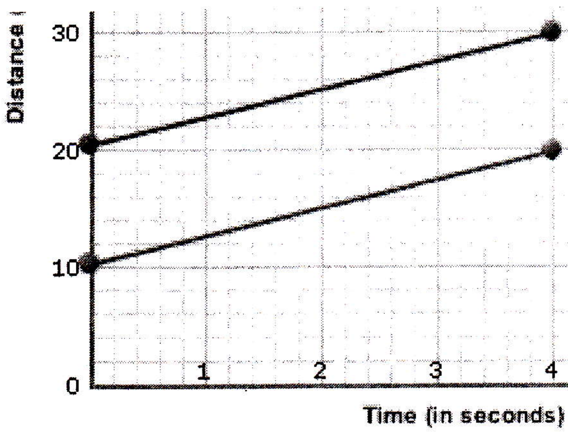
In which of the graphs below are both runners moving at the same speed? Explain your answer.



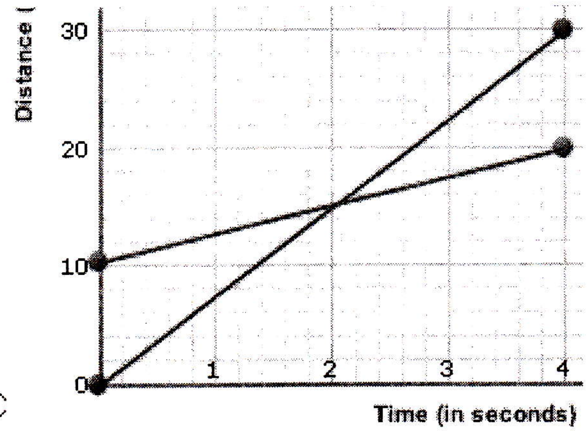
A



B

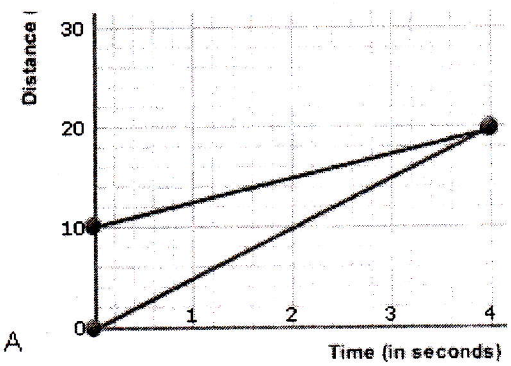


D

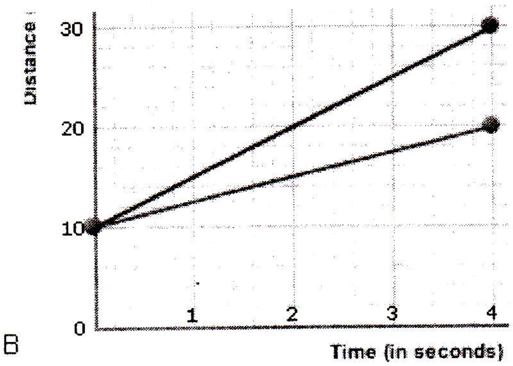


C

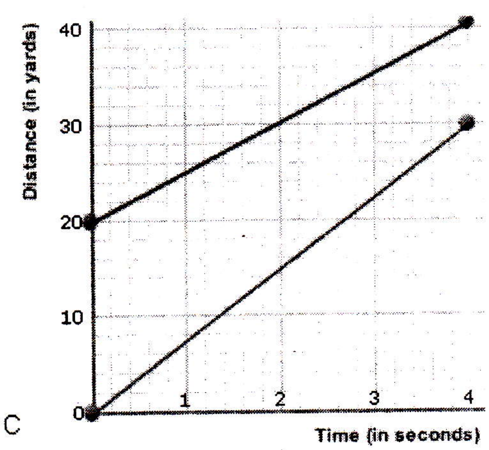
Which of the graphs below shows one runner starting 10 yards ahead of the other? Explain your answer.



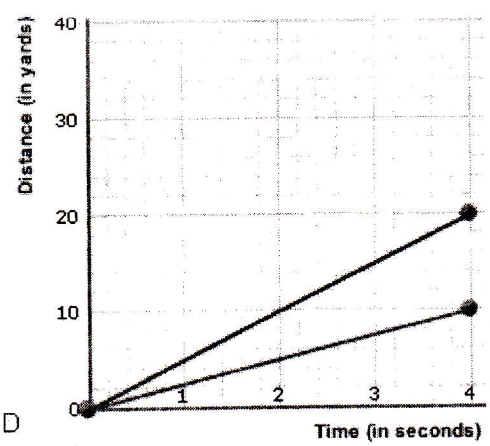
A



B



C

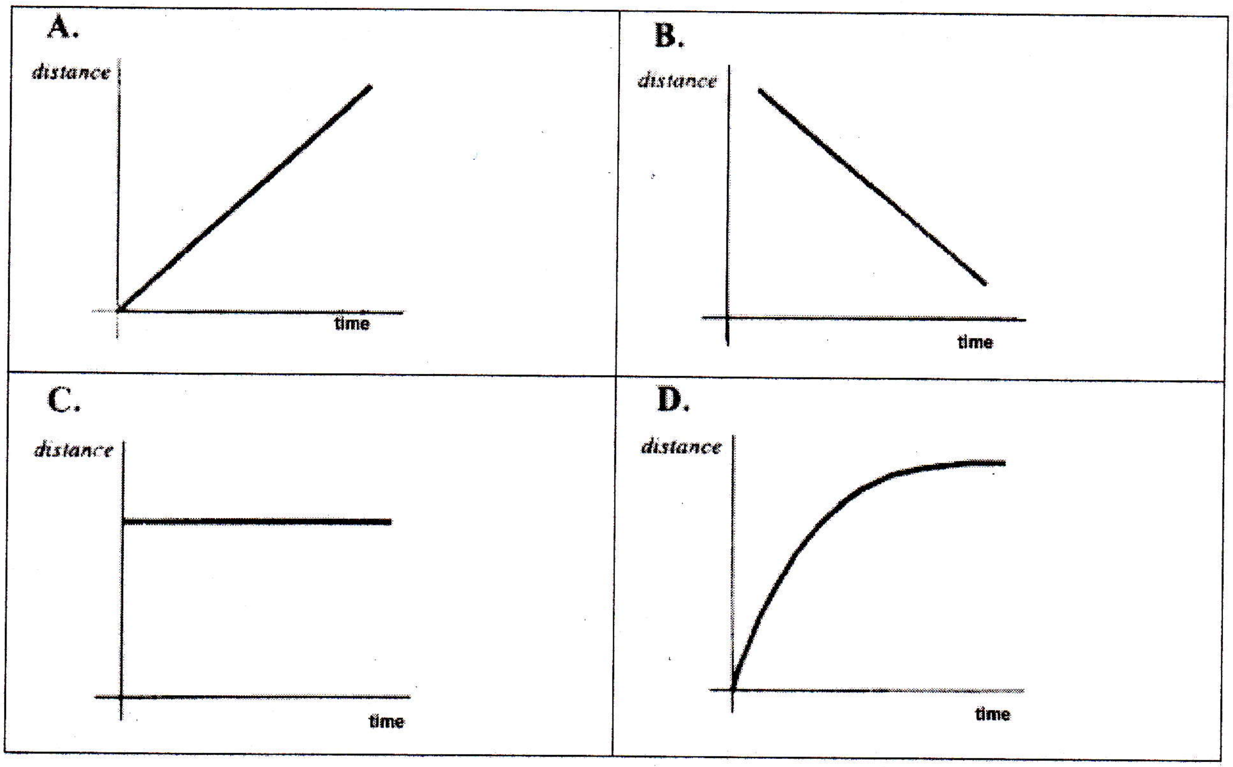


D

The distance-time graphs below represent the motion of a car. Match the descriptions with the graphs. **Explain your answers.**

Descriptions:

1. The car is stopped.
2. The car is traveling at a constant speed.
3. The speed of the car is decreasing.
4. The car is coming back.



Graph A matches description _____ because ________________________________.

Graph B matches description _____ because ________________________________.

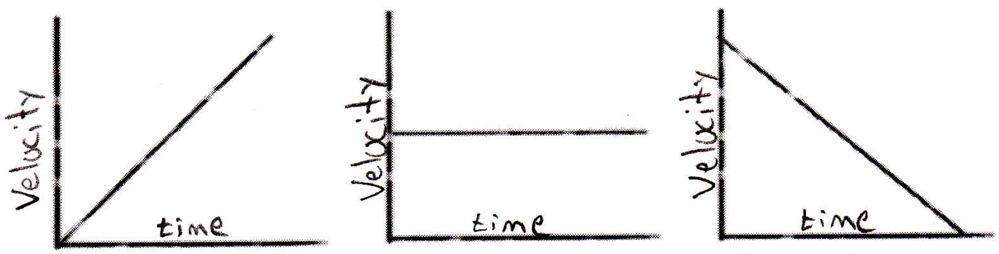
Graph C matches description _____ because ________________________________.

Graph D matches description _____ because ________________________________.

Speed (velocity) Vs. Time Graphs

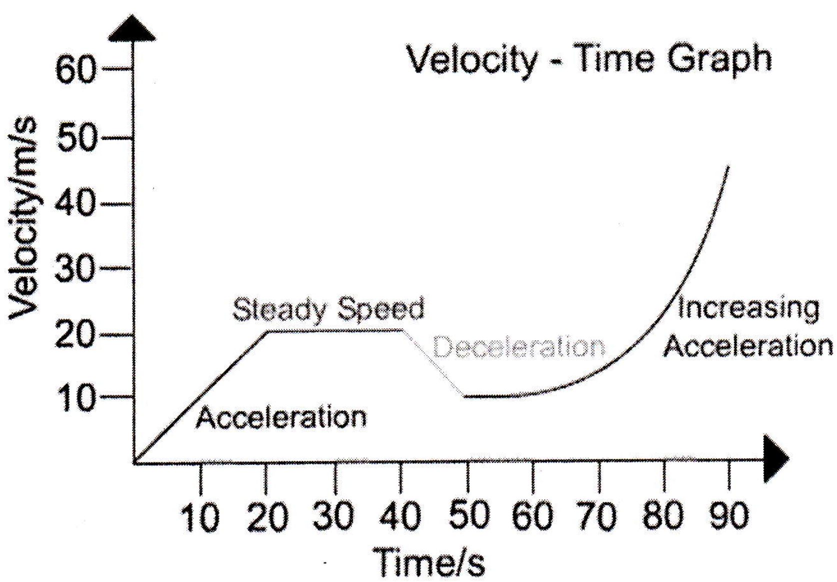
Speed (velocity) vs. Time graphs look much like Position (distance) Vs. Time graphs. Be sure to read the labels. Time is plotted on the X-axis (independent). Speed/Velocity is plotted on the Y-axis (dependent). A straight horizontal line on a speed (velocity) vs. time graph means that speed is constant. It is not changing over time. A straight line does not mean that the object is not moving.

A straight line with a positive slope shows the object is accelerating. A straight line with a negative slope shows the moving object is decelerating (slowing down). The steeper the slope the greater the acceleration.



Positive Acceleration | Constant Velocity | Negative Acceleration or Deceleration

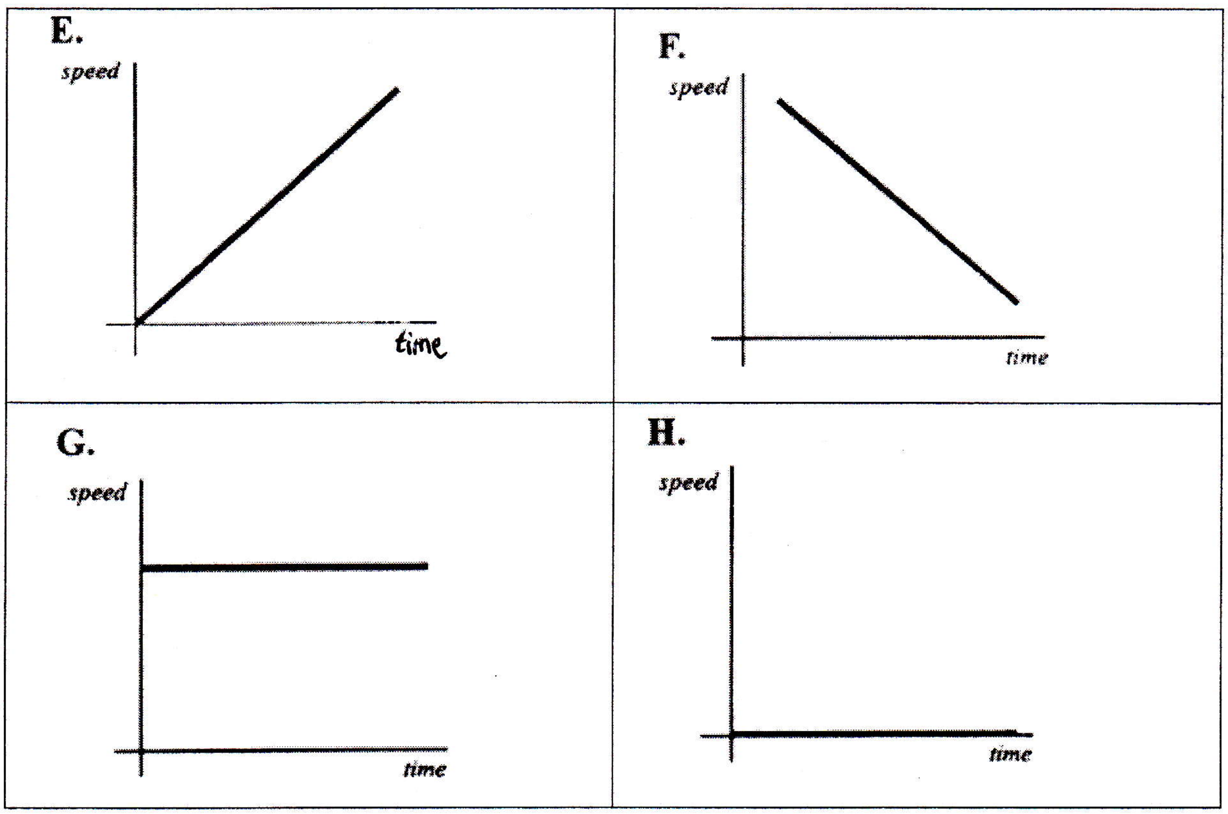
Summary: A Speed (velocity) Vs. Time graph shows us how the speed of a moving object changes with time. The steeper the graph, the greater the acceleration. A horizontal line means the object is moving at a constant speed. A downward sloping line means the object is slowing down (decelerating).



The speed-time graphs below represent the motion of a car. Match the descriptions with the graphs. **Explain your answers.**

Descriptions:

5. The car is stopped.
6. The car is traveling at a constant speed.
7. The car is accelerating.
8. The car is slowing down.



Graph E matches description _____ because ______________________________________.

Graph F matches description _____ because ______________________________________.

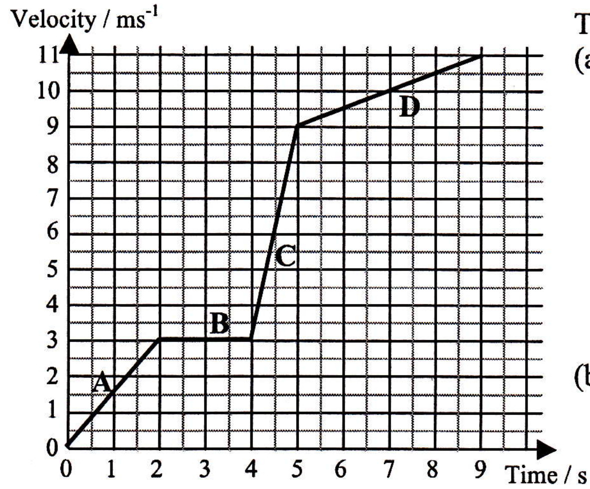
Graph G matches description _____ because ______________________________________.

Graph H matches description _____ because ______________________________________.

GRAPHS OF MOTION

VELOCITY TIME GRAPHS

1.



The graph for a journey is shown.

(a) Calculate the acceleration for each section.

A ____________________

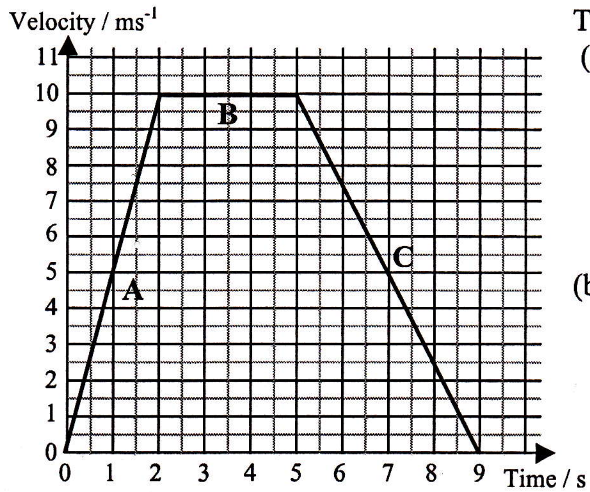
B ____________________

C ____________________

D ____________________

(b) Calculate the distance travelled in the first 4 seconds.____________________

2.



The graph for a journey is shown.

(a) Calculate the acceleration for each section.

A ____________________

B ____________________

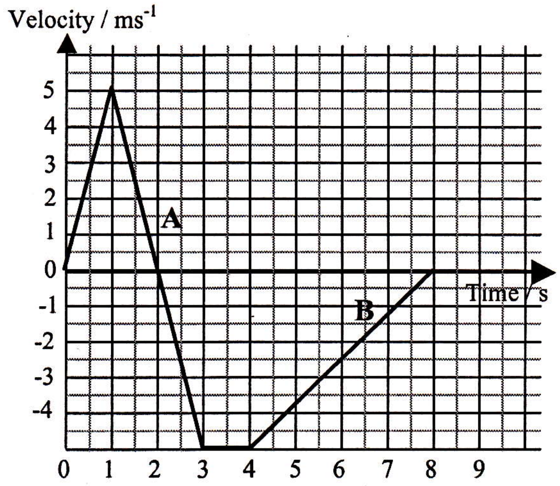
C ____________________

(b) Why is C negative?

____

____

3.



The graph for a journey is shown.

(a) Calculate the acceleration for section;

A ____________________

B ____________________

(b) What distance has been travelled in 8 s?

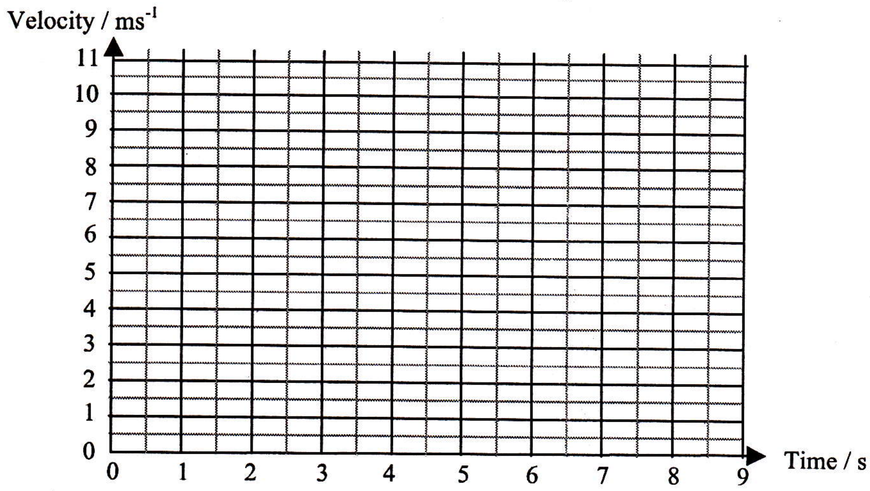
____

____

____

4. A car accelerates from rest and reaches a velocity of 6 ms^{-1} after 2 seconds. It remains at this velocity for 1 second and then accelerates again for 3 seconds to a final velocity of 10 ms^{-1}. At this point it brakes to a stop, taking 3 seconds to do so.

(a) Graph the velocity-time graph of this journey on the grid below.



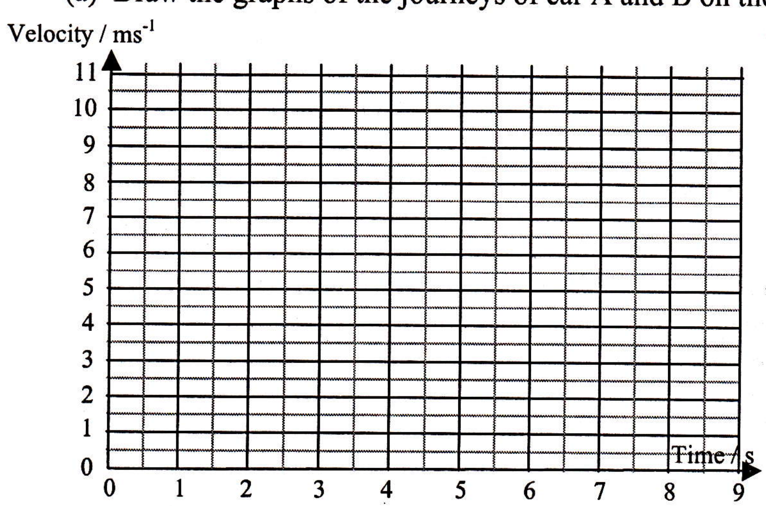
(b) Calculate the total distance travelled by the car.

____

____

5. Car A starts from rest and accelerates steadily to 8 ms^{-1} in 6 seconds and then travels at that speed for the rest of its journey. Car B also starts from rest but begins its journey at the same point as car A three seconds after car A starts. It accelerates uniformly to 10 ms^{-1} in 4 seconds and then continues at that speed for the rest of its journey.

(a) Draw the graphs of the journeys of car A and B on the same grid below. Label them.



(b) What is the significance of the point where the lines cross?

____

____

____

(c) Calculate the distance each car has travelled after 9s.

A.______________________

B.______________________

(d) If the two cars were both planning a journey of 80 m, which car would arrive first?

____

____

____

Answer the following questions by showing the equation, calculations, and answer with units.

V = D/T   D = V×T   T = D/V   Acceleration = (final speed – beginning speed) / time

1. A football field is about 100 m long. If it takes a person 20 seconds to run its length at what **speed** were they running?

2. The pitcher's mound in baseball is 85 m from the plate. It takes 4 seconds for a pitch to reach home plate. At what **speed** does the ball travel in this example?

3. If you drive at 100 km/hr for 6 hours what **distance** have you traveled?

4. If you run at 12 m/sec for 15 minutes what distance have your traveled? (hint: unit conversion)

5. You drive 3900 km with an average speed of 100 km/hr. How much **time** did you spend driving?

6. A bullet travels at 850 m/sec. How much **time** is required for the bullet to travel 1 km?

7. The distance between S.F. and N.Y. is 2,908.0 miles. If you fly from S.F. to N.Y. in 5.5 hrs what would your average **speed** be?

8. The fastest train in the world moves at 500 km/hr. What **distance** can it travel in 3.5 hours?

9. How much **time** will it take light moving at 299,792.5 km/sec to reach us from the sun which is 149,597,871.0 km form earth?

10. The circumference of planet Earth is 21,000 km. Earth rotates once in 23.934 hours. At what **speed** does planet Earth rotate?

11. A car goes from 0 to 100 km/hr in 10 seconds. What is the **acceleration** of the car?

12. A bus decelerates form 30 km/her to 15 km/hr in 4 seconds. What is the acceleration of the bus?

Answer the following questions by showing the equation, calculations, and answer with units.

Graphing: Use the data in the following table, construct a graph (using the graph paper on pg 10) of distance vs. time. Then answer questions 13 & 14 using your graph.

Distance (m)	Time (sec)
10	20
20	40
35	70
65	130
85	170
100	200

13. Does this graph represent constant or changing speed? How do you know?

14. Find the slope of the line and find the average speed.

Graphing: Use the data in the following table, construct a graph (using the graph paper on pg 10) of distance vs. time. Then answer questions 15 & 16 using your graph.

Distance (m)	Time (sec)
15	20
25	50
40	65
70	130
90	185
100	200

15. Does this graph represent constant or changing speed? How do you know?

16. Which section of the graph represents the greatest speed?

Graph I

Graph II