MINISTRY OF EDUCATION

SECONDARY ENGAGEMENT PROGRAMME

GRADE 10

PHYSICS

WEEK 10 **Lesson 2**

Topic: **Dynamics: motion in a straight line**

Sub-topic: **Distance time graph/ velocity time graph**

Objective: Given information and with the aid of formulae, students will:

iv. Describe the term distance time graph.
v. Explain velocity time graph
vi. Calculate gradient for straight lines.

Content:

Distance time graph

In a distance–time graph:

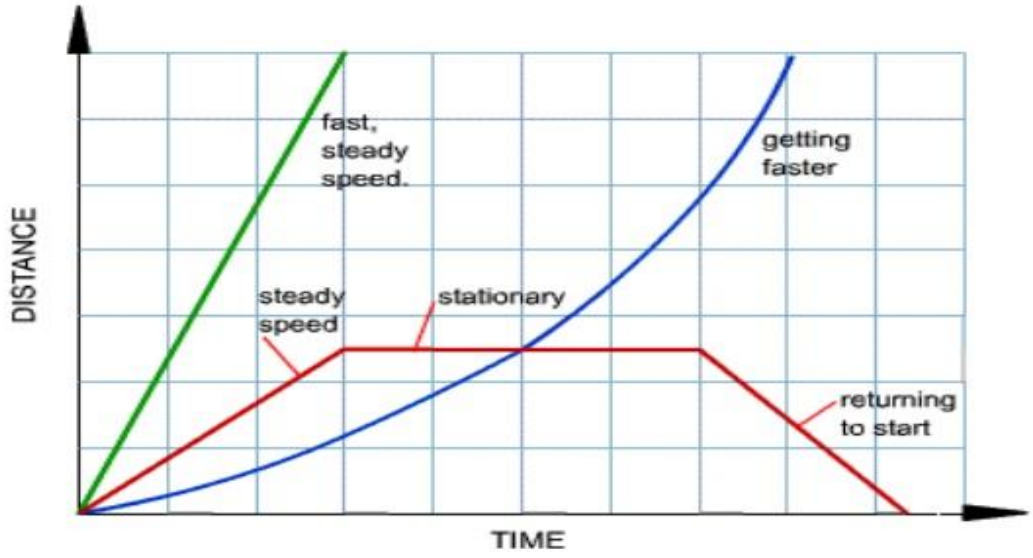
- a horizontal line means the object is stopped
- a straight line sloping upwards means it has a steady speed.

The steepness, or gradient, of the line shows the speed:

- a steeper gradient means a higher speed
- a curved line means the speed is changing.

If the direction of travel is being considered:

- A negative distance is in the opposite direction to a positive distance.
- A straight line sloping downwards means it has a steady speed, and a steady velocity in the negative direction.



Example: Between 30 s and 50 s the cyclist stopped. The graph has a steeper gradient between 50 s and 70 s than between 0 s and 20 s – the cyclist was travelling at a greater speed.

To calculate a speed from a graph, work out the gradient of the straight line section as shown below in fig, 9.1.

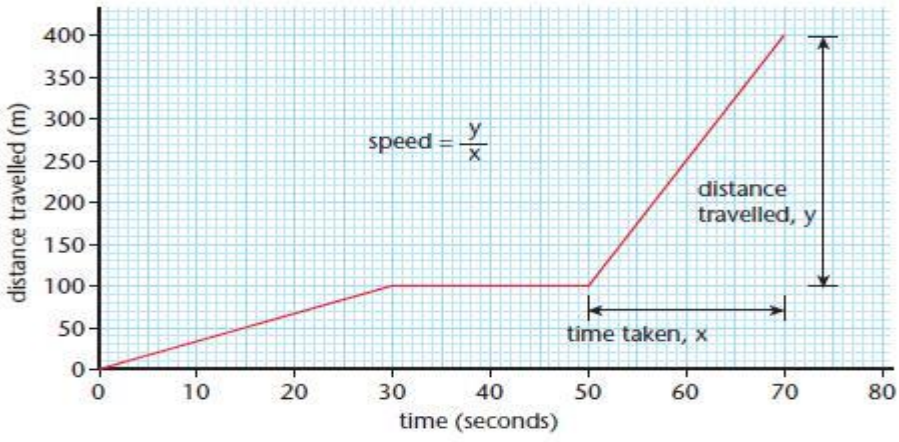


Fig. 9.1 Distance–time graph for a cycle ride.

Answer:

$$\text{speed} = \frac{y}{x} \text{ where } y = 400\,\text{m} - 100\,\text{m} = 300\,\text{m} \text{ and } x = 70\,\text{s} - 50\,\text{s} = 20\,\text{s}.$$

$$\text{speed} = \frac{300\,\text{m}}{20\,\text{s}} = 15\,\text{m/s}.$$

Average speed and instantaneous speed

You can calculate the average speed of the cyclist for the total journey in Fig 9.1 above using:

$$\text{average speed} = \frac{\text{total distance}}{\text{total time}}$$

$$\frac{400\,\text{m}}{70\,\text{s}} = 5.7\,\text{m/s}$$

This is not the same as the instantaneous speed at any moment because the speed changes during the journey. If you calculate the average speed over a shorter time interval you get closer to the instantaneous speed.

Velocity time graph

A change of velocity is called acceleration. Speeding up, slowing down and changing direction are all examples of acceleration. Fig. 9.2 shows how to interpret a velocity–time graph.

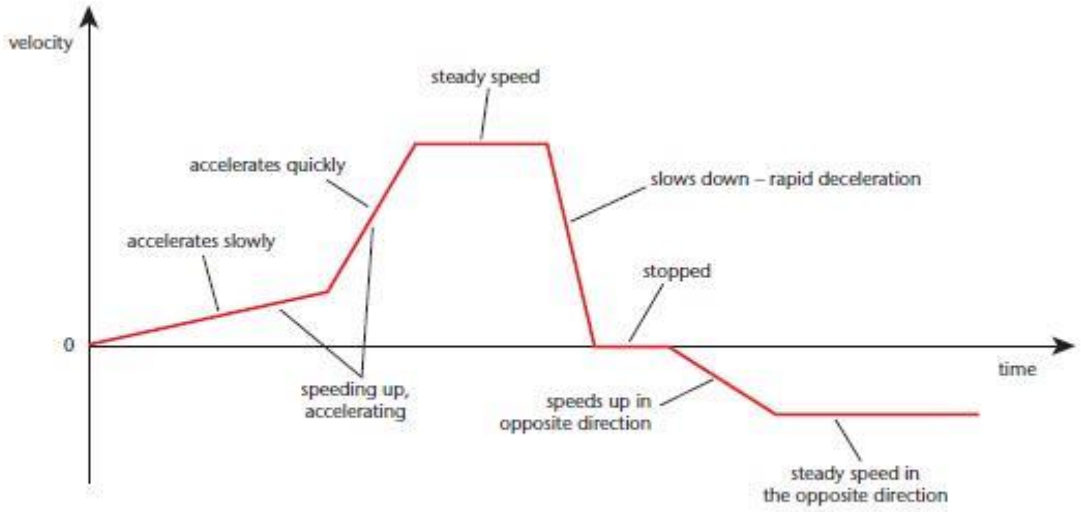


Fig. 9.2 A velocity–time graph.

- A positive slope (gradient) means that the speed is increasing – the object is accelerating.
- A horizontal line means that the object is travelling at a steady speed.
- A negative slope (gradient) means the speed is decreasing – negative acceleration.
- A curved slope means that the acceleration is changing – the object has non-uniform acceleration.

Example:

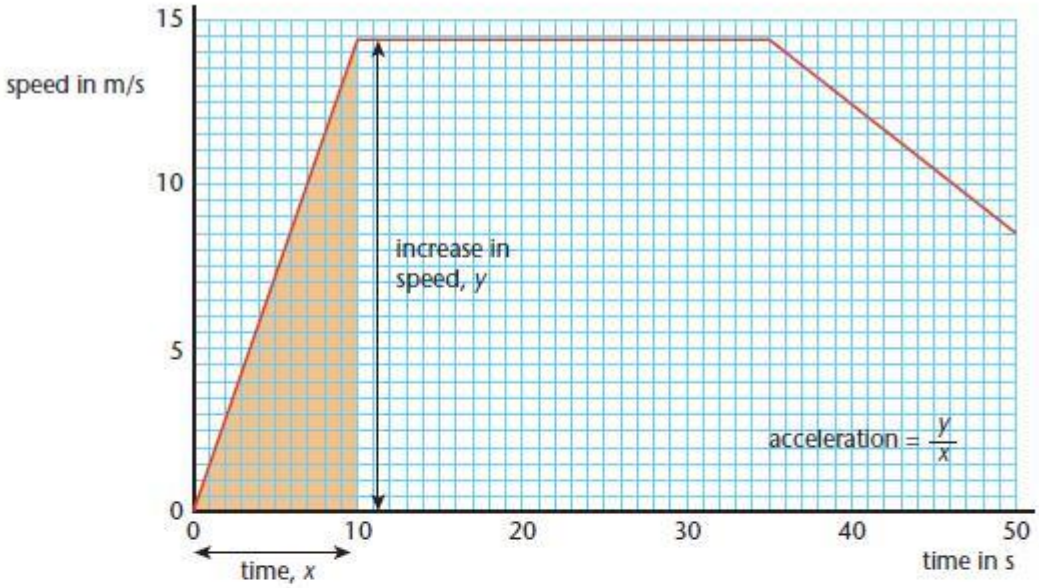


Fig 9.4 Speed–time graph for a car journey.

In the first 10 s the acceleration is: $\frac{(14 - 0)\,\text{m/s}}{10\,\text{s}} = 1.4\,\text{m/s}^2$

The distance travelled in the first 10 seconds is given by the shaded area.

Distance travelled = average speed × time

average speed = $\frac{1}{2}(14 - 0)$ m/s and time = 10 s

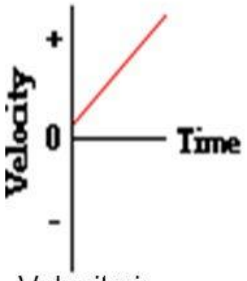
Distance travelled in metres = $\frac{1}{2}(14 - 0) \times 10$ which is the area of the shaded triangle ($\frac{1}{2}$ base × height).

The distance travelled in the next 25 s is represented by the rectangle.

Distance = 14 m/s × 25 s = 350 m

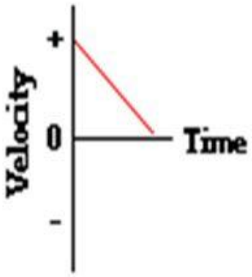
Example: describe velocity and acceleration for each v-t diagram

These objects are moving with a positive velocity.



Velocity is positive. increasing, speeding up

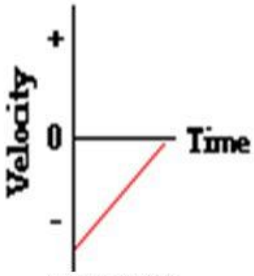
Acceleration is constant, positive



Velocity is positive decreasing, slowing down

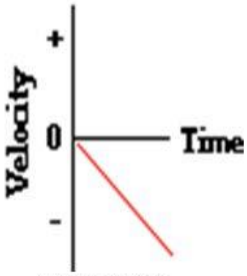
Acceleration is constant, negative

These objects are moving with a negative velocity.



Velocity is negative decreasing, slowing down

Acceleration is constant, positive



Velocity is negative, increasing, speeding up

Acceleration is constant, negative

Reference

- https://www.onlinemathlearning.com/distance-velocity-time-graph.html
- https://www.physicsclassroom.com/class/1DKin/Lesson-4/Meaning-of-Shape-for-a-v-t-Graph