Travel Graphs

Starter

1. **(Review of last lesson)** A car accelerates such that its velocity is given by $v = 14 + 0.45t^2 - 0.03t^3$. Find:
   (a) a formula for acceleration and
   (b) the speed of the car once the car stops accelerating.

2. **(Review of last lesson)** A hot air balloon is at a height of 200 m and descending at 6 m/s. The burner is operated for 15 seconds, providing an upward acceleration given by $a = (0.03t^2 - 0.002t^3)$ m/s² after t seconds.
   (a) How long does it take for the balloon to stop descending?
   (b) Find its height at this point.
   N.B. For (a), you will need to solve the equation using your calculator: Menu >> xy = 0 >> 2:Polynomial >> Degree 4.

3. A girl goes for a run along a straight path. Her journey is detailed below:
   - She runs 1.5 km in 5 minutes, then rests for 2 minutes.
   - She then jogs 0.5 km in 4 minutes, in the same direction as before.
   - Finally she runs 2.5 km back in the same direction she came, passing her starting point along the way.
   - She finishes 20 minutes after she first set off.

   Show her journey on a displacement-time graph.

Notes

The following was covered at GCSE:

	Displacement-time graph	Velocity-time graph
Height of graph	Displacement from starting point	Velocity
Gradient of line	Velocity	Acceleration
Zero gradient	Stationary	Constant velocity
Area under graph	No meaning	Displacement

Displacement-time graphs

Velocity is the gradient — the ***steeper*** the line, the ***faster*** the object is moving.

$$\text{Velocity} = \frac{\text{Change in displacement}}{\text{Time}}$$

The direction of motion is defined by whether the line is moving upwards or downwards.

Velocity—time graphs

Acceleration is the gradient — the ***steeper*** the line, the ***greater*** the object is accelerating/ decelerating.

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{Time}}$$

N.B. Area of a trapezium = half the sum of the parallel sides times the distance between them.

i.e. Area $= \frac{1}{2}(a+b)h$

E.g. 1 A train takes 10 minutes to travel between two stations. The train accelerates from rest at a rate of 0.5 m/s² for 30 s. It then travels at a constant speed and is finally brought to rest in 15 s with a constant deceleration.

(a) Sketch a velocity-time graph for the journey.

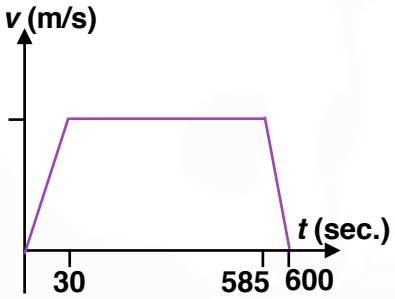
(b) Find

(i) the steady speed

(ii) the rate of deceleration and

(iii) the distance between the two stations.

Working: (a)



(b) (i) Velocity $= 0.5 \times 30 = 15$ m/s

(ii) Deceleration $= \frac{15}{15} = 1$ m/s²

(iii) Distance between stations = Area under graph

$$= \frac{1}{2}(600+555)\times 15$$
$$= 8662.5 \text{ m}$$

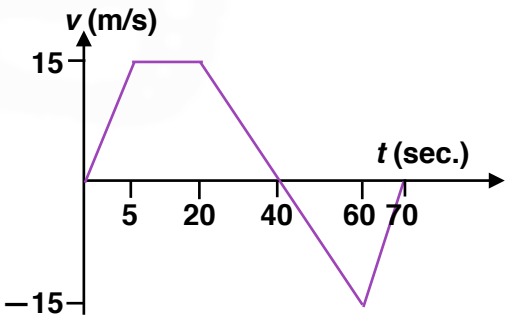
N.B. Area under the $t-$axis of a velocity—time graph means the object is going in the opposite direction.

E.g. 2 The velocity time graph shows the motion of a particle moving in a straight line. Find:

(a) the magnitude of the particle's greatest acceleration during the motion

(b) the total distance travelled

(c) the total displacement of the particle



Video: Displacement-time graphs
Video: Velocity-time graphs

Velocity-time graphs EQ

Solutions to Starter and E.g.s

Exercise
p438 19D Qu 1, 3, 4ab, 5-8

Summary
Displacement-time graphs:

Velocity is the gradient: $$\text{Velocity} = \frac{\text{Change in displacement}}{\text{Time}}$$

Velocity—time graphs:

Acceleration is the gradient: $$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{Time}}$$

Area under the graph is distance travelled
Displacement means that area above the $t-$axis is positive but area below the $t-$axis is negative.