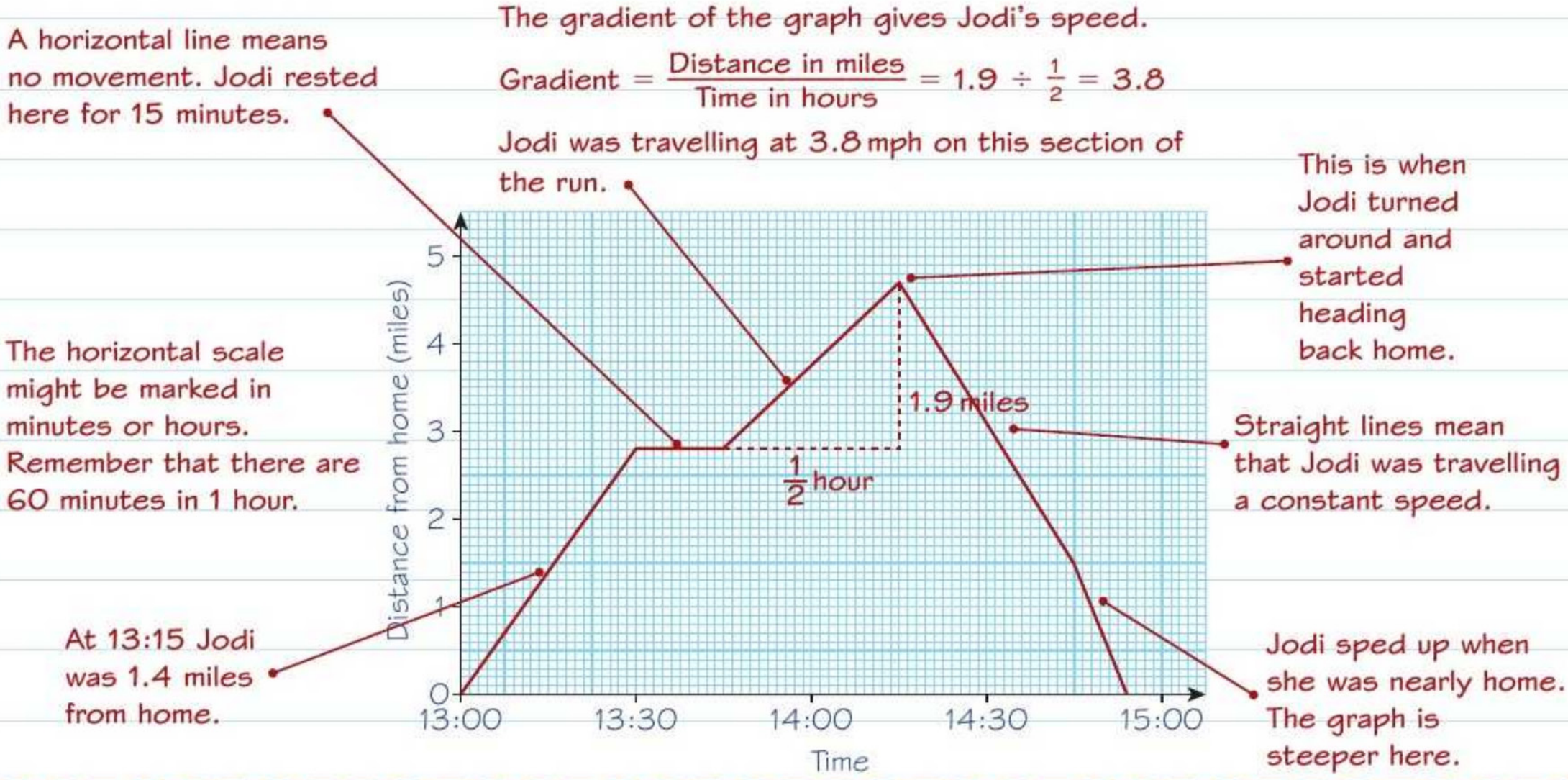
Had a look ☐ Nearly there ☐ Nailed it! ☐

Real-life graphs

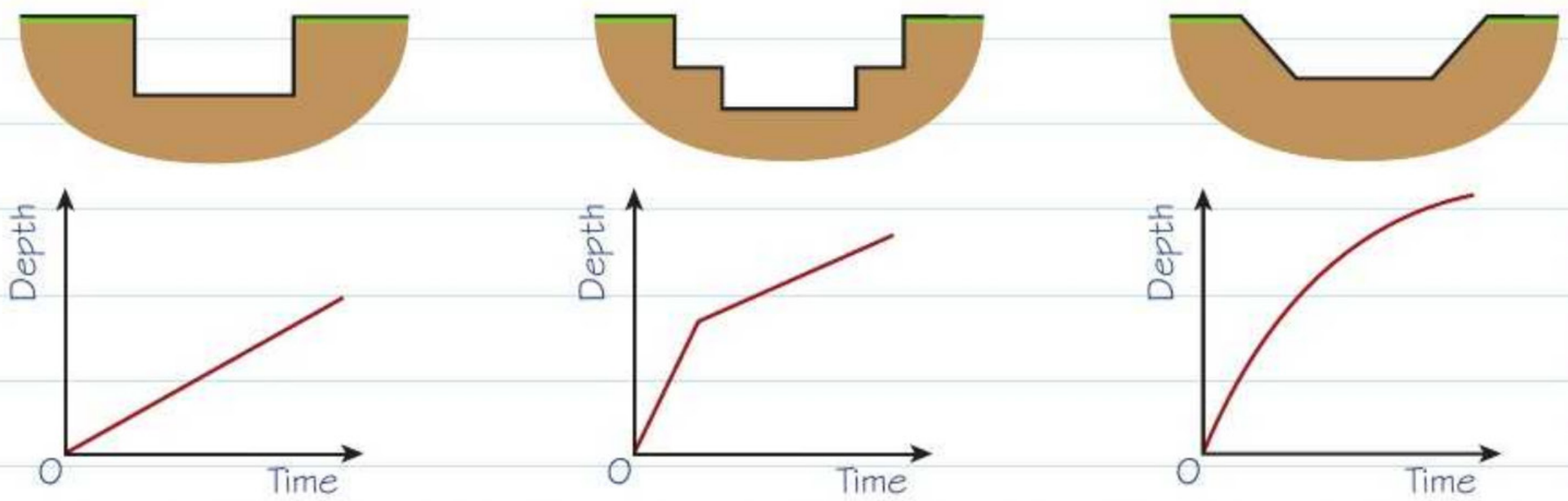
Distance-time graphs

A **distance–time** graph shows how distance changes with time. This distance–time graph shows Jodi's run. The shape of the graph gives you information about the journey.



Rates of change

The **gradient** on a distance–time graphs tells you the **rate of change** of distance with time. This is also called **speed**. You can use graphs to find other rates of change. These garden ponds are filled with water at a constant rate. The graphs show how the depth of water in each pond changes with time.



The gradient of the graph tells you the **rate of change** of the depth of water at that point. Where the pond is narrower, the rate of change will be higher.

Now try this

Target grade 4

Worked solution video

Christina rode her bike to a friend's house. She rested once on the way. She had coffee at her friend's house, then rode home.

(a) How long did Christina spend at her friend's house? **(1 mark)**

(b) Work out Christina's average speed for her return journey. **(2 marks)**

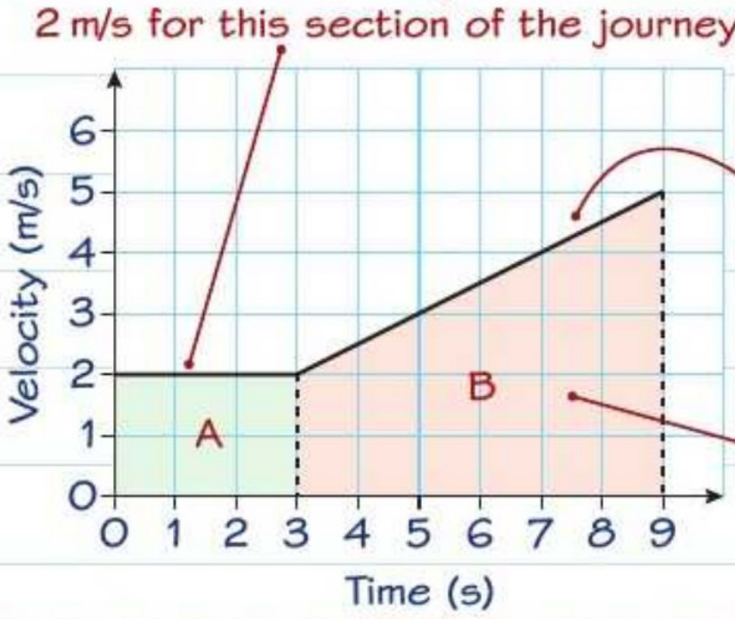
Had a look ☐ Nearly there ☐ Nailed it! ☐

Tricky Topic

Velocity–time graphs

Velocity means **speed** in a certain direction. A velocity–time graph is sometimes called a **speed–time graph**. You need to be able to interpret a velocity–time graph. Use the two golden rules on the right to answer questions involving speed, time and acceleration.

This velocity–time graph shows the motion of a remote-controlled car.



Golden rules

1. The **gradient** of a velocity–time graph tells you the **acceleration**.

The most common units of acceleration are m/s^2.

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

2. The **area underneath** a velocity–time graph tells you the **distance travelled**.

If you have to estimate the area under a curve use the techniques shown on the next page.

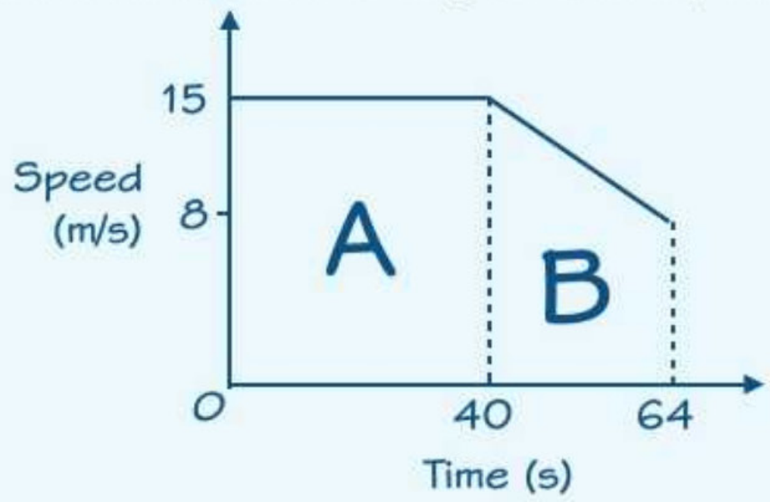
Area A = $2 \times 3 = 6$
Area B = $\frac{1}{2}(2 + 5) \times 6 = 21$
Total **distance travelled**
$= 6 + 21 = 27$ m

Worked example

Target grade 8

A boat travels at a constant speed of 15 m/s for 40 seconds. It then decelerates to a speed of 8 m/s in 24 seconds.

Assuming the deceleration is constant, calculate the total distance travelled by the boat. **(4 marks)**



Area A = $15 \times 40 = 600$
Area B = $\frac{1}{2}(15 + 8) \times 24 = 276$
Total distance travelled = $600 + 276$
$= 876$ m

Problem solved! The easiest way to solve this problem is to sketch a velocity–time graph of the journey. The graph doesn't have to be to scale, but make sure you label the axes and mark any important points. **Constant** deceleration means that this section of the velocity–time graph will be a straight line.

To calculate the total distance travelled you need to work out the total area underneath the graph. Divide it into sections, work out the area of each section, and then add them together.

Be careful when you are calculating areas. You need to read values off the **scale**. Don't just count grid squares. The units of speed are m/s and the units of time are seconds, so the distance travelled will be in metres.

Now try this

Target grade 8

Ashley gets on her bike and accelerates at a constant rate to a speed of 4.5 m/s in 20 seconds. She remains at this speed for a further 40 seconds.
She then decelerates at a constant rate to rest in 8 seconds.

(a) Sketch a velocity–time graph of Ashley's journey. **(3 marks)**

(b) Calculate the total distance Ashley travelled. **(2 marks)**