LOCKERBIE ACADEMY

TRANSPORT UNIT

GRAPHS

S1-S3 Road Safety & PHYSICS

Velocity-Time GRAPHS

advanced 2

Complete after the acceleration section

Back to mind map

Velocity-Time GRAPHS

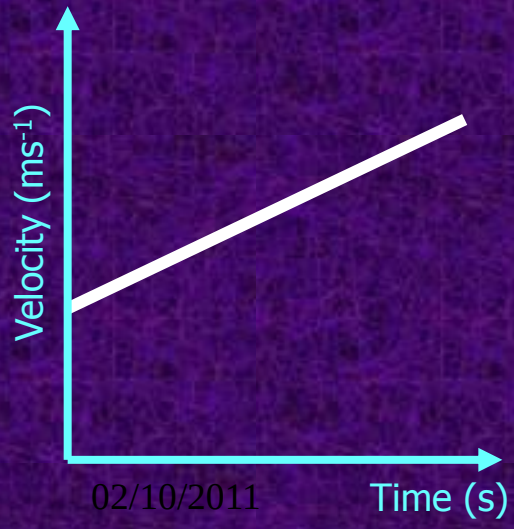
Describing graphs

Back to mind map

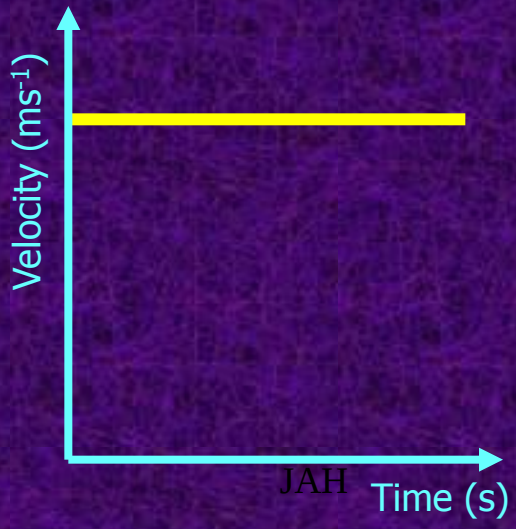
The motion of any object can be represented by a **line** drawn on a **speed-time or velocity-time graph**. This give a visual indication of how objects are moving.

Examples

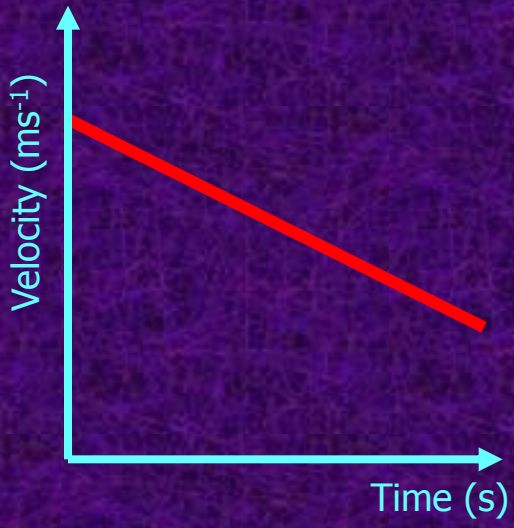
- Speeding up
- increasing velocity
- (accelerating)



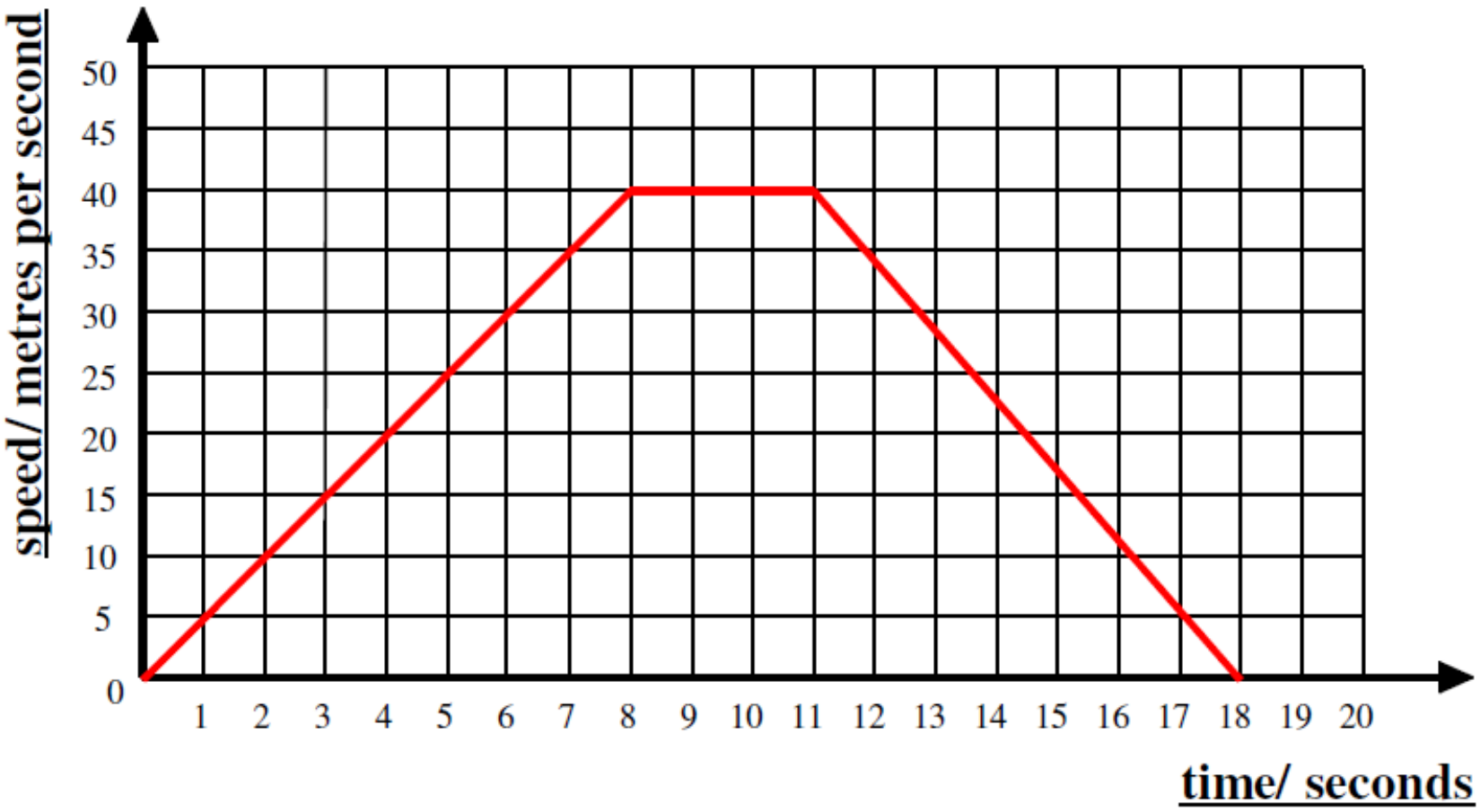
- Uniform/ Steady speed
- constant velocity
- (constant speed)



- Slowing down
- negative acceleration
- (decelerating)



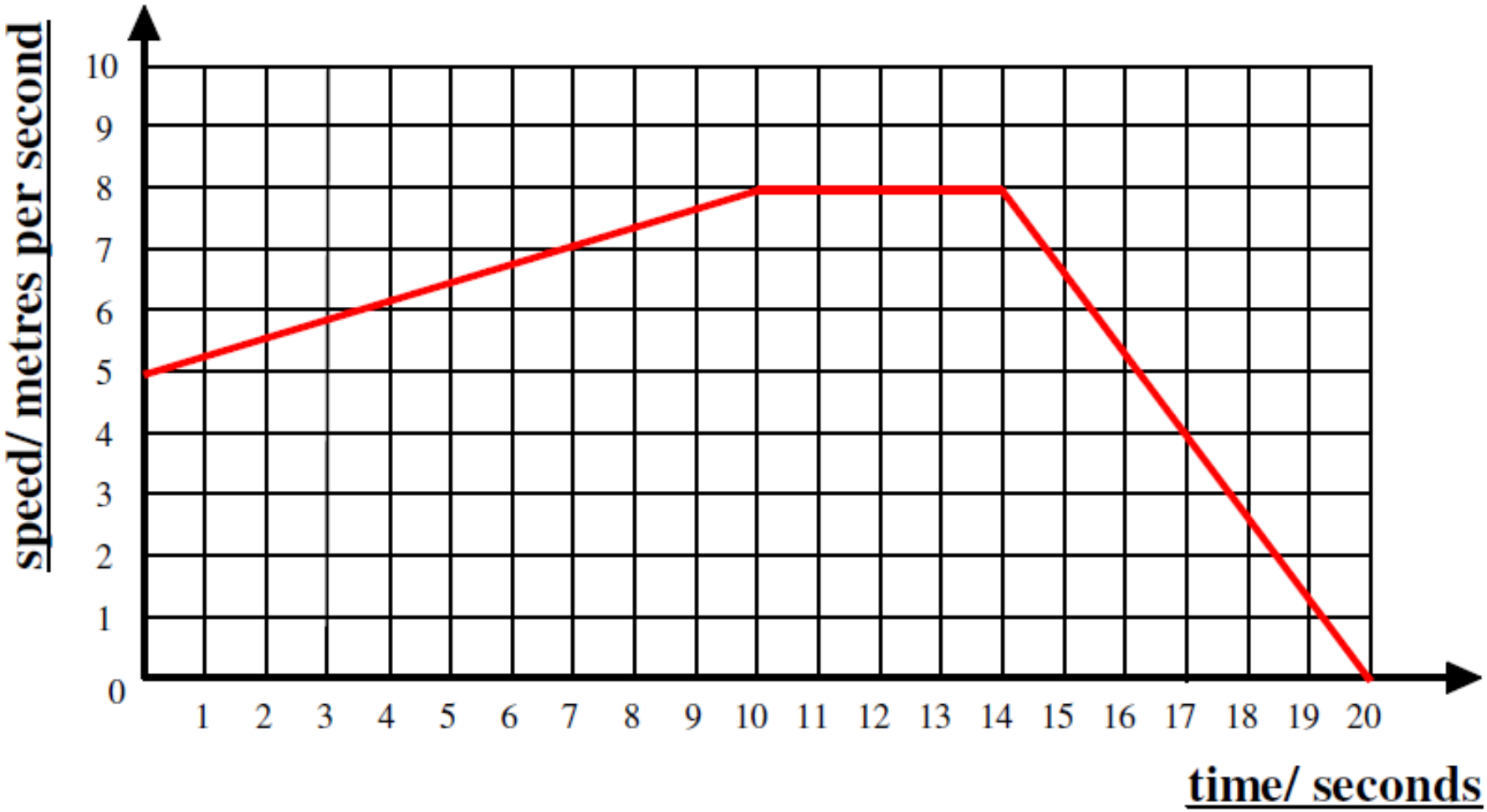
Describe the motion represented by the **line** on each **speed-time graph**:



0 - 8 seconds: _____ _____ from _____ metres per second to _____ metres per second. (Constant/uniform _____).

8 - 11 seconds: _____ _____ of _____ metres per second.

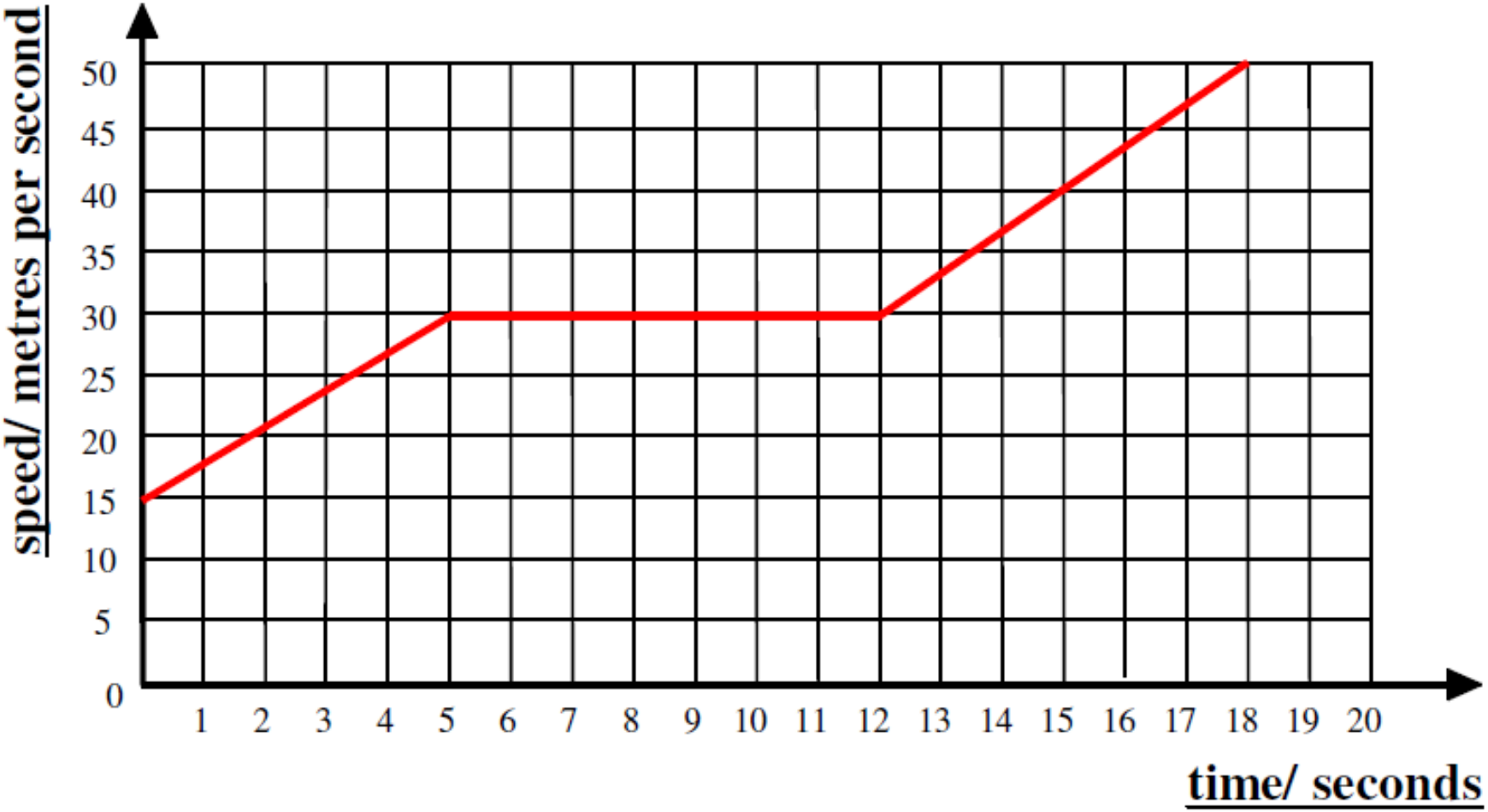
11 - 18 seconds: _____ _____ from _____ metres per second to _____ metres per second. (Constant/uniform _____).



0 - 10 seconds: _____ ____ from ____ metres per second to ____ metres per second. (Constant/uniform _____).

10 - 14 seconds: _____ _____ of ____ metres per second.

14 - 20 seconds: _____ _____ from ____ metres per second to ____ metres per second. (Constant/uniform _____).



0 - 5 seconds: _____ _____ from _____ metres per second to _____ metres per second. (Constant/uniform _____).

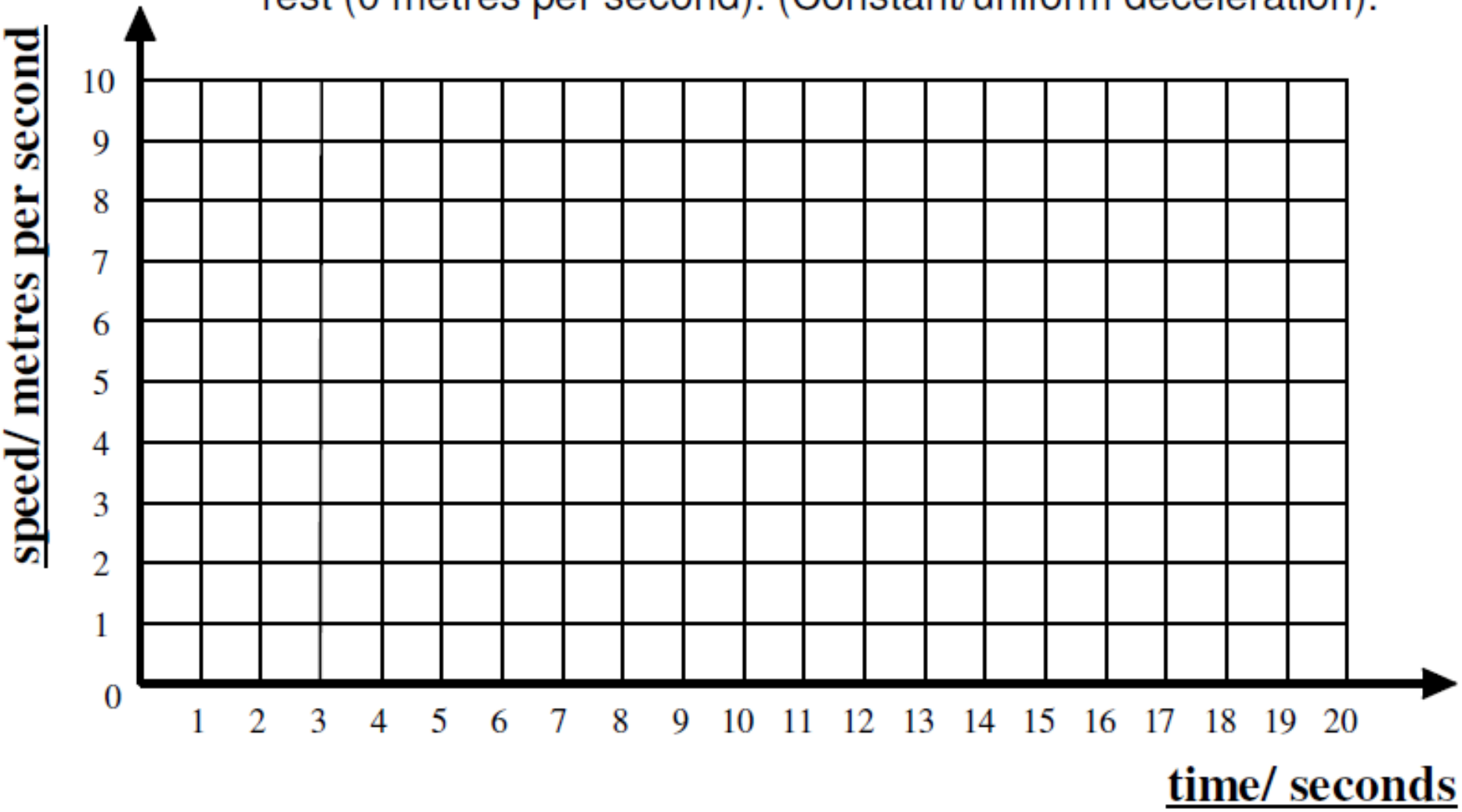
5 - 12 seconds: _____ _____ of _____ metres per second.

12 - 17 seconds: _____ _____ from _____ metres per second to _____ metres per second. (Constant/uniform _____).

0 - 5 seconds: Speeding up from rest (0 metres per second) to 10 metres per second. (Constant/uniform acceleration).

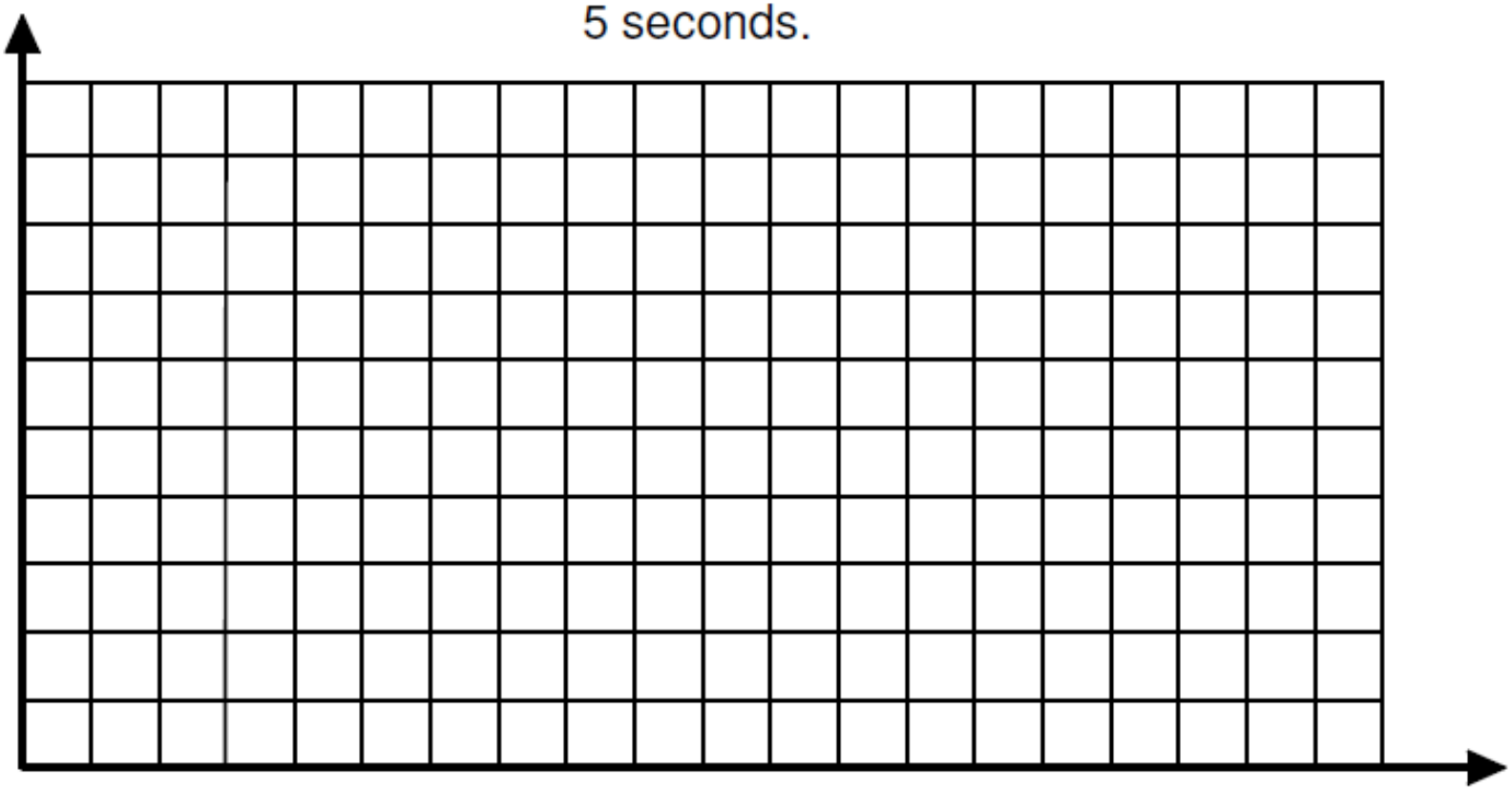
5 - 15 seconds: Steady speed of 10 metres per second.

15 - 20 seconds: Slowing down from 10 metres per second to rest (0 metres per second). (Constant/uniform deceleration).

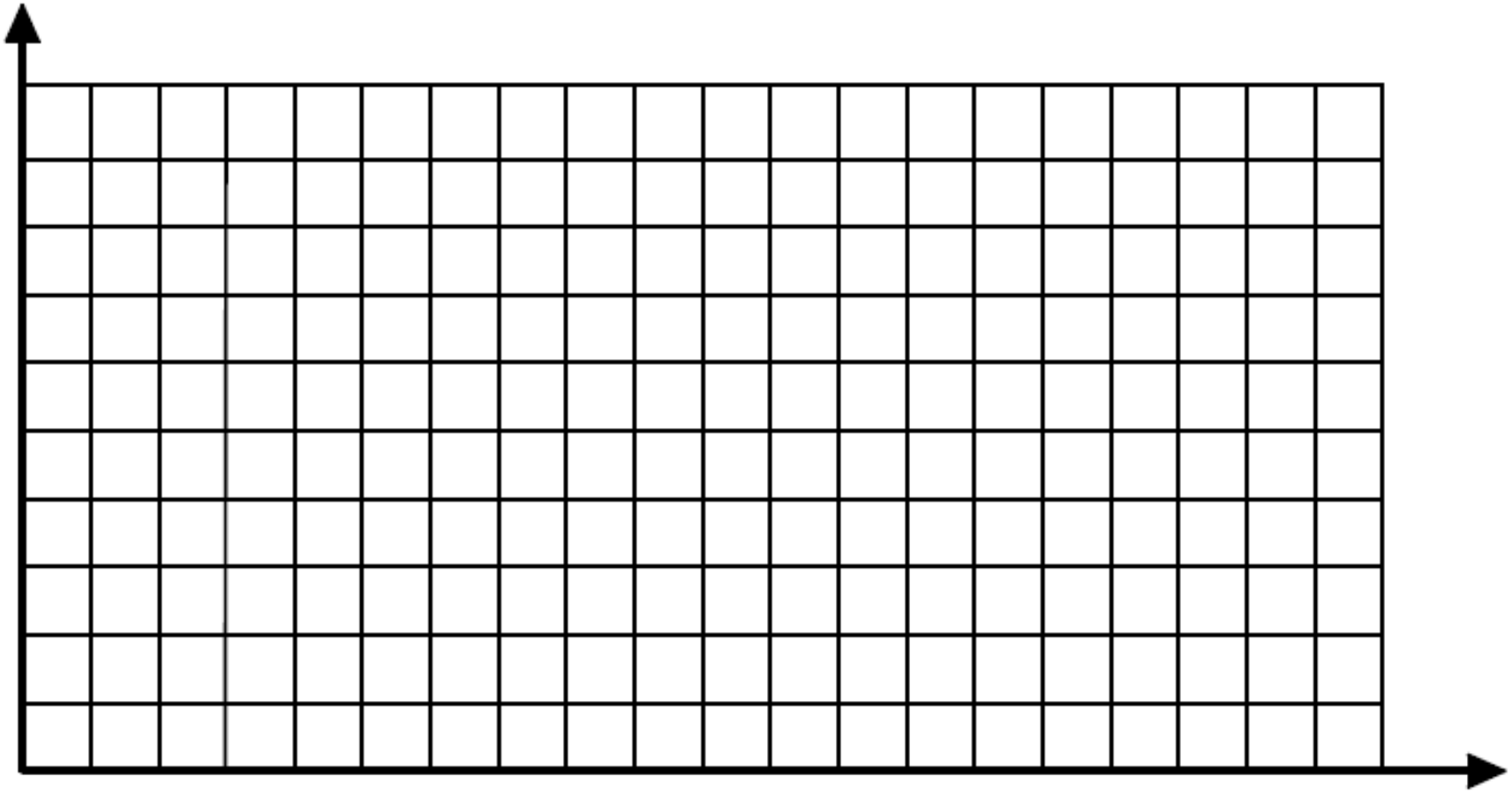


Maximum speed = 9 metres per second. Total time = 18 seconds.

A cyclist travels at a steady speed of 9 metres per second for 6 seconds before decelerating constantly/uniformly to a speed of 2 metres per second in 7 seconds. She then travels at this steady speed for a further 5 seconds.



A racing car travels at a steady speed of 10 metres per second for 2 seconds before accelerating constantly/uniformly for 12 seconds to a speed of 90 metres per second. The car then immediately decelerates constantly/uniformly for 6 seconds to a speed of 70 metres per second.



time/ seconds

0 - 8 seconds: _____ ____ from ____ metres per second to ____ metres per second. (Constant/uniform _____).

8 - 11 seconds: _____ _____ of ____ metres per second.

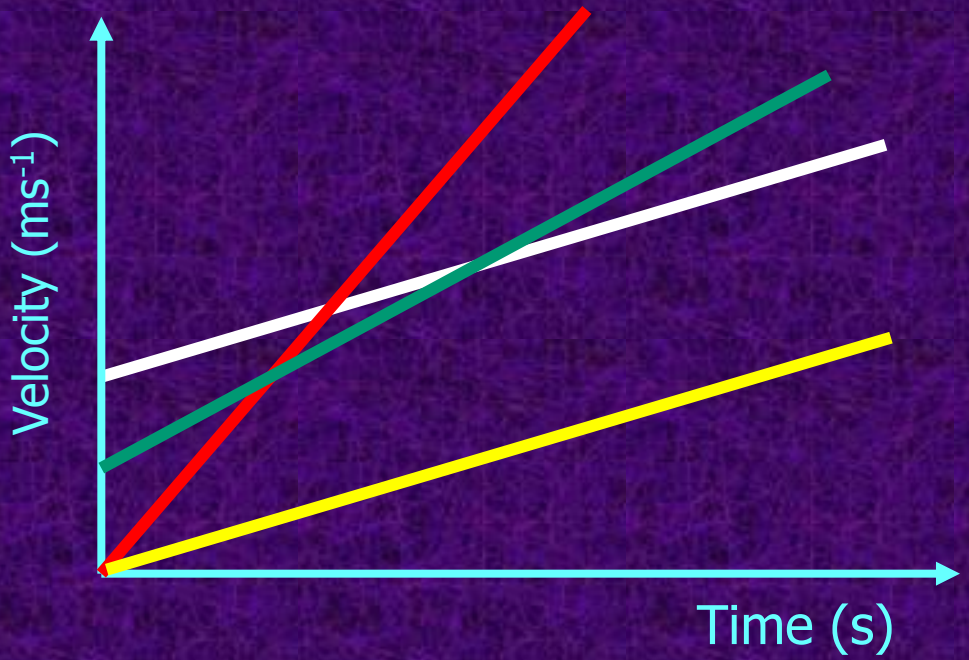
11 - 18 seconds: _____ _____ from ____ metres per second to ____ metres per second. (Constant/uniform _____).

Velocity-Time GRAPHS

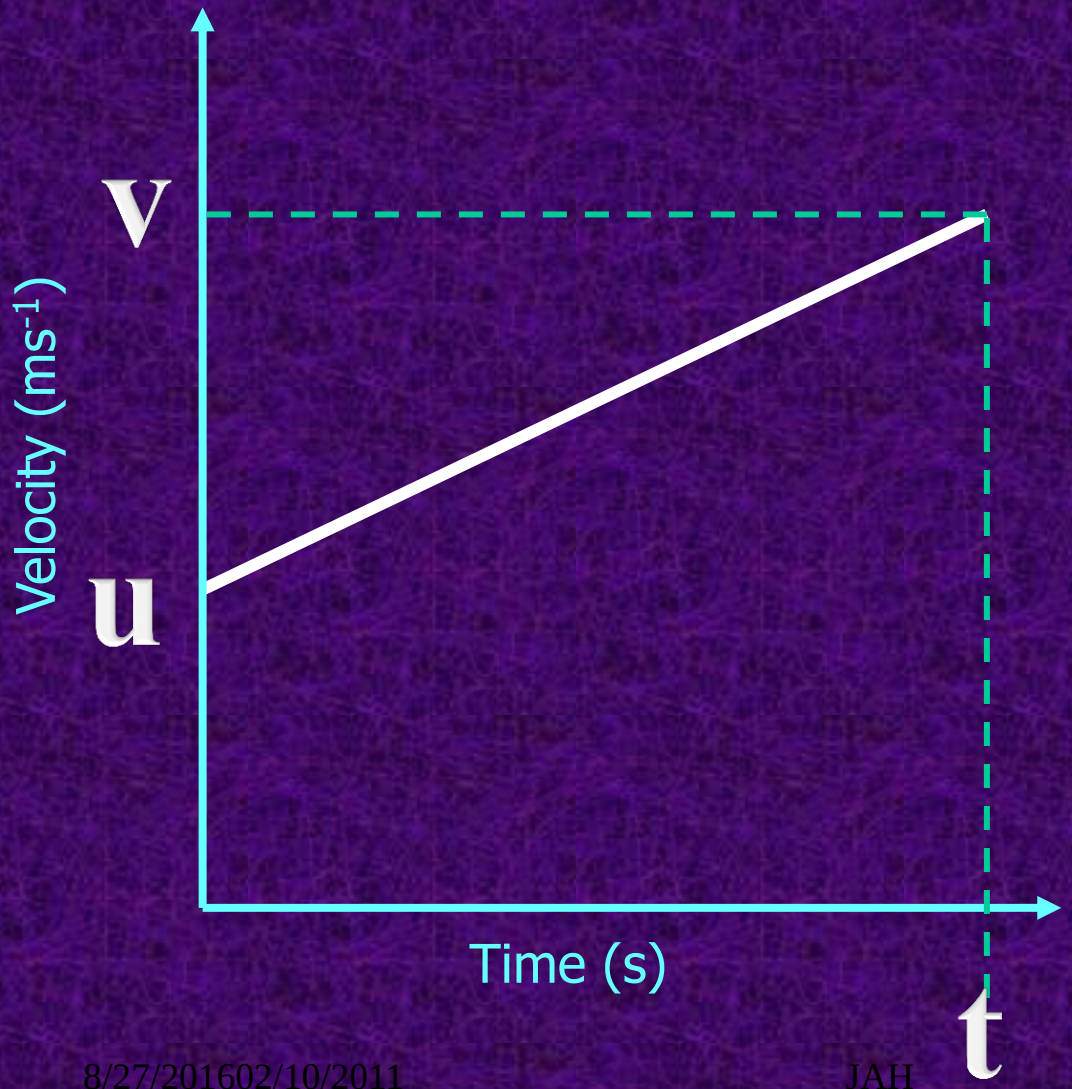
Finding the acceleration from velocity-time graphs

Back to mind map

The gradient of a velocity time graph (steepness) tells us the acceleration of the object. The steeper the graph (bigger the gradient) the greater the acceleration.



Finding the gradient of a velocity-time graph



Gradient= rise/run
Or v/h

In our case that is
vertical= (v-u)
Horizontal=t

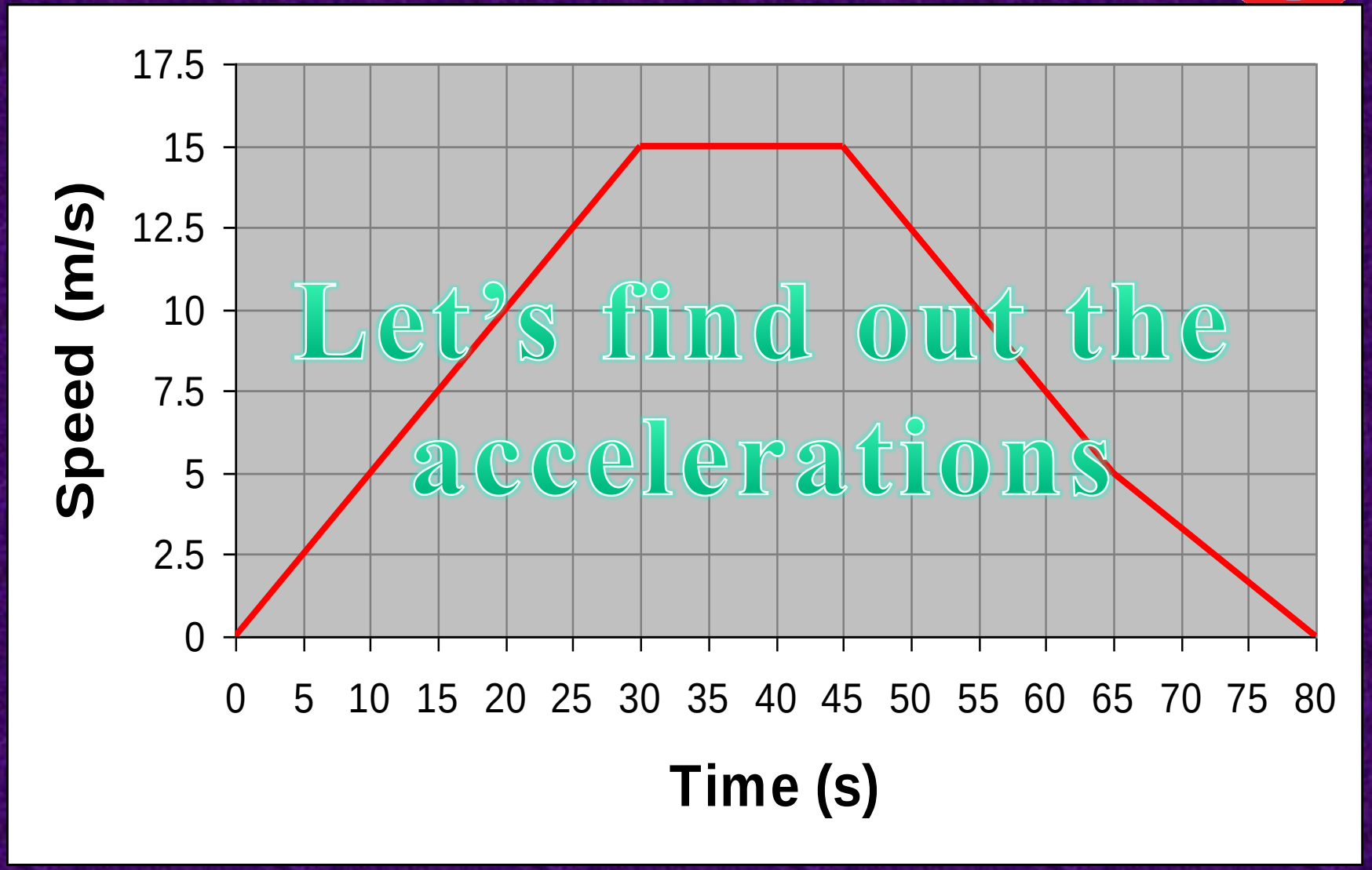
Gradient=(v-u)/t
Gradient = acceleration

Drawing Speed-Time Graphs

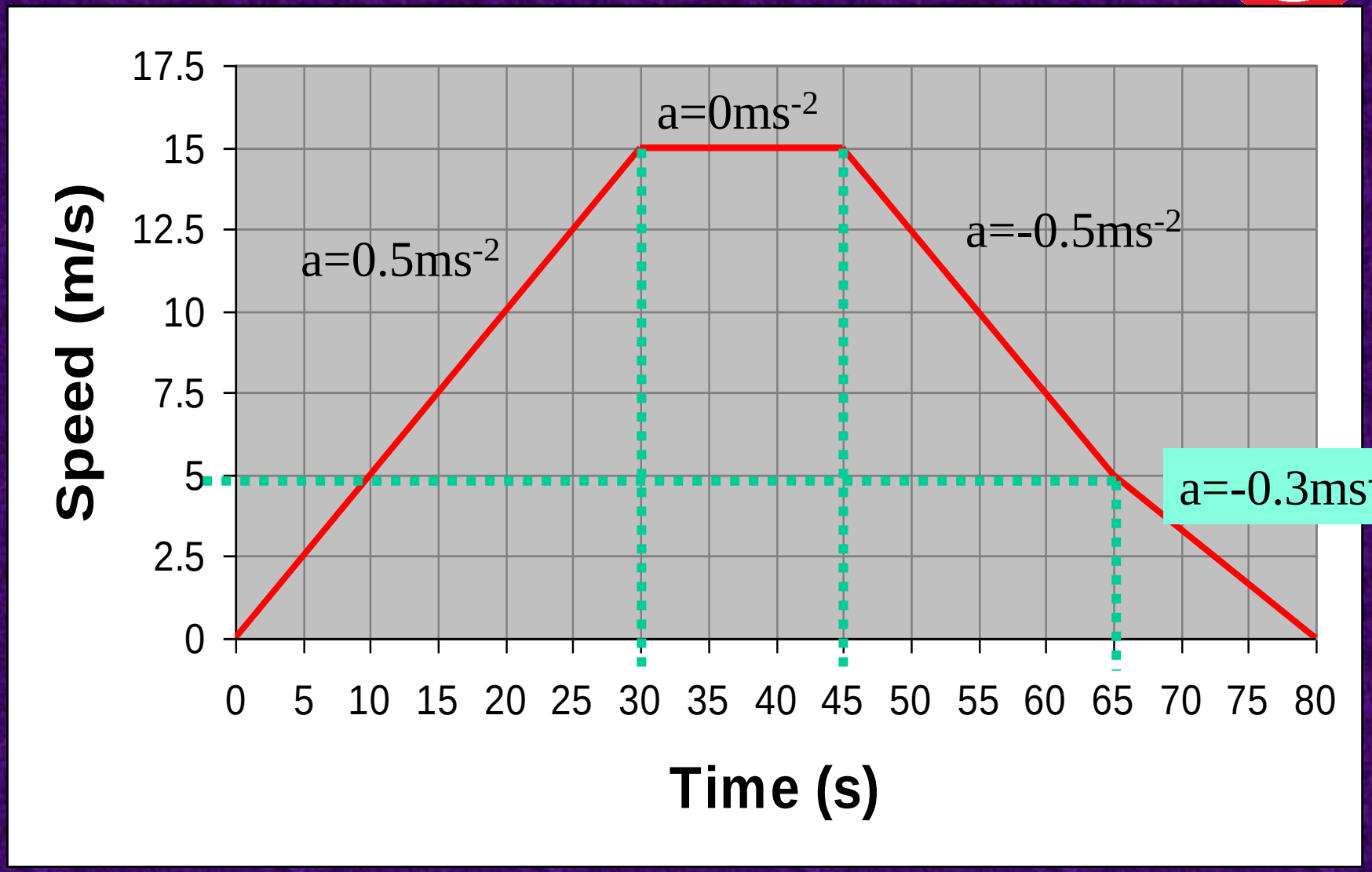
Draw a speed-time graph for the following journey

- A train leaves the station and take 30s to accelerate to 15m/s.
- It remains at this speed for a further 15 seconds.
- As it approaches the next station it slows to 5m/s. It takes 20 seconds to decelerate to this speed
- As it finally pulls into the next station it slows to a stop in 15 seconds.

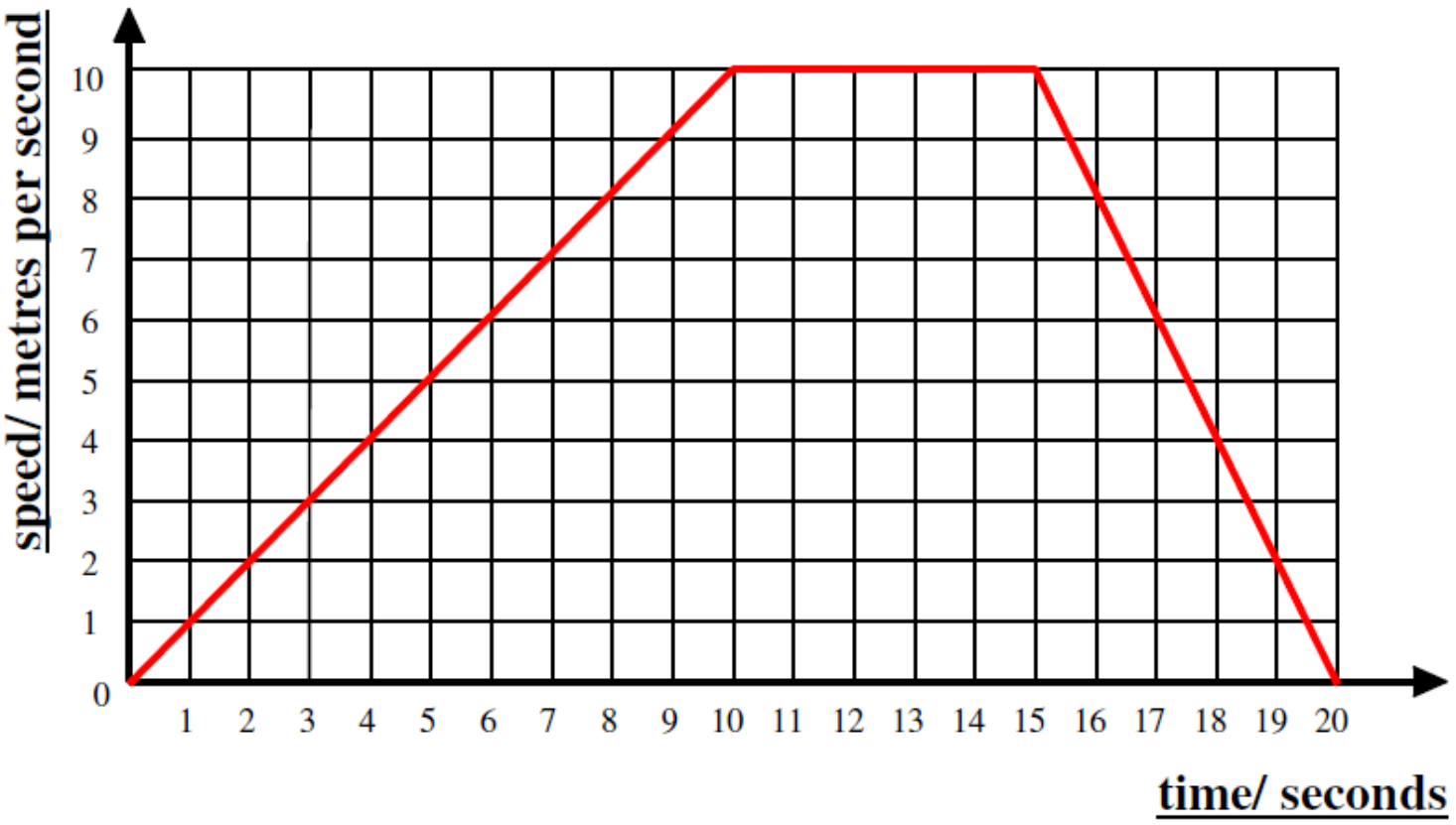
What It Should Look Like



What It Should Look Like



Describe the motion represented by the **line** on each **speed-time graph**:

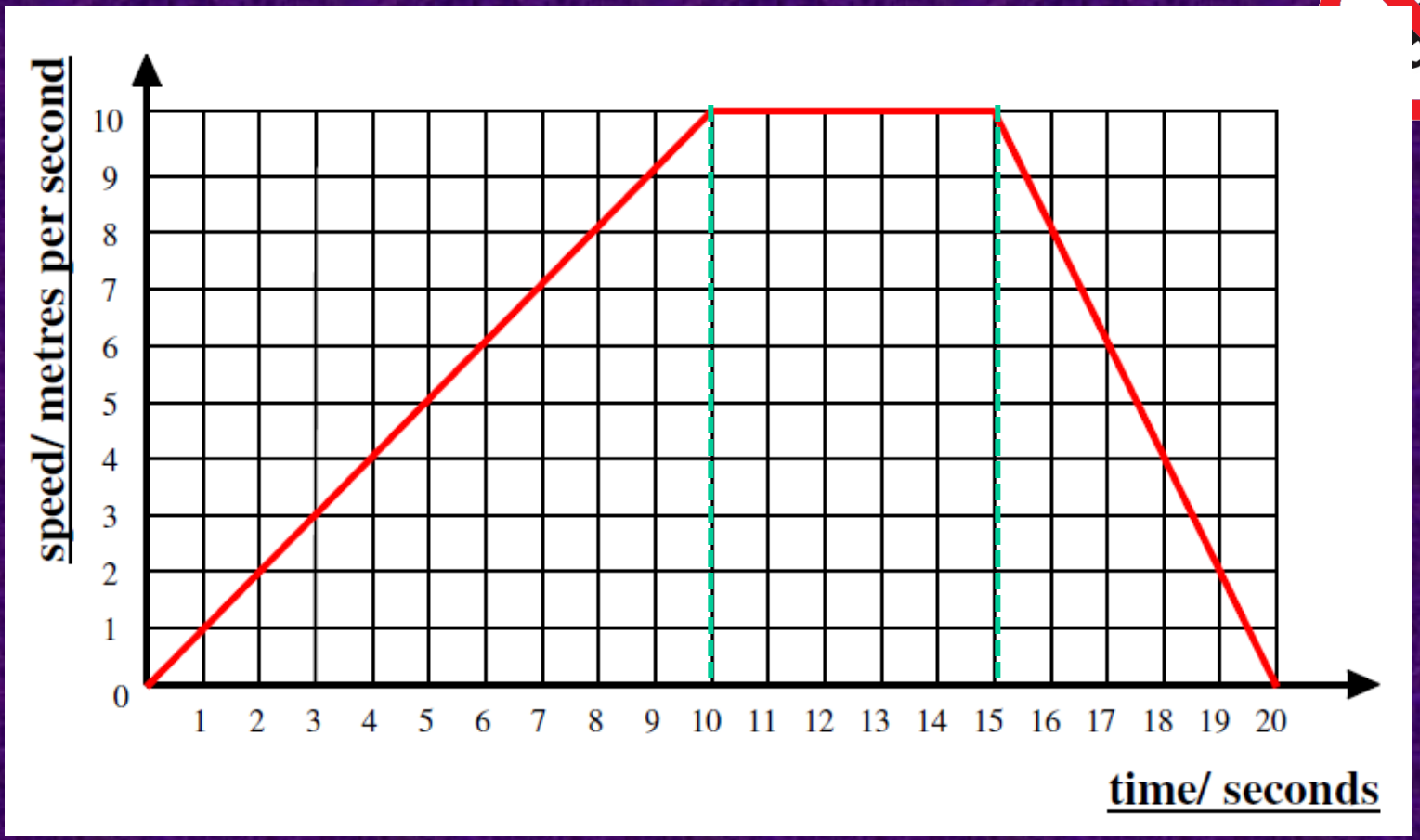


0 - 10 seconds: _____ _____ from _____ metres per second to _____ metres per second. (Constant/uniform _____).

10 - 15 seconds: _____ _____ of _____ metres per second.

15 - 20 seconds: _____ _____ from _____ metres per second to _____ metres per second. (Constant/uniform _____).

Finding the Acceleration from velocity-time graph:



Gradient = rise/run
a=(v-u)/t
a=(10-0)/10
a=1m/s^2

Gradient = rise/run
a=(v-u)/t
a=(10-10)/5
a=0m/s^2

Gradient = rise/run
a=(v-u)/t
a=(0-10)/5
a=-2m/s^2

Problems

1. Calculate the average velocity over OA AB and BC

2. Calculate (a)the acceleration over OA, AB and BC
(b) the total distance traveled in the 12 s

$5 m/s^2$, 0, $3.75 m/s^2$, 127.5m

Velocity-Time GRAPHS

Finding the distance and displacement from velocity-time graphs

Back to mind map

- The AREA under a speed time graph tells us HOW FAR we have travelled (DISTANCE)

- The area under a velocity time graph tells us the DISPLACEMENT of the object.

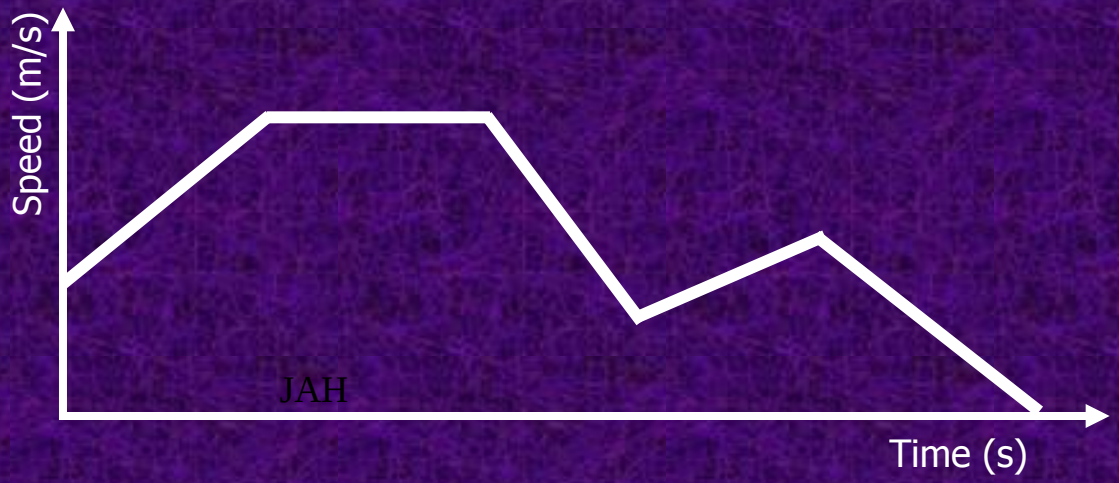
Speed – Time Graphs 2

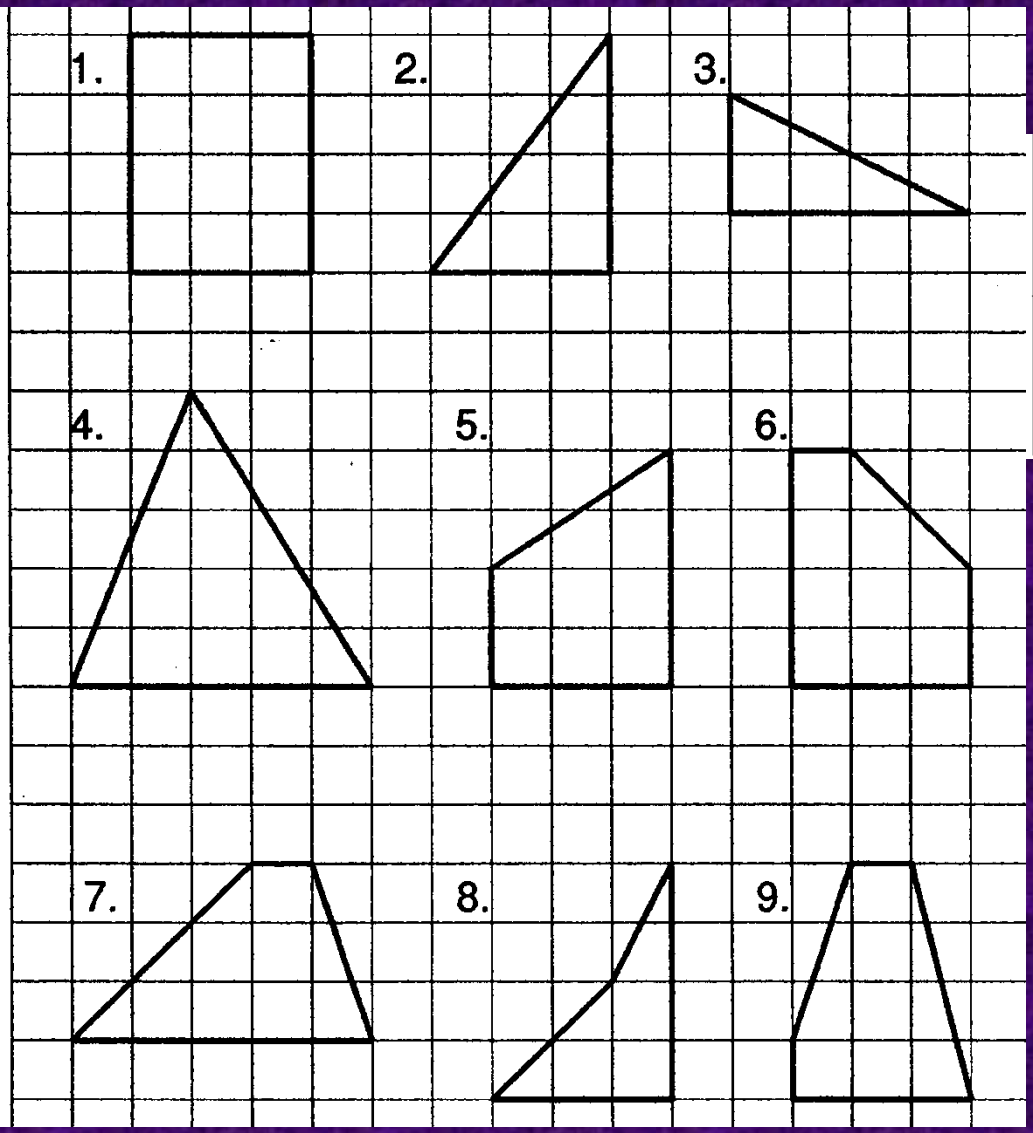
Speed time graphs, when drawn accurately can be used to find the total distance travelled during a journey. No matter what the shape of the graph….

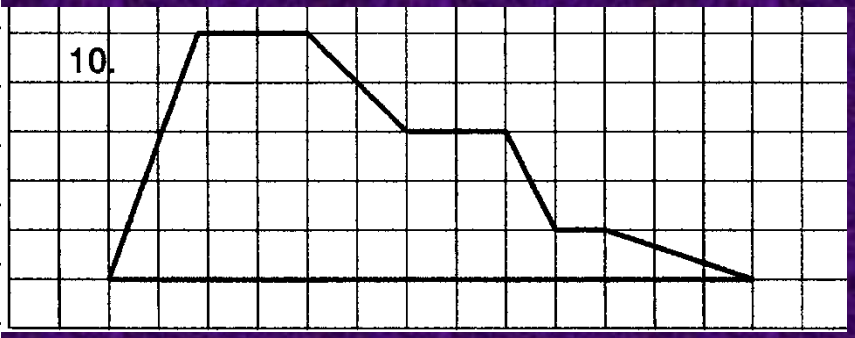
Total distance covered=Area under a speed time graph

Often, to find the area, the graph will need to be split into standard geometrical shapes like triangles and rectangles

Make a sketch of this graph and divide it up into appropriate shapes

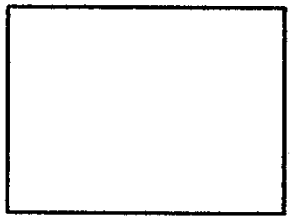






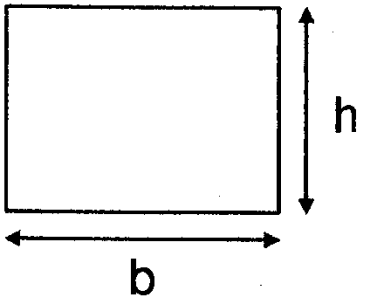
Copy out the shapes and find the area of each shape.
Include your working

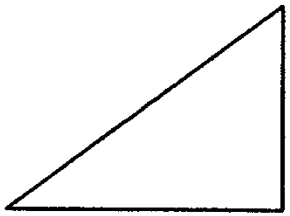
Finding the area of different shapes



Q. How would you find the area of a square or a rectangle?

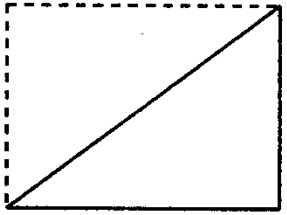
A. *You would multiply the base by the height to find the area.*
Area = b × h

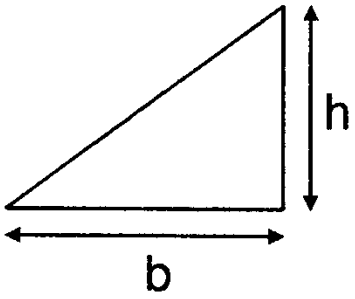




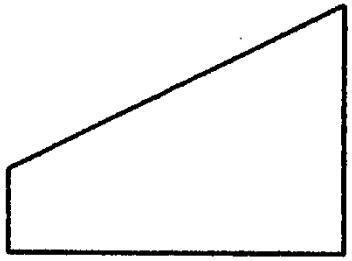
Q. How would you find the area of a triangle?

The triangle is half of a rectangle with the same base and height. The triangle therefore has half the area of the rectangle.

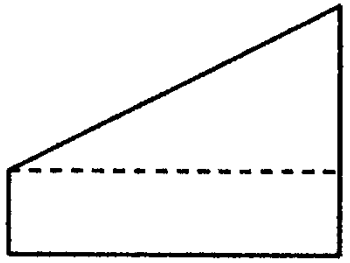




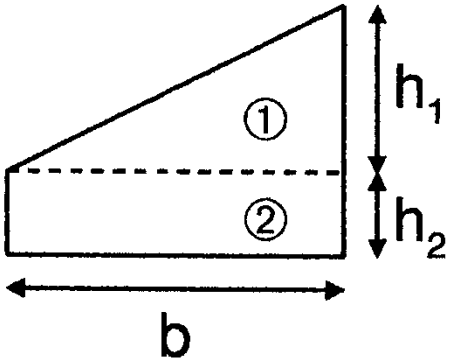
A. *The area of the triangle is ½ base x height.*
Area = ½ × b × h



Q. How could you find the area of this shape (called a trapezium)?



You could divide it up into triangles and rectangles, and then find the area of each part.



A.

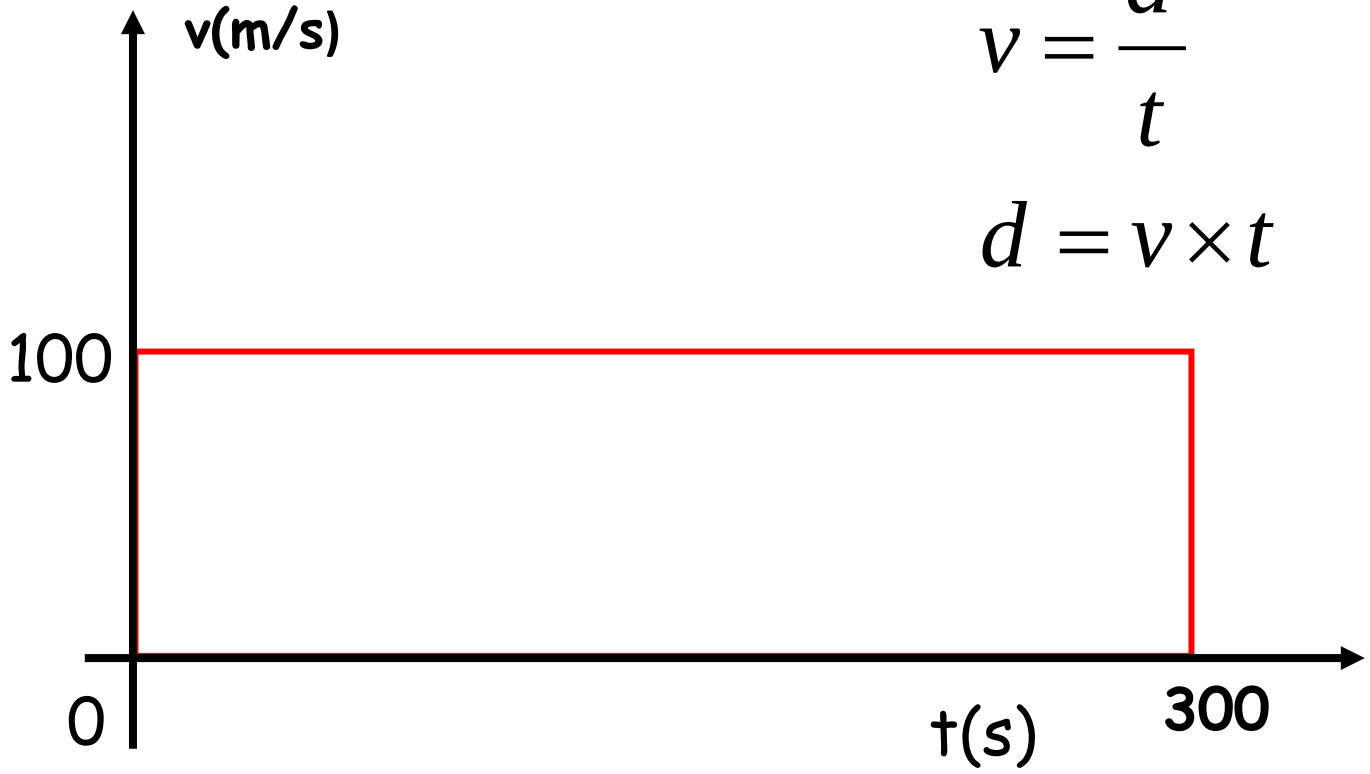
Area 1 = $\frac{1}{2} \times b \times h_1$

Area 2 = $b \times h_2$

The AREA under a speed time graph tells us HOW FAR we have travelled (DISTANCE)

$$v = \frac{d}{t}$$

$$d = v \times t$$



My object is travelling very fast. It is travelling at constant speed, its instantaneous speed is constant. It's acceleration is zero. To find the distance travelled, *d*, we'd use the formula;

$$v = \frac{d}{t}$$

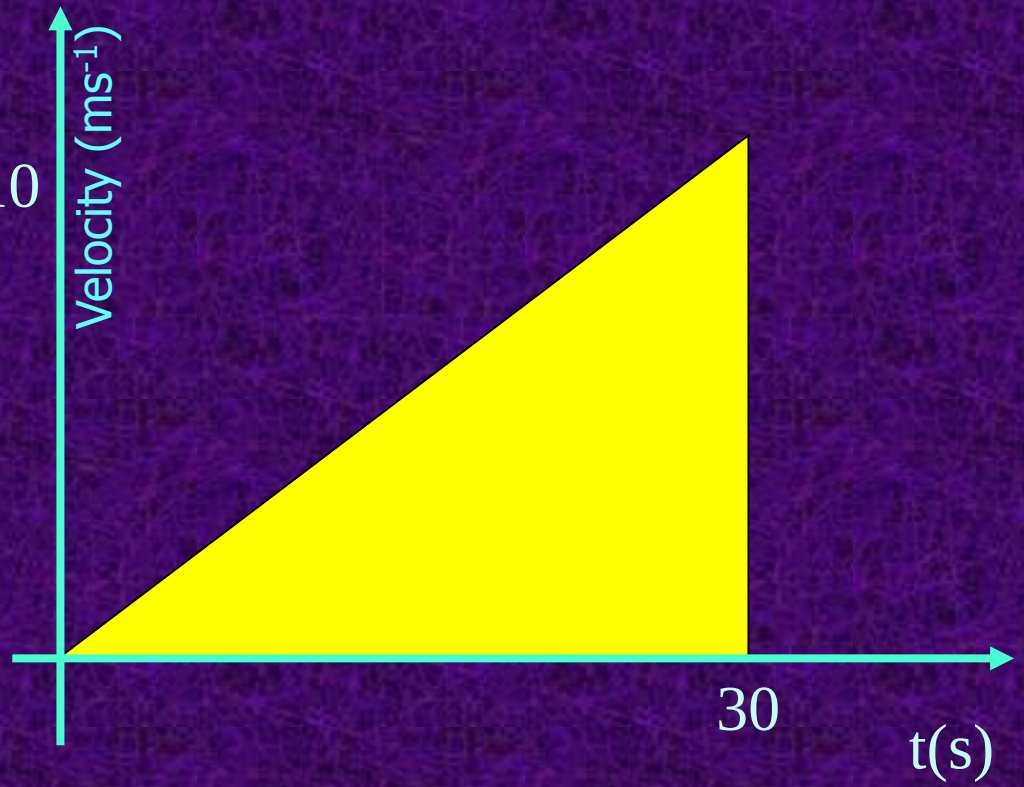
$$d = v \times t$$

d= 100x 300=30 000m

Find the average speed for this journey.

$$\bar{v} = \frac{u+v}{2}$$

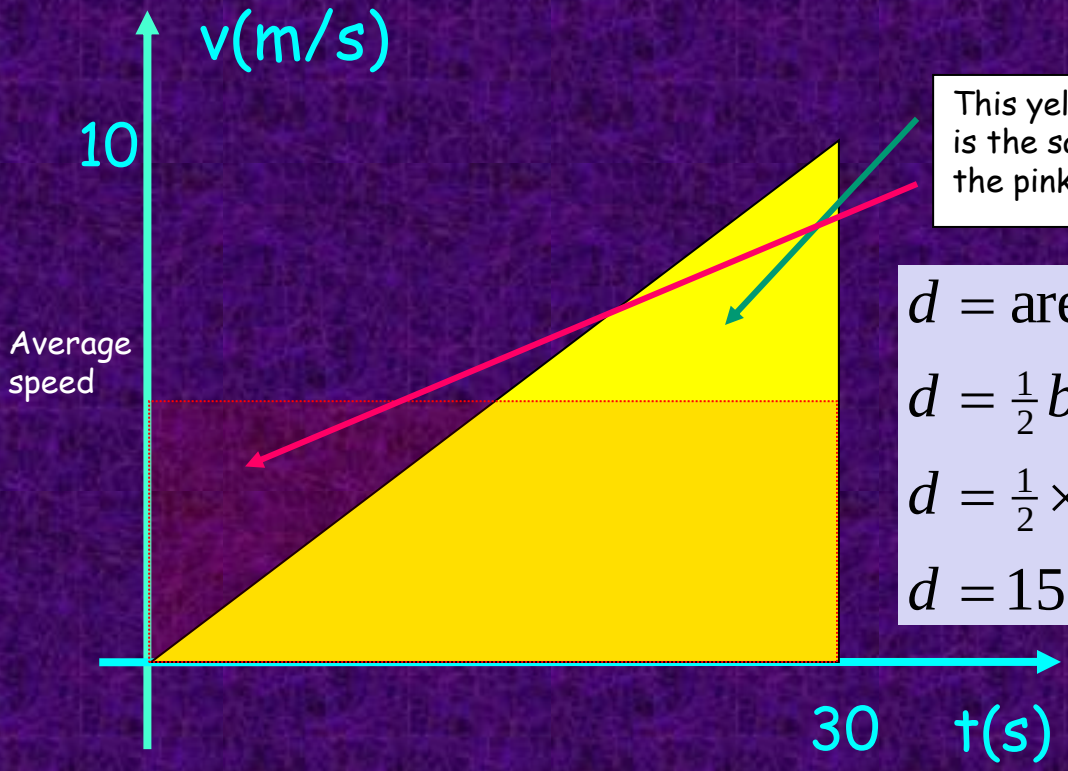
$$\bar{v} = \frac{0+10}{2} = 5m/s$$



The area of the triangle is exactly the same as the area of the rectangle with a speed exactly half way between the two values, *u* & *v*

$$d = \bar{v} \times t$$

$$d = 5 \times 30 = 150m$$



This yellow area is the same as the pink area

$$d = \text{area under a speed time graph}$$

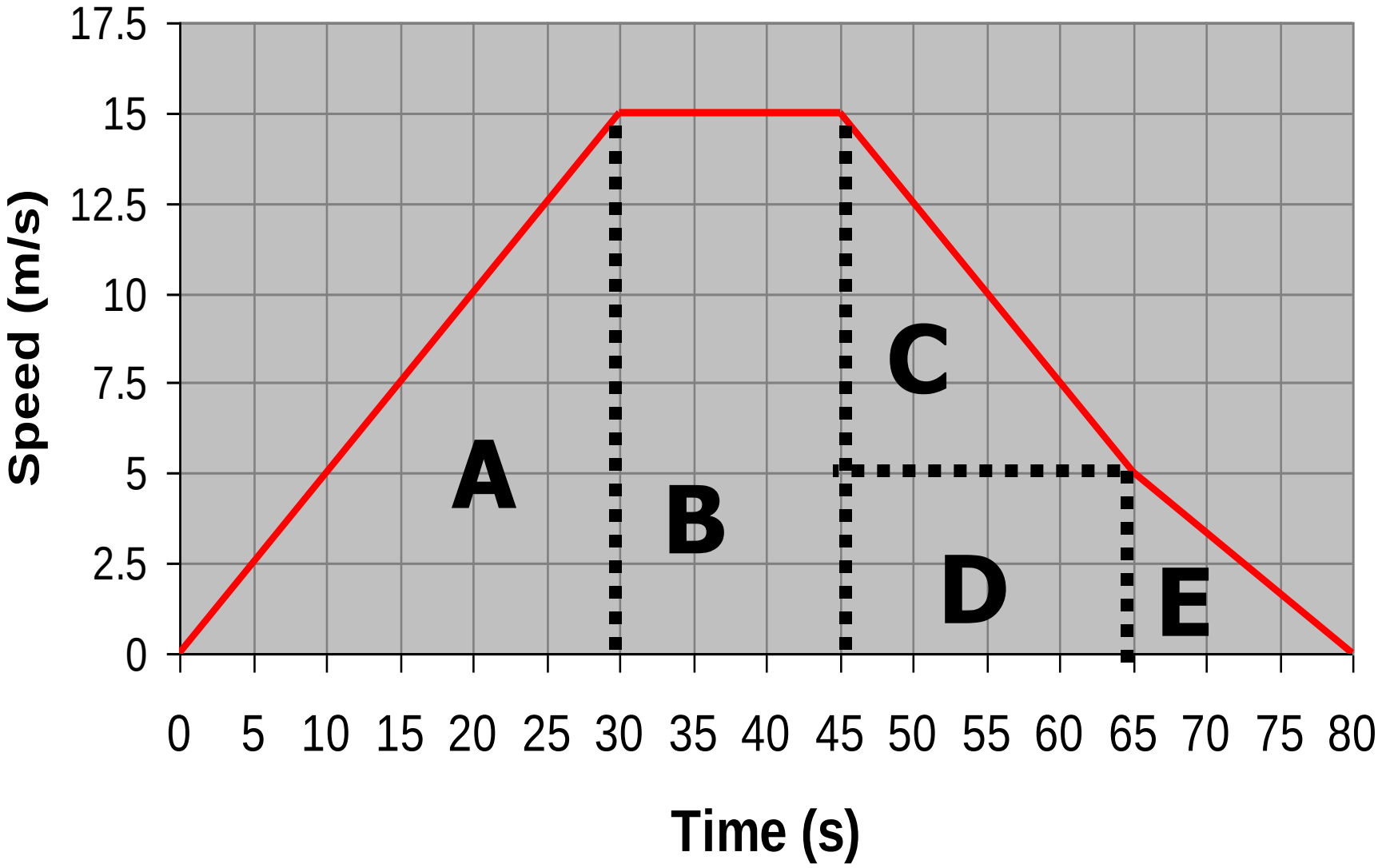
$$d = \tfrac{1}{2}bh$$

$$d = \tfrac{1}{2} \times 30 \times 10$$

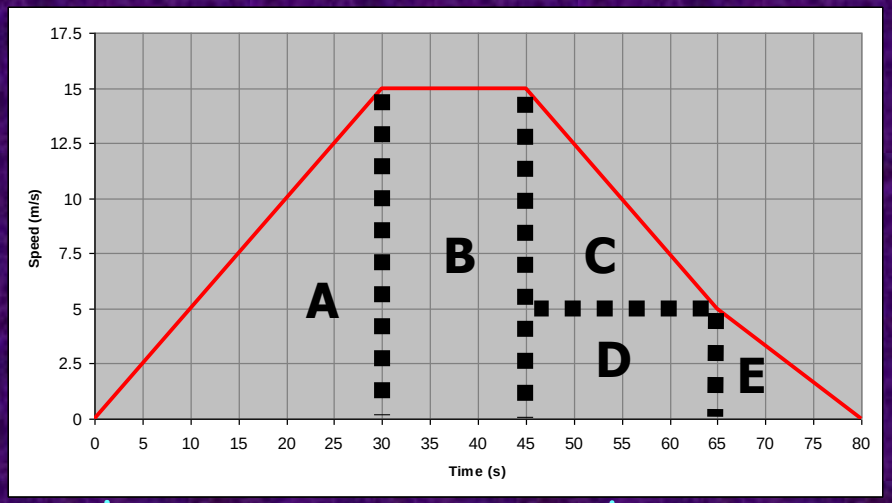
$$d = 150m$$

the area of the pink shape is the same as the area of the yellow triangle. Both give you the distance travelled

How far did it go?



How far did it go?



Displacement = area under v-t graph

= Triangle A + Rectangle B + Triangle C + Rectangle D + Triangle E

= ($\frac{1}{2}$x30x15) + (15x15) + ($\frac{1}{2}$x10x20) + (20x5) + ($\frac{1}{2}$x15x5)

= 225 + 225 + 100 + 100 + 37.5

= **687.5 m**

Problem

2. Calculate the total distance traveled in the 12 s 127.5m

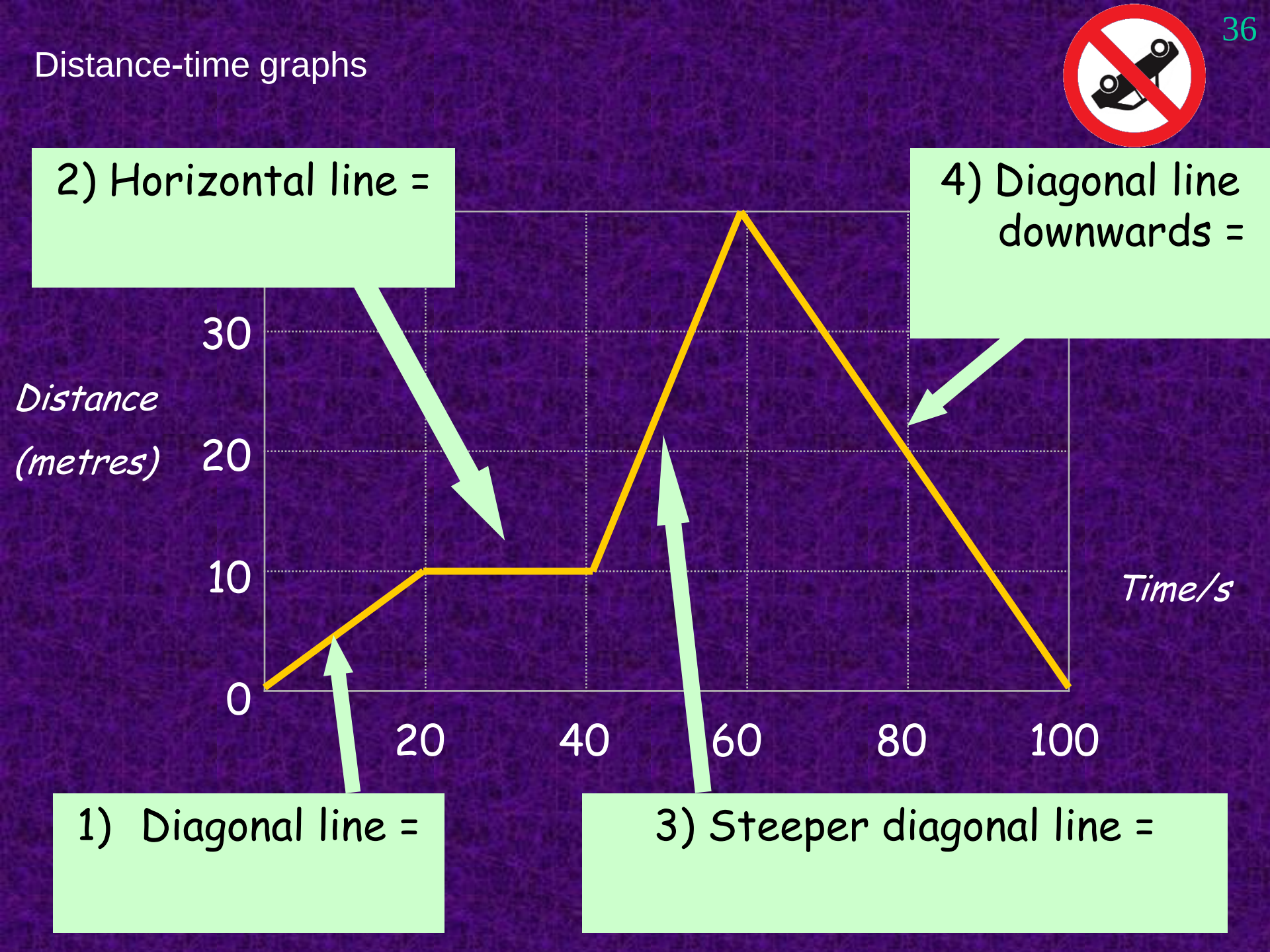
Velocity time graphs; Summary

- The gradient of a velocity time graph gives the acceleration of an object
- the area under a velocity time graph gives the total distance travelled
- *Increasing* or *decreasing* gradient gives the rate at which the acceleration is increasing or decreasing
- *Zero* gradient means the object is travelling at constant speed

Distance-Time GRAPHS

Back to mind map

Distance-time graphs

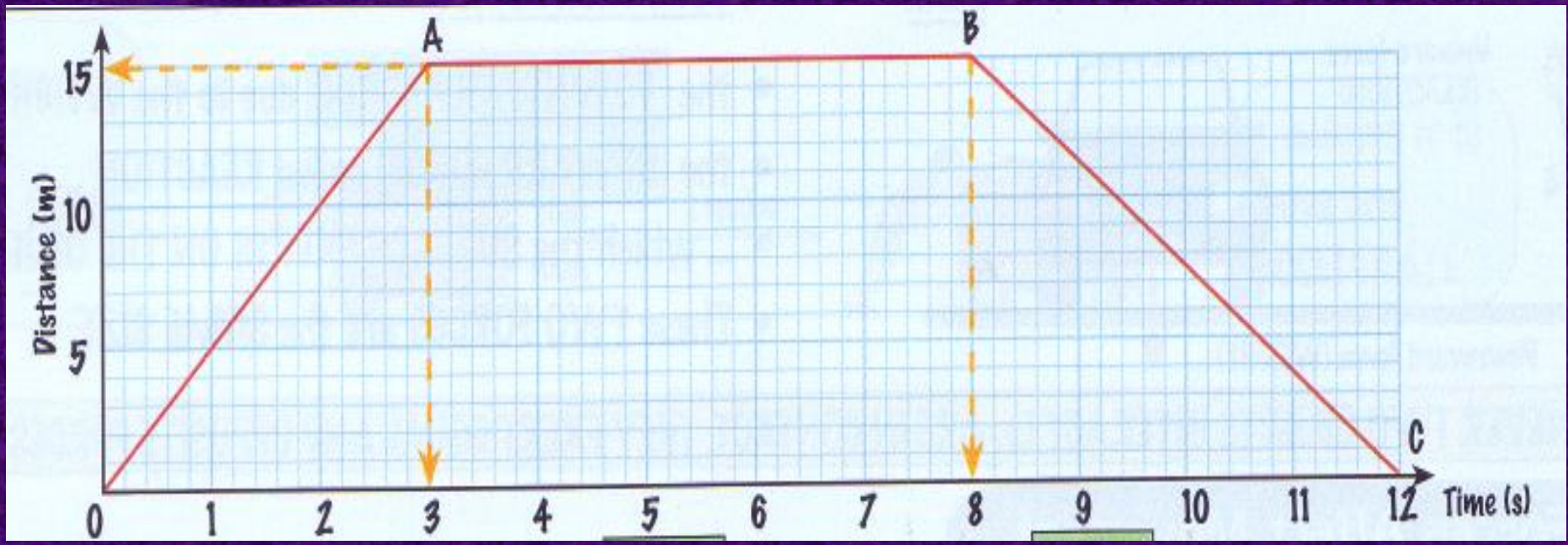


Distance time graphs ; Summary

- The gradient of a distance time graph gives the velocity
- *increasing* gradient means object is accelerating
- *decreasing* gradient means object is decelerating
- *zero* gradient means object is stationary

Problems

1. Describe the motion of the vehicle during the 12s journey
2. Calculate the average speed over OA AB and BC



5m/s, 0m/s, 3.75m/s