LOCKERBIE ACADEMY
TRANSPORT UNIT
GRAPHS

S1-S3 Road Safety & PHYSICS

JAH 02/10/2011

Velocity-Time GRAPHS

advanced 2

Complete after the acceleration section

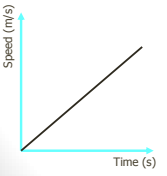
Velocity-Time GRAPHS

Describing graphs

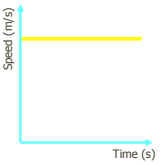
The motion of any object can be represented by a **line** drawn on a **speed-time or velocity-time graph**. This give a visual indication of how objects are moving.

Examples

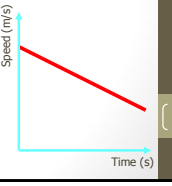
- Speeding up
- increasing velocity
- (accelerating)



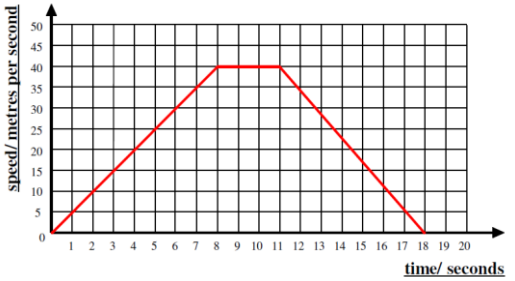
- Uniform/ Steady speed
- constant velocity
- (constant speed)



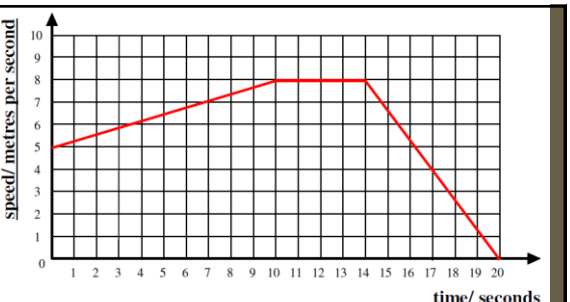
- Slowing down
- negative acceleration
- (decelerating)



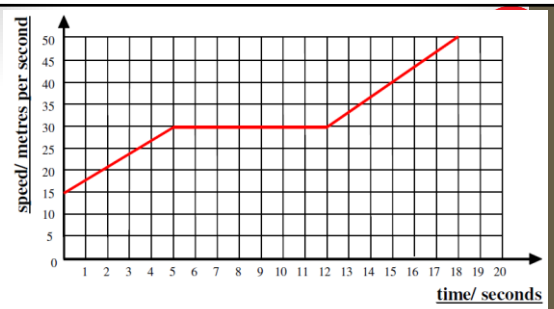
Describe the motion represented by the **line** on each **speed-time graph**:



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 _____).

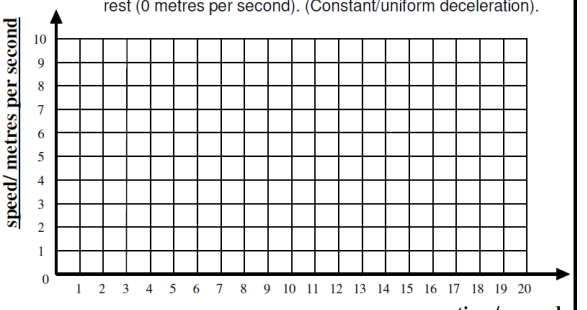
5 - 12 seconds: _____ _____ of ____ metres per second.

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).

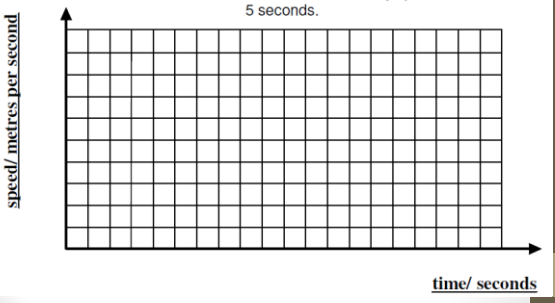
5 - 15 seconds: Steady speed of 10 metres per second.

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

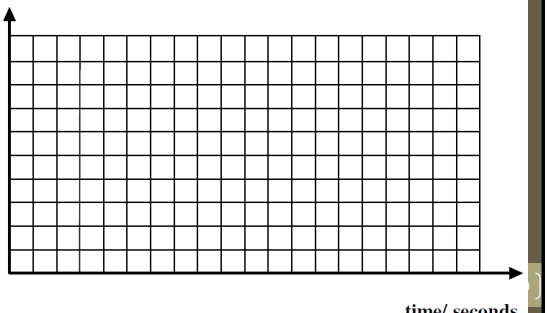


Maximum speed = 9 metres per second. Total time = 18 seconds.

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.



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 _____).

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S1-S3 Physics Transport

Velocity-Time GRAPHS

Finding the acceleration from velocity-time graphs

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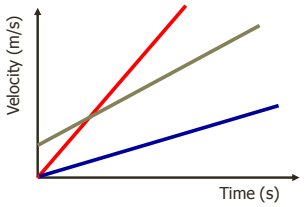
The gradient of a velocity time graph (steepness) tells us the acceleration of the object. The steeper the graph (bigger the gradient) the greater the acceleration.



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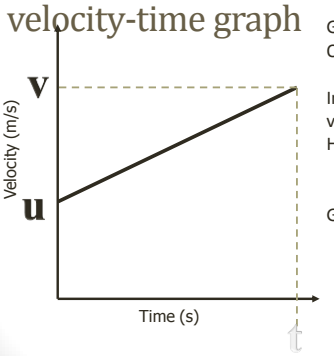
Finding the gradient of a velocity-time graph

Gradient= rise/run
Or v/h

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

Gradient = acceleration



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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.

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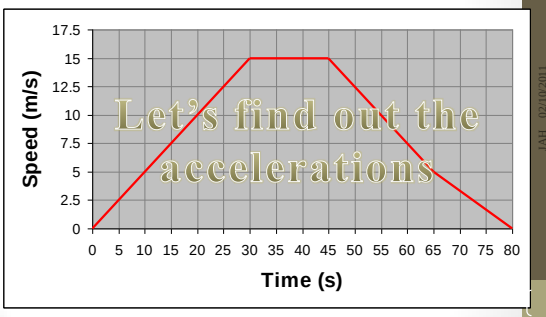
What It Should Look Like



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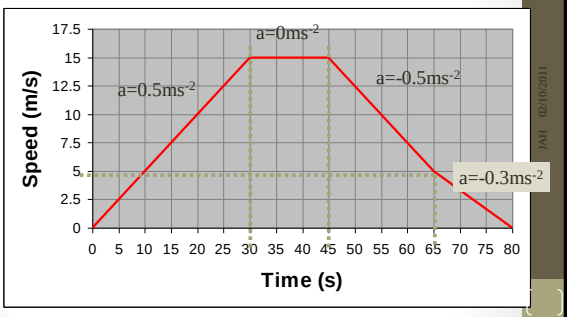
What It Should Look Like



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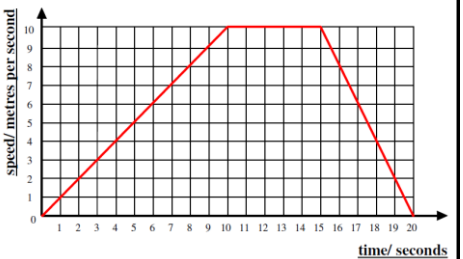
Describe the motion represented by the **line** on each **speed-time graph**.



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/s²

Gradient = rise/run
a=(v-u)/t
a=(10-10)/5
a=0m/s²

Gradient = rise/run
a=(v-u)/t
a=(0-10)/5
a=-2m/s²

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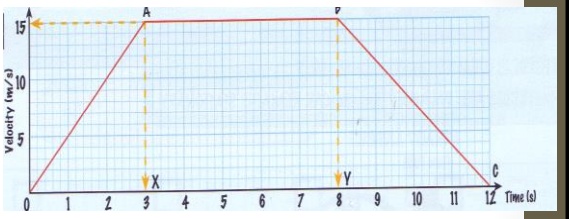
Problems

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

5m/s², 0, 3.75m/s², 127.5m

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S1-S3 Physics Transport

Velocity-Time GRAPHS

Finding the distance and displacement from velocity-time graphs

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- 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.

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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

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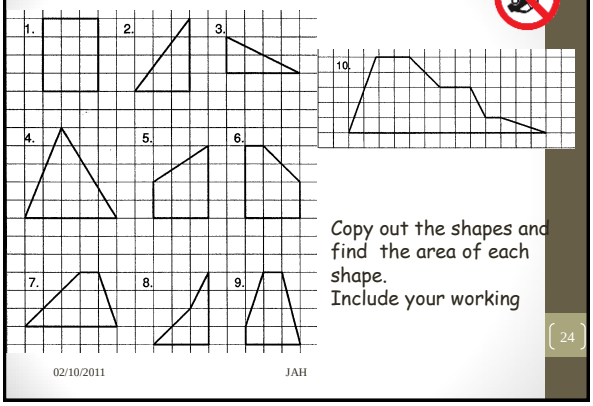

Copy out the shapes and find the area of each shape.
Include your working

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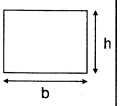
Finding the area of different shapes

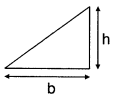
Q. How would you find the area of a square or a rectangle?

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

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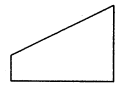
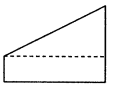
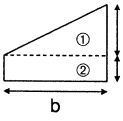


Q. How could you find the area of this shape (called a trapezium)?



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



A.
Area 1 = ½ x b x h1
Area 2 = b x h2

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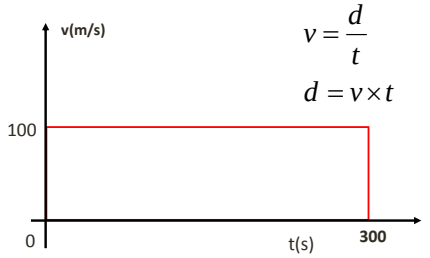
The AREA under a speed time graph tells us HOW FAR we have travelled (DISTANCE)



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

$$d = v \times t$$

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

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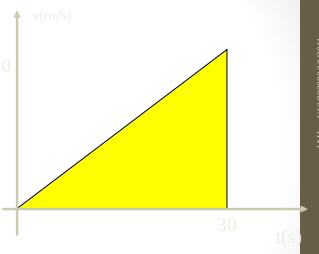
Find the average speed for this journey.

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

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

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*



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

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

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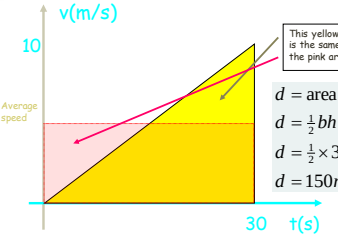

d = area under a speed time graph

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

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

$d = 150m$

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

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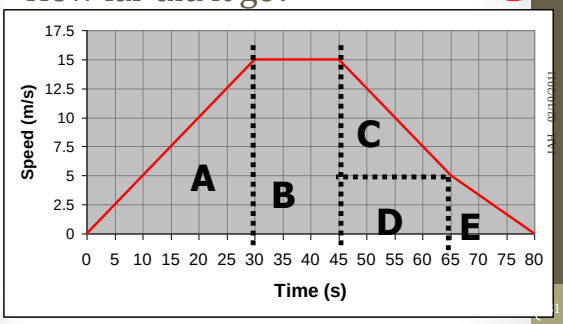
How far did it go?



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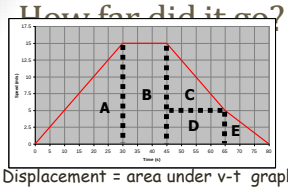
How far did it go?



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**

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Problem

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

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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
- means the object is travelling at

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S1-S3 Physics Transport

Distance-Time GRAPHS

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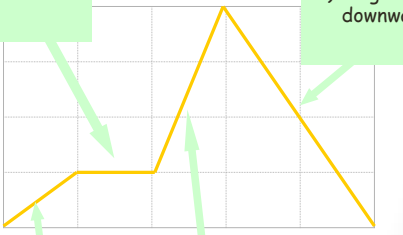
Distance-time graphs

2) Horizontal line =

4) Diagonal line downwards =



1) Diagonal line =

3) Steeper diagonal line =

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

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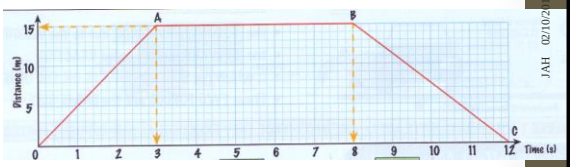
Problems

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

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