

# VelocityTime GRAPHS 

N5 Physics

## 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.


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


0-8 seconds:
from $\qquad$ to ___ metres per second. (Constant/uniform metres per second

8-11 seconds: $\qquad$ of $\qquad$ metres per second. 11-18 seconds: $\qquad$ from $\qquad$ metres per second to $\qquad$ metres per second. (Constant/uniform $\qquad$

$0-10$ seconds: $\qquad$ from $\qquad$ metres per second to ____ metres per second. (Constant/uniform $\qquad$ ).
$\qquad$ of $\qquad$ metres per second. 14-20 seconds: $\qquad$ from $\qquad$ metres per second
$\qquad$ metres per second. (Constant/uniform $\qquad$ ).


0-5 seconds: $\qquad$ from $\qquad$ metres per second. (Constant/uniform $\qquad$ ).
$\square$ metres per second to
$\qquad$
$\qquad$ of $\qquad$ metres per second. 12-17 seconds: $\qquad$ from $\qquad$ metres per second to $\qquad$ metres per second. (Constant/uniform $\qquad$ ).
$0-5$ 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


With uniform/constant acceleration, a motorcycle takes 8 seconds to speed up from rest to 20 metres per second. The motorcycle continues to travel at this steady speed for 4 seconds. It then increases its speed to 45 metres per second (constant/uniform acceleration) in 7 seconds.

time/ seconds

Maximum velocity $9 \mathrm{~ms}-1$, total time 18 s
A cyclist travels at a steady velocity of $9 \mathrm{~ms}-1$ for 6 s , before slowing down (negative constant acceleration) to a velocity of $2 \mathrm{~ms}-1 \mathrm{in} 7 \mathrm{~s}$. She then travels at this constant velocity for a further 5 s .

Velocity time graph


Draw a velocity time graph for the following motion.

A car brakes at traffic lights, its velocity changes from $9 \mathrm{~m} / \mathrm{s}$ to rest in 6 s . It remains at rest for 14 s . It then accelerates to $12 \mathrm{~m} / \mathrm{s}$ in 8 s .


Maximum speed $=90$ metres per second. Total time $=20$ 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.



|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  | - |

## Velocity-time graph challenge

1. Draw a set of axes for a velocity-time graph in your jotter.
2. In your neighbour's jotter, neatly and using a ruler, draw in a simple journey involving at least two changes in acceleration.
3. In your own jotter write a short story which could be described by the graph your neighbour drew in your jotter.
4. LATER WE WILL calculate the accelerations and the total distance travelled on the journey, so leave space.

## Now you try drawing a graph

 0-8 seconds: $\qquad$ from $\qquad$ metres per second to $\qquad$ metres per second. (Constant/uniform $\qquad$ ). 8-11 seconds: $\qquad$$\qquad$ of $\qquad$ metres per second.

11-18 seconds: $\qquad$ from $\qquad$ metres per second to $\qquad$ metres per second. (Constant/uniform $\qquad$

S1-S3 Physics Transport

## Finding the acceleration from velocity-time graphs

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


## Finding the gradient of a velocity-time graph

## $\xrightarrow{\text { Vime (s) }}$

Gradient= rise/run Or

$$
\begin{gathered}
m=\frac{\text { vertical }}{\text { horizontal }} \\
m=\frac{y_{2}-y_{1}}{X_{2}-X_{1}}
\end{gathered}
$$

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

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

## Drawing velocity-time Graphs

Draw a velocity-time graph for the following journey

- A train leaves the station and take 30 s to accelerate to $15 \mathrm{~m} / \mathrm{s}$.
- It remains at this speed for a further 15 seconds.
- As it approaches the next station it slows to $5 \mathrm{~m} / \mathrm{s}$. 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
$\qquad$
metres per second to ___ metres per second. (Constant/uniform of
$\qquad$
10-15 seconds: $\qquad$ metres per second.
15-20 seconds:
from $\qquad$ metres per second
to $\qquad$ metres per second. (Constant/uniform $\qquad$ ).

Finding the Acceleration from velocity-time graph


$$
\begin{aligned}
& \text { Gradient }=\text { rise } / \text { run } \\
& \mathrm{a}=(\mathrm{v}-\mathrm{u}) / \mathrm{t} \\
& \mathrm{a}=(10-0) / 10 \\
& \mathrm{a}=1 \mathrm{~m} / \mathrm{s}^{2}
\end{aligned}
$$

Gradient $=$ rise/run
$a=(v-u) / t$
$a=(0-10) / 5$
$a=-2 \mathrm{~m} / \mathrm{s}^{2}$

## Problems

2. Calculate (a)the acceleration over $\mathrm{OA}, \mathrm{AB}$ and BC

$5 \mathrm{~m} / \mathrm{s}^{2}, 0,3.75 \mathrm{~m} / \mathrm{s}^{2}, 127.5 \mathrm{~m}$

# Finding the distance and displacement from velocity-time graphs 

Distance and Displacement from a graph

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.

| 1. |  |  |  |  | 2. |  |  |  | 3. |  |  |  |  |  |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

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.

$$
\text { Area }=b \times h
$$


b
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

A. The area of the triangle is $1 / 2$ base $x$ height.
Area $=1 / 2 \times b \times h$


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


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

$$
\begin{aligned}
& d \\
& v=- \\
& t \\
& d=v \times t \\
& \mathrm{~d}=100 \times 300=30000 \mathrm{~m}
\end{aligned}
$$

Find the average speed for this journey.

$$
\begin{aligned}
& \bar{v}=\frac{u+v}{2} \\
& \bar{v}=\frac{0+10}{2}=5 \mathrm{~m} / \mathrm{s}
\end{aligned}
$$



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, $u \& v$

$$
\begin{aligned}
& d=\bar{v} \times t \\
& d=5 \times 30=150 \mathrm{~m}
\end{aligned}
$$


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

## Speed/ velocity - Time Graphs

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

## How far did it go? Distance!



## How far did it go?



Displacement = area under v-t graph
= Triangle A + Rectangle B + Triangle C + Rectangle D + Triangle E
$=(1 / 2 \times 30 \times 15)+(15 \times 15)+(1 / 2 \times 10 \times 20)+(20 \times 5)+(1 / 2 \times 15 \times 5)$
$=225+225+100+100+37.5$
$=687.5 \mathrm{~m}$

## Problem


2. Calculate the total distance traveled in the 12 s

## Problems

1. Calculate the average velocity over $\mathrm{OA} A B$ and BC


## 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

S1-S3 Physics Transport

# Distance-Time GRAPHS 

## Distance-time graphs

2) Horizontal line =

3) Diagonal line $=$
4) 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


## Problems

1. Describe the motion of the vehicle during the 12 s journey
2. Calculate the average speed over $\mathrm{OA} A B$ and BC


## Speed Worksheet: Label the graph

Sima and Julie wait at the bus? stop.

Sima waits for her friend Julie ; to get ready.

$:$| Sima walks $\overline{1 / 2}$ mile to her |
| :--- |
| friend's house. |
| in |

Sima and Julie are on the bus going to school.

Sima and Julie walk slowly to the bus stop.


TIME

