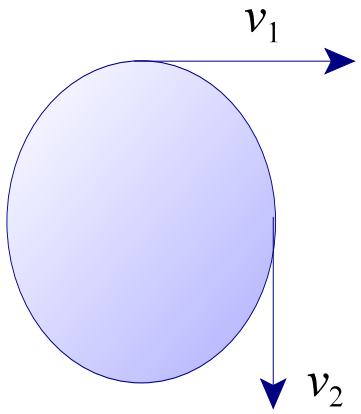
Calculating Acceleration

Acceleration is the rate of change of velocity (in other words, acceleration happens when you change speed and / or direction). Therefore, it is a vector quantity and directions are important.



Acceleration DOES NOT necessarily mean you're slowing down or speeding up. It could mean you are changing direction.

Can an object move at a constant speed and STILL accelerate ? Give an example.

Acceleration = Change in Velocity
Time Interval

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_2 - \vec{v}_1}{t_2 - t_1}$$ and if $t_1 = 0$, then

$$\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{t}$$

The SI unit for velocity is **m/s** and the unit for time is **s**. Hence, the unit for acceleration is **m/s/s** or **m/s^2**.

An acceleration of 3 m/s^2 [E] means that the velocity changes in magnitude by an average of 3 m/s every second in an easterly direction. Other units for acceleration include km/h^2, km/h/s.

An acceleration of 6km/h/s [N] means that the velocity changes by an average of 6 km/h each second in a northerly direction.

When trying to find acceleration from a position time graph, you would.....

1. Draw TWO tangents that touch the curve at two points (usually identified in the question)

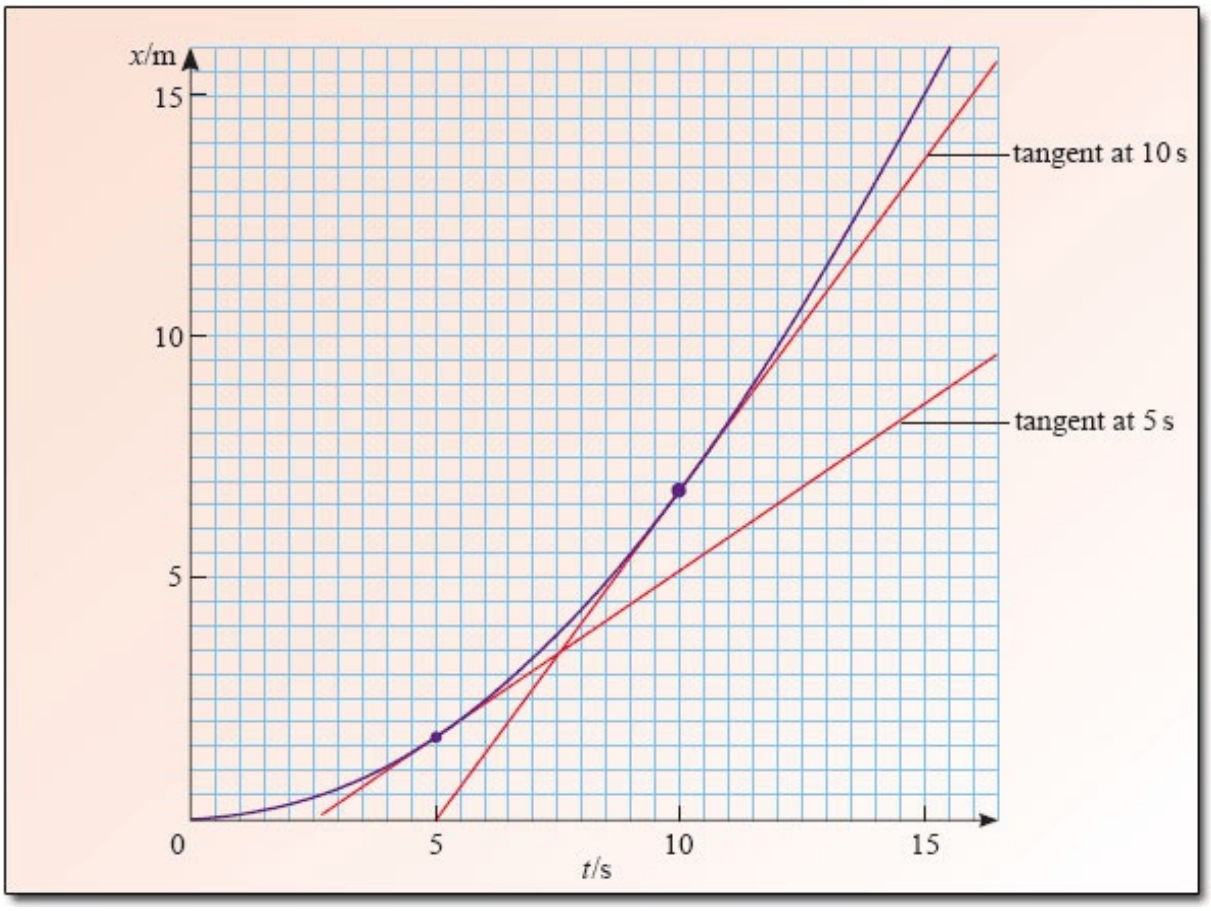
2. Determine the slope of each tangent (which IS the instantaneous velocity of the object at that point of its trip). This gives you v_1 and v_2.

3. Determine the time period that's passed between v_2 and v_1.

4. Plug everything into the acceleration formula to determine the acceleration.

Ex....

Using this position - time graph, determine the acceleration of the object between five and ten seconds.



`Ex...

If a car changes its velocity from 12 m/s to 18 m/s in four seconds, what is its acceleration ?

$v_1 = 12 m/s$

$v_2 = 18 m/s$

$\Delta t = 4.0 s$

$a = ?$

$$\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{t}$$

$$\vec{a} = \frac{18 m/s - 12 m/s}{4.0 s}$$

$$\vec{a} = 1.5 m/s^2$$

Note the acceleration is in the same direction as the velocity (both velocities are positive, acceleration is positive). Therefore, the object is speeding up.

Ex...

A cyclist is travelling with a speed of 12.0 m/s when she applies the brakes. After slowing for 3.0 s, her speed has been reduced to 4.0 m/s. What is her acceleration?

$v_1 = 12 m/s$

$v_2 = 4.0 m/s$

$\Delta t = 3.0 s$

$a = ?$

$$\vec{a} = \frac{\vec{v}_2 - \vec{v}_1}{t}$$

$$\vec{a} = \frac{4.0 m/s - 12.0 m/s}{3.0 s}$$

$$\vec{a} = -2.7 m/s^2$$

Note the acceleration is in the opposite direction as the velocity (both velocities are positive, but acceleration is negative). Therefore, the object is slowing down.

A bullet accelerates uniformly along a barrel, exiting the gun in 24 ms with a speed of 196 m/s. What is the acceleration of the bullet ?

In an emergency braking exercise, a student driver stops a car traveling at 83 km/h [W] in a time of 4.0 s. What is the car's acceleration during this time? (Remember...[W] is negative !)

A car is driving along the highway behind a slower vehicle when it pulls out to pass. If the car's acceleration is uniform at 2.0 m/s^2 for 4.0 s and it reaches a speed of 28 m/s, what was its speed when it first pulled out to pass the slower vehicle?