Constant acceleration

Year 12 Specialist Maths
Units 3 and 4

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Learning Objectives

By the end of the lesson I hope that you understand and can apply the following to a range of questions from the Unit 3 and 4 Specialist Mathematics course.

- Understand where the suvat equations come from
- Understand how to apply them to questions to find:
    - Distance/Displacement
    - Initial speed
    - Final speed
    - Acceleration
    - Time taken for flight

Recap of past learning

You might be excused for thinking that the previous lesson would assist you with this one! Well, I fear it might not.

Another example where Physics might come in handy is the *suvat* equations.

Whilst they are pretty straightforward to remember, there are some nuances which mean you might get tricked into which to use.

The *suvat* equations

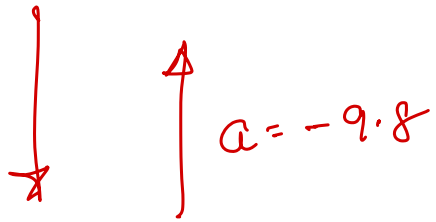
The following four equations must be learned!

$$v = u + at$$
$$s = ut + \frac{1}{2}at^2$$
$$v^2 = u^2 + 2as$$
$$s = \frac{1}{2}(u + v)t$$

For a particle moving in a straight line with **constant acceleration** a, we can use the above formulas, where u is the initial velocity, v is the final velocity, s is the displacement and t is the time taken.

It is really important that these only apply when the acceleration is constant!

$g = 9.8\ m/s^2$



Example

An object is moving in a straight line with uniform acceleration. Its initial velocity is 12 m/s and after 5 seconds its velocity is 20 m/s. Find:

- the acceleration
- the distance travelled during the first 5 seconds
- the time taken to travel a distance of 200 m.

$s =$

$u = 12$

$v = 20$

$a =$

$t = 5$

$v = u + at$

$20 = 12 + a \cdot 5$

$8 = 5a$

$a = \frac{8}{5}\ m/s^2$

$s = ut + \frac{1}{2}at^2$

$s = 12.5 + \frac{1}{2} \cdot \frac{8}{5} \cdot 5^2$

$= 50\ m$

$\therefore \quad 200 = 12.t + \frac{1}{2} \cdot \frac{8}{5} \cdot t^2$

$\therefore t = 10\ secs$

Example

A body is moving in a straight line with uniform acceleration and an initial velocity of 12 m/s. If the body stops after 20 metres, find the acceleration of the body.

$s = 20$

$u = 12$

$v = 0$

$a =$

$t =$

$$v^2 = u^2 + 2as$$

$$0^2 = 12^2 + 2 \cdot a \cdot 20$$

$$0 = 144 + 40a$$

$$a = -\frac{18}{5} \text{ m/s}^2$$

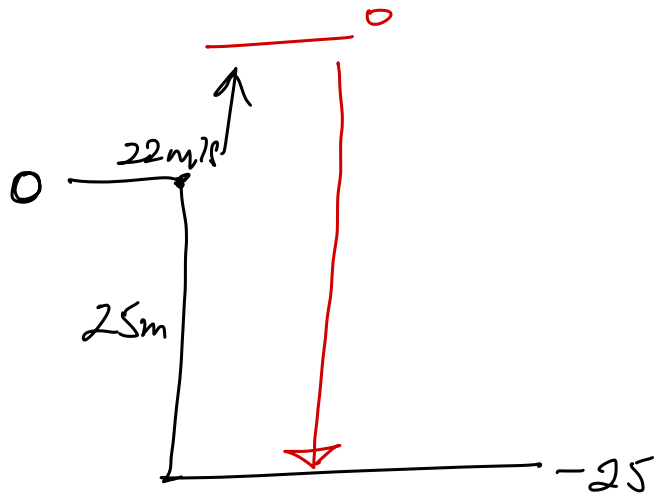
Example

A stone is thrown vertically upwards from the top of a cliff which is 25 m high. The velocity of projection of the stone is 22 m/s. Find the time it takes to reach the base of the cliff. (Give answer correct to two decimal places.)

$$s = ut + \frac{1}{2}at^2$$

$$-25 = 22.t + \frac{1}{2}.(-9.8).t^2$$

$$\therefore t = 5.43 \text{ secs}$$



$s = -25$

$u = 22$

$v =$

$a = -9.8$

$t =$

Learning Objectives: Reviewed

By the end of the lesson I hope that you understand and can apply the following to a range of questions from the Unit 3 and 4 Specialist Mathematics course.

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Questions to complete

The following represents an indication of the minimum number of questions to complete for this exercise. If you choose to do more, then all good. Note that you should also aim to complete some questions from Chapter Reviews too.

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Questions: 1, 3, 5, 7, 9, 11, 13