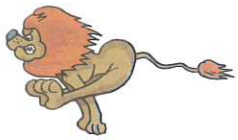
Acceleration

Uniform acceleration sounds fancy, but it's just speeding up (or slowing down) at a constant rate.

Acceleration is How Quickly You're Speeding Up



1) Acceleration is definitely not the same as velocity or speed.
2) Acceleration is the change in velocity in a certain amount of time.
3) You can find the average acceleration of an object using:

$$a = \frac{(v - u)}{t}$$

Acceleration (m/s^2) — a

Change in velocity (m/s) — $(v - u)$, where u is the initial velocity in m/s and v is the final velocity in m/s

Time (s) — t

Initial velocity is just the starting velocity of the object.

4) Deceleration is just negative acceleration (if something slows down, the change in velocity is negative).

You Need to be Able to Estimate Accelerations

You might have to estimate the acceleration (or deceleration) of an object:

EXAMPLE: A car is travelling at 15 m/s, when it collides with a tree and comes to a stop. Estimate the deceleration of the car.

1) Estimate how long it would take the car to stop.
2) Put these numbers into the acceleration equation.
3) As the car has slowed down, the change in velocity and so the acceleration is negative — the car is decelerating.

The car comes to a stop in ~1 s.

$a = (v - u) \div t$
$= (0 - 15) \div 1$
$= -15 \text{ m/s}^2$

So the deceleration is about 15 m/s^2

The ~ symbol just means it's an approximate value (or answer).

From the deceleration, you can estimate the forces involved too — more about that on page 149.

Uniform Acceleration Means a Constant Acceleration

1) Constant acceleration is sometimes called uniform acceleration.
2) Acceleration due to gravity (g) is uniform for objects in free fall. It's roughly equal to 10 m/s^2 near the Earth's surface and has the same value as gravitational field strength (p.150).
3) You can use this equation for uniform acceleration:

$$v^2 - u^2 = 2 \times a \times x$$

Final velocity (m/s) — v

Initial velocity (m/s) — u

Acceleration (m/s^2) — a

Distance (m) — x

EXAMPLE: A van travelling at 23 m/s starts decelerating uniformly at 2.0 m/s^2 as it heads towards a built-up area 112 m away. What will its speed be when it reaches the built-up area?

1) First, rearrange the equation so v^2 is on one side.
2) Now put the numbers in — remember a is negative because it's a deceleration.
3) Finally, square root the whole thing.

$v^2 = u^2 + (2 \times a \times x)$
$v^2 = 23^2 + (2 \times -2.0 \times 112)$
$= 81$
$v = \sqrt{81} = 9 \text{ m/s}$

Uniform problems — get a clip-on tie or use the equation above...

You might not be told what equation to use in the exam, so make sure you can spot when to use the equation for uniform acceleration. Make a list of the information you're given to help you see what to do.

Q1 A ball is dropped from a height, h, above the ground. The speed of the ball just before it hits the ground is 5 m/s. Calculate the height the ball is dropped from. (acceleration due to gravity $\approx$ 10 m/s^2) [2 marks]

Acceleration

Warm-Up

Draw one line from each scenario on the left to the typical acceleration for that object.

A sprinter starting a race	10 m/s^2
A falling object	2×10^5 m/s^2
A bullet shot from a gun	1.5 m/s^2

1 Describe the motion of an object that has a negative acceleration. Grade 4-6

.....

[Total 1 mark]

2 A dog sets off from rest and reaches a speed of 3.2 m/s in 8.0 s. Grade 6-7

a) Calculate the dog's average acceleration.

Acceleration = ... m/s^2

[3]

b) The dog keeps running with this acceleration for a further 6.0 s. Calculate the dog's final speed.

Speed = ... m/s

[3]

[Total 6 marks]

3 A pebble is dropped from a height level with the end of a diving board above a lake. The velocity of the pebble immediately before it hits the surface of the water is 12 m/s. Grade 6-7

Calculate the height of the diving board.

Height = ... m

[Total 3 marks]

4 A boat is travelling at a constant velocity of 5.0 m/s. It then starts to accelerate with a constant acceleration of 0.25 m/s^2 for a distance of 1.2 km.

Grade 6-7

a) Calculate the final velocity of the boat.

Velocity = ... m/s
[3]

b) Calculate the time it takes for the boat to travel this 1.2 km.

Time = ... s
[3]
[Total 6 marks]

5 A train travelling at 30 m/s slows down to 18 m/s over a distance of 360 m. Calculate the average deceleration of the train over this distance.

Grade 7-9

Deceleration = ... m/s^2
[Total 3 marks]

6 A cyclist is travelling along a main road. The cyclist stops at a red light. When the light changes to green, the cyclist accelerates with a uniform acceleration up to a speed of 21 km/hr. Estimate the cyclist's acceleration in m/s^2.

Grade 7-9

Acceleration = ... m/s^2
[Total 3 marks]

Exam Practice Tip

Watch out for questions on acceleration — if you aren't given an equation in the question, you'll have to decide which acceleration equation you need to use. Making a list of the information you have can help, and look out for key words — 'uniform', 'constant', 'increasing' or 'decreasing' might give you a clue as to which equation to use.