Name: ……..

Y11 into Y12
Applied Science transition work

In applied science you will cover topics from Biology, chemistry and physics. This transition booklet is designed to give you a refresh of some of what you learnt at GCSE in order to give you a head start at A Level.

What it covers

<u>Biological molecules</u>

- Enzymes
- DNA
- Cells

<u>Enzymes</u>

- Atoms
- Bonding

<u>Nucleotides and nucleic acids</u>

- Equations
- Units
- Conversions

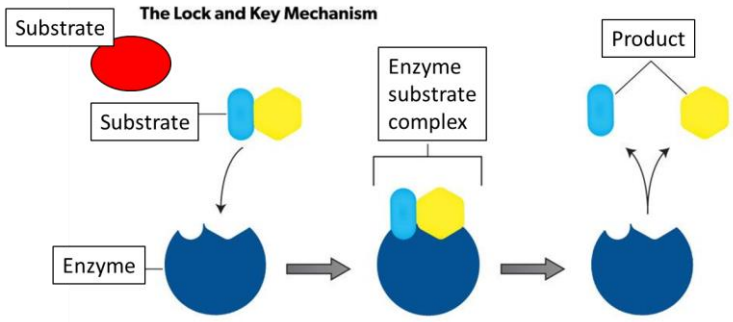
Biology

The Basics

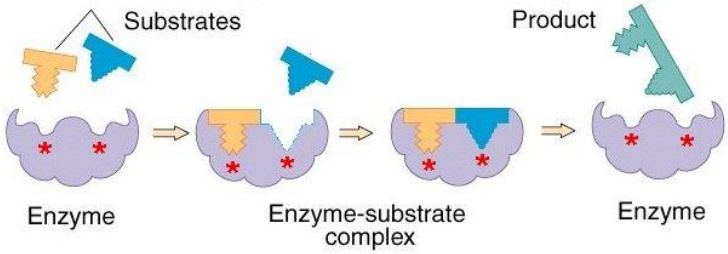
Enzymes

Enzymes are biological catalyst this means they speed up a reaction without being used up. It does this by decreasing the activation energy but there are two mechanisms for enzyme action

1) The lock and key mechanism – In this mechanism the substrate fits perfectly in the specifically shaped active site, the enzyme then speeds up the reaction and the product leaves.

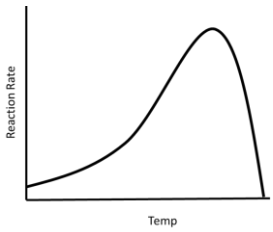


2) The induced fit mechanism – In this mechanism the substrate enters the active site and the enzyme then adjusts slightly so that the substrate fits. The reaction is then catalysed like in the other mechanism and the product leaves.

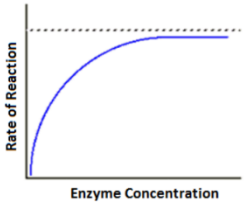


There are 3 main factors impact the rate of enzyme catalysed reactions. These are;

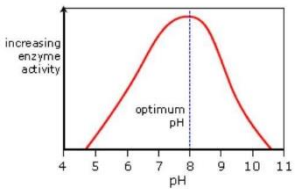
1) Temperature- As temperature increases so does the rate of reaction until it reaches the optimum temperature where the enzyme starts to denature. This is due to the increase in energy increasing the movement of the substrates increasing the rate of collisions and so the number of successful reactions.



2) Concentration – As the concentration increases so does the rate of reaction (due to an increase in collisions) until the reaction is unable to increase in rate further due to another limiting factor.



3) pH – Enzyme activity is fastest at the optimum pH and decreases either side as the enzymes change shape and denature.



Knowledge Tasks

1. What is the role of enzymes in the body?

   _____

2. Why will enzymes only work on specific reactions?

   _____

3. Describe how enzymes work via the lock and key mechanism (use a diagram to help you with your answer)

   _____
   _____
   _____
   _____
   _____

4. Describe how enzymes work via the induced fit mechanism (use a diagram to help you with your answer)

   _____
   _____
   _____
   _____
   _____

5. How does temperature effect the rate of enzyme catalysed reactions?

   _____
   _____
   _____

6. Why is this?

   _____
   _____
   _____

7. How does concentration effect the rate of enzyme catalysed reactions?

   _____
   _____
   _____

8. Why is this?

   _____
   _____
   _____

9. How does pH effect the rate of enzyme catalysed reactions?

   _____

   _____

   _____

10. Why is this?

    _____

    _____

    _____

11. Design an experiment to test the effect of one of these factors on amylase (the enzyme that catalyses the break down of starch in the body).
    You should include:
    - The equipment you would need
    - The variables
    - The risks and safety procurations you would take to avoid these risks

_____

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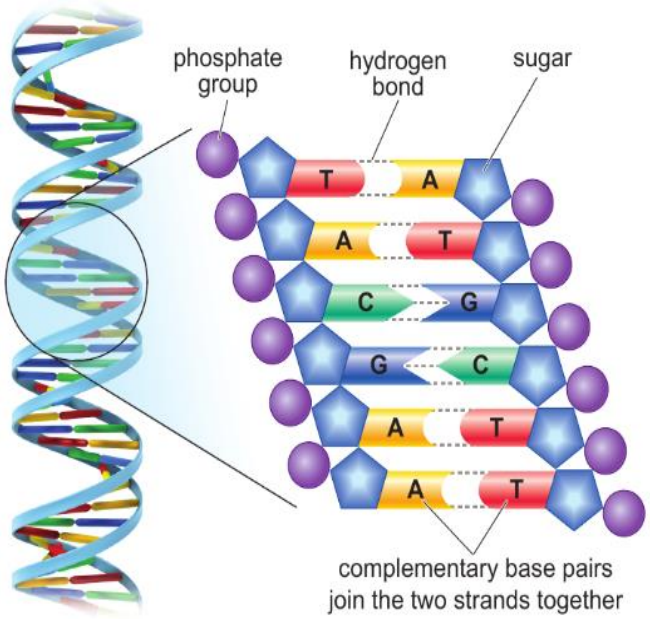
The Basics

DNA

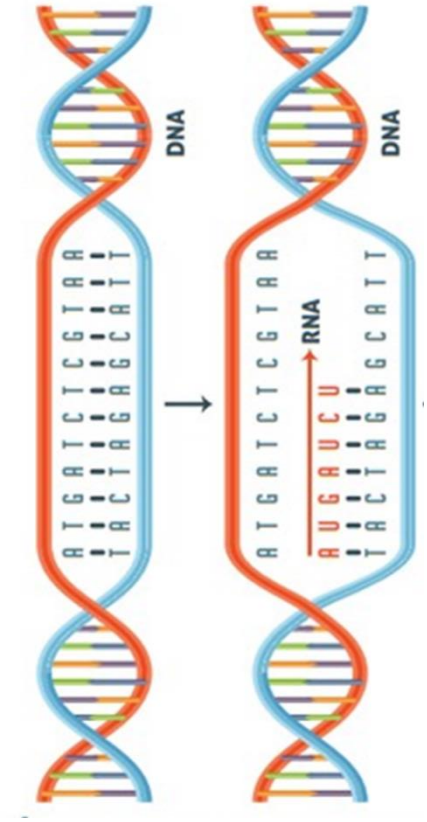
DNA is made up of different bases, these are unique to each person. These bases bond complimentary to each other

1. Adenine (A) will always bond to Thymine (T)
2. Cytosine (C) will always bond to Guanine (G)

These bases code for different proteins which can then code for characteristic



DNA double helix



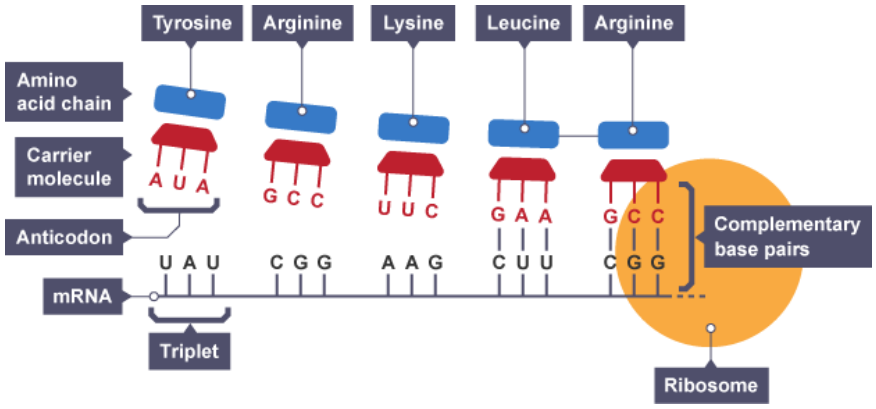
Transcription

1. The two strands of the DNA helix are unzipped by breaking of the weak Hydrogen bonds between base pairs. This unwinding of the helix is caused by an enzyme (helicase enzyme).
2. The enzyme RNA polymerase attaches to the DNA in a non-coding region just before the gene.
3. RNA polymerase moves along the DNA strand. Free RNA nucleotides form hydrogen bonds with the exposed DNA strand nucleotides by complementary base pairing to form a strand of mRNA (RNA has U instead of T)
4. The newly formed strand of mRNA is now ready to leave the nucleus and travel to the ribosome.

Translation

1. The mRNA strand travels through the cytoplasm and attaches to the ribosome. The strand passes though the ribosome.
2. For every three mRNA bases the ribosome lines up one complementary molecule of tRNA. We call every three bases a **codon**.
3. tRNA molecules transport specific amino acids to the ribosome which they leave behind shortly after lining up opposite the DNA. Because there are three mRNA bases for each tRNA molecule, we call this the **triplet code**.
4. Used tRNA molecules exit the ribosome and collect another specific amino acid.
5. A chain of several hundred amino acids in the correct order according to the original DNA is then made. This is called a **polypeptide**.

After translation, the polypeptide is finally folded into the correct shape and becomes a protein. Peptide bonds form between the adjacent amino acids to finalise the structure.



Extracting DNA

1. Dissolve 3g sodium chloride in 100ml water and mix in 10ml washing up liquid. Stir it well to dissolve the salt.
2. Mash the peas and add the pulp to the mixture. The detergent will break down the cell membranes and release DNA from inside the nucleus.
3. Stand the beaker in a water bath at 60°C for 15 minutes.
4. Add 2 drops of protease enzyme to 10cm3 of the mixture to help break down the proteins into the measuring cylinder. You only need a very small amount of this enzyme.
5. Pour iced ethanol VERY SLOWLY AND CAREFULLY down the side of the measuring cylinder to form a layer on top of the pea extract. And it must be added slowly to form two separate layers.
6. You can wind the DNA threads onto a cotton bud or a glass rod to see them more clearly.

https://www.youtube.com/watch?v=67KXatgoNKs

Knowledge Tasks

1. Describe the structure of DNA?

   _____

2. What is DNA made up of?

   _____

3. How are the strands of DNA held together?

   _____

4. Describe complementary pairing

   _____
   _____
   _____

5. A section of DNA has the base sequence ATGGCAT write the complementary sequence for this

   _____

6. For each of the steps of DNA extractions draw a diagram to show the process below

7. Describe the role of the extraction buffer in this process

   _____
   _____
   _____

8. Explain why we filter the solution

   _____
   _____
   _____

9. Explain why a water bath is used in this process

   _____
   _____
   _____

10. Describe the role of Ethanol in this process

_____
_____
_____

11. Describe the process of transcription (Use a diagram to help with your description)

_____
_____
_____
_____
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_____

12. Describe the process of translation

_____
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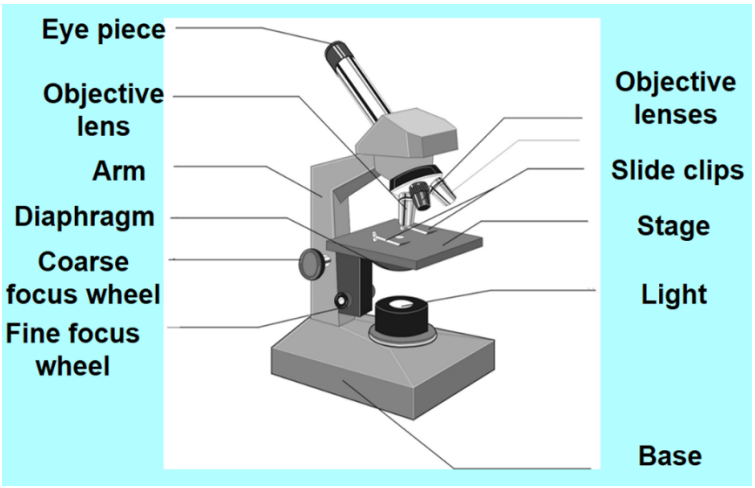
The Basics

Cell Structure

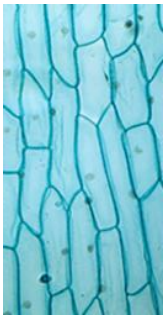


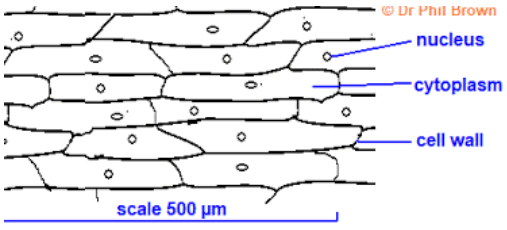
Using a microscope

1. Carry the microscope with two hands (one on the bottom of the microscope one on the handle)
2. Direct the light into the microscope so you can see through the eye piece *(make sure light isn't going directly into your eyes)*
3. Start with the **lowest magnification** moving it as close to the stage as possible without touching it.
4. Move the magnification further away slowly until it comes into focus.
5. Move onto the next magnification up and repeat until you reach the highest magnification

Making an onion cell slide

1. Peel skin of onion.
2. Place carefully and flat on the slide.
3. Put one drop of iodine onto the slide to stain the cells and make them easier to see
4. Place the cover slip over the onion carefully this helps to keep the skin flat and protects it.
5. Push down with paper towel and remove any excess iodine.
6. Your slide is now ready to be viewed





Magnification - The number of times bigger an image is compared to the real object calculated by image size / actual size.

Resolution - The smallest distance between two points that allows them to be seen as distinct objects.

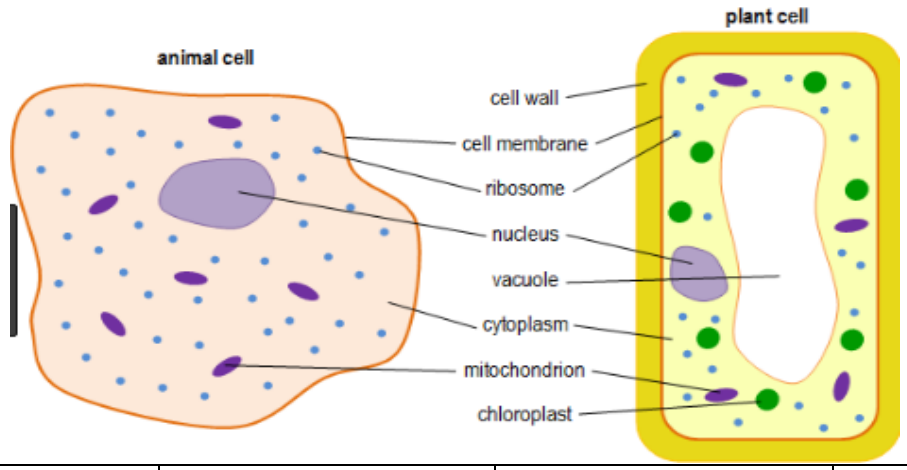
Light vs. election microscopes

Light microscopes can now magnify up to x1500 with a resolution as small as 0.0001mm. But this is still not as good as electron microscopes.

Electron microscopes use a beam of electrons instead of light to build up an image. These microscopes can magnify up to x2,000,000 with a resolution as small as 0.0000002mm this means the structures inside cells can be seen much more clearly. For example a white blood cell is 0.0000025 mm so cant be seen with a light microscope but can be seen clearly with an electron microscope.

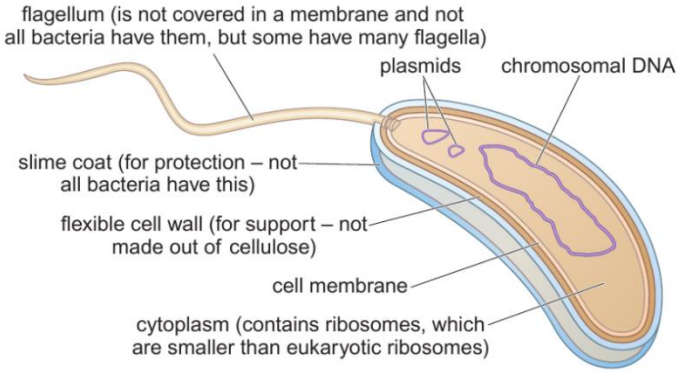
The problem is that electron microscopes are very large and very expensive so are only found in places like universities.

Eukaryotic cells- Eukaryotic cells are cells like animal and plant cells they have membrane bound organelles such as a nucleus and mitochondria.



Cell Wall	Made of Cellulose, supports and protects the cell	Cell Membrane	Thin layer, controls what enters and leaves the cell. Separates one cell from another.
Ribosome	Tiny round structures, make new proteins for a cell.	Nucleus	Controls the cell and its activities. Inside it are chromosomes, which are made of DNA.
Vacuole	A store of cell sap, helps to keep the cell rigid and firm.	Cytoplasm	A watery jelly where most of the cells activities take place.
Mitochondrion	Where respiration takes place.	Chloroplast	Where photosynthesis takes place.

Prokaryotic cells- Prokaryotic cells are cells like bacteria they have no membrane bound organelles such as a nucleus and mitochondria.



Instead of a nucleus, bacterium have Chromosomal DNA, which is a large loop of DNA in the cell that controls most of the cells activities, and Plasmids, these are small loops of DNA that control some of the prokaryotic cells activities.

Bacteria cells also have a cell wall like plants but unlike plant cells these are flexible cell walls which still provide structure but allow movement as they are not as rigid.

Two structures that only Bacteria cells contain are a Flagellum, which is a tail like structure that spins like a propeller allowing the bacteria to move, and a Slime coat which is in only some bacteria and provides protection for the cell.

Knowledge Tasks

1. What is the meaning of the word magnification?

   _____

2. What is the meaning of the work resolution?

   _____

3. Write a step by step method of how to use a microscope to view cells

   _____

   _____

   _____

   _____

   _____

   _____

4. Write a step by step how to make an onion and cheek cell slide

   _____

   _____

   _____

   _____

   _____

   _____

5. Why do we use a cover slip when making microscope slides?

   _____

   _____

6. Why is staining important?

   _____

   _____

7. Compare light and electron microscopes using a table or Venn diagram in the space below

8. What is the equation for calculating magnification?

   _____

   _____

9. A cell is 100um large but appears to be 10mm under a microscope. What is the magnification of this microscope?

   _____

   _____

10. What is a eukaryotic cell?

_____

11. What is a prokaryotic cell?

_____

12. List 5 cell structures in an animal cell

_____

_____

_____

_____

_____

13. Describe the role of each of these structures

_____

_____

_____

_____

_____

14. List 3 structures that a plant cell has and an animal cell does not

_____

_____

_____

15. Describe the roles of each of these structures

_____

_____

_____

16. List 4 subcellular structures found in bacteria cell that are not found in plant or animal cells

_____

_____

_____

_____

17. Describe the roles of these different subcellular structures

_____

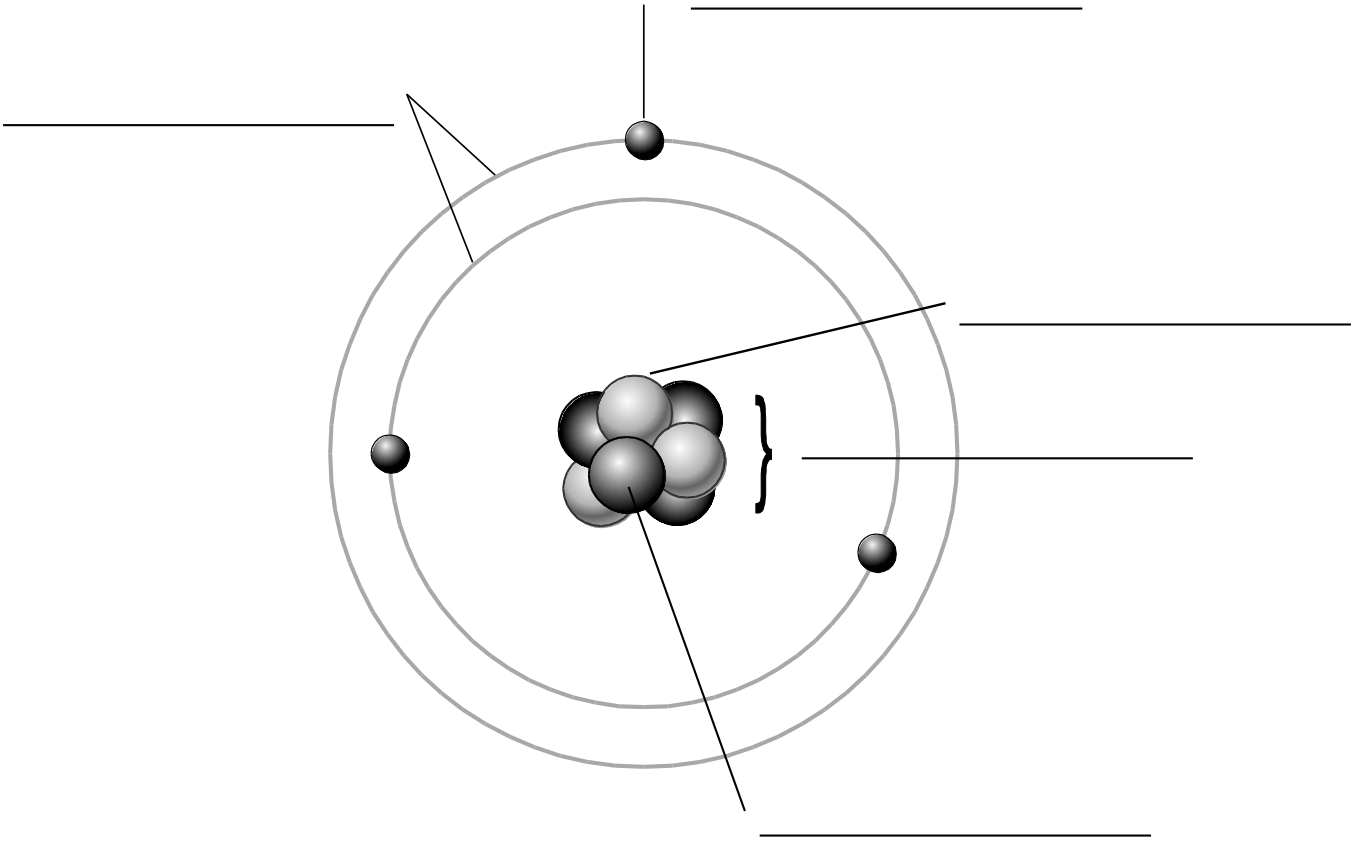
_____

_____

_____

Chemistry

1. Complete the diagram below:



2. Complete the table below:

Subatomic particle	Relative charge	Relative mass
	+1	1
neutron		
electron		

3. Write the equation that links moles, mass and relative atomic mass

4. Write the equation that link moles, concentration and volume

5. Define Rate of Reaction

6. Define Exothermic

7. Define Endothermic

8. Describe how concentration affects the rate of reaction

9. Describe how temperature affects the rate of reaction

10. Describe how temperature affects the rate of reaction

11. What is an ion?

12. What is the charge on a potassium ion?

13. What is the charge on a chlorine ion?

14. What is the charge on a calcium ion?

15. Draw a sodium ion

16. Draw a hydrogen ion

17. How do covalent bonds form?

18. What type of molecules do covalent bond form between?

19. How many bonds can a carbon atom make? Why?

20. A methane molecule has 1 carbon how many hydrogens must it have?

21. Draw a dot and cross diagram of water (H_2O)

22. How do metallic bonds form? (draw a diagram)

23. Why do metals conduct electricity

Physics

Equations

Equations are efficient ways of stating some of the key laws of physics, and allow us to work out how quantities that we know or want to predict are related to each other.

We meet lots of equations in A-level Physics, but there are very few you have to memorise (they are <u>almost</u> all given on a formula sheet). However, you will need to become used to working with the equations and rearranging them.

At GCSE many of the equations are similar to

$A = B \times C$ or $X = Y \div Z$

which you may have manipulated using equation triangles. Many of the A-level Physics equations can't be worked using equation triangles, but they <u>can</u> all be controlled using the standard rules about rearranging that you learned in GCSE Maths.

The following section uses the following three formulas you will have met at GCSE:

average speed = distance ÷ time	$v = s / t$
force = mass × acceleration	$F = m \times a$
wave speed = frequency × wavelength	$v = f \times \lambda$

Below you will be asked a number of questions, and in each case will need to select which formula to use.

Write out your answers in the way shown below in the example question. You may have your own way of working questions out, but for this exercise use the following approach. Show all your working, and follow these steps each time:

1. Read the question and identify out which two quantities you have been given, and which one you are being asked to work out
2. Choose the formula that links those three quantities
3. Write out the symbol formula in the format given above on the first line
4. Write another line with the values you have been given substituted into the formula – you should be left with one unknown quantity (just use the symbol to represent it)
5. (If needed) Rearrange the formula so you have an equation for the unknown quantity.
6. Evaluate the unknown quantity – work it out with a calculator and give it in a decimal form. Don't leave it as a fraction if division is involved.

Example question:

A cheetah travels a distance of 120 m in 5.5 seconds. What speed did it run at?

The three quantities are <u>distance</u>, <u>time</u> and <u>speed</u>, so you know which equation to use

$v = s / t$ *(write out the symbol equation first!)*

$v = 120 / 5.5$ *(substitute in the given values)*

$v = 21.8$ m/s *(no rearrangement needed, so evaluate)*

Practice questions:

Q1.1: What is the <u>speed</u> of sound wave with a <u>frequency</u> of 200 Hz and a <u>wavelength</u> of 1.65 m?

(Remember: identify the three quantities involved, choose a formula, write it out in its symbol form, then substitute, rearrange if needed, and then evaluate)

Q1.2: A motorbike with a mass of 160 kg must accelerate at 1.2 m/s^2 to win a time trial. What force is required to produce this acceleration?

Q1.3: What is the speed of a surveillance drone that moves a distance of 330 metres in 15 seconds?

Q1.4: A student on a beach watches a wave on the surface of the sea. She estimates the speed of the wave at 3 m/s, and that it had a wavelength of 5 m. What is the frequency of the wave?

Q1.5: A bee takes 3.2 seconds to fly between two flowers, moving at a speed of 2.5 m/s. How far did it fly?

Q1.6: The arm of a manufacturing robot accelerates at 1.22 m/s^2 when a force of 350 N is applied to it. What is the mass of the arm?

Q1.7: What is the frequency of a sound wave with a wavelength of 0.2 m (sound moves at a speed of 340 m/s in air)?

Prefixes & Unit conversions

Quantities in physics can range from the very small (e.g. diameter of an electron) to the very large (e.g. the mass of a galaxy). One of the ways we deal with this range is by using prefixes.

We also use prefixes in everyday life. For instance, journey distances are often given in kilometres (km) rather than metres, as the resulting number is smaller; it is easier to say that the distance from London to Paris is 343 km, rather than 343,000 m!

In the same way we use the prefixes centi- and milli- in everyday life when talking about smaller lengths. A typical mobile phone is around 12 centimetres (cm) long (which is easier to remember than 0.12m), and around 8 millimetres (mm) thick (0.008m).

However, we usually ‘remove’ these prefixes before we put a quantity into an equation. We convert km to metres, cm to metres, mm to metres, and then put the resulting number of metres into our calculators.
It is quite easy to remember that a factor of 1000 is involved when converting km to m, or mm to m, but sometimes it can be hard to decide if a quantity must be *multiplied* or *divided* by 1000.

This skill will come with practice, but until it does ask yourself the question “Am I expecting to get a bigger or smaller number when I’ve done the conversion?”. If you expect a bigger number then multiply, if you expect a smaller number then divide.

Example 1

Q: Convert 13.2 km to metres.
“Am I expecting the number of metres to be bigger or smaller than 13.2?”
The answer is bigger, so we know we have to multiply.
13.2km = 13.2 × 1000 = 13200 m

Example 2

Q: Convert 55.1 mm to metres.
“Am I expecting the number of metres to be bigger or smaller than 55.1?”
The answer is smaller, so we know we must divide. 55.1mm = 0.0551 m

Q1.8: Use that approach to complete the following table, converting between km, m and mm

km	m	mm
65	*65000*	
14.4		
		32
		8.6
	1.2	
	1500	
0.01		

The same rules apply when converting between kilohertz and hertz. The highest frequency humans can hear is around 20 kHz. What is 20 kHz in Hz?
These rules apply to all the other units you have met in GCSE and will meet in A-level; kilojoules, mJ, kilonewtons, millitesla, millifarads, kNm…
The same rules can be used to convert from the other prefixes that you will have met once or twice at GCSE, but we use a lot in A-level (nano-, micro-, mega-, giga-). Once you have the skill about deciding to multiply or divide, then you’ll be able to use these prefixes with no problem.
There are a couple of special cases that we have to remember for units, however.

Units for mass
When working with masses in equations we have to convert to kilograms, not to grams. Why is this? It is the convention that we are stuck with due to scientific history, and it will be easier for us to work with it than to try to convince every scientist in the world to change! You can still use the same rules to convert between kg, g and mg, but remember that you convert to kilograms (kg) before you put your number into an equation, not to grams (g).

Units for time

We do meet time quantities measure in milliseconds, microseconds and nanoseconds (used for measuring smaller lengths of time), but we don't use kiloseconds, megaseconds etc.

Instead, we use minutes, hours, days, years for longer time intervals. These have to be converted to seconds before they are put into an equation. Remember that there are 60 seconds in a minute, 60 minutes in an hour, 24 hours in a day and 365 days in a year (sometimes we say there are 365.25 days in a year to account for leap-days).

Using your knowledge about prefixes and unit conversions, answer the following three equation questions.

Practice questions:

Q1.9: An F14 jet travels a distance of 22 km in 35 seconds. What is its speed (in m/s)?

Q1.10: A cheetah has a mass of 41 kg. When it starts to run its legs can exert a force of 0.39 kN. What will the resulting acceleration be?
(Hint: remember to leave the mass in kg!)

Q1.11: A seismic wave moves at a speed of 200 km/h. If it has a frequency of 30 Hz, what is its wavelength?
(Hint: work on the speed of the wave first – what is its speed in m/s? You could first work out its speed in km/s, and then work it out in m/s!)