Getting Ready for...

KS4 (GCSE) Combined Science

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Preparing for Your Biology Studies

Cells and organisms, including the role of diffusion and respiration

a. Can you describe how to use a light microscope to observe and draw plant and animal cells? This is a required practical at GCSE and you will need to be able to calculate magnification using the formula:

magnification = size of the image/real size of the object

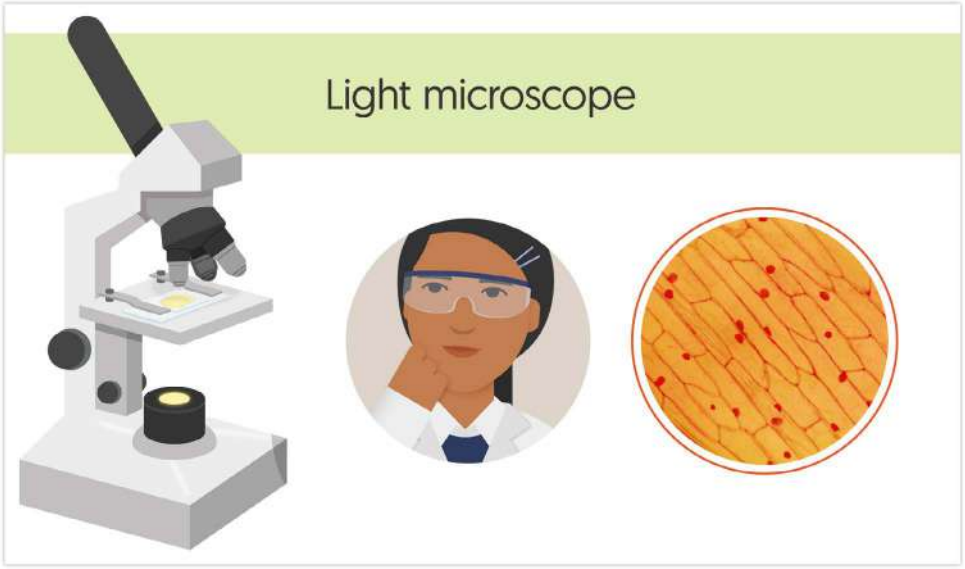
You will need to be able to make use of standard form, which you will also learn in your maths lessons.

b. Are you able to name the structures (also known as components and organelles) found in plants and animal cells and describe their functions? You will need to be able to compare the structures of plant and animal cells. Can you describe how some unicellular organisms are adapted and how cells in multicellular organisms are specialised to carry out certain roles? Practise drawing and labelling animal and plant cells.

c. Are you familiar with the hierarchical organisation of multicellular organisms? This takes us from cells to tissues to organs to systems to organisms. Can you name examples of each?

d. Can you describe diffusion as the movement of molecules from where they are more concentrated to where they are less concentrated and relate that to key processes in living things? This includes the exchange of carbon dioxide and oxygen in the lungs. You should be familiar with diagrams that model this.

e. Can you compare aerobic and anaerobic respiration (in humans and microbes) and summarise both using word equations? This needs to include the reactants and products and energy implications for the organism. Learn the word equations.



Nutrition and digestion

a. Can you name the contents (carbohydrates, proteins, lipids, vitamins, minerals, fibre and water) of a healthy human diet, why each component is needed and sources of them in our food? Summarise this in a table.

b. You will need to know the parts of the digestive system and the ways in which it is adapted to help digest and absorb food. This should include the role of enzymes and of bacteria in the gut.

c. Are you able to calculate energy requirements of different diets, for example a pregnant woman, an athlete, and an office worker? Can you relate imbalances in the diet to dietary diseases such as deficiency and obesity?

d. Can you describe how a green plant gets the nutrients it needs from the soil and makes carbohydrates in its leaves?

Photosynthesis, including the adaptations of a leaf

a. Learn the word equation that summarises photosynthesis. Can you relate the structure of the leaf to the requirements for photosynthesis? Practise drawing a section through a leaf and labelling it, identifying each feature in relation to its contribution to photosynthesis.

b. Learn the role of photosynthesis in the carbon cycle and practise drawing a simple version of the carbon cycle to show the relationship between photosynthesis and the other processes that contribute to carbon stores and carbon dioxide in the atmosphere.

Evolution and extinction

a. Learn the definition that "heredity is the transfer of genetic formation from one generation to the next". Can you describe the role of DNA, genes and chromosomes in heredity and the role of the scientists Watson, Crick, Wilkins and Franklin in establishing the model of the DNA molecule?

b. Can you explain the difference between continuous and discontinuous variation between individuals of the same species and name examples of such variation? Are you familiar with how these differences may be measured and displayed in graphs?

c. The differences (variation) between species and between individuals of a species mean that some are better adapted for their environment, so are more likely to survive and pass on this adaptation and this drives natural selection. Learn some examples of how animals and plants are adapted to their environment and be able to relate that to successful competition.

d. Environmental changes can lead to species being unable to compete or have poor adaptation and this can lead to extinction. This is where every individual from a species has died and that species no longer exists. Can you name examples of species that have become extinct? Human activity is also leading to extinction but we have taken steps, such as gene banks and seed banks, to preserve species for the future.

e. Can you explain why it is important for us to preserve biodiversity (the variety of living things) on Earth?

Inheritance and genetics, competition and interdependence

a. Can you draw and interpret simple food webs and food chains and describe the relationships between species in them? You should be able to identify producers and different levels of consumers and recognise that there is interdependence between different parts of an ecosystem. This includes the dependence on insects for pollination by many flowering plants.

b. Can you explain the importance of insects, such as bees, to the security of human food supply?

c. Can you describe examples of how living things affect their environment and are in turn affected by it? This includes the behaviour of humans and how toxic materials that we have used and discarded find their way into other things and accumulate in their tissues. You should be able to name examples of this, such as the use of the pesticide DTT, lead in petrol and the steps that were taken to lower impact.

Reproduction in mammals (with humans as an example) and flowering plants

a. Can you label the parts of the male and female reproductive systems? Practise labelling diagrams of them.

b. Learn the key stages of the menstrual cycle and be able to define gametes (the sex cells), fertilisation, gestation and birth and the role that each stage plays in the perpetuation of human life. Can you identify healthy and unhealthy choices for lifestyle and diet during pregnancy?

c. Practise drawing and labelling diagrams of a flowering plant. Can you relate the structure of flowers and pollen to wind and insect pollination? Can you describe the structure of a seed and name different methods of seed dispersal? Are you able to describe a scientific investigation into methods of seed dispersal, such as size of sycamore related to distance dispersed?

Gas exchange in humans and in plants

d. Can you describe the structure and function of the gas exchange system in humans and how it is adapted to make it more efficient?

e. Can you describe the steps in the breathing mechanism to move air in and out of the lungs and relate that to a model that you have seen (bell jar and rubber diaphragm)? Can you describe a simple experiment that would allow you to measure lung volume?

f. Can you explain the impact of asthma, exercise and smoking on the breathing system?

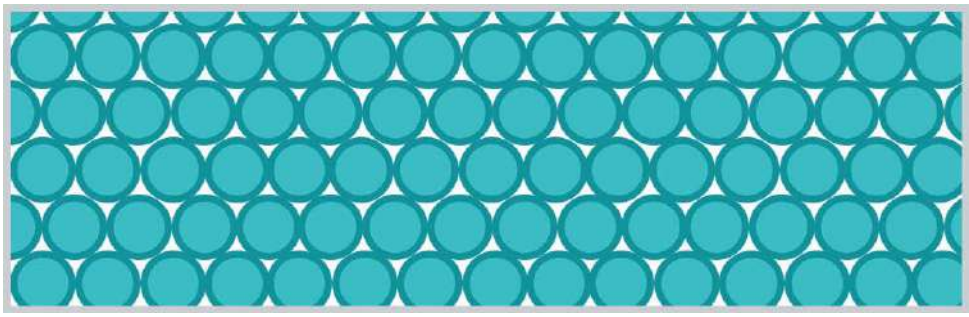
g. Can you explain the role of the stomata in the leaf of a plant in gas exchange? Practise drawing the guard cells and the opening and closing of the stoma.

Preparing for Your Chemistry Studies

Particles and states of matter

a. Can you describe how particles in the three different states will behave? Can you explain gas pressure in terms of the movement of particles? You should be able to identify states from descriptions of the behaviour of the particles or from simple diagrams. You should be familiar with the use of the state symbols s (solid), l (liquid), g (gas) and aq (aqueous or in solution). Practise drawing the particles in solids, liquids and gases.

b. Can you name the different changes of state (melting, freezing, evaporating, condensing) and explain them in terms of the energy and movement of particles? Write down why ice and iron have different melting points, using the idea of forces between the particles in your explanation. Write an explanation of why salt is able to dissolve in water in terms of what happens to the sodium and chloride ions in dissolving.



Atoms, elements and compounds

a. Can you define the terms atom, element, compound and mixture and explain the differences between them? Can you name examples of each?

b. Are you confident in your knowledge of the use of chemical symbols to represent elements and the formulae of commonly encountered compounds? Learn the symbols of the first 20 elements of the periodic table and formula for water, carbon dioxide, sodium hydroxide, ammonia, ammonium hydroxide and hydrochloric, nitric and sulphuric acids.

c. Can you recall and compare the properties of metals and non-metals? Are you able to give examples? Can you describe or predict the properties of different elements according to where they are on the periodic table?

d. Can you draw and label a simple model of an atom? Practise doing so. Do this for each of the first 20 elements of the periodic table if you can.

Pure and impure substances

a. What is meant by a pure substance in chemistry?

b. Can you name examples of mixtures? Do you understand that a solution is a mixture and can you explain what happens to the particles in the solid when it dissolves? What mass does 5g of salt dissolved in 100ml (g) of water have? Why?

c. Can you describe how to carry out different methods of separating the components of a mixture, including filtration, evaporation, distillation, and chromatography?

d. Can you define diffusion as the movement of particles of a liquid or gas from a region of high concentration to one of low concentration and explain it in terms of the movement of the particles? Can you use this knowledge to predict what will happen to the movement of particles in different situations?

Chemical reactions

a. Can you explain chemical reactions as a rearrangement of chemical bonds and the changes that would be observed to indicate that a reaction has taken place? These include a change in temperature, colour or state or the production of light or sound as energy changes. Can you recall the law of the conservation of mass (and energy)?

b. Can you represent chemical reactions as word equations and symbol equations? Have you interpreted symbol equations? Practise writing in longhand what is represented in different chemical (symbol) equations. Show these as word equations too.

c. Can you explain what would happen in different kinds of chemical reactions such as combustion, thermal decomposition, oxidation and displacement? Can you name different examples of each?

d. Can you define acids and alkalis in terms of their role in neutralisation reactions and place acidic and alkaline substances on the pH scale? Can you name different indicators and the colours they change to in different conditions of acidity and alkalinity? This includes the use of universal indicator, the pH scale and the range of colours that we see. Learn these and the pH of common substances.

e. Learn the general equations:

Acid + metal —> a salt + hydrogen

and

Acid + alkali —> a salt + water

f. You should be able to write word equations for common examples of those general equations and ideally also the balanced chemical equations. Remember that hydrochloric acid will produce salts that are chlorides, nitric

acid will produce salts that are nitrates and sulphuric acid will produce sulphates. The name of the metal (or ammonium) comes at the start of the salt. Write word and balanced equations for the reactions of lithium and calcium with each of the three commonly encountered acids.

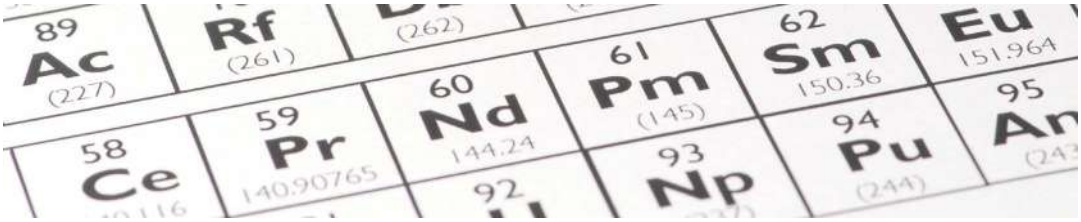
The periodic table and materials

a. Can you recall and compare the properties of metals and non-metals? Are you able to give examples? Can you describe or predict the properties of different elements according to where they are on the periodic table?

b. Can you explain the creation of Mendeleev's version of the periodic table and describe its features? Can you define the terms group and period in relation to the periodic table?

c. Are you familiar with the reactivity series of metals and carbon? Practise 'read, cover, write, check' with it until you have learned it.

d. Can you relate the use of carbon to extract metals from their compounds to the reactivity series? You should be familiar with the extraction of copper and iron in this way.



The Earth and atmosphere

a. Learn the composition of gases in the Earth's atmosphere and be able to express these as percentages and fractions. Practise drawing the gases of the atmosphere in a labelled pie chart.

b. Can you describe the processes in the carbon cycle, such as photosynthesis, combustion, respiration, decay, the development of fossil fuels and the role of the world's oceans and marshes in contributing to the atmospheric reservoir of carbon dioxide? Practise drawing the carbon cycle diagram.

c. Can you describe the production of carbon dioxide by humans and explain arguments for and against human activity causing the greenhouse effect that is leading to global warming? Can you explain the impact of climate change on the environment and the implications of rising sea levels?

d. Learn some examples of the natural resources that humans use. Can you explain the difference between finite and renewable resources? Can you explain what we mean by reduce, reuse and recycle? What are the benefits of this approach?

Preparing for Your Physics Studies

Magnets

a. Imagine you have a tray of assorted items – bits of metal, pieces of wood, bits of plastic, etc. You've been told that several of the items are magnets and that your job is to sort them all out into three groups: magnets, magnetic items and nonmagnetic items. Suggest how you could do this.

b. Some magnets are bar magnets but they can be other shapes too. These ones are circular magnets, with the North pole on one face and the South pole on the other.

c. Look at this arrangement of circular magnets. The upper surface of the top magnet is a South pole. Make a quick sketch of the set up and see if you can label all of the other poles as either North or South.

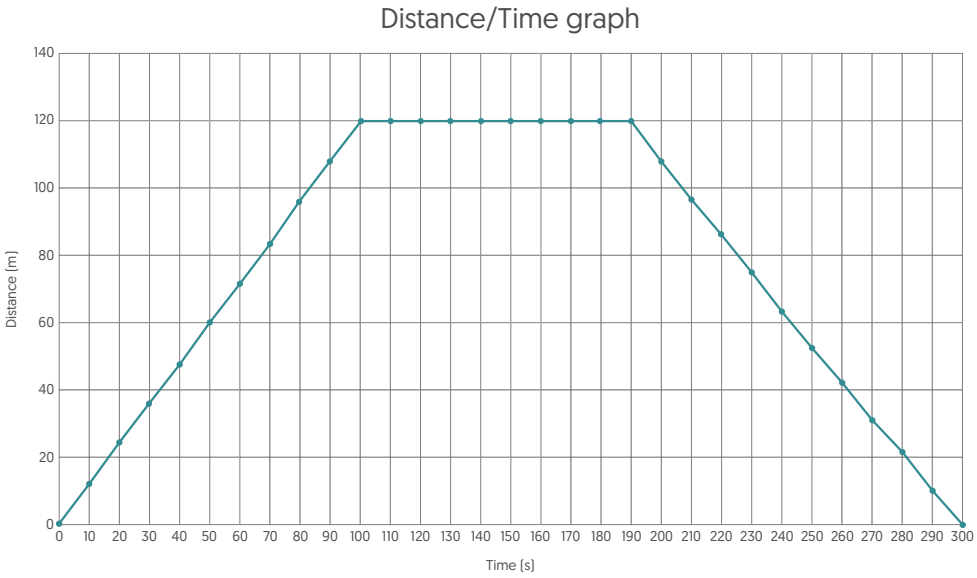
d. Now look at this arrangement. The upper surface of the top magnet is a South pole. Again, make a sketch and label all of the poles.

e. On this sketch, see if you can add the magnetic field lines in the gaps between the magnets. Remember that the lines go from North to South.

Motion and forces

Distance, speed and time

Rebecca walks from home to the shop to buy some fruit and a bottle of milk, which she then brings home. Using an app on her phone she can measure the distance she has walked. On a graph, the data looks like this:



- Write down everything that you can about the graph and the journey that it shows.
- What units have been used to measure:
    a. Distance?
    b. Time?
- How far does Rebecca live from the shop?
- Look at the graph and use it to work out:
    a. How long it takes her to walk to the shop.
    b. How long it takes her to walk back.
    c. How long she spends at the shop.
- We can do some calculations on her speed.
    a. What is the formula to work out speed from distance and time?
    b. Look at the units of distance and time; what units will speed be in if it is worked out from these?
    c. What is her speed when walking to the shop?
    d. What is her speed when walking back?
- Acceleration is a measure of how speed is changing.
    a. At which points on the graph is there a change of speed?
    b. Explain how you recognised those.

Motion

This picture shows an experiment to investigate motion. A model railway wagon has been set up on a length of track. There is a pulley at the end of the track.

Some weights are attached by means of a piece of string to the wagon; the string goes over the pulley. When the weights are released the wagon accelerates along the track.

a. What will happen to the speed of the wagon as it travels along the track?

b. How do you think the motion would alter if the experiment was repeated with a larger weight? Try to use the words 'speed' and 'acceleration' in your answer.

This is a picture of the wagon on the track.

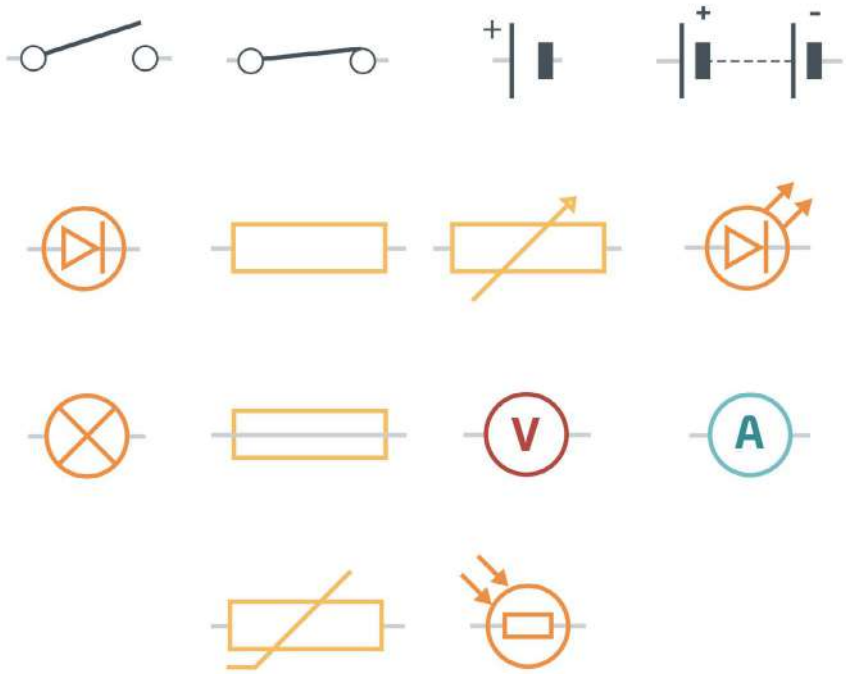
c. Which direction is the force due to the weights acting?

d. Do a simple sketch of the wagon and show this force by means of an arrow to show the direction it is acting in.

e. There are other forces acting on the wagon as well – friction and air resistance. Add arrows to your diagram to show these too.

Circuit symbols and circuits

It is useful when drawing circuits to use symbols rather than having to draw pictures of the actual components every time. Here are some symbols; see if you can work out what each of them means. Some of them you may know but others you may have to research.



a. Practise drawing the circuit symbols. Your knowledge of this is often tested at GCSE.

These questions are about current flowing in a circuit. You may have done some work on this either using batteries or power packs. The questions refer to batteries, but the ideas are the same if power packs were used instead.

b. Draw a circuit with a battery, a switch and a bulb. Imagine setting this up and getting the bulb to light. Think of the bulb as being at 'normal brightness'.

c. Now draw another circuit with a battery, a switch and two bulbs in series. Describe the brightness of these bulbs in relation to 'normal brightness'.

d. Now draw a circuit with a battery, a switch and two bulbs in parallel. Describe the brightness of these bulbs in relation to 'normal brightness'.

e. Imagine that one of the bulbs was faulty and had stopped working. Describe how this would affect the series circuit and the parallel circuit you drew before.

f. In the mains electricity circuit in a classroom or in the home various appliances can be plugged in. Suggest whether this is a series or a parallel circuit and explain your answer.

Pressure

In solids

Lucy has a job driving large machinery on building sites. She drives a huge caterpillar tractor with wide tracks that will go over soft mud. She goes to work on a bike. "It's weird" she says "I spend all day driving over soft mud without any

difficulty but when it's time to go home there's no way I can ride my bike on this ground. I just sink in, even though me and my bike weigh a fraction of the tractor."

a. Explain why the bike gets stuck in the mud and the tracked vehicle doesn't. Your answer should include the words 'area', 'force' and 'pressure'.

In fluids (liquids and gases)

This picture shows an experiment on water pressure. A large plastic bottle has had some holes made in it at different points. The bottle has been filled with water and the water is running out.

a. What do you notice about the different jets of water? Suggest a reason for this.

b. Three students are discussing why the jets are like this. Comment on what each of them says and indicate which you think is the best answer and why.

- Anil says, "I think the water pressure is greater nearer the bottom of the bottle – that's why the upper jet comes out the shortest distance from the side of the bottle."
- Bea says, "I think the water pressure is higher up the bottle. Pressure always gets more when you go higher – that's why your ears pop in an express lift."
- Carl says, "I don't think the pressure of the water varies – nothing is compressing the water. It's just sat there in the bottle."

Think about the collapsing can experiment that you might have seen demonstrated for you. If you haven't seen it, or want a reminder, it can be found easily on YouTube (DO NOT TRY THIS AT HOME).

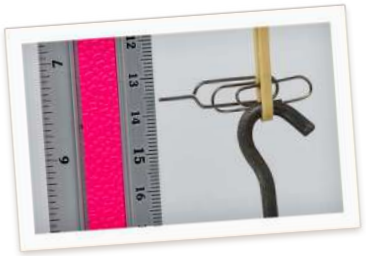
c. Why is it that the can collapses when inverted (turned upside down) in the water? Use your knowledge of particles and pressure to explain it.

Applying a force to a material

Will's group are doing an experiment to see how an elastic band stretches when it is loaded. They set up an elastic band next to a ruler and they add weights to it.

They know that each of the weights applies a force of 1 Newton.

They were going to start with no load at all but when they tried this the elastic band went into an oval shape instead of hanging down straight so they decided to start at 1N. Each time they add another weight they record the length. They set up a pointer to take the readings with. They are using the scale down the right-hand side of the ruler, which is marked in centimetres. They decided to stop at 6N because the elastic band was tightly stretched and they thought it might break.



These are their results:

Load (N)	Reading on scale (cm)
1	12.7
2	13.6
3	14.5
4	15.9
5	16.3
6	17.1

a. Work out the difference between each pair of readings and find out how much it goes up by every time they add another Newton. Generally speaking, how much does the length increase for every Newton added?

b. They got one of the readings wrong; suggest which one it was. What should they do about it?

c. If they had found a way of keeping the elastic band straight with no load on it, what do you think its length would have been?

d. Will says, "I think that adding the same extra load should cause the same extra extension, as long as we don't overdo it." Explain whether this is supported by their evidence.

Scientific method

This is quite a tricky but important section as there are lots of words to learn the meaning of and many of them are quite similar. Unfortunately, you just need to put in the time to learn them!

a. Can you describe what is meant by a hypothesis and a prediction? Can you explain the difference between the independent, dependent and control variables in a test?

b. Can you define repeats, repeatable and reproducible? Can you identify possible sources of random and systematic error and can you define these?

c. Are you familiar with the names of common chemical apparatus such as test tube, boiling tube, Bunsen burner, tripod, gauze, evaporating basin, beaker, measuring cylinder, conical flask, and thermometer and are you able to draw them using chemical notation?

d. Can you read measurements from a ruler, a newton meter, measuring cylinder, a beaker and thermometer accurately and record them appropriately? Are you able to identify hazards in a practical procedure and suggest methods of reducing them?

e. Are you familiar with the correct method for recording data and how to make your table of data clear? Can you do the same for graphs, including plotting the points accurately with a cross and drawing in an appropriate line of best fit (that shows the relationship between variables)? This might be a straight line but often, in science, is a curve.

f. Can you identify patterns and trends in data that has been presented to you in diagrammatic, table or graphical form and draw a conclusion? Look at examples from your textbook or even in the news and write down trends or patterns that you see.

g. Can you calculate the average (mean, median and mode) from a set of data? When calculating the mean, can you do so to an appropriate degree, with no more decimal places than the source data? Can you round numbers to the nearest decimal place?

Scientific theories and models

This is another tricky and important section as you really need to understand how scientists work and communicate in your further studies of science. Put in the time and you will be rewarded!

a. Models and theories change as we learn more and new evidence is gathered that helps us refine them. Write down the basics of the theory of “blending”, which was the predominant belief of how heredity occurred before Darwin and Wallace. Compare that to the theory of natural selection.

b. The development of the periodic table is another classic example of this development and refinement of ideas. List the way in which thinking

about the periodic table changed from Dobereiner, to Newlands and to Mendeleev.

c. In physics (and chemistry), the same thing has happened with the development of ideas about the structure of the atom. Look up which scientists were involved in this and try to become familiar with their work and how each advanced the ideas of those that went before.

d. Can you describe the different ways in which scientists communicate about their work and findings? What is meant by "peer review" and what benefits does it bring? What are the potential issues with the reporting of science in the media?

e. Theories lead to predictions which can then be tested experimentally. This will often allow a relationship to be shown using mathematics and graphs. Sketch graphs to show relationships that are linear, directly proportional and indirectly proportional.