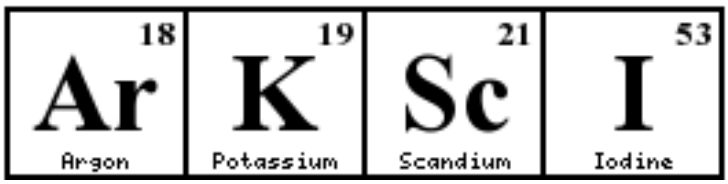

COMBINED SCIENCE STUDY PACK

AQA GCSE Combined Science: Trilogy 8464

Paper	Exam Date
Physics Paper 1 4.1 Energy 4.3 Particle Model 4.4 Atomic Structure 4.2 Electricity	23rd May 2018
Physics Paper 2 4.5 Forces 4.6 Waves Magnets and Electromagnetism	15th June 2018
Biology Paper 1 4.1 Cell Biology 4.2 Organisation 4.3 Infection and Response 4.4 Bioenergetics	15th May 2018
Biology Paper 2 4.5 Homeostasis and Response 4.6 Inheritance, Variation and Evolution 4.7 Ecology	11th June 2018
Chemistry Paper 1 5.1 Atomic Structure and the Periodic Table 5.2 Bonding, Structure and the Properties of Matter 5.3 Quantitative Chemistry 5.4 Chemical Changes 5.5 Energy Changes	17th May 2018
Chemistry Paper 2 5.6 The Rate and Extent of Chemical Change 5.7 Organic Chemistry 5.8 Chemical Analysis 5.9 Chemistry of the Atmosphere 5.10 Using Resources	13th June 2018

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37	Waves Waves in Air, Fluids and Solids Electromagnetic Waves
45	Energy Energy Changes in a System Conservation and Dissipation of Energy National and Global Energy Resources Changes of State and the Paticle Model Internal Energy and Energy Transfers Particle Model and Pressure Atoms and Isotopes Atoms and Nuclear Radiation
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96	Genetics and Evolution Reproduction Variation and evolution Development of understanding genetics and evolution Classification of living organisms

109	Interdependence Adaptations, interdepence and competition Organisation of an ecosystem Biodiversity and the effect of human interaction on ecosystems
122	Microbes and Health Human digestive system and enzymes Non-communicable diseases Discovery and development of drugs Plant diseases and defence responses
136	Particles and Bonding Atomic Structure Structure and Bonding Organic Chemistry Chemical Analysis
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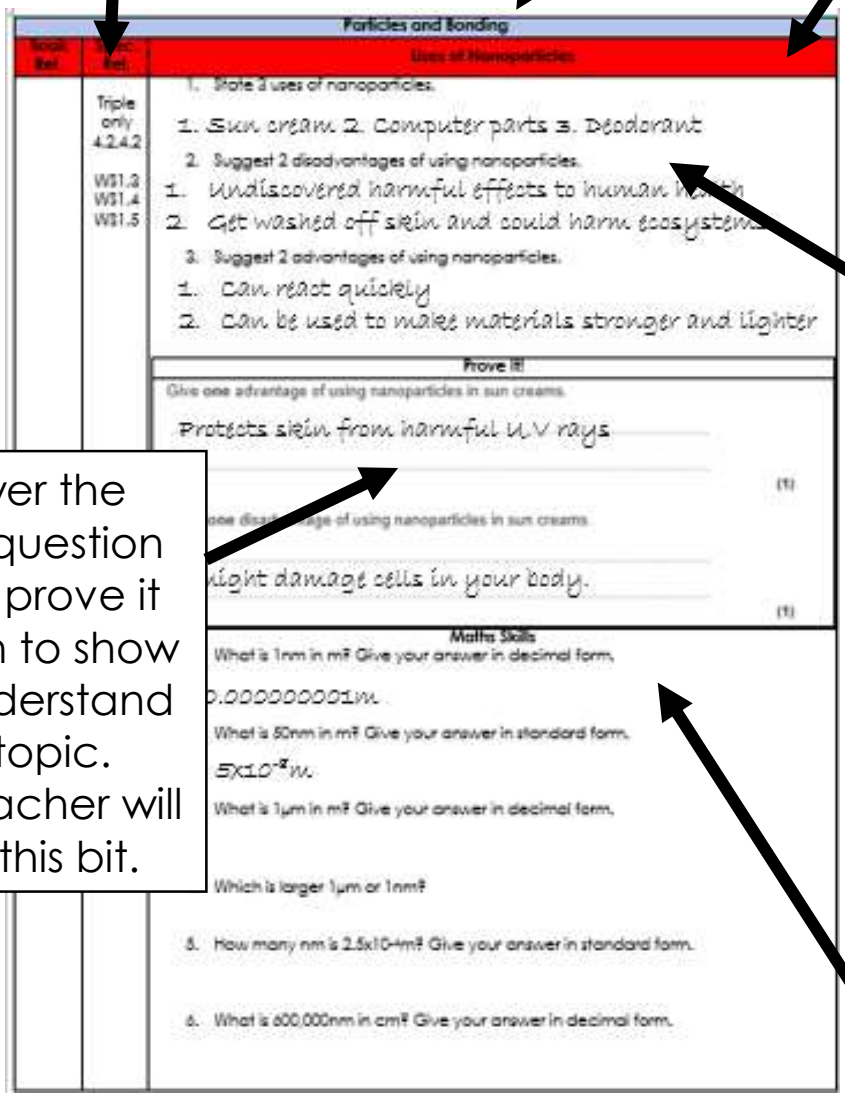
How To Use Your Study Pack

This tells you which bit of the specification you are studying. If says here if it is a triple only topic.

This is the big idea this topic is part of

This is the topic you are studying



Particles and Bonding

Uses of Nanoparticles

Triple only 4.2.4.2

WS1.3 WS1.4 WS1.5

1. State 2 uses of nanoparticles.

1. Sun cream 2. Computer parts 3. Deodorant

2. Suggest 2 disadvantages of using nanoparticles.

1. Undiscovered harmful effects to human health
2. Get washed off skin and could harm ecosystems

3. Suggest 2 advantages of using nanoparticles.

1. Can react quickly
2. Can be used to make materials stronger and lighter

Prove it!

Give one advantage of using nanoparticles in sun creams.

Protects skin from harmful UV rays

(1)

one disadvantage of using nanoparticles in sun creams

might damage cells in your body.

(1)

Maths Skills

What is 1nm in m? Give your answer in decimal form.

0.000000001m

What is 50nm in m? Give your answer in standard form.

$5x10^{-8}$m

What is 1μm in m? Give your answer in decimal form.

Which is larger 1μm or 1nm?

5. How many nm is 2.5x10-4m? Give your answer in standard form.

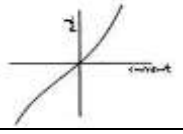
6. What is 600,000nm in cm? Give your answer in decimal form.

1. Try and answer the questions in this box.
2. Use your revision guide to check your answers and correct any you got wrong.
3. Use the revision guide to help you answer the questions you didn't know.

Answer the exam question in the 'prove it 'section to show you understand the topic. Your teacher will mark this bit.

This section will help you prepare for any questions that involve maths in the exam.

GCSE Command Words

Command Word	Definition	Example Question	Example Answer
State, give, name, write down	Short answer only and does not require an explanation.	**State** the units for acceleration.	m/s^2
Describe (not graphs or practical)	Recall facts, events or process in an accurate way.	**Describe** how quadrats should be used to estimate the number of plants in a field.	Place a large number of quadrats randomly in the field. Count the number of plants in the quadrat. Calculate the mean number in each quadrat then use the area of the quadrat and field to estimate the number of plants.
Describe (graphs)	Identify the pattern in the graph and use numbers from the graph to make this clear.	**Describe** the pattern of tooth decay in Figure 3 for water without fluoride.	The percentage of tooth decay increases with age by 4% for each age group in figure 3.
Describe (practical)/ Plan	Write the method for the practical or the results that you would expect to see.	**Plan** an experiment to test the hypothesis "the higher the temperature, the faster the rate of reaction".	Measure the rate of reaction by adding a set amount of metal to set type, volume and concentration of acid and time how long it takes to stop fizzing. Repeat the experiment at 5 different temperatures.
Determine	Use given data or information to obtain and answer.	**Determine** the half-life of a sample if it decreases from 1000g to 250g in 2.6million years.	1.3 million years
Explain	Make something clear or state the reasons for something happening. You will need to state what is happening and then say why it happens.	**Explain** why soot forms.	Soot forms during incomplete combustion when not enough oxygen is present.
Evaluate	Use the information supplied and your own knowledge to consider the evidence for and against a point. You may also be required to include a *justified conclusion*.	A company stated: 'A Life Cycle Assessment shows that using plastic bags has less environmental impact than using paper bags'. **Evaluate** this statement.	Paper bags are made from a renewable resource whereas plastic bags are made from finite resources. However paper bags are bad because they produce much more solid waste and more CO_2 is released when they are produced therefore the negative impacts of paper bags outweigh the problem of plastic coming from a finite resource.
Compare	Describe the similarities and/or differences between things. Avoid writing about just one.	**Compare** the differences between cracking and distillation.	Cracking involves a catalyst *whereas* distillation does not.
Sketch	Draw approximately.	**Sketch** a current–potential difference graph for a filament lamp.	

Forces Keywords

Add all the important keywords for this big idea in the grid below as you come across them in the study pack.

Word	Definition

Forces

Book Ref.	Spec. Ref.	Scalar/Vector and Contact/Non Contact forces
	CS 6.5.1.1 6.5.1.2 Triple 4.5.1.1 4.5.1.2	

1. State the difference between a scalar and vector quantity.

Give examples of scalars and vectors.

Scalars	Vectors

2. A vector quantity may be presented by an arrow. Explain what the features of the arrows represent.

3. The forces between two objects can be categorised as a contact or non-contact force. Explain the difference.

4. Give 3 examples of contact and non-contact forces.

Contact force	Non-contact force

Prove It!

Complete the table to show which quantities are scalars and which quantities are vectors.
Put **one** tick (✓) in each row. The first row has been completed for you.

Quantity	**Scalar**	**Vector**
Momentum		✓
Acceleration		
Distance		
Force		
Time		

(3)

Forces		
Book Ref.	**Spec. Ref.**	**Gravity**
	CS 6.5.1.3 Triple 4.5.1.3 MS3a,3c	1. State the equation which links the weight of an object to its mass and the gravitational field strength. Give the units. 2. The gravitational field strength near the Earth's surface is 9.81 N/kg. Calculate the weight of a 5kg object. Give the units. 3. An object on Earth is hung from a calibrated spring-balance (a newton meter). The meter shows a reading of 120N. Calculate the mass of the object. 4. This equation can be interpreted as "The weight of an object is **directly proportional** to the mass of object". Explain with a numerical example how changing the mass will affect weight. What is the symbol used to represent direct proportionality? 5. Describe how the gravitational field strength at a point depends on the distance from the object. 6. Define the term *centre of mass*.

Prove It!

Every object has a *centre of mass*. What is meant by the *centre of mass*?

.....

..... **(1)**

The child has a weight of 343 N. Gravitational field strength = 9.8 N / kg

Write down the equation which links gravitational field strength, mass and weight.

..... **(1)**

Calculate the mass of the child.

.....

.....

.....

Mass = ... kg **(3)**

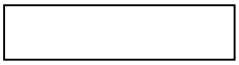
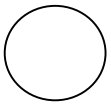
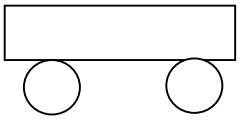
Forces

Book Ref.	Spec. Ref.	Resultant force
	CS 6.5.1.4 Triple 4.5.1.4	

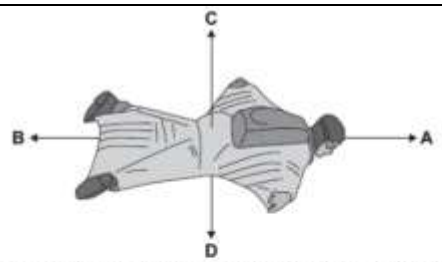
1. For both situations shown below give the magnitude and direction of the resultant force.

2. Describe the purpose of resultant force.

3. In each case draw and label the forces acting on the object.

A stationary book on a table	A ball falling down. It's accelerating downwards.
	
A shark swimming to the left at constant speed.	A car moving to the right but decelerating because the breaks are applied.
	

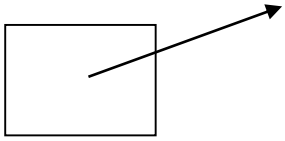
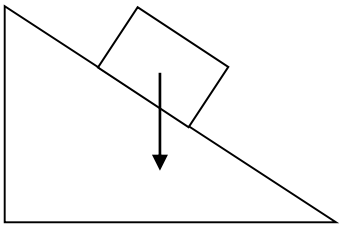
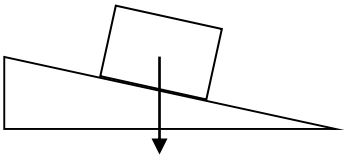
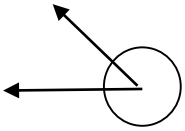
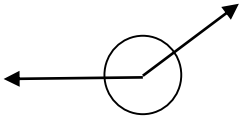
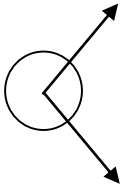
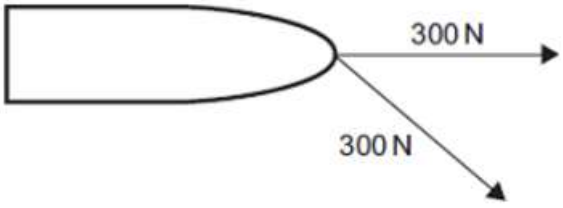
Prove It!

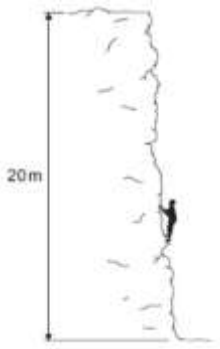


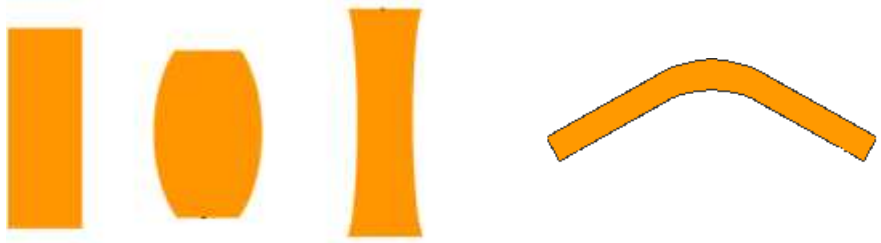
Draw a ring around the correct answer in the box to complete each sentence.

The BASE jumper accelerates forwards when force **A** is [smaller than / equal to / bigger than] force **B**.

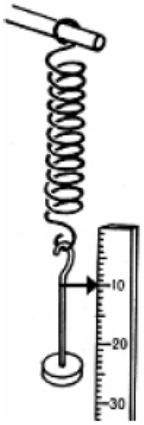
The BASE jumper falls with a constant speed when force **C** is [smaller than / equal to / bigger than] force **D**. **(2)**

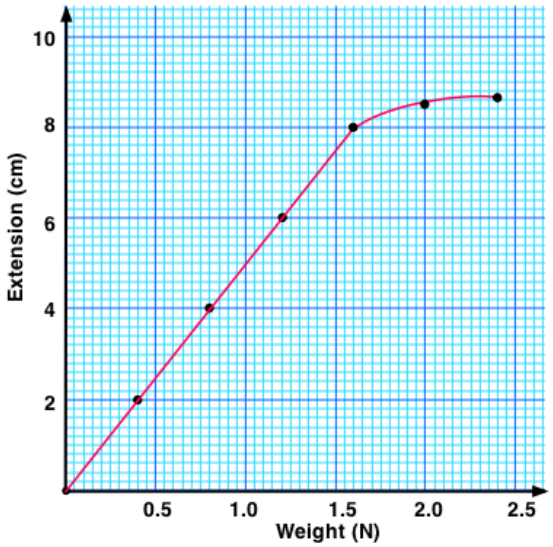
Forces		
Book Ref.	**Spec. Ref.**	**Resolving forces**
	CS 6.5.1.4 Triple 4.5.1.4 (HT only) MS5b	1. In the diagram below, add two arrows in order to resolve the force into two components, horizontal and vertical.  2. The diagrams below show weight acting on the same object on two different slopes. Add two arrows to each diagram to resolve the force into two components. One parallel to the slope and other perpendicular.   3. Which object will accelerate down the slope quickest? Use your answer to question 2 to explain your answer. 4. In each case below draw add the forces using a parallelogram. Label the resultant force with its length. The diagrams are drawn to scale.    **Prove It!** Add to **Diagram 2** to show the single force that has the same effect as the two 300 N forces. Determine the value of this resultant force. **Diagram 2** is drawn to scale. **Diagram 2**  Resultant force = ... N **(4)**

Forces		
Book Ref.	**Spec. Ref.**	**Work Done and Energy Transferred**
	CS 6.5.2 Triple 4.5.2 WS4.5	1. Define the term 'work done'. 2. State the equation that links work done, force and distance. State the units for each. 3. What is 1 Joule equal to in newton-metres? 4. If 2000J of work is done, how much energy is transferred? 5. What will happen to the temperature of an object when work is done against frictional forces?
	MS3b,3c	**Maths Skills** 1. A child drags a tyre 5m over the ground. He pulls with the resultant force of 340N in the direction of motion. Calculate the work done. 2. A brick is pushed 1.4m along rough ground with a total force of 45N. Find the total energy transferred?
		Prove It  The climber weighs 660 N. (i) Calculate the work the climber must do against gravity, to climb to the top of the cliff. .... Work done = ... J **(2)** (ii) It takes the climber 800 seconds to climb to the top of the cliff. During this time the energy transferred to the climber equals the work done by the climber. Calculate the power of the climber during the climb. .... Power = ... W **(2)**

Forces		
Book Ref.	**Spec. Ref.**	**Forces and Elasticity**
	CS 6.5.3 Triple 4.5.3 MS3 MS3c	1. Add arrows to show the force acting on the objects as they are compressed, stretched and bent  compressed stretched bent 2. Explain why more than one force is required to change the shape of an object. 3. State Hooke's law. 4. What is meant by the term limit of proportionality? 5. State Hooke's law as an equation, explain what each variable represents and give the units. 6. A spring with an elastic constant of 4N/m is compressed by 0.3m. Calculate the force required to this. 7. A rubber strip which has an original length of 10cm is stretched to 15cm when 12N of weight is hanged from it. Calculate the spring constant in N/m. 8. Use the diagram below to explain the difference between elastic and inelastic deformation.

Forces		
Book Ref.	**Spec. Ref.**	**CS: RPA19** **Triple: RPA6**
	CS 6.5.3 Triple 4.5.3 MS4a WS2.4 WS3.7	**Required Practical:** Investigate the relationship between force and extension for a spring.





1. The graph shows the results of an investigation carried out with the setup shown. Mark the limit of proportionality on the graph with an **X.**
2. Determine the spring constant using the graph the linear section of the graph. Show your working and give its units.

3. What is meant by the term accuracy?

4. Identify the hazard, risks and how to reduce the risks for this experiment.

Prove It!

Before taking any measurements, the student adjusted the ruler to make it vertical. Explain why adjusting the ruler was important.

.....

.....

..... **(2)**

Describe **one** technique that you could have used to improve the accuracy of the measurements taken by the student.

.....

.....

..... **(2)**

Forces

Book Ref.	Spec. Ref.	Distance, displacement, speed and velocity

CS
6.5.6.1.1
6.5.6.1.2
6.5.6.1.3

Triple
4.5.6.1.1
4.5.6.1.2
4.5.6.1.3

1. Define displacement.

2. State the equation, with units, that links speed, distance and time.

3. Match the columns

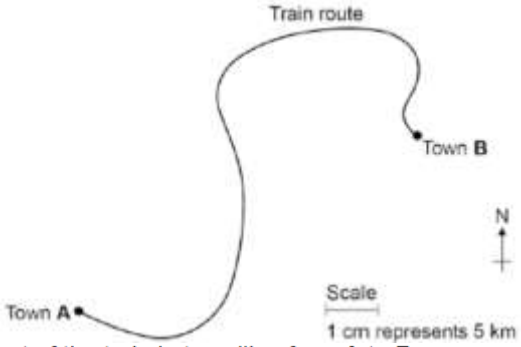
Distance		100km/h		Scalar
Displacement		30m at 53° from north		Scalar
Speed		20m/s to the right		Vector
Velocity		5m		Vector

4. Estimate the typical speeds for the following in m/s.

Walking: _____ Running: _____ Cycling:_____

Speed of sound:_____

Prove It!



determine the displacement of the train in travelling from **A** to **B**.
Show how you obtain your answer.

.....

.....

Displacement = ... km

Direction = ... **(2)**

MS2f,3b, 3c

Maths Skills

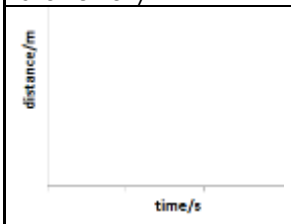
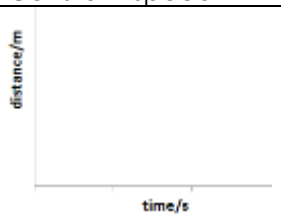
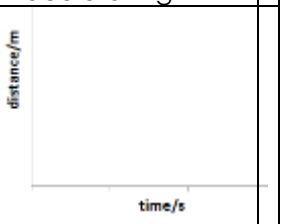
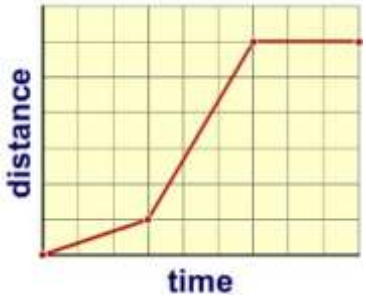
1. A car travels 250m in 14 seconds. Calculate the speed of car with units.

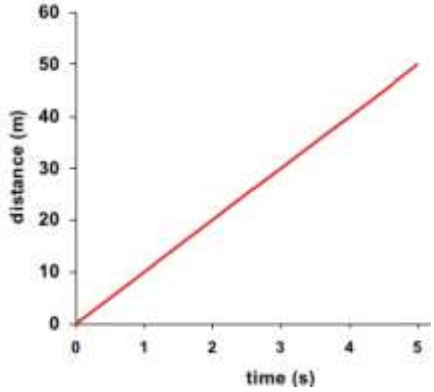
2. A train moves at a constant speed of 27m/s. Calculate the distance it travels in 120 seconds.

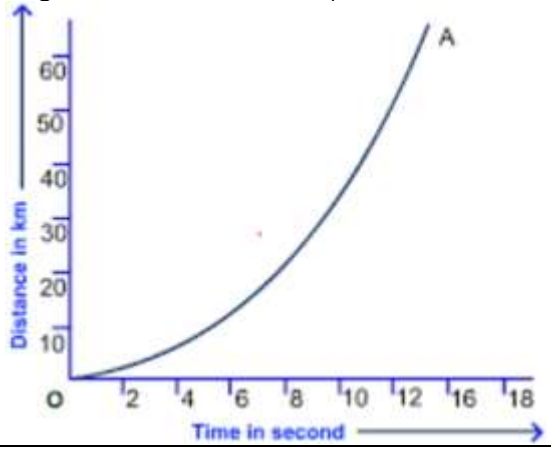
3. A car moves at 30m/s for an hour. Calculate the distance it travels.

4. A person initially runs along a track at 1.0 m/s for 20m and then speed up to 3.0 m/s for the remaining 30m. Calculate the average speed.

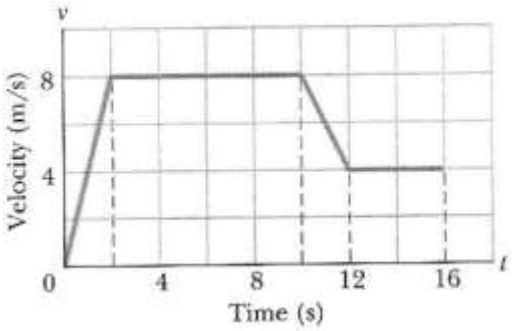
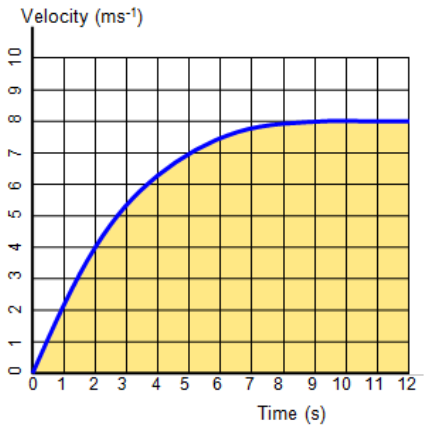
<table>
<tr><th colspan="3">Forces</th></tr>
<tr><th>Book Ref.</th><th>Spec. Ref.</th><th>Distance-time relationship</th></tr>
<tr><td></td><td>CS
6.5.6.1.4

Triple
4.5.6.1.4</td><td>
1. Sketch the graph to show the motion of the following objects
<table>
<tr><th>Stationary</th><th>Constant speed</th><th>Accelerating</th><th>Decelerating</th></tr>
<tr><td> 
</td><td> 
</td><td>
</td><td> 
</td></tr>
</table>
2. Describe the motion of the object shown in the diagram below.


</td></tr>
<tr><td></td><td>MS
4a,4d,4e</td><td>
Maths Skills
1. Use the graph below to calculate the velocity of the object


2. HT only Use a tangent to calculate the speed 10 seconds into the journey.


</td></tr>
</table>

Forces		
Book Ref.	**Spec. Ref.**	**Acceleration**
	CS 6.5.6.1.5 Triple 4.5.6.1.5 MS3b MS3c MS3d MS4f	1. State the equation, with units, that links acceleration, change in velocity and time. 2. Define acceleration. 3. **Higher only** Explain why an object going in circles at constant speed is still considered to be accelerating.  4. Use the graph above to calculate the acceleration of the object between 0 and 2 seconds. 5. Describe the motion of the object between 2 and 10 seconds. 6. **Higher only** Calculate the distance travelled in the first 10 seconds of the journey.  7. **Higher only** Using the graph above estimate the total distance travelled by the object over the 12 seconds. 8. An object accelerates from 10m/s to 30m/s over a distance of 100m. Use the equation $v^2 - u^2 = 2as$ to calculate the acceleration of the object. 9. State the acceleration of an object falling freely under gravity near Earth's surface. Provide units.

10. Explain why objects falling through a fluid accelerate and then reach a terminal velocity.

Prove It!

There are places on the journey where the train accelerates without changing speed. Explain how this can happen.

.....

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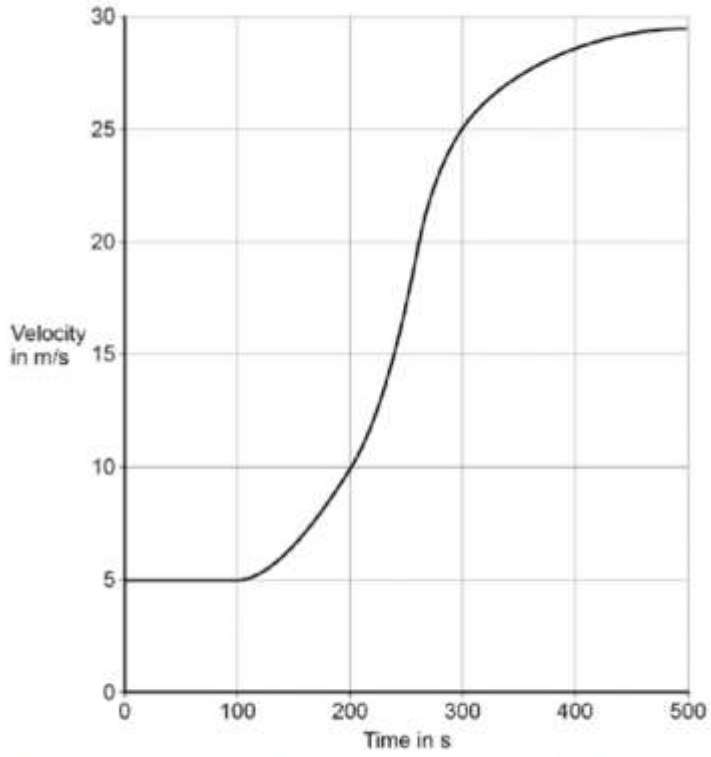
.....

..... **(2)**

Figure 2 shows how the velocity of the train changes with time as the train travels along a straight section of the journey.

Figure 2



Estimate the distance travelled by the train along the section of the journey shown in **Figure 2**. To gain full marks you must show how you worked out your answer.

.....

.....

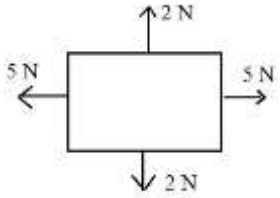
.....

Distance = ... m **(3)**

WS4.4
WS3.3
MS2h

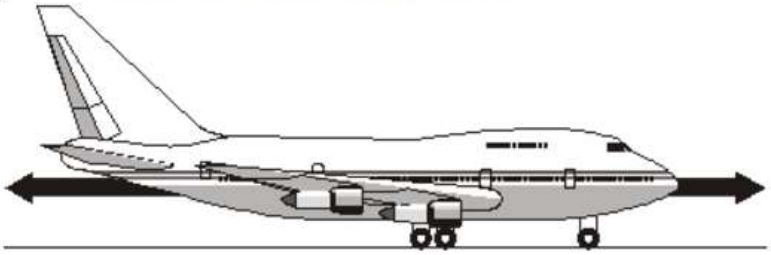
Maths Skills

1. How many orders of magnitude is giga compared to mega?
2. How many orders of magnitude is centi compared to mega?
3. How many orders of magnitude is giga compared to milli?
4. How many orders of magnitude is tera compared to kilo?
5. How many orders of magnitude is mico compared to mega?
6. How many orders of magnitude is nano compared to mega?

Forces		
Book Ref.	**Spec. Ref.**	**Newton's First Law**
	CS 6.5.6.2.1 Triple 4.5.6.2.1	 1. State the resultant force on the object. 2. The box is initially stationary. Describe what will happen to the object next. 3. Explain why the velocity of the car constant even though there are two force acting on it. 4. **HT only** Define the term Inertia

Prove It!

The diagram shows an aircraft and the horizontal forces acting on it as it moves along a runway. The *resultant force* on the aircraft is zero.



(i) What is meant by the term *resultant force*?

.....

..... **(1)**

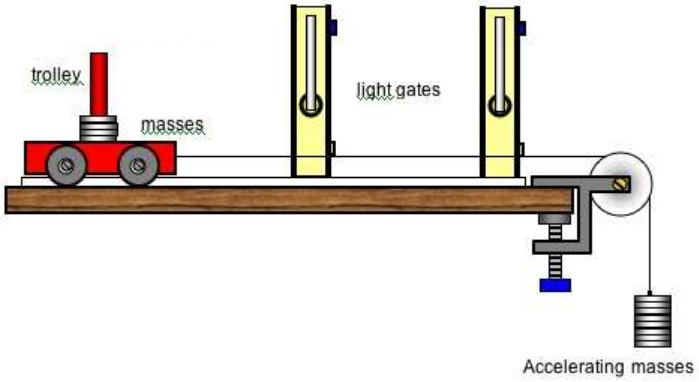
(ii) Describe the movement of the aircraft when the resultant force is zero.

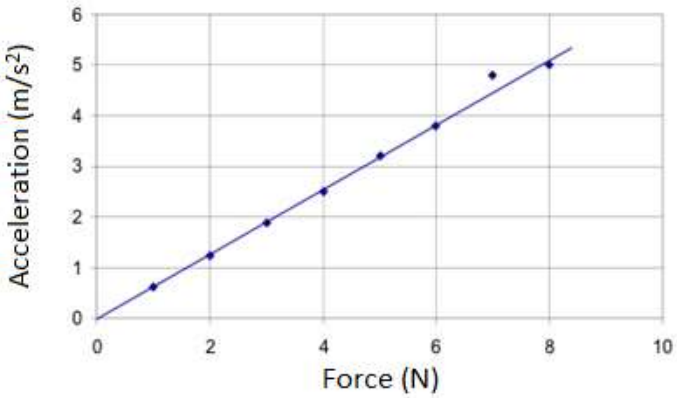
.....

..... **(1)**

Forces		
Book Ref.	**Spec. Ref.**	**Newton's 2nd law**
	CS 6.5.6.2.2 Triple 4.5.6.2.2 MS3a	1. State the equation for Newton's second Law, include units. 2. State Newton's second law in words. 3. The mass of the car above is 1200 kg. Calculate the acceleration of the cart. 4. **HT only** Define inertial mass 5. **HT only** Explain what affect inertial mass has on the ability to change the speed of an object. 6. Acceleration of a sprinter ~ 8m/s^2. State what the symbol ~ means. 7. Large Trucks weigh approximately 38 000kg. Calculate the resultant force required to accelerate at the same rate as the car above. **Maths Skill** Equation 1 : acceleration $\propto$ Force Equation 2 : acceleration $\propto \frac{1}{mass}$ 1. Explain what equation 1 means in words and describe what will happen to the acceleration if the force is doubled. 2. Explain what equation 2 means in words and describe what will happen to acceleration if the mass is doubled. **Prove It!** The aircraft has a take-off mass of 320 000 kg. Each of the 4 engines can produce a maximum force of 240 kN. Calculate the maximum acceleration of the aircraft. Show clearly how you work out your answer and give the unit. .... Acceleration = ... **(3)**

Forces		
Book Ref.	**Spec. Ref.**	**CS: RPA19** **Triple: RPA7**
	CS 6.5.6.2.2 Triple 4.5.6.2.2 WS3.7	**Required Practical** Investigate the effect of varying the force on the acceleration of an object of constant ass, and the effect of varying the mass of an object on the acceleration produced by a constant force.





1. Describe how the set up shown above can be used to produce the graph.

2. Explain how this graph is evidence for Newton's second law.

3. The accuracy of this experiment is reduced by friction between the table and the cart. Is this a random or systematic error, explain your answer.

4. This experiment can be done with a person using a stop watch to time the cart.
   However the results will be less accurate explain why.

   Using the stop watch will also be less precise explain why.

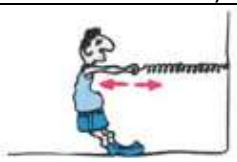
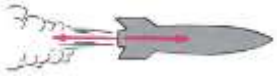
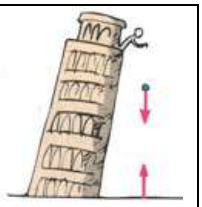
Forces		
Book Ref.	**Spec. Ref.**	**Newton's 3rd law**

CS 6.5.6.2.3

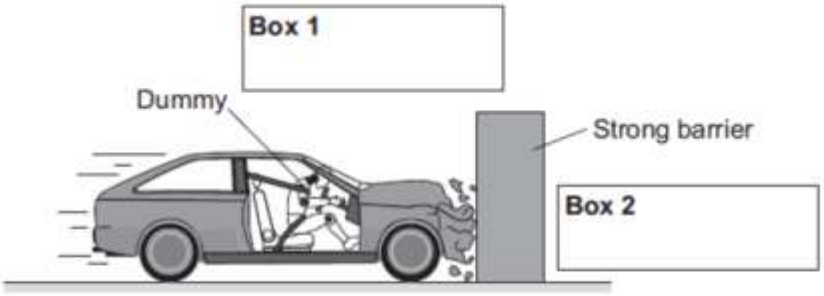
Triple 4.5.6.2.3

1. State Newton's 3rd Law.

2. In each case describe the Newton's 3rd law pair. The first one has been done for you.

			
The man pulls the spring on the spring. The spring pulls on the man with an equal and opposite force.			

Prove It!



(i) Draw an arrow in **Box 1** to show the direction of the force that the car exerts on the barrier.

(1)

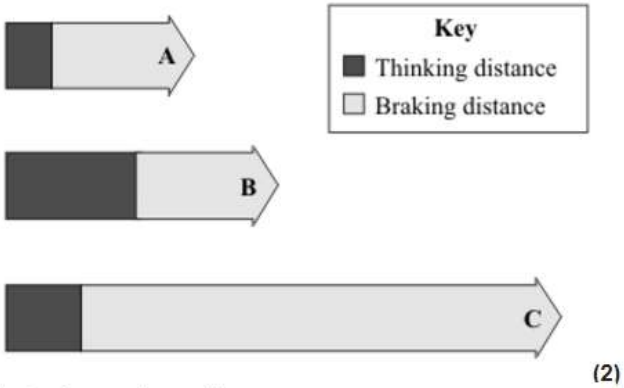
(ii) Draw an arrow in **Box 2** to show the direction of the force that the barrier exerts on the car.

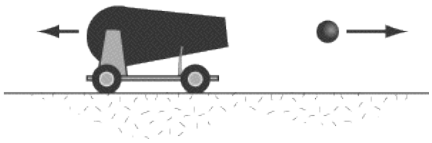
(1)

(iii) Complete the following by drawing a ring around the correct line in the box.

The car exerts a force of 5000 N on the barrier. The barrier does not move. The force exerted by the barrier on the car will be [more than / equal to / less than] 5000 N.

(1)

Forces		
Book Ref.	**Spec. Ref.**	**Stopping distance**
	CS 6.5.6.3.1 6.5.6.3.2 6.5.6.3.3 6.5.6.3.4 Triple 4.5.6.3.1 4.5.6.3.2 4.5.6.3.3 4.5.6.3.4 MS 1d	1. A driver attempts an emergency stop. The distance travelled from spotting the hazard to completely stopping the car can be is called the stopping **distance.** Name and define the two distances which make up stopping **distance.** 2. Write the equation which links thinking distance, speed and reaction time and give units. 3. What is the typical reaction time of a person? Describe and explain 3 factors which can affect this. 4. Describe an experiment which can be used to investigate the reaction time of students. 5. Describe and explain how adverse road conditions and vehicle condition affects braking distance. 6. **Physics only** .The stopping distance of a typical car at 30mph is 23m. Estimate the stopping distance of the same car at 60mph. **Prove It!** Draw straight lines to match each chart to the correct conditions. Draw only **three** lines. **Conditions** **Charts** Speed = 22 m/s driver wide awake Speed = 13 m/s driver wide awake Speed = 13 m/s driver very tired  **(2)** The three charts above all apply to dry road conditions. How would the braking distances be different if the road were wet? .... **(1)**

Forces		
Book Ref.	**Spec. Ref.**	**Momentum**
	HT only CS 6.5.7.1 6.5.7.2	1. State the equation which links momentum, mass and velocity 2. State the law of conservation of momentum.
	Triple 4.5.7.1 4.5.7.2	3. The total momentum before the explosion is zero. With reference to the velocity of the canon gun and ball, explain why how momentum the diagram shows that momentum after is also zero. before after 

Prove It!

The figure below shows a skateboarder jumping forwards off his skateboard.
The skateboard is stationary at the moment the skateboarder jumps.

The skateboard moves backwards as the skateboarder jumps forwards.
Explain, using the idea of momentum, why the skateboard moves backwards.

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.....

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.....

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.....

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..... **(3)**

Electricity and Magnetism

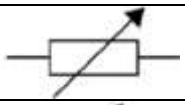
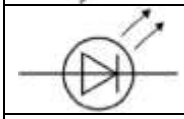
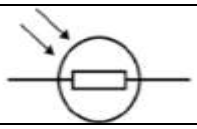
Add all the important keywords for this big idea in the grid below as you come across them in the study pack.

Word	Definition

Electricity

Book Ref.	Spec. Ref.	Circuit symbols and current
	CS 6.2.1.1 6.2.1.2 Triple 4.2.1.1 4.2.1.2 MS3b MS3c	

1. Complete the table

Symbol	Name	Function/Description
	Open switch	
	Battery	
		Only lets current flow in one direction.
	Resistor	
		
		
		Turns electrical energy into light.
	Fuse	
		Measure the current though components which are in series with it.
	Thermistor	
		

2. State the equation which links current, charge and time. Give the units.

3. In words, what does the term *electrical current* mean?

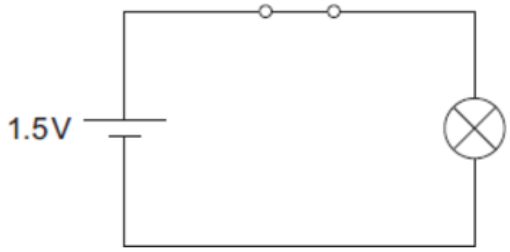
4. Calculate the current when 12.0 C of charge flows past a point in 20 seconds.

5. Calculate how much charge will flow if a 20 mA current flows for 5 minutes.

Electricity		
Book Ref.	**Spec. Ref.**	**Current, resistance and potential difference**
	CS 6.2.1.3 Triple 4.2.1.3 MS2a MS3b MS3c WS3.3	1. Describe the effect increasing the resistance in circuit has on the current through it. 2. The potential difference across a circuit component can be increased by adding more cells. What effect will this have on the current through the component? 3. State the equation which link potential difference, charge and work done (energy transferred). Give the units 4. A 25V power supply is connected to a bulb. In the time it was on, 25C of charge flowed through the bulb. Calculate the energy transferred. 5. State the equation which links current, potential difference and resistance. Give the units. 6. Calculate the resistance of a bulb with 0.6A flowing through it and a potential difference of 25V across it. Give your answer to 2sf with units.

Prove It!

The lamp is now included in a circuit. The circuit is switched on for 2 minutes. During this time, 72 coulombs of charge pass through the lamp.



calculate the energy transformed by the lamp while the circuit is switched on.

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.....

Energy transformed = ... J **(2)**

Calculate the resistance of the lamp.

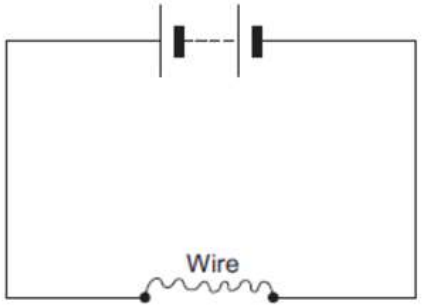
.....

.....

Resistance = ... Ω **(2)**

Electricity		
Book Ref.	**Spec. Ref.**	**CS: RPA15** **Triple: RPA3**
	CS 6.2.1.3 Triple 4.2.1.3 WS2.2 WS3.7	**Required Practical:** Use circuit diagrams to set up and check appropriate circuits to investigate the factors affecting the resistance of electrical circuits.

1. Add two components to the circuit diagram below which will allow the resistance of the wire to be determined.



2. To investigate what affect the length of the wire has on its resistance describe the graph you will need to plot. Explain what goes on each axis and how these numbers are obtained.

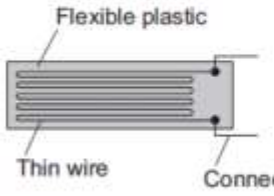
   x-axis :
   y-axis :

3. Name three other variables which need to be controlled.

4. A student said they got an anomaly, what did they mean?

Prove It!

The diagram shows a strain gauge, which is an electrical device used to monitor a changing force. Applying a force to the gauge causes it to stretch.
This makes the electrical resistance of the wire change.



Using the correct symbols, **add** to the diagram to show how a battery, an ammeter and a voltmeter can be used to find the resistance of the strain gauge drawn above. **(2)**

Before any force is applied, the unstretched gauge, correctly connected to a 3.0 V battery, has a current of 0.040 A flowing through it. Calculate the resistance of the unstretched gauge.

.....

.....

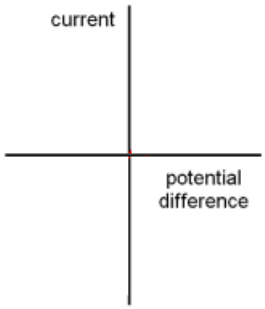
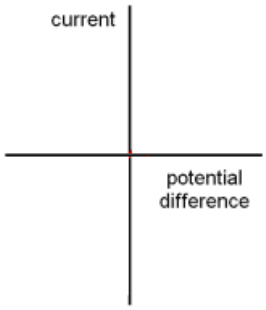
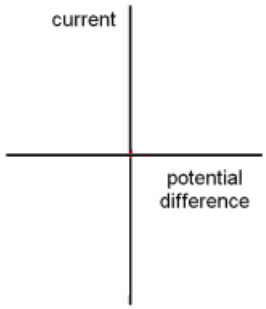
Resistance = ... Ω **(2)**

Stretching the gauge causes the current flowing through the gauge to decrease.
What happens to the resistance of the gauge when it is stretched?

..... **(1)**

Electricity

Book Ref.	Spec. Ref.	Resistors
	CS 6.2.1.4	1. State Ohm's Law
	Triple 4.2.1.4	2. Sketch the IV graphs for the following components and explanation of the shape.

Component	Ohmic conductor	Filament lamp	diode
I-V Graph			
Explanation of graph			

3. Describe the properties and applications of thermistors.

4. Describe the properties and applications of LDRs.

Prove It!

Temporary traffic signs uses many small lights all powered by a rechargeable battery. These lights need to be very bright during the day so that they can be seen clearly. They do not need to be as bright at night.

Explain how using a light-dependent resistor can make the energy stored in the battery last longer. **(6)**

Electricity		
Book Ref.	**Spec. Ref.**	**CS: RPA16** **Triple: RPA4**
	CS 6.2.1.4 Triple 4.2.1.4	**Required Practical:** Use circuit diagrams to construct appropriate circuits to investigate the I-V characteristics of different circuit components.

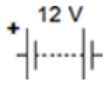
1. Name the two measurements that need to be taken to determine the resistance of an unknown component and identify the equipment needed.

2. Describe how the devices must be connected to the unknown component.

3. Which addition component is required in order to change the current in the circuit?

Prove It!

A student wants to investigate how the current through a filament lamp affects its resistance.
Use the circuit symbols in the boxes to draw a circuit diagram that she could use.

12 V battery	variable resistor	filament lamp	voltmeter	ammeter
				

(2)

Describe how the student could use her circuit to investigate how the current through a filament lamp affects its resistance.

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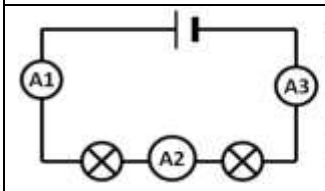
(4)

Electricity

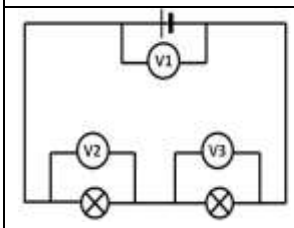
Book Ref.	Spec. Ref.	Series and parallel
	CS 6.2.2 Triple 4.2.2 MS3c MS3d	

1. Complete the tables, assume all the filament bulbs have the same resistance.

Series

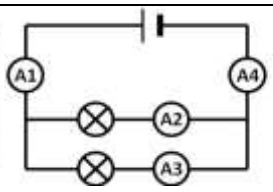


Position	Current (A)
A1	1.5
A2	
A3	

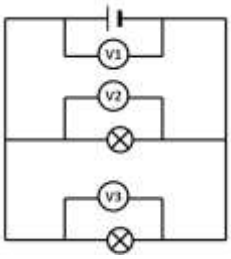


Position	Voltage (V)
V1	12
V2	
V3	

Parallel

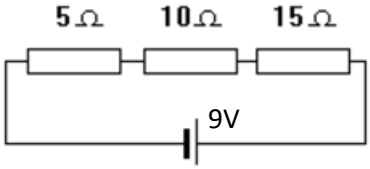


Position	Current (A)
A1	6.0
A2	
A3	
A4	



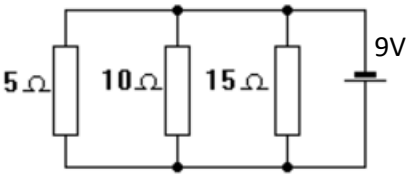
Position	Voltage (V)
V1	12
V2	
V3	

2. What effect does adding resistors in series have on the total resistance? Calculate the total resistance in the circuit below.



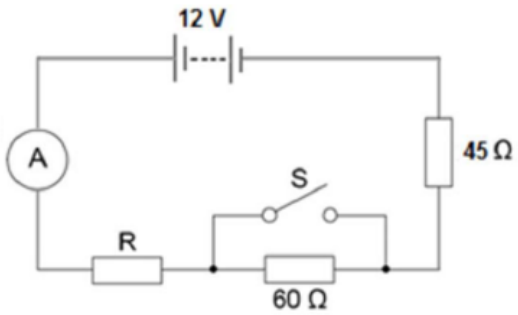
3. Use Ohm's Law to calculate the current in the series circuit. Use your answer to calculate the potential difference across the 10Ω resistor.

4. What effect does adding resistor in series have on the total resistance?



5. Apply Ohm's law to find the current through each resistor. Use your answer to calculate the current through the battery.

Prove It!



(a) The ammeter displays a reading of 0.10 A.
Calculate the potential difference across the 45 Ω resistor.

.....

.....

Potential difference = ... V **(2)**

(b) Calculate the resistance of the resistor labelled **R**.

.....

.....

.....

Resistance = ... Ω **(3)**

(c) State what happens to the total resistance of the circuit and the current through the circuit when switch **S** is closed.

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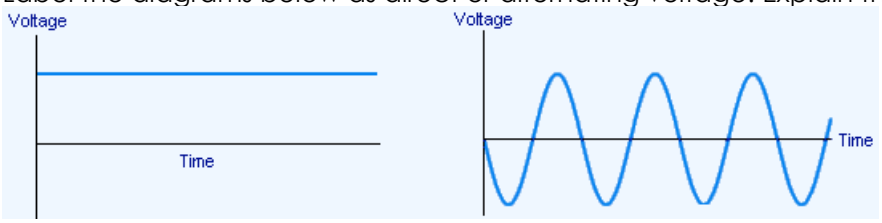
..... **(2)**

Electricity

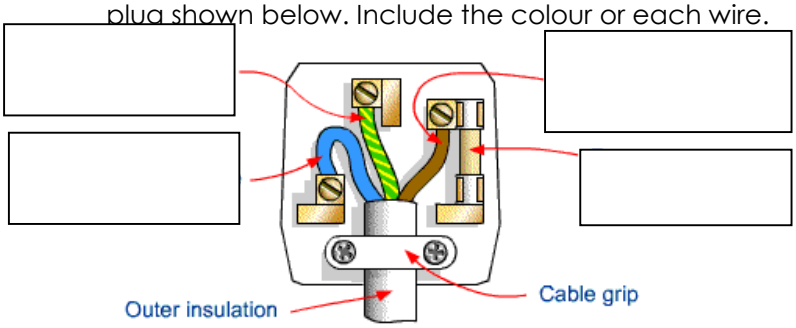
Book Ref.	Spec. Ref.	Domestic uses and safety
	CS 6.2.3 Triple 4.2.3	

1. Label the diagrams below as direct or alternating voltage. Explain the difference.



2. The UK's domestic electricity supply is an AC supply. What is the frequency and average voltage of this supply?

3. Three-core cables connect the mains to electrical appliances. Label the three-pin plug shown below. Include the colour or each wire.



4. Complete the table below.

Wire	Function	Voltage (V)
Live		
Neutral		
Earth		

Prove It!

An electrician is replacing an old electric shower with a new one.
If the electrician touches the live wire he will receive an electric shock.
Explain why.

.....

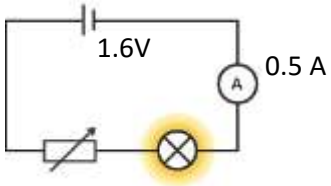
.....

.....

.....

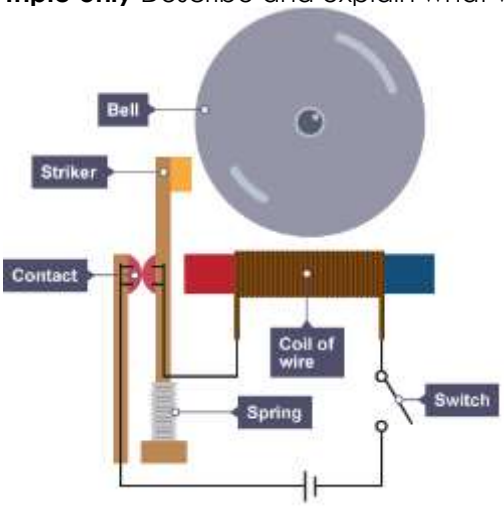
.....

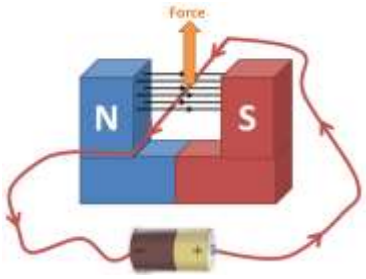
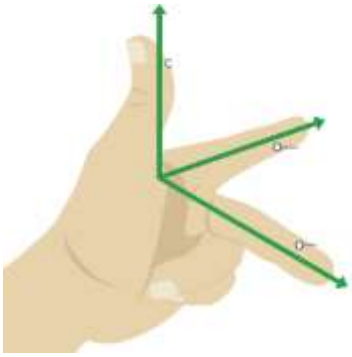
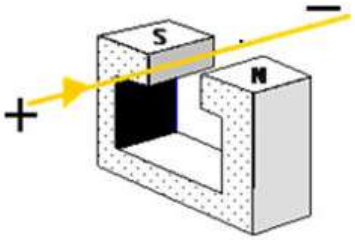
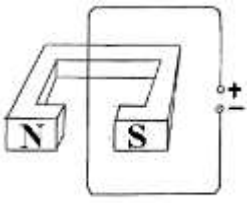
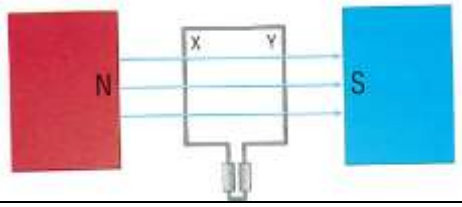
..... **(4)**

Electricity		
Book Ref.	**Spec. Ref.**	**Power and Energy Transfers**
	CS 6.2.4.1 6.2.4.2 Triple 4.2.4.1 4.2.4.2 MS2a MS3b MS3c	1. State the equation which links Power to energy and time. Give the units. 2. State the equation which links Power to current and voltage. Give the units. 3. State the equation which links power to current and resistance. Give the units. 4. A bulb transfers 70,000J of energy in 1hour. Calculate the power of the bulb with units. 5. A heater with a power rating of 1000W is connected to the UK mains supply. Calculated the current through the heater to 3sf. Give the units. 6. Calculate the power of a fan with current of 1.2A flowing through it and 500Ω resistance. 7. Describe 3 ways in which the total energy transferred by the bulb shown can be increased.  8. Describe the energy transfer in a heater connected to the mains supply. 9. Describe the energy transfer in an electric motor which is powered by a battery. **Prove It!** The charge that flows through the new shower in 300 seconds is 18 000 C. The new electric shower has a power of 13.8 kW. Calculate the resistance of the heating element in the new shower. Write down any equations you use. .... (5) Resistance = ... Ω

Electricity		
Book Ref.	**Spec. Ref.**	**National grid**
	CS 6.2.4.3 Triple 4.2.4.3	1. Label the parts of the national grid. 2. The voltage produced at the power station is approximately 25,000V. Explain why a step up transformer is used to increase the voltage. 3. Explain why it is necessary to decrease the voltage before it goes to people's houses. **Prove It!** Electricity is distributed from power stations to consumers along the National Grid. The voltage across the overhead cables of the National Grid needs to be much higher than the output voltage from the power station generators. Explain why. .... **(3)**

Electricity		
Book Ref.	**Spec. Ref.**	**Magnetic fields**
	CS 6.7.1.1 6.7.1.2 Triple 4.7.1.1 4.7.1.2	1. Draw the magnetic fields around this magnet. 2. Where in your diagram is the magnetic field the strongest? What happens to the strength of the field you increase the distance from the magnet? 3. Describe what would happen if a second north pole was placed near the north pole above. 4. Describe what would happen if the north pole was placed near the south pole? Explain the direction of the arrows on your magnetic field. 5. Describe the difference between a permanent magnet and an induced magnet. 6. List 4 different magnetic materials. 7. The north pole of a bar magnet is pointed at a block of magnetic material. The bar magnet is rotated so the south pole faces the block of magnetic material. Describe what happens in each case. 8. What creates the magnetic field around the earth? Describe and explain the behaviour of a magnetic compass as it moves around the earth.

Electricity		
Book Ref.	**Spec. Ref.**	**Electromagnetism**
	CS 6.7.2.1 Triple 4.7.2.1	1. Current flowing through a wire produces a magnetic field around itself. Draw the magnetic field on the diagram below. Explain how the strength of the magnetic field depends on distance. 2. The diagram below shows a solenoid. Draw the magnetic field around it and describe 3 ways to increase the strength of the magnetic field. 3. In the diagram above where is the strength of the magnetic field greatest? 4. **Triple only** Describe and explain what will happen when the switch is closed. 

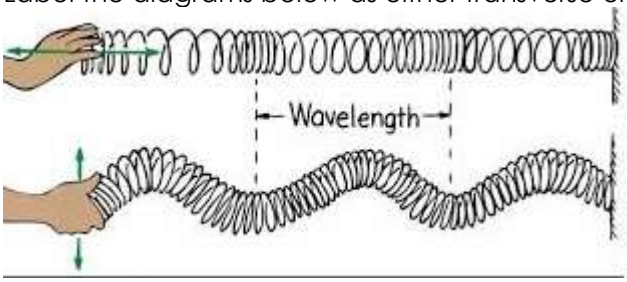
Electricity		
Book Ref.	**Spec. Ref.**	**Fleming's left-hand rule**
	CS 6.7.2.2 (HT only) Triple 4.7.2.2 (HT only)	1. When a _____ carrying conductor is placed in a _____ _____ the magnet and the conductor exert a _____ on each other. This is known as the _____ effect. 2. Describe 3 ways in which the force on the wire can be increased.  3. A current carrying wire of length 0.03m is placed at right angles to the field from a magnet. The magnetic flux density, B produced by the magnet is 0.05T. A current of 3.0A flows through the wire. Use the equation $F = BIl$ to calculate the force on the wire. 4. Fleming's left hand rule can be used to determine the direction of the force on the wire.  5. Add arrows to the diagrams below to show the direction of the force on the wires.   6. In the diagram below what is the force on the section between X and Y? Explain your answer. 

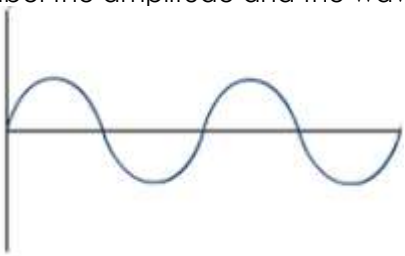
	What does it represent?	Rule for finding direction?
First finger		
Se**c**ond finger		
Thu**m**b		

Waves Keywords

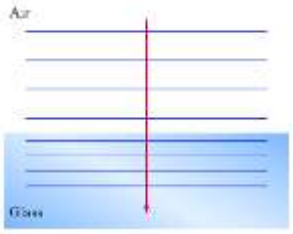
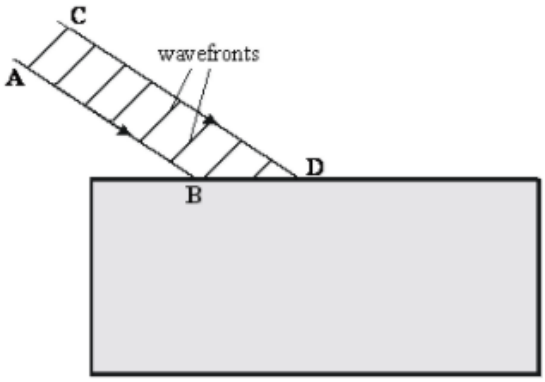
Add all the important keywords for this big idea in the grid below as you come across them in the study pack.

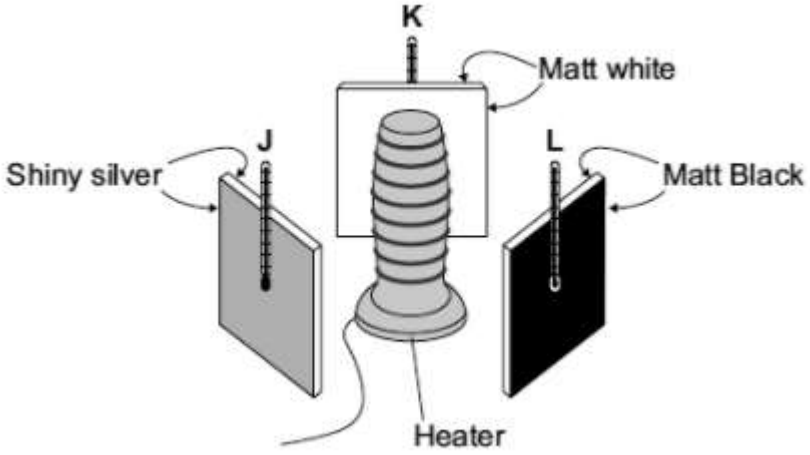
Word	Definition

Waves		
Book Ref.	**Spec. Ref.**	**Transverse and Longitudinal Waves**
	CS 6.6.1.1 Triple 4.6.1.1	1. Label the diagrams below as either transverse or longitudinal.  2. On the diagram above label a compression and a rarefaction on the longitudinal wave. 3. Explain the difference between longitudinal and transverse waves. Give an example of each in your explanation. 4. Describe the evidence that during a sound or water wave, particles (air or water) do not travel.
		Prove It! Waves may be either longitudinal or transverse. (a) Describe the difference between a longitudinal and a transverse wave. .... **(2)** (b) Describe **one** piece of evidence that shows when a sound wave travels through the air it is the wave and not the air itself that travels. .... **(1)**

Waves		
Book Ref.	**Spec. Ref.**	**Properties of Waves**
	CS 6.6.1.2 Triple 4.6.1.2	1. Label the amplitude and the wavelength on the wave below:  2. Define the term 'frequency'. 3. What is the equation to calculate a period? Give the units of each component. 4. What is the equation that links frequency, wavelength and wave speed? Give the units for each component. 5. Outline a method to measure the speed of sound in air.
	MS1a MS1b MS3b MS3c	Maths Skills 1. The frequency of an ocean wave is measured as 0.2Hz. Calculate the period of this wave. Include units with your answer and give it to an appropriate number of significant figures. 2. A wave has a frequency of 4.0 x 107 Hz and a speed of 3.0 x 108 m/s. Find its wavelength. Give your answer in decimal form. 3. The wavelength of a wave is 1.2m and exactly 2 complete waves are produced per second. Calculate the speed of the wave. Give your answer to an appropriate number of significant figures.

Waves		
Book Ref.	**Spec. Ref.**	**RPA8 (triple), RPA 20 (CS)** **Make observations to identify the suitability of apparatus to measure the frequency, wavelength and speed of waves in a ripple tank and waves in a solid and take appropriate measurements.**
	CS 6.6.1.2 Triple 4.6.1.2 AT4 WS2.2 WS2.3 WS2.6 WS3.4 WS3.8	1. Describe how a ripple tank can be set up to measure the speed of a wave. Include any measurements you will need to take and any calculations you will need to do. 2. Explain why the waves appear not to move when you reach a certain frequency. 3. A student conducted an experiment and she noticed the shadow lines were very close together which was making it very hard to measure the wavelength. How could she improve her results? Why would they be better? 4. A different student wanted to measure the speed of waves through a solid. Outline an experiment they could do to obtain these results. 5. All results contain uncertainty. What does this mean?

Waves		
Book Ref.	**Spec. Ref.**	**Properties of Electromagnetic Waves**
	CS 6.6.2.2 (HT only) Triple 4.6.2.2 (HT only)	1. Draw a ray diagram to show the refraction of a wave at the boundary between two different media – air and a glass block. 2. **HT only** - A wave is travelling between substance A and substance B. The wave travels at the same speed in both substances. Would refraction occur? Explain your answer. 3. **HT only** - This is a wave front diagram. Use this diagram to explain what is happening to the wavelength as it travels from air to glass. **Note the frequency does not change**.  4. Explain why this diagram **does not** show refraction.
		Prove It! **HT only** - The diagram below shows a beam of light striking a perspex block.  (i) Continue the paths of the rays AB and CD inside the perspex block. (ii) Draw the wavefronts of the beam of light in the perspex. (iii) Explain why the beam behaves in the way you have shown. ....

Waves		
Book Ref.	**Spec. Ref.**	**RPA10 (triple), RPA 21 (CS)** **Investigate how the amount of infrared radiation absorbed or radiated by a surface depends on the nature of that surface.**
	CS 6.6.2.2 Triple 4.6.2.2	1. A student set up the equipment below to find out the amount of infrared radiation absorbed by 3 different surfaces: 
	WS2.1	Suggest a hypothesis for this investigation.
	WS2.2	2. What measurements would the students need to take for this investigation?
		3. Outline the control variables for this experiment and why control variables are necessary.
	WS3.7	4. A second student did this experiment but replaced the thermometer with a temperature sensor connected to a computer. What was the advantage of this?
		5. Although the second student used different equipment they still obtained very similar results to the first student. Would these results be considered repeatable or reproducible? Explain the difference.

Waves		
Book Ref.	**Spec. Ref.**	**Properties of Electromagnetic Waves**
	CS 6.6.2.3 Triple 4.6.2.3 WS1.5	1. **HT only** - How are radio waves produced? 2. **HT only** - Explain how radio waves can induce oscillations in an electrical circuit. 3. Explain how gamma rays originate from the nucleus of an atom. 4. What is radiation dose measured in and state the three most dangerous types of electromagnetic radiation. What are the risks of using electromagnetic radiation? 5. Explain the term ionising with respect to gamma and X-rays.
		Prove It! Some types of food are treated with *gamma* radiation. Low doses of radiation slow down the ripening of fresh fruit and vegetables while higher doses of radiation kill the bacteria that make the food go off. (a) (i) What is *gamma* radiation? ..... **(1)** (ii) Food packed in crates or boxes can be treated using this method. Why must a source that emits *gamma* radiation be used? .... **(1)** (iii) A suitable source of gamma radiation is the isotope caesium 137. Complete the following sentence by choosing the correct word from the box. **electrons** **neutrons** **protons** An atom of caesium 137 has two more ..... than an atom of caesium 135. **(1)**

Waves

Book Ref.	Spec. Ref.	Uses and Applications of Electromagnetic Waves

CS 6.6.2.4

Triple 4.6.2.4

WS1.4

1. Complete the table to summarise the practical applications of the electromagnetic waves:

EM Wave	Use	(HT) Why is this wave suited to this use?
Radio waves		
Microwaves		
Infrared		
Visible light		
Ultra-violet		
X-ray		
Gamma ray		

Energy Keywords

Add all the important keywords for this big idea in the grid below as you come across them in the study pack.

Word	Definition

Energy

Book Ref.	Spec. Ref.	Energy Stores and Systems
	CS 6.1.1.1 Triple 4.1.1.1	1. Complete the table to summarise the types of energy stores and an explanation:

Energy Store	Objects with energy in this store
Kinetic	Anything moving has energy in its kinetic energy store e.g. a car.
Electrostatic	
Nuclear	
Thermal	

2. A system is an object or group of objects. What is a closed system?

3. Describe the changes in stored energy that occur in…

a) An electric kettle boiling water.

b) A car braking and coming to a stop.

c) A tennis ball hitting a racket.

Prove It!

The student jumps off the bridge.

Complete the sentences to describe the energy transfers.

Use answers from the box.

elastic potential	gravitational potential	kinetic	sound	thermal

Before the student jumps from the bridge he has a store of

..... energy.

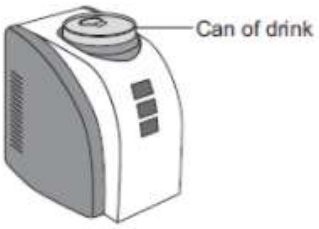
When he is falling, the student's store of ..... energy increases.

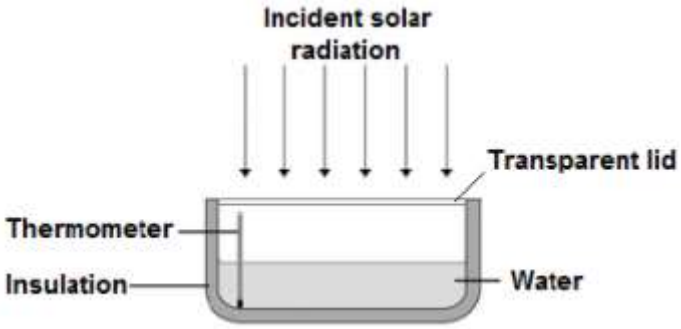
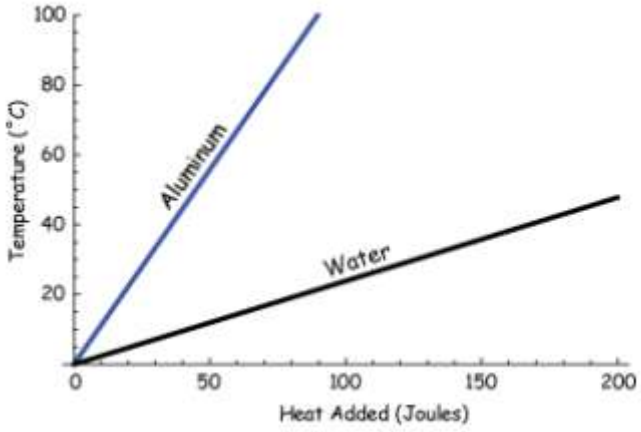
When the bungee cord is stretched, the cord stores energy as

..... energy.

(3)

Energy		
Book Ref.	**Spec. Ref.**	**Changes in Energy**
	CS 6.1.1.2 Triple 4.1.1.2 WS4.3	1. State the equation that links kinetic energy, mass and velocity. Give units for each. 2. The equation to calculate elastic potential energy is: elastic potential energy = 0.5 × spring constant × (extension)^2 $\quad E_e = \frac{1}{2} k e^2$ State the units for each of the variables in the equation. 3. State the equation that links gravitational potential energy, height, gravitational field strength and mass. Give units for each. 4. From the equations above, which would you use to calculate… a) Energy of a moving object? b) Energy of an object raised off the ground? c) Energy stored in a stretched spring? 5. In a closed system, if a raised object had 20,000J of gravitational potential energy stored before it was dropped, how much kinetic energy would it have when it was dropped? What is the law called?
	MS1b MS2a MS3b MS3c	Maths Skills 1. A van of mass 2450kg is travelling at 40.0m/s. Calculate the energy in its kinetic energy store. Give your answer in standard form. 2. A moped with 1.17 x 10^4 J of energy in its kinetic energy store travels at 12.0m/s. What is the mass of the moped? Give your answer to an appropriate number of significant figures. 3. A 50kg mass is raised through a height of 6m. Find the energy transferred to its gravitational potential energy store. The gravitation field strength is 9.8N/kg on Earth. 4. A flea of mass 1.0 x 10^{-3}g jumps vertically from the ground. At the top of the jump the flea has gained 1.96x10^{-6}J of energy in its g.p.e store. How high has the flea jumped? 5. The flea from Q5 falls from the top of the jump. Assuming there is no air resistance, calculate the speed of the flea when it hits the ground. Give your answer to 2 significant figures.

Energy		
Book Ref.	**Spec. Ref.**	**Energy Changes in Systems**
	CS 6.1.1.3 Triple 4.1.1.3	1. What is the equation that links specific heat capacity, mass, change in thermal energy and temperature change? Give units for each. 2. What is the definition of specific heat capacity?
		Prove It! A 'can-chiller' is used to make a can of drink colder. **Figure 1** shows a can-chiller. **Figure 1**  (a) The can-chiller decreases the temperature of the liquid in the can by 15 °C. The mass of liquid is 0.33 kg. The specific heat capacity of the liquid is 4200 J / kg °C. Calculate the energy transferred from the liquid as it cools. .... Energy = ... J **(2)** (b) Complete the following sentence. The specific heat capacity of a substance is the amount of energy required to change the ..... of one kilogram of the substance by one degree Celsius. **(1)**
	MS3b	**Maths Skills** 1. Water has a specific heat capacity of 4200J/kg°C. How much energy is needed to heat 2.00kg of water from 10°C to 100°?

Energy		
Book Ref.	**Spec. Ref.**	**RPA1 (triple) RPA14 (CS)** **Investigation to determine the specific heat capacity of one or more materials. The investigation will involve linking the decrease of one energy store to the increase in temperature and subsequent increase in thermal energy stored.**
	CS 6.1.1.3 Triple 4.1.1.3 AT1,5 WS2.7 MS3a MS4d	1. A student set up the apparatus below:  She wanted to calculate the thermal energy change over an hour. She knew the specific heat capacity of water is 4200J/kg°C. What other measurements would she need to take? 2. Why would this calculation not give her an exact value for the thermal energy from the Sun? How could she improve her experiment? 3. As mass and and specific heat capacity are constants. The results should show that energy transferred is directly proportional to change in temperature. What does that mean? What is the symbol used to show to variables are directly proportional? 4. The graph below shows the energy transferred as 2 materials are heated:  Calculate the gradient of the line for water. What is the intercept?

Energy		
Book Ref.	**Spec. Ref.**	**Power**
	CS 6.1.1.4 Triple 4.1.1.4 MS3b MS3c	1. What is the definition of power? 2. What is the equation that links power, energy transferred and time? Give units. 3. What is the equation that links power, work done and time? Give units. 4. What can you infer from the 2 equations about energy transferred and work done? 5. What is 1 Watt in Joules/second? 6. Two cars are identical in every way except the power of their engines. They completed the same race but the car with the more powerful energy crossed the line first. Explain why in terms of energy transferred. 7. Two electric motors lift 20kg. Motor A does this in 3 seconds and motor B does this in 5 seconds. Which is the more powerful? Why? 8. Two different electric motors lift two different objects. The first motor requires 8000J to lift object A to the top of a building and it takes 40s. The second motor requires 20,000J to life object B to the top of the same building and it takes 20s. Which motor is more powerful? Use calculations in your answer.
		Prove It! A company that makes light bulbs provides information about some of their products. The table shows some of this information. **Power in watts** / **Lifetime in hours** / **Cost of bulb in £** **Filament bulb**: 60 / 1250 / 2.00 **LED bulb**: 12 / 50 000 / 16.00 (i) Suggest why it is important to confirm this information independently. ..... **(1)** (ii) A homeowner is thinking about replacing his filament bulbs with LED bulbs. A 12 W LED bulb gives the same light output as a 60 W filament bulb. Suggest reasons why the homeowner is likely to choose LED bulbs. Use the information given in the table. (2)

Energy		
Book Ref.	**Spec. Ref.**	**Energy Transfers in a System**
	CS 6.1.2.1 Triple 4.1.2.1	1. Complete the sentence: Energy cannot be …….. or …….. It can only be transferred, stored or dissipated. 2. What does the term dissipated mean? Give an example. 3. What type of energy is most likely to be dissipated? 4. What happens to the surroundings when energy is dissipated? 5. Name the energy transfers taking place in… a) A hairdryer. b) A mobile phone. c) A compressed spring 6. A student oiled the gears on his bike. What is the name of this process? Explain how this reduced unwanted energy transfers. 7. A metal spoon has higher thermal conductivity than a wooden spoon. What does this mean? 8. When designing a house, builders consider the thickness of the walls and the thermal conductivity of the materials used to build the walls. Explain why. 9. What other design features are built into houses to minimise unwanted energy transfers?
		Prove It! Which **two** of the following statements are true? Tick (✓) **two** boxes. Appliances only transfer part of the energy usefully. ☐ The energy transferred by appliances will be destroyed. ☐ The energy transferred by appliances makes the surroundings warmer. ☐ The energy output from an appliance is bigger than the energy input. ☐

Energy		
Book Ref.	**Spec. Ref.**	**Efficiency**
	CS 6.1.2.2 Triple 4.1.2.2 MS1c	1. State the equation that links useful output energy transfer, efficiency and total input energy transfer. 2. What is the unit of energy transfer? 3. Why does efficiency have no units? 4. If you wanted to express efficiency as a percentage, what would you have to do to your answer? 5. As well as using energy transfer, efficiency can be measured using another variable. Name that variable. 6. HT only – Look at the old car below and explain how the design of cars has changed to improve their efficiency.
	MS1a MS3b MS3c	**Maths Skills** 1. A motor is supplied with 250W of power and outputs 120W of useful power. What is the efficiency of the motor? Give your answer as a decimal. 2. A lamp with an efficiency of 74% is supplied with 350J of energy. How much energy is usefully transferred by the lamp?
		Prove It! The total power input to a pumped storage power station is 600 MW. The useful power output is 540 MW. (i) Calculate the efficiency of this pumped storage power station. .... Efficiency = ... **(2)** When the total power input to the motor was 5 W the motor could not lift the 2.5 N weight. State the efficiency of the motor. Efficiency = ... % **(1)**

Energy		
Book Ref.	**Spec. Ref.**	**National and Global Energy Resources**
	CS 6.1.3 Triple 4.1.3 WS1.3 WS1.4 WS1.6	1. What are the 3 types of fossil fuel? 2. Name 8 other sources of energy. 3. What is the definition of a renewable resource? 4. Identify each of the sources in Q2 as renewable (R) or finite (F). 5. Which of the energy resources are the least reliable? Why? 6. Which of the energy resources have the biggest environmental impact? Outline what these environmental impacts are. 7. If scientists know about the negative impacts to the environment of using some of these energy resources, why hasn't everyone stopped using them? 8. Some people don't believe that burning fossil fuels contributes to global warming. Explain why peer review of scientists work is very important.
		Prove It! Information about the two electricity generation systems is given in **Figure 2**. **Figure 2** The wind turbine costs £50 000 to buy and install. The hydroelectric generator costs £20 000 to buy and install. The average power output from the wind turbine is 10 kW. The hydroelectric generator will produce a constant power output of 8 kW. Compare the advantages and disadvantages of the two methods of generating electricity. Use your knowledge of energy sources as well as information from **Figure 2**. **(6)**

Energy

Book Ref.	Spec. Ref.	Density
	CS 6.3.1.1 6.3.1.2 Triple 4.3.1.1 4.3.1.2	

1. State the equation for density with units.

2. Calculate the mass of a block of wood with volume of 0.001 m^3. The density of wood is typically 0.70 x 10^3 kg/m^3. Give the units.

3. Draw a particle diagram for each state of matter.

Solid	Liquid	Gas

4. Describe how the density changes from solid to gas.

5. In terms of the arrangement of particles explain why one of these has significantly lower density.

Prove It!

The information in the box is about the properties of solids and gases.

Solids:
- have a fixed shape
- are difficult to compress (to squash).

Gases:
- will spread and fill the entire container
- are easy to compress (to squash).

Use your knowledge of kinetic theory to explain the information given in the box.
You should consider:
- the spacing between the particles
- the movement of individual particles
- the forces between the particles.

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(Total 6 marks)

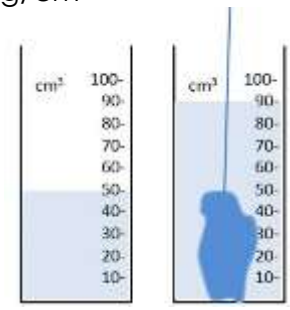
Energy		
Book Ref.	**Spec. Ref.**	**CS: RPA17** **Triple: RPA5**
	CS 6.3.1.1 Triple 4.3.1.1	**Required Practical:** Determine the densities of regular and irregular solid objects and liquids.

1. A 20.00ml sample of liquid is put into an empty beaker that had a mass of 31.44g. The breaker with the liquid was weighed at 55.89g. What is the mass of the liquid?

2. Given 1ml = 1cm^3, calculate the density of the liquid in g/cm^3.

3. The length width and height of a rectangular cuboid is measured using a venire calliper. Length is 21.50cm, width is 5.03cm and height is 10.01cm. Given the mass of the cuboid is 800g. Calculate the density of the object in g/cm^3

4. The mass of the rock shown below is 100g. Calculate the density of the rock in g/cm^3



Prove It!

A student wants to calculate the density of the two objects shown in the figure below.

Metal cube

Small statue

© Whitehoune/iStock/Thinkstock, © Marc Dietrich/Hemera/Thinkstock

Describe the methods that the student should use to calculate the densities of the two objects.

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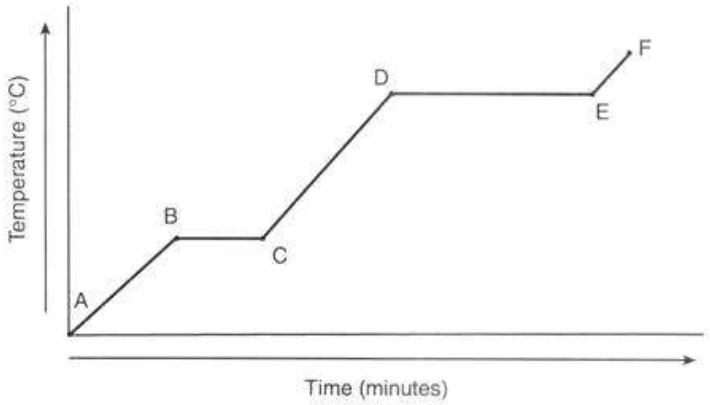
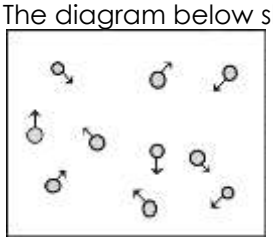
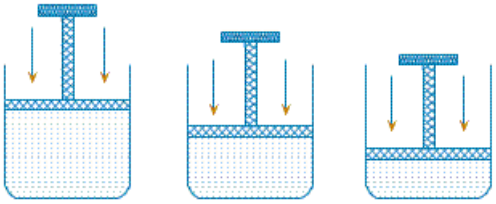
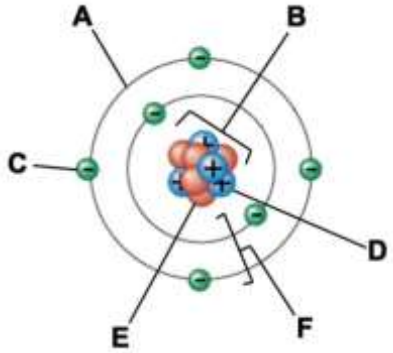
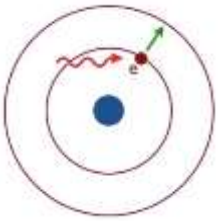
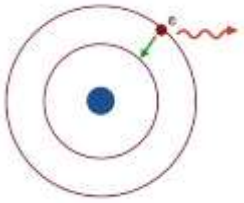
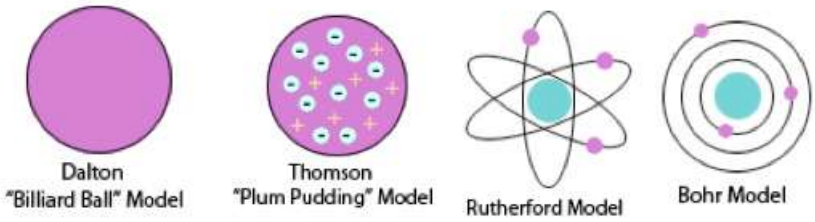
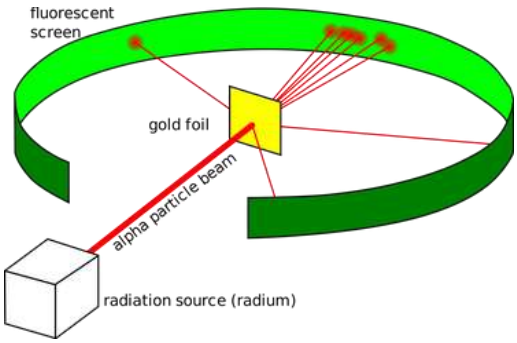
(Total 6 marks)

Energy		
Book Ref.	**Spec. Ref.**	**Internal energy and specific heat capacity**
	CS 6.3.2.1 6.3.2.2 Triple 4.3.2.1 4.3.2.2	1. What is meant by the term internal energy? 2. The diagram below shows what happens as ice is heated until it becomes steam.  For each example describe and explain the change in internal energy. a) C-D Water is heated from 0°C to 100°C b) B-C Ice is melted into water at 0°C. 3. Define the term specific heat capacity. 4. The increase in temperature can be determined using the following equation: $\Delta E = m\,c\,\Delta\theta$. How much energy is needed to heat 0.2kg of oil from 10°C to 60°C. The heat capacity of oil is 2000J/kg°C. 5. Define specific latent heat of fusion. 6. Define specific latent het of vaporisation. 7. When 0.15kg of a molten metal is allowed to solidify it released 75000J of energy. Using the equation $E = mL$ calculate the specific latent heat of fusion of metal. Give the units. 8. Explain when specific heat capacity and specific latent heat are used.

Energy		
Book Ref.	**Spec. Ref.**	**Particle motion in gases**
	CS 6.3.3.1 Triple 4.3.3.1	1. The diagram below shows gas particles in a box. Describe their motion.  2. Describe the effect that adding heat has on the temperature and motion/energy of the particles. 3. What causes pressure on the walls of the container? Explain what will happen to the pressure if the temperature is increased but the volume kept constant. 4. Sketch a graph of pressure against temperature. **5. Physics only**. By considering the force on the piston from the motion of the particles, describe and explain the effect on pressure as a result of pressing down on the piston (assume mass of the gas and temperature is constant).  6. The pressure of the gas is initially 200kPa and its volume is 0.30m^3 Calculate the pressure when the volume is reduced to 0.12m^3. Use the equation $pV = constant$ and give your answer to 2 significant figures with units. 7. **Physics only HT only**. The term work done and energy transferred are equivalent. A person pressing down on a bike pump does work on the gas. Describe and explain the effect this has on the gas.

Energy		
Book Ref.	**Spec. Ref.**	**Atoms isotopes and ions**
	CS 6.4.1.1 6.4.1.2 Triple 4.4.1.1 4.4.1.2	1. Label the structure of the atom from A-F. Give the charge and mass of the sub atomic particles.  2. State the approximate radius of an atom in meters. How much smaller is the nucleus compared to the whole atom? 3. The diagrams below show how electrons can move between energy levels. Describe what is happening in each diagram.   4. Complete the table for an atom of sodium. $^{23}_{11}Na$ 5. Describe, with the help of numbers the difference and similarities between the atoms shown below. $^{12}_{6}C$ $^{13}_{6}C$ $^{14}_{6}C$ 6. The carbon atoms above are neutral. Explain how a positive carbon ion can be produced from one of these atoms.

Mass number	
Atomic number	
Number of electrons	
Number of neutrons	

Energy		
Book Ref.	**Spec. Ref.**	**Model of the atom**
	CS 6.4.1.3 Triple 4.4.1.3 WS1.1	1. The world was once believed to be flat. Explain why scientific models change over time. The following questions refer to change in the model of atoms shown below.  2. The discovery of the electron led to the formation of the plum pudding model. Describe the plum pudding model. 3. According to the plum pudding model firing alpha particles at atoms is like firing a bullet at paper. The diagram below shows the results of the alpha particle scattering experiment. Complete the table.  4. Describe how Bohr modified the nuclear model of the atom. 5. Suggest why the neutron wasn't discovered until 20 years after the discovery of the nucleus.

Observation	Conclusion
Most alpha particles went straight through	
A few alpha particles were deflected back by more than 90°	

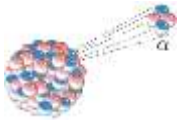
Energy

Book Ref.	Spec. Ref.	Radioactive decay and nuclear radiation
	CS 6.4.2.1 6.4.2.2	1. Uranium-238 is an example of an unstable isotope. What will eventfully happen to unstable atoms? Explain why.
	Triple 4.4.2.1 4.4.2.2	2. Describe what effect, if any, increasing temperature or pressure has on the rate of radioactive decay. Explain your answer.

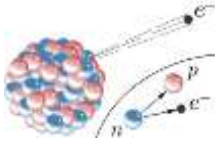
3. Why alpha, beta and gamma particles are called ionising radiation.

4. A Geiger-Muller tube can be used measure the activity of a radioactive source. Define the term *activity* and give its units.

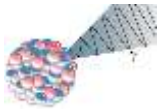
5. The diagram below shows the alpha decay of $^{238}_{92}U$. Write an equation for the decay.



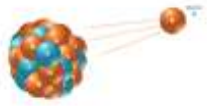
6. The diagram below shows the beta decay of $^{234}_{90}Th$. What's happening in the nucleus is shown in the corner. Write an equation for the decay.



7. The diagram below shows the gamma emission from $^{240}_{94}Pu$. Write an equation for the decay.



8. The diagram below shows the neutron emission from a $^{13}_{4}Be$.

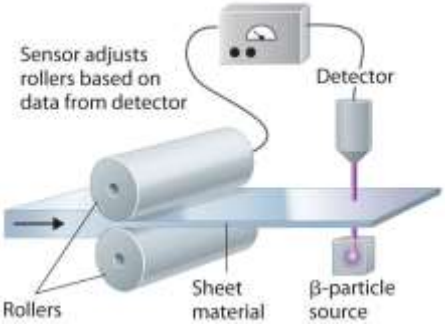


9. Complete the table.

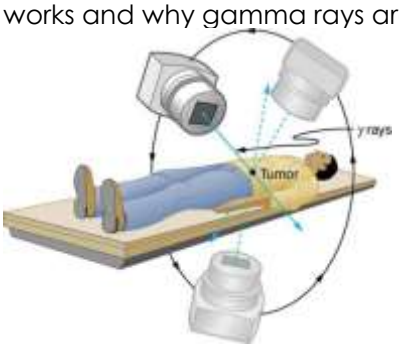
Type of radiation	Stop by which material?	Range in air	Ionising power (rank from 1st to 3rd)
Alpha			
Beta			
Gamma			

10. The diagram below shows how smoke alarms use alpha particles. Explain why the smoke causes the alarm to sound.

11. The diagram below shows how beta particles are used to monitor the thickness of paper. Describe and explain what will happen if the paper comes in too thick.

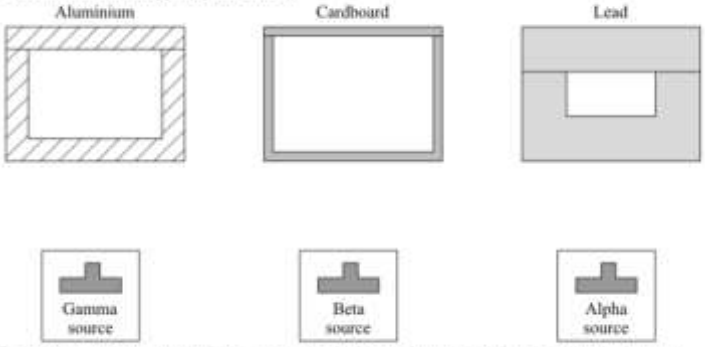


12. Gamma rays are be used in radiotherapy. Explain the how the machine shown below works and why gamma rays are used rather than beta and gamma.



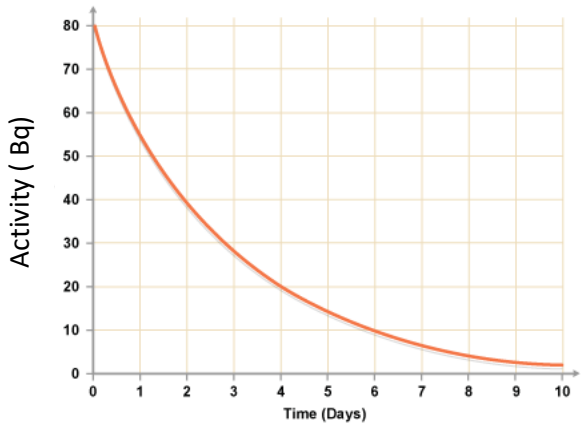
Prove It!

The diagram shows three different boxes and three radioactive sources. Each source emits only one type of radiation and is stored in a different box. The box reduces the amount of radiation getting into the air.



(2)

Draw **three** lines to show which source should be stored in which box so that the minimum amount of radiation gets into the air.

Energy		
Book Ref.	**Spec. Ref.**	**Half-lives and the random nature of radioactive decay**
	CS 6.4.2.3 6.4.2.4 Triple 4.4.2.3 4.4.2.4 WS1.5	1. Define the term half-life. 2. Use the diagram below to determine the half-life of the sample.  **3. HT only** A radioactive sample contains 200mg of a radioactive isotope. The half life of the isotope is 5 hours. Calculate how much of the sample will be radioactive after 20hours. 4. Due to the nature of radioactive decay, the mass of radioactive isotopes left cannot be predicted this accurately. Explain why. **5.** HT only The half life of a radioactive sample is 3 days. What fraction of the sample will still be radioactive after 9days. **6. HT only** The activity of an old block of wood is 25 counts per minute. The activity of a living block of wood is 200 counts per minute. Given the half life of the isotope in the wood is 5730 years. Calculate the age of the wood 7. Explain the difference between contamination and irradiation. Which of these will result in an object becoming radioactive? 8. Describe and explain the precautions needed when using radioactive samples.

Cells and Systems Keywords

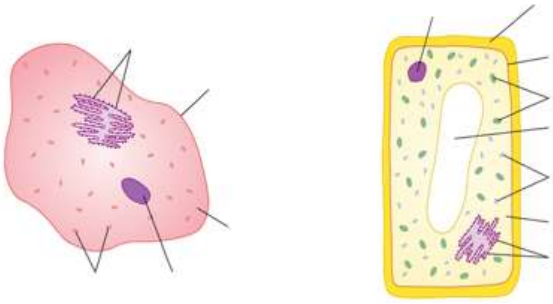
Add all the important keywords for this big idea in the grid below as you come across them in the study pack.

Word	Definition

<table>
<tr><th colspan="3">Cells and systems</th></tr>
<tr><th>Book Ref.</th><th>Spec. Ref.</th><th>Eukaryotes and prokaryotes</th></tr>
<tr><td></td><td>4.1.1.1</td><td>Key information:
- Plant and animal cells (eukaryotic cells) have:
- genetic material enclosed in a nucleus to control the activity of the cell
- a cell membrane to control what enters and exits the cell
- cytoplasm to allow reactions to take place
- Bacterial cells (prokaryotic cells) are much smaller in comparison. The genetic material is not enclosed in a nucleus. It is a single DNA loop and there may be one or more small rings of DNA called plasmids. They also have cytoplasm, a cell membrane and a cell wall to provide strength and support to the cell.</td></tr>
<tr><td></td><td></td><td>1. What type of cells are eukaryotic cells?

2. What type of cells are prokaryotic cells?

3. Outline 3 differences between prokaryotes and eukaryotes.</td></tr>
<tr><td></td><td></td><td>Maths Skills</td></tr>
<tr><td></td><td>MS2h</td><td>
<table>
<tr><th>Size of image (mm)</th><th>Magnification</th><th>Size of real object (mm)</th></tr>
<tr><td>5</td><td>40</td><td></td></tr>
<tr><td>10</td><td>1000</td><td></td></tr>
<tr><td>12</td><td>60</td><td></td></tr>
<tr><td>8</td><td>200</td><td></td></tr>
<tr><td>15</td><td>500</td><td></td></tr>
</table>
How many orders of magnitude bigger is the first sample compared to the second?
</td></tr>
</table>

<table>
<tr><th colspan="3">Cells and systems</th></tr>
<tr><th>Book Ref.</th><th>Spec. Ref.</th><th>Animal and plant cells</th></tr>
<tr><td></td><td>4.1.1.2</td><td>Key information:
Most animal cells have the following parts:
a nucleus, cytoplasm, a cell membrane, mitochondria to carry out aerobic respiration which releases energy for the cell, ribosomes to carry out protein synthesis by joining many amino acids.
In addition to the parts found in animal cells, plant cells often have:
• chloroplasts filled with chlorophyll to absorb light for photosynthesis
• a permanent vacuole filled with cell sap to provide support to the cell
Plant and algal cells also have a cell wall made of cellulose, which strengthens the cell.</td></tr>
<tr><td></td><td></td><td>1. Label the cells:
 
2. Fill in the table with the functions of each organelle.
<table><tr><td>Organelle</td><td>Function</td></tr><tr><td>Nucleus</td><td></td></tr><tr><td>Cytoplasm</td><td></td></tr><tr><td>Cell membrane</td><td></td></tr><tr><td>Mitochondria</td><td></td></tr><tr><td>Ribosomes</td><td></td></tr><tr><td>Chloroplasts</td><td></td></tr><tr><td>Vacuole</td><td></td></tr><tr><td>Cell wall</td><td></td></tr></table>
3. Identify three organelles found in plant cells but not animal cells.</td></tr>
<tr><td></td><td></td><td>Prove It!</td></tr>
<tr><td></td><td></td><td>Living organisms are made of cells.
(a) Animal and plant cells have several parts. Each part has a different function.
Draw one line from each cell part to the correct function of that part.
Cell part | Function
Cell membrane
Mitochondria
Nucleus
Where most energy is released in respiration
Controls the movement of substances into and out of the cell
Controls the activities of the cell
Where proteins are made
(3)</td></tr>
</table>

<table>
<tr><th colspan="3">Cells and systems</th></tr>
<tr><th>Book Ref.</th><th>Spec. Ref.</th><th>Required practical 1: Use a light microscope to observe, draw and label a selection of plant and animal cells.</th></tr>
<tr><td></td><td>4.1.1.2

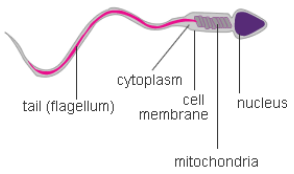
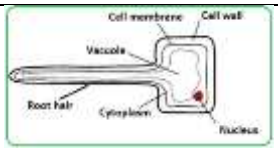
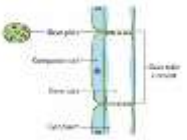
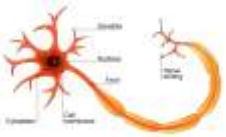
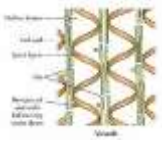
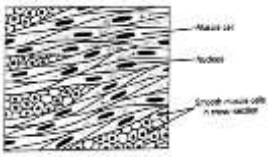
AT 1 and 7</td><td>Key information:
- A light microscope shines a beam of light across a thin, dead, stained specimen.
- The resolution (ability to distinguish between two points) and magnification of a light microscope is high enough the view the nucleus and cell membrane.
- Most organelles are too small to be viewed with a light microscope.
- When drawing an image from a microscope a pencil must be used. Labels should</td></tr>
<tr><td></td><td>WS 1.2</td><td>
1. The image shows human cheek cells. In the space below, draw a biological drawing of this image. Label the organelles which are visible.
2. Describe how the slide of cheek cells would have been prepared.
3. State what is meant by the term resolution.
4. Give the equation that links magnification, image size and actual size.</td></tr>
<tr><td></td><td></td><td>Maths Skills</td></tr>
<tr><td></td><td>Ma 1a, 1b, 2a</td><td>Convert the following:
1. 3cm into mm =
2. 3mm into µm =
3. 50µm into mm =

Put these numbers into standard form:
1. 6 000
2. 400
3. 80 000
4. 0.007

Answer the following questions:
1. A heart muscle cell with a length of 23µm is magnified 200x. What is the image size? Give your answer in metres in standard form.
2. A root hair cell image is 7.8 cm in length. The image is being magnified 4500x. Calculate the real length of the object in metres. Giving your answer in standard form to 3 significant figures.
3. The image of a nerve cell measures 3.5 cm. It has been magnified 3000x. Calculate the real size of the nerve cell, giving your answer in metres and standard form.</td></tr>
</table>

Cells and systems

Book Ref.	Spec. Ref.	Cell specialisation
	4.1.1.3	**Key information:** Cells may be specialised to carry out a particular function: • sperm cells, nerve cells and muscle cells in animals • root hair cells, xylem and phloem cells in plants.

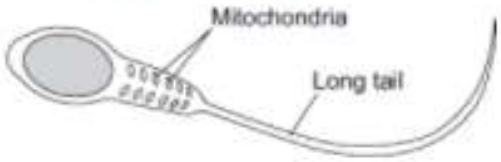
NAME OF CELL	PICTURE	STRUCTURE	FUNCTION
PHLOEM CELLS		Has a large surface area because of a long finger-like projection	Allows electrical impulses to pass around the body
ROOT HAIR CELL		Has a long flagella and lots of mitochondria	Transports water and mineral ions around a plant
NERVE CELL		Has a long axon and a cell body found in the CNS	Fertilises an egg cell
SPERM CELL		Consists of long hollow tubes strengthened with lignin	Absorbs water for a plant
XYLEM CELLS		Consists of long hollow tubes	Transports dissolved sugars around a plant
MUSCLE CELLS		Have hairs on the tops of cells to increase surface area	Control movement of the skeleton in animals
CILIATED CELLS		Have lots of mitochondria to release extra energy	Absorb nutrients from the small intestine

Prove It!

1. Describe how the structure of a sperm cell relates to its function.

2. Describe how the structure of a root hair cell relates to its function.

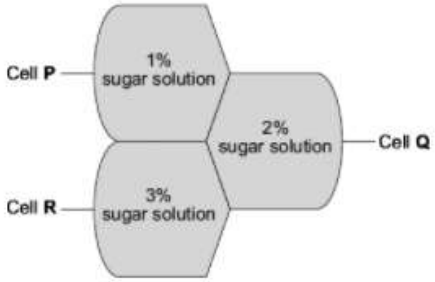
3. Describe how the structure of a nerve cell relates to its function.

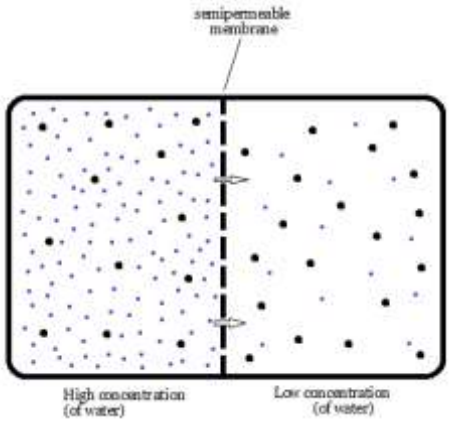
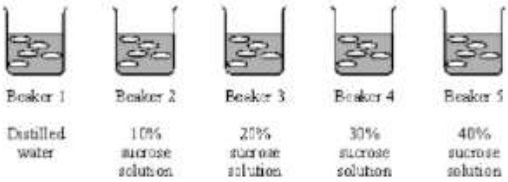
Cells and systems		
Book Ref.	**Spec. Ref.**	**Cell differentiation**
	4.1.1.4	**Key information:** As an organism develops, cells differentiate to form different types of cells. • Most types of animal cell differentiate at an early stage. • Many types of plant cells can differentiate throughout life. In mature animals, cell division is mainly restricted to repair and replacement. As a cell differentiates it gets different sub-cellular structures so it can carry out a certain function. It has become a specialised cell.
		1. **State** what is meant by the term 'differentiation'. 2. **Describe** why cell division is important for animals. 3. **Give** one example of a specialised cell and outline how it is specialised to carry out its function. 4. **State** the name of the tissue in plants which allows plant cells to differentiate throughout life.
		Prove It!
		(b) Cells can be specialised for a particular job. The diagram shows the structure of a human sperm cell.  Describe how the long tail and the mitochondria help the sperm to do its job. Long tail..... .... Mitochondria..... .... (4)

Cells and systems		
Book Ref.	**Spec. Ref.**	**Diffusion**
	4.1.3.1	**Key information:** - Diffusion is the spreading out of the particles of any substance in solution, or particles of a gas, resulting in a net movement from an area of higher concentration to an area of lower concentration.
		1. **Define** the term 'diffusion'. 2. **Give** two examples of molecules which diffuse in and out of cells. **Name** the process these molecules are involved in. 3. **State** three factors that affect the rate of diffusion. 4. **Describe** the relationship between surface area: volume ratio and the rate of diffusion. 5. Complete the table to show how the following are adapted for exchanging materials.

Organ	**How it is adapted for exchange**
Lungs	
Small intestine	
Gills	
Leaves	
Roots	

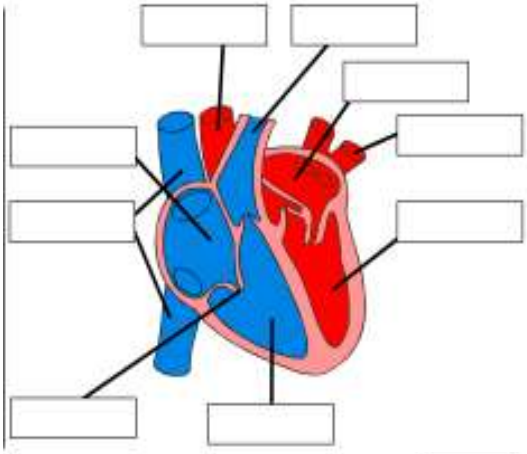
		Prove It!
		Diffusion is an important process in animals and plants. The movement of many substances into and out of cells occurs by diffusion. Describe why diffusion is important to animals and plants. In your answer you should refer to: • animals • plants • examples of the diffusion of named substances. **(6)**

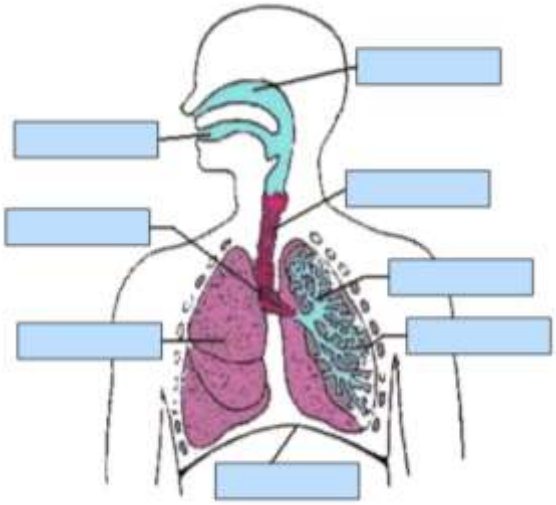
Cells and systems		
Book Ref.	**Spec. Ref.**	**Osmosis**
	4.1.3.2	**Key information:** Water may move across cell membranes via osmosis. Osmosis is the diffusion of water from a dilute solution to a concentrated solution through a partially permeable membrane.
		1. **Define** the term 'osmosis'. 2. The information shows the percentage concentration of sugar solution in cells **P**, **Q** and **R**. **Diagram 2**  Water can move from cell to cell. Into which cell, **P**, **Q** or **R**, will water move the fastest? ☐
		Prove It!
		Plant roots absorb water from the soil by osmosis. (a) What is osmosis? .... **(3)** (b) The image below shows part of a plant root. The plant root is adapted for absorbing water from the soil. Use information from the diagram to explain how this plant root is adapted for absorbing water. **(3)**

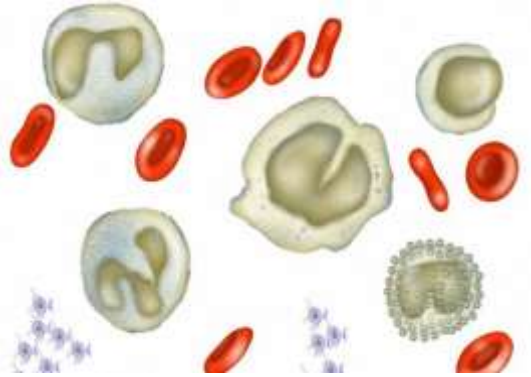
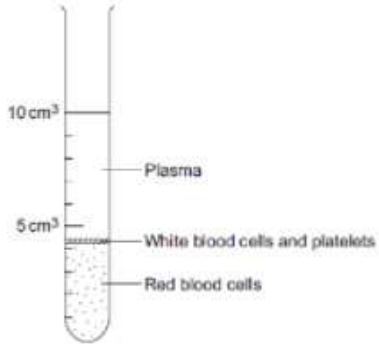
Cells and systems		
Book Ref.	**Spec. Ref.**	**Required practical 2 (biology: required practical 3): Investigate the effect of a range of concentrations of salt or sugar solutions on the mass of plant tissue.**
	AT 1, 3, 5	**Key information:** - Plant tissue can be used to measure the rate of uptake of water in different solutions. - During these experiments, only the water moves. Salt and sugar molecules are too large to pass across the partially permeable membranes. - The higher the concentration of salt or sugar, the lower the concentration of water.
		 **1. Describe** why the water moves from the left to the right side. 2. **Explain** why the sugar molecules do not move.
		Maths Skills
	MS1a, 1c	Some students set up an experiment using osmosis to find the concentration of sucrose solution in potato cell sap. They used discs of potato cut to the same size and weighing approximately 10 gms. The discs were put into each of five beakers.  (a) (i) After two hours they reweighed the discs after carefully blotting them first. Why did the students blot the potato before weighing it? .... (1) (ii) Their results are shown in the table below. **Beaker 1 / Beaker 2 / Beaker 3 / Beaker 4 / Beaker 5** Final mass in g: 13.0 / 12.2 / 9.0 / 7.9 / 7.3 Initial mass in g: 10.0 / 10.6 / 10.0 / 10.1 / 10.4 The students calculated the % gain or loss in mass of potato. Complete this table of results for Beakers 2, 4 and 5. **Beaker 1**: 13 – 10.0 = 3.0; $\frac{3.0}{10.0} \times 100\% = 30\%$; Gain in mass = 30% **Beaker 2**: **Beaker 3**: 9.0 – 10.0 = –1.0; $\frac{-1.0}{10.0} \times 100\% = -10\%$; Loss in mass = 10% **Beaker 4**: **Beaker 5**: (3)

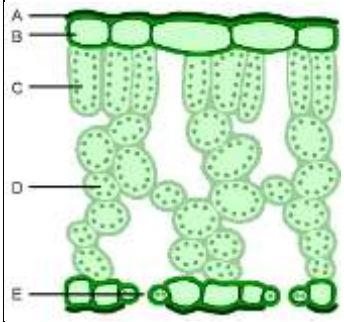
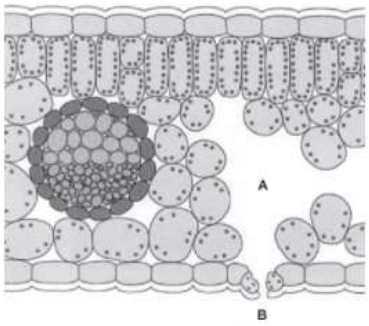
Cells and systems		
Book Ref.	**Spec. Ref.**	**Active transport**
	4.1.3.3	**Key information:** - Active transport moves substances from a more dilute solution to a more concentrated solution (against a concentration gradient). This requires energy from respiration. - Active transport allows mineral ions to be absorbed into plant root hairs from very dilute solutions in the soil. Plants require ions for healthy growth. It also allows sugar molecules to be absorbed from lower concentrations in the gut into the blood which has a higher sugar concentration. Sugar molecules are used for cell respiration.
		1. **Outline** the main differences between diffusion and active transport. 2. **Explain,** using examples, the importance of active transport for plant growth. 3. **Explain** why active transport cannot occur in the absence of oxygen. 4. **Describe** when active transport is used by the cells lining the small intestine.
		Prove It!
		Plants must use active transport to move some substances from the soil into root hair cells. (i) Active transport needs energy. Which part of the cell releases most of this energy? Tick (✓) **one** box. mitochondria ☐ nucleus ☐ ribosome ☐ **(1)** (ii) Explain why active transport is necessary in root hair cells. .... **(2)**

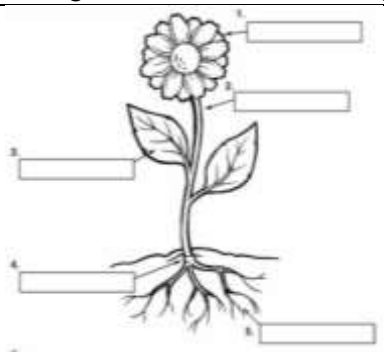
Cells and systems		
Book Ref.	**Spec. Ref.**	**Principles of organisation**
	4.2.1	**Key information:** Cells are the basic building blocks of all organisms. A tissue is a group of cells with a similar structure and function. Organs are aggregations of tissues performing specific functions. Organs are organised into organ systems, which work together to form organisms.
	MS 1c	1. Put the following in order of size (smallest to largest): Tissue Organ Cell Organ system _____ → _____ → _____ → _____ 2. **Describe** the difference between a tissue and an organ. 3. **Name** the three tissues of the stomach. Give the function of each. 4. **Give an example** of a plant organ and state its function.
		Prove It!
		In a living organism, the cells are organised into organs, systems and tissues. (a) Use words from the box to complete the list of these structures in order of size. **organs systems tissues** The smallest structure is at the top of the list and the largest is at the bottom. 1 **cells** (smallest) 2 ..... 3 ..... 4 ..... 5 **organism** (largest) (1) (b) **List A** gives three tissues found in the human body. **List B** gives four functions of tissues. Draw a straight line from each tissue in **List A** to its correct function in **List B**. **List A – Tissue**: Muscular tissue; Glandular tissue; Epithelial tissue **List B – Function**: Covers many parts of the body; Contracts to cause movement; Divides by meiosis; Releases hormones or enzymes (3)

Cells and systems		
Book Ref.	**Spec. Ref.**	**The heart and blood vessels**
	4.2.2.2	**Key information:** - The heart is an organ that pumps blood around the body in a double circulatory system. The right ventricle pumps blood to the lungs where gas exchange takes place. The left ventricle pumps blood around the rest of the body. - The natural resting heart rate is controlled by a group of cells located in the right atrium that act as a pacemaker. Artificial pacemakers are electrical devices used to correct irregularities. - The three different types of blood vessel are arteries, veins and capillaries.
		 1. **Label** the diagram of the heart 2. **Describe** the passage of blood through the left hand side of the heart. 3. **Explain** the importance of valves in the heart. 4. **Name** the artery that supplies the heart with blood. **Explain** the importance of the heart having its own blood supply. 5. Where are the group of cells that control the natural resting heart rate found? 6. **Outline** the difference in the structure of arteries and veins. 7. **Describe** how the structure of a capillary relates to its function.
		Prove It!
		The circulatory system contains arteries and veins. (a) (i) Describe how the structure of an artery is different from the structure of a vein. .... **(2)**

Cells and systems		
Book Ref.	**Spec. Ref.**	**The lungs**
	4.2.2.2	**Key information:** The lungs are specialised organs adapted to allow for efficient gas exchange. They have a large surface area: volume ratio to ensure that gas exchange can occur at a high rate.
		 1. **Label** the following parts: Trachea, bronchus, bronchiole, trachea, alveoli, lung, mouth, nasal cavity 2. **Describe** how the alveoli are adapted for efficient gas exchange.
		Maths Skills
		The table shows the composition of blood entering and leaving the lungs. **Gas** / **Concentration in arbitrary units**: **Blood entering lungs**, **Blood leaving lungs** Oxygen: 40, 100 Carbon dioxide: 46, 40 (a) Describe, in as much detail as you can, the changes that take place in the composition of blood as it passes through the lungs. .... **(3)**

Cells and systems		
Book Ref.	**Spec. Ref.**	**Blood**
	4.2.2.3	**Key information:** Blood is a tissue consisting of plasma, in which the red blood cells, white blood cells and platelets are suspended.
		1. **Describe** the function of plasma. 2. **Identify** the part of the blood which transports oxygen. 3. **Describe** the role of white blood cells 4. **Describe** the role of platelets. 5. **Explain** why blood is described as a tissue. 6. **Label** the blood cells in this image. 
		Prove It!
	MS1a	The parts of the blood can be separated from each other by spinning the blood in a centrifuge. The image below below shows the separated parts of a 10 cm^3 blood sample.  (a) Calculate the percentage of the blood that is made up of plasma. .... Answer = ... % (2) (b) Name **three** chemical substances transported by the plasma. 1..... 2..... 3..... (3)

Cells and systems		
Book Ref.	**Spec. Ref.**	**Plant tissues**
	4.2.3.1	**Key information:** - Plant tissues include epidermal tissues, palisade mesophyll, spongy mesophyll, xylem and phloem, and meristem tissue. - The lead is a plant organ which is adapted in order to carry out photosynthesis.
		 1. Identify the structures in the cross-sectional diagram of the leaf. A = B = C = D = E = 2. Describe two ways in which the leaf is adapted for photosynthesis. 3. Describe the structure and function of a xylem vessel. 4. Describe the structure and function of a phloem vessel.
		Prove It!
		The diagram shows a section through a plant leaf.  (a) Use words from the box to name **two** tissues in the leaf that transport substances around the plant. **epidermis** **mesophyll** **phloem** **xylem** ..... and ..... (1) (b) Gases *diffuse* between the leaf and the surrounding air. (i) What is *diffusion*? .... (2) (ii) Name **one** gas that will diffuse from point **A** to point **B** on the diagram on a sunny day. ..... (1) **(Total 4 marks)**

Cells and systems		
Book Ref.	**Spec. Ref.**	**Plant organ systems**
	4.2.3.2	**Key information:** Transpiration occurs due to the evaporation of water vapour from the leaves. It is the movement of water from the roots to the atmosphere via the xylem and leaves. Xylem vessels and hollow tubes strengthened by lignin. Their role is to transport water in the transpiration stream. Phloem tissue is made up of long cells with pores in their ends. Dissolved sugars (sucrose) travel from the leaves to the rest of the plant for immediate use (in respiration) or for storage. The movement of sugar through the phloem tissue is called translocation.
		 **1. Label** the plant with the plant organs. 2. **Describe** the passage of water through the plant. 3. **Explain** how the structure of the root hair cell is adapted to its function. 4. Plants living in very hot areas have very few stomata on the underside of the leaf. **Explain** why. 5. **Describe** the difference in the structure and function of phloem and xylem vessels. 6. **Complete** the table to show the effects of changing conditions on rate of transpiration:

Condition Change	Effect on Rate of Transpiration
Increased temperature	
Decreased humidity	
Decreased air movement	
Increased light intensity	

		Prove It!
		Describe how water moves from roots to the leaves. .... (2)

Cells and systems		
Book Ref.	**Spec. Ref.**	**The stomata**
	4.2.3.2	**Key information:** - The stomata and guard cells are found on the underside of the leaf and are used to control gas exchange and water loss.
		1. **Describe** how the following equipment could be used to investigate the number of stomata on the underside of a leaf. Nail varnish Sticky tape Microscope 2. **Suggest** why the stomata are closed at night.
		Maths Skills
	MS 2a, 2b, 2d,	Plants lose water through the stomata in the leaves. The epidermis can be peeled from a leaf. The stomata can be seen using a light microscope. The table below shows the data a student collected from five areas on one leaf.

Leaf area	Number of stomata	
	Upper surface	Lower surface
1	3	44
2	0	41
3	1	40
4	5	42
5	1	39
Mean	**2**	**X**

Describe how the student might have collected the data.

(3)

What is the median number of stomata on the upper surface of the leaf?

.....

(1)

Calculate the value of **X** in the table.

Give your answer to 2 significant figures.

.....

.....

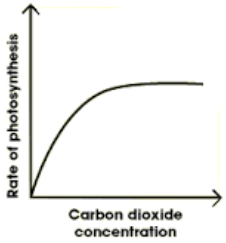
Mean number of stomata on lower surface of leaf = ...

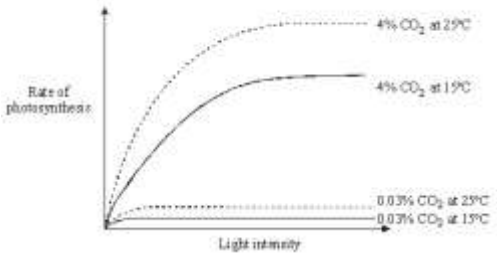
(2)

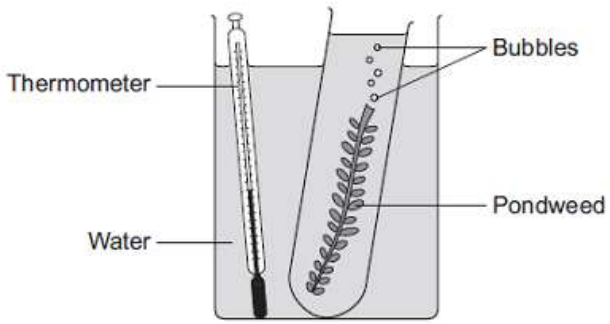
The plant used in this investigation has very few stomata on the upper surface of the leaf.

Explain why this is an **advantage** to the plant.

Cells and systems		
Book Ref.	**Spec. Ref.**	**Photosynthesis – the reaction**
	4.4.1.1	**Key information:** - Photosynthesis is an endothermic reaction in which energy is transferred from the environment to the chloroplasts by light to produce glucose.
		1. **Write** the word and symbol equation for photosynthesis. 2. **Explain** why photosynthesis only occurs during the day. 3. **Explain** why photosynthesis is described as an endothermic reaction. 4. **Describe** how a leaf is adapted in order to carry out photosynthesis.
		Prove It!
		(a) The equation describes the process of photosynthesis. carbon dioxide + ... + light energy ⟶ glucose + ... (i) Write in the names of the **two** missing substances. **(2)** (ii) Name the green substance which absorbs the light energy. ..... **(1)** (b) (i) In bright sunlight, the concentration of carbon dioxide in the air can limit the rate of photosynthesis. Explain what this means. .... **(2)** (ii) Give **one** environmental factor, other than light intensity and carbon dioxide concentration, which can limit the rate of photosynthesis. ..... **(1)** **(Total 6 marks)**

Cells and systems		
Book Ref.	**Spec. Ref.**	**The rate of photosynthesis**
	4.4.1.2	**Key information:** - The rate of photosynthesis can be limited by a number of different factors.
		1. **Name** four factors which limit the rate of photosynthesis. 2. The sketch graph shows the effect of carbon dioxide on photosynthesis. **Describe** and **explain** the shape of the graph.  3. **Explain** the effect of temperature on the rate of photosynthesis.
		Prove It!
		The rate of photosynthesis in a plant depends on several factors in the environment. These factors include light intensity and the availability of water. Describe and explain the effects of **two other** factors that affect the rate of photosynthesis. You may include one or more sketch graphs in your answer. **(5)**

Cells and systems		
Book Ref.	**Spec. Ref.**	**The rate of photosynthesis (HIGHER TIER ONLY)**
	4.4.1.2	**Key information:** - Farmers and gardeners use their knowledge of limiting factors to design greenhouses which increase the rate of photosynthesis in plants to ensure profits. - The intensity of light at different distances from a light source can be described by the inverse square law. This states that the intensity of light is inversely proportional to the square of the distance from the source.
	MS 3a, 3d	1. Give the equation which links light intensity and distance. **State** the unit for light intensity. 2. **Describe** and **explain** the shape of the graph below. The graph shows how the rate of photosynthesis is affected by different conditions.  3. **Describe** how greenhouses are designed to ensure gardeners are able to maximise their profits.
		Prove It!
		Plants are grown in glasshouses to protect them from the weather or extend the growing season. Plants make food by photosynthesis. $6CO_2 + 6H_2O \xrightarrow[\text{light}]{\text{energy from}} C_6H_{12}O_6 + 6O_2$ glucose In winter, when days are shorter, glasshouses are heated to keep the enzyme reactions in plants at optimum rates. What else should a grower do to make sure that the plants are photosynthesising at the optimum rate? Give a reason for your answer. .... **(Total 3 marks)**

Cells and systems		
Book Ref.	**Spec. Ref.**	**Required practical 5 (biology: required practical 6): Investigating the effect of light intensity on the rate of photosynthesis using an aquatic organism such as pondweed.**
	4.4.1.2 AT 1, 2, 3, 4, 5 WS2.2	1. **Name** the equipment needed for this experiment. 2. **Describe** how to change the light intensity. **Identify** the piece of equipment needed to record light intensity. 3. **Identify** the dependent variable in this investigation. **Suggest** how this is measured. 4. **Name** two control variables. **Describe** how you would ensure these variables are kept constant. 5. How are the dependent variable and one of the control variables used to calculate rate?
		Prove It!
		A student investigated the effect of temperature on the rate of photosynthesis in pondweed. The diagram shows the way the experiment was set up.  (i) The student needed to control some variables to make the investigation fair. State **two** variables the student needed to control in this investigation. 1..... 2..... **(2)** (ii) The bubbles of gas are only produced while photosynthesis is taking place. What **two** measurements would the student make to calculate the rate of photosynthesis? 1..... 2..... **(2)**

Cells and systems		
Book Ref.	**Spec. Ref.**	**Uses of glucose from photosynthesis**
	4.4.1.3	**Key information:** - The glucose produced in photosynthesis is required by plants for a number of processes. It is often converted into different molecules required for plant survival. - Plants require nitrate ions from the soil in order to produce proteins.
		1. **State** five uses of glucose. 2. **Explain** why glucose is stored as starch. 3. **Explain** why a seed needs a store of fats/oils for growth. 4. **Name** the molecules necessary to synthesise proteins.
		Prove It!
		Green plants can make glucose. (a) Plants need energy to make glucose. How do plants get this energy? .... **(2)** (b) Plants can use the glucose they have made to supply them with energy. Give **four** other ways in which plants use the glucose they have made. .... **(4)** **(Total 6 marks)**

Cells and systems		
Book Ref.	**Spec. Ref.**	**Aerobic and anaerobic respiration**
	4.4.2.1	**Key information:** - Cellular respiration is an exothermic reaction which is continuously occurring in living cells. - Respiration releases the energy needed for living processes. - Anaerobic respiration in yeast is also known as fermentation.
		1. **Write** a word and balanced symbol equation for aerobic respiration. 2. **Compare** the processes of aerobic and anaerobic respiration. Give at least three differences. 3. **Outline** three uses of the energy released in respiration. 4. **Using equations**, outline the difference between anaerobic respiration in muscles and in plants/yeast. 5. **State** two uses of fermentation.
		Prove It!
		Respiration is a process which takes place in living cells. What is the purpose of *respiration*? .... **(1)** (i) Balance the equation for the process of respiration when oxygen is available. $C_6H_{12}O_6$ + O_2 → CO_2 + H_2O **(1)** (ii) What is the name of the substance in the equation with the formula $C_6H_{12}O_6$? ..... **(1)** Compare anaerobic respiration in a yeast cell with anaerobic respiration in a muscle cell. **(3)**

Cells and systems		
Book Ref.	**Spec. Ref.**	**Response to exercise**
	4.4.2.2	**Key information:** - During exercise the human body reacts to the increased demand for energy. - The heart rate, breathing rate and breath volume increase during exercise to supply the muscles with more oxygenated blood. - If insufficient oxygen is supplied, anaerobic respiration takes place in muscles. This causes a build-up of lactic acid which causes muscles to become fatigued and stop contracting. (HT ONLY) - Blood flowing through the muscles transports the lactic acid to the liver where it is converted back into glucose. Oxygen debt is the amount of extra oxygen the body needs after exercise to react with the accumulated lactic acid and remove it from the cells.
		1. **Explain** why the heart rate must increase during exercise. 2. **Explain** why the breathing rate must increase during exercise. **Suggest** what happens to the volume of breath breathed in. 3. **Explain** what causes cramp and why. 4. **Describe** what an oxygen debt is. 5. HT ONLY – **Describe** how lactic acid is converted into glucose.
		Prove It!
		An increased cardiac output will provide more oxygen and more glucose to the working muscles. Explain how this helps the athlete during exercise. .... **(4)**

Cells and systems		
Book Ref.	**Spec. Ref.**	**Metabolism** **(PLEASE NOTE: This section is covered in more detail throughout the course. It is important however to appreciate how all reactions in the body are linked.)**
	4.4.2.3	**Key information:** - Metabolism is the sum of all reactions in a cell or the body.
		1. **Name** a metabolic reaction that occurs in all cells. 2. **Identify** the building blocks (monomers) of the following molecules: - Carbohydrates: - Lipids: - Proteins: 3. **Explain** why glucose is converted to starch in plants, and glycogen in animals. 4. **Describe** the structure of a lipid. 5. **Explain** how excess proteins are excreted.
		Prove It!
		Bread contains starch, protein and fat. (a) Complete each sentence by choosing the correct words from the box. **amino acids** **protein** **fat** **starch** **fatty acids** **sugar** Amylase speeds up the digestion of ..... . The product of this digestion is ..... . Protease speeds up the digestion of ..... . The product of this digestion is ..... . **(4)** (b) Why do molecules of starch, protein and fat need to be digested? .... **(2)** (c) In which part of the digestive system does the digestion of starch begin? Draw a ring around your answer. **large intestine** **mouth** **small intestine** **stomach** **(1)** (d) What do we call substances like amylase and protease which speed up chemical reactions? ..... **(1)**

<table>
<tr><th colspan="3">Cells and systems</th></tr>
<tr><th>Book Ref.</th><th>Spec. Ref.</th><th>Homeostasis</th></tr>
<tr><td></td><td>4.5.1</td><td>Key information:
- Homeostasis is the regulation of the conditions inside a cell or organism.</td></tr>
<tr><td></td><td></td><td>1. What 3 variables are controlled in the body by homeostasis?

2. Why do cells need optimum conditions?

3. Complete the table to explain what each part of the control centre does:
<table>
<tr><th>Part of the control system</th><th>Example</th><th>What it does</th></tr>
<tr><td>Receptors</td><td></td><td></td></tr>
<tr><td></td><td></td><td>Receive and process information from receptors</td></tr>
<tr><td></td><td>Muscles or glands</td><td></td></tr>
</table></td></tr>
<tr><td></td><td></td><td>Prove It!</td></tr>
<tr><td></td><td></td><td>(b) A response is caused when information in the nervous system reaches an effector.
(i) There are two different types of effector.
Complete the table to show:
• the two different types of effector
• the response each type of effector makes.
<table>
<tr><th>Type of effector</th><th>Response the effector makes</th></tr>
<tr><td>1 .....</td><td>.....
.....</td></tr>
<tr><td>2 .....</td><td>.....
.....</td></tr>
</table>
(4)

(ii) Some effectors help to control body temperature.
Give one reason why it is important to control body temperature.
.....
.....
(1)</td></tr>
</table>

Cells and systems		
Book Ref.	**Spec. Ref.**	**Structure and function of the human nervous system**
	4.5.2.1	**Key information:** - The nervous system enables humans to react to their surroundings and to coordinate their behaviour. - Reflex actions are rapid; they do not involve the conscious part of the brain.
		4. What is the function of the central nervous system? **Identify** its two main parts. 5. Order the following into a reflex arc: COORDINATOR (CNS) STIMULUS EFFECTOR RESPONSE R ECEPTOR _____ → _____ → _____ → _____ → _____ 6. **Explain** why it is important that reflex actions are rapid. 7. **Describe** how information passes through the nervous system including the names of the neurones, a description of how the synapses work and what effectors and receptors are/do. 8. **Describe** how a sensory neurone is adapted to carry out its function.
		Prove It!
		Whilst observing mouse behaviour, a student drops a pen near the mouse's cage. The mouse jumps at the noise. Describe, as fully as you can, the processes by which the mouse responds to the stimulus of the dropped pen. **(6)**

<table>
<tr><th colspan="3">Cells and systems</th></tr>
<tr><th>Book Ref.</th><th>Spec. Ref.</th><th>Required practical 6 (biology: required practical 7): Plan and carry out an investigation into the effect of a factor on human reaction time.</th></tr>
<tr><td></td><td>4.5.2.1

AT 1, 3, 4</td><td>1. Identify two factors that can affect human reaction time.

2. Describe a method for using a ruler to investigate human reaction time.

3. Describe how to make sure that the results are reliable.

4. State the receptor and effector in the investigation you have described.</td></tr>
<tr><td></td><td></td><td>Maths Skills</td></tr>
<tr><td></td><td>MS 2c</td><td>Table 1 shows the students' results.

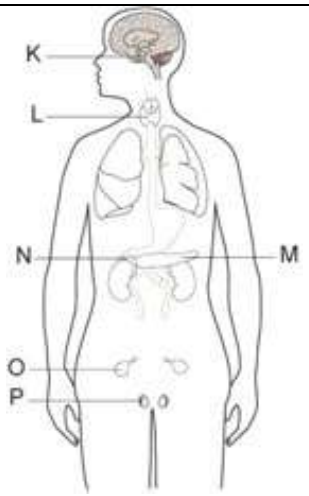
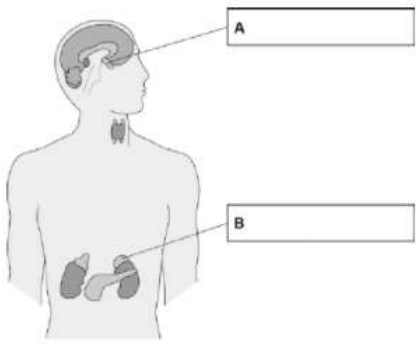
Table 1
<table><tr><th rowspan="2">Test number</th><th colspan="2">Distance ruler dropped in cm</th></tr><tr><th>Student A</th><th>Student B</th></tr><tr><td>1</td><td>9</td><td>12</td></tr><tr><td>2</td><td>2</td><td>13</td></tr><tr><td>3</td><td>6</td><td>13</td></tr><tr><td>4</td><td>7</td><td>9</td></tr><tr><td>5</td><td>7</td><td>8</td></tr><tr><td>Mean</td><td>7</td><td>X</td></tr></table>
Circle the anomalous result in Table 1 for Student A.
(1)

What is the median result for Student B?

Calculate the value of X in Table 1.

.....

Mean distance ruler dropped = ... cm
(1)</td></tr>
</table>

Cells and systems		
Book Ref.	**Spec. Ref.**	**Human endocrine system**
	4.5.3.1	**Key information:** - The endocrine system is composed of glands which secrete hormones directly into the bloodstream. The blood carries the hormone to a target organ where it produces an effect. - The pituitary gland in the brain is a 'master gland' which secretes several hormones into the blood in response to body conditions. These hormones in turn act on other glands to stimulate other hormones to be released to bring about effects
		 1. **Identify** the structures associated with the endocrine system: K: L: M: N: O: P: 2. **Describe, using an example**, the role of the pituitary gland. 3. **Name** the hormone released by: a) The testes b) The adrenal gland c) The thyroid gland 4. **Compare** the action of the endocrine system with the nervous system.
		Prove It!
		Glands in the body produce hormones. (a) Use words from the box to label gland **A** and gland **B** on the diagram below. **Adrenal** **Pancreas** **Pituitary** **Testis** **Thyroid**  **(2)** (b) Which gland produces oestrogen?

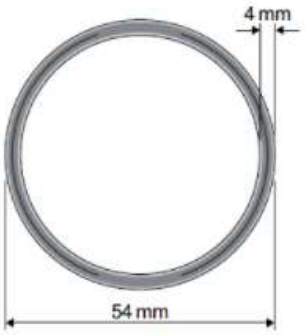
Cells and systems		
Book Ref.	**Spec. Ref.**	**Contraception**
	4.5.3.5	1. **Complete** the table to explain how each method of controlling fertility works.

Contraceptive Method	How it works
Oral contraceptives (the pill)	
Injection/Implant/Patch	
Barrier method e.g. condoms/ diaphragms	
Intrauterine Devices e.g. coil	
Spermicidal agents	
Timed abstinence	
Surgical sterilisation e.g. vasectomy	

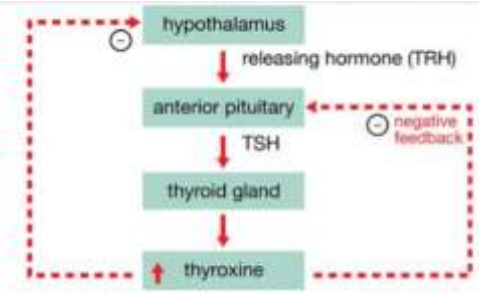
2. **Identify** the methods in the table above that are hormonal contraception.

3. **Explain** why some people oppose the use of contraception.

4. Some people choose to avoid having sexual intercourse when an egg may be in the oviduct. **Evaluate** this method of contraception.

		Prove It!
		Two methods of giving contraceptive hormones to a woman are the vaginal ring and the hormone implant. **Vaginal ring** The vaginal ring is a flexible ring 54 mm in diameter containing hormones.  The woman puts in and takes out the vaginal ring herself; there is no 'wrong' way to put the ring in. Each ring is designed for one cycle of use, which is three weeks of continuous ring use, followed by one week without the ring. About 0.3 % of women become pregnant in the first year of ring use. 4 % of women stop using the ring because of vaginal discomfort. **Hormone implant** A health professional puts the hormone implant under the skin of the woman's arm. The implant releases contraceptive hormones for three years before the implant needs to be replaced. The hormone implant is 100 % effective. About 2 % of women stop using the hormone implant, mainly because of irregular menstrual bleeding. Evaluate the use of the vaginal ring compared with the hormone implant. Remember to give a conclusion to your evaluation.

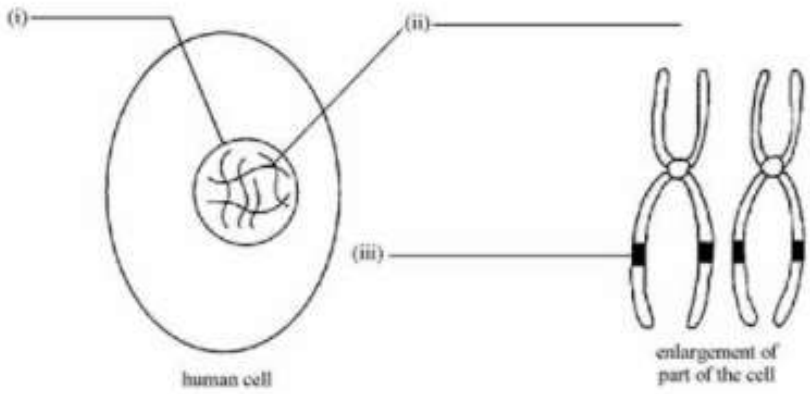
Cells and systems		
Book Ref.	**Spec. Ref.**	**The use of hormones to treat infertility (HT ONLY)**
	4.5.3.6	**Key information:** - Fertility drugs can be given to women to help them become pregnant naturally. - In Vitro Fertilisation (IVF) is an alternative method used by couples unable to get pregnant.
	WS1.3 WS1.4	1. **Name** the hormones in the drug given to women to help them become pregnant 'normally'. 2. **Explain** how these drugs interact to trigger the release of an egg. 3. **Describe** the process of IVF. 4. **Evaluate** (outline the advantages of disadvantages) the use of IVF as a fertility treatment.
		Prove It!
		The hormones FSH and LH are used in fertility treatment. Give the function in fertility treatment of: (i) FSH .... **(1)** (ii) LH. .... **(1)** In the first stage of in-vitro fertilisation (IVF), eggs from the mother are fertilised with sperm from the father. Describe the next stages of IVF. .... **(2)**

Cells and systems		
Book Ref.	**Spec. Ref.**	**Negative feedback (HT ONLY)**
	4.5.3.7	**Key information:** - Negative feedback processes ensure internal conditions are maintained within a narrow range.
		1. **Name** the hormone secreted by the adrenal gland. 2. **Describe** the effect of this hormone on heart rate. **Explain** the importance of this. 3. **Describe** the role of thyroxine in the human body.  4. **Explain** the concept of negative feedback, using thyroxine level control as an example.
		Prove It!
		Hyperthyroidism is caused by an overactive thyroid gland. Suggest what would happen in the body of a person with hyperthyroidism. .... **(3)**

Genetics and Evolution Keywords

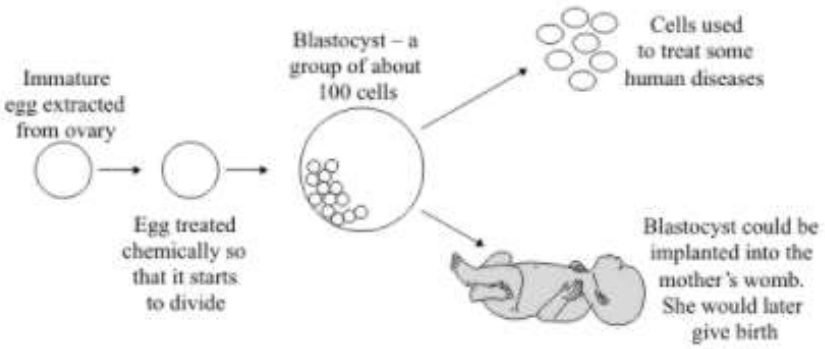
Add all the important keywords for this big idea in the grid below as you come across them in the study pack.

Word	Definition

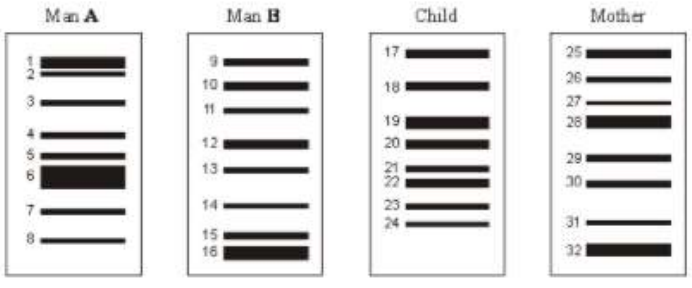
Genetics and evolution		
Book Ref.	**Spec. Ref.**	**Chromosomes**
	4.1.2.1	**Key information:** - The nucleus of a cell contains chromosomes made of DNA molecules. Each chromosome carries a large number of genes. In body cells the chromosomes are normally found in pairs.
		1. Order the following in terms of size (smallest to largest) CHROMOSOME NUCLEUS GENE CELL 2. **Explain** why we have two copies of each chromosome. 3. **State** what is meant by the term 'gene'. 4. **Identify** the two types of cell in the human body which contain half a set of chromosomes. **Outline** the importance of this.
		Prove It!
		The diagram shows a human cell and some of its contents. (a) Choose words from this list to label the diagrams. **chromosome** **cytoplasm** **gene** **nucleus**  **(3)** (b) Choose words from this list to complete the sentence. **a body cell** **an egg cell** **a gamete** **a sperm cell** In the cell above, the chromosomes are found in pairs so this cell must be ..... **(1)** **(Total 4 marks)**

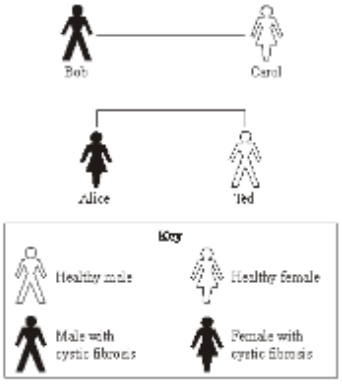
Genetics and evolution		
Book Ref.	**Spec. Ref.**	**Mitosis and the cell cycle**
	4.1.2.2	**Key information:** - Cells divide in a series of stages called the cell cycle. During the cell cycle, the genetic material is doubled and then divided into two genetically identical daughter cells. - Mitosis is important in the growth, repair and development of multicellular organisms.

		1. **Name** the organelle which contains genetic material. 2. **Describe** what happens in the 3 phases of the cell cycle. 3. **Explain** why a cell needs to grow before dividing by mitosis. 4. **State** the number of chromosomes in a human body cell: a) During stage 1 of the cell cycle: b) Just before mitosis: c) Just after mitosis: 5. **Suggest** why a root tip can be used for observing mitosis under the microscope.
		Prove It!
		(a) How many pairs of chromosomes are there in a body cell of a human baby? ..... **(1)** (b) Place the following in order of size, **starting with the smallest,** by writing numbers **1 – 4** in the boxes underneath the words. chromosome nucleus gene cell ☐ ☐ ☐ ☐ **(1)** (c) For a baby to grow, its cells must develop in a number of ways. Explain how each of the following is part of the growth process of a baby. (i) Cell enlargement ..... **(1)** (ii) The process of cell division by mitosis .... **(3)**

Genetics and evolution		
Book Ref.	**Spec. Ref.**	**Stem cells**
	4.1.2.3	**Key information:** - A stem cell is an undifferentiated cell of an organism which is capable of giving rise to many more cells of the same type, and from which certain other cells can arise from differentiation. - Stem cells from embryos can be cloned and made to differentiate into most different types of human cells. Stem cells from adult bone marrow can form many types of cells including blood cells. Treatment with stem cells may be able to help conditions such as diabetes and paralysis. Meristem tissue in plants can differentiate into any type of plant cell, throughout the life of a plant.
	WS1.3	1. **Define** the term 'stem cell'. 2. **Describe** the function of stem cells in: a) Embryos b) Adult animals c) Meristems in plants 3. **Describe** the process of therapeutic cloning using embryos. 4. **Evaluate** the use of embryonic stem cells for the treatment of diseases such as diabetes. 5. Stem cells from meristems can be used to produce clones quickly and economically. **Describe** two uses of this technique.
		Prove It!
		The diagram shows how an immature egg could be used either to produce cells to treat some human diseases or to produce a baby.  Scientists may be allowed to use this technique to produce cells to treat some human diseases, but not to produce babies. Using information from the diagram, suggest an explanation for this. (4)

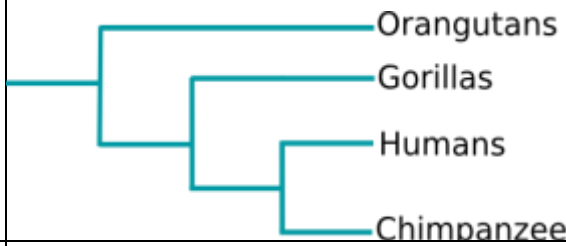
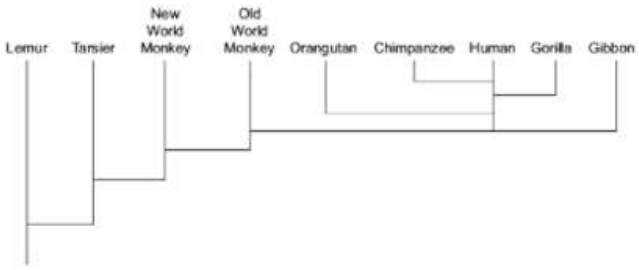
Genetics and evolution		
Book Ref.	**Spec. Ref.**	**Cancer**
	4.2.2.7	**Key information:** - Cancer is the result of changes in cells that lead to uncontrolled growth and division. - Tumours can be malignant or benign. - Both genetic factors and lifestyle choices can affect an individual's likelihood of developing cancer.
		1. What is cancer? 2. **Outline** the difference between a benign and a malignant tumour. 3. **Describe** how malignant tumours spread. 4. **Suggest** why cancer is more common in older people. 5. **Identify** three lifestyle choices that can increase an individual's risk of developing cancer. 6. Breast cancer is an example of a type of cancer that sometimes runs in families. **Suggest** why.
		Prove It!
		The number of people in the UK with tumours is increasing. (a) (i) Describe how tumours form. .... **(1)** (ii) Tumours can be malignant or benign. What is the difference between a malignant tumour and a benign tumour? .... **(1)** (b) Describe how some tumours may spread to other parts of the body. .... **(1)**

Genetics and evolution		
Book Ref.	**Spec. Ref.**	**DNA and the genome**
	4.6.1.4	**Key information:** - The genetic material in the nucleus is composed of a chemical called DNA. DNA is a polymer made up of two strands forming a double helix. The DNA is contained in structures called chromosomes. - Genes code for a particular sequence of amino acids which make a specific protein. - The genome of an organism is the entire genetic material of that organism. The whole human genome has now been studied and this will have great importance for medicine in the future.
		1. **Describe** the basic structure of DNA. 2. **State** the number of chromosomes in a normal human body cell. 3. **Define** the term 'gene'. **Outline** what a gene codes for. 4. **Explain** the difference between a *gene* and a *genome*. 5. **Name** the project which took twenty years to complete and involved mapping the entire human genome. 6. **Outline** the importance of understanding the human genome.
		Prove It!
		Chromosomes contain molecules of DNA. Genes are small sections of DNA. (a) Each gene contains a code. What does a cell use this code for? .... **(2)** (b) DNA fingerprints can be used to identify people. One example of the use of DNA fingerprints is to find out which man is the father of a child. The diagram shows the DNA fingerprints of a child, the child's mother and two men who claim to be the child's father. The numbers refer to the bars on the DNA fingerprints.  (i) Which man, **A** or **B**, is more likely to be the father of the child? ☐ Use the numbers on the DNA fingerprints to explain your choice. In your answer you should refer to all four people. (3)

Genetics and evolution		
Book Ref.	**Spec. Ref.**	**Inherited disorders**
	4.6.1.7	**Key information:** - Some disorders are caused by the inheritance of certain alleles, e.g. cystic fibrosis and polydactyly.
	MS 2d	1. **Name** a genetic disorder caused by a recessive allele. **Describe** the symptoms of this disorder. 2. **Explain** why disorders caused by dominant alleles are more common than disorders caused by recessive alleles. 3. **HT ONLY:** Construct a Punnett Square to show the possible genotypes and phenotypes of the offspring between two cystic fibrosis *carriers*. What is the proportion of healthy offspring to offspring with cystic fibrosis? What is the probability that their child will have cystic fibrosis? 4. **Explain** why embryos are screened for genetic disorders. Suggest reasons why some people are against the screening of embryos for polydactyly, despite it being caused by a dominant allele. 5. **Describe** the role of gene therapy in reducing the number of individuals who suffer from cystic fibrosis.
		Prove It!
		Cystic fibrosis is an inherited disorder that can seriously affect health. (a) Which **one** of these is affected by cystic fibrosis? Draw a ring around your answer. **blood system** **cell membranes** **kidneys** **nervous** **(1)** (b) The diagram shows the inheritance of cystic fibrosis in a family. The allele that produces cystic fibrosis is recessive.  (i) Explain why Alice inherited cystic fibrosis. .... **(2)** (ii) Explain why Ted did **not** inherit cystic fibrosis. .... **(2)**

Genetics and evolution		
Book Ref.	**Spec. Ref.**	**Sex determination**
	4.6.1.8	**Key information:** - Human body cells contain a pair of chromosomes, which carry the genes that determine sex.
		1. **State** the number of chromosomes found in human body cells. 2. A person has the genotype XX. **State** whether this person is male or female. 3. **State** the probability of a couple having a male. **Carry out a genetic cross** to support your answer.
		Prove It!
		(a) Complete the following passage Chromosomes carry genetic information. Chromosomes are made up of ..... . Human body cells contain 46 chromosomes. There are twenty-two matching pairs but the final pair does not always match. It is these two that determine the gender, or sex, of the human. If you are a ..... the final pair of chromosomes matches. If you are a ..... the final pair of chromosomes does not match. **(2)** (b) Draw a labelled diagram to show that there is an equal chance of parents producing a baby boy or girl. Use the symbols **X** and **Y** for the chromosomes. **(4)** **(Total 6 marks)**

Genetics and evolution		
Book Ref.	**Spec. Ref.**	**Variation**
	4.6.2.1	**Key information:** - There is extensive variation within a population of a species. - The phenotype (observable characteristics) of an organism is affected by both genetics and the environment. - Mutations occur continuously. Very rarely, a mutation will lead to a new characteristic. If the new characteristic is advantageous it can lead to a change in the species.
		1. **Give two examples each of variation caused by:** • genes - • the environment - • both - 2. **State** what causes variation. 3. **Explain** why there is extensive variation in human skin colour. 4. **Describe, using an example,** how a mutation can result in a change in a species.
		Prove It!
		Peas grow in pods on pea plants. A gardener grew four varieties of pea plants, **A** , **B** , **C** and **D** , in his garden. The gardener counted the number of peas in each pod growing on each plant. The table shows his results. **Variety** / **Range of number of peas in each pod** / **Mean number of peas in each pod** A / 2–6 / 4 B / 3–7 / 5 C / 3–8 / 6 D / 6–8 / 7 (a) Give **one** environmental factor and **one other** factor that might affect the number of peas in a pod. Environmental factor..... Other factor..... (2) (b) The gardener thinks that he will get the largest mass of peas from his garden if he grows variety **D**. Why is the gardener **not** correct? Suggest **one** reason. .... (1)

Genetics and evolution		
Book Ref.	**Spec. Ref.**	**Evolution**
	4.6.2.2	**Key information:** - The theory of evolution states that all species of living things have evolved from simple life forms that first developed more than three billion years ago. - Evolution is a change in the inherited characteristics of a population over time through a process of natural selection, which may result in the formation of a new species. - If two populations of one species become so different that they are no longer able to interbreed to produce fertile offspring, they have formed two new species.
		1. **State** what is meant by the term 'evolution'. 2. **Describe** the process of evolution by natural selection. 3. **Define** the term 'species'.  4. The diagram shows an evolutionary tree. **Identify** the species which is: a) the most closely related to humans. b) the most distantly related to humans.
		Prove It!
		The diagram shows the evolution of a group called the primates.  (a) Which primate evolved first? ..... (1) (b) Name **two** primates that developed most recently from the same common ancestor as humans. 1 ..... 2 ..... (2) (c) (i) The theory of evolution by natural selection was suggested in the 1800s. Which scientist suggested this theory? ..... (1) (ii) Use words from the box to complete the passage about natural selection. evolution / environment / generation / mutate / survive / variation Individual organisms of a species may show a wide range of ..... because of differences in their genes. Individuals with characteristics most suited to the ..... are more likely to ..... and breed successfully. The genes that have helped these individuals to survive are then passed on to the next .....

Genetics and evolution		
Book Ref.	**Spec. Ref.**	**Selective breeding**
	4.6.2.3	**Key information:** - Selective breeding is the process by which humans breed plants and animals for particular genetic characteristics. Humans have been doing this for thousands of years since they first bred food crops from wild plants and domesticated animals. - Selective breeding can lead to 'inbreeding', where some breeds are particularly prone to disease or inherited defects.
		1. **Give** three uses of selective breeding. 2. **Describe** why selective breeding is known as 'artificial selection'. 3. **Describe** the process of selective breeding. **Explain** why it occurs over many generations. 4. Pedigree dogs are often selectively bred. **Outline** the advantages and disadvantages of this.
		Prove It!
		Many different types of animals are produced using selective breeding. Some cats are selectively bred so that they do not cause allergies in people. (a) Suggest **two other** reasons why people might selectively breed cats. 1 .... 2 .... (2) (b) Selective breeding could cause problems of inbreeding in cats. Describe **one** problem inbreeding causes. ..... (1) (c) Many people have breathing problems because they are allergic to cats. The allergy is caused by a chemical called Fel D1. Different cats produce different amounts of Fel D1. A cat has been bred so that it does not produce Fel D1. The cat does **not** cause an allergic reaction. Explain how the cat has been produced using selective breeding. (4)

<table>
<tr><th colspan="3">Genetics and evolution</th></tr>
<tr><th>Book Ref.</th><th>Spec. Ref.</th><th>Classification of living organisms</th></tr>
<tr><td></td><td>4.6.4</td><td>Key information:
- Traditionally living things have been classified into groups depending on their structure and characteristics in a system developed by Carl Linnaeus.
- As evidence of internal structures become more developed due to improvements in microscopes, and the understanding of biochemical processes progressed, new models of classification were proposed.
- Due to evidence available from chemical analysis there is now a three domain system developed by Carl Woese.</td></tr>
<tr><td></td><td></td><td>1. Outline the Linnaeus system of classification.

2. Describe what is meant by the term ‘binomial naming system’.

3. Outline the three domains proposed by Carl Woese.

4. Humans are known as Homo sapiens. State the genus of humans.

5. Explain why classification systems are continually developing.</td></tr>
<tr><td></td><td></td><td>Prove It!</td></tr>
<tr><td></td><td></td><td>Table 1 shows how a bird called the bluethroat (Luscinia svecica) is classified by biologists.

Table 1
<table><tr><th>Taxon</th><th>Name of taxon</th></tr><tr><td>Domain</td><td>Eukaryota</td></tr><tr><td></td><td>Animalia</td></tr><tr><td></td><td>Chordata</td></tr><tr><td></td><td>Aves</td></tr><tr><td></td><td>Passeriformes</td></tr><tr><td></td><td>Muscicapidae</td></tr><tr><td>Genus</td><td></td></tr><tr><td>Species</td><td></td></tr></table>
(a) Complete Table 1 by filling the seven blank spaces with the correct terms.</td></tr>
</table>

Interdependence Keywords

Add all the important keywords for this big idea in the grid below as you come across them in the study pack.

Word	Definition

Interdependence

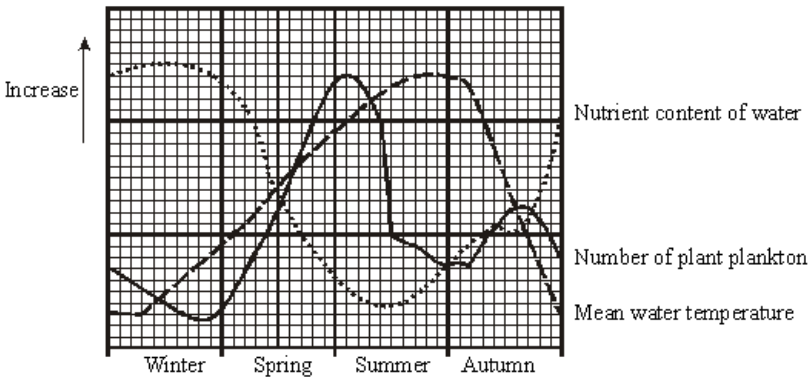
Book Ref.	Spec. Ref.	Communities
	4.7.1.1	**Key information:** - An **ecosystem** is the interaction of a community of living organisms with the non-living parts of their environment. - Organisms require a supply of materials from their surroundings and other living organisms there. - Plants compete with each other for light, space, water and mineral ions. - Animals compete with each other for food, mates and territory. - **Interdependence** means that communities of species depend on other species for food, shelter, pollination, water etc. If one species is removed, it can affect the whole community. - In a stable community, all the species and environmental factors are in balance and population sizes remain fairly constant.
		5. **Define** the term 'ecosystem'. 6. **Explain** why plants must compete for light. 7. Bees are pollinators. **Describe** the importance of bees to plants within a community. 8. Give another example of interdependence. 9. What is meant by the term 'stable community'?
	MS 4a	**Prove It!** Red squirrels are native to the UK. Grey squirrels were introduced to the UK from the USA over 100 years ago. **Table 2** gives information about the two types of squirrel. **Table 2** **(3)**

	Grey squirrel	Red squirrel
Population in UK	2.5 million	140 000
Main food types	Seeds, nuts, tree bark, birds' eggs, young birds	Cones from coniferous trees, nuts, tree bark, berries
Health	Can become immune to parapox virus	Cannot become immune to parapox virus
Reproduction	Up to 9 young, twice a year	Up to 6 young, twice a year
Survival rate of young in mixed populations	41 %	14 %
Length of life	2 – 4 years	Up to 7 years

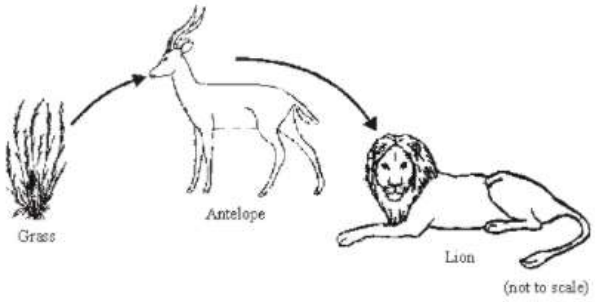
In most parts of the UK the population of grey squirrels is increasing, but the population of red squirrels is decreasing.

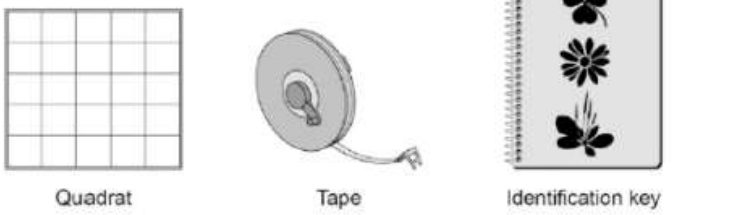
Suggest why.

Use information from **Table 2**.

Interdependence		
Book Ref.	**Spec. Ref.**	**Biotic and Abiotic factors**
	4.7.1.2 4.7.1.3	**Key information:** - Non-living factors which affect a community are known as **abiotic factors.** - Examples include: light intensity (photosynthesis), temperature (enzymes), moisture levels, soil pH and mineral content, wind intensity and direction, carbon dioxide levels (plants), oxygen levels (aquatic animals). - Living factors which affect a community are known as **biotic factors.** - Examples include: availability of food, new predators arriving, new pathogens, one species outcompeting another so the numbers are no longer sufficient to breed.
		1. **Outline** the difference between biotic and abiotic factors, using examples. 2. **Give** two factors for which animals may compete. 3. **State** the process that occurs in animals and plants which requires oxygen. **Explain** the importance of this process for growth. 4. **Give two reasons why** plants grow slowly in winter.
	MS 4a WS 1.2	**Prove It!** Plant plankton are aquatic microscopic organisms that photosynthesise. The graph shows the numbers of plant plankton in the North Sea at different times of the year.  Use the data and your knowledge of photosynthesis and growth to explain: (a) why numbers of plant plankton were low in winter but increased rapidly during the spring, ... **(3)**

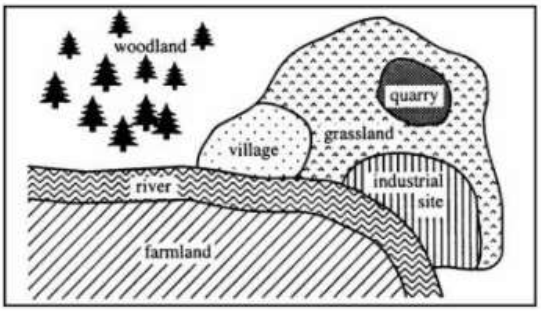
Interdependence		
Book Ref.	**Spec. Ref.**	**Adaptations**
	4.7.1.4	**Key information:** - Adaptations are features that enable them to survive in the conditions in which they normally live. These adaptations may be structural, behavioural or functional. - **Extremophiles** live in environments that are very extreme, such as at high temperature, pressure, or salt concentration.
		1. **Describe** how a cactus is adapted to survive in the desert. 2. **Explain** how having a large surface area to volume ratio keeps an organism cool. 3. **Describe** what is meant by the term 'extremophile', using an example.
		Prove It!
		In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate. Animals and plants have features (adaptations) that allow them to survive in the conditions in which they normally live. Describe how animals and plants are adapted to survive in dry conditions such as deserts. For each adaptation that you give, describe how the adaptation helps the animal or plant to survive in dry conditions. To obtain full marks you should refer to **both** animals and plants. **(6)**

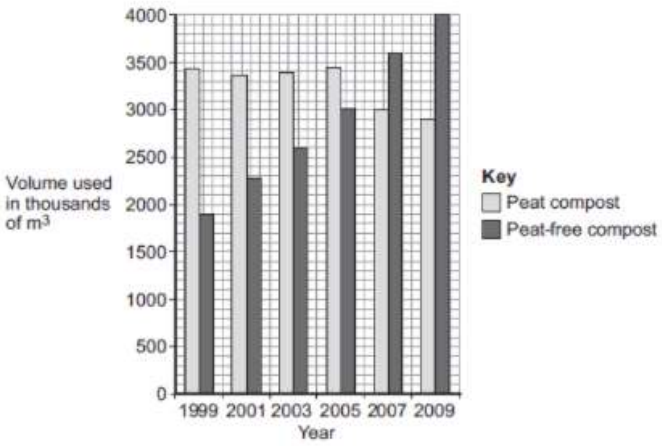
Interdependence		
Book Ref.	**Spec. Ref.**	**Levels of organisation**
	4.7.2.1	**Key information:** - Photosynthetic organisms (plants and algae) are the **producers** of biomass for life on Earth. - Transects and quadrats are used to determine the distribution and abundance of species in an ecosystem. - All organisms are part of a food chain: Producer → Primary consumer → Secondary consumer → Tertiary consumer - **Predators** kill and eat other animals. **Prey** are the animals eaten.
		The diagram shows a food chain. **oak tree** → **caterpillar** → **blue-tit** → **hawk** 1. **Name** the producer in this food chain. **State** the process that the producer uses to produce glucose. 2. **Name** the tertiary consumer. 3. **Describe**, using examples from the food chain, the relationship between a predator and prey. 4. Define the term 'biomass'.
		Prove It!
		Figure 1 shows a food chain containing three organisms.  **Figure 1** (a) (i) In this food chain, name: the predator; ..... the prey. ..... **(2)** (ii) What is the source of energy for the grass? Draw a ring around **one** answer. **carbon dioxide** **light** **nitrates** **water** **(1)** (iii) **Figure 2** shows a pyramid of biomass for the organisms in **Figure 1.** Write the names of the organisms on the correct lines in **Figure 2.** **Figure 2** **(1)**

Interdependence		
Book Ref.	**Spec. Ref.**	**Required practical 7 (biology: required practical 9): Measure the population size of a common species in a habitat. Use sampling techniques to investigate the effect of a factor on the distribution of this species.**
	4.7.2.1 AT 1, 3, 4, 6	**Key information:** - Quadrats are used to measure the abundance of plants or slow moving organisms in an area. The area to be sampled is given grid references and a random number generator is used to randomly place the quadrat in different places. This reduces bias and increases validity. - Transects can be used to measure how the distribution and abundance of plants changes across a certain distance. - Repeats are used in order that a mean number of organisms can be calculated. This ensures repeatability - Other scientists may carry out the same investigation. This ensures reproducibility.
	WS 2.2	 Quadrat Tape Identification key Not drawn to scale **Describe** how the student would use the equipment shown to estimate how many clover plants there are in the school field.
		Maths skills
	MS 2b, 2f	The table below shows the student's results. **Quadrat number** / **Number of clover plants counted** 1 — 11 2 — 8 3 — 11 4 — 9 5 — 1 Total — 40 The area of the school field was 500 m^2. The quadrat used in the table above had an area of 0.25 m^2. 1. **Calculate** the mean average of clover plants. Make sure to remove anomalous results. 2. **Calculate** the estimated number of clover plants in the school field. 3. **Identify** the mode number of clover plants from the results in the table above.

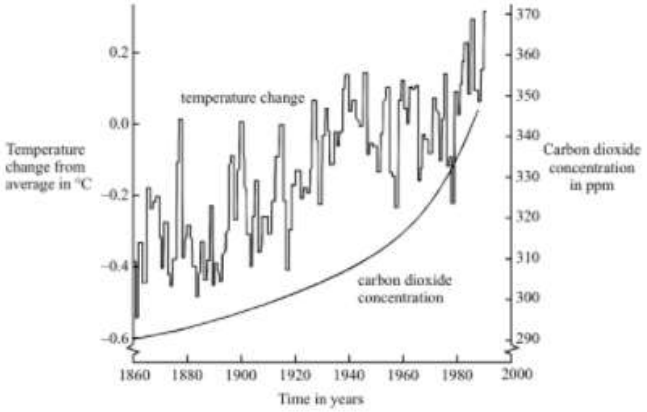
Interdependence		
Book Ref.	**Spec. Ref.**	**How materials are cycled**
	4.7.2.2	**Key information:** - The carbon cycle returns carbon from organisms to the atmosphere as carbon dioxide to be used by plants in photosynthesis. - The water cycle provides fresh water for plants and animals on land before draining into the seas. Water is continuously evaporated and precipitated. - Microorganisms cycle materials through an ecosystem through the process of decay. As the microorganisms respire, they release the carbon trapped in materials as carbon dioxide into the atmosphere. At the same time, mineral ions are released to the soil.
		1. **Give** an example of a material that is cycled through an ecosystem. 2. **Name** the process plants carry out which converts carbon dioxide into organic compounds (glucose). **Outline** three uses of this glucose in plants. 3. **Name** the process carried out by animals and plants that releases carbon dioxide back into the atmosphere. 4. **Describe** the role of micro-organisms in the cycling of nutrients.
		Prove It!
		Some of the leaves from the gardener's strawberry plant die. The dead leaves fall off the strawberry plant onto the ground. The carbon in the dead leaves is recycled through the carbon cycle. Explain how the carbon is recycled into the growth of new leaves. .... (6)

Interdependence		
Book Ref.	**Spec. Ref.**	**Biodiversity**
	4.7.3.1	**Key information:** - Biodiversity is the variety of all the different species of organisms on Earth, or within an ecosystem. - A great biodiversity ensures the stability of ecosystems by increasing the availability of food and shelter for organisms. - Many human activities, such as deforestation, are reducing biodiversity. Only recently have measures been taken to try and stop this reduction. One way is carbon sequestration.
	WS 1.4	1. **Define** the term 'biodiversity'. 2. **Suggest** why deforestation causes a reduction in biodiversity. **Explain** the negative impact of this to human populations. 3. **Outline** one way in which carbon can be 'sequestered'. Give a reason why carbon sequestration is important.
		Prove It!
		Deforestation affects the environment in many ways. (a) Deforestation increases the amount of carbon dioxide in the atmosphere. Give **two** reasons why. 1 .... 2 .... **(2)** (b) Deforestation also results in a loss of *biodiversity*. (i) What is meant by *biodiversity*? .... **(1)** (ii) Give **two** reasons why it is important to prevent organisms becoming extinct. 1 .... 2 .... **(2)** **(Total 5 marks)**

Interdependence		
Book Ref.	**Spec. Ref.**	**Waste management**
	4.7.3.2	**Key information:** - Rapid growth in the human population and an increase in the standard of living mean that increasingly more resources are used and more waste is produced. - Pollution kills plants and animals which can reduce biodiversity. - Water pollution can occur from sewage, fertiliser or toxic chemicals. - Air pollution can occur from smoke and acidic gases. - Land pollution can occur from landfill and from toxic chemicals.
		1. **Describe** why pollution can result in a loss of biodiversity. 2. **Name** two human activities which result in air pollution. 3. Sewage reduces the concentration of oxygen in water. **Explain** why this results in a loss of biodiversity. 4. **Suggest** how we can reduce the amount of land pollution. 5. **Explain** why waste management is becoming more important.
		Prove It!
		The diagram shows a village and its surroundings.  (a) Use words from the list to complete the sentences about pollution. **oxygen** **pesticides** **sewage** **sulphur dioxide** The air might be polluted by ..... from the industrial site. The river might be polluted by ..... from the village and by ..... from the farmland. **(3)** (b) The owners of the quarry want to make it larger. Give **one** effect that this might have on wild plants and animals that live near the quarry. .... **(1)** **(Total 4 marks)**

Interdependence		
Book Ref.	**Spec. Ref.**	**Land use**
	4.7.3.3	**Key information:** - Humans reduce the amount of land available for other animals and plants by building, quarrying, farming and dumping waste. - Peat bogs are wetland areas made up of partially decomposing material. Peat is used as garden compost because it contains a high concentration of mineral ions. The destruction of peat bogs results in a loss of biodiversity. - The decay or burning of peat releases carbon dioxide into the environment.
	WS 1.4, 1.5	1. **Identify** four ways in which humans reduce the amount of land available for other animals and plants. 2. **Explain** why farmers often use peat as a fertiliser. 3. **Describe** why the burning of peat contributes to global warming. 4. **Evaluate** (consider the reasons for and against) the use of peat as a fertiliser for growing crops.
		Maths skills
	WS 3.5	Human activities have many effects on our ecosystem. The graph shows the volume of peat compost and peat-free compost used in gardening from 1999 to 2009.  (a) Describe the trends shown in the graph. .... **(2)** (b) What effect does the destruction of peat bogs have on the gases in the atmosphere? .... **(1)**

Interdependence		
Book Ref.	**Spec. Ref.**	**Deforestation**
	4.7.3.4	**Key information:** - Large-scale deforestation in tropical areas has occurred in order to provide land for cattle and rice fields, and grow crops for biofuel.
	WS 1.4	1. **Describe** why deforestation has occurred in tropical areas. 2. **Evaluate** (consider the reasons for and against) the carrying out of large-scale deforestation in order to provide land for cattle and rice fields. 3. **Explain**, using your knowledge of the carbon cycle, why deforestation affects the composition of atmospheric gases.
		Prove It!
		Clearing forests and replacing the forests with palm oil trees to produce fuel for motor vehicles will affect the composition of the atmosphere. Explain how. .... **(5)**

Interdependence		
Book Ref.	**Spec. Ref.**	**Global warming**
	4.7.3.5 WS 1.6	**Key information:** - Global warming is the observed increase in the average surface temperature due to the effect of greenhouse gases. Increasing levels of the two main greenhouse gases, carbon dioxide and methane, are contributing to global warming. - Scientific publications are always peer-reviewed. Scientists review each other's work regularly in order to understand more about global warming and climate change. During this process, scientists try and repeat each other's work in order to check its validity and give each other feedback.
		1. **Describe**, using examples, the consequences of global warming for biodiversity. 2. **Give three reasons** why the levels of carbon dioxide and methane in the atmosphere are increasing. 3. **Describe** the process of peer-review. Explain why it is important.
		Prove It!
	WS 1.4	The graph shows changes in temperature and in carbon dioxide concentration in the earth's atmosphere between 1860 and 1990.  (a) Give **two** human activities which may have helped to increase the concentration of carbon dioxide in the atmosphere. 1 ..... 2 ..... (2) (b) (i) Describe the changes in temperature shown by the graph between 1860 and 1990. .... (2) (ii) Do the data in the graph prove that increased carbon dioxide concentrations in the atmosphere caused the changes in temperature you described in part (b)(i)? Give a reason for your answer. .... (1) (c) Describe **one** way in which a change in temperature such as that shown in the graph might affect the environment. .... (1)

<table>
<tr><th colspan="3">Interdependence</th></tr>
<tr><th>Book Ref.</th><th>Spec. Ref.</th><th>Maintaining biodiversity</th></tr>
<tr><td></td><td>4.7.3.6</td><td>Key information:
- Scientists and concerned citizens have put in place programmes to reduce the negative effects of humans on ecosystems and biodiversity. These include breeding programmes for endangered species, protection and regeneration of rare habitats, re-introduction of hedgerows in agricultural areas where farmers grow only one type of crop, reduction of deforestation and carbon dioxide emissions and recycling initiatives.</td></tr>
<tr><td></td><td></td><td>1) Explain why breeding programmes are important for maintaining biodiversity.

2) Suggest why rare habitats are protected. Describe the effect of this on global biodiversity.

3) Explain why hedgerows between fields are important for maintaining biodiversity.

4) Give three examples of materials which can be recycled. Outline two environmental benefits of recycling.</td></tr>
<tr><td></td><td></td><td>Prove It!</td></tr>
<tr><td></td><td>WS 1.4</td><td>The table below shows how the mass of household waste in the UK has changed from 2004 to 2012.

<table>
<tr><th>Year</th><th>Total mass of household waste in thousands of tonnes (including total household recycling)</th><th>Total mass of household recycling in thousands of tonnes</th><th>Percentage of household waste recycled</th></tr>
<tr><td>2004</td><td>25 658</td><td>5785</td><td>22.5</td></tr>
<tr><td>2006</td><td>25 775</td><td>7976</td><td>30.9</td></tr>
<tr><td>2008</td><td>24 334</td><td>9398</td><td>38.6</td></tr>
<tr><td>2010</td><td>23 454</td><td>9733</td><td></td></tr>
<tr><td>2012</td><td>22 643</td><td>9782</td><td>43.2</td></tr>
</table>

The UK government has been encouraging a 'zero waste economy'.

In a 'zero waste economy', we reduce, reuse and recycle as much waste as possible.

A newspaper concluded that: 'The government's 'zero waste economy' has been successful.'

Use information from the table to describe the reasons for and against the newspaper's conclusion.

(4)</td></tr>
</table>

Microbes and Health Keywords

Add all the important keywords for this big idea in the grid below as you come across them in the study pack.

Word	Definition

Microbes and Health

Book Ref.	Spec. Ref.	The human digestive system
	4.2.2.1	**Key information:** - The digestive system is an organ system where several organs work together to absorb and digest food. - Digestive enzymes convert large insoluble molecules into smaller soluble ones so they can be absorbed into the blood stream.

1. **Complete** the table to summarise the role of the organs in the digestive system:

Organ	Role
Salivary glands	
Oesophagus	
Stomach	
Liver	
Pancreas	
Small intestine	
Large intestine	

2. What does a digestive enzyme do?

3. Complete the table about enzymes:

Enzyme	Large insoluble molecule the enzyme breaks down	Small soluble molecule(s) that are formed	Where the enzyme is produced	Where the enzyme works
Carbohydrase				
	Fats (lipids)			
		Amino acids		

4. **Explain** enzyme action using the lock and key theory.

5. **Describe** the 2 functions of bile and **state** where it is made and where it is stored.

Prove It!

A student has eaten a steak for dinner. The steak contains protein and fat.

(i) Describe how the **protein** is digested.

(3)

(ii) Explain **two** ways in which bile helps the body to digest **fat**.

(4)

<table>
<tr><th colspan="3">Microbes and Health</th></tr>
<tr><th>Book Ref.</th><th>Spec. Ref.</th><th>Required practical 3 (biology: required practical 4): Use qualitative reagents to test for a range of carbohydrates, lipids and proteins.</th></tr>
<tr><td></td><td>4.2.2.1

AT2,8</td><td>1. Outline how you would prepare a sample of solid food for a food test.

2. Complete the table to summarise the 4 food tests:
<table>
<tr><th>Test</th><th>What type does it test for?</th><th>What is the method?</th><th>What does the positive result look like?</th></tr>
<tr><td>Benedict's</td><td></td><td></td><td></td></tr>
<tr><td>Iodine solution</td><td></td><td></td><td></td></tr>
<tr><td>Biuret</td><td></td><td></td><td></td></tr>
<tr><td>Sudan III</td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td></td><td></td><td>Risk Assessment</td></tr>
<tr><td></td><td>WS2.4</td><td>Outline any hazards in this experiment along with the associated risks and how to minimise them.</td></tr>
</table>

Microbes and Health		
Book Ref.	**Spec. Ref.**	**Required practical 4 (biology: required practical 5): Investigate the effect of pH on the rate of reaction of amylase enzyme.**
	4.2.2.1 AT1,2,5,8 WS2.1 WS2.2 WS2.5	1. **Outline** a method for this practical that uses a continuous sampling technique. 2. **Suggest** a hypothesis for the experiment outlined above. 3. **Identify** 3 possible sources of error in the experiment and identify how you would control or monitor them.

Microbes and Health

Book Ref.	Spec. Ref.	Coronary heart disease: a non-communicable disease
	4.2.2.4	1. **Describe** what has happened inside the body of someone who has coronary heart disease. 2. Describe the consequence of a person having a faulty valve and the methods used to treat it. 3. Complete the table to summarise some treatments for CHD:

Treatment	Description of treatment	When it is used
Statins		
Stents		
Mechanical or biological valves		
Transplant		

Prove It!

Explain how the build-up of fatty material can damage the heart.

.....

.....

.....

.....

.....

.....

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.....

.....

.....

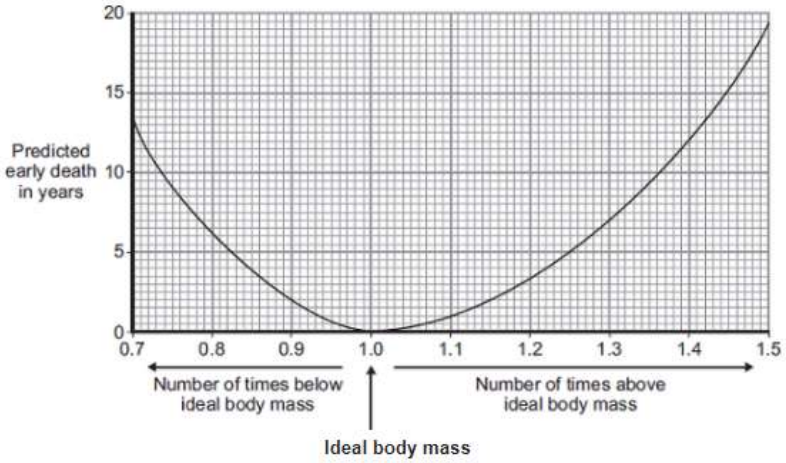
(4)

Describe how statins can help to reduce deaths from CHD.

.....

.....

.....

Microbes and Health		
Book Ref.	**Spec. Ref.**	**Health Issues and the effect of lifestyle on some non-communicable diseases**
	4.2.2.5 4.2.2.6	1. **State** 3 lifestyle factors that can affect both mental and physical health. 2. Which type of pathogen, living in cells, can be a trigger for cancer? 3. What can immune reactions (originally caused by a pathogen) be a trigger for? 4. What mental illness can severe physical health problems cause? 5. What physical problems can smoking cause? 6. Which organs does drinking alcohol affect the most?
		Maths Skills
	MS2c MS4a	(b) Predicted early death is the number of years that a person will die before the mean age of death for the whole population. The predicted early death of a person is affected by their body mass. Scientists have calculated the effect of body mass on predicted early death. The graph shows the results of the scientists' calculations.  The number of times above or below ideal body mass is given by the equation: Actual body mass In the UK the mean age of death for women is 82. A woman has a body mass of 70 kg. The woman's ideal body mass is 56 kg. (i) Use the information from the graph to predict the age of this woman when she dies. .... Age at death = ... years **(2)**

Microbes and Health		
Book Ref.	**Spec. Ref.**	**Cancer**
	4.2.2.7	1. **Describe** what is happening to cells in someone with cancer. 2. What is a benign tumour? 3. How are malignant tumours different to benign tumours? 4. **Suggest** three factors that are linked with an increased risk of getting cancer.
		Prove It!
		(b) Why can cancers grow very large? Tick **one** box. Cancer cells are specialised ☐ Cell division is slow ☐ Cell division is uncontrolled ☐ (c) Give **one** factor which increases the risk of getting cancer. ..... (g) Suggest **two** reasons why the survival rates for all cancers have increased. 1 .... 2 ....

Microbes and Health		
Book Ref.	**Spec. Ref.**	**Communicable Diseases**
	4.3.1.1	**Key information:** - Pathogens are microorganisms that can cause disease. They can infect plants or animals and can be spread by direct contact, water or air.
		1. **Define the term 'pathogen'.** 2. **State** the names of the 4 types of pathogen. 3. **Suggest** 2 ways the spread of disease can be reduced or prevented. 4. How do bacteria make you feel ill? 5. How do viruses make you feel ill?
		Prove it!
		1. a) What causes infectious diseases? (1) …… a) How do pathogens make you feel ill? (2) …… 2. a) Give two ways in which diseases are spread from one person to another. (2) …… …… b) Give two ways in which diseases are spread from one plant to another. (2) …… …… c) For each method given in part a) and part b), explain how the pathogens are passed from one organism to another. (4) …… …… …… ……

Microbes and Health

Book Ref.	Spec. Ref.	Viral and Bacterial Diseases
	4.3.1.2 4.3.1.3	**Key information:** - The flu (influenza), measles, HIV and tobacco mosaic virus (TMV) are all examples of viral diseases. - Salmonella which causes food poisoning and Gonorrhoea (a sexually transmitted infection) are caused by bacteria.

1. Complete the table about viral diseases.

Disease	Affects humans or plants?	Symptoms	How is it spread?	How can it be prevented or treated?
Measles				
HIV				
TMV			N/A	N/A

2. Complete the table about bacterial diseases.

Disease	Symptoms	How is it spread?	How can it be prevented or treated?
Salmonella			
Gonorrhoea			

Prove It!

TMV destroys chloroplasts in the leaf.

Explain how this could affect the growth of the plant.

(3)

Microbes and Health

Book Ref.	Spec. Ref.	Fungal and Protist Diseases
	4.3.1.4 4.3.1.5	**Key information:** - Rose black spot is a fungal disease affecting plant growth. - Malaria is caused by protists.

1. Complete the table about fungal and protist diseases.

Disease	Affects humans or plants?	Caused by protist or fungus?	Symptoms	How is it spread?	How can it be prevented or treated?
Rose black spot					
Malaria					

Prove It!

Pathogens cause infectious diseases in animals and plants.

(a) Draw **one** line from each disease to the type of pathogen that causes the disease.

Disease	Type of pathogen
Gonorrhoea	Bacterium
Malaria	Fungus
Measles	Protist
	Virus

Microbes and Health		
Book Ref.	**Spec. Ref.**	**Human Defence Systems**
	4.3.1.6	1. Complete the table to summarise the defence systems of the human body:

Body Part	How it defends against pathogens
Skin	
Nose	
Trachea and bronchi	
Stomach	

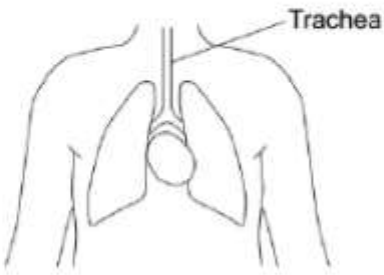
2. **Describe** the 3 ways which white blood cells defend the body against pathogens.

Prove It!

Some parts of the human body have adaptations to reduce the entry of live pathogens.

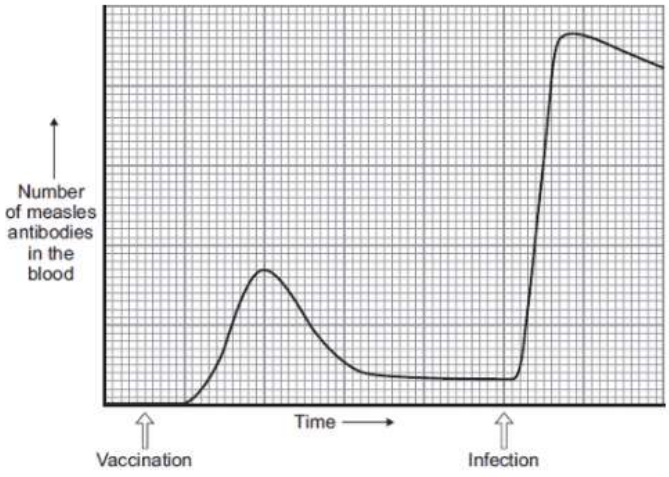
Look at **Figure 1**.

Figure 1



Explain how the trachea is adapted to reduce the entry of live pathogens.

(3)

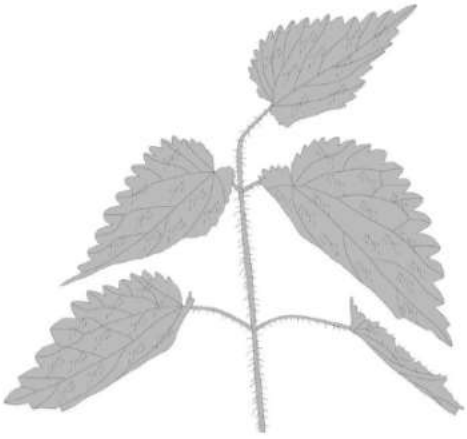
Microbes and Health		
Book Ref.	**Spec. Ref.**	**Vaccination**
	4.3.1.7	**Key information:** - Spread of pathogens can be reduced by vaccinating a large amount of the population. - A vaccine prevents an individual becoming infected with and spreading a specific pathogen. - Vaccinations work by introducing small amounts of dead/inactive pathogens into the body causing the white blood cells to respond.
		1. What does a vaccination contain? 2. **Describe** how a vaccination protects a person from becoming infected by a specific pathogen. 3. **Evaluate** the idea that it should be compulsory for all parents to get their child vaccinated.
		Prove It!
		(ii) A few weeks after the vaccination, the child becomes infected with measles viruses from another person. The graph shows the number of measles antibodies in the child's blood from before the vaccination until after the infection.  More measles antibodies are produced after the infection than after the vaccination. 1. Describe other differences in antibody production after infection compared with after vaccination. (3) 2. Vaccination against measles will not protect a child against rubella. Why? (1) 3. What is the advantage of protecting a large proportion of the population against measles? (1)

Microbes and Health		
Book Ref.	**Spec. Ref.**	**Antibiotics and Painkillers**
	4.3.1.8	1. What is an antibiotic? Give an example. 2. Why are doctors being encouraged to reduce the amount of antibiotics they are prescribing? 3. Why can antibiotics not be used to treat the flu? 4. Why is it difficult to create a drug that kills the flu? 5. What is a painkiller? How is it different to an antibiotic?
		Prove It!
		Antibiotics are used to treat bacterial infections, but not viral infections. (a) Explain why antibiotics are **not** effective against viral infections. .... **(2)** (b) New strains of bacteria have developed that are resistant to antibiotics. There is no effective treatment against these resistant strains. What must be done to make sure we will be able to treat bacterial infections in the future? .... **(2)**

Microbes and Health		
Book Ref.	**Spec. Ref.**	**Detection and identification of plant diseases (biology only - HT only)**
	HT and triple only 4.3.3.1	**1. List** 7 ways plant diseases can be detected. **2. List** 3 ways an identification of a plant disease can be made. **3.** Other than pathogens, how else can plants get infected? Give an example. **4. Complete** the table to summarise the problems plants have with mineral deficiency:

Ion that is deficient	Problem caused	Process interfered with
Nitrate		
Magnesium		

		Prove It!
		A gardener is looking at the plants in his greenhouse. (a) Some of the plants have a disease. Give **two** ways the gardener could identify the pathogen infecting the plants. 1 .... 2 .... **(2)** (b) Plants can become unhealthy if they do not have essential mineral ions. Describe the appearance of plants with: • **nitrate** deficiency • **magnesium** deficiency. Nitrate deficiency .... Magnesium deficiency .... **(2)**

Microbes and Health		
Book Ref.	**Spec. Ref.**	**Plant defence responses**
	4.3.3.2	1. **Describe** in detail 3 physical defence responses that plants have to resist invasion of microorganisms. 2. **Describe** 2 chemical plant defence responses. 3. **Suggest** 3 mechanical adaptations plants may have to defend against being eaten by animals.
		Prove It!
		Plants have adaptations to help defend themselves and to help them survive. **Figure 1** shows a nettle plant. **Figure 1**  (a) Explain how the nettle is adapted for defence and protection.

Particles and Bonding Keywords

Add all the important keywords for this big idea in the grid below as you come across them in the study pack.

Word	Definition

Particles and Bonding		
Book Ref.	**Spec. Ref.**	**Atoms, Elements and Compounds**
	CS 5.1.1.1 Triple 4.1.1.1	10. What is the smallest part of an element that can exist? 11. Define the term compound and give an example. 12. Complete the table below:

Name	Formulae	Element or compound?	Number of atoms?	Number of elements?
Oxygen				
	$CaCl_2$			
Sodium sulfate				

Prove It!

When sulfuric acid is added to sodium hydroxide a reaction occurs to produce two products.

The equation is:

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

How many elements are in the formula H_2SO_4?

Tick **one** box.

3 ☐

4 ☐

6 ☐

7 ☐

(1)

Maths Skills

Balance the following equations:

$H_2 + O_2 \rightarrow H_2O$

$CH_4 + O_2 \rightarrow CO_2 + H_2O$

$Na + Cl_2 \rightarrow NaCl$

$Fe + O_2 \rightarrow Fe_2O_3$

$Al + Br_2 \rightarrow AlBr_3$

$CaO + H_2O \rightarrow Ca(OH)_2$

Particles and Bonding

Mixtures

Book Ref. | **Spec. Ref.**

CS 5.1.1.2

Triple 4.1.1.2

WS2.7 MS2c

1. Define the term mixture and give an example.

2. When mixtures are separated is this a physical or chemical process?

3. Complete the table below:

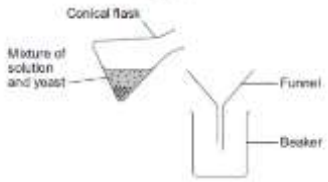
Substances to be separated	Name of separating technique	Description of how the technique works.
Sand and water		
Salt and water		
Water and ethanol		
Mixture of food colourings		

4. What is wrong with the setup of the equipment below to separate the solid yeast from the solution?

The student wanted to separate the solid yeast from the solution.

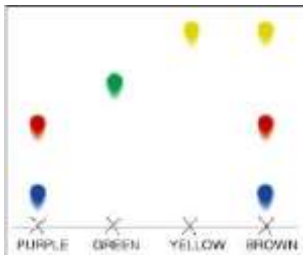
Figure 3 shows the apparatus used.

Figure 3



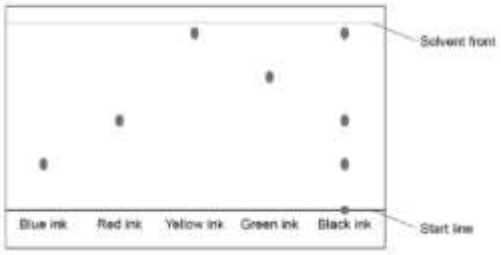
5. Which property of substances in a mixture allows-distillation to work?

6. How many colours make up brown? How do you know? Which colour is the most soluble?



Prove It!

The figure below shows a paper chromatogram of five different inks.



Analyse the chromatogram. Describe and explain the result for black ink. (4)

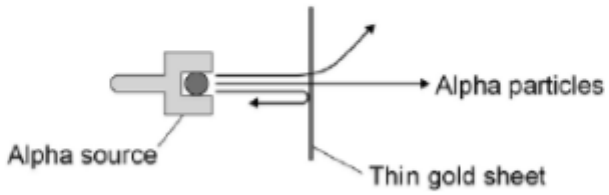
Particles and Bonding		
Book Ref.	**Spec. Ref.**	**The Development of the Model of the Atom**
	CS 5.1.1.3 Triple 4.1.1.3 WS1.1 WS1.2	1. Which model describes the atom as s a ball of positive charge with negative electrons embedded in it? 2. Name the experiment which led scientists to believe the mass of an atom was mostly in the centre. 3. What evidence led them to believe there was a positive nucleus? 4. What was the name of the model resulting from the experiment above? 5. How did Niels Bohr improve the nuclear model? 6. Which scientist provided evidence to show the nucleus contained neutrons as well as protons?

Prove It!

In 1911 the scientists Geiger and Marsden investigated the effect of firing alpha particles at very thin sheets of gold foil.

Their experiment is shown in **Figure 2**. The arrows show the paths taken by alpha particles in the experiment.

Figure 2



(a) Explain why scientists replaced the plum pudding model of the atom with the nuclear model of the atom as a result of the experiment.

(4)

Particles and Bonding

Book Ref.	Spec. Ref.	Atoms

CS 5.1.1.4 5.1.1.5

Triple 4.1.1.4 4.1.1.5

1. Complete the table to show the names of the 3 sub-atomic particles and their relative charges and masses.

Sub-Atomic Particle	Relative Mass	Relative Charge
	1	
electron		
		+1

2. In terms of sub-atomic particles, define the following terms:
   a) atomic number

   b) mass number

3. Where is the majority of mass found in an atom?

4. What is the approximate radius of:
   a) an atom?
   b) the nucleus of an atom?
   Give your answer in standard form.

5. Define the term isotope and give an example.

Prove It!

Explain the difference between the two isotopes of carbon below in terms of their sub atomic particles.

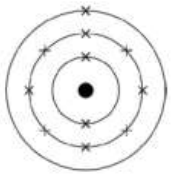
$^{12}_{6}C$ $^{13}_{6}C$

MS 1b

Maths Skills

Convert the following numbers into standard form and vice versa:

Ordinary Number	Standard Form
80000000	
724000	
371.45	
1200	
400	
	2.168×10^7
	7×10^2
	8.1×10^3
	3×10^5
	5.4718×10^2

Particles and Bonding		
Book Ref.	**Spec. Ref.**	**RAM and Electronic Structure**
	CS 5.1.1.6 5.1.1.7 Triple 4.1.1.6 4.1.1.7 WS1.2	1. Define the term relative atomic mass. 2. Explain why the relative atomic mass of chlorine is not a whole number. 3. Name the element that has its electron configuration shown below.  4. On the diagram above, label the lowest and highest energy levels (shells). Which shell is filled first?

Maths Skills

Balance the following equations:

Element	Isotopes	Percentage Abudance	Relative atomic mass
Lithium	$^{6}_{3}Li$	**7.6%**	
	$^{7}_{3}Li$	**92.4%**	
Magnesium	$^{24}_{12}Mg$	**79%**	
	$^{25}_{12}Mg$	**10%**	
	$^{26}_{12}Mg$	**11%**	
Copper	$^{63}_{29}Cu$	**70%**	
	$^{65}_{29}Cu$	**30%**	

Particles and Bonding		
Book Ref.	**Spec. Ref.**	**Chemical Bonds and Ionic Bonding**

CS 5.2.1.1 5.2.1.2

Triple 4.2.1.1 4.2.1.2

1. Tick the correct box to show which bond occurs between which types of atom

Type of bond	Non-metal + Non-metal	Metal + Metal	Metal + Non-metal
Ionic			
Covalent			
Metallic			

2. How is a positively charged ion formed? Give an example of a positive ion. State the electron configuration.

3. How is a negatively charged ion formed? Give an example of a negative ion. State the electron configuration.

4. What do you notice about the electron configurations of the ions? HINT: Are they similar to another group in the Periodic table?

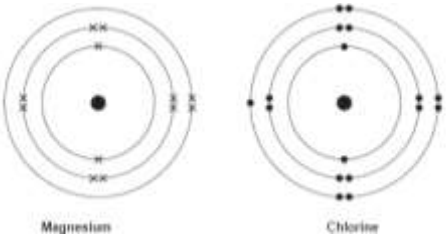
5. Describe what happens to electrons when an ionic bond is formed?

6. Draw a dot and cross diagram for a sodium atom and a fluorine atom.

7. Draw a dot and cross diagram to show sodium fluoride. Include charges on the ions.

Prove It!

The diagram shows an atom of magnesium and an atom of chlorine.

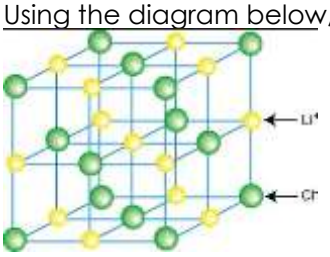


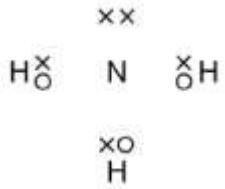
Describe, in terms of electrons, how magnesium atoms and chlorine atoms change into ions to produce magnesium chloride ($MgCl_2$).

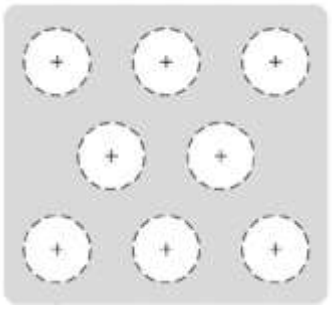
(4)

Particles and Bonding		
Book Ref.	**Spec. Ref.**	**Ions**
	CS 5.2.1.1 5.2.1.2 Triple 4.2.1.1 4.2.1.2	1. Do metals form positive or negative ions? Why? 2. Do non-metals form positive or negative ions? Why? 3. Complete the table to show the ion formed from each atom?

Atom	**Number of electrons in outer shell**	**Ion**
Lithium	1	Li^+
		Cl^-
Aluminium		
Hydrogen		
Bromine		
Calcium		
Oxygen		
Barium		
		NO_3^-
Sulfate		
Phosphate		
Phosphide		

Particles and Bonding		
Book Ref.	**Spec. Ref.**	**Ionic Compounds**
	CS 5.2.1.3 Triple 4.2.1.3	1. What structure do ionic compounds from? 2. Name the force that holds oppositely charged ions together? 3. Using the diagram below, state the empirical formula for lithium chloride.  4. Draw a diagram to represent the 3D structure of sodium chloride.
		Maths Skills Work out the formulae for the following compounds: a) lithium chloride b) sodium bromide c) magnesium fluoride d) potassium oxide e) calcium chloride f) beryllium sulphide g) aluminium chloride h) aluminium oxide

Particles and Bonding		
Book Ref.	**Spec. Ref.**	**Covalent Bonding**
	CS 5.2.1.4 Triple 4.2.1.4	1. Give an example of a molecule that is covalently bonded. 2. How is a covalent bond formed between 2 hydrogen atoms? Draw a dot and cross diagram to help explain your answer. 3. Draw a dot and cross diagram to show the bonding in methane (CH_4). 4. Draw a dot and cross diagram to show the bonding in oxygen (O_2). 5. Suggest 3 limitations of the dot and cross model. 6. Use the diagram to work out a) the molecular formula of ammonia. b) the number of atoms in ammonia. c) the number of elements in ammonia.  d) What is a polymer? Draw a diagram showing poly(ethene).

Particles and Bonding		
Book Ref.	**Spec. Ref.**	**Metallic Bonding**
	CS 5.2.1.5 Triple 4.2.1.5	1. Name the bonding shown in the diagram below.  2. Describe the structure of a compound containing this type of bonding. Include a labelled diagram in your answer. **Prove It!** Glass can be coloured using tiny particles of gold. Gold is a metal. Describe the structure of a metal. .... **(3)**

Particles and Bonding

Book Ref.	Spec. Ref.	States of Matter
	CS 5.2.2.1 5.2.2.2 Triple 4.2.2.1 4.2.2.2	

1. What are the 3 states of matter? Draw particle diagrams for each state in the table below.

Solid	_____	_____

2. What do the following state symbols mean; (g), (l), (s), (aq)?

3. Name the process when a …
a) gas becomes a liquid.
b) solid becomes a liquid.
c) liquid becomes a solid.
d) liquid becomes a gas.

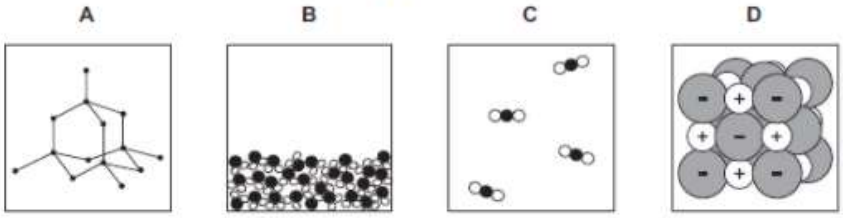
4. What affects the amount of energy needed for a substance to change state?

5. HT only: give three limitations of the particle model?

Prove It!

The structures of four substances, A, B, C and D, are represented in **Figure 1**.

Figure 1



Use the correct letter A,B,C or D to answer each question
i) Which substance is a gas?
ii) Which substance is a liquid?
iii) Which substance is an element?
iv) Which substance is made of ions?

Maths Skills

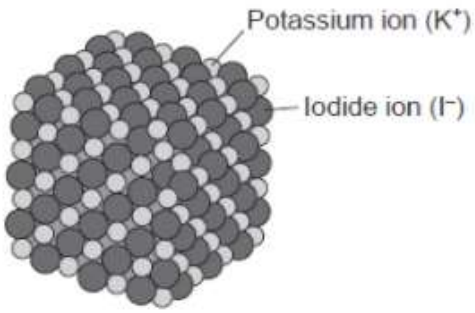
What state is each of the following substance at room temperature (20°C).

Substance	Melting Point (°C)	Boiling Point (°C)	State of matter at room temperature
Helium	-272	-268	
Sulfur	112	444	
Bromine	-7	59	

Particles and Bonding		
Book Ref.	**Spec. Ref.**	**Properties of Ionic Compounds**
	CS 5.2.2.3 Triple 4.2.2.3	1. What causes a substance to have a high melting point or boiling point? 2. What enables a substance to conduct electricity? 3. Do giant ionic substances have high or low melting points? Explain why. 4. Do giant ionic substances conduct electricity? Explain your answer.

Prove It!

The diagram shows the structure of potassium iodide.



Explain why a high temperature is needed to melt potassium iodide.

.....

.....

.....

.....

(2)

Solid sodium iodide does not conduct electricity.

Why does sodium iodide solution conduct electricity?

.....

.....

(1)

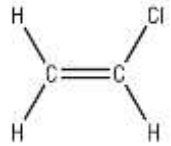
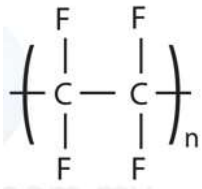
Particles and Bonding		
Book Ref.	**Spec. Ref.**	**Properties of Small Molecules**
	CS 5.2.2.4 Triple 4.2.2.4	1. Give an example of a simple molecular substance. 2. Do giant molecular substances have high or low melting points? Explain why. 3. Why does C_2H_6 have a lower melting point than C_5H_{12}? 4. Do simple molecular substances conduct electricity? Explain your answer.

Prove It!

Why is hydrogen chloride a gas at room temperature (20 °C)?

Tick (✓) **two** boxes.

- Hydrogen chloride has a low boiling point. ☐
- Hydrogen chloride has a high melting point. ☐
- Hydrogen chloride is made of simple molecules. ☐
- Hydrogen chloride does not conduct electricity. ☐
- Hydrogen chloride has a giant structure. ☐

Particles and Bonding		
Book Ref.	**Spec. Ref.**	**Polymers**
	CS 5.2.2.5 Triple 4.2.2.5	1. Give one example of a polymer. 2. What are polymer chains made of? 3. What sort of bonding is present in polymers? 4. Why do polymers have high melting points? 5. Draw the repeating unit for this monomer.  6. Draw the following polymer as a monomer. 

Prove It!

(i) Poly(ethene) is often used for packaging. Poly(ethene) is made from ethene.

Ethene is an alkene with the chemical formula C_2H_4

Draw the displayed structure for ethene.

(1)

(ii) Poly(ethene) is formed from ethene in a polymerisation reaction.

Describe, in terms of molecules, what happens in a polymerisation reaction.

.....

.....

.....

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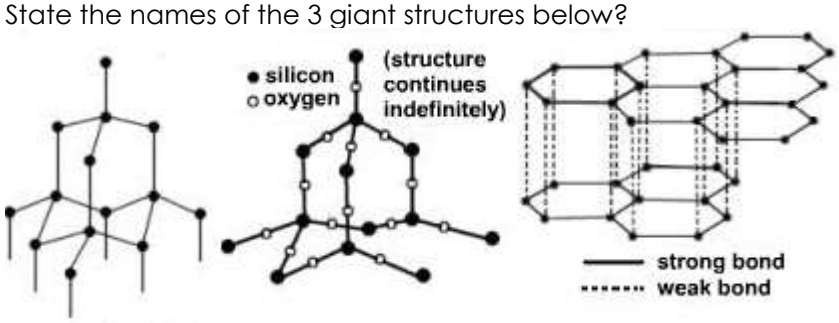
.....

.....

(3)

Particles and Bonding		
Book Ref.	**Spec. Ref.**	**Giant Covalent Structures**
	CS 5.2.2.6 Triple 4.2.2.6	1. State the names of the 3 giant structures below?  2. Name the strong bonds that link the atoms in the diagrams above? 3. Do the structures above have high or low melting points? Explain your answer.

Prove It!

The structures above and the simple molecular substances both contain the same type of bonding but the structures above are solid at room temperature whereas the simple molecular substances are mostly liquids or gases at room temperature. Explain this difference.

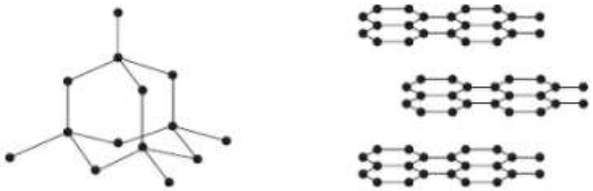
(6)

Particles and Bonding		
Book Ref.	**Spec. Ref.**	**Properties of Metals**
	CS 5.2.2.7 5.2.2.8 Triple 4.2.2.7 4.2.2.8	1. Why do metals have high melting and boiling points? 2. Draw a diagram to show the structure of a pure metal and another diagram to show the structure of an alloy. Label the diagram. 3. Using your diagrams above, explain why alloys are harder than pure metals. 4. Why are metals good conductors of heat? 5. Do metals conduct electricity? Explain your answer. **Prove It!** Explain why titanium conducts electricity. .... (3)

Particles and Bonding		
Book Ref.	**Spec. Ref.**	**Diamond and Graphite**
	CS 5.2.3.1 5.2.3.2 Triple 4.2.3.1 4.2.3.2 MS5b	1. Staet 3 properties of diamond. 2. Explain how the structure and bonding of diamond leads to these properties. 3. Describe the structure of graphite. 4. Explain why graphite is able to conduct electricity but diamond is not. 5. Explain why graphite is soft.

Prove It!

The diagrams show the structures of diamond and graphite.



Diamond Graphite

(a) Diamond and graphite both contain the same element.

What is the name of this element? .....

(1)

(b) Use the diagrams above and your knowledge of structure and bonding to explain why:

- Graphite is very soft.
- Diamond is very hard.
- Graphite conducts electricity. (6)

Particles and Bonding		
Book Ref.	**Spec. Ref.**	**Graphene and Fullerenes**
	CS 5.2.3.3 Triple 4.2.3.3 WS1.4	1. What is graphene? What is it used for? 2. Name 3 properties of graphene. 3. What is a fullerene? 4. Which element makes up fullerenes? What shape rings do they form? How many atoms are in each ring? 5. What was the name of the first fullerene to be discovered? 6. What is a nanotube? 7. Describe the structure of a nanotube. 8. What properties do nanotubes have? 9. Why are nanotubes useful?

Prove It!

Carbon nanotubes are cylindrical fullerenes.

Explain the properties of carbon nanotubes.

Answer in terms of structure and bonding.

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(Total 6 marks)

Particles and Bonding

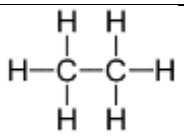
Book Ref.	Spec. Ref.	Crude Oil and Alkanes

CS 5.7.1.1

Triple 4.7.1.1

WS1.2 MS5b

1. What is crude oil made up of?
2. Define the term hydrocarbon?
3. How was crude oil formed?
4. What is the general formula for an alkane?
5. Complete the table below:

Name	Molecular Formula	Structural Formula
Methane		
		
Propane		
	C_4H_{10}	

Prove It!

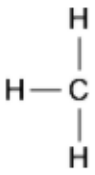
What is the formula of propane?

.....

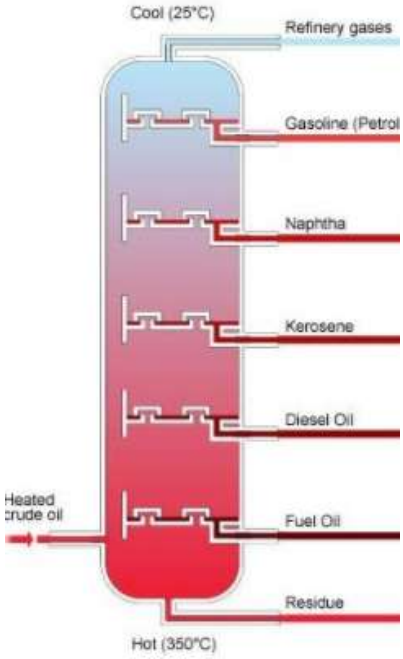
(1)

Butane has the formula C_4H_{10}

Complete the displayed (structural) formula for one molecule of butane.



(1)

Particles and Bonding		
Book Ref.	**Spec. Ref.**	**Fractional Distillation**
	CS 5.7.1.2 Triple 4.7.1.2	1. Which process separates crude oil into groups of compounds with a similar number of carbon atoms? 2. Name 3 fuels that are produced from crude oil by this process. 3. Outline the steps in the process above. Use the diagram to help you. 

Prove It!

Describe and explain how **petrol** is separated from the mixture of hydrocarbons in crude oil.

(6)

Particles and Bonding

Book Ref.	Spec. Ref.	Properties of Hydrocarbons
	CS 5.7.1.3 Triple 4.7.1.3	

1. Complete the following table to define the key properties of hydrocarbons

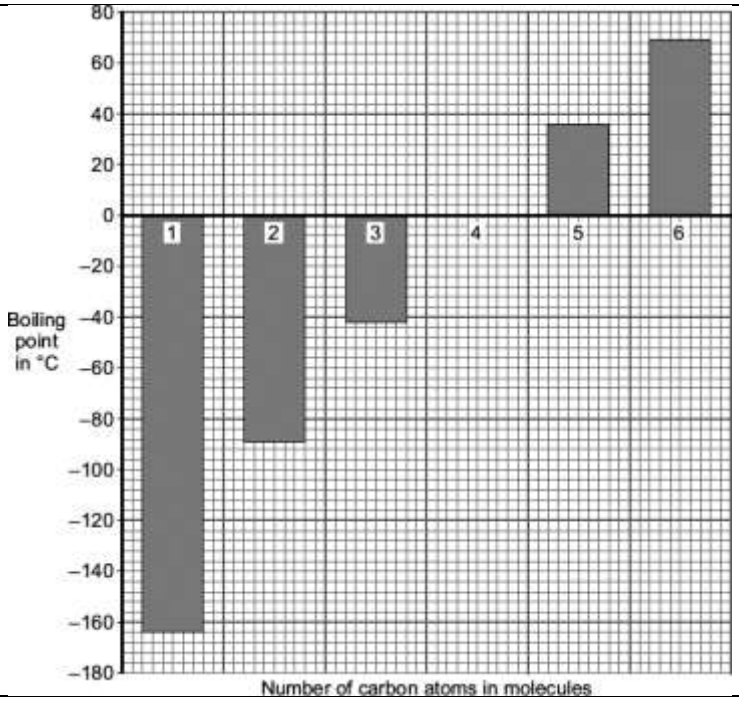
Property	Definition	What happens to the property as the carbon chain increases
Viscosity		
Boiling Point		
Flammability		

2. Write a word equation to show the complete combustion of methane.

3. Write a balanced symbol equation to show the complete combustion of undecane ($C_{11}H_{24}$).

Prove It!

Suggest **two** reasons why all of the butane is a better fuels than the alkane with the formula $C_{30}H_{62}$



Maths Skills

1. Describe the pattern between the number of carbon atoms in a molecule and its boiling point.

2. Predict the boiling point of a molecule with 7 carbon atoms in it.

Particles and Bonding

Book Ref.	Spec. Ref.	Cracking and Alkenes
	CS 5.7.1.4 Triple 4.7.1.4	

1. Which process breaks down large hydrocarbons into smaller, more useful molecules?

2. What are the 2 products of cracking?

3. Describe the tests you could carry out to identify each product in Q2?

4. Complete the table to summarise the conditions needed for each type of cracking.

Method	Conditions Required
Thermal	
Catalytic	

5. Describe how both products of cracking can be useful.

Prove It!

Paraffin contains decane. The cracking of decane can be represented by the equation below. A decane molecule is split into two smaller molecules.

Complete the equation by adding the formula of the other product.

$C_{10}H_{22}$ (l) → ..... (l) + C_2H_4 (g)
decane

(1)

Explain, as fully as you can, why cracking is used in the oil industry.

(3)

Describe how fuel oil is broken down into smaller, more useful molecules such as gasoline (petrol).

(2)

Particles and Bonding		
Book Ref.	**Spec. Ref.**	**Pure Substances and Formulations**
	CS 5.8.1.1 5.8.1.2 Triple 4.8.1.1 4.8.1.2	1. What is a pure substance? Give an example. 2. How could you tell if a substance is pure or a mixture? 3. What is a formulation? Give 2 examples.

Prove It!

Aqamed is a medicine for children.

(a) The medicine is a formulation.

What is meant by a formulation?

.....

.....

(1)

(b) Children often do not like taking medicine.

Suggest a substance that could be added to Aqamed to increase the desire for children to take it.

Give a reason for your suggestion.

Substance .....

Reason .....

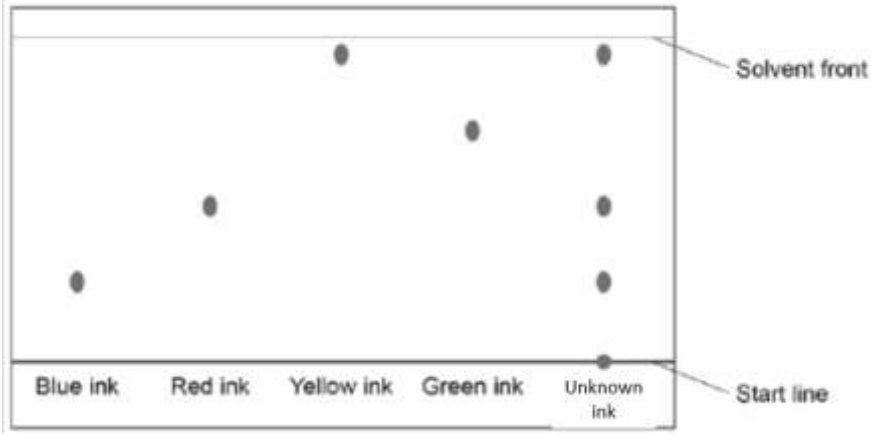
.....

(2)

Maths Skills

2 samples of copper chloride are made. Look at the data and explain which of the 2 samples is purer.

	Melting Point (°C)	**Boiling Point (°C)**
Sample A	494	995
Sample B	475	1000-1005
Pure copper chloride	498	993

Particles and Bonding		
Book Ref.	**Spec. Ref.**	**CS: RPA12** **Triple: RPA6**
	CS 5.8.1.3 Triple 4.8.1.3 AT1 AT4 WS2.2 WS2.3 WS2.6	**Required Practical** Investigate how paper chromatography can be used to separate and tell the difference between coloured substances. **Method** You have been given 4 samples of food colouring of known colour and 1 sample of unknown colour. You also have a solvent, a piece of filter paper and capillary tubes. Outline a method that would allow you to get the results below.
		Results A sample set of results are shown below:  1) Identify the colours present in the unknown ink. 2) Explain which colour is the most soluble. 3) Calculate the Rf value for the red ink. 4) Identify the mobile phase and the stationary phase.

Particles and Bonding		
Book Ref.	**Spec. Ref.**	**Identification of Common Gases**
	CS 5.8.2.1 5.8.2.2 5.8.2.3 5.8.2.4 Triple 4.8.2.1 4.8.2.2 4.8.2.3 4.8.2.4	Complete the table to summarise the test for the following gases and the positive result.

Name of Gas	Formula of Gas	Description of Test	Positive Result
Hydrogen			
Oxygen			
Carbon Dioxide			
Chlorine			

Quantitative Chemistry Keywords

Add all the important keywords for this big idea in the grid below as you come across them in the study pack.

Word	Definition

Quantitative Chemistry

Book Ref.	Spec. Ref.	Conservation of Mass and RFM
	CS 5.3.1.1 5.3.1.2 Triple 4.3.1.1 4.3.1.2	1. In a reaction, why does the mass of reactants always equal the mass of products? 2. In the equation: $2Li + F_2 \rightarrow 2LiF$ a) What does the 2 in front of LiF mean? b) What does the $_2$ mean in F_2? 3. Explain why the following equation needs to be balanced: $2H_2 + O_2 \rightarrow 2H_2O$

Prove It!

The chemical equation for the reaction of titanium(IV) chloride with sodium is:

$TiCl_4 + 4Na \rightarrow Ti + 4NaCl$

titanium(IV) chloride + sodium → titanium + sodium chloride

For one reaction:

- 1615 kg titanium(IV) chloride reacted completely with 782 kg sodium
- 1989 kg sodium chloride was produced.

Calculate the mass of titanium produced from this reaction.

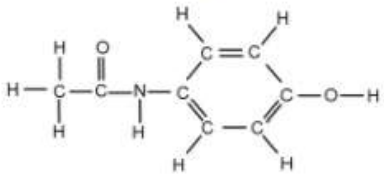
.....

.....

Mass of titanium = ... kg

(1)

The figure below represents a molecule of paracetamol.



Give the molecular formula of paracetamol.

Calculate its relative formula mass (M_r).

Maths Skills

Calculate the relative formula mass of the following compounds:

a) H_2
b) H_2O
c) $CaCl_2$
d) CO_2
e) $CaCO_3$
f) $Ca(OH)_2$

Quantitative Chemistry

Book Ref.	Spec. Ref.	Mass Change and Chemical Measurements
	CS 5.3.1.3 5.3.1.4 Triple 3.3.1.3 3.3.1.4 WS3.4 WS3.7	1. In a reaction, the mass of the products must always equal the mass of the reactant. However if a gas is involved in can often look like the mass has gone up or down. a) Give an example of a reaction where it appears the mass of the product is greater than the reactant. b) Give an example of a reaction where it appears the mass of the reactant is greater than the product. 2. Give 2 reasons why a set of results will contain uncertainty. 3. If you have higher uncertainty in your results, does that mean they are more or less precise? Why?

Prove It!

A student heated 5g of calcium in an unsealed test tube so that it reacted with oxygen. At the end of the reaction, the mass of the product inside the test tube was 7g. Explain this observation.

The student repeated the experiment twice more and found the mass of the product was 7.1g and 6.8g for these experiments. Calculate the uncertainty and suggest what might have caused it.

Maths Skills

Calculate the uncertainty for the following sets of data:

Repeat 1	Repeat 2	Repeat 3	Mean	Uncertainty
2.30	2.35	2.38	2.34	
111	121	109	114	
0.02	0.03	0.02	0.02	
49.1	58.1	48.7	52.0	

Quantitative Chemistry		
Book Ref.	**Spec. Ref.**	**Moles**
	CS 5.3.2.1 (HT only) **Triple 4.3.2.1 (HT only)**	1. What is the mass of 1 mole of a substance in grams equal to? 2. What is the equation that links number of moles, mass and relative formula mass? 3. What is the name of the constant that tells us the number of atoms, particles, molecules or ions in a mole of any given substance? What is the value of this constant? 4. How would you calculate the number of molecules present in a substance if you were given the mass of the substance? **Prove It!** Calculate the **number of molecules** in 14 g of carbon dioxide. Give your answer in standard form. Relative atomic masses (A_r): C = 14; O = 16 .... Answer = ... molecules **(4)**
	MS3b MS3c	**Maths Skills** Complete the following mole calculations using the equation you wrote above: a) How many moles are there in 42g of carbon? b) How many moles are there in 66g of carbon dioxide? c) What is the mass in g of 0.80 moles of sulfuric acid (H_2SO_4)? d) What is the mass in g of 1.6 moles of ammonia (NH_3)? e) Prove that the relative formula mass of NaCl is 58.5 if you know that you have 23.4g in 0.4 moles.

Quantitative Chemistry

Book Ref.	Spec. Ref.	Amount of Substance
	CS 5.3.2.2 (HT only) **Triple 4.3.2.2 (HT only)**	1. In the following equation, how many moles of magnesium are reacting with how many moles of hydrochloric acid? $Mg + 2HCl \rightarrow MgCl_2 + H_2$
	MS3b MS3c	**Maths Skills** **1)** How many moles of water are formed if 2 moles of methane combust completely in oxygen? $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ **2)** What mass of calcium chloride is produced when 3.7g of calcium hydroxide reacts with an excess of hydrochloric acid? $Ca(OH)_2 + 2\ HCl \rightarrow CaCl_2 + 2\ H_2O$ **3)** What is the mass of aluminium oxide produced when 135g of aluminium is burned in air? $4Al + 3O_2 \rightarrow 2Al_2O_3$ **4)** How much zinc carbonate would need to decompose to form 24.2g of zinc oxide? $ZnCO_3 \rightarrow ZnO + CO_2$

Prove It!

Iron(III) chloride can be produced by the reaction shown in the equation:

$$2\ Fe + 3\ Cl_2 \rightarrow 2\ FeCl_3$$

(i) Calculate the maximum mass of iron(III) chloride ($FeCl_3$) that can be produced from 11.20 g of iron.

Relative atomic masses (A_r): Cl = 35.5; Fe = 56.

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Maximum mass of iron(III) chloride = ... g

(3)

Quantitative Chemistry		
Book Ref.	**Spec. Ref.**	**Maths Skills (Balancing Equations Using Moles)**
	CS 5.3.2.3 (HT only) **Triple 4.3.2.3 (HT only)**	1. 8.1g of zinc oxide reacts completely with 0.60g of carbon to form 2.2g of carbon dioxide and 6.5g of zinc. Balance the symbol equation below. $ZnO + C \rightarrow CO_2 + Zn$ 2. Potassium nitrate (KNO_3) decomposes on heating to give potassium nitrite (KNO_2) and oxygen (O_2). When 4.04 g of KNO_3 is heated, 3.40 g of KNO_2 is produced. Write a balanced equation for this reaction. 3. 2.7g of an element, X, reacts completely with 2.4g of oxygen to form 5.1g of an oxide, X oxide. Write a balanced equation for this reaction. 4. Iron(III) oxide (Fe_2O_3) is reduced by carbon on heating to give iron metal (Fe) and carbon dioxide (CO_2). When 480 g of Fe_2O_3 is heated with carbon, 336 g of Fe and 198 g of CO_2 are produced. Write a balanced equation for this reaction.

Quantitative Chemistry		
Book Ref.	**Spec. Ref.**	**Limiting Reactants and Concentration of Solutions**
	CS 5.3.2.4 (HT only) **Triple 4.3.2.4 (HT only)**	1. Why do chemical reactions sometimes stop? For example, when you add magnesium to acid it eventually stops fizzing. 2. What is a limiting reactant? Why is it called this? 3. In the example in question 1, which reactant is usually in excess, acid or metal, and which is the limiting reactant? 4. Does the limiting reactant or the reactant in excess determine how much product can be formed? Explain your answer. 5. When 2.24g of iron were reacted with an excess of copper sulfate solution, 2.54g of copper were produced. How much copper would be produced if 6.72g of iron were reacted in an excess of copper sulfate solution? 6. What is the equation that links concentration, mass of solute and volume of solution? 7. If the mass is measured in grams and the volume in dm^3, what are the units of concentration? 8. If you increase the mass of solute in a solution, what happens to the concentration?
	CS 5.3.2.5 Triple 4.3.2.5 MS3b MS3c WS4.5	**Maths Skills (Concentration)** 1. What is 2300cm^3 in dm^3? 2. What is the concentration of a solution of sodium chloride solution that is made by dissolving 30g of sodium chloride in 0.20dm^3 of water? 3. What is the concentration in g/dm^3 of a solution of iron chloride solution that is made by dissolving 10g of iron chloride in 25cm^3 of water? 4. What is the mass of copper chloride in 20cm^3 of an 80g/dm^3 solution of copper chloride?

Trends and Patterns Keywords

Add all the important keywords for this big idea in the grid below as you come across them in the study pack.

Word	Definition

Trends and Patterns

Book Ref.	Spec. Ref.	The Periodic Table
	CS 5.1.2.1 5.1.2.2 Triple 4.1.2.1 4.1.2.2	13. In what order are elements in the periodic table organised? e.g. Why does carbon come before nitrogen? 14. What is similar about the electronic structure of the elements of group 1 (Li, Na, K etc.)? 15. Name 2 elements in the periodic table that react in a similar way and explain the reason for this. 16. How were the elements in the periodic table first organised? 17. Which scientist improved the periodic table by leaving gaps for elements he hadn't thought had been discovered?
	WS1.1 WS1.2	18. Evaluate whether hydrogen has been put in the correct place on an early version of the periodic table below. **Justify** your answer. The table shows part of an early version of the periodic table.

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
H						
Li	Be	B	C	N	O	F
Na	Mg	Al	Si	P	S	Cl

Prove It!

Explain the arrangement of the first 20 elements in today's periodic table.

You should answer in terms of atomic structure.

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(2)

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Metals, Non-metals and Group 0**
	CS 5.1.2.3 5.1.2.4 Triple 4.1.2.3 4.1.2.4	1. Where are metals found on the periodic table? What sort of ions do they form? Give an example. 2. Where are non-metals found on the periodic table? What sort of ions do they form? Give an example. 3. What is another name for the group 0 elements? 4. How is the electron configuration of group 0 elements similar? 5. How does the electron configuration of group 0 elements affect their reactivity? 6. Does neon or krypton have a higher boiling point? What is the trend as you go down the group?

Prove It!

Explain why Group 0 elements are monatomic.

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(2)

Trends and Patterns

Book Ref.	Spec. Ref.	Group 1
	CS 5.1.2.5 5.1.2.6 Triple 4.1.2.5 4.1.2.6	

1. State the other name for the group 1 elements.

2. How many electrons do group 1 elements have on their outer shell?

3. Describe and explain the trend in the reactivity of group 1 metals as you descend group 1?

4. Which group 1 element is the least reactive? Why?

5. Complete the table to describe the reactions of the first 3 group 1 elements with oxygen, chlorine and water.

Group 1 Metal	Reaction with oxygen	Reaction with chlorine	Reaction with water
Lithium			
Sodium			
Potassium			

Prove It!

Potassium is also in Group 1 of the periodic table.
Potassium reacts with water in a similar way to lithium.

Write down **two** differences you would see between the reactions of potassium and lithium with water.

1 .....

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2 .....

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(2)

Trends and Patterns

Book Ref.	Spec. Ref.	Group 7
	CS 5.1.2.5 5.1.2.6 Triple 4.1.2.5 4.1.2.6	1. What is another name for the group 7 elements? 2. How many electrons do group 7 elements have on their outer shell? 3. Write the formula for a **molecule** of chlorine. 4. Which group 7 element a) has the highest melting point? b) has the lowest boiling point? 5. Why is fluorine the most reactive halogen? 6. Would a displacement reaction take place if chlorine gas was reacted with potassium bromide? Explain your answer.

Prove It!

A student put some potassium bromide solution in a test tube.

She added a few drops of chlorine solution and observed the result.

She repeated the process using different potassium halide salts and different halogens.

The table below shows the student's results.

Solution of halogen	Potassium chloride solution	Potassium bromide solution	Potassium iodide solution
Chlorine		Orange colour forms	Brown colour forms
Bromine	No reaction		Brown colour forms
Iodine	No reaction	No reaction	

Give the order of reactivity of the halogens from the results in the table above.

Explain how you used the results to show this order of reactivity.

Order .....

Explanation .....

.....

.....

.....

(2)

Explain the order of reactivity of Group 7 elements.

Include information about atomic structure.

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(2)

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Reactivity of metals**
	CS 5.4.1.1 5.4.1.2 Triple 4.4.1.1 4.4.1.2	1. What is the general equation for the reaction of: metal + oxygen →

2. Complete the equations:
   a) zinc + oxygen →
   b) copper + …….. → copper oxide
   c) …….. + …….. → magnesium oxide

3. Define oxidation and reduction in terms of oxygen.

4. For the equation in 2a, identify the species that gets oxidised.

5. Explain why the reaction between zinc and hydrochloric acid is a redox reaction

6. Put the following metals into order of reactivity: magnesium, calcium, copper, zinc, iron, aluminium, potassium and sodium. Include the position of non-metals carbon and hydrogen.

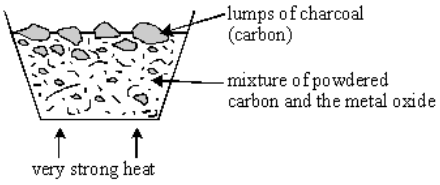
7. Why is potassium more reactive than sodium?

8. Complete the equations:
   a) zinc + iron sulfate →
   b) zinc + copper sulfate →
   c) magnesium + iron (II) chloride →

9. Explain why the above equations are called 'displacement reactions'

10. Summarise the reactions of metals of acid and water

Metal	Reaction with water	Reaction with dilute acid
potassium		
lithium		
magnesium		
zinc		
Iron		
copper		
Gold		

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Reactivity of metals**
	CS 5.4.1.3 5.4.1.4 (HT) Triple 4.4.1.3 4.4.1.4 (HT)	1. Define the term metal ore 2. Platinum is found in its native state. What does this tell you about its reactivity? 3a. What does it mean to reduce zinc oxide? 3b. Zinc oxide, ZnO, can be reduced to zinc by heating it in a furnace with carbon. Write a balanced symbol equation for this reaction, labelling what is reduced and what is oxidised 4. Explain why carbon can reduce zinc oxide but magnesium cannot. 5. a. (HT only) Write an ionic equation, including state symbols for the reaction between zinc and iron (II) sulfate b. Explain in terms of the transfer of electrons which species is oxidised and which is reduced in this reaction (Hint: OILRIG). **Prove It!** A student was trying to extract the metals from lead oxide and aluminium oxide. She heated each oxide with carbon in a fume cupboard as shown below. She was able to extract lead from lead oxide but not aluminium from aluminium oxide. Explain the results of these experiments [3] 

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Reactions of acids with metals**
	CS 5.4.2.1 Triple 4.4.2.1	1. Write the general equation for the reaction: acid + metal → 2. Write a balanced **symbol equation**, including state symbols, for: a) iron + sulfuric acid b) zinc + hydrochloric acid 3. Why can't copper sulfate be prepared by adding copper metal to dilute sulfuric acids? 4. Why can't potassium chloride be prepared by adding potassium to dilute hydrochloric acid? 5. What gas is produced when a meal and acid are reacted together? What would you **see**? 6. (HT only) Using the reaction of zinc and dilute hydrochloric acid: a) Write an ionic equation for the reaction with state symbols b) From your answer to part a, construct two half equations showing the electron transfers taking place. c) Explain why this is a redox reaction in terms of electron transfer.

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Neutralisation of acids and salt production**
	CS 5.4.2.2 Triple 4.4.2.2	1. What is a neutralisation reaction? Give an example. 2. Complete the general word equations for neutralisation: acid + base → acid + alkali → acid + metal carbonate → 3. Define and give an example of: a. Acid b. Alkali c. Base 4. Name the salts formed when a lithium is reacted with the following acids:

Acid	Lithium salt formed
Hydrochloric acid	
Sulfuric acid	
Nitric acid	

5. Write the word equation for the reaction between zinc oxide and dilute hydrochloric acid.

6. Write the word equation for the reaction between calcium carbonate and dilute sulfuric acid,

7. What is the formulae for the following salts:
   a) sodium bromide

   b) potassium nitrate

   c) magnesium sulfate

8. Write a balanced symbol equation, including state symbols for the reaction of lithium oxide (in excess) and dilute hydrochloric acid.

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**CS: RPA8** **Triple: RPA1**
	CS 5.4.2.3 Triple 4.4.2.3 AT 2,4,6 WS 2.2 WS 2.3	**Required Practical** Preparation of a pure, dry sample of a soluble salt from an insoluble oxide or carbonate using a Bunsen burner to heat dilute acid and a water bath or electric heater to evaporate the solution. **Method** Describe a safe method for making pure, dry crystals of copper sulfate. You should identify the chemicals and apparatus you will use.
	WS3.6 WS3.7	**Evaluating Data** 1. 2 students did the experiment using the same quantities of reactants and compared the amount of product they made. Student 1 got closest to the theoretical yield. Student 1 said they were more precise than student 2 but student 2 thought they should have used the word accurate. Who was correct? Explain your answer. 2. A student made a hypothesis "the greater the mass of sodium carbonate used, the greater the mass of carbon dioxide formed". Using the data below explain if and to what extent the student was correct. The student's results are shown in the table below **Mass of sodium carbonate in g** / **Volume of carbon dioxide gas in cm^3** 0.07 / 16.0 0.12 / 27.5 0.23 / 52.0 0.29 / 12.5 0.34 / 77.0 0.54 / 95.0 0.59 / 95.0 0.65 / 95.0

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Strong and weak acids (HT only)**
	CS 5.4.2.5 (HT) Triple 4.4.2.6 (HT)	1. Define the term strong acid and give an example. 2. Define the term weak acid and give an example. 3. What is the relationship between acid strength and pH? 4. As the pH decreases by one unit what does the hydrogen ion concentration of solution increase by? 5. Explain the difference between a strong acid and a concentrated acid. Can you have a weak concentrated acid?

Prove It!

Acids of the same concentration were reacted with magnesium ribbon. The volume of gas produced after 5 minutes was recorded. The results are shown in the table.

Acid	pH	Volume of gas in cm3
A	2	18
B	5	6
C	1	24
D	4	12

Use the results to arrange the acids in order of decreasing acid strength

Most acidic…… Least acidic

Complete the sentence:
A solution with more hydrogen ions than hydroxide ions is……

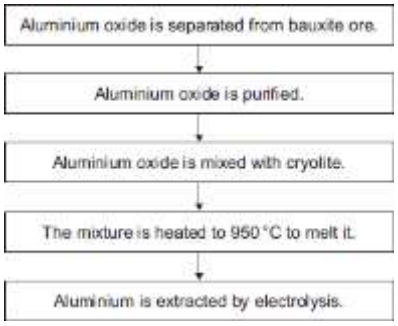
MS1a
MS1b

Maths skills

Concentration of H+ (aq) ions in mol/dm^3	pH value
0.10	1.0
0.010	2.0
0.0010	3.0
0.00010	4.0

A solution of sodium chloride is neutral, what will be the concentration of hydrogen ions in the solution? Give your answer in mol/dm^3 in decimal form and in standard form.

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Electrolysis**
	CS 5.4.3.1 5.4.3.2 Triple 4.4.3.1 4.4.3.2	1. Complete the sentence below. Electrolysis is the splitting apart of a …… using ……
		2. What do you call the substance being electrolysed?
		3. What type of bonding is present in compounds that can be electrolysed? What must happen to these compounds before they can be electrolysed?
		4. What is the name given to the negative electrode? What is the name given to the positive electrode?
		5. Explain which type of ion moves to the positive electrode and what happens to that ion.
		6. Predict the product formed at the cathode and anode when molten lead bromide ($PbBr_2$) is electrolysed. Describe what you would observe at each electrode.
		7. Solid ionic substances do not conduct electricity. Explain why they can conduct when molten or in aqueous solution, but not when solid.
		Prove It! Sodium chloride is an ionic compound. It contains sodium ions, Na^+, and chloride ions, Cl^-. When **molten** sodium chloride is electrolysed, sodium metal and chlorine gas are formed. Describe how the sodium ions and chloride ions in solid sodium chloride are converted into sodium and chlorine by electrolysis. **(6)**

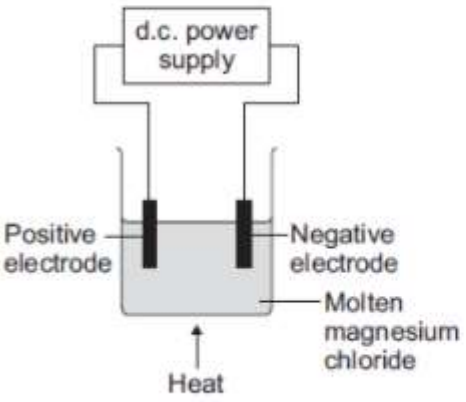
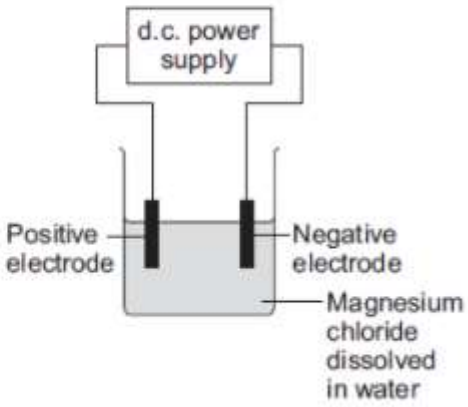
Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Electrolysis of Aluminium Oxide**
	CS 5.4.3.3 5.4.3.5 (HT) Triple 4.4.3.3 4.4.3.5 (HT)	1. Why would you use electrolysis to obtain the metal from sodium chloride but not from zinc chloride? 2. Why is aluminium oxide dissolved in molten cryolite before being electrolysed? 3. Why are the carbon anodes regularly replaced in the industrial electrolysis of aluminium oxide? 4. (HT only) Write half equations for the changes at each electrode in the electrolysis of molten aluminium oxide. Identify each reaction as either reduction or oxidation. 5. Explain why the extraction of aluminium requites so much energy **Prove It!** The flow chart shows the main steps in the extraction of aluminium from aluminium ore. Aluminium is recycled by melting scrap aluminium at 700 °C. Use your own knowledge and the information given to answer. Suggest why most aluminium is recycled. 

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Electrolysis of Aqueous Compounds**
	CS 5.4.3.4 5.4.3.5 (HT) Triple 4.4.3.4 4.4.3.5 (HT)	1. Name the four ions present in sodium chloride **solution**. 2. Which of these positive ions is discharged at the negative electrode during electrolysis? Explain how you know which positive ion is reduced when there is more than one positive ion in a solution. 3. Which of these negative ions is discharged at the positive electrode? Explain how you know which negative ion is oxidised when there is more than one negative ion in a solution. 4. What happens to the 2 remaining ions? 5. (HT only)Write the half equations, including state symbols, for the reactions at the anode and at the cathode of sodium chloride solution. 6. Predict the 3 products that would be formed if aqueous lithium bromide solution was electrolysed.

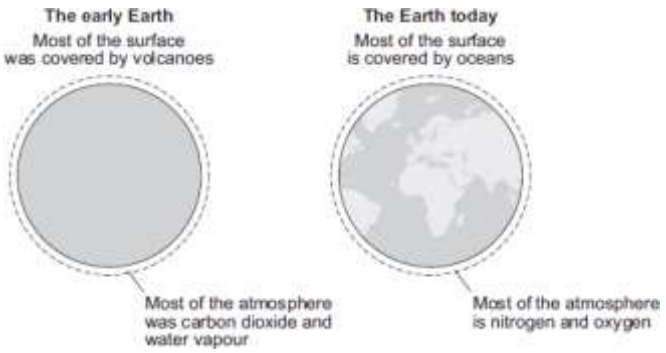
Prove It!

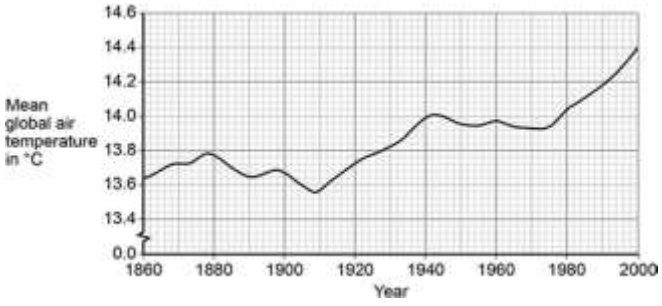
Sodium sulfate solution contains sodium ions, Na^+, sulfate ions, SO_4^{2-}, hydrogen ions, H^+, and hydroxide ions, OH^-. Hydrogen is produced at one electrode and oxygen is produced at the other electrode. Explain how these products are formed from the ions in the electrolysis process, indicating how you would identify the products. You may give ionic equations in your answer.

(6)

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Required practical activity 9 (CS)** **Required practical 3 (Triple)**
	CS 5.4.3.4	Investigate what happens when aqueous solutions are electrolysed using inert electrodes. This should be an investigation involving developing a hypothesis.
	Triple 4.4.3.4 AT 3 AT 7 WS2.1	1. Suggest a hypothesis for the electrolysis of potassium chloride solution 2. Suggest what the pH around the cathode would be? 3. What chemical test could you perform to confirm your hypothesis to Q2? 4. Write the half equations, including state symbols, for the changes at the anode and cathode. 5. Suggest a hypothesis for each experiment below. Magnesium chloride can be electrolysed. The diagram below shows two experiments for electrolysing magnesium chloride. **Experiment 1**  **Experiment 2** 

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Chemistry of the atmosphere** **The composition and evolution of the Earth's atmosphere**
	CS 5.9.1.1 5.9.1.2 Triple 4.9.1.1 4.9.1.2	1. What is the approximate percentage of nitrogen and oxygen in the atmosphere today? 2. Other than those gases named above, what other gases are present in the atmosphere today? 3. Describe what the early atmosphere was made up of. Which planets' atmosphere today is it like? 4. Explain how the Earth's early atmosphere was probably formed during its first billion years of existence. 5. Explain how the oceans formed. 6. What effect did the formation of the oceans have on the levels of carbon dioxide in the air? Explain your answer. 7. Why have theories about the Earth's early atmosphere and how it has changed developed over time? **Prove it!** For the last 200 million years the amount of carbon dioxide in the atmosphere has remained almost the same. Describe the natural processes which remove carbon dioxide from the atmosphere. (6)

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**The composition of the Earth's atmosphere**
	CS 5.9.1.3 5.9.1.4 Triple 4.9.1.3 4.9.1.4	1. Explain how levels of oxygen in our atmosphere increased. 2. Write the word and symbol equation for photosynthesis. 3. What were the first organisms to produce oxygen called? How long ago did this happen? 4. Explain why the increase in oxygen was important to life on Earth today. 5. Explain 4 factors that contributed to decrease in levels of carbon dioxide. **Prove it!**  Describe and explain how the surface of the early Earth and its atmosphere have changed to form the surface of the Earth and its atmosphere today (6)
Trends and Patterns		

Book Ref.	Spec. Ref.	Carbon dioxide and methane as greenhouse gases
	CS 5.9.2.1 5.9.2.2 Triple 4.9.2.1 4.9.2.2 WS1.6	1. Explain what is meant by the term 'greenhouse gas' and name 3 greenhouse gases. 2. What is the greenhouse effect? 3. Explain the greenhouse effect in terms of short and long wavelength radiation and matter. 4. Describe two human activities that increase the amount of carbon dioxide in the atmosphere. 5. Describe two human activities that increase the amount of methane in the atmosphere. 6. A scientist peer reviewed some work on the greenhouse effect. What does 'peer review' mean? Why is it important this is done? 7. What do most scientists believe is the relationship between greenhouse gases and global temperatures? Why do some members of the public not believe this to be true?
	WS3.5	**Prove it!** The figure below shows the change in mean global air temperature from 1860 to 2000. Explain how human activities have contributed to the main trend shown from 1910 in the figure below (4) 

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Carbon dioxide and methane as greenhouse gases**
	CS 5.9.2.3 5.9.2.4 Triple 4.9.2.3 4.9.2.4 WS1.4 WS1.6	1. What is meant by the term 'global climate change'? 2. Describe four potential effects of global climate change 3. Describe why these consequences are difficult to predict. 4. What is meant by the term 'carbon footprint'? 5. Describe two actions that can reduce emission of carbon dioxide and methane. 6. Suggest two problems representatives of countries face in reaching international agreements such as the Paris climate agreement. 7. Suggest and explain the relationship between a nation's wealth and its emissions of carbon dioxide. 8. What can be the problems of only using the media as your source of knowledge about climate change?

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Common atmospheric pollutants and their sources**
	CS 5.9.3.1 5.9.3.2 Triple 4.9.3.1 4.9.3.2	1. What are the products of the complete combustion of a hydrocarbon e.g. methane (CH_4)? 2. What are the products of the incomplete combustion of a hydrocarbon? 3. Some fossil fuels contain impurities that can produce an acidic gas. Name the element, the gas formed and the pollution problem it contributes to. 4. Which other non-metal oxides released from cars also cause this pollution problem? How is this non-metal oxide formed? 5. What health problems are caused by the substances named in Q3. and Q4.? 6. What other substance may be released that form particulates in the atmosphere? What problems can these cause? 7. Why is carbon monoxide dangerous?
		Prove it! Complete and balance the symbol equation for the complete combustion of methane. CH_4 + ... ⟶ CO_2 + ... **(2)** Explain why the **incomplete** combustion of methane is dangerous. .... **(2)**

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Using Resources** **Using the Earth's resources and obtaining potable water**
	CS 5.10.1.1 Triple 4.10.1.1	1. Define finite resources and give two examples. 2. Define renewable resources and give two examples. 3. Explain what is meant by "sustainability". 4. Give an example of a natural product that is supplemented or replaced by agricultural products. 5. Give an example of a natural product that is supplemented or replaced by synthetic products
	MS2h	**Maths skills** As a rough estimate, there is 1.5 x 10^{16} metric tonnes of fossil carbon on Earth. In 2014, it was also estimated that 9,2 x10^{9} metric tonnes of carbon were burned worldwide that year. Assuming that the 2013 rate of carbon use was to continue calculate an order of magnitude estimate of how long carbon will last.

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Using the Earth's resources and obtaining potable water**
	CS 5.10.1.2 5.10.1.3 Triple 4.10.1.2 4.10.1.3	1. Define potable water. 2. Define pure water. 3. Describe the method used to produce potable water in the UK, explaining the reason for each step. You could use a flow chart. 4. Identify three sterilising agents. 5. If supplies of fresh water are limited, what alternate water sources may be used? 6. Define desalination and describe the 2 methods of how it is carried out. 7. Describe two differences between the treatment of ground water and salty water. 8. Why does waste water require treatment at a sewage works before being released into the environment? 9. Draw a basic flow diagram listing the main steps used in sewage treatment plant to make waste water safe **Prove it!** Explain why it is more difficult to produce drinking water from waste water than from water in lakes.

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Triple RPA8** **CS RPA13** **Analysis and purification of water samples from different sources, including pH, dissolved solids and distillation.**
	CS 5.10.1.2 5.10.1.3 Triple 4.10.1.2 4.10.1.3 WS2.2 WS2.5 WS3.7	1. How do you test the pH of water? How would you adjust it if necessary? 2. How do you test if water contains salt (sodium chloride)? How would you remove this if present? 3. Some countries add chlorine to their water. Why do they do this? How do you test for it? 4. A student wanted to collect 25cm^3 of water. What piece of equipment should they use? If the piece of equipment was faulty and the student took 10 samples, what sort of error would they have? 5. A student took 10 samples of water from the same source and tested them. Only 1 result gave an acidic pH but all the others were neutral. What is this type of result called? What should they do about it? 6. A different student only took 1 sample of water and tested it. Is this a sufficient sample? Why? 7. A student wanted to heat the water to exactly 30°C. They used a Bunsen burner but there teacher told them there was a better way. What should they have done? Why would it be better?

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Using the Earth's resources and obtaining potable water**
	CS 5.10.1.4 (HT) **Triple 4.10.1.4 (HT)**	1. Why is copper important in our technological society? 2. Describe how these two main methods can obtain copper metal from its ore: a) smelting b) electrolysis 3. (HT only) Copper ores are becoming scarce and phytomining and bioleaching are two new methods of extraction. Describe both phytomining and bioleaching. 4. (HT only) State one advantage of extracting copper using these methods in Q3. over traditional methods. 5. (HT only) Describe one disadvantage of bioleaching. 6. (HT only) Once the metal compound is obtained, how can the metal be extracted from the compound? **Prove it!** (HT only) Soil near copper mines is often contaminated with low percentages of copper compounds. Phytomining is a new way to extract copper compounds from soil. Describe how copper compounds are extracted by phytomining

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Life cycle assessment**
	CS 5.10.2.1 Triple 4.10.2.1	1. Why are life cycle assessments (LCAs) carried out? 2. Using a simple flowchart outline the stages in an LCA. 3. Name the input showing on an LCA report that would be the raw material mined to produce aluminium in an alloy to make the wings of an aeroplane. 4. Name the output shown on a LCS that would be: a. the greenhouse gas given off when a product is distributed from a factory to shops around the country on lorries b. the gas that causes acid rain given off as result of using electricity generated in a coal-fired power station when making a product 5. Explain why parts of some LCAs may not be totally objective. 6. Carry out a simplified LCA for a supermarket that is deciding whether to use plastic, poly(ethene) bags or paper bags at its checkouts.

Prove it!

The table below gives information about milk bottles.

	Glass milk bottle	Plastic milk bottle
Raw materials	Sand, limestone, salt	Crude oil
Bottle material	Soda-lime glass	HD poly(ethene)
Initial stage in production of bottle material	Limestone and salt used to produce sodium carbonate.	Production of naphtha fraction.
Maximum temperature in production process	1600 °C	850 °C
Number of times bottle can be used for milk	25	1
Size(s) of bottle	0.5 dm^3	0.5 dm^3, 1 dm^3, 2 dm^3, 3 dm^3
Percentage (%) of recycled material used in new bottles	50 %	10 %

Evaluate the production and use of bottles made from soda-lime glass and those made from HD poly(ethene).

Use the information given and your knowledge and understanding to justify your choice of material for milk bottles.

Trends and Patterns		
Book Ref.	**Spec. Ref.**	**Reducing Use of Resources**
	CS 5.10.2.2 Triple 4.10.2.2	1. Suggest 4 reasons why it is important that people recycle materials? 2. Name 2 other methods of conserving limited resources. 3. Name a negative impact of extracting limited resources from the Earth. 4. Glass bottles are made from a limited resource. Describe how we can conserve this limited resource. **Prove it!** When a car reaches the end of its useful life, the car body can be recycled, reused, or sent to landfill. Give **three** reasons why a steel car body should be recycled and **not** reused or sent to landfill.

Physical Chemistry Keywords

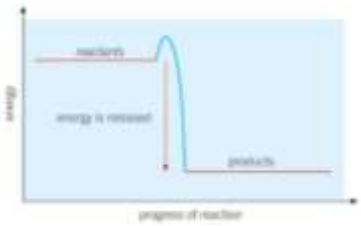
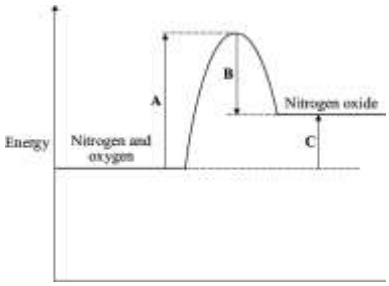
Add all the important keywords for this big idea in the grid below as you come across them in the study pack.

Word	Definition

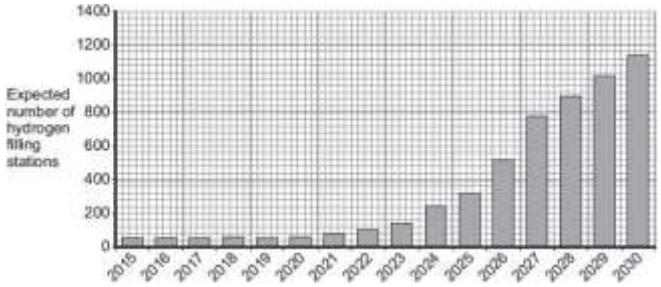
Physical Chemistry		
Book Ref.	**Spec. Ref.**	**Energy changes** **Exothermic and endothermic reactions**
	CS 5.5.1.1 Triple 4.5.1.1	1. What is meant by the law of conservation of energy? 2. Define an exothermic reaction in terms of energy transfer. 3. Give 2 examples of exothermic reactions and an everyday use. 4. Define an endothermic reaction in terms of energy transfer. 5. Give 2 examples of endothermic reactions and an everyday use.
	WS3.3 WS3.4 WS3.7	**Maths Skills** 1. Is the data in the table above showing an endo or exothermic reaction? 2. Calculate the mean decrease in temperature of water excluding an anomalous results. Give your answer to an appropriate number of significant figures. 3. The uncertainty of the thermometer is +/- 0.05°C. Calculate the uncertainty of the results in the table. 4. One student did all 5 experiments using the same equipment. Explain whether her results are repeatable, reproducible, both or neither.

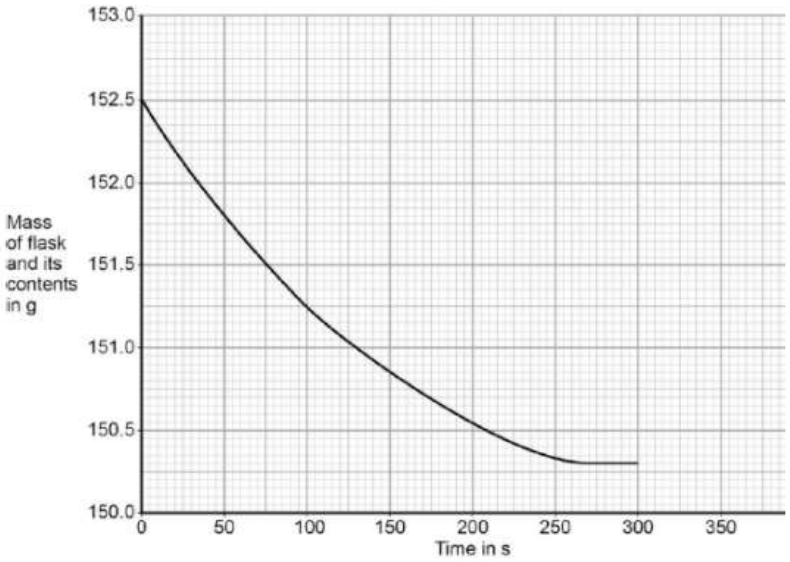
Experiment	Decrease in temperature of water in °C
1	5.9
2	5.7
3	7.2
4	5.6
5	5.8

Physical Chemistry		
Book Ref.	**Spec. Ref.**	**Required practical 10 (CS)** **Required practical 4 (Triple)**
	CS 5.5.1.1	Investigate the variables that affect temperature changes in reacting solutions for e.g. acid + metal, acid + carbonates, neutralisations, displacement of metals.
	Triple 4.5.1.1 AT 1,3, 5 and 6 WS3.7 WS2.2	A student conducted an experiment to find out which metal was the most reactive. They did this by selecting a range of metals (copper, zinc, tin and magnesium), adding them to an acid and measuring the temperature rise in 120 seconds. 1. Identify the independent variable. 2. Identify the dependent variable. 3. Suggest as many control variables as possible. Why do they need to be controlled? 4. Draw a results table that the students could put their results in (not forgetting to include units in the headings where appropriate). 5. Suggest a common source of error for this experiment and suggest what could be done to reduce this error.

Physical Chemistry		
Book Ref.	**Spec. Ref.**	**Exothermic and endothermic reactions**
	CS 5.5.1.2 Triple 4.5.1.2	1. What must happen to particles in order for them to react? 2. Define the term activation energy.  3. Is the following endothermic or exothermic? Explain why. 4. Draw a simple reaction profile diagram for an exothermic reaction. Show the relative energies of reactants and products, the activation energy and the overall energy change, with a curved line to how the energy as the reaction proceeds 5. Draw a reaction profile for the following reaction: $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$ The energy transferred to the surroundings is +184kJ/mol **Prove it!** The energy level diagram for the reaction between nitrogen and oxygen is shown:  Use the energy level diagram to help you to answer these questions. (i) Which energy change, **A**, **B** or **C**, represents the *activation energy*? (ii) Which energy change, **A**, **B** or **C**, shows that this reaction is *endothermic*?

Physical Chemistry		
Book Ref.	**Spec. Ref.**	**Chemical cells and fuel cells**

	4.5.2.2	1. Define the term 'fuel cell'. 2. In a hydrogen fuel cell, which gases are pumped into the fuel cell? 3. What is the waste product of the fuel cell? 4. Write a word equation for the overall reaction in the fuel cell. 5. (HT only) Write two half equations that show what happens to both hydrogen and oxygen gases in a hydrogen fuel cell. 6. Identify 3 advantages of hydrogen fuel cells. 7. Identify 3 disadvantages of hydrogen fuel cells. **Prove it!** Owners of cars powered by fuel cells buy hydrogen from hydrogen filling stations. **Figure 2** shows how the number of hydrogen filling stations in the UK is expected to increase up to the year 2030.  Use the information in **Figure 2** and your own knowledge to answer this question. Suggest **two** reasons why the UK government might encourage the building of more hydrogen filling stations. (2)

Physical Chemistry		
Book Ref.	**Spec. Ref.**	**The rate and extent of chemical change** **Calculating Rates of Reaction and Factors Affecting Rate**
	CS 5.6.1.1 5.6.1.2 Triple 4.6.1.1 4.6.1.2	1. What is meant by 'rate of a chemical reaction'? 2. What are the two ways to work out the rate of a chemical reaction? Give the units. 3. (HT only) What does the gradient of the line on a graph plotting [product] against time tell you about the rate of reaction? 4. What are the 5 factors that affect rate of reaction (be specific to the state of matter where appropriate).
	MS2a MS2b MS4e	**Maths Skills** (e) Another student investigated the rate of reaction by measuring the change in mass. **Figure 3** shows the graph plotted from this student's results. **Figure 3**  e) Calculate the mean rate of the reaction up to the time the reaction is complete. Give your answer to 3 significant figures. (4) f) Determine the rate of reaction at 150 seconds. Show your working on the graph above. Give your answer in standard form (4)

Physical Chemistry		
Book Ref.	**Spec. Ref.**	**Collision Theory and Activation Energy**
	CS 5.6.1.3 Triple 4.6.1.3	1. Use the collision theory to explain why only some collisions result in a chemical reaction. 2. Define the term activation energy. 3. How do the following affect the rate of reaction in terms of increasing frequency of collisions: a) Increase in pressure b) Increase in surface area c) Decrease in concentration d) Use of a catalyst 4. Explain **2 reasons** why increasing the temperature increases the rate of reaction. 5. What is the relationship between the size of pieces of solid material and its surface area to volume ratio?
	MS5c MS1d	**Maths skills** In an investigation of the reaction between zinc and dilute sulfuric acid, a student compared the rates of reaction by measuring the time taken for a set volume of hydrogen gas (250cm^3) to be given of. The student tested 2 different sized zinc granules and then zinc pellets of equal mass. The granules took 225s to disappear and the pellets took 113s 1. Calculate the mean rate of reaction with the granules and with the pellets. Include units. 2. Estimate how much larger the surface area to volume ratio is for the pellets compared to the granules. 3. Imagine the granules were cubes with sides of 0.1mm. Calculate the surface area, the volume and the surface area to volume ratio for 1 granule of zinc.

Physical Chemistry		
Book Ref.	**Spec. Ref.**	**Required practical 11 (CS)** **Required practical 5 (Triple)**
	CS 5.6.1.2 Triple 4.6.1.2 AT 1,3,5 and 6 WS2.2	Investigate how changes in concentration affect the rates of reaction by a method involving the volume of a gas produced and a method involving a change in colour or turbidity.

1. What does the term 'turbidity' mean? How could you use this to measure a rate of reaction for a give chemical change?

2. Suggest another method of measuring the rate of reaction that involves a gas syringe.

3. A student investigated the rate of reaction of magnesium and hydrochloric acid.

$$Mg(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2(g)$$

The student studied the effect of changing the concentration of the hydrochloric acid.

She measured the time for the magnesium to stop reacting.

Concentration of hydrochloric acid in moles per dm^3: 0.5 1.0 1.5 2.0

(a) The student changed the concentration of the hydrochloric acid.

Give **two** variables that the student should control.

1 .....

2 .....

(2)

(b) (i) The rate of reaction increased as the concentration of hydrochloric acid increased. Explain why.

(2)

(ii) Explain why increasing the temperature would increase the rate of reaction.

(3)

Physical Chemistry		
Book Ref.	**Spec. Ref.**	**Rate of reaction**
	CS 5.6.1.4 Triple 4.6.1.4	1. What is a catalyst? 2. How does a catalyst affect the rate of a chemical reaction? How does it do this? 3. Why is a catalyst not included in the reactants of a word equation for a reaction? 4. What are enzymes? 5. Draw a reaction profile for an endothermic reaction showing the activation energy with a catalyst and without a catalyst. 6. Explain catalytic action in terms of activation energy.
		Prove it! Nitrogen and hydrogen are passed over iron to produce ammonia in the Haber Process. Balance the equation for the reaction. N_2 + H_2 → NH_3 **(1)** What is iron used for in the Haber process? Tick **one** box. catalyst ☐ fuel ☐ monomer ☐ reactant ☐ **(1)**

Physical Chemistry		
Book Ref.	**Spec. Ref.**	**Reversible reactions and dynamic equilibrium**
	CS 5.6.2.1 5.6.2.2 5.6.2.3 Triple 4.6.2.1 4.6.2.2 4.6.2.3	1. Define a reversible reaction. 2. Write a word equation for hydrated copper sulfate becoming anhydrous copper sulfate and water. Include the reversible reaction symbol. 3. Add the colours of the compounds to the equation above. 4. If the forward direction of a reversible reaction is exothermic, what must the backward reaction be? 5. A reaction takes in 203kJ of energy in the forward reaction. What will happen when the reaction is reversed? 6. Under what conditions will equilibrium be reached?
		Prove it! Hydrated copper sulphate is a blue solid. When it is heated, white solid anhydrous copper sulphate is made. This is a reversible reaction. hydrated copper sulphate (blue) [+ heat energy] ⇌ anhydrous copper sulphate (white) + water (a) To make the forward reaction work, the hydrated copper sulphate must be heated all the time. What type of reaction is this? .... **(1)** (b) Anhydrous copper sulphate can be used in a test for water. What **two** things will happen when water is added to anhydrous copper sulphate? 1 .... 2 .... **(2)**

Physical Chemistry		
Book Ref.	**Spec. Ref.**	**Reversible reactions and dynamic equilibrium (HT only)**
	CS 5.6.2.4 (HT) 5.6.2.5 (HT) Triple 4.6.2.4 (HT) 4.6.2.5 (HT)	1. Describe Le Chatelier's Principle. 2. How will a system respond if the concentration of a reaction is increased? 3. How will a system respond if the concentration of reaction is decreased? 4. An equilibrium mixture is set up in a closed system with iodine monochloride, chlorine gas, and iodine trichloride. $ICl + Cl_2 \rightarrow ICl_3$ In order to make more iodine trichloride, would you pump more gas into the mixture or remove chlorine gas? Explain your answer using Le Chatelier's Principle.
	MS3a	Maths Skills What do the following symbols mean: a) = b) < c) < d) >> e) > f) ~ g) ∝

Physical Chemistry		
Book Ref.	**Spec. Ref.**	**Reversible reactions and dynamic equilibrium (HT only)**
	CS 5.6.2.6 (HT) 5.6.2.7 (HT) Triple 4.6.2.6 (HT) 4.6.2.7 (HT) WS3.8	

1. Complete the table to describe the effect of temperature change on the amount of products in a reaction:

	Increase Temperature	Decrease Temperature
Exothermic Forward Reaction		
Endothermic Forward Reaction		

2. Look at the reaction below:

$$H_2O\ (g) + C(s) \rightleftharpoons CO\ (g) + H_2.$$

The forward reaction is endothermic. Describe how the amount of $H_2(g)$ will change if temperature is increased.

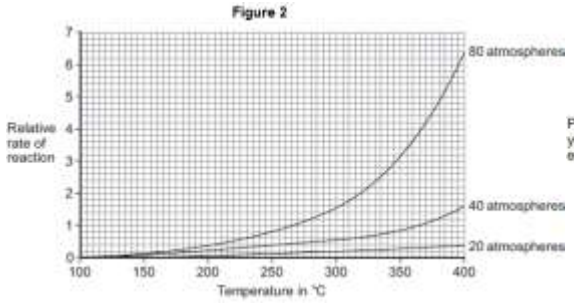
3. Explain what effect increasing the pressure would have on the equilibrium mixture below:

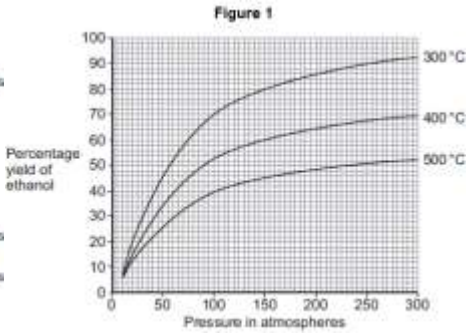
$$H_2(g) + I_2(g) \rightleftharpoons 2HI\ (g)$$

Prove it!

Ethanol can be made by reacting ethene with steam in the presence of a catalyst with the following equation: $C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$

Figure 1 shows how the percentage yield of ethanol changes as the pressure is changed at three different temperatures. **Figure 2** shows how the rate of reaction changes as the temperature changes at three different pressures.





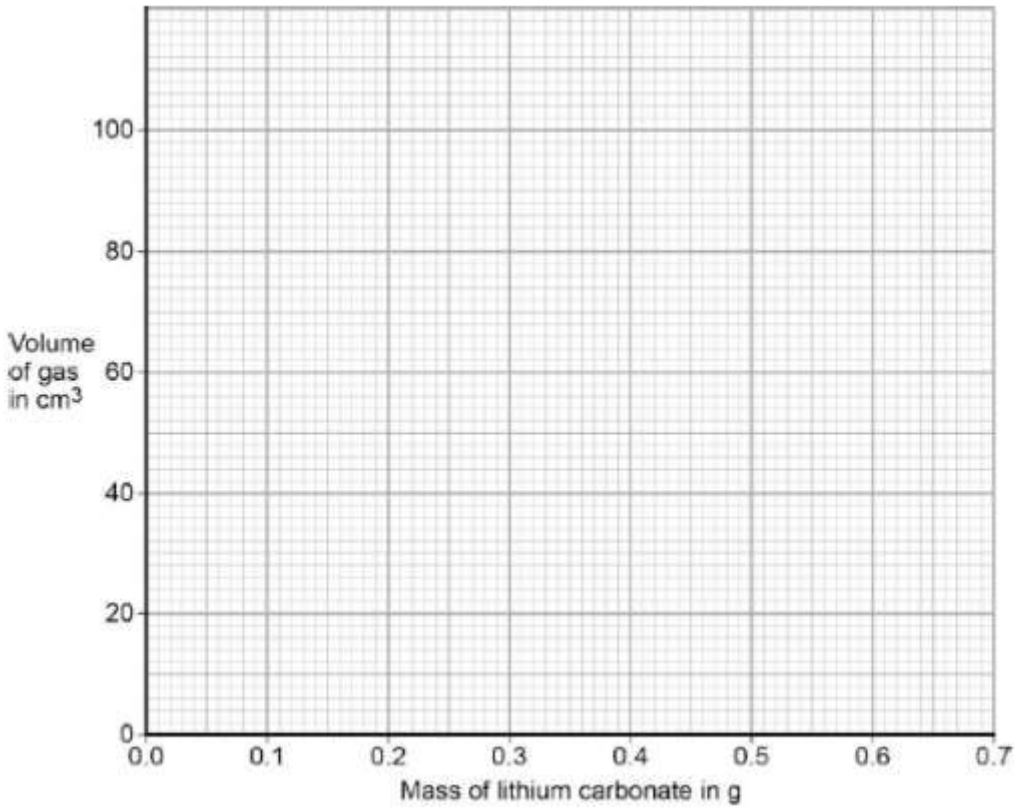
In one process for the reaction of ethene with steam the conditions are; 300 °C, 65 atmospheres, a catalyst.
Use the information in **Figure 1** and **Figure 2**, and your own knowledge, to justify this choice of conditions. (6)

Physical Chemistry		
Book Ref.	**Spec. Ref.**	**Graph Skills**
	WS3.1 WS3.2 MS4a MS4c	

Mass of lithium carbonate in g	Volume of gas in cm^3
0.0	0
0.1	22
0.2	44
0.3	50
0.4	88
0.5	96
0.6	96
0.7	96

On **Figure 3**:

- Plot these results on the grid.
- Complete the graph by drawing **two** straight lines of best fit.



(4)

Physical Chemistry		
Book Ref.	**Spec. Ref.**	**Graph Skills**

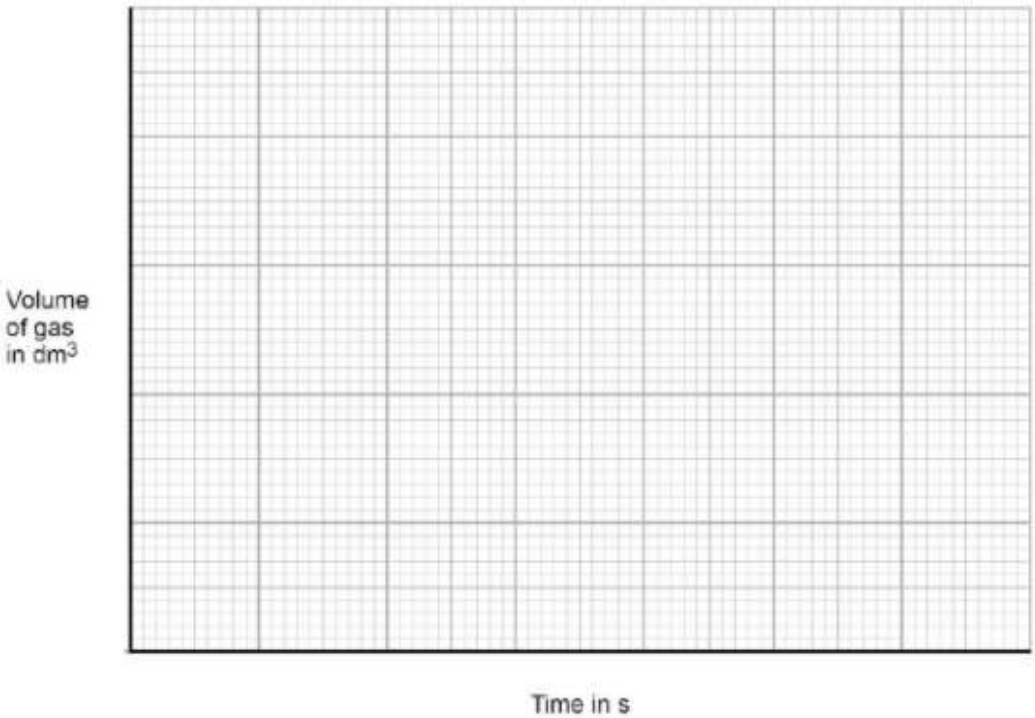
The table below shows the student's results.

Time in s	Volume of gas in dm^3
0	0.000
30	0.030
60	0.046
90	0.052
120	0.065
150	0.070
180	0.076
210	0.079
240	0.080
270	0.080

On **Figure 2**:

- Plot these results on the grid.
- Draw a line of best fit.

Figure 2



(4)

Graph drawing

Top tips for getting full marks in graph-drawing questions:

1. Axes should be drawn in pencil.

2. Labels (including units!) should only be written in pen when you are sure of them.

3. Your scale should be even – 0.1, 0.2, 0.3… or 10, 20, 30… or 100, 200, 300 …. ***not*** 18, 22,13.

4. When you draw a bar chart the bars should be of equal width.

5. If you draw a line graph then a line or curve of best fit should show the pattern of the points – they should not be connected dot to dot.

6. Your graph needs to take up over half of your graph paper. If it doesn't then you should redo your scale.

<u>Important terms</u>

Independent variable: this is the variable you have chosen to change. **These are always drawn on the x-axis.**

Dependent variable: this changes when you have changed the independent variable. It *depends* on the independent variable. **These are always drawn on the y-axis.**

Categoric variable: this is the names of groups such as eye colour or type of energy resource. You draw a **bar chart** to represent this type of variable.

Continuous variable: this is data such as temperature or time which can be any value. You draw a **line graph** to represent this type of variable.

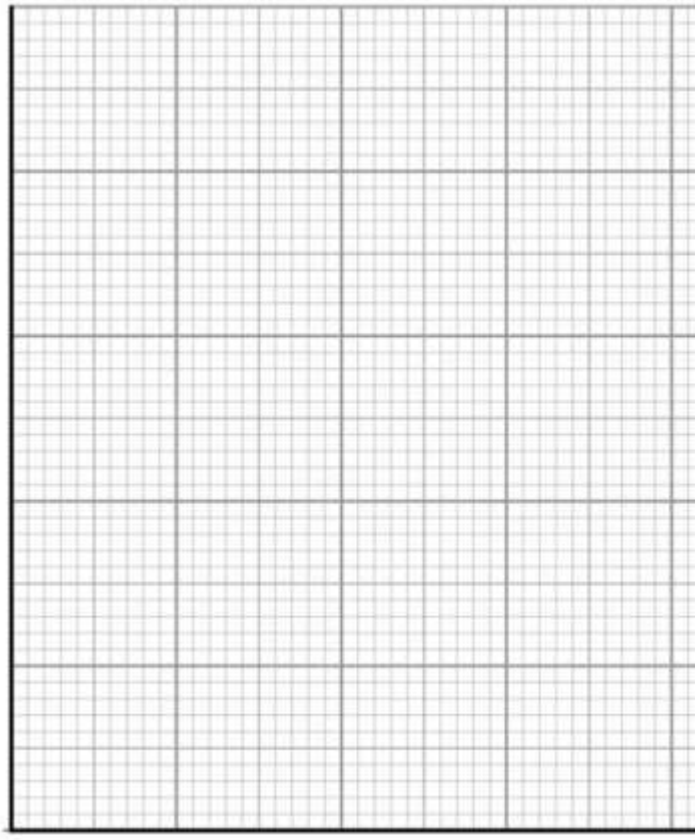
Graph drawing practice

1. Bar chart

A student carried out a survey to find out the blood group of each student in Year 11. He calculated the % of students in each blood group, as shown in the table below.

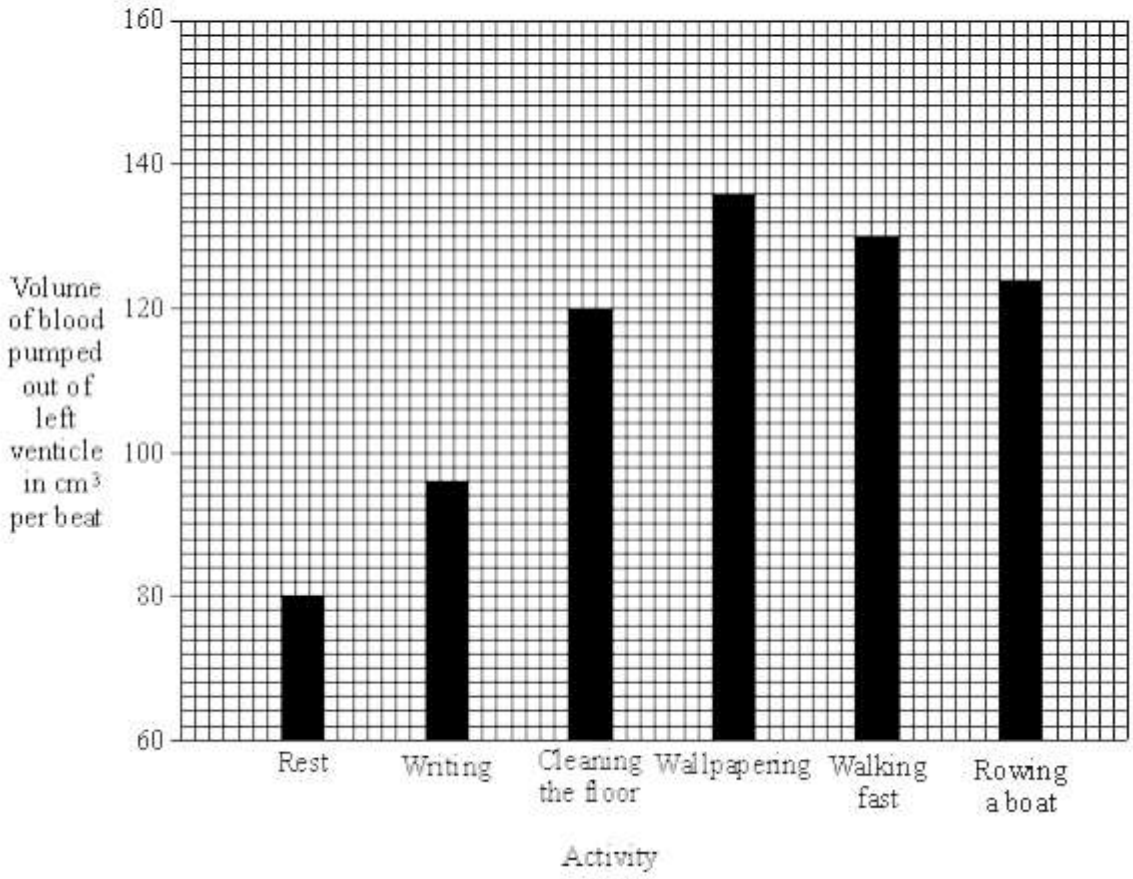
Blood group	% students
A	41
B	9
AB	4
O	46

Plot a bar graph of the data shown above.



Prove it!

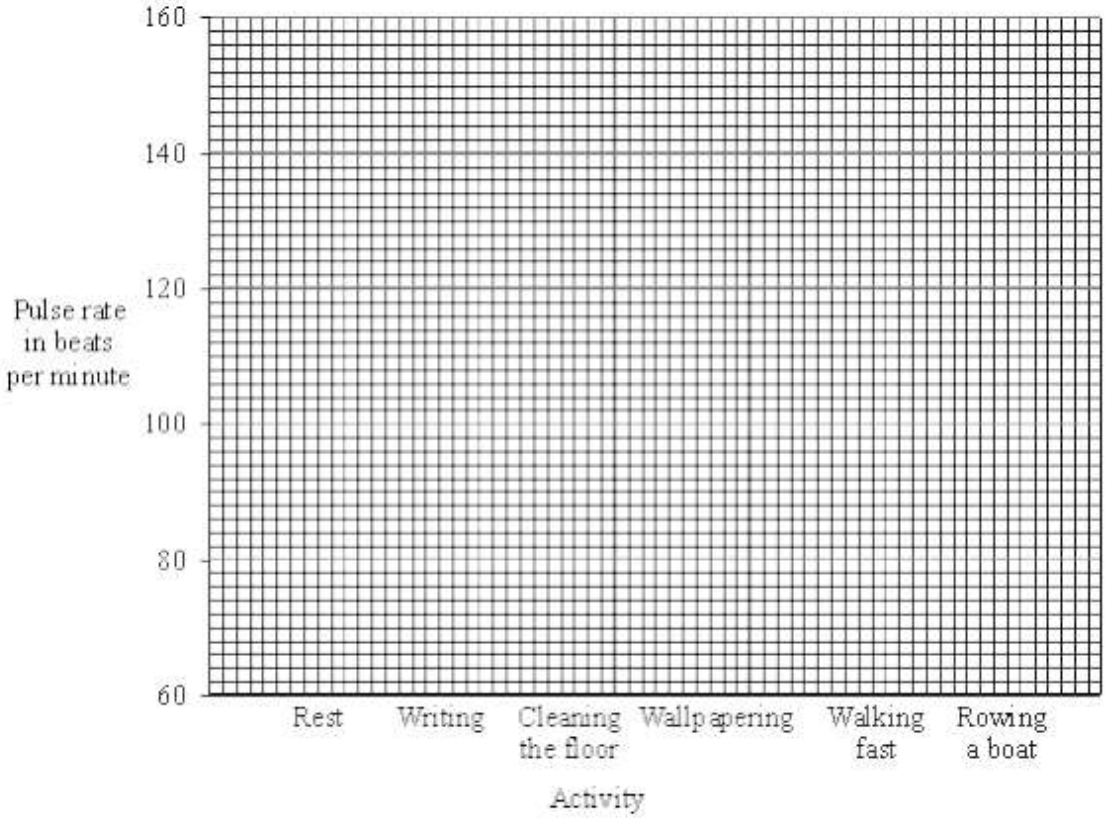
(a) The volume of blood pumped out of the left ventricle at each beat was measured for a person during six different activities. These activities showed an increasing energy demand, with rest requiring the least energy and rowing a boat the most. The results of these measurements are shown on the bar chart.



(i) The pulse rate was also measured for the person during the same activities. The table shows the results that were obtained.

Activity	Pulse rate in beats per minute
Rest	70
Writing	85
Cleaning the floor	100
Wallpapering	120
Walking fast	132
Rowing a boat	153

On the graph paper below draw a bar chart of the results obtained for the measurements of the pulse rate.



(2)

(ii) Undertaking activities with increasing energy demand has an effect on the volume of blood pumped from the left ventricle (per beat) and on the pulse rate. What do the bar charts show these effects to be? Use only information shown in the bar charts in your answer.

.....

.....

.....

(2)

(b) The pulse rate changed when the activity changed. Explain the reason for this.

.....

.....

.....

(2)
(Total 6 marks)

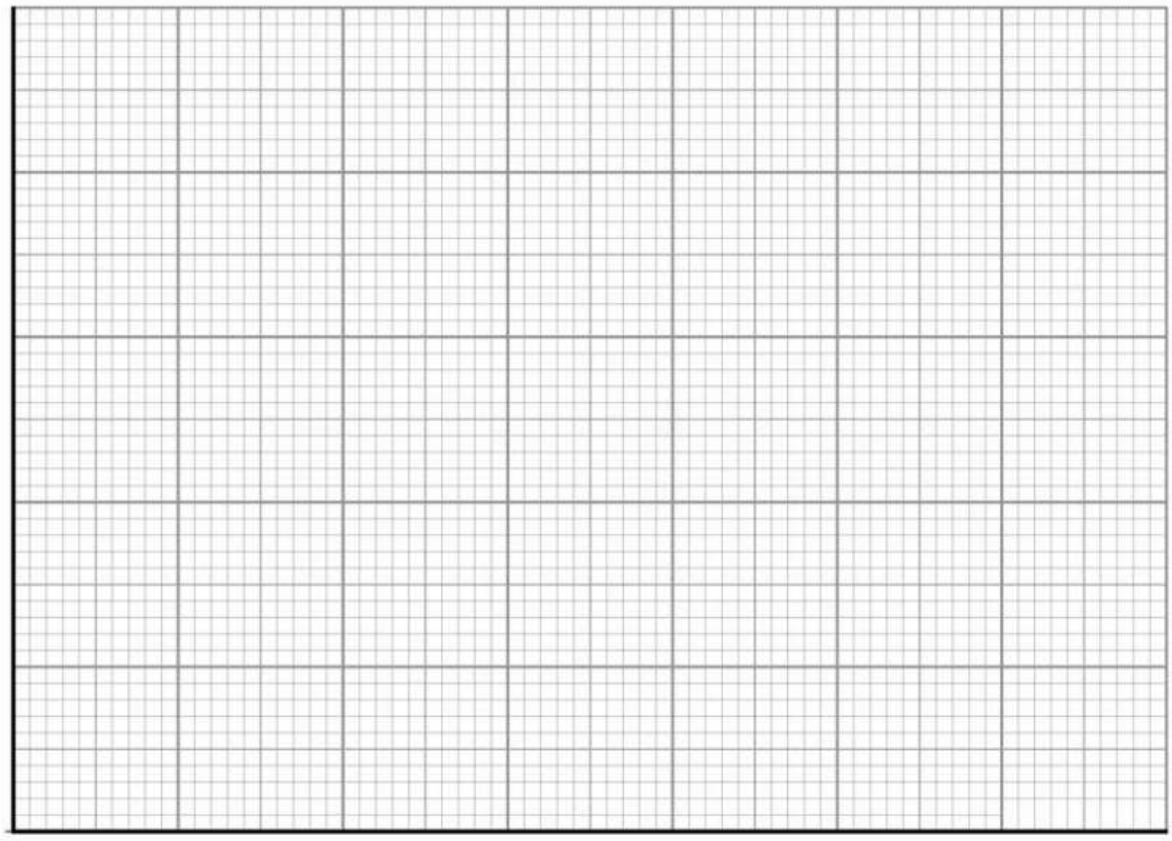
2. Line graph

A student investigated the effect of temperature on the rate of photosynthesis.

Her results are shown in the table below.

Temperature in °C	Number of bubbles produced in one minute
5	7
10	15
15	21
20	24
25	24

Draw a line graph of the data shown above.



Prove it!

(a) (i) What name is given to an enzyme which catalyses the breakdown of protein?

.....

(1)

(ii) What product is formed when protein is broken down by the enzyme?

.....

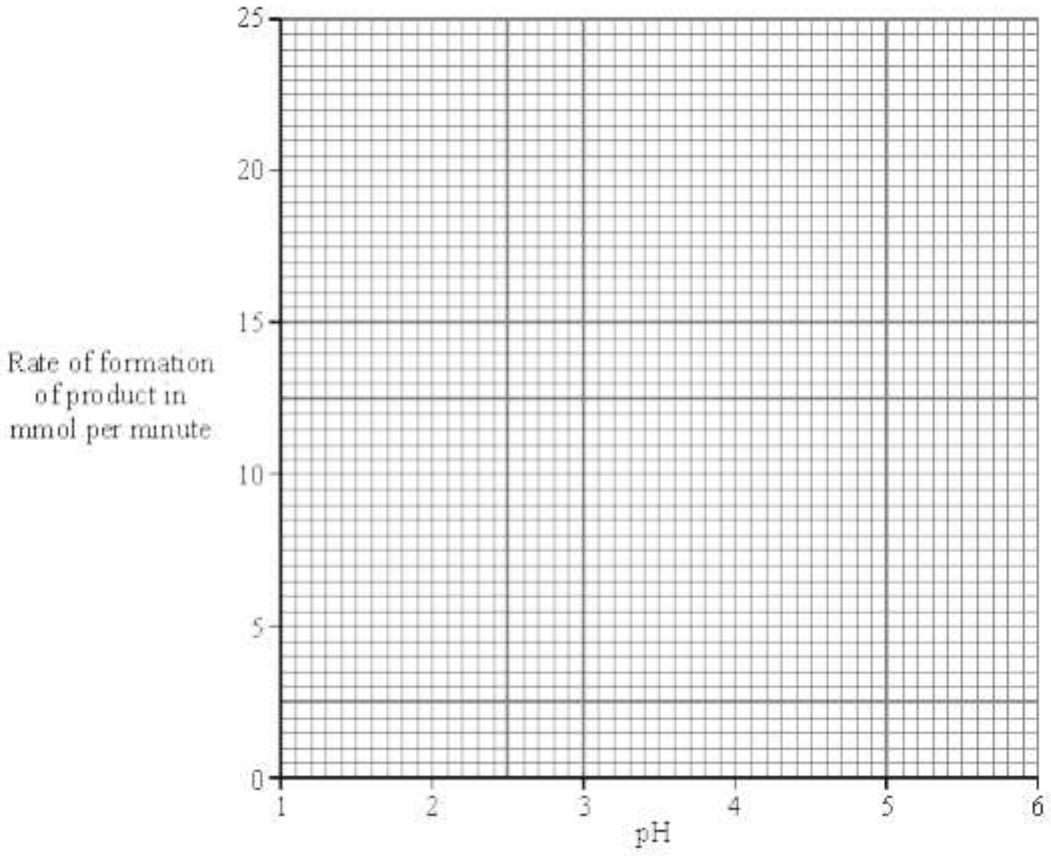
(1)

The table shows the effect of pH on the activity of an enzyme which catalyses the breakdown of protein.

pH	1.0	2.0	3.0	4.0	5.0
Rate of formation of product in mmol per minute	10.5	23.0	10.5	2.5	0.0

(b) Draw a graph of the data in the table.

(b) Draw a graph of the data in the table.



(3)

(c) The enzyme is produced by the human digestive system.

(i) At what pH does this enzyme work best? .....

(1)

(ii) Suggest which part of the digestive system produces this enzyme.

.....

(1)

(d) Why is it necessary to break down proteins in the digestive system?

.....

.....

.....

.....

.....

.....

(3)
(Total 10 marks)

3. Pie chart

The table below shows the world energy demand and sources of energy in 2013.

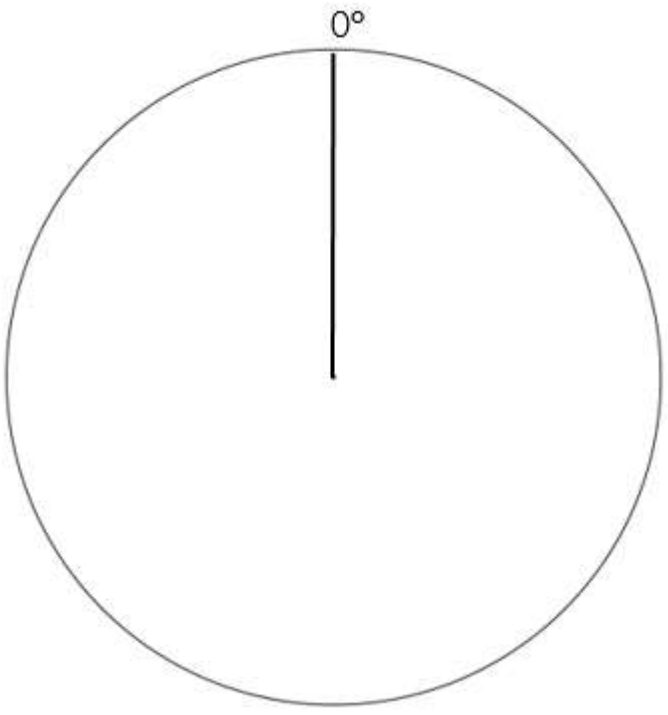
Energy source	%	Calculation	Degrees of a circle (°)
Coal	31	$(^{31}/_{100})$ x 360	112
Gas	24		
Oil	31		
Nuclear	4		
Hydroelectricity	7		
Other renewables	3		

Draw a pie chart of the data shown above.

Help! How do I work out the size of each part of the pie chart?

- To draw a pie chart, we need to represent each part of the data as a proportion of 360, because there are 360 degrees in a circle.
- For example, if 31% of world energy demand comes from coal, we will represent this on the circle as a segment with an angle of: $(^{31}/_{100})$ x 360 = 111.6, or 112°.
- *Complete the additional columns of the table shown in red above.*
- Once you have done this, check that all the values you have calculated add up to 360°!

Now draw your pie chart!



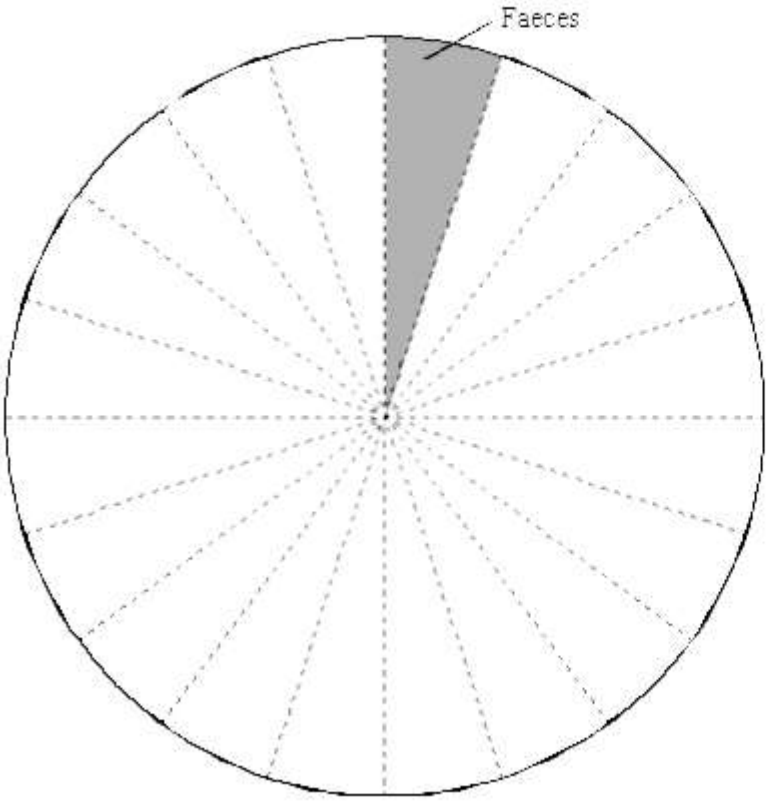
Prove it!

The table shows how much water is lost in different ways from a student's body.

Way in which water is lost	Percentage of total
Breath	15
Faeces	5
Sweat	50
Urine	30

(a) Complete the pie chart.

One part has been done for you. Remember to label the pie chart.



(3)

Reflections Page

Each time you come across something you find hard, write it down here and ask your teacher to help you with it.

Topic I Found Hard	Page Number	What was difficult about this?	Tick when you have got help from your teacher