Chemistry Paper 2
Combined Science
Foundation

Rates of Reaction

Answers to Questions

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Mean Rate of a Chemical Reaction	
1a	The steeper the slope of the curve, the faster / slower the reaction
1b	Only a small number of reactant molecules are reacting per second = stage 2 Here all of the reactant has been used up = stage 3 The reaction has stopped = stage 3 The reaction is slowing down = stage 2 The reaction is at its fastest = stage 1 Here the amount of reactant is greatest = stage 1 The maximum number of reactant molecules are reacting per second = stage 1 Here the amount of reactant is running out = stage 2 Because there is no reactant no more product forms = stage 3
1c	Stage 1: Here the amount of reactant is greatest. The maximum number of reactant molecules are reacting per second. The reaction is at its fastest. Stage 2: Here the amount of reactant is running out. Only a small number of reactant molecules are reacting per second. The reaction is slowing down. Stage 3: Here all of the reactant has been used up. Because there is no reactant no more product forms The reaction has stopped
2a	Mean rate of reaction = quantity of product formed / time taken Mean rate of reaction = 25g / 100s = 0.25 g / s
2b	Mean rate of reaction = quantity of product formed / time taken Mean rate of reaction = $100cm^3$ / 200s = 0.5 cm^3 / s
3a	Mean rate of reaction = quantity of reactant used / time taken Mean rate of reaction = 6g / 18s = 0.33 g / s (to 2 significant figures)
3b	Mean rate of reaction = quantity of reactant used / time taken Mean rate of reaction = $80cm^3$ / 40s = 2 cm^3 / s

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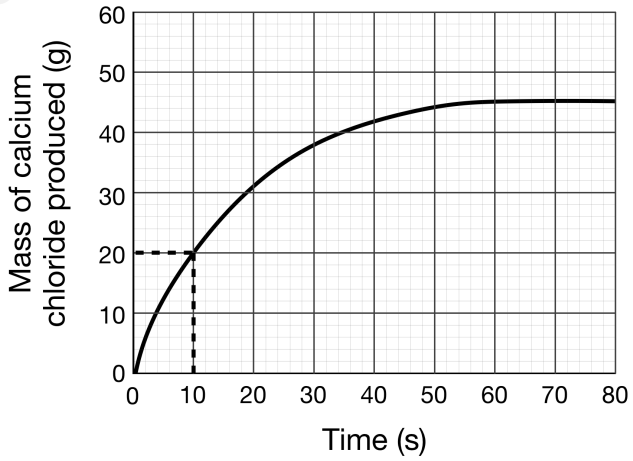
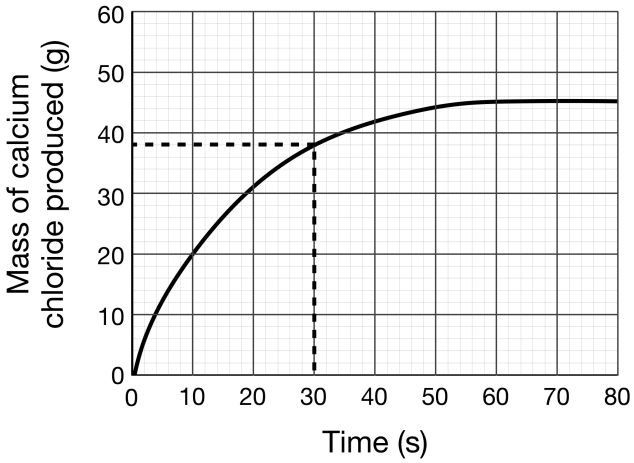
Mean Rate of a Chemical Reaction	
4a	To answer this question, first use the graph to work out the mass of calcium chloride produced in 10 seconds.  From the graph, we can see that 20g of calcium chloride was produced in 10 seconds. Mean rate of reaction = quantity of product formed / time taken Mean rate of reaction = 20g / 10s = 2 g / s
4b	To answer this question, first use the graph to work out the mass of calcium chloride produced in 30 seconds.  From the graph, we can see that 38g of calcium chloride was produced in 30 seconds. Mean rate of reaction = quantity of product formed / time taken Mean rate of reaction = 38g / 30s = 1.27 g / s
4c	The rate at 30 seconds is less than the rate at 10 seconds. This is because by 30 seconds a large amount of the reactant has already reacted. This means that the frequency of successful collisions is less at 30 seconds than at 10 seconds.
4d	The point where the reaction is finished is where the line becomes horizontal (ie no more product is being made). From the graph, we can see that the line becomes horizontal at 58-60 seconds. In the exam, if you are asked to determine when the reaction has finished from a graph, please be careful to be specific. Try to get as close to the horizontal point as possible. Many students lose marks by being approximate. There will be a range of possible answers but it won't be very broad so you do need to try to be specific.

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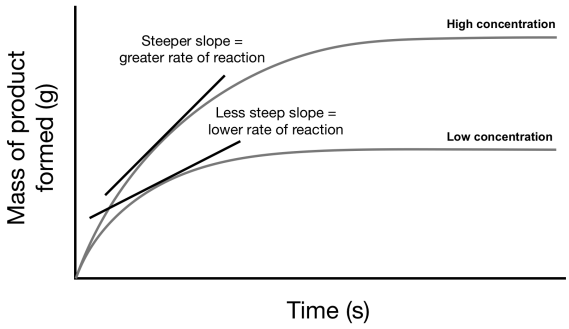
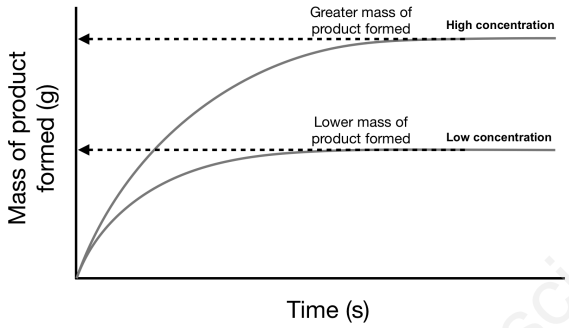
Effect of Concentration of Reactants on Rate	
1a	For a reaction to take place, the reacting particles must **collide** with each other. If these have sufficient **energy** then the collision is successful and a reaction happens. The rate of the chemical reaction is determined by the **frequency** of successful collisions.
1b	This is a really important difference. The *frequency* of successful collisions means the number of successful collisions **per second**. However the *number* of successful collisions does not refer to any time period so it could mean in a second, a minute, an hour, a day etc. It's really important when referring to successful collisions that you say frequency since that means per second. Some students say "number of successful collisions per second" and that's also fine.
2a	The fastest reaction will be container B as that has the highest concentration (or pressure) of particles. The next fastest is container C as that has a lower concentration (or pressure) than container B but a greater concentration (or pressure) than container A. The slowest reaction will be container A as this has the lowest concentration (or pressure) of the three containers.
2b	We can see from the slope of the two graphs that the higher concentration has a greater rate of reaction than the lower concentration (we can see this because it has a steeper slope). This is because there is a higher concentration of reactant particles which means that there is a greater frequency of successful collisions and therefore a greater rate of reaction.  We can see that we have a greater mass of product when we have a higher concentration of reactant. This is because we have a greater total number of reactant particles in the higher concentration than in the lower concentration. When these particles react, we will have a greater mass of product formed. 

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Required Practical: Rates of Reaction	
1a	A hypothesis is a proposal which could **explain** a fact or an observation. A key idea in science is that a hypothesis must be **testable**.
1b	The higher the concentration of reactants, the faster the rate of reaction. This is because there will be a greater frequency of successful collisions with a higher concentration of reactants than with a lower concentration of reactants.
2a	In the reaction equation, we can see that one of the products is sulfur. Sulfur is a solid which forms tiny particles in the liquid. These tiny particles turn the liquid cloudy.
2b	A measuring cylinder allows us to measure a volume of liquid with a high degree of accuracy. Because of this, a measuring cylinder is described as volumetric. If we tried to measure the volume of a liquid using a beaker (beakers are not volumetric) then our volume would only be approximate.
2c	The main issue with the disappearing cross experiment is that the final result depends on whether you think you can still see the cross. If we allow students to make their own crosses (for example by drawing one on a piece of paper) then we cannot be certain that the crosses are all the same. For example one student may draw a small faint cross, whereas other students may draw a large thicker cross. By giving all the students an identical printed cross, we can reduce this variability.
2d	By swirling the conical flask we ensure that the reactants mix thoroughly. If we did not swirl, then the reactants may not mix and the reaction may be slower than it should be.
2e	As we saw in question 2c, this method has a problem. The students judge the reaction by eye, deciding when they can no longer see the printed cross. Students with good eyesight may see the cross for longer than other students. This means that there will always be some variability in the results between different students. One way to reduce this is to ask all the students in a group to watch the cross and write down when they can no longer see it. We can then take a mean of all their results. This means that the final result does not depend on one person's eyesight.
2f	Person looking at the cross: control variable. Temperature of the solutions: control variable. Even though we do not take any action to keep this the same, it is a good idea to monitor the temperature to make sure that it does not change. We can do this with a thermometer. Concentration of sodium thiosulfate solution: independent variable. This is what we change in our experiment. Volume of hydrochloric acid: control variable: This is always kept at $10cm^3$. Time for cross to no longer be visible: dependent variable. This is what we measure for each change in the independent variable. Concentration of hydrochloric acid: Control variable. We do not change this between experiments. Volume of sodium thiosulfate solution: Control variable.
3a	Remember that we do not include anomalous results in a mean. In this case, we can see that repeat 3 is an anomalous result as it is very different to repeats 1 and 2. To calculate the mean, we add our numbers together and then press = on our calculator. Then we divide by the number of numbers. 48 + 44 = 92 92 / 2 = 46

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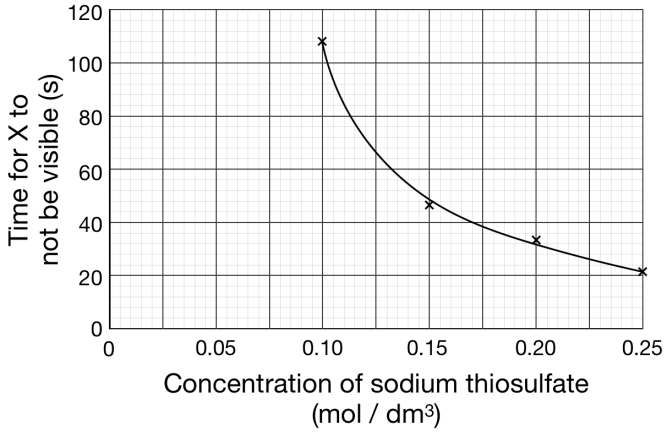
3b

We can see from the table that the student's results are repeatable. Remember that results are repeatable if the same student repeats the experiment and gets the same results.

The repeats are close together for each concentration of sodium thiosulfate solution. This tells us that the results are repeatable.

The only exception is for 0.15 mol/dm^3 repeat number 3. This is much greater than the other values for that concentration. This is an anomalous result.

3c



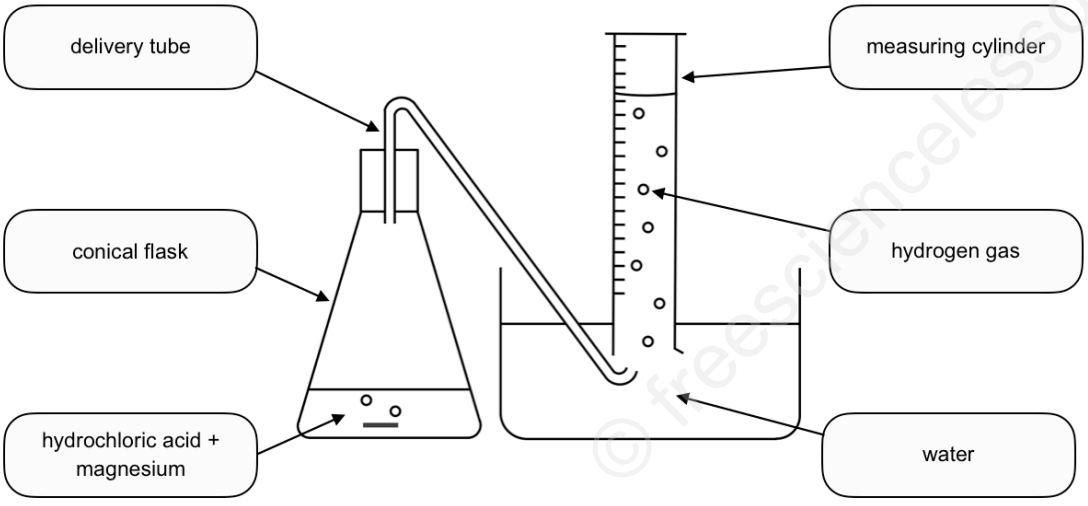
3d

The results show that as the concentration of sodium thiosulfate solution increases, the time taken for the cross to not be visible decreases (in other words the reaction gets faster). This agrees with our hypothesis.

4a

At this point, we add a 3cm strip of magnesium to the acid.	5	The reaction produces hydrogen gas which will bubble into the measuring cylinder.	7
First we use a measuring cylinder to transfer 50 cm^3 of hydrochloric acid into a conical flask.	1	When the reaction has stopped, we repeat the experiment using different concentrations of hydrochloric acid.	10
Now we replace the bung and start timing.	6	We now place the end of the delivery tube into the mouth of the measuring cylinder.	4
Place an upturned measuring cylinder into water so that the measuring cylinder is filled with water.	3	We then attach the conical flask to a bung and a delivery tube.	2
Every ten seconds we read the volume of hydrogen gas.	8	Continue taking readings until the reaction has stopped.	9

4b



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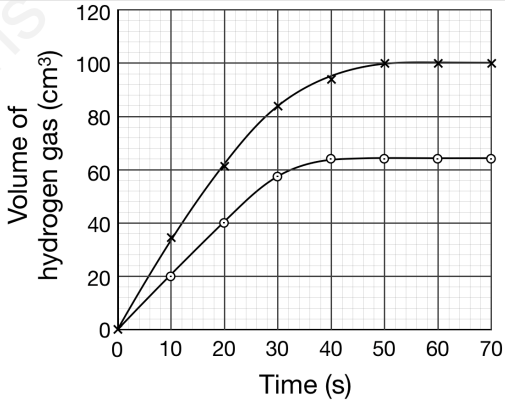
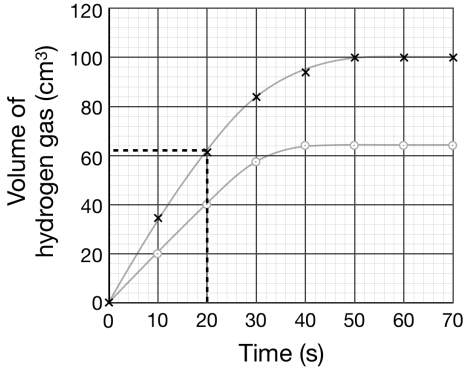
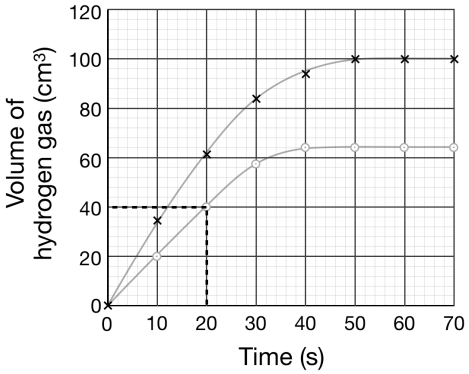
Required Practical: Rates of Reaction	
4c	
4d	 To calculate the mean rate of reaction from a graph, we first draw a vertical line from the time. In this question, the time is 20 seconds. We then draw a horizontal line and read the volume of hydrogen gas produced. In this case, we can see that 62 cm^3 of hydrogen gas have been produced for the higher concentration of hydrochloric acid. The mean rate of reaction is calculated using the equation: Mean rate of reaction = quantity of product formed / time taken Mean rate of reaction = 62 / 20 = 3.1 cm^3 / s
	 In this case, we can see that 40 cm^3 of hydrogen gas have been produced for the lower concentration of hydrochloric acid. Mean rate of reaction = 40 / 20 = 2 cm^3 / s
4e	Both of the experiments in this required practical show that the rate of reaction increases as the concentration of reactants increases. Because these two experiments involve different methods and have produced the same results, we can say that the results are reproducible.

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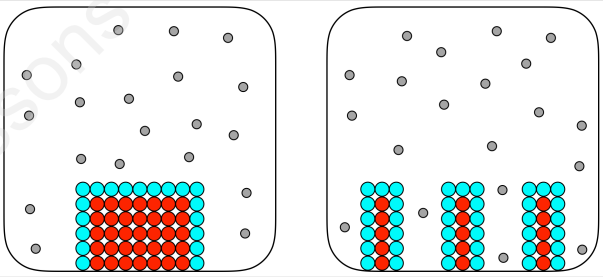
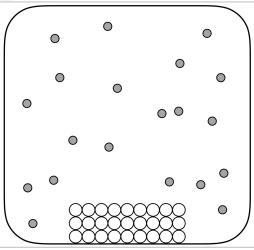
Effect of Surface Area on the Rate of Reaction

1a

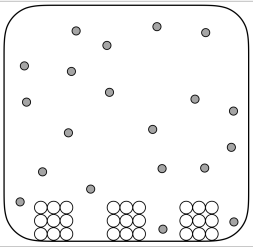


1b If we take a solid and break it into smaller pieces, we have a **greater** rate of reaction. This is because the smaller pieces have a **greater** surface area to volume ratio than the larger pieces. Because of this, the **frequency** of successful collisions is greater with the smaller pieces.

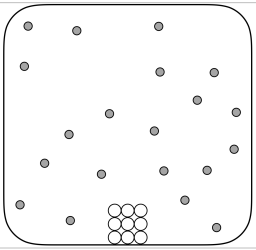
2



This diagram represents line B on the graph. We can see that both this diagram and the diagram below have the same amount of calcium carbonate, so the final amount of product must be the same in both cases. Lines A and B both have the same amount of product. However, in the case of this diagram, the calcium carbonate is in one piece. This will have a smaller surface area than in the diagram below. Because of this, the reaction will be slower.



This diagram represents line A on the diagram. As discussed above, the amount of calcium carbonate is the same as the diagram above. However, in this diagram the calcium carbonate has a greater surface area and so will react faster. Line A shows a faster reaction than Line B.



This diagram represents line C on the graph. The amount of calcium carbonate is one third the amount of the other two diagrams so the final amount of product will be one third as much. Line C shows around one third the amount of final product of lines A or B.

3 If the total mass is the same, smaller pieces of solid will react faster than larger pieces. This is **true** as the smaller pieces will have a larger surface area than the larger pieces.

Smaller pieces of solid will have a smaller surface area than larger pieces. This is **false**. Smaller pieces of solid have a larger surface area than larger pieces.

If the mass is the same, smaller pieces of solid will produce more product than larger pieces. This is **false**. Because we have the same mass, we will have the same amount of product.

Smaller pieces of solid will have a greater frequency of collisions than larger pieces. This is **true** as smaller pieces of solid have a larger surface area than larger pieces.

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Effect of Surface Area on the Rate of Reaction	
4a	A gas syringe is more accurate for measuring the volume of a gas than using an upturned measuring cylinder. Firstly, reading a measuring cylinder upside down is difficult. Secondly, the bubbles can move rapidly, disturbing the level of the water, making it very difficult to read the volume. Also, it is easier to carry out a repeat experiment using the gas syringe. If we want to repeat the experiment using the measuring cylinder, we need to refill the measuring cylinder with water and submerge it in the container. This is tricky to do.
4b	The cotton wool allows the carbon dioxide gas to escape from the reaction but stops any acid from splashing out. If any acid splashed out, the mass would fall more than it should.
4c	In this experiment, we are monitoring the mass of gas that leaves the reaction. Gases have a low density so we would not expect to see a very large mass decrease. Because of this, we need a balance with a high resolution in order to detect the change in mass. If we used a balance which read to the nearest gram, we may not measure any mass change at all.
4d	All three of these experiments could be too fast to measure accurately. One way to overcome this problem is to video the experiments (eg on a mobile phone) and then replay them at a slower speed.

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Effect of Temperature on the Rate of Reaction	
1a	The energy profile shows that the products of the reaction have less energy than the reactants. Because of this, energy must have been transferred to the surroundings. Therefore the reaction must be exothermic.
1b	The activation energy is the minimum amount of **energy** that the particles need in order to react (in other words to **collide** successfully).
1c	Particles in B. These particles have less energy than the activation energy. This means that these particles will not collide successfully and will not react (they will simply bounce off each other). Particles in C. These particles have more energy than the activation energy. These particles will collide successfully and react.
2a	To answer this question, you need to remember that the rate of reaction is proportional to the temperature. Lowest temperature = A (this line shows the lowest rate of reaction). Highest temperature = B (this line shows the highest rate of reaction). Mid temperature = C (this line shows a reaction rate between A and B).
2b	Apart from the activation energy, temperature also increases the rate of reaction because at higher temperatures, the frequency of collisions increases. This is because at higher temperatures, the particles are moving more rapidly and colliding more frequently.

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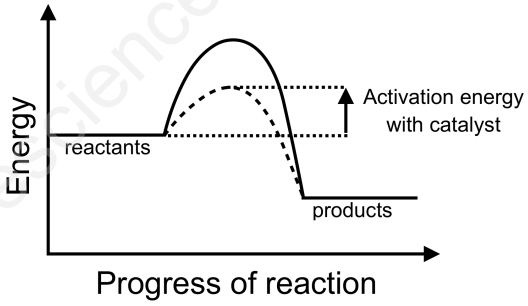
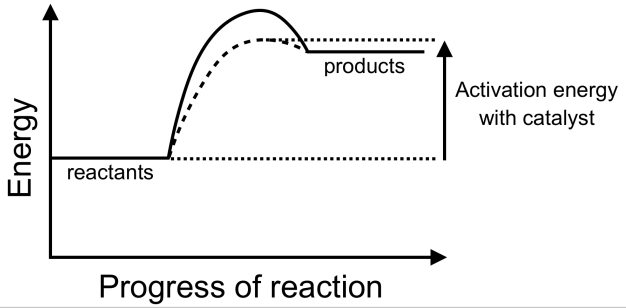
Catalysts	
1a	For a chemical reaction to occur, the particles must collide with a certain amount of **energy**. Scientists call this the **activation** energy. Catalysts increase the rate of chemical reactions by providing a different **pathway** with a lower activation energy **barrier**. This means that particles require less energy to **collide** successfully and react. Catalysts are not **used up** during the reaction and can be reused. By using a catalyst, we can make a reaction faster without increasing the **temperature**. This saves energy and **money**.
1b	 
2a	In the equation, the iron catalyst is shown as a reactant (ie it is on the left hand side of the arrow). A catalyst is not a reactant (as it is not used up in a chemical reaction). Catalysts should be shown above the arrow.
2b	Different chemical reactions require different catalysts so iron cannot be used as a catalyst in all chemical reactions.
2c	Catalysts in living organisms are called enzymes.

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Reversible Reactions

1a

sodium + bromine → sodium bromide

The arrow tells us that this is a **non reversible** reaction.

The products **cannot** go back and reform the reactants.

ammonium chloride ⇌ (heat / cool) ammonia + hydrogen chloride

The arrow tells us that this is a **reversible** reaction.

The products **can** go back and reform the reactants.

1b

Heat the reaction

Reaction moves **forwards**

Cool the reaction

Reaction moves **backwards**

2a In this reaction, we make the reaction move forward by heating it. Because we are putting energy in, the forward reaction must be endothermic.

2b When we add water to anhydrous copper sulfate, the reaction moves to the left and releases heat.

This is because when we add water, we are reversing the direction of the reaction (in other words we are making the reaction move backwards). The backwards reaction is exothermic (we know this because the forward reaction is endothermic) so when we add water, the reaction releases energy to the surroundings, which increase in temperature.

3 If we place the reactants for a reversible reaction into a sealed container, the reaction will move forward to produce the products. However, because the reaction is reversible, the reaction can also move backwards, to create the reactants.

After some time, the rate of the forward reaction and the reverse reaction will be the same. Now the concentrations of the reactants and products will stop changing. This is called equilibrium.

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Chemistry Paper 2
Combined Science
Foundation

Organic Chemistry

Answers to Questions

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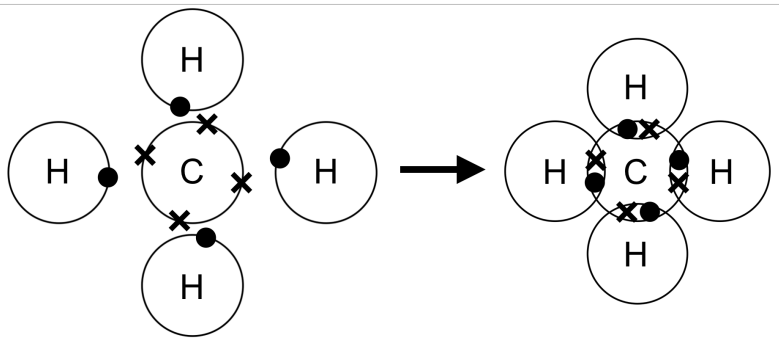
Crude Oil and Hydrocarbons	
1	Products made from crude oil include: cosmetics, petrol and diesel, pharmaceuticals and plastics.
2	Crude oil is found in **rocks**. Crude oil is described as a **finite** resource. This means that if we keep using it, crude oil will one day **run out**. Crude oil is formed from the remains of **plankton**, which are tiny creatures found in the **sea**. These were buried in **mud** and formed crude oil over **millions** of years. Crude oil is a mixture of chemicals called **hydrocarbons**. These contain only the elements hydrogen and **carbon**.
3	Ethane is a hydrocarbon. This is because ethane only contains hydrogen and carbon atoms. Ethanol is not a hydrocarbon. Ethanol does contain carbon and hydrogen atoms. However, ethanol also contains an oxygen atom. Because of this, ethanol is not a hydrocarbon.
4a	The general formula for alkanes is C_nH_{2n+2}. You need to make sure that you learn this and can use it.
4b	Hexane. Number of carbon atoms = 6. Number of hydrogen atoms = 14 (which is (6 x 2) + 2). Formula = C_6H_{14}. Nonane. Number of carbon atoms = 9. Number of hydrogen atoms = 20 (which is (9 x 2) + 2). Formula = C_9H_{20}. Decane. Number of carbon atoms = 10. Number of hydrogen atoms = 22 (which is (10 x 2) + 2). Formula = $C_{10}H_{22}$. Dodecane. Number of carbon atoms = 12. Number of hydrogen atoms = 26 (which is (12 x 2) + 2). Formula = $C_{12}H_{26}$.
5a	The formula CH_4 tells us that a molecule of methane contains one atom of carbon bonded to four atoms of hydrogen.
5b	
5c	Hydrogen has one electron in its outer energy level (shell). This energy level can hold a maximum of two electrons. This means that each hydrogen atom needs one more electron to achieve a full outer energy level. Because of this, hydrogen atoms only form one covalent bond. Carbon atoms have four electrons in their outer energy level. This energy level can hold a maximum of eight electrons. This means that each carbon atom needs four more electrons to achieve a full outer energy level. Because of this, carbon atoms form four covalent bonds.

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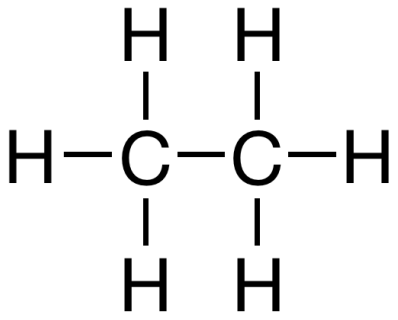
6

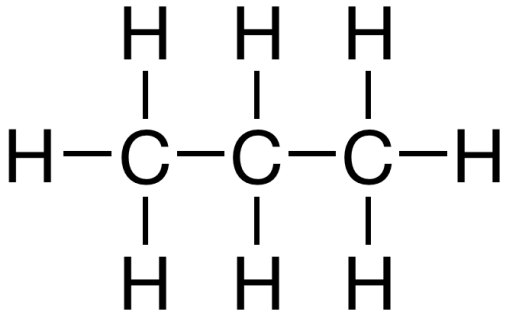
Name = ethane

Formula = C_2H_6



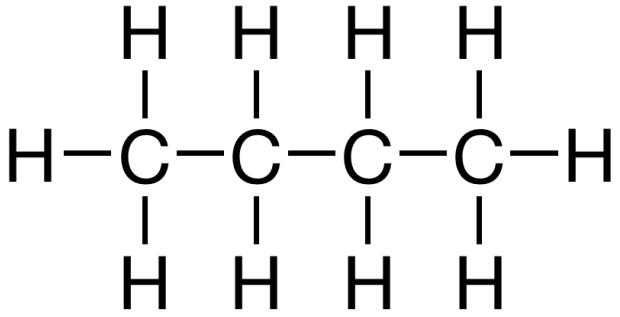
Name = propane

Formula = C_3H_8



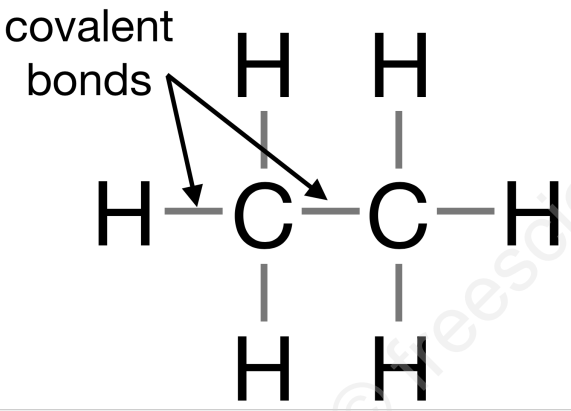
Name = butane

Formula = C_4H_{10}



7

The kind of chemical bonding found in hydrocarbons is covalent bonding. We saw this in question 5b. Remember that in covalent bonding, atoms share electrons in order to achieve a full outer energy level. In the diagram below, I have labelled two of the covalent bonds. However, remember that all of the bonds in hydrocarbons are covalent.



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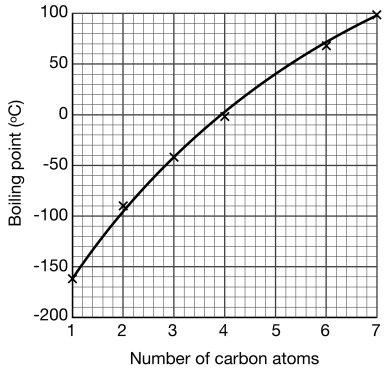
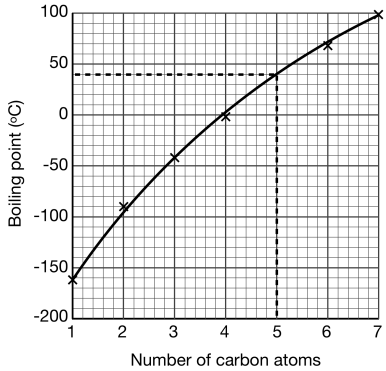
Properties of Hydrocarbons	
1	Least viscous = C_8H_{18} Medium viscosity = $C_{15}H_{32}$ Most viscous = $C_{20}H_{42}$ The viscosity of hydrocarbons increases as the carbon chain length increases. The shortest chain length in the question is C_8H_{18} so this will be the least viscous. The longest chain length is $C_{20}H_{42}$ so this will be the most viscous. $C_{15}H_{32}$ has a medium chain length, so this will have a viscosity between the other two.
2a	Flammability tells us how easily a material burns (combusts).
2b	As we increase the length of the hydrocarbon chain, the flammability decreases. Very short chain hydrocarbons are very flammable. Very long chain hydrocarbons are much less flammable.
3a	Remember that in Science GCSE a line of best fit does not have to be a straight line. Also a line of best fit does not need to pass through every point. However, a line of best fit does need to be smooth. 
3b	From the graph, we can see that the boiling point of the alkane with 5 carbon atoms should be around +40°C. The actual value is +36°C. 
3c	Any alkane with a boiling point below 20°C will be a gas at room temperature. Methane, ethane, propane and butane are gases at room temperature.
3d	As the number of carbon atoms increases, the strength of the forces between the molecules increases.

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Combustion of Hydrocarbons	
1a	When hydrocarbons are combusted, they are oxidised. This means that the carbon and hydrogen atoms react with oxygen atoms.
1b	In complete combustion of hydrocarbons, carbon dioxide and water are produced.
2a	$C_5H_{12} + 8O_2 \longrightarrow 5CO_2 + 6H_2O$ $C_8H_{18} + 12.5O_2 \longrightarrow 8CO_2 + 9H_2O$
2b	In both pentane and octane, the number of hydrogen atoms is twice the number of carbon atoms plus two. This tells us that both pentane and octane are alkanes.

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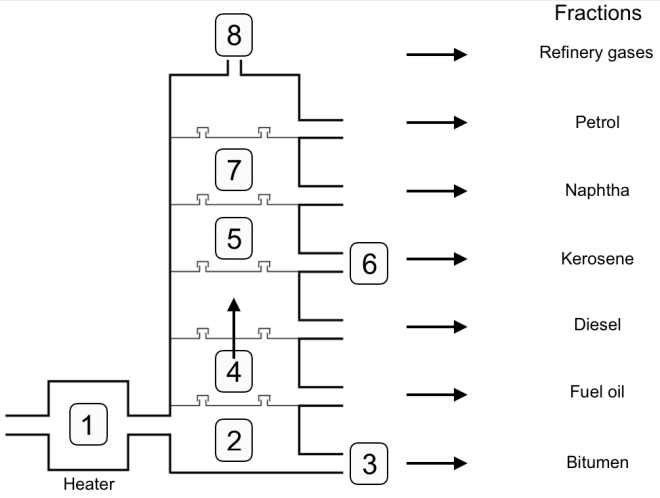
Fractional Distillation of Crude Oil	
1	The following statements are true: Crude oil is a mixture of molecules called hydrocarbons Each hydrocarbon has a different boiling point Longer chain hydrocarbons have a higher boiling point than shorter chains
2	Crude oil is separated by **fractional distillation**. The crude oil is separated into fractions containing a number of different hydrocarbons. Each hydrocarbon has a similar number of **carbon** atoms. Fractional distillation works because the **boiling** point of each hydrocarbon is different.
3a	Hydrocarbon fractions that are used as fuels include refinery gases, petrol, kerosene, diesel and fuel oil.
3b	A feedstock is a chemical used to make other chemicals such as polymers.
4	1 - Crude oil passes into a heater. All of the hydrocarbons evaporate. 2 - The hydrocarbons pass into a column which is hotter at the bottom than at the top. 3 - Very long chain hydrocarbons condense and are removed from the bottom of the column. 4 - The hydrocarbon gases make their way up the fractionating column. 5 - When each hydrocarbon reaches its boiling point it condenses back to a liquid. 6 - The liquid hydrocarbon is removed from the fractionating column. 7 - Shorter chain hydrocarbons continue moving up the column. 8 - Very short chain hydrocarbons are removed from the top as gases.
5a	The bottom of the column is hot (because the hot hydrocarbon gases enter here) and the top of the column is cool.
5b	
5c	The bitumen fraction will contain hydrocarbons with the greatest number of carbon atoms. Remember that the boiling point of the hydrocarbon increases as the number of carbon atoms increases. Because the bitumen fraction has the highest boiling point, it must contain hydrocarbons with the greatest number of carbon atoms.
5d	Very short chain hydrocarbons such as ethane have very low boiling points. The top of the fractionating column is not cool enough for these hydrocarbons to condense. This means that very short chain hydrocarbons are removed as gases.
5e	Dodecane will be found in the kerosene fraction as its boiling point (216^{o}C) is between 180^{o}C-250^{o}C.

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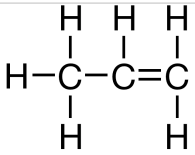
Cracking	
1a	Number of carbon atoms = 3 Number of hydrogen atoms = 8
1b	The general formula of alkanes (such as propane) is CnH2n+2. This tells us that we can work out the number of hydrogen atoms by doubling the number of carbon atoms and then adding two. In the case of propane, we have 3 carbon atoms. Doubling 3 and adding 2 gives us a value of 8 hydrogen atoms.
1c	We find single covalent bonds between the carbon atoms in alkanes.
2a	The reason that we crack long chain hydrocarbons is because long chain hydrocarbons are less flammable than short chain hydrocarbons. This means that long chain hydrocarbons are not very useful as fuels. By cracking them, we convert them to short chain hydrocarbons. These are more flammable and are therefore more useful as fuels.
2b	Catalytic cracking: high temperature and catalyst Steam cracking: high temperature and steam
2c	The alkene molecules produced in cracking are used to make other molecules for example polymers (this is the example that you need to learn).
3a	bromine water (orange) $\xrightarrow{\text{alkene}}$ bromine water (colourless)
3b	Alkenes turn bromine water from orange to colourless. The first molecule and the last molecule are alkenes (as they have a double bond). These will turn bromine water from orange to colourless. The second and third molecules are alkanes and these will have no effect on bromine water.
4a	 Please note that in this molecule, the position of the double bond is not important. We can place it between the first and second carbon atoms or the second and third carbon atoms (which I have done in the above diagram). However, remember that each carbon atom must have four covalent bonds.
4b	Top example = C_5H_{10} Middle example = $C_{18}H_{38}$ Bottom example = $C_{20}H_{42}$
4c	In $C_{30}H_{62}$, the number of hydrogen atoms is twice the number of carbon atoms plus two. This tells us that $C_{30}H_{62}$ is an alkane.

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Chemical Analysis

Answers to Questions

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Purity and Formulations	
1	Sea water is a mixture (it contains lots of different salts and gases dissolved in water). Carbon dioxide is a pure substance (because it is a compound). Ethane is a pure substance (because it is a compound). The atmosphere is a mixture (it contains a range of different gases included pollutants). Alloys are mixtures (they contain a metal blended with other elements). Oxygen is a pure substance (because it is an element).
2a	The first horizontal line shows us the point where the iodine is melting. This has a melting point around 115^{o}C. The second horizontal line shows us the point where the iodine is boiling. This has a boiling point around 185^{o}C.
2b	The graph shows us that this is a pure sample of iodine. We know that because both the melting point and boiling point take place at single, fixed temperatures.
2c	The graph shows that the sample of water is not pure. We can tell that because both the melting point and boiling point cover a range of temperatures.
3a	A formulation is a mixture where each part is carefully selected and measured so that the formulation has the properties that we need.
3b	Formulations include fuels, cleaning products, paints, medicines, alloys, fertilisers and foods.

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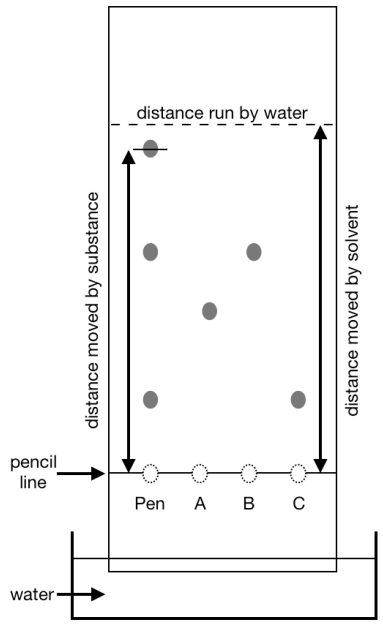
Paper Chromatography	
1a	From the diagram, we can see that in this case the solvent is water. Remember that in paper chromatography, we can use a number of different solvents.
1b	The solvent is the mobile phase because it moves up the paper. The paper is the stationary phase because it does not move.
2	The starting line is drawn in pencil because if it was drawn in pen, the pen ink could dissolve in the solvent and move up the paper. Pencil is insoluble and will not move up the paper.
3a	The pen ink contains colours B and C. We can tell that because the spots in the pen ink line up with the spots in colours B and C.
3b	Colours A is not present in the pen ink. We know that because the spot for colour A does not line up with any of the spots in the pen ink.
3c	We can see from the diagram that the pen contains a colour with a spot running near the top of the paper. This does not line up with any of the known colours so we cannot tell what colour this is.
4a	To calculate the Rf value, we need to know the distance moved by the substance and the distance moved by the solvent. To measure the distance moved by the substance, we measure from the pencil line to the vertical centre of the spot as shown below.  From the diagram we can see that the distance moved by the substance is 54 mm and the distance moved by the solvent is 58 mm. Putting this into the equation gives us an Rf value of 54 / 58 = 0.93. Remember that the Rf value cannot be greater than 1.
4b	Sometimes two different substances will run the same distance in a given solvent (which means that they have the same Rf value in that solvent). To solve this problem, we can use a different solvent. The substances may now run to different distances and have different Rf values, allowing us to identify them.

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Required Practical: Paper Chromatography	
1	We are going to place our colours onto the pencil spots. If the spots are too close together, then the colours can merge together when they run up the paper. This prevents them from running normally.
2a	A capillary tube is a very fine glass tube.
2b	As we saw in question 1, if the spots of colour are too close together, they can run into each other as they move up the paper. This can also happen if the colour spots are too large. By keeping the spots as small as we can, we prevent them from running into each other.
3	The water is the solvent. This will dissolve the different colours.
4a	The lid prevents the water from evaporating while the colours are running. If the water evaporates, this can cause the colours to run more or less than they should. This means that their Rf values will not be accurate.
4b	If the paper touches the side walls of the beaker, this can interfere with the way that the water moves up the paper. For example, the water near the edges of the paper may move faster than the water in the centre. For this reason, we need to make sure that the paper does not touch the side walls of the beaker.
4c	If we move the beaker during the experiment, then we run the risk that the water will wash the coloured spots off the paper before they have a chance to move. Once we have placed the paper into the beaker, we need to make sure that we do not move it.
5a	The mix contains three colours. Two of the spots line up with the known colours (ie colours B and D) so we know that the mix contains these colours. However, we cannot identify the top spot in the mix as this does not line up with any of the known colours. Also, we can see that the mix does not contain any of colour A or colour C as there is no spot in the mix lining up with the spots in colours A or C.
5b	From the diagram, we can see that the vertical centre of the spot has run a distance of 21 mm from the pencil line and the solvent has run a distance of 58 mm. To calculate the Rf value, we divide the distance moved by the substance (21 mm) by the distance moved by the solvent (58 mm). This gives us a value of 21 / 58 = 0.36 (to 2 significant figures).

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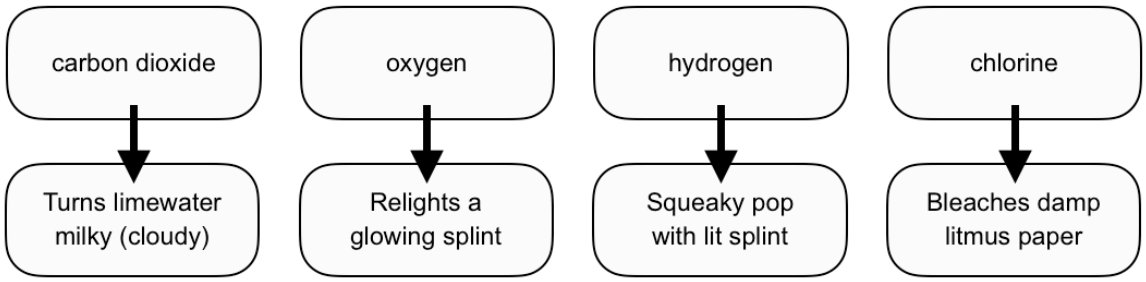
Testing for Gases	
1a	If hydrogen gas is present, we will hear a squeaky pop.
1b	$2H_{2\,(g)} + O_{2\,(g)} \rightarrow 2H_2O_{(l)}$
1c	The small letters are called state symbols. "g" tells us that the chemical is a gas and "l" tells us that the chemical is a liquid. There are two other state symbols: "s" tells us that the chemical is a solid and "aq" tells us that the chemical is dissolved in water.
2	If oxygen is present then a glowing splint will relight.
3	If the gas is carbon dioxide, then the limewater will turn milky (cloudy).
4	Chlorine gas bleaches damp litmus paper (in other words turns it white).
5	

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Atmosphere

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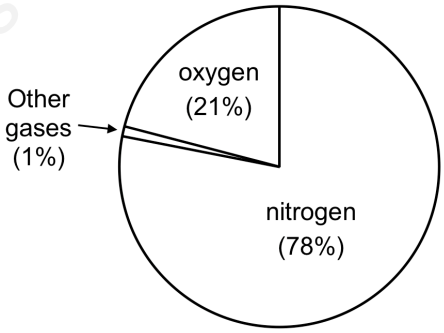
The Atmosphere	
1a	
1b	The "other gases" in the atmosphere include argon, carbon dioxide and water vapour plus a whole range of gases such as pollutants.
2a	The Earth is around 4600 million years old. Because this is a huge amount of time, scientists cannot be absolutely certain of the gases in the early atmosphere.
2b	1. The early atmosphere is thought to have contained a huge percentage of carbon dioxide. However, the current atmosphere contains a very small percentage of carbon dioxide. 2. The early atmosphere is thought to have contained little or no oxygen. However, oxygen forms around 21% of the current atmosphere. 3. The early atmosphere is thought to have contained only a very small percentage of nitrogen. However, the current atmosphere contains around 78% nitrogen.
2c	Firstly, volcanoes released a large amount of nitrogen and this continued for a very long time, leading to the current level of nitrogen in the atmosphere. Secondly, volcanoes also released small amounts of methane and ammonia.
2d	As we saw above, scientists think that the Earth's early atmosphere contained a large amount of carbon dioxide and little or no oxygen. This would make it very similar to the atmospheres of Mars and Venus today. The atmospheres of these planets also contain large amounts of carbon dioxide and little or no oxygen.
3	• Volcanoes released large amounts of carbon dioxide and **water vapour**. • As the Earth cooled, the water vapour **condensed** to form the oceans. • Some carbon dioxide **dissolved** in the oceans forming a weak acid. • The weak acid reacted with minerals in the oceans forming a solid **precipitate** (a precipitate is a solid which forms out of a solution). • The solid precipitate settled on the sea bed forming layers of **sediment** (a sediment is simply a layer of fine solid particles). • Some of the carbon dioxide in the sea formed the shells of animals such as **mussels**. • When sea animals die, they formed the sedimentary rock **limestone**. • **Algae** evolved and used photosynthesis to take in carbon dioxide. • When algae died, the carbon was trapped underground as **fossil fuels**.
4a	Scientists think that algae first evolved around 2.7 billion years ago.
4b	carbon dioxide + water —(light)→ glucose + oxygen $6\ CO_2$ + $6\ H_2O$ → $C_6H_{12}O_6$ + $6\ O_2$
4c	When photosynthetic algae and photosynthetic plants evolved, they carried out photosynthesis. As you can see from the equation, photosynthesis produces oxygen gas. Animals need oxygen gas to release energy by aerobic respiration. So the evolution of photosynthetic algae and plants created the oxygen atmosphere needed for the evolution of animals.

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Fossil Fuels	
1a	The carbon is part of the carbon dioxide taken in by plants during photosynthesis.
1b	A non-renewable resource is one that is not replenished (replaced) at the same rate as it is being used. Fossil fuels are non-renewable. That's because humans are using fossil fuels at a much faster rate than they can ever be formed. This means that if we continue using fossil fuels at the same rate, they will run out.
2a	The conditions in marshy wetlands are: Acidic and No oxygen.
2b	When plant and animal remains decompose, they are broken down by bacteria which convert the carbon in the remains back to carbon dioxide. However, to do this the bacteria require oxygen. In marshy wetlands, there is little or no oxygen so any bacteria present cannot decompose the plant remains. Also the bacteria cannot survive in the acidic conditions. So for these reasons, plant remains do not decompose in marshy wetlands.
2c	Over time, the plant remains are compressed by layers of fine solid particles called sediment. High pressure and high temperatures then convert the plant remains to coal (over many millions of years).
3a	The starting material for coal consists of ferns and plants which are found on land. However, the starting material for oil consists of plankton. Plankton are tiny plants and animals found in the sea. When these die, they settle in mud on the sea bed and over time they form oil.
3b	The mud on the sea bed contains no oxygen. As we saw before, any bacteria present need oxygen to decompose dead remains. Because there is no oxygen, any bacteria cannot decompose the remains of the plankton. This allows the remains to form oil.
4	Natural gas is formed from plankton in a similar way to oil. This means that we often find natural gas near oil deposits,

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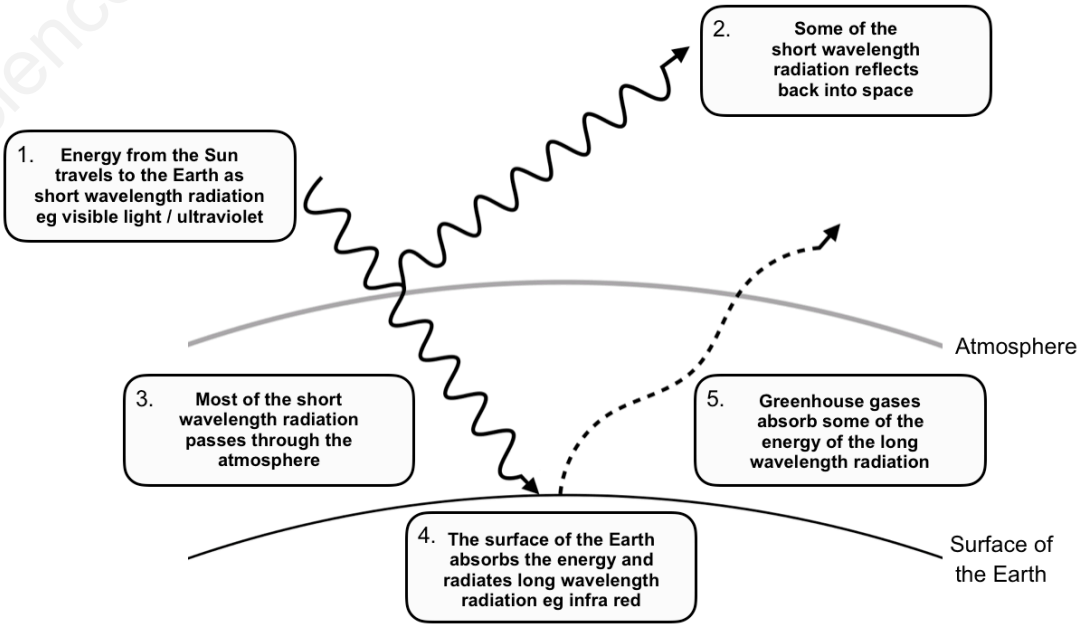
The Greenhouse Effect	
1a	The three main greenhouse gases are: Carbon dioxide (which is present in 0.04%) Methane (which is present in very small amounts) Water vapour (the amount of water vapour in the atmosphere changes depending on the temperature)
1b	
1c	As we saw in question 1b, the surface of the earth emits long wavelength radiation (infrared). As this passes through the atmosphere, it interacts with the greenhouse gases. The energy from the infrared radiation is absorbed by the greenhouse gases and this increases the temperature of the atmosphere.
1d	Without the greenhouse effect, the temperature of the atmosphere would be much colder and most living organisms would not be able to survive. Because of the greenhouse effect, the temperature of the atmosphere is high enough to allow the Earth to support a massive range of living organisms.

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Climate Change	
1a	Humans burn a lot of fossil fuels to provide energy (for example coal for electricity; petrol and diesel for transport, and gas for heating). Burning fossil fuels releases a great deal of carbon dioxide which is a greenhouse gas. Humans also carry out deforestation, for example to provide land for cattle such as cows to graze on. Normally, growing forests absorb carbon dioxide by photosynthesis. By chopping down trees, we reduce the amount of carbon dioxide taken out of the atmosphere. Also, in many cases, forests are simply cleared by burning. Burning trees releases the carbon trapped in the wood back to carbon dioxide.
1b	Methane is released by agriculture in two main ways. Firstly, methane is released from flooded paddy fields (used to grow rice). Secondly, cattle such as cows release a great deal of methane when they pass wind.
1c	Global ice and sea levels: climate change is causing glaciers and polar ice sheets to melt. This is causing the sea level to rise and this can lead to flooding of low-lying areas. Weather: climate change is making weather more severe for example increasing storms in the UK and increasing heat-waves around the world. Insects: climate change may cause insects to change their distribution (in other words move from one region to another). In some cases, these insects could transmit diseases (for example mosquitoes carry the pathogen for malaria).
2	Many scientists believe that climate change is caused by the release of **greenhouse** gases by human activities. Scientists share their **evidence** with other scientists who can criticise the data and decide whether it is **valid**. This process is called **peer**-review. This can be used to detect data which may show **bias**. One of the problems with climate change is that it is **complex** and difficult to model. This means that media reports about climate change can be biased or over-**simplified**. Another problem is that scientists cannot be certain about how much the temperature of the **atmosphere** will increase. This has led to wild **speculation** in the media. Scientists must work harder to educate the public about the issues around climate change.

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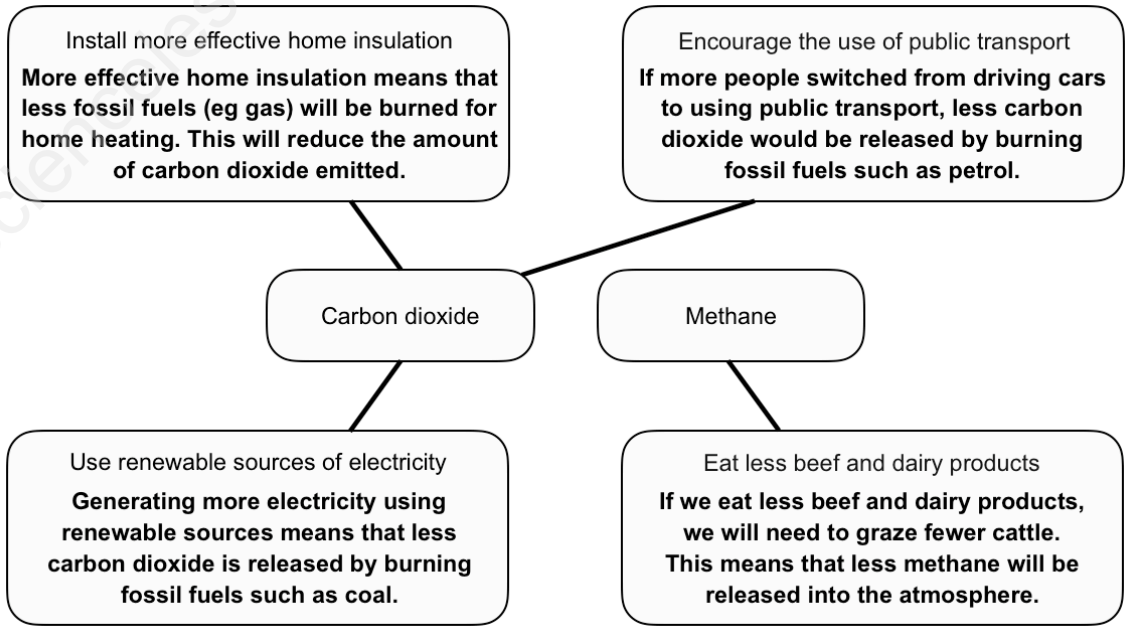
Carbon Footprint	
1a	The carbon footprint is the total amount of **carbon dioxide** and other greenhouse gases emitted over the full **lifecycle** of a product, service or event. We can use this to find ways to reduce **climate change**.
1b	
1c	There are two ways that we can reduce our carbon footprint due to electricity. First, we can switch to low-energy appliances for example low-energy light bulbs. Secondly, we can turn off our electrical appliances (such as TVs) at the plug rather than leaving them on standby. Electrical appliances use electricity when they are left on standby.
1d	People may not be willing to reduce their carbon footprint for two reasons. Firstly, it can be expensive. For example replacing power stations that burn fossil fuels with renewable power systems does cost money and may lead to an increase in energy bills. Secondly, it can be inconvenient. For example using a car can be easier and quicker than using public transport.

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Pollutants from Fuels	
1a	methane + oxygen → carbon dioxide + water CH_4 + $2O_2$ → CO_2 + $2H_2O$
1b	The word oxidised means "reacted with oxygen". From the equation, we can see that the carbon atom in methane has reacted with oxygen to form carbon dioxide and the hydrogen atoms in methane have reacted with oxygen to produce water.
1c	We can tell that the reaction above is complete combustion because carbon dioxide has been produced in the reaction.
1d	Carbon monoxide is a highly toxic gas (in the exam you must say toxic, rather than harmful). Also carbon monoxide has no smell so it is hard to detect. This makes carbon monoxide extremely dangerous.
2	Sulfur dioxide forms when **sulfur** in coal reacts with oxygen during burning. Oxides of nitrogen form when oxygen and **nitrogen** in the air react due to the **heat** inside engines for example in **cars**. Sulfur dioxide and oxides of nitrogen dissolve in rain to form acid rain. This damages **trees** and corrodes **limestone** buildings.
3a	Global dimming is when carbon particles in the atmosphere reduce the amount of sunlight reaching the surface of the Earth. Global dimming may affect rainfall patterns.
3b	Particles of carbon increase the risk of heart disease and lung disease in humans.

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Resources

Answers to Questions

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Using the Earth's Resources	
1	Humans use resources to provide **warmth** for example burning wood or **fossil fuels**. Resources are also used to grow **crops** or raise animals for **food**. Homes, factories and **offices** are built from wood, **concrete**, glass and bricks. These provide us with shelter. Lastly, many different resources are used to build and to power **cars**, airplanes and trains. These provide us with **transport**.
2a	Materials for clothing: lots of clothing materials come from natural resources. For example, cotton is produced from cotton plants which are farmed. Silk is produced from moths which are also farmed. Fuels: wood from forests can be used as a fuel to provide warmth or generate electricity.
2b	Finite resources cannot be replaced as quickly as they are being used. A good example are fossil fuels. These take millions of years to form but we are using large amounts every day. Metals are also finite as new metal is not formed in the Earth's crust. If we continue using them then finite resources will one day run out. Renewable resources can be replaced as quickly as we use them. For example, we can always grow new trees to replace the ones that we cut down for wood.
2c	Aluminium - finite. This is a metal and metals are not being formed in the Earth's crust. Fish - renewable. Provided that we do not overfish, fish stocks can replace those that are removed from the sea. Wood - renewable. We can always plant new trees to replace the trees that we cut down. Olive oil - renewable. Olive oil is a farmed product produced from olives which grow on trees. Crude oil - finite. Crude oil is a fossil fuel. Fossil fuels take millions of years to form but are being used at a very rapid rate. Cocoa beans - renewable. Cocoa beans are a farmed product produced from plants. Coal - finite. Like crude oil, coal is a fossil fuel.
2d	To be sustainable, humans must be able to satisfy their needs in a way that does not prevent future generations from satisfying their needs.

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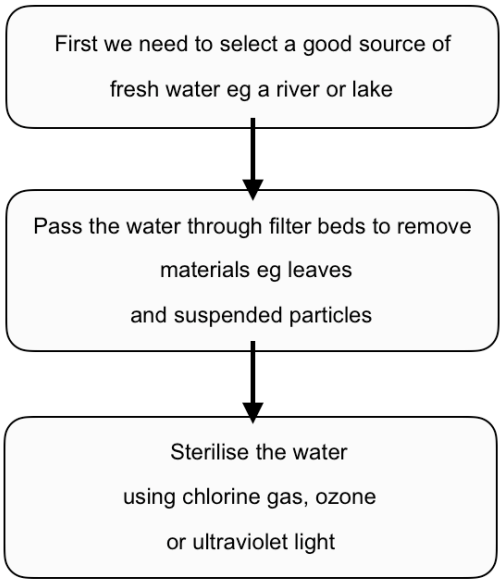
Potable Water	
1	Statement 1: True. Drinking (potable) water can have low levels of dissolved salts eg sodium chloride. Statement 2: False. Drinking water should contain no microbes. Statement 3: True. Potable water is water that is safe to drink. Statement 4: False. Pure water must have no dissolved substances at all. Statement 5: False. Potable water is not the same as pure water as potable water can have low levels of dissolved salts. We can drink pure water but potable water does not have to be pure.
2a	Rain water contains low levels of dissolved substances. Scientists call this fresh water. This is ideal for making potable water. Remember though that we need to process rainwater to make it potable (ie safe to drink).
2b	Sources of fresh water in the UK: Rivers, lakes, underground sources (aquifers), reservoirs (made-made lakes).
3a	
3b	If we took fresh water from a river running too close to a farm, we might find that this contains high levels of dissolved fertilisers and pesticides (as well as substances such as animal waste). It is better to choose a river which does not run near farms.
3c	Microbes such as bacteria are too small to be removed by the filter beds used to produce potable water.
3d	Sterilising the water kills microbes such as bacteria. Many of these could be pathogens. If we did not sterilise the water, these pathogens could cause diseases in humans who drink the water. Remember that potable water has to be safe to drink.
4a	Untreated seawater contains very high levels of dissolved minerals such as sodium chloride. Drinking this would be extremely harmful to humans.
4b	In reverse osmosis, the sea water is passed through a series of filters or membranes which gradually reduce the levels of dissolved minerals. In distillation, the seawater is heated to evaporate the water (leaving the minerals behind). The water vapour is then condensed back to liquid water.
4c	Both reverse osmosis and distillation use large amounts of energy. This makes them extremely expensive.

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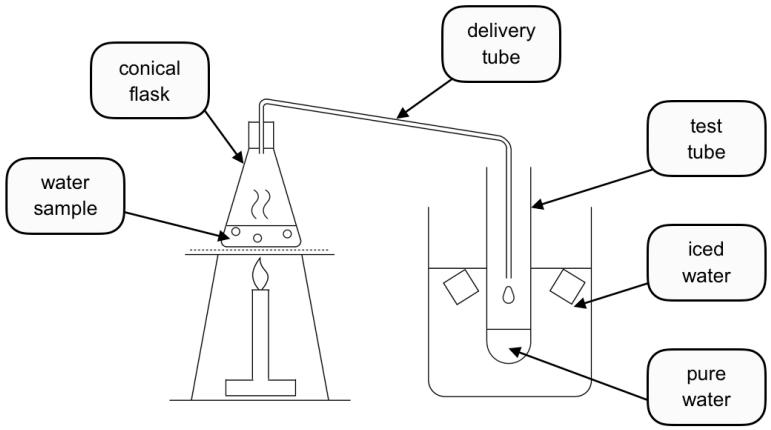
Required Practical: Water	
1a	Red = pH 1 (acid), Green = pH 7 (neutral), Purple = pH 14 (alkali). I'd strongly recommend learning these colours. This has come up before as an exam question.
1b	Pure water does have a pH of 7. However, pure water also must contain no dissolved substances. It is possible for a sample of water to have a pH of 7 but still to contain dissolved substances. This would not be pure water.
2a	The resolution is the smallest value that a measuring instrument can measure. Looking at the diagram of the balance, we can see that it can measure to the nearest 0.01 g so that is the resolution.
2b	When we heat the water with the Bunsen burner, the water is evaporating (in other words turning from a liquid into the gas water vapour).
2c	If the water sample is pure then the final mass of the empty evaporating basin (after heating) will be the same as the initial mass of the empty evaporating basin (ie before heating). This shows that the water contained no dissolved salts. If the water had contained dissolved salts, they would have been left after the water evaporated and this would have meant that the mass of the empty evaporating basin was greater after heating than before.
3a	The pure water sample was sample B. We can see that the final mass of the empty evaporating basin is the same as the initial mass. This tells us that water sample B contained no dissolved substances and was therefore pure.
3b	The anomalous result is water sample C. In this case, the evaporating basin appears to have lost mass at the end compared to the start. This should be impossible, if the evaporating basin was empty at the start.
3c	The anomalous result could be explained if the evaporating basin contained some water when it was first weighed. When this evaporates, the mass of the evaporating basin will appear to have decreased.
4a	
4b	The water evaporates to form water vapour in the conical flask.
4c	The water vapour condenses to form liquid water in the test tube which is in the iced water (some condensation will also take place in the delivery tube).
4d	Distillation uses a great deal of energy to evaporate the water so it's an expensive way to purify water. Other, less expensive methods are used in labs.

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Waste Water Treatment	
1a	Manufacturing clothes: Industrial Drinking water for cattle: Agriculture Watering crops: Agriculture Manufacturing paper: Industrial Bathing and Showering: Homes Preparing food: Homes (although this could also be industrial as many factories make food products). Drinking: Homes Flushing the toilet: Homes Manufacturing chemicals: Industrial Manufacturing computers: Industrial
1b	Waste water from homes and farms contains a great deal of harmful microorganisms (eg bacteria) and organic molecules (these are molecules containing carbon and we find these in faeces, urine, waste food etc). Returning this untreated waste water to rivers would be extremely dangerous to aquatic organisms such as fish. Bacteria in the river (and in the waste water) would feed on the organic molecules. The bacteria would reproduce and before long there would be a huge number of bacteria. These bacteria would use all of the oxygen in the water. Lack of oxygen would cause other organisms to die.
2a	Screening involves passing the water through fine metal meshes. These filter out solids (eg materials flushed down the toilet such as cotton buds) and also grit.
2b	During sedimentation, the waste water is placed in large tanks. Solid organic material (faeces) settles to the bottom to form sludge. The liquid organic material (urine etc) does not sink and is called effluent.
2c	The biogas produced by anaerobic digestion is often used by the water treatment company to generate electricity.
3	Effluent is the **liquid** part of sewage formed during sedimentation. Effluent contains a very large amount of **organic** molecules and harmful **microorganisms**. If we simply returned the effluent to waterways, it would kill **aquatic** organisms such as fish. To prevent this, the effluent undergoes digestion by **aerobic** bacteria. Air is bubbled through the effluent to provide **oxygen**. After aerobic digestion, levels of organic molecules and harmful microorganisms are **reduced** to safe levels. Now the effluent can be safely discharged into waterways or the sea.
4	The chemicals from industrial waste may be toxic (poisonous) to aquatic life. If we discharged these to waterways, they would kill fish and other organisms. Secondly, the chemicals may kill the bacteria needed for sewage treatment. In this case, the bacteria would not digest the organic molecules and harmful microorganisms.
5a	Making potable water from waste water requires a large number of stages. This only makes sense if water is extremely scarce (for example on the International Space Station).
5b	Producing potable water from sea water (using distillation or reverse osmosis) requires a great deal of energy. This makes it an expensive way to produce potable water.

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Life Cycle Assessment

1a

Stage 1: Crude oil extracted from the ground
Stage 2: Transport of oil to refineries
Stage 3: Hydrocarbons separated
Stage 4: Cracking to produce alkenes
Stage 5: Manufacture of the polymer

1b

Burning fossil fuels releases carbon dioxide which contributes to climate change.

1c

Mining and transport of metal ore: Mining destroys habitats and produces large amounts of waste rock. Fossil fuels are use in trucks to transport the ore. Burning fossil fuels produces carbon dioxide and contributes to climate change.

Extraction of the metal from the ore: Extraction of metal also uses a large amount of energy. It produces large amount of toxic waste products.

2a

Manufacturing a product can harm the environment in two ways: Release of harmful chemicals from factories and energy used by machines in factories.

2b

Toys often use batteries. Producing batteries releases a large amount of toxic waste.

3

Firstly products have to be transported for disposal. During transportation, trucks burn fossil fuels. This releases carbon dioxide, contributing to climate change.

Secondly many products (especially computer equipment) contain large amounts of harmful chemicals. These have to be extracted and disposed of carefully. Again this requires energy.

4a

	Plastic bags	**Paper bags**
Extraction of raw materials	Plastic bags are produced using crude oil. Crude oil is a non-renewable resource. It could eventually run out.	Paper bags are produced from paper which is renewable (we can plant more trees).
	Oil is transported in tankers. If there is an accident or oil leak, the oil can destroy habitats (eg for sea birds).	Cutting down trees in forests can destroy habitats for animals and plants.
Manufacturing	Manufacturing plastics needs a lot of energy. If this is produced by burning fossil fuels then this contributes to climate change. Harmful waste chemicals are also produced.	Manufacturing paper requires a great deal of energy. Manufacturing paper also uses a very large amount of water and harmful chemicals.
Lifetime use	Plastic bags are strong and are often reused. They can also be repurposed eg as bin liners.	Paper bags are not strong and are generally only used once before being thrown away.
Disposal	Plastic bags are not heavy so transportation to landfill does not require a lot of energy. Plastic bags are non-biodegradable (they are not broken down by microorganisms). They last for many years in the environment and fill up landfills.	Paper bags are heavy so transportation to landfill can use a lot of energy. Paper bags are biodegradable (especially when wet). This means that they do not take up large amounts of landfill space.

4b

It can be very difficult to accurately work out the environmental impact of different processes so sometimes we have to make estimates. Also, lifecycle assessments may be biased for example to make a product look less harmful to the environment than it actually is.

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Recycling	
1a	Availability of raw materials: Many raw materials are finite (eg metals) and in many cases these are becoming scarce (eg copper). Extraction of raw materials: Extracting raw materials uses a lot of energy (often generated by burning fossil fuels, which contributes to climate change). It also produces large amounts of waste products and many of these are toxic chemicals. Quarrying and mining is very destructive to habitats. Manufacturing of finished product: Manufacturing uses a lot of energy and also produces toxic chemicals. Note: if you are answering a question on environmental impact, you need to be specific for example "destroys habitats". Just saying "bad for the environment" won't get you the mark.
1b	Throwing away products generates a lot of waste. This is a real waste of finite resources and energy. Lots of this waste simply ends up in landfills and space in landfills is becoming more scarce.
2	Glass products can be reused, for example when milk is delivered in glass bottles, the bottles are returned for cleaning and then reused by the milk company. Many consumers also reuse glass containers for example using old jam jars to store spices. Glass can also easily be recycled. For example old glass bottles can be melted and recycled into glass jars. Plastic bottles can also be recycled into completely different products for example fleece jackets and carpets.
3a	Scrap metal often contains a mixture of different metals. Often these cannot be recycled together and have to be separated before recycling. This can add to the cost. For example, in same cases the metals are separated by hand which means that the cost of labour has to be included.
3b	If we recycle steel, this means that we need to extract less iron from iron ore. Mining iron ore destroys habitats. Transporting iron ore involves burning fossil fuels. This releases carbon dioxide, contributing to climate change.

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Chemistry Paper 2
Combined Science
Foundation

Specimen Exam Paper

Answers to Questions

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Question	Answers	Mark	Extra information	Workbook page
1.1	Water that is safe to drink	1	This is a key definition that you need to learn.	Resources page 53
1.2	Group 7 elements are called the halogens Group 7 elements have 7 electrons in their outer energy level (shell)	1 1	This is from the Unit 1 topic Atomic Structure and the Periodic Table. This is one of the three topics that can be tested on the Unit 2 paper.	Chemistry 1 Atomic Structure and the Periodic Table
1.3	Evaporates Condenses 7 (accept neutral)	1 1 1	This is from the Unit 1 topic Atomic Structure and the Periodic Table. This is one of the three topics that can be tested on the Unit 2 paper.	Chemistry 1 Atomic Structure and the Periodic Table
1.4	Simple distillation	1	This is from the Unit 1 topic Atomic Structure and the Periodic Table. This is one of the three topics that can be tested on the Unit 2 paper.	Chemistry 1 Atomic Structure and the Periodic Table
1.5	The melting point is a range not a single fixed value (accept answer referring to boiling point)	1	Remember that a pure substance will have a fixed melting point and a fixed boiling point.	Chemical Analysis page 38
1.6	Water is a small covalent compound There are weak forces between water molecules	1 1 **Total = 10**	This is from the Unit 1 topic Structure and Bonding. This is one of the three topics that can be tested on the Unit 2 paper.	Chemistry 1 Structure and Bonding

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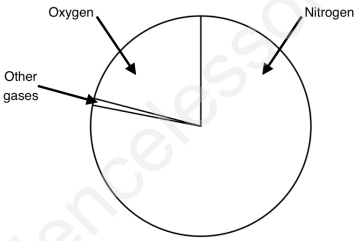
Question	Answers	Mark	Extra information	Workbook page
2.1		2	You are meant to know the approximate proportions of oxygen (20%) and nitrogen (80%) in the atmosphere today.	The Atmosphere page 44
2.2	Limewater Turns milky (cloudy)	1 1	This is one of the four tests for gases that you need to learn.	Chemical Analysis page 42
2.3	The Earth is 4.6 billion years old (accept very old).	1	Because the Earth is so old, we cannot be certain of the amounts of the gases in the atmosphere of the early Earth.	The Atmosphere page 44
2.4	Venus	1	Venus has a similar atmosphere to the early Earth (ie large amounts of carbon dioxide and little or no oxygen).	The Atmosphere page 44
2.5	Methane Water vapour	1	The levels of methane are increasing due to human activity. The levels of water vapour vary widely depending on location.	The Atmosphere page 47
2.6	Ultraviolet (accept visible light) Infrared	1 1	You need to learn how short wavelength and long wavelength radiation interact with the greenhouse gases in the atmosphere.	The Atmosphere page 47
2.7	Accept any one from: Burn less fossil fuels Generate electricity using renewable methods / nuclear power Encourage use of public transport Encourage use of energy saving appliances / home insulation Reduce cattle farming Capture greenhouse gases and store them (carbon capture and storage)	1	This question specifically refers to the emission of greenhouse gases. Reject answers linked to planting more trees or reducing deforestation since these do not reduce the <u>emission</u> of greenhouse gases. Reject answers to electrical vehicles unless it is clear that less fossil fuels will be burned.	The Atmosphere page 49
2.8	Peer review	1 **Total = 11**	Scientific journals will only publish results that have been through peer review.	The Atmosphere page 48

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Question	Answers	Mark	Extra information	Workbook page
3.1	A finite resource exists in only a limited amount Accept a finite resource is not replenished as it is used Accept a finite resource will run out if it continues to be used	1	Resources such as metals are finite and will run out if we continue to extract them. Resources such as wood are renewable and can be replenished.	Resources page 52
3.2	Accept any two from: Destruction of habitats Use of toxic chemicals Burning fossil fuels to generate energy contributing to climate change Production of waste materials (eg rock)	2	Remember to be specific when referring to environmental damage. It is better to say toxic rather than harmful. Toxic means poisonous.	Resources page 59
3.3	Total mass of reactants = 640 + 72 = 712 g Mass of iron = 712 - 264 = 448 g	1 1	This is from the Unit 1 topic Quantitative Chemistry. This is one of the three topics that can be tested on the Unit 2 paper.	Chemistry 1 Quantitative Chemistry
3.4	The current generation can meet their needs Without preventing future generations from meeting their needs	1 1	This is an important definition that you need to learn.	Resources page 52
3.5	Alnico contains more different elements (metals) which need to be separated	1	Recycling alloys can be expensive as the different elements may need to be separated before recycling.	Resources page 61
3.6	Formulation	1 **Total = 9**	You should learn the definition of a formulation and examples.	Chemical Analysis page 38

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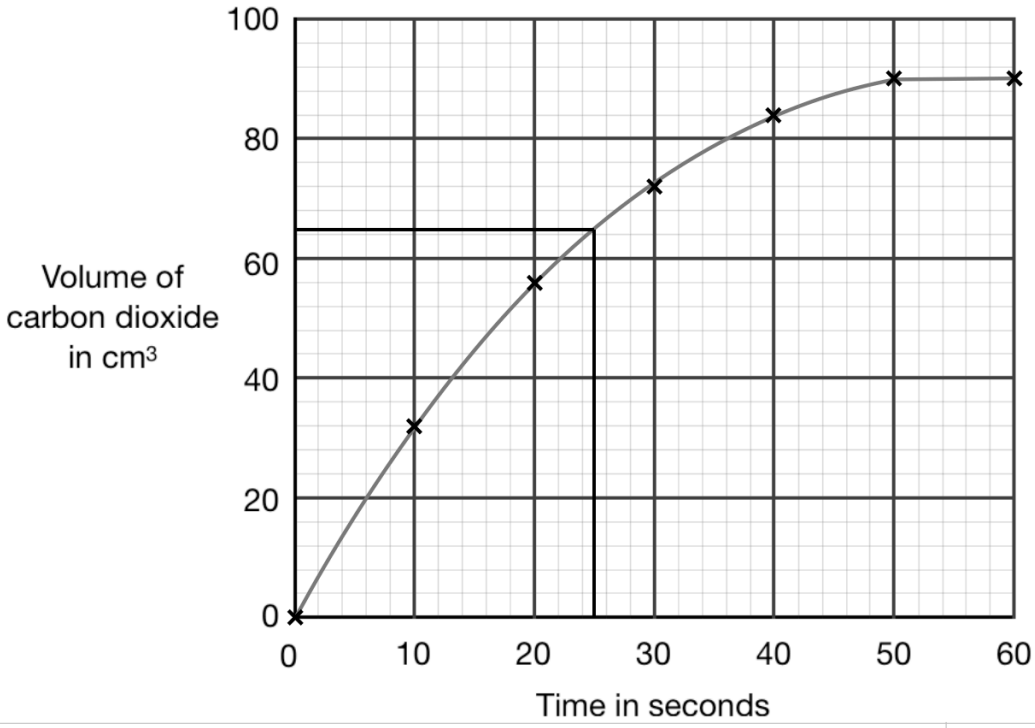
Question	Answers	Mark	Extra information	Workbook page
4.1	Concentration of hydrochloric acid Volume of carbon dioxide gas (produced over time) Mass of marble chips / surface area of marble chips / volume of acid / temperature	1 1 1	This is a required practical. It is worth spending time learning the key details of the required practicals. Remember that the independent variable is what is changed for each experiment. The dependent variable is what is measured for each change in the independent variable. The control variables are kept the same (or checked to make sure that they do not change).	Rates of Reaction pages 15-19
4.2				
	3 marks for all points plotted accurately (within half a square) and correct line of best fit. If one point is incorrectly plotted but remaining points and line of best fit are correct, award 2 points. If points are incorrect but line of best fit is correct, award 1 point.			Graph plotting is covered throughout the workbooks

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Question	Answers	Mark	Extra information	Workbook page
4.3	Correctly reads volume of gas at 25 seconds from graph = 65cm^3 Mean rate of reaction = 65 / 25 Answer = 2.6 cm^3 / s	1 1 1	Accept any answer between 64-68 cm^3	Rates of Reaction pages 12
4.4	50 seconds No more gas produced (accept line becomes horizontal)	1 1	Look at the candidate's line of best fit to check for the first mark. However, do not accept any answer less than 40 seconds as the table shows that the reaction is still active.	Rates of Reaction pages 12
4.5	Acid or marble chips have all reacted / run out Accept a reactant has all reacted / run out	1	The reaction stops when a reactant has all reacted. From this question, we have two reactants. From the information given, we cannot tell which will have reacted first.	Rates of Reaction pages 12
4.6	Increase Frequency Proportional	1 1 1 **Total = 15**	If you are answering a question on rates, remember to say "frequency" of successful collisions or "number of collisions per second". The rate of reaction is proportional to the concentration of reactants. This is because, if we increase the concentration of reactants, we increase the rate.	Rates of Reaction pages 13

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Question	Answers	Mark	Extra information	Workbook page
5.1	Pencil is not soluble or Pen ink is soluble	1	Accept pencil will not run. or Pen ink would run.	Chemical Analysis page 39
5.2	Mobile	1	Remember that the mobile phase moves. The stationary phase (the paper in this case) does not move).	Chemical Analysis page 39
5.3	Measures distance moved by centre of spot from pencil line (50mm) **and** distance moved by solvent from pencil line (65mm) Rf = 50/65 = 0.7692 Rounded to 2 significant figures = 0.77	1 1 1	You should measure to the vertical centre of the spot. In the exam, there will be a range of possible answers but you need to measure as accurately as you can.	Chemical Analysis page 39
5.4	Any three from: Ketchup contains three colours Ketchup contains colour A Ketchup contains colour C Ketchup does not contain colour B	3 max	Safe colours A and C line up with two of the spots in the ketchup. Safe colour B does not line up with any spot in the ketchup.	Chemical Analysis page 39
5.5	No Ketchup contains a colour which could not be identified	1 1 **Total =10**	If we cannot identify a colour in the ketchup then we cannot be certain that the ketchup is safe to eat.	This is not referred to specifically in the workbook but is a common question.

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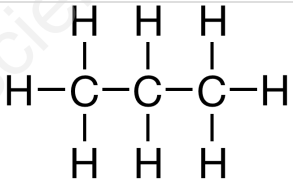
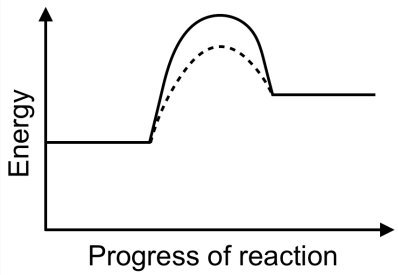
Question	Answers	Mark	Extra information	Workbook page
6.1	(a molecule that contains) carbon and hydrogen atoms Only	1 1	This is an important definition that you need to learn.	Organic Chemistry page 27
6.2	Plankton	1	Plankton consists of tiny creatures living in the sea.	Organic Chemistry page 27
6.3	 Eight hydrogen atoms Correct bonds between atoms	 1 1	You are meant to know the structures of the first four alkanes: methane, ethane, propane and butane.	Organic Chemistry page 29
6.4	Lower C_nH_{2n+2}	1 1	Remember that the hydrocarbons get less flammable as the chain length increases. Propane has three carbon atoms so it is more flammable than decane which has ten carbon atoms. The alkanes all have this general formula as the number of hydrogen atoms is twice the number of carbon atoms plus two.	Organic Chemistry page 30
6.5	Fractional distillation Crude oil heated to evaporate hydrocarbons Hydrocarbons condense at specific temperatures and are removed	1 1 1	Fractional distillation is a very popular question with the examiners. It's worth learning the stages.	Organic Chemistry page 32-34
6.6	C_8H_{18}	1	Remember that the number of atoms on the left hand side of the arrow must be the same as the number of atoms on the right hand side of the arrow.	Organic Chemistry page 35-36
6.7		1 1	Line starts and ends at same place as original line. Line is lower than the original line.	Rates of Reaction pages 24
6.8	Bromine water Turns from orange to colourless	1 1 **Total = 15**	With the test for alkenes, remember to state the starting and final colours for the bromine water. And remember that the bromine water turns colourless not clear.	Organic Chemistry page 36

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Suggested Level Boundaries

Please note that the level boundaries shown below are very approximate.

This is because the paper above is a specimen paper. Real exam papers go through a long process of review where questions are analysed and modified before being issued.

In the real GCSE Science exams, the level boundaries are determined when all of the candidates' papers have been marked. This allows the exam boards to adjust the grade boundaries up (if the exam appeared slightly easier than usual) or down (if the exam appeared slightly harder than usual).

I do not offer any guarantee that the level you achieve in this specimen paper is the level that you will achieve in the real exam.

Mark / 70	Level
42	5
36	4
28	3
17	2
10	1

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