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EDEXCEL GCSE CHEMISTRY: QUESTIONS BY TOPIC

Key Concepts in Chemistry (1)

GCSE Chemistry (Foundation) Topic 1

32 questions · 330 marks · Mark schemes included

Pearson Edexcel GCSE (9-1) Chemistry 1CH0, Foundation Tier, June 2018 - June 2025

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HOW TO USE THIS BOOKLET

Questions run from the lowest mark tariff to the highest, so similar questions sit together.

Click any row below to jump straight to that question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

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QUESTIONS

32 questions · 330 marks · lowest tariff first



7-MARK QUESTIONS

3 questions in this booklet



3 (a) Atoms contain electrons, neutrons and protons.

(i) Draw one line to link each particle to its correct relative charge.

(2)

particle	relative charge
electron	+1
neutron	0
proton	-1

(ii) Which of the following is the relative mass of a proton?

(1)

- ☐ A 0
- ☐ B $\frac{1}{1837}$
- ☐ C 1
- ☐ D -1

(b) Argon is in group 0 of the periodic table.

Identify, using the periodic table on the back cover of this paper, which of these elements is in the same period as argon.

(1)

- ☐ A bromine
- ☐ B iron
- ☐ C magnesium
- ☐ D xenon



(c) Figure 4 shows the atomic number and mass number of two isotopes of argon.

isotope	atomic number	mass number
argon-38	18	38
argon-40	18	40

Figure 4

Describe the structure of an atom of argon-38 and of an atom of argon-40.

(3)

.....

.....

.....

.....

.....

.....

(Total for Question 3 = 7 marks)



- 1 (a) When solid sodium chloride is mixed with water, sodium chloride solution forms.

What name is given to the process of mixing a solid with water to form a solution?

(1)

- ☐ A crystallising
- ☐ B diluting
- ☐ C dissolving
- ☐ D melting

- (b) Sodium reacts with hydrochloric acid to form sodium chloride and hydrogen.

(i) Write the word equation for this reaction.

(2)

→

- (ii) The hazard symbol shown in Figure 1 is used on containers of sodium.



Figure 1

What is the meaning of this hazard symbol?

(1)

- ☐ A corrosive
- ☐ B flammable
- ☐ C oxidising
- ☐ D toxic

(iii) Hydrogen has one electron in its electron shell.

Figure 2 shows the incomplete dot and cross diagram of a hydrogen molecule.

Complete Figure 2 to show the electrons in the covalent bond between the two atoms of hydrogen.

(1)

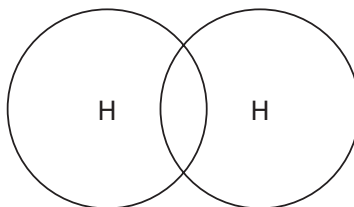


Figure 2

(c) The pH of a sodium chloride solution was measured.

(i) State what could be used to measure the pH of a solution.

(1)

(ii) Sodium chloride solution is neutral.

Give the pH of this solution.

(1)

(Total for Question 1 = 7 marks)

- 2 (a) Nitrogen reacts with hydrogen to form ammonia.

The reaction is reversible.

- (i) Complete the word equation for the reaction by adding the **symbol** to show that the reaction is reversible.

(1)

nitrogen + hydrogen ammonia

- (ii) Figure 4 shows the electronic configuration of an atom of hydrogen.

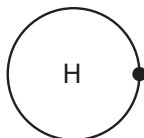
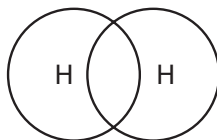


Figure 4

Complete the dot and cross diagram for a molecule of hydrogen, H₂.

(1)



(b) Ammonia reacts with sulfuric acid to form ammonium sulfate.

(i) Write the word equation for this reaction.

(2)

..... + ... →

(ii) Ammonium sulfate contains ammonium ions, NH_4^+ , and sulfate ions, SO_4^{2-} .

What is the formula of ammonium sulfate?

(1)

- ☐ A NHSO
- ☐ B NH_4SO_4
- ☐ C $(\text{NH}_4)_2\text{SO}_4$
- ☐ D $\text{NH}_4(\text{SO}_4)_2$

(iii) Explain why some farmers spread ammonium sulfate on their fields.

(2)

.....

.....

.....

.....

(Total for Question 2 = 7 marks)



8-MARK QUESTIONS

4 questions in this booklet



2 Chlorine has an atomic number of 17.

(a) Figure 3 shows the arrangement of electrons in an atom of chlorine.

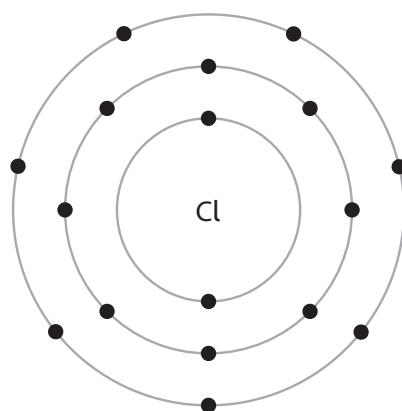


Figure 3

(i) What is the electronic configuration of this atom?

(1)

- ☐ A 10.7
- ☐ B 17
- ☐ C 2.8.7
- ☐ D 7.8.2

(ii) Explain, using Figure 3, why chlorine belongs to group 7 of the periodic table.

(2)

.....

.....

.....

.....

- (b) The nucleus of an atom is made up of protons and neutrons.
Atoms of chlorine contain 17 protons.

Figure 4 shows some information about a proton, a neutron and an electron.

	relative mass	relative charge
proton	1	+1
neutron	1	0
electron	very small	-1

Figure 4

- (i) Explain, using the information in Figure 3 and Figure 4, why atoms of chlorine have no overall charge.

(2)

.....

.....

.....

.....

- (ii) Atoms of chlorine-37 have a mass number of 37.

Calculate the number of neutrons in atoms of chlorine-37.

(1)

.....

number of neutrons = ...

- (iii) There are two isotopes of chlorine, chlorine-35 and chlorine-37.

Explain the meaning of the term **isotopes**.

(2)

.....

.....

.....

.....

(Total for Question 2 = 8 marks)



3 (a) A student investigated the reaction between potassium iodide and lead nitrate.

- (i) Solutions of potassium iodide and lead nitrate were mixed together.
Lead iodide and potassium nitrate were formed.

Complete the word equation.

(2)

.....
+ → + ...

- (ii) The student recorded the total mass of the reactants and the total mass of the products.

The results are shown in Figure 4.

	reactants	products
total mass in g	21.7	21.7

Figure 4

State how the results in Figure 4 show that mass is conserved in this reaction.

(1)

.....
.....



- (b) In another experiment, a student investigated the temperature decrease when different amounts of ammonium nitrate crystals were dissolved in 100 cm^3 of water.

The apparatus used is shown in Figure 5.

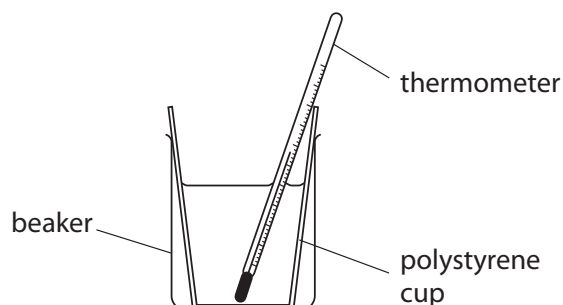


Figure 5

The student used the following method.

- step 1** pour 100 cm^3 of water into the polystyrene cup
- step 2** add one spatula of ammonium nitrate crystals to the water
- step 3** stir the mixture
- step 4** use the thermometer to record the lowest temperature reached by the mixture
- step 5** repeat steps 1 to 4 using different amounts of ammonium nitrate

- (i) Name a piece of apparatus that should be used to measure the 100 cm^3 of water in **step 1**.

(1)

- (ii) The student cannot work out the temperature decrease using the method described.

State what the student must do before **step 2** to be able to work out the temperature decrease.

(1)

- (iii) State why a polystyrene cup is used in this experiment.

(1)

(iv) Figure 6 shows the reaction profile for this reaction.

Use the words from the box to complete the labels on Figure 6.

activation energy

products

reactants

(2)

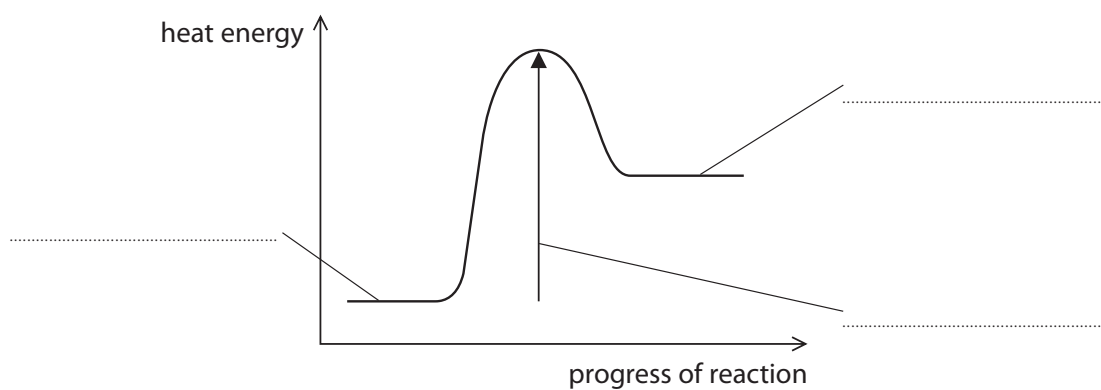


Figure 6

(Total for Question 3 = 8 marks)

1 Figure 1 shows the structure of a molecule of each of four compounds, **A**, **B**, **C** and **D**.

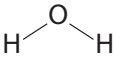
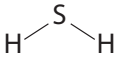
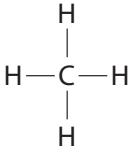
compound A	compound B	compound C	compound D
	$\text{O}=\text{C}=\text{O}$		

Figure 1

(a) The formula of a molecule of compound **A** is H_2O .

Give the formula of a molecule of compound **D**.

(1)

(b) The names of two of the compounds in Figure 1 are shown below.

Draw one straight line from each name to the structure of a molecule of that compound.

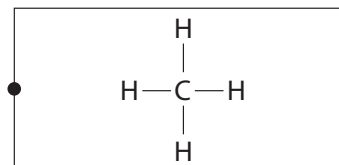
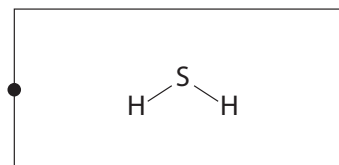
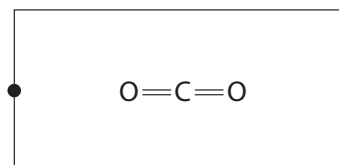
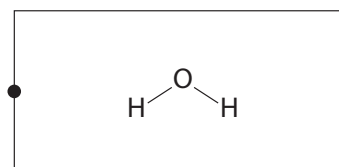
(2)

name of compound

structure of molecule

carbon dioxide

methane



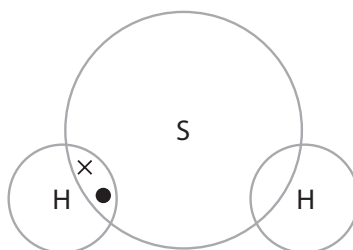
- (c) Figure 2 shows information about the number of electrons in the outer shell of each of the different atoms in a molecule of compound **C**.

symbol of element	number of electrons in outer shell of the atom
H	1
S	6

Figure 2

Use the information in Figure 2 to complete the dot and cross diagram for a molecule of compound **C**.

(2)



- (d) The atomic number of phosphorus, P, is 15.

One atom of phosphorus has a relative atomic mass of 31.

Give the number of protons, neutrons and electrons in this atom of phosphorus.

(3)

number of protons = ...

number of neutrons = ...

number of electrons = ...

(Total for Question 1 = 8 marks)

2 This question is about the metals and non-metals in period 3 of the periodic table.

(a) Figure 3 shows some data about some of the elements in period 3.

symbol	atomic number	melting point in °C
Na	11	98
Mg	12	650
Al	13	660
Si	14	1410
P	15	44
Cl	17	−101
Ar	18	−189

Figure 3

Use the periodic table to answer these questions.

(i) Give the **name** of the element in period 3 that is not shown in Figure 3.

(1)

.....

(ii) Give the relative atomic mass of silicon.

(1)

.....

(iii) State which metal and which non-metal in Figure 3 have the lowest melting points.

(2)

metal with lowest melting point

.....

non-metal with lowest melting point

.....



(b) Alkali metals react with water to produce an alkaline solution and hydrogen gas.

A test tube of gas can be tested to see if the gas is hydrogen by putting a lighted splint at the top of the test tube.

A student suggests the following method to show that an alkaline solution and hydrogen gas are produced in this reaction.

step 1 pour 150 cm^3 water into the container shown in Figure 4

step 2 add a small piece of lithium to the water in the container shown in Figure 4

step 3 hold a lighted splint above the container

step 4 hold some damp red litmus paper above the mixture in the container.

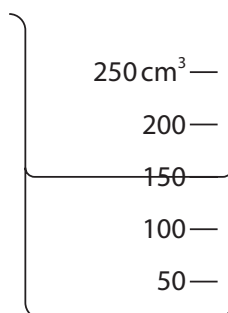


Figure 4

(i) Give the name of the container shown in Figure 4.

(1)

(ii) A teacher says that step 3 and step 4 will **not** work to show that hydrogen gas and an alkaline solution are produced in the reaction.

Explain **one** change that could be made in each step to make the method work.

(3)

step 3.....

.....

.....

step 4.....

.....

.....

(Total for Question 2 = 8 marks)



9-MARK QUESTIONS

5 questions in this booklet



1 Figure 1 shows the dot and cross diagram for a molecule of ammonia.

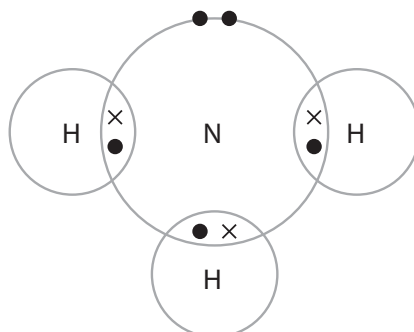


Figure 1

(a) (i) What do the dots and crosses represent in the diagram?

(1)

- ☐ A electrons
- ☐ B neutrons
- ☐ C protons
- ☐ D nuclei

(ii) Give the formula for the molecule of ammonia.

(1)

(b) (i) Ammonia can be manufactured by the Haber process.

The word equation for the reaction is



State the meaning of the $\rightleftharpoons$ symbol.

(1)

- (ii) In the Haber process, the percentage yield of ammonia at equilibrium changes with temperature.

Figure 2 shows how the percentage yield of ammonia at equilibrium changes with temperature.

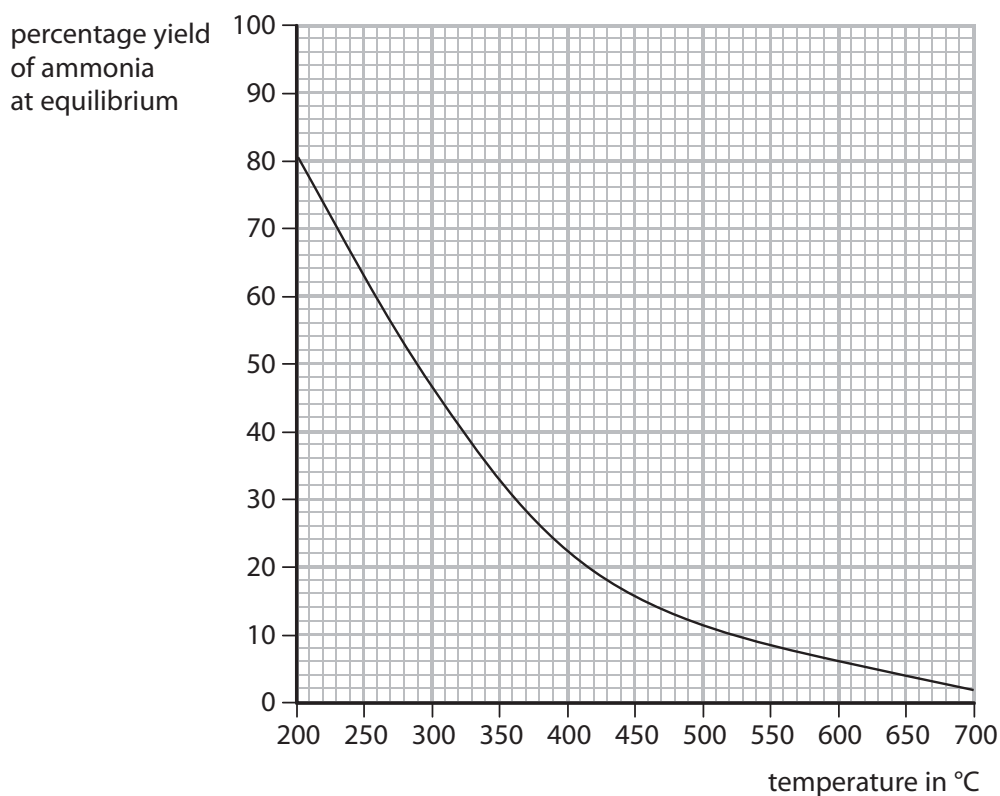


Figure 2

State what happens to the percentage yield of ammonia at equilibrium as the temperature increases.

(1)

- (iii) Use the graph to find the percentage yield of ammonia at equilibrium at 450°C.

(1)

percentage yield of ammonia at equilibrium = ...



(c) Ammonia reacts with nitric acid to form ammonium nitrate.

(i) Complete the word equation for this reaction.

(1)

..... + ... →

(ii) An ammonium ion has the formula NH_4^+ .

A nitrate ion has the formula NO_3^- .

Which of the following is the formula for ammonium nitrate?

(1)

☐ **A** $(\text{NH})_4\text{NO}_3$

☐ **B** $(\text{NH}_4\text{NO})_3$

☐ **C** NH_4NO_3

☐ **D** $(\text{NHNO})_{12}$

(iii) Explain why farmers spread ammonium nitrate on their fields.

(2)

.....

.....

(Total for Question 1 = 9 marks)



4 (a) The molecular formula of butene is C_4H_8 .

Which of the following is the empirical formula of butene?

(1)

- ☐ A CH
- ☐ B CH_2
- ☐ C C_4H_8
- ☐ D $(CH_2)_4$

(b) Calculate the relative formula mass of butene, C_4H_8 .

(relative atomic masses: H = 1, C = 12)

(2)

relative formula mass

(c) When burnt completely in air, butene forms carbon dioxide and water.

(i) Balance the equation for this reaction by putting numbers in the spaces provided.

(2)



(ii) Describe the test to show that a gas is carbon dioxide.

(2)



- (d) Substance X is a gas at room temperature.
It is a simple molecular, covalent substance.

Which row of the table shows the properties that substance X is most likely to have?

(1)

	boiling point in °C	relative solubility in water
☐ A	–6	low
☐ B	600	high
☐ C	–6	high
☐ D	600	low

- (e) Diamond has a giant covalent structure.

State one property of diamond that is the result of its giant covalent structure.

(1)

(Total for Question 4 = 9 marks)

4 (a) When chromium reacts with oxygen, chromium oxide is formed.

(i) Write the word equation for this reaction.

(1)

..... + ... →

(ii) What type of reaction occurs when chromium reacts with oxygen?

(1)

☐ A condensation

☐ B evaporation

☐ C neutralisation

☐ D oxidation

(iii) Calculate the relative formula mass of chromium oxide, Cr_2O_3 .

(relative atomic masses: O = 16, Cr = 52)

(2)

.....
.....

relative formula mass = ...

(b) Three different metals are added to separate test tubes of acid.

The observations are shown in Figure 4.

metal	observation
silver	no change is seen
iron	very slow bubbling
magnesium	steady bubbling

Figure 4

(i) Place the metals in order of reactivity from most to least reactive.

(1)

most reactive

.....

least reactive

- (ii) Hydrogen is given off when magnesium reacts with acid.
The hydrogen is tested by collecting the gas in a test tube and igniting it.

What is the safest way to ignite the gas?

(1)

- ☐ A add fuel to the test tube
- ☐ B heat the test tube with a Bunsen burner
- ☐ C put a lighted splint at the open end of the test tube
- ☐ D put the test tube in an oven

- (iii) State the observation made in this test that shows that the gas is hydrogen.

(1)

.....

.....

- (c) Iron is extracted by heating iron oxide with carbon.
Electrolysis of molten iron oxide is not used to extract iron.

- (i) State why iron can be extracted by heating iron oxide with carbon.

(1)

.....

.....

- (ii) State why electrolysis is **not** used to extract iron.

(1)

.....

.....

.....

.....

(Total for Question 4 = 9 marks)



5 Ethanol can be made by fermentation of a solution of glucose, a carbohydrate.

A student used the apparatus shown in Figure 9 for the fermentation reaction.

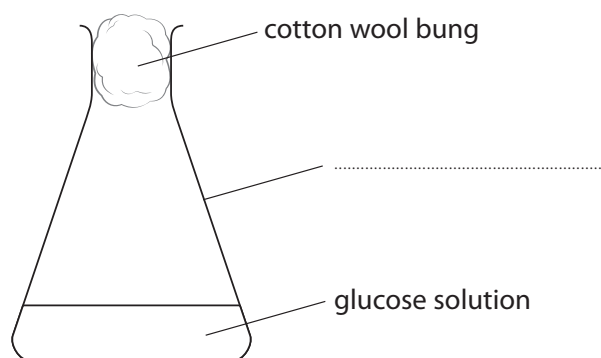


Figure 9

(a) Complete the missing label on Figure 9.

(1)

(b) The student dissolved 45 g of glucose in water to make 150 cm^3 of glucose solution.

Calculate the concentration of this solution in g dm^{-3} .

(2)

.....
.....

concentration of glucose solution = ... g dm^{-3}

(c) State what should be added to the glucose solution to cause the fermentation reaction.

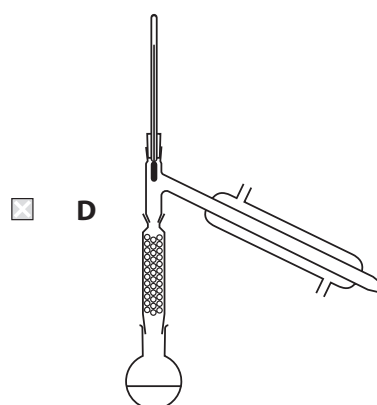
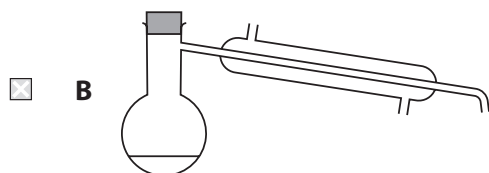
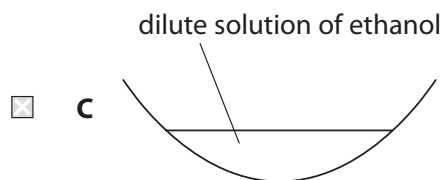
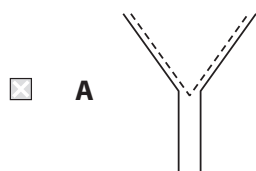
(1)

.....

(d) After a few days, a dilute solution of ethanol is formed.

Which piece of apparatus should be used to produce a concentrated solution of ethanol from the dilute solution of ethanol by fractional distillation?

(1)



(e) The complete fermentation of 180 g of glucose produces 92 g of ethanol.

Calculate the maximum mass of ethanol, in g, produced from the complete fermentation of 45 g of glucose.

(2)

.....

.....

.....

maximum mass of ethanol = ... g

(f) The structure of a molecule of ethanol is shown in Figure 10.

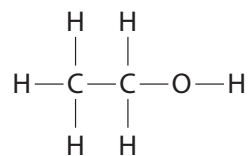
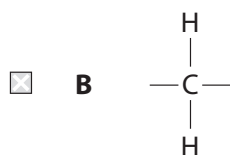
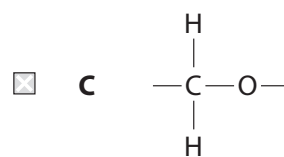
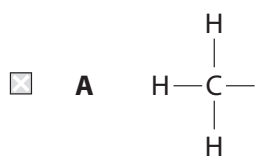


Figure 10

Ethanol is an example of an alcohol.

What is the functional group of an alcohol?

(1)



(g) Ethanol can be oxidised to form ethanoic acid.

State what is seen when a piece of universal indicator paper is placed in some dilute ethanoic acid.

(1)

.....

.....

(Total for Question 5 = 9 marks)

3 Water treatment is needed to make most sources of water suitable for drinking.

- (a) Water treatment includes the processes of **chlorination**, **filtration** and **sedimentation**.

Place these processes in the order that they take place during water treatment.

(2)

first		last

- (b) Some tap water contains chloride ions.

- (i) Explain, in terms of electrons, how a chlorine atom, Cl, forms a chloride ion, Cl⁻.

(2)

.....

.....

.....

.....

- (ii) Why is chlorine added to water during water treatment?

(1)

- ☐ A to clean the water
- ☐ B to dissolve insoluble substances in the water
- ☐ C to increase the pH of the water to 11
- ☐ D to kill any bacteria in the water

- (iii) State why tap water is not suitable for use in chemical analysis.

(1)

.....

.....



- (c) A student was asked to distil a sample of tap water. Figure 5 shows the apparatus the student used.

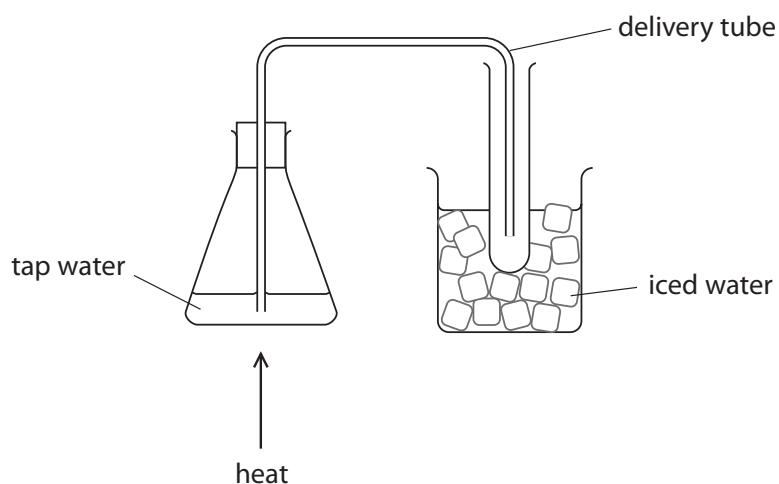


Figure 5

- (i) The student made an error when setting up the apparatus in Figure 5.

This error meant that pure water could **not** be collected in the test tube.

Explain what the student needs to change so that pure water can be collected in the test tube.

(2)

.....

.....

.....

.....

.....

- (ii) State what the student should use to heat the water.

(1)

.....

(Total for Question 3 = 9 marks)

10-MARK QUESTIONS

4 questions in this booklet



5 Two compounds of barium are barium sulfide and barium chloride.

(a) The hazard symbol shown in Figure 5 is on bottles containing barium metal.



Figure 5

State the meaning of this hazard symbol.

(1)

(b) Give the names of the elements combined in barium sulfide.

(1)

(c) Barium chloride is toxic.

Explain one safety precaution that should be taken when using barium chloride.

(2)

- (d) (i) A beaker of barium chloride solution and a beaker of dilute sulfuric acid were placed on a balance, as shown in Figure 6.

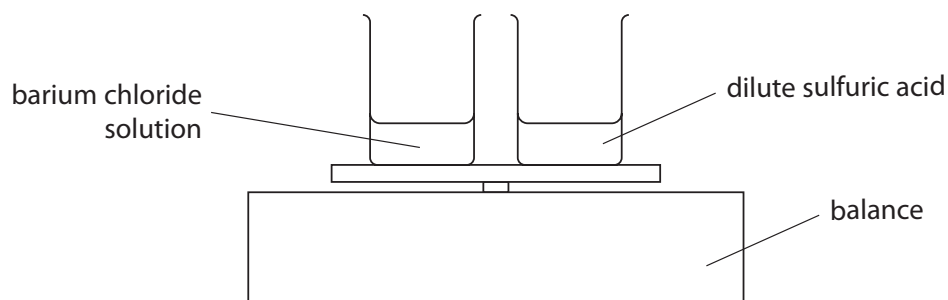


Figure 6

The total mass reading on the balance was 25.7 g.

The dilute sulfuric acid was poured into the barium chloride solution and the beaker replaced on the balance, as shown in Figure 7.

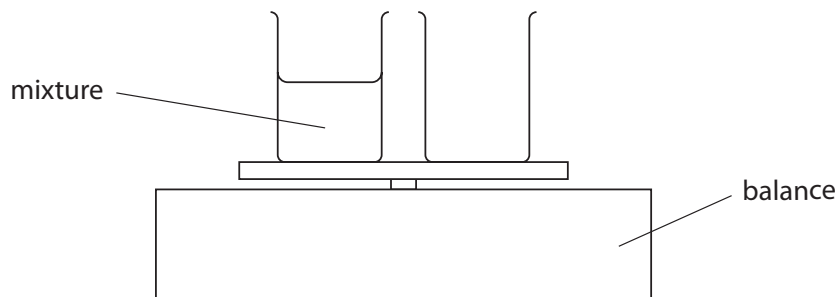


Figure 7

The mixture formed contained a white precipitate.

State the total mass reading on the balance after the reaction.

(1)

- (ii) Give the name of the white precipitate formed by the reaction of barium chloride solution with dilute sulfuric acid.

(1)

(e) Solid sodium chloride is dissolved in water.

The sodium chloride solution is electrolysed in the apparatus shown in Figure 8.

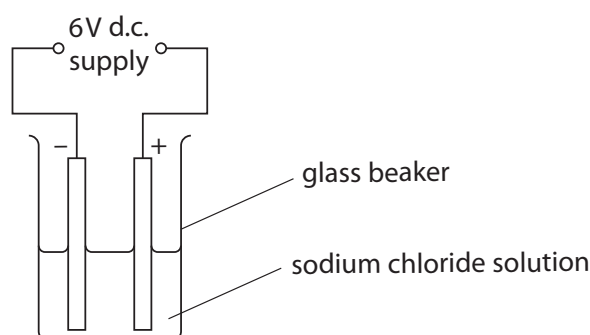


Figure 8

(i) State why sodium chloride solution, rather than solid sodium chloride, must be used in this experiment.

(1)

(ii) The formulae of the ions present in the sodium chloride solution are



Circle the ions that would be attracted to the anode.

(1)

(iii) Molten lead bromide can be electrolysed to form molten lead and bromine gas.

Explain how a student could modify the apparatus shown in Figure 8 to carry out this electrolysis.

(2)

(Total for Question 5 = 10 marks)

- 4 (a) In the 19th century, Mendeleev arranged the elements known at the time to form his periodic table.

Mendeleev's periodic table is different from the modern periodic table.

State **one** difference between Mendeleev's periodic table and the modern periodic table.

(1)

- (b) Aluminium oxide reacts with hydrochloric acid to form a salt and water.

- (i) State the name of the salt formed.

(1)

- (ii) In this reaction aluminium oxide is a base.

State the type of reaction that takes place when an acid reacts with a base.

(1)

- (c) Gallium, Ga, is in the same group of the modern periodic table as aluminium.

The formula of aluminium oxide is Al_2O_3 .

- (i) Predict the formula of gallium oxide.

(1)

- (ii) Gallium oxide has a very high melting point.

Gallium oxide does not conduct electricity when solid but does conduct electricity when molten.

What type of substance is gallium oxide?

(1)

- ☐ **A** giant covalent
- ☐ **B** ionic
- ☐ **C** metallic
- ☐ **D** simple molecular

- 5 (a) An atom of aluminium has an atomic mass of 27.

Aluminium has an atomic number of 13.

State the number of electrons, neutrons and protons in this atom.

(3)

number of electrons = ...

number of neutrons = ...

number of protons = ...

- (b) Aluminium reacts with bromine to form aluminium bromide.

A sample of aluminium bromide contains 1.35 g of aluminium atoms and 12.00 g of bromine atoms.

Calculate the empirical formula of this sample of aluminium bromide.

(relative atomic masses: Al = 27.0, Br = 80.0)

(3)

.....

.....

.....

.....

.....

.....

empirical formula = ...



(c) Gallium is in the same group in the periodic table as aluminium and in the same period in the periodic table as bromine.

(i) State in which group and period of the periodic table gallium can be found.

You may want to refer to the periodic table.

(2)

group = ...

period = ...

(ii) Gallium had not been discovered when Mendeleev created his first periodic table.

Figure 9 shows some properties of gallium that Mendeleev predicted and some of the actual properties of gallium.

property	predicted property	actual property
relative atomic mass	about 68	70
density in g/cm^3	about 6.0	5.9
melting point	lower than 40°C	29.8°C
density of oxide in g/cm^3	about 5.5	5.9

Figure 9

Describe how Mendeleev predicted these properties of gallium.

(2)

.....

.....

.....

.....

(Total for Question 5 = 10 marks)

- 5 (a) Figure 8 shows some information about an atom of chlorine.



Figure 8

State the number of protons, neutrons and electrons in this atom.

(3)

number of protons = ...

number of neutrons = ...

number of electrons = ...

- (b) Chlorine reacts with silicon to form silicon chloride.

A sample of silicon chloride contains 1.4 g of silicon atoms and 7.1 g of chlorine atoms.

Calculate the empirical formula of this sample of silicon chloride.

(relative atomic masses: Si = 28, Cl = 35.5)

(3)

.....

.....

.....

.....

.....

.....

empirical formula = ...

- (c) The modern periodic table is organised into groups and periods.

State in which group and in which period of the periodic table silicon is found.

You should use the periodic table to help you answer this question.

(2)

group = ...

period = ...



(d) Describe **two** differences between Mendeleev's periodic table and the modern periodic table.

(2)

1

.....

2

.....

(Total for Question 5 = 10 marks)



11-MARK QUESTIONS

7 questions in this booklet



6 Figure 8 shows one molecule of each of four different substances, **A**, **B**, **C** and **D**.

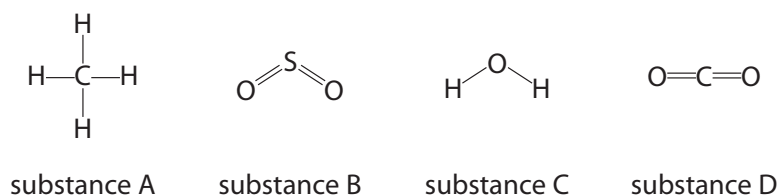


Figure 8

(a) State the formula of a molecule of substance **B**.

(1)

(b) (i) Substance **C** can be formed by burning an element in oxygen.

Write the word equation for this reaction.

(1)

(ii) Consider substances **A**, **B**, and **D**.

Give the letters of the two substances that can be formed by burning an element in oxygen.

(1)

(c) The amount of oxygen in the atmosphere has increased since the Earth's early atmosphere was formed.

Explain what has caused this change.

(2)

(d) Carbon dioxide is present in the Earth's atmosphere.

Some processes increase the amount of carbon dioxide in the atmosphere, other processes decrease it.

Draw one straight line from each change in the amount of carbon dioxide in the atmosphere to the process causing the change.

(2)

**change in the amount of
carbon dioxide in the atmosphere**

increase

decrease

process causing the change

carbon dioxide absorbing
the Sun's energy

carbon dioxide dissolving
in oceans

volcanic emissions

using argon in light bulbs

burning hydrogen



- (e) Figure 9 shows a graph of the amount of carbon dioxide in the Earth's atmosphere from 1985 to 2005.

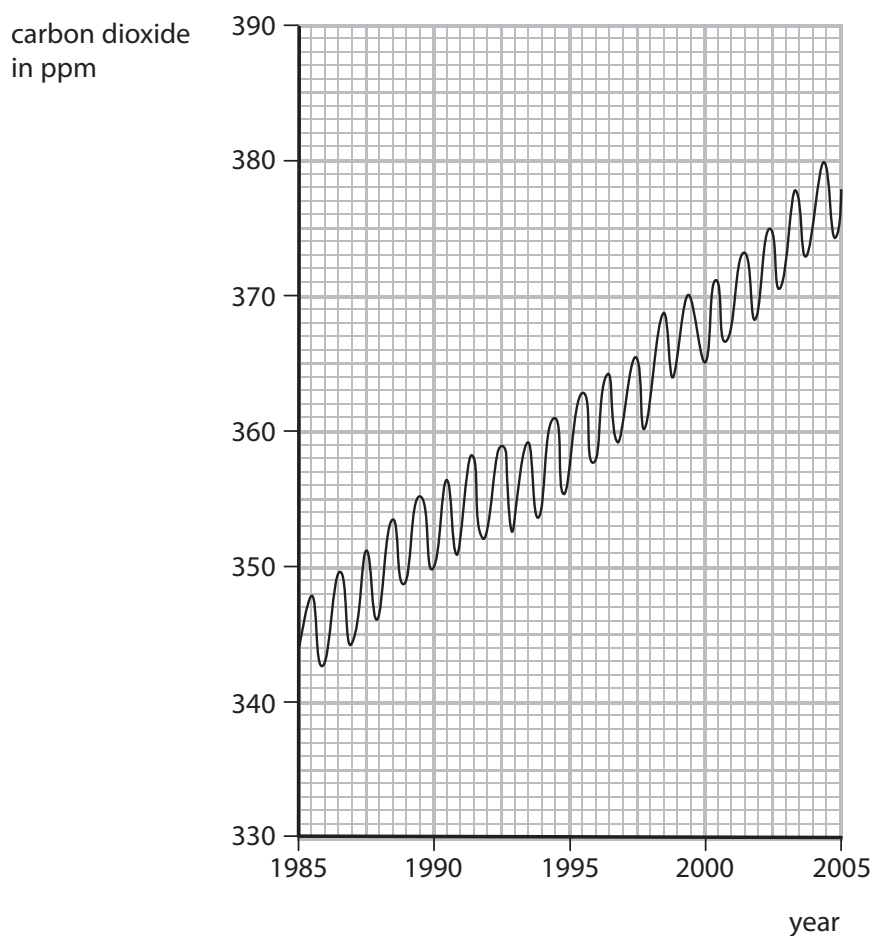


Figure 9

- (i) Describe how the amount of carbon dioxide in the Earth's atmosphere varies within each year.

(1)

- (ii) Describe the overall trend in the amount of carbon dioxide in the Earth's atmosphere from 1985 to 2005.

(1)



(iii) Calculate the change in the amount of carbon dioxide in the Earth's atmosphere from the beginning of 1990 to the beginning of 2000.

(2)

.....

.....

.....

change in amount = ... ppm

(Total for Question 6 = 11 marks)



8 (a) A chlorine atom contains 17 electrons, 18 neutrons and 17 protons.

(i) State the mass number of this chlorine atom.

(1)

(ii) Give the electronic configuration of this chlorine atom.

(1)

(b) Describe what you would **see** if damp, blue litmus paper is placed into chlorine gas.

(2)



(c) Chlorine exists as diatomic molecules.

In a molecule, two chlorine atoms are joined by a covalent bond.

(i) Describe what is meant by a **covalent bond**.

(2)

(ii) Explain why chlorine is a gas, rather than a liquid, at room temperature.

(2)

(d) When the gas hydrogen chloride, HCl , is dissolved in water, a solution forms.
Blue litmus paper dipped in this solution turns red.

State why the litmus paper turns red.

(1)

- (e) (i) Figure 13 lists the halogens in the order in which they appear in group 7 of the periodic table.

The melting points of four of the halogens are given.

halogen	melting point in °C
fluorine	–220
chlorine	–101
bromine	–7
iodine	
astatine	302

Figure 13

Estimate the melting point of iodine.

(1)

..... °C

- (ii) Bromine reacts with heated iron.

Give the name of one halogen that would react with iron more vigorously than bromine.

(1)

.....

(Total for Question 8 = 11 marks)



8 The scientist John Dalton lived over 200 years ago.

(a) John Dalton suggested an early model of atoms.

When Dalton first described atoms he said that

- all elements are made of atoms
- atoms are not formed of any smaller particles
- all atoms of the same element are identical.

Give two differences between Dalton's model of atoms and today's model of atoms.

(2)

1

.....

.....

2

.....

.....

(b) Dalton also investigated different gases.

One of the gases that Dalton investigated was ethene.

The structure of one molecule of ethene is shown in Figure 8.

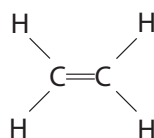


Figure 8

Give the molecular formula and the empirical formula of ethene.

(2)

molecular formula

empirical formula



(c) Another gas that Dalton investigated was chlorine.

Chlorine gas reacts with water.

The two products are a solution of hydrogen chloride and the substance HClO.

(i) Complete the balanced equation for this reaction, including the three missing state symbols.

(3)

..... (.....) + ... (.....) $\rightleftharpoons$ (.....) + HClO (aq)

(ii) Hydrogen chloride solution is acidic.

The formulae of four ions are shown in Figure 9.

H ⁺	H ⁻	Cl ⁺	Cl ⁻
----------------	----------------	-----------------	-----------------

Figure 9

Give the formula of the ion in Figure 9 that causes the hydrogen chloride solution to be acidic.

(1)

formula

(iii) An acid reacts with an alkali.

Give the name of this type of reaction.

(1)

(iv) Describe what you would **see** when some copper carbonate powder is added to a beaker of dilute sulfuric acid.

(2)

(Total for Question 8 = 11 marks)



- 8 (a) The concentration of a solution can be calculated using the equation

$$\text{concentration of solution} = \frac{\text{mass of solid}}{\text{volume of solution}}$$

A student dissolved 9.25 g of ammonium chloride in water and made up the solution to a volume of 200 cm³.

Use the equation to calculate the concentration of this solution in g dm⁻³.

(2)

concentration = ... g dm⁻³

- (b) Dissolving ammonium chloride in water is an endothermic process.

Figure 17 shows part of the reaction profile for this process.

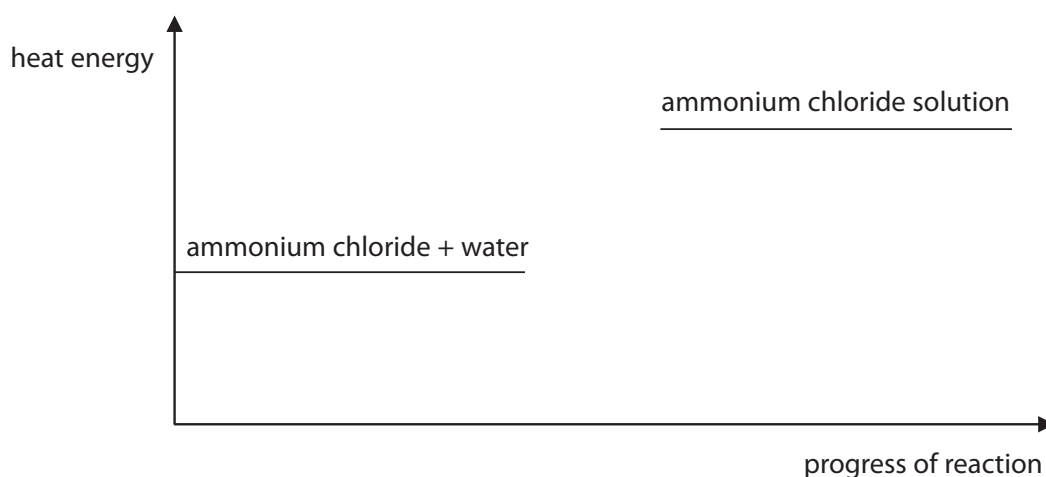


Figure 17

- (i) Explain how Figure 17 shows that dissolving ammonium chloride in water is an endothermic process.

(2)

(ii) Complete the reaction profile in Figure 17 and label the activation energy.

(2)

(c) A student used the equipment in Figure 18 to investigate whether electricity can pass through solid ammonium chloride and through ammonium chloride solution.

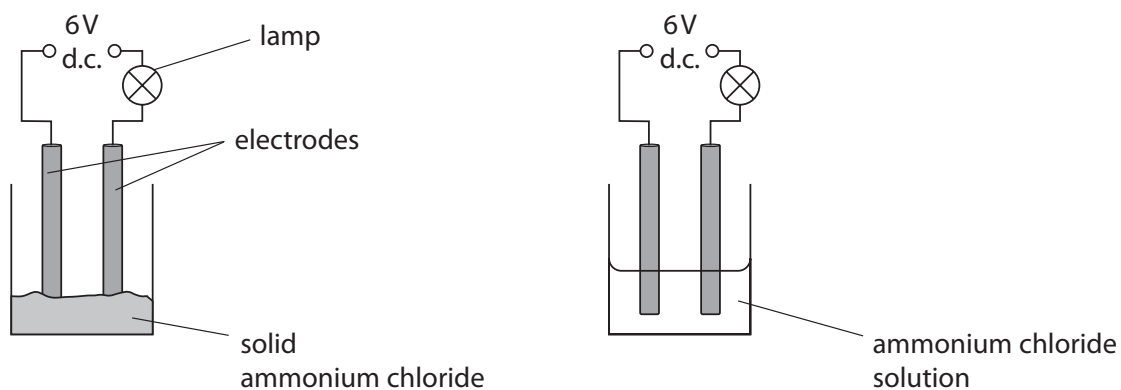


Figure 18

If an electrical current flows in the circuit, the lamp will light up.

Figure 19 shows the results of the investigation.

substance	lamp
solid ammonium chloride	did not light up
ammonium chloride solution	lit up brightly

Figure 19

Explain the results of the investigation.

(3)

.....

.....

.....

.....

.....

.....

(d) Ammonia gas is toxic.

(i) Which symbol should be placed on a container of a toxic gas?

(1)



(ii) Give **one** safety precaution that should be taken when working with toxic gases in the laboratory.

(1)

.....

.....

(Total for Question 8 = 11 marks)

- 6 (a) 3.14 g of solid copper sulfate was dissolved in water and made up to 250 cm³ of solution.

$$\text{concentration (g dm}^{-3}\text{)} = \frac{\text{mass of solid (g)}}{\text{volume of solution (dm}^3\text{)}}$$

Calculate the concentration of this copper sulfate solution in g dm⁻³.

(2)

.....

.....

.....

concentration = ... g dm⁻³

- (b) Sodium hydroxide solution was added to a solution of copper sulfate.
A precipitate of copper hydroxide and a solution of sodium sulfate were formed.

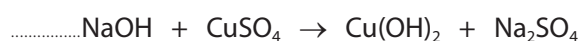
- (i) State what would be **seen** in the reaction.

(1)

.....

- (ii) Complete the balanced equation for the reaction by adding a number in front of NaOH.

(1)



- (iii) Describe how to obtain a pure, dry sample of the precipitate of copper hydroxide from the reaction mixture.

(3)

.....

.....

.....

.....

.....

.....



- (c) Figure 10 shows the equipment used to electrolyse a sample of sodium sulfate solution.

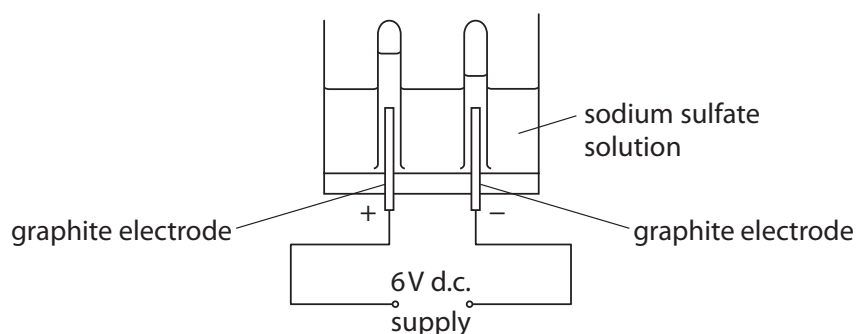


Figure 10

Graphite electrodes are used in the electrolysis of sodium sulfate solution. Graphite is used because it is inert and conducts electricity.

- (i) Figure 11 shows the ions in the sodium sulfate solution.

Draw a circle around each of the ions in Figure 11 that are attracted to the negative graphite electrode during the electrolysis.

(1)



Figure 11

- (ii) State why it is important that the electrodes are inert.

(1)

.....

.....

- (iii) Explain, in terms of its structure, how graphite conducts electricity.

(2)

.....

.....

.....

(Total for Question 6 = 11 marks)

4 Steel is an alloy containing iron.

When exposed to damp air, some steels will corrode to form rust.

(a) (i) Which gas in the air is needed for corrosion to occur?

(1)

- ☐ **A** argon
- ☐ **B** carbon dioxide
- ☐ **C** nitrogen
- ☐ **D** oxygen

(ii) What type of reaction happens when the iron in steel corrodes?

(1)

- ☐ **A** the iron has been displaced
- ☐ **B** the iron has been neutralised
- ☐ **C** the iron has been oxidised
- ☐ **D** the iron has been reduced

(b) Rust can be removed from steel by treating it with dilute hydrochloric acid.

One product formed in this reaction is iron chloride, FeCl_3 .

Calculate the relative formula mass of this iron chloride.

(relative atomic masses: Fe = 56.0, Cl = 35.5)

(2)

.....

.....

.....

relative formula mass = ...

- (c) Figure 6 shows the composition of one type of steel that has a low resistance to corrosion and another type of steel that has a high resistance to corrosion.

element	percentage of element in steel	
	steel with low resistance to corrosion	steel with high resistance to corrosion
iron	98.2	80.6
carbon	0.4	1.1
chromium	0.0	17.0
manganese	0.9	0.8
nickel	0.5	0.5

Figure 6

- (i) Using Figure 6, state which non-metal is in both types of steel.

(1)

.....

- (ii) Using Figure 6, state which metal is added to steel to increase its resistance to corrosion.

(1)

.....

- (iii) Explain **one** other way that corrosion of steel can be prevented.

(2)

.....

.....

.....

.....



(d) A student is given **two** nails of the same size but made of different types of steel.

They are also given two boiling tubes and some distilled water.

Devise an experiment to show which nail corrodes more quickly.

(3)

(Total for Question 4 = 11 marks)



- 6 (a) A 250 cm³ solution of copper sulfate contains 6.52 g of dissolved solid.

Calculate the concentration of this copper sulfate solution in g dm⁻³.

$$\text{concentration (g dm}^{-3}\text{)} = \frac{\text{mass of solid (g)}}{\text{volume of solution (dm}^3\text{)}} \quad (2)$$

.....

.....

.....

concentration = ... g dm⁻³

- (b) Sodium hydroxide solution and copper sulfate solution were reacted together completely.

The result was a mixture of a precipitate of copper hydroxide in a solution of sodium sulfate.

Describe how to obtain

- a pure sample of solid copper hydroxide from the mixture
- a pure sample of solid sodium sulfate from the mixture.

(4)

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- (c) Figure 9 shows the equipment used to electrolyse a sample of sodium sulfate solution.

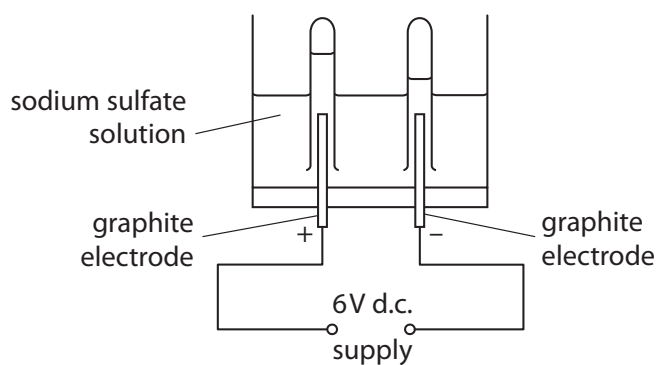


Figure 9

Graphite electrodes are used in the electrolysis.

- (i) Give **two** reasons why graphite is a suitable material for the electrodes.

(2)

1

2

- (ii) Sodium sulfate solution contains ions.

Which ions are attracted to the positive electrode during the electrolysis?

(1)

- ☐ **A** H^+ ions only
- ☐ **B** OH^- ions only
- ☐ **C** H^+ and Na^+ ions
- ☐ **D** SO_4^{2-} and OH^- ions

- (iii) Draw **one** straight line from each electrode to the product formed at that electrode during the electrolysis of sodium sulfate solution.

(2)

electrode

product

anode

hydrogen

hydroxide

cathode

oxygen

sodium

(Total for Question 6 = 11 marks)



12-MARK QUESTIONS

2 questions in this booklet



8 (a) An atom of potassium has atomic number 19 and mass number 39.

(i) Give the electronic configuration of this potassium atom.

(1)

.....

(ii) This potassium atom forms the ion K^+ .

Which row shows the number of protons and the number of neutrons in this potassium ion, K^+ ?

(1)

	number of protons	number of neutrons
☐ A	19	19
☐ B	19	20
☐ C	20	19
☐ D	20	20

(b) Potassium and caesium are in the same group of the periodic table.

Explain, in terms of electrons, why potassium and caesium are in the same group.

(2)

.....

(c) Fluorine boils at -188°C .

There are forces between fluorine molecules.

Explain, in terms of these forces, why the boiling point of fluorine is low.

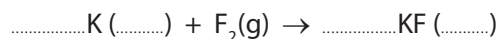
(2)

.....

- (d) Potassium reacts with fluorine to form potassium fluoride.
Potassium fluoride is a solid.

Complete the balanced equation for this reaction and add the state symbols.

(3)



- (e) What are the elements in group 1 of the periodic table called?

(1)

- ☒ **A** alkali metals
☐ **B** fullerenes
☐ **C** halogens
☐ **D** noble gases

- (f) Figure 14 shows the melting points and boiling points of elements in group 7 of the periodic table.

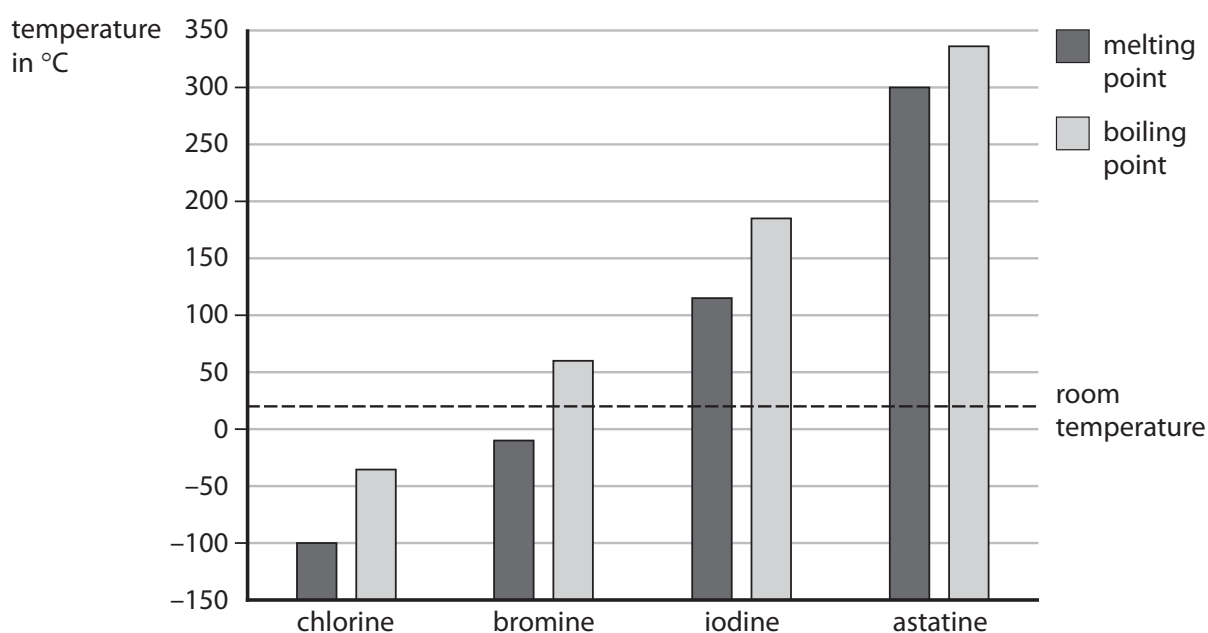


Figure 14

- (i) Give, using Figure 14, the boiling point of bromine.

(1)

boiling point of bromine = ... °C

- (ii) State which **two** elements from Figure 14 are solids at room temperature.

(1)

(Total for Question 8 = 12 marks)



6 (a) Magnesium is a metal.

(i) State **one** physical property of magnesium.

(1)

(ii) Which element is in the same group of the periodic table as magnesium?
Use the periodic table to help you answer this question.

(1)

- ☐ **A** carbon
- ☐ **B** chromium
- ☐ **C** sodium
- ☐ **D** strontium

(b) (i) Magnesium atoms have 12 electrons.

Complete the electronic configuration of a magnesium atom.

(1)

2.8.

(ii) The electronic configuration of a chlorine atom is 2.8.7

Explain how the electronic configuration of chlorine is linked to its period in the periodic table.

(2)

.....

.....

.....

.....



- (c) 1.20 g of magnesium reacts completely with 3.55 g of chlorine to form magnesium chloride.

Calculate the empirical formula of the magnesium chloride.

(relative atomic masses: $\text{Mg} = 24.0$, $\text{Cl} = 35.5$)

You must show your working.

(3)

.....

.....

.....

.....

.....

.....

.....

empirical formula = ...



(d) Sodium reacts with chlorine to form sodium chloride, which contains ionic bonds.

Hydrogen reacts with chlorine to form hydrogen chloride, which contains covalent bonds.

Figure 9 shows dot and cross diagrams of these compounds.

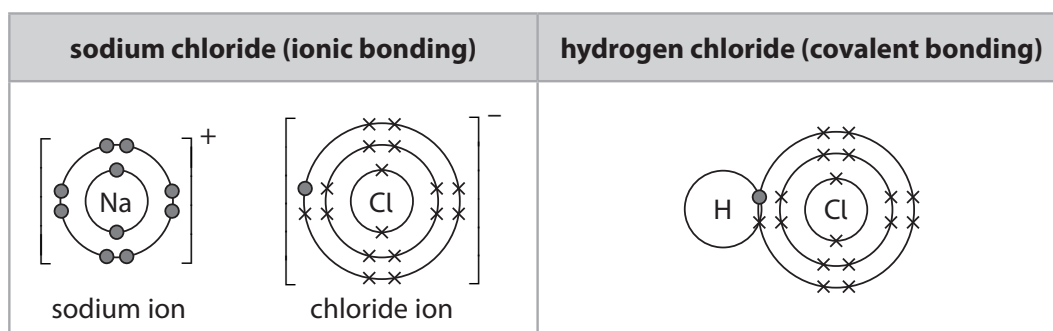


Figure 9

Describe the differences between an ionic bond and a covalent bond.

(4)

.....

.....

.....

.....

.....

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.....

.....

(Total for Question 6 = 12 marks)

13-MARK QUESTIONS

7 questions in this booklet



9 Lithium, sodium and potassium are reactive metals in group 1 of the periodic table.

- (a) Sodium metal tarnishes in air to form a layer of sodium oxide on its surface.
0.92 g of sodium combined with 0.32 g of oxygen in this oxide.

Calculate the empirical formula of this sodium oxide.

(relative atomic masses: O = 16, Na = 23)

You must show your working.

(3)

.....

.....

.....

.....

.....

.....

empirical formula of sodium oxide = ...

- (b) Sodium reacts with water to form sodium hydroxide in solution and hydrogen.

Complete the balancing of the equation for this reaction and add the state symbols for each substance.

(3)



(c) In an experiment equal-sized pieces of lithium, sodium and potassium are added to separate samples of water.

(i) A flame is produced only with potassium because potassium

(1)

- ☐ **A** is the softest metal
- ☐ **B** has the lowest melting point
- ☐ **C** is the most reactive
- ☐ **D** is the only flammable metal

*(ii) A teacher demonstrated this experiment.

The results are shown in Figure 14.

	lithium	sodium	potassium
position of metal in water	floats	floats	floats
movement of metal	slow	fast	very fast
effervescence / bubbling	slow	fast	very fast

Figure 14

Describe, in detail, how the teacher would demonstrate this experiment safely, showing how the results give the order of reactivity of the metals.

(6)

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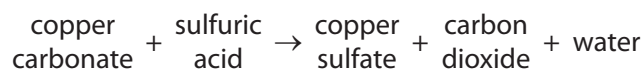
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Handwriting practice area with 20 horizontal dotted lines.

(Total for Question 9 = 13 marks)



9 The word equation for the reaction between copper carbonate and dilute sulfuric acid is



(a) (i) Complete the balanced equation for this reaction.

(2)



(ii) Calculate the relative formula mass of copper carbonate, CuCO_3 .
(relative atomic masses: C = 12.0, O = 16.0, Cu = 63.5)

(2)

.....

.....

.....

relative formula mass of CuCO_3 = ...

(iii) What is the chemical test to show that a gas is carbon dioxide?

(1)

- ☐ **A** bubble the gas through limewater, limewater turns cloudy
- ☐ **B** put damp blue litmus paper in the gas, litmus paper turns red
- ☐ **C** put a lighted splint into the gas, splint is extinguished
- ☐ **D** measure the pH of the gas, pH = 4

- (b) Figure 12 shows a conical flask containing dilute sulfuric acid. Copper carbonate is added to the acid in the flask. The copper carbonate is added one spatula measure at a time until the reaction has finished.

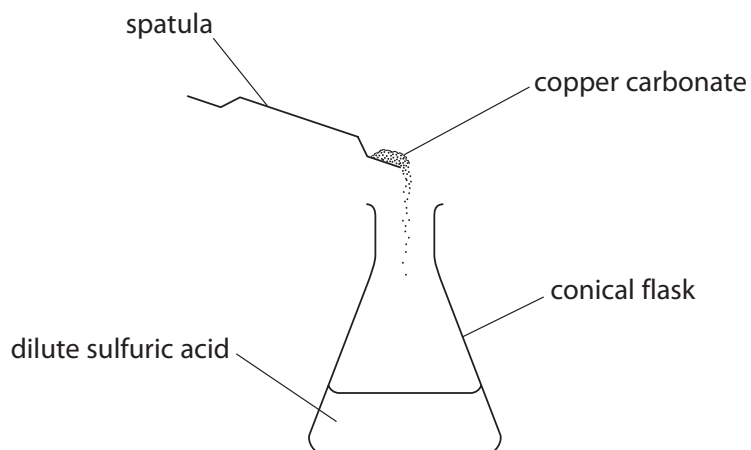


Figure 12

- (i) State **two** observations that would show the reaction has finished.

(2)

- 1
- 2

*(ii) Describe how you would obtain a solution of copper sulfate from the mixture and how you would obtain pure, dry copper sulfate crystals from this solution.

Your description should include the apparatus you would use.

You may wish to use diagrams in your answer.

(6)



(Total for Question 9 = 13 marks)



9 Magnesium carbonate has the formula MgCO_3 .

(a) Magnesium carbonate contains Mg^{2+} and CO_3^{2-} ions.

(i) The atomic number of magnesium is 12.

What is the electronic configuration of the Mg^{2+} ion?

(1)

- ☐ A 2
- ☐ B 2.8
- ☐ C 2.8.2
- ☐ D 2.8.4

(ii) Explain why solid magnesium carbonate cannot conduct electricity but solid magnesium can.

(3)

.....

.....

.....

.....

.....

.....

(b) Calculate the percentage by mass of magnesium in magnesium carbonate, MgCO_3 .

(relative atomic masses: C = 12.0, O = 16.0, Mg = 24.0)

(3)

.....

.....

.....

.....

percentage by mass of magnesium = ...



*(c) A student has two separate test tubes containing sulfuric acid.

The student adds a spatula measure of magnesium carbonate, MgCO_3 , to the first test tube and a piece of magnesium to the second test tube.

Explain what the student would see in each test tube and the tests that they should carry out to identify the gases produced.

Your answer should include word equations for the reactions that would take place.

(6)



(Total for Question 9 = 13 marks)



9 This question is about gases.

(a) When sodium is added to water, hydrogen gas is produced.

Which observation shows that a gas has been produced?

(1)

- ☐ A a white precipitate forms
- ☐ B effervescence is seen
- ☐ C the sodium sinks in the water
- ☐ D the water changes to a pink colour

(b) Some damp litmus paper is placed in a gas.
The litmus paper is bleached.

Which gas bleaches damp litmus paper?

(1)

- ☐ A carbon dioxide
- ☐ B chlorine
- ☐ C hydrogen
- ☐ D oxygen

(c) When calcium carbonate is heated it decomposes.



When 5.000 g of calcium carbonate is heated, the mass of solid remaining is 2.800 g.

Calculate the mass of carbon dioxide that has been released.

Give your answer to three significant figures.

(2)

.....
.....

mass of carbon dioxide = ... g

(d) A diagram of an atom of helium is shown in Figure 15.

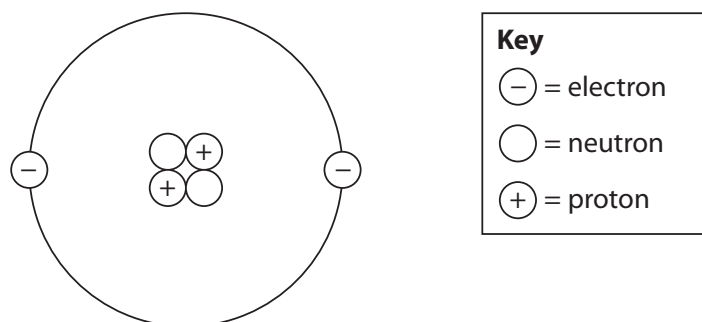


Figure 15

(i) Explain, using Figure 15, why helium is inert.

(2)

.....

.....

.....

(ii) Helium is used to fill balloons.

State one property of helium, apart from it being inert, that makes it suitable for filling balloons.

(1)

.....

(Total for Question 9 = 13 marks)



9 Sodium carbonate has the formula Na_2CO_3 .

(a) Sodium carbonate contains Na^+ ions and CO_3^{2-} ions.

(i) The atomic number of sodium is 11.

What is the electronic configuration of the Na^+ ion?

(1)

- ☐ A 1
- ☐ B 2.8
- ☐ C 2.8.1
- ☐ D 2.8.2

(ii) Explain why solid sodium carbonate **cannot** conduct electricity but a solution of sodium carbonate **can** conduct electricity.

(3)

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(b) Calculate the percentage by mass of sodium in sodium carbonate, Na_2CO_3 .

$$\text{percentage by mass of element} = \frac{\text{total relative atomic mass of element}}{\text{relative formula mass of compound}} \times 100$$

(relative atomic masses: C = 12, O = 16, Na = 23)

(3)

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percentage by mass of sodium = ...



*(c) A student has three solids, **A**, **B** and **C**.

The solids are sodium carbonate, powdered zinc and copper oxide, but the student does not know which solid is which.

The student reacted each solid with dilute sulfuric acid.

Figure 15 shows the student's observations and the results of tests on any gases produced.

	observations and results		
	reaction with dilute sulfuric acid	gas bubbled through limewater	gas tested with a lit splint
solid A	bubbles seen colourless solution formed	no change	squeaky pop
solid B	blue solution formed some black solid remains at bottom of test tube	no gas produced	no gas produced
solid C	bubbles seen colourless solution formed	limewater turned cloudy	puts out lit splint

Figure 15

Use the observations and results in Figure 15 to identify which solid is which.

Your answer should include

- how each test result helps you to identify the solid
- word equations to support your answer.

(6)

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(Total for Question 9 = 13 marks)



8 (a) Atoms of neon are made up of subatomic particles.

(i) Figure 14 shows some information about the subatomic particles in neon atoms.

Complete Figure 14 with the missing information.

(3)

subatomic particle	relative charge	relative mass
proton		1
neutron	0	
electron		negligible

Figure 14

(ii) All atoms of neon have an atomic number of 10.

Describe what information about the number of subatomic particles can be obtained from the atomic number of neon.

(2)

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(iii) Explain why atoms of neon are electrically neutral.

(2)

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(Total for Question 8 = 13 marks)



9 Crude oil is a mixture of hydrocarbons.

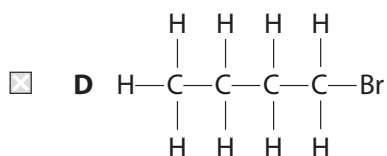
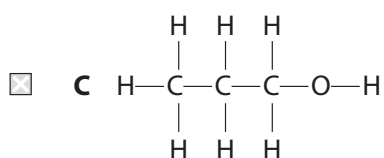
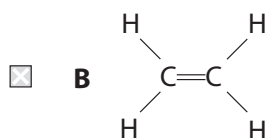
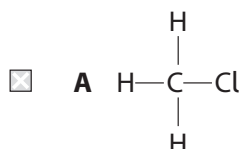
(a) (i) The majority of hydrocarbons in crude oil belong to one homologous series.

Give the name of this series.

(1)

(ii) Which structure represents a molecule of a hydrocarbon?

(1)



(b) When hydrocarbons undergo combustion, water is produced.

Draw a dot and cross diagram of a molecule of water.

(2)

(c) One compound in crude oil contains 0.96 g of carbon atoms combined with 0.32 g of hydrogen atoms.

Calculate the empirical formula of this compound.

(relative atomic masses: C = 12, H = 1.0)

(3)

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empirical formula of this compound = ...



- *(d) Crude oil is separated into useful products called fractions using fractional distillation.

Figure 14 shows a fractional distillation column and the fractions kerosene and fuel oil.

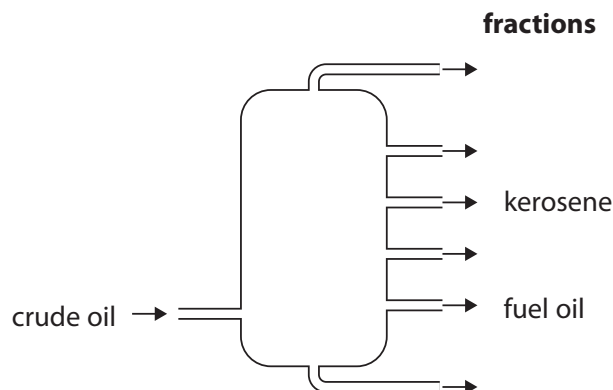


Figure 14

Kerosene and fuel oil have different uses depending on their properties.

Describe the properties and uses of kerosene and fuel oil.

Include in your answer

- the difference in boiling point
- the difference in viscosity
- the difference in ease of ignition
- their uses and how fuel oil can be converted into kerosene.

(6)

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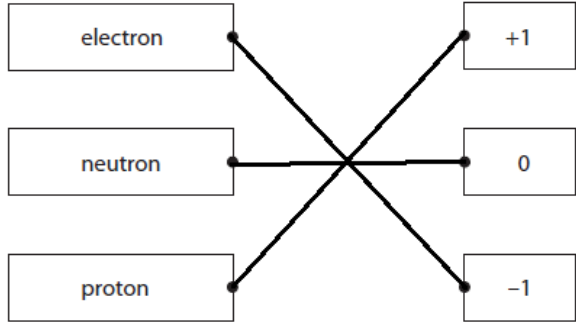
(Total for Question 9 = 13 marks)



MARK SCHEMES

official Pearson Edexcel mark schemes



Question Number	Answer	Additional guidance	Mark
3(a)(i)	particle  3 correct = 2 marks 1 correct = 1 mark	do not allow more than 1 line from any particle	(2) AO 1 1

Question Number	Answer	Mark
3(a)(ii)	C 1 1. The only correct answer is C <i>A is not correct because mass is 1</i> <i>B is not correct because this is relative mass of electron</i> <i>D is not correct because mass cannot be negative</i>	(1) AO 1 1

Question Number	Answer	Mark
3(b)	C magnesium 1. The only correct answer is C <i>A is not correct because this element is in period 4</i> <i>B is not correct because this element is in period 4</i> <i>D is not correct because this element is in period 5</i>	(1) AO 3 2b

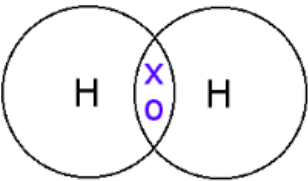
Question Number	Answer	Additional guidance	Mark
3(c)	A description to include - both have 18 electrons/2.8.8 (in shells /orbits) (1) - both have 18 protons (in the nucleus) (1) - argon-38 has 20 neutrons AND argon-40 has 22 neutrons (in the nucleus) (1)	allow argon 40 has two more neutrons than argon 38 / ORA ignore generic definition of an isotope	(3) AO 3 1a AO 3 1b

(Total for Question 3 = 7 marks)

Question number	Answer	Mark
1(a)	C dissolving A, B, D – these answers are about different processes	(1)

Question number	Answer	Additional guidance	Mark
1(b)(i)	sodium + hydrochloric acid (1) → sodium chloride + hydrogen (1)	allow reactants either way round allow products either way round reject 'sodium chlorine' allow $\text{Na} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2$ (1) $2\text{Na} + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{H}_2$ (2)	(2)

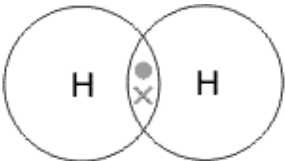
Question number	Answer	Mark
1(b)(ii)	B flammable A corrosive has a different hazard symbol C oxidising has a different hazard symbol D toxic has a different hazard symbol	(1)

Question number	Answer	Additional guidance	Mark
1(b)(iii)		allow dots or crosses or mixture allow other suitable symbols	(1)

Question number	Answer	Additional guidance	Mark
1(c)(i)	pH meter	allow universal indicator / pH paper ignore datalogger alone ignore pH scale / pH strip ignore indicator alone	(1)

Question number	Answer	Additional guidance	Mark
1(c)(ii)	7 / seven	allow pH7 / PH7	(1)

Question number	Answer	Additional guidance	Mark
2(a)(i)	$\rightleftharpoons$ / $\rightleftarrows$ / two single headed arrows in opposite directions	allow double headed arrows: $\rightleftharpoons$ / $\rightleftarrows$ / ignore $\leftrightarrow$	(1) AO1-1

Question number	Answer	Additional guidance	Mark
2(a)(ii)		allow all dots or all crosses or a mixture of both allow dots/crosses with overlapped area OR on lines of the shells where overlapped	(1) AO1-1

Question number	Answer	Additional guidance	Mark
2(b)(i)	ammonia + sulfuric acid $\rightarrow$ (1) $\rightarrow$ ammonium sulfate (1)	reject ammonium reject ammonia sulfate	(2) AO2-1

Question number	Answer	Mark
2(b)(ii)	C $(\text{NH}_4)_2\text{SO}_4$ is the only correct answer A , B and D are incorrect as they are not the formula for ammonium sulfate	(1) AO2-1



Question number	Answer		Mark
2(b)(iii)	an explanation linking • as a fertiliser (1) • to help their crops grow (1)	allow to help plant production / increase yield allow to put (fixed) nitrogen back into the soil / source of nitrogen for the plants / provides nutrients (for the plants) reject protects from disease / kills pests for MP2	(2) A01-1

Total for Question 2 = 7 marks



Question number	Answer	Mark
2(a)(i)	C 2.8.7 A, B, D do not represent electronic configurations	(1)

Question number	Answer	Additional guidance	Mark
2(a)(ii)	An explanation linking - in {outer / 3rd} shell (1) - seven electrons (1) or - number of electrons in outer shell (1) - is the same as group number (1)	allow last shell / outer ring MP2 depends on MP1 allow 7 is the last number of the electronic configuration / OWTTE (1)	(2)

Question number	Answer	Additional guidance	Mark
2(b)(i)	An explanation linking - same number of electrons and protons (1) - so charges {cancel / balance one another} (1)	allow same number of positive and negative charges	(2)

Question number	Answer	Additional guidance	Mark
2(b)(ii)	37 – 17 (1) (= 20) (neutrons)	allow 20 without working reject '– 20'	(1)

Question number	Answer	Additional guidance	Mark
2(b)(iii)	An explanation linking - atoms {of same element / with same number of protons} / same atomic number (1) - different number of neutrons / different mass number (1)	ignore electrons reject neutrons reject protons /electrons	(2)

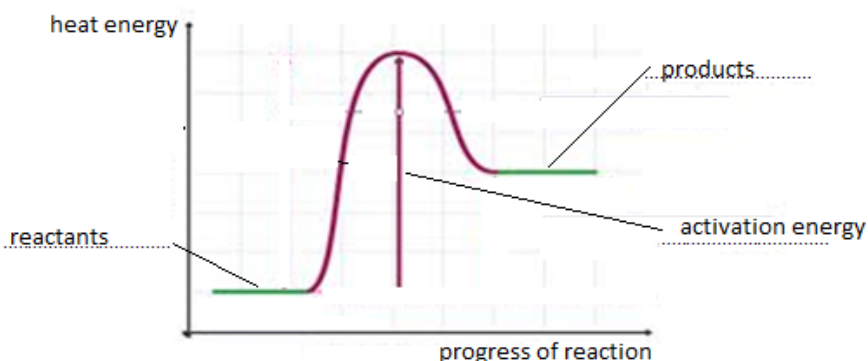
Question number	Answer	Additional guidance	Mark
3(a)(i)	potassium + lead (1) → lead + potassium (1) iodide nitrate iodide nitrate left hand side (1) right hand side (1)	ignore formulae	(2)

Question number	Answer	Additional guidance	Mark
3(a)(ii)	(mass conserved because) the numbers are the same/nothing is lost/nothing is gained	allow same mass / same weight / same amount	(1)

Question number	Answer	Additional guidance	Mark
3(b)(i)	measuring cylinder / (volumetric) pipette / burette	ignore dropping pipette / beaker	(1)

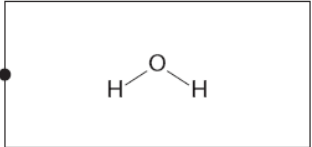
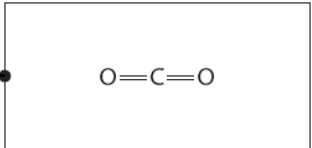
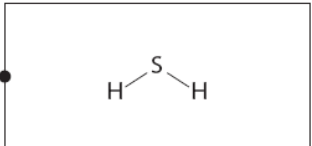
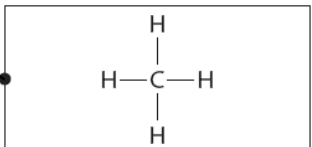
Question number	Answer	Additional Guidance	Mark
3(b)(ii)	measure the initial temperature (of the water)	allow subtract initial temperature from final temperature OR vice versa allow temperature before mixing	(1)

Question number	Answer	Additional Guidance	Mark
3(b)(iii)	insulator / reduces heat transfer / poor conductor of heat	ignore references to heat loss	(1)

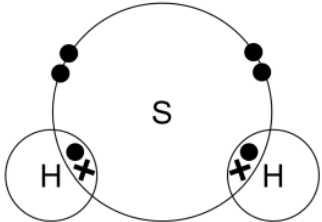
Question number	Answer	Mark
3(b) (iv)	- any one label correct (1) - all three labels correct (1)  The diagram is a reaction energy profile. The vertical axis is labeled 'heat energy' and the horizontal axis is labeled 'progress of reaction'. A red curve represents the energy path of the reaction. It starts at a green horizontal line labeled 'reactants'. The curve rises to a peak and then falls to a lower green horizontal line labeled 'products'. A vertical line segment from the reactant level to the peak is labeled 'activation energy'.	(2)

(Total for Question 3 = 8 marks)

Question number	Answer	Additional guidance	Mark
1(a)	CH ₄	allow H ₄ C / C ₁ H ₄ reject CH ₄ / H ₄ C / CH ⁴ / Ch ₄ / ch ₄	(1) AO3-1

Question number	Answer	Additional guidance	Mark
1(b)	name of compound carbon dioxide methane structure of molecule     one mark for each line	do not award mark if more than one line join a left hand box with those on the right	(2) AO1-1



Question number	Answer	Additional guidance	Mark
1(c)	 shared pair (1) rest of molecule correct (1)	allow all dots or all crosses or a mixture of both allow remaining electrons not shown as pairs MP2 depends on MP1	(2) A02-1
1(d)	protons – 15 (1) neutrons – 16 (1) electrons – 15 (1)	accept ONLY whole numbers if no marks scored then maximum 1 mark for number of electrons = number of protons OR $p + n = 31$	(3) A01-1

Total for Question 1 = 8 marks

Question number	Answer	Additional guidance	Mark
2(a)(i)	sulfur	ignore S	(1) AO2 1

Question number	Answer	Mark
2(a)(ii)	28	(1) AO2 1

Question number	Answer	Additional guidance	Mark
2(a)(iii)	- metal: sodium / Na (1) - non-metal: argon / Ar (1)	if elements swapped score max 1 do not penalise case of letters if symbols used	(2) AO3 1

Question number	Answer	Additional guidance	Mark
2(b)(i)	beaker	ignore any numbers before 'beaker' reject measuring beaker	(1) AO2 2

Question number	Answer	Additional guidance	Mark
2(b)(ii)	an explanation to include any three from: STEP 3 - collect the gas (in suitable apparatus) (1) - otherwise the gas will {disperse / escape} / hydrogen gas above the beaker is too dilute (1) OR - hold (the lighted splint) close to reaction mixture / in container (1) - that's where most of the gas will be (1) STEP 4 - dip the litmus paper into the reaction mixture (1) - so it is in contact with the (alkaline) solution / because above the beaker it does not touch the solution (1)	mark independently allow any reasonable pieces of apparatus eg test tube / boiling tube allow cover container (before applying splint) reject splint going into solution allow drop liquid onto litmus paper add to solution universal indicator / use a pH meter allow other named indicators reject blue litmus to see the change (in colour /pH)	(3) AO3 3

Total for question 2 = 8 marks



Question Number	Answer	Mark
1(a)(i)	A electrons 1. The only correct answer is A <i>B is factually incorrect</i> <i>C is factually incorrect</i> <i>D is factually incorrect</i>	(1) AO 1 1

Question Number	Answer	Additional guidance	Mark
1(a)(ii)	NH ₃	do not allow NH³ / nh₃ / NH3 etc allow H₃N	(1) AO 3 2b

Question Number	Answer	Additional guidance	Mark
1(b)(i)	reversible (reaction) / reaction can go both ways	OWTTE allow reaction is happening forwards and backwards allow equilibrium	(1) AO 1 1

Question Number	Answer		Mark
1(b)(ii)	(the percentage of ammonia produced) decreases / goes down	allow goes lower	(1) AO 3 1a

Question Number	Answer		Mark
1(b)(iii)	any number between 15 and 16 inclusive		(1) AO 3 2b

Question Number	Answer	Additional guidance	Mark
1(c)(i)	ammonia + nitric acid → ammonium nitrate	accept reactants in either order ignore formula	(1) AO 2 1

Question Number	Answer	Mark
1(c)(ii)	C NH_4NO_3 1. The only correct answer is C <i>A is factually incorrect</i> <i>B is factually incorrect</i> <i>D is factually incorrect</i>	(1) AO 2 1

Question Number	Answer	Additional guidance	Mark
1(c)(iii)	An explanation linking two from: - as a fertiliser (1) - contains (a high percentage of) nitrogen (1) - help promote plant growth / increases crop yield (1)	allow make crops grow faster ignore use as a pesticide	(2) AO 1 1

(Total for Question 1 = 9 marks)

Question Number	Answer	Mark
4(a)	B CH₂ 1. The only correct answer is B <i>A is not correct because there are not equal C and H</i> <i>C is not correct because it is not simplest ratio</i> <i>D is not correct because it is not simplest ratio</i>	(1) AO 2 1

Question Number	Answer	Additional guidance	Mark
4(b)	56 with or without working (2) OR $(4 \times 12) + (8 \times 1) = (1)$ $= 56 (1)$	allow for ONE mark correctly evaluated expression of form: $(4 \times 12) + (Y \times 1) = \dots$ $(X \times 12) + (8 \times 1) = \dots$ OR $(8 \times 12) + (4 \times 1) = 100$ [In each case working and correctly evaluated answer required]	(2) AO 2 1

Question Number	Answer	Additional guidance	Mark
4(c)(i)	$\text{C}_4\text{H}_8 + 6\text{O}_2 \rightarrow 4\text{CO}_2 + 4\text{H}_2\text{O}$ 4CO ₂ (1) 4H ₂ O (1)		(2) AO 2 1

Question Number	Answer	Additional guidance	Mark
4(c)(ii)	A description linking • (bubble gas through) limewater (1) • (limewater) turns {milky / cloudy / white precipitate} (1)	second mark dependent on first ignore lit splint goes out	(2) AO 1 1

Question Number	Answer	Mark
4(d)	A -6 low 1. The only correct answer is A <i>B is not correct because bpt is too high and solubility not high</i> <i>C is not correct because solubility not high</i> <i>D is not correct because bot is too high</i>	(1) AO 3 2b

Question Number	Answer	Additional guidance	Mark
4(e)	high melting point / high boiling point / hard / insoluble (in water) / does not conduct (electricity)	ignore strong bonds ignore strong ignore values given ignore any other properties but reject contradictions to allowed answers	(1) AO 1 1

(Total for Question 4 = 9 marks)



Question number	Answer	Mark
4(a)(i)	chromium + oxygen → chromium oxide	(1) AO2

Question number	Answer	Mark
4(a)(ii)	D oxidation is the only correct answer. A, B are incorrect because these are physical changes. C is incorrect because there is no acid-base reaction.	(1) AO1

Question number	Answer	Mark
4(a)(iii)	152 with or without working scores 2. (52 × 2) + (16 × 3) (1) = 152 (1)	(2) AO2

Question number	Answer	Mark
4(b)(i)	magnesium iron silver	(1) AO3

Question number	Answer	Mark
4(b)(ii)	C put a lighted splint at the open end of the test tube is the only correct answer A, B and D are incorrect because they would not work	(1) AO2

Question number	Answer	Additional guidance	Mark
4(b)(iii)	(squeaky) pop / flame	ignore references to ignites reject references to relights	(1) AO1

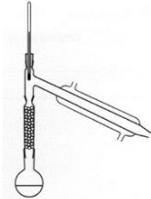
Question number	Answer	Mark
4(c)(i)	iron is less reactive (than carbon) ORA	(1) AO2

Question number	Answer	Mark
4(c)(ii)	electrolysis is expensive/ more expensive method than heating with carbon/ heating with carbon is cheaper/ electrolysis needs a large amount of electricity	(1) AO2

Question number	Answer	Additional guidance	Mark
5(a)(i)	(conical) flask	ignore volumetric flask	(1) AO2-2

Question number	Answer	Additional guidance	Mark
5(b)	$\frac{45}{150} = 0.3 \text{ (1)}$ $0.3 \times 1000 \text{ (1)} = 300 \text{ (g dm}^{-3}\text{)}$ OR $\frac{150}{1000} = 0.15 \text{ (dm}^3\text{) (1)}$ $\frac{45}{0.15} = 300 \text{ (g dm}^{-3}\text{) (1)}$	answer of 300 (g dm⁻³) alone scores (2) allow ecf from MP1 on both methods $\frac{150}{45} = 3.333 \text{ (0)}$ $3.333 \times 1000 = 3333 \text{ (1)}$	(2) AO2-1

Question number	Answer	Additional guidance	Mark
5(c)	yeast / zymase	allow enzyme / biological catalyst	(1) AO2-2

Question number	Answer	Mark
5(d)	D is the only correct answer  A is filtration B is simple distillation, C is evaporation / crystallisation	(1) AO1-1

Question number	Answer	Additional guidance	Mark
5(e)	$\frac{92}{180} = 0.5111111 \quad (1)$ $0.5111111 \times 45 = 23 \text{ (g)} \quad (1)$ OR $\frac{180}{92} = 1.956 \quad (1)$ $\frac{45}{1.956} = 23 \quad (1)$ OR $\frac{180}{45} = 4 \quad (1)$ $\frac{92}{4} = 23 \quad (1)$ OR $\frac{45}{180} = 0.25 \quad (1)$ $92 \times 0.25 = 23 \quad (1)$ OR $92 \times 45 = 4140 \quad (1)$ $\frac{4140}{180} = 23 \quad (1)$	answer of 23 (g) alone scores (2) allow any number of sig figs on step 1 except 1 for any method calculation, allow ecf from MP1 to MP2	(2) AO2-1

Question number	Answer	Mark
5(f)	D -O-H is the only correct answer A , B and C are not correct functional groups of an alcohol	(1) AO1-1

Question number	Answer	Additional guidance	Mark
5(g)	turns {orange /red / yellow}	allow combinations of red, orange & yellow ignore 'changes colour'	(1) AO2-2

Total for Question 5 = 9 marks



Question number	Answer		Mark
3(a)	sedimentation → filtration → chlorination (2) first or last step correct (1)		(2) AO1-1

Question number	Answer	Additional guidance	Mark
3(b)(i)	An explanation linking - gain of electron(s) (1) - one electron (1)	MP2 depends on MP1 gains an electron (2)	(2) AO1-1

Question number	Answer	Mark
3(b)(ii)	D to kill any bacteria in the water is the only correct answer A, B, C are not reasons why chlorine is added	(1) AO1-1

Question number	Answer	Additional guidance	Mark
3(b)(iii)	any one from - ions {present / make test invalid} - the water is impure - tap water would interfere with analysis	allow named substances that could be present in tap water eg calcium ions / chlorine / chloride ions / magnesium ions / minerals allow (water) is not pure ignore 'sterile' / 'contains chemicals' / 'not clean' / 'contains bacteria' ignore any substances not found in tap water	(1) AO1-1



Question number	Answer	Additional guidance	Mark
3(c)(i)	An explanation linking either - remove (delivery) tube from below water line (1) - so that {gas / water vapour / steam} can move through (delivery) tube / to prevent water being pushed up the delivery tube (1) or (delivery) tube is too low (1) {gas / water vapour / steam} not being able to get into the tube (1)	allow alternative description of delivery tube allow error circle on Figure 5 allow move delivery tube higher in conical flask ignore change the delivery tube (alone) MP2 depends on MP1 allow error circle on Figure 5 MP4 depends on MP3	(2) A03-3

Question number	Answer	Additional guidance	Mark
3(c)(ii)	Bunsen (burner) / spirit burner	allow electric heater ignore other forms of heat and equipment	(1) A02-2

Total for Question 3 = 9 marks



Question Number	Answer	Additional guidance	Mark
5(a)	flammable	allow inflammable	(1) AO 3 2b

Question Number	Answer	Additional guidance	Mark
5(b)	barium and sulfur	both elements must be present for the mark allow Ba and S reject sulfide/sulfate reject if any other elements included	(1) AO 2 1

Question Number	Answer	Additional guidance	Mark
5(c)	An explanation linking one of the following pairs of points - wear gloves (1) {so does not contact/to protect your} skin (1) OR - wear goggles (1) {so does not contact/to protect} the eyes (1) OR - use in fume cupboard / mask (1) - so you do not inhale it (1)	second mark dependent on first ignore protective/safety clothing	(2) AO 3 2a AO 3 2b

Question Number	Answer	Additional guidance	Mark
5(d)(i)	25.7 (g)	do not allow 25 answer may be written on the lower diagram	(1) AO 2 1

Question Number	Answer	Additional guidance	Mark
5(d)(ii)	barium sulfate	do not allow barium sulfide	(1) AO 1 2

Question Number	Answer	Additional guidance	Mark
5(e)(i)	so that the ions can move	allow the solid does not conduct allow conducts when {in solution/liquid} ignore conducts when molten allow so cations / anions can move ignore so particles can move reject electrons move	(1) AO 2 2

Question Number	Answer	Mark
5(e)(ii)	OH ⁻ <u>and</u> Cl ⁻ <u>only</u> circled	(1) AO 1 1

Question Number	Answer	Additional guidance	Mark
5(e)(iii)	An explanation linking one of the following pairs of points • use a crucible/metal container (instead of a beaker) (1) • which will not break/melt (when heated strongly) (1) OR • add a Bunsen burner (under the container) (1) • because heat needed to melt the lead bromide / to make the lead bromide a liquid (1)	allow blow torch ignore hot water bath	(2) AO 3 3b

(Total for Question 5 = 10 marks)



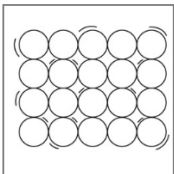
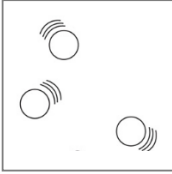
Question number	Answer	Additional guidance	Mark
4(a)	arranged by order of (relative) atomic mass / (in Mendeleev's early periodic table) gaps / missing elements / fewer elements / noble gases were not present	assume answer refers to Mendeleev's table unless specifically referred to modern table so reverse arguments apply	(1)

Question number	Answer	Additional guidance	Mark
4(b)(i)	aluminium chloride	reject 'aluminium chlorine'	(1)

Question number	Answer	Additional guidance	Mark
4(b)(ii)	neutralisation	allow acid + base allow 'acid-base' allow 'exothermic'	(1)

Question number	Answer	Additional guidance	Mark
4(c)(i)	Ga ₂ O ₃	allow Ga ₂ O ₃ / GA ₂ O ₃ reject Ga ² O ³	(1)

Question number	Answer	Mark
4(c)(ii)	B ionic A giant covalent structures do not conduct electricity at all C metallic structures conduct when solid D simple molecular structures do not conduct electricity when molten and have low melting points	(1)

Question number	Answer	Additional guidance	Mark
4(d)(i)	 solid (1) (regular arrangement and touching)  gas (1) (widely spaced, fewer shown)		(2)

Question number	Answer	Additional guidance	Mark
4(d)(ii)	condensing / condensation		(1)

Question number	Answer	Additional guidance	Mark
4(e)	An explanation linking • electrons (1) • can move / are delocalised (1)	MP2 depends on MP1 allow charged particles can move / are delocalised (1)	(2)

Total for Question 4 = 10 marks

Question number	Answer	Additional guidance	Mark
5(a)	number of electrons = 13 (1) number of neutrons = 14 (1) number of protons = 13 (1)	allow 27-13 (=14)	(3) A01-1

Question number	Answer	Additional guidance	Mark
5(b)	fractions $\frac{1.35}{27}$ and $\frac{12.00}{80}$ (1) ratios derived from two fractions into simplest whole number ratio $\frac{0.05}{1}$ $\frac{0.15}{3}$ (1) whole number ratio to formula AlBr_3 (1)	answer with no working scores 0 MP2 depends fractions being shown to give ratio allow ECF for MP2 and MP3 inverted fractions correctly followed through to Al_3Br scores 2 allow Al_1Br_3 allow errors in case or using superscript e.g. albr^3	(3) A02-1

Question number	Answer	Mark
5(c)(i)	group = 3 period = 4	(2) A03- 1a - 1 1b - 1



Question number	Answer	Additional guidance	Mark
5(c)(ii)	A description including: - compared to the elements in same {group / period} (1) (and used the) {trend/pattern} going {down the group / across a period} (1)	<i>MP1 is for idea of which other elements to consider</i> allow elements {above and below / to left and right / around} reference to reactivity can score MP2 but not MP1 e.g elements get more reactive down the group (1) reject incorrect alternatives to 'element' (allow 'metals') but mark on <i>MP2 is for idea of how properties predicted from elements selected in MP1</i> allow {'averaged' / value between} surrounding elements reject compare Ga with elements with similar properties/ reactions	(2) AO1-1

Question number	Answer	Additional guidance	Mark
5(a)	number of protons = 17 (1) number of neutrons = 18 (1) number of electrons = 17 (1)	Accept ONLY whole numbers If no marks scored then maximum 1 mark for number of electrons = number of protons OR $p + n = 35$	(3) A01-1



Question number	Answer	Additional guidance	Mark
5(b)	empirical formula alone without working scores 0 silicon: $\frac{1.4}{28}$ and chlorine $\frac{7.1}{35.5}$ (1) or 0.05 and 0.2 simplest whole number ratio: 1 4 (1) empirical formula SiCl_4 / Cl_4Si (1)	allow ecf throughout <u>inverted division:</u> silicon: $\frac{28}{1.4}$ and chlorine $\frac{35.5}{7.1}$ (0) or 20 5 simplest whole number ratio: 4 1 (1) empirical formula Si_4Cl / ClSi_4 (1) <u>error in step 2:</u> MP1 still scores, MP2 (0), allow ecf for MP3 <u>division other relative atomic mass:</u> silicon: $\frac{1.4}{35.5}$ and chlorine $\frac{7.1}{28}$ (0) 0.0394 / 0.04 and 0.254 / 0.25 or 1 6.43 / 6.25 simplest whole number ratio: 5 / 4 32 / 25 (1) empirical formula $\text{Si}_5\text{Cl}_{32}$ / $\text{Si}_4\text{Cl}_{25}$ (1) <u>division by atomic number:</u> MP1 – 0, correctly calculated, can still score MP2 and MP3	(3) A02-1



Question number	Answer	Mark
5(c)	group = 4 (1) period = 3 (1)	(2) A03-1

Question number	Answer	Additional guidance	Mark
5(d)	A description to include any two from : • left gaps / incomplete (1) • fewer elements / not all elements discovered (1) • elements ordered by atomic mass (1) • no group 0 (/8/18)) / fewer groups (1) • no atomic numbers (1) • some elements in different positions (1) • names of some elements were different (1)	allow reverse arguments for modern periodic table for all these points, except: modern periodic table ordered by atomic number allow gaps left for undiscovered elements (on Mendeleev's table) (2)	(2) A01-1

Total for Question 5 = 10 marks



Question Number	Answer	Additional guidance	Mark
6(a)	SO ₂	allow O ₂ S reject SO ₂ , SO ²	(1) AO 2 1

Question Number	Answer	Additional guidance	Mark
6(b)(i)	hydrogen + oxygen → water	allow 2H ₂ + O ₂ → 2H ₂ O: this must be fully correct and balanced with correct subscripts reject 'hydrogen and oxygen', hydrogen oxide, hydrogen hydroxide if word and symbol equation given or mixture of symbols and words, ignore all symbols allow = for →	(1) AO 2 1

Question Number	Answer	Additional guidance	Mark
6(b)(ii)	B and D	For B allow SO ₂ For D allow CO ₂ reject answers containing any other letters/ names	(1) AO 3 2a

Question Number	Answer	Additional guidance	Mark
6(c)	An explanation including - plants (grow/ evolve etc.) (1) photosynthesis occurs (1)	allow trees or any other reference to plants reject respiration/breathing for MP2 ignore all other information	(2) AO 1 1

Question Number	Answer	Mark
6(d)	change in the amount of carbon dioxide in the atmosphere process causing the change increase decrease carbon dioxide absorbing the Sun's energy carbon dioxide dissolving in oceans volcanic emissions using argon in light bulbs burning hydrogen reject multiple lines from a box	(2) AO 1 1

Question Number	Answer	Additional guidance	Mark
6(e)(i)	suitable description of variation (within a year) (1)	allow increases and decreases / goes up and down [or vice-versa] allow fluctuates reject a pattern described for a timescale other than a year e.g. goes up one year and down the next	(1) AO 3 2a

Question Number	Answer	Additional guidance	Mark
6(e)(ii)	increases (over time) (1)	ignore from (number) to (number) allow positive correlation, trend etc.	(1) AO 3 2a

Question Number	Answer	Additional guidance	Mark
6(e)(iii)	15 with no working or correct working scores 2 figures read from graph 364-366 and 349-351 (1) subtraction of numbers from above (1)	negative answer does not score 2nd mark	(2) AO 2 1

(Total for Question 6 = 11 marks)

Question Number	Answer	Additional guidance	Mark
8(a)(i)	35	reject 35.5	(1) AO 1 1

Question Number	Answer	Additional guidance	Mark
8(a)(ii)	2.8.7	allow any separator including gaps e.g. 2 8 7 send to review any diagrams	(1) AO 1 1

Question Number	Answer	Additional guidance	Mark
8(b)	A description to include • (blue litmus) (first turns) red (1) • (then) bleaches / turns white (1)	allow shades of red and pink but not other colours e.g. red-purple allow colour disappears/goes colourless ignore yellow/ colour fades /discolours white then red = 0; just 'goes white' = 1	(2) AO 1 2

Question Number	Answer	Additional guidance	Mark
8(c)(i)	A description to include • shared electron(s) (1) • {a pair of / two} (electrons) (1)	allow a diagram for both mark points reference to ionic bonding/ions scores 0 e.g. gains two electrons = 0	(2) AO 1 1

Question Number	Answer	Additional guidance	Mark
8(c)(ii)	An explanation linking any two from - intermolecular forces / forces between molecules (1) (intermolecular) forces {weak / take little energy to break} / little energy to separate molecules (1) - boiling point is below room temperature / has a low boiling point (1)	if answer relates to the breaking of any type of bond first two marking points cannot be scored (but 3rd could) allow “attractions” instead of “forces”	(2) AO 1 1

Question Number	Answer	Additional guidance	Mark
8(d)	(the solution is) acid(ic) / contains {hydrogen ions/ H ⁺ }	allow pH < 7 allow hydrogen chloride is acidic If incorrect identity of acidic solution then 0 marks (e.g. chlorine is acidic = 0)	(1) AO 2 1

Question Number	Answer	Additional guidance	Mark
8(e)(i)	any value from 20 to 301	allow a range within these numbers e.g. 25 to 45 answer may be given in the table. if values are given on the answer line and the table mark only the answer on the answer line	(1) AO 1 1

Question Number	Answer	Additional guidance	Mark
8(e)(ii)	fluorine/ chlorine	reject iodine / astatine allow F/F₂/Cl/Cl₂	(1) AO 2 1

(Total for Question 8 = 11 marks)

Question number	Answer	Additional guidance	Mark
8(a)	Any two from (in modern model) - atoms are formed of sub-atomic particles (1) - atoms have a nucleus (1) - atoms contain protons (1) - atoms contain neutrons (1) - atoms contain (shells of) electrons (1) - atoms of same element can have different numbers of neutrons / isotopes exist (1)	allow (for Dalton's model) atoms are indivisible ignore statements that are simply the negative of those in the question reject each comparison with 'plum pudding model'	(2) AO1

Question number	Answer	Additional guidance	Mark
8(b)	molecular formula: C ₂ H ₄ (1) empirical formula: CH ₂ (1)	allow H ₄ C ₂ allow H ₂ C allow use of small letter / superscripts / non-subscripts	(2) AO2

Question number	Answer	Additional guidance	Mark
8(c)(i)	Cl ₂ (g) + H ₂ O(l) ⇌ HCl(aq) + HClO(aq) (3)	all three formulae (only) on correct sides of equation with no incorrect balancing (2) two formulae correct regardless of any other error (1) all three state symbols (1) Do not allow incorrect symbols or non subscripts eg CL ²	(3) AO2

Question number	Answer	Additional guidance	Mark
8(c)(ii)	H ⁺	if any other ions included 0 marks	(1) AO1

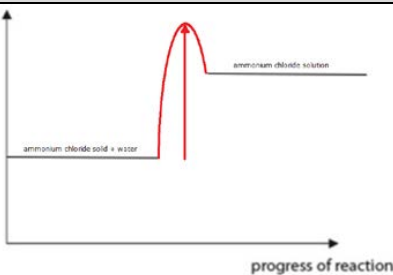
Question number	Answer	Additional guidance	Mark
8(c)(iii)	neutralisation	allow exothermic reject endothermic	(1) AO1

Question number	Answer	Additional guidance	Mark
8(c)(iv)	A description including any two from: - powder disappears (1) - effervescence/ bubbles/ fizzing (1) - blue solution forms (1)	allow dissolves	(2) AO2



Question number	Answer	Additional guidance	Mark
8(a)	46.25 / 46 with or without working scores 2 marks $\frac{200}{1000} (1) = 0.200 \text{ (dm}^3\text{)}$ $\frac{9.25}{0.200} (1) = 46.25 / 46$ OR $\frac{9.25}{200} = (0.04625) (1)$ $0.04625 \times 1000 = 46.25 (1)$	answer to 2 or more sig fig	(2) AO2

Question number	Answer	Additional guidance	Mark
8(b)(i)	an explanation linking two of: { ammonium chloride solution/product } has more energy than { ammonium chloride solid and water/reactant } / ORA (1) - heat (energy) has increased / energy change is positive (1) (therefore) heat energy has been { absorbed/taken in } (1)	ignore arguments about bond making / bond breaking	(2) AO3

Question number	Answer	Additional guidance	Mark
8(b)(ii)	heat energy ↑  (2)	curve from reactants to products with peak higher than product energy (1) arrow labelled activation energy on correct curve (1)	(2) AO2

Question number	Answer	Additional guidance	Mark
8(c)	An explanation linking - ammonium chloride solution conducts electricity and solid ammonium chloride does not conduct electricity (1) - ammonium chloride contains ions (1) - in solution ions can move / in solid ions cannot move (1)	Answer must refer to both solid and solution for full marks	(3) AO3

Question number	Answer	Mark
8(d)(i)	D  A is incorrect as it is the symbol for flammable substances. B is incorrect as it is the symbol for corrosive substances. C is incorrect as it is the symbol for substances that are harmful to health.	(1) AO1

Question number	Answer	Additional guidance	Mark
8(d)(ii)	use a fume cupboard	ignore wear PPE / masks ignore wear goggles / gloves	(1) AO1

Question number	Answer	Additional guidance	Mark
6(a)	12.56 with or without working scores 2 $\frac{3.14}{250}$ (1) (= 0.01256) 0.01256 x 1000 (1) (= 12.56) OR $\frac{250}{1000}$ (1) (= 0.250) $\frac{3.14}{0.250}$ (1) (= 12.56)	0.01256 / 0.0126 / 0.013 scores 1 ECF for MP2 final answer of: 12.6 scores 2 13 with working scores 2 200.96 scores 1 0.0796 scores 1 2.0096 x 10⁻⁴ scores 1 2.0096 x 10⁻⁷ scores 0	(2) A02-1

Question number	Answer	Additional guidance	Mark
6(b)(i)	solid (forms) / (goes) cloudy / {<u>solution/ liquid/ mixture</u>} will go colourless	ignore crystals ignore any colour given for solid ignore liquid changes colour / colour change ignore precipitate reject any answer including fizzing/ bubbles/ effervescence	(1) A02-2

Question number	Answer	Additional guidance	Mark
6(b)(ii)	$2\text{NaOH} + \text{CuSO}_4 \rightarrow \text{Cu(OH)}_2 + \text{Na}_2\text{SO}_4$	reject answer if numbers before any other substance	(1) A02-1

Question number	Answer	Additional guidance	Mark
6(b)(iii)	A description to include: • filter (1) • (residue is) rinsed / washed / has distilled water added (1) • leave in warm place / put in oven (1)	if heating with Bunsen to evaporate all water before filtration, score 0 for whole answer if heating to warm reaction mixture ignore if no filtering score 0 marks for whole answer allow leave for water to evaporate / pat dry (with filter paper/ paper towel) / leave on windowsill allow heat (with Bunsen) ignore just 'leave' / leave to dry ignore 'crystallisation'	(3) A02-2

Question number	Answer	Additional guidance	Mark
6(c)(i)	H ⁺ and Na ⁺ only circled		(1) A01-1

Question number	Answer	Additional guidance	Mark
6(c)(ii)	so that they do not react (with the electrolyte/sodium sulfate solution / products formed)	allow graphite is unreactive allow so they do not corrode	(1) A01-1

Question number	Answer	Additional guidance	Mark
6(c)(iii)	An explanation linking: electrons (1) - move (through graphite) / are {delocalised / free / sea of electrons} (1)	ignore 'charged particles' for MP1 but allow for MP2 reject ions for MP1 and MP2 'electrons in bonds/ electrons in outer shell' scores MP1 only MP2 depends on electrons or charged particles being mentioned ignore any other material about structure of graphite, correct or otherwise	(2) A01-1

Question number	Answer	Mark
4(a)(i)	D oxygen is the only correct answer A , B and C are incorrect because they are not required for corrosion to occur.	A01-1 (1)

Question number	Answer	Mark
4(a)(ii)	C the iron has been oxidised is the only correct answer A , B and D are incorrect because in corrosion the metal is oxidised.	A01-1 (1)

Question number	Answer	Additional guidance	Mark
4(b) Group B	162.5 with or without working scores 2 marks 56 + 35.5 + 35.5 + 35.5 (1) = 162.5 (1)	allow 91.5 scores 1 mark	A01-1 (2)

Question number	Answer	Additional guidance	Mark
4(c)(i)	carbon	allow C, c	A03-1 (1)

Question number	Answer	Additional guidance	Mark
4(c)(ii)	chromium	Allow Cr, cr, CR, cR	A03-1 (1)



Question number	Answer	Additional guidance	Mark
4(c)(iii) Group A	an explanation linking • paint / grease / coat with plastic (1) • prevents {oxygen / water} reaching the iron (1) OR • galvanising (1) • prevents {oxygen / water} reaching the iron / sacrificial protection / zinc is more reactive than iron (1) OR • sacrificial protection (1) • the more reactive metal corrodes instead of iron (1)	allow waterproof as an alternative for preventing water reaching the iron allow • electroplate / plate with another metal (1) • prevents {oxygen / water} reaching the iron (1)	A01-1 (2)

Question number	Answer	Additional guidance	Mark
4(d) Group A	a plan to include • put nails in boiling tubes with water (1) • leave for some time (1) • observe which nail forms rust {first / most}-(1)	if answers introduce further variables to one tube then MP1 cannot score. allow any idea of time passing – even if too short for corrosion allow colour change for rust	A03-3 (3)

Total for Question 4 = 11 marks

Question number	Answer	Additional guidance	Mark
6(a)	26.08 with or without working scores 2 marks $\frac{6.52}{250} = 0.02608 / 0.026 / 0.0261$ (1) [MP1] MP1 $\times 1000 = 26.08 / 26(.0) / 26.1$ (1)	allow ecf on all methods ignore 0.03 OR $\frac{1000}{250} = 4$ (1) $4 \times 6.52 = 26.08$ (1) OR $\frac{250}{1000} = 0.25$ (1) $\frac{6.52}{0.25} = 26.08$ (1)	(2) A02-1

Question number	Answer	Additional guidance	Mark
6(b)	A description to include any two for each substance copper hydroxide • filter (off the copper hydroxide) (1) • wash the copper hydroxide with distilled water (1) • dry the solid (1) sodium sulfate • pour {sodium sulfate solution /filtrate} into evaporating basin (1) • heat to evaporate water from solution (1) • dry the solid (1)	ignore sieve allow any suitable means of drying except heating allow 'crystallisation' allow any suitable means of drying eg leave on side to evaporate (1)	(4) AO2-2
Question number	Answer	Additional guidance	Mark
6(c)(i)	does not react / chemically stable (1) conducts (electricity) / a conductor (1)	allow inert (1) ignore cheap / not soluble	(2) AO1-1



Question number	Answer	Mark
6(c)(ii)	D SO_4^{2-} and OH^- ions is the only correct answer A is not correct as H^+ would be attracted to the negative electrode B is not correct as SO_4^{2-} and OH^- ions would be attracted to the positive electrode C is not correct as H^+ and Na^+ would be attracted to the negative electrode	(1) AO1-1

Question number	Answer	Additional guidance	Mark
6(c)(iii)	electrode product	do not award answers with more than one line from any of the boxes on the left	(2) AO1-1

Total for Question 6 = 11 marks



Question number	Answer	Additional guidance	Mark
8(a)(i)	2.8.8.1	allow any separator including gaps e.g. 2 8 8 1 send to review any diagrams	(1)

Question number	Answer	Mark
8(a)(ii)	B 19 (protons) 20 (neutrons) This is the only correct answer. A is incorrect because there are 20 neutrons in the ion C is incorrect because there are 19 protons and 20 neutrons D is incorrect because there are 19 protons in the ion	(1)

Question number	Answer	Additional guidance	Mark
8(b)	An explanation linking - outer (electron) shell (1) (both have) {same number / 1} electron(s) (1)	allow both lose 1 electron (to form ion / to form noble gas configuration) reject same number of outer shells / same number of electrons MP2 depends on MP1	(2)

Question number	Answer	Additional guidance	Mark
8(c)	An explanation linking (intermolecular) forces are weak (1) - little energy needed (to overcome forces) (1)	allow intermolecular bonds / weak bonds between molecules ignore needs a low temperature to break	(2)

Question number	Answer	Additional guidance	Mark
8(d)	$2\text{K (s)} + \text{F}_2\text{ (g)} \rightarrow 2\text{KF (s)}$ 2 K (1) 2 KF (1) s, s (1)	ignore words	(3)

Question number	Answer	Mark
8(e)	A alkali metals A is the only correct answer. B is incorrect because fullerenes are not a group in the periodic table C is incorrect because halogens are group 7 D is incorrect because noble gases are group 0	(1)

Question number	Answer	Mark
8(f)(i)	any value between 51 (°C) and 70 (°C)	(1)

Question number	Answer	Mark
8(f)(ii)	iodine and astatine	(1)

(Total for Question 8 = 12 marks)

Question number	Answer	Additional guidance	Mark
6(a)(i) Group B	any one of the following - shiny - high {melting / boiling} point - good conductor of {electricity / heat} - malleable / ductile - grey coloured	allow easily shaped / can be drawn into wires allow silver coloured ignore density / sonorous / solid ignore strength / strong / hard	AO1-1 (1)

Question number	Answer	Mark
6(a)(ii)	D strontium is the only correct answer A, B and C are incorrect because they are all in a different group to magnesium.	AO1-1 (1)

Question number	Answer	Mark
6(b)(i)	2.8.2	AO1-1 (1)

Question number	Answer	Additional guidance	Mark
6(b)(ii) Group B	an explanation linking any two of (chlorine has) 3 shells / 3 numbers in electronic configuration (1) (so) (chlorine is in) period 3 (1) - number of shells is the period number (1)	reject '3 outer shells' allow electron configuration diagram for 1 st mark	AO1-1 (2)

Question number	Answer	Additional guidance	Mark
6(c) Group B	MP1 for dividing by atomic mass Mg : Cl $\frac{1.20}{24.0}$: $\frac{3.55}{35.5}$ (1) MP2 for deriving ratio from MP1 0.05 : 0.1 OR 1 : 2 (1) MP3 for formula using ratio in MP2 MgCl₂ (1)	MgCl₂ without working scores 0 Allow ECF allow Mg $\frac{24.0}{1.20}$: Cl $\frac{35.5}{3.55}$ (0) 20 : 10 OR 2 : 1 (1) empirical formula Mg₂Cl (1) reject superscript numbers for MP3 only	A02-1 (3)
Question number	Answer	Additional guidance	Mark
6(d) Group B	A description to include ionic (max 2 marks) (electrostatic) force between (oppositely charged) ions / between anions and cations (2) covalent (max 2 marks) - atoms share a pair electrons (2)	other creditable responses (max 1 mark) including any one from: {ions / cations / anions} are charged particles - ionic bonds between metals and non-metals - electrons transferred (from metal to non-metal) - metals lose electrons / non-metals gain electrons reject electrons transferred from non-metal to metals other creditable responses (max 1 mark) including any one from: - covalent bonds are formed when electrons are shared - covalent bonds form molecules - covalent bonds between non-metals	A01-1 (4)

Total for Question 6 = 12 marks

Question Number	Answer	Additional guidance	Mark
9(a)	Na : O $\frac{0.92}{23} : \frac{0.32}{16}$ (1) 0.04 : 0.02 OR 2 : 1 (1) (empirical formula from ratio) Na₂O (1)	formula alone scores 0 2nd MP is either for working out correct number of moles OR for finding the correct ratio by dividing by the smaller number from an incorrect first step 3rd MP is for correctly converting a ratio to a formula with whole numbers only example $\frac{23}{0.92} : \frac{16}{0.32}$ 25 : 50 (0) 1 : 2 (1) NaO₂ (1)	(3) AO 2 1

Question Number	Answer	Additional guidance	Mark
9(b)	$2\text{Na(s)} + 2\text{H}_2\text{O(l)} \rightarrow 2\text{NaOH(aq)} + \text{H}_2\text{(g)}$ 2Na (1) 2NaOH (1) s, l, aq, g (1)	allow S, L, AQ, G ignore words	(3) AO 2 1

Question Number	Answer	Mark
9(c) (i)	C is the most reactive The only correct answer is C <i>A is not correct because this is irrelevant</i> <i>B is not correct because this is irrelevant</i> <i>D is not correct because this is irrelevant</i>	(1) AO 2 1

Question Number	Indicative content	Mark
*9(c)(ii)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Aspect one: METHOD • trough/large container of water • equal volumes of water for each experiment • remove metal from container with tongs • remove oil • cut small piece • add metal with tongs/tweezers etc. to water • teacher wears safety glasses • gloves • use of safety screen • class well back • class wear goggles ignore general safety ideas – hair tied back, lab coat etc. ignore equal sized pieces of metal Aspect 2: ANALYSIS • most vigorous effervescence of hydrogen with potassium and least with lithium • fastest movement with potassium and slowest with lithium • potassium is most reactive, then sodium, then lithium ignore copying of results from table e.g potassium bubbles very fast ignore writing up of results/ put in table etc	(6) AO 2 2 AO 3 1a AO 3 1b
Level	Descriptor	
	No rewardable material.	
Level 1	• Demonstrates elements of biological understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. • Presents an explanation with some structure and coherence.	
Level 2	• Demonstrates biological understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. • Presents an explanation that has a structure which is mostly clear, coherent and logical.	
Level 3	• Demonstrates accurate and relevant biological understanding throughout. Understanding of the scientific ideas is detailed and fully developed. • Presents an explanation that has a well-developed structure which is clear, coherent and logical.	

(Total for Question 9 = 13 marks)



Question number	Answer	Additional guidance	Mark
9(a)(i)	Left : H_2SO_4 (1) Right : CuSO_4 (1)	reject superscript numbers reject superscript numbers incorrect balancing max 1	(2)

Question number	Answer	Mark
9(a)(ii)	$63.5 + 12 + 3 \times 16$ (1) $= 123.5$ (1)	(2)

Question number	Answer	Mark
9(a)(iii)	A bubble the gas through limewater, limewater turns cloudy The only correct answer is A B is not correct because test shows only an acidic gas C is not correct because test shows only that the gas does not support combustion D is not correct because test shows only an acidic gas	(1)

Question number	Answer	Additional guidance	Mark
9(b)(i)	Any TWO from - no more bubbles / fizzing (1) - no further change in colour (1) {solid / copper carbonate} remains at bottom of flask / no more {solid / copper carbonate} dissolves (1)	ignore references to pH allow cloudy/opaque liquid ignore no more copper carbonate will react	(2)



Question number	Indicative content	Mark
*9(b)(ii)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. AO2 and A03 (6 marks) • filter mixture • using filter funnel and paper • collect filtrate / copper sulfate solution • in conical flask / suitable (named) container • pour into an evaporating basin • heat on water bath / on tripod over Bunsen • until half volume / concentrated / partially evaporated / crystals start to appear around the edge • remove from heat and cover with filter paper • allow to cool • and crystallise • separate crystals using a suitable method • put/place crystals onto absorbent/filter paper • dry in a warm place	(6)



Level	Mark	Additional Guidance	General additional guidance – the decision within levels Eg - At each level, as well as content, the scientific coherency of what is stated backed up by planning detail will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	<u>Additional guidance</u> Identifies relevant practical operations	<u>Possible candidate responses</u> - filter the mixture (alone) - allow solution to crystallise (alone) - filter mixture using filter paper - upper part of level
Level 2	3–4	<u>Additional guidance</u> Some correct sequencing of correct operations	<u>Possible candidate responses</u> - filter mixture and collect solution/liquid - evaporate solution and leave to cool - sequence with detail – upper part of level
Level 3	5–6	<u>Additional guidance</u> Sequence of operations to include two from filter to remove excess copper carbonate, crystallise (includes heating & cooling), separate crystals & dry	<u>Possible candidate responses</u> - filter mixture then cool and crystallise - evaporate/heat solution then allow to cool and crystallise - sequence with detail – upper part of level

Total for Question 9 = 13 marks

Question number	Answer	Mark
9(a)(i)	B 2.8 is the only correct answer A is incorrect as there are too few electrons C and D are incorrect as there are too many electrons	(1) A01-1

Question number	Answer	Additional guidance	Mark
9(a)(ii)	An explanation linking ions (in magnesium carbonate) {cannot move / in a fixed position / <u>held</u> in a lattice / <u>held</u> together by strong electrostatic forces} (1) - magnesium contains {delocalised/free} electrons (1) - electrons (in magnesium) can {flow / move} / are mobile (1)	ignore charged particles throughout allow magnesium carbonate does not have {delocalised / free} electrons reject references to covalent bonding in magnesium carbonate for MP1 allow sea of electrons ignore ions in magnesium ignore carry a {charge / current}	(3) A02-1

Question number	Answer	Additional guidance	Mark
9(b)	MP1 – relative formula mass MgCO_3 $24.0 + 12.0 + 3 \times 16.0$ (1) (= 84.0) MP2 – division $\frac{24(.0)}{84(.0)}$ (1) (= 0.28571429) MP3 – conversion to percentage $(0.28571429) \times 100$ (= 28.57 / 28.6 / 29) (1)	28.57 / 28.6 / 29 with or without working gains 3 marks. allow ECF for MP2 and MP3 must have 2 or more sig figs for MP2 e.g $M_r = 52$ (0) $\frac{24}{52} = 0.4615$ (1) $\times 100 = 46.2$ (1) MP3 - $\times 100$ mark only if using all 3 pieces of data in calculation allow any number of sig figs except 1 correctly rounded allow $\frac{84(.0)}{24(.0)} \times 100 = 350$ (2)	(3) A02-1

Question number	Indicative content	Mark
*9(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. AO1 (3 marks) AO3 (3 marks) magnesium carbonate • bubbles / fizzing / effervescence • magnesium carbonate gets smaller / disappears (allow 'dissolves') • metal carbonate + acid → metal salt + carbon dioxide + water • magnesium carbonate + sulfuric acid → magnesium sulfate + carbon dioxide + water • therefore, gas is carbon dioxide • test using limewater • limewater will turn cloudy magnesium • bubbles / fizzing / effervescence • metal gets smaller / disappears (allow 'dissolves') • gas is hydrogen • metal + acid → salt + hydrogen • test gas with a lit splint • (lit splint) burns with a squeaky pop • magnesium + sulfuric acid → magnesium sulfate + hydrogen Credit symbol equations. Incorrect/ incomplete equations could be partially credited for identifying product(s).	(6) AO1 AO3

Level	Mark	Descriptor
	0	• No rewardable material.
Level 1	1-2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) • Analyses the scientific information but understanding and connections are flawed. (AO3)
Level 2	3-4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. (AO3)
Level 3	5-6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Analyses the scientific information and provide logical connections between scientific enquiry, techniques and procedures throughout. (AO3)



Level	Mark	Descriptor	Possible candidate response
Read whole answer. Ignore all incorrect material and discard any contradictory material.			
	0	No rewardable material.	
Level 1	1–2	Candidate gives about one substance: brief description of observations / an observation and gas test / identification of two products for one reaction OR two bare facts about one or both substances	Possible candidate responses One / both bubble (1) Magnesium fizzes (1) Magnesium gives off hydrogen (1) Magnesium gives off hydrogen which gives a squeaky pop when lit (2) One correct word equation (2) Magnesium gives hydrogen and magnesium carbonate gives carbon dioxide (2) Test hydrogen: lit splint, squeaky pop; test carbon dioxide: limewater milky (2)
Level 2	3–4	Candidate gives about both substances: brief description of observations / an observation and gas test / the word equation OR Candidate gives about one substance: detailed description of observations with either gas test or the word equation	Possible candidate responses Magnesium gives hydrogen and magnesium carbonate gives carbon dioxide which turns limewater milky (3) Magnesium bubbles and disappears. The test for hydrogen is a lit splint which gives a squeaky pop. (3) Magnesium bubbles and disappears, the bubbles are hydrogen, the test for hydrogen is a lit splint which gives a squeaky pop. (4) magnesium produces hydrogen because metal + acid → salt + hydrogen, test hydrogen with lit splint which will give a squeaky pop (4) Two fully complete word equations (4)
Level 3	5–6	Candidate gives about both substances: at least two from: two observations gas test complete word equation OR a detailed description of observations with either gas test or the word	Possible candidate responses magnesium produces hydrogen and fizzes, magnesium + sulfuric acid → magnesium sulfate + hydrogen ; Magnesium carbonate produces carbon dioxide because it is a carbonate, so test the carbon dioxide with limewater and the limewater will turn cloudy (5) magnesium produces hydrogen and fizzes, magnesium + sulfuric acid → magnesium sulfate + hydrogen ; Magnesium carbonate disappears and

Question number	Answer	Additional guidance	Mark
9(a)	B effervescence is seen is the only correct answer. A, C and D are incorrect as they are not linked to gas production		(1) AO1 2

Question number	Answer	Mark
9(b)	B chlorine is the only correct answer. A, C and D are incorrect because only chlorine bleaches litmus	(1) AO1 1

Question number	Answer	Additional guidance	Mark
9(c)	2.20 with or without working scores (2) $5(.000) - 2.8(00) = 2.2(00)$ (1) $= 2.20$ (1)	reject additional processing for MP1 (e.g $5 - 2.8 = 2.2$ then $\frac{2.2}{100} = 0.0220$) does not score MP1 – additional process of dividing by 100 does not score MP2 - using a number not in the question for MP2 final answer must be to 3sf, correct evaluation of expression using only numbers from the question 2.2 / 2.200 scores 1 mark $\frac{5.000}{2.800} = 1.79$ scores 1 mark $\frac{2.800}{5.000} = 0.560$ scores 1 mark [0.56 = 0] $5.000 \times 2.800 = 14.0$ scores 1 mark [14 = 0] $5.000 + 2.800 = 7.80$ scores 1 mark [7.8 = 0]	(2) AO2 1

Question number	Answer	Additional guidance	Mark
9(d)(i)	An explanation linking: - it has two electrons in outer shell/ it has a full outer shell / OWTTE (1) - so does not {gain/ lose/ transfer/ share} electrons (1)	MP1 – reject if number of electrons in outer shell is stated and not 2 ignore references to protons and neutrons allow helium has two electrons in its (only) shell / helium's (only) shell is full ignore helium does not need to react	(2) AO1 1

Question number	Answer	Additional guidance	Mark
9(d)(ii)	less dense than air	allow less dense than nitrogen allow low density / not (very) dense allow diffuses slowly out of balloon ignore less dense than oxygen ignore it is a gas / light / lightweight / inert/ unreactive/ non-flammable / lighter than air / makes balloon float / it rises/ it floats ignore non-toxic / not poisonous	(1) AO2 1



Question number	Indicative content	Mark
*9(e)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. AO1 (6 marks) Natural: Origins: • {carbon dioxide / water / gases} from volcanoes • the Earth cooled • so water vapour condensed (to form oceans/seas) reducing amount of water vapour • carbon dioxide {dissolves in/absorbed by} the oceans reducing amount of carbon dioxide • some carbon dioxide incorporated into sea animals' shells Natural: Evolution • plants evolved • photosynthesis • photosynthesis releases oxygen increasing amount of oxygen • photosynthesis absorbs carbon dioxide reducing amount of carbon dioxide Human effects • amounts of carbon dioxide in recent time increasing due to burning fossil fuels • amounts of carbon dioxide in recent time increasing due to agriculture • deforestation means less carbon dioxide absorbed • reforestation means more oxygen produced	(6) AO1



Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of chemical knowledge, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3–4	• Demonstrates chemical knowledge, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	• Demonstrates accurate and relevant chemical knowledge throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)



Level	Mark	Descriptor	Additional Guidance
	0	No rewardable material.	Read whole answer and ignore all incorrect material/ discard any contradictory material then: Information directly copied from the table is not credited e.g water vapour goes down Water vapour has gone down (0) Humans respire giving carbon dioxide (0)
Level 1	1–2	<u>Additional Guidance</u> Candidate gives basic ideas only, these may or may not be linked	<u>Possible candidate response</u> Carbon dioxide is produced by volcanoes (1) Water vapour decreased because the earth cooled (1) Water vapour in the atmosphere condensed to form oceans (2) Trees photosynthesise and absorb carbon dioxide (2) Trees take in carbon dioxide and produce oxygen (2) Plants release oxygen, burning fossil fuels release carbon dioxide (2)
Level 2	3–4	<u>Additional Guidance</u> candidate gives basic idea about two areas. OR candidate gives a detailed explanation about one process	<u>Possible candidate response</u> Carbon dioxide is absorbed during photosynthesis by plants and burning fossils produces carbon dioxide (3) Trees photosynthesise which absorb carbon dioxide and release oxygen. The Earth cooled and water condensed to produce oceans, these oceans absorbed carbon dioxide (4) Trees photosynthesise which absorb carbon dioxide and release oxygen (3) Primitive plants evolved in oceans and started to photosynthesise which decreased the amount of carbon dioxide and increase the amount oxygen in the atmosphere. (4)
Level 3	5–6	<u>Additional Guidance</u> candidate explains ideas about all three areas	<u>Possible candidate response</u> Trees photosynthesise which absorb carbon dioxide and release oxygen. The Earth cooled and water condensed to produce oceans, these oceans absorbed carbon dioxide. Cars produce carbon dioxide (5) Trees photosynthesise which absorb carbon dioxide and release oxygen. The Earth cooled and water condensed to produce oceans, these oceans absorbed carbon dioxide. Burning fossil fuels produces carbon dioxide and deforestation has led to fewer trees and therefore less carbon dioxide being absorbed (6)



Question number	Answer	Mark
9(a)(i)	B 2.8 is the only correct answer A is incorrect as there are too few electrons C and D are incorrect as there are too many electrons	(1) A01-1

Question number	Answer	Additional guidance	Mark
9(a)(ii)	an explanation linking SOLID - is an (ionic) lattice / (ions are) held by strong (electrostatic) attractions (1) - so the ions {cannot move / are fixed / just vibrate} (1) SOLUTION - in solution the ions {can move / are free} (1)	allow giant structure / regular arrangement / regular structure for lattice allow atoms / (charged) particles in MP1 only ignore electrons for MP1 reject molecules / elements reject electrons allow liquid for solution reject electrons reject intermolecular forces	(3) A02-1

Question number	Answer	Additional guidance	Mark
9(b)	43(.4) with or without working scores 3 $2 \times 23 + 12 + 3 \times 16 = 106$ (1) $\frac{46}{106} = 0.4339622642$ (1) $0.4339622642 \times 100 = 43.4$ (1)	43.39622642 rounded correctly to 2 or more sig. fig. scores 3 if M_r incorrect, must show working to allow ecf on MP2 and MP3 $\frac{46}{\text{attempt of } M_r \text{ Na}_2\text{CO}_3}$ $\frac{23 \text{ or } 46}{\text{attempt of } M_r \text{ Na}_2\text{CO}_3} \times 100$ the following common answers with working are awarded 21.69811321 rounded correctly to 2 or more sig. fig. scores 2 76.6666667 rounded correctly to 2 or more sig. fig. scores 2 48.11320755 rounded correctly to 2 or more sig. fig. scores 1	(3) A02-1



Question number	Indicative content	Mark
9(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. AO1 (3 marks) AO3 (3 marks) • solid A is powdered zinc • metal + acid → metal salt + hydrogen • zinc + sulfuric acid → zinc sulfate + hydrogen • bubbles seen so gas is produced • does not turn limewater cloudy so gas is not carbon dioxide • test for hydrogen is lit splint • lit splint makes squeaky pop • so gas produced is hydrogen • solid B is copper oxide • metal oxide + acid → metal salt + water • copper oxide + sulfuric acid → copper sulfate + water • no gas is produced • copper oxide is black • some left in excess at bottom of test tube • copper sulfate solution is blue • solid C is sodium carbonate • metal carbonate + sulfuric acid → metal sulfate + carbon dioxide + water • sodium carbonate + sulfuric acid → metal sulfate + carbon dioxide + water • bubbles seen so gas is produced • test for carbon dioxide is limewater • limewater turned cloudy so gas produced is carbon dioxide • no reaction with lit splint • so no hydrogen gas produced	(6) AO1; AO3



Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	- The plan attempts to link knowledge and understanding of scientific enquiry, techniques and procedures, flawed or simplistic connections made between elements in the context of the question. (AO1) - Analyses the scientific information but understanding and connections are flawed. An incomplete plan that provides limited synthesis of understanding. (AO3)
Level 2	3–4	- The plan is mostly supported through linkage knowledge and understanding of scientific enquiry, techniques and procedures, some logical connections made between elements in the context of the question. (AO1) - Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. A partially completed plan that synthesises (AO3)
Level 3	5–6	- The plan is supported throughout by linkage knowledge and understanding of scientific enquiry, techniques and procedures, logical connections made between elements in the context of the question. (AO1) - Analyses the scientific information and provide logical connections between scientific concepts throughout. A well-developed plan that synthesises relevant understanding coherently. (AO3)



Level	Mark	Descriptor	Additional Guidance
	0	No rewardable material.	Read whole answer and ignore all incorrect material and any references to other metals / discard any contradictory material then:
Level 1	1–2	<u>Additional Guidance</u> Correctly identifies at least 1 solid or product Identifies product with correct test Gives at least 1 general observation Gives at least 1 general word equation Identifies all 3 substances	<u>Possible candidate response</u> (all examples, not a definitive list) solid A – zinc (1) reaction with solid A gives off hydrogen (1) limewater cloudy so is carbon dioxide (1) gas is released so must be bubbles (1) metal + acid → salt + hydrogen (2) solid A is zinc and the gas given off is hydrogen (2) A – zinc, B – copper oxide, C – sodium carbonate (2)
Level 2	3–4	<u>Additional Guidance</u> Correctly identifies at least 2 solids with at least one linked explanation Correctly identifies at least 1 solid and 1 product with at least one linked explanation Gives at least one correct word equation Identifies one solid with correct word equation Correctly identifies all 3 solids with linked explanations for just 1 solid	<u>Possible candidate response</u> solid A is zinc and solid B is copper oxide. Copper oxide is black (3) solid C is sodium carbonate as carbon dioxide turned limewater cloudy (3) solid B is copper oxide, which is black. It produces copper sulfate, which is blue (4) zinc + sulfuric acid → zinc sulfate and hydrogen (3) Solid B: copper oxide + sulfuric acid → copper sulfate + water (4) A – zinc, B – copper oxide, C – sodium carbonate; and hydrogen is produced when zinc reacts with an acid as zinc is a metal (4)
Level 3	5–6	<u>Additional Guidance</u> Correctly identifies 2/3 solids with linked explanations for at least two Fully identifies one solid with all products and a linked explanation Identifies all 3 solids backed by relevant information	<u>Possible candidate response</u> solid A is zinc as hydrogen is produced. Solid B is copper oxide as it is black. (5) Solid B: copper oxide + sulfuric acid → copper sulfate (blue solution) + water (5) solid A is zinc because hydrogen is produced. Solid B is copper oxide, which forms blue copper sulfate solution. Solid C is sodium carbonate as it is the only solid that could produce carbon dioxide (6)

Total for Question 9 = 13 marks



Question number	Answer	Additional guidance	Mark	
8(a)(i)			(3) AO1-1	
	proton	+1 (1)		1
	neutron	0		1 (1)
	electron	-1 (1)		negligible
		allow 1(+) / +, reject -1		
		reject +1, -1		
		allow (1)-, reject +1 / 1		

Question number	Answer	Additional guidance	Mark
8(a)(ii)	A description including 10 protons (1) 10 electrons (1)	allow {'how many' / 'number of'} protons allow {'how many' / 'number of'} electrons / (electronic configuration) 2.8 allow 'number of protons and (number of) electrons' (2) ignore any reference to location of subatomic particles ignore neutrons	(2) AO1-1

Question number	Answer	Additional guidance	Mark
8(a)(iii)	An explanation linking <u>same number</u> of protons and electrons (1) (so) the (+ and -) <u>charges</u> cancel (1)	ignore reference to neutrons allow <u>charge</u> (on neon atom) = <u>0</u> +10 plus -10 = 0 (2)	(2) AO2-1



Question number	Indicative content	Mark
*8(b)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive, and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. Read whole answer and ignore all incorrect material/ discard any contradictory material. Ignore irrelevant material not linked to electrons e.g metals on left, non-metals on right; change in reactivity down a group; periodic table arranged in order of atomic number; groups based on similar chemical properties Allow row for period, allow column for group. AO1 (6 marks) • number of electrons increases • from left to right / Li to Ne • down the group / Li to Na / symbols for elements in other groups • {first 2 elements / H & He} electrons in 1st shell • {elements 3-10 / Li to Ne} added electron in 2nd shell • {next 2 elements / Na & Mg} outer electrons in 3rd shell • more electrons need more electron shells • so no of shells = period number • no of electrons in outer shell = group no • examples of electronic configurations of elements	(6)

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • Presents an explanation with some structure and coherence. (AO1)
Level 2	3–4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

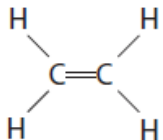


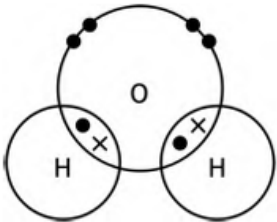
Level	Mark	Descriptor	Additional Guidance
	0	No rewardable material.	
Level 1	1–2	Additional Guidance Describes some information about the periodic table	Possible candidate response - the atomic number gives the number of electrons (1) - the electronic configuration of magnesium is 2.8.2 (1) - the group number gives the number of electrons in the outer shell (1) - the period number gives then number of shells of electrons (1) - sodium is in group 1 because it has 1 electron in its outer shell (2) - all group 1 elements have 1 outer electron (1)
Level 2	3–4	Additional Guidance A full explanation linking group to outer electron with example AND attempt to link period to number of shells OR A full explanation linking period to number of shells with example AND attempt to link group to number of electrons in outer shell	Possible candidate response - The number of electrons in the outer shell is the group, so group 1 elements such as have 1 electron in their outer shell (3) - The number of electrons in the outer shell is the group, so lithium has 1 electron in their outer shell (3) - The number of electrons in the outer shell is the group, so group 1 elements such as have 1 electron in their outer shell and the period number is the number of shells (4) - The number of shells of electrons is the period number for example lithium is period 2 because it has 2 shells (3) - The number of shells of electrons is the period number for example period 3 elements have 3 shells (3) - The number of shells of electrons is the period number for example period 3 elements have 3 shells and the number of outer electrons gives the group number. (4)
Level 3	5–6	Additional Guidance A full explanation linking group to outer electron with example AND a full explanation linking period to number of shells with example AND example of an electronic configuration	Possible candidate response - The number of electrons in the outer shell is the group, so group 1 elements such as have 1 electron in their outer shell. The number of shells of electrons is the period number for example period 3 elements have 3 shells and the number of outer electrons (5) - The number of electrons in the outer shell is the group, so group 1 elements such as have 1 electron in their outer shell. The number of shells of electrons is the period number for example period 3 elements have 3 shells and the number of outer electrons gives the group number so the electronic configuration of potassium is 2.8.1 (6)

Total for Question 8 = 13 marks



Question number	Answer	Additional guidance	Mark
9(a)(i)	alkane(s)	ignore saturated hydrocarbons reject alkenes reject unsaturated hydrocarbons	AO1 1 (1)

Question number	Answer	Mark
9(a)(ii)	B  is the only correct answer A, C and D are not correct because they are not hydrocarbons	AO2 1 (1)

Question number	Answer	Additional guidance	Mark
9(b)	 a shared pair of electrons (1) rest of molecule correct including correct atomic symbols, if given (1)	allow all dots / all crosses allow unlabelled atoms ignore inner electrons even if incorrect if no circles present, atomic symbols must be present ignore double / triple bonds MP2 depends on MP1	AO1 1 (2)

Question number	Answer	Additional guidance	Mark
9(c)	CH₄ without working (0) carbon $\frac{0.96}{12}$ (= 0.08) and hydrogen $\frac{0.32}{1}$ (= 0.32) (1) simplest whole number ratio 1 : 4 (1) empirical formula CH₄ (1)	marks awarded for working using the masses from the question MP2 for MP1 converted to simplest whole number ratio MP3 for whole number ratio from MP2 correctly converted to formula allow C₁H₄ / CH₄ (3 with working) allow C₄H / C₄H₁ (2 with working, scores MP2 and 3 only)	A02 1 (3)



Question number	Indicative content	Mark
*9(d)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. AO1 (6 marks) PROPERTY DIFFERENCES - boiling point of kerosene is lower (than fuel oil) - viscosity of kerosene is lower (than fuel oil) - ease of ignition of kerosene is greater (than fuel oil) - kerosene is more volatile / more flammable - kerosene is lighter in colour (than fuel oil) - kerosene burns with cleaner flame (than fuel oil) USES - kerosene used as jet fuel / in lamps / cooking etc. - fuel oil used as fuel for ships / power stations etc. CRACKING - process is known as cracking - using high temperature - and catalyst (of aluminium oxide / ceramic) - fewer carbon and hydrogen atoms in a molecule of kerosene - long chain hydrocarbons (fuel oil) broken into shorter chains (kerosene) - cracking also produces alkenes	AO1 1 (6)



Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) • Presents a description which is not logically ordered and with significant gaps. (AO1)
Level 2	3–4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5–6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)



Level	Mark	Descriptor	Additional Guidance
	0	No rewardable material.	Read whole answer and ignore all incorrect material/ discard any contradictory material then:
Level 1	1–2	<u>Additional Guidance</u> Full description of one aspect OR Description of two aspects	<u>Possible candidate response</u> - Fuel oil is more viscous than kerosene (1) - Fuel oil has a higher boiling point and viscosity (2) - Fuel oil is used in ships and kerosene is used in planes (2) - Fuel oil is heated with a catalyst to form kerosene (2) - Kerosene has low bpt and fuel oil high bpt (1) - Kerosene is used as jet fuel and is easier to ignite than fuel oil (2) - Kerosene and fuel oil are fuels (1) - Kerosene is a fuel (0)
Level 2	3–4	<u>Additional Guidance</u> Full description of two aspects OR Full description of one aspect AND description of other two aspects	<u>Possible candidate response</u> - Fuel oil is cracked by passing it over a catalyst to form kerosene. Kerosene is then used as jet fuel (3) - Fuel oil is a fuel in ships and kerosene in aeroplanes. Fuel oil is harder to ignite and is more viscous (4) - Kerosene is used in planes and fuel oil is used in ships. Fuel oil has a higher boiling point than kerosene, and can be cracked (4)
Level 3	5–6	<u>Additional Guidance</u> Full description of three aspects	<u>Possible candidate response</u> - Fuel oil is a fuel in ships and kerosene in aeroplanes. Fuel oil is harder to ignite and is more viscous. Fuel oil can be converted to kerosene using cracking (5) - Fuel oil is a fuel in ships and kerosene in aeroplanes. Fuel oil is harder to ignite and is more viscous. Fuel oil can be converted to kerosene using cracking with a catalyst (6)

Total for Question 9 = 13 marks

