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GCSE (9–1) Chemistry B (Twenty First Century Science)

J258/01 Breadth in Chemistry (Foundation Tier)

Thursday 17 May 2018 – Morning

Time allowed: 1 hour 45 minutes

7030025614

You must have:
- the Data Sheet (for GCSE Chemistry B (inserted))
- a ruler (cm/mm)

You may use:
- a scientific or graphical calculator
- an HB pencil

J258 01

First name									
Last name									
Centre number						Candidate number				

INSTRUCTIONS
- The Data Sheet will be found inside this document.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- This document consists of **24** pages.

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PLEASE DO NOT WRITE ON THIS PAGE

Answer **all** the questions.

1 The greenhouse effect keeps the Earth warm so that life can survive.

(a) Carbon dioxide and water vapour are greenhouse gases.

Which gas in the list below is also a greenhouse gas?

Tick (✓) **one** box.

Hydrogen ☐

Methane ☐

Nitrogen ☐

Oxygen ☐

[1]

(b) This table shows the average surface temperature increase of the Earth since 1952.

Year	Temperature Increase since 1952 (°C)
1952	0.00
1962	0.05
1972	0.00
1982	0.14
1992	0.22
2002	0.62
2012	0.62

(i) Describe how the Earth's temperature has increased since 1952.

.....

..... **[1]**

(ii) Roughly how many times greater was the temperature increase in 2002 compared to the temperature increase in 1962?

Tick (✓) **one** box.

0.6 ☐

1.2 ☐

12 ☐

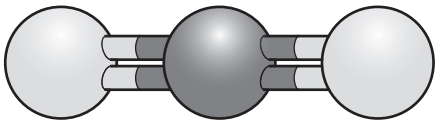
60 ☐

[1]

(c) Here is a model of a molecule of carbon dioxide.

Draw lines to link parts of this model to the correct labels.

Some of the labels are incorrect.



Carbon dioxide

Carbon atom

Double bond

Hydrogen atom

Ionic bond

Oxygen atom

[3]

2 'Sherbet' is a powder that fizzes on your tongue. This happens because the powder reacts with water.

(a) Beth thinks that the reaction between sherbet and water is endothermic.

She does an experiment to find out if she is right.

Describe what she does.

What result will she get if the reaction is endothermic?

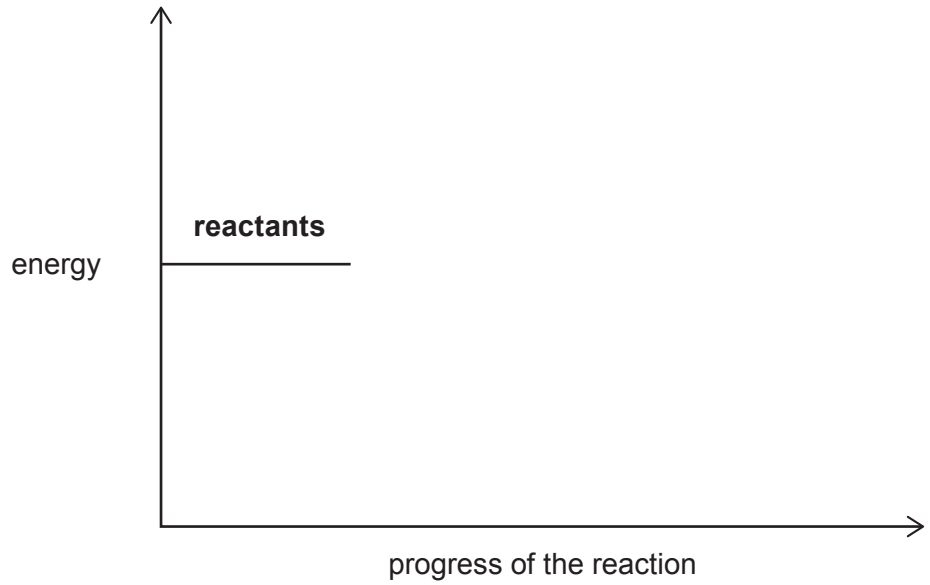
.....

.....

..... **[2]**

(b) Complete the reaction profile for an **endothermic** reaction.

Label your diagram with these words: **products**, **activation energy**



[3]

3 Some farmers use manure from cows as a natural fertiliser. Other farmers use ammonium sulfate as a synthetic fertiliser.

(a) (i) The formula of ammonium sulfate is $(NH_4)_2SO_4$.

Which elements does ammonium sulfate contain?

Tick (✓) **four** boxes.

Ammonia	☐
Hydrogen	☐
Nitrogen	☐
Oxygen	☐
Sodium	☐
Sulfur	☐

[1]

(ii) Plants need one of the elements in ammonium sulfate to grow faster.

Write down the name of this element.

..... **[1]**

(b) Farmers can choose manure or ammonium sulfate as a fertiliser.

Farmers need to consider the cost of the fertiliser.

(i) Suggest **one** reason, **other than cost**, why some farmers use manure rather than ammonium sulfate as a fertiliser.

.....

..... **[1]**

(ii) Suggest **one** reason, **other than cost**, why some farmers use ammonium sulfate rather than manure as a fertiliser.

.....

..... **[1]**

(c) Alex has a solution of ammonium sulfate.

(i) Alex uses barium chloride solution to show that the solution contains sulfate ions.

Describe what Alex sees **and** name the substance formed.

Alex sees .....

.....

Name of substance formed .....

[3]

(ii) Alex wants to make **solid** ammonium sulfate from the solution of ammonium sulfate.

What would Alex do first?

Tick (✓) **one** box.

- Distil the solution. ☐
- Evaporate the solution. ☐
- Filter the solution. ☐
- Use chromatography. ☐

[1]

(d) 132 g of ammonium sulfate contain 28 g of nitrogen.

Calculate the mass of nitrogen in **1.0 kg** of ammonium sulfate.

Give your answer in kg and to **2** decimal places.

Mass = ... kg **[3]**

4 Amir investigates the halogens.

Table 4.1 shows some information about the halogens.

(a) Complete **Table 4.1** by filling in the missing information.

	Chlorine	**Bromine**	**Iodine**
Appearance and state at room temperature and pressure	yellow-green gas		grey solid
Colour as a gas	yellow-green	red-brown	
Product when reacted with sodium		NaBr	NaI

Table 4.1

[3]

(b) Amir reacts some chlorine solution with a solution of potassium bromide.

The solution turns brown.

(i) Complete **word** and **chemical** equations for the reaction that happens.

chlorine + potassium bromide → ..... + bromine

Cl_2 + 2 ..... → 2KCl + Br_2

[2]

(ii) Use the equations in **(b)(i)** to explain why the solution turns brown.

.....

..... **[1]**

5 **Table 5.1** shows some data for four elements **Q**, **R**, **T** and **X**.

Element	Melting point (°C)	Boiling point (°C)	Electrical conductivity when solid	Reactivity
Q	−189	−186	none	unreactive
R	98	883	good	very reactive
T	−101	−35	none	very reactive
X	119	445	none	fairly reactive

Table 5.1

(a) Which element in **Table 5.1** is a metal?

Explain your answer.

Element .....

Explanation .....

..... **[1]**

(b) Which element in **Table 5.1** is a liquid at 500 °C? ..... **[1]**

(c) Which element in **Table 5.1** has an atom with eight electrons in its outer shell?

Explain your answer.

Element .....

Explanation .....

..... **[2]**

(d) Element **T** in **Table 5.1** reacts with a metal to make a compound.

What type of structure does this compound have?

Tick (✓) **one** box.

Giant covalent ☐

Giant ionic ☐

Simple covalent ☐

[1]

(e) An element has an atomic number of 16.

How many electrons are there in an atom of this element?

..... **[1]**

6 A factory electrolyses sodium chloride solution to make useful products.

(a) The electrolysis produces chlorine.

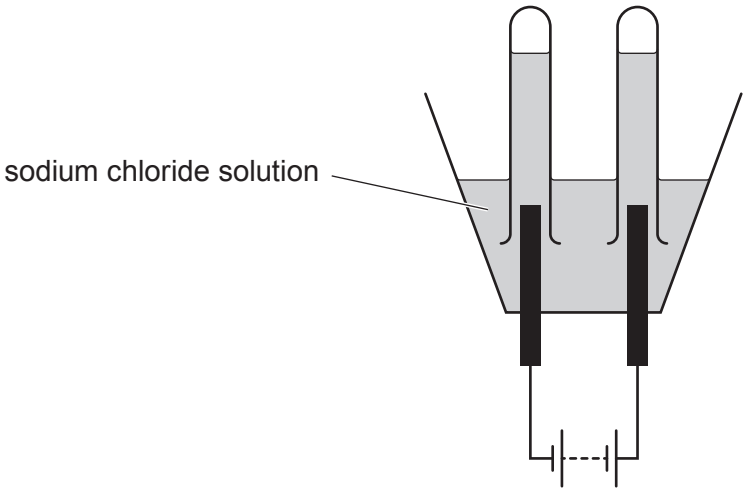
Complete the sentence by putting a (ring) around one word in each pair.

The **chlorine / chloride** ions are attracted to the **positive / negative** electrode, where they lose **electrons / protons**.

[3]

(b) Nina electrolyses a solution of sodium chloride.

She uses this apparatus.



Nina thinks that the experiment makes chlorine gas at one electrode.

She is not sure if the gas at the other electrode is hydrogen or oxygen.

Describe the tests Nina can do to identify chlorine, hydrogen and oxygen **and** the results she should expect.

Chlorine .....

.....

Hydrogen .....

.....

Oxygen .....

.....

[3]

7 Manganese is a metallic element. It is mixed with iron to make an alloy.

(a) Manganese is made by heating manganese oxide with carbon.

(i) Write a **word** equation for this reaction.

..... **[1]**

(ii) Aluminium **cannot** be made by heating aluminium oxide with carbon.

Which of the statements below are **true** and which are **false**?

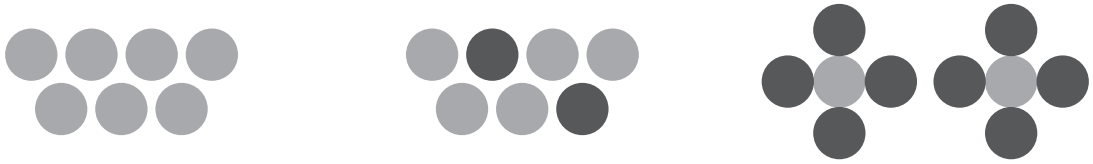
Put a tick (✓) in one box in **each** row.

	True	False
Carbon is more reactive than aluminium.		
Carbon reduces manganese oxide.		
Aluminium is more reactive than manganese.		
Carbon reduces aluminium oxide.		

[4]

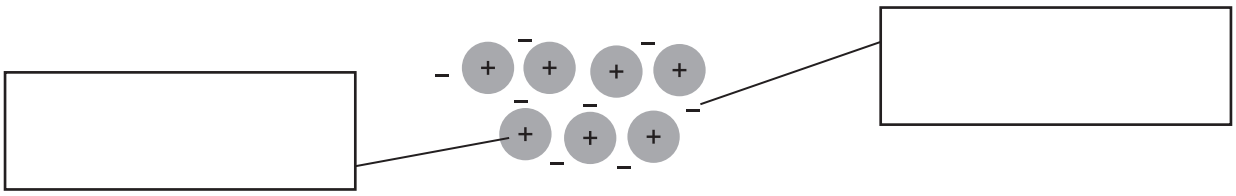
(b) **(i)** Which model is an alloy?

Put a (ring) around the correct answer.



[1]

(ii) Label the diagram below to describe metallic bonding.



[1]

8 Milk of magnesia cures indigestion.

It neutralises acid in the stomach.

Milk of magnesia is a mixture of magnesium hydroxide and water.

The formula of magnesium hydroxide is $Mg(OH)_2$.

(a) Complete the equation for neutralisation.

$$H^+ + \text{.....} \rightarrow H_2O$$

[1]

(b) Kai buys two bottles of milk of magnesia, called **Gutcalm** and **Milkomag**.

He has a solution of hydrochloric acid.

He finds out how much acid is needed to neutralise 25 cm^3 from each bottle.

Here are Kai's results.

	Medicine	
	Gutcalm	**Milkomag**
Cost of a 250 cm^3 bottle	£1.75	£1.50
Volume of acid needed to neutralise 25.0 cm^3	24.0 cm^3	21.0 cm^3

(i) Which medicine gives the best value for money for neutralising acid?

[2]

(ii) Kai measures the 25 cm^3 of milk of magnesia using a beaker.

What could he do to measure the volume **more** accurately?

Tick (✓) **one** box.

Use a volumetric pipette. ☐

Use a conical flask. ☐

Use a large measuring cylinder. ☐

Use a gas syringe. ☐

[1]

9 **Table 9.1** shows the properties of three polymers.

Polymer	Relative breaking strength	Flexibility	Temperature at which it softens (°C)	Cost
A	very high	fairly flexible	250	very high
B	low	very flexible	70	low
C	fairly low	stiff	150	low

Table 9.1

(a) A company wants to make cups to hold boiling water.

Which polymer, **A**, **B** or **C**, should the company choose?

Give **two** reasons for your choice using the information in **Table 9.1**.

Polymer .....

Reason 1 .....

Reason 2 ..... **[2]**

(b) Which of polymers, **A**, **B** and **C**, has the **weakest** intermolecular forces?

Give a reason for your answer.

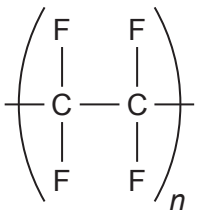
Polymer .....

Reason .....

..... **[2]**

(c) Polymer **A** is an addition polymer.

Draw the structure of the monomer that forms polymer **A**.

Repeating unit of polymer A	Structure of monomer
	

[1]

10 Some fractions from crude oil are cracked to give ethene, C_2H_4.

(a) Which homologous series is ethene a member of?

Tick (✓) **one** box.

Alcohols	☐
Alkanes	☐
Alkenes	☐
Carboxylic acids	☐

[1]

(b) Some fractions from crude oil are used as fuels.

Some fractions are used as a feedstock to make chemicals like ethene.

In the future, more crude oil will be used as a feedstock and less will be used as a fuel.

Give **two** reasons for this.

1 .....

.....

2 .....

.....

[2]

(c) Compound **A** is a hydrocarbon in crude oil.

This equation shows the ratio of carbon atoms to hydrogen atoms in some hydrocarbons.

$$\frac{\text{number of carbon atoms}}{\text{number of hydrogen atoms}} = \frac{1}{3}$$

(i) The empirical formula of compound **A** is CH_3.

Does this formula agree with the equation?

Explain your answer.

..... **[1]**

(ii) Explain why CH_3 **cannot** be the molecular formula of compound **A**.

.....

..... **[1]**

(iii) Another hydrocarbon has a formula which fits the equation.

The formula has two carbon atoms.

Draw a fully displayed formula for this hydrocarbon.

[1]

11 Nanoparticles of cerium oxide, CeO_2, are added to diesel fuel.

(a) What is the size of a nanoparticle?

Tick (✓) **one** box.

0.1 nm	☐
10 nm	☐
150 nm	☐
1000 nm	☐

[1]

(b) Cerium oxide is a very expensive solid.

The cerium oxide nanoparticles act as a catalyst.
They help the fuel to burn completely so that less pollutant gases are formed.

Nanoparticles have a much higher surface area to volume ratio than solids.

Explain the advantages of using cerium oxide in the form of nanoparticles rather than as a solid.

.....

.....

..... **[2]**

(c) Diesel is a fossil fuel.

Name **two** pollutants caused by the incomplete combustion of fossil fuels.

1 .....

2 .....

[2]

(d) (i) CeO_2 contains O^{2-} ions.

What is the charge on the cerium ion?

Put a (ring) around the correct answer.

1+ **2+** **3+** **4+** **5+** **6+**

[1]

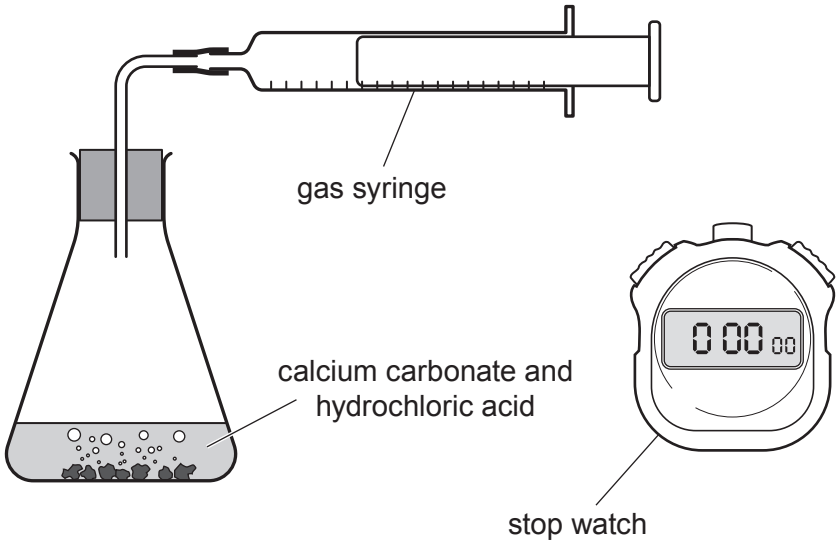
(ii) 160 g of CeO_2 contains 30 g of oxygen.

Calculate the percentage of **cerium** in CeO_2.

Percentage of cerium = ... % **[3]**

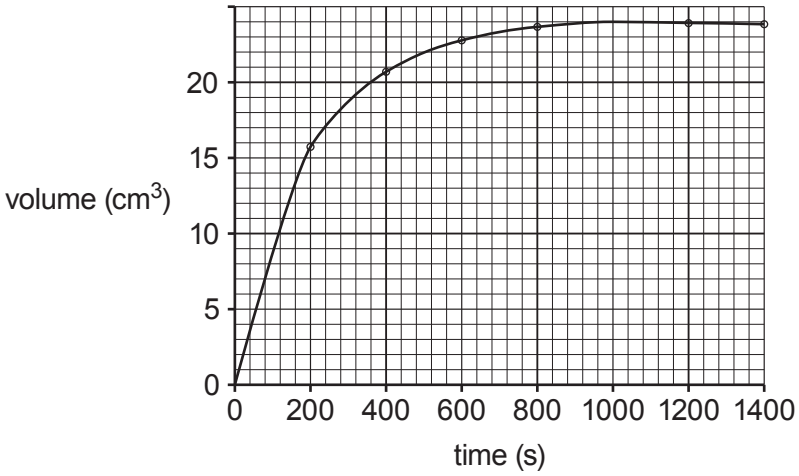
12 Calcium carbonate reacts with excess hydrochloric acid to make carbon dioxide.

Here is the apparatus Jack uses to investigate the reaction.



Jack records the volume of carbon dioxide made every 200 seconds.

Here is a graph of his results.



(a) Use the graph to calculate the rate of reaction over the first 100 s.

Rate = ... cm^3 / s **[2]**

(b) Amaya wants to repeat Jack's experiment.

She uses the same mass of calcium carbonate.

She uses the same volume and concentration of hydrochloric acid.

Which **two** other factors does she need to keep the same?

1 .....

2 .....

[2]

(c) Jack repeats his experiment with more concentrated hydrochloric acid.

He keeps **all** other factors the same. The rate of reaction is faster.

Explain why.

Write about particles in your answer.

.....

.....

..... **[2]**

(d) 0.10 g of calcium carbonate makes 24 cm^3 of carbon dioxide.

Jack uses 0.070 g of calcium carbonate.

What volume of carbon dioxide does he make?

Give your answer to **2** significant figures.

Volume = ... cm^3 **[3]**

13 Fizzy water can be found naturally.

The water is fizzy because it contains dissolved carbon dioxide gas. The carbon dioxide comes from the decomposition of rocks that contain carbonate compounds.

One compound found in rocks is magnesium carbonate.

Ali investigates the decomposition of magnesium carbonate by heating a small amount in a test tube. This is the equation for the reaction.

$MgCO_3(s) \longrightarrow MgO(s) + CO_2(g)$

(a) Ali weighs the test tube before and after heating.

The mass of the test tube after heating is less.

Ali says that this means the **law of conservation of mass** is not correct.

Explain why Ali is **wrong**.

.....

.....

..... **[2]**

(b) Calculate the atom economy for the production of carbon dioxide in this reaction.

Use the formula: atom economy = $\frac{\text{mass of atoms in desired product}}{\text{total mass of atoms in reactants}} \times 100\ \%$

Give your answer to **1** decimal place.

Atom economy = ... % **[4]**

(c) In theory, 42.0 g of $MgCO_3$ loses 22.0 g of carbon dioxide when it completely decomposes.

Ali heats 4.2 g of $MgCO_3$.

(i) Calculate the mass of carbon dioxide lost when 4.2 g of $MgCO_3$ completely decomposes.

Mass = ... g **[1]**

(ii) In Ali's experiment, the mass of carbon dioxide lost is 1.8 g.

Calculate the percentage yield of carbon dioxide in Ali's experiment.

Percentage yield = ... % **[1]**

(d) Magnesium oxide, MgO, is an ionic compound.

Draw a 'dot and cross' diagram for the ions in magnesium oxide.

Show the outer electron shells only.

[2]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).