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Thursday 16 May 2019 – Morning

GCSE (9–1) Combined Science (Chemistry) A (Gateway Science)

J250/03 Paper 3 (Foundation Tier)

Time allowed: 1 hour 10 minutes

7708736562

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

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

J250003

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- The Data Sheet will be found inside this document.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **20** pages.

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SECTION A

Answer **all** the questions.

You should spend a maximum of 20 minutes on this section.

Write your answer to each question in the box provided.

1 Which of these processes is an example of a **physical** change?

A Combustion

B Freezing

C Neutralisation

D Oxidation

Your answer ☐ **[1]**

2 The equation shows the reaction of sodium with water.

Sodium hydroxide and hydrogen are made.

Two of the **state symbols** are missing.

$2Na(s) + 2H_2O..... \rightarrow 2NaOH(aq) + H_2.....$

What are the missing state symbols?

A (l), (l)

B (s), (g)

C (aq), (g)

D (l), (g)

Your answer ☐ **[1]**

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3 A student tests which gas is produced in a reaction using a glowing splint. The gas re-lights the glowing splint.

What is the name of the gas?

A Carbon dioxide

B Chlorine

C Hydrogen

D Oxygen

Your answer ☐ **[1]**

4 What is the **relative formula mass** of sulfuric acid, H_2SO_4?

The relative atomic mass, A_r, of H is 1.0, of S is 32.1 and of O is 16.0.

A 49.1

B 81.2

C 98.1

D 129.2

Your answer ☐ **[1]**

5 Na^+ is a **positively** charged ion.

What is the name given to a positively charged ion?

A Anion

B Cathode

C Cation

D Electrolyte

Your answer ☐ **[1]**

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6 Fluorine is in Group 7 of the Periodic Table.

Which statement best describes fluorine?

A It has a full outer shell of electrons

B It is a metal

C It is a non-metal

D It is a solid at room temperature and pressure

Your answer ☐ **[1]**

7 Calcium carbonate, $CaCO_3$, decomposes when heated. Calcium oxide, CaO, and carbon dioxide, CO_2, are made.

Look at the equation for the reaction.

$CaCO_3 \rightarrow CaO + CO_2$

In an experiment, 20.0 g of $CaCO_3$ are used. 11.2 g of CaO are made.

What is the mass of CO_2 made?

A 8.8 g

B 11.2 g

C 20.0 g

D 31.2 g

Your answer ☐ **[1]**

8 The molecular formula of a compound is $C_{12}H_{26}$.

What is its **empirical formula**?

A C_2H_4

B C_2H_6

C C_4H_6

D C_6H_{13}

Your answer ☐ **[1]**

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9 Phosphorus sulfide, P_4S_3, has a relative formula mass of 220.3.

What is the percentage, by mass, of phosphorus in P_4S_3?

Use the Periodic Table to help you.

A 6.8

B 14.1

C 27.2

D 56.3

Your answer ☐ **[1]**

10 Which statement best describes an atom?

A The nucleus is small compared to the atom and contains little of the atom's mass.

B The nucleus is large compared to the atom and contains little of the atom's mass.

C The nucleus is small compared to the atom and contains most of the atom's mass.

D The nucleus is large compared to the atom and contains most of the atom's mass.

Your answer ☐ **[1]**

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SECTION B

Answer **all** the questions.

11 Atoms are made of particles called protons, neutrons and electrons.

(a) Complete the table to show the **relative charges** of protons, neutrons and electrons.

Particle	Relative charge
Proton	.....
Neutron	0
Electron	.....

[2]

(b) Sodium is a metal in the Periodic Table.

(i) Use the Periodic Table to work out the following:

The **relative atomic mass** of sodium = ...

The number of **protons** in an atom of sodium = ...

The number of **electrons** in an atom of sodium = ...

[3]

(ii) Sodium is an example of an atom that can form an ion.

Describe what happens to a sodium atom when it becomes an ion.

.....

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

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(c) Look at this statement about the Periodic Table.

'Atoms are placed in groups according to the total number of electrons they have.'

Explain why this statement is incorrect.

.....

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

(d) A new element has been discovered and has these properties:

- a high melting point
- reacts with oxygen to form oxides
- conducts electricity
- solid at room temperature.

Suggest what type of **bonding** the new element has.

Explain your answer.

Type of bonding .....

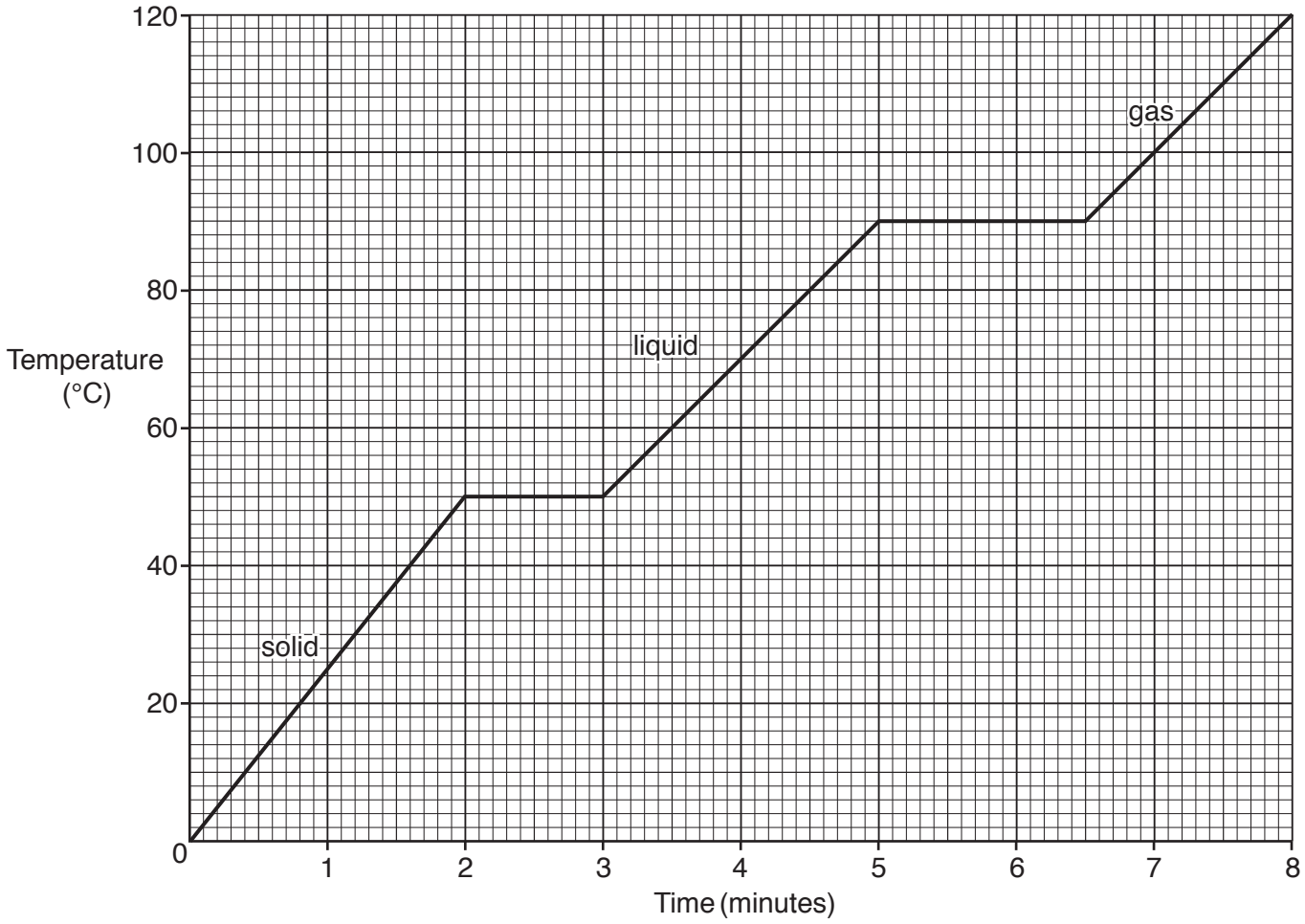
Explanation .....

.....

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

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12 Look at the graph. It shows how the temperature changes as substance **X** is heated.



(a) (i) What is the **melting point** of substance **X**?

Melting point = ... °C **[1]**

(ii) What is the **state of matter** of substance **X** at 70 °C?

Tick (✓) **one** box.

Solid ☐

Liquid ☐

Gas ☐ **[1]**

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(b) In which state of matter do the particles of **X** have the **most** energy?

Tick (✓) **one** box.

Solid ☐

Liquid ☐

Gas ☐ **[1]**

(c) Another substance, **Y**, is heated.

Substance **Y** is an **ionic** compound.

Substance **Y** has a much higher melting point than substance **X**.

Substance **X** is a **simple covalent** compound.

(i) Which substance, **X** or **Y**, is made up of **molecules**?

Tick (✓) **one** box.

X ☐

Y ☐

Explain your answer.

.....

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

(ii) Explain the difference between the melting points of substances **X** and **Y**.

Use ideas about the forces between the particles.

.....

.....

.....

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

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13 A student tests three solutions **A**, **B** and **C**. He wants to identify which solution is acidic.

The student adds a metal carbonate to each solution.

Table 13.1 shows his results.

Solution	Observations with metal carbonate
A	no reaction
B	bubbles and fizzing
C	no reaction

Table 13.1

(a) (i) Which solution, **A**, **B** or **C**, is acidic?

Tick (✓) **one** box.

A ☐

B ☐

C ☐ **[1]**

(ii) Suggest a **pH value** for the acidic solution.

pH value = ... **[1]**

(iii) Write down **two** other tests the student could use to identify that the solution is acidic.

1 .....

2 .....

[2]

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(b) The student adds the acidic solution to a solution of sodium hydroxide. A neutralisation reaction takes place.

He records the pH of the mixture.

Table 13.2 shows his results.

Volume of acidic solution added (cm^3)	pH of mixture
0	12.2
5	11.0
10	9.0
15	7.5
20	7.0

Table 13.2

Describe the relationship between the volume of acidic solution added and the pH of the mixture.

.....

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

(c) Sodium hydroxide is an **alkali**.

Which ion do solutions of alkalis contain?

Put a (ring) around the correct answer.

H^+ **Na^+** **OH^-** **SO_4^{2-}**

[1]

(d) In a different neutralisation reaction sulfuric acid, H_2SO_4, reacts with sodium hydroxide, NaOH.

Complete the **balanced symbol** equation for this reaction.

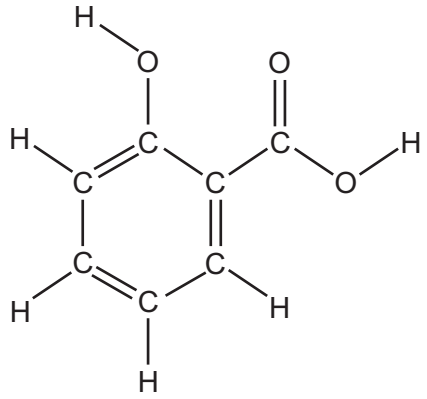
$$H_2SO_4 + \text{.....} NaOH \rightarrow Na_2SO_4 + \text{.....} H_2O$$

[1]

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14 Aspirin is a widely used painkiller and is sold as tablets.

One of the chemicals in aspirin is salicylic acid. The structure of salicylic acid is shown below.



Salicylic acid

(a) What is the **empirical formula** of salicylic acid?

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

(b) It is important that aspirin is **pure** for it to be safely used in tablets.

(i) Explain the meaning of the term pure.

.....

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

(ii) Three students, **A**, **B** and **C** make aspirin and check its purity. The students test the purity of the aspirin by measuring the melting point.

Their results are shown in the table.

Student	Melting point (°C)
A	160
B	139
C	137

The melting point of pure aspirin is in the range 138–140 °C.

Which student made pure aspirin?

Tick (✓) **one** box.

A ☐

B ☐

C ☐ **[1]**

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(c) Another method of checking the purity of a substance is paper chromatography.

Look at the diagram of the apparatus used for paper chromatography.

Label the chromatography diagram.

Choose your labels from the list.

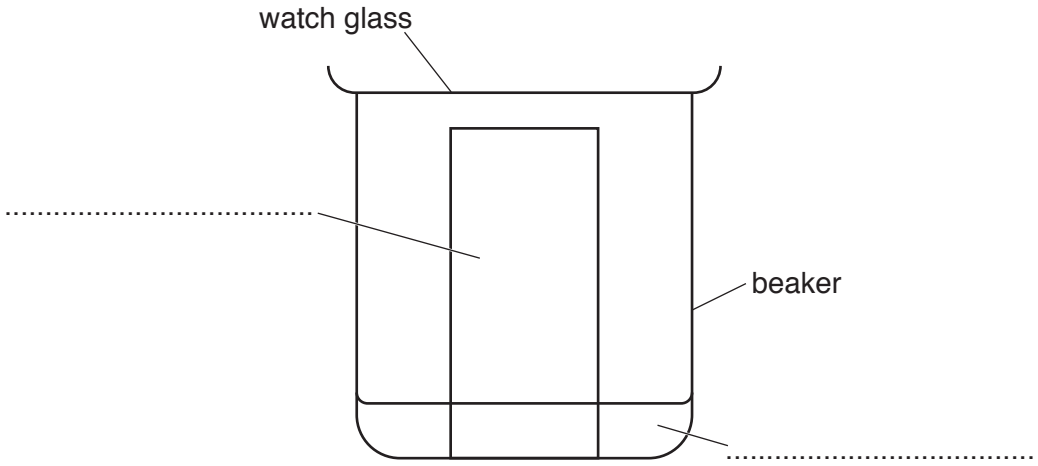
active phase

inactive phase

gas phase

mobile phase

stationary phase



[2]

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(d)* This is the method the students follow for the paper chromatography experiment.

1. Draw a pen line near the bottom of the paper.
2. Put a spot of the substance to be tested onto the line.
3. Stand the paper in the solvent. The solvent should be at the same level as the spot.
4. Cover the beaker.
5. Remove the paper from the beaker before the solvent reaches the top.
6. Calculate the R_f value of the substance by using this equation:

$$R_f \text{ value} = \frac{\text{distance moved by solvent}}{\text{distance moved by spot}}$$

Their teacher notices some mistakes with this method.

Describe and explain the **mistakes** in the method and suggest improvements that could be made.

.....

.....

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.....

..... **[6]**

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15 A student does an experiment to identify an unknown metal **M**.

The student weighs metal **M**. Then the student adds metal **M** to a solution of copper sulfate, $CuSO_4(aq)$.

A reaction takes place forming copper metal, Cu:

$\mathbf{M}(s) + CuSO_4(aq) \rightarrow Cu(s) + \mathbf{M}SO_4(aq)$

The student separates the copper and then weighs the copper.

These are the student's results:
Mass of metal **M** = 8.10 g
Mass of copper = 21.2 g

(a) How could the student separate the copper from the solution?

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

(b) (i) Calculate the relative atomic mass of metal **M**.

Use the equation:

$$\text{relative atomic mass of metal } \mathbf{M} = \frac{\text{relative atomic mass of copper} \times \text{mass of metal } \mathbf{M}}{\text{mass of copper}}$$

The relative atomic mass of copper is 63.5.

Give your answer to **3** significant figures.

Relative atomic mass of metal **M** = ... **[3]**

(ii) Use your answer from **(b)(i)** and the Periodic Table to identify the metal **M**.

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

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16 A student investigates three reactions.

She wants to find out if the reactions are exothermic or endothermic.

Look at her results.

Reaction	Start temperature (°C)	Final temperature (°C)
X	21	25
Y	20	18
Z	22	24

(a) Which reaction, **X**, **Y** or **Z**, is **endothermic**? .....

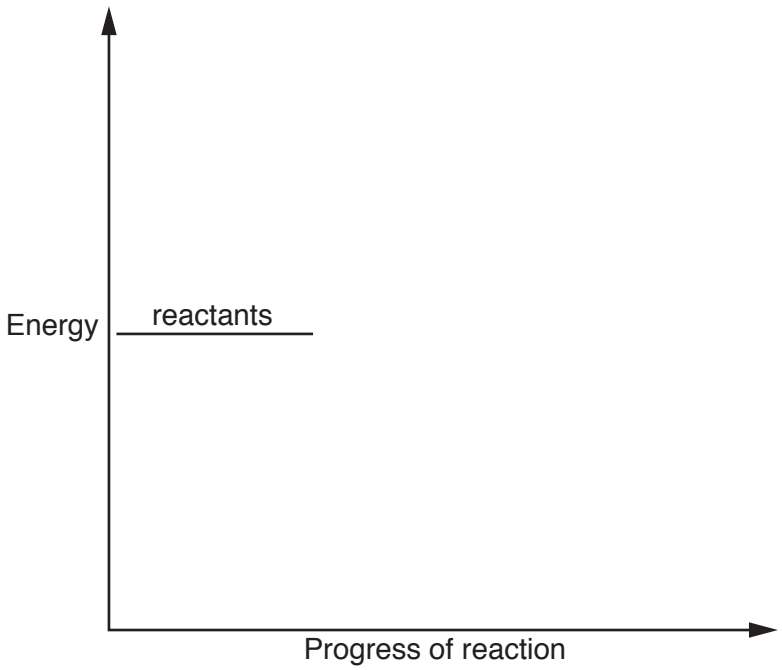
Explain your answer.

.....

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

(b) Draw a labelled reaction profile for an **endothermic** reaction.

Use the following labels on your reaction profile:
- products
- energy change
- activation energy.



[4]

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(c) Another student repeats the same reactions.

The student does the experiment in a polystyrene cup instead of a beaker.

Explain why using a polystyrene cup is an improvement to the method.

.....

.....

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

(d) The reaction between iron oxide and aluminium is very exothermic.

Look at the equation for the reaction.

$Fe_2O_3(s) + 2Al(s) \longrightarrow Al_2O_3(s) + 2Fe(l)$

(i) During this reaction the aluminium is **oxidised**.

Explain what is meant by the term oxidised.

.....

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

(ii) Pure iron metal is produced in the reaction.

Draw a diagram to show the bonding in a metal.

Label your diagram clearly.

[3]

END OF QUESTION PAPER

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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).

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