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Thursday 16 May 2019 – Morning

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

J250/09 Paper 9 (Higher Tier)

Time allowed: 1 hour 10 minutes

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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

J250/09

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 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]**

2 Metals can have atoms of other elements mixed with them to change their properties.

What is the name for the type of substance formed?

A Alloy

B Compound

C Solution

D Suspension

Your answer ☐ **[1]**

3 How are atoms arranged in the modern Periodic Table?

A In order of atomic number

B In order of relative atomic mass

C In order of the number of neutrons

D In order of reactivity

Your answer ☐ **[1]**

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4 Which separation technique in the laboratory requires a condenser?

A Chromatography

B Crystallisation

C Filtration

D Distillation

Your answer ☐ **[1]**

5 The following table contains information about protons, neutrons and electrons.

Particle	Relative mass	Relative charge
Proton	1	+1
Neutron	1	–1
Electron	0.0005	–1

One piece of information in the table is **incorrect**.

Which correction needs to be made?

A Electron charge should be 0.

B Electron mass should be 1.

C Neutron charge should be 0.

D Proton charge should be 0.

Your answer ☐ **[1]**

6 The particle model does not take into account certain information about the particles.

Which of the following **does** the particle model take into account?

A The size of the particles.

B The space between the particles.

C The number of particles.

D The force of attraction between the particles.

Your answer ☐ **[1]**

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7 Magnesium ions react with chloride ions to form magnesium chloride.

What is the correct ionic equation for this reaction?

A $Mg^{+} + Cl^{-} \longrightarrow MgCl$

B $Mg^{2+} + Cl^{2-} \longrightarrow MgCl$

C $Mg^{2+} + 2Cl^{-} \longrightarrow MgCl_2$

D $Mg^{2+} + Cl^{-} \longrightarrow Mg_2Cl$

Your answer ☐ **[1]**

8 The table shows bond energies.

Bond	Bond energy (kJ / mol)
H–H	436
Cl–Cl	243
H–Cl	432

Hydrogen reacts with chlorine to form hydrogen chloride.

$H–H + Cl–Cl \longrightarrow 2\ H–Cl$

What is the energy change, in kJ / mol?

A –247

B –185

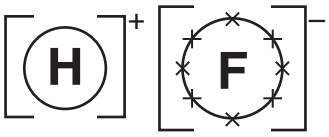
C +185

D +247

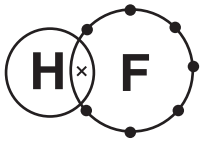
Your answer ☐ **[1]**

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9 Which diagram correctly shows the bonding in a molecule of hydrogen fluoride?

A 

B 

C 

D 

Your answer ☐ **[1]**

10 What is the mass of 2 moles of calcium hydroxide?

A 148.2 g

B 164.1 g

C 220.1 g

D 328.2 g

Your answer ☐ **[1]**

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SECTION B

Answer **all** the questions.

11 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**? .....

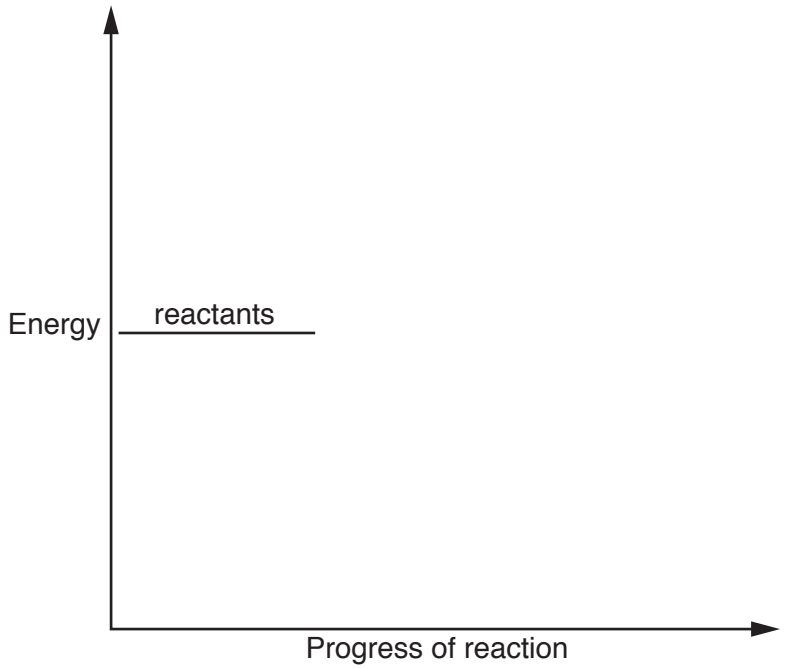
Explain your answer.

.....

..... **[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.

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

(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]

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12* A student carries out an experiment using paper chromatography to distinguish between three substances.

Here is his method.

1. Draw a pen line half way up the paper.
2. Put a large 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. Leave the beaker uncovered.
5. Remove the paper from the beaker before the solvent reaches the top.

He calculates the R_f value for each substance.

Look at his results.

Substance	Distance moved by solvent (mm)	Distance moved by spot (mm)	R_f value
X	95	78	1.22
Y	95	65	1.46
Z	95	51	1.86

His teacher noticed some mistakes with his method **and** his R_f values.

Describe and explain the **mistakes** the student has made and suggest corrections.

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

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13 Aluminium, phosphorus and magnesium are all in Period 3 of the Periodic Table.

(a) Aluminium has an atomic number of 13 and mass number of 27.

(i) Describe the **nucleus** of an aluminium atom in terms of sub-atomic particles.

.....

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

(ii) What is the overall charge on the nucleus of an atom of aluminium?

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

(iii) Which sub-atomic particles surround the nucleus?

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

(b) Phosphorus has a higher atomic number and a higher mass number than aluminium.

A student says that phosphorus must be an isotope of aluminium because it has a different number of neutrons.

Is the student correct?

Tick (✓) one box.

Yes ☐

No ☐

Explain your answer.

.....

.....

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

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(c) Phosphorus can react with oxygen to form oxides. One oxide of phosphorus is called phosphorus pentoxide.

Phosphorus pentoxide has the molecular formula P_4O_{10}.

(i) What is the **empirical formula** of phosphorus pentoxide?

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

(ii) Aluminium oxide and phosphorus pentoxide have different types of bonding.

The boiling point of aluminium oxide is 2977 °C.

The boiling point of phosphorus pentoxide is 360 °C.

What conclusion can you make about the **type of bonding** in each oxide?

Explain your answers.

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

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(d) The student is given a sample of the metal magnesium and a solution of an unknown nitrate of metal **M**, **M**NO_3(aq).

The student does an experiment to identify metal **M**.

The student weighs the magnesium. Then the student adds the magnesium to the solution of the metal nitrate.

A displacement reaction takes place forming metal **M**:

$Mg(s) + 2\mathbf{M}NO_3(aq) \rightarrow 2\mathbf{M}(s) + Mg(NO_3)_2(aq)$

The student separates the metal **M** and then weighs metal **M**.

Look at the student's results:
Mass of magnesium = 0.729 g
Mass of metal **M** = 6.476 g

(i) Calculate the moles of magnesium used in the experiment.

Moles of magnesium = ... **[1]**

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

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

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

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

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

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14 Brine is the name given to the solution formed when sodium chloride, NaC*l*, dissolves in water.

(a) During the electrolysis of sodium chloride solution, two ions are attracted to the **negative** electrode (cathode).

(i) Identify the **two** ions attracted to the negative electrode (cathode).

1 .....

2 .....

[2]

(ii) State and explain which product is formed at the negative electrode (cathode).

.....

.....

.....

.....

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

(b) Electrolysis can also be carried out on molten ionic compounds such as magnesium oxide, MgO.

During the electrolysis of molten magnesium oxide, magnesium ions, Mg^{2+}, are **reduced** at the cathode.

Write a **balanced half equation** for this reaction.

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

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15 (a) Carbon is an element which can form a very wide range of compounds.

This is partly due to the number of bonds that a carbon atom can form.

State the **type** and **maximum number of bonds** that a carbon atom forms.

Type of bonds .....

Maximum number of bonds ..... **[2]**

(b) Hex-1-ene is a carbon-based compound with the formula C_6H_{12}.

20.0 g of hex-1-ene is burned in oxygen. Carbon dioxide and water are made. Look at the equation for this reaction.

$$C_6H_{12} + 9O_2 \rightarrow 6CO_2 + 6H_2O$$

(i) Calculate the number of molecules in 20.0 g of hex-1-ene.

Avogadro's constant = $6.02 \times 10^{23}\,mol^{-1}$

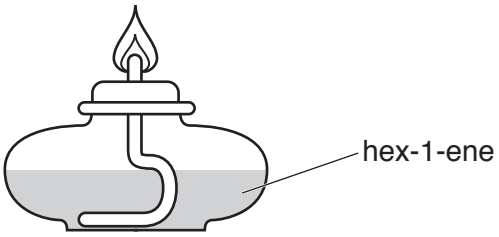
Give your answer to **3** significant figures.

Number of molecules of C_6H_{12} = ... **[4]**

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(ii) Hex-1-ene was burned using a spirit burner in the laboratory.

The diagram shows the spirit burner.



Burning 20.0 g of hex-1-ene should produce 62.9 g of carbon dioxide.

The actual mass of carbon dioxide produced in the reaction was 48.4 g.

What conclusion can be made about the **mass of oxygen** available for combustion?

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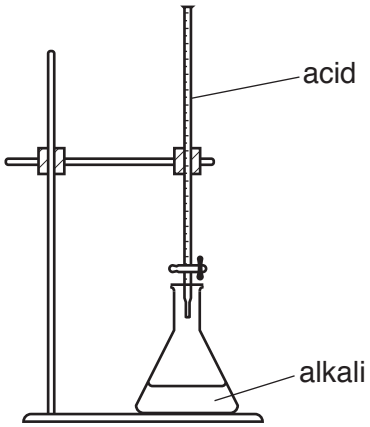
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..... **[1]**

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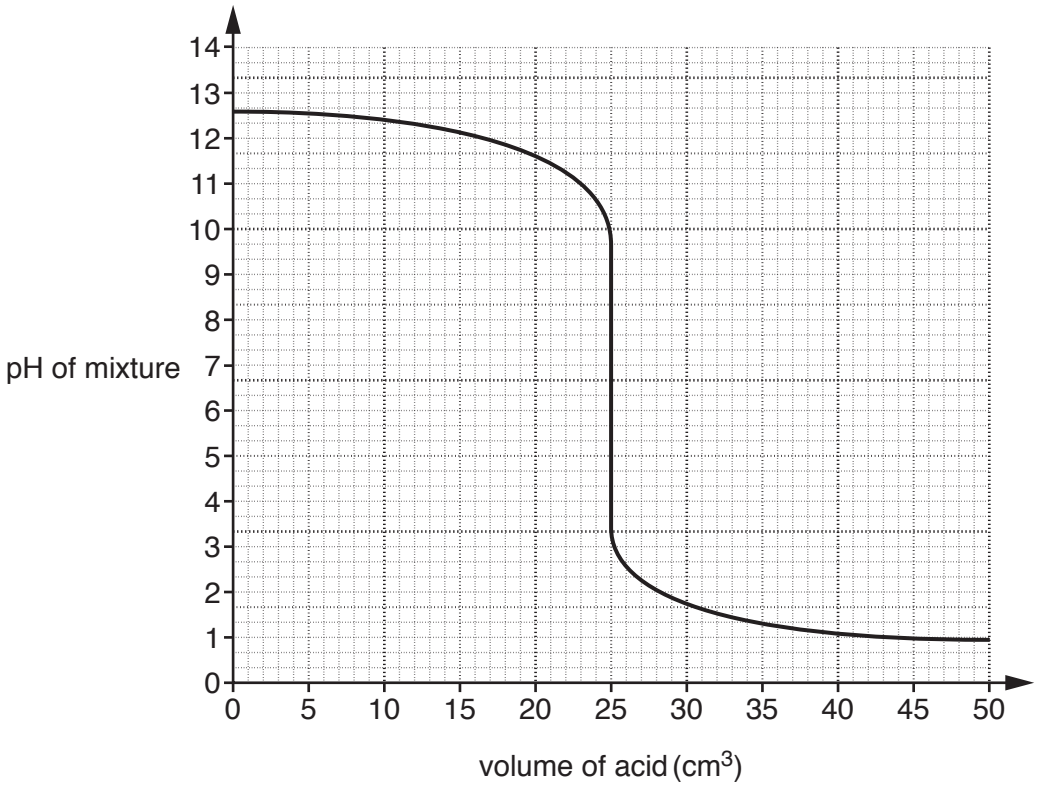
16 A student adds sulfuric acid to a solution of the alkali sodium hydroxide. A neutralisation reaction takes place.

This is the apparatus she uses.



The student measures how the pH of the solution changes as the acid is added.

Look at the graph of her results.



(a) What **volume of acid** is needed to neutralise the alkali?

Volume of acid = ... cm^3 **[1]**

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(b) The mixture becomes less alkaline as the acid is added.

Describe how the **pH of the mixture** changes as the acid is added.

.....

.....

.....

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

(c) Explain why the mixture becomes **less alkaline** as the acid is added.

Use ideas about hydrogen ions and pH in your answer.

.....

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.....

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

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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