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

J248/03 Paper 3, C1–C3 and C7 (Higher Tier)

Thursday 17 May 2018 – Morning

Time allowed: 1 hour 45 minutes

7024423078

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

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

J248/03

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, 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 **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **24** pages.

SECTION A

Answer **all** the questions.

You should spend a maximum of 30 minutes on this section.

1 What is the name of the gas made when magnesium reacts with sulfuric acid?

A Carbon dioxide

B Carbon monoxide

C Hydrogen

D Oxygen

Your answer ☐ **[1]**

2 Which equation represents **neutralisation**?

A $4H^+ \longrightarrow 2H_2$

B $H_2O \longrightarrow 2H^+ + O^{2-}$

C $H^+ + OH^- \longrightarrow H_2O$

D $O_2 + H_2 \longrightarrow H_2O + O^{2-}$

Your answer ☐ **[1]**

3 Which statement about nanoparticulate materials is **not** correct?

A Nanoparticles are much smaller than atoms.

B Nanoparticulate materials can be used as catalysts.

C Nanoparticulate materials have an extremely large surface area to volume ratio.

D There are possible risks when using nanoparticulate materials which are difficult to predict.

Your answer ☐ **[1]**

4 Ethanol is a liquid at room temperature. It has a low melting point and boiling point.

Why?

A Ethanol is an ionic compound.

B The forces of attraction between ethanol molecules are strong.

C The forces of attraction between ethanol molecules are weak.

D There are no forces of attraction between ethanol molecules.

Your answer ☐ **[1]**

5 Look at the equation.

$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

Which substance is the **oxidising agent** in this reaction?

A CH_4

B CO_2

C H_2O

D O_2

Your answer ☐ **[1]**

6 Which statement about **covalent** bonding is true?

A Electrons are transferred from one atom to another.

B Electrons are delocalised.

C Electrons are shared between atoms.

D Ions are formed.

Your answer ☐ **[1]**

7 Which statement correctly describes a pure substance?

A Consists of just one element or compound

B Has a low melting point

C Is a mixture of two or more substances

D Melts over a range of temperatures

Your answer ☐ **[1]**

8 A student separates a dye using thin layer chromatography.

She puts a thin layer of solid alumina onto a glass plate. She puts the dye on the pencil line. She puts the glass plate into a tank containing water.

Which of the following is the **stationary** phase?

A Alumina

B Glass

C Pencil line

D Water

Your answer ☐ **[1]**

9 What is the **activation energy** for a reaction?

A The difference between the energy of the reactants and the products

B The energy needed for a reaction to start

C The energy of the products

D The energy of the starting materials

Your answer ☐ **[1]**

10 Which is the **best** explanation of a **concentrated** acid?

A The acid is completely ionised in solution in water.

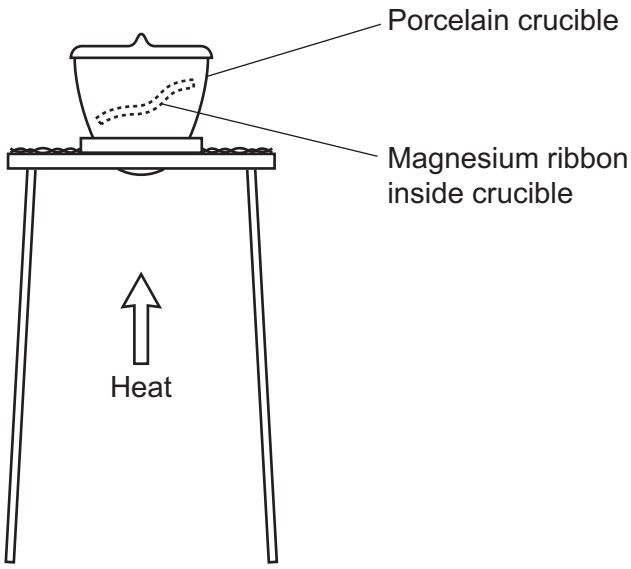
B The acid is partially ionised in solution in water.

C There is a large amount of acid and a small amount of water.

D There is a large amount of water and a small amount of acid.

Your answer ☐ **[1]**

11 Magnesium is heated in a crucible.



The mass of the crucible and magnesium **increases**.

Which statement is the **best** explanation for this?

A Oxygen is given off.

B The magnesium melts.

C The magnesium is oxidised to magnesium oxide.

D The magnesium reacts to make magnesium carbonate.

Your answer ☐ **[1]**

12 The equation shows a reaction that involves both oxidation and reduction.

$$Fe_2O_3 + 2Al \longrightarrow Al_2O_3 + 2Fe$$

Which statement about **reduction** is correct?

A The gain of oxygen and the gain of electrons by a substance

B The gain of oxygen and the loss of electrons by a substance

C The loss of oxygen and the gain of electrons by a substance

D The loss of oxygen and the loss of electrons by a substance

Your answer ☐ **[1]**

13 Niels Bohr was involved in the development of the atomic model.

Which of these statements describes his work?

A He developed the idea of a nuclear atom.

B He developed the plum-pudding model of the atom.

C He stated that atoms were like tiny solid balls.

D He stated that electrons exist in fixed energy levels.

Your answer ☐ **[1]**

14 What is the approximate size of a nanoparticle?

A 0.07 nm

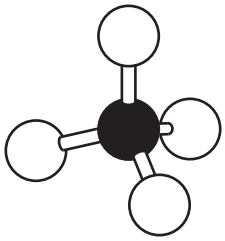
B 0.40 nm

C 50 nm

D 1000 nm

Your answer ☐ **[1]**

15 Look at the diagram of a methane molecule.



Which statement about methane is correct?

A Electrons are transferred from hydrogen atoms to carbon atoms.

B The covalent bonds in methane are weak.

C The force of attraction between methane molecules is weak.

D The ionic bonds between carbon and hydrogen are very strong.

Your answer ☐ **[1]**

SECTION B

Answer **all** the questions.

16 Magnesium is an element. It is solid at room temperature.

(a) (i) **Solid** magnesium cannot be compressed.

Why?

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

(ii) **Solid** magnesium **cannot** flow, but **liquid** magnesium **can** flow.

Explain why.

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..... **[3]**

(iii) Magnesium **gas** completely fills any container it is put in.

Explain why.

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

(b) Magnesium reacts with water. Magnesium hydroxide, $Mg(OH)_2$, and hydrogen, H_2, are made.

Write a balanced symbol equation for this reaction.

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

(c) Magnesium nitrate has the formula $Mg(NO_3)_2$.

Calculate the relative formula mass of magnesium nitrate.

Answer = ... **[1]**

17 A student has a solution of hydrochloric acid, HCl, and a solution of sodium hydroxide, NaOH.

He wants to make a pure, dry sample of sodium chloride.

(a) Describe how he can do this.

Include the apparatus he should use and his method.

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..... **[4]**

(b) Write a **balanced symbol** equation for the reaction.

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

(c) The student also investigates other reactions.

The table shows the salts he can make from different starting materials.

Complete the table.

Acid used	Other starting material	Salt made
Sulfuric acid	Copper oxide	.....
.....	Zinc carbonate	Zinc nitrate
Hydrochloric acid	.....	Magnesium chloride

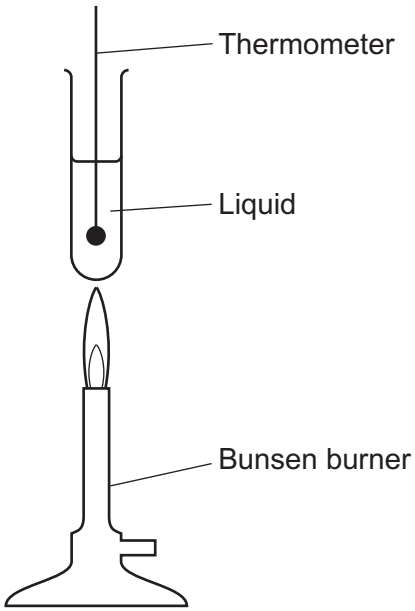
[3]

(d) What **type** of reaction happens when sulfuric acid reacts with copper oxide?

.....

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

18 A student is measuring the boiling point of some liquids.



She measures the boiling point of water, petrol and ethanol.

(a) The student's method is not safe.

Explain why it is not safe and explain how she could improve her method to make it safer.

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.....

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

(b) The student looks up some data on melting points and boiling points.

Substance	Formula	Melting point (°C)	Boiling point (°C)	State at 25 °C
Propane	C_3H_8	–188	–42	.....
Hexane	C_6H_{14}	–95	69	.....
Icosane	$C_{20}H_{42}$	37	343	Solid

Complete the table to show the states of propane and hexane at 25 °C. **[2]**

(c) Propane burns in oxygen, O_2. Carbon dioxide and water are made.

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

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

19 Look at the information about two atoms of chlorine.

$^{35}_{17}Cl$ $^{37}_{17}Cl$

The **atomic number** of chlorine is 17.

(a) What is meant by atomic number?

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

(b) These two atoms of chlorine are **isotopes**.

Explain why these two atoms of chlorine are isotopes.

.....

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

(c) Look at the information about other atoms and ions.

Atom or ion	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons	Electronic structure
S	16	32	.....	16	16	.....
B	5	11	5	.....	.....	2.3
F^-	9	19	.....	.....	10	2.8
Li^+	3	7	3	4	.....	.....

Complete the table. **[4]**

(d) **(i)** The electronic structure of sodium is 2.8.1. The electronic structure of oxygen is 2.6. Sodium and oxygen react together to make sodium oxide.

Sodium oxide is an **ionic** compound.

Draw 'dot and cross' diagrams to show the ions made when sodium reacts with oxygen.

Show the charges on the ions.

[3]

(ii) What is the **formula** of sodium oxide?

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

20 A student has a mixture of three substances.

Look at some information about these substances.

Substance	Melting point (°C)	Boiling point (°C)	Solubility in water
Sand	1710	2230	Insoluble
Sodium chloride	801	1413	Soluble
Water	0	100	

(a) Describe how the student can separate the mixture to get pure samples of all **three** substances.

Explain why each method of separation works.

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..... **[4]**

(b) The student separates two solid substances **A** and **B**.

She wants to check that they are **pure**.

She measures the melting points of four samples of solid **B**.

Look at her results.

Sample	Melting point (°C)
1	109
2	105
3	104–108
4	110–112

The student knows that a pure sample of solid **B** has a melting point of 110 °C.

She concludes that sample 4 is the purest sample of solid **B**.

Do the results support her conclusion?

Explain your answer using evidence from the table.

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..... **[3]**

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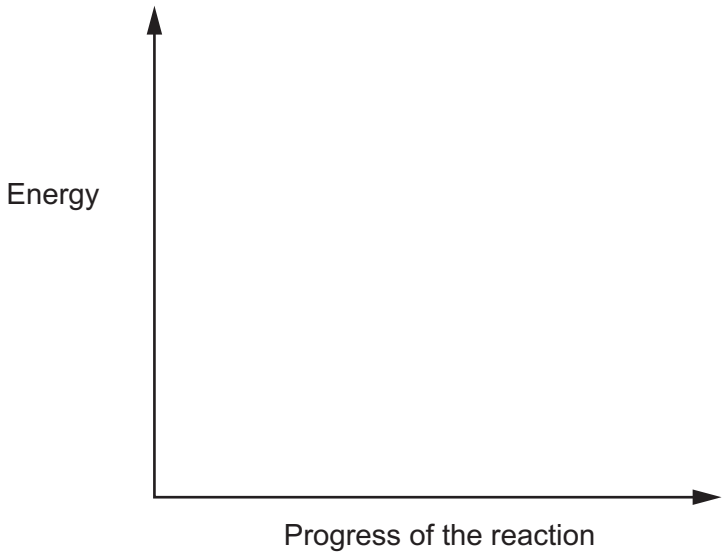
21 Anhydrous copper sulfate reacts with water to make hydrated copper sulfate.

$$CuSO_4 + 5H_2O \longrightarrow CuSO_4.5H_2O$$

Anhydrous copper sulfate + Water ⟶ Hydrated copper sulfate

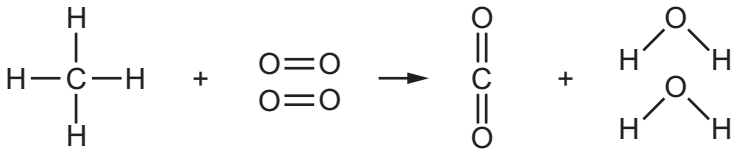
The reaction is **exothermic**.

(a) Draw and label a reaction profile for this reaction.



[3]

(b) Two students investigate the burning of methane in oxygen.



Methane Oxygen Carbon dioxide Water

Look at the table of bond energies.

Bond	Bond energy (kJ / mol)
O–H	459
C=O	799
O=O	494
C–H	

The reaction is exothermic and 802 kJ of energy are given out when 1 mole of methane burns.

The students have looked up the bond energies. They have different values for the C–H bond energy.

Student A thinks the C–H bond energy is 432 kJ / mol. Student B thinks the C–H bond energy is 411 kJ / mol.

Who is correct?

Use the bond energies and the energy given out in the reaction to calculate the C–H bond energy.

Answer = ... kJ / mol **[3]**

22 Copper oxide can be reduced to copper by reaction with hydrogen.

$CuO + H_2 \longrightarrow Cu + H_2O$

A reaction mixture contains 1.59 g of copper oxide and 0.20 g of hydrogen.

1.27 g of copper and 0.36 g of water are made.

Calculate the number of moles of each substance to determine the **limiting reactant** in this reaction.

Explain your choice.

The relative atomic mass of Cu is 63.5, of O is 16 and of H is 1.

Number of moles of CuO = ...

Number of moles of H_2 = ...

Number of moles of Cu = ...

Number of moles of H_2O = ...

The limiting reactant is ..... because .....

..... **[4]**

23 Look at the diagram.

It shows part of Mendeleev's Periodic Table which was developed in 1871.

Mendeleev arranged the elements in order of relative atomic mass.

Group	1	2	3	4	5	6	7	
Periods								
1	H 1.008							
2	Li 6.939	Be 9.012	B 10.81	C 12.011	N 14.007	O 15.999	F 18.998	
3	Na 22.99	Mg 24.31	A*l* 29.98	Si 28.09	P 30.974	S 32.06	C*l* 35.453	
4	K 39.102	Ca 40.08			As 74.92	Se 78.96	Br 79.909	
5	Rb 85.47	Sr 87.62	In 114.82	Sn 118.69	Sb 121.75	Te 127.60	I 126.90	
6	Cs 132.90	Ba 137.84	T*l* 204.37	Pb 207.19	Bi 208.98			

Describe the differences between Mendeleev's Periodic Table and the modern-day version found in the insert.

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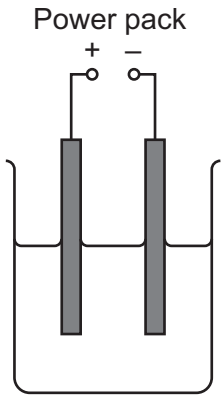
..... **[3]**

24 A student is investigating the electrolysis of copper sulfate solution.



He does two experiments.

Experiment **1** uses platinum electrodes. Experiment **2** uses copper electrodes.

(a) Complete the table to show the products at each electrode.

Experiment	What happens at cathode (–)	What happens at anode (+)
1	.....	Oxygen made
2	Copper deposited	.....

[2]

(b) Copper electrodes are **non-inert** electrodes.

What is meant by non-inert electrodes?

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

(c) Look at the results for experiment 2 using **copper** electrodes.

At the cathode copper ions, Cu^{2+} gain electrons to make copper atoms.

Write the **half equation** for this reaction.

Use e^- to represent an electron.

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

(d) The student also electrolyses sodium chloride solution using platinum (inert) electrodes.

At the cathode, hydrogen gas is made rather than sodium metal.

Explain why.

.....

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

25* Look at the data about some substances.

Substance	Melting point (°C)	Boiling point (°C)	Does it conduct electricity?	Density (g/cm^3)
A	0	100	no	1.0
B	>3000	>4000	no	3.5
C	801	1413	Solid does not conduct but conducts when melted or when dissolved in water	2.2

Explain the type of **bonding** present in each substance **A**, **B** and **C**.

Relate the type of bonding to the **properties** of each substance.

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

26 The value of the Avogadro constant is 6.02×10^{23}.

(a) What is meant by the Avogadro constant?

.....

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

(b) Calculate the number of water molecules in 72 g of water, H_2O.

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

Answer = ... **[3]**

(c) A student is reacting magnesium oxide with nitric acid.

Look at the equation for the reaction.

$$MgO + 2HNO_3 \longrightarrow Mg(NO_3)_2 + H_2O$$

The student wants to make 14.8 g of magnesium nitrate, $Mg(NO_3)_2$.

Calculate the masses of magnesium oxide and nitric acid that he needs.

Mass of magnesium oxide needed = ... g

Mass of nitric acid needed = ... g **[4]**

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).