OCR
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Thursday 16 May 2019 – Morning

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

J248/03 Paper 3 (Higher Tier)

Time allowed: 1 hour 45 minutes

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

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 **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 **28** pages.

SECTION A

Answer **all** the questions.

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

Write your answer to each question in the box provided.

1 Sodium is an element that can be found in the Periodic Table.

A sodium atom contains 11 electrons.

Which statement about sodium is **true**?

A Sodium is in Group 2 of the Periodic Table.

B Sodium is in Period 2 of the Periodic Table.

C Sodium is in Period 3 of the Periodic Table.

D Sodium is in Group 3 of the Periodic Table.

Your answer ☐ **[1]**

2 Carbon dioxide exists as a simple molecule.

Why do simple molecules have low boiling points?

A Simple molecules have weak covalent bonds between atoms.

B Simple molecules have weak intermolecular forces between atoms.

C Simple molecules have weak ionic bonds between the molecules.

D Simple molecules have weak intermolecular forces between the molecules.

Your answer ☐ **[1]**

3 Mendeleev's arrangement of elements led to our modern Periodic Table.

How did Mendeleev arrange the elements in his Periodic Table?

A In order of decreasing atomic mass and similar physical properties.

B In order of increasing atomic number and similar physical properties.

C In order of decreasing atomic number and similar chemical properties.

D In order of increasing atomic mass and similar chemical properties.

Your answer ☐ **[1]**

4 R_f values are used to compare the different spots on a chromatogram.

What is the formula used to calculate an R_f value?

A $R_f = \frac{\text{distance travelled by solvent}}{\text{distance travelled by substance}}$

B $R_f = \frac{\text{distance travelled by substance}}{\text{distance travelled by solvent}}$

C $R_f = \frac{\text{distance travelled by stationary phase}}{\text{distance travelled by mobile phase}}$

D $R_f = \frac{\text{distance travelled by solvent}}{\text{distance travelled by mobile phase}}$

Your answer ☐ **[1]**

5 Carbon can form different **allotropes**.

Which of these are allotropes of carbon?

A Diamond, graphite, graphene.

B Diamond, granite, graphite.

C Fullerene, graphene, ethene.

D Granite, graphite, graphene.

Your answer ☐ **[1]**

6 Magnesium reacts with copper oxide.

Magnesium oxide and copper are made.

magnesium + copper oxide $\rightarrow$ magnesium oxide + copper

Which substance is the **reducing agent**?

A Copper

B Copper oxide

C Magnesium

D Magnesium oxide

Your answer ☐ **[1]**

7 The atomic radius of a helium atom is 0.031 nm.

What is the atomic radius of a helium atom in standard form?

A 3.1×10^{-1}

B 3.1×10^{-2}

C 3.1×10^{-3}

D 3.1×10^{-4}

Your answer ☐ **[1]**

8 What is the electronic structure of sulfur?

A 2

B 2, 6

C 2, 8, 6

D 2, 8, 8, 6

Your answer ☐ **[1]**

9 The melting point of bromine is −7 °C.

The boiling point of bromine is 59 °C.

What state would bromine be at room temperature?

A Aqueous

B Gas

C Liquid

D Solid

Your answer ☐ **[1]**

10 Avogadro's constant has a value of 6.02×10^{23}.

How many **oxygen atoms** are in 0.25 moles of oxygen molecules?

A 1.204×10^{24}

B 1.505×10^{23}

C 3.010×10^{23}

D 6.020×10^{23}

Your answer ☐ **[1]**

11 Methane burns in oxygen to form carbon dioxide and water.

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

Calculate the amount of carbon dioxide made when 6.4 g of methane is burnt.

A 2.8 g

B 4.4 g

C 14.4 g

D 17.6 g

Your answer ☐ **[1]**

12 Paper chromatography can be used to separate the colours in ink.

Water is the solvent used to separate the colours in water soluble ink.

What name is given to the water used in paper chromatography?

A Absorption phase

B Liquid phase

C Mobile phase

D Stationary phase

Your answer ☐ **[1]**

13 What is the amount, in mol, of 15 g of carbonate ions, CO_3^{2-}?

A 0.18

B 0.25

C 4.0

D 5.6

Your answer ☐ **[1]**

14 During the electrolysis of molten lead bromide, bromine is made at the anode.

Which half equation shows that bromine is made at the anode?

A $2Br^- \longrightarrow Br_2 + 2e^-$

B $Br^- \longrightarrow Br + e^-$

C $Br_2 + 2e^- \longrightarrow 2Br^-$

D $2Br^- \longrightarrow Br_2 - 2e^-$

Your answer ☐ **[1]**

15 Which of these substances has a **giant covalent structure**?

A Carbon dioxide

B Magnesium oxide

C Sulfur dioxide

D Silicon dioxide

Your answer ☐ **[1]**

SECTION B

Answer **all** the questions.

16 Lithium is a metal found in Group 1 of the Periodic Table.

(a) (i) Describe the structure and bonding in a metal.

You may include a diagram in your answer.

.....

.....

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

(ii) Lithium is **malleable** even though metallic bonds are strong.

Explain why metals are malleable.

.....

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

(iii) Lithium can conduct electricity in the solid and liquid state.

Explain why metals can conduct electricity.

.....

.....

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

(b) An alloy is a mixture of a metal with one or more other elements.

When lithium is mixed with aluminium it makes an alloy that can be used in aircraft.

Adding different amounts of lithium to the aluminium changes the properties of the alloy.

Alloy	Percentage of lithium (%)	Density (g/cm^3)	Melting point (°C)	Strength (MPa)
A	2.00	2.58	670	550
B	2.20	2.56	580	555
C	2.45	2.55	655	565

A scientist thinks that alloy **C** is best for making an aircraft.

Is she correct?

Explain your answer using evidence from the table.

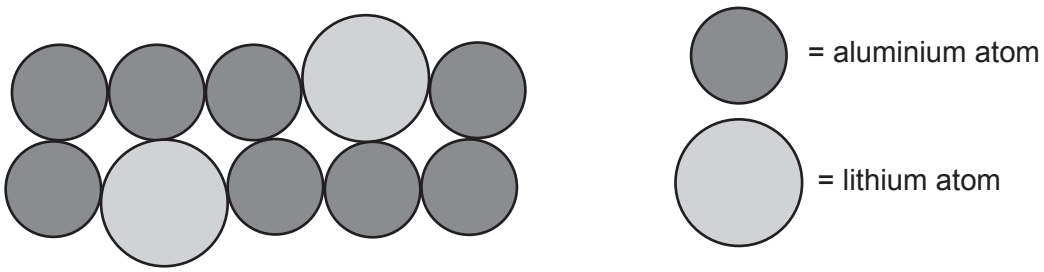
.....

.....

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

(c) The scientist uses the particle model to show the elements present in alloy **B**.

Look at her diagram.



Alloy **B**

not to scale

(i) Calculate the **percentage of lithium atoms** in the diagram of alloy **B**.

Percentage of lithium atoms = ... % **[1]**

(ii) Use your answer to part **(c)(i)** to explain if the diagram accurately shows the structure of alloy **B**.

.....

.....

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

17 A new sun cream has been developed using zinc oxide nanoparticles.

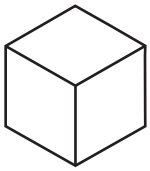
The small particles provide better protection from the sun and they do not leave white marks on the skin.

(a) Explain **one** possible risk of using nanoparticles in sun cream.

.....

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

(b) A cube-shaped nanoparticle has sides of length 50 nm.



Calculate the surface area to volume ratio for this nanoparticle.

Use the equation: ratio = surface area ÷ volume

Surface area to volume ratio = ... **[4]**

(c) (i) Scientists compare the size of nanoparticles to the sizes of other small objects.

Look at the table.

Object	Diameter (nm)
Gold atom	0.14
Water molecule	0.27
DNA strand	2.5
Zinc oxide nanoparticle	32
Red blood cell	7000
Human hair	100 000

The diameter of a DNA strand is 2.5 nm.

Explain why DNA is a nanoparticle but a water molecule is **not** a nanoparticle.

.....

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

(ii) Calculate how many zinc oxide nanoparticles would fit across a human hair.

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

Number of nanoparticles = ... **[2]**

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18 Simple distillation can be used to separate mixtures of liquids.

A scientist is using simple distillation to separate a mixture of alcohols.

Look at the table. It shows the boiling points of three alcohols.

Alcohol	Boiling point (°C)
Methanol	65
Ethanol	78
Propanol	97

(a) (i) Which alcohol will be distilled first?

Tick (✓) **one** box.

Methanol ☐

Ethanol ☐

Propanol ☐

Explain your answer.

.....

.....

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

(ii) Simple distillation uses evaporation and condensation to separate mixtures.

ethanol (l) $\underset{\text{condensation}}{\overset{\text{evaporation}}{\rightleftharpoons}}$ ethanol (g)

Describe the change in the **arrangement** of particles as substances evaporate.

.....

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

(iii) Describe the change in the **movement** of particles as substances evaporate.

.....

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

(iv) The scientist wants to improve the separation of the mixture of alcohols.

Suggest a piece of equipment he could use.

Explain how this will improve the separation of the mixture of alcohols.

.....

.....

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

(b) Ethanol can be used as a biofuel. The combustion of ethanol is an **exothermic** reaction.

Explain why combustion is an exothermic reaction.

Use ideas about bond breaking and bond making in your answer.

.....

.....

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

(c) **(i)** Methanol is another biofuel that can be used in combustion reactions.

$CH_3OH + 2O_2 \rightarrow CO_2 + 2H_2O$

Look at the table. It shows some bond energies.

Bond	Bond energy (kJ / mol)
C−H	413
O=O	498
C−O	358
C=O	805
O−H	464

Calculate the energy transferred to break all the bonds in the reactants.

Energy transferred = ... kJ / mol **[2]**

(ii) Calculate the energy transferred when all the bonds form in the products.

Energy transferred = ... kJ / mol **[2]**

(iii) Use your answers to parts **(i)** and **(ii)** to calculate the energy change for this reaction.

Energy change = ... kJ / mol **[1]**

19 Metal elements and non-metal elements have different physical properties.

The table shows the physical properties of some elements.

Element	Melting point (°C)	Density (g/cm^3)	Electrical conductivity	Thermal conductivity	Cost
A	high	high	good	good	high
B	low	low	good	poor	high
C	high	low	good	good	low
D	high	high	poor	poor	low

(a) (i) Which element, **A**, **B**, **C** or **D**, would be best to use for cables in overhead pylons to transfer electricity?

Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

Explain your answer.

.....

.....

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

(ii) What is meant by **physical** property?

.....

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

(b) Element **C** burns in oxygen to make white clouds of its oxide.

Describe how you could test the oxide to find out if the element is a metal.

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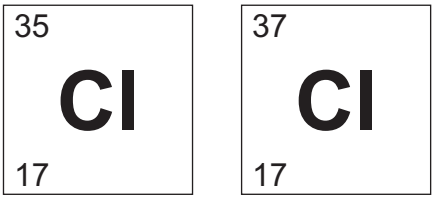
..... **[3]**

(c) (i) Chlorine is a non-metal.

Chlorine has two common **isotopes**.

Look at the information about the common isotopes of chlorine.



Complete the table to show the atomic structure for each isotope of chlorine.

Isotope	Number of protons	Number of neutrons	Number of electrons
Chlorine-35	.....	.....	.....
Chlorine-37	.....	.....	.....

[2]

(ii) Chlorine gas, Cl_2, reacts with barium, Ba.

Barium chloride, $BaCl_2$, is made.

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

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

(iii) Barium chloride solution reacts with sodium sulfate solution, Na_2SO_4.

A white precipitate of barium sulfate, $BaSO_4$, is made.

Write a **balanced ionic** equation to show the formation of barium sulfate.

Include state symbols.

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

20 A teacher investigates neutralisation. She uses hydrochloric acid, HC*l*, and sodium hydroxide, NaOH.

$HCl + NaOH \rightarrow NaCl + H_2O$

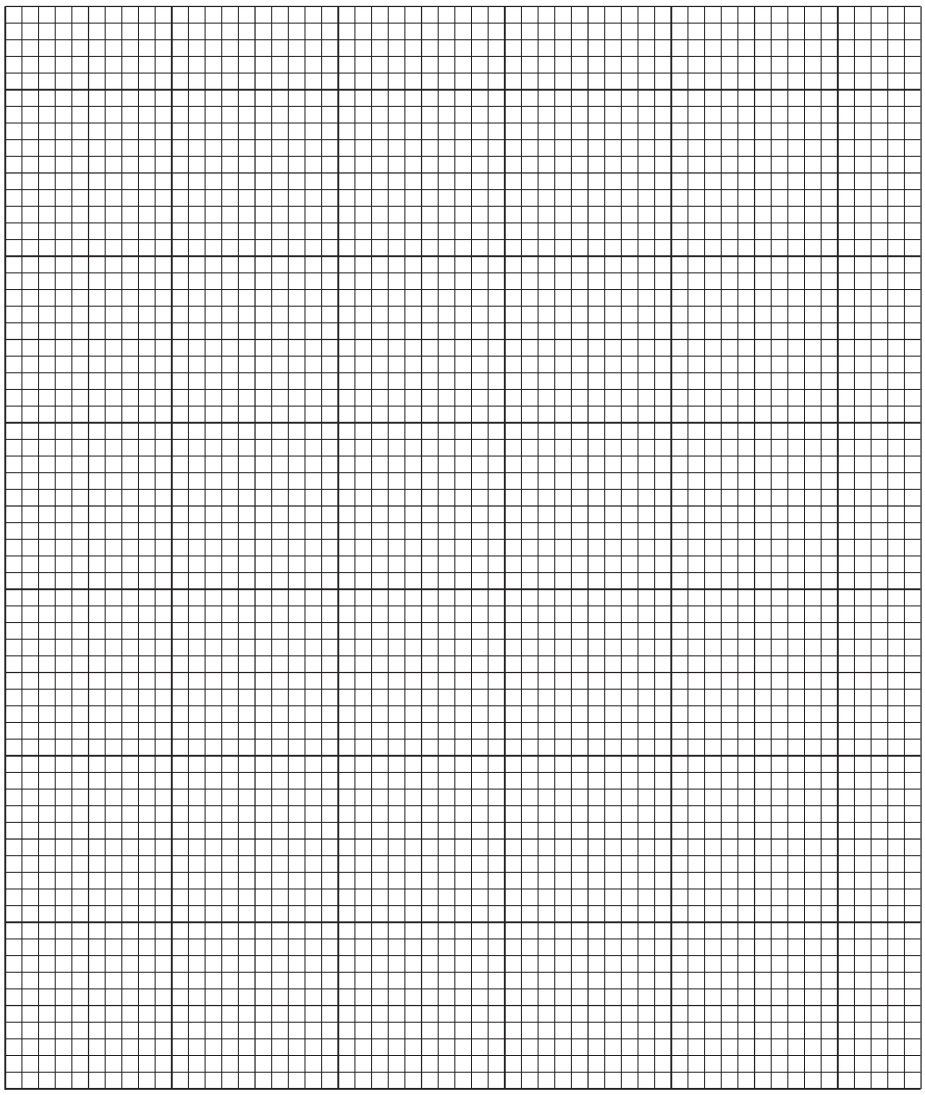
She slowly adds 1.0 cm^3 portions of the hydrochloric acid to 20.0 cm^3 of 1.0 mol/dm^3 sodium hydroxide.

She records the pH until she has added an excess of acid.

Look at her results.

Volume of hydrochloric acid added (cm^3)	**pH**
0	12.0
1	11.8
2	11.6
3	11.4
4	11.2
5	7.0
6	3.0
7	2.8
8	2.5
9	2.3
10	2.3

(a) (i) Plot a graph of the pH value against the amount of hydrochloric acid added and draw a line of best fit.



[3]

(ii) Use your graph to estimate the **volume of hydrochloric acid** when the pH is 10.

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

(iii) What happens to the **concentration of hydroxide ions**, OH^-, as the hydrochloric acid is added to the sodium hydroxide?

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

(iv) Acidic solutions contain hydrogen ions, H^+. Alkaline solutions contain hydroxide ions, OH^-.

Write the **balanced ionic** equation for neutralisation.

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

(b) Hydrochloric acid, HCl (aq), is a strong acid. Ethanoic acid, CH_3COOH (aq), is a weak acid.

Explain the difference between a strong and a weak acid.

.....

.....

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

(c) **(i)** Nitric acid, HNO_3, is another strong acid.

Nitric acid has a pH of 2.

The teacher adds enough water to reduce the concentration of the nitric acid by a factor of 100.

Calculate the new pH of the nitric acid.

pH = ... **[2]**

(ii) Nitric acid, HNO_3, can also neutralise sodium hydroxide, NaOH.

Sodium nitrate, $NaNO_3$, and water are made.

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

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

(iii) Describe how dry sodium nitrate crystals can be made using this reaction.

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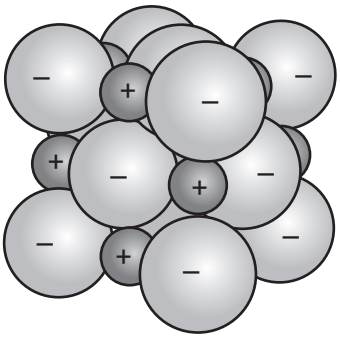
..... **[2]**

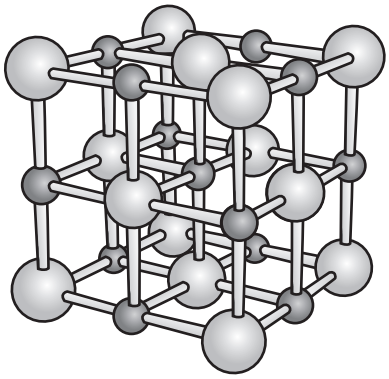
21 Sodium chloride, NaC*l*, is an ionic compound.

Sodium chloride forms a giant ionic lattice that can be represented using different models.

Look at the diagrams. They show two models of sodium chloride.



Space-filling model



Ball-and-stick model

(a) (i) A scientist thinks the ball-and-stick model should be used to model ionic compounds.

Describe **two limitations** of using the ball-and-stick model for ionic compounds.

.....

.....

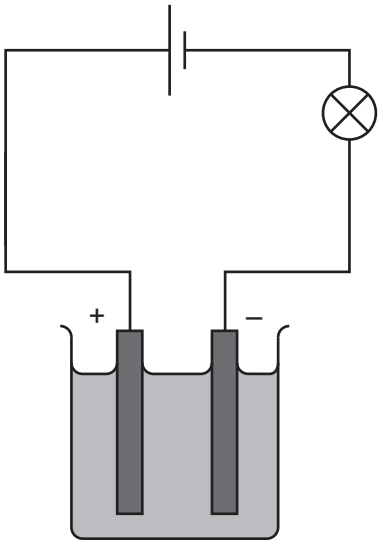
..... **[2]**

(ii) Ionic compounds can also be modelled using a dot-and-cross diagram.

Draw a dot and cross diagram to show the ions in sodium chloride.

[2]

(b)* A student investigates the electrolysis of potassium bromide solution.



He notices that different products are formed at each electrode.

Explain the formation of the products during the electrolysis of potassium bromide solution.

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

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22 Lead is most commonly extracted from an ore called galena, PbS.

(a) Extracting lead from the galena ore involves two steps.

Step **1**: The galena ore is roasted in air to produce lead oxide, PbO.

Step **2**: The lead oxide is heated in a blast furnace with carbon.

(i) The reaction in step **1** is an **exothermic** reaction.

Draw a labelled reaction profile diagram for an exothermic reaction.

Label the **activation energy** and the **energy change** on your diagram.

[4]

(ii) In step **2** the lead oxide is reduced by carbon.

$PbO + C \longrightarrow Pb + CO$

Explain, in terms of electron transfer, why carbon is called a **reducing agent** in this reaction.

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

(b) (i) Solid lead reacts with nitric acid, HNO_3.

Lead nitrate, $Pb(NO_3)_2$, nitrogen oxide, NO, and water are made.

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

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

(ii) How many moles of lead nitrate would be produced if 20.7 g of lead reacts with nitric acid?

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

Moles of lead nitrate = ... **[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).