OCR
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Friday 27 May 2022 – Morning

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

J248/01 Paper 1 (Foundation Tier)

Time allowed: 1 hour 45 minutes

You must have:
- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Chemistry A (inside this document)

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

J248801

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

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

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if the answer is wrong.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **28** pages.

ADVICE
- Read each question carefully before you start your answer.

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 Which state symbol is used for liquids?

A (aq)

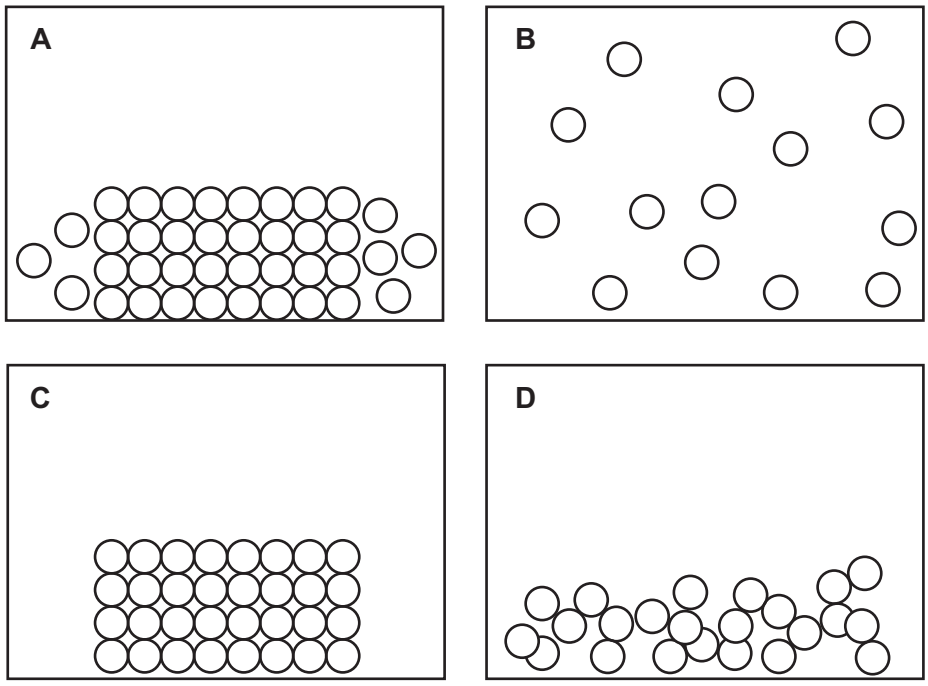
B (g)

C (l)

D (s)

Your answer ☐ **[1]**

2 Which particle model diagram shows a gas?



Your answer ☐ **[1]**

3 Which substance has **four** covalent bonds to each carbon atom?

A Carbon nanotubes

B Diamond

C Graphene

D Graphite

Your answer ☐ **[1]**

4 Which is correct about any two elements with the **same** number of electron shells?

A They are both metals.

B They are both non-metals.

C They are both in the same group on the Periodic Table.

D They are both in the same period on the Periodic Table.

Your answer ☐ **[1]**

5 The table shows the results when four solutions are tested with universal indicator and a pH probe.

Solution	Colour when universal indicator is added	Reading on pH probe
A	blue	12
B	green	7
C	purple	14
D	red	2

Which solution is an acid?

Your answer ☐ **[1]**

6 Which pieces of apparatus are used for **filtration**?

A Beaker, filter paper and condenser

B Beaker, filter paper and funnel

C Beaker, funnel and mass balance

D Filter paper, funnel and condenser

Your answer ☐ **[1]**

7 Which description is correct for melting ice?

A There is a chemical change and a change of state.

B There is a chemical change and a reaction occurs.

C There is a physical change and a change of state.

D There is a physical change and a reaction occurs.

Your answer ☐ **[1]**

8 The symbol for a calcium ion is Ca^{2+}. The symbol for an iodate ion is IO_3^-.

What is the formula for calcium iodate?

A $CaIO_3$

B $CaIO_{32}$

C $Ca(IO_3)_2$

D Ca_2IO_3

Your answer ☐ **[1]**

9 During the electrolysis of molten sodium chloride, sodium and chlorine are formed.

What happens at the **positive** electrode (anode)?

A The chloride ion, Cl^-, gains an electron.

B The chloride ion, Cl^-, loses an electron.

C The sodium ion, Na^+, gains an electron.

D The sodium ion, Na^+, loses an electron.

Your answer ☐ **[1]**

10 What did Rutherford suggest about the model of the atom?

A Atoms contain a nucleus.

B Atoms contain electrons.

C The atom is a solid sphere like a billiard ball.

D The nucleus is made up of protons and neutrons.

Your answer ☐ **[1]**

11 What is the relative formula mass of potassium chloride, KCl?

Relative atomic mass (A_r): Cl = 35.5 K = 39.1

A 36.0

B 67.4

C 74.6

D 79.0

Your answer ☐ **[1]**

12 Mendeleev swapped the positions of the elements tellurium and iodine when he was creating his Periodic Table. This meant that the atomic masses were not in order.

Why were the atomic masses not in order?

A He developed his table without knowing about atomic structure.

B He measured the atomic masses incorrectly.

C He left gaps for undiscovered elements.

D He put the elements in order of increasing reactivity.

Your answer ☐ **[1]**

13 Which particles are smaller than 1×10^{-9} m?

A Nanoparticles, molecules and atoms

B Nanoparticles, neutrons and electrons

C Neutrons, atoms and electrons

D Neutrons, polymers and protons

Your answer ☐ **[1]**

14 The element mercury is a liquid at 25 °C.

Which row about mercury is correct?

	Melting Point (°C)	**Boiling Point (°C)**
A	above 25	above 25
B	below 25	below 25
C	below 25	above 25
D	above 25	below 25

Your answer ☐ **[1]**

15 Which products are formed in the electrolysis of aqueous copper sulfate, $CuSO_4$ using inert electrodes?

A Copper and oxygen

B Copper and sulfur dioxide

C Hydrogen and oxygen

D Hydrogen and sulfur dioxide

Your answer ☐ **[1]**

SECTION B

Answer **all** the questions.

16 (a) Complete the sentences about the structure of an atom. Use words from the list.

electrons	**negative**	**neutral**	**neutrons**	**positive**	**protons**

An atom has a nucleus with a ..... charge. The nucleus is made up of

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

(b) (i) Look at the information about two **isotopes** of boron.

5 B 10	5 B 11

Which statements about the isotopes of boron are correct?

Tick (✓) **two** boxes.

Boron has 11 protons. ☐

The atomic number of boron is 5. ☐

The electrons are heavier than the protons. ☐

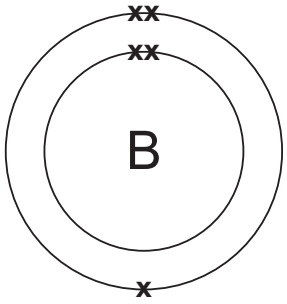
The isotopes of boron have different numbers of neutrons. ☐

The isotopes of boron have different numbers of protons. ☐

The mass number of boron is the same for both isotopes. ☐

[2]

(ii) The diagram shows a boron atom.



Explain why boron is in Group 3 of the Periodic Table.

.....

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

(c) Chlorine is in Group 7 of the Periodic Table. Chlorine is a non-metal.

Why do non-metals form negative ions?

.....

.....

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

(d) Chlorine reacts with aluminium to form aluminium chloride.

- The formula for aluminium chloride is $AlCl_3$.
- The symbol for a chloride ion is Cl^-.

What is the **symbol** for an aluminium ion?

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

17 **(a)** Complete the **word** equation for neutralisation.

acid + alkali ⟶ salt + ...

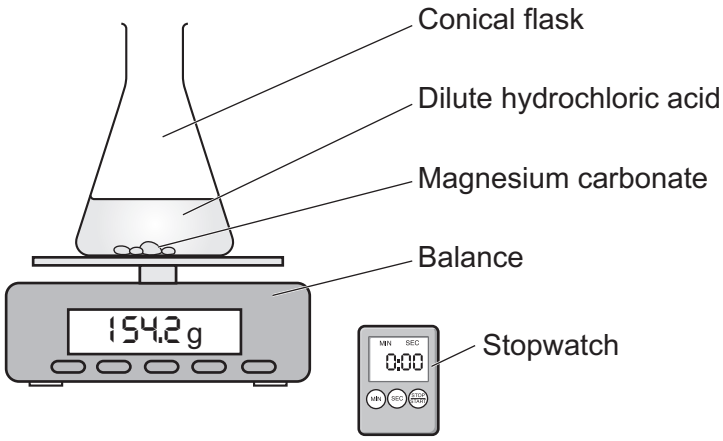
[1]

(b) A student reacts magnesium carbonate with dilute hydrochloric acid.
Carbon dioxide gas and a salt are made.

(i) What is the name of the salt made?

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

(ii) The diagram shows the apparatus the student uses.



How can the student tell when the reaction is complete?

.....

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

(iii) The student records the mass on the balance every 2 minutes for 12 minutes.

The student's results are shown in the table.

Time (minutes)	Mass (g)
0	154.2
2	150.5
4	148.2
6	146.5
8	145.3
10	144.0
12	142.9

The mass before the reaction starts is 154.2 g.

How much carbon dioxide gas is made after 8 minutes?

Mass of carbon dioxide = ... g **[2]**

(c) (i) The student wants to prepare a **pure**, **dry** sample of the soluble salt.
This is made by reacting magnesium carbonate and dilute hydrochloric acid.

Select the **three** correct steps that the student uses to prepare the pure, dry salt.

Put them in the order the student completes each step by labelling them 1, 2 and 3.

Crystallise the filtrate in an evaporating basin. ☐

Distil the filtrate using fractional distillation. ☐

Filter the solution, leaving the magnesium carbonate in the filter paper. ☐

Filter the solution, leaving the salt in the filter paper. ☐

React hydrochloric acid with excess magnesium carbonate. ☐

React magnesium carbonate with excess hydrochloric acid. ☐

[3]

(ii) The student does the experiment 4 times.

They measure the mass of salt produced. Their results are shown in the table.

Experiment number	Mass of salt (g)
1	20.95
2	22.36
3	21.78
4	23.40

Calculate the mean mass of salt produced.

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

Mean mass of salt produced = ... g **[3]**

18 The table shows data about four different substances.

Substance	Melting point (°C)	Boiling point (°C)	Soluble in water?	Conducts electricity as a solid?	Conducts electricity when molten or dissolved?
A	550	1300	yes	no	yes
B	–183	–162	no	no	no
C	420	907	no	yes	yes
D	1670	>1670	no	no	no

A scientist uses the information to find out what type of bonding is present in each substance.

(a) (i) The scientist thinks substance **A** is an **ionic** compound.

Explain why the scientist is correct.

.....

.....

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

(ii) Which of the substances is a **simple covalent** compound?

Explain your answer.

Substance .....

Reason 1 .....

Reason 2 .....

[3]

(iii) What is the state of substance **B** at room temperature?

Put a (ring) around the correct answer.

Solid **Liquid** **Gas**

[1]

(b) The scientist investigates some metals and metal alloys.

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

You can include a labelled diagram in your answer.

.....

.....

.....

.....

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

(ii) Explain why metals are malleable.

.....

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

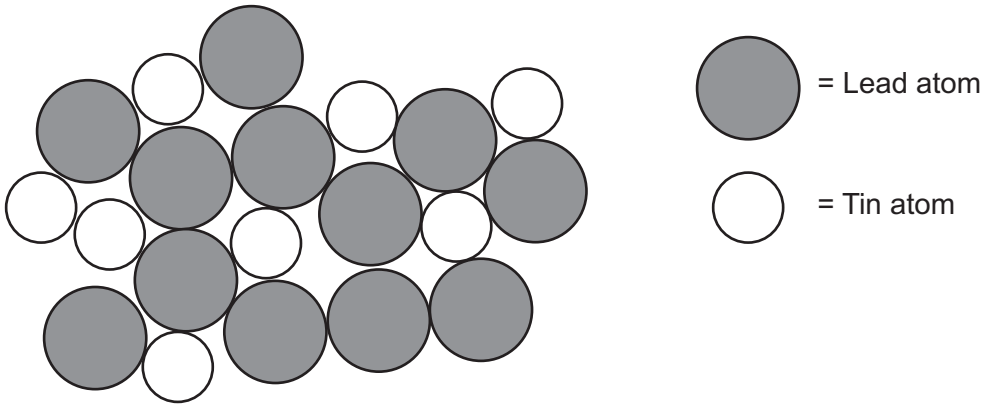
(iii) Explain why metals can conduct electricity.

.....

.....

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

(iv) The scientist has a diagram of one type of metal alloy as shown.



What is the smallest ratio of lead to tin in the alloy?

Ratio of lead to tin = ... **[2]**

(v) The table shows data about other alloys made from tin, copper and silver.

	Alloy 1	**Alloy 2**	**Alloy 3**
Tin content (%)	95.5	99.0	96.5
Copper content (%)	0.7	0.7	0.5
Silver content (%)	3.8	0.3	3.0
Melting point (°C)	217	227	220

What is the relationship between the silver content and the melting point?

.....

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

19 A student investigates dyes.

(a) Some dyes are nanoparticles.

(i) What is the size of a nanoparticle?

Tick (✓) **one** box.

Less than 1 nm ☐

Between 1 and 100 nm ☐

Between 100 and 1000 nm ☐

Greater than 1000 nm ☐

[1]

(ii) Some people think using nanoparticulate materials is dangerous. Other people want to keep using them.

State **one advantage** and **one disadvantage** of using nanoparticulate materials.

Advantage .....

.....

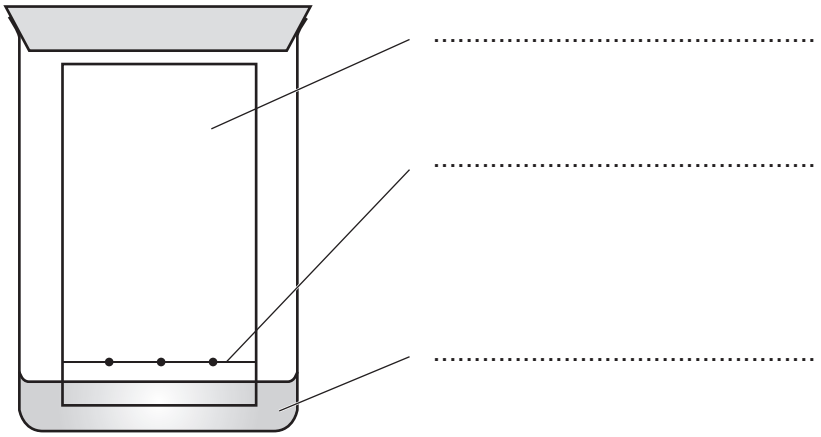
Disadvantage .....

.....

[2]

(b) The student uses paper chromatography to separate the dyes.

The diagram shows the apparatus at the start of the experiment.



Label the apparatus. Use phrases from the list.

Ink spot
Mobile phase
Pencil line
Solvent front
Stationary phase

[3]

(c) At the end of the experiment one of the dyes has moved 55 mm.

The solvent has moved 65 mm.

(i) Calculate the R_f value of this dye.

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

R_f value of dye = ... **[2]**

(ii) Another dye, **X**, has an R_f value of 0.22.

The student knows that the food colouring tartrazine has an R_f value of 0.11.

The student thinks dye **X** is tartrazine.

Explain why the student is incorrect.

.....

.....

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

20* The table shows the results of two chemical reactions, **A** and **B**.

	Temperature at the start of the reaction (°C)	**Temperature at the end of the reaction (°C)**	**Energy change (kJ / mol)**
Reaction **A**	25.5	32.1	– 157
Reaction **B**	23.4	18.3	+ 241

(a) Use the information in the table to state if each of the reactions, **A** and **B**, are exothermic or endothermic.

Explain your answers.

.....

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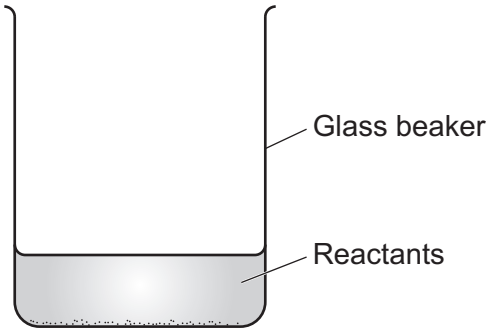
..... **[6]**

(b) A teacher wants to calculate the temperature change of another reaction.

The diagram shows the apparatus they use.



(i) The teacher measures the temperature of the reaction at the start and end of the reaction.

What apparatus do they use to measure the temperature?

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

(ii) The temperature of the reaction does not change. The teacher thinks too much heat is escaping from the apparatus.

Suggest **two** ways they can improve the apparatus to stop the heat escaping.

1 .....

.....

2 .....

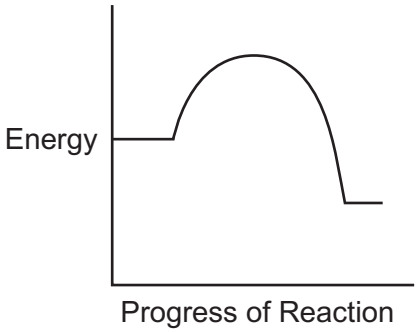
.....

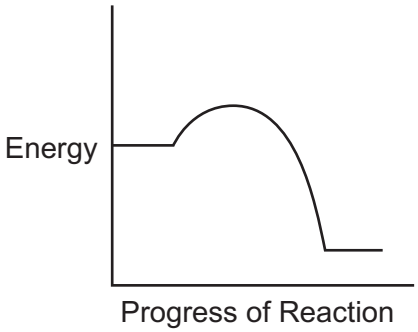
[2]

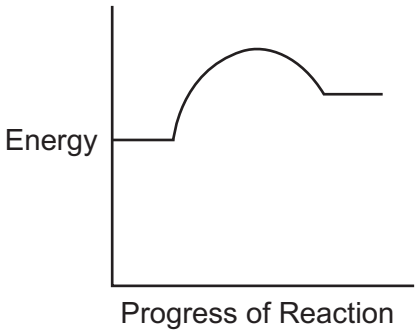
(c) The diagrams show the reaction profiles for four different reactions.

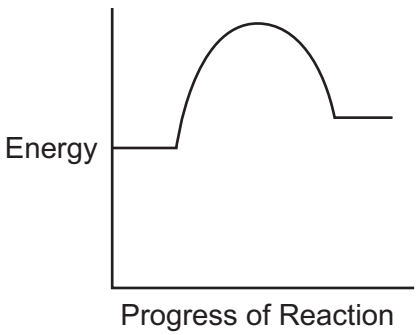
Draw **three** lines to connect the **reaction profile** with its correct **description**.

Reaction profile









Description

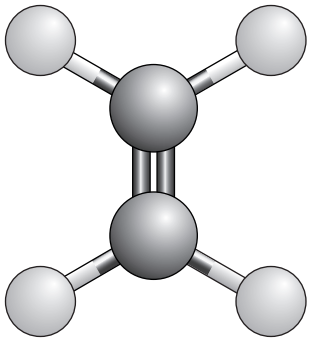
Exothermic reaction with low activation energy

Endothermic reaction with low activation energy

Exothermic reaction with high activation energy

[3]

21 The diagram shows a ball and stick model for ethene, C_2H_4.



(a) Which statements about this ball and stick model of ethene are correct?

Tick (✓) **two** boxes.

The model shows how many electrons the carbon atoms have. ☐

The model shows how many electrons the hydrogen atoms have. ☐

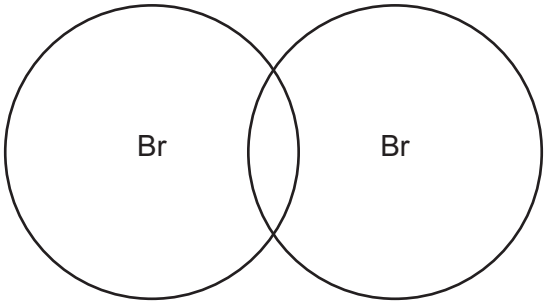
The model shows how much space each atom fills. ☐

The model shows that the carbon atoms are bigger than the hydrogen atoms. ☐

The model shows the difference between double bonds and single bonds. ☐

[2]

(b) Molecules can be drawn using dot and cross diagrams.



Complete the dot and cross diagram for bromine, Br_2.

Show the electrons in the outer shells only.

[2]

(c) At room temperature, ethene is a gas and bromine is a liquid.

Use the particle model to describe **two** differences between the movement or arrangement of the particles in ethene and the particles in bromine.

1 .....

.....

2 .....

.....

[2]

(d) Ethene reacts with bromine to make a product.

The relative formula mass of the product is 187.8.

There are **2** carbon atoms and **4** hydrogen atoms in the product.

Calculate how many bromine atoms are in the product.

Number of bromine atoms = ... **[3]**

22 A student has a sample of a **liquid**.

(a) (i) State a method the student uses to find out if the sample is **pure**.

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

(ii) The student finds out that the sample is **impure**.

The sample contains hexane, C_6H_{14}, and cyclohexane, C_6H_{12}.

What is the **empirical formula** of hexane?

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

(iii) The boiling point of hexane is lower than the boiling point of cyclohexane.

Describe a method the student could use to obtain a sample of **pure** hexane from the mixture of cyclohexane and hexane.

You can include a labelled diagram in your answer.

.....

.....

.....

.....

.....

.....

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

(b) (i) The student obtains 12.0 g of hexane from 15.2 g of the mixture of hexane and cyclohexane.

Calculate the percentage of hexane obtained.

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

Percentage of hexane = ... % **[2]**

(ii) Hexane reacts with oxygen in a combustion reaction.

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

2 C_6H_{14} + ...O_2 → .....CO_2 + ...H_2O

[1]

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).