Please write clearly in block capitals.

Centre number | Candidate number

Surname

Forename(s)

Candidate signature

AS
CHEMISTRY

Paper 1: Inorganic and Physical Chemistry

Specimen materials (set 2) 1 hour 30 minutes

Materials

For this paper you must have:
- the AS Chemistry Data Sheet/Periodic Table
- a ruler with millimetre measurements
- a calculator, which you are expected to use where appropriate.

Instructions
- Use black ink or black ball-point pen.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this paper is 80.
- The AS Chemistry Data Sheet/Periodic Table is provided.

Advice
- You are advised to spend about 65 minutes on **Section A** and 25 minutes on **Section B**.

Section A

Answer **all** questions in this section.

0 1 This question is about a toxic chloroalkane, **X**, that has a boiling point of 40 °C.

A student carried out an experiment to determine the M_r of **X** by injecting a sample of **X** from a hypodermic syringe into a gas syringe in an oven at 97 °C and 100 kPa.
The student's results are set out in **Table 1** and **Table 2**.

Table 1

Mass of hypodermic syringe filled with **X** before injection / g	10.340
Mass of hypodermic syringe with left over **X** after injection / g	10.070
Mass of **X** injected / g	

Table 2

Volume reading on gas syringe before injection of **X** / cm^3	0.0
Volume of **X** in gas syringe after injection of **X** / cm^3	105.0
Volume of **X** / cm^3	

0 1 . 1 Complete **Table 1** and **Table 2** by calculating the mass and volume of **X**.

[1 mark]

0 1 . 2 **X** is known to be one of the following chloroalkanes: CCl_4 $CHCl_3$ CH_2Cl_2 or CH_3Cl

Justify this statement by calculating a value for the M_r of **X** and use your answer to suggest the most likely identity of **X** from this list.

Give your answer for the M_r of X to an appropriate precision.
(The gas constant R = 8.31 J K^{-1} mol^{-1})

[5 marks]

M_r of **X**

M_r of **X** = ______________________

Identity of **X**
(If you have been unable to calculate a value for M_r, you may assume that the M_r value is 52. This is **not** the correct value).

Identity of **X** = ______________________

0 1 . 3 Suggest a reason, other than apparatus inaccuracy, why the M_r value determined from the experimental results differs from the actual M_r. Explain your answer.

[2 marks]

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Question 1 continues on the next page

0 1 . 4 Suggest, with a reason, an appropriate safety precaution that the student should take when using the toxic chloroalkane, **X**, in the experiment.

[2 marks]

Safety precaution ______________________________

____

Reason ______________________________

____

10

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

0 2

This question is about enthalpy changes.

0 2 . 1

Write an equation, including state symbols, to show the reaction taking place when the standard enthalpy of combustion for ethanol is measured.

[2 marks]

____

0 2 . 2

State the name given to the enthalpy change represented by the following chemical equation.
Explain why this enthalpy change would be difficult to determine directly.

[2 marks]

$$C(s) + \frac{1}{2}O_2(g) \longrightarrow CO(g)$$

Enthalpy change ____

Explanation ____

____

____

0 2 . 3

Standard enthalpies of combustion for carbon and carbon monoxide are -393 kJ mol^{-1} and -283 kJ mol^{-1}, respectively.

Use these data to calculate the enthalpy change for the reaction in **02.2**.

[2 marks]

Enthalpy change = ______________ kJ mol^{-1}

0 2 . 4 Use the following data to calculate a value for the Xe–F bond enthalpy in XeF_4

$$Xe(g) + 2F_2(g) \longrightarrow XeF_4(g) \qquad \Delta H = -252\ kJ\ mol^{-1}$$
$$F_2(g) \longrightarrow 2F(g) \qquad \Delta H = +158\ kJ\ mol^{-1}$$

[3 marks]

Xe–F bond enthalpy = ______________ $kJ\ mol^{-1}$

0 2 . 5 Suggest a reason why the value calculated in **02.4** differs from the mean Xe–F bond enthalpy quoted in a data source.

[1 mark]

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10

Turn over for the next question

0 3 Magnesium exists as three isotopes: ^{24}Mg, ^{25}Mg and ^{26}Mg

0 3 . 1 In terms of sub-atomic particles, state the difference between the three isotopes of magnesium.

[1 mark]

____

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0 3 . 2 State how, if at all, the chemical properties of these isotopes differ.
Give a reason for your answer.

[2 marks]

Chemical properties ____

____

Reason ____

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0 3 . 3 ^{25}Mg atoms make up 10.0% by mass in a sample of magnesium.
Magnesium has A_r = 24.3

Use this information to deduce the percentages of the other two magnesium isotopes present in the sample.

[4 marks]

^{24}Mg percentage = ______________ % ^{26}Mg percentage = ______________ %

0 3 . 4 In a TOF mass spectrometer, ions are accelerated to the same kinetic energy (KE).

$KE = \frac{1}{2}mv^2$ where m = mass (kg) and v = velocity (m s^{-1})

$v = \frac{d}{t}$ where d = distance (m) and t = time (s)

In a TOF mass spectrometer, each $^{25}Mg^{+}$ ion is accelerated to a kinetic energy of 4.52×10^{-16} J and the time of flight is 1.44×10^{-5} s.
Calculate the distance travelled, in metres, in the TOF drift region.
(The Avogadro constant L = 6.022×10^{23} mol^{-1})

[4 marks]

Distance = ____________________ m

11

0 4 A sample of strontium ore is known to contain strontium oxide, strontium carbonate and some inert impurities. To determine the mass of strontium carbonate present, a student weighed a sample of the solid ore and then heated it in a crucible for 5 minutes. The sample was allowed to cool and then reweighed. This heating, cooling and reweighing was carried out three times.

The results are set out in **Table 3**.

Table 3

Mass of crucible / g	9.85
Mass of crucible and ore sample / g	16.11
Mass of crucible and sample after first heating / g	14.66
Mass of crucible and sample after second heating / g	14.58
Mass of crucible and sample after third heating / g	14.58

0 4 . 1 When strontium carbonate is heated it decomposes according to the following equation.

$$SrCO_3 \longrightarrow SrO + CO_2$$

Give a reason why the mass of the solid sample changed during the experiment.

[1 mark]

0 4 . 2 Use the data in **Table 3** to calculate the mass of strontium carbonate in the original ore sample. Give your answer to an appropriate precision.

[5 marks]

Mass of strontium carbonate = ________________________ g

0 4 . 3 Each balance reading has an uncertainty of ±5.00 mg.

Calculate the percentage error in the initial mass of ore used.

[1 mark]

Percentage error = ________________________ %

Question 4 continues on the next page

0 4 . 4 The mass of inert impurities in the sample was 347 mg.

Deduce the mass of SrO in the sample and justify any assumption made in calculating your answer.
(If you have been unable to answer **04.2**, assume the mass of strontium carbonate was 4.85 g. This is **not** the correct answer.)

[2 marks]

Mass of SrO = ______________________

____

____

0 4 . 5 Strontium metal can be extracted by heating strontium oxide with aluminium metal.
In this reaction, strontium vapour and solid aluminium oxide are formed.

Write an equation for the reaction and state the role of the aluminium in the process.
Explain why strontium forms a vapour but aluminium oxide is formed as a solid.

[5 marks]

Equation

____

Role of aluminium ______________________________

____

Explanation ___________________________________

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14

0 5

A student was given a 50.0 g sample of solid silver chloride contaminated with solid silver carbonate.
The student suggested the following method to obtain the maximum amount of pure dry silver chloride from the sample:

1. Tip the solid into a boiling tube.
2. Add dilute nitric acid.
3. Allow the remaining solid to settle.
4. Decant off the liquid.
5. Leave the sample to dry on a shelf.

0 5 . 1 Identify any faults or omissions in the method suggested by the student.
Suggest improvements to the method, using commonly available laboratory equipment.

The following chemicals are also available:
distilled water, dilute solutions of NaOH, NH_3, HCl, H_2SO_4

[6 marks]

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6

0 6 This question is about elements in Group 7 of the Periodic Table and their compounds.

0 6 . 1 Bromine (Br_2), strontium chloride ($SrCl_2$) and iodine monochloride (ICl) all have similar M_r values.

Suggest, with reasons, the order of melting points for these three substances.

[6 marks]

0 6 . 2 Write an equation for the reaction of chlorine with cold water.
State a reason why chlorine is added to drinking water, and suggest a disadvantage of treating water in this way.

[3 marks]

Equation

Reason

Disadvantage

0 6 . 3 Bromine reacts with phosphorus to form phosphorus tribromide.

Write an equation for this reaction and draw the shape of the phosphorus tribromide molecule formed.
Suggest the bond angle in phosphorus tribromide.

[3 marks]

Equation

Shape

Bond angle

Question 6 continues on the next page

0 6 . 4 Phosphorus pentabromide in the solid state consists of PBr_4^+ and Br^- ions.

Draw the shape of the PBr_4^+ ion and suggest its bond angle.

[2 marks]

Shape

Bond angle ______________________

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Section B

Answer **all** questions in this section.

Only **one** answer per question is allowed.

For each answer completely fill in the oval alongside the appropriate answer.

CORRECT METHOD WRONG METHODS

If you want to change your answer you must cross out your original answer as shown.

If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown.

0 7 Which is the correct classification for the element yttrium (Y)?

[1 mark]

A s block

B p block

C d block

D f block

0 8 Which of the following is a correct statement about the trend in atomic radius across Period 3 of the Periodic Table?

[1 mark]

A radius increases because the atoms have more electrons

B radius decreases because nuclear charge increases

C radius increases because shielding (screening) increases

D radius decreases because shielding (screening) decreases

0 9 A measuring cylinder has an uncertainty of ±5 cm^3.

What is the minimum volume of liquid that can be measured if the percentage error in the volume is to be less than 0.20%?

[1 mark]

A 0.025 dm^3 ⬭

B 0.25 dm^3 ⬭

C 2.5 dm^3 ⬭

D 25 dm^3 ⬭

1 0 Element Q forms a sulfate with formula QSO_4

Which of these could represent the electronic configuration of an atom of Q?

[1 mark]

A $[Ne]3s^1$ ⬭

B $[Ne]3s^2$ ⬭

C $[Ne]3s^23p^1$ ⬭

D $[Ne]3s^13p^2$ ⬭

1 1 Which equation represents a reaction that does take place?

[1 mark]

A $Cl_2 + 2NaI \longrightarrow 2NaCl + I_2$ ⬭

B $Br_2 + 2NaCl \longrightarrow 2NaBr + Cl_2$ ⬭

C $NaCl + H_2O \longrightarrow HCl + NaOH$ ⬭

D $2HCl + H_2SO_4 \longrightarrow Cl_2 + SO_2 + 2H_2O$ ⬭

1 2 The following equilibrium was established in a container with volume V cm^3 at 393 K and 200 kPa.

$$M_2(g) + R(g) \rightleftharpoons RM_2(g) \quad \Delta H = +150 \text{ kJ mol}^{-1}$$

Which change would increase the yield of RM_2 ?

[1 mark]

A change the pressure to 150 kPa ⬭

B change the temperature to 293 K ⬭

C remove RM_2 as it is formed ⬭

D change the volume of the vessel to 2V cm^3 ⬭

1 3 Which of these shows nitrogen in its correct oxidation states in the compounds given?

[1 mark]

	NH_3	**N_2O**	**HNO_2**	
A	+3	–1	+5	⬭
B	–3	+1	+3	⬭
C	–3	+1	–5	⬭
D	+3	-1	–3	⬭

1 4 What is the volume of 0.200 mol dm^{-3} $Ba(OH)_2$ (aq) required to neutralise exactly 30.0 cm^3 of 0.100 mol dm^{-3} HCl(aq)?

[1 mark]

A 150.0 cm^3

B 75.0 cm^3

C 15.0 cm^3

D 7.50 cm^3

1 5 Which reaction has the largest atom economy for the production of hydrogen?

[1 mark]

A $C + H_2O \longrightarrow CO + H_2$

B $Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

C $CH_4 + H_2O \longrightarrow CO + 3H_2$

D $CO + H_2O \longrightarrow CO_2 + H_2$

1 6 Which species is the best oxidising agent?

[1 mark]

A Cl_2

B Cl^-

C Br_2

D Br^-

1 7 Which of these correctly shows the numbers of sub-atomic particles in a $^{41}K^{+}$ ion?

[1 mark]

	Number of electrons	Number of protons	Number of neutrons	
A	19	19	20	⬭
B	18	20	21	⬭
C	18	19	22	⬭
D	19	18	23	⬭

1 8 After reaction of some zinc metal with excess sulfuric acid, a student collected 40.8 g of $ZnSO_4.7H_2O$ crystals. The yield of crystals was 70.0%.

What was the original mass of zinc used?

[1 mark]

A 9.28 g ⬭

B 13.3 g ⬭

C 23.6 g ⬭

D 58.3 g ⬭

Turn over for the next question

1 9 Which of these is a redox reaction?

[1 mark]

A $CaO + SiO_2 \longrightarrow CaSiO_3$

B $H_2SO_4 + Na_2O \longrightarrow Na_2SO_4 + H_2O$

C $NaBr + H_2SO_4 \longrightarrow NaHSO_4 + HBr$

D $Mg + S \longrightarrow MgS$

2 0 2.40 g of an explosive, J, contains 0.473 g of nitrogen. J also contains 33.8% carbon and 1.41% hydrogen by mass. The remainder of J is oxygen.

What is the empirical formula of J?

[1 mark]

A C_4HNO_2

B CH_2N_2O

C C_2HNO_2

D CHNO

2 1 What is the number of atoms in 0.0100 mol of NH_3?
(The Avogadro constant $L = 6.022 \times 10^{23}$ mol^{-1})

[1 mark]

A 6.02×10^{25} ⬭

B 1.20×10^{23} ⬭

C 1.81×10^{22} ⬭

D 2.41×10^{22} ⬭

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END OF QUESTIONS

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There are no questions printed on this page

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