Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

AS CHEMISTRY

Paper 1 Inorganic and Physical Chemistry

Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:
- the Periodic Table/Data Sheet, provided as an insert (enclosed)
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- 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.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
Section B	
TOTAL	

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.

Advice

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

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Section A

Answer **all** questions in this section.

0 1 This question is about ionisation energies of Group 2 elements.

0 1 . 1 Explain why the first ionisation energy of the Group 2 elements decreases down the group.

[2 marks]

0 1 . 2 Give an equation, including state symbols, to represent the process that occurs when the third ionisation energy of magnesium is measured.

[1 mark]

0 1 . 3 Explain why the third ionisation energy of magnesium is much higher than the second ionisation energy of magnesium.

[2 marks]

5

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0 2 This question is about acid–base titrations.

Citric acid reacts with sodium hydroxide.

$$C_6H_8O_7(aq) + 3\,NaOH(aq) \rightarrow Na_3C_6H_5O_7(aq) + 3\,H_2O(l)$$

0 2 . 1 A student makes a solution of citric acid by dissolving some solid citric acid in water.

Describe a method to add an accurately known mass of solid to a beaker to make a solution.

[2 marks]

0 2 . 2 The student dissolves 0.834 g of citric acid in water and makes the solution up to 500 cm^3

Calculate the concentration, in mol dm^{-3}, of citric acid in this solution.

[3 marks]

Concentration _____ mol dm^{-3}

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0 2 . 3 The student uses this method to complete a titration.

- Rinse a burette with distilled water.
- Fill the burette with sodium hydroxide solution.
- Use a measuring cylinder to transfer 25 cm^3 of the citric acid solution into a conical flask.
- Add 5 cm^3 of indicator.
- Slowly add the sodium hydroxide solution from the burette into the conical flask.
- Add the sodium hydroxide solution dropwise near the end point until the indicator just changes colour.
- Repeat the titration to get concordant results.

The method used by the student includes three practical steps that will lead to an inaccurate final result.

For each of these three steps
- identify the mistake
- explain why it is a mistake
- suggest how the mistake can be overcome.

[6 marks]

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0 2 . 4 **Table 1** shows the student's burette readings after the mistakes in the practical procedure have been corrected.

Table 1

	Rough	**Run 1**	**Run 2**	**Run 3**
Final reading / cm^3	23.65	22.95	46.05	26.30
Start reading / cm^3	0.00	0.00	22.95	3.40
Titre / cm^3	23.65			

Complete **Table 1**.

Use the data in **Table 1** to calculate the mean titre.

[2 marks]

Mean titre _____ cm^3

0 2 . 5 The total uncertainty in the use of the burette is ±0.15 cm^3

Calculate the percentage uncertainty in the use of the burette in **Run 1**.

[1 mark]

Percentage uncertainty _____

14

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0 3 This question is about shapes of molecules.

Complete **Table 2** by drawing the shapes of both the AsF_5 and KrF_2 molecules, showing all lone pairs of electrons that influence the shape.

Deduce the bond angle(s) in AsF_5

[3 marks]

Table 2

	AsF_5	**KrF_2**
Diagram of shape		
Bond angle(s)		

3

Turn over for the next question

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0 4 This question is about intermolecular forces.

0 4 . 1 Complete the diagram to show how one molecule of ammonia can form a hydrogen bond with one molecule of ethanol.
Include all lone pairs of electrons and partial charges on atoms involved in the hydrogen bond.

[3 marks]

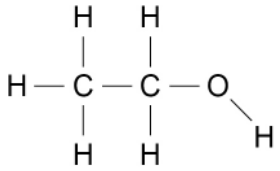


Table 3 shows the electronegativity values of atoms of some elements.

Table 3

Atom	H	C	N	O	Br
Electronegativity	2.1	2.5	3.0	3.5	2.8

0 4 . 2 Define the term electronegativity.

[1 mark]

0 4 . 3 Deduce the **two** atoms from **Table 3** that will form the most polar bond.

[1 mark]

Do not write outside the box

0 4 . 4 The C–Br bond is polar.

Explain why CBr_4 is **not** a polar molecule.

[2 marks]

0 4 . 5 Suggest, in terms of the intermolecular forces for each compound, why CBr_4 has a higher boiling point than $CHBr_3$

[3 marks]

10

Turn over for the next question

Do not write outside the box

0 5 A sample of antimony is analysed in a time of flight (TOF) mass spectrometer and is found to contain two isotopes, ^{121}Sb and ^{123}Sb

After electron impact ionisation, all of the ions are accelerated to the same kinetic energy (*KE*) and then travel through a flight tube that is 1.05 m long. A $^{121}Sb^{+}$ ion takes 5.93×10^{-4} s to travel through the flight tube.

The kinetic energy of an ion is given by the equation $KE = \frac{1}{2}mv^2$

KE = kinetic energy / J
m = mass / kg
v = speed / m s^{-1}

Calculate the mass, in kg, of one $^{121}Sb^{+}$ ion.

Calculate the time taken for a $^{123}Sb^{+}$ ion to travel through the same flight tube.

The Avogadro constant, $L = 6.022 \times 10^{23}$ mol^{-1}

[5 marks]

Mass of one $^{121}Sb^{+}$ ion _____ kg

Time taken by a $^{123}Sb^{+}$ ion _____ s

5

Do not write outside the box

0 6 Iodide ions can be oxidised to iodine using oxidising agents such as iodate(V) ions (IO_3^-) and concentrated sulfuric acid.

0 6 . 1 State, in terms of electrons, the meaning of the term oxidising agent.

[1 mark]

In acidic solution, IO_3^- ions oxidise iodide ions to iodine.

$$IO_3^- + 5I^- + 6H^+ \rightarrow 3I_2 + 3H_2O$$

0 6 . 2 Give a half-equation for the oxidation of iodide ions to iodine.

Deduce the half-equation to show the reduction process in this reaction.

[2 marks]

Oxidation half-equation

Reduction half-equation

0 6 . 3 When iodide ions are oxidised using concentrated sulfuric acid, sulfur dioxide, a yellow solid and a foul-smelling gas are all formed.

Give an equation to show the reaction between iodide ions and concentrated sulfuric acid to form the yellow solid.

Identify the foul-smelling gas.

[2 marks]

Equation

Identity of foul-smelling gas

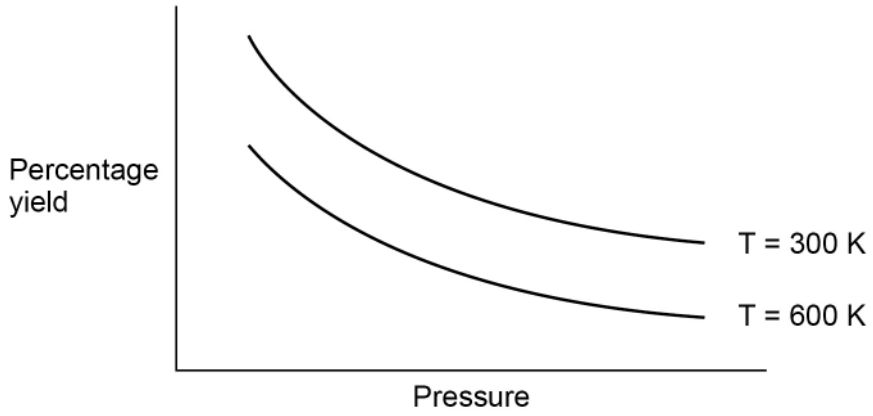
5

Do not write outside the box

0 7 This question is about gaseous equilibria.

Figure 1 shows the effect of pressure on the percentage yield of a reaction at equilibrium at two different temperatures.

Figure 1



0 7 . 1 Explain how **Figure 1** shows that the forward reaction in this equilibrium is exothermic.

[2 marks]

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0 7 . 2 State whether the forward reaction in this equilibrium results in an increase, decrease or no change in the amount, in moles, of gas.

Explain your answer.

[3 marks]

Tick (✓) **one** box.

increase ☐

decrease ☐

no change ☐

Explanation _____

_____

_____

_____

_____

0 7 . 3 Explain why using a catalyst has no effect on the percentage yield.

[1 mark]

_____

_____

_____

Question 7 continues on the next page

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Hydrogen and nitrogen react to form ammonia.

$$3\,H_2(g) + N_2(g) \rightleftharpoons 2\,NH_3(g)$$

At 745 K, the equilibrium constant, $K_c = 0.118\ mol^{-2}\ dm^6$

0 7 . 4 At 745 K, 0.150 dm^3 of an equilibrium mixture contains 0.0285 mol of hydrogen and 0.0870 mol of nitrogen.

Calculate the amount, in moles, of ammonia present in this equilibrium mixture.

[5 marks]

Amount of ammonia _____ mol

0 7 . 5 Calculate the value, at 745 K, for the equilibrium constant K_c for this dissociation of ammonia to give hydrogen and nitrogen.

State the units.

$$2\,NH_3(g) \rightleftharpoons 3\,H_2(g) + N_2(g)$$

[2 marks]

Value _____

Units _____

13

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Turn over for the next question

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0 8 A student does two test-tube reactions on four colourless solutions (**A**, **B**, **C** and **D**).

Table 4 shows the student's observations.

Table 4

Solution	**Test 1** Add $Na_2CO_3(s)$	**Test 2** Add acidified $AgNO_3(aq)$
A	Effervescence	No visible change
B	Effervescence	White precipitate
C	No visible change	No visible change
D	No visible change	Very pale yellow precipitate

0 8 . 1 Identify the gas formed in **Test 1**.

Describe a further test to confirm the identity of this gas.

[2 marks]

Identity of gas _____

Test

_____

_____

0 8 . 2 Explain how the observations from **Test 1** and **Test 2** can be used to show that solution **B** contains hydrochloric acid.

[2 marks]

_____

_____

_____

_____

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0 8 . 3 Describe a series of tests that the student can use to show that solution **C** contains ammonium sulfate.

[4 marks]

0 8 . 4 The student does an additional experiment to show that solution **D** contains a mixture of halide ions. One of the halide ions is chloride.

Method:

Step 1 Add an excess of $AgNO_3(aq)$ to 10.0 cm^3 of solution **D**.
Step 2 Filter, wash, dry and weigh the precipitate.
Step 3 Add an excess of dilute ammonia to the dry precipitate.
Step 4 Filter, wash, dry and weigh the solid that remains.

Explain how the masses recorded during this experiment can be used to show that solution **D** contains a mixture of halide ions.

[2 marks]

10

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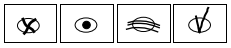
Section B

Answer **all** questions in this section.

Only **one** answer per question is allowed.
For each answer completely fill in the circle 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. 

You may do your working in the blank space around each question but this will not be marked. Do **not** use additional sheets for this working.

0 9 Which atom has two more protons and two more neutrons than $^{52}_{24}Cr$?

[1 mark]

A $^{54}_{26}Cr$ ⬭

B $^{56}_{26}Cr$ ⬭

C $^{54}_{26}Fe$ ⬭

D $^{56}_{26}Fe$ ⬭

1 0 An atom has all its electrons in their lowest energy levels.

Which atom contains only two unpaired electrons?

[1 mark]

A Helium ⬭

B Beryllium ⬭

C Oxygen ⬭

D Iron ⬭

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1 1 The first six ionisation energies, in kJ mol^{-1}, of an element are:

1090, 2350, 4610, 6220, 37 800, 47 000

What is the element?

[1 mark]

A Boron ⬭

B Carbon ⬭

C Nitrogen ⬭

D Oxygen ⬭

1 2 In which pair is the first ionisation energy of atom **Y** greater than that of atom **X**?

[1 mark]

	Electron configuration of atom **X**	Electron configuration of atom **Y**	
A	$1s^2 2s^2$	$1s^2 2s^2 2p^1$	⬭
B	$1s^2 2s^2 2p^3$	$1s^2 2s^2 2p^4$	⬭
C	$1s^2 2s^2 2p^5$	$1s^2 2s^2 2p^6$	⬭
D	$1s^2 2s^2 2p^6$	$1s^2 2s^2 2p^6 3s^1$	⬭

1 3 Which statement about isotopes of an element is **not** correct?

[1 mark]

A They have the same chemical properties. ⬭

B They have the same number of electrons in ions of the same charge. ⬭

C They have the same number of neutrons. ⬭

D They have the same number of protons. ⬭

Turn over ►

Do not write outside the box

1 4 5.0 g of an oxide contains 4.0 g of molybdenum.

What is the empirical formula of this oxide?

[1 mark]

A MoO_2 ⬭

B MoO_5 ⬭

C Mo_2O_3 ⬭

D Mo_3O_2 ⬭

1 5 The equation for a reaction is

$$AsH_3 + H^+ \rightarrow AsH_4^+$$

What type of interaction forms in this reaction?

[1 mark]

A Co-ordinate bond ⬭

B Dipole–dipole force ⬭

C Hydrogen bond ⬭

D Ionic bond ⬭

1 6 Which is a correct trend down Group 7 from fluorine to iodine?

[1 mark]

A The boiling point of the element decreases. ⬭

B The oxidising ability of the element decreases. ⬭

C The electronegativity of the atom increases. ⬭

D The first ionisation energy of the atom increases. ⬭

Do not write outside the box

1 7 Which of these ions has the largest ionic radius?

[1 mark]

A S^{2-} ⬭

B Cl^{-} ⬭

C K^{+} ⬭

D Ca^{2+} ⬭

1 8 Which statement is correct?

[1 mark]

A Chloride ions reduce concentrated sulfuric acid to form sulfur dioxide. ⬭

B Bromide ions reduce concentrated sulfuric acid to form sulfur. ⬭

C Bromide ions reduce iodine to form iodide ions. ⬭

D Iodide ions reduce chlorine to form chloride ions. ⬭

1 9 In which of these substances is oxygen in the highest oxidation state?

[1 mark]

A OF_2 ⬭

B H_2O ⬭

C O_2 ⬭

D H_2O_2 ⬭

Do not write outside the box

2 0 Which block in the Periodic Table contains the element samarium (Sm)?

[1 mark]

A d block ⬭

B f block ⬭

C p block ⬭

D s block ⬭

2 1 Which species is **not** a possible product of the reactions between chlorine and water?

[1 mark]

A Cl^- ⬭

B ClO^- ⬭

C O_2 ⬭

D OH^- ⬭

2 2 Which statement is correct?

[1 mark]

A Magnesium reacts with steam to give magnesium oxide as one of the products. ⬭

B Magnesium acts as an oxidising agent in the extraction of titanium. ⬭

C Magnesium has a lower melting point than sodium. ⬭

D Magnesium hydroxide is very soluble in water. ⬭

Do not write outside the box

2 3 Which is **not** responsible for conducting electricity?

[1 mark]

A The sodium ions in molten sodium chloride ⬭

B The electrons between layers of carbon atoms in graphite ⬭

C The bonding electrons in a metal ⬭

D The lone pair electrons in liquid water molecules ⬭

15

END OF QUESTIONS

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