AQA

AS
CHEMISTRY
(7404/1)

Paper 1: Inorganic and Physical Chemistry

Specimen 2015	Session	Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:
- the Data Sheet, provided as an insert
- a ruler
- a calculator.

Instructions
- Answer **all** questions.
- Show **all** your working.

Information
- The maximum mark for this paper is 80.

Please write clearly, in block capitals, to allow character computer recognition.

Centre number ☐☐☐☐☐   Candidate number ☐☐☐☐

Surname ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Forename(s) ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Candidate signature _____

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Section A

Answer **all** questions in this section.

1   This question is about the elements in Group 2 and their compounds.

| 0 | 1 | . | 1 | Use the Periodic Table to deduce the full electron configuration of calcium.

[1 mark]

| 0 | 1 | . | 2 | Write an ionic equation, with state symbols, to show the reaction of calcium with an excess of water.

[1 mark]

| 0 | 1 | . | 3 | State the role of water in the reaction with calcium.

[1 mark]

| 0 | 1 | . | 4 | Write an equation to show the process that occurs when the first ionisation energy of calcium is measured.

[1 mark]

| 0 | 1 | . | 5 | State and explain the trend in the first ionisation energies of the elements in Group 2 from magnesium to barium.

[3 marks]

Trend _____

Explanation _____

_____

_____

_____

_____

Turn over ▶

0 2 . 1 A sample of sulfur consisting of three isotopes has a relative atomic mass of 32.16
Table 1 gives the relative abundance of two of these isotopes.

Table 1

Mass number of isotope	32	33
Relative abundance / %	91.0	1.8

Use this information to determine the relative abundance and hence the mass number of the third isotope.
Give your answer to the appropriate number of significant figures.

[4 marks]

Mass number = _____

0 2 . 2 Describe how ions are formed in a time of flight (TOF) mass spectrometer.

[2 marks]

_____

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| 0 | 2 | . | 3 | A TOF mass spectrometer can be used to determine the relative molecular mass of molecular substances.

Explain why it is necessary to ionise molecules when measuring their mass in a TOF mass spectrometer.

[2 marks]

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Turn over for the next question

Turn over ▶

0 3 . 1 Write an equation, including state symbols, for the reaction with enthalpy change equal to the standard enthalpy of formation for $CF_4(g)$.

[1 mark]

0 3 . 2 Explain why CF_4 has a bond angle of 109.5°.

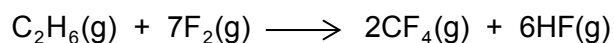**[2 marks]**

0 3 . 3 **Table 2** gives some values of standard enthalpies of formation ($\Delta_f H^\ominus$).

Table 2

Substance	$F_2(g)$	$CF_4(g)$	HF(g)
$\Delta_f H^\ominus$ / kJ mol^{-1}	0	–680	–269

The enthalpy change for the following reaction is –2889 kJ mol^{-1}.

$$C_2H_6(g) + 7F_2(g) \longrightarrow 2CF_4(g) + 6HF(g)$$

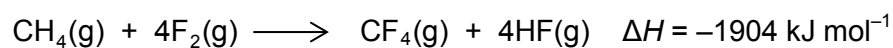Use this value and the standard enthalpies of formation in **Table 2** to calculate the standard enthalpy of formation of $C_2H_6(g)$.

[3 marks]

Standard enthalpy of formation of $C_2H_6(g)$ = _____ kJ mol^{-1}

0 3 . 4 Methane reacts violently with fluorine according to the following equation.

$$CH_4(g) + 4F_2(g) \longrightarrow CF_4(g) + 4HF(g) \quad \Delta H = -1904 \text{ kJ mol}^{-1}$$

Some mean bond enthalpies are given in **Table 3.**

Table 3

Bond	C–H	C–F	H–F
Mean bond enthalpy / kJ mol^{-1}	412	484	562

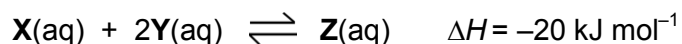A student suggested that one reason for the high reactivity of fluorine is a weak F–F bond .

Is the student correct? Justify your answer with a calculation using these data.

[4 marks]

Turn over for the next question

4   Colourless solutions of **X**(aq) and **Y**(aq) react to form an orange solution of **Z**(aq) according to the following equation.

$$\textbf{X}(aq) + 2\textbf{Y}(aq) \rightleftharpoons \textbf{Z}(aq) \qquad \Delta H = -20 \text{ kJ mol}^{-1}$$

A student added a solution containing 0.50 mol of **X**(aq) to a solution containing 0.50 mol of **Y**(aq) and shook the mixture.
After 30 seconds, there was no further change in colour.
The amount of **Z**(aq) at equilibrium was 0.20 mol.

0 4 . 1 Deduce the amounts of **X**(aq) and **Y**(aq) at equilibrium.

[2 marks]

Amount of **X**(aq) =＿＿＿＿＿＿mol   Amount of **Y**(aq) =＿＿＿＿＿＿＿mol

0 4 . 2 On the grid below, draw a graph to show how the amount of **Z**(aq) changed from the time of initial mixing until 60 seconds had elapsed.

[3 marks]
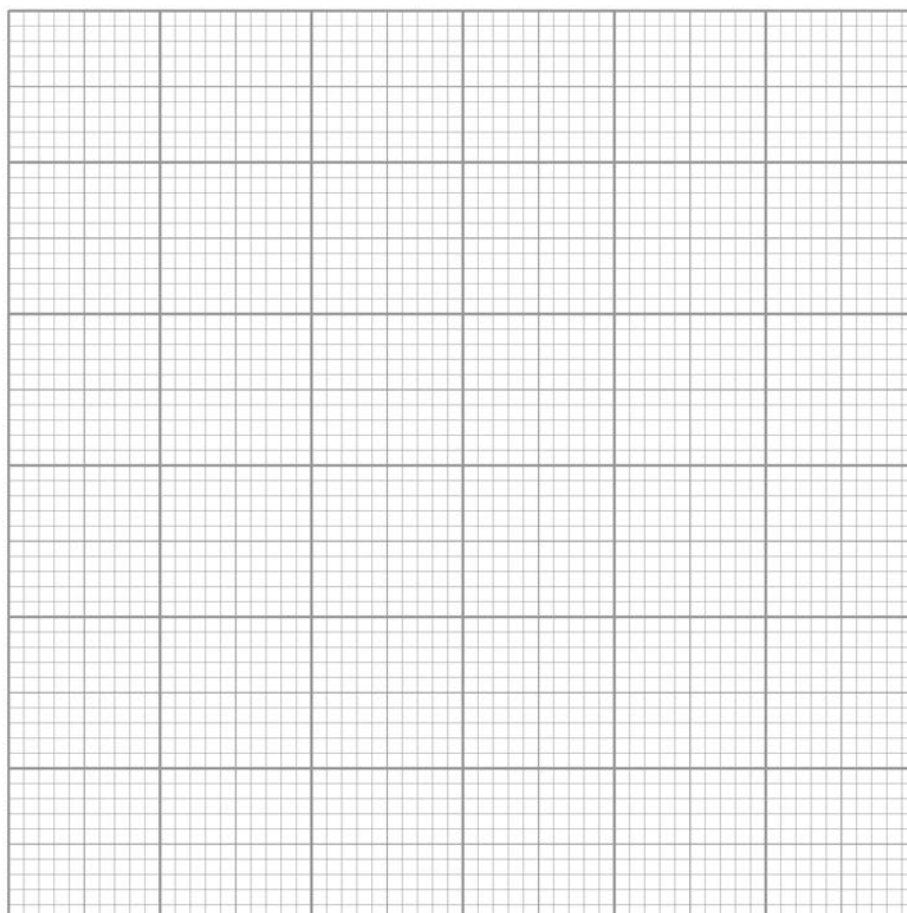
| 0 | 4 | . | 3 | The student prepared another equilibrium mixture in which the equilibrium concentrations of **X** and **Z** were:

X(aq) = 0.40 mol dm^{-3} and Z(aq) = 0.35 mol dm^{-3}.

For this reaction, the equilibrium constant K_c = 2.9 mol^{-2} dm^6.
Calculate a value for the concentration of **Y** at equilibrium.
Give your answer to the appropriate number of significant figures.

[3 marks]

$[Y]$ = _____ mol dm^{-3}

| 0 | 4 | . | 4 | The student added a few drops of **Y**(aq) to the equilibrium mixture of **X**(aq), **Y**(aq) and **Z**(aq) in Question **4.3**.

Suggest how the colour of the mixture changed. Give a reason for your answer.

[3 marks]

Colour change _____

Reason _____

_____

_____

_____

| 0 | 4 | . | 5 | The student warmed the equilibrium mixture from Question **4.3**.

Predict the colour change, if any, when the equilibrium mixture was warmed.

[1 mark]

_____

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Turn over ▶

5 This question is about the chemical properties of chlorine, sodium chloride and sodium bromide.

0 5 . 1 Sodium bromide reacts with concentrated sulfuric acid in a different way from sodium chloride.

Write an equation for this reaction of sodium bromide and explain why bromide ions react differently from chloride ions.

[3 marks]

Equation _____

Explanation _____

_____

_____

_____

0 5 . 2 A colourless solution contains a mixture of sodium chloride and sodium bromide.

Using aqueous silver nitrate and any other reagents of your choice, develop a procedure to prepare a pure sample of silver bromide from this mixture.
Explain each step in the procedure and illustrate your explanations with equations, where appropriate.

[6 marks]

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0 5 . 3 Write an ionic equation for the reaction between chlorine and cold dilute sodium hydroxide solution.
Give the oxidation state of chlorine in each of the chlorine-containing ions formed.

[2 marks]

Turn over for the next question

6 This question is about reactions of calcium compounds.

0 6 . 1 A pure solid is thought to be calcium hydroxide. The solid can be identified from its relative formula mass.

The relative formula mass can be determined experimentally by reacting a measured mass of the pure solid with an excess of hydrochloric acid. The equation for this reaction is

$$Ca(OH)_2 + 2HCl \longrightarrow CaCl_2 + 2H_2O$$

The unreacted acid can then be determined by titration with a standard sodium hydroxide solution.

You are provided with 50.0 cm^3 of 0.200 mol dm^{-3} hydrochloric acid.
Outline, giving brief practical details, how you would conduct an accurate experiment to calculate the relative formula mass of the solid using this method.

[8 marks]

0	6	.	2

A 3.56 g sample of calcium chloride was dissolved in water and reacted with an excess of sulfuric acid to form a precipitate of calcium sulfate.

The percentage yield of calcium sulfate was 83.4%.

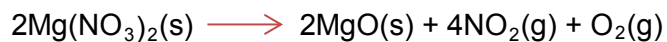Calculate the mass of calcium sulfate formed.
Give your answer to an appropriate number of significant figures.

[3 marks]

Mass of calcium sulfate formed = _____ g

Turn over for the next question

7 A sample of pure $Mg(NO_3)_2$ was decomposed by heating as shown in the equation below.

$$2Mg(NO_3)_2(s) \longrightarrow 2MgO(s) + 4NO_2(g) + O_2(g)$$

0 7 . 1 A 3.74×10^{-2} g sample of $Mg(NO_3)_2$ was completely decomposed by heating.

Calculate the total volume, in cm^3, of gas produced at 60.0 °C and 100 kPa.
Give your answer to the appropriate number of significant figures.
The gas constant R = 8.31 J K^{-1} mol^{-1}.

[5 marks]

Total volume of gas = _____ cm^3

0 7 . 2 The mass of MgO obtained in this experiment is slightly less than that expected from the mass of $Mg(NO_3)_2$ used.
Suggest **one** practical reason for this.

[1 mark]

_____

_____

_____

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. ⊗

| 0 | 8 | Which of these atoms has the largest atomic radius? |

[1 mark]

A Ar ⬭

B Cl ⬭

C Mg ⬭

D Na ⬭

| 0 | 9 | Which of these species is the best reducing agent? |

[1 mark]

A Cl_2 ⬭

B Cl^- ⬭

C I_2 ⬭

D I^- ⬭

1 0	Which of these pieces of apparatus has the lowest percentage error in the measurement shown?

[1 mark]

A   Volume of 25 cm^3 measured with a burette with an error of ±0.1 cm^3.   ⬭

B   Volume of 25 cm^3 measured with a measuring cylinder with an error of ±0.5 cm^3.   ⬭

C   Mass of 0.150 g measured with a balance with an error of ±0.001 g.   ⬭

D   Temperature change of 23.2 °C measured with a thermometer with an error of ±0.1 °C.   ⬭

1 1	A student is provided with a 5.00 cm^3 sample of 1.00×10^{-2} mol dm^{-3} hydrochloric acid. The student is asked to devise a method to prepare a hydrochloric acid solution with a concentration of 5.00×10^{-4} mol dm^{-3} by diluting the sample with water.

Which of these is the correct volume of water that should be added?

[1 mark]

A   45.0 cm^3 ⬭

B   95.0 cm^3 ⬭

C   100 cm^3 ⬭

D   995 cm^3 ⬭

1 2	Which of these species has a trigonal planar structure?

[1 mark]

A PH_3 ⬭

B BCl_3 ⬭

C H_3O^+ ⬭

D CH_3^- ⬭

1 3 Use your understanding of intermolecular forces to predict which of these compounds has the highest boiling point.

[1 mark]

A HF ⬭

B HCl ⬭

C HBr ⬭

D HI ⬭

1 4 Which type of bond is formed between N and B when a molecule of NH_3 reacts with a molecule of BF_3?

[1 mark]

A Ionic. ⬭

B Covalent. ⬭

C Co-ordinate. ⬭

D Van der Waals. ⬭

1 5 Which of these atoms has the highest electronegativity?

[1 mark]

A Na ⬭

B Mg ⬭

C Cl ⬭

D Ar ⬭

1 6 Which of these atoms has the smallest number of neutrons?

[1 mark]

A ^3H ⬭

B ^4He ⬭

C ^5He ⬭

D ^4Li ⬭

1 7 Which of these substances does **not** show hydrogen bonding?

[1 mark]

A HF ⬯

B NH_3 ⬯

C CH_3COOH ⬯

D CHF_3 ⬯

1 8 What is the formula of calcium nitrate(V)?

[1 mark]

A $CaNO_3$ ⬯

B $Ca(NO_3)_2$ ⬯

C Ca_2NO_2 ⬯

D $Ca(NO_2)_2$ ⬯

1 9 Which of these elements has the highest second ionisation energy?

[1 mark]

A Na ⬯

B Mg ⬯

C Ne ⬯

D Ar ⬯

2 0 Which of the following shows chlorine in its correct oxidation states in the compounds shown?

[1 mark]

	HCl	KClO$_3$	HClO	
A	−1	+3	+1	⬭
B	+1	−5	−1	⬭
C	−1	+5	+1	⬭
D	+1	+5	−1	⬭

2 1 Which substance is **not** produced in a redox reaction when solid sodium iodide reacts with concentrated sulfuric acid?

[1 mark]

A H$_2$S ⬭

B HI ⬭

C SO$_2$ ⬭

D I$_2$ ⬭

2 2 Which of the following contains the most chloride ions?

[1 mark]

A 10 cm^3 of 3.30 × 10^{-2} mol dm^{-3} aluminium chloride solution ⬭

B 20 cm^3 of 5.00 × 10^{-2} mol dm^{-3} calcium chloride solution ⬭

C 30 cm^3 of 3.30 × 10^{-2} mol dm^{-3} hydrochloric acid ⬭

D 40 cm^3 of 2.50 × 10^{-2} mol dm^{-3} sodium chloride solution ⬭

END OF QUESTIONS

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