AQA

AS
Chemistry
(7404/1)

Paper 1: Inorganic and Physical Chemistry

Specimen 2015 v0.5 Session 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.

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

Surname

Forename(s)

Candidate signature _____

There are no questions printed on this page

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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

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]

_____

_____

_____

_____

_____

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]

Turn over for the next question

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.

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

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.

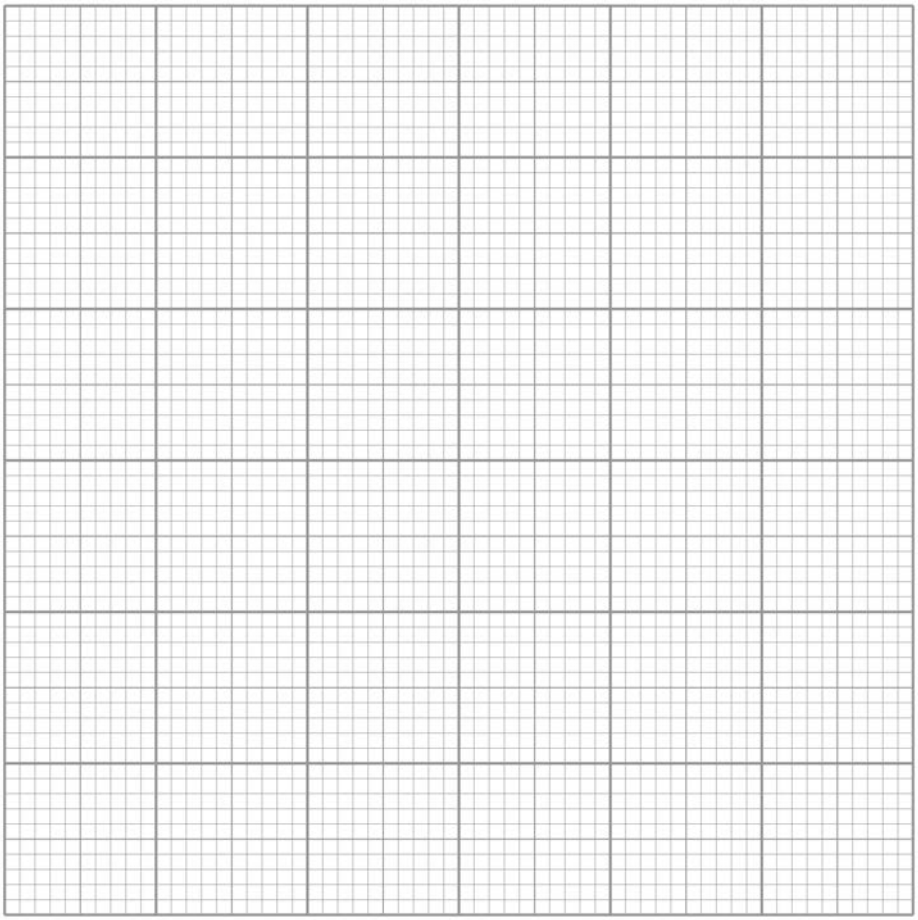
0 4 . 1 Deduce the amounts of **X**(aq) and **Y**(aq) at equilibrium.

[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]

_____

_____

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]

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 experiment to calculate accurately 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]

_____

_____

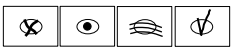
_____

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 uncertainty in the measurement shown?

[1 mark]

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

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

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

D Temperature change of 23.2 °C measured with a thermometer with an uncertainty 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 ^{3}H ⬭

B ^{4}He ⬭

C ^{5}He ⬭

D ^{4}Li ⬭

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_2S ⬭

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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