AQA

AS
Chemistry (7404/1)

Paper 1: Inorganic and Physical Chemistry

Specimen 2014 Session 1 hour 30 minutes

Materials
For this paper you must have:
- the Data Booklet, 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 _____

Section A

Answer **all** questions in this section.

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

0 1 . 1 Write the full electron configuration of calcium.

[1 mark]

0 1 . 2 Write an equation to show the reaction of calcium with water.

[1 mark]

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

[1 mark]

0 1 . 4 Give a use of the calcium-containing product from the reaction of calcium with water.

[1 mark]

0 1 . 5 Write an equation to show the process that occurs when the first ionisation energy of calcium is measured.

[1 mark]

0 1 . 6 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 for the next question

0 2 . 1 State the meaning of the term **relative atomic mass**.

[2 marks]

0 2 . 2 **Table 1** gives the relative abundance of each isotope in a sample of sulfur.

Table 1

Mass number of isotope	32	33	34
Relative abundance / %	91.0	1.8	7.2

Use the data in **Table 1** to calculate the relative atomic mass of sulfur.
Give your answer to 1 decimal place.

[3 marks]

Relative atomic mass = _____

0 2 . 3 Explain how molecules are ionised in a time of flight (TOF) mass spectrometer.

[2 marks]

0 2 . 4 Give **two** reasons why it is necessary to ionise molecules in a TOF mass spectrometer.

[2 marks]

1 _____

_____

2 _____

_____

Turn over for the next question

0 3 . 1 State the meaning of the term **standard enthalpy of formation**.

[3 marks]

0 3 . 2 State why the standard enthalpy of formation of fluorine is zero.

[1 mark]

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

[2 marks]

0 3 . 4 **Table 2** gives some values of standard enthalpies of formation ($\Delta H_f^{\ominus}$).

Table 2

Substance	$C_2H_6(g)$	$F_2(g)$	$CF_4(g)$	HF(g)
$\Delta H_f^{\ominus}$ / kJ mol^{-1}	–85	0	–680	–269

Use the standard enthalpies of formation in **Table 2** to calculate the standard enthalpy change for the following reaction.

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

[3 marks]

Standard enthalpy change = _____ kJ mol^{-1}

0 3 . 5 Hydrogen fluoride can be made by the reaction shown.

$$H_2(g) + F_2(g) \longrightarrow 2HF(g)$$

Use the bond enthalpies in **Table 3** to calculate the enthalpy of formation of HF

Table 3

Bond	H–H	F–F	H–F
Bond enthalpy / kJ mol^{-1}	436	158	562

[3 marks]

Enthalpy of formation = _____ kJ mol^{-1}

4 Hydrogen is formed in an industrial process when methane reacts with steam as shown below.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

0 4 . 1 State Le Chatelier's principle.

[1 mark]

0 4 . 2 State and explain the effect on the yield of hydrogen when the pressure at equilibrium is increased.

[3 marks]

Effect on yield

Explanation

0 4 . 3 A high yield of hydrogen is favoured by high temperature.

Deduce the sign of the enthalpy change for the forward reaction.
Explain your answer.

[2 marks]

Sign of the enthalpy change

Explanation

0 4 . 4 Suggest **one** reason why it is difficult to obtain a pure sample of hydrogen in this process.

[1 mark]

Turn over for the next question

5 The elements fluorine, chlorine, bromine and iodine are in the group called the halogens.

0 5 . 1 State and explain the trend in the electronegativities of the halogens from fluorine to iodine.

[3 marks]

Trend _____

Explanation _____

_____

_____

_____

0 5 . 2 Two colourless solutions are known to be sodium chloride and sodium bromide.

Describe how you would positively identify the halide ion in each solution.

[5 marks]

_____

_____

_____

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0 5 . 3 Write an equation to show the reaction between solid sodium chloride and concentrated sulfuric acid.

[1 mark]

0 5 . 4 A student needed to make a 250 cm^3 standard solution of 0.100 mol dm^{-3} Na_2CO_3

Give practical details of how to make this standard solution.

[7 marks]

6 This question is about reactions of magnesium compounds.

The equation for the reaction between magnesium carbonate and hydrochloric acid is given below.

$$MgCO_3 + 2HCl \longrightarrow MgCl_2 + H_2O + CO_2$$

A 1.32 g sample of impure $MgCO_3$ reacted with 50.0 cm^3 of 0.520 mol dm^{-3} hydrochloric acid.

0 6 . 1 Calculate the percentage purity of the $MgCO_3$ in the sample.
Give your answer to 3 significant figures.

[5 marks]

Percentage purity = _____ %

0 6 . 2 Write an equation to show the reaction of magnesium carbonate with nitric acid.

[1 mark]

_____

7 A sample of pure $MgCO_3$ was decomposed by heating as shown in the equation below.

$$MgCO_3(s) \longrightarrow MgO(s) + CO_2(g)$$

0 7 . 1 A 3.65 g sample of $MgCO_3$ was completely decomposed by heating.

Calculate the volume of CO_2 produced at 60 °C and 100 kPa.
The gas constant R = 8.31 J K^{-1} mol^{-1}.
Give your answer to 3 significant figures and state the units.

[4 marks]

Volume = _____ Units = _____

0 7 . 2 Calculate the mass of MgO that should be produced when 3.65 g of $MgCO_3$ is completely decomposed.
Give your answer to 3 significant figures.

[2 marks]

Mass of MgO = _____ g

0 7 . 3 The mass obtained in this experiment is slightly less than that calculated in Question **7.2**.
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 F_2 ⬭

B F^- ⬭

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 **Table 4** shows the results of a titration.

Table 4

Titration number	1	2	3	4
Final volume / cm^3	23.40	47.00	23.45	46.85
Initial volume / cm^3	0.20	23.40	0.00	23.45

Which results in **Table 4** should be included when the mean is calculated?

[1 mark]

A All the results. ⬭

B Titrations 1 and 3. ⬭

C Titrations 3 and 4. ⬭

D Titrations 2, 3 and 4. ⬭

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 In which of these reactions is sulfur reduced?

[1 mark]

A $MgSO_4(aq) + BaCl_2(aq) \longrightarrow MgCl_2(aq) + BaSO_4(s)$ ⬭

B $H_2SO_4(l) + NaCl(s) \longrightarrow NaHSO_4(s) + HCl(g)$ ⬭

C $2H_2SO_4(l) + 2NaI(s) \longrightarrow Na_2SO_4(s) + SO_2(g) + I_2(s) + 2H_2O(l)$ ⬭

D $Na_2SO_3(aq) + Cl_2(g) + H_2O(l) \longrightarrow Na_2SO_4(aq) + 2HCl(aq)$ ⬭

END OF QUESTIONS

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