OXFORD AQA

INTERNATIONAL QUALIFICATIONS

Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

INTERNATIONAL AS

CHEMISTRY (9620)

Unit 1: Inorganic 1 and Physical 1

Tuesday 13 January 2026 07:00 UK Time Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:

- the Periodic Table/Data Sheet, provided as an insert
- 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.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 70.

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

Answer **all** questions in the spaces provided.

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0 1 This question is about shapes of molecules and bonding in some boron compounds.

0 1 . 1 Explain why BH_3 has a bond angle of 120°

[2 marks]

0 1 . 2 A BH_4^- ion is formed when a BH_3 molecule reacts with a hydride ion (H^-).

State the type of bond formed in this reaction.

Explain how it is formed.

[2 marks]

Type of bond _____

Explanation _____

0 1 . 3 Which is correct about the bond angles in BH_3 and BH_4^- ?

Tick (✓) **one** box.

[1 mark]

The bond angle in BH_3 is smaller than the bond angle in BH_4^- ☐

The bond angle in BH_3 is the same as the bond angle in BH_4^- ☐

The bond angle in BH_3 is larger than the bond angle in BH_4^- ☐

5

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0 2 This question is about titration experiments between phosphoric acid (H_3PO_4) and sodium hydroxide.

0 2 . 1 A student does an experiment to determine the percentage purity of some impure phosphoric acid.

Method

1.56 g of the impure phosphoric acid are weighed directly into a 500 cm^3 volumetric flask.
De-ionised water is then added to the volumetric flask to make exactly 500 cm^3 of solution.
25.0 cm^3 portions of the diluted acid are titrated with 0.100 mol dm^{-3} sodium hydroxide solution.

The mean titre is 22.45 cm^3

The equation for the reaction is

$$H_3PO_4 + 3\,NaOH \rightarrow Na_3PO_4 + 3\,H_2O$$

Calculate the purity of the phosphoric acid as a percentage by mass.

[5 marks]

Purity by mass _____ %

Question 2 continues on the next page

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0 2 . 2 De-ionised water is added to the volumetric flask to make the solution up to exactly 500 cm^3

Describe how the water is added to the flask to make sure the volume is exactly 500 cm^3

[2 marks]

0 2 . 3 Another student does the same experiment with a different sample of the impure phosphoric acid.

Table 1 shows the results of their mass readings.
Table 2 shows the results of titrations.

Table 1

Mass of volumetric flask and phosphoric acid / g	398.73
Mass of empty volumetric flask / g	396.87

Table 2

	1	**2**	**3**	**4**
Final reading / cm^3	32.55	31.40	26.05	31.80
Initial reading / cm^3	4.50	5.00	1.05	5.50
Titre / cm^3	28.05	26.40	25.00	26.30

Calculate the mass of acid used **and** calculate the mean titre using appropriate results.

[2 marks]

Mass of acid used _____ g

Mean titre _____ cm^3

Do not write outside the box

0 2 . 4 The phosphoric acid solution can also be prepared by weighing the acid into a beaker and then dissolving it in de-ionised water.
The solution is then transferred to the volumetric flask.

State **one** advantage of weighing the phosphoric acid directly into the volumetric flask.

[1 mark]

0 2 . 5 A different student suggests using five times the mass of the phosphoric acid **and** a solution of sodium hydroxide that is five times as concentrated.

State the effect on the total uncertainty in the measurement of the mass of the impure phosphoric acid.

State the effect on the total uncertainty in the measurement of the titre.

[2 marks]

Effect on uncertainty in mass

Effect on uncertainty in titre

0 2 . 6 The volumetric flask needs to be rinsed with de-ionised water before the addition of the phosphoric acid but does not need to be dry.

State why the flask needs to be rinsed with de-ionised water before the addition of the phosphoric acid.

State why the flask does not need to be dry before the addition of the phosphoric acid.

[2 marks]

Why flask needs to be rinsed

Why flask does not need to be dry

14

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0 3 This question is about periodicity and the Period 3 elements from sodium to chlorine.

0 3 . 1 Give the meaning of the term periodicity as applied to the elements in the Periodic Table.

[1 mark]

0 3 . 2 Name the Period 3 element that has the highest electronegativity.

[1 mark]

There is a general trend of increasing first ionisation energies across Period 3.

0 3 . 3 Give the meaning of the term first ionisation energy.

[2 marks]

0 3 . 4 Identify **one** element that deviates from this trend.

[1 mark]

0 3 . 5 **Table 3** shows the successive ionisation energies of a Period 3 element.

Table 3

	1st	2nd	3rd	4th	5th	6th	7th	8th
Ionisation energy / kJ mol^{-1}	786	1 580	3 230	4 360	16 000	20 000	23 600	29 100

Identify this element.

[1 mark]

6

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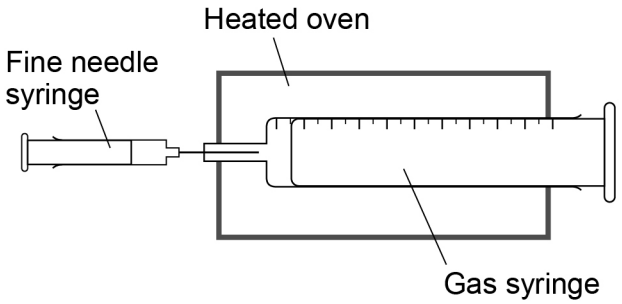
0 4 A student uses a gas syringe in an experiment to determine the relative molecular mass of a liquid with a low boiling point.

The student uses the apparatus in **Figure 1**.

Figure 1



The student injects a 0.146 g sample of the liquid into the gas syringe in an oven. When the liquid evaporates, the gas formed has a volume of 78.2 cm^3 measured at a pressure of 100 000 Pa and a temperature of 100 °C

Calculate the relative molecular mass of the liquid.
Give your answer to 3 significant figures.

The gas constant, R = 8.31 J K^{-1} mol^{-1}

[4 marks]

Relative molecular mass _____

4

Turn over ►

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0 5 This question is about energetics.

0 5 . 1 State Hess's Law.

[1 mark]

0 5 . 2 An equation for a reaction with an enthalpy change equal to the standard enthalpy of combustion of butane is shown.

$$CH_3CH_2CH_2CH_3(g) + 6\frac{1}{2}O_2(g) \rightarrow 4\,CO_2(g) + 5\,H_2O(l)$$

Table 4 shows some enthalpy change data.

Table 4

	Enthalpy change $\Delta H^{\ominus}$ / kJ mol^{-1}
$C(s) + O_2(g) \rightarrow CO_2(g)$	–394
$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$	–286
$4\,C(s) + 5\,H_2(g) \rightarrow CH_3CH_2CH_2CH_3(g)$	–125

Use Hess's Law and the data in **Table 4** to calculate a value, in kJ mol^{-1}, for the standard enthalpy of combustion of butane.

[2 marks]

Standard enthalpy of combustion of butane _____ kJ mol^{-1}

Do not write outside the box

0 5 . 3 Butane can react with oxygen to form gaseous water.

$$CH_3CH_2CH_2CH_3(g) + 6\tfrac{1}{2}O_2(g) \rightarrow 4CO_2(g) + 5H_2O(g) \qquad \Delta H = -2\,676 \text{ kJ mol}^{-1}$$

Use this information and your answer to Question **05.2** to determine the enthalpy change, in kJ mol^{-1}, for the reaction

$$H_2O(l) \rightarrow H_2O(g)$$

(If you did not answer Question **05.2**, you should use the value –3 326 kJ mol^{-1} This is **not** the correct answer.)

[2 marks]

Standard enthalpy change _____ kJ mol^{-1}

0 5 . 4 **Table 5** contains some bond enthalpy data.

Table 5

	C–H	**O=O**	**C=O**	**O–H**
Bond enthalpy / kJ mol^{-1}	412	496	805	463

Use the data in **Table 5** and the equation in Question **05.3** to calculate a value for the mean bond enthalpy, in kJ mol^{-1}, for the C–C bond in butane ($CH_3CH_2CH_2CH_3$).

[3 marks]

Mean C–C bond enthalpy _____ kJ mol^{-1}

8

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0 6 This question is about the elements in Group 2 and their compounds.

0 6 . 1 Explain, in terms of structure and bonding, why the melting points of the Group 2 elements decrease from calcium to barium.

[2 marks]

0 6 . 2 Explain, in terms of structure and bonding, why the melting point of barium chloride is high.

[3 marks]

0 6 . 3 An aqueous solution of a barium compound is reacted with an excess of a solution containing sulfate ions.
A precipitate of barium sulfate is formed.
The precipitate is filtered off and weighed.

Suggest **two** practical steps the student should include in their method **before** weighing the precipitate so that the mass of barium sulfate is accurate.

[2 marks]

1 _____

2 _____

Do not write outside the box

0 6 . 4 A student dissolves 2.91 g of barium chloride crystals ($BaCl_2 \cdot xH_2O$) in de-ionised water and adds an excess of a solution containing sulfate ions.

The mass of barium sulfate formed is 2.78 g
The ionic equation for the reaction is

$$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$$

Determine the value of x

[4 marks]

Value of x _____

0 6 . 5 State why the method used in Question **06.4** cannot be used to determine the value of x in $MgCl_2 \cdot xH_2O$

[1 mark]

_____

_____

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Turn over ►

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0 7 This question is about germanium.

0 7 . 1 Give the full electron configuration of a germanium atom.

[1 mark]

0 7 . 2 Explain why the second ionisation energy of germanium is lower than the second ionisation energy of gallium.

[2 marks]

0 7 . 3 Give the symbol, including the atomic number and the mass number, for the atom that has two more protons and three more neutrons than an atom of ^{73}Ge

[2 marks]

A sample of germanium is analysed using time of flight (TOF) mass spectrometry.
The sample is ionised by electron impact to form 1+ ions.
The sample is made up of five different isotopes: ^{70}Ge, ^{72}Ge, ^{73}Ge, ^{74}Ge and ^{76}Ge

0 7 . 4 State why the $^{70}Ge^{+}$ ion reaches the detector first.

[1 mark]

0 7 . 5 State how the detector allows the relative abundance of each isotope to be determined.

[1 mark]

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0 7 . 6 **Table 6** shows data about three of the peaks in the spectrum.

Table 6

m/z	Percentage abundance
70	20.6
72	27.4
73	7.8

The sample has a relative atomic mass, A_r = 72.7

Calculate the percentage abundance of ^{74}Ge **and** the percentage abundance of ^{76}Ge in the sample.
Give your answers to 1 decimal place.

[4 marks]

Percentage abundance of ^{74}Ge _____

Percentage abundance of ^{76}Ge _____

11

Turn over ►

Do not write outside the box

0 8 This question is about the elements in Group 7 (Group 17) and their compounds.

0 8 . 1 Give **one** observation when chlorine is added to an aqueous solution of potassium bromide.

Write the simplest ionic equation for the reaction.

[2 marks]

Observation _____

Ionic equation

_____

0 8 . 2 Give the formula of a compound which can be used to show the presence of bromide ions in an aqueous solution of potassium bromide.

Give the observation you would make.

[2 marks]

Formula of compound _____

Observation _____

The presence of bromide ions in a solid potassium halide can be shown by adding a few drops of concentrated sulfuric acid to the solid in a test tube.
A sulfur-containing gas is formed in a redox reaction.

0 8 . 3 Write an ionic equation for the redox reaction between potassium bromide and sulfuric acid.

Identify one environmental problem that is caused by the sulfur-containing gas formed.

State the role of bromide ions in the reaction.

[3 marks]

Ionic equation

_____

Environmental problem _____

Role _____

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0 8 . 4 Van der Waals forces exist between chlorine molecules.

Explain how these forces arise.

[3 marks]

10

END OF QUESTIONS

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