2021 ASSESSMENT MATERIALS

AS CHEMISTRY

Physical and Inorganic Chemistry

Total number of marks: 45

0 6 This question is about shapes of molecules and ions.

Draw the shape of NCl_3 and of NCl_4^+

Include any lone pairs of electrons that influence the shape.

Name the shape of NCl_3

State and explain the bond angle in NCl_4^+

[5 marks]

Shape of NCl_3 **Shape of NCl_4^+**

Name of shape of NCl_3 _____

Bond angle in NCl_4^+ _____

Explanation of bond angle in NCl_4^+ _____

0 9 . 3 Silicon tetrafluoride (SiF_4) is a tetrahedral molecule.

Deduce the type of intermolecular forces in SiF_4
Explain how this type of intermolecular force arises and why no other type of intermolecular force exists in a sample of SiF_4

[3 marks]

Intermolecular forces in SiF_4 _____

Explanation _____

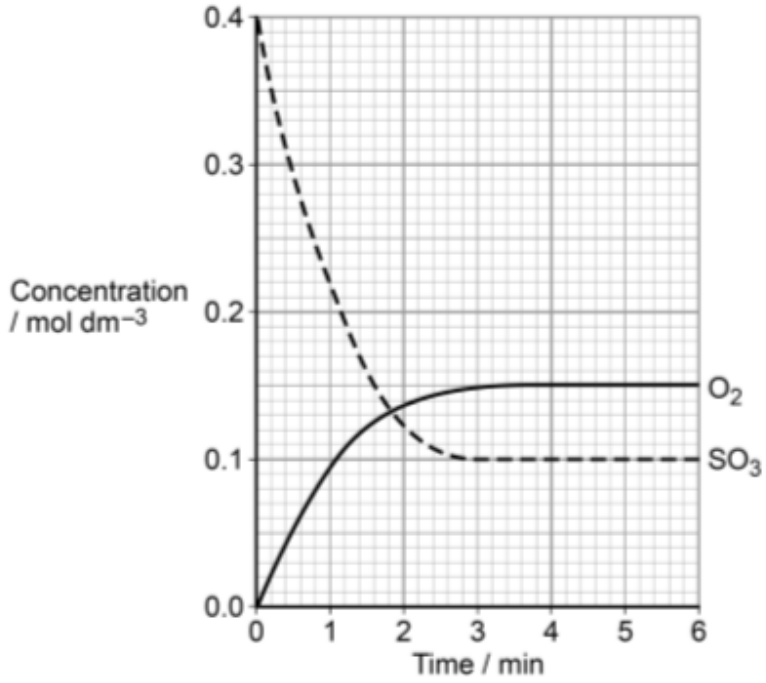
0 5 This question is about equilibrium.

Sulfur trioxide decomposes to form sulfur dioxide and oxygen at temperature T_1 according to the equilibrium shown.

$$2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g) \qquad \Delta H = +196 \text{ kJ mol}^{-1}$$

The graph in **Figure 4** shows the concentrations of sulfur trioxide and of oxygen over a period of 6 minutes at temperature T_1

Figure 4



0 5 . 1 State the time, to the nearest minute, when equilibrium is first established.
Explain your answer.

[2 marks]

Time _____ minutes

Explanation _____

0 5 . 2 Sketch on the graph in **Figure 4** how the concentration of sulfur dioxide changes over these 6 minutes at temperature T_1

[2 marks]

0 5 . 3 The temperature of the mixture was changed to T_2 and the mixture left to establish a new equilibrium.
In the new equilibrium mixture the concentration of sulfur trioxide was found to be 0.07 mol dm^{-3}

Deduce which of T_1 and T_2 is the higher temperature.
Explain your deduction.

[2 marks]

Higher temperature _____

Explanation _____

0 5 This question is about Group 2 elements and their compounds.

0 5 . 1 Explain why the melting point of magnesium is higher than the melting point of sodium.

[2 marks]

0 5 . 2 Give an equation to show how magnesium is used as the reducing agent in the extraction of titanium.

Explain, in terms of oxidation states, why magnesium is the reducing agent.

[2 marks]

Equation

_____

Explanation _____

0 5 . 3 State what is observed when dilute aqueous sodium hydroxide is added to separate solutions of magnesium chloride and barium chloride.

[2 marks]

Observation with magnesium chloride _____

Observation with barium chloride _____

0 7 Chlorine is used to decrease the numbers of microorganisms in water.

When chlorine is added to water, there is a redox reaction, as shown by the equation

$$Cl_2 + H_2O \rightleftharpoons HClO + HCl$$

0 7 . 1 Deduce the oxidation state of chlorine in HClO and the oxidation state of chlorine in HCl

[1 mark]

Oxidation state of chlorine in HClO _____

Oxidation state of chlorine in HCl _____

0 7 . 2 Give two half-equations to show the oxidation and reduction processes that occur in this redox reaction.

[2 marks]

Oxidation half-equation _____

Reduction half-equation _____

0 1 This question is about atomic structure.

0 1 . 1 There is a general trend for an increase in ionisation energy across Period 3.
Give **one** example of an element that deviates from this trend.

Explain why this deviation occurs.

[3 marks]

Element _____

Explanation _____

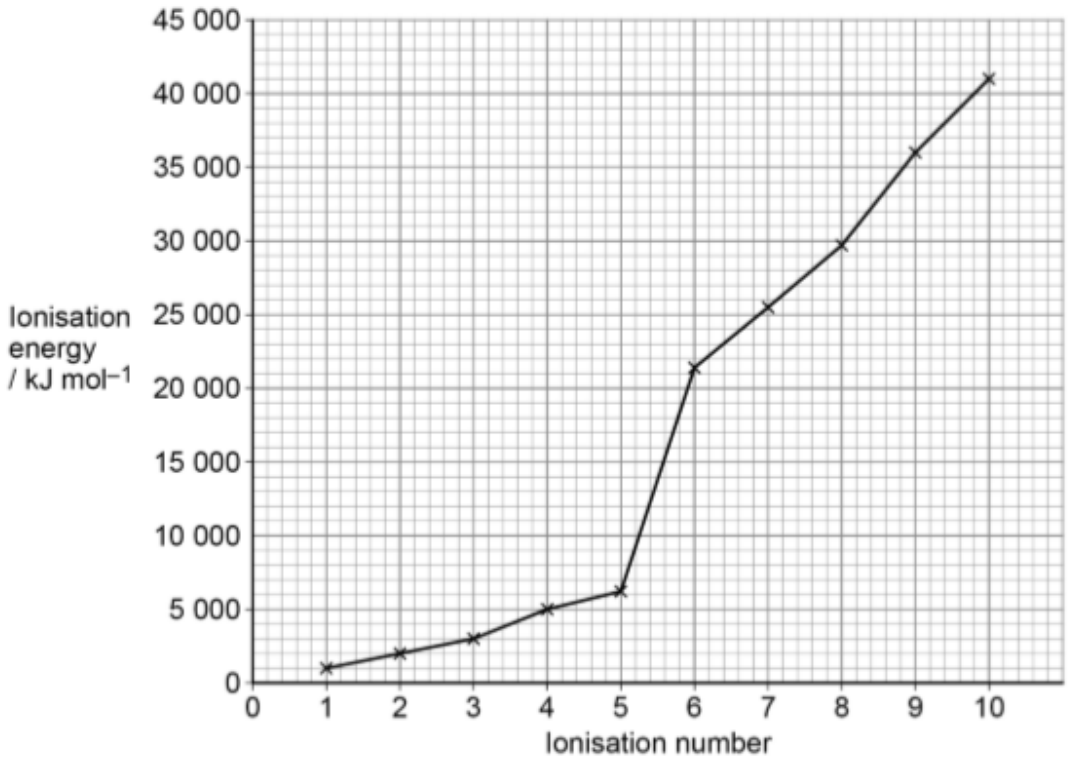
0 1 . 2 Give an equation, including state symbols, to represent the process that occurs when the **third** ionisation energy of sodium is measured.

[1 mark]

_____

0 1 . 3 **Figure 1** shows the successive ionisation energies of a Period 3 element, **X**.

Figure 1



Identify element **X**.
Explain your choice.

[3 marks]

Element _____

Explanation _____

0 7 . 2 Solid sodium iodide reacts with concentrated sulfuric acid to form iodine and sulfur in a redox reaction.

Give a half-equation to show the conversion of iodide ions to iodine.

Give a half-equation to show the conversion of sulfuric acid to sulfur.

Give an overall equation for this redox reaction.

Identify one other sulfur-containing reduction product formed when solid sodium iodide reacts with concentrated sulfuric acid.

[4 marks]

Half-equation for the conversion of iodide ions to iodine

Half-equation for the conversion of sulfuric acid to sulfur

Overall equation

Other sulfur-containing reduction product

A student completes an experiment to determine the percentage by mass of sodium chloride in a mixture of sodium chloride and sodium iodide.

The student uses this method.

- 600 mg of the mixture are dissolved in water to form a solution.
- An excess of aqueous silver nitrate is added to the solution. This forms a precipitate containing silver chloride and silver iodide.
- Excess dilute ammonia solution is then added to the precipitate. The silver chloride dissolves.
- The silver iodide is filtered off from the solution, and is then washed and dried.

The mass of the silver iodide obtained is 315 mg

0 7 . 3 Silver nitrate is added to the solution.

Suggest why an excess is used.

[1 mark]

0 7 . 4 Calculate the amount, in moles, of silver iodide obtained.

M_r(AgI) = 234.8

[1 mark]

Amount of silver iodide _____ mol

0 7 . 5 Calculate, using your answer to Question **07.4**, the mass, in grams, of sodium iodide in the mixture.

M_r(NaI) = 149.9

[1 mark]

Mass of sodium iodide _____ g

0 7 . 6 Calculate, using your answer to Question **07.5**, the percentage by mass of sodium chloride in the mixture.

[2 marks]

Percentage of sodium chloride _____

0 9 Which sample, measured at room temperature and pressure, contains the greatest number of the stated particles?

[1 mark]

A 1 g of hydrogen molecules ⬭

B 1 g of helium atoms ⬭

C 1 dm^3 of hydrogen molecules ⬭

D 1 dm^3 of helium atoms ⬭

1 0 5.0 g of an oxide of molybdenum contain 4.0 g of molybdenum.

What is the empirical formula of this oxide?

[1 mark]

A MoO_2 ⬭

B Mo_4O_5 ⬭

C Mo_2O_3 ⬭

D Mo_3O_2 ⬭

1 6 Which property would you expect the element radium, Ra, to possess?

[1 mark]

A It forms a soluble sulfate. ⬭

B It does not react with water. ⬭

C It is a good conductor of electricity. ⬭

D It forms a covalent fluoride. ⬭

1 5 Which equation does **not** represent a redox reaction?

[1 mark]

A $Mg + 2HCl \rightarrow MgCl_2 + H_2$ ⬭

B $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ ⬭

C $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$ ⬭

D $CuO + 2HCl \rightarrow CuCl_2 + H_2O$ ⬭

1 3 NO_2^- ions can be reduced in acidic solution to NO
How many electrons are gained when each NO_2^- ion is reduced?

[1 mark]

A 1 ⬭

B 2 ⬭

C 3 ⬭

D 4 ⬭

1 1 How many protons are there in 6.0 g of nitrogen gas?

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

[1 mark]

A 1.3×10^{23} ⬭

B 9.0×10^{23} ⬭

C 1.8×10^{24} ⬭

D 3.6×10^{24} ⬭