**AS LEVEL CHEMISTRY**

**PAPER 1**

**PRACTICE PAPER 7**

Answer all questions

Max 80 marks

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|  | Name …………………………………………………………….. |  |
|  | Mark ……../80 ……....% Grade ……… |  |

**Note – the multiple choice questions used in this paper are recycled from the assessed homeworks, tests and assessment points for the AS-level/1st Year course**

**1.**          Ionisation energies provide evidence for the arrangement of electrons in atoms.

(a)     Complete the electron configuration of the Mg+ ion.

1s2 ................................................................................................................

**(1)**

(b)     (i)      State the meaning of the term *first ionisation energy*.

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**(2)**

(ii)     Write an equation, including state symbols, to show the reaction that occurs when the **second** ionisation energy of magnesium is measured.

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**(1)**

(iii)     Explain why the second ionisation energy of magnesium is greater than the first ionisation energy of magnesium.

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**(1)**

(iv)    Use your understanding of electron arrangement to complete the table by suggesting a value for the third ionisation energy of magnesium.

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| --- | --- | --- | --- | --- | --- |
|  | First | Second | Third | Fourth | Fifth |
| Ionisation energies of magnesium / kJ mol–1 | 736 | 1450 |  | 10 500 | 13 629 |

**(1)**

(c)     State and explain the general trend in the first ionisation energies of the Period 3 elements sodium to chlorine.

Trend ...........................................................................................................

Explanation ..................................................................................................

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**(3)**

(d)     State how the element sulfur deviates from the general trend in first ionisation energies across Period 3. Explain your answer.

How sulfur deviates from the trend ..............................................................

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Explanation ..................................................................................................

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**(3)**

(e)     A general trend exists in the first ionisation energies of the Period 2 elements lithium to fluorine. Identify **one** element which deviates from this general trend.

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**(1)**

**(Total 13 marks)**

**2.**      The following two-stage method was used to analyse a mixture containing the solids magnesium, magnesium oxide and sodium chloride.

**Stage 1**A weighed sample of the mixture was treated with an excess of dilute hydrochloric acid.  
The sodium chloride dissolved in the acid. The magnesium oxide reacted to form a solution of magnesium chloride. The magnesium also reacted to form hydrogen gas and a solution of magnesium chloride. The hydrogen produced was collected.

(a)     Write equations for the two reactions involving hydrochloric acid.

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**(2)**

(b)     State how you would collect the hydrogen. State the measurements that you would make in order to calculate the number of moles of hydrogen produced. Explain how your results could be used to determine the number of moles of magnesium metal in the sample.

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**(6)**

**Stage 2**Sodium hydroxide solution was added to the solution formed in **Stage 1** until no further precipitation of magnesium hydroxide occurred. This precipitate was filtered off, collected, dried and heated strongly until it had decomposed completely into magnesium oxide. The oxide was weighed.

(c)     Write equations for the formation of magnesium hydroxide and for its decomposition into magnesium oxide.

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**(3)**

(d)     When a 6.25 g sample of the mixture of the three solids was analysed as described above, the following results were obtained.

Hydrogen obtained in **Stage 1**                                              0.0528 mol

Mass of magnesium oxide obtained in **Stage 2**                   6.41 g

Use these results to calculate the number of moles of original magnesium oxide in 100 g of the mixture.

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**(4)**

**(Total 15 marks)**

**3.** Fluorine forms compounds with many other elements.

(a)     Fluorine reacts with bromine to form liquid bromine trifluoride (BrF3).  
State the type of bond between Br and F in BrF3 and state how this bond is formed.

Type of bond ..................................................................................................

How bond is formed ......................................................................................

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**(2)**

(b)     Two molecules of BrF3 react to form ions as shown by the following equation.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | 2BrF3 |  | BrF2+ | + | BrF4– |

(i)      Draw the shape of BrF3 and predict its bond angle.  
Include any lone pairs of electrons that influence the shape.

Shape of BrF3

Bond angle ............................................................................................

**(2)**

(ii)     Draw the shape of BrF4– and predict its bond angle.  
Include any lone pairs of electrons that influence the shape.

Shape of BrF4–

Bond angle ............................................................................................

**(2)**

(c)     BrF4– ions are also formed when potassium fluoride dissolves in liquid BrF3 to form KBrF4Explain, in terms of bonding, why KBrF4 has a high melting point.

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**(3)**

(d)     Fluorine reacts with hydrogen to form hydrogen fluoride (HF).

(i)      State the strongest type of intermolecular force between hydrogen fluoride molecules.

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**(1)**

(ii)     Draw a diagram to show how two molecules of hydrogen fluoride are attracted to each other by the type of intermolecular force that you stated in part (d)(i). Include all partial charges and all lone pairs of electrons in your diagram.

**(3)**

(e)     The boiling points of fluorine and hydrogen fluoride are –188 °C and 19.5 °C respectively.  
Explain, in terms of bonding, why the boiling point of fluorine is very low.

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**(2)**

**(Total 15 marks)**

**4.** A student investigated the chemistry of the halogens and the halide ions.

(a)     In the first two tests, the student made the following observations.

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| --- | --- |
| **Test** | **Observation** |
| **1.** Add chlorine water to aqueous     potassium iodide solution. | The colourless solution turned a brown colour. |
| **2.** Add silver nitrate solution to aqueous     potassium chloride solution. | The colourless solution produced a white precipitate. |

(i)      Identify the species responsible for the brown colour in Test **1**.

Write the **simplest ionic** equation for the reaction that has taken place in Test **1**.

State the type of reaction that has taken place in Test **1**.

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**(3)**

(ii)     Name the species responsible for the white precipitate in Test **2**.

Write the **simplest ionic** equation for the reaction that has taken place in Test **2**.

State what would be observed when an excess of dilute ammonia solution is added to the white precipitate obtained in Test **2**.

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**(3)**

(b)     In two further tests, the student made the following observations.

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| **Test** | **Observation** |
| **3.** Add concentrated sulfuric acid to     solid potassium chloride. | The white solid produced misty white fumes which turned blue litmus paper to red. |
| **4.** Add concentrated sulfuric acid to     solid potassium iodide. | The white solid turned black. A gas was released that smelled of rotten eggs. A yellow solid was formed. |

(i)      Write the **simplest ionic** equation for the reaction that has taken place in Test **3**.

Identify the species responsible for the misty white fumes produced in Test **3**.

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**(2)**

(ii)     The student had read in a textbook that the equation for one of the reactions in Test **4** is as follows.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 8H+ | + | 8I– | + | H2SO4 |  | 4I2 | + | H2S | + | 4H2O |

Write the **two** half-equations for this reaction.

State the role of the sulfuric acid and identify the yellow solid that is also observed in Test **4**.

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**(4)**

(iii)    The student knew that bromine can be used for killing microorganisms in swimming pool water.  
The following equilibrium is established when bromine is added to cold water.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Br2(I) | + | H2O(I) |  | HBrO(aq) | + | H+(aq) | + | Br–(aq) |

Use Le Chatelier’s principle to explain why this equilibrium moves to the right when sodium hydroxide solution is added to a solution containing dissolved bromine.

Deduce why bromine can be used for killing microorganisms in swimming pool water, even though bromine is toxic.

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**(3)**

**(Total 15 marks)**

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| **5.** |  |
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**(Total 8 marks)**

**6.** Which one of the following statements concerning halogen chemistry is true?

**A**       Sodium chloride produces chlorine when treated with concentrated sulphuric acid.

**B**       Sodium chloride produces chlorine when treated with bromine.

**C**       Sodium bromide produces bromine when treated with concentrated sulphuric acid.

**D**       Sodium bromide produces bromine when treated with iodine in aqueous potassium iodide.

**(Total 1 mark)**

**7.** The boiling points of the halogens increase down Group VII because

**A**       covalent bond strengths increase.

**B**       bond polarities increase.

**C**       the surface areas of the molecules increase.

**D**       electronegativities increase.

**(Total 1 mark)**

**8.** Which one of the following is the electronic configuration of the strongest reducing agent?

**A**       1s2 2s2 2p5

**B**       1s2 2s2 2p6 3s2

**C**       1s2 2s2 2p6 3s2 3p5

**D**       1s2 2s2 2p6 3s2 3p6 4s2

**(Total 1 mark)**

**9.** On heating, magnesium reacts vigorously with element **X** to produce compound **Y**. An aqueous solution of **Y**, when treated with aqueous silver nitrate, gives a white precipitate that is readily soluble in dilute aqueous ammonia. What is the minimum mass of **X** that is needed to react completely with 4.05 g of magnesium?

**A**       11.83 g

**B**       5.92 g

**C**       5.33 g

**D**       2.67 g

**(Total 1 mark)**

**10.** This question relates to the equilibrium gas-phase synthesis of sulphur trioxide:

2SO2(g) + O2(g)  2SO3(g)

At equilibrium in a vessel of volume 1.80 dm3 under altered conditions, the reaction mixture contains 0.0700 mol of SO3(g), 0.0500 mol of SO2(g) and 0.0900 mol of O2(g) at a total pressure of 623 kPa. The temperature in the equilibrium vessel is

**A**       307 °C

**B**       596 K

**C**       337 °C

**D**       642 K

**(Total 1 mark)**

Questions **11 – 13** refer to the industrial production of nitric acid from ammonia:

*Reaction 1*    4NH3(g) + 5O2(g)   4NO(g) + 6H2O(g)            ∆*H* = −909 kJ mol−1

*Reaction 2*    2NO(g) + O2(g)   2NO2(g)                               ∆*H* = −115 kJ mol−1

*Reaction 3*    3NO2(g) + H2O(l)   2HNO3(aq) + NO(g)         ∆*H* = −117 kJ mol−1

**11.** Possible units for the equilibrium constant, *K*c, for *reaction 2* are

**A**       mol−2 m6

**B**       mol−1 dm3

**C**       no units

**D**       mol dm−3

**(Total 1 mark)**

**12.**The equilibrium yield in **all three** reactions is increased when

**A**       the pressure is increased.

**B**       the pressure is decreased.

**C**       the temperature is increased.

**D**       the temperature is decreased.

**(Total 1 mark)**

**13.** The direct oxidation of ammonia to nitrogen dioxide can be represented by the equation

4NH3(g) + 7O2(g) → 4NO2(g) + 6H2O(g)

for which the standard enthalpy change, in kJ mol−1, is

**A**       −1139

**B**       −1024

**C**       −794

**D**       −679

**(Total 1 mark)**

**14.** Sodium hydrogencarbonate decomposes on heating as shown by the equation below.

2NaHCO3 → Na2CO3 + H2O + CO2

The volume of carbon dioxide, measured at 298 K and 101 kPa, obtained by heating 0.0500 mol of sodium hydrogencarbonate is

**A**       613 cm3

**B**       1226 cm3

**C**       613 dm3

**D**       1226 dm3

**(Total 1 mark)**

**15.** Use the information below to answer this question.

A saturated solution of magnesium hydroxide, Mg(OH)2, contains 0.1166 g of Mg(OH)2 in 10.00 dm3 of solution. In this solution the magnesium hydroxide is fully dissociated into ions.

Which one of the following is the concentration of Mg2+(aq) ions in the saturated solution?

**A**       2.82 × 10−2 mol dm−3

**B**       2.00 × 10−3 mol dm−3

**C**       2.82 × 10−3 mol dm−3

**D**       2.00 × 10−4 mol dm−3

**(Total 1 mark)**

**16.** A particular sample of iron ore contains 85% by mass of Fe2O3 (*M*r= 159.6) and no other iron compound. The maximum mass of iron that could be extracted from 1.0 tonne of this ore is

**A**       0.59 tonne

**B**       0.66 tonne

**C**       0.75 tonne

**C**       0.85 tonne

**(Total 1 mark)**

**17.** This question is about the reaction given below.

CO(g) + H2O(g)  CO2(g) + H2(g)

Enthalpy data for the reacting species are given in the table below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Substance | CO(g) | H2O(g) | CO2(g) | H2(g) |
|  | Δ*H* / kJ mol−1 | −110 | −242 | −394 | 0 |

The standard enthalpy change for this reaction of carbon monoxide and steam is

**A**       +42 kJ mol−1

**B**       −42 kJ mol−1

**C**       +262 kJ mol−1

**D**       −262 kJ mol−1

**(Total 1 mark)**

**18.** Chlorine has two isotopes, 35Cl and 37Cl. The number of molecular ion peaks in the mass spectrum of a sample of Cl2 is

**A**       2

**B**       3

**C**       4

**D**       5

**(Total 1 mark)**

**19.** The standard enthalpy of formation, Δ*H*f for O3(g) is + 142 kJ mol–1. In which one of the following would both the changes shown increase the amount of O2 gas in an equilibrium mixture containing only O2(g) and O3(g)?

**A**       increasing the temperature and increasing the pressure

**B**       increasing the temperature and decreasing the pressure

**C**       decreasing the temperature and increasing the pressure

**D**       decreasing the temperature and decreasing the pressure

**(Total 1 mark)**