CHAPTER 22 REACTIONS OF PERIOD 3 ELEMENTS & THEIR OXIDES

1 (a) Suggest why the melting point of magnesium oxide is much higher than the melting point of magnesium chloride.

.....

.....

.....

(2 marks)

(b) Magnesium oxide and sulphur dioxide are added separately to water. In each case describe what happens. Write equations for any reactions which occur and state the approximate pH of any solution formed.

.....

.....

.....

.....

.....

.....

.....

.....

(6 marks)

(c) Write equations for two reactions which together show the amphoteric character of aluminium hydroxide.

.....

.....

.....

.....

.....

(4 marks)

2 State what is observed when separate samples of sodium oxide and phosphorus(V) oxide are added to water. Write equations for the reactions which occur and, in each case, state the approximate pH of the solution formed. *(6 marks)*

.....

.....

.....

.....

.....

.....

.....

.....

(6 marks)

3 In the questions below, each of the three elements **X**, **Y** and **Z** is one of the Period 3 elements Na, Mg, Al, Si or P.

(a) Both the chloride and the oxide of element **X** have high melting points. The oxide reacts readily with water. The chloride dissolves in water to form a neutral solution.

(i) Deduce the type of bonding present in the chloride of element **X**.

.....

(ii) Identify element **X**.

.....

(iii) Write an equation for the reaction between water and the oxide of element **X**.

.....

(3 marks)

(b) Element **Y** has a chloride and an oxide which react vigorously with water to form solutions containing strong acids.

(i) Deduce the type of bonding present in the oxide of element **Y**.

.....

(ii) Identify element **Y**.

.....

(iii) Identify an acid which is formed when **both** the oxide and the chloride of element **Y** react separately with water.

.....

(3 marks)

(c) The oxide of element **Z** is a crystalline solid with a very high melting point. This oxide is classified as an acidic oxide but it is not soluble in water.

(i) Deduce the type of crystal shown by the oxide of element **Z**.

.....

(ii) Identify element **Z**.

.....

(iii) Write an equation for a reaction which illustrates the acidic nature of the oxide of element **Z**.

.....

(4 marks)

4 Consider the following oxides.

Na_2O, MgO, Al_2O_3, SiO_2, P_4O_{10}, SO_3

(a) Identify one of the oxides from the above which

(i) can form a solution with a pH less than 3 .....

(ii) can form a solution with a pH greater than 12 .....

(2 marks)

(b) Write an equation for the reaction between

(i) MgO and HNO_3

.....

(ii) SiO_2 and $NaOH$

.....

(iii) Na_2O and H_3PO_4

.....

(3 marks)

(c) Explain, in terms of their type of structure and bonding, why P_4O_{10} can be vaporised by gentle heat but SiO_2 cannot.

.....

.....

.....

.....

(4 marks)

5 Write equations for the reactions which occur when the following compounds are added separately to water. In each case, predict the approximate pH of the solution formed when one mole of each compound is added to 1 dm^3 of water.

(a) Sodium oxide

Equation .....

pH of solution formed .....

(b) Sulphur dioxide

Equation .....

pH of solution formed .....

(4 marks)

6 (a) **P** and **Q** are oxides of Period 3 elements.

Oxide **P** is a solid with a high melting point. It does not conduct electricity when solid but does conduct when molten or when dissolved in water. Oxide **P** reacts with water forming a solution with a high pH.

Oxide **Q** is a colourless gas at room temperature. It dissolves in water to give a solution with a low pH.

(i) Identify **P**. State the type of bonding present in **P** and explain its electrical conductivity. Write an equation for the reaction of **P** with water.

.....

.....

.....

.....

(4 marks)

(ii) Identify **Q**. State the type of bonding present in **Q** and explain why it is a gas at room temperature. Write an equation for the reaction of **Q** with water.

.....

.....

.....

.....

.....

.....

(5 marks)

(b) **R** is a hydroxide of a Period 3 element. It is insoluble in water but dissolves in both aqueous sodium hydroxide and aqueous sulphuric acid.

(i) Give the name used to describe this behaviour of the hydroxide.

.....

(1 mark)

(ii) Write equations for the reactions occurring.

.....

.....

.....

(4 marks)

(iii) Suggest why **R** is insoluble in water.

.....

.....

.....

(1 mark)

7 This question is about some Period 3 elements and their oxides.

(a) Describe what you would observe when, in the absence of air, magnesium is heated strongly with water vapour at temperatures above 373 K.
Write an equation for the reaction that occurs.

[3 marks]

Observations .....

.....

.....

.....

.....

Equation .....

(b) Explain why magnesium has a higher melting point than sodium.

[2 marks]

.....

.....

.....

.....

(c) State the structure of, and bonding in, silicon dioxide.
Other than a high melting point, give **two** physical properties of silicon dioxide that are characteristic of its structure and bonding.

[4 marks]

Structure .....

Bonding.....

Physical property 1 .....

Physical property 2.....

(d) Give the formula of the species in a sample of solid phosphorus(V) oxide.
State the structure of, and describe fully the bonding in, this oxide.

[4 marks]

Formula .....

Structure .....

Bonding .....

.....

.....

.....

(e) Sulfur(IV) oxide reacts with water to form a solution containing ions.

Write an equation for this reaction.

[1 mark]

.....

(f) Write an equation for the reaction between the acidic oxide, phosphorus(V) oxide, and the basic oxide, magnesium oxide.

[1 mark]

.....

8 Magnesium oxide, silicon dioxide and phosphorus(V) oxide are white solids but each oxide has a different type of structure and bonding.

(a) State the type of bonding in magnesium oxide.
Outline a simple experiment to demonstrate that magnesium oxide has this type of bonding.

Type of bonding .....

Experiment .....

.....

.....

.....

.....

.....

(3 marks)

(b) By reference to the structure of, and the bonding in, silicon dioxide, suggest why it is insoluble in water.

.....

.....

.....

.....

.....

.....

.....

(3 marks)

(c) State how the melting point of phosphorus(V) oxide compares with that of silicon dioxide. Explain your answer in terms of the structure of, and the bonding in, phosphorus(V) oxide.

Melting point in comparison to silicon dioxide .....

Explanation .....

.....

.....

.....

.....

.....

(3 marks)

(d) Magnesium oxide is classified as a basic oxide.

Write an equation for a reaction that shows magnesium oxide acting as a base with another reagent.

.....

(2 marks)

(e) Phosphorus(V) oxide is classified as an acidic oxide.

Write an equation for its reaction with sodium hydroxide.

.....

(1 mark)

9 White phosphorus (P_4) is a hazardous form of the element. It is stored under water.

(a) Suggest why white phosphorus is stored under water.

.....

.....

.....

(1 mark)

(b) Phosphorus(V) oxide is known as phosphorus pentoxide.
Suggest why it is usually represented by P_4O_{10} rather than by P_2O_5

.....

.....

.....

(1 mark)

(c) Explain why phosphorus(V) oxide has a higher melting point than sulfur(VI) oxide.

.....

.....

.....

.....

.....

(2 marks)

(d) Write an equation for the reaction of P_4O_{10} with water to form phosphoric(V) acid.
Give the approximate pH of the final solution.

Equation .....

pH .....

(2 marks)

(e) A waste-water tank was contaminated by P_4O_{10}. The resulting phosphoric(V) acid solution was neutralised using an excess of magnesium oxide. The mixture produced was then disposed of in a lake.

(i) Write an equation for the reaction between phosphoric(V) acid and magnesium oxide.

.....

(1 mark)

(ii) Explain why an excess of magnesium oxide can be used for this neutralisation.

.....

.....

.....

(1 mark)

(iii) Explain why the use of an excess of sodium hydroxide to neutralise the phosphoric(V) acid solution might lead to environmental problems in the lake.

.....

.....

.....

(1 mark)