## **Stage 2 Chemistry**

## **Birdwood**

HIGH SCHOOL **Topic 2: Elemental & Environmental Chemistry**

**Electronic Configuration, molecular shape,**

**Review Paper 4 acid rain, photochemical smog, water treatment, greenhouse effect**

**DUE DATE:**

**Question 1**

Photochemical smog is a significant problem associated with the use of motor vehicles in urban areas.

1. Ozone is one of the major components of photochemical smog. The *partially written* equations below show how it can be formed:

NO2 NO + \_O\_ *Reaction* A

followed by:

O2 + O O3\_ *Reaction* B

Complete each equation by writing in the missing *products*. (2 marks)

1. The nitrogen dioxide in *Reaction* A is also a major component of photochemical smog.

Explain, with the aid of equations, how nitrogen dioxide forms in the troposphere.

Nitrogen and oxygen make up ~98% of the troposphere, but under normal conditions do not react due to the highly stable triple bonded nitrogen. In high heat conditions, such as combustion engines and industrial furnaces, there is enough activation energy to form nitrogen oxide, N2 + O2 -> 2NO.

Nitrogen oxide can then further react with oxygen in the air to form nitrogen dioxide 2NO + O2 -> 2NO2 (4 marks)

1. State *one* undesirable effect of ozone in photochemical smog. (1 mark)

Respiratory problems, cracking of rubber seals, bleaching of green plants

1. Catalytic converters are devices that reduce the amount of pollutants in motor vehicles’ exhaust gases. The catalyst in the converters increases the rate of conversion of nitric oxide (NO) and carbon monoxide into nitrogen and carbon dioxide. Write a balanced equation for this conversion reaction.

2CO(g) + O2(g)  2CO2(g)

2CO(g) + 2NO(g) N2(g) + 2CO2(g)

(2 marks)

**Question 2**

Rainwater polluted with sulfurous, sulfuric, nitrous and nitric acids can be termed acid rain if its pH falls below 5.6.

1. Calculate the hydrogen ion concentration in rainwater with a pH of 5.6.

10-5.6= 2.5x10-6 mol L-1 (2 marks)

1. Water in a mountain stream is known to have a [OH-] = 4.5 x 10-6 mol L-1.

Calculate the pH of the water. (2 marks)

pOH =-log(4.5x10-6) = 5.35

pH = 14 – pOH

pH = 14 – 5.35

pH = 8.65

1. One effect of acid rain is that it corrodes metal structures, particularly those made of iron.

Write an ionic equation for the reaction between iron and acid rain. (2 marks)

H+(aq) + Fe(s) -> H2(g) + Fe2+(aq)

1. State the likely source of the nitrogen oxides responsible for the formation of acid rain.

Combustion engines or industrial furnaces (1 mark)

1. Sulfur dioxide is commonly associated with acid rain.

i Write an equation for the reaction between water and sulfur dioxide.

H2O + SO2 -> H2SO3

ii State what this equation suggests about the nature of this oxide of sulfur. Acidic

iii State the shape of the sulfur dioxide molecule and explain why it has this shape. Sulfur dioxide is bent due to the non-bonding pairs of electrons on the sulfur, giving 3 regions of electron density.

iv In what state would sulfur dioxide be found at room temperature?

Gas (5 marks)

**Question 3**

Water quality in Australia is quite good. While not always pure, it is safe. The most common water treatment used is chlorination. Chlorine dissolves in water according to the following equation:

Cl2 + 2H2O HOCl + H3O+ + Cl-

1. State whether a solution of chlorine in water would have a pH of greater than 7,

equal to 7 or less than 7. (1 mark)

less than 7 (due to formation of H3O+)

1. What is the significance of the double arrow in the equation? (1 mark)

It is an equilibrium reaction

1. Name the species HOCl in the equation above. (1 mark)

Hypochlorous acid

1. When HOCl acts as an acid, it produces the hypochlorite ion.

Write the formula for the hypochlorite ion. (1 mark)

OCl-

1. State the function of the hypochlorite ion that allows it to act as a disinfectant. (1 mark)

Oxidation of bacteria cell walls

1. Chlorination is often used in large swimming pools. The pH of swimming pools should be checked regularly. Describe the likely effect on swimmers if the pH of the water decreases? (1 mark)

Low pH will lead to eye irritation, degradation of metal/plaster

1. Sodium hydroxide is often added to a solution of chlorine in water if the pH decreases.

*Use Le Chalelier’s Principle to state* and *explain* the effect adding sodium hydroxide

will have on the concentration of HOCl in the water.

NaOH will react with the hydronium ions, removing them from the equilibrium. By doing the equilibrium will reestablish itself to produce more of the hydronium ion and hence more of the hypochlorous acid (3 marks)

**Question 4**

Nitrogen, phosphorus and potassium are the three key elements required by plants for healthy growth. When a soil becomes deficient in these elements, it is common to use inorganic fertilizers to improve the soil. One such fertilizer is ammonium phosphate, (NH4)3PO4.

1. Write the equation showing how ammonium phosphate dissociates in water.

(NH4)3PO4(s) + aq -> 3NH4+(aq) + PO43-(aq) (2 marks)

1. The phosphate ion has the formula PO43-.

Draw and name the shape of the phosphate ion. (2 marks)



tetrahedral

1. Describe how plants are able to make use of ions such as the ammonium and phosphate ions in fertilizers. (2 marks)

Ions such as ammonium and phosphate are water soluble and so can be taken up via the roots of plants to be used for cellular processes

**Question 5**

1. Describe how carbon dioxide helps maintain a

steady temperature in the Earth’s atmosphere.

Carbon dioxide is a greenhouse gas. This means that it absorbs some of the radiation leaving the Earth’s surface and re-radiates it in all directions. The net effect being that some of the radiation that would leave the atmosphere is trapped, warming the earth

1. State the effect of an increased concentration of

carbon dioxide on the temperature of the

Earth’s atmosphere.

Increasing the concentration of carbon dioxide will increase this warming effect, leading to climate change.

1. Describe one human activity this century that has

led to an increase of carbon dioxide in the

Earth’s atmosphere.

Burning fossil fuels, destruction of rainforest.

(6 marks)

**TOTAL MARK = 42**