Elemental and Environmental Chemistry Exam Questions

2005 Exam Question 1

The elements titanium and zinc make important contributions to modern society

a. Identify the block of the periodic table to which titanium can be found

_____/1 mark

b. The element titanium occurs natural as the mineral form titanium dioxide TiO_2

i. TiO_2 reacts with sodium hydroxide to form the ion TiO_3^{2-}

1. Write an equation for the reaction of TiO_2 with sodium hydroxide

/2 marks

2. Explain how this reaction indicates that titanium has some non-metallic properties:

_____

_____

_____

_____/2 marks

2006 Exam Question 2

Aura is a satellite that orbits the Earth. It collects data about molecules in the troposphere and the stratosphere.

a. The concentration of the oxides of sulfur and nitrogen in the troposphere are measured to determine their contribution to the formation of acid rain.

i.1. Write an equation for the reaction of SO_2 with water

/2 marks

2. This reaction leads to the formation of acid rain.

Explain how the reaction of SO_2 with water lowers the pH of rainwater

_____

_____

_____

_____/2 marks

ii. Identify one environmental problem, other than acid rain, that may result from the presence of oxides of nitrogen in the troposphere

_____/1 mark

b. The concentration of carbon dioxide in the troposphere is critical to life on Earth.

i. Describe how carbon dioxide acts to maintain a steady temperature in the troposphere

_____

_____

_____

_____

_____/3 marks

ii. Plants require carbon dioxide for photosynthesis.

Write an equation for photosynthesis.

/2 marks

c. i. The concentration of ozone in the stratosphere was measured by Aura and compared with the concentration measured by another satellite. The results are shown in the table below:

concentration of ozone measured by *Aura*	253.9 units
concentration of ozone measured by other satellite	253 units

State how the measurement from Aura displays a greater resolution than the measurement from the other satellite:

_____

_____/1 mark

2006 Exam Question 6

Exhaust gases from motor vehicles may contain oxides of carbon and oxides of nitrogen.

a. CO and CO_2 are two oxides of carbon present in the exhaust gases of motor vehicles that burn hydrocarbon fuels.

i. State why both CO and CO_2 are present

_____

_____

_____/2 marks

b. NO and NO_2 are two oxides of nitrogen present in the exhaust gases of motor vehicles that burn hydrocarbon fuels Explain with the aid of equations why both NO and NO_2 are present:

_____

_____

_____

_____

_____

_____/4 marks

2006 Exam Question 7

ii. 1. The solution in the stomach has a pH of 2.1

Calculate the concentration of H^+ in the solution in the stomach

/2 marks

2006 Exam Question 12

Many different compounds are used to improve the quality of water.

a. Compounds of phosphorus can be used to soften water.

i. Write the electronic configuration of phosphorus, using subshell notation

_____/2 marks

2007 Exam Question 1

Oxides of sulfur and nitrogen are major pollutants that contribute to the formation of acid rain in industrialised countries.

a. i. State whether sulfur has a high, an intermediate or low electronegativity:

_____/1 mark

ii. 1. Draw a diagram to show the bonding and shape of a molecule of SO_2

2. On the diagram that you've drawn above, shown the polarity of one bond, using the appropriate convention:

/2 marks

3. State why the bond between S & O are polar:

_____

_____/1 mark

4. State why the molecule is polar

_____

_____/1 mark

b.i. State one natural process that releases oxides of nitrogen into the atmosphere.

_____

_____/1 mark

ii. State the pH below which rainfall is classified as acid rain:

_____/1 mark

iii. NO_2 reacts with rainwater to form the acid containing HNO_3

1. Write an equation for this reaction

/2 marks

2. This acid rain affects plant growth in several ways.

A. Identify the component of this acid rain that improves soil for plant growth and explain your answer.

Component: _____

_____/1 mark

Explanation: _____

_____

_____

_____/2 marks

B. Many plants do not thrive under acid conditions.

Identify one effect of acid rain on soil that reduces plant growth: _____

_____/1 mark

iv. Acid rain causes iron structures to deteriorate.

Write an ionic equation for the reaction of acid rain with iron.

/2 marks

2007 Exam Question 4

Ancient coins often contain copper and silver.

a. Many ancient coins were composed mainly of copper.

i. Write the electron configuration of copper, using subshell notation

_____ /2 marks

ii. Green spots on ancient coins contain the corrosion product, copper II ethanoate.

Write the formula of copper II ethanoate /2 marks

b. The ancient Romans discovered that copper coins dipped in molten silver chloride became coated with silver.

Write an equation for this reaction

/2 marks

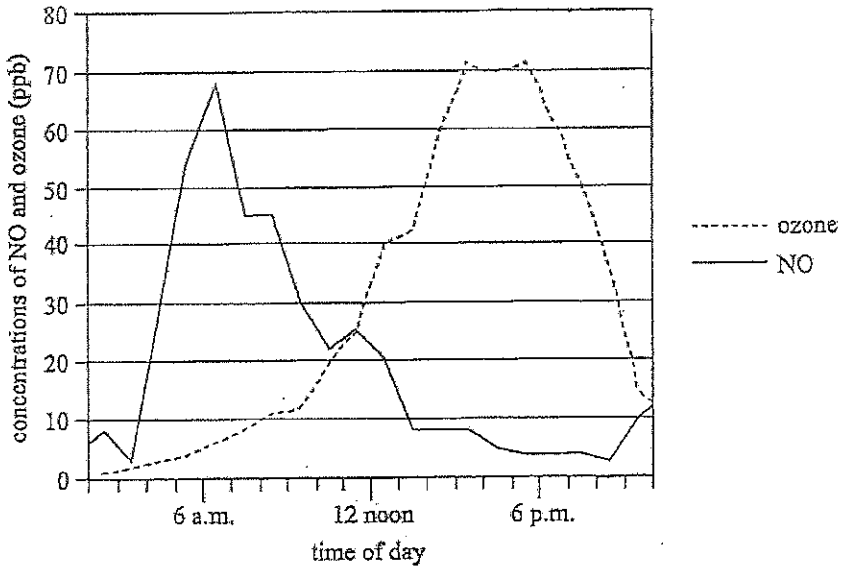
2007 Exam Question 5

Combustion of fuels in vehicles leads to the formation of nitrogen oxides. The concentration of nitrogen oxides affects the concentration of ozone in the troposphere.

a. Write an equation for the formation of NO

/2 marks

b. NO, NO_2 and ozone are formed above a city street on a sunny day. The concentration of NO and ozone are shown in the graph below:



i. When the concentration of ozone reaches 50ppb, its effect on living organisms can be observed.

1. Using the graph above, identify the earliest time of day at which the effect of ozone on living organisms is likely to be observed.

_____ /1 mark

2. State one harmful effect of ozone in the troposphere.

_____ /1 mark

ii. 1. Explain why, one a sunny day, the concentration of ozone reaches a maximum after the concentration of NO reaches a maximum. Include two relevant equations in your answer

_____

_____

_____

_____

_____

_____/4 marks

2. Using the graph opposite, estimate the time of day at which the concentration of NO_2 reaches a maximum

_____/1 mark

2007 Exam Question 12

The amount of carbon dioxide emitted into the atmosphere is increasing which has the potential to enhance the greenhouse effect.

a. Identify one major reason why the amount of carbon dioxide emitted into the atmosphere is increasing

_____/1 mark

b. Explain how this increase could lead to an increase in the average temperature of the Earth's atmosphere

_____

_____

_____

_____

_____/3 marks

2008 Exam Question 1

Catalytic converters reduce the amount of pollutants emitted from motor vehicles that use carbon-based fuels.

a. Several pollutants are produced in the engines of motor vehicles.

i. Explain how NO is produced in the engines of motor vehicles

_____

_____

_____

_____

_____/2 marks

II. Explain why CO is produced in the engines of motor vehicles

_____

_____

_____

_____/2 marks

iii. State and explain one disadvantage that unburned hydrocarbons in the emissions from a motor vehicle may have for the owner of the vehicle

_____

_____

_____/2 marks

2009 Exam Question 1

b. In the production of copper, large amounts of SO_2 are produced when the sulfide moderal isroasted at high temperatures.

i. The release of SO_2 into the atmosphere may lead to the formation of acid rain.

Describe with the aid of two equations, how the release of SO_2 into the atmosphere lowers the pH of rainwater: _____

_____

_____

_____

_____/4 marks

2009 Exam Question 7

The concentration of GH gases in the Earth's atmosphere is increasing.

a. Explain how an increase in the concentration of GH gases may lead to an increase in the average tempterature of the earth's atmosphere: _____

_____

_____

_____

_____

_____/3 marks

c. Farming practices are responsible for the emission of large amounts of GH gases such as CO_2 CH_4 into the atmosphere. Various methods can be used to reduce these GH gas emissions.

1. Growing animal feed involves the process of photosynthesis.

Write an eqaution for the process of photosynthesis

/2 marks

2. Explain one way in which CO_2 emissions can be reduced by growing animal feed on the farm instead of tnrasporting it from other places

_____

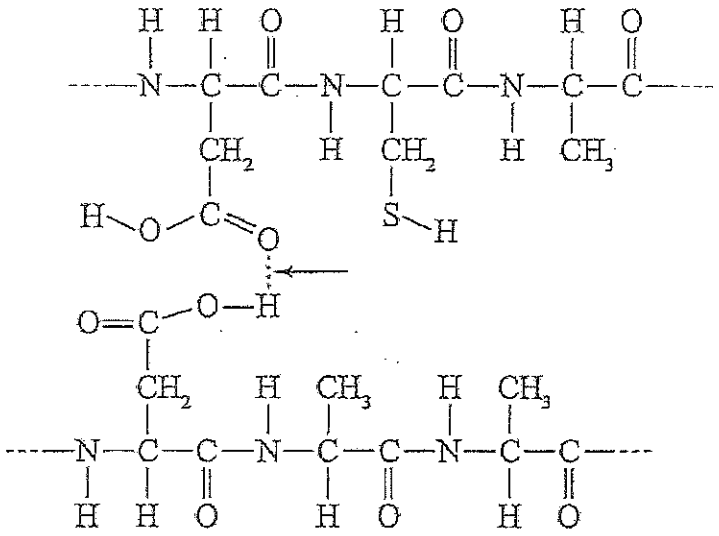
_____

_____

_____/2 marks

ii. CH_4 emissions from cows can be reduced by modifying a protein in cows.

1. Sections of adjacent protein chains in one unmodified piece of protein are shown in the diagram below.



State the type of interaction between the protein chains that is indicated by the arrow on the diagram above:

_____/1 mark

2009 Exam Question 9

Acidic soils are causing serious environmental problems in many coastal and rural areas. When waterlogged soils, rich in FeS_2 are exposed to air, they become acidic as a result of the formation of H_2SO_4

a. H_2SO_4 mobilised Al^{3+} and Mg^{2+} from clays into the soil water and into waterways.

i. Explain how H_2SO_4 mobilises Al^{3+} and Mg^{2+} from clays into soil water

_____

_____

_____ /2 marks

ii. In addition to their many uses in nature, waterways are a potential source of water for domestic use.

State one reason why it is undesirable for Al^{3+} and Mg^{2+} to be mobilised from clays into waterways:

Al^{3+} _____

_____

Mg^{2+} _____

_____ /2 marks

2. The final pH of the reaction solution water 1.5

   Calculate the concentration in $molL^{-1}$ of H^+ in the reaction solution.

/2 marks

iii. Explain one advantage of repeating this procedure on several samples of the same soil

_____

_____

_____ /2 marks

2010 Exam Question 3

Over the last century, there has been a considerable increase in the use of titanium. The main source of titanium is in the mineral rutile, TiO_2

a. Explain why TiO_2 is a solid with a high melting point

_____

_____

_____

_____ /2 marks

b. TiO_2 reacts with hydrochloric acid

   Write an equation for this reaction

/2 marks

c. In the production of titanium, TiO_2 is treated with coke and chlorine gas to form titanium tetrachloride $TiCl_4$

   Draw a diagram to show the bonding and shape of the CCl_4 molecule

/2 marks

2011 Exam Question 11

Arsenic, which is toxic is found in drinking water in some places. Arsenic-rich groundwater can be treated by the SORAS method. In this process the arsenic is oxidised to form products that are adsorbed onto the surface of iron III oxides in the groundwater.

a. Iron III oxides contain the Fe^{3+} ion.

Write the electronic configuration of the Fe^{3+} ion using subshell notation

_____/2 marks

b. Arsenic in the groundwater is in the +3 oxidation state in the form of uncharged arsenous acid $H_2AsO_3^-$ in the SORAS method, it is oxidised to the +5 state and is in the form of ions $H_2AsO_4^-$

i. Arsenous acid is formed when arsenic III oxide reacts with water.

Write an equation for this reaction

/2 marks

2011 Exam Question 12

Increasing the concentration of atmospheric CO_2 has been associated with global warming.

a. Carbon and oxygen form CO_2 molecules. Although they contain polar covalent bonds, the molecules are nonpolar.

i. Explain why the covalent bonds in CO_2 are polar

_____

_____

_____

_____/2 marks

ii. Explain why the CO_2 molecules are nonpolar

_____

_____

_____

_____/2 marks

c. It has been suggested that the oceans have absorbed more than half of the carbon dioxide generated by human activity in the last two centuries. Carbon dioxide dissolves in water and is used by marine organisms for photosynthesis. However, the capacity of the oceans to absorb carbon dioxide is limited. Furthermore, absorption of carbon dioxide by the oceans may have negative environmental consequences in the long term.

Discuss the present-day benefit of the oceans' absorption of carbon dioxide and the possible long-term environmental consequences for the oceans. You may use one or two equations in your answer:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____/8 marks