Test 3: The Acidic Environment I

Total 24 marks (Suggested time 45 minutes)

Directions to students

- Answer the following questions on your own paper.
- Part A contains 5 multiple-choice questions, each worth 1 mark. Select the alternative A, B, C or D that best answers the question.
- Part B contains 6 short answer and longer response questions.
- You may use the standard formula sheet supplied.

PART A

1. Buffers are often found in natural chemical systems. This is because buffers
   (A) allow pH changes to occur rapidly.
   (B) help to maintain the pH of a system at a specific pH.
   (C) help to maintain the pH of that system within a range of values.
   (D) increase reaction rates of the system by providing the appropriate acid or base.

2. Methanal, CH_2O, is used industrially in the production of some types of plastics. It can be formed when methanol reacts with oxygen gas as shown in the following equation:

$$2CH_3OH_{(g)} + O_{2(g)} \rightleftharpoons 2CH_2O_{(g)} + 2H_2O_{(g)}$$

   The addition to the system of solid sodium hydroxide would
   (A) have no effect.
   (B) increase the pH forcing the reaction to the left.
   (C) increase the yield of methanal as the sodium hydroxide deliquesces.
   (D) force the reaction to the left as the sodium hydroxide would neutralise the methanol.

3. Which of the following aqueous solutions has the highest pH?
   (A) 0.1 mol L^{-1} sulfuric acid
   (B) 1 mol L^{-1} ethanoic acid
   (C) 0.1 mol L^{-1} ammonium chloride
   (D) 1 mol L^{-1} sodium ethanoate

4. A pipette is about to be used to transfer 20.00 mL of 0.10 mol L^{-1} hydrochloric acid into a conical flask. Just before this is done, the pipette needs to be rinsed with

   (A) 0.10 mol L^{-1} hydrochloric acid.

   (B) 0.10 mol L^{-1} sodium hydroxide.

   (C) distilled water.

   (D) soapy water.

5. 10 mL of a pH of 1 mol L^{-1} nitric acid solution has 90 mL of water added to it. Compared with the original solution,

   (A) the concentration has increased by a factor of 10 but its pH has decreased by a factor of 1.

   (B) the concentration has decreased by a factor of 10 but its pH has increased by a factor of 1.

   (C) the concentration has increased by a factor of 11 but its pH has decreased by a factor of 10.

   (D) the concentration has decreased by a factor of 1 but its pH has increased by a factor of 10.

PART B

Marks

Question 6 (2 marks)

Coal is a rock-like substance which is a major source of energy used around the world. The carbon present in coal burns to produce carbon dioxide gas. Coal can contain impurities such as sulfur. The presence of sulfur can give coal a brown colour. 2

Explain with the aid of an equation why the combustion of sulfur produces an atmospheric pollutant.

Question 7 (3 marks)

In a classroom experiment, 8 g of pure magnesium is dropped into an excess amount of hydrochloric acid.

(a) Write a balanced equation for this reaction. 1

(b) Calculate the volume of gaseous product formed at room temperature and pressure. 2

Question 8 (4 marks)

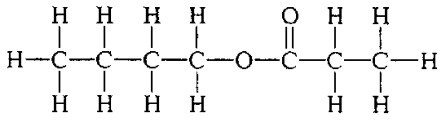
25 mL of a 1 mol L^{-1} monoprotic acid X is poured into a beaker. 25 mL of a 1 mol L^{-1} monoprotic acid Y is poured into a second beaker. Solution Y has a lower pH than solution X.

(a) Why does the pH of these two solutions differ? 2

(b) Both solutions are to be neutralised by adding 1 mol L^{-1} sodium hydroxide solution. Is the same volume of sodium hydroxide used in each case? Explain your answer. 2

Question 9 (2 marks) Marks

The following structural formula represents an ester:



(a) Name the organic reactants which formed this ester. 1

(b) Concentrated sulfuric acid was added to the reaction mixture. Explain why this was necessary. 1

Question 10 (3 marks)

Hydrogen cyanide, HCN, forms the weak acid hydrocyanic acid in water.

(a) Explain what is meant by the term *weak acid*. 1

(b) Write an equation which shows how hydrocyanic acid behaves as a Bronsted-Lowry acid in water. 1

(c) Give the formula of the conjugate base of hydrocyanic acid. 1

Question 11 (5 marks)

A student performed a titration to find the molarity of a nitric acid solution. She firstly weighed 2.496 g of anhydrous sodium carbonate. She then dissolved the sodium carbonate in water and made the solution up to 200 mL in a volumetric flask. 25 mL samples of this solution were each titrated with the nitric acid solution. The average titre required to reach the endpoint was 15.65 mL.

(a) Write a balanced equation for this reaction. 1

(b) Calculate the molarity of the nitric acid solution. 2

(c) Explain why it was important that the sodium carbonate was anhydrous in determining the concentration of the acid. 2