Sydney Girls High School

Student number:……………………..

2002
Assessment Task 2

Chemistry

This paper has two parts, Part A and Part B

General Instructions

- Reading time – 5 minutes
- Working time – 1.5 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil

Part A

Total marks (**12**)

- Attempt questions 1 – 12
- Answer on the answer sheet provided for Part A

Part B

Total marks (**48**)

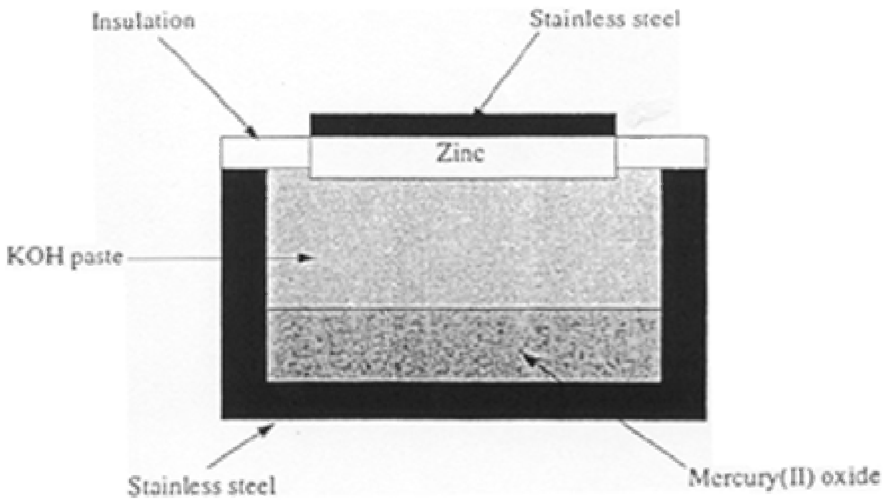
- Attempt questions 13 – 22
- Answer in the spaces provided on this paper

PART A

Multiple Choice (1 mark each)
Choose the most correct alternative and indicate your choice on the Part A Answer Sheet

Questions 1 and 2 refer to the diagram and information provided below.

The diagram shows a mercury cell, which can be used to power hearing aids.



The half equations for the reaction process are given as follows:

$Zn(s) + 2OH^-(aq) \rightarrow ZnO(s) + H_2O(l) + 2e^-$

$HgO(s) + H_2O(l) + 2e^- \rightarrow Hg(l) + 2OH^-(aq)$

1 Select the correct summary of the parts of the cell.

	Anode reactant	Cathode reactant	Electrolyte
A	mercury (II) oxide	zinc	potassium hydroxide
B	stainless steel	zinc	water
C	zinc	mercury (II) oxide	potassium hydroxide
D	zinc	mercury (II) oxide	Water

2 One of the advantages of using this cell is

(A) It polarises quickly enabling a steady current.
(B) It does not pollute the environment when discarded.
(C) It is east to recharge the battery at night
(D) It provides a steady EMF in a compact shape.

3 When fluorine is bubbled through a solution of sodium bromide, bromine liquid is formed. The reaction can be represented as:

$$2Br^-_{(aq)} + F_{2(g)} \rightarrow Br_{2(l)} + 2F^-_{(aq)}$$

In this reaction:

(A) F_2 is the reducing agent
(B) F_2 is the oxidant
(C) Br^- is the oxidising agent
(D) F^- is the reductant.

4 Two radioactive decay processes are shown below:

$$^{214}_{83}Bi \rightarrow X + {}^{4}_{2}He$$

$$X \rightarrow Y + {}^{0}_{-1}e$$

The isotopes represented by X and Y respectively are:

(A) $^{218}_{85}At$ and $^{218}_{84}Po$
(B) $^{210}_{85}At$ and $^{210}_{86}Rn$
(C) $^{210}_{81}Tl$ and $^{210}_{82}Pb$
(D) $^{210}_{81}Tl$ and $^{210}_{80}Hg$

5 The pH of 0.1M hydrochloric acid (HCl) is about 1.0 and the pH of 0.1M acetic acid (CH_3COOH) is about 2.9.

The pH of the acetic acid is higher because:

(A) CH_3COOH contains more hydrogen ions
(B) HCl ionises more fully than CH_3COOH
(C) CH_3COOH is amphiprotic in water
(D) HCl is a weaker acid than CH_3COOH

6 50mL of a 0.200 $molL^{-1}$ solution of sodium hydroxide is diluted to 2.0 L with distilled water. The correct pH of the diluted solution is:

(A) 11.7
(B) 12.3
(C) 12.7
(D) 13.3

7 Select the reaction in which water is acting as an acid.

(A) $H_3O^+_{(aq)} + HPO_4^{2-}{}_{(aq)} \Leftrightarrow H_2O_{(l)} + H_2PO_4^-{}_{(aq)}$
(B) $H_2O_{(l)} + HCO_3^- \Leftrightarrow H_3O^+_{(aq)} + CO_3^{2-}{}_{(aq)}$
(C) $H_2O_{(l)} + NH_{3(g)} \Leftrightarrow NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$
(D) $H_3O^+_{(aq)} + HS^-{}_{(aq)} \Leftrightarrow H_2S_{(aq)} + H_2O_{(l)}$

8 The hydrogen carbonate ion (HCO_3^-) is amphiprotic. Select the correct statement.

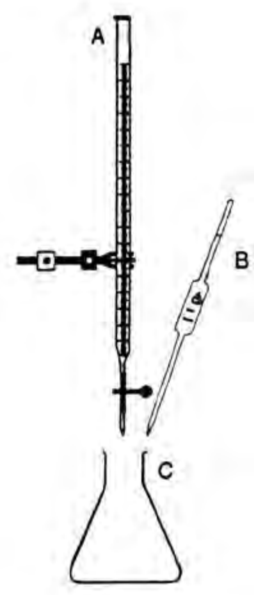
(A) H_2CO_3 is the conjugate acid of HCO_3^-
(B) H_2CO_3 is the conjugate acid of CO_3^{2-}
(C) CO_3^{2-} is the conjugate base of H_2CO_3
(D) HCO_3^- is the conjugate base of CO_3^{2-}

9 In volumetric analysis, a standard solution is one:

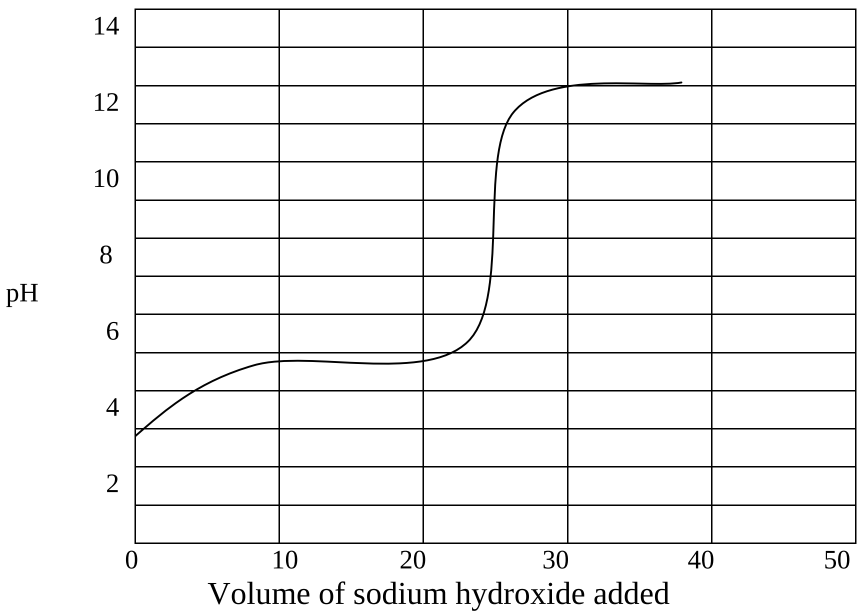
(A) made up at 25°C
(B) of concentration 1.000 $molL^{-1}$
(C) of accurately known concentration
(D) which is put in the burette.

10 Select the pieces of equipment, shown in the diagram below, which should be rinsed with the appropriate reagent rather than water before beginning a titration.

(A) A and B only
(B) A and C only
(C) B and C only
(D) A, B and C.



11 The diagram shows the titration curve of a dilute solution of sodium hydroxide and a dilute solution of ethanoic acid. The accompanying table shows a list of indicators and pH ranges over which they are useful.

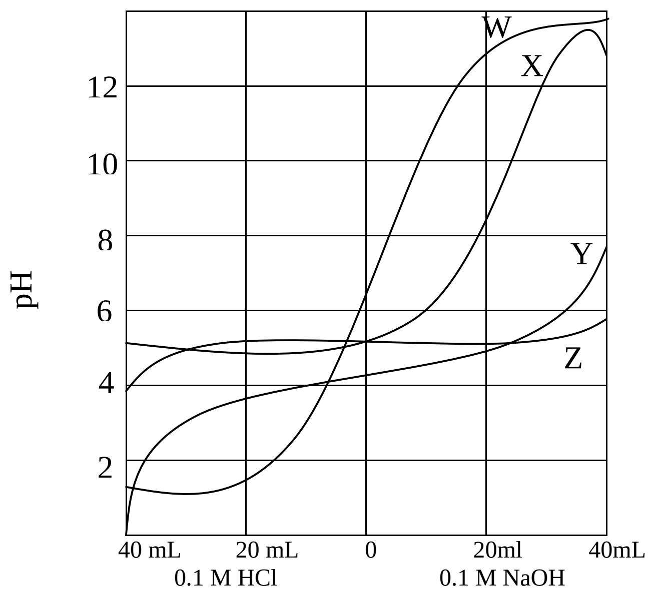


Indicator	pH Range
Bromocresol green	3.8 – 5.4
Methyl red	4.4 – 6.0
Methyl orange	3.1 – 4.4
Phenol red	6.8 – 8.4

The most suitable indicator for this titration is:

(A) methyl orange.
(B) bromocresol green.
(C) methyl red.
(D) phenol red.

12 The graph below shows buffer solutions W, X , Y, and Z reacting with varying amounts of 0.1 mol L^{-1} HCl and 0.1 mol L^{-1} NaOH.



The solution which is the most effective buffer for these situations is:

(A) W
(B) X
(C) Y
(D) Z

Part B – 48 marks

Attempt Questions 13 – 22

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 13 (3 marks)

Radioactive isotopes are used in industry, medicine and for determining reaction mechanisms in chemistry.

(a) Name one example of a radioisotope
(b) Describe one way in which it is used and discuss why that isotope was selected for its particular use.

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Question 14 (3 marks)

A student was measuring the pH of a variety of salt solutions including potassium ethanoate. Predict whether this solution is acidic, basic or neutral. Use an equation to justify your prediction.

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Question 15 (5 marks)

A galvanic cell is set up using the overall reaction

$$2Ag^{+}(aq) \;+\; Cu(s) \rightarrow 2Ag(s) \;+\; Cu^{2+}(aq)$$

(a) Calculate the expected voltage of this cell under standard conditions.

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(b) As the cell is operating, its voltage falls. Explain.

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(c) **Draw** a **labelled diagram** showing how you would set up this cell.

(d) Describe one factor that you had to consider when selecting an appropriate chemical for the salt bridge.

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Question 16 (4 marks)

The reaction between hydrogen sulfide gas (H_2S) and water is an acid-base reaction according to Bronsted-Lowry theory.

(a) Define a Bronsted-Lowry acid.

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(b) Write a balanced symbol equation for this reaction.

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(c) Explain with the inclusion of electron dot diagrams, how the reaction can also be classified as a Lewis acid-base reaction.

Question 17 (3 marks)

A solution of ethanoic acid has the same pH (3.0) as a solution of HCl. Equal volumes of each acid solution are titrated with 0.10 mol L^{-1} NaOH.

Which acid will require a greater titre (volume) of base for neutralisation ? Explain your answer.

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Question 18 (6 marks)

Soda water is made by dissolving carbon dioxide in water under pressure.

$$CO_2\,(g) \quad \Leftrightarrow \quad CO_2(aq)$$

(a) When the lid is removed from a bottle of soda water, bubbles of carbon dioxide suddenly appear throughout the solution. Use Le Chatelier's Principle to explain why these bubbles appear in the soda water.

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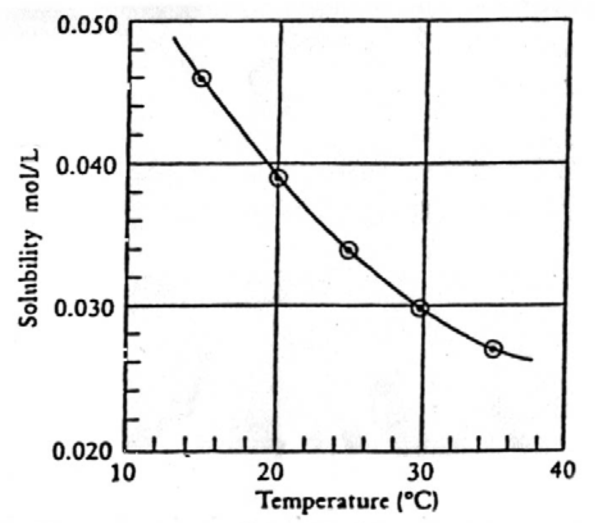
(b) The graph below shows the solubility of carbon dioxide in water at different temperatures.



Is the enthalpy of solution of carbon dioxide endothermic or exothermic? Explain

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(c) The carbon dioxide is removed from one litre of soda water at 25°C and the gas stored at 101.3 kPa pressure. Use the information on this graph to calculate the volume of carbon dioxide collected at this temperature.

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Question 19 (6 marks)

(a) Identify a substance which contributes to acid rain. Give both a natural and an industrial source of this substance.

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(b) Explain the formation and effects of acid rain.

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Question 20 (3 marks)

Consider the reaction:

$$NH_3\,(g) + H_2O(l) \Leftrightarrow NH_4^+\,(aq) + OH^-\,(aq)$$

Is this reaction a redox reaction and /or a Lewis acid-base reaction ? Discuss.

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Question 21 (10 marks)

A student exhales carbon dioxide for one minute into a large plastic bag containing a saturated solution of barium hydroxide. A precipitate of barium carbonate forms. The precipitate is filtered off and dissolved in 100mL of 0.200 mol L^{-1} hydrochloric acid solution. The resulting solution, containing excess acid, is titrated with a 0.105 mol L^{-1} standardised solution of sodium hydroxide. At the end point with phenolphthalein as indicator, the volume of sodium hydroxide added was 24.67 mL.

(a) Write balanced chemical equations for two of the chemical reactions that are described above.

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(b) Identify one acid involved in the above reactions and its conjugate base.

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(c) What is a standardised solution of sodium hydroxide and how is it prepared ?

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(d) Determine the number of moles of carbon dioxide that was exhaled in the one minute interval.

Question 22 (5 marks)

In a titration, the equivalence point can be determined by a number of different methods.

(a) Discuss one important factor that needs to be considered when choosing an indicator for an acid-base titration.

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(b) Briefly outline another method that could be used in the laboratory to measure the equivalence point of a titration.

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