KNOX GRAMMAR SCHOOL

2001 - TERM 1 EXAMINATION

CHEMISTRY

2 UNIT

Time allowed – 2.5 Hours
(Plus 5 minutes reading time)

NAME:

DIRECTIONS TO CANDIDATES

- Board approved calculators may be used.
- Attempt ALL questions.
- **Part A** 15 multiple choice questions, each worth 1 mark. Complete your answers In either blue or black pen, or in pencil by placing a cross (X) in the box that corresponds to the best answer..
- **Part B** 15 short answer questions, mark allocation is shown for each question. Answer all questions in the spaces provided in the answer book.
- A **periodic table** and **data sheet** are provided on the last page of this examination. This page may be removed for your convenience.

Question or Answer Booklets are NOT to be removed from the examination room. Make sure your names are clearly printed on the front of each.

Part A

Attempt ALL questions

15 multiple choice questions, each worth 1 mark.

Complete your answers in either blue or black pen by placing a cross (X) in the box that corresponds to the best answer.

1. The pH of 0.1 mol/L hydrochloric acid (HCl) is about 1.0 and the pH of 0.1 mol/L acetic acid (CH_3COOH) is about 2.9.

   The pH of the acetic acid solution is higher because:

   (A) HCl ionises more fully than CH_3COOH. x
   (B) CH_3COOH contains more hydrogen atoms. x
   (C) HCl is a weker acid than CH_3COOH. x cant even spell weaker.
   (D) CH_3COOH is amphiprotic in water.

2. The structural formula for glycerol is:

   (A)
   CH_2OH
   |
   CH_2
   |
   CH_2OH

   (B)
   CH_2OH
   |
   CH_2OH

   (C)
   CH_2OH
   |
   $CHOH$
   |
   CH_2COOH

   (D)
   CH_2OH
   |
   $CHOH$
   |
   CH_2OH

3. In volumetric analysis, a burette, a pipette and a titration flask are used. *Just before* being used each must be rinsed appropriately. Which must be rinsed with distilled water *just before* use?

(A) burette only
(B) pipette only
(C) titration flask only
(D) burette and titration flask only

4. Which of the following dissolves in water to produce an alkaline solution?

(A) sodium nitrate
(B) potassium ethanoate
(C) ammonium chloride
(D) lithium sulfate

5. A radioactive atom of a Group 5 element emits one β-particle. The decay product will be an atom of an element in

(A) Group 3
(B) Group 4
(C) Group 5
(D) Group 6

6. The rise in boiling points of the alkanoic acids with increasing carbon chain length is due to the increasing strength of

(A) hydrogen bonds only
(B) dispersion forces only
(C) covalent bonds only
(D) covalent bonds and hydrogen bonds

7. In which of the following reactions is water acting as an acid?

(A) $H_3O^+ (aq) + HPO_4^{2-} (aq) \leftrightarrow H_2O (l) + H_2PO_4^- (aq)$

(B) $H_2O (l) + HCO_3^- (aq) \leftrightarrow H_3O^+ (aq) + CO_3^{2-} (aq)$

(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. In volumetric analysis, a standard solution is one

(A) made up at 25°C
(B) of concentration 1.000 mol/L
(C) of a known concentration
(D) which is put in the burette

9. The following represents part of a natural radioactive decay series.

$$^{x}U \xrightarrow{\alpha} {}^{y}Th \xrightarrow{\beta} {}^{231}Pa$$

Which of the following represents the mass numbers of "x" and "y" ?

	x	y
(A)	235	231
(B)	231	227
(C)	226	230
(D)	227	231

10. Which of these mixtures would function as a buffer in a water solution?

(A) propanoic acid / sodium propanoate
(B) hydrochloric acid / sodium chloride
(C) nitric acid / sodium hydroxide
(D) ammonia / sodium sulfate

11. Arrhenius defined an acid as one that

(A) reacts with active metals to produce hydrogen gas
(B) neutralises bases
(C) forms hydrogen ions when dissolved in water
(D) donates protons

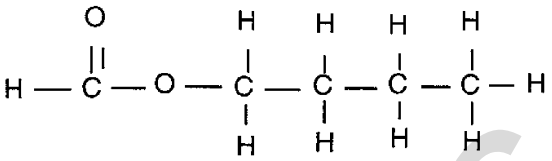
12. A substance that could *not* be formed when ethanol is burned in air is

(A) hydrogen
(B) carbon
(C) water
(D) carbon monoxide

13. Oil refineries use *catalytic cracking* to produce sufficient petrol to meet consumer demand. Select the correct statement concerning catalytic cracking.

(A) The cracked hydrocarbons are always straight chained.
(B) A zeolite catalyst is commonly used.
(C) A long chain alkane is always split into 2 shorter chained alkanes.
(D) Catalytic cracking is used to convert alkenes to alkanes.

14. Rum flavoured foods are commonly made using an ester. The compound that produces this flavour has the following structural formula.



The reactants used to make this ester are

(A) methanol and butanoic acid
(B) propanol and ethanoic acid
(C) butanol and methanoic acid
(D) propanol and propanoic acid

15. A student measures the pH of water solutions of sodium oxide and phosphorus(III)oxide. Which of the following gives his results?

	pH of solution	
	Sodium oxide	Phosphorus(III)oxide
(A)	7	7
(B)	7	< 7
(C)	> 7	< 7
(D)	> 7	7

Part B

Attempt ALL questions.

15 short answer questions. Mark allocation is given at the end of each question.

Complete your answers in the Answer Book.

Marks

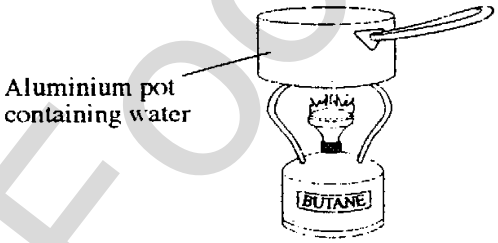
16. Aluminium oxide, aluminium chloride and aluminium sulfate are three compounds of aluminium.

    (a) Aluminium oxide is *amphoteric*. Define the term '*amphoteric oxide*'. 1

    (b) Draw the Lewis electron dot diagram for a molecule of aluminium chloride. 1

    (c) Aluminium sulfate has the formula $Al_2(SO_4)_3$. Calculate the number of moles of aluminium ions in 3.42g of aluminium sulfate. 2

17. A student used a cylinder of camping gas to measure the enthalpy of combustion of butane. The experimental set up is shown below.



The student found that 2.8g of butane burned to give out 72.4 kJ of energy.

    (a) Write a balanced equation for the complete combustion of butane. 1

    (b) Use the student's results to calculate the experimental value for the enthalpy of combustion of butane in kJ/mol. 2

    (c) The published value for the enthalpy of combustion of butane is – 2877 kJ/mol. Give TWO reasons why the experimental value is much lower than the theoretical value. 2

18. Biopolymers are defined as compounds made up of very long chain molecules made by living things. These compounds can now be produced industrially by providing the right environment for microbes to synthesise the polymers.

(a) Describe a process currently used to produce a named biopolymer on an industrial scale. Include the name of the enzyme or organism involved with its production. 3

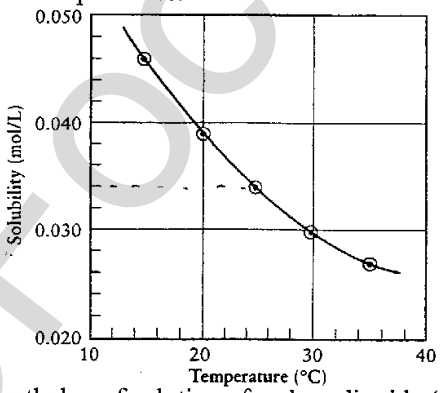
(b) Assess current developments in the use of biopolymers. 4

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

$$CO_2(g) \leftrightarrow CO_2(aq)$$

(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. 3

(b) This graph shows the solubility of carbon dioxide in water at different temperatures. 4



Is the enthalpy of solution of carbon dioxide (the *forward* reaction) endothermic or exothermic? Explain.

(c) The carbon dioxide is removed from one litre of soda water at 25°C and the gas is stored at 101.3 kPa pressure. Use the information in the graph to calculate the volume of carbon dioxide collected at this temperature. 2

20. Design an experiment that would enable you to ferment glucose and monitor the mass change that results. 3
In your answer, describe the steps you would take in point form and any measurements you would make.

21. Human activity sometimes results in the release of acidic oxides into the atmosphere.

(a) Name one such oxide. 1

(b) What is the human activity that results in the production of this oxide? 1

(c) Give an equation to show how this oxide is acidic. 1

(d) Give ONE reason for concern about the release of this oxide into the environment. 1

22. (a) Name a radioisotope that is used in medicine. 1

(b) For the isotope named, describe the way in which it is used and relate this to the chemical properties of the isotope. 4

23. Ammonia, NH_3, is amphiprotic. In the reaction below, ammonia is acting as a base.

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

(a) A 1.0 mol/L ammonia solution has a pH of 9.4.
(i) Calculate the $[\,H^+\,]$ in mol/L in this solution. 1
(ii) Calculate the $[\,OH^-\,]$ in mol/L in this solution. 1

(b) Give the formula of the conjugate base of ammonia. 1

24. The table contains the pH ranges of some common acid/base indicators.

Some common acid/base indicator pH ranges		
Name	Colour low pH – high pH	pH Range
Cresol red	red – yellow	0.2 – 1.8
Thymol blue	red – yellow	1.2 – 2.8
Methyl orange	red – yellow	3.1 – 4.4
Methyl red	pink – yellow	4.4 – 6.2
Litmus	red – blue	5.0 – 8.0
Phenol red	yellow – red	6.8 – 8.4
Phenolphthalein	colourless - red	8.3 – 10.0

(a) The equivalence point in a titration between 0.10 mol/L CH_3COOH and 0.10 mol/L NaOH occurs at about pH 7.9.

(i) Give ONE reason why Thymol blue is not a suitable indicator. 1

(ii) Select the indicator you would expect to be most suitable and explain your choice. 2

(b) From the data, suggest a reason why Litmus is not widely used in volumetric analyses. 1

(c) Sketch an expected titration curve when an excess of 0.10 mol/L NaOH is added to 0.10 mol/L HCl. 2

25. Polymers are the result of many small identical molecules (monomers) combining to produce a large molecule (polymer).

(a) Draw the monomer used in the production of polyvinylchloride. 1

(b) Draw a small section of the polyvinylchloride polymer chain. 1

(c) Give ONE use for polyvinylchloride. 1

(d) Account for the above use in terms of ONE property of this polymer. 1

26. Propanoic acid is an organic acid.

(a) Give the structural formula for propanoic acid. 1

(b) On your structural formula, circle any acidic hydrogen. 1

(c) Propanoic acid that has been diluted with water causes dry, blue litmus paper to turn red. However, pure propanoic acid does not cause a colour change with dry, blue litmus paper. Explain this observation. 2

27. A chemist makes up a buffer solution by dissolving ethanoic acid and sodium ethanoate in water. The final concentrations of ethanoic acid and ethanoate ions are both 0.100 mol/L.

(a) Write a balanced equation for the reversible reaction in this buffer solution. 1

(b) What is the general purpose of buffer solutions? 1

(c) Explain how the above buffer solution operates. 2

28. An electrochemical cell is set up using the overall reaction

$$Br_2\,(l) + Cu\,(s) \rightarrow 2\,Br^-\,(aq) + Cu^{2+}\,(aq)$$

(a) Calculate the expected voltage of this cell under standard conditions. 1

(b) As the cell is operating, its voltage falls. Explain. 1

(c) Draw a labeled sketch showing how you would set up this cell. 2

29. A student wishes to prepare the ester ethyl propanoate. To do this he refluxes a mixture of ethanol, propanoic acid and a few drops of concentrated sulphuric acid.

(a) Draw the structural formula of ethyl propanoate. 1

(b) What is the function of the concentrated sulphuric acid? 1

(c) Sketch the apparatus suitable for refluxing the mixture. Label your sketch. 2

(d) What is the purpose of refluxing the mixture? 1

30. A chemist makes a saturated solution of calcium hydroxide by shaking excess calcium hydroxide with water. He takes 25.00mL portions of the saturated solution and titrates them against 0.0528 mol/L hydrochloric acid solution. The average volume of hydrochloric acid needed to react with each 25.00 mL portion of calcium hydroxide is 20.15mL.

The equation for the titration is:

$$Ca(OH)_2\,(aq) + 2HCl\,(aq) \rightarrow CaCl_2\,(aq) + 2H_2O\,(l)$$

4

(a) Write a balanced net ionic equation for the titration reaction. 1

(b) Calculate the concentration of saturated calcium hydroxide solution in mol/L. 3

END OF PAPER