1995

CHEMISTRY
2 UNIT

NEW SOUTH WALES
HSC TRIAL EXAMINATION
AND SOLUTIONS

CHEMISTRY ASSOCIATES
PO BOX 2227
KEW
VICTORIA 3101
AUSTRALIA
TEL: (03) 9817 5374 FAX: (03) 9817 4334

email: chemas@vicnet.net.au
Internet: http://www.vicnet.net.au/~chemas/education.htm

CHEMISTRY ASSOCIATES
PO BOX 2227
KEW VIC 3101 **FAX: (03) 9817 4334**

HIGHER SCHOOL CERTIFICATE EXAMINATION

1995
CHEMISTRY
2 UNIT
Section I - Core Trial

(not to be used before Monday July 31, 1995)

Time allowed - Two hours
(Plus 5 minutes reading time)

DIRECTIONS TO CANDIDATES

Section I - Core

- ALL questions in Section I are COMPULSORY.
- **Part A** 15 one-mark multiple-choice questions.
  Mark your answers in pencil on the Answer Sheet provided.
- **Part B** 10 three-mark questions.
  Write your answers in the Part B Answer Book.
- **Part C** 6 five-mark questions
  Write your answers in the Part C Answer Book.
- Write your Student Number and Centre Number on each Answer Book.
- You may keep this Question Book, which you may use for rough work.
- Anything written in the Question Book will NOT be marked.

SECTION I - CORE

PART A

Questions 1 - 15 are worth one mark each.

Answer **ALL** questions

For each question (1-15) choose the best answer and indicate your choice by filling in the space in the Answer Sheet provided. Fill in only ONE choice for each question, using a pencil. Do NOT use a ball-point or ink pen. If you change your mind, erase your first mark completely.

1. Select the group in which **one** substance only has ionic bonds.

(A) Water, ethanol, carbon dioxide, calcium oxide.

(B) Hydrogen chloride, water, butane, paraffin wax.

(C) Diamond, steam, paraffin wax, ethanol.

(D) Potassium chloride, oxygen, magnesium oxide, steam.

2. The compound 1, 2, 3-propantriol will react with stearic acid to form

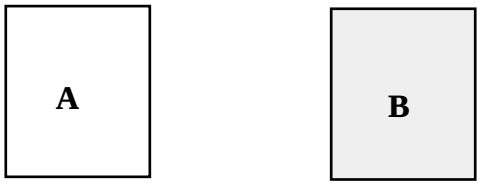
(A) a sugar

(B) a triglyceride

(C) an alcohol

(D) an antifreeze

3. Two drops of the indicator phenolphthalein are added to each of solutions **A** and **B** as shown in the diagram below.



(colourless) **(pink)**

Solution **A** remains colourless while solution **B** turns pink.
Which one of the following conclusions is best?

(A) **A** is acidic and **B** is alkaline

(B) **A** is alkaline and **B** is acidic

(C) **A** is either neutral or acidic and **B** is alkaline.

(D) **A** is either neutral or alkaline and **B** is acidic.

4. Hydrogen gas (H_2) reacts with ethene gas (C_2H_4) in the presence of a catalyst to produce ethane gas (C_2H_6). This type of reaction is called

(A) oxidation.

(B) substitution.

(C) hydrolysis.

(D) addition.

5. If two compounds are **isomers**, they have

(A) the same molecular formula and the same structural formula.

(B) the same structural formula but different molecular formulae.

(C) the same molecular formula but different structural formulae.

(D) different molecular formulae and different structural formulae.

6. When 50 mL of 1 M HCl solution reacts exactly with 50 mL of 1 M NaOH solution, the pH of the resulting solution is

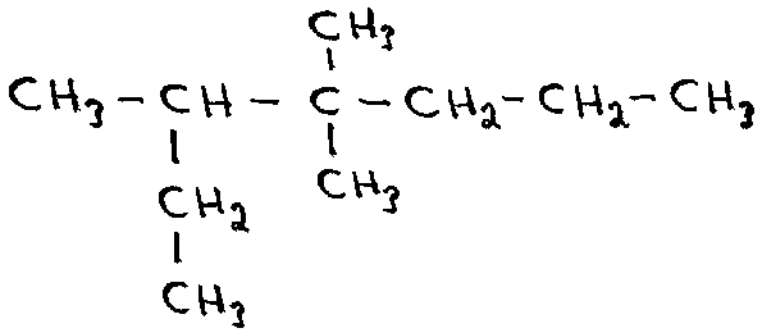
(A) 0.

(B) 1.

(C) $-\log_{10} 0.5$.

(D) 7.

7. The following is the formula of a branched hydrocarbon.



The systematic formula for this compound is

(A) 2-ethyl, 3, 3-dimethylhexane

(B) 3, 4, 4-trimethylheptane

(C) 4, 4-dimethyl 5-ethylhexane

(D) 4, 4, 5-trimethylheptane

8. A scientist measures the melting temperature and the electrical conductivity of each of the following solids: iodine, sodium, diamond and sodium chloride.

The solid with the lowest melting temperature and the solid with the greatest electrical conductivity **in that order** are

(A) sodium and diamond

(B) sodium chloride and iodine.

(C) diamond and sodium chloride

(D) iodine and sodium.

9. Two molecules which are members of the same homologous series are

(A) CH_4 and C_2H_4.

(B) C_2H_6 and C_3H_8.

(C) C_4H_{10} and C_4H_8.

(D) CO and CO_2.

10. Which one of the following lists contains oxides which are acidic only?

(A) Cl_2O_7 , MgO , SO_2

(B) Na_2O , P_4O_{10} , SO_3

(C) SiO_2 , P_4O_{10} , SO_2

(D) Al_2O_3 , SO_2 , SO_3

11. The main type of force holding the molecules of water together in ice (solid water) is

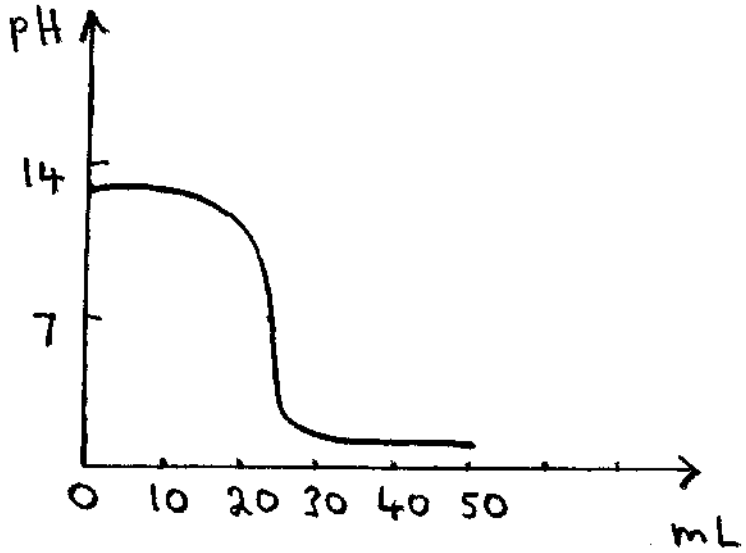
(A) nuclear.

(B) gravitational.

(C) electrostatic.

(D) magnetic.

12. 25 mL of 0.2 mol L^{-1} sodium hydroxide is placed in a conical flask. An acid is added drop by drop to the sodium hydroxide solution and the following graph of pH against added volume is obtained.



The acid that has been added to the sodium hydroxide **could** have been

(A) 0.2 mol L^{-1} HCl

(B) 0.2 mol L^{-1} H_2SO_4

(C) 0.1 mol L^{-1} HCl

(D) 0.1 mol L^{-1} H_2SO_4

13. Gaseous H_2 and I_2 are added to gaseous HI in a large glass vessel. When equilibrium is reached, according to the equation $H_2(g) + I_2(g) \Leftrightarrow 2HI(g)$,
the value of the equilibrium constant, K, will depend on

(A) the initial concentration of H_2.

(B) the initial concentration of HI.

(C) the volume of the reaction vessel.

(D) the temperature of the system.

14. The acid-base indicator methyl red, is involved in the equilibrium reaction:
yellow anion(aq) + H^+(aq) $\Leftrightarrow$ red molecule(aq)
The equilibrium constant for this reaction has the value 10^5 M^{-1}.

The pH at which the concentration of the red molecule is 10 times the concentration of the yellow anion is

(A) 0.5

(B) 4

(C) 5

(D) 10

15. The equilibrium between NO(g), O_2(g) and NO_2(g) is described by the equation:
$2NO(g) + O_2(g) \Leftrightarrow 2NO_2(g)$; exothermic reaction
At a temperature of 500 K , the equilibrium constant is 6.6×10^5.

When the temperature of this equilibrium mixture is decreased at constant volume, the number of mole of NO_2 in the equilibrium mixture

(A) increases.

(B) remains the same.

(C) decreases.

(D) changes in an unpredictable way

PART B

Questions 16 - 25 are worth 3 marks each.

Attempt **ALL** questions.

Write your answers in the Part B Answer Book.

Question 16

(a) Write the electronic configuration of

(i) the calcium atom, Ca

(ii) the calcium cation, Ca^{2+}

in terms of shells and subshells.

(b) While aluminium forms the oxide Al_2O_3, there is no oxide of calcium with the formula Ca_2O_3.
Explain why calcium does not easily form the ion Ca^{3+}.

Question 17 Some of the properties of ethane and methanol are listed in the table below.

Substance	Relative mass	State at 25°C	Solubility in water
ethane (C_2H_6)	**30**	**gas**	**insoluble**
methanol (CH_3OH)	**32**	**liquid**	**completely soluble**

(a) What is the type of bonding within

(i) ethane

(ii) methanol

(b) Explain in terms of bonding, the different properties of ethane and methanol listed in the table above.

Question 18

(a) How much water must be added to 50 mL of 0.50 mol L^{-1} hydrochloric acid to obtain a solution of concentration 0.20 mol L^{-1}?

(b) 20.0 mL of 0.15 mol L^{-1} potassium hydroxide solution is titrated with 0.20 mol L^{-1} hydrochloric acid.
What volume of hydrochloric acid is required for neutralisation?

Question 19

(a) If the hydroxide ion concentration in an egg white is $10^{-6.48}$ mol L^{-1},
what is the pH of the egg white?

(b) In the reaction, $NH_3 + H_2O = NH_4^+ + OH^-$, state whether the NH_3 is acting as an ACID, a BASE or NEITHER. Give a reason for your answer.

(c) Write the formula of the conjugate acid of the ion HPO_4^{2-}.

Question 20

Write equations for each of the following reactions:

(a) Chlorine gas reacts with methane.

(b) Bromine gas reacts with 1-butene.

(c) Ethanoic acid reacts with 2-propanol

Question 21

Write down the names and structural formulae, where required, for the missing products, labelled **F , G** in each of the following reactions.

C_2H_4 + H_2O (H_2SO_4 catalyst) → **F** ethene	**F** + strong oxidant → **G** (e.g. acidified $K_2Cr_2O_7$)

(a) What is the name of compound **F**?

(b) What is the name of compound **G**?

(c) Write the structural formula of **G**?

Question 22

Ethanol can produced industrially by fermentation.

(a) Write a balanced chemical equation for this reaction using sucrose ($C_{12}H_{22}O_{11}$) as the starting material.

(b) What conditions are required for this reaction?

(c) Give one hazard which is associated with the handling of ethanol on an industrial scale.

Question 23

Formic acid is a weak acid which ionises slightly in aqueous solution according to the equation: $HCOOH(aq) \Leftrightarrow H^+(aq) + HCOO^-(aq)$

(a) Calculate the equilibrium constant for this equation at 25^{o}C if the equilibrium concentrations are:

$[HCOOH] = 10^{-2}$ mol L^{-1} , $[H^+] = [HCOO^-] = 10^{-2.87}$ mol L^{-1}

(b) Sodium formate is added to this equilibrium mixture at 25^{o}C i.e. more $HCOO^-$ is added. Will the pH of the solution increase or decrease? Explain your answer.

Question 24

A solution of ammonium chloride, NH_4Cl, in water is slightly acidic because the ammonium ion, NH_4^+, is a weak acid in water:

$$NH_4^+(aq) \Leftrightarrow H^+(aq) + NH_3(aq); \quad \text{endothermic reaction}$$

The equilibrium constant for this reaction is 5.6×10^{-10} M at 25^oC.

(a) Ignore the dissociation of water, i.e. assume $[H^+(aq)] = [NH_3(aq)]$, and calculate the concentration of hydrogen ions in a solution of ammonium chloride in water at 25^oC in which the NH_4^+ concentration is 1.1 mol L^{-1} at equilibrium.

(b) Would the equilibrium hydrogen ion concentration in a solution of NH_4Cl in water, increase or decrease if the temperature were lowered? Explain your answer.

Question 25

The equation describing the formation of ammonia is:

$$N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g); \quad \text{exothermic reaction}$$

In a particular industrial experiment at 350^oC in a 1 L closed vessel, the equilibrium mixture contained 2.16 mol N_2, 1.00 mol H_2 and 2.00 mol NH_3.

(a) Write the expression for the equilibrium constant and calculate the value of the equilibrium constant at this temperature.

(b) If the volume of the vessel is decreased at a constant temperature of 350^oC, what would be the effect on the number of mole of NH_3 present when equilibrium is re-established? Explain your answer.

PART C

Questions 26 - 31 are worth 5 marks each.

Attempt **ALL** questions.

Write your answers in the Part C Answer Book.

Question 26

(a) On spacecraft the cabin atmosphere can be cleansed of carbon dioxide by passing the air through canisters of potassium hydroxide, KOH.

Write a balanced equation to describe this reaction.

(b) During the industrial production of copper metal, the gas sulfur dioxide is produced.

Give two reasons why sulfur dioxide should not be allowed to enter the atmosphere.

(c) This sulfur dioxide can be prevented from entering the atmosphere by reacting it with oxygen (O_2) and limestone ($CaCO_3$) to form calcium sulfate.

Write a balanced equation to describe this reaction.

(d) The water in a swimming pool is left untreated with chemicals over a long period of time. Would you expect the pH of the water in the pool to increase, decrease or remain the same? Give a reason for your answer.

Question 27

The columns and rows of 11 elements in the Periodic Table are given below. The elements are not given their normal symbols.

ELEMENT	COLUMN	ROW
A	I	I
D	I	II
X	I	V
L	II	III
Q	II	IV
M	III	III
T	III	IV
E	IV	II
G	V	I
Z	V	II
J	VII	II

(a) What is the formula of the compound formed between element **J** and element **Q**? Explain your answer.

(b) An atom has 6 protons and 7 neutrons in the nucleus. Which element has this atom as an isotope? Explain your answer.

(c) Name **three** elements from the list above that exhibit similar chemical properties.

(d) Give the electronic structure of the ion usually formed by element **M**.

(e) Which elements in this list are non-metals?

Question 28

Methanol can be produced industrially from methane. In the first step the methane is converted to a mixture of carbon monoxide and hydrogen according to the equation:

$$CH_4(g) + H_2O(g) \Leftrightarrow CO(g) + 3H_2(g) \; ; \qquad \text{endothermic reaction}$$

The methanol is then formed by reaction with hydrogen gas according to the equation:

$$CO(g) + 2H_2(g) \Leftrightarrow CH_3OH(g) \; ; \qquad \text{exothermic reaction}$$

(a) For EACH of the reactions above, predict the effect on the position of equilibrium when

(i) The pressure in the reaction vessels is increased.

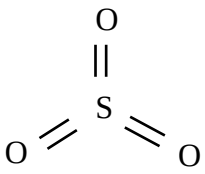
(ii) The temperature at which the reactions are conducted is increased.

(b) Both reactions proceed at low rates at room temperature and pressure. Suggest action which might be taken to get the best yield of methanol while minimising the cost of the process.

Question 29

The formulae of some of the oxides of the third period of the Periodic Table are: Na_2O, MgO, Al_2O_3, SiO_2, P_4O_{10}, SO_3, Cl_2O_7.

(a) Sulfur trioxide has the shape:



Is this a polar or non-polar molecule? Justify your choice.

(b) What is the name given to the major type of intermolecular force that exists between sulfur dioxide molecules

(c) Explain how the chemical bonding in these oxides changes from sodium across to chlorine.

Question 30

"Cloudy ammonia" is used as a cleaning agent. It contains both soap and ammonia (NH_3). Ammonia is a weak base which reacts according to the equation:

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

A 20.0 mL sample of "Cloudy ammonia" is diluted to 250 mL in a volumetric flask.
A 25.0 mL sample of this diluted solution was titrated with 0.0900 mol L^{-1} hydrochloric acid.

The volume of acid used was 27.23 mL.

(a) Write the equation for the reaction between NH_3 and HCl.

(b) Calculate the concentration of the ammonia in the original sample in mol L^{-1}.

Question 31

You are provided with equal quantities of 1-propanol and methanoic (formic) acid so that you can prepare an ester.

(a) Write a balanced equation with structural formulae showing the reactants and product in this reaction.

(b) Give the name of the ester that is produced in this reaction.

(c) Describe how you would prepare a pure sample of this ester.

END OF QUESTION BOOKLET

1995 HSC CHEMISTRY TRIAL EXAMINATION (CORE)

CHEMISTRY ASSOCIATES
P.O. BOX 2227
KEW, VIC., 3101
AUSTRALIA
TEL:(03) 9817 5374 FAX: (03) 9817 4334

1995 HSC CHEMISTRY 2 UNIT TRIAL EXAMINATION

DATA SHEET

- Values of several numerical constants -

Avogadro's constant, N_A	6.022 x 10^{23} mol^{-1}
Boltzmann's constant, *k*	1.381 x 10-23 J K^{-1}
Elementary charge, *e*	1.602 x 10^{-19} C
Faraday constant, *F*	96 490 C mol^{-1}
Gas constant, *R*	8.314 J K^{-1} mol^{-1}
	0.0821 L atm K^{-1} mol^{-1}
Ionisation constant for water at 298 K (25^{o}C), K_w	1.0 x 10^{-14}
Mass of electron, m_e	9.109 x 10^{-31} kg
Mass of neutron, m_n	1.675 x 10^{-27} kg
Mass of proton, m_p	1.673 x 10^{-27} kg
Volume of 1 mole ideal gas at 101.3 kPa (1.00 atm) and	
at 273 K (0^{o}C)	22.41 L
at 298 K (25^{o}C)	24.47 L

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P.O. BOX 2227
KEW, VIC., 3101
AUSTRALIA
TEL:(03) 9817 5374 FAX: (03) 9817 4334

Higher School Certificate Core Trial Examination 1995

CENTRE NO.				

DIRECTIONS:

Write your Student Number in the slots provided below as indicated by the large arrow.

Then, in the column of digits below each box, blacken the area which has the same number as you have written in the box. Fill in one area only in each column.

Read each question and its suggested answers. When you have decided which answer is correct, fill in the response area completely with an ordinary pencil. Mark only one area per question. If you change your mind, erase your first mark completely, then make a new mark. Make no stray marks, they may count against you. Do not use a ball-point or ink pen.

SAMPLE: Sydney is A-a country B-a mountain C-an island D-a city

A	**B**	**C**	■

CHEMISTRY - 2 UNIT

PART A - ATTEMPT ALL QUESTIONS

STUDENT NUMBER

1	1	1	1	1	1	1
2	2	2	2	2	2	2
3	3	3	3	3	3	3
4	4	4	4	4	4	4
5	5	5	5	5	5	5
6	6	6	6	6	6	6
7	7	7	7	7	7	7
8	8	8	8	8	8	8
9	9	9	9	9	9	9

PART A

1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D
11	A	B	C	D
12	A	B	C	D
13	A	B	C	D
14	A	B	C	D
15	A	B	C	D

STUDENTS SHOULD NOW CONTINUE WITH PART B

CHEMISTRY ASSOCIATES
P.O. BOX 2227
KEW, VIC., 3101
AUSTRALIA
TEL:(03) 9817 5374 FAX: (03) 9817 4334

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CENTRE NUMBER

Higher School Certificate Core Trial Examination

1995

CHEMISTRY

2 UNIT

PART B ANSWER BOOK

DIRECTIONS TO CANDIDATES

- Write your Student Number and Centre Number at the top right hand corner of this page.
- You should receive this paper with an Answer Sheet for Part A and a Part C Answer Book.
- Answer Questions 16 to 25 in this Answer Book.
- Each question is worth 3 marks.

EXAMINER'S USE ONLY

PART	Mark	Examiner	Check
B			

EXAMINER'S USE ONLY

PART B

Questions 16to 25 (3 marks each)
Attempt ALL questions.
Answer questions 16 to 25 in the spaces provided.

16. **(a) (i)** .....

(ii).....

(b) .....

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17. **(a) (i)** .....

(ii).....

(b) .....

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18. **(a)** .....

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(b) .....

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EXAMINER'S USE ONLY

19. **(a)** .....

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(b) .....

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(c) .....

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20. **(a)** .....

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(b) .....

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(c) .....

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21. **(a)** .....

(b) .....

(c)

EXAMINER'S USE ONLY

22. **(a)** .....

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(b) .....

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(c) .....

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23. **(a)** .....

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(b) .....

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24. **(a)** .....

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(b) .....

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EXAMINER'S USE ONLY

25. **(a)** .....

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(b) .....

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END OF PART B ANSWER BOOK

CHEMISTRY ASSOCIATES
P.O. Box 2227
Kew, Vic., 3101
Fax: (03) 9817 4334

CHEMISTRY ASSOCIATES
P.O. BOX 2227
KEW, VIC., 3101
AUSTRALIA
TEL:(03) 9817 5374 FAX: (03) 9817 4334

STUDENT NUMBER

CENTRE NUMBER

Higher School Certificate Core Trial Examination

1995

CHEMISTRY

2 UNIT

PART C ANSWER BOOK

DIRECTIONS TO CANDIDATES

- Write your Student Number and Centre Number at the top right hand corner of this page.
- You should receive this paper with an Answer Sheet for Part A and a Part B Answer Book.
- Answer Questions 26 to 31 in this Answer Book.
- Each question is worth 5 marks.

EXAMINER'S USE ONLY

PART	Mark	Examiner	Check
C			

EXAMINER'S USE ONLY

PART C

Questions 26 to 31 (5 marks each)
Attempt ALL questions.
Answer questions 26 to 31 in the spaces provided.

26. **(a)** .....

(b) .....

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(c) .....

(d) .....

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27. **(a)** .....

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(b) .....

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(c) .....

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(d) .....

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(e) .....

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EXAMINER'S USE ONLY

28. **(a) (i)** .....

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(a) (ii) .....

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(b) .....

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29. **(a)** .....

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(b) .....

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(continued)

EXAMINER'S USE ONLY

29. **(c)** .....

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30. **(a)** .....

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(b) .....

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31. **(a)**

(continued)

EXAMINER'S USE ONLY

31. **(b)** .....

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(c) .....

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END OF PART C ANSWER BOOK

CHEMISTRY ASSOCIATES
P.O. Box 2227
Kew, Vic., 3101
Fax: (03) 9817 4334

PART A.

1. A Calcium oxide only has ionic bonding. Others have covalent bonding.

2. B A fat is formed. This is called a triglyceride since it is formed from glycerol.

3. C A pink colour indicates an alkaline solution. A colourless solution indicates either a neutral or an acidic solution.

4. D The hydrogen is added to the ethene. The double bond is destroyed and ethane is formed by addition. An addition reaction

5. C Isomers have the same molecular formula but different structural formulae.

6. D The number of mole of HCl = the number of mole of NaOH = 0.050 x 1 = 0.050. Hence, the HCl and NaOH are completely used up since they react in a 1 : 1 ratio. Hence, the solution is neutral and pH =7.

7. B The longest possible carbon chain has seven carbon atoms (heptane).
Using the lowest possible numbers for side-chains, there is a methyl group on carbon 3 and two methyl groups on carbon 4.
Hence, the name is 3, 4, 4-trimethylheptane.

8. D The solid with the lowest melting temperature is the molecular solid iodine which has only weak dispersion forces holding the molecules together. The solid with the best electrical conductivity is the metal sodium which has weakly held valence electrons.

9. B Successive members of an homologous series differ by CH_2.
Hence, C_2H_6 and C_3H_8 are successive members of the same homologous series.

10. C SiO_2, P_4O_{10} and SO_2 are all acidic oxides.

11. C All chemical bonding is electrostatic in nature. That is, it involves the attraction between positive and negative charges.

12. A From the graph, a pH of 7 is reached when 25 mL of the acid has been added. Hence, the acid must have the same hydrogen ion concentration as the sodium hydroxide has hydroxide concentration (0.2 mol $L^{-1)}$
Therefore, the acid is 0.2 mol L^{-1} HCl.

13. D The value of the equilibrium constant does not depend upon the initial concentrations or the volume of the reaction vessel. It does depend upon the temperature.

14. B $\frac{10}{1\ [H^+]} = 10^{5.}$ Hence, $[H^+] = 10^{-4}$ Therefore, pH = 4.

15. A When the temperature decreases, the equilibrium constant increases for an exothermic reaction. Hence, the number of mole of NO_2 in the equilibrium mixture increases.

PART B
Question 16

(a) (i) Ca (20) 2.8.8.2 or $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
(ii) Ca^{2+} 2.8.8 or $1s^2 2s^2 2p^6 3s^2 3p^6$

(b) The third ionisation energy for calcium is much larger than the first or the second ionisation energies. Therefore, Ca^{3+} does not form easily.

Question 17

(a) (i) covalent
(ii) covalent

(b) The bonding between ethane molecules (dispersion forces) is much weaker than the bonding between methanol molecules (dipole-dipole interaction). Hence, ethane is a gas while methanol is a liquid at 25^oC. Unlike ethane, methanol can form hydrogen bonds with water molecules. Hence, methanol is soluble in water while ethane is insoluble.

Question 18

(a) n(HCl) = 0.05 x 0.5 = 0.025.
Hence, V(HCl) = $\frac{0.025}{0.2}$ = 0.125 L.
Hence, V(water added) = 125 - 50 = 75 mL **ANS**

(b) The balanced equation is: $HCl + KOH = KCl + H_2O$

Hence, n(HCl) = n(KOH) = 0.02 x 0.15 = 0.003.
Hence, V(HCl) = $\frac{0.003}{0.20}$ = 0.015 L = 15 mL **ANS**

Question 19

(a) $[H^+] = \frac{10^{-14}}{10^{-6.48}} = 10^{-7.52}$. Hence, pH = 7.52 **ANS**

(b) NH_3 is a proton acceptor. It is a base.

(c) The conjugate acid of HPO_4^{2-} is $H_2PO_4^-$.

Question 20

(a) $Cl_2 + CH_4 = CH_3Cl + HCl$
(up to four substitutions to give products CH_2Cl_2, $CHCl_3$, CCl_4)

(b) $CH_2{=}CHCH_2CH_3 + Br_2 = CH_2BrCHBrCH_2CH_3$

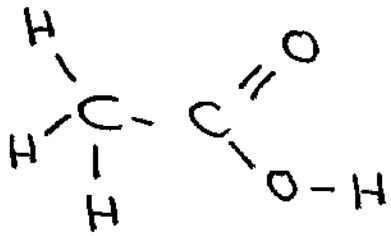
(c) $CH_3COOH + CH_3CHOHCH_3 = CH_3COO\text{-}CH(CH_3)_2 + H_2O$

Question 21

(a) **F** is ethanol

(b) **G** is ethanoic acid (acetic acid)

(c) The structural formula of **G** is



Question 22

(a) $C_{12}H_{22}O_{11} + H_2O = 4C_2H_5OH + 4CO_2$

(b) Yeast is added to sugar solution at a controlled temperature. The ethanol concentration cannot rise above 15% since greater concentrations kill the yeast and stop the fermentation.

(c) Ethanol is a volatile liquid and flammable.

Question 23

(a) $K = \frac{[HCOO^-]\,[H^+]}{[HCOOH]} = \frac{10^{-2.87} \times 10^{-2.87}}{10^2} = 10^{-7.74}$ **ANS**

(b) When more $HCOO^-$ is added, the equilibrium shifts to the left and the $[H^+]$ decreases. Hence, the pH increases.

Question 24

(a) $K = \frac{[H^+]]NH_3]}{[NH_4^+]} = 5.6 \times 10^{-10}$.

Hence, $[H^+][NH_3] = 1.1 \times 5.6 \times 10^{-10}$.

Hence, $[H^+]^2 = 6.16 \times 10^{-10}$.

Therefore, $[H^+] = 2.5 \times 10^{-5}$ mol L^{-1} **ANS**

(b) When the temperature is lowered, the equilibrium shifts to the left (the exothermic reaction). Hence, the equilibrium hydrogen ion concentration will decrease.

Question 25

(a) $K = \frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{2.00^2}{2.16 \times 1.00^3} = 1.85\ M^{-2}$ ANS

(b) When the volume is decreased at constant temperature, the equilibrium shifts in favour of the reaction producing the smaller number of mole of gas. Hence, the equilibrium shifts to the right and the number of mole of NH_3 increases.

PART C

Question 26

(a) $2KOH + CO_2 = K_2CO_3 + H_2O$

(b) Sulfur dioxide is an irritant to the nose, throat and lungs. It is acidic and increases the acidity of rainwater which, in turn, increases the corrosion of metals and other materials.

(c) $2SO_2 + O_2 + 2CaCO_3 = 2CaSO_4 + 2CO_2$

(d) Water dissolves carbon dioxide gas. This produces an acidic solution according to the equation: $CO_2 + H_2O = H^+ + HCO_3^-$. Hence, the pH of the water will decrease.

Question 27

(a) **Q** is in Group II and **J** is in Group VII. Hence, **Q** will form the ion $\mathbf{Q}^{2+}$ and **J** will form the ion $\mathbf{J}^{-}$. Hence, the formula will be $\mathbf{QJ}_2$.

(b) An atom with 6 protons is an element in Group IV. Hence, element **E** has this atom as an isotope.

(c) Elements **A**, **D** and **X** are all in Group I and therefore will exhibit similar chemical properties.

(d) Element **M** is in Group III and Period III. It will form the ion $\mathbf{M}^{3+}$ and the electronic structure of this ion is 2.8 or $1s^2 2s^2 2p^6$.

(e) The non-metals in this list are elements **G**, **Z** and **J**.

Question 28

(a) (i) An increase in pressure shifts the equilibrium in favour of the reaction that produces the smaller number of mole of gas. Hence, for the first reaction, the equilibrium shifts to the left and for the second reaction, the equilibrium shifts to the right.

(ii) An increase in temperature favours the endothermic reaction. Hence, for the first reaction, the equilibrium shifts to the right and for the second reaction, the equilibrium shifts to the left.

(b) The first reaction should be carried out at high temperature and low pressure with a catalyst. The second reaction should be carried out at a lower temperature and high pressure with a catalyst.

Question 29

(a) Sulfur trioxide is a non-polar molecule. Each of the bonds is polar, but the molecule is symmetrical.

(b) Dispersion forces (caused by instantaneous dipoles) exist between the sulfur dioxide molecules.

(c) Sodium and magnesium oxides have ionic bonding. Aluminium oxide has bonding with some covalent character. Silicon dioxide has strong covalent bonding throughout a giant lattice structure. Phosphorus, sulfur and chlorine oxides are molecular with strong covalent bonding within the molecules and dispersion forces between the molecules.

Question 30

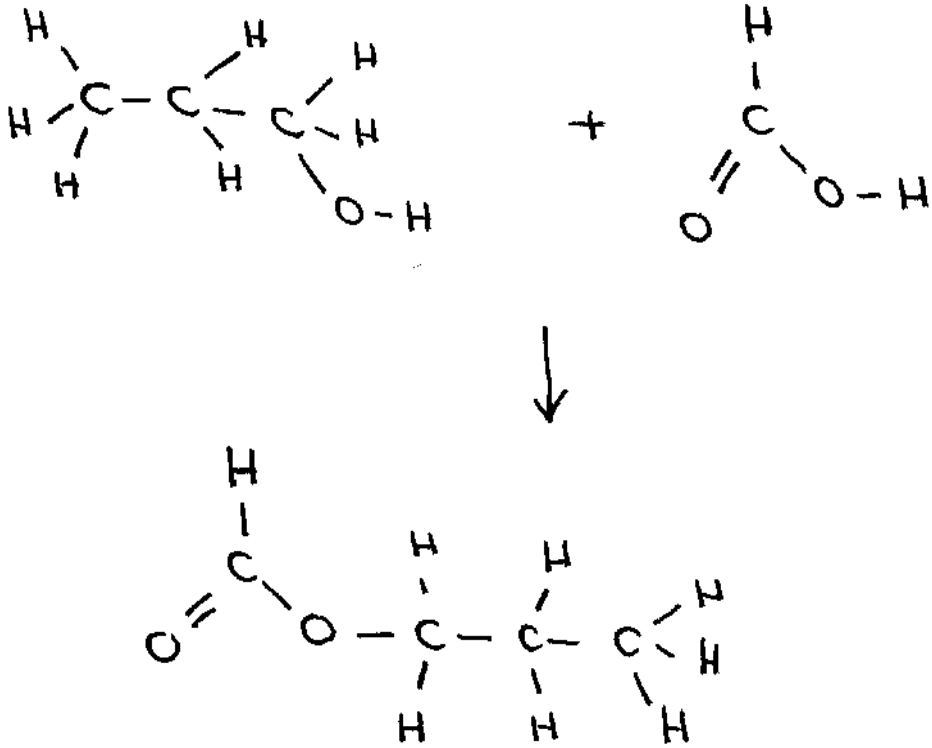
(a) $NH_3 + HCl = NH_4Cl$

(b) n(HCl) used = 0.0900 x 0.02723 = n(NH_3) in the 25 mL sample of the diluted solution. Hence, n(NH_3) in 250 mL of the diluted solution = 10 x 0.0900 x 0.02723 = n(NH_3) in the original 20 mL sample. Hence, the concentration of NH_3 in the original sample

$$= \frac{n}{V} = \frac{10 \times 0.0900 \times 0.02723}{0.020} = 1.23 \text{ mol } L^{-1}$$ **ANS**

Question 31

(a)



(b) The ester produced is n-propyl methanoate.

(c) Reflux 1-propanol with excess methanoic acid with a small amount of concentrated sulfuric acid (protective glasses and clothing must be worn) for approximately 10 minutes. Cool the reaction mixture and pour the mixture into water. Stir the mixture and allow the mixture to separate into two layers. Discard the lower layer which is the aqueous layer. Add solid sodium carbonate to the organic layer to react with the excess methanoic acid. The acid has been removed when no further gas is given off. Add water, shake the mixture and once again discard the aqueous layer. Add anhydrous calcium chloride to the organic layer to remove water. Filter the solution. Distil the organic layer to obtain pure n-propyl methanoate.

END OF SUGGESTED SOLUTIONS

CHEMISTRY ASSOCIATES
P.O. BOX 2227
KEW, VIC., 3101
AUSTRALIA
TEL:(03) 9817 5374 FAX: (03) 9817 4334

PERIODIC TABLE

Key

Atomic Number — 79 Au — symbol of element
Atomic Mass — 197.0 — name of element
Gold

1 H 1.008 Hydrogen

																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.06 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.90 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.71 Nickel	29 Cu 63.55 Copper	30 Zn 65.38 Zinc	31 Ga 69.72 Gallium	32 Ge 72.59 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc 98.91 Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Cesium	56 Ba 137.3 Barium	57 La 138.9 Lanthanum	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.9 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po — Polonium	85 At — Astatine	86 Rn — Radon
87 Fr — Francium	88 Ra 226.0 Radium	89 Ac — Actinium	104	105	106												

58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm — Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.0 Ytterbium	71 Lu 175.0 Lutetium
90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np 237.0 Neptunium	94 Pu — Plutonium	95 Am — Americium	96 Cm — Curium	97 Bk — Berkelium	98 Cf — Californium	99 Es — Einsteinium	100 Fm — Fermium	101 Md — Mendelevium	102 No — Nobelium	103 Lr — Lawrencium