BOARD OF STUDIES
NEW SOUTH WALES

HIGHER SCHOOL CERTIFICATE EXAMINATION

1995

CHEMISTRY

2 UNIT

Time allowed—Three hours
(Plus 5 minutes' reading time)

DIRECTIONS TO CANDIDATES

Section I—Core

- Attempt ALL questions.
- **Part A** 15 multiple-choice questions, each worth 1 mark.
  Mark your answers in pencil on the Answer Sheet provided.
- **Part B** 10 questions, each worth 3 marks.
  Answer this Part in the Part B Answer Book.
- **Part C** 6 questions, each worth 5 marks.
  Answer this Part in the Part C Answer Book.
- Write your Student Number and Centre Number on each Answer Book.
- You may keep this Question Book. Anything written in the Question Book will NOT be marked.

Section II—Electives

- Attempt ONE question.
- Each question is worth 25 marks.
- Answer the question in a *separate* Elective Answer Booklet.
- Write your Student Number and Centre Number on the cover of each Elective Answer Book.
- Write the Course, Elective Name, and Question Number on the cover of each Elective Answer Book.
- You may ask for extra Elective Answer Books if you need them.

A Periodic Table and Data Sheet are provided as a tear-out sheet at the back of this paper.

SECTION I—CORE

PART A

Attempt ALL questions.
Each question is worth 1 mark.
Select the alternative A, B, C, or D that best answers the question.
Mark your answers in pencil on the Answer Sheet provided.

1. Chlorine reacts with butene to form 1,2-dichlorobutane. This type of reaction is called

(A) addition.
(B) oxidation.
(C) hydrolysis.
(D) substitution.

2. Which of the following solutions has the lowest pH?

(A) 0·1M ethanoic (acetic) acid.
(B) 0·1M hydrochloric acid.
(C) 0·2M sodium hydroxide.
(D) 0·2M nitric acid.

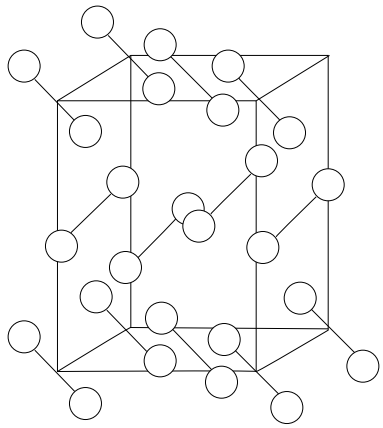
3. Which of the following pairs of substances are isomers?

(A) dichloromethane and trichloromethane
(B) propanoic acid and 1,2-propanediol.
(C) pentane and 2,3-dimethylbutane
(D) 1-butene and cyclobutane

4. The list of substances that contain ionic bonds only is:

(A) potassium chloride, magnesium oxide, copper(II) chloride.
(B) potassium chloride, magnesium nitrate, carbon dioxide.
(C) magnesium oxide, copper(II) chloride, sulfur trioxide.
(D) magnesium nitrate, potassium oxide, carbon dioxide.

5. The diagram below represents the structure of a solid chemical substance.



The solid represented is most likely to be

(A) silver.
(B) iodine.
(C) graphite.
(D) sodium fluoride.

6. The correct expression for the equilibrium constant K for the equation

$$2Cl_2(g) + 2H_2O(g) \rightleftharpoons 4HCl(g) + O_2(g)$$

is

(A) $\dfrac{[H_2O]\,[Cl_2]}{[HCl]\,[O_2]}$

(B) $\dfrac{[HCl]\,[O_2]}{[H_2O]\,[Cl_2]}$

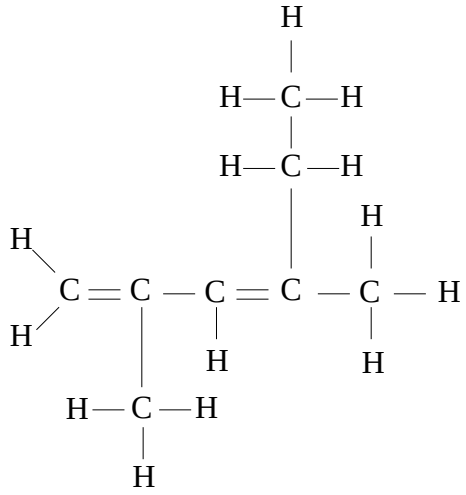
(C) $\dfrac{2[H_2O]\,2[Cl_2]}{4[HCl]\,[O_2]}$

(D) $\dfrac{[HCl]^4\,[O_2]}{[H_2O]^2\,[Cl_2]^2}$

7. Stable aluminium ions have the same electronic configuration as

(A) fluoride ions.
(B) beryllium ions.
(C) lithium atoms.
(D) sodium atoms.

8. The structural formula below represents a compound.



The IUPAC systematic name for this compound is

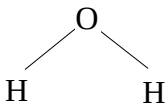
(A) 2-methyl-4-ethyl-1,3-pentadiene.

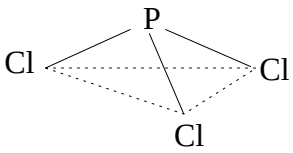
(B) 2-ethyl-4-methyl-2,4-pentadiene.

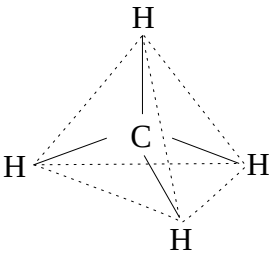
(C) 2,4-dimethyl-1,3-hexadiene.

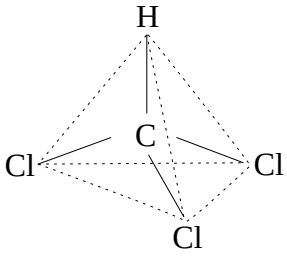
(D) 3,5-dimethyl-3,5-hexene.

9. Given the following shapes, which of the molecules is NOT polar?

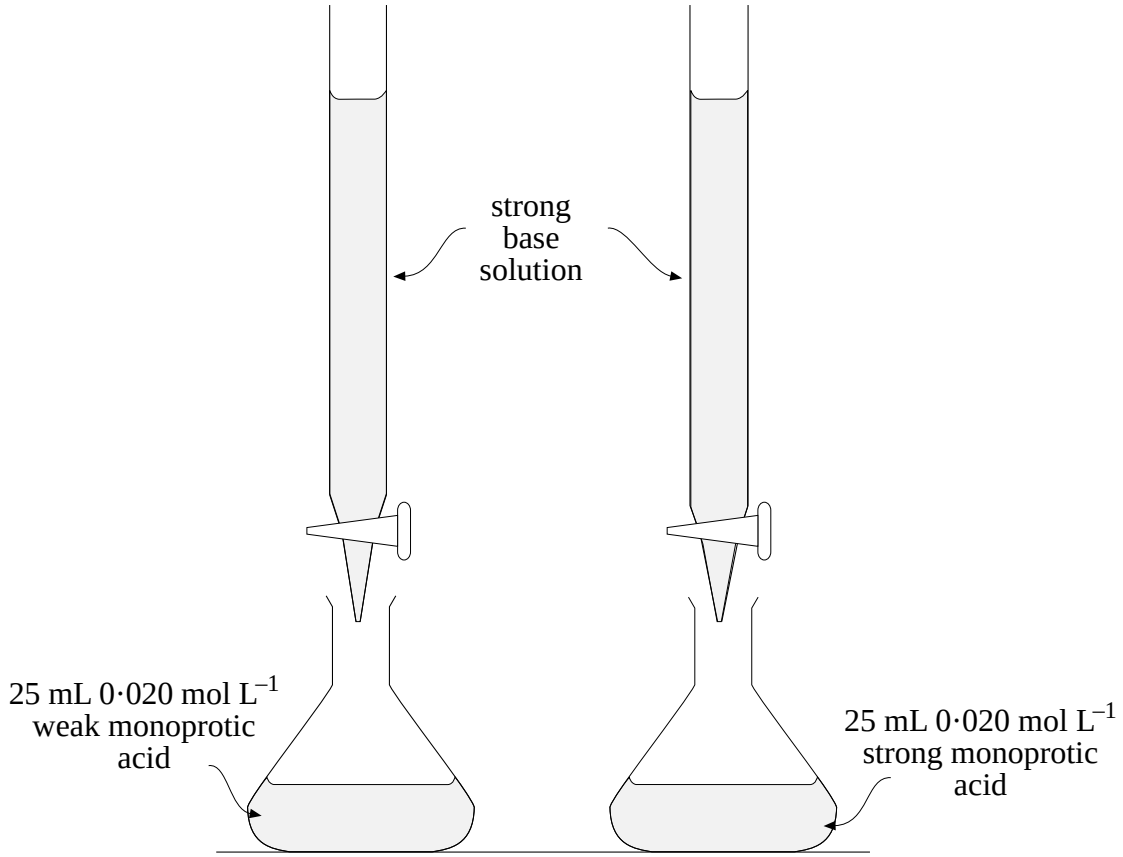
(A) H_2O 

(B) PCl_3 

(C) CH_4 

(D) $CHCl_3$ 

10. Two titrations are carried out as shown below.



Which of the following statements is true?

(A) The volume of base required to reach the equivalence point will depend upon the particular acid used.

(B) The weak acid will require the same amount of base as the strong acid to reach the equivalence point.

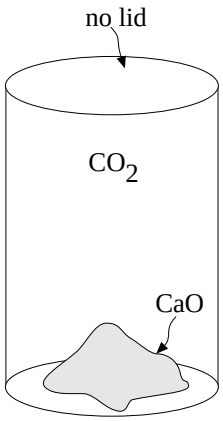
(C) The weak acid will require less base than the strong acid to reach the equivalence point.

(D) The weak acid will require more base than the strong acid to reach the equivalence point.

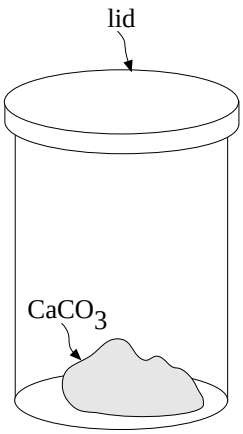
11. The conversion of calcium carbonate to calcium oxide and carbon dioxide is a reversible reaction and will reach equilibrium under certain conditions.

Which of the following diagrams shows that the system may have reached equilibrium?

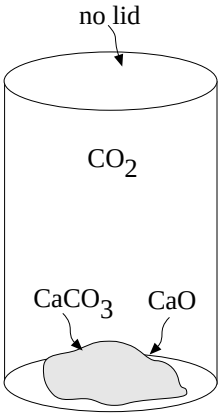
(A)



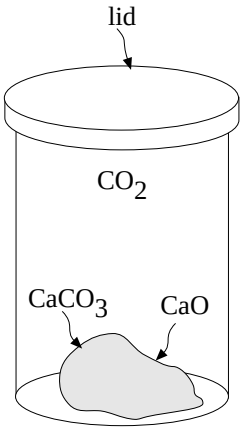
(B)



(C)



(D)



12. An investigation of the properties of the third-period elements shows that the boiling-points of sodium chloride and silicon tetrachloride are 1465°C and 57°C respectively. This difference in boiling-points is a result of

(A) covalent bonds being weaker than ionic bonds.

(B) sodium chloride having strong metallic bonds.

(C) silicon tetrachloride having weak intermolecular bonds.

(D) silicon forming weaker bonds with chlorine than does sodium.

13. The electronic configuration for the sulfide ion, S^{2-}, is

(A) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$

(B) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

(C) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

(D) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4\ 4s^2$

14. A saturated solution of barium carbonate was stored in a conical flask. Solid barium carbonate was added to the solution. This carbonate contained some radioactive isotope carbon-14 in its structure in place of the more common carbon-12 isotope. The mixture was allowed to stand for several days before being filtered into a beaker. The carbon-14 isotope could reasonably be expected to be found

(A) only in the filtrate in the beaker.

(B) both in the residue and in the filtrate.

(C) neither in the residue nor in the filtrate.

(D) only in the carefully rinsed residue left in the filter paper.

15. 5 litres of a solution contain 0·245 g of pure sulfuric acid. Assuming complete dissociation, the pH of this solution is closest to

(A) 3·5

(B) 3·0

(C) 2·5

(D) 2·0

PART B

Attempt ALL questions.

Each question is worth 3 marks.

Answer all questions in the Answer Book provided.

In questions involving calculations, you are advised to show working, as marks may be awarded for relevant working.

16. (a) Draw a structural formula for 2-methyl-2-pentanol and for 3-methyl-2-pentanol.

(b) Describe, and give the results of, a chemical test to distinguish between these two compounds.

17. A compound containing $FeSCN^{2+}$ dissolves in water. The reaction is endothermic, forming an equilibrium mixture of the red-brown $FeSCN^{2+}(aq)$ ion, the pale yellow $Fe^{3+}(aq)$ ion, and the colourless $SCN^{-}(aq)$ ion.

(a) Write an equation for this equilibrium.

(b) Explain the term 'equilibrium'.

(c) Describe the colour change observed if the temperature of the mixture is lowered.

18. In an experiment, a student mixed 15·0 mL of 0·030 mol L^{-1} HCl with 20·0 mL of 0·010 mol L^{-1} $Ba(OH)_2$.

(a) Write an equation for the reaction.

(b) Calculate the pH of the resulting solution.

19. (a) Sodium hydrogen carbonate ($NaHCO_3$) is an amphiprotic compound. Write TWO ionic equations showing its amphiprotic behaviour in water.

(b) Give ONE conjugate acid–base pair from your equations.

20. Butanoic acid is a natural product and a component of human sweat.

(a) Write a mathematical expression for the acid dissociation constant, K_a, of butanoic acid.

(b) Calculate the value of K_a for butanoic acid if a 0·10 mol L^{-1} solution has a pH of 2·9 at 298 K.

21. The dissociation of any weak acid, HA, in water may be represented as

$$HA + H_2O \rightleftharpoons H_3O^+ + A^-$$

Acid dissociation constants for three weak acids are given below.

Acid	K_a (mol L^{-1})
HX	$2{\cdot}3 \times 10^{-4}$
HY	$7{\cdot}1 \times 10^{-5}$
HZ	$5{\cdot}2 \times 10^{-4}$

(a) Arrange these three acids in order of decreasing acid strength. Explain your answer.

(b) If all three acid solutions had the same concentration, which would best conduct electricity? Explain your answer.

22. The colourless gas nitrogen monoxide (NO) reacts with oxygen to form a brown gas nitrogen dioxide (NO_2). This results in a light-brown equilibrium mixture according to the equation:

$$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H = -5{\cdot}66 \text{ kJ}$$

What change in colour of this equilibrium mixture is observed if:

(a) the pressure is decreased?

(b) more oxygen gas is added?

(c) a catalyst is added?

23. Chlorine forms different types of compounds with various elements. Two examples are sodium chloride and tetrachloromethane. Some properties of these compounds are listed below.

Compound	*Melting-point* (°C)	*Boiling-point* (°C)	*Conductivity in liquid state*
NaCl	801	1465	high
CCl_4	–23	77	low

(a) Explain in terms of chemical bonding why these differences exist between the two compounds.

(b) Draw a labelled diagram of the apparatus you would use to test the conductivity of an aqueous solution of sodium chloride.

24. The data below refer to the homologous series of straight-chain alkanes and their densities.

Straight-chain alkanes	*Density* (g cm^{-3})
C_4H_{10}	0·579
C_5H_{12}	0·626
C_6H_{14}	0·655
C_7H_{16}	*X*
C_8H_{18}	0·703
$C_{10}H_{22}$	0·726

(a) Plot the points, and then draw the graph to represent this information.

(b) Predict the density, *X*, of C_7H_{16} from your graph.

(c) Write the balanced equation for the complete combustion of the alkane, butane. Include physical states for each species.

25. Glycerol has good moisturizing properties. It is therefore widely used in sunscreen lotions.

(a) State the IUPAC name for glycerol.

(b) Name the functional group present in glycerol.

(c) The boiling-point of 1-pentanol is 138°C while glycerol is still a liquid at 250°C. Give a reason for this difference.

PART C

Attempt ALL questions.

Each question is worth 5 marks.

Answer all questions in the Answer Book provided.

In questions involving calculations, you are advised to show working, as marks may be awarded for relevant working.

26. The element carbon can exist in a number of different forms and in a variety of compounds. Properties for some of these are described in the table below.

Substance	*Melting-point*	*Boiling-point*	*Solubility (in water)*
graphite	high	high	insoluble
diamond	high	high	insoluble
methane	low	low	insoluble
methanol	low	low	good
sodium carbonate	high	high	good

(a) Explain with reference to structure and bonding why:

(i) graphite has much higher melting and boiling points than methane;

(ii) diamond can be used for drilling rocks.

(b) Explain the difference between the solubilities of methane and methanol in water.

(c) With the aid of an equation, explain what happens when sodium carbonate dissolves in water.

27. Chemists standardize sodium hydroxide solutions using the monoprotic acid potassium hydrogen phthalate ($KHC_8H_4O_4$) as a primary standard. A 25·0 mL aliquot (sample) of a sodium hydroxide solution requires 23·1 mL of 0·0994 mol L^{-1} potassium hydrogen phthalate solution for complete reaction.

(a) What is a standard solution?

(b) Why does a solution of sodium hydroxide need to be standardized? Give TWO reasons.

(c) Draw and label the apparatus necessary to measure the 25·0 mL aliquot of sodium hydroxide solution.

(d) Calculate the concentration of the sodium hydroxide solution.

28. Methyl ethanoate is an ester.

(a) Draw the structural (constitutional) formula for methyl ethanoate.

(b) Name the chemical reagents that would be needed to prepare this ester in the laboratory.

(c) Instructions for preparing esters indicate that the reagent mixture should be 'heated under reflux' for an extended period.

(i) Explain why the mixture is heated under reflux.

(ii) Draw a labelled scientific diagram to show the mixture being heated under reflux.

29. The production of ammonia from nitrogen and hydrogen is given by the equation below.

$$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$$

	Concentration of species at 500°C		
	$[H_2]$ (mol L^{-1})	$[N_2]$ (mol L^{-1})	$[NH_3]$ (mol L^{-1})
Initial	1·542	0·881	0·000
Equilibrium			0·281

Using the table above:

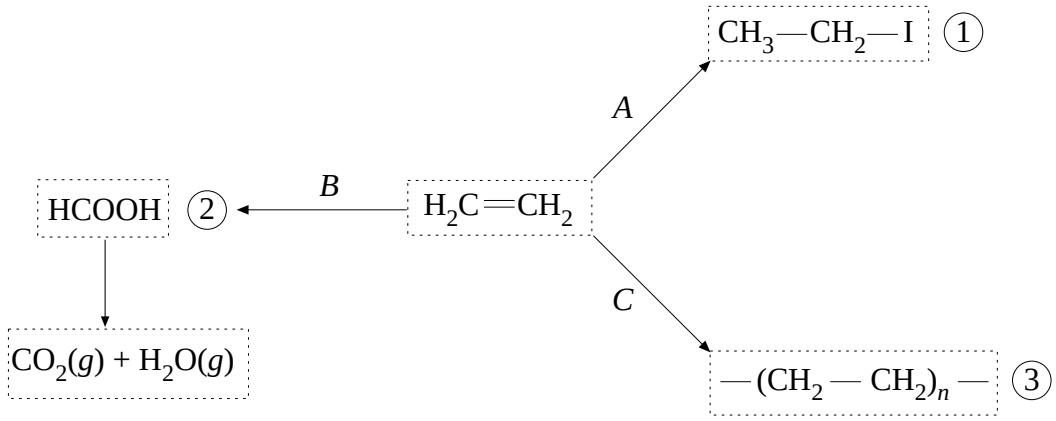
(a) calculate the equilibrium concentrations of N_2 and H_2 under these conditions;

(b) write the equilibrium expression (K) for the reaction;

(c) calculate the value of K for the reaction;

(d) give the units of K.

30. Ethene is a highly reactive compound used as a starting material for many industrial chemical processes. Some reactions of ethene are shown below.



(a) Identify the types of reactions represented by the letters *B* and *C* in the diagram above.

(b) Name the products labelled (1) and (2).

(c) Suggest a suitable reagent for carrying out reaction *B*.

(d) Give a use for the compound labelled (3).

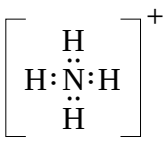
31. 0·0200 g of gaseous ammonia is dissolved in water to make 50·0 mL of solution.

(a) Calculate the molarity of this solution.

(b) What volume of a 0·100 mol L^{-1} HCl solution is required to react completely with the ammonia solution?

(c) Ammonia reacts with water to form a basic solution. Given that *K*, the equilibrium constant, for this reaction is $1{\cdot}74 \times 10^{-3}$ mol L^{-1}, calculate $[OH^-]$ for the ammonia solution in part (a).

(d) When ammonia reacts with hydrochloric acid, the ammonium ion is formed. The electron dot formula for this ion is shown below.



All four bonds in this ion are equivalent, yet the term 'coordinate covalent bond' is used to correctly describe the formation of NH_4^+ from NH_3 and H^+.

Explain the term 'coordinate covalent bond', using this example.

SECTION II—ELECTIVES

(25 Marks)

Attempt ONE question.

Answer the question in a *separate* Elective Answer Book.

In questions involving calculations, show all necessary working.

Marks may be awarded for relevant working.

Marks

QUESTION 32. Chemical Energy

(a) Methane is a major component of natural gas but can only be liquefied at high pressures and below –82°C. **3**

If methane is to be used as a portable fuel in motor cars, it has to be carried as compressed gas in heavy cylinders to withstand the high pressures required.

(i) Explain why a leak from such a methane cylinder would be dangerous.

(ii) Calculate the mass of methane present in a 60·0 L cylinder at a temperature of 20·0°C and a pressure of $9{\cdot}12 \times 10^2$ kPa.

(b) Ethanol is a component of some petrols sold in Australia. **3**

(i) What is ONE environmental advantage of using ethanol as a fuel?

(ii) Calculate the energy that can be obtained through the combustion of 1·00 litre of ethanol. The heat of combustion of ethanol is 1360 kJ mol^{-1}. (At 25°C, the density of ethanol is 0·79 g mL^{-1}, i.e. the mass of 1 mL of ethanol is 0·79 g.)

(c) During your study of the elective Chemical Energy, you will have carried out an experiment in which you measured the enthalpy change for a combustion reaction. **6**

(i) State the name of the substance whose enthalpy of combustion was measured.

(ii) Draw a clearly labelled diagram of the apparatus you used for this experiment.

(iii) What quantities must be measured when using this apparatus, in order to calculate the enthalpy change for this combustion reaction?

(iv) List TWO major sources of error in this experiment.

Question 32 continues on page 16

Marks

QUESTION 32. (Continued)

(d) Ethanol is produced from glucose ($C_6H_{12}O_6$) by fermentation. Carbon dioxide is the only by-product. **5**

A fermentation reaction was carried out in a large plastic vessel contained in a wooden box. The fermentation vessel was surrounded by insulating material to reduce the loss of heat generated by the fermentation reaction. 600 g of glucose was added to water. The total volume was 20·0 litres of solution. Some yeast was added to start the fermentation.

(i) Write a balanced equation for this reaction.

(ii) The temperature of the mixture in the fermentation vessel increased from 20·0°C to 34·5°C. Calculate the minimum heat generated by the reaction. Assume the density of the reaction mixture to be 1·00 g mL^{-1} and the specific heat capacity to be 4·18 J g^{-1} K^{-1}.

(iii) Use the value calculated in part (ii) to determine the heat of reaction for the fermentation of glucose in kJ mol^{-1}.

(e) Methane, butane, and hydrogen can all be used as rocket fuels. The heats of combustion for these fuels are listed in the table below. **3**

Fuel	*Formula*	*Heat of combustion* (kJ mol^{-1})
methane	CH_4	890
butane	C_4H_{10}	2877
hydrogen	H_2	286

(i) Use the thermochemical data listed in the table to calculate the heat released per gram for each of the fuels.

(ii) Use the values calculated in part (i) to suggest which would be the best rocket fuel. Explain your choice.

Marks

QUESTION 32. (Continued)

(f) Some average bond enthalpies at 25°C are listed below. Use these to calculate the enthalpy change for the reaction, **2**

$$C_2H_4(g) + Br_2(g) \rightarrow C_2H_4Br_2(g)$$

	ΔH (kJ mol^{-1})
C — H	414
C ═ C	614
C — C	346
C — Br	285
Br — Br	193
H — H	436
H — Br	366

(g) The following table shows the enthalpy of vaporization of some organic compounds. **3**

Homologous series	*Compound*	*Formula*	*Enthalpy of vaporization* (kJ mol^{-1})
alkane	butane	C_4H_{10}	22
	pentane	C_5H_{12}	27
	hexane	C_6H_{14}	32
	heptane	C_7H_{16}	37
	octane	C_8H_{18}	42
alkanol	1-butanol	C_4H_9OH	51
	1-pentanol	$C_5H_{11}OH$	55
	1-hexanol	$C_6H_{13}OH$	60
	1-heptanol	$C_7H_{15}OH$	64
	1-octanol	$C_8H_{17}OH$	68

(i) Define the term ‘enthalpy of vaporization’.

(ii) Why does the enthalpy of vaporization increase uniformly within each of the two homologous series?

(iii) Explain why the values for the enthalpy of vaporization are larger for the alkanols than for the alkanes.

Marks

QUESTION 33. Oxidation and Reduction

(a) During your study of the elective Oxidation and Reduction, you will have carried out an experiment in which you investigated the relationship between the difference in reactivity of two metals and the voltage of the cell that may be constructed from them. **6**

(i) Name the two metals you used in the school laboratory. State which was the cathode and which was the anode.

(ii) Draw the working cell that you constructed and *label it fully*.

On your cell, show the flow of ions and the flow of electrons.

(iii) For your cell:

1. write the half-equation for the oxidation reaction;
2. write the half-equation for the reduction reaction;
3. write the overall equation for the reaction;
4. calculate the standard potential for your reaction.

(b) The table below lists some standard electrode potentials. **5**

$Al^{3+} + 3e^- \rightleftharpoons Al(s)$	–1·66 V
$Au^+ + e^- \rightleftharpoons Au(s)$	+1·68 V
$Ba^{2+} + 2e^- \rightleftharpoons Ba(s)$	–2·90 V
$Co^{2+} + 2e^- \rightleftharpoons Co(s)$	–0·28 V
$Fe^{2+} + 2e^- \rightleftharpoons Fe(s)$	–0·41 V

Use this information to answer the following questions.

(i) Give the formula for the weakest oxidizing agent in the table.

(ii) What reaction, if any, would occur when:

1. a piece of iron is placed in a solution of cobalt(II) nitrate?

2. a piece of aluminium is placed in a solution of barium nitrate?

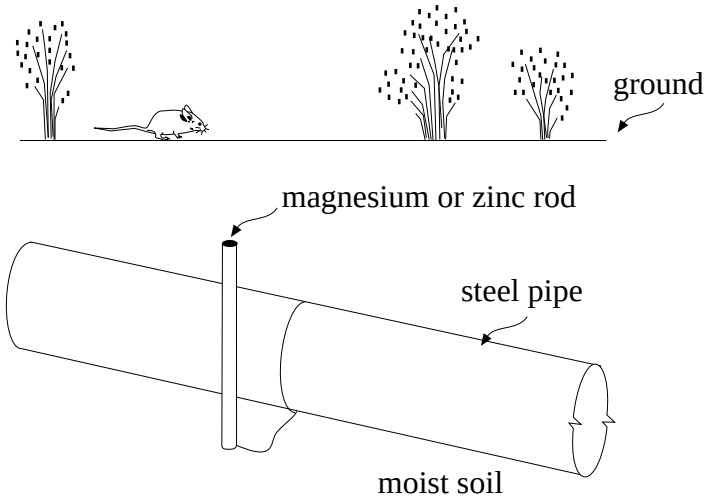
Write equations for any reactions that occur.

(iii) Use the table above to explain why gold compounds are rarely found in nature.

Marks

QUESTION 33. (Continued)

(c) Steel rusts readily, yet gas pipelines are often made of steel and buried in the ground. To stop the steel rusting, the pipe is connected at regular intervals by a metal wire to a magnesium or zinc rod. A section of pipe is illustrated below. **4**



(i) Explain how attaching a magnesium or zinc rod stops the pipe from rusting.

(ii) Describe TWO other methods that could be used to protect the pipe from rusting. Explain how each of these methods prevents rusting.

(d) A $1{\cdot}0\ \text{mol L}^{-1}$ solution of copper sulfate was electrolysed using platinum electrodes. Copper was produced at one electrode and a gas at the other. **5**

(i) Write the equation for the reaction that occurs at the cathode.

(ii) Write the equation for the reaction that occurs at the anode.

(iii) Calculate the minimum voltage that will need to be supplied to operate this cell.

(iv) What change will be observed in the colour of the solution?

(v) Why is it necessary to use platinum for the electrodes?

(e) For the unbalanced equation **5**

$$H_2S(aq) + Cr_2O_7^{2-}(aq) + H^+(aq) \rightarrow Cr^{3+}(aq) + H_2O(l) + S(s)$$

answer the following questions.

(i) Identify the species that has been oxidized in the reaction.

(ii) Write the oxidation half-equation.

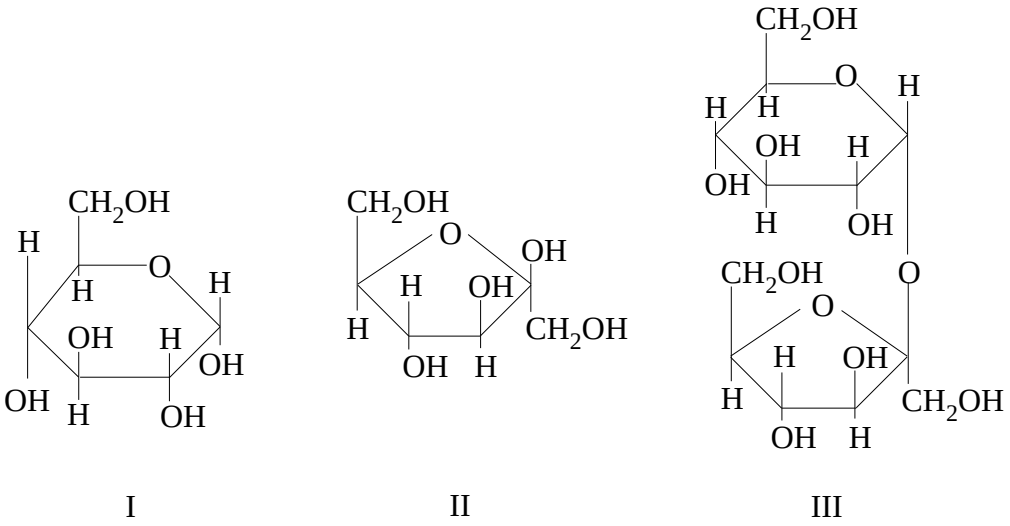
(iii) Write the reduction half-equation.

(iv) Use your half-equations to write the balanced overall reaction.

Marks

QUESTION 34. Biological Chemistry

(a) The diagrams below show three important carbohydrates. **2**



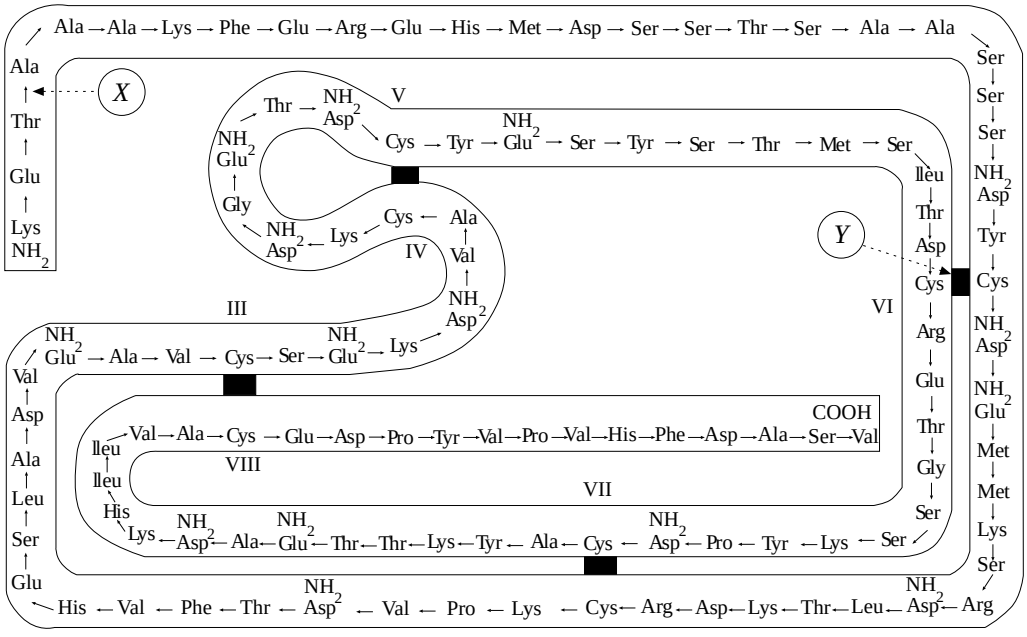
I II III

(i) Name the TWO groups of carbohydrates represented by these molecules.

(ii) What relationship is there between compounds I and II?

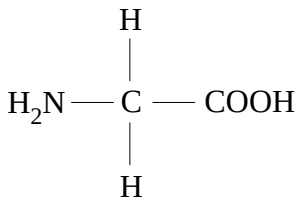
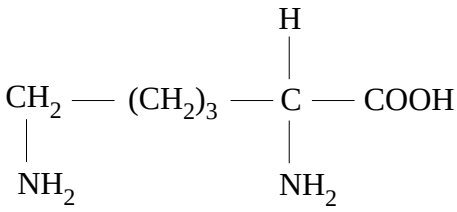
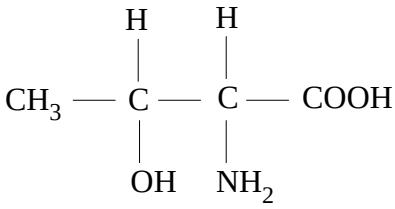
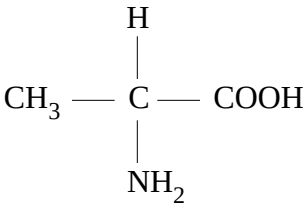
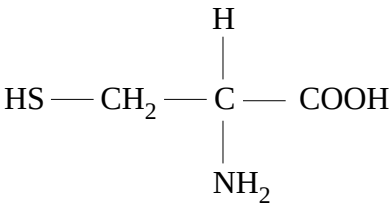
(b) Name the carbohydrate that gives strength to cell walls. **1**

(c) The diagram below is a representation of the enzyme ribonuclease, showing its amino-acid sequence, using abbreviated names. The table on page 21 gives the formulae for some of these amino acids. **5**



Marks

QUESTION 34. (Continued)

Abbreviation	*Name*	*Formula*
gly	glycine	
lys	lysine	
thr	threonine	
ala	alanine	
cys	cysteine	

(i) Name the type of bond labelled (X) in the diagram. Use the structural formulae in the table to write an equation to show how this bond is formed.

(ii) Name the type of bond labelled (Y) in the diagram. Explain its significance in this molecule.

(iii) If ribonuclease is heated to 65°C, it loses its ability to function as an enzyme. Explain this loss of enzyme activity.

Question 34 continues on page 22

Marks

QUESTION 34. (Continued)

(d) During your study of the elective Biological Chemistry, you will have carried out characteristic tests for carbohydrates and proteins. **5**

Design and complete a table to describe how you tested for the presence of:

(i) protein;

(ii) starch;

(iii) glucose.

The table should include:

- the name of the reagent you used;
- how the test was carried out;
- the results you obtained.

(e) (i) Write the equation for the overall process of photosynthesis. **5**

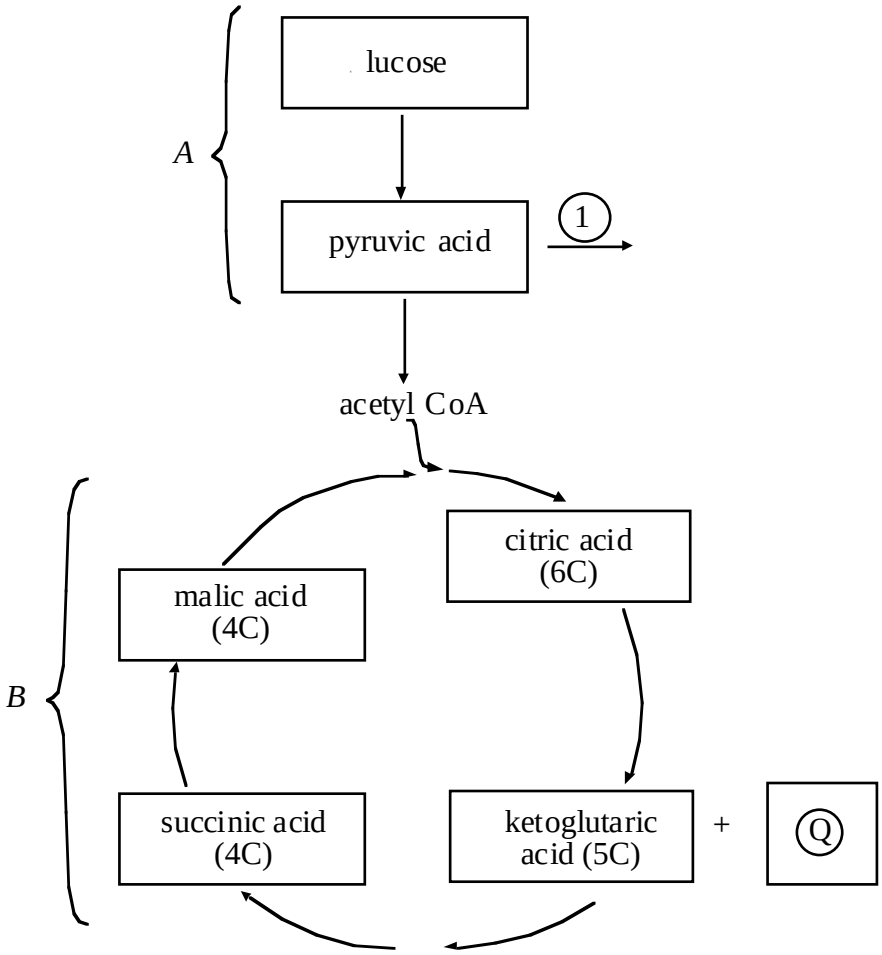
(ii) Briefly describe the terms 'light reactions' and 'carbon fixation processes' as applied to photosynthesis.

(iii) Photosynthesis is a vital process on Earth. Give TWO *chemical* reasons to support this statement.

Marks

QUESTION 34. (Continued)

(f) The diagram below represents part of the process by which glucose is broken down in living cells. **4**



(i) Name the two stages labelled *A* and *B*.

(ii) Name the product labelled (Q).

(iii) The arrow labelled (1) represents pyruvic acid reacting via an alternate chemical pathway.

1. What product is formed under these conditions?

2. Under what conditions will this alternate chemical pathway operate?

(g) Some yeasts possess an enzyme called *maltase,* which can convert *maltose* into compounds that can be used in the production of ethanol by fermentation. **3**

(i) Name the product(s) of the reaction between maltase and maltose.

(ii) Give the equation for the fermentation reaction.

(iii) What mass of ethanol could be obtained from 10 g of maltose, assuming 100% conversion?

Marks

QUESTION 35. Chemistry and the Environment

(a) In your study of the elective Chemistry and the Environment, you will have collected and analysed various water samples. **2**

How did you determine the mass of:

(i) undissolved solids

(ii) dissolved solids

in your water sample?

(b) The table below shows analyses of water samples from three different sources. **6**

Ions	*Sea water* (g per 100 g)	*Sample X* (g per 100 g)	*Sample Y* (g per 100 g)
Hg^{2+}	$1{\cdot}0 \times 10^{-6}$	–	$1{\cdot}0 \times 10^{-4}$
Pb^{2+}	$1{\cdot}0 \times 10^{-10}$	–	$2{\cdot}0 \times 10^{-6}$
Cu^{2+}	$1{\cdot}0 \times 10^{-5}$	$1{\cdot}0 \times 10^{-6}$	$1{\cdot}5 \times 10^{-4}$
F^{-}	$1{\cdot}0 \times 10^{-4}$	$1{\cdot}0 \times 10^{-4}$	$1{\cdot}0 \times 10^{-5}$
Sr^{2+}	$8{\cdot}0 \times 10^{-4}$	–	–
Br^{-}	$3{\cdot}1 \times 10^{-3}$	–	–
HCO_3^{-}, CO_3^{2-}	$1{\cdot}1 \times 10^{-2}$	$4{\cdot}6 \times 10^{-2}$	$3{\cdot}0 \times 10^{-2}$
K^{+}	$4{\cdot}2 \times 10^{-2}$	$1{\cdot}0 \times 10^{-4}$	$1{\cdot}0 \times 10^{-4}$
Ca^{2+}	$4{\cdot}5 \times 10^{-2}$	$9{\cdot}0 \times 10^{-4}$	$9{\cdot}0 \times 10^{-5}$
Mg^{2+}	$1{\cdot}3 \times 10^{-2}$	$3{\cdot}0 \times 10^{-4}$	$2{\cdot}0 \times 10^{-5}$
SO_4^{2-}	$2{\cdot}7 \times 10^{-2}$	$2{\cdot}0 \times 10^{-3}$	$2{\cdot}0 \times 10^{-4}$
Na^{+}	$1{\cdot}1$	$2{\cdot}0 \times 10^{-3}$	$2{\cdot}0 \times 10^{-3}$
Cl^{-}	$2{\cdot}0$	$2{\cdot}5 \times 10^{-3}$	$2{\cdot}5 \times 10^{-3}$

(i) Suggest a likely source for each of the water samples *X* and *Y*. Explain the reasons for your choice.

(ii) From the table above, name:

1. a halide ion;

2. a metal ion.

Describe a test you used to identify each of these ions in a water sample. Include your observations.

Marks

QUESTION 35. (Continued)

(c) What is meant by a 'pollutant'? **1**

(d) Explain why the concentration of dissolved oxygen in fresh water is an indicator of water quality. **1**

(e) A dam contains $2{\cdot}0 \times 10^6$ L of water with a hydrogen ion concentration $[H^+] = 1{\cdot}0 \times 10^{-3}$ mol L^{-1} in the form of nitric acid. What mass of calcium oxide will be required to neutralize the acid in this dam? **3**

(f) Early in 1995, a truckload of low-level radioactive waste contained in drums was on its way from Lucas Heights to South Australia for storage. The media reported that while passing through the western suburbs of Sydney, some of the drums were found to be leaking. This was subsequently found to be a false alarm—the 'leakage' was simply rainwater dripping from the drums. **7**

(i) What form(s) of radiation might be harmful to residents of the area? How can such radiation damage living things?

(ii) Suggest TWO effective disposal methods for such waste.

(iii) Australia has no nuclear power stations and yet uranium is used in reactors at Lucas Heights. What is it used for?

(iv) Where in Australia is uranium mined commercially?

(v) Describe how uranium is extracted from its ore.

(g) Ozone is a pale blue gas that is toxic at the Earth's surface. It contributes to unpleasant fogs, and causes breathing difficulties. However, in recent years the lack of ozone, and in particular the 'ozone hole', have received much attention in the media. **5**

(i) What is the 'ozone hole', and where is it?

(ii) Describe one cause of this 'ozone hole'.

(iii) Describe why the lack of ozone, referred to above, is so dangerous.

(iv) Rubber is a large complex hydrocarbon used in the manufacture of tyres. At the Earth's surface, ozone can cause the deterioration of rubber by breaking the double bonds between carbon atoms. A simplified equation for the reaction is:

$$\underset{\text{simplified rubber}}{(CH_3)_2C{=}C(CH_3)_2} + O_3 + H_2O \rightarrow H_2O_2 + 2(CH_3)_2C{=}O$$

Use this equation to calculate the mass of ozone required to destroy 8400 g of this simplified rubber.

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CHEMISTRY DATA SHEET

Values of several numerical constants

Avogadro's constant, N_A	$6{\cdot}022 \times 10^{23}$ mol^{-1}
Gas constant, R	$8{\cdot}314$ J K^{-1} mol^{-1}
	$0{\cdot}0821$ L atm K^{-1} mol^{-1}
Mass of electron, m_e	$9{\cdot}109 \times 10^{-31}$ kg
Mass of neutron, m_n	$1{\cdot}675 \times 10^{-27}$ kg
Mass of proton, m_p	$1{\cdot}673 \times 10^{-27}$ kg
Volume of 1 mole ideal gas:	
at 101·3 kPa (1·00 atm) and	
at 273 K (0°C)	22·41 L
at 298 K (25°C)	24·47 L
Ionization constant for water	
at 298 K (25°C), K_w	$1{\cdot}0 \times 10^{-14}$

Some standard potentials

$K^+ + e^-$	$\rightleftharpoons$	$K(s)$	–2·92 V
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	$Ba(s)$	–2·90 V
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	$Ca(s)$	–2·87 V
$Na^+ + e^-$	$\rightleftharpoons$	$Na(s)$	–2·71 V
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	$Mg(s)$	–2·36 V
$Al^{3+} + 3e^-$	$\rightleftharpoons$	$Al(s)$	–1·66 V
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	$Mn(s)$	–1·18 V
$H_2O + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g) + OH^-$	–0·83 V
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	$Zn(s)$	–0·76 V
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	$Fe(s)$	–0·41 V
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	$Ni(s)$	–0·23 V
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	$Sn(s)$	–0·14 V
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	$Pb(s)$	–0·13 V
$H^+ + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g)$	0·00 V
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$H_2SO_3 + H_2O$	0·17 V
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	$Cu(s)$	0·35 V
$\frac{1}{2}O_2(g) + H_2O + 2e^-$	$\rightleftharpoons$	$2OH^-$	0·40 V
$Cu^+ + e^-$	$\rightleftharpoons$	$Cu(s)$	0·52 V
$\frac{1}{2}I_2(s) + e^-$	$\rightleftharpoons$	I^-	0·54 V
$\frac{1}{2}I_2(aq) + e^-$	$\rightleftharpoons$	I^-	0·62 V
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	0·77 V
$Ag^+ + e^-$	$\rightleftharpoons$	$Ag(s)$	0·80 V
$\frac{1}{2}Br_2(l) + e^-$	$\rightleftharpoons$	Br^-	1·07 V
$\frac{1}{2}Br_2(aq) + e^-$	$\rightleftharpoons$	Br^-	1·09 V
$\frac{1}{2}O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O	1·23 V
$\frac{1}{2}Cl_2(g) + e^-$	$\rightleftharpoons$	Cl^-	1·36 V
$\frac{1}{2}Cl_2(aq) + e^-$	$\rightleftharpoons$	Cl^-	1·40 V
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	1·51 V
$\frac{1}{2}F_2(g) + e^-$	$\rightleftharpoons$	F^-	2·87 V

PERIODIC TABLE

KEY

Atomic Number
Atomic Mass
Symbol of element
Name of element

																	2 He 4·003 Helium
3 Li 6·941 Lithium	4 Be 9·012 Beryllium				79 Au 197·0 Gold				1 H 1·008 Hydrogen			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

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BOARD OF STUDIES
NEW SOUTH WALES

STUDENT NUMBER

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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 Answer Book with an Answer Sheet for Part A, a Part C Answer Book, and an Elective Answer Book.
- Answer Questions 16 to 25 in this Answer Book.

EXAMINER'S USE ONLY

PART	Mark	Examiner	Check
B			

Questions 16 to 25 are worth 3 marks each.
Answer the questions in the spaces provided below.

EXAMINER'S USE ONLY

16. (a) (2-methyl-2-pentanol) (3-methyl-2-pentanol)

(b) .....

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17. (a) .....

(b) .....

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(c) .....

EXAMINER'S USE ONLY

18. (a) .....

(b) .....

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19. (a) .....

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(b) .....

EXAMINER'S USE ONLY

20. (a) .....

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(b) .....

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21. (a) .....

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(b) .....

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22. (a) .....

(b) .....

(c) .....

EXAMINER'S USE ONLY

23. (a) .....

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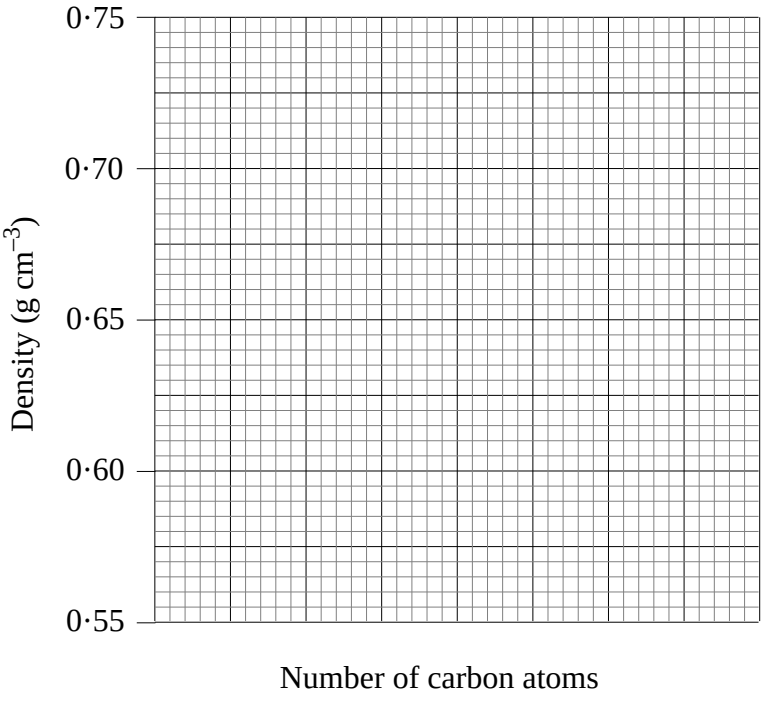
(b)

24. (a)



(b) .....

(c) .....

.....

EXAMINER'S USE ONLY

25. (a) .....

(b) .....

(c) .....

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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 Answer Book with an Answer Sheet for Part A, a Part B Answer Book, and an Elective Answer Book.
- Answer Questions 26 to 31 in this Answer Book.

EXAMINER'S USE ONLY

PART	Mark	Examiner	Check
C			

Questions 26 to 31 are worth 5 marks each.
Answer the questions in the spaces provided below.

EXAMINER'S USE ONLY

26. (a) (i) .....

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(ii) .....

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(b) .....

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(c) .....

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27. (a) .....

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(b) .....

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(c)

(d) .....

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EXAMINER'S USE ONLY

28. (a)

(b) .....

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(c) (i) .....

.....

.....

(ii)

EXAMINER'S USE ONLY

29. (a) .....

.....

	Concentration of species at 500°C		
	$[H_2]$ (mol L^{-1})	$[N_2]$ (mol L^{-1})	$[NH_3]$ (mol L^{-1})
Initial	1·542	0·881	0·000
Equilibrium			0·281

(b) .....

.....

(c) .....

.....

.....

(d) .....

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

C.....

(b) ① .....

② .....

(c) .....

(d) .....

EXAMINER'S USE ONLY

31. (a) .....

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(b) .....

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(c) .....

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(d) .....

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