1995 HSC CHEMISTRY

DETAILED SUGGESTED SOLUTIONS

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SECTION I: CORE

PART A

l. ANS A

When chlorine reacts with butene to form 1,2-dichlorobutane, the unsaturated molecule becomes saturated as the chlorine adds across the double bond. The reaction is addition.
The balanced equation is $C_4H_8(g) + Cl_2(g) = C_4H_8Cl_2(l)$

2. ANS D

The lowest pH is the acid with the highest $[H^+(aq)]$. Sodium hydroxide is a base. Ethanoic acid is a weak acid. Both hydrochloric acid and nitric acid are strong acids. Nitric acid has the higher concentration and, therefore, will have the lower pH.

3. ANS D

Isomers have the same molecular formula but different structural formulae. 1-butene and cyclobutane have the molecular formula C_4H_8. However, 1-butene has one double bond while cyclobutane has the four carbon atoms arranged in a ring.

4. ANS A

Carbon dioxide (CO_2) has covalent bonding. Sulfur trioxide (SO_3) has covalent bonding. Potassium chloride (KCl), magnesium oxide (MgO) and copper(II) chloride ($CuCl_2$) contain ionic bonds only.

5. ANS B

The solid chemical substance shown in this diagram is made up of diatomic covalently bonded molecules held in a lattice structure by dispersion forces. Solid iodine is best represented by this molecular lattice. Silver is a metallic lattice. Graphite is a layer lattice. Sodium fluoride is an ionic lattice.

6. ANS D

For the chemical equation: $2Cl_2(g) + 2H_2O(g) = 4HCl(g) + O_2(g)$, the equilibrium constant K is

given by the expression: $\dfrac{[HCl]^4[O_2]}{[H_2O]^2[Cl_2]^2}$

7. ANS A

Stable aluminium ions have the formula Al^{3+} . The electronic configuration is $1s^2\ 2s^2\ 2p^6$. This is the same electronic configuration as the fluoride ion, F^-.

8. ANS C

This is a diene since there are two double bonds. Use the longest possible carbon chain (six carbons). Hence, the IUPAC systematic name is 2,4-dimethyl-1,3-hexadiene.

SECTION I: CORE

PART A

9. ANS C

A molecule is not polar either when the bonds are non-polar or when the shape is symmetrical. Even though the C-H bonds are slightly polar, the CH_4 molecule is symmetrical.
Hence, the CH_4 (methane) molecule is not polar.

10. ANS B

The number of mole of weak acid and the number of mole of strong acid are the same. Hence, the number of mole of base required in each titration will be the same.

1 l. ANS D

Equilibrium can only be achieved when **all components** of the equilibrium system are in contact with each other in a **closed environment**. (C) will probably not reach equilibrium since the carbon dioxide can escape(even though it is heavier than air).

12. ANS C

Sodium chloride (NaCl) has strong ionic bonding throughout the structure and, therefore, has a high boiling point. Silicon tetrachloride ($SiCl_4$) has strong covalent bonding within the molecules but weak intermolecular bonding (dispersion forces). Hence, silicon tetrachloride has a much lower boiling point.

13. ANS C

An atom of sulfur has 16 electrons. Hence, the sulfide ion, S^{2-} , has 18 electrons with the electronic configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$.

14. ANS B

A saturated solution of barium carbonate is in equilibrium with solid barium carbonate. In this equilibrium system, reactions still continue. Some of the solid barium carbonate goes into solution and some of the barium carbonate solution is precipitated. This is dynamic equilibrium in which the rate of the forward reaction is equal to the rate of the reverse reaction. Hence, the carbon-14 isotope will be found in both the residue and the filtrate.

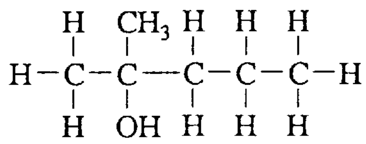
15. ANS B

$n(H_2SO_4) = 0.245/98$. Hence, $n(H^+)$, assuming complete dissociation = 2 x (0.245/98) = 0.005.
Hence, $[H^+] = 0.005/5 = 0.001 = 10^{-3}$. Hence, pH = 3.0

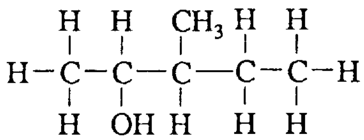
PART B

16.

(a) The structural formulae for 2-methyl-2-pentanol is shown below.



The structural formulae for 3-methyl-2-pentanol is shown below.



(b) A chemical test to distinguish between the compounds shown in (a) is as follows.
Treat excess of each with acidified potassium dichromate solution.
Because 2-methyl-2-pentanol is a tertiary alcohol, it will not be oxidised by this reagent, but 3-methyl-2-pentanol, being a secondary alcohol, will be oxidised.
The reaction is observed by a colour change from orange to blue/green. The equation is outline is:

$$CH_3CH_2CH(CH_3)CH(OH)CH_3 \xrightarrow{\text{(acidified potassium dichromate solution)}} CH_3CH_2CH(CH_3)COCH_3$$

PART B

17.

(a) The balanced equation for this equilibrium is: $FeSCN^{2+}$ (aq) = Fe^{3+} (aq) + SCN^{-} (aq)

(b) Dynamic equilibrium is the state reached when the rate of formation of products or forward reaction is identical to the rate of the reverse reaction in which products are converted back to reactants.

(c) As the forward reaction is endothermic, lowering the temperature causes an increase in the concentration of reactants and a decrease in the concentration of products. Therefore the colour of the solution will become darker due to the concentration of the red-brown ion, $FeSCN^{2+}$ (aq), increasing while the concentration of the pale yellow Fe^{3+} (aq) ion simultaneously decreases.

PART B

1 8.

(a) The balanced equation for the reaction is: $2HCl(aq) + Ba(OH)_2(aq) = BaCl_2(aq) + 2H_2O(l)$

or the ionic equation $H^+(aq) + OH^-(aq) = H_2O(l)$

(b) Moles of HCI = 0.0150 x 0.030 = 4.50 x 10^{-4} mol = moles H^+

Moles of $Ba(OH)_2$ = 0.0200 x 0.010 = 2.00 x 10^{-4} mol

Now, 1 mole $Ba(OH)_2$ contains 2 moles of OH^- ,

moles of OH^- = 2 x 2.00 x 10^{-4} = 4.00 x 10^{-4} mol

From the equation above, 1 mole H^+ reacts with 1 mole OH^-

moles of H^+ in excess = 4.50 x 10^{-4} - 4.00 x 10^{-4} = 0.50 x 10^{-4} mol

Final volume = 15.0 + 20.0 = 35.0 mL

$[H^+]$ = (0.500 x 10^{-4})/0.035 = 1.43 x 10^{-3} M.

Hence, pH = $-\log_{10}(1.43 \times 10^{-3})$ = 2.84 **ANS**

PART B

19.

(a) The balanced equation for the reactions are:

$HCO_3^-(aq) + OH^-(aq) = H_2O(l) + CO_3^{2-}(aq)$

$HCO_3^-(aq) + H_3O^+(aq) = H_2CO_3(aq) + H_2O(l)$

(b) Conjugate acid-base pairs differ in formula by one H^+.

The conjugate acid-base pairs are: HCO_3^- / CO_3^{2-} and H_2CO_3 / HCO_3^-

PART B

20.

(a) The balanced equation for the ionisation of butanoic acid is:

$CH_3CH_2CH_2COOH(aq) + H_2O(l) = H_3O^+(aq) + CH_3CH_2CH_2COO^-(aq)$

Hence, the expression for the acid dissociation constant, Ka, is

$$K_a = \frac{[H_3O^+][CH_3CH_2CH_2COO^-]}{[CH_3CH_2CH_2COOH]}$$

(b) If pH = 2.9, then $[H_3O^+] = 10^{-2.9}$ M = 1.26×10^{-3} M = $[CH_3CH_2CH_2COO^-]$

Also, $[CH_3CH_2CH_2COOH] = (0.10 - 1.26 \times 10^{-3}$ M), which is close to 0.10 M.

Hence, $K_a = \frac{(1.26x10^{-3})(1.26x10^{-3})}{0.10}$ = 1.6 x 10-5 M **ANS**

PART B

21.

(a) Acids which are more dissociated have higher concentrations of the products ($[H_3O+]$, $[A^-]$) and lower concentrations of the molecular form ([HA]). Thus K_a increases as acid strength increases.

The acid HZ has the largest K_a and is the strongest acid. Acid HY has the smallest K_a and is the weakest acid. The third acid, HX, has a K_a value which lies between that of HZ and of HY. Therefore, in order of decreasing strength, the arrangement is HZ > HX > HY

(b) Acid HZ would best conduct electricity. For identical concentrations, the most dissociated acid (i.e. the strongest acid) would carry the most electricity because it would have the most ions present. The molecular form of the acid would not conduct electricity in solution as it carries no charge.

PART B

22.

(a) From the balanced equilibrium equation given, decreasing pressure favours an equilibrium shift to the side with more molecules present, i.e. to the left. This would result in more colourless NO(g) and less of the brown NO_2(g) being present and thus an overall lighter colour would be observed.

(b) Increased concentration of O_2(g) causes the equilibrium to shift to the right in order to partly cancel the change. (Le Chatelier's Principle) The increased proportion of brown NO_2(g) would cause the mixture to darken.

(c) Catalysts do not alter the position of an equilibrium but only allow the equilibrium state to be achieved more quickly. As the system is already at equilibrium, no change in colour would be observed.

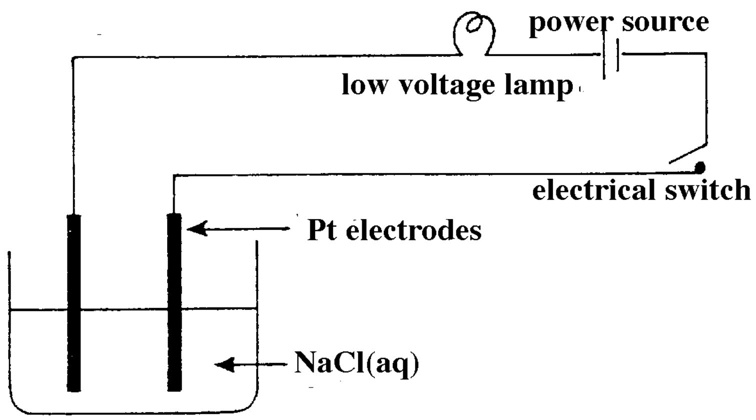
PART B

23.

(a) Sodium chloride is an ionic compound and therefore has strong electrostatic attractive forces operating between oppositely charged ions in the crystal lattice. This leads to a high melting temperature and, due to attractive forces present between ions in the molten state, to a high boiling temperature. Due to the mobility of ions in the molten (liquid) state, sodium chloride will be a good conductor of electricity by means of electrolysis.

On the other hand, carbon tetrachloride consists of discrete molecules which have only weak dispersion forces operating between them in the solid and liquid states. Consequently only relatively small amounts of energy are needed to melt and to boil this substance. As there are no ions present, the liquid form of carbon tetrachloride is not a conductor of electricity as no electrolysis can occur.

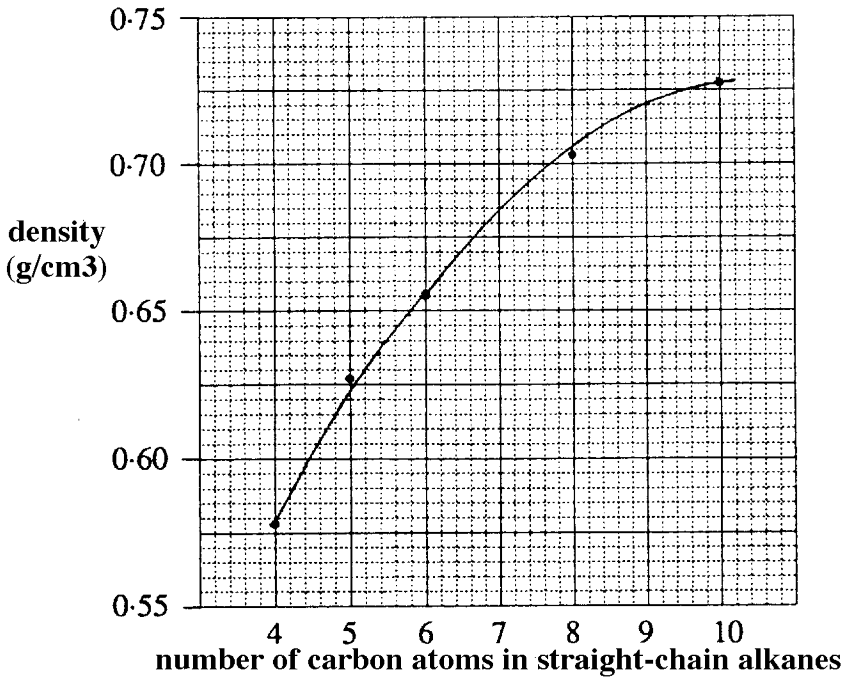
(b) Shown below is a diagram of the apparatus that could be used to test the conductivity of an aqueous solution of sodium chloride.



PART B

24.

(a) The graph of density variation with the number of carbon atoms is shown below.



(b) From the graph, the density of C_7H_{16} = 0.685 g cm^{-3} **ANS**

(c) The balanced equation for the complete combustion of butane is:

$2C_4H_{10}(g) + 13O_2(g) = 8CO_2(g) + 10H_2O(g)$

PART B

25.

(a) Glycerol has the IUPAC systematic name 1,2,3-propanetriol.

(b) The functional group in glycerol is the hydroxy group (-OH).

(c) Glycerol has a much higher boiling temperature than 1-pentanol.
Molecules containing the -OH group can hydrogen bond to each other. Additional energy must be supplied to break these hydrogen bonds when the liquid is boiled to form individual molecules in the vapour state. Glycerol molecules have three -OH groups which are able to participate in hydrogen bonding while l-pentanol has only one -OH group per molecule. This more extensive hydrogen bonding in glycerol causes it to have a higher boiling temperature.

PART C

26. (a)

(i) **Graphite has much higher melting and boiling temperatures than methane.**

Graphite consists of infinite arrays of covalently bonded atoms (network covalent bonding) and large amounts of energy are needed to break these covalent bonds in order to form small enough units that can escape into the liquid and vapour states when melting or boiling. Methane consists of small molecules which only have dispersion forces holding them together in the solid and liquid states. Consequently a smaller amount of energy is required for individual methane molecules to escape to the liquid and vapour phases when melting and boiling.

(ii) **Diamond can be used for drilling rocks.**

Diamond is extremely hard due to its crystal structure. Each carbon atom in diamond is covalently bonded to four other carbon atoms in a very stable tetrahedral arrangement to form an infinitely large giant molecule. To break diamond or to wear it down requires enough energy to break these strong covalent bonds.

(b) **Methane and methanol have quite different solubilities in water.**

Hydrogen bonding occurs between the -OH group of the methanol molecule, CH_3OH, and the water molecules. This aids in solubility as the hydrophobic characteristic of the CH_3 group of the molecule is more than compensated for by the hydrogen bonding of the -OH group. Methane has no group which can interact with water in this manner and is thus less soluble.

(c) When solid sodium carbonate dissolves in water, the balanced equation is

$Na_2CO_3(s) + H_2O(l) \;=\; 2Na^+(aq) + CO_3^{2-}(aq)$

When an ionic solid such as sodium carbonate dissolves in water, the crystal lattice breaks down to release the component Na^+ and CO_3^{2-} ions which are immediately hydrated by interaction with the water. Energy released by this hydration process assists in the breaking down of the crystal lattice.

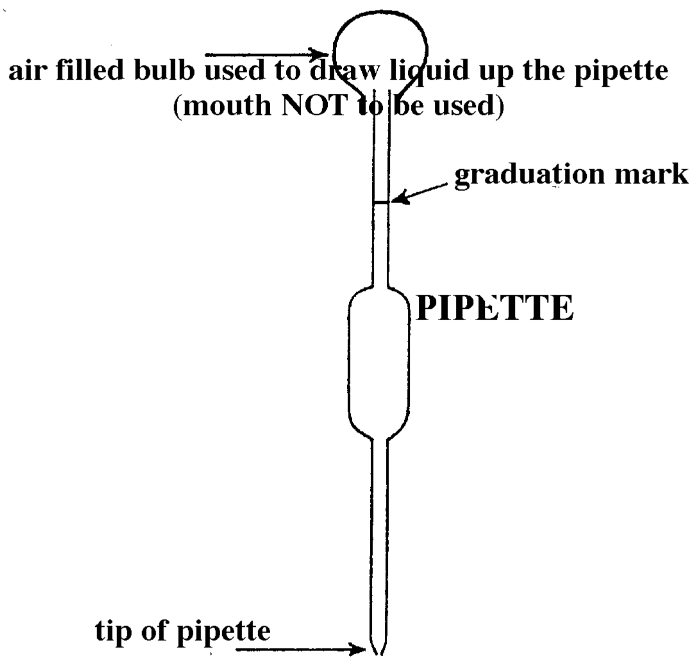
PART C

27.

(a) A standard solution is one in which the concentration of solute present is known.

(b) Sodium hydroxide solutions must be standardised because solid sodium hydroxide is not a primary standard. This means that it cannot be obtained as 100% pure sodium hydroxide and the solutions produced gradually change their concentrations due to reaction with carbon dioxide in the air according to the equation: $2NaOH(aq) + CO_2(aq) = Na_2CO_3(aq)$

(c) A diagram of a pipette is shown below.



(d) The balanced equation is: $KHC_8H_4O_4(aq) + NaOH(aq) = NaKC_8H_4O_4(aq) + H_2O(l)$

From the equation, equimolar amounts of $KHC_8H_4O_4$ and NaOH react.

$n(KHC_8H_4O_4)$ used = 0.0231 x 0.0994 = 2.296 x 10^{-3} mole.

n(NaOH) in 25.0 mL = 2.296 x 10^{-3} mole

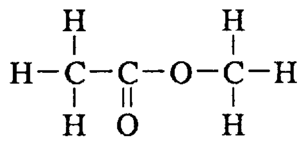
n(NaOH) in 1000.0 mL = (1000/25) x 2.296 x 10^{-3} = 0.0918 mole

concentration of NaOH = 0.0918 mol L^{-1}. **ANS**

PART C

28.

(a) The structural formula for methyl ethanoate is shown below.

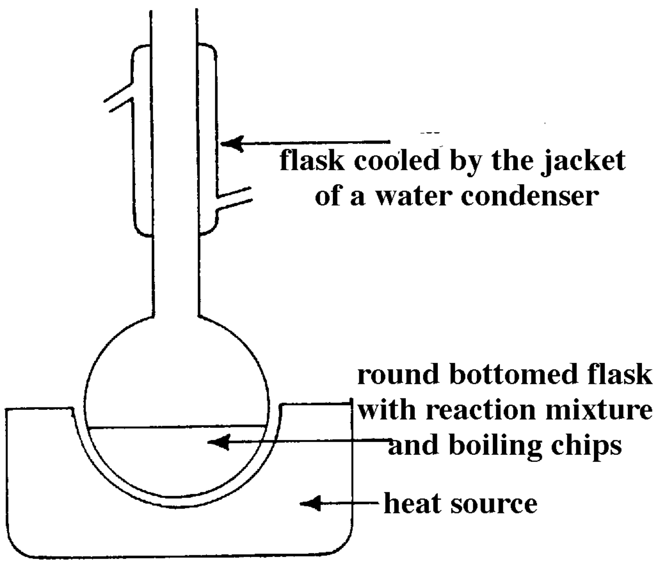


(b) The reagents necessary to prepare this ester in the laboratory are methanol and ethanoic acid (acetic acid) as reactants and concentrated sulfuric acid as a catalyst.

(c)

(i) Heating under reflux is used because reactions proceed more rapidly at the higher temperatures reached by this method. Also, heating under reflux prevents the loss of reactants and products and enables equilibrium to be achieved more rapidly.

(ii) A labelled diagram showing heating under reflux is given below.



PART C

29.

(a) From the equation given, each mole of NH_3(g) produced requires 1.5 moles of H_2(g) and 0.5 mole of N_2(g) to react completely.

to produce 0.281 moles of NH_3(g) would require 1.5 x 0.281 moles of H_2(g) and 0.5 x 0.281 moles of N_2(g) to react.

0.422 moles of H_2(g) and 0.141 moles of N_2(g)

amount of H_2(g) left unreacted at equilibrium = 1.542 - 0.422 = 1.120 mole

and amount of N_2(g) left = 0.881 - 0.141 = 0.740 mole

(b) The equilibrium value expression is
$K = \frac{[NH_3]^2}{[H_2]^3[N_2]}$ where each of the concentrations is measured at equilibrium.

(c) The value of K for this equation at this temperature = $\frac{(0.281)^2}{(1.120)^3(0.740)}$ = 0.0759 M^{-2} **ANS**

(d) The units of K are M^{-2} or $(\text{mol L}^{-1})^2$

PART C

30.

(a) Reaction B is the oxidation of ethene to methanoic acid. Reaction C is the polymerisation of ethene into polyethene (polyethylene)

(b) Product 1 is iodoethane and product 2 is methanoic acid (formic acid).

(c) Strong oxidants such as acidified potassium dichromate solution , $H^+(aq)/ K_2Cr_2O_7(aq)$, or acidified potassium permanganate solution, $H^+(aq)/ KMnO_4(aq)$, will convert the ethene to carbon dioxide and water, as the intermediate HCOOH is more readily oxidised than ethene.

(d) Polyethylene (polythene) is used for flexible plastic sheeting, flexible bottles (milk containers) and electrical insulation.

PART C

31.

(a) n(NH_3) in 50.0 mL = 0.0200/17.03 = 1.174 x 10^{-3} mole

in 1000 mL, n(NH_3) = (1000/50) x 1.174 x 10^{-3}

= 0.0235 mol L^{-1} **ANS**

(b) The balanced equation for the reaction is NH_3(aq) + HCI(aq) = NH_4Cl(aq)

1 mole NH_3 reacts with 1 mole HCl

n(NH_3) used = 1.174 x 10^{-3} mole

moles of HCI required = 1.174 x 10^{-3} mole

V(HCl) required = n/c = 1.174 x 10^{-3}/0.100

= 11.74 mL

= 11.7 mL **ANS**

(c) The balanced equation for the reaction is NH_3(g) + H_2O(l) = NH_4^+(aq) + OH^-(aq)

Assume that x = [OH^-] = [NH_4^+] at equilibrium and that
[NH_3] remaining = 0.0235 - x = 0.0235 since x is very small.

$$K = 1.74x10^{-3} = \frac{[NH_4^+][OH^-]}{[NH_3]} = \frac{x^2}{0.0235}$$

Hence, $x = \sqrt{1.74x10^{-3}x0.0235}$

x = 6.39 x 10^{-3} mol L^{-1} **ANS**

(d) The term coordinate covalent bond (or dative bond) is indicates that both of the electrons in one of the N-H bonds originated from the N atom and that the H atom contributed no electrons. Hence, there is an overall +1 charge on the ammonium ion produced.

SECTION II: THE ELECTIVES

CHEMICAL ENERGY

32.

(a) (i) Methane gas can form an explosive mixture with air. In a confined space, a spark could ignite such a mixture.

(ii) $m(CH_4)$ = M_rPV/RT (M_r = relative molecular mass of methane)

= $(16.04 \times (9.12 \times 10^2) \times 60.0)/(8.314 \times 293)$

= 361 g **ANS**

(b) (i) Ethanol is a renewable resource (unlike crude oil) since it is produced from vegetation in a short time period.

(ii) Mass of 1.00 L ethanol = 1000 x 0.79 g = 790 g

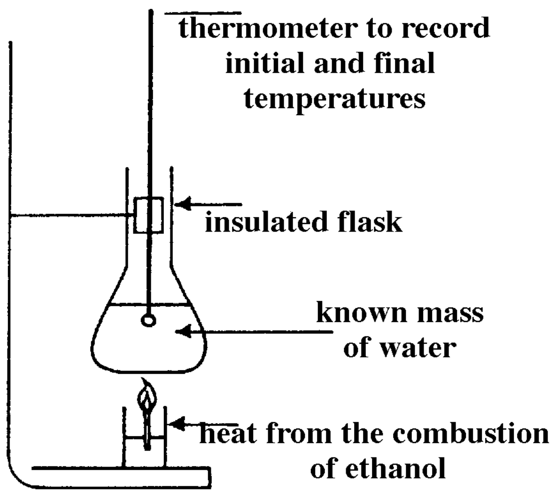
Heat derived from combustion of 1 mole of ethanol (= 46.07 g) = 1360 kJ

heat obtained from 790 g = (790/46.07) x 1360 kJ

= 23×10^3 kJ **ANS**

(c) (i) One possible substance is ethanol [This is one example of possible experiments.]

(ii) The following experimental apparatus could be used to determine the enthalpy of combustion of ethanol.



(iii) In order to calculate the enthalpy change for this combustion, the initial and final temperature of the water, the mass of the water and the mass of ethanol burnt must be known.

SECTION II: THE ELECTIVES

CHEMICAL ENERGY

(iv) Major sources of error in this experiment include:

(1) errors in the reading of the thermometer,

(2) heat absorbed by the flask

(3) heat lost to the surroundings.

(d)

(i) The balanced equation for this reaction is: $C_6H_{12}O_6(aq) = 2CH_3CH_2OH(aq) + CO_2(g)$

(ii) The minimum heat generated by the reaction can be calculated in the following way.

Temperature increase = 34.5° - 20.0° = 14.5°C

Mass of mixture = 20.0 x 1.00 x 1000 g =20.0x 10^3g

Minimum heat evolved = mass x specific heat capacity x temperature rise

= (20.0 x 10^3) x 4.18 x 14.5 J

= 1212 x 10^3 J from 600 g of glucose **ANS**

(iii) Mass of 1 mole of glucose = 180.2 g

heat evolved from 1 mole of glucose = ((1212 x 10^3)/600) x 180.2

= 364 x 103 J mol^{-1}

= 364 kJ mol^{-1} **ANS**

(e)

(i) Methane: 1 mole = 16.05 g

heat from 1 g methane = 890/16.04 kJ g^{-1} = 55.5 kJ g^{-1} **ANS**

Butane: 1 mole = 58.14 g

heat from 1 g butane = 2877/58.14 kJ g^{-1} = 49.5 kJ g^{-1} **ANS**

Hydrogen: 1 mole = 2.02 g

heat from 1 g hydrogen = 286/2.02 kJ g^{-1} = 141.6 kJ g^{-1} **ANS**

SECTION II: THE ELECTIVES

CHEMICAL ENERGY

(ii) In choosing a rocket fuel, the most suitable would deliver the maximum heat from a given mass of fuel. (Mass in a rocket is critical.) Thus hydrogen would be the best of the three fuels listed.

(f)

(i) The balanced equation is: $C_2H_4(g) + Br_2(g) = C_2H_4Br_2(g)$

Bonds broken:	Bonds formed:
C=C +614 kJ	C-C -346 kJ
Br-Br +193 kJ	2 x C-Br 2 x -285 =-570 kJ
Total +807 kJ	Total -916 kJ

Hence, ΔH for the reaction as written above = (+807 - 916) kJ mol^{-1} = -109 kJ mol^{-1} **ANS**

(g)

(i) Molar enthalpy of vaporisation is the energy required to convert 1 mole of substance from the liquid state to the vapour state at the normal boiling temperature.

(ii) To boil a substance, molecules must absorb enough energy to overcome the attractive intermolecular forces which operate in the liquid phase. These attractive forces depend, among other factors, on the size of the molecules, and for a homologous series this increases by a constant amount for each additional CH_2 group in the molecule.

(iii) Alkanols all contain the -OH group which participates in hydrogen bonding between alkanol molecules. This hydrogen bonding requires additional energy when the molecules are separated by boiling, leading to a higher boiling temperature than would otherwise be the case for molecules of the same mass such as alkanes. As alkanes have no -OH group in their molecules, there is no hydrogen bonding present and thus they have lower boiling temperatures than corresponding mass alkanol molecules.

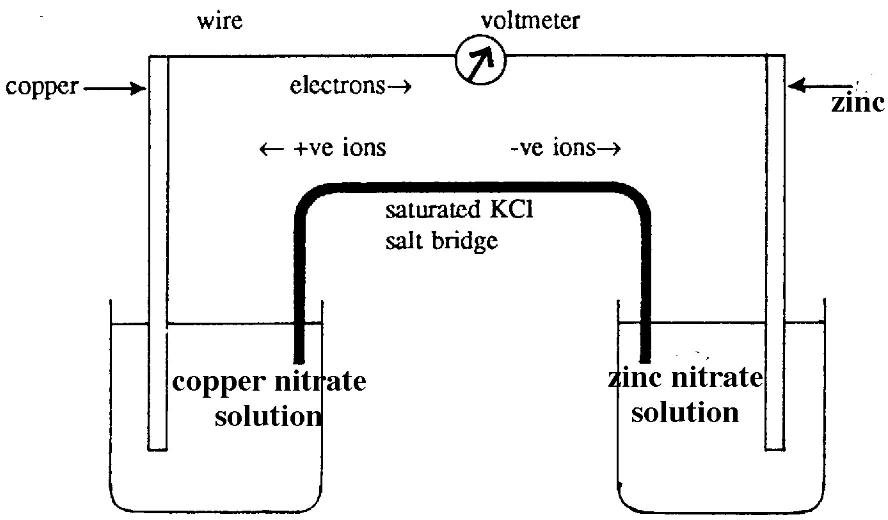
SECTION II: THE ELECTIVES

OXIDATION AND REDUCTION

33.
(a)

(i) [This is only an example of possible experiments.]

(ii) Zinc (anode) and copper (cathode)



(iii) 1. Oxidation reaction: $Zn(s) = Zn^{2+}(aq) + 2e^-$

2. Reduction reaction: $Cu^{2+}(aq) + 2e- = Cu(s)$

3. Overall reaction: $Zn(s) + Cu^{2+}(aq) = Zn^{2+}(aq) + Cu(s)$

4. E°(cell) = E°(larger) - E°(smaller) = 0.35 - (-0.76) = 1.11 V

(b)

(i) The weakest oxidising agent in the table is Ba^{2+} (aq).

(ii) 1. The Fe would be oxidised and Co^{2+} would be reduced according to the equation

$Co^{2+}(aq) + Fe(s) = Co(s) + Fe^{2+}(aq)$

2. No reaction between aluminium metal and barium nitrate solution.

(iii) The potential for the oxidation of Au to Au^+ is very low (-1.68 V), indicating that this reaction has very little tendency to occur, thereby favouring gold to remain as the element.

SECTION II: THE ELECTIVES

OXIDATION AND REDUCTION

(c)

(i) The magnesium or zinc acts as a sacrificial anode because these metals are more easily oxidised than iron. Thus they oxidise before the iron which is electrochemically protected by electrons which flow from the zinc or magnesium to the pipe through the wire.

(ii) Painting protects iron from rusting by placing a physical barrier between the pipe and the water and oxygen which cause the oxidation. Galvanising (coating the iron with zinc) stops iron from rusting by providing similar electrochemical protection to that from the magnesium and zinc rods, and, in addition, zinc oxide which forms on its surface is physically protective because it adheres strongly to the zinc.

(d)

(i) The balanced equation for the reaction at the cathode is: Cu^{2+} (aq) + $2e^-$ = Cu(s)

(ii) The balanced equation for the reaction at the anode is: $2H_2O$(l) = O_2(g) + $4H^+$(aq) + $4e^-$

(iii) The cell voltage for the electrochemical cell = 1.23 - 0.35 = 0.88 V
in order to bring about the electrolysis reaction, a voltage greater than 0.88 V is required.

(iv) The blue colour of the solution will become lighter as the Cu^{2+}(aq) ions are converted to Cu metal.

(v) Platinum is an inert metal that can provide a conducting material through which electrons can move but which will not itself undergo any redox reaction.

(e)

(i) The species that has been oxidised in the reaction is S in H_2S (-2) to S elemental (0)

(ii) The oxidation half-equation is: H_2S(aq) = S(s) + $2H^+$(aq) + $2e^-$

(iii) The reduction half-equation is: $Cr_2O_7^{2-}$ (aq) + $14H^+$(aq) + $6e^-$ = $2Cr^{3+}$ (aq) + $7H_2O$(l)

(iv) The balanced overall equation is:

$Cr_2O_7^{2-}$ (aq) + $8H^+$(aq) + $3H_2S$(aq) = 3S(s) + $2Cr^{3+}$ (aq) + $7H_2O$(l)

SECTION II: THE ELECTIVES

BIOLOGICAL CHEMISTRY

34.
(a)

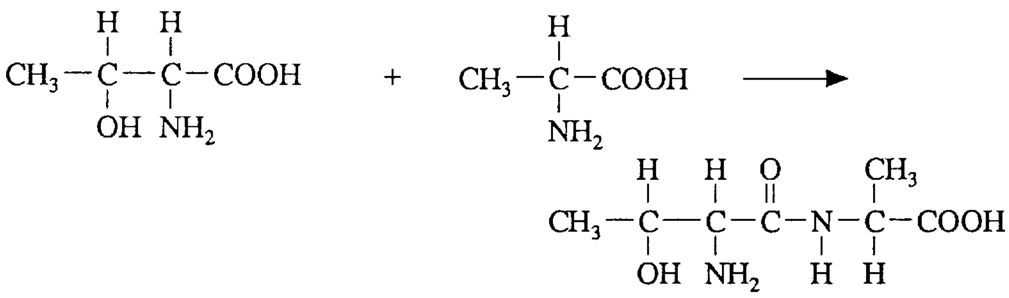
(i) These carbohydrates are either monosaccharides or disaccharides

(ii) Compounds I and II have the same molecular formula but different structural formulae. They are structural isomers or constitutional isomers

(b) The carbohydrate that gives strength to cell walls is cellulose.

(c)

(i) Bond X in the diagram is a peptide or amide linkage as shown in the equation below.



(ii) Bond Y in the diagram is a disulfide linkage. The S-S bonds between cysteine residues in different parts of the enzyme, in conjunction with the peptide linkages, determine the primary structure of proteins.

(iii) Heating an enzyme destroys its secondary, tertiary and quaternary structures, rendering it inactive. Hydrogen bonds which help to maintain these structures are broken by the heating process.

SECTION II: THE ELECTIVES

BIOLOGICAL CHEMISTRY

(d)

	reagent used	how test was carried out	results obtained
(i) protein	sodium hydroxide solution and copper(II) sulfate	One test for proteins is the Biuret test in which the protein suspension is made alkaline with sodium hydroxide solution and then copper(II) sulfate solution is added.	A violet colour develops if the compound tested has two or more amide linkages present.
(ii) starch	iodine solution in water	Starch is mixed with iodine solution in water	a characteristic deep blue colour.
(iii) glucose	any weak oxidising agent such as Fehling's solution.	heat together	When heated together, the mixture will precipitate a red coloured solid, Cu_2O. Glucose is a reducing sugar.

(e)

(i) The balanced equation for the overall process of photosynthesis is:
$6CO_2(g) + 6H_2O(l) = C_6H_{12}O_6(aq) + 6O_2(g)$

(ii) The light reaction in photosynthesis is the process in which chlorophyll systems use the energy from sunlight to convert water molecules into oxygen and activated chemical compounds. These activated compounds can then be used to provide energy for the carbon fixation process where carbon dioxide is converted to carbohydrates. As this second step does not require simultaneous illumination, it is also called the dark reaction.

(iii) Photosynthesis recycles elemental oxygen which has previously been combined with carbon in carbon dioxide. Photosynthesis also stores energy from the sun in the chemical bonds of carbohydrates which are then used to release that energy for use by living cells.

SECTION II: THE ELECTIVES

BIOLOGICAL CHEMISTRY

(f)

(i) A is glycolysis and B is the Krebs cycle or citric acid cycle.

(ii) Q is carbon dioxide

(iii) 1. The product formed under these conditions is lactic acid.

2. This alternate chemical pathway will operate under anaerobic conditions.

(g)

(i) The product of the reaction between maltase and maltose is glucose.

(ii) The balanced equation for the fermentation reaction is
$C_6H_{12}O_6(aq) = 2C_2H_5OH(aq) + 2CO_2(g)$

(iii) 1 mole of maltose produces 2 moles of glucose, and 2 moles of glucose produces 4 moles of ethanol, assuming complete conversion.

Moles of maltose = 10/360 = 0.0278 mole
moles of ethanol = 4 x 0.0278 = 0.111 mole
and mass of ethanol = 0.111 x 46.1 g = 5.1 g **ANS**

SECTION II: THE ELECTIVES

CHEMISTRY AND THE ENVIRONMENT

35.
(a)

(i) The mass of undissolved solids in a sample of water can be obtained by measuring the mass of a dried filter paper, then filtering a measured volume of water through it and reweighing the filter paper after drying it again. The difference between the two weighings is the mass of undissolved solids present in the volume of water used.

(ii) To determine the mass of dissolved solids, a measured volume of the filtrate from (i) is transferred to a dry, weighed flask and evaporated until just dry. The flask is reweighed and the difference between the two masses is the mass of dissolved solids present in the volume of water used.

(b)

(i) Sample X has low Na^+ and Cl^- concentrations and also is free of heavy metal ions. (Hg^{2+} and Pb^{2+}) It is therefore fresh water from an uncontaminated source.
Sample Y is similar to X in that it also contains low levels of ions found in sea water, but Y contains the heavy metal ions Hg^{2+} and Pb^{2+} , indicating that it may be from a source of fresh water containing industrial effluent.

(ii) Halide ions present are fluoride (F^-) bromide (Br^-) and chloride (Cl^-). Metal ions in the list are mercury(II) (Hg^{2+}), lead (Pb^{2+}), copper(II) (Cu^{2+}), strontium (Sr^{2+}), potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}) and sodium (Na^+).

Choose chloride ion as an example of a halide. Add nitric acid followed by silver nitrate solution. This produces a white precipitate of silver chloride according to the equation:
$Ag^+(aq) + Cl^-(aq) = AgCl(s)$

The bromide ion would behave in the same way. Do the following to distinguish bromide from chloride. Add some chlorine water solution and a small amount of chloroform to a new sample of the water, and shake vigorously. Bromide produces an orange colour in the chloroform layer due to the formation of bromine, while chloride does not form any colour.

Choose sodium from the list of metals. Na^+ can be detected by a flame test. To do this, a sample of water by boiling to dryness. A platinum wire is then cleaned by repeatedly dipping it in concentrated hydrochloric acid and then placing it in the flame of a burner. When the wire shows no colour upon being heated, dip the wire in concentrated hydrochloric acid and the dried sample, and place it in the flame. A yellow colour observed in the flame indicates the presence of Na^+. The wire is easily contaminated and care must be taken that it is cleaned thoroughly.

(c) A pollutant in a particular environment is any substance which is normally either absent or at lower levels than those observed, and which has undesirable effects as a consequence.

SECTION II: THE ELECTIVES

CHEMISTRY AND THE ENVIRONMENT

(d) Water polluted by nutrients has a low level of dissolved oxygen because oxygen is used in the breakdown of organic mater and is also used by algae at a rate which may be faster than that at which it can be replaced. Hence, a low concentration of dissolved oxygen would indicate poor water quality.

(e) The balanced equation for the reaction is: $CaO(s) + 2HNO_3(aq) = Ca(NO_3)_2(aq) + H_2O(l)$

From the equation, 1 mole of HNO_3 reacts exactly with 0.5 mole of CaO

$n(HNO_3) = 2.0 \times 10^6 \times 1.0 \times 10^{-3} = 2.0 \times 10^3$ mole

$n(CaO)$ required $= 0.5 \times 2.0 \times 10^3 = 1.0 \times 10^3$ mole

Mass of CaO $= 1.0 \times 10^3 \times 56.08$ g $= 5.6 \times 10^4$ g **ANS**

(f)

(i) Nuclear radiation (ionising radiation), mainly in the form of β and γ rays emitted by radioactive atoms could be harmful due to their strong penetrating power and consequent ability to damage cells by forming ions which are very reactive.

(ii) Nuclear waste must be stored until the radiation has diminished to a safe level. Storage in metal containers, usually in stable underground structures, is one method. Another method under development is incorporation of waste into an inert synthetic mineral (Synrock) which can also be stored underground.

(iii) Reactors at Lucas Heights make radioactive isotopes for industrial and medical purposes.

(iv) Uranium is mined commercially at Roxby Downs mine in South Australia and Ranger mine in the Northern Territory.

(v) Uranium is extracted from its ore by treating uranium ore with sulfuric acid and an oxidising agent.

SECTION II: THE ELECTIVES

CHEMISTRY AND THE ENVIRONMENT

(g)

(i) There is a thin band of ozone in the upper atmosphere which absorbs much of the ultraviolet that comes from the sun. In the southern hemisphere, each summer, large areas extending from Antarctica to Australia suffer a depletion of ozone in the layer as a result of chemical reactions with various pollutants.

(ii) Ozone (O_3) is converted to O_2 by the reaction with chlorine atoms which are derived from chlorofluorocarbons (CFC's).

(iii) Loss of ozone results in higher levels of ultraviolet light reaching the surface of the earth. This lead to increased incidence of cancers in humans and to damage to other living organisms.

(iv) From the balanced equation: 1 mole of rubber reacts with 1 mole of O_3
Mass of 1 mole of rubber = 84.16 g

moles of rubber in 8400 g =8400/84.16 = 99.81 mole = n(O_3) required

mass of O_3 = 99.81 x 48.00 g = 4791 g **ANS**

END OF NSW HSC CHEMISTRY 1995
SUGGESTED SOLUTIONS

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