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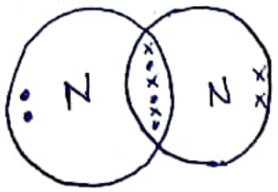
1 The atomic numbers of nitrogen and fluorine are 7 and 9 respectively.

(a) Draw electron dot (•) and cross (x) diagrams to illustrate bonding in the molecules of:

(i) nitrogen; (1 mark)

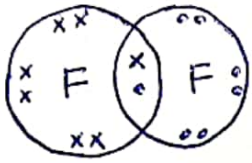


// :N⋮⋮N:

Accept dots or crosses consistently used throughout the structure

01

(ii) fluorine. (1 mark)



// :F:F:

01

(b) With reference to the diagrams in (a), state why fluorine is more reactive than nitrogen. (1 mark)

Nitrogen has a tripple bond // Fluorine has a single bond

Single bond is weaker than tripple bond hence easier to break.

Any 1

01

2 Classification of types of salts includes normal and acid salts.

(a) Give the name of another type of salt. (1 mark)

Double salt // Basic salt

Accept: Base salts

Any 1

01

(b) (i) Describe how an acid salt can be prepared using 0.1 M sulphuric(VI) acid and 0.1 M sodium hydroxide. (1 mark)

Mix/react equal volumes of 0.1M H_2SO_4 / NaOH

01

(ii) Write an equation for the reaction in b(i). (1 mark)

$H_2SO_4(aq) + NaOH(aq) \longrightarrow NaHSO_4(aq) + H_2O(l)$

01

06

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3 Complete **Table 1** by writing the formulae of all the products formed when the metal nitrates are heated strongly. (3 marks)

Table 1

Nitrate	Formulae of products
Potassium nitrate	KNO_2 ½ + O_2 ½ — 1 mk
Lead(II) nitrate	$PbO + NO_2 + O_2$ — 1 mk
Silver nitrate	$Ag + NO_2 + O_2$ — 1 mk

03

All the 3 given — 1 mk
Only 2 given — ½ mk
Only 1 given — 0 mk

4 Zinc metal is extracted from zinc blende ore through the following processes; concentration, roasting and reduction.

(a) Explain how the ore is concentrated. (2 marks)

The ore is ground/crushed ½, water and oil added, air blown ½ thro' the mixture. The earthy material is wetted and sinks. The ore ½ floats on the surface

02

(b) Write an equation for the reaction that takes place when the ore is roasted. (1 mark)

$2ZnS_{(s)} + 3O_{2(g)} \longrightarrow 2ZnO_{(s)} + 2SO_{2(g)}$ ✓1

01

5 **Figure 1** shows how the solubility of oxygen varies with changes in temperature.

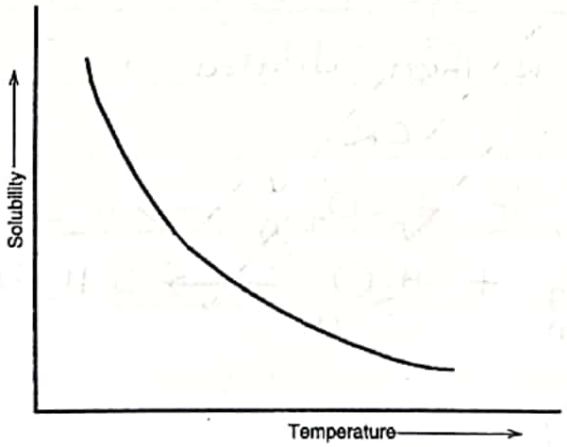

Figure 1

(a) Explain using kinetic theory why the solubility varies as shown. (2 marks)

With increase in temp., oxygen molecules gain ✓1 kinetic energy and escape from the soln ✓1 hence solubility decreases.

02

oxygen molecules repelled/

08

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(b) With reference to **Figure 1**, explain the pollution effect that may be caused by a large increase in the temperature of sea water. (1 mark)

Less dissolved oxygen in sea water results to the death of marine life (animals/plants) (Tied)

01

6 A flow diagram for production of sulphuric(IV) acid is shown in **Figure 2**.

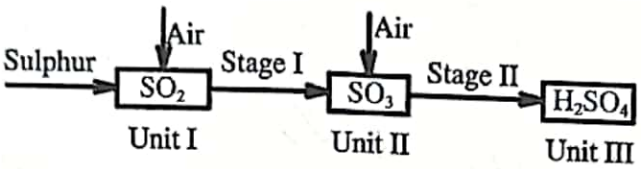

Figure 2

(a) State the optimum conditions necessary for carrying out the reaction in unit **II**. (1 mark)

High temp of btn 450 - 500°C
Vanadium (V) oxide / Platinum catalyst.
2 - 3 atm pressure

01

2/3 given - 1mk
1 given - ½ mk

(b) Stage **II** takes place in two steps. Describe the steps. (2 marks)

✓1 SO_3 is dissolved in conc H_2SO_4 to make oleum.
✓1 Oleum is then diluted with water

OR

✓1 $SO_{3(g)} + H_2SO_{4(l)} \longrightarrow H_2S_2O_{7(l)}$
✓1 $H_2S_2O_7 + H_2O \longrightarrow 2H_2SO_4$
(1) (1) (1)

02

7 The following equilibrium exists in aqueous ammonia:

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

(a) With reference to this equilibrium, explain why ammonia is a weak base. (1 mark)

Ammonia dissociates partially //
Rxn is reversible // str
Equilibrium position lies to the left hence very few OH^- ions in the soln

✓ Any 1

01

05

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(b) When aqueous ammonia is added drop-wise to aqueous copper(II) sulphate, a blue precipitate is formed. The blue precipitate redissolves giving a deep blue solution. Write the formula of the substance responsible for the:

(i) blue precipitate; (1 mark)

01 $Cu(OH)_2$ ✓1

Ignore state symbols

(ii) deep blue colour. (1 mark)

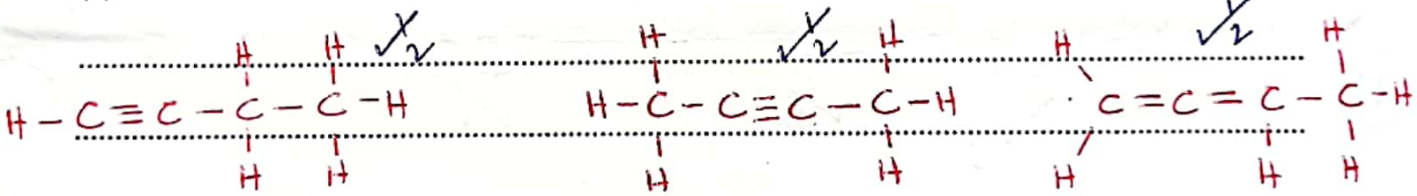
01 $Cu(NH_3)_4^{2+}$ ✓1 // $[Cu(NH_3)_4]^{2+}$

8 The molecular formula of two straight chain hydrocarbons is C_4H_6.

(a) Give the general formula of the homologous series to which the hydrocarbons belong. (1 mark)

01 C_nH_{2n-2} ✓1

(b) Draw the structures of the **two** compounds and give their names. (2 marks)



02 ✓½ ✓½ ✓½

But-1-yne // Butyne ✓½ But-2-yne But-1,2-diene.

Names of structures are not tied.

9 Water hardness may be temporary or permanent.

(a) Write the formula of an ion that causes temporary hardness. (1 mark)

01 HCO_3^-

(b) Temporary hardness can be removed by boiling. Give **one** disadvantage of using this method in industries. (1 mark)

01 Leaves deposits/$CaCO_3$/$MgCO_3$/scales/fur which reduces heat conductivity/efficiency in boiler/consumes a lot of energy/expensive/blockage/clogging ✓½ ✓½

07

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- Distillation ✓1 Any 1

(c) State **one** method that can be used to remove permanent hardness. (1 mark)

(01) - Addition of Na_2CO_3/Washing soda/Soda ash to precipitate $MgCO_3$/$MgCO_3$ (Remove Ca^{2+}, Mg^{2+})

- Use of ion-exchange resins/sodium permutit

10 (a) **Figure 3** shows an energy level diagram for the formation of hydrogen fluoride. (1 mark)

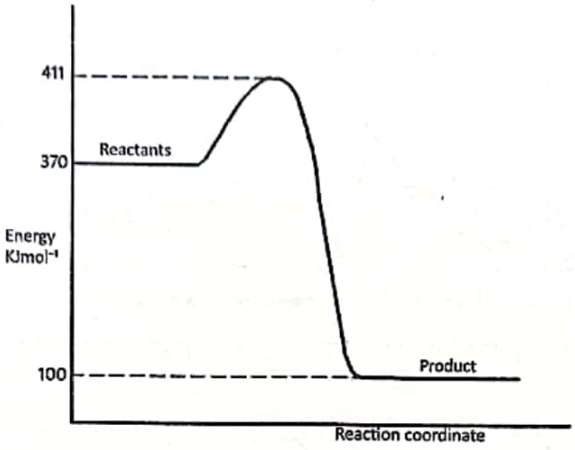

Figure 3

✓1
✓ Accept −270 shown without workings.
✓ Reject 270 without −ve sign.

Calculate the:

(i) enthalpy change for the formation of hydrogen fluoride; (1 mark)

(01½) $100 - 370 = -270\ kJmol^{-1}$ ✓½ ✓1

(ii) activation energy of the reaction. (1 mark)

(01½) $411 - 370 = +41\ kJmol^{-1}$ ✓½ ✓1

11 At high temperature, hydrogen and oxygen react as shown in the following equation:

$$O_2(g) + 2H_2(g) \rightarrow 2H_2O(g)$$

In an experiment, a mixture containing 200 cm^3 oxygen and 300 cm^3 hydrogen was heated to form water.

(a) Determine which gas was in excess and by how much. (1 mark)

(01) Oxygen ✓½ was in excess by $200 - 150 = 50\ cm^3$ ✓½

(b) Calculate the volume of water that was formed. (1 mark)

(01) $300\ cm^3$ ✓1

06

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Reject: Gravity
Refractive Index

(c) Explain how one could confirm that the product was pure water. (1 mark)

(01) Determine the boiling point (about 100°C) at 1atm pressure
Freezing/melting point of 0°C ✓1 Any 1
Density of 1 gcm⁻³

12 Silk and rubber are examples of natural polymers.

(a) Give the name of another natural polymer. (1 mark)

(01) Silk // wool // Cotton // cellulose // proteins // starch // DNA // ✓ Any 1

(b) State the sources of: gum from tree // wood.

(i) silk; (1 mark)

(01) Silk worm ✓1

(ii) natural rubber. (1 mark)

(01) Rubber tree / Latex from tree ✓1

13 (a) Give the formula of the compound referred to as rust. (1 mark)

(01) $Fe_2O_3 \cdot 2H_2O$ // $Fe_2O_3 \cdot H_2O$ //
$Fe_2O_3 \cdot XH_2O$ $(x = 1 - 10)$

(b) Four test tubes were setup to investigate rusting of iron as shown in **Figure 4**. The setup was allowed to stand for one week.

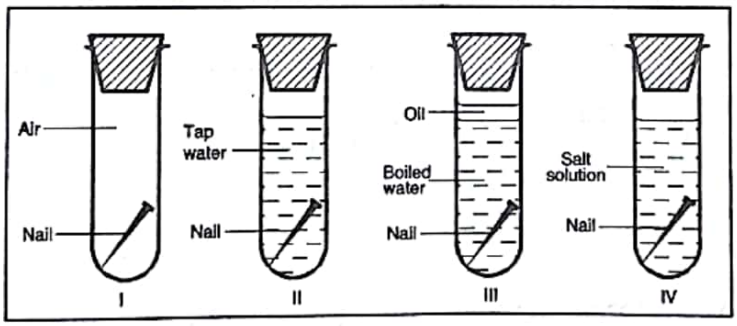

Figure 4

Explain why:

(i) no rusting took place in test tube **III**. (1 mark)

(01) Absence of ½ oxygen (boiling removes dissolved oxygen) and oil keep off the oxygen in the air ½

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(ii) select the test tube in which there was highest amount of rust. Give a reason. (1 mark)

(01) IV ½ Salt accelerates rusting ½

14 (a) Avogadro's constant is $6.02 \times 10^{23} mol^{-1}$. Determine the total number of ions that are present in 500 cm^3 of 2.0 M calcium nitrate. (2 marks)

½ Moles of $Ca(NO_3)_2 = \frac{500 \times 2}{1000} = 1$ mol ½

(02) Moles of all ions ($1 Ca^{2+}$, $2 NO_3^-$) = 3 × 1 ions = 3 ions ½

Total N° of ions = $3 \times 6.02 \times 10^{23}$ ½

Ions of NO_3^- Ions of Ca^{2+}

$(1 \times 6.023 \times 10^{23}) + (2 \times 6.023 \times 10^{23}) = 1.806 \times 10^{24}$ ½

½ ½

1.806×10^{24} ½

(b) The electrical conductivity of 2.0 M calcium nitrate is higher than that of 2.0 M potassium nitrate. Explain. (1 mark)

(01) More/higher N° of ions in $Ca(NO_3)_2$ than KNO_3 //

Higher charge on Ca^{2+} compared to K^+

(Conductivity depends on the N° of ions & charge on the i

15 Carbon(IV) oxide and methane are gases found in the atmosphere.

(a) State **one** disadvantage of carbon(IV) oxide in the atmosphere. (1 mark)

(01) Causes global warming // Green house effect //

Acid rain Any 1

(b) Name **one** source of emissions of methane into the atmosphere. (1 mark)

(01) - Production of natural gas/fossil fuel (From crude oil)/Coal mining/decomposition of manure and biomass (Excretion of animals.

- Cracking long chain alkanes Any 1

(c) State how emissions of carbon(IV) oxide into the atmosphere can be reduced. (1 mark)

(01) - Reduction of use of fossil fuels/burning of wood/charcoal production

- Tree planting

- Scrubbing using alkali Any 1

- Green energy / Electric vehicles.

- Solar energy.

- Reduce N° of greenhouses.

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Mass of D = 5.70 − 4.55
= 1.159 ✓½

16 5.70g of a chloride of element **D** was found to contain 4.55g of chlorine.

(a) Determine the empirical formula of the chloride (D = 27.0; Cl = 35.5). (2 marks)

No. of moles — D: $\frac{1.15}{27} = 0.0426$ — Cl: $\frac{4.55}{35.5} = 0.128$ ✓½

(02) Mole ratio — $\frac{0.0426}{0.0426} = 1$ — $\frac{0.128}{0.0426} = 3$ ✓½

∴ EF = DCl_3 ✓½

(b) Given that the relative formula mass of the chloride is 267, determine its molecular formula. (1 mark)

$(DCl_3)_n = 267$

(01) $135.5n = 267$ ✓½

$n = 2$

∴ MF = D_2Cl_6 ✓½ Reg. $(DCl_3)_2$

17 **Table 2** shows the boiling points of ethane, butane and ethanol.
(H = 1.0; C = 12.0; O = 16.0)

Table 2

Compound	CH_3CH_3	$CH_3CH_2CH_2CH_3$	CH_3CH_2OH
Relative molecular mass	30	58	46
Boiling point, °C	- 88.6	- 0.5	78.5

Give reasons for the following: Reg. more covalent bond. 1

(a) boiling point of butane is higher than that of ethane; (1½ marks)

(01½) Butane has a higher mass / larger molecules / longer Carbon chain / Hydrogen / more carbon atoms, hence has stronger van der waals forces compared to ethane. ✓1 ✓½

(b) boiling point of ethanol is higher than that of butane. (1½ marks)

(01½) Ethanol has hydrogen bonding ✓1 which is stronger ✓½ than weak van der waals forces in butane

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Reactivity of the metals with water
Ca > Mg > Be

10

18 Small pieces of beryllium, magnesium and calcium metals were placed in test tubes containing cold distilled water mixed with phenolphthalein indicator as shown in **Figure 5**.

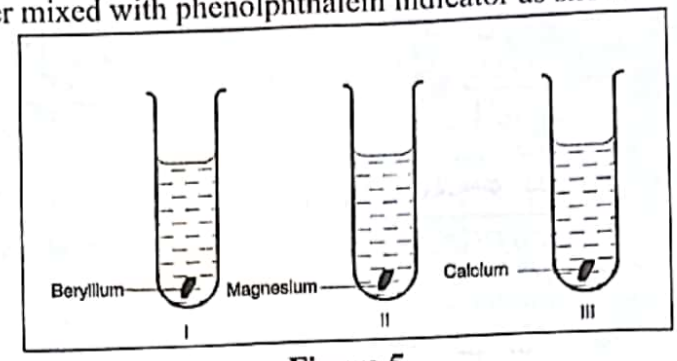

Figure 5

State and explain the observations that were made in each of the following test tubes:

Test tube **I**; Does not React. (1 mark)

No rxn, the soln remains colourless ½

Reject: No observable change. ½ ½ (01)

Test tube **II**; (1 mark)

Bubbles/Pink colour forms after some time. ½

Mg reacts slowly ½ with water to form $Mg(OH)_2$ (01)

Test tube **III**. (1 mark)

Bubbles/Effervescence ½/Soln turns pink

Vigorous rxn ½ (01)

19 A laboratory assistant wanted to investigate the effect of an electric current on substances. **Figure 6** shows arrangement of the apparatus used.

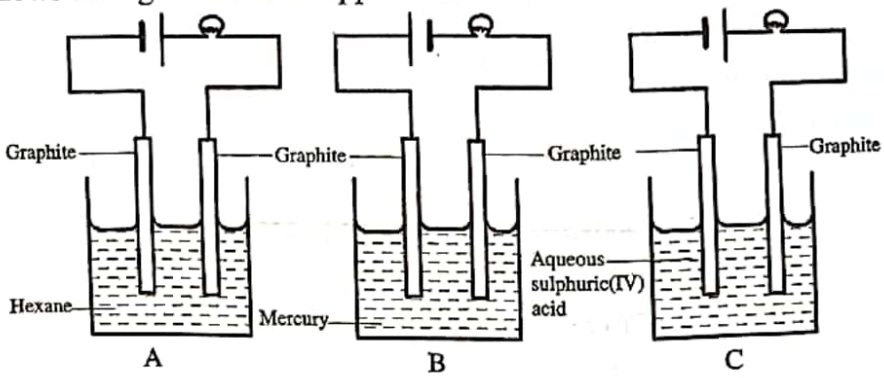

Figure 6

Explain why:

(a) in **A**, the bulb did not light up and no electrolysis took place; (1 mark)

Hexane is a non-conductor ½ ½, has no free ions ½

Hexane is a non-electrolyte ½ ½, it is molecular ½ (01)

Reg. Poor conductor.
Does not conduct electricity; lacks ions.

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(b) in **B**, the bulb lit but no electrolysis took place; (1 mark)

01 Mercury is a metal // good conductor of electricity // has delocalized e^- hence bulb lights but it cannot be decomposed because it is an element. (Any one mark)

(c) in **C**, the bulb lit and electrolysis took place.

01 Aq: H_2SO_4 is an electrolyte hence contains ions that conducts an electric current // it decomposes // ions are discharged (dissociates)

20 Carbon - 14 , ^{14}C, is a radioactive isotope of carbon. It decays to form an isotope of nitrogen (Atomic numbers of : N = 7; C = 6).

(a) Write a nuclear equation for the decay process. (1 mark)

01 $^{14}_{6}C \longrightarrow {}^{14}_{7}N + {}^{0}_{-1}e$

(b) Archeologists calculate the age of organic matter using the proportion of carbon - 14 present and the half-life of carbon -14.

(i) State what is meant by the term half-life of carbon - 14. (1 mark)

01 Time taken for the quantity of a radioactive substance to reduce/decay to half its initial/original mass.

(ii) Given that the half-life of carbon -14 is 5570 years, calculate the age of a piece of bone found to contain $\frac{1}{16}$ as much carbon -14 as living matter. (1 mark)

01 $1 \xrightarrow{t_{1/2}} \frac{1}{2} \xrightarrow{t_{1/2}} \frac{1}{4} \xrightarrow{t_{1/2}} \frac{1}{8} \xrightarrow{t_{1/2}} \frac{1}{16} \Rightarrow$ 4 Half lives.

Age $= 4 \times 5570 = 22,280$ years.

$\left(\frac{1}{16}\right) = \left(\frac{1}{2}\right)^{\frac{T}{5570}} \Rightarrow \left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^{\frac{T}{5570}} \Rightarrow 4 = \frac{T}{5570} \Rightarrow T = 22\,280$

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21 A student used the following procedure when standardising sodium hydroxide. The student placed 25.00 cm^3 of the hydroxide in a conical flask and titrated it with 0.1 M hydrochloric acid using phenolphthalein indicator. The average titre was 21.50 cm^3 of the acid.
State and explain how each of the following steps in the procedure may have affected the titre value:

(a) the student rinsed the conical flask with the sodium hydroxide before using it; (1 mark)

Rinsing leaves some extra ½ NaOH in the conical flask, this will increase ½ the titre value. 01

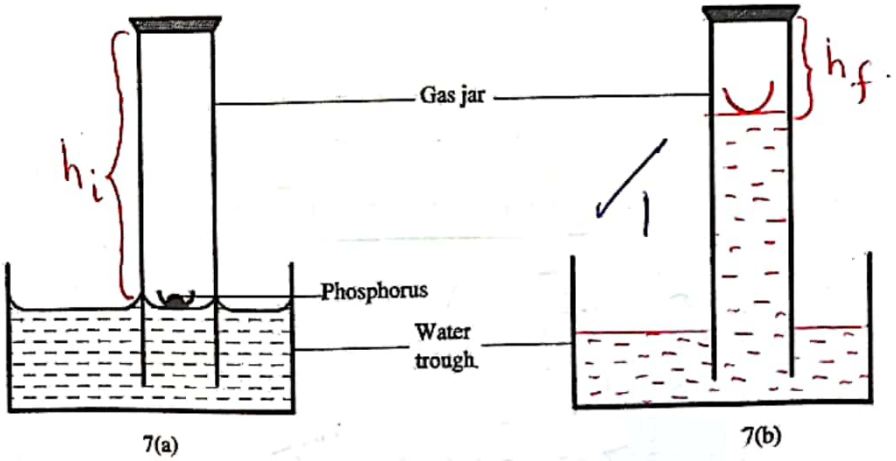
(b) the student did **not** rinse the freshly cleaned burette with the hydrochloric acid before filling it; (1 mark)

Some water ½ was left in the burette after cleaning this dilutes the HCl increasing ½ the titre value. 01

(c) the student used about 2.0 cm^3 of the phenolphthalein indicator. (1 mark)

Phenolphthalein is a ½ weak acid, this reacts with some NaOH and this lowered ½ the titre value 01

22 The setup shown in **Figure 7 (a)** was used to determine the approximate percentages of the major components of air.



01

Figure 7

(a) Complete **Figure 7 (b)** to show the setup after it was left standing until no further changes were observed. (1 mark)

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Measure the height of gas jar above water level in 7(a), h_i and when there is no further change, in 7(b), h_f.

(b) Explain how the percentages of the major components of air are calculated. (2 marks)

02

% of Active component = $\frac{h_i - h_f}{h_i} \times 100\%$ ✓1

% of Inactive component = $\frac{h_f}{h_i} \times 100\%$ ✓1

23 The heat energy value of a fuel is defined as the amount of energy produced by 1.0 gram of the fuel. (C = 12.0; H = 1.0; O = 16.0)

(a) Calculate the heat energy values of the fuels, hydrogen and ethanol and complete **Table 3**.

Table 3

Fuel	Enthalpy of Combustion ($kJmol^{-1}$)	Heat energy value kJg^{-1}
H_2	286.0	$\frac{286}{2} = 143$ ✓½
C_2H_5OH	1371.0	$\frac{1371}{46} = 29.804$ ✓½

01

(b) Other than its heat energy value, state **one** advantage of using hydrogen and ethanol as fuels: (1 mark)

(i) hydrogen;

01

Produces water // which does not pollute environment ✓1 (1 mark)

(ii) ethanol.

01

It is renewable source of energy // cheap // Easy to store // Easy to transport. Any 1 ✓1 (1 mark)

24 Study the structures of substances **L** and **M** shown in **Figure 8** and complete **Table 4** by giving the names that describe the type of structure and bonding in each substance.

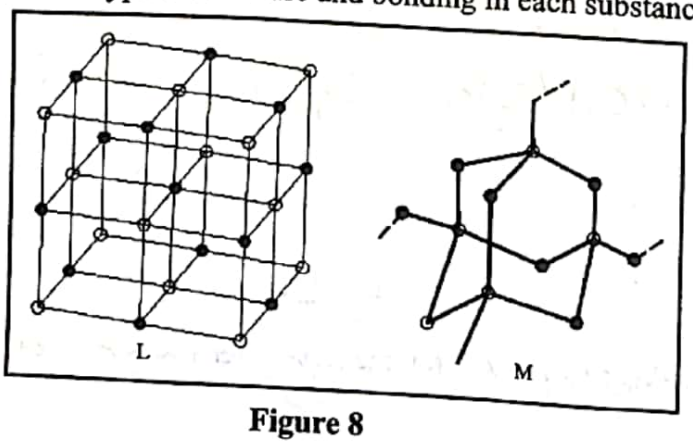

Figure 8

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Must used the term (Giant)

Table 4

Substances	L	M
Structure	Giant Ionic ✓½	Giant Covalent/Atomic/Molecular ✓½
Bonding	Ionic / Electrovalent ✓½	Covalent ✓½

(2 marks)

02

25 State **one** physical property that would suggest the presence of each of the following gases from a leaking gas cylinder:

(a) H_2S (1 mark)

Smell of rotten eggs ✓1

01

(b) N_2O (1 mark)

Sweet odour / Pleasant smell ✓1

01

(c) Cl_2 (1 mark)

Green-yellow / Yellow-green ✓1 gas.

01

26 (a) Give the names of the type of compounds whose reaction is described as:

(i) esterification; (1 mark)

✓1 Alkanoic/Carboxylic and Alkanol/Alcohol

(ii) saponification. (1 mark)

03

✓1 Fat/Oil/Estencaid/Lipids and KOH/NaOH

Suitable alkali/hydroxide

(b) State the importance of vulcanisation. (1 mark)

✓1 Hardening of rubber for use in tyre industry / Making rubber strong(er)

08

Acc. Manufacture Rubber.

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27 **Figure 9** shows a setup used to separate a mixture of two liquids, **Q** (boiling point 117°C) and **R** (boiling point 103°C).

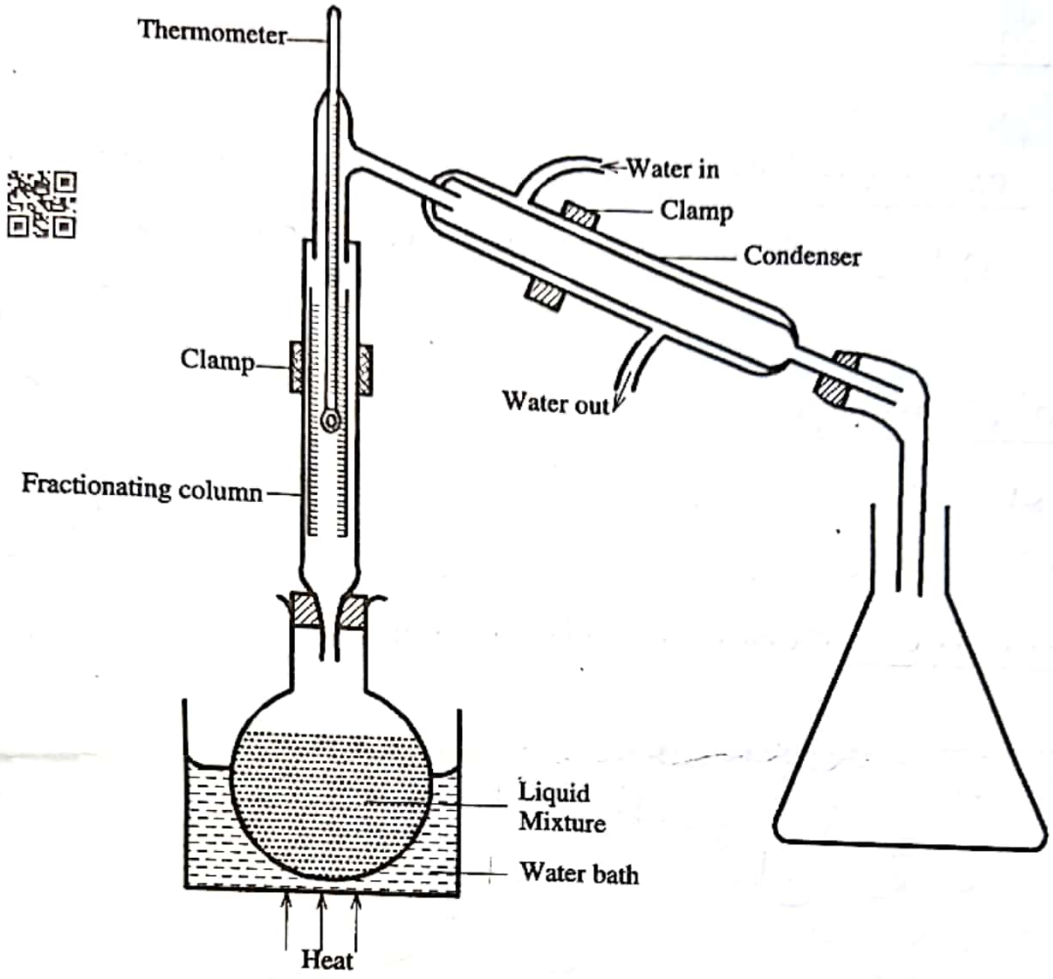

Figure 9

Identify **three** mistakes in this setup. Give a reason in each case.

Mistake 1 (1 mark)

Thermometer is too far inside the column ½

01 It should be at the end of the adaptor to measure the temp of the vapour. ½

01

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(1 mark)

Mistake 2 ½

Use of water bath.

(01)

The liquids have ½ higher b.p than water so they will not boil at 100°C

(1 mark)

Mistake 3 ½

Water in and water out in condensor is reversed.

(01)

The liquid will not cool sufficiently (No effective condenstation ½

THIS IS THE LAST PRINTED PAGE.

Alt. 4.

Absence of glass beads to make the fractionating column long enough.

02

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