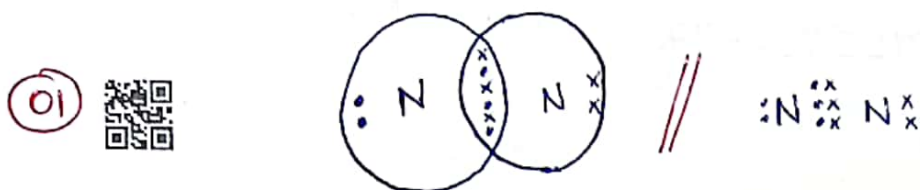


1 The atomic numbers of nitrogen and fluorine are 7 and 9 respectively.

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

(i) nitrogen;

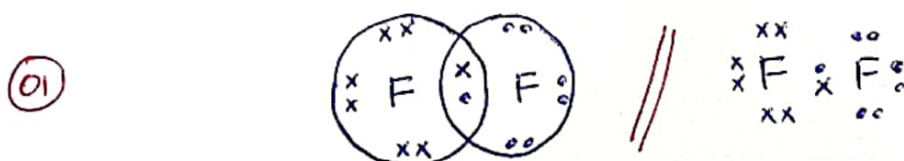
(1 mark)



Accept dots or crosses consistently used throughout the structure

(ii) fluorine.

(1 mark)



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

(1 mark)

01 Nitrogen has a tripple bond // Fluorine has a single bond
Single bond is weaker than tripple bond hence
easier to break. Any 1

2

Classification of types of salts includes normal and acid salts.

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

Accept: Base salts (1 mark)

01 Double salt // Basic salt Any 1

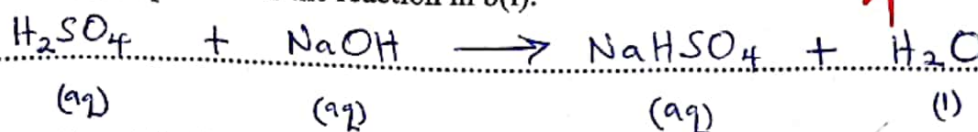
(b) (i) Describe how an acid salt can be prepared using 0.1 M sulphuric(VI) acid and 0.1 M sodium hydroxide.

(1 mark)

01 Mix/react equal volumes of 0.1 M H_2SO_4 & NaOH

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

(1 mark)



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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	$\text{KNO}_3 \checkmark + \text{O}_2 \checkmark$ 1mk
Lead(II) nitrate	$\text{PbO} + \text{NO}_2 + \text{O}_2$ } 1mk All the 3 given
Silver nitrate	$\text{Ag} + \text{NO}_2 + \text{O}_2$ } 1mk Only 2 given 1/2mk

(03)

1mk
Only 2 given 1/2mk
Only 1 given 0mk

4

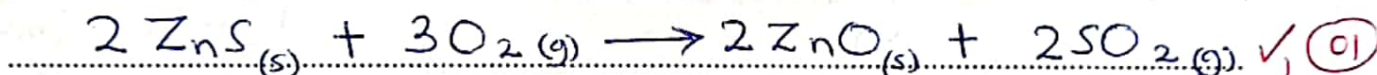
Zinc metal is extracted from zinc blende ore through the following processes; concentration, roasting and reduction.

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

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

(02)

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



5

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

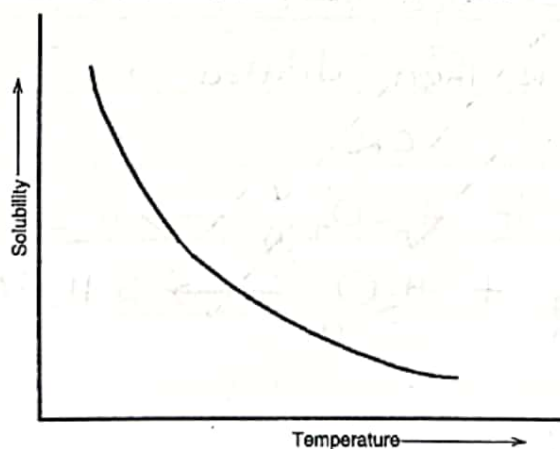


Figure 1

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

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

(02)

oxygen molecules repelled/

- (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)

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

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

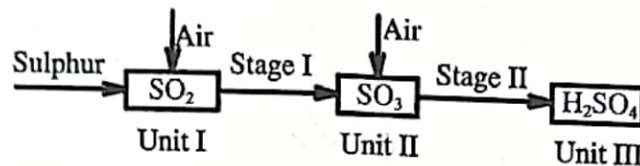


Figure 2

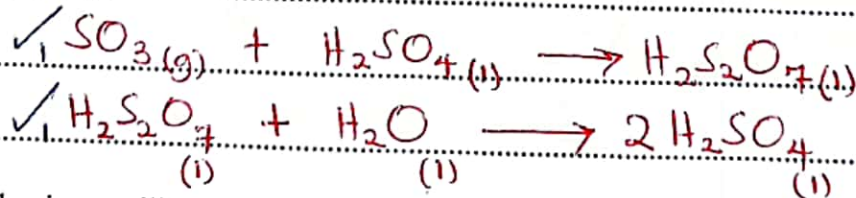
- (a) State the optimum conditions necessary for carrying out the reaction in unit II. (1 mark)

01 High temp of btm 450-500°C
Vanadium (V) oxide/Platinum catalyst.
2-3 atm pressure 2/3 given - 1mk
1 given - 1/2mk
 (2 marks)

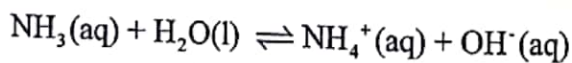
- (b) Stage II takes place in two steps. Describe the steps.

02 ✓ SO₃ is dissolved in conc H₂SO₄ to make oleum.
✓ Oleum is then diluted with water.

OR



- 7 The following equilibrium exists in aqueous ammonia:



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

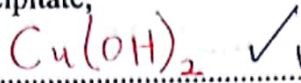
01 Ammonia dissociates partially //
Rxn is reversible // ✓ Any 1
Equilibrium position lies to the left hence
very few OH⁻ ions in the soln

- (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

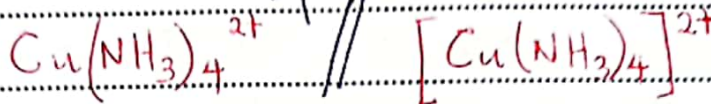


Ignore state symbols

(ii) deep blue colour.

(1 mark)

01

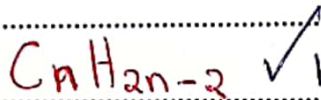


The molecular formula of two straight chain hydrocarbons is C_4H_6 .

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

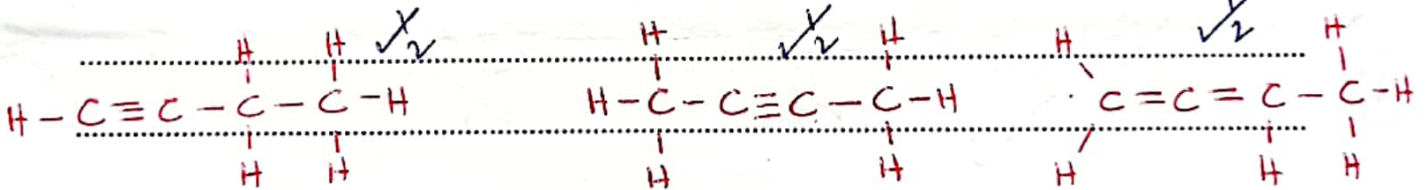
(1 mark)

01



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

(2 marks)



02

But-1-yne

But-2-yne

But-1,2-diene

Butyne

Names & 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



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

(1 mark)

Leaves deposits / CaCO_3 / MgCO_3 / scales / fur which

reduces heat conductivity / efficiency in boiler / consumes

a lot of energy / expensive / blockage / clogging.

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- Distillation

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

- 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 permittit

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

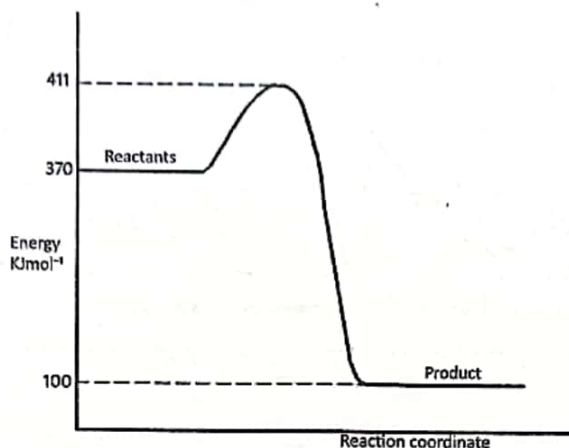


Figure 3

Calculate the:

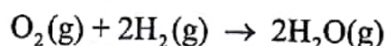
(i) enthalpy change for the formation of hydrogen fluoride; (1 mark)

$$100 - 370 = -270 \text{ kJmol}^{-1}$$

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

$$411 - 370 = +41 \text{ kJmol}^{-1}$$

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



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)

Oxygen was in excess by $200 - 150 = 50 \text{ cm}^3$

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

300 cm^3

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 1 atm pressure

Freezing/melting point of 0°C ✓

Density of 1 g cm^{-3}

- 12 Silk and rubber are examples of natural polymers.

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

01 ~~Sisal~~ // wool // Cotton // cellulose // proteins // starch // DNA //

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

- (i) silk; (1 mark)

01

Silk worm ✓

- (ii) natural rubber. (1 mark)

01

Rubber tree / Latex from tree ✓

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

$\text{Fe}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$ // $\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O}$ //

01

$\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ ($x = 1 - 10$)

- (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.

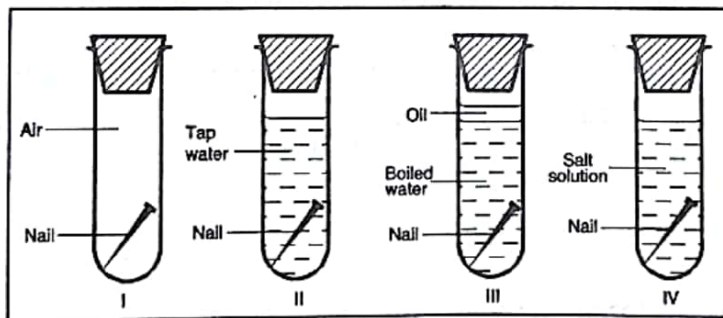


Figure 4

Explain why:

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

01

Absence of $\frac{1}{2}$ oxygen (boiling removes dissolved oxygen)

and oil keep off the oxygen in the air

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

(1 mark)



IV Salt accelerates rusting

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

Moles of $\text{Ca}(\text{NO}_3)_2 = \frac{500 \times 2}{1000} = 1 \text{ mol}$

Moles of all ions (1 Ca^{2+} , 2 NO_3^-) = $3 \times 1 \text{ mol} = 3 \text{ mol}$

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

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

1.806×10^{24}

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

More/higher N° of ions in $\text{Ca}(\text{NO}_3)_2$ than KNO_3

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

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

- 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)

Causes global warming // Green house effect

Acid rain

Any 1

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

From crude oil
- Production of natural gas/fossil fuel/oil mining/decomposition of manure and biogas (Excretion of animals)
- Cracking long chain alkanes

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

- Reduction of use of fossil fuels/burning of wood/charcoal products

- Tree planting

- Scrubbing using alkali

- Green energy / Electric vehicles

- Solar energy

- Reduce N° of greenhouses

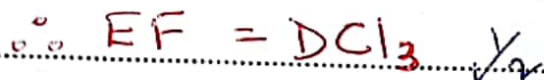
$$\text{Mass of D} = 5.70 - 4.55 = 1.15 \text{ g} \checkmark_2$$

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 $\frac{1.15}{27} = 0.0426$ $\frac{4.55}{35.5} = 0.128 \checkmark_2$

Mole ratio $\frac{0.0426}{0.0426} = 1$ $\frac{0.128}{0.0426} = 3 \checkmark_2$

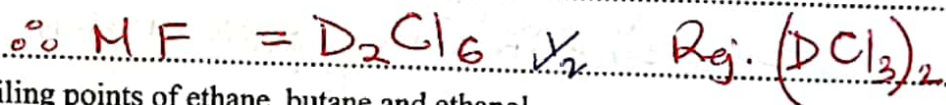


(b) Given that the relative formula mass of the chloride is 267, determine its molecular formula. (1 mark)

$$(DCl_3)_n = 267$$

$$135.5n = 267 \checkmark_2$$

$$n = 2$$



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, $^{\circ}C$	-88.6	-0.5	78.5

Give reasons for the following:

Req. more covalent bonds $\checkmark_1$

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

(1½ marks)

Butane has a higher mass/larger molecules/longer carbon chain, more carbon atoms, hence has stronger van der Waals forces compared to ethane. $\checkmark_2$

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

(1½ marks)

Ethanol has hydrogen bonding, which is stronger than weak van der Waals forces in butane. $\checkmark_2$

Reactivity of the metals with water
 $10 \text{ Ca} >> \text{Mg} > \text{Be}$

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.

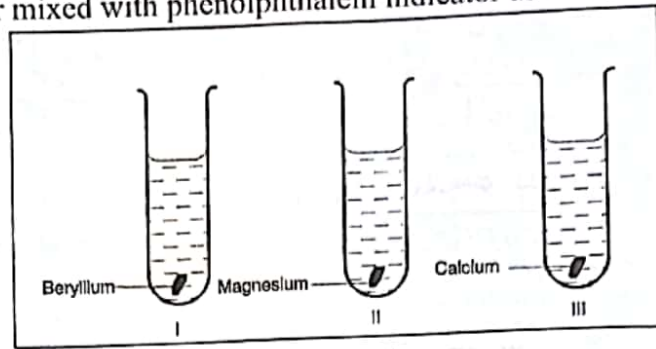


Figure 5

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

$\frac{1}{2}$

Reject: No observable change.

Test tube II;

(1 mark)

Bubbles/Pink colour forms after some time;

Mg reacts slowly with water to form $\text{Mg}(\text{OH})_2$

Test tube III.

(1 mark)

Bubbles/Effervescence/Soln turns pink

Vigorous rxn

19

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

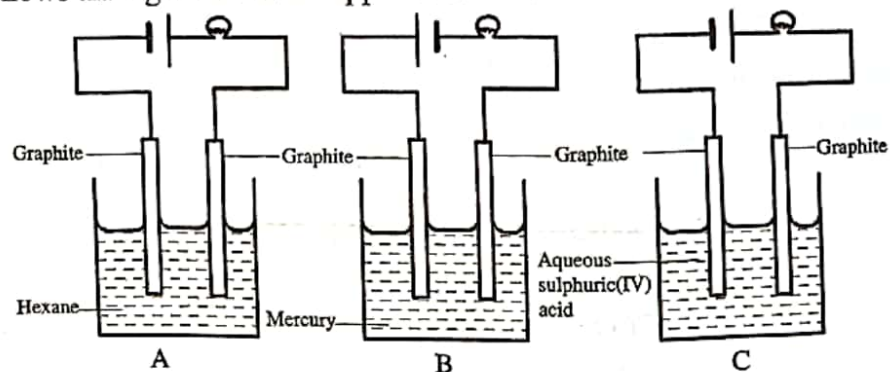


Figure 6

Explain why:

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

(1 mark)

Hexane is a non-conductor has no free ions

Hexane is a non-electrolyte, it is molecular

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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)

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

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

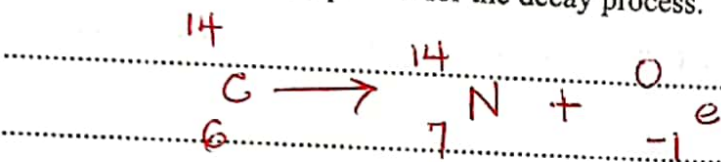
Aq. H_2SO_4 is an electrolyte hence contains ions that conducts an electric current // it decomposes // ions are discharged

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)



- (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)

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)

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

$$\text{Age} = 4 \times 5570$$

$$= 22,280 \text{ years.}$$

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

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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 NaOH in the conical flask, this will increase the titre value.

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

Some water was left in the burette after cleaning. This dilutes the HCl increasing the titre value.

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

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

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

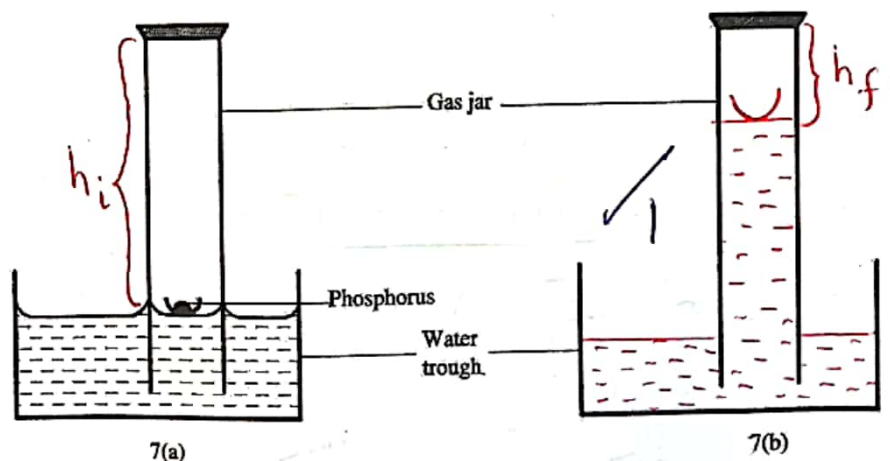


Figure 7

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

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)

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

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

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 (kJ mol^{-1})	Heat energy value kJ g^{-1}
H_2	286.0	$\frac{286}{2} = 143$ ✓
$\text{C}_2\text{H}_5\text{OH}$	1371.0	$\frac{1371}{46} = 29.804$ ✓

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

(i) hydrogen;

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

(ii) ethanol.

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

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.

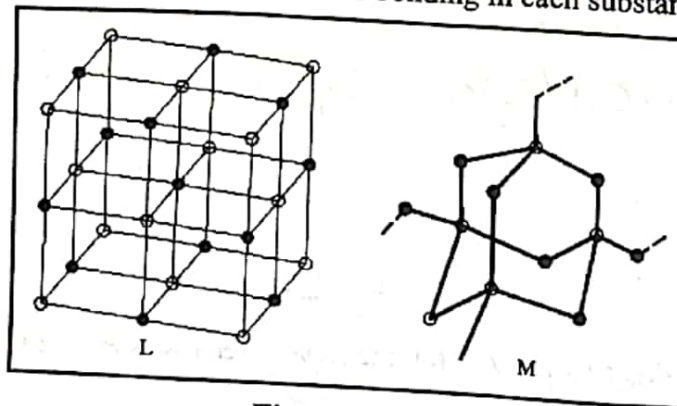


Figure 8

Must used the term (Giant)

Table 4

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

(2 marks)

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



(1 mark)

(a) H_2S

Smell of rotten eggs ✓

(b) N_2O

Sweet odour / Pleasant smell ✓

(c) Cl_2

Green-yellow / Yellow-green gas ✓

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

(i) esterification;

(1 mark)

✓ Alkanoic/carboxylic and Alkanol/Alcohol

(ii) saponification.

(1 mark)

✓ Fat/Oil/Esteric acid/Lipids and KOH/NaOH

Suitable alkali/hydroxide

- (b) State the importance of vulcanisation.

(1 mark)

✓ Hardening of rubber for use in tyre industry / Making rubber stronger

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

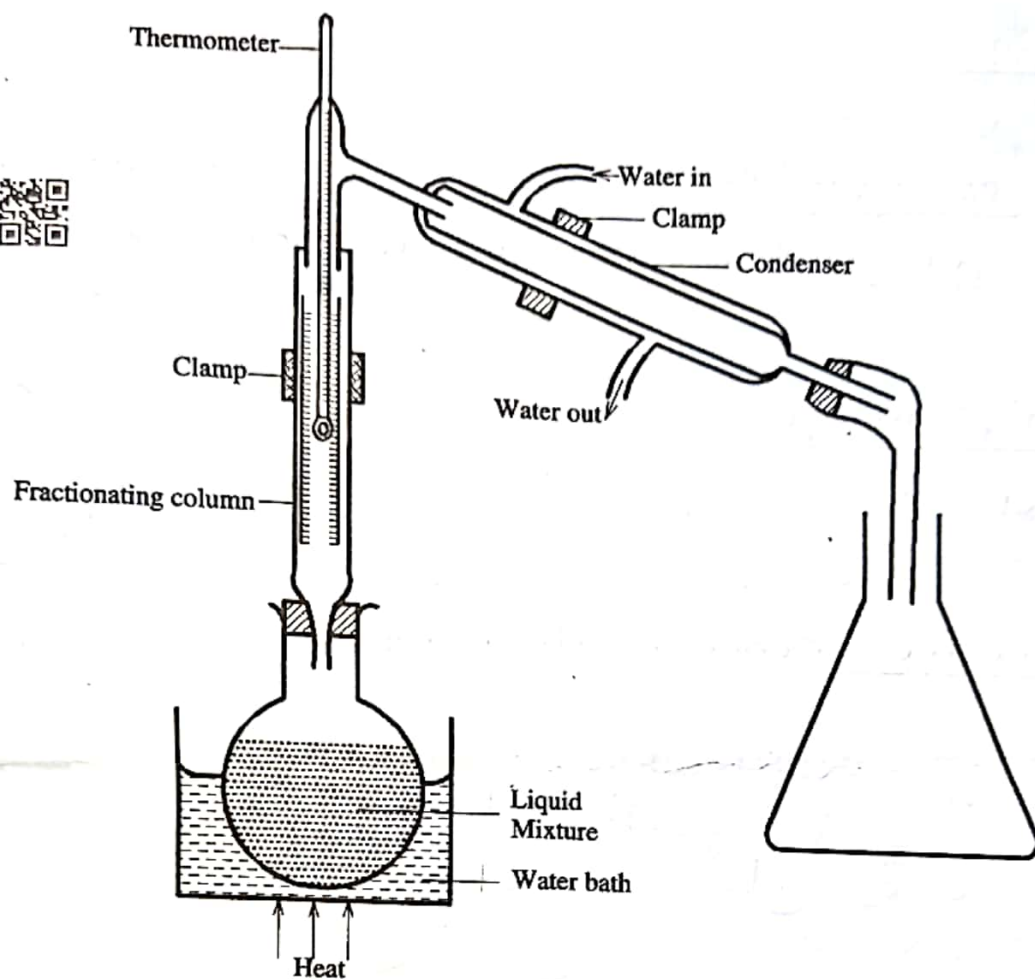


Figure 9

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

Mistake 1

(1 mark)

Thermometer is too far inside the column

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

Mistake 2

$\checkmark_2$
Use of water bath.

(01)

$\checkmark_2$
The liquids have higher b.p than water so they will not boil at 100°C

Mistake 3

(1 mark)

$\checkmark_2$
Water in and water out in condenser is reversed.

(01)

The liquid will not cool sufficiently (No effective condensation) $\checkmark_2$

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Att. 4.

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

02