Name...   Index No....................../..........

School..   Candidates Signature............

                                             Date.......................................

233/2
CHEMISTRY
Paper 2
(THEORY)
September 2021
TIME 2 HOURS

Marking Scheme

JOINT PREMOCK 1
Kenya Certificate of Secondary Education (K.C.S.E)

INSTRUCTIONS TO CANDIDATES

- Write your name, school and index number in the spaces provided above.
- Sign and write date of examination in the spaces provided above.
- Answer **ALL** questions in the spaces provided.
- Mathematical tables and silent electronic calculators may be used.
- All workings **MUST** be clearly shown where necessary.

Questions	Maximum Score	Candidate's Score
1	14	
2	14	
3	11	
4	14	
5	16	
6	11	
TOTAL	80	

This paper consists of 11 printed pages
Candidates should check the question paper to ensure that all the
Papers are printed as indicated and no questions are missing

1. The scheme below shows a series of reactions and compounds. Study it and use it to answer the questions that follow.

propanoic acid *(handwritten)*

C	$\xleftarrow{K_2Cr_2O_7(aq),\ H^+}$	**Propan-1-ol**

Gas A — hydrogen *(handwritten)*

Propan-1-ol $\xrightarrow{\text{Sodium metal}}$ Gas A / B — sodium propoxide *(handwritten)*

Reagent D

Polymer E — polypropene *(handwritten)* $\leftarrow$ **Propene** $\xrightarrow[\text{gas}]{\text{Bromine}}$ **F** — 1,2-dibromopropane *(handwritten)*

Step 1 hydrogenation *(handwritten)*

Propane C_3H_8

cracking

C_2H_4 *(handwritten)*

G $\longleftarrow$ (cracking) $\longrightarrow$ **Methane** — CH_4 *(handwritten)*
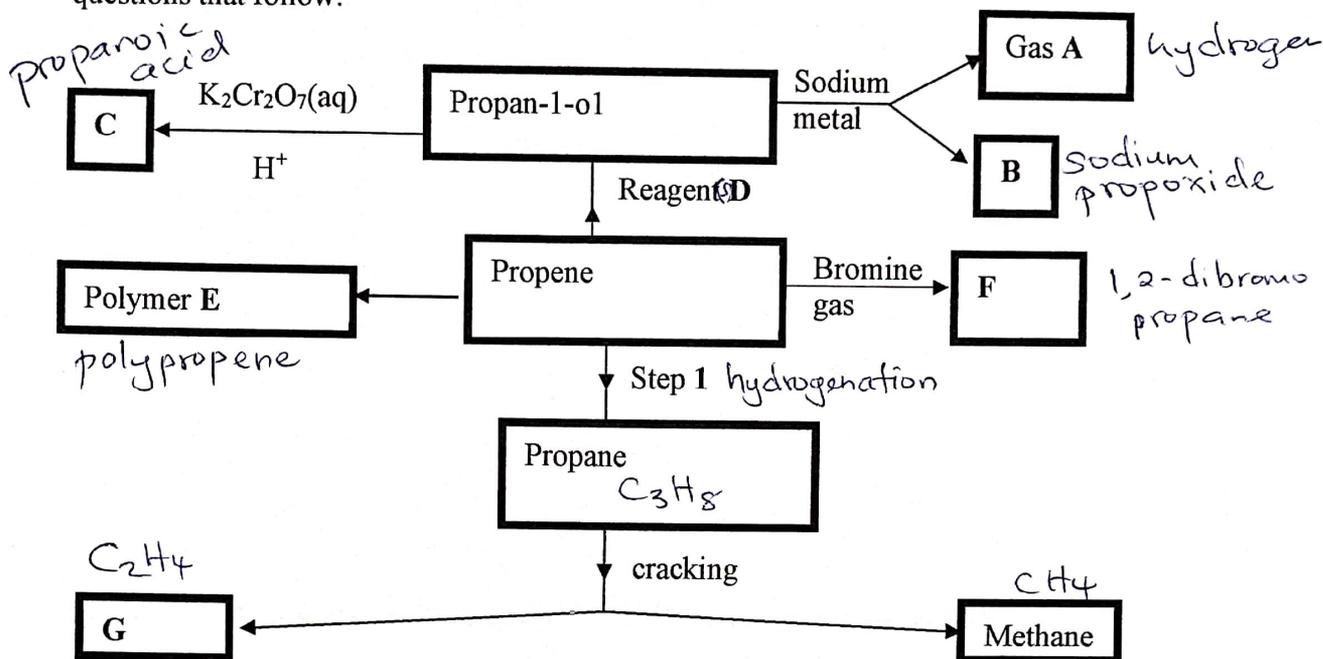
(a) Identify the following compounds and products   (6marks) ✓ ⑥

A.... Hydrogen / H_2 ✓

B.... Sodium propoxide / $CH_3CH_2CH_2ONa$ ✓

C.... Propanoic acid / CH_3CH_2COOH ✓

E.... Polypropene / $\left[\begin{array}{c} -C-C- \\ \end{array}\right]_n$ (with CH_3) ✓

F.... 1,2-dibromopropane / H–C–C–C–H structure / $C_3H_6Br_2$ ✓

G.... ethene / C_2H_4 ✓

(b) State 2 conditions for **step 1** to occur.   (1 mark) ①
   – 150°C – 250°C ✓
   – Nickel / Palladium catalyst Any ✓ ½×2

(c) Write an equation for the formation compound **F.**   (1 mark) ①
   $C_3H_6 + Br_2 \longrightarrow C_3H_6Br_2$ ✓½ ✓½
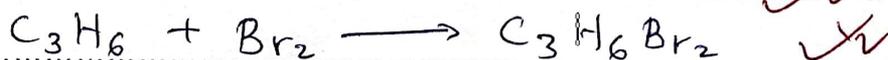
(d) Identify reagent D. *(s)*   (1 mark) ①
   Steam ✓   OR ✓   concentrated H_2SO_4 tied Any
   $H_2O(g)$ and water

9 *(handwritten total)*

(e) State one industrial use of methane. (1 mark)

Used as a fuel ✓ ①

(f) Name the following organic compounds. (3 marks)

(i) C_3H_4

Propyne ✓

(ii) $CH_3CH_2 CH_2 CH CH_2 CH_3$
$|$
OH

Hexan-3-ol ✓ ③

(iii) $CH_2 = C - CH_3$
$|$
CH_3

2-methylprop-2-ene ✓

(g) Draw the structure of a section of polymer E showing three repeat units. (1 mark).

✓ ①
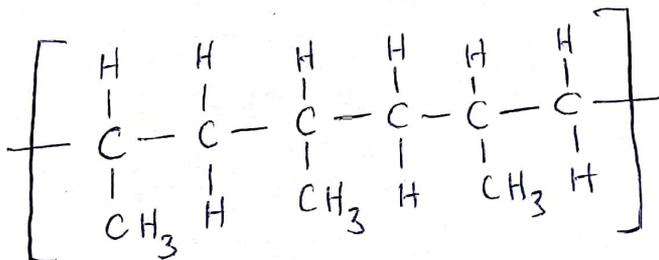
2. The table below shows the elements in period 3 of the periodic table. Study it and answer the questions that follow.

Element	Na	Mg	Al	Si	P	S	Cl	Ar

(a) Write the formulae of two oxides for each of the following: ✓✓ (2 marks) ②

(i) Sodium: Oxide I ... Na_2O ✓ ... Oxide II ... Na_2O_2 ✓
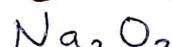
(ii) Sulphur: Oxide I ... SO_2 ✓ ... Oxide II ... SO_3 ✓

(b) The products of the reaction between phosphorus and chlorine depend on the conditions used.

Write the equation for the reaction when phosphorus reacts with limited phosphorus. (1 mark) ① ✓✓

$2P_{(s)} + 3Cl_{2 (g)} \longrightarrow 2PCl_{3 (s)}$ OR $P_{4(s)} + 6Cl_{2 (g)} \longrightarrow 4PCl_{3 (s)}$ Any
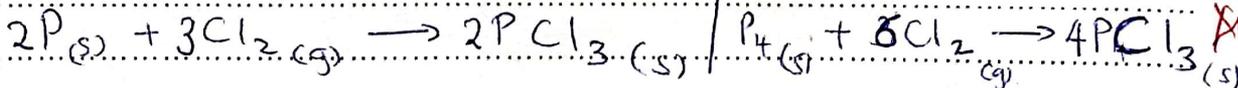
(c) Identify the most electronegative element. Give a reason. (2 marks)

Cl or chlorine ✓

It most readily gains electrons ② ✓

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(d) State and explain the differences in the boiling points of:
      Sulphur
   (i)   Magnesium oxide and ~~silicon~~ (IV) oxide.   (2 marks)

Magnesium oxide has higher boiling point than Sulphur (IV) oxide. Magnesium oxide has strong ionic bonds in a giant ionic structure that requires more energy to break than sulphur (IV) oxide which has weak van der (2 marks) waals forces between molecules.

   (ii)   Sulphur and phosphorus.   (2 marks)

Sulphur has higher boiling point than phosphorus. Sulphur has a larger S_8 molecule hence more intermolecular forces of attraction than (P₄) phosphorus molecules. More energy is required to break the bonds between sulphur molecules than phosphorus molecules.

   (e) The diagram below shows the electrolysis of the chloride of sodium.

Battery

X   Y

molten sodium
chloride

heat
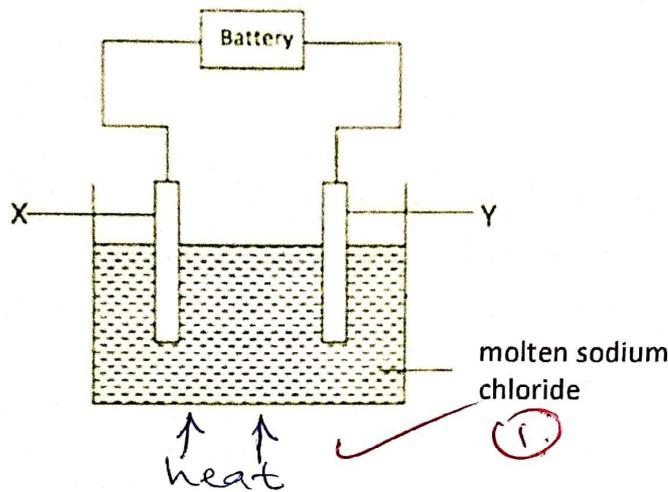
   (a) On the diagram, indicate the missing condition.   (1 mark)

   (b) During the electrolysis, chlorine gas was formed at electrode Y. Identify the:

   (i)   Anode.   Y   (1 mark)

   (ii)   Cathode.   X   (1 mark)

   (c) Write the half equation for the reaction taking place at the:

   (i)   Anode.   (1 mark)

$$2Cl^-_{(l)} \longrightarrow Cl_{2(g)} + 2e^-$$

   (ii)   Cathode.   (1 mark)

$$2Na^+_{(l)} + 2e^- \longrightarrow Na_{(s)}$$
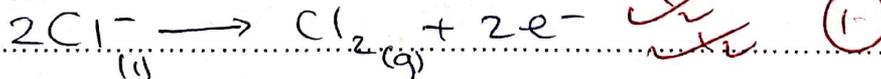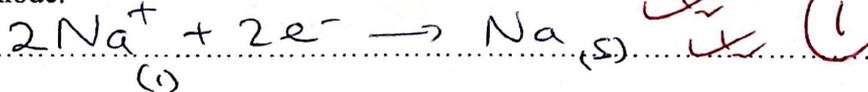
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3. A student set up the apparatus shown below to prepare and collect dry carbon (IV) oxide gas.

Dilute H₂SO₄ acid

Water

Calcium carbonate   Concentrated sulphuric (VI) acid
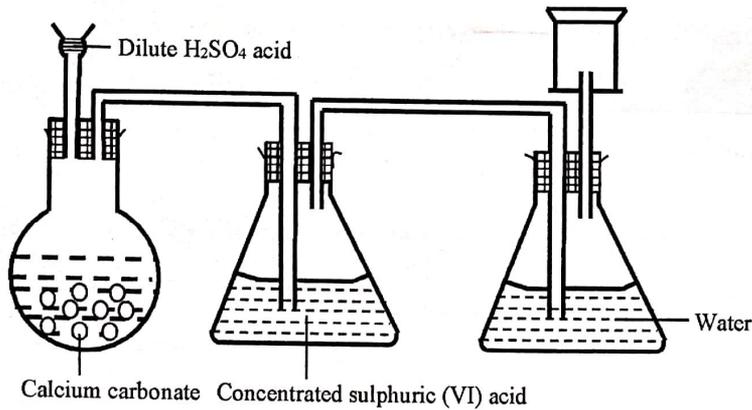
(a) State a correction for three mistakes in the set up above   (3 marks)

(i) Dip the thistle funnel into the solution in the flask

(ii) Remove the conical flask with water. ③

(iii) Collect the gas using downward delivery or upward displacement.

(b) Give two reasons why carbon (IV) oxide is used as a fire extinguisher   (1 mark) ①
- It is denser than air hence covers the fire.
- It does not support combustion extinguishing the fire.

(c) The flow chart below is for the manufacture of sodium carbonate by the Solvay process. Use it to answer the questions that follow.

Brine → Ammoniacal Brine → Tower P Carborector → Filter → NaHCO₃

Gas Q CO₂

Gas M Ammonia

Heating limestone

CaO ← Add water

Chamber K

L CaCl₂

Solution F NH₄Cl

Chamber G Solid X — NaHCO₃

Heat

Na₂CO₃
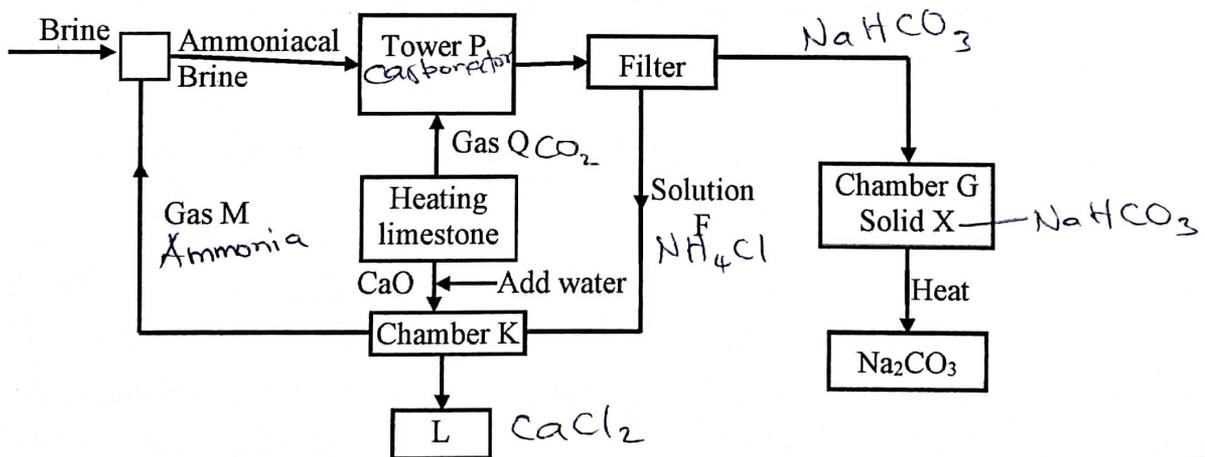
(i)   Name:
       Gas M Ammonia   Gas Q Carbon (IV) oxide   (1 mark) ②
       Solution F Ammonium chloride   Solid X Sodium hydrogen carbonate (1 mark)

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(ii)   Name the product L formed and give one of its uses.   ① (2 marks)

Name: ...... Calcium   chloride ✓ ... ① Any one

Use: - Used in road sur facing ✓ | - Used in extraction of
     - Used in de-icing of roads | sodium from rock salt
                                   by electrolysis.

(iii)   Write equations of the reactions in: (2 marks)

Tower P (Overall equation)   ½ ½ ①

$NaCl_{(aq)} + NH_{3(g)} + H_2O_{(l)} + CO_{2(g)} \longrightarrow NaHCO_{3(s)} + NH_4Cl_{(aq)}$

Chamber K   ½ ①

$2NaHCO_{3(s)} \longrightarrow Na_2CO_{3(s)} + H_2O_{(l)} + CO_{2(g)}$ ½

(v) Name the two raw materials required in the manufacture of sodium carbonate   (1 mark)

- Ammonia ✓   - Limestone ✓   Any two ①
- Brine ✓   - Coke ✓

4.   Study the flow chart below and answer the questions that follow.

(a) Identify:

(i)   Gas C ...... Chlorine / Cl_2 ✓ .... (1½) (½ mark)

(ii)   Solid Q ...... Iron (II) chloride / $FeCl_2$ ✓ .... (½ mark)

(iii) Solid P ...... Iron (III) chloride / $FeCl_3$ ✓ .... (½ mark)

(b) From the flow chart, give two solutions that contain the same metallic ions.   (1 mark)

Solution Q ✓ ½
Solution R ✓   ①

7½

(c) Give two precipitates in the flow chart that are the same and name them. (3 marks)

Precipitates: Green ppt S and green ppt T

Name: Iron (II) hydroxide

(d) Explain the difference between HCl (g) in water and in methylbenzene as shown in the flow chart.

(2 marks)

When HCl (g) dissolves in water it ionises to H^+ and Cl^- where H^+ exhibit acidic properties such as reacting with iron. However, when HCl (g) dissolves in methylbenzene, it does not ionise and does not exhibit acidic properties hence, no reaction with iron metal.

(e) Name reagent W. (½ mark)

Sodium hydroxide solution / Ammonia solution

(f) Write the equations for:

(i) The formation of solid P. (1 mark)

$$2Fe_{(s)} + 3Cl_{2 (g)} \longrightarrow 2FeCl_{3 (g)}$$
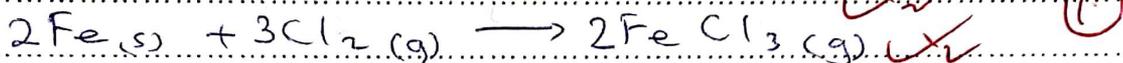
(ii) The formation of solid Q. (1 mark)

$$Fe_{(s)} + 2HCl_{(g)} \longrightarrow FeCl_{2 (g)} + H_{2 (g)}$$

(g) In the preparation of a bleaching agent (sodium hypochlorite), excess chlorine gas was bubbled into 15 litres of cold 2M sodium hydroxide.

(i) Write the equation for the reaction between chlorine gas and cold dilute sodium hydroxide. (1 mark)

$$2NaOH_{(aq)} + Cl_{2 (g)} \longrightarrow NaOCl_{(aq)} + NaCl_{(aq)} + H_2O_{(l)}$$
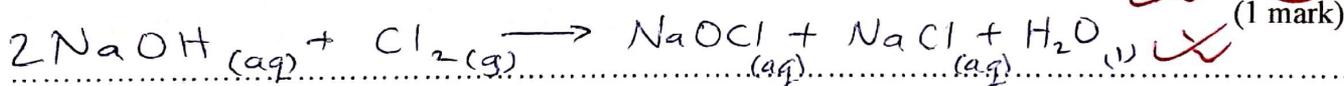
(ii) Calculate the mass in **kilograms** of sodium hypochlorite produced. ($Na = 23.0$, $Cl = 35.5$, $O = 16.0$)

(3 marks)

Moles of NaOH used.

2moles → 1000 cm³
? → 15000 cm³

$\dfrac{15000 \times 2}{1000} = 30$ moles

M.R   NaOH : NaOCl
         2   :   1
      30 moles :   ?

$\dfrac{30 \times 1}{2} = 15$ moles of NaOCl

RFM = 23 + 16 + 35.5 = 74.5

mass = 15 × 74.5 = 1117.5 g

$\dfrac{1117.5}{1000} = 1.1175$ kg

$\left(-\frac{1}{2} \text{ if no units or wrong units}\right)$

5. Study the flow chart below and answer the questions that follow.

```
┌─────────┐   ┌─────────┐              ┌───────────────┐  Frasch Process
│   Air   │   │  Brine  │              │   Process S   │
└─────────┘   └─────────┘              └───────────────┘
 Fractional     Electrolysis                  │
 Process Q      Process P                      ▼
 distillation                          ┌───────────────┐
     │             │                   │    Sulphur    │
     ▼             ▼                   └───────────────┘
┌──────────┐  ┌───────────┐                   │◄──────── Gas D  Oxygen
│ Nitrogen │  │ Hydrogen  │                    ▼
└──────────┘  └───────────┘           ┌──────────────────┐
        Haber                         │ Sulphur (IV) oxide│
      Process R                       └──────────────────┘
       process                         Contact
   ┌──────────┐  NH3                   Process T ◄──── Gas D  Oxygen
   │  Gas A   │                               ▼
   └──────────┘                       ┌──────────────────┐
      (NH4)2SO4                       │ Sulphur (VI) oxide│
┌──────────────┐                      └──────────────────┘
│ Fertilizer B │                               │◄──────── Liquid C  concentrated
└──────────────┘                               ▼                    H2SO4
        ▲                             ┌──────────────────┐
┌──────────────┐                      │      Oleum       │
│ Concentrated │◄─────────────────────└──────────────────┘
│ sulphuric(VI)│        Water
│     acid     │
└──────────────┘
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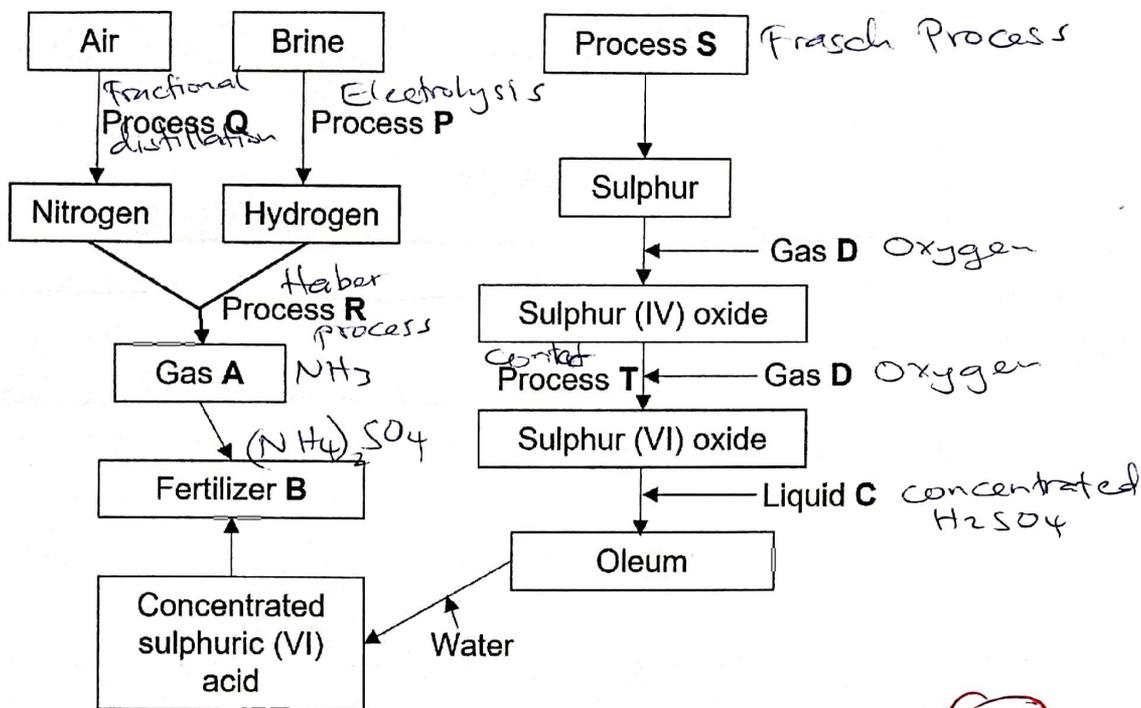
(a) Name the following: ③   (3 marks)

   (i)   Process Q ..... Fractional distillation ✓ ......

   (ii) Process R ..... Haber process ✓ ...... only

   (iii) Process S ..... Frasch process ✓ ...... Name

   (iv) Process T ..... Contact process ✓ ...... reject

   (v)   Gas A ..... Ammonia ✓ ...... formulae

   (vi) Fertilizer B ..... Ammonium sulphate ✓ ......

(b) Why is liquid C used instead of water? ①   (1 mark)

If water is used SO_3 will dissolve producing a lot of heat causing the acid to boil / forming acid fumes that are harmful to factory workers.

(c) Write the formula of oleum.   (1 mark)

   $H_2S_2O_7$ ✓ ①

(d) Write the equation for the formation of:

   (i) fertilizer B.   (1 mark)

   $2NH_{3(g)} + H_2SO_{4(l)} \longrightarrow (NH_4)_2SO_{4(s)}$ ½ ½ ①

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(ii)   gas **A**.   (1 mark)

$$N_2 + 3H_2 \underset{}{\overset{Fe\ catalyst}{\rightleftharpoons}} 2NH_{3\ (g)}$$
$$(g) \qquad (g)$$
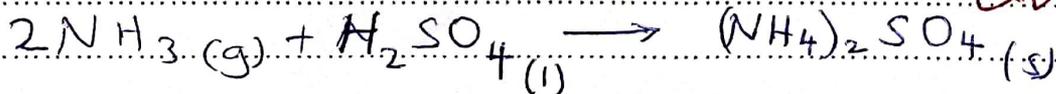
(e) Name the **catalyst** and give the **conditions** for:

   (i) Process **R**.   (3 marks)

Catalyst ...... Finely divided iron ✓

Conditions ...... 400°C – 500°C and 200 – 500 atmospheres

   (ii) Process **T**.   (3 marks)

Catalyst ...... Vanadium (v) oxide / Platinum   Any catalyst

Conditions ...... 450°C and 2 – 3 atmospheres.

(h) Explain how nitrogen is obtained from air using process **Q**.   (3 marks)

Air is passed through electrostatic filters to remove dust.
Dust free air is passed through concentrated sodium hydroxide
to remove carbon(IV)oxide. The air is then cooled to –25°C
to remove water vapour. The remaining part of air is
repeatedly compressed and allowed to expand rapidly to
cool it to –200°C. The liquid air is passed through
a fractional distilation tower where nitrogen is collected
as the first fraction at –196°C.

6. The following is a procedure that was used to obtain the solubility of a salt **Q** in water at 25⁰C. Study it and answer the questions that follow.

Salt **Q** was dissolved in warm distilled water until no more could dissolve. The mixture was then cooled to 25⁰C and allowed to settle. A dry evaporating dish and dry watch glass were weighed. Some of the solution was decanted into the dish, covered with the watch glass, and then weighed.

The solution was evaporated to dryness over a small flame. This residue, the dish and the watch glass were weighed. The residue was then heated repeatedly until a constant mass was obtained. The results below were obtained.

Mass of dish + Watch glass = 50.60g
Mass of solution + dish + watch glass = 80.6g
Mass of residue + dish + watch glass = 62.60g

(a) Use the data to answer the questions that follow.

(i) What is the purpose of the watch glass in such an experiment? ~~Any~~ (1 mark) ①

To prevent loss of solid & spitting out of solid.

(ii) Why should the heating be continued until a constant mass is obtained? (1 mark)

To ensure all water is removed. ✓ ①

(iii) Calculate the mass of the solution. (1 mark) ①

80.6 − 50.6 = 30g ✓

(iv) Calculate the mass of the residue. (1 mark)

62.6 − 50.6 = 12g ① ·1

(v) Calculate the mass of the water. (1 mark)

30 − 12 = 18g OR ~~Any~~ ①
80.6 − 62.6 = 18g

(vi) Calculate the solubility of salt **Q** in g per 100g of water at 25⁰C. ✓ (2 marks)

Solubility = $\frac{12}{18}$ × 100 = 66.67 g/100g of water

② penalise −½ m.k ✓ if units are wrong or missing

Joint Pre-mock 1

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(b) Hard water has both advantages and disadvantages. Give one advantage and one disadvantage of using hard water. (2 marks)

Any one

Advantage
- Provides Calcium ions essential for strengthening bones and teeth
- Good for beer brewing.
- Hard water does not dissolve in lead pipes.

Disadvantage
- Wastes soap
- Stains white clothes ✓   Any one
- Deposition of fur in kettles, pipes and boilers

(c) Using an equation, explain how addition of sodium carbonate is used to remove water hardness. (2 marks)

When sodium carbonate is added, it precipitates out Ca^{2+} and Mg^{2+}

either $Ca^{2+}_{(aq)} + CO^{2-}_{3\,(aq)} \longrightarrow CaCO_{3\,(s)}$

OR

$Mg^{2+}_{(aq)} + CO^{2-}_{3\,(aq)} \longrightarrow MgCO_{3\,(s)}$

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