1. a) Compounds with the same molecular formula but different structural formulae.

b) [Diagrams of different compounds]

(1mk)

2. a) [Diagram of a gas jar]

b) Calibrate the gas jar before the start of experiment (1mk)

3. \[
\frac{\text{Time for SO}_2}{\text{Time for O}_2} = \sqrt[2]{\frac{\text{R.M.M of SO}_2}{\text{R.M.M of SO}_2}}
\]

\[
\text{R.M.M of SO}_2 = 64
\]
\[
\text{R.M.M of SO}_2 = 32
\]

\[
\text{Time for SO}_2 = 50
\]

\[
= \sqrt{\frac{64}{32}}
\]

Time for SO\textsubscript{2} = 70.7 seconds (3marks)

4. a) \[37 + 0 \rightarrow 37\]

\[18^A - 1^c \rightarrow 17^B\]

b) i) Studding rate of absorption of phosphorus from a fertilizer (1mk)
ii) May result to babies with deformities
   May cause cancer (1mk)

5. a) In solid state - Does not conduct
   Ions are fixed (1 ½ mks)
   b) Aquous solution - Conducts
   Ions are mobile (1 ½ mks)

6. a) \[ C_6H_{12}O_6 + 2H_2SO_4(g) + 2H_2O (l) + 2SO_2(g) \] (1mk)
   b) Carbon changes from 0 to +4.. Oxidation has taken place
   Sulphur changes from +6 to +4.. Reduction has occurred (2mks)

7. a) Refrigeration (1mk)
   b) - They deplete the ozone layer.
    - They cause green house effect. (2mks)

8. Mass of water 94.5 – 51.3 = 43.2
   R.M.M. of Ba(OH)\(_2\) = 171
   R.M.M of H\(_2\)O = 18

   \[
   \frac{51.3}{171} = \frac{43.2}{18} = 8
   \]

   \[
   \frac{0.3}{0.3} = 1 \quad \frac{2.4}{0.3} = 8
   \]

9. a) Mass
   - Pale yellow intensifies.
   - Forward reaction is exothermic
   - Lowering temperature shifts the equilibrium to the right. (1 ½ mks)

   b) - Pale yellow intensified
    - Reducing the volume of syringe.
    - Increases the pressure
    - The equilibrium shifts to the rights.

10. a) sublimation (1 mk)
    b) Bleaching. (1mk)
    c) Polymerisation (1mk)

11. a)
    - Acidify water with nitric acid.
    - Add aqueous lead nitrate.
    - Formation of white PPt shows presence of CT

    b) provides essential minerals e.g Ca\(_2\)+ (1mk)

12. \[
62.93 \times 69.09 + 64.93 \times 30.91 = 43.4783 + 20.0698 = 63.548
\] (3mks)
13.  a) It is a drying agent.  
    b) \( \text{Fe(s)} + 2\text{HCl(g)} \rightarrow \text{FeCl}_2(\text{s}) + \text{H}_2(\text{s}) + \text{H}_2\text{(g)} \)  
    c) Picking of metals  
14.  a) \( \text{N}_2\text{O} \)  
    b) \( \text{K}_2\text{O} \)  
    c) \( \text{Al}_2\text{O}_3 \)  
15.  a) \( \text{N} \)  
    b) \( \text{E}_\theta = 0.80 + 0.76 = 1.56 \text{ volts} \)  
16.  a) The solution changed from brown/yellow to light/pale green.  
    b) \( 2\text{FeCl}_3(\text{aq}) + \text{H}_2\text{S(g)} \rightarrow \text{FeCl}_2(\text{aq}) + 2\text{HCl(aq)} + \text{S(s)} \)  
    c) Oxidation.  
17.  a) Platinum  
    b) Platinum- Rhodium  
    c) Fertilizers  
18.  add anhydrous copper(II) Sulphate to substance S. It changes from white to blue.  
    Dip cobalt chloride paper into Substance s. It changes from blue to pink.  
19.  a) To \( \text{M}_3\text{O} \) and excess \( \text{HCl} \) or \( \text{H}_2\text{SO}_4 \). Add \( \text{NaOH} \) or \( \text{KOH} \) to the mixture.  
    Filter and dry the residue.  
20.  a) Covalent bond is formed by equal contribution of the shared electrons by the atoms. Co-ordinate bond is where the shared electrons are contributed by one  
    b) Antacid (treatment of acid indigestion)  
21.  a) They have delocalized valency electrons  
    b) Aluminium has three delocalized electrons. It is resistant to corrosion  
22.  a) Oxalic acid and Conc. \( \text{H}_2\text{SO}_4 \)  
    b) \( 2\text{KOH(aq)} + \text{CO}_2(\text{g}) \rightarrow \text{K}_2\text{CO}_3(\text{aq}) + \text{H}_2\text{O(l)} \)  
    c) CO is odourless. Co is colourless  
23.  In addition to van der waals forces, strong hydrogen bonds exist in ethanol.
These bonds require more energy to break (2mks)

24. a) Acidic Basic
    Orange Pink (1mk)

    b) The pH of 0.1 M KOH is higher than that of 0.1 M aqueous ammonia. KOH is strongly dissociated in solution (1mk)

25. a) $V_1$ and $V_3$ (1mk)
    b) Add petrol to the mixture. Filter. $V_2$ is the residue. Filtrate is $V_4$ (2mks)
        Distill the filtrate.

26. a) They gain energy and move faster. The intermolecular distance increases. (1mk)
    b) XY (1mk)
    c) The energy supplied changes molecules of water from liquid to gaseous state. (1mk)

27. a) Conc. $H_2SO_4$ (1mk)
    b) Heat the solution to concentrate it. Allow for crystals to form. Filter.
    C) Anhydrous copper(II) Sulphate (1mk)

28. a) $\Delta H_1 =$ Lattice energy
    $\Delta H_2 =$ Hydration energy (2mks)
    b) $\Delta H_3 = \Delta H_2$ (1mk)
K.C.S.E 2006 CHEMISTRY PAPER 2 (233/2)
MARKING SCHEME

1. a) A substance that allows the passage of an electric current and is decomposed by it.
   (1mk)

b) i) Molten calcium chloride: Conducts by movement of ions. (1mk)
   ii) Graphite: Conducts by movement of ions. (1mk)

c) i) Syringe. The H⁺ ions migrate to the negatively charged electrode (cathode) where they get discharged to form hydrogen gas. (1mk)
   ii) Heat Change
   
   \[ 25 \times 4.2 \times 18 = 1890 \text{ Joules} \]  

   (2mks)

d) The amount of water used to produce \( \text{O}_2 \) and \( \text{H}_2 \) gases is MORE than that produced at the anode. (2mks)

e) Quantity of electricity 
   \[ 15 \times 0.72 \times 60 = 648 \text{ coulombs} \]

   \[ \frac{4 \text{ OH}^{-} (aq)}{\rightarrow 2\text{H}_2\text{O}(l) + \text{O}_2(g) + 4e^{-}} \]

   Faradays of electricity 
   \[ \frac{648}{96500} = 0.006715 \text{F} \]

   Moles of oxygen produced 
   \[ = 0.006715 \]

   \[ = 0.006175 \]

   Volume of oxygen 
   \[ = 0.001675 \times 24000 \]

   \[ = 40.2888 \text{cm}^3 \]

   \[ = 40.29 \text{ cm}^3 \] (4mks)

2. a) i) The blue colour of solution fades. Brown solid is deposited because the coloured copper ions are discharged to form copper. (3 mks)

   (ii) Heat Change
   
   \[ 25 \times 4.2 \times 18 = 1890 \text{ Joules} \]  

   (2mks)

   (iii) Moles of \( \text{M}_g \) used
   
   \[ \frac{0.15}{24} = 0.00625 \]

   \[ = 1890 \text{ Joules} \]
1 mole = \frac{1890}{0.00625} = -302.4 \text{ Kj mol}^{-1} \quad (2\text{mks})
(iv) $\text{Mg(s)} + \text{Cu}^{2+}(aq)$ → $\text{Mg}^{2+}(aq) + \text{Cu(s)}$ (l) (1mk)

\[ \text{Mg(s)} + \text{Cu}^{2+}(aq) \quad \text{Energy} \quad \text{Mg}^{2+}(aq) + \text{Cu(s)} \]

\[ \text{Reaction co-ordinate} \]

b) Zinc is higher than copper in the reactivity series of zinc is more reactive than copper or zinc will dissolve in the solution leading to weakening of the container or Redox reaction will take place.

(2mks)

3. a) Isotopes are atoms with same atomic number (protons) but different mass numbers while allotropes are different forms/structure of an element in the same physical state.

(2mks)

b) (i) E Atomic radius decrease across a period/E has the highest nuclear attraction/E has the highest no. of protons.

(2mks)

(ii)

(iii) used in Advertising sign Lamps/ Light /fluorescent lamps Weather/metrological/arch welding.

(1mark)

(iv) $2\text{CNO}_3(s)$ → $2\text{CNO}_2(s) + \text{O}_2(g)$
$2\text{NaNO}_3(s)$ (s) → $2\text{NaNO}_2(s) + \text{O}_2(g)$ (1mk)

\[ 2\text{CNO}_3(s) \quad \text{Heat} \quad 2\text{CNO}_2(s) + \text{O}_2(g) \]

\[ 2\text{NaNO}_3(s) \quad \text{Heat} \quad 2\text{NaNO}_2(s) + \text{O}_2(g) \]

\[ \text{Moles of chlorines used} \quad \frac{3}{24} = 0.125 \]

\[ \text{Mass of Cl}_2 \text{ in product formed} = 0.125 \times 71 \times \frac{1}{2} = 8.875 \]

\[ \text{Moles of D} = 0.125 \]

\[ \text{Mass of D} 11.875-8.875 = 3g \]

\[ \text{R.A.M of D} = 24 \]

(3mks)
4. a) i) \[2\text{pbS(s)} + 3\text{O}_2(g) \rightarrow 2\text{PbO(s)} + 2\text{SO}_2(g)\] (1mark)

To avoid poisoning of the catalyst (1mark)

SO$_3$ is absorbed in 98% conc. Sulphuric acid to make Oleum

Or \[\text{SO}_2 + \text{H}_2\text{SO}_4 \rightarrow \text{H}_2\text{SO}_7(l)\] (1 mark)

SO$_2$ and SO$_3$ (1mks)

They form acid rain which corrodes buildings / toxic – kills /causes respiratory problems. (1mks)

To minimize costs (mks)

b) i) Substance Observations

Iron filings - Effervescence starts and stops immediately. - Bubbles of a colourless gas with a pungent smell. - A brown solution is formed (1mk)

Crystal of white sugar - Black spongy solid (1mk)

ii) I Heating is required for conc. H$_2$SO$_4$ to react

Some SO$_2$ is formed / produced (1mk)

II Formation of Carbon by dehydration of sugar. (1mk)

c) (NH$_4$)$_2$SO$_4$ – Ammonium sulphate. (1mks)

2CaSO$_4$ + Ca(H$_2$PO$_4$)$_2$ Calcium super phosphate (1mk)

d) It is insoluble in water hence cannot be washed easily. (1mk)

5. a) Hydrocarbon (1mk)

b) i) Fractional distillation. (1mk)

ii) Fuel solvent / source of H$_2$ gas (1mk)

c) i) \[\text{L} = \text{Calcium cabide, CaC}_2\] (1mk)

ii) Phosphoric acid / aluminium oxide / H$_2$SO$_4$ (1mk)

iii) \[\text{H} – \text{C} \equiv \text{C – H}\] (1mk)

iv) Hydrolysis or hydration or Oxidation (1mk)

iv) I

- Making rain coats.
- Plastic water pipes
- Electrical insulation
- Floor tiles. (1mk)

II Hardening of oils to form fats/ margarine manufacture (1mk)

d) i) \[\text{CH}_3\text{COOH(aq)} + \text{NaOH(aq)} \rightarrow \text{CH}_3\text{CO} – \text{ONa(aq)} + \text{H}_2\text{O(l)}\] (1mk)

ii) HCl is fully dissociated while ethanoic acid dissociates partially \:. Ethanoic acid is weak while HCl is strong (2mks)

6. a) i) Calcium silicate / calcium aluminate (1mk)

ii) Magnetite, Fe$_3$O$_4$

Siderite, FeCO$_3$ / Iron pyrites / iron limonite

Accept both the name and or a correct formula (1mk)

iii) Carbon dioxide, CO$_2$ /Carbon (IV)oxide (1mk)
b) Air reacts with carbon (coke) to form carbon dioxide (CO₂). Carbon dioxide reacts with coke to form carbon monoxide. The carbon monoxide reacts with Fe₂O₃ to form iron. (3mks)

c) To produce calcium oxide which reacts with silica to form slag. (1mk)

d) Cast iron is impure. (1mk)

e) Manufacture of
   - Rails.
   - Drainage pipes
   - Engine blocks / Utensils / Nails / Cutlery / Surgical instruments / Bridges / Cars / Iron sheets etc. (2mk)
7. a) Nitric acid is a strong oxidizing acid. It oxidizes hydrogen gas to water
(1mk)
b) Increase Molecules acquire the necessary activation energy. This increases
the frequency of collisions hence the rate of reaction.(2mk)
c) 

d) i) 360 cm\(^3\) (Correct value read from graph) (1mk)
ii) 40 cm\(^3\) (Correct value read from graph) (1mk)
e) i) Moles of lead = \(\frac{2.07}{2.07}\) 
\[\therefore 1 \text{ mole of lead} = \frac{40}{0.01}\]
\[= 4000 \text{ cm}^3 \] (2mks)
ii) 480 = 48000 cm\(^3\) (2mks)
f) i) Moles of nitric acid = \(\frac{4000}{1000}\)
\[= 4\] (1mk)
ii) Moles of nitrogen dioxide = \(\frac{48000}{24000}\)
\[= 2\] (1mk)
g) \(\text{Pb}_\text{(s)} + 4\text{HNO}_\text{3(aq)} \rightarrow \text{pb(NO}_3)_2\text{(aq)} + 2\text{H}_2\text{O(l)} + 2\text{NO}_2\text{(g)}\)
1. (a) Carbon (IV) oxide
   (b) Blue flame, carbon (II) oxide is burning
2. Mass in 500cm$^3 = 15 \times 1.05 = 15.75g$
   Mass in 100cm$^3 = 15.75 \times 2 = 31.5$
   Molarity $= \frac{315}{60} = 0.103$
3. (a) Group (VIII) elements
   (b) Chlorine molecule is smaller and the strength of vanderwaals forces between molecules of chlorine is weak as compared to iodine.
4. C- unburnt gas  D- Luminous yellow flame
5. The product from nettle plant is acidic aqueous ammonia solution being basic neutralize the acidic product.
6. a) Colour change from green to brown.
   b) $\text{Fe}^{3+} + 3\text{OH}^- \rightarrow \text{Fe(OH)}_3$
5. a) Colour change from green to brown.
   b) $\text{Fe}^{3+} + 3\text{OH}^- \rightarrow \text{Fe(OH)}_3$
7. a)
   ![Diagram](https://www.kenyanexams.com)
   b) $E^0 \text{cell} = E^0 \text{oxidized} = E^0 \text{reduced} = -0.14V - 0.74V = +0.6V$
1. Across the period there is a gradual increase in number of proteins in the nucleus. This increases the force as attracted between the nucleus and the electrons.
2. a) Dilute Nitric acid
   b) Silver metal
   c) oxygen
10. i) $\text{H}_2\text{O}_2(g) \rightarrow \text{H}_2\text{O}_2 \Delta H^\circ_f = -133kjmol^{-1}$
    ii) $\text{H}_2\text{O}(l) \rightarrow \text{H}_2(g) + \text{O}_2(g) \Delta H_f = +188kjmol^{-1}$
    iii) $\text{H}_2\text{O}(l) \rightarrow \text{H}_2\text{O}_2(g) \Delta H_f = +55kjmol^{-1}$
11. It is denser than air.
   It will react calcium oxide since $\text{CO}_2$ is acidic and $\text{CaO}$ is basic.
12. a) The volume of a fixed mass of gas is directly proportional to its temperature in kelvin.
   b) $V_1 = \frac{V_2}{T_1} \times T_2$
\[ T_2 = \frac{291 \times (1.0 \times 10^5) \times 2.8 \times 10^{-2}}{(1.0 \times 10^5) \times 3.5 \times 10^{-2}} \quad 2328 \text{ K} \]

13. (a) (i) Deliquescency  
(ii) Esterification  
(iii) Thermal crucking

14. (a) Nuclear fusion is where two light nuclei combine to give a heavy release of energy while nuclear fusion is where a large nucleus splits into smaller nuclei with the release of enormous amount of energy. 
(b) Wrap with aluminium or lead foil and bury them deep underground

15. (a) The calcium and magnesium compounds in this water can not be decomposed by heating i.e. CaCl\(_2\), CaSO\(_4\), MgSO\(_4\) and MgCl\(_2\)  
(b) Ionic exchange  
Uses sodium carbonate (washing soda)

16. (a) O\(^0\)  
(b) [Zn(OH)\(_4\)]\(^2-\)

17. Butane  
\[ \begin{align*} 
& \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\
& \text{H} \quad \text{C} \quad \text{C} \quad \text{C} \quad \text{C} \\
& \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\
& \text{H} \quad \text{CH}_3 \quad \text{H} \\
\end{align*} \]

Methyl Propane

18. React sodium with water to get sodium hydroxide  
Bubble into this solution excess carbon (iv) oxide to get sodium hydrogen carbonate.

19. (a) Froth Floatation  
(b) ZnCO\(_3\)(g) \(\rightarrow\) ZnO(s) + CO\(_2\)(g)  
(c) Manufacture of dry cells. Zinc casing forms the anode of dry cells

20. (a)

<table>
<thead>
<tr>
<th>Element</th>
<th>C</th>
<th>H</th>
<th>O</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>64</td>
<td>21</td>
<td>13</td>
</tr>
<tr>
<td>Mole</td>
<td>5.4</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>Ratio</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

[E.F. = C\(_4\)H\(_5\)OH]
21. (a) Chlorine ions in Brime are high concentration compared to oxide ions in solutions
(b) Hydrogen gas

22. \( \text{Al}_2(\text{SO}_4)_3 \rightarrow 3\text{SO}_4^{2-} + 2\text{Al}^{3+} \)
Moles \( \text{a}^2 \text{Al}_2(\text{SO}_4)_3 = 6.84 \times 0.02 \)
Moles \( \text{a}^2\text{SO}_4^{2-} = 0.02 \times 3 = 0.06 \)

23. Pentene -1Al is polar. There are two forces, Vanderwaals and hydrogen bonds holding its molecules together. Pentene is non-polar.

24. White flames produced, Ammonia react with chlorine producing hydrogen chloride gas which react with excess ammonia to give ammonium chloride

25. (a) No change in volume since the number of moles of acid is equal in both cases.
(b) It is less dense and does not burn like hydrogen

26. (a) They are both metals and need to lose electrons to be stable
(b) \( \text{RCO}_3(s) \rightarrow \text{RO}(s) + \text{CO}_2(g) \)
(c) \( \text{Q}^3 \)

27.

28. (a) \( \text{Ag}(a) + e^- \rightarrow \text{AG}(s) \)
(b) \( \text{Ce} = 1t = 5.0 \times 3 \times 60 = 54000c \)
Mass of silver deposited

\[
= \frac{108 \times 54000}{96500}
\]
29. (a) Metallic bonding  
(b) Group 1 Each atom contains one electron in its outer most energy level

30. The molecules which were inform of a ring open up to give chained molecules (S₈). This entangles each other reducing the flow of molten sulphur and increases its viscosity
1. (a) The type of flame produced
   - Amount of heat produced
(b) (i) Heat produced = MC\Delta T
   \[ \Delta T = 46.5 = 25 = 21.5 ^\circ C \]
   \[ \Delta H = 450 \times 21.5 = 40635 \text{ Joules} \]
(ii) Moles of ethanol = \( \frac{1.5}{46} = 0.0326 \)
   Molar heat = \( \frac{40635}{0.0326} \)
   = 1246472.392 Joules
(c) \( \text{C}_2\text{H}_5\text{OH} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O} \)
   (aq) (g) (L)
(d) - Heat less by radiation, conduction and convectional current
   - Experimental errors when reading thermometer
2. (a) (i) 2-Methyl – Prop – i – ene
   Pent – I – yne
(b) (i) Change from orange to green
(iii) Effervescence and a colourless gas which burn with a ‘pop’ sound produced
(c) **Step 1**
   **Fermentation:** Glucose solution is mixed with yeast. The enzyme zymase from yeast converts glucose to ethanol
   **Step II**
   **Dehydration:** Ethanol is mixed with concentrated sulphuric acid and heated in presence of \( \text{Al}_2\text{O}_3 \) as a catalyst
(d)
\[
\begin{align*}
\text{H} & \quad \text{H} & \quad \text{O} \\
\text{H} & \quad \text{C} & \quad \text{C} & \quad \text{C} & \quad \text{O} & \quad \text{H} \\
\text{H} & \quad \text{H}
\end{align*}
\]
(ii)
\[
\begin{align*}
\text{H} & \quad \text{O} & \quad \text{H} \\
\text{H} & \quad \text{C} & \quad \text{C} & \quad \text{O} & \quad \text{C} & \quad \text{H} \\
\text{H} & \quad \text{H}
\end{align*}
\]
(e) Produced \( \text{CO}_2 \) which causes global warming
   Produces acidic – compounds which causes acidic rain
3. (a) (i) Effervescence and brown gas produced
   Blue solution formed
(ii) Dilute HCL is not an oxidizing agent
(iii) \( 1 \text{CU(s)} + 4\text{HN}_3(aq) \rightarrow \text{CU(NO}_3(aq) + 2\text{NO}_2(g) + 2\text{H}_2\text{O(l)} \)
   II moles of \( \text{Cu} = \frac{0.5}{63.5} = 0.007874 \)
Moles of HNO\textsubscript{3} = 0.0067874 \times 4 = 0.31496
Volume of HNO\textsubscript{3} = \frac{0.031496 \times 1000}{3} = 10.49\text{cm}^3

(b)
Step 4 - Neutralization
Step 5 – Displacement

(c)
Resistant to corrosion
It is tough, 1 strong metal

4. (a)
(i) Forward reaction is faster than the reverse reaction
(ii) I production will reduce since equilibrium will shift backward so as to raise the pressure.

II No change in amount of methanol since a catalyst will help reaction to come to equilibrium
(iii) I Negative: the reaction is exothermic since it require low temperature to be fast.

II To ensure that the reacting particles posses more activation energy.

(b)
(i) no. of seconds = 2 \times 60 = 120\text{Sec}
Moles of H2O2 decomposed
= 120 \times 6.0 \times 10^{-8} = 7.20 \times 10^{-6}
Concentration of H\textsubscript{2}O\textsubscript{2} may be higher since concentration increases the rate of reaction.

5.

(ii) The ions are not free at 25\textdegree\text{C} since the salt is in solid state but between 801\textdegree\text{C} and 1413\textdegree\text{C} the ions are free since electrostatic forces between the ions is overcome

(b) Ammonia react with water to form ammonia solution
(c) Dative/coordinate bond
(d) Allotropes
(ii) Add salt to methylbenzene, fullerene dissolves. Filter the mixture to remove the residue. Heat the filtrate to make it concentrated cool the solution slowly to get crystals.
(iii) 12n = 720: n = \frac{720}{12} = 60
M.f = C\textsubscript{60}

6. (a)
(i) To the mixture in test tube and fresh prepared iron (II) sulphate solution. Then add concentrated sulphuric acid to form a brown ring.

(ii) RMM of (NH\textsubscript{4})\textsubscript{2}HPO\textsubscript{4} = 132
Percentage of (N) = \(\frac{28 \times 100}{132}\) = 21.212%  
Mass of (N) = \(\frac{21.212 \times 25}{100}\) = 5.303 kg
(ii) 71g/100mm of water
(iii) I a solution which has dissolved a lot of solute till it can dissolve no more
II Mass of solution at 25°C = 100 + 71 = 17g
    Mass in (g) = 1000 x 71 = 41.52g
    171
(c) I Put soil in water in a beaker. To the mixture add a universal indicator compare
    the colour change to the pH chart
II Addition nitrogenic fertilizers which are acidic
7. (a) Carry experiment in a fume cupboard
    Chlorine should not be allowed to escape to the atmosphere
(b) MnO₂ or K₂Cl₂O₇
(c) General chlorine and drive out air which may combine with heat aluminium foil
(d) Aluminium chloride sublimes when heated
(e) (i) 2Al(s) + 3Cl(g) → 2AlCl₃(s)
    Moles of Al = 1.08 = 0.04
    27
    Moles of Cl₂ = 0.04 x 3 = 0.6
    2
    Mass of Cl₂ = 0.06 x 71 = 4.26g
(iii) 3.47 x 100 = 81.45%
    4.26
(f) Pass the vapor of phosphorous trichloride through a lie big condenser to condense it.
CHEMISTRY PAPER 1
MARKING SCHEME 2008 K.C.S.E EXAMINATIONS

1. Crystal dissolves
Purple colour spreads in the water
The crystal break into smaller particles of potassium manganate (VII) which moves in all directions.
Crystals dissolves through diffusion
Purple colour of Km spread uniformly throughout the water KmNO4 diffused from the area of high con.

2. Mass of hydrated salt = (33.111 – 30.296) = 2.815g
Mass of anhydrous salt = 32.781 – 30.296) = 2.485g
E.F = CaSO₄ 33.111g
32.781g = 0.330
Mass of water = (2.815 – 2.485) = 0.330g
Accept any correct method
CaSO₄ x H₂O
Mass 2.485 0.320
Moles 2.485 = 0.0183 0.330/18 = 0.0183
Ration 0.0183/0.0183 = 0.0183/0.0183

Or; CaSO₄. XH₂O → CaSO₄ + XH₂O

2.815g = 2.485g
CaSO₄ x H₂O 136
Y= 2.815 x 136 = 154
2.485
CaSO₄ x H₂O= 154
136 + 18x = 154
18x = 154 – 136 = 18
X= 18/18 = 1

3. | No | Gas | Test | Observation |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Chlorine</td>
<td></td>
<td>The red litmus paper turn white/ the litmus paper bleached</td>
</tr>
<tr>
<td>II</td>
<td>Acidified must be the</td>
<td>Put a filter paper dipped in acidified potassium dichro (VI) into the gas</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td></td>
<td></td>
<td>The bromine water is decolorized</td>
</tr>
</tbody>
</table>
4. (a) \(\text{C}_{13}\text{H}_{27}\text{COONa}^+\)  Regardless of charges i.e. \(\text{C}_{13}\text{H}_{27}\text{COONa}\)
(b) Soapy detergent/ soaps
(c) \((\text{C}_{13}\text{H}_{27}\text{COO}^-)_2 \text{Ca}\) or \((\text{C}_{13}\text{H}_{27}\text{COO}^-)_2 \text{Mg}^{2+}\)

5. RFM of \(\text{Ca}_3(\text{PO}_4)_2\)
   \[\text{Ca}=40 \times 3 = 120\]
   \[\text{P} = 31 \times 2 = 62\]
   \[\text{O} = 16 \times 8 = 128\]
   \[\text{H}_3\text{PO}_4\]
   \[\text{H}=1 \times 3 = 3\]
   \[\text{P} = 31 \times 1 = 31\]
   \[\text{O} = 16 \times 4 = 64/98\]
   1 mole \(\text{Co}_3(\text{PO}_4)2\) gives moles of \(\text{H}_3\text{PO}_4\)
   \[155 \times 100 \text{g} \text{Co}_3(\text{PO}_4)2 \text{gives} \frac{2.98 \times 155 \times 100}{310} = 98000 \text{g}\]
   \[= 98 \text{kg}\]

6. Propanol  Propan - 1 - ol
Butanoic acid
Are elements with the same atomic number but different masses
Are different elements with the same atomic no but different masses

7. (a) Atoms of the same element having different masses or atoms of the
Same element having different number of neutrons.
(b) 18-8 = 10 neutrons

8. (a) A black solid
(b) \(\text{FeS (s)} + 2 \text{HCl (aq)} \rightarrow \text{FeCL}_2 (\text{aq}) + \text{H}_2\text{S} (\text{g})\)
(c) The powder has a larger surface area than the iron fillings hence the
Reaction is faster

9. \(\text{Zn(s)} + \text{H}_2\text{SO}_4 (\text{aq}) \rightarrow \text{ZnSO}_4(\text{aq}) + \text{H}_2(\text{g})\)
   \(\text{Zn(s)} + 2\text{H}_2\text{SO}_4 (\text{l}) \rightarrow \text{ZnSO}_4(\text{aq}) + \text{SO}_2 (\text{g}) + 2\text{H}_2\text{O(l)}\)

10. Magnesium burns in air to form \(\text{Mgo}\) and \(\text{Mg}_3\text{N}_2\), \(\text{Mg}_2\text{N}_2\) reacts with water to
Liberate ammonia gas
   \(\text{Mg}_3\text{N}_2(\text{s}) + 6 \text{H}_2\text{O (l)} \rightarrow 2\text{NH}_3 (\text{g}) + \text{Mg (OH)}_2(\text{ag})\)

11. (a) Ionic/ electrovalent
(b) Has 7 electrons in its outermost energy level and hence easily gains an
electron to complete the octet or it is most electronegative.

12. (a) Oxygen; \(\text{O}_2\)
(b) The Ph decreases
   \(\text{HoCL}\) decomposes to give more \(\text{HCL}\) in the mixture
   \(2 \text{HOCL (ag)} \rightarrow 2 \text{HCL (ag)} + \text{O}_2 (\text{g})\)
13. Pass product ever anhydrous copper (II) sulphate (I) which turns from white to blue (I) turns to blue or anhydrous copper (II) sulphate or use Cobalt Chloride (anhydrous which turns from blue to pink.

14. (a) A (I)
(b) A₁ (l) using baseline

15. J- the solubility of the substance decreases with increase with temperature it dissolves more in cold water than in hot water.

16. Heat the metal in air to form the oxide CUO
Add excess dilute HCL to the oxide to get CUCL₂
Concentrate the filtrate and leave to crystallize Filter and dry the crystals at room temperature between pieces of filter paper Add excess Cu to nitric acid (dilute concentrate) K₂CO₃/ NH₄ ( CO₃) Filter to remove unreacted copper. Add Na₂CO₃ to the filtrate to pp CuCO₃ filter and add dilute HCL to residue to obtain CUCL₂
Add nitric to obtain Cu (No3)₂. Filter to remove excess CU. Add NaOH

17. (a) Amphoteric
(b) Lead (II), Zinc and Aluminium (any two)

18. (a) Position for silicon
(b) U
(c) Q(s) + T₂ (g) → QT₂(s)

Mg(s) + CL₂ (g) →MgCl₂(s)

19. (a) Zn(s) / Zn²⁺(aq) // Ag⁺ / Ag (s)
Zn/Zn²⁺ // Ag⁺/Ag(s)
(b) The solution changes to blue because Cu metal is corroded dissolves to form Cu
(c) Metal silver is deposited on the sides of beaker BCO3 silver is deposited on the sides of beaker
Cu(s) + Ag⁺(aq) → Cu₂(aq) + 2 Ag(s)

20. (a) At constant temperature and pressure, the rate of diffusion of a gas is inversely proportional to the square root of its density.

\[ \frac{RW}{RX} = \sqrt{\frac{RMMX}{MMWE}} \]

\[ \frac{12.0}{4} = \frac{44}{4} \]

\[ 12.0 \times 4 = 48 \]

\[ RX \]

\[ = 6.63 \]

=7.24 cm

21. a) Cu²⁺ moving towards the cathode
b) \( 4OH⁻(aq) - 4 \text{e}^- \rightarrow 2 \text{H}_2\text{O(l)} + \text{O}_2(g) \)
\( 4OH⁻(aq) \rightarrow 2 \text{H}_2\text{O(l)} + \text{O}_2 (g) + 4\text{e}^- \)
22. **Diagram (check)**

![Diagram](image)

23. The brown colour of the mixture intensifies / increases and the green colour of the mixture fades/ decreases or the yellow deposit/ sulphur decreases Iron (II) is converted to Fe$^{3+}$
Sulphur is converted to H$_2$S OR Equilibrium shift to the left.

24. (a) 4 He $\rightarrow$ reject $\rightarrow$ He, $\rightarrow$ \underline{He}$^+$

(b) (i) $Z_1 = 235 \quad Z_2 = 54$

(ii) Nuclear fission
Accept fission

25. (a) Cooling
(b) Latent heat of fusion

26. (a) I $\underline{\text{Pb}}^{2+}$
II $\underline{\text{Co}}^{3-}$
(b) PbO(s) + 2H$^+(aq) \rightarrow \underline{\text{Pb}}^{2+}(aq) + \text{H}_2\text{O}(l)$

27. (a) Mg (OH)$_2$(aq) + 2 HCL (aq) $\rightarrow$ Mg Cl$_2$ (aq) + H$_2$O(l)
Mole ration (1:2)
No of moles of acid = $0.1 \times 23 = 0.0023$
\[\text{1000} \times 0.0023 = 0.00115 \]
No of moles of Mg (OH)$_2 = \frac{1}{2} \times \frac{1}{2} \times 23 \times 0.00115 = 0.00115$
Mass of Mg (OH)$_2$ in antacid $= 0.00115 \times 58 = 0.067g$

(b) % of Mg (OH)$_2$ in anti- acid
\[\text{Mg (OH)}_2 = \frac{0.67 \times 100}{0.50} = 13.34\%\]
28. (a) (i) Cryolite  
   (ii) Electrolysis  
(b) Good conductor does not rust  
   Malleable  
   Light  
   High m.p  
   Does not corrode easily

29. (a) Gas syringe/ graduated gas cylinder/ measuring cylinder

(b) (i) 

(ii) The molecules of the reactants have higher energy marking points  
    The reaction is faster/ are more effective collusions

30. It burns to form SO2SO3 which is a pollutant  
    Accept any other effect e.g. – Acid rain  
    - Corrosion of buildings  
    - Irritation of respiratory systems  
    - Yellowing of leaves of plants

31. (a) Neutralization
(b) (i) Calcium hydrogen carbonate
(ii) Drying agent  
    Extraction of sodium metal
2008 K.C.S.E CHEMISTRY PAPER 2 (THEORY)
MARKING SCHEME

1. (a) (i) Contain methane which is a fuel/ methane can burn/ flammable
(ii) Pass a weigh a known volume of biogas (VI) through dissolved NaOH or KOH/ Ca (OH)\_2 CO\_2 will be observed
Or CH\_4 will not be absorbed – measure volume (v\_2)
CH\_4 \[
\text{Volume methane} \times 100 \\
\text{Volume of biogas}
\]

(b) (i) Mass = KH\_4 = \frac{35.2 \times 1000}{1000} = 1.76 \text{ kg}
No. of moles methane = \frac{35.2 \times 5 \times 1000}{100 \times 16}
Mass kg = 1.76 \times 1000
= 1760 \text{ g}
Molar of methane = \frac{1760}{16} \text{ = 110 moles}

(ii) CH\_4 + 2O\_2 \rightarrow CO\_2 + H\_2O
110 \times 24 = 2,640

(c) (i) Global warning
(ii) I Ammonium nitrate
II Aerosols, Propellant, Freons

2. (a) (i) 2 KNO\_3(l) \text{ heat } 2\text{KNO}_2(l) + 0\_2(g)

(ii) 2 AgNO\_3(s) \text{ heat } 2 \text{Ag(s)} + 2\text{NO}_2(g) + O\_2(g)

(b) (i) Period 2, two energy levels
(ii) A\_2 has greater atomic number than A\_1
A\_2 has greater nucleus charge than A\_1
A\_2 has more protons than A\_1
Therefore
I Across the period from left to right nuclear charge, exert greater pull on Electrons hence reduction in size.
II A\_4 gains electrons, incoming electron is repelled by existing electrons, electrons cloud increases.

(iii) A\_2

(iv) \[
\begin{array}{c}
\cdot \\
A\_1
\end{array} + \left[ \begin{array}{c}
xx \\
x \\
A\_4 \\
xx
\end{array} \right]
\]
3. (a) - Filter the air/ electrostatic precipitation/ Purify the air
- Pass air through NaOH in KOH to remove CO$_2$
- Cool to remove to remove water vapour
- Cool the remaining gases from a liquid air
- Perform fractural distillation of liquid air
- Nitrogen is collected at $-196^0$ C

(b) (i) Nitrogen II Oxide (NO)
(ii) $4\cdot 3$NH$_3$ (g) + 3 CUO $\rightarrow$2N$_2$ (g) + 3H$_2$O(l) + 3 Cu
Oxidation no of N in ammonia increases from -3 to 0
Oxidation number of reducing agent increases
Oxidation number Cu decreases from + 2 to O hence an oxidizing agent
Ammonia is a reducing agent
(iii) NH$_4$NO$_3$(s) or (aq) $\rightarrow$N$_2$O(g) + 2H$_2$O(g or l)
(iv) Fertilizer/explosive

(c) (i) G or G$^{2+}$
(ii) E$^{2+}$(ag) + 2OH$_{(ag)}$ $\rightarrow$ E (OH)$_2$(s)

4. (a) (i) When change is made to a system in equilibrium the
System moves so as to oppose the change.
(ii) Pressure has no effect to equilibrium
The moles/Volume/ molecules of gases is reactants and product are equal
(iii) DH $-$ve (negative)
Since lowering of temperature moves to equilibrium to direction
which heat is produced. Decrease in temperature favours
exothermic reaction

(b) (i) Manganese IV oxide
Drawing tangent at any time above 24 sec/ between 24th sec and 40 sec, correct use of tangent to calculate rate.

Or

Average rate after 24th sec = value of \( \text{O}_2 \) at 24 sec

Time at which the graph levels

5. (a)

\[
\begin{align*}
\text{H} & \\
\text{H} - \text{C} &= \text{C} - \text{H} & \text{CHCCH}_3 \\
\text{H} &
\end{align*}
\]

(b) (i) Heat temperature \( \geq 400k \)
Catalyst temperature \( \geq 700k \)

(ii) Ethane, \( \text{CH}_3\text{CH}_3, \text{C}_2\text{H}_6 \)
(iii) I Pollutes environment / produces poisonous gases when burnt.

II Hydrolysis - Hydrogen
   - Oxidation
   - Addition

III Ethyl propenoeate
   CH₃CH₂C-O-CH₂CH₃ C₅H₁₀O₂

(iv) Calculations of empirical formula mass = 28
     \[
     \frac{16800}{28} = 600
     \]

(c) (i) M or C₃H₆
      M is unsaturated / M is an alkene/ carbon dioxide bond

(ii) N is an acidic compound/ alkanoic acid

6. (a) (i) OH⁻ migrate to anode, OH⁻ discharged to form oxygen or equation
     \[
     4OH^-(ag) \rightarrow 2 H_2O (l) + O_2 (g) + 4e^-
     \]
     OH oxidized to produce oxygen gas.

(ii) Copper anode would dissolve to give Cu^{2+}
     Oxidation of copper in pure energetically favorable than oxidation hydroxide ions

(b) (i) Copper pyrite
      Malasclite
      Cuprite
      Chalco Pyrite

(ii) \[
Cu^{2+}(ag) + 2e^- \rightarrow Cu(s)
\]

(iii) Q= IT
     \[
     0.5 \times 18 \times 16 = 540c
     0.5 \times 18 \times 60 = 540c
     108 \times 540 = 540000
     \]
     \[
     \frac{96500}{540} = 0005596
     \]
     \[
     0.005596 \times 108 = 0.60g
     \]

(iv) Prevent corrosion
     Decoration/ improve appearance
     Prevent turning of metals
7. (a) The heat change when mole of substance is formed from its constituent elements.

(b) (i) Heat of combustion of hydrogen
Heat of formation of water stream

(ii) \[ \text{C}_2\text{H}_6(g) + \text{O}_2(g) \rightarrow \text{2CO}_2(g) + 3\text{H}_2(l) \]
\[ \Delta = -1560 \text{ KJ/mol} \]

(iii) \[ 2\text{CO}_2 + \text{N}_3\text{H}_2\text{O}(l) \rightarrow \text{C}_2\text{H}_1(g) + \frac{7}{2} \text{O}_2 \Delta H = 1560 \text{ kj/mol} \]
\[ 2\text{C}(s) + 2\text{O}_2(g) \rightarrow 2\text{CO}_2 - 788\text{KJ} \quad \text{Multiply equation by 2} \]
\[ 3\text{H}_2 + \frac{3}{2} \text{O}_2 \rightarrow 3 \text{H}_2\text{O}(g) = 858 \text{ KJ} \]
\[ 2\text{C}(s) + 3\text{H}_2 \rightarrow \text{C}_2\text{H}_6(g) - 86 \text{ KJ/mol} \]

(iv) Heat produced = \( \frac{500 \times 21.5 \times 4.3}{1000} \)
\[ = 45.15 \text{ KJ} \]

II Moles of ethane = \( \frac{45.15}{1560} \)
\[ = 0.02894 \times 39 \]
\[ = 0.868 \]
K.C.S.E

CHEMISTRY P1 2009

1. (a) Energy required to remove 1 mole of electrons from 1 mole of gaseous atoms

(b) B (1) 418???

It loses electrons most readily (l)

Reject lowest i.e. Mg (HCO₃)₂ →MgC₅O₃ + H₂O + CO₂ (g)

2. (a) Ca (HCO₃)₂ →CaCO₃(S) + H₂O(l) + CO₂ (g)

(b) Sodium carbonate (l) Soda ash/ washing soda

Calcium hydroxide (l) / Lime water + Ammonia Sol;

Sol; Sodium per mutito/ Sodium Duminium Silicate.

3. (i) 2.8.8

(ii) 2.8.2

4. (a) Water (l)

(b) The second / other product of burning candle is carbon (IV) oxide (l). It can be prevented from getting into the environment by passing it though a hydroxide solution/ alkaline solution e.g. K.O.H NaOH or aqueous ammonia (l).

To form K₂CO₃

5. Oxygen exists as diatomic molecules (½) / Simple Molecular

The forces of attraction between the molecules are very weak (½) therefore less energy is required to separate them. (½)
Atoms are sodium are held by strong metallic bonds (l). These require a lot of energy to break them \( \left( \frac{1}{2} \right) \)

6. 60

30\(^{\text{E+21}}\) wrong/ correct change \( \left( - \frac{1}{2} \right) \)

7. (a) Al\(^{3+}\) + (l) + 3e\(^-\) → AL (s) (l)

(b) 27 g require 3 faradays (l)

\[
1800 \times 1000 \text{g requires } 3 \times 1800 \times 1000 \\
= 2 \times 10^5 \text{ Faradays } \left( \frac{1}{2} \right) = 200,000 \text{ F} \quad (3 \text{ mks})
\]

8.

9. (a) Heat change when one mole of a solute dissolve in excess of the solvent (l)

(i) \( \Delta H_1 = +733 \text{ kJ Mol}\) -1 Until no further \( \Delta \) in temperature

\( \Delta H_2 = 406 \text{ kJ mol}\) -1 / Infinitely dilute solution

\( \Delta H_3 = 335 \text{ kJ mol}\) -1

(ii) Molar heat of solution

Must be correct \( (733 - (+406 + 335) = 733 - 406 - 335) \)
10. At anode \(40H (aq) \rightarrow 2H_2O (l) + O_2 (g) + 4e^-\)

At cathode \(2H^+ (aq) + 2e^- \rightarrow H_2 (g) / 4N^+ (aq) + 4e^- \rightarrow 2 Hg\)

Or \(4OH^- (aq) + 4 H(aq) \rightarrow 2 H_2O(l) + O_2 (g) + 2 H_2(g) (l)\)

11. To \(50 \text{ cm}^3\) of \(2.8 \text{ M NaOH}\), add \(25 \text{ cm}^3\) of \(2.8 \text{ M H}_2\text{SO}_4\) or \(50 \text{ cm}^3\) of \(1.4 \text{ M}\)

- Heat mixture to concentrate (½)
- Cool it for crystals to form (½)
- Filter and dry the residue (3 mks)

12.

13. Moles of oxygen = 0.83 = 0.026 (½) / 0.0259375

Moles of \(\text{NaNO}_3\) = \(2 \times 0.026 / 0.051875\)

\(0.05 (½) / 0.051875\)

R. M. M \(\text{NaCO}_3 = 85 (½)\)

\[
\text{Mass of } \text{NaNO}_3 = \text{converted } 0.052 \times 85 / 4.4094 (½)
\]

\[
\begin{align*}
4.41 \\
8.53 \\
51.693\%5
\end{align*}
\]
14. (a) \[
\begin{array}{c}
\text{H} \\
\text{Br (l)} \\
\text{H}
\end{array}
\]
\[ \text{Bromoethane (l) / 1 bromoethane} \quad (2 \text{ mks}) \]

(b) \[
\begin{array}{c}
\text{H} \\
\text{–} \\
\text{C-} \\
\text{C=–C} \\
\text{–} \\
\text{H (½)}
\end{array}
\]
\[ (1 \text{ mk}) \]

(c) \[
\begin{array}{c}
\text{H} \\
\text{–} \\
\text{C} \\
\text{≡} \\
\text{C} \\
\text{–} \\
\text{C-} \\
\text{–} \\
\text{H}
\end{array}
\]
\[ (1 \text{ mk}) \]

15. (a) The gas burns with a blue flame \[ (1) \]

(b) (i) The iron is less reactive than magnesium \[ (1) \]

(ii) Heat the iron powder \[ (1) \quad (3 \text{ mks}) \]

16. (a) To be read from graph \[ (x) = \frac{79 \text{ g}}{100 \text{ g water}} + \frac{1 \text{ g}}{100 \text{ g H}_2\text{O}} \]

\[ (77, 78, 79) \]

(b) R.F.M of KNO\textsubscript{3} = 101

\[
\text{Molar concentration} = \frac{79 \frac{1}{2} \times \frac{1000}{101}}{\frac{100}{100}} = 7.82 \text{ m} \]

17. 10 electrons \[ (l) \]

3 single bonds constitutes 6 electrons – There are 5 covalent bonds
Double bond – 4 electrons (l) – 3 single bonds 1 double bond

18. Bottle Correct label
   1 Sodium chloride
   2 Sugar
   3 Sodium carbonate (3 mks)

19. (a) Catalyst (l) or words to that effect
    (b) Add bromine water or acidified potassium magnate (VII) (1) if they
decolorize (½) then gas is either an alkene or an alkynes (½) (3 mks)

20. (a) Chemical change
    (b) Physical change
    (c) Chemical change

21. Magnesium phosphate (reject formula)

22. Tests 2 (½) and 3 (½) for test 2 iron is above hydrogen in the reactivity series
    hence it displaces hydrogen (i) for test 3. Dilute sulphuric acid is not an
    oxidizing agent (1).

23. (a) Pale green solution turns yellow (i)
    (b) Sodium hydroxide (l) Potassium hydroxide
    (c) Water (l)

24. (a) S\textsubscript{1}H\textsubscript{4} it has a higher boiling point (l)
    (b) No hydrogen bonding in CH\textsubscript{4} and S\textsubscript{1}H\textsubscript{4} (l) while the hydrogen bond in H\textsubscript{2}O is
    stronger than that in H\textsubscript{2}S\textsubscript{1} (l)

25. (a) Colourless solution becomes brown/black
L₂ (aq)/S

(b) Blue PPt dissolving to form a deep blue solution (l) Cu(NH₃)₄²⁺ (3 mks)

26. (a) Temperature and pressure are directly proportional (l) IR words towards that of eal

(b) With increase in temperature, the gas particles gain more Kinetic energy (l) They move faster and collide with the walls of the container more frequently hence increasing pressure.

27. The amount of hydrogen would reduce (l) increase in pressure shifts the reaction to the side with fewer molecules or Equation shifts to the left.

Less Volume

28. (a) Energy of the activated energy (l) Therefore more molecules will take part in effective collision. (3 mks)

₂H ᴡ H  O  O

29. (a) |   |   |   |

N—(CH₂)₆—N—C—(CH₂)—Cₙ

(b) Making synthetic fibres such as for

- Ropes
- Blouses
- Stockings
- Undergarments
- Trousers

30. (a) Crush the roses with a suitable solvent (½) Filter/ decant/ Scape wilt, droper to obtain pigment/ e.g. ethanol – Methanol – Propanus - Aocome
(b) Add pigment to an acid or base

It shows different colours in each
K.C.S.E 2009 CHEMISTRY PAPER 2 MARKING SCHEME

1. (a) (i) \( \text{MnO}_2 + 4\text{HCl (aq)} \rightarrow \text{MnCl}_2 (aq) + \text{Cl}_2 (g) + 2\text{H}_2\text{O(g)} \)

(ii) \( \text{KMnO}_4 / \text{CaOCl}_2 (aq) / \text{PbO}_2 \)

(iii) Passing it through a U-tube containing dehydration calcium chloride (CaCl)<sub>2</sub>

- Passing Chlorine gas through concentrated sulphuric acid in a flask.

(b) (i) Aluminium chloride – AlCl<sub>3</sub>

(ii) \( 2\text{Al(s)} + 3 \text{Cl}_2 (g) \rightarrow 2 \text{AlCl}_3(g) \)

(iii) Moles of Al metal used = \( \frac{0.84}{27} \)

= 0.0311

Moles of Cl<sub>2</sub> gas = 0.0311 x 3/2

= 0.047

Vol of Cl<sub>2</sub> gas = 0.047 x 24

= 1.12 dm<sup>3</sup>

(iv)

- Prevent water moisture from entering the apparatus/absorbing
- React with excess Chlorine/prevent environmental pollution
- Prevent hydrolysis of Aluminium Chloride
2. (a) (i) 2-methyl but-2-ene;

\[ \text{H} \quad \text{H} \]
\[ \text{H} \quad \text{C} - \text{C} = \text{C} - \text{C} - \text{H} \rightarrow \text{CH}_3 = (\text{CH}_3) \text{CHCH}_3 \]
\[ \text{H} \quad \text{CH}_3 \quad \text{H} \quad \text{H} \]

(ii) \[ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{O} \]
\[ \text{H} \quad \text{C} \quad \text{C} \quad \text{C} \quad \text{C} \quad \text{C} \quad \text{C} \quad \text{O} \quad \text{H} \]
\[ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \quad \text{O} \quad \text{H} \]

\[ \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{C} \quad \text{O} \quad \text{O} \quad \text{H} \]

(b)
- Determine the boiling points/temperature of the two alkanols. Hexanol has a higher boiling point temperature.
- Add equal amounts of water to each pollow of alkanol and shake for hexanol, two layers of liquids are formed while for methanol a homogeneous solution is formed.
- Determine the density of the two alkanols. Hexanol is denser than methanol
- Refractive index, hexanol has a higher refractive index

(c) (i) (I) Esterification accept condensation

(II) Chloroethane / CH$_3$ CH$_2$ Cl/C$_2$ H$_5$Cl
(ii) CH₃CH₂ONa C₂H₅ONa

(iii) Hydrogen gas

High temperature (150₀ – 250₀°C)  \textit{Reject unspecified conditions}

High pressure (200 – 250 atm)

2 mks for any 2 conditions tied to correct reagent

Nickel catalyst

3.  (i)  \[ \text{D(l)}^2+ + 2\text{e}^- \rightarrow \text{D (S)} \]  \hspace{1cm} (1 mk)

(ii)  \[ 2\text{B}^+ (l) \rightarrow \text{Br}_2 (g) + 2\text{e}^- (-1/2 \text{ for wrong/ missing}) \]

(ii) Carbon Graphite

It will not be attacked by/ react Bromine gas & D reacts with bromine vapours

(iii) Chlorine gas is poisonous/ toxic gas

(iv) (I) weigh the cathode before the start of the expt

Weigh cathode after the experiment / 90 minutes get the differences in weights

\text{(II) } Q = It \quad Q = 0.4 \times 90 \times 60 = 2160 \text{C} \quad \text{RAM} = 2.31 \times 96500 \frac{1}{2} \text{ mk}

\[ \frac{2160}{2} = 1 \text{ mole of D} \quad = 96500 \]

\[ 2.31 = 2160 \times \text{RAM} \quad = 206.4 \frac{1}{2} \text{ mk} \]

\[ 2 \times 96500 \]
4.  (a) (i) Channel / pump sea water into shallow ponds. Evaporation of water occur at the ponds sodium Chloride crystallizes out.

(ii) 1. \( \text{NH}_3(g) + \text{CO}_2(g) + \text{H}_2\text{O}(w) \rightarrow \text{NH}_4\text{HCO}_3(aq) \)

2. \( \text{NH}_4\text{HCO}_3(aq) + \text{NaCl}(aq) \rightarrow \text{NaHCO}_2(s) + \text{NH}_4 \text{Cl(aq)} \)

(iii)

1. Filtration

2. Heating

(iv) I. \( \text{NaCO}_3(s) + \text{H}_2\text{SO}_4(aq) \rightarrow \text{Na}_2\text{SO}_4(aq) + \text{CO}_2(g) + \text{H}_2\text{O}(l) \)

Moles of \( \text{H}_2\text{SO}_4 = 40 \times 0.5 \)

\[
\begin{align*}
\text{Moles of } \text{H}_2\text{SO}_4 &= 0.02 \\
\text{Moles of } \text{NaCO}_3 &= \text{Moles of } \text{H}_2\text{SO}_4 = 0.02 \\
\text{Mass of } \text{Na}_2\text{CO}_3 &= 0.02 \times 106 \\
&= 2.12 \text{ g} \\
\text{Percentage purity} &= (2.12 \times 100) \% \\
&= 98.6\%
\end{align*}
\]

II. Mass of \( \text{Na}_2\text{CO}_3 = 0.02 \times 106 \)

\[
\begin{align*}
&= 2.12 \text{ g} \\
\text{Percentage purity} &= (2.12 \times 100\%) \\
&= 98.6\% 
\end{align*}
\]
b. - Used in textile industries - used in photography
  - Manufacture of glass - Making anti acid drugs
  - Softening hard water - In paper industries
  - Making of detergents - As a food additive

5. (a)
   (i) I. Condensation
       II. Melting
   (ii) Iodine, Benzoic acid, Camphos, Dry Ice. Solid Co\textsubscript{2} Naphthalene
   (iii) \( H_2O(g) \to H_2O(g) \)

(b)
   (i) Van des waals and hydrogen bonding
       II Van des waals forces
   (ii) I. The separation distance is smaller during fusion than during vaporization hence requires much lower energy than in vaporization and vice versa.
       II. Heating time NP is far much less than heating time in QR/ Heating time

c)
   (i) Hydrogen burns to produce steam which is a non pollutant/ does not cause pollution to the environment
   - Hydrogen has a high energy content hence very small amount produce a lot of heat energy
   - Hydrogen is renewable hence cannot be exhausted/ used completed.
(ii) It can easily explore when burning/ highly flammable unlike fossils fuels expensive.

6. (a)

<table>
<thead>
<tr>
<th>Ion</th>
<th>Number of protons</th>
<th>Number of neutrons</th>
<th>Mass Number</th>
<th>Electron arrangement</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>$17 \frac{1}{2}$ mark</td>
<td>20</td>
<td>$37 \frac{1}{2}$ mark</td>
<td>2.8.8</td>
</tr>
<tr>
<td>X4+</td>
<td>14</td>
<td>$14 \frac{1}{2}$ mark</td>
<td>28</td>
<td>2.8 $\frac{1}{2}$ mark</td>
</tr>
</tbody>
</table>

(b) (i) Sodium burns with a yellow flame & yellow white/ solid powder is formed while copper burn with a blue green flame & black powder/ silic is formed.

(ii) Sodium darts on the surface of water / rapid fast effervescence (fast production of bubbles; solution becomes pink immediately.

Magnesium sinks in water/ slow (production of bubbles) effervescence/ solution becomes pink gradually.

(c) Magnesium it has a higher nuclear charge which pulls outer electrons more strongly

(d) $^{238}_{920}$ it is the most abundant

(ii) $\frac{0.01 \times 2.34 + 0.72 \times 235 + 238 \times 99.27}{100}$

$\frac{(2.34 + 169.2 + 236.2626)/100}{2.26} \text{ mk}$

$= 23797.80 \text{ mk}$
= 237.978 ½ mk

(iii) $^{235} \text{U} \rightarrow ^{231} \text{Th} + ^{4}\text{He}$

(iv) Control thickness of paper

(a) Coke/ coal/ Charcoal/ Carbon

(b) $\text{C}_\text{(s)} + \text{CO}_2 \text{ (g)} \rightarrow 2 \text{CO}_\text{(g)}$

(c) The reaction between coke/ coal and the hot air is highly exothermic

(d) Slog is immiscible with molten iron

(e) Nitrogen (iv) oxide gas forms acid rain. Which corrodes metallic materials and destroys vegetation the environment.

(f) (i) By passing/ blowing oxygen into molten iron which converts carbon into carbon

   (iv) Oxide

(ii) To increase the tensile strength/ making the iron less brittle/ making it more malleable / making it more ductile.