COMPLETE MSCE

CHEMISTRY

New Syllabus Based Questions and Answers

GELSON KALOMBOLA

Topic 1: Waste management *(Go to page 25 for answers)*

Part A: structured question

1. Distinguish between waste and waste management
2. With respect to physical state, name the four categories of wastes.
3. State the methods of solid waste disposal
4. State any three social and economic benefits of recycling wastes.
5. State three examples of each of the following wastes:
   a. Agricultural wastes
   b. Laboratory wastes
   c. Industrial wastes
6. What is the meaning of 3Rs in waste management?
7. Define waste Management
8. Give two reasons why waste management is important
9. Wastes can be degradable or non-degradable. Explain the terms;
   a. Degradable and
   b. Non-degradable
10. Define the following terms and give three examples for each;
    a. Solid wastes
    b. Liquid wastes
11. Why is it important to characterize wastes?
12. State one advantage of each of the following ways of waste treatments:
    a. Recycling
    b. Incinerators
13. Give one importance of the following :
    a. Reuse
    b. Reduce
    c. Recycle
14. Give any **three** major sources of wastes. (3 marks)
15. Explain how compost manure is one way of solid waste disposal.(2 marks)

Part B: Essay questions

16. Explain any five effects of poor waste disposal to the environment
17. Explain the recycling process of metals
18. Explain the recycling process of plastics

Topic 2: Greenhouse gases and the ozone layer *(go to page 29 for answers)*

1. Volcanoes and bushfires are two examples of natural disasters. Give one effect of each natural disaster. (2 marks)
2. a. What are greenhouse gases? (1 mark)
   b. Give two examples of greenhouse gases (2 marks)
3. How do greenhouse gases impact negatively on:
   a. The climate (1 mark)
   b. The environment (1 mark)
4. State two human activities that contribute to the emission of greenhouse gases into the air (2 marks)
5. a. Define ozone layer (1 mark)
   b. Where in the atmosphere is it located? (1 mark)
6. How is the ozone layer important?(2 marks)
7. Discuss how the depletion of ozone take place, in your explanation include the equations for the reactions (6 marks)
8. State any three effects of global warming (3 marks)
9. Describe two effects of ozone layer depletion(2 marks)
10. Mention any three ways through which ozone layer depletion can be controlled.(3 marks)
11. Mention any **two** ways of protecting the ozone layer. (2 marks)
12. Explain how combustion is a source of greenhouse gases (2 marks)
13. Give any two ways of preventing atmospheric pollution. (2 marks)
14. Define air pollution (1 mark)
15. List down any two common pollutants of air (2 marks)
16. State any two mitigation measures taken to reduce CFCs (2 marks)
17. Identify the most abundant air in the atmosphere(1 mark)
18. Why should air be dried before being subjected to fractional distillation(1 mark)
19. List the stages followed in fractional distillation(4 marks)
20. Describe how carbon dioxide is separated from air (2 marks)
21. Give two applications of each of the following air components(6 marks)
    a. Oxygen
    b. Nitrogen
    c. Carbon dioxide
22. Write the equations to show how each of the following substances causes acid rain:
    a. Carbon dioxide
    b. Sulphur dioxide
    c. Nitrogen dioxide (6 marks)
23. Give four substances that can destroy the ozone layer(4 marks)

Topic 3: Water *(Go to page 32 for answers)*

1. Name the three natural sources of water (3 marks)
2. Discuss the importance of water(10 marks)
3. a. What is meant by hard water?(1 mark)
4. b. What is the difference between hard water and soft water?(2 marks)
5. c. State two advantages and two disadvantages of hard water (4 marks)
6. Differentiate between permanent and temporary hardness of water (2 marks)
7. How does permutit process soften hard water?(4 marks)
8. Give two methods of removing hardness in water (2 marks)
9. Explain ways in which hard water is a nuisance in industries (2 marks)
10. Differentiate between soft and hard water(2 marks)
11. Give the two types of water hardness(2 marks)
12. Describe how the following methods remove water hardness:
    a. Boiling (3 marks)
    b. Addition of calcium hydroxide (3 marks)
    c. Addition of sodium carbonate(3 marks)
13. One of the substances found in some temporary hard water is Magnesium Hydrogen Carbonate. Write a balanced chemical equation to show the effect of heat on this substance in aqueous solution(2 marks)
14. Some samples of water were tested in the laboratory. The results are shown in the table below:

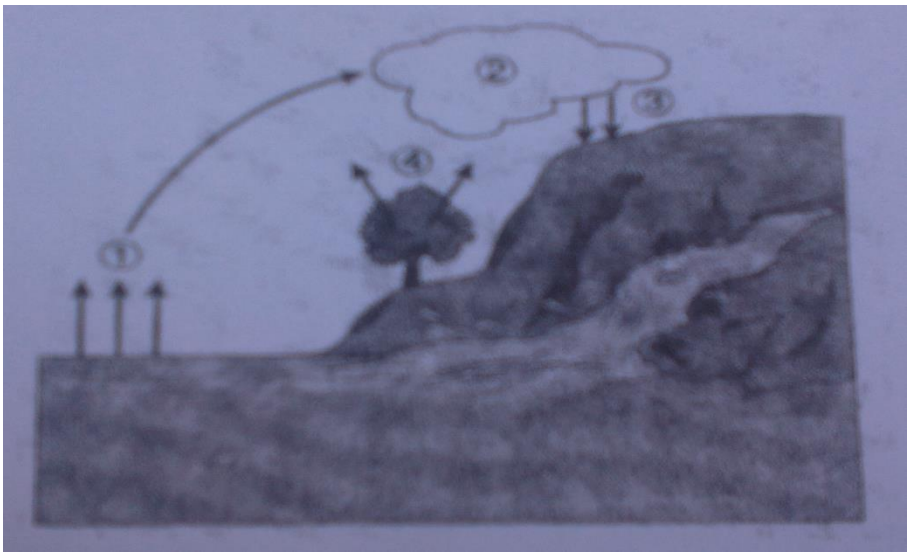
TEST	SAMPLE		
	X	Y	Z
Boiled first and then shaken with soap solution	Good lather	Good lather	Poor lather
Some bath salts added shaken with soap solution after filtering	Good lather	Good lather	Good lather
Shaken with soap solution	Poor lather	Good lather	Poor lather

    a. Identify the sample that is pure water. Explain your answer. (2 marks)
    b. The other two samples were both from hard and soft water areas
        i. Which one contained temporary hardness? (1 mark)
        ii. Which one contained permanent hardness? (1 mark)
    c. Mention one substance that could cause the hardness (1 mark)
15. 20cm^3 of water from four different areas were tested with soap solution to see how much soap solution was needed for a lather that lasted at least 30 seconds. The experiment was repeated a second time the samples were boiled and then the third time using samples that had been passed through an ion exchanger. The results are shown in the table below:

Sample	Volume of a soap Solution in cm^3		
	Untreated	Boiled	Passed through ion exchanger
A	28	3.8	3.8
B	32	32	3.6
C	50	40	3.8
D	3.6	3.6	3.6

a. Which of the samples is the Hardest water? Give a reason for your choice. (1 mark)
b. Which sample behaved like distilled water? Explain your answer (2 marks)
c. Decide whether the hardness is temporary, permanent or both in:
   i. Sample A
   ii. Sample B
   iii. Sample C(3 marks)
d. Name the chemical which could be responsible for the hardness in:
   i. Sample A
   ii. Sample B (2 marks)
e. Explain how an ion exchanger works in removing hardness from waters (10 marks)

16. Use the diagram below to answer questions that follow



a. Provide labels for the missing terms 1 to 4. (4 marks)
b. What factor initiates the terms 1 to 4? (1mark)
c. How is 3 related to 4? (1mark)
d. Mention any two form of label 3. (2marks)
e. Mention any one role played by each of the following.
   (i) Rain water (1mark)
   (ii) Underground water (1mark)
   (iii) Surface water (1mark)

17. Use a chemical equation to show how water acquires hardness. (2 marks)
18. The resin in an ion exchanger is regenerated using concentrated solution of sodium chloride. Explain this. (2 marks)

19. Explain the term ‘ion exchange’ in relation to the removal of permanent water hardness. (3 marks)
20. Explain briefly the causes and effects of water pollution (10 marks)
21. With the aid of a well labelled diagram describe the hydrological cycle(10 marks)
22. With the aid of a well labelled diagram design an experiment can be used to investigate the hardness and softness of water using soap(10 marks)

Topic 4: Acid and base reactions *(Go to page 38 for answers)*

1. Define an acid according to Lowry-Bronsted theory (1 mark)
2. Outline any **two** properties of a base (2 marks)
3. Ammonia is an example of a strong base.
    a. What is a "strong base" (1 mark)
    b. Write a chemical equation to show the ionisation of ammonia in water (2 marks)
    c. Identify one conjugate acid – base pair from the equation given above (1 mark)
4. Complete the following by writing the conjugate acid-base (4marks)
    a. H_2SO_4 + NH_3 _____ + _____
    b. HNO_3 + H_2O _____ + _____
5. Explain how hydronium ion is produced. (2 marks)
6. Explain how you can test for the strength of an acid (2 marks)
7. Differentiate between conjugate acid and conjugate acid (2 marks)
8. Describe how you would determine the pH of ethanoic acid in vinegar using universal indicator. (3 marks)
9. Identify a conjugate acid base pairs from the given equations below:
    a. $HCl + H_2O \rightarrow Cl^- + H_3O^+$
    b. $HNO_2 + HS^- \rightarrow NO_2 + H_2S$
    c. $H_2S + H_2O \rightarrow H_3O^+ + HS^-$
    d. $NaOH + HCl \rightarrow NaCl + H_2O$
10. Study the table below and answer the questions that follow

SOLUTION	PH VALUE
A	7
B	4
C	8
D	2

Which solution is:

a. Weak acid 1 mark
b. Strong acid 1 mark
c. Neutral 1 mark
d. Basic 1 mark

11. With the aid of a well labelled diagram, describe an experiment that can be carried out to compare the electrical conductivity of a strong acid and a weak acid. (10 marks)
12. With the aid of a well labelled diagram, describe an experiment on how conductivity can be used to determine the strength of an acid. (10 marks)

Topic 5: Oxidation and Reduction *(Go to page 40 for answers)*

1. What is oxidation in terms of hydrogen transfer? **(1 marks)**
2. Study the chemical equation below and use it to answer questions that follow:

   $2FeCl_{2\,(aq)} + Cl_{2\,(g)} \longrightarrow 2FeCl_{3\,(aq)}$

   i. Write the net equation for the reaction. **(2 marks)**
   ii. Write oxidation half equation for the reaction. **(2 marks)**
   iii. Write reduction half equation for the reaction. (2 marks)
3. Aluminium reacts with chlorine gas according to the following equation:

   $2Al_{(s)} + 3Cl_{2\,(g)} \longrightarrow 2AlCl_{3\,(S)}$

   Write oxidation and reduction half reactions (4 marks)

4. Study the chemical equations bellow and use them to answer the questions that follow:

$Fe + Mg^{+2}$	No reaction
$Mg^{+2} + Al$	No Reaction
$Al^{+3} + Fe$	No Reaction
$Cu^{2+} + Pb$	Reaction
$Pb2^{+} + Fe$	Reaction

   a. Arrange the elements in order of increasing reactivity. (5 marks)
   b. Write down the products formed when aluminum metal is dipped in a solution of lead (2 marks)
   c. Draw an electrochemical cell for the reaction above and label any three parts (3 marks)
5. Given the following information, use it to answer the questions that follows

		E^{θ}/Volts
$Cu^{2+}_{(aq)} + 2e^{-} \rightleftharpoons$	$Cu_{(s)}$	+0.34
$O_{2(g)} + 4H^{+}_{(aq)} + 4e^{-} \rightleftharpoons$	$2H_2O_{(l)}$	+1.23
$Ag^{+}_{(aq)} + e^{-} \rightleftharpoons$	$Ag_{(s)}$	+0.80
$F_{2(g)} + 2e^{-} \rightleftharpoons$	$2F^{-}_{(aq)}$	+2.87
$I_{2(g)} + 2e^{-} \rightleftharpoons$	$2I^{-}_{(aq)}$	+0.54
$Mg^{2+}_{(aq)} + 2e^{-} \rightleftharpoons$	$Mg_{(s)}$	-2.36

   a. Show whether the reaction of Magnesium metal with copper nitrate solution will occur or not (2 marks)
   b. Write the overall equation for the cell between magnesium and silver (1 mark)
6. Workout the oxidation number of
   a. Mn in MnO_4 (2 marks)
   b. Cr in $Cr_2O_2^{2-}$ (2 marks)

7. The following is an overall equation for the reaction of zinc metal and silver ions

$$Zn°(s) + 2Ag^{+}(aq) \longrightarrow 2Ag°(s) + Zn^{+2}(aq)$$

   a. Identify
      i. An oxidizing agent (1 mark)
      ii. A reducing agent (1 mark)
   b. What is the meaning of (+2) on Zn^{+2} (aq) (1 mark)

8. Magnesium reacts with Zinc sulphate according to the following equation:

$$Mg + ZnSO_4 \longrightarrow MgSO_4 + Zn$$

   a. Write the half equation for the reduction process (2 marks)
   b. Identify the oxidizing agent (1 mark)

9. With aid of a well labelled diagram design an experiment to investigate the conditions necessary for rusting. (10 marks)

Topic 6: Electrolysis *(Go to page 43 for answers)*

1. Define "electroplating" (1 mark)
2. Define preferential discharge (1 mark)
3. Mention **three** factors affecting preferential discharge. (3marks)
4. Give **three** uses of electrolysis (3 marks)
5. What is the difference between the following;
    a. Cation and anion (2 marks)
    b. Anode and cathode (2 marks)

6. Give the name of the precipitate formed when Lead Nitrate solution is mixed with Sodium bromide. (1 mark)
7. With the aid of a well labelled diagram explain how the electrolysis of dilute sodium chloride solution occurs.(hint: the explanation should include type of reaction and discharge on each electrode and half equations) (10 marks)
8. With the aid of a well labelled diagram, describe an experiment that could be done to electroplate copper spoon with silver metal (10 marks)
9. With the aid of a well labelled diagram, describe how copper Can be refined using electrolysis. In your description, include half equations at the cathode and anode. (10 marks)

Topic 7: Stoichiometry *(Go to page 46 for answers)*

1. Define;
   i. Empirical formula (1 mark)
   ii. Mole (1 mark)
2. When 2.4g of magnesium ribbon is burnt in excess oxygen, a white powder weighing 4g was formed. Determine the empirical formula. (5 marks)
3. 21g of compound **A** contains 8.4g of carbon, 1.4g of hydrogen and 11.2g of oxygen. What is the simplest formula A can have? (C=12, H=1, O = 16) (3 marks)
4. Work out:
   i. The mass of 0.6moles of calcium carbonate (2 marks)
   ii. The number of moles contained in 3.2g of oxygen molecule (2 marks)
5. Sodium (Na) reacts with water (H_2O) to produce sodium hydroxide (NaOH) and hydrogen gas (H_2) according to the following chemical equation

   $Na_{(s)} + H_2O_{(l)} \longrightarrow NaOH_{(aq)} + H_{2\,(g)}$

   a. Balance the equation. **(3marks)**
   b. If 46g of sodium metal reacts completely with 18g of water, what mass of sodium hydroxide is produced?
   (2marks)
   c. What volume of hydrogen gas is produced in the reaction 1 (a) above assuming the reaction takes place at room temperature and pressure?
   (2 marks)
6. (i) Which element is more reactive between Sodium (Na) and Magnesium (Mg)? (1 mark)
   (ii) Give a reason for your answer the question above (2 marks)
7. A hydrocarbon contains 85.7% carbon and 14.3% hydrogen by mass. Write the molecular formula of the hydrocarbon if its relative formula mass is 56. (7 marks)
8. Solusilium is a newly discovered metal element by form 4 learners at Solusi Private Secondary. After taking a series of tests, they found that the element is very soft and reacts vigorously with water giving out a gas that produces a pop sound to a glowing splint. Its solution turns red litmus paper to blue
   a. Suggest the family of this element (1 mark)
   b. i. Would this element be found along the banks of river? (1 mark)
      ii. Suggest a reason for your answer to question above? (1 mark)
   c. Suggest how you can keep Solusilium in the laboratory (1 mark)
   d. Give the name of the gas that was produce from the reaction (1 mark)
9. Calculate the concentration in moles per litre of 40% Sodium hydroxide solution (40% NaOH). RAM, Na = 23, O = 16 and H = 1. (3 marks)
10. Calculate the volume of 8M KNO_3 stock solution to be diluted to 400ml so that the final concentration is 0.2M (3 marks)
11. What is the molarity of the solution if 0.65 moles of Lithium Chloride is dissolved in 200cm^3 of water? (3 marks)
12. Titanium is a strong light weight corrosion resistant metal that is used in rockets, aircraft, Jet engines and Bicycle frames. It is prepared by the reaction of Titanium (iv) Chloride with molten magnesium between **950 ^oc** and **1150 ^oc.** $TiCl_{4(g)} + 2Mg_{(l)} \rightarrow Ti_{(s)} + 2MgCl_{2(l)}$ in a certain industrial operation 3.54×10^7 g of $TiCl_4$ was reacted with 1.13×10^7g of Mg. **(RAM ; Ti= 47.9 , Cl= 35.5, Mg =24.3)**

a. Calculate the theoretical yield of **Ti** in gas. (4 marks)
b. Calculate the percentage yield of 7.91×10^6 g of **Ti** that was actually obtained. (3 marks)

13. When 2.34g of aluminium reacted with excess copper (II) sulphate solution 3.89g of copper were formed according to the equation

$$2Al(s) + 3CuSO_4(g) \longrightarrow Al_2(SO_4)_3 + 3Cu(s)$$

Calculate the percentage yield of copper in the reaction (Al = 27, Cu = 63.5) (4 marks)

14. a. In an experiment, 136g of gaseous ammonia (NH_3) reacted with excess oxygen (O_2) to produce nitric acid (HNO_3) and water (H_2O)
i. Write a balanced equation for the reaction **(2 marks)**
ii. How much nitric acid (HNO_3) could be produced from this reaction?
(RAM: N = 14, H = 1, O = 16) **(3 marks)**

b. Workout the number of nitrogen atoms in 8 molecules of urea $CO(NH_2)_7$ **(2 marks**

15. In a titration, 25cm3 of hydrochloric acid (HCl) of an unknown concentration was titrated against 20cm3 of 2M sodium hydroxide (2M NaOH) to which phenolphthalein was added.
a. Name the standard solution in the titration. (1 mark)
b. Give a reason for your answer (1 mark)
c. Workout the concentration of HCl (3 marks)

16. Describe an experiment that could be done to find the concentration of HCl using 0.1M of NaOH by titration. (10 marks)

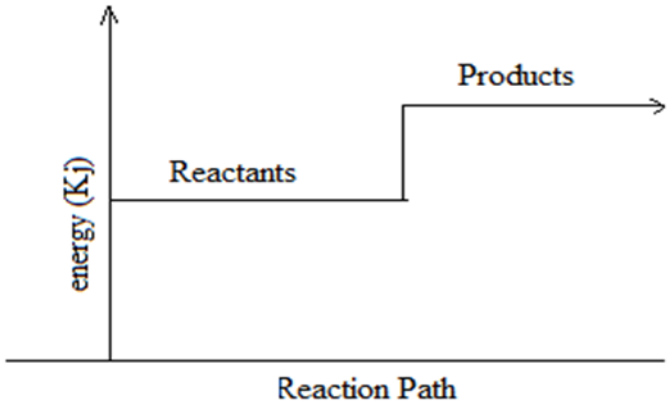
17. A 300 mg tablet of a drug was completely dissolved in 10ml of water. The molecular formula of the drug is $C_9H_8O_4$
a. Calculate the number of moles in the tablet (RAM: C 12, H = 1 and O = 16)
b. Calculate the molarity of the solution. (2 marks)

18. A bottle containing potassium chloride solution of unknown concentration was found in the chemistry laboratory. Describe an experiment that could be done to find the concentration of potassium chloride solution using **evaporation method**(10 marks)

Topic 8: Heats of reactions *(Go to page 50 for answers)*

1. Draw the heat energy level diagram for the reaction below:
   $C_{(s)} + H_2O_{(l)} \longrightarrow CO_{(g)} + H_{2\,(g)} : \Delta H = +132kJ$ (3 marks)

2. Study the figure below and use it to answer the questions that follow



   a. What type of change is shown by the energy level diagram above? (1 mark)
   b. Give a reason for your answer (2 marks)

3. Table below shows bond energies of some elements. Use it to answer the questions that follow

bond	Energy(kj/mol)
C-H	413
O=O	498
O-H	464
C=O	805

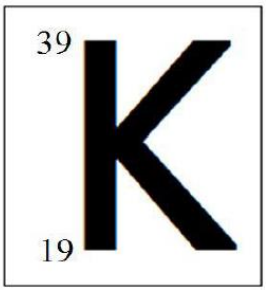
   Methane reacts with oxygen to produce carbon dioxide and water according to the equation $CH_4(g) + O_2(g) \rightarrow CO_2(g) + H_2O(l)$
   a. Use the table of bond enthalpies to calculate bond breaking energy and bond making energy (3 marks)
   b. Identify the type of reaction (1 mark)

Topic 9: Rates of Reactions *(Go to page 51 for answers)*

1. Explain how surface area of reactants affect the rate of chemical reaction (2 marks)
2. Why do catalyst do not affect the position of the equilibrium in a reversible chemical reaction? (2 marks)
3. Mention **two** factors that affects the rate of reaction (2 marks)
4. Briefly explain **two** methods of measuring the rates of reaction (2 marks)
5. Design an experiment to show that a catalyst enhance chemical reaction. (7 marks)
6. Describe an experiment that you would conduct to determine the rate of a reaction by change in mass using calcium carbonate chips and hydrochloric acid solution. (10 marks)

Topic 10: Inorganic compounds *(Go to page 53 for answers)*

1. Figure below shows the nuclide symbol of an element from the periodic table



   a. What is the name of the element? (1 mark)
   b. Workout its;
      i. Number of neutrons (2 marks)
      ii. Electron configuration (1 mark)
   c. How many shells does this element have? (1 mark)
   d. Draw the atomic structure of the element in figure above and label any three parts (3 marks)
   e. Give any one use of electron configuration (1 mark)
2. Define Isotopes (1 mark)
3. Complete the table below

Isotope	Number neutrons	Atomic number
$^{24}_{12}$Mg		
$^{25}_{12}Mg$		

(4 marks)

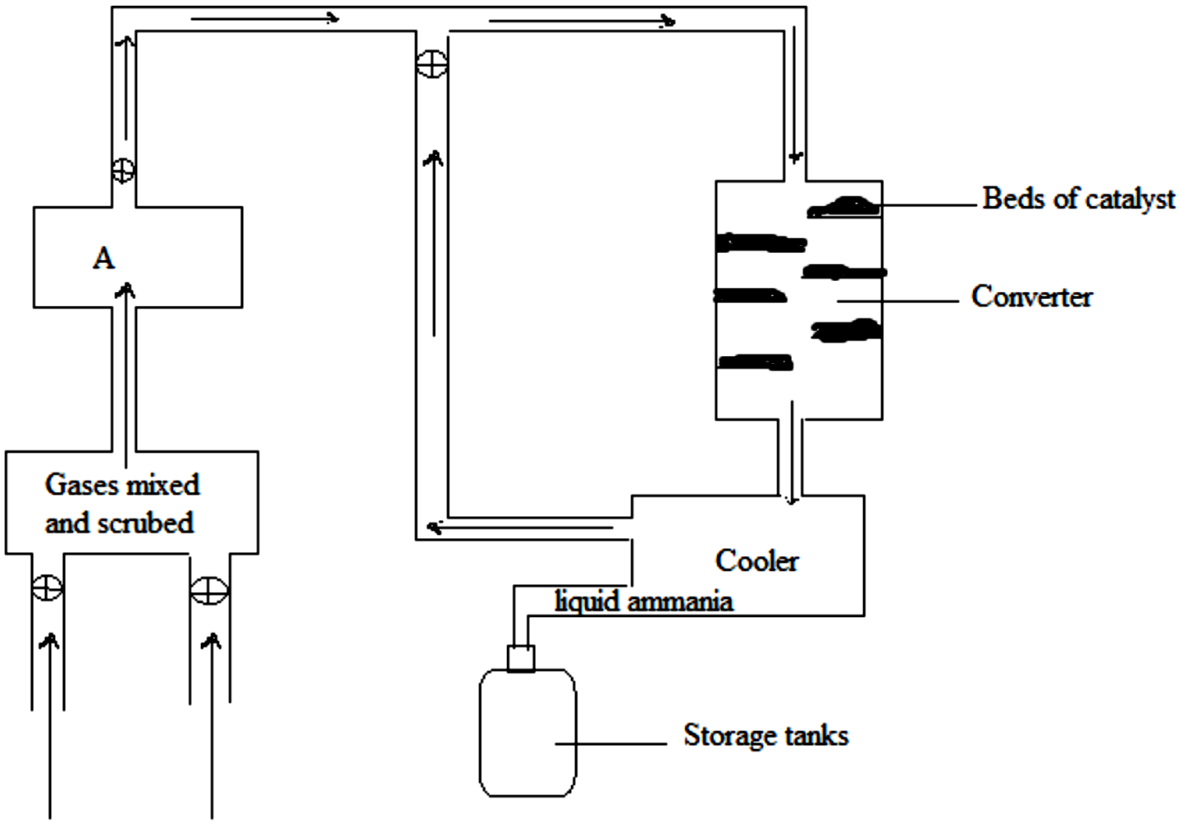
4. The table below shows electron configuration and relative abundance of isotopes of an element

Isotope	**Electron configuration**	**Relative abundance**
X – 28	2 – 8 – 4	8/10
X – 29	2 – 8 – 4	1/10
X – 30	2 – 8 – 4	1/10

   a. To which group of the periodic table does the element X belong?(1 mark)
   b. Element X reacts with element Y whose valency is 2. Write the chemical formula of the product (2 marks)

5. The control rods in a nuclear reactor often contain boron. Natural boron contains about 20% boron -10 and 80% boron -11. Boron is the 5th element.
   a. Give the electronic structure of a boron atom (1 mark)
   b. Calculate the Relative Atomic Mass of boron (4 marks)
6. A certain element could be represented as $^{28}_{14}X$:
   a. To which group of the periodic table does **X** belong? Give a reason. **(2 marks)**
   b. Identify element **X** in the periodic table. **(1 mark)**
7. Explain why;
   a. Group I elements are called alkali metals (1 mark)
   b. Group VIII elements are called inert gases (1 mark)
8. Give any one source of phosphorus (1 mark)

9. State any one product that is manufactured using phosphorus apart from fertilizers (1 mark)
10. Mention any **two** allotropes phosphorus. (2 marks)
11. Give any **two** uses of sulphates. (2 marks)
12. List one source of Nitrogen (1 mark)
13. Explain two chemical properties of Nitrogen (2 marks)
14. Describe two application of phosphorus in everyday life (2 marks)
15. Diamond and graphite are allotropes of carbon; explain why graphite conducts electricity while diamond does not. (2 marks)
16. Briefly explain how sulphuric acid is formed through contact process (6 marks)
17. With the help of the diagram, explain how ammonia is produced in Haber process (7 marks)
18. Figure below shows production of ammonia



a. Identify the process in the above figure (1 mark)
b. List two gases that are pumped into the system (2 marks)

Topic 11: Chemical bonding and properties of matter

(Go to page 56 for answers)

1. Draw the dot cross diagram for the formation of Aluminum trioxide (Al_2O_3). (3 marks)
2. Aluminium sulphate is an ionic compound formed through the combination of aluminium ions ($Al^{3+}_{(aq)}$) and sulphate ions($SO_3^{2-}{}_{(aq)}$)

a. Write down the valences for $Al^{3+}_{(aq)}$ and $SO_3^{2-}{}_{(aq)}$ radicals (2 marks)

b. Write down the chemical equation for the formation of Aluminium Sulphate (3 marks)

3. Define a polar bond (1 mark)
4. List any three properties of covalent compounds (3 marks)
5. Table below shows ionization energies of some elements

Element	Ionization energy (Kj)
Lithium (Li)	520
Sodium (Na)	496
Potassium (K)	479

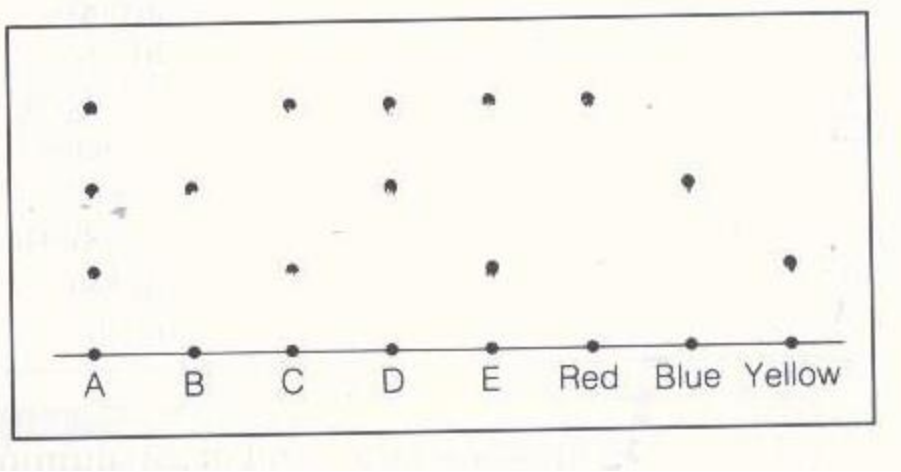
   a. Define ionization energy (1 mark)
   b. Explain the trend in ionization energies (2 marks)
   c. Mention any two physical properties of alkali metals (2 marks)
6. Describe any one chemical properties of alkaline metals (2 marks)
7. Give reason why helium is preferred in filling balloons than hydrogen which is the lightest (1 mark)
8. Give any two uses of sodium hydroxide. (2 marks)
9. On a wall built using bricks and mortar, as to how matter is put together,
   a. What do the bricks represent? (1mark)
   b. What does the mortar represent? (1mark)
10. Differentiate between melting and melting point (2 marks)
11. Explain the difference between a mixture of iron and sulphur and the compound iron sulphide (2marks)
12. Explain the effect of temperature on solubility. (3marks)
13. Describe how you would separate a mixture of iron and sulphur (2 marks)
14. Write the chemical formula of the compound formed when sodium (Na) and a sulphate (SO_4) with valency of 1 and 2 respectively react. (1 mark)
15. Define allotropy (1 mark)
16. State the two uses of alloys (2 marks)
17. a. Give any two metals used to form stainless steel (2 marks)
    b. Why is stainless steel used to make surgical instruments? (1 mark)
18. Differentiate the following terms **:**
    a. An element and a compound **(2 marks)**
    b. An atom and an ion **(2 marks)**
    c. A pure substance and a mixture **(2 marks)**
19. State two properties of ionic compounds (2 marks)
20. Differentiate ionic and covalent compounds (2 marks)

21. Write a balanced equation for the reaction of Magnesium with Oxygen to form Magnesium Oxide (3 marks)
22. Mixtures can be separated using various methods at household and industrial levels. Suggest a mixture that can be separated using each of the following methods; **(3 marks)**
    a. Evaporation
    b. Chromatography:
    c. Distillation
23. Define matter **(1 mark)**
24. Mention the three phases of matter.**(3 marks)**
25. Discuss any two evidence of particulate of matter. **(4 marks)**

26. A certain boy, accidentally mixed water, petrol, diesel and salt in a bucket. With the aid of a well labelled diagram, explain how the boy would separate the mixture using fractional distillation. (10 marks)

Topic 12: Experimental skills *(Go to page 59 for answers)*

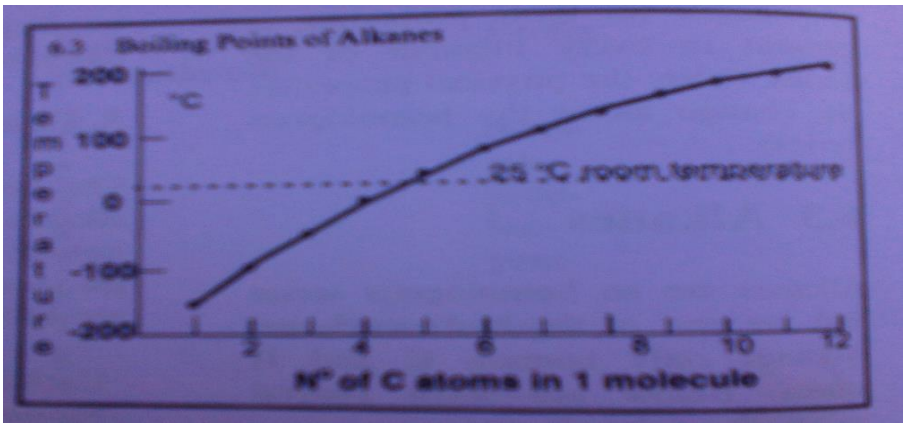
1. Define the following terms as used in chromatography;
   a. Retention flow value/Retention Factor (2 marks)
   b. Analyte (2 marks)
   c. Eluent (2 marks)
2. Eight coloured substances were spotted on to a piece of filter paper, which was then stood in a covered glass tank containing a little propanone. Three of the substances were the basic colours red, blue and yellow. The other dyes were labeled **A, B, C, D** and **E**. The resulting chromatogram is below.



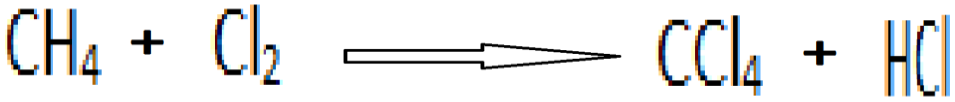
   a. Which dye contains only one colour? (1 mark)
   b. Which dyes have same composition? (1 mark)
   c. Which dye has all the three basic colours? (1 mark)
   d. Which basic colour is most soluble in propanone? (1 mark)
3. Define ignitable wastes (1 mark)
4. Explain how to dispose dirty papers and plastics (2 marks)
5. Describe the simple tests for ;
   a. Water (3 marks)
   b. Oxygen (3 marks)
   c. Cations (3 marks)
   d. Hydrogen (3 marks)
6. Discuss any five safe ways of disposing laboratory waste. Give any one example of the laboratory waste for each safe way discussed (10 marks)
7. With the aid of a well labelled diagram explain how a mixture of ink or dye can be separated using chromatography. (10 marks)
8. With the aid of a well labelled diagram, describe an experiment that you can use to identify different pigments in a green leaf (10 marks)

Topic 13: Organic compounds *(Go to page 62 for answers)*

1. Figure below shows boiling points of alkanes



   a. What is happening to the boiling points as the sizes of the molecules increase? (1mark)
   b. Explain your answer given to 1(a) above. (2marks)
   c. Is the boiling point of hexane below or above 25°C? (1mark)
   d. What state is hexane at room temperature? (1mark)
2. Use the overall equation below to show how the reactions occur from first to the end. Use structures



   i. marks)
3. Describe any two addition reactions of alkenes (4 marks)
4. Complete and balance the equation below. Assume complete combustion

   $C_4H_{10(l)} + O_{2(g)} \longrightarrow$ (2marks)

5. Hexane $\xrightarrow[Al_2O_3]{500°C}$ butane + ethane

   a. Identify the type of cracking in the equation above. Give a reason (2marks)
   b. What role does Al_2O_3 play? (1mark)
   c. Write a chemical equation for the equation above (2 marks)
6. With the aid of word and chemical equations explain how ethanol is produced by fermentation of sugar (6 marks)
7. Differentiate between addition and condensation polymerization (2 marks)
8. Using the structures of monomer, show how polyvinylchloride(PVC) is formed (2 marks)

9. The Molecular formulae of organic compounds R, S, T and U are;

R = C_2H_5OH,

S = C_6H_{12},

T = $H\text{-}\overset{\overset{O}{\|}}{C}\text{-}OCH_2CH_3$

U = CH_3COOH

a. Draw the structure of **T** (2 marks)

b. Classify the compounds as soluble or insoluble in water

Soluble	Insoluble

c. Which of the compounds would undergo addition reaction with Chlorine gas (1 mark)

d. Give a reason for your answer to the question (1 mark)

e. Write down a well balanced chemical equation for the reaction between **R** and **U** (2 marks)

10. Given below are formulae of some organic compounds **A, B, C** and **D**.

A. C_2H_5OH **B**. C_3H_6 **C**. C_2H_5COOH **D**. CH_3CHO

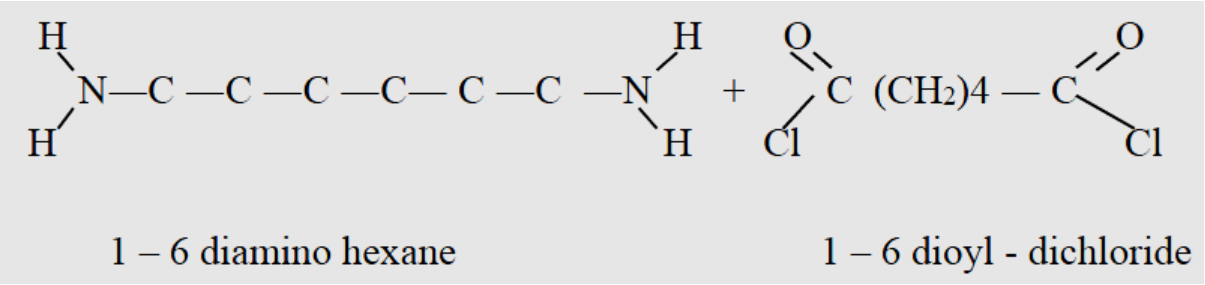
a. What kind of reaction process occurs between compound A and C(1 mark)

b. Name the product formed from the reaction mentioned above (1 mark)

c. Which compound has a general formula of RCHO? (1 mark)

11. Mention two types of polymerization (2 marks)

12. Polymerization of 1-6 diaminohexane and hexane 1-6 dioyl-dichloride takes place as follows



a. Identify the type of polymerization in the reaction (1 mark)

b. Name the polymer (1 mark)

13. Write two Isomers of Butene C_4H_8 using carbon chain and name them (4 marks)

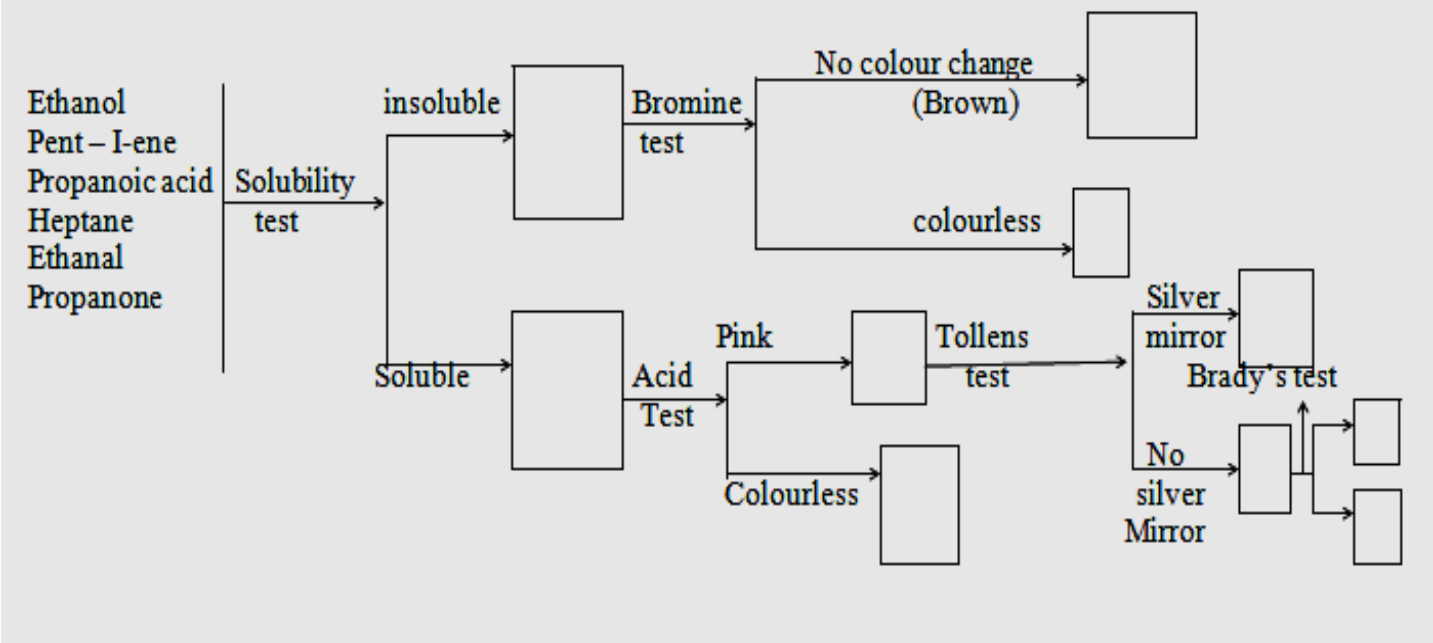
14. Briefly explain how soap is made in the process of saponification (4 marks)

15. Discuss the process of Soap making (10 marks)

16. Construct a flow diagram that could be used to identify ethanol, propanone, acetic acid, ethanal and hexane, using tests that make use of distilled water, sodium hydroxide solution, phenolphthalein, Brady's solution and Tollens reagent. (10 marks)

17. Imagine the laboratory technician has left ethanol, ethanal, ethanone, hexane in unlabeled bottles. Design an experiment you could use to identify the unknown organic compounds. (10 marks)

18. Copy and complete the flow diagram

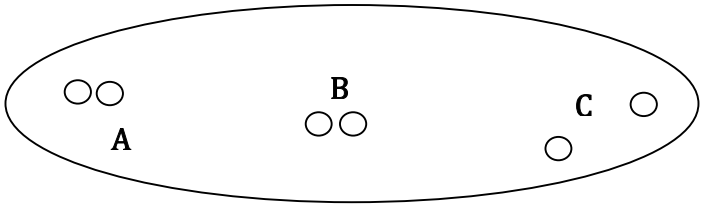


Topic 14: Soil *(Go to page 66 for answers)*

1. Describe any two chemical properties of soil (4 marks)
2. How does soil form? (2 marks)
3. Describe the composition of soil (3 marks)
4. Mention six chemical elements found in the soil (6 marks)
5. Why do different samples have different chemical properties?(1 mark)
6. Give the four chemical properties of soil(4 marks)
7. Describe why most crops grow well in neutral soils(2 marks)
8. Define soil pollution(1 mark)
9. Mention four sources of soil pollutants, their effects on human health and environment and how they can be controlled(12 marks)
10. Explain how salinity of soil sample can be investigated(10 marks)
11. Explain how soil pH can be investigated (10 marks)

Topic 15: Introduction to chemistry *(Go to page 68 for answers)*

1. Define chemistry (1 mark)
2. State the difference between accuracy and precision (2 marks)
3. Figure below is a diagram of a container with molecular models in various positions. The models are supposed to be at the Centre of the container.



Using the letters A, B and C, identify the molecular models that have;

   a. Good precision but poor accuracy (1 mark)
   b. Both poor precision and accuracy (1mark)
   c. Both good precision and accuracy (1 mark)

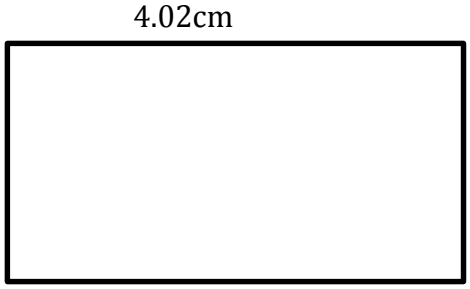
4. The table below shows results of an experiment showing number of bubbles produced per minutes in boiling wine against temperature.

Number of bubbles/minute	8	10	12	14
Temperature (^{0}C)	40	50	60	70

   a. Using a scale of 2cm to represent 1 unit on the horizontal axis and 2cm to represent 10 units on the vertical axis, draw a graph of Number of bubbles per minute against temperature (5 marks)
   b. Explain the relationship between temperature and number of bubbles in the graph drawn above (1 mark)
   c. At what temperature would the number of bubbles be 11 per minute? (1 mark)

5. Mention any one laboratory rule (1 mark)
6. Observing laboratory safety rules is important in chemistry.
   a. Name two safety equipment that should be worn when using acids **(2 marks)**
   b. What should you do if your clothes catch fire? (2 marks)
7. Write 0.0000167kg in standard form (1 mark)
8. Write 10076 to two significant figures (1 mark)

9. Calculate the area of the rectangle and express the answer to the proper number of significant figures



(3 marks)

10. Construct a pie chart to represent the percentage composition of elements in ethanoic acid (CH_3COOH) (5marks)
11. The table below shows the safety symbols. Use it to answer the questions that follow

Number	Safety Symbol	Meaning
1		
2		
3		

a. For each symbol, write its correct meaning in the table above (3 marks)
b. State one precaution when handling a substance with the safety symbol Number 2 (1 mark)
c. Which group of elements in the periodic table can have safety symbol Number 3? (1 mark)

12. State four ways of presenting data for easy interpretation (4 marks)
13. Describe how the volume of irregular object can be determined (7 marks)
14. Discuss the importance of five chemistry careers in the society. (10 marks)

Topic 1: Waste management

Part A: structured question

1. Waste is any material or substance in liquid or solid form which is no longer fit for use while waste management is the collection, transportation, disposal, controlling and monitoring of wastes
2. Can be categorized as:
    - Solid wastes
    - Liquid wastes
    - Sludge wastes
    - Gas wastes
3. Solid wastes disposal methods :
    - Burning
    - Burying
    - Animal feeds
    - Compost manure
    - Recycling
    - Re-use
    - Incineration
4. Social and economic benefits of recycling wastes
    - Saves energy – recycling a material requires less energy than fresh production of materials
    - Reduces air and water pollution by reducing the need of other waste disposal mechanisms such as burning and open dumping
    - It provides jobs to unemployed
5. Examples of:
    a. Agricultural wastes :
        - Plant remains
        - Excess agricultural chemicals(fertilizers and herbicides)
        - Dead farm animals
    b. Laboratory wastes:
        - Plastics
        - Expired chemicals
        - Broken glass wares
    c. Industrial wastes :
        - Metals
        - Oils
        - Toxic gasses
6. 3Rs in wastes management mean; **R**educe, **R**ecycle and **R**e-use
7. Waste management is the collection, transportation, disposal, controlling and monitoring of wastes
8. Importance in waste management:
    - It beautifies the environment
    - It helps in reducing the spread of diseases

9. Terms:
    a. Degradable means type of wastes that can be broken down into harmless substances by micro-organisms
    b. Non-degradable means the type of wastes that cannot be broken down into harmless components by micro-organisms
10. Terms and examples:
    a. Solid wastes are any worthless, unwanted and discarded material that is neither liquid nor gas for example: food leftovers, old newspaper and crop residues
    b. Liquid wastes are any worthless, unwanted and discarded material that is neither solid nor gas for example: contaminated water, agricultural chemicals, expired vaccines
11. Because it helps to control and monitor them easily
12. Advantages of :
    - Recycling
        - Provides employment and source of income
        - Beautifies the environment
    - Incinerators
        - They reduce waste up to 50%
        - They are weather dependent
13. Importance of :
    a. Reuse
        - Saves the cost of buying new product

    b. Reduce
        - Reduces pollution by reducing the amount of waste(using less)

    c. Recycle
        - Saves raw materials for making new products

14. Three major sources of wastes:
    - Industrial wastes
    - Agricultural wastes
    - Domestic wastes
    - Laboratory wastes
15. Compost manure is made from biodegradable wastes. It reduces air pollution as well as other health hazards hence a solid waste disposal method

16. FIVE EFFECTS OF POOR WASTE DISPOSAL TO THE ENVIRONMENT

Waste is any material or substance in liquid or solid form which is no longer fit for use. Waste management is the collection, transportation, disposal, controlling and monitoring of wastes. If this is done poorly, it brings about death of people, pollution and respiratory infections just to mention a few.

To begin with, poor waste disposal can cause pollution. Pollution is the introduction of harmful substances to the environment. The most common types of pollution caused by waste are

water and soil pollution. For example industrial effluents and plastic wastes degrades water thereby making it unfit for human consumption.

Another effect is the spread of water borne diseases. In many rural areas, collection and disposal of wastes is not taken seriously. Such wastes are usually human refuse and animal wastes. These wastes end up in water bodies where they contaminate the water leading to the transmission of diseases such as cholera and typhoid

Respiratory infections are the next effect of poor waste disposal. Burning of wastes from medical sources and decomposing litter produce toxic gases. These toxic gases increase the occurrence of respiratory infections.

On top of these comes death. There are some heavy metals such as mercury which have an accumulative effect, that is to say they get transferred along the food chain. Once consumed, these metals can cause death.

Lastly, poor waste disposal can lead to human brain damage. Lead compounds such as tetraethyl lead cause a lot of air pollution which in turn damages the human brain once inhaled. Many countries banned the use of leaded petrol as a result.

To conclude, burying of non-biodegradable wastes has to be avoided as this causes soil pollution.

17. THE RECYCLING PROCESS OF METALS

Recycling is the process of turning of wastes into useful products. The metal recycling process involves collecting, sorting, processing, shredding and Melting and purification.

Collecting: metals are collected from different sources where they are regarded as wastes. These are sold to the metal processing factories and companies.

Sorting: huge magnets are used to separate metals which contain iron from those which do not contain iron

Processing: metal are compacted and broken down so that they are in manageable particle sizes.

Shredding: the metals are broken down further into small pieces so that they are in much smaller and manageable particle sizes

Melting and purification: metals are heated in very hot setup in order to melt them. The impurities from the molten metals are removed using electrolysis.

18. THE RECYCLING PROCESS OF PLASTICS

Recycling is the process of turning of wastes into useful products. The plastic recycling process involves sorting, washing, shredding, identifying and classifying and extruding.

Sorting: at this stage bottles are separated from their bottle tops.

Washing plastics: the plastics are cleaned by washing them in hot water. It also involves removing of labels and impurities on the plastics.

Shredding plastics: as this stage plastic are broken down into smaller and easy to handle particles

Identifying and classifying plastics: the plastic are analysed to determine their chemical compositions. The processing temperatures differ according to chemical compositions of plastics.

Extruding: the clean plastic gets into the processing machine to make sheets of plastics which can be made into different new products.

Topic 2: Greenhouse gases and the ozone layer

1. Effects of natural disaster
   a. Volcanoes
      - Kill people and their properties
      - Sweep away the forests
   b. Bushfires
      - Emit poisonous gases that cause air pollution
      - Destroys crops and wildlife
2. Greenhouse gases are gases in the atmosphere that can trap the heat escaping from the earth
   b. Examples of greenhouse gases
      - Carbondioxide
      - Water vapour
      - Methane
      - Chloroflourocarbons
3. Negative impacts of greenhouse gases on
   a. The climate
      - It causes acid rain
   b. The environment
      - Results to the formation of deserts due to global warming
4. Bushfires and cutting down of trees carelessly
5. Ozone layer is the layer of gas that is made up of three atoms of oxygen, O_3
   b. it is located in the atmosphere 25km above the sea level
6. Ozone layer blocks the ultraviolet radiation from the sun from reaching the Earth so that it does not damage life on Earth
7. Depletion of ozone layer
   One of the gases that deplete the ozone layer is carbon monoxide. This carbon monoxide reacts with the ozone to produce carbon dioxide and oxygen atom. Since the oxygen atom is unstable it reacts with the formed carbon dioxide again to produce carbon monoxide and oxygen gas. This carbon monoxide will continue with this process until ozone layer is depleted. Below are the equations for these reactions;

$$CO + O_3 \rightarrow CO_2 + 2O$$
$$\underline{CO_2 + O \rightarrow CO + O_2}$$
Overall reaction $$O_3 \rightarrow O_2 + O$$

8. Effects of global warming
   - Expansion of deserts
   - Melting of mountain glaciers and polar ice
   - Sub-merging of islands
9. Effects of ozone layer depletion
   - Human health problems: exposure to Ultra violet radiation causes skin cancer
   - Climate change: Earth's temperature increases leading to melting of ice glaciers

10. Ozone layer depletion control
    - No CFCs emitting appliances should be imported into the country
    - Find chemicals that will take the place of CFCs without damaging the environment
    - Completely ban the production of gases and substances which destroy the ozone layer
11. Ozone layer depletion protection methods
    - No CFCs emitting appliances should be imported into the country
    - Find chemicals that will take the place of CFCs without damaging the environment
    - Completely ban the production of gases and substances which destroy the ozone layer
12. Combustion produces carbon dioxide and carbon monoxide which are good examples of greenhouse gases
13. Ways of preventing atmospheric pollution
    - Avoidance of careless setting of bushfires
    - Avoid cutting down of trees carelessly
14. Air pollution is the introduction of harmful substances into air
15. Common pollutants of air
    - Carbondoxide
    - Sulphur dioxide
    - Carbon monoxide
16. Mitigation measures taken to reduce
    - Safe disposal procedures of the materials that emit CFCs
    - Banning the importation of materials that emit CFCs
17. Nitrogen which is 78%
18. To separate it from water
19. Stage of fractional distillation
    - Removing dust particles
    - Removing carbon dioxide and water
    - Liquefying the dry air components
    - Fractional distillation of liquid air
20. Carbon dioxide is removed by cooling the air to a temperature of about -80^{o}C. Since carbon dioxide condenses at -78^{o}C, it is separated from the air as a liquid hence the remaining air is carbon dioxide free.
21. Applications of
    i. Oxygen
        - Used in hospitals to help the patients who cannot breathe well
        - Used in treatment of sewage
        - Used to restore life to polluted lakes
    ii. Nitrogen
        - Used in the manufacturing of dyes and fertilizers
        - Used in shrink fitting
        - Used in freezing liquids in damaged pipes while they are being repaired

iii. Carbon dioxide
- Used in carbonated drinks
- Used in fire extinguishers
- Used by plants in the process of photosynthesis

22. Acidic rain
    a. Carbon dioxide
    $CO_2 + H_2O \rightarrow H_2CO_3$(CARBONIC ACID)
    b. Sulphur dioxide
    $SO_2 + H_2O \rightarrow H_2SO_3$
    $H_2SO_3 + H_2O \rightarrow H_2SO_4$(SULPHURIC ACID)
    c. Nitrogen dioxide
    $NO_2 + H_2O \rightarrow HNO_3$(NITRIC ACID)
23. Substances that can destroy the ozone layer
    - Carbon monoxide(CO)
    - Nitrogen monoxide(NO)
    - Chlorofluorocarbons(CFCs)
    - Alkylhalides

Topic 3: Water

1. The three natural sources of water
    - Surface water
    - Ground water
    - Atmospheric water

2. THE IMPORTANCE OF WATER

Water is used for different purposes depending on where it is used. Such uses are commercial use, domestic use, industrial use and many more

Firstly, water is used for commercial purposes. Commercial use of water includes fresh water for hotels, motels, restaurants and even office buildings.

Second one is water is used for domestic purposes. Domestic use of water includes normal household purposes such as drinking, cooking food, bathing, washing clothes and plates, flushing toilets and even watering gardens and flowers

Next is industrial usage. Water is also used for industrial purposes such as processing, cleaning, transportation, dilution and cooling the engines

Water is the Universal solvent. Water makes an excellent solvent due to its polarity. Water is also an inert solvent, i.e. it does not alter the substance being dissolved. For this reason, most of the nutrients and minerals required by plants and animals are dissolved and carried by water

Lastly, water is used for homeostasis. Water maintains temperature balance not only in bodies of organisms but also within the land and water bodies on the planet. Water resists temperature changes and controls the planet's climate.

3. Hard water refers to water with that has high concentration of salts
4. Soft water readily forms lather with soap while hard water does not readily form lather with soap
5. Advantages of hard water
    - It contains salts good for growth of bones and teeth in people and animals
    - Calcium and magnesium are for root development in plants
    - The salt form a harmless coating in lead water pipes which prevent lead from dissolving into water. Lead is poisonous!

   Disadvantages of hard water
    - Hard water irritates when bathed
    - It makes soap ineffective
    - It makes kettles inefficient

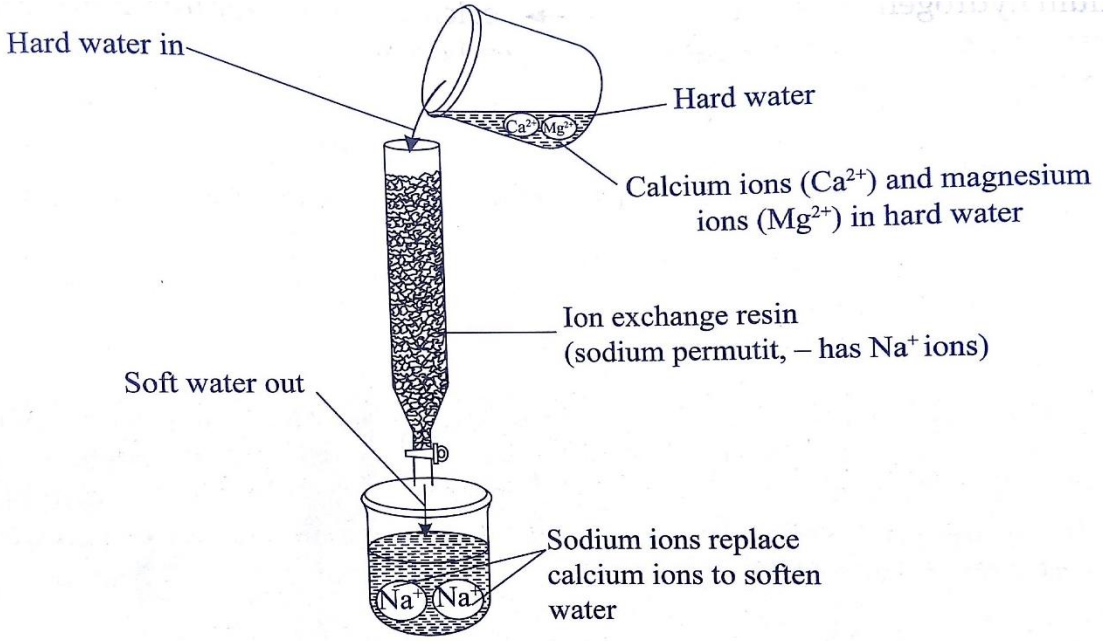
6. Temporary hardness occurs when water contains hydrogen carbonates of calcium and magnesium while permanent hardness occurs when water contains sulphates of calcium and magnesium.
7. **Permutit process**
   Permitit releases Sodium (Na+) ions which exchange with the calcium and magnesium ions in the hard water. Sodium ions in water do not cause water hardness. Calcium and magnesium ions now become part of the insoluble complex compound.
8. Two methods of removing hardness in water
   - Boiling
   - Ion Exchange column
   - Addition of chemicals
9. Effects of hard water in industries
   - Salts in hard water accumulate in water pipes and in turn block them. This increases the cost of distribution of water to residents
   - Hard water makes heating appliances such as kettles inefficient. This makes industries to spend a lot of money on electricity.
10. Soft water readily forms lather with soap while hard water does not readily form lather with soap
11. Types of water hardness
    - Temporary water hardness
    - Permanent water hardness
12. Methods of removing water hardness
    a. Boling
       On boiling the calcium hydrogen carbonate and magnesium hydrogen carbonate decompose to give calcium carbonate or magnesium carbonate which is insoluble in water. These would precipitate and be separated out from water.

    b. Addition of calcium hydroxide
       Calcium hydroxide reacts with magnesium or calcium hydrogen carbonate to form insoluble precipitates of calcium carbonate which separate out from water.

    c. Addition of sodium carbonate
       Sodium carbonate reacts with magnesium sulphates or calcium sulphates to form calcium or magnesium carbonate and sodium sulphate. The magnesium or calcium carbonate is filtered out while sodium sulphate remains in the water as it does not make water hard.
13. Magnesium hydrogen carbonate + heat $\rightarrow$ magnesium carbonate + water + carbondioxide
    $Mg(HCO_3)_2$ + HEAT $\rightarrow$ $MgCO_3(s)$ + $H_2O(l)$ + $CO_2(g)$
14. Water samples tested in lab
    a. Sample Y is pure water since it readily gives lather with soap without any treatment
    b. The other two samples
       i. Sample X contained temporary hardness which was removed by simply boiling
       ii. Sample Z contained permanent hardness
    c. Magnesium Sulphate

15. 20cm3 of water from different areas
    a. Sample C because it requires large volumes of soap to form lather
    b. Sample D since it requires a constant volume of 3.6cm3 in all tests
    c. Temporary or permanent
        i. Sample A contains temporary hardness
        ii. Sample B contains permanent hardness
        iii. Sample C contains both temporary and permanent hardness
    d. Responsible chemical for hardness
        i. In Sample A; it is Hydrogen carbonates of either magnesium or calcium
        ii. In Sample B; it is sulphates of either magnesium or calcium
    e. How an ion exchanger works

    This method uses a resin. The resin is made of an insoluble complex salt known as sodium permutit. Permitit releases Sodium (Na+) ions which exchange with the calcium and magnesium ions in the hard water as shown below.



Sodium ions in water do not cause water hardness. Calcium and magnesium ions now become part of the insoluble complex compound. When all the sodium ions in the resin have been exchanged with calcium and magnesium ions, a concentrated sodium chloride solution is passed through it to regenerate it. This regeneration washes away all the calcium or magnesium ions leaving permutit full of Sodium ions and ready for re use.

16. From the diagram
    a. 1 is evaporation , 2 is condensation, 3 is precipitation and 4 is transpiration
    b. 1 is initiated by high temperatures, 2 is initiated by low temperatures, 3 is initiated by accumulation of water vapour while 4 is initiated by high temperatures
    c. When process 4 increases process 3 also increases.
    d. Process 3 happens as mist and hails

e. Role of ;
   i. Rain water :
   ii. Underground water:
   iii. Surface water:

17. How water acquires hardness
$CaCO_3(s) + H_2CO_3(aq) \rightarrow Ca(HCO_3)_2(aq)$

18. To regenerate resin in an ion exchanger, a concentrated solution of sodium chloride is passed through the column. This washes away all the calcium or magnesium ions leaving the permutit full of Sodium ion and ready for the next use.

19. Ion exchange is the removal of water hardness using a resin column that contains an excess of sodium ions

20. CAUSES AND EFFECTS OF WATER POLLUTION

Water pollution is the introduction of harmful substances into the water as a result of human activities. Substance like toxic metals, fertilizers or plastic wastes can kill aquatic organisms and make water less suitable for drinking.

Waste and sewage from homes. The release of organic wastes such as human faeces and sewage into the water bodies causes water pollution. Organisms that decompose these wastes use up the oxygen in water which leads to death of aquatic organisms due to suffocation. Sewage also promotes the growth of disease causing organisms such as cholera, typhoid and dysentery

.

Industrial wastes: effluents from breweries, textiles and paper industries contain toxic chemicals. These chemicals have the ability of accumulating in fish and some organisms and be transferred along the food chain.

Agricultural practices: pesticides and excess fertilisers may enter the rivers and lakes through surface run off. Excessive use of nitrate fertilisers promotes eutrophication which causes the death of aquatic organisms.

Hot water from industries: hot water result in release of oxygen from water. This leads to the death of fish due to suffocation. High temperatures in water denature some enzymes involved in many biological processes hence many aquatic organisms die.

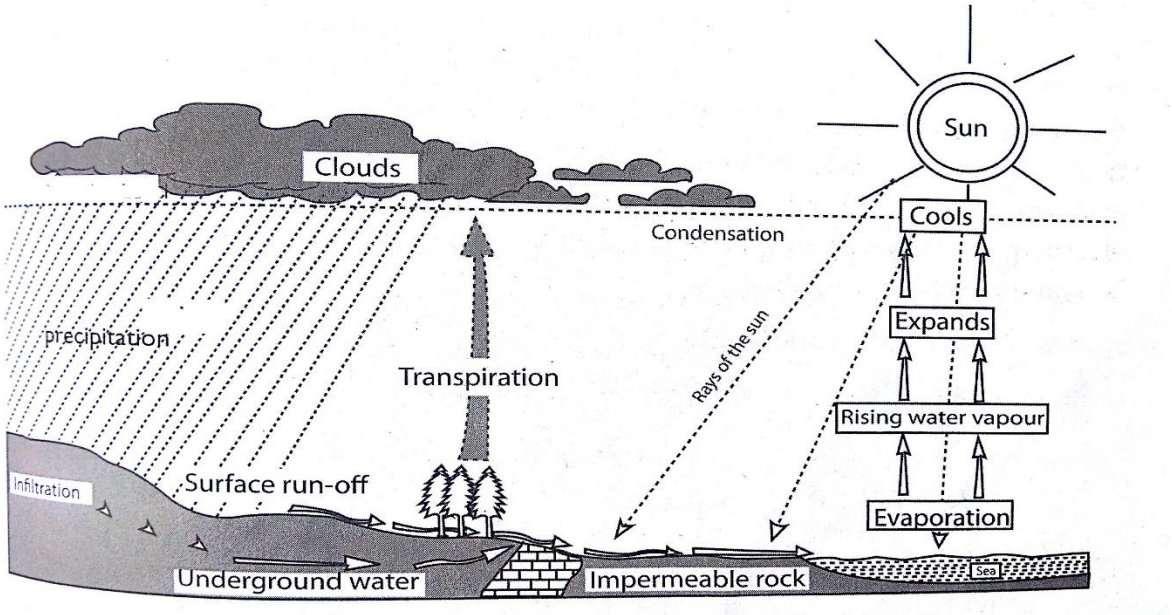
Detergents from washing in homes and hospitals: detergents release phosphates into water. These phosphates cause frothing and promote eutrophication

Always remember water is life!

21. THE HYDROLOGICAL CYCLE

The Hydrological (water) cycle is the continuous circulation of water from the Earth's surface to the atmosphere and back to the Earth's surface. The water cycle consists of different

processes such as Evapotranspiration, Condensation, Precipitation and many more as shown in the figure below.



Evapotranspiration: in this process, liquid water becomes water vapour in the atmosphere. Evaporation is when liquid water is introduced into the atmosphere from surface water bodies such as oceans, lakes and rivers. Transpiration is when liquid water is introduced into the atmosphere from bodies of plants and animals. Evapotranspiration is the combination of evaporation and transpiration and it is initiated by heat from the sun.

Condensation: this is the process in which water vapour in the atmosphere turns back into liquid. This process is facilitated by lower temperatures in the atmosphere. These water droplets remain suspended in the atmosphere in form of clouds.

Precipitation: this is the process whereby water droplets falls back to the Earth's surface. This can be in the form of rain, hail sleet or snow.

Surface runoff: as water returns to the Earth's surface, it moves over land and flows following gravity into streams, rivers, ponds and lakes.

Infiltration: when precipitation occurs, not all the water returns to the ocean as surface runoff. Some is soaked into the ground where it returns to the surface as springs or becomes the groundwater.

22. Hardness and softness of water

A. Aim: <u>To show the difference in hard and soft water</u>

B. Apparatus and reagents

- Liquid soap
- Distilled water
- Tap water
- Four large jars with lids
- Chalk(crush one piece of blackboard chalk)
- Marker to write on jars
- Spatulas

C. Procedure

- Use the marker to label each jar number 1, 2 and 3
- Fill jar 1 about 1/3 with tap water
- Fill jar 2 about 1/3 with distilled water
- Add 2 spatulas of crushed chalk to jar 3. Shake the jar to dissolve the chalk as much as possible
- Add a 20ml of liquid soap in each jar
- Record the results in the table below

D. Results

JAR	OBSERVATION	DISCUSSION
1	Lather was not formed	Tap water is hard water
2	Lather was formed easily	Distilled water is Soft water
3	White cloudy water	Soap stuck to calcium sulphate of chalk

Topic 4: Acid and Base Reactions

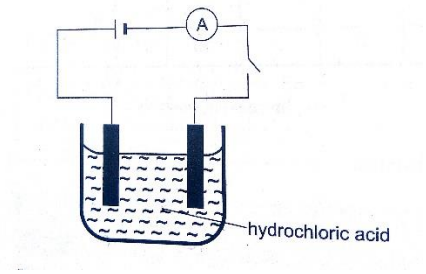
1. An acid is a proton donor
2. Properties of a base
    - It is soluble in water
    - It has a sour test
    - They have a soapy texture
3. Ammonia
    b. Strong base is the base that ionizes completely with water
    c. Ionization of Ammonia

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

    d. Either NH_3/ NH_4^+ or OH^- /H_2O
4. Conjugate acid-base
    a. $H_2SO_4 + NH_3 \rightarrow HSO_4^- + NH_4^+$
    b. $HNO_3 + H_2O \rightarrow NO_3^- + H_3O^+$
5. Hydronium ion is formed when a water molecule of receives a proton from an acid
6. Using conductivity test. The stronger acid would have a higher reading on the ammeter than weak acid
7. A conjugate acid is base the has donated H^+ while a conjugate base is an acid that has accepted H^+
8. Add 3 to 5 drops of universal indicator to vinegar and note the colour changes
9. Conjugate acid base pairs
    a. HCl/ Cl^- and H_3O^+/ H_2O
    b. HNO_2/ NO_2 and H_2S/ HS^-
    c. H_2S/HS^- and H_3O+/H_2O
    d. HCl/NaCl and H_2O/NaOH
10. Identification of solutions
    a. Solution B is Weak acid
    b. Solution D is Strong acid
    c. Solution A is Neutral
    d. Solution C is Basic
11. An Experiment
    A. Aim: Comparing the electrical conductivity of strong acids and weak acid
    B. Apparatus and Reagents
        - Conductivity apparatus
        - Ethanoic acid
        - Hydrocholoric acid
        - Ammeter

C. Procedure

(i) Set up the apparatus as shown below



(ii) close the switch and observe the ammeter reading

(iii) replace the hydrochloric acid with ethanoic acid, and observe the ammeter reading

(iv) Compare the conductivity of hydrochloric acid and ethanoic acid

D. Results

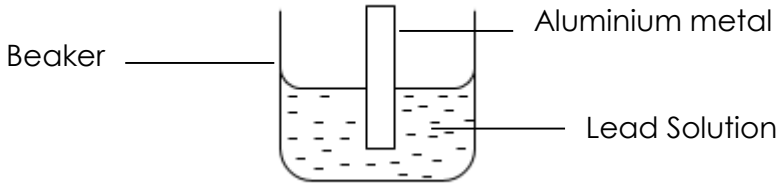
The reading on the ammeter should be high when hydrochloric acid is used than when ethanoic acid is used. This shows that hydrochloric acid is stronger than ethanoic acid.

12. Same as in 11 above

Topic 5: Oxidation and Reduction

1. Oxidation is the loss of hydrogen
2. From the equation
   i. $Fe^{2+} + Cl_2 \rightarrow Fe^{3+} + Cl^-$
   ii. $Fe^{2+}(aq) - e^- \rightarrow Fe^{3+}(aq)$
   iii. $Cl_2(g) + 2e^- \rightarrow Cl^-(aq)$
3. Oxidation and reduction reactions
   Oxidation : $Al(s) - 3e^- \rightarrow Al^{3+}(aq)$
   Reduction : $Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$
4. from the table
   a. order of reactivity (From the most reactive to the least)
      1. Mg
      2. Al
      3. Fe
      4. Pb
      5. Cu

   b. Lead metal deposits and Aluminium solution
   c. An Electrochemical cell



5. From the equations
   a. $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ +0.34V
   $Mg(s) - 2e^- \rightarrow Mg^{2+}(aq)$ +2.36 V (reversed)
   $Mg(s) + Cu^{2+}(aq) \rightarrow Cu(s) + Mg^{2+}(aq)$ +2.70V
   Since the overall E^θ value is positive, the reaction of Magnesium metal and copper nitrate solution would occur
   b. $Mg(s) + 2Ag^+(aq) \rightarrow 2Ag(s) + Mg^{2+}(aq)$ +3.16V
6. oxidation numbers of
   a. Mn in MnO_4
   Let the oxidation number of Mn be x;
   $\therefore x + -2(4) = 0$ *Since the oxidation number for O is* -2 *and total charge is* 0
   $\therefore x = 6$
   b. Cr in $Cr_2O_2^{2-}$
   Let the oxidation number of Cr be x;
   $\therefore 2x + -2(2) = -2$ *Since the oxidation number for O is* -2 *and total charge is* -2
   $\therefore 2x = 2$
   $\therefore x = 1$
7. From the equation

a. Identifying
   i. An oxidizing agent is Ag^+
   ii. A reducing agent is Zn^o

b. +2 on Zn means that Zinc has lost 2 electrons(has been oxidized)

8. From the reaction
   a. $Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$ is the equation for reduction
   b. The oxidizing agent is $ZnSO_4$
9. An Experiment

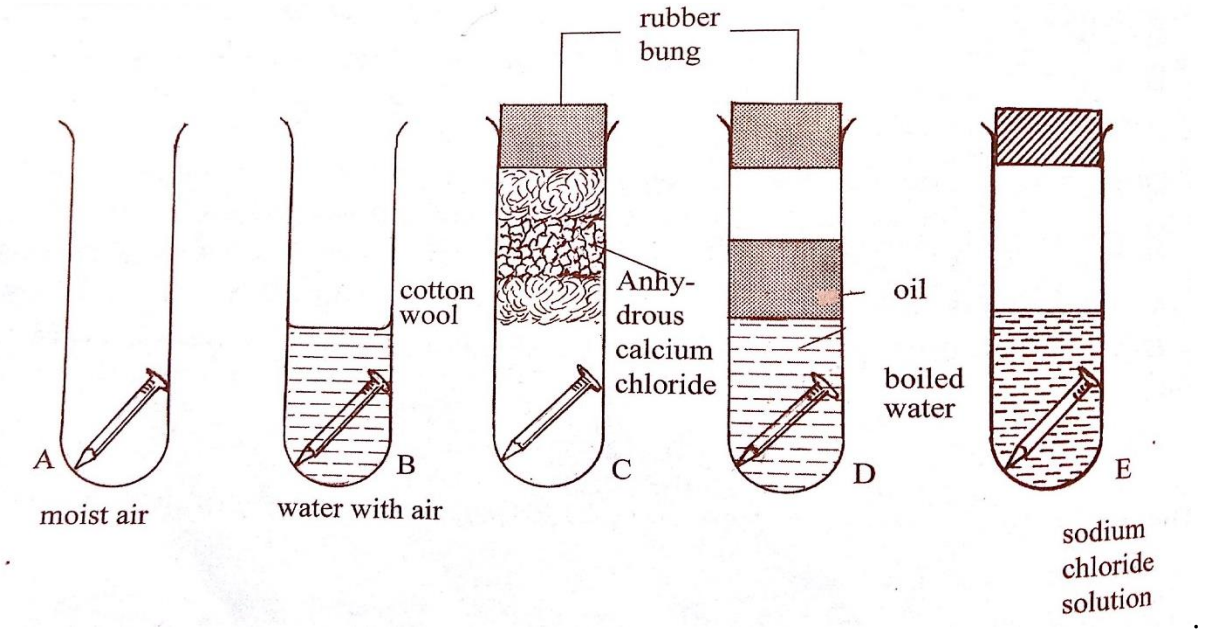
A. Aim: To Investigate the conditions necessary for rusting

B. Apparatus and Reagents

- 5 test tubes
- Test tube rack
- 5 iron nails
- 100ml distilled water
- 100ml tap water
- Anhydrous calcium chloride
- Oil
- Cotton wool
- Emery paper
- Sodium chloride
- Rubber bung

C. Procedure

i. Label the test tubes A, B, C, D and E
ii. Clean the nails thoroughly with emery paper
iii. Put one nail in each test tube and place the test tubes in a test tube rack
iv. Do not add anything to test tube A
v. Add Tap water to cover the nail in test tube B
vi. Push a plug of cotton wool above the nail in test tube C. Add anhydrous calcium chloride. Close the test tube with the rubber bung
vii. Add boiled water to test tube D. Add a layer of oil and close the test tube with the rubber bung
viii. Add sodium Chloride solution to the test tube E. Leave the test tubes undisturbed for one week as shown below.



D. Results

Test tube	Rusted or not?	Explanation
A	Rusted	Oxygen and moisture were both present
B	Rusted	Oxygen and water were both present
C	Did not rust	Anhydrous calcium chloride absorbed water vapour from the air leaving the air dry
D	Did not rust	Boiled water is oxygen free water
E	Rusted a lot	Sodium chloride speeds up the rusting process

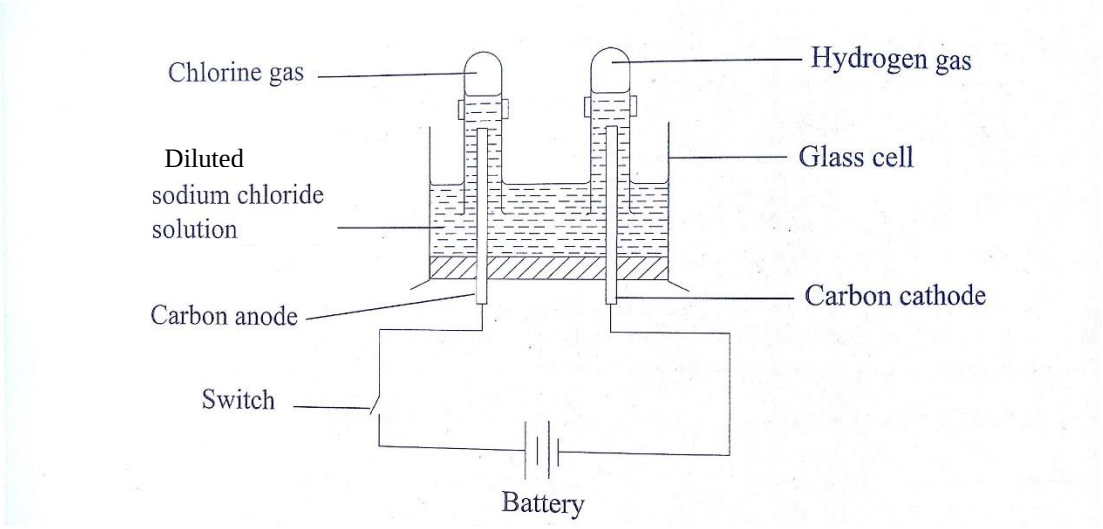
Topic 6: Electrolysis

1. Electroplating is the process of coating a metal by another metal using electrolysis
2. Preferential discharge is the loss of charge of ions in aqueous solutions based on concentration, nature of electrode and position of a metal in the electrochemical series
3. Factors affecting preferential discharge
    - Concentration
    - Position of a metal in the electrochemical series
    - Nature of the electrode
4. Uses of electrolysis
    - Electroplating
    - Purification of metals
    - Extraction of reactive metals
5. Differences between the following;
    a. Cation is a positively charged ion while anion is a negatively charged ion
    b. Anode is the positive electrode while cathode is a negative electrode
6. Lead bromide
7. **THE ELECTROLYSIS OF DILUTE SODIUM CHLORIDE**

    Electrolysis is the decomposition of ionic compounds by passing electric current through them. When Sodium Chloride dissolves in water it forms sodium ions and chlorine ions.

    $NaCl(s) + H_2O(l) \rightarrow Na^+(aq) + Cl^-(aq)$

    The apparatus are set as shown below



When the switch is closed the following will be observed

At the cathode	At the Anode
Ions present are Na^+ and H^+	Ions present are Cl^- and OH^-
H^+ is discharged in preference to Na^+ ions because H+ ion is lower in electrochemical series than Na+ ion	Although OH^- ion is lower in the electrochemical series than Cl^-, the concentration of Cl^- ions is greater than the OH^- ion (why?). Therefore Cl^- ions are discharged in preference to OH^- ions
$2H^+(aq) + 2e^- \rightarrow H_2(g)$	$2Cl^-(aq) - 2e^- \rightarrow Cl_2(g)$
Hydrogen gas is formed	Chlorine gas is formed
H^+ ions are reduced to hydrogen gas	Cl^- ions are oxidized to chlorine gas

8. An experiment

A. Aim: To electroplate copper spoon with silver metal

B. Apparatus and reagents

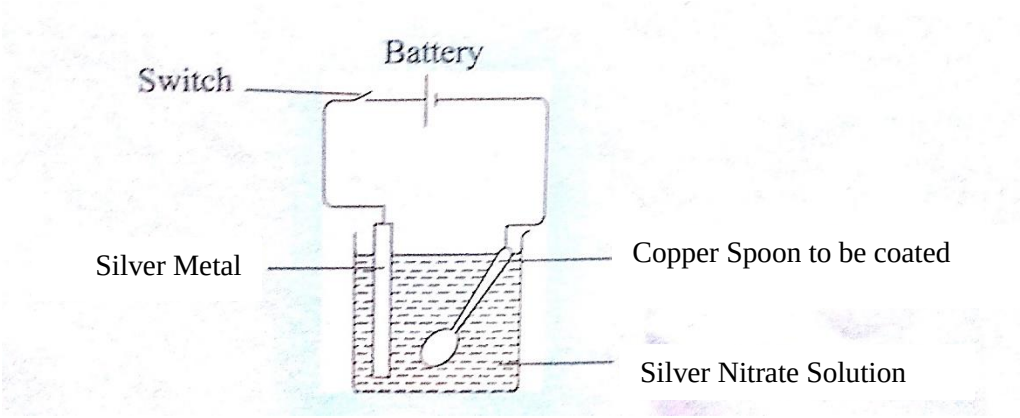
- Conductivity apparatus
- Copper spoon
- Silver metal
- Beaker
- Silver Nitrate solution

C. Procedure

i. Clean the silver metal thoroughly and make it an anode

ii. Clean the spoon thoroughly and make it the cathode

iii. Set the apparatus as shown below



iv. Close the switch and record the observation

D. Results

a. Silver metal anode dissolves; $Ag(s) - e^- \rightarrow Ag^+(aq)$.The silver cation goes to the cathode

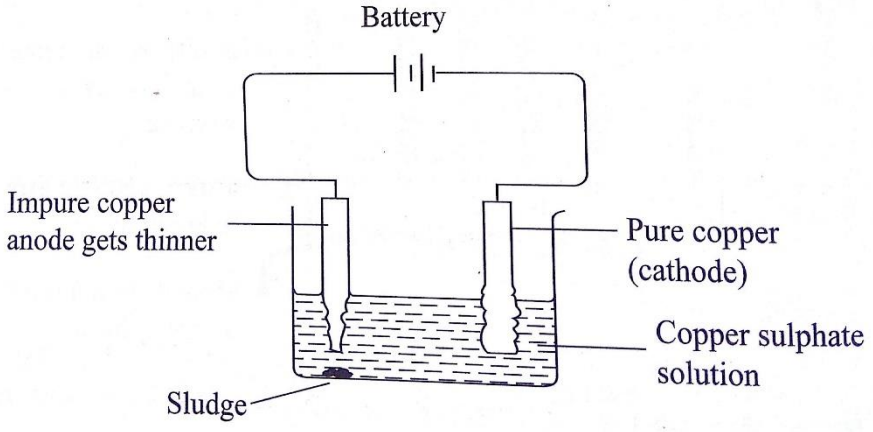
b. Silver coating at the copper spoon; $Ag^+(aq) + e^- \rightarrow Ag(s)$. The silver ion gains one electron at the cathode forming a silver metal. This silver metal coats the copper spoon

c. Ammeter gives a reading

d. Bulb lights up

9. Refining of copper using electrolysis

Copper is widely used as a conductor in various electrical applications. Copper extracted from ores is not pure enough to be used for desired purposes. Therefore it must first be purified (refined) using electrolysis process as shown below



The cathode must be made of thin sheet of pure copper, the anode must be made of impure copper and the electrolyte must contain copper ions.

At the anode: the copper atoms lose electrons and enter into the solution as ions

$$Cu(s) - 2e^- \rightarrow Cu^{2+}(aq)$$

At the cathode: copper ions are reduced then get deposited on the cathode as pure copper solid.

$$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$$

Topic 7: Stoichiometry

1. Definitions
   ii. The empirical formula is the lowest ratio of atoms that make up a compound
   iii. The mole is the amount of a substance that contain avogadro's number of particles
2. Magnesium + oxygen produces magnesium oxide
   Therefore, mass of oxygen used is 4 – 2.4 = 1.6g

Element	Number of moles	Simplest Ratio
Mg	$\frac{2.4}{24} = 0.1$	$\frac{0.1}{0.1} = 1$
O	$\frac{1.6}{16} = 0.1$	$\frac{0.1}{0.1} = 1$

   Therefore the Empirical formula is MgO
3. Simplest formula for compound A

Element	Number of moles	Simplest Ratio
C	$\frac{8.4}{12} = 0.7$	$\frac{0.7}{0.7} = 1$
H	$\frac{1.4}{1} = 1.4$	$\frac{1.4}{0.7} = 2$
O	$\frac{11.2}{16} = 0.7$	$\frac{0.7}{0.7} = 1$

   Therefore the Empirical formula for compound A is CH_2O
4. Working out
   i. Mass of 0.6moles of calcium carbonate(CaCO3)
   Mass = number of moles x RFM
   = 0.6 x (40 + 12 + 48)
   = 0.6 x 100
   = 60g
   ii. Number of moles is 3.2g of oxygen

$$n = \frac{mass}{RAM}$$

$$n = \frac{3.2}{16} = 0.2moles$$

5. $Na_{(s)} + H_2O_{(l)} \rightarrow NaOH_{(aq)} + H_{2\,(g)}$
   a. $2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2\,(g)}$
   b. From the equation above; 36g of water produces 80g of sodium hydroxide
      If 36g = 80g
      Then, 18g = $\frac{18 \times 80}{36} = 40g$
   c. At RTP, one mole of gas occupies 24dm3
      Therefore 24dm3 of hydrogen gas was produced
6. Sodium is more reactive than Magnesium because it has one electron in the outermost shell

7. RFM for the hydrocarbon
   To find the masses of each element;
   85.7/100 x 56 = 48g for carbon
   14.3/100 x 56 = 8g for hydrogen
   To find the number of atoms of each element
   48/12 = 4 atoms
   8/1 = 8 atoms
   Therefore its RFM is C_4H_8
8. Solusilium
   a. Group one / alkali metals
   b. This element would not be found along river banks since it reacts vigorously with water
   c. Keeping it in paraffin/ alkanes
   d. Hydrogen gas
9. 40% is same as dissolving 40g of NaOH in 100ml of water
   Moles of NaOH in 100ml = $\frac{mass}{RFM} = \frac{40}{40} = 1mole$

$$if\ 100ml = 1mole$$

$$then\ 1000ml = \frac{1000ml/l \times 1mole}{100ml} = 10moles/litre$$

10. $C_1V_1 = C_2V_2$
    $8 \times V_1 = 400 \times 0.2$
    $V_1 = 80/8 = 10ml$
11. Molarity = Number of moles/dm^3
    $Molarity = \frac{0.65moles \times 1000cm3/l}{200cm3} = 3.25M$
12. From the equation;

a. 189.9g of $TiCl_4$ produces 47.9g of Ti
   If 3.54 x 10^7g of $TiCl_4$ was used; then $\frac{3.54\times10^7\times47.9}{189.9} = 14.034 \times 10^7 g$
   Therefore, the theoretical yield of Ti is 14.034 x 10^7g

b. $Percentage\ yield = \frac{Actual\ yield \times 100\%}{Theoretical\ yield} = \frac{7.91\times10^6\times100\%}{14.034\times10^7} = 5.36\%$

13. From the equation, 54g of Al produces 190.5g of Cu
    If 2.34g of Al was used; then $\frac{2.34\times190.5}{54} = 8.255g\ of\ Cu\ would\ be\ produced$
    $Percentage\ yield = \frac{Actual\ yield \times 100\%}{Theoretical\ yield} = \frac{3.89g\times100\%}{8.255} = 47.12\%$

14. a. ammonia reacting with oxygen to produce nitric acid and water
    i. $NH_3\ (g) + 2O_2\ (g) \rightarrow HNO_3\ (aq) + H_2O\ (l)$
    ii. If 17g of ammonia produces 63g of nitric acid
    136g would be $\frac{136\times64}{17} = 504g$
    c. 8 molecules x 7 atoms/molecule = 56atoms
15. Titration of HCl and NaOH
    a. NaOH is the standard solution since its concentration was known
    b. Its concentration is known
    c. $M_1V_1 = M_2V_2$
    $V_1 = 25cm^3$, $M_2 = 2M$, $V_2 = 20cm^3$,

Therefore, $M_1 = \frac{2 \times 20}{25} = 1.6M$

16. An Experiment

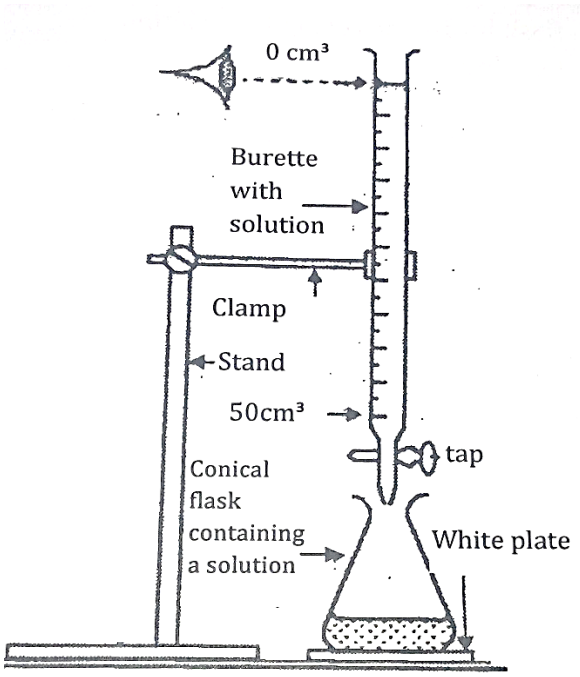
A. Aim: To find the concentration of HCl using 0.1M of NaOH by titration.

B. Materials

- Burette
- Clamp stand
- Conical flask
- 0.1M NaOH
- HCl of unknown concentration
- White plate

C. Procedure

i. Arrange the apparatus as below



ii. Pour the acid into the burette to zero mark

iii. Put a measured volume of NaOH in a conical flask

iv. Add a few drops phenolphthalein indicator in the flask and observe the colour change to pink

v. Gradually add the HCl into the flask while swirling the flask

vi. Stop when there is a colour change of the indicator

vii. Record the new level of the solution in the burette

viii. Find the volume of the acid used

ix. Write a balanced chemical equation

$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

x. Workout the molarity of HCl using the formula

$M_1V_1 = M_2V_2$

17. 300mg tablet dissolved in 10ml of water

a. $n = \frac{mass}{RMM} = \frac{0.3g}{180g} = 0.0017moles$

b. Molarity = moles/ dm^3

$= \frac{1000ml/dm3 \times 0.0017}{10ml} = 0.17M$

18. An experiment

A. Aim: To determine the concentration of Potassium hydroxide using Evaporation

B. Materials

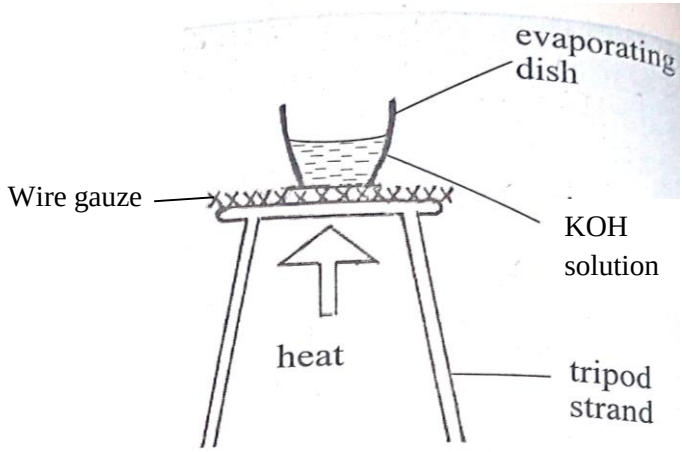
- Evaporating dish
- Measuring cylinder
- Triple beam balance
- Spirit burner
- Tripod stand
- Wire gauze
- Matches

C. Procedure

i. Measure the 50ml of KOH using the measuring cylinder

ii. Add the solution into the evaporating dish

iii. Light the spirit burner and set the apparatus as shown below



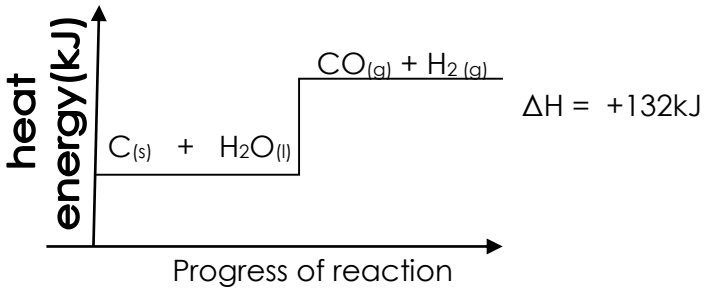
iv. Heat the solution until all the water evaporates leaving the KOH salt behind

v. Measure the mass of the salt remaining in the basin using the triple beam balance

vi. work out the concentration using the formula; $C = \frac{mass}{volume}$

Topic 8: Heats of Reactions

1. Heat energy level diagram

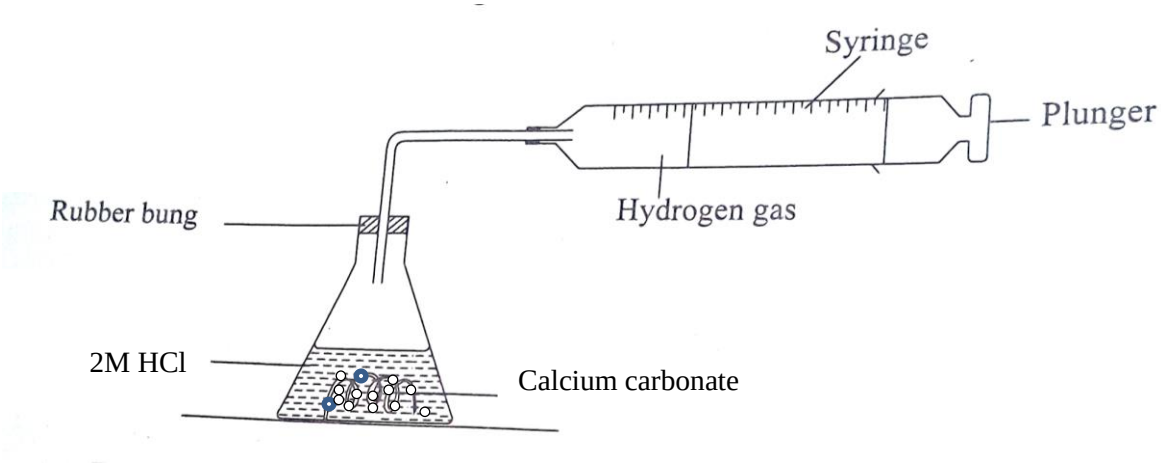


2. From the figure
    a. Endothermic reaction
    b. Because the products have high heat energy than reactants
3. From the table;
    b. 4(413) + 498 → 2(805) + 2(464)
    1652 + 498 → 1610 + 928
    2150 → 2538
    ΔH =2538 – 2150 = 388kJ
    c. This is endothermic reaction

Topic 9: Rates of Reactions

1. The bigger the surface area the higher the rate of reaction
2. Because the catalyst only speeds up the rate at which the products get formed.
3. Factors that affect the rate of reaction
    - Temperature
    - Catalyst
    - Surface area
4. Methods of measuring the rate of reaction
    - Measuring the rate at which reactants are used up
    - Measuring the rate at which products are being formed
5. Catalyst enhances chemical reaction
6. An experiment
    A. Aim: To determine the rate of reaction by change in mass using Calcium carbonate chips and Hydrochloric acid solution
    B. Materials
    - Electronic compact scale
    - Three 250cm^3 Conical flasks
    - Rubber bung with one hole
    - Watch glass
    - Stop watch
    - Chips of Calcium Carbonate($CaCO_3$)
    - 2 M Hydrochloric acid
    - Delivery tube
    - Graduated syringe

    C. Procedure
    i. Put three conical flasks on the bench
    ii. Measure 50cm^3 of 2M Hydrochloric acid and transfer into each of the conical flasks. Label them A,B and C
    iii. Make sure the plunger of the syringe is at zero before the reaction begins
    iv. Arrange the apparatus as shown below

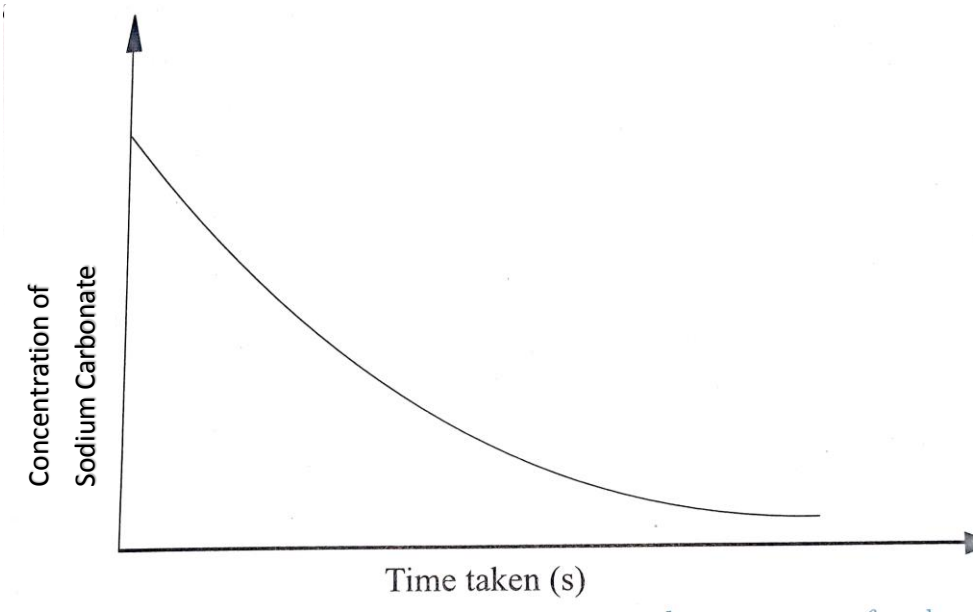


    v. Put 1.5g of Calcium carbonate in flasks A and insert the rubber bung as quickly as possible and start a stop watch as the same time.
    vi. Record the volume of carbon dioxide gas liberated after every 30 seconds until the reaction is over. Record the results in the table below
    vii. Repeat the steps ii to vi using 2.0g and 2.5g of Calcium carbonate in flasks B and C in that order

D. Observation

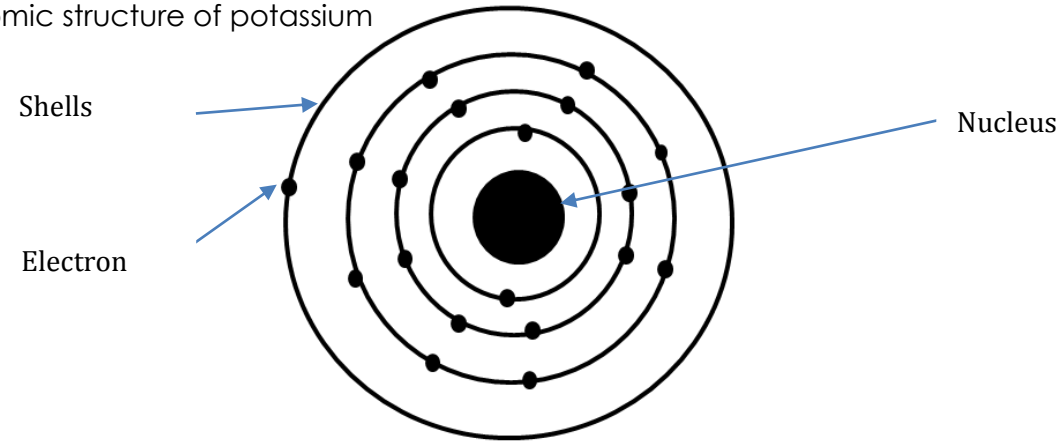
Time taken (seconds)	30	60	90	120	150	180	210
Volume of carbon dioxide gas produced(cm^3)							

Increasing the mass of Sodium carbonate (concentration) increases the rate at which carbon dioxide gas would be produced. If the graph of volume carbon dioxide produced against time taken is plotted a graph as shown is obtained.



Topic 10: Inorganic Compounds

1. From the figure
   a. Potassium
   b. Number of neutrons = 39 – 19 = 20neutrons
      2, 8, 8, 1 is its electron configuration
   c. 4 shells
   d. Atomic structure of potassium



   e. Electron configuration is used to identify the group of the element

2. Isotopes are elements that have the same number of protons but different number of neutrons
3.

Isotope	Number neutrons	Atomic number
$^{24}_{12}$Mg	12	12
$^{25}_{12}Mg$	13	12

4. From the table
   b. Group 4
   c. Y_2X_4 which is YX_2
5. Boron
   a. $^{11}_{5}B$
   b.

$$11 \times 0.8 + 10 \times 0.2 = 10.8$$

6. Given the structure
   a. Group 4 because if 14 electrons are grouped into shell (2, 8,4)the last number is 4
   b. The element is silicon
7. Explanation
   a. Because when they react with water they produce a basic solution
   b. They do not react

8. Sources of phosphorus
    - Crab shells
    - Eggs
    - Banana peels
9. Products from phosphorus
    - Toothpastes
    - Bread and biscuits
10. Allotropes of phosphorus
    - Red phosphorus
    - Black phosphorus
    - White phosphorus
11. Uses of sulphates
    - For making matches
    - Making fertilizers
    - Manufacturing of dyes
12. Naturally as gas and by fixation of legumes
13. Chemical properties of Nitrogen
    - It reacts with group one elements under high temperatures
    - Reacts with hydrogen to form ammonia gas
14. Application of phosphorus
    - For baking
    - For fertilizer manufacturing
    - For toothpaste
15. Graphite conducts electricity because every carbon atom in graphite has three electrons that take part in the covalent bonds, therefore the other electron is free to move
16. Formation of sulphuric acid through contact process
    - **Stage 1:** Sulphur reacts with Oxygen to form Sulphur dioxide.

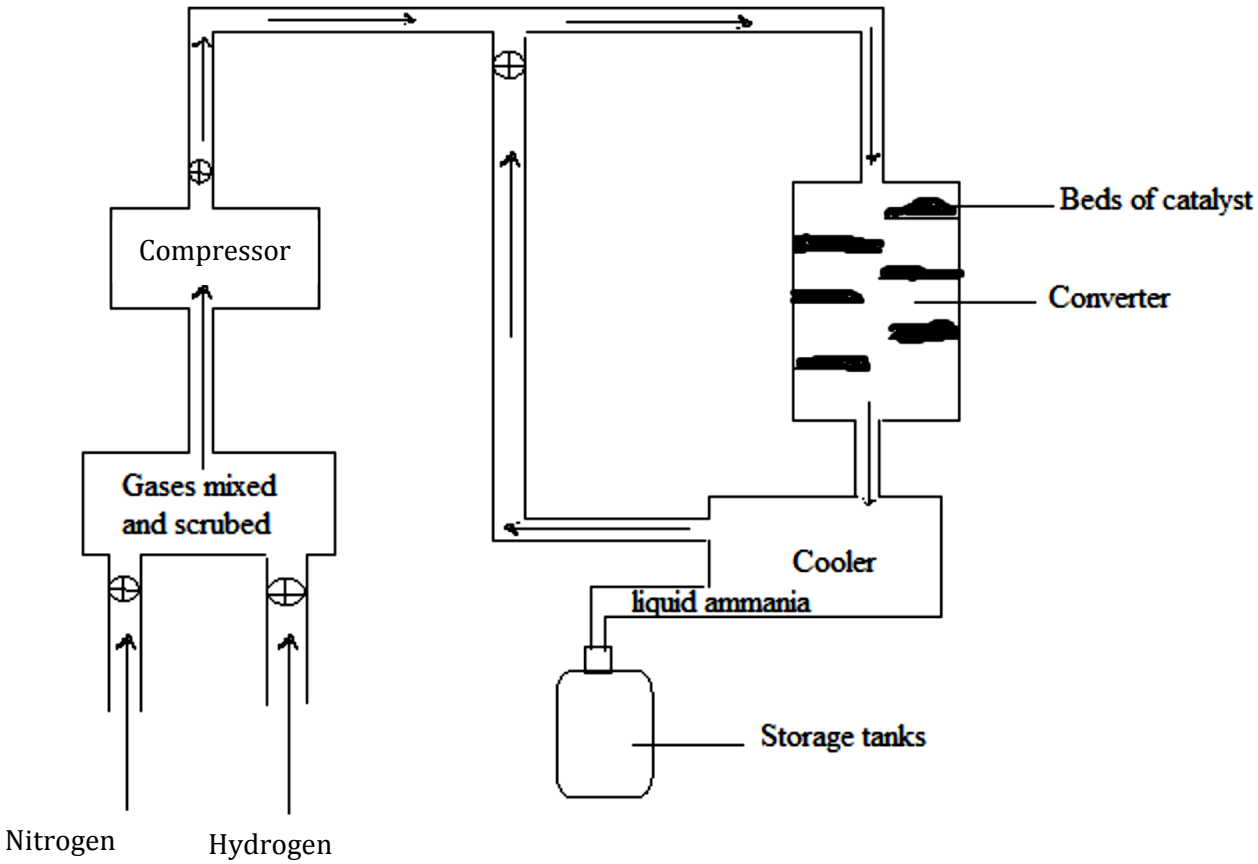
      $$S(s) + O_2(g) \rightarrow SO_2(g)$$
    - **Stage 2:** sulphur dioxide reacts with excess oxygen to form sulphur trioxide

      $$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$$
    - **Stage 3:** sulphur trioxide is dissolved in already made highly concentrated sulphuric acid to form Oleum

      $$SO_3(g) + H_2SO_4(l) \rightarrow H_2S_2O_7(l)$$
    - **Stage 4:** Oleum is mixed with water to produce Sulphuric acid

      $$H_2S_2O_7(l) + H_2O(l) \rightarrow 2H_2SO_{4(l)}$$

17. Production of Ammonia through Haber process



The Haber process combines Nitrogen from the air with Hydrogen from natural gas such as methane into ammonia. $N_2(g) + 3H_2(g) \rightarrow NH_3(g)$

Nitrogen and Hydrogen are mixed. The mixture is cleaned to get rid of impurities. The mixture is thereafter compressed to a pressure of about 200atm. Then the mixture goes to as converter, reactor, round tank containing beds of hot iron. The iron is the catalyst for the reaction. The mixture of all gases that is $N_2(g)$, $3H_2(g)$ and $NH_3(g)$ leave the converter. These gases are cooled until the ammonia condenses. Then the excess nitrogen and hydrogen are pumped back to the reactor to react again. Ammonia is run into tanks and stored as liquid

18. Production of ammonia
    a. Haber process
    b. Nitrogen and Hydrogen

Topic 11: Chemical bonding and Properties of Matter

1. 

2. Valences
   a. For aluminium ions is +3 while sulphate ions is -2
   b. Al^{3+} ⇄ SO_3^{2-} → $Al_2(SO_3)_3$

   The valence for Al becomes the subscript for SO3 and vice versa
3. Polar bond is the bond that is formed between elements where one is more electronegative than the other
4. Properties of covalent compounds
   - They are non-electrolytes
   - They have low melting points than ionic compounds
5. Ionization energy
   a. Ionization energy is the energy required to remove the electron from an atom
   b. Ionization energy decreases as we go down the groups since the more reactive the element is the low the ionization energy
   c. Properties of alkali metals
      - They are soft
      - They are light
      - They are silver shiny when freshly cut
6. Alkaline metals react with water to produce a basic solution
7. Because helium is non-reactive
8. Uses of sodium hydroxide
   - For soap formation- it reacts with esters to form soap and water
   - It is used in salt formation when it reacts with acids
   - For lab experiments in schools
9. Wall built using bricks and mortar
   a. Particles
   b. Inter molecular Force
10. Melting is the process through which solids change into liquids while melting point is the temperature at which a particular solid changes into liquid
11. Compound iron sulphide is a pure substance since is made up of one kind of molecules in its composition while the mixture of iron and sulphur is not a pure substance because it made of two different atoms
12. The higher the temperature the faster the solubility and the lower the temperature the slower the solubility
13. By passing the mixture through a magnetic field. All iron would be attracted by the magnet while sulphur would just pass without being attracted
14. Na_2SO4
15. Allotropy is the existence of an element in two or more forms at the same physical state

16. Uses of alloys
    - Brass is used for making ship propellers
    - Bronze is used for making church bells and coins
    - Steel is used for making bridges
17. Stainless steel
    a. Iron, chromium and Nickel
    b. Because it does not rust
18. Differences
    a. An element is a molecule that is made of one kind of atoms while a compound is a molecule that is made of more than one kind of atoms
    b. An atom is the smallest part of an element that still has the properties of that element while an ion is the charged atom due to unequal numbers of protons and electrons
    c. A pure substance contains one type of molecules in its composition while a mixture contains two or more types of molecules in its composition

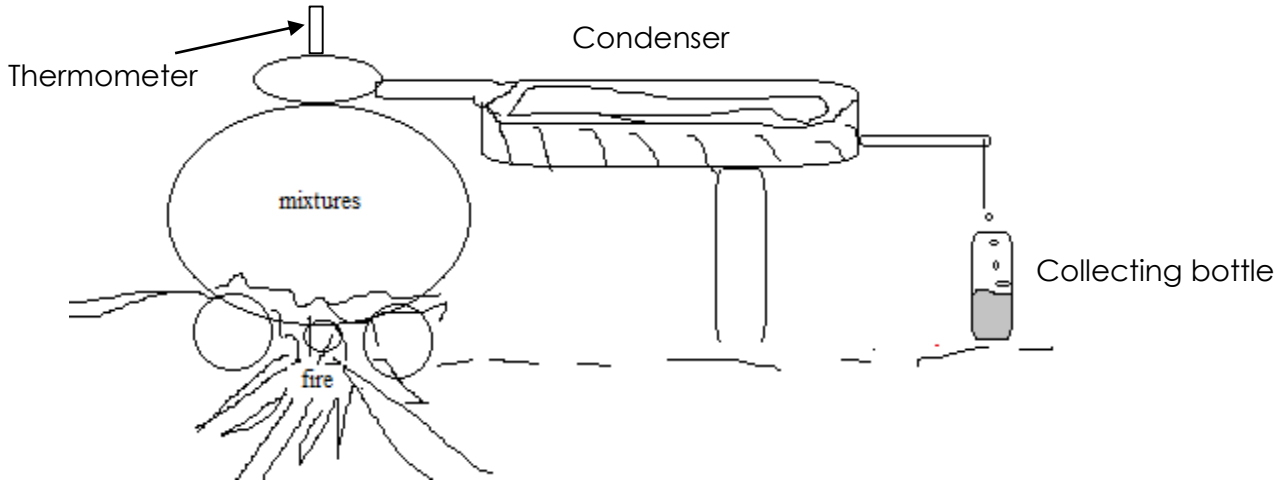
19. Properties of ionic compounds
    - They are good electrolytes
    - They have high melting points than covalent compounds
20. Ionic compounds are compounds that consist of a metal and non-metal while covalent compounds consist of non-metals only
21. $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$
22. Separation of mixtures
    a. A mixture of water and salt
    b. Leaf pigments
    c. Water and ethanol
23. Matter is anything that has mass and occupies space
24. Phases of matter
    - Solid
    - Liquid
    - Gas

25. Evidence of particulate of matter
    - Put a drop of water on a piece of paper. The wet spot will enlarge after 5 minutes. This shows that water has spread outwards. In other words water is leaving the area of high concentration to the region of low concentration

    - Drop potassium permanganate crystals in a beaker that contains water using a thistle funnel. Leave the beaker undisturbed for 10minutes. The whole beaker will be filled with pink colour. Which shows that potassium permanganate moved from the region of high concentration to the region of low concentration.

26. Separation of the mixture of Water, petrol, diesel and Salt using fractional distillation

Fractional distillation is used to separate liquids of different boiling points. To separate water, petrol, diesel and salt set the apparatus as shown on the next page.



The boiling points of liquids in the pot have to be known first. For example water boils at 100°C, petrol starts to boil at 60°C while diesel at 80°C.

The first liquid to come out will be petrol at 60°C. When temperature increases to 80°C, diesel would start to come out at the delivery tube. When the temperature increases further to 100°C water would be the liquid that would be produced at the delivery tube

When every level of temperature has reached a new collecting bottle has to be put at the end of delivery tube.

Salt would remain in the pot. This is how the mixture would be separated.

Topic 12: Experimental skills

1. Chromatography
   a. Retention flow value is the ration of the distance travelled by the spot to the distance travelled by the solvent
   b. Analyte is a chemical substance that is subject to chemical analysis
   c. Eluent is a solvent that is used to remove analyte from the adsorbent
2. Eight coloured substances
   a. B
   b. C and E
   c. A
   d. Red
3. Ignitable wastes are wastes that can easily catch fire
4. Collect them in separate containers and burn them at an open ground
5. Tests for
   a. Water
      - Add the liquid to anhydrous copper sulphate(white in colour)powder
      - If the liquid is water the powder will change to blue
   b. Oxygen
      - Insert a glowing splint in the jar that contains the suspected to be oxygen
      - If the gas is really oxygen the splint would be relighted.
   c. Cations
      - Add aqueous sodium hydroxide to the solutions that contain the metal ions.
      - There would be a precipitation in the solution if the solution contain metal ions due to the formation of metal hydroxides.
   d. Hydrogen
      - Insert a glowing splint in the jar that contains the suspected to be hydrogen
      - The gas would burn with pop sound if it is hydrogen

6. **Five ways of disposing laboratory wastes**
   Laboratory waste is anything from the room that was designed for experiments that is not fit for use. Chemical wastes are very dangerous to the environment if not disposed properly. These wastes can either be burnt, buried, recycled. Re used or incinerated.

   Burning: using this method, wastes are burnt to ashes. Wastes such as filter papers, beaker wrappers and carton boxes

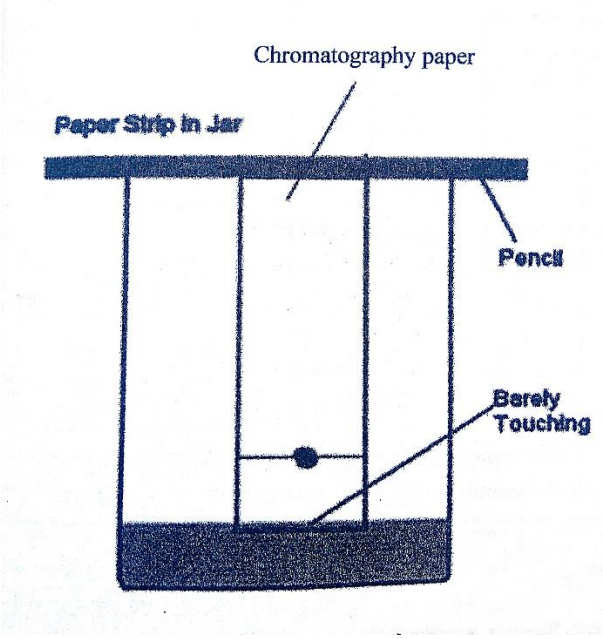
   Burying: this is used to dispose inorganic wastes such as empty chemical containers and broken glassware.

   Recycling: this is the reprocessing of the material that could otherwise be considered waste. For example empty cartons and packaging materials can be recycled by manufacturing industries.

Re using: this is the use of something for what it was not initially intended for. For example, plastic chemical containers can be rinsed with tap water to store standard solutions that are prepared during experiments.

Incineration: most of the chemical wastes are burnt to ashes in a controlled chambers known as incinerators.

7. **Separation of the mixture of ink Dyes using chromatography**
   1. **Aim: To Separate the mixture of ink using chromatography**
   2. **Materials**
      - black ink
      - beaker
      - ethanol
      - filter paper
      - pencil
      - 30cm ruler
   3. **Procedure**
      - **i.** Tear a filter paper into a rectangular shape, 2cm and 8cm long
      - **ii.** Put a drop of ink on one edge of the strip of the filter paper, 3cm away from the edge
      - **iii.** Dip the edge of the filter paper with ink into the ethanol in the beaker, 1.5cm away from the edge of the ethanol as shown below.



   4. **Results**
      Ethanol rises up the filter paper by capillary action. While passing over the ink it will dissolve it. Different ingredients will rise to different heights on the chromatography paper. When they dry they will form separate spots on the paper

8. **Identification of different leaf pigments**

E. Aim : To identify different pigments in a green leaf

F. Materials

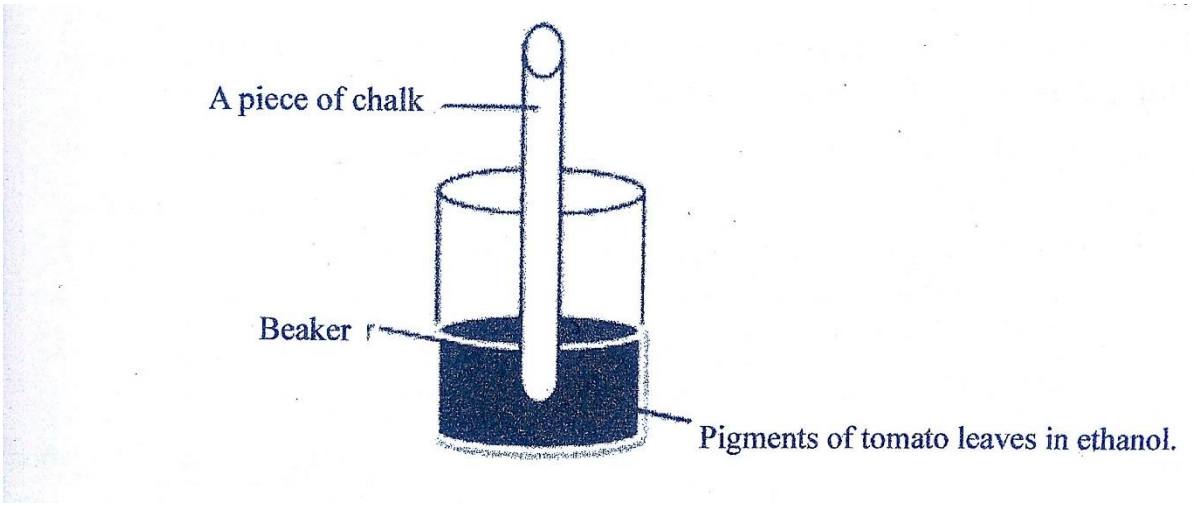
- Green tomato leaves
- Ethanol
- beaker
- mortar and pestle
- white chalk
- Filter paper

G. Procedure

i. Crush tomato leaves in ethanol in a mortar using a pestle. Ethanol is a solvent for the pigments in leaves

ii. Filter the mixture and collect it in a beaker. The filtrate is a solution of the pigments in the leaves in ethanol

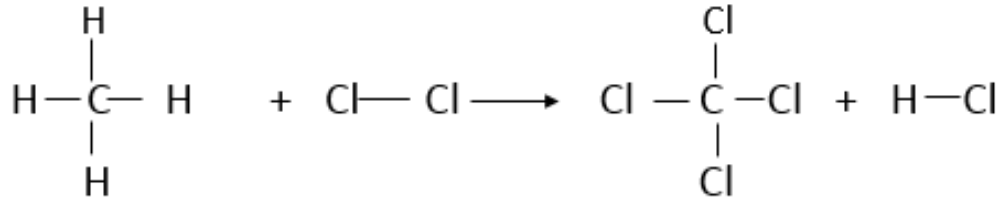
iii. Dip the piece of white chalk in the filtrate and observe it for 30 minutes as shown below



H. Results

As ethanol rises up the piece of chalk, it carries with it the dissolved pigments. Each pigment is carried at a different speed so that ethanol separates out the pigments in the mixture. The different layers of the different colours on the piece of chalk represent the different pigments that were in tomato leaves.

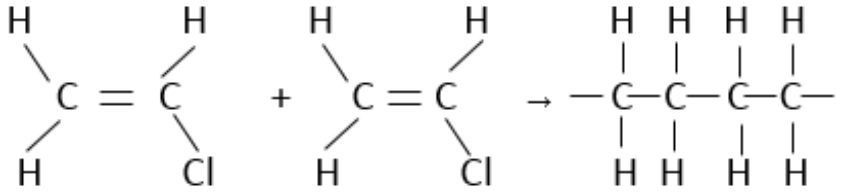
Topic 13: Organic compounds

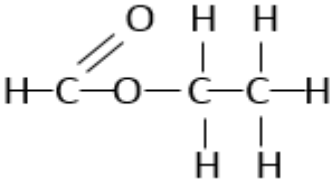
1. Boiling points of alkanes
   a. The boiling points are increasing as the sizes of molecules increase
   b. The boiling point is increasing as number of carbon atoms in 1 molecule increases
   c. Above 25°C
   d. Liquid
2. 

3. Addition reactions of alkenes
   - Halogenation: the addition of halogens to the double bond to form alkylhalides(halogenalkenes)
   - Hydrogenation: the addition of hydrogen to the double bond to form alkanes
   - Hydration: addition of water to the double bond to form alkanol
4. $2C_4H_{10}(l) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)$
5. Hexane
   a. Catalytic cracking since there is Aluminium oxide as a catalyst
   b. To speed up the rate of reaction
   c. $C_6H_{14}(l) \xrightarrow[Al_2O_3]{500^oC} C_4H_{10}(g) + C_2H_6(g)$

6. Fermentation is the decomposition of glucose to ethanol and carbon dioxide by action of yeast known as zymase

   Glucose → ethanol + carbon dioxide
   $C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$

7. Addition polymerization is the joining of monomers end to end to form polymers while condensation polymerization is the joining of monomers using functional groups
8. 

   Vinyl chloride vinyl chloride poly vinyl chloride polymer
9. Organic compounds R, S, T and U
   a. Structure of T 

b. Classification

Soluble	Insoluble
R	S
U	
T	

c. Compound S
d. S has a double carbon-carbon bond since it is an alkene
e. $C_2H_5OH(l) + CH_3COOH(l) \rightarrow CH_3COOC_2H_5(l) + H_2O(l)$

10. Organic compounds A, B, C, and D
    a. Esterification
    b. Ethylpropanoate and water
    c. Compound D
11. Types of polymerization
    - Addition polymerization
    - Condensation polymerization
12. Polymerization of 1, 6-diaminohexane and hexane 1-6 dioyl-dichloride
    a. Condensation
    b. Nylon
13. Two isomers of Butene

But-2-ene

But-1-ene

14. Esters react with bases such as sodium hydroxide or potassium hydroxide to form Soap and alkanols

15. Making Soap

Materials

- Vegetable oil
- Sodium hydroxide
- Distilled water
- A large beaker
- Filter paper
- Source of heat

Procedure

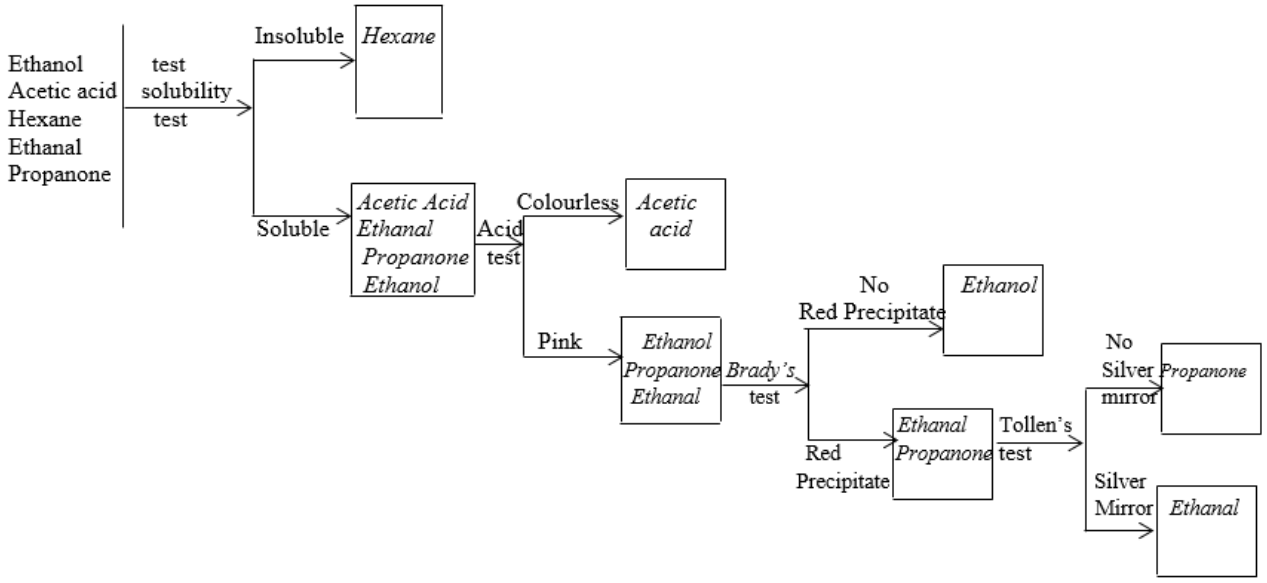
i. Put 25 ml of vegetable oil into an empty 400ml beaker
ii. Add 100ml of 1M sodium hydroxide solution
iii. Heat the mixture gently for 30 minutes in order to mix the contents thoroughly
iv. Continue heating stirring and adding distilled water until all the solids separate out
v. Allow the mixture to cool and then add the concentrated salt solution. Stir the mixture continuously for 5 minutes
vi. Pour the solution into the beaker and allow it to settle. The solution should solidify

Results and conclusion

Soap is produced when sodium salt of the fatty acid is produced from the reaction vegetable oil with sodium hydroxide. The soap cleans the oily piece of cloth.

16. **Flow diagram**

Given ethanol, propanone, acetic acid, ethanal and hexane



17. An experiment

A. Aim: To identify unknown organic compound

B. Materials

- Dropper bottles labelled A, B, C, and D containing ethanol, ethanal, ethanone, hexane not in that order
- Tollen's reagent
- Distilled water
- Test tubes
- 2,4 DNPH solution

C. Procedure

On each unknown compound perform the tests shown in the table below and record the observations. ***Remember to wash with distilled water after each test.***

Test / **Substance**	Add 3- 5 drops of distilled water to 15 drops of the unknown compound	Add 3- 5 drops of 2,4 DNPH to 15 drops of the unknown compound	Add 3- 5 drops of Tollen's reagent to 15 drops of the unknown compound
	RESULT	RESULT	RESULT
A			
B			
C			
D			

D. Results

Hexane would be the compound that could

- be insoluble in water
- show no orange or yellow precipitate with 2,4 DNPH solution
- show no silver mirror with Tollen's reagent

Ethanol would be the compound that could

- be soluble in water
- show no orange or yellow precipitate with 2,4 DNPH solution
- show no silver mirror with Tollen's reagent

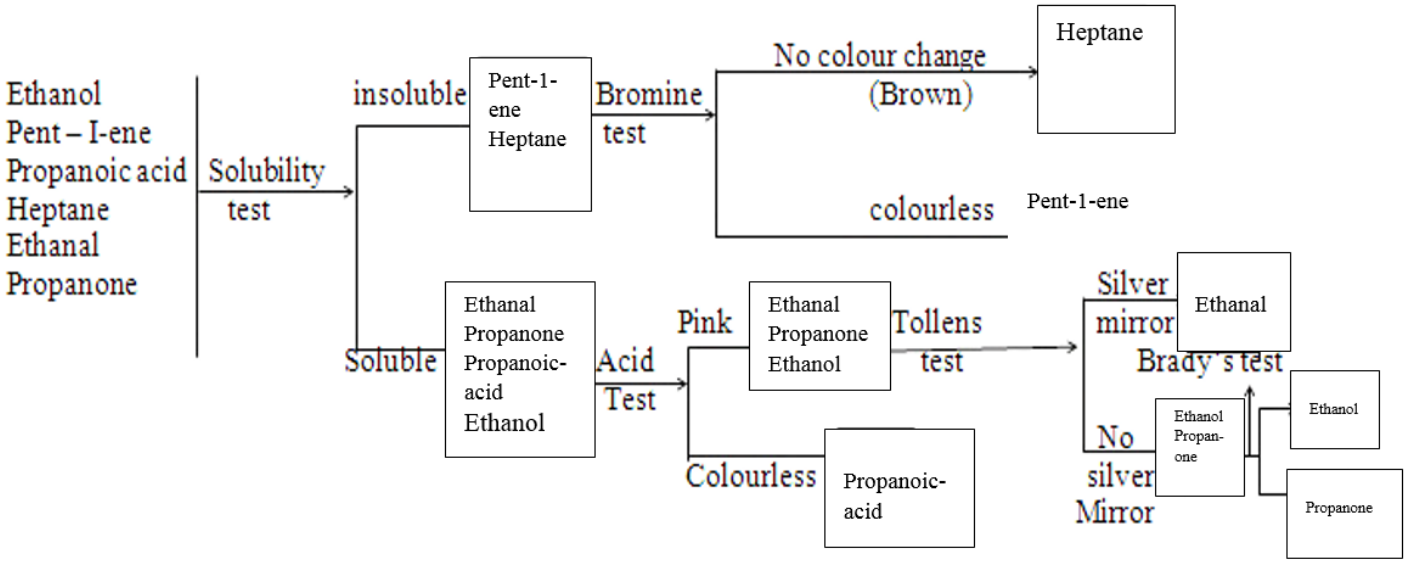
Ethanal would be the compound that could

- be soluble in water
- show orange or yellow precipitate with 2,4 DNPH solution
- show silver mirror with Tollen's reagent

Ethanone would be the compound that could

- be soluble in water
- show orange or yellow precipitate with 2,4 DNPH solution
- show no silver mirror with Tollen's reagent

18. the flow diagram



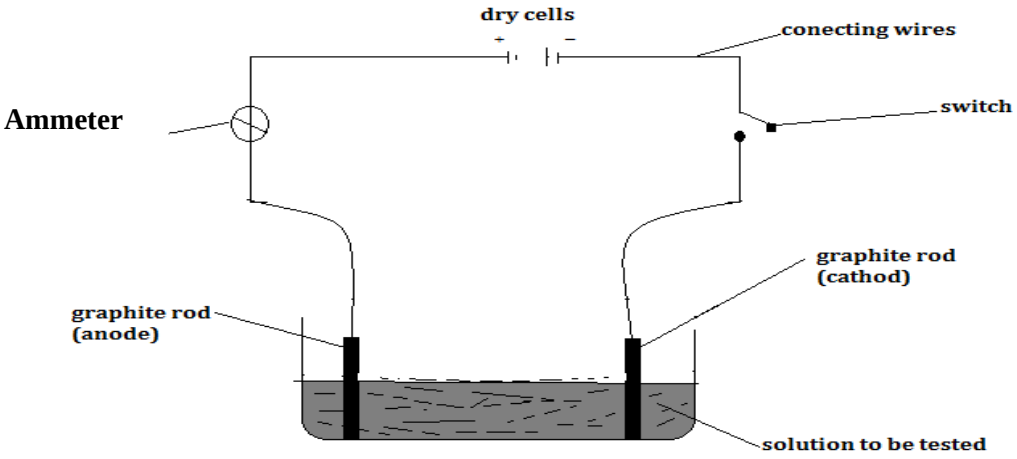
Topic 14: Soil

1. Chemical properties of soil
    - Cation Exchange Capacity: this is the ability of soil to exchange cations at a given pH. CEC depends of the amount of organic matter and the type of clay in the soils. The higher the organic matter and clay content, the higher the CEC
    - Soil Salinity: this the build-up of excessive salts in the soil.
2. Formation of soil
    - Rocks undergo weathering processes where small pieces are produced. These pieces are made of inorganic particles. When the decayed dead animals and plants mix with the inorganic particles they form soil.
3. Soil is a mixture of organic matter, mineral particles, soil water and soil air.
4. Chemicals found in the soil
    - Iron
    - Zinc
    - Oxygen
    - Sulphur
    - Silicon
    - Carbon dioxide
    - water
5. Because different types of soil have different chemical contents.
6. Chemical properties of soil
    - Cation Exchange Capacity
    - Soil Salinity
    - Soil pH
    - Organic matter
7. Because most nutrients are available at neutral pH(between 5.5 to 7.5)
8. Soil pollution is the addition of harmful substances to the soil
9. Table

SOURCE OF POLLUTANT	EFFECTS	CONTROL
Inorganic fertilizers	Deterioration in quality of the soil	Applying organic fertilizers
Poor farming practices	Siltation of rivers and lakes due to soil erosion	Afforestation and making ridges across the slopes
Solid wastes	Soil infertility due to the death of microorganisms that fix nitrogen	Recyle, reuse or reduce
Overgrazing and over cropping	Soil erosion	Avoid overgrazing and over cropping

10. Experiment
    1. **Aim: To Investigate the salinity of samples of soil**
    2. **Materials**
        - 3 different soil samples
        - Water
        - 3 Beakers
        - 2 carbon rods and crocodile clips
        - 2 1.5v cells and cell holders
        - Connecting wires
        - Ammeter
        - Filter paper

3. **Procedure**
   - **i.** Put one sample of soil in water in a beaker and stir
   - **ii.** Wait for the soil to settle down
   - **iii.** Filter the water using a filter cloth
   - **iv.** Use the water as an electrolyte in the conductivity apparatus as shown below



   - **v.** Observe the reading of the ammeter
   - **vi.** Repeat the steps i to v with the remaining 2 soil samples

4. **Results**

   The sample that would display the highest reading on the ammeter is the most saline soil while the one with the lowest ammeter reading is the least saline sample

11. Experiment

A. Aim: investigating the pH of a soil sample

B. Materials

- 3 different soil samples
- Water
- Beakers
- pH meter
- filter cloth

C. Procedure

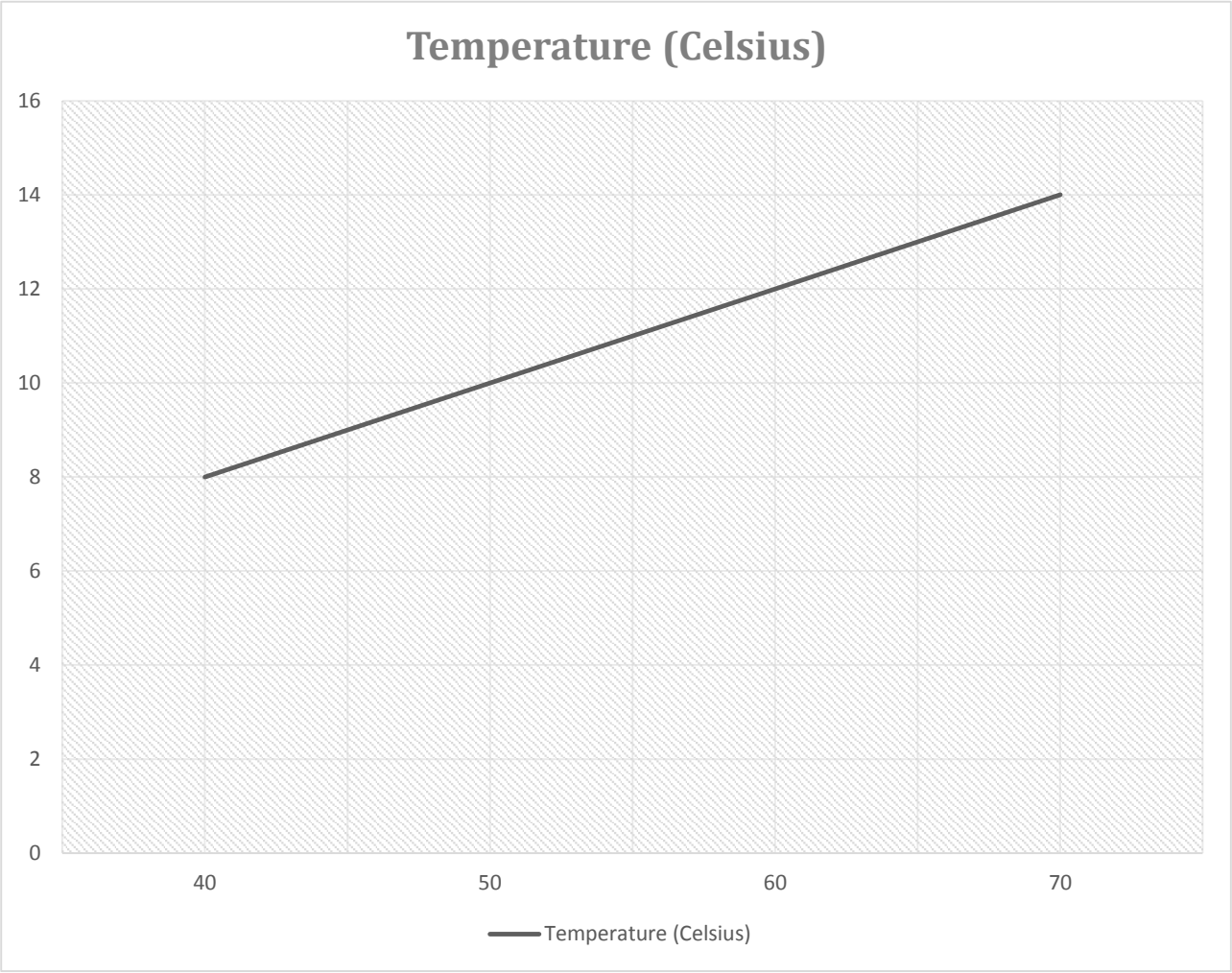
   - i. Put one sample of soil in water in a beaker and stir
   - **i.** Wait for the soil to settle down
   - **ii.** Filter the water using a filter cloth
   - **iii.** Dip the electrodes of the pH meter in the water
   - **iv.** Observe the meter reading
   - **v.** Repeat steps i to v with the remaining 2 soil samples

D. Results

The lower the pH the higher the acidity

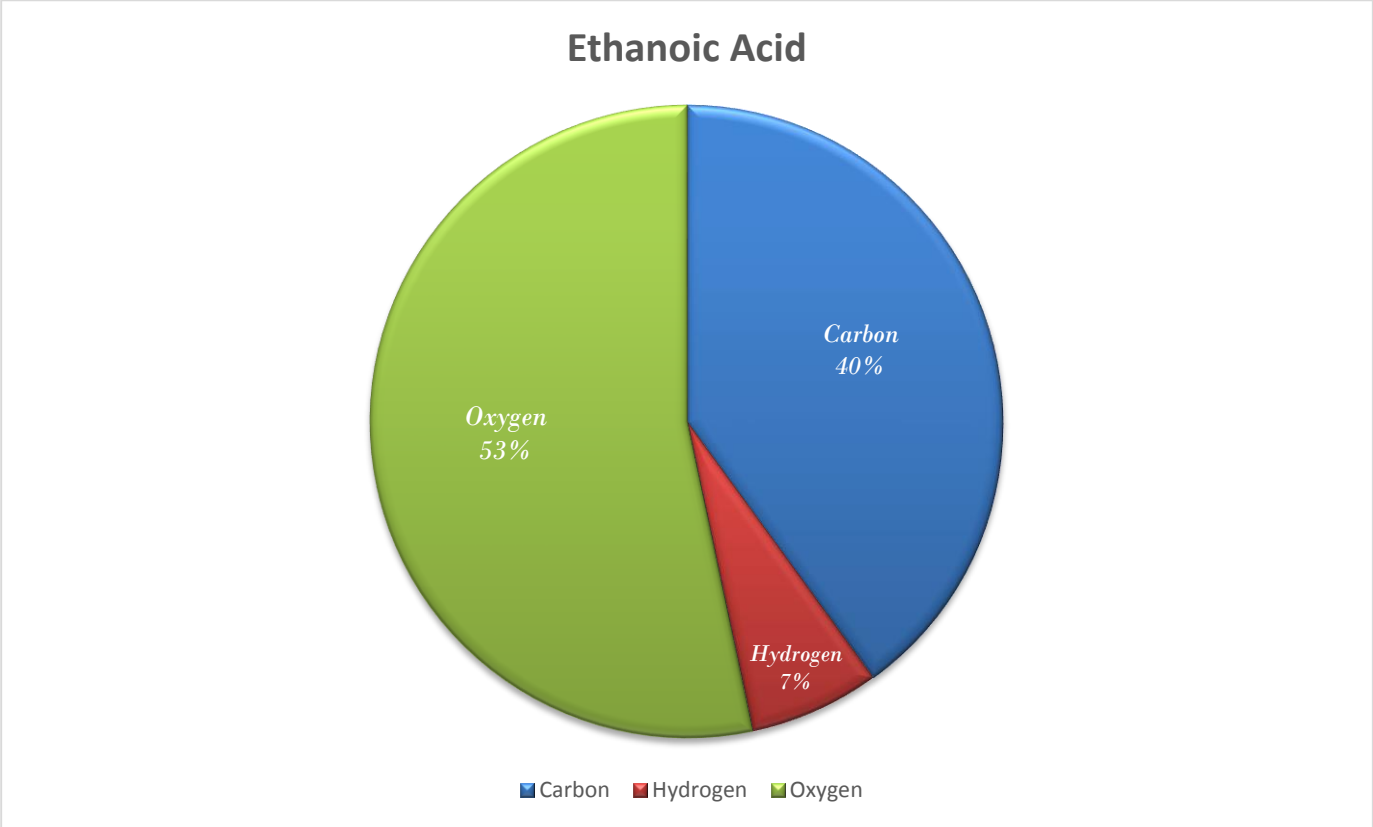
Topic 15: Introduction to Chemistry

1. Chemistry is the study of composition, properties and uses of all material that make up the world
2. Accuracy is how close a measured value is to the exact value while precision is how close data values are to each other
3. From the figure
    d. A
    e. C
    f. B
4. From the table
    a. Graph



    b. As the temperature increases the number of bubbles also increases
    c. 55 ^{o}C
5. Enter the laboratory in an orderly manner
6. Safety measures
    a. Gloves
    b. Use the fire extinguisher to put out the fire
7. 1.67 x 10^{-5}kg
8. 10000 to two significant figures

9. Area = 4.02 x 0.1 = 0.402cm^2
10. Percentage composition of elements in ethanoic acid (CH3COOH)
    RMM = 24 + 4 +32 = 60amu

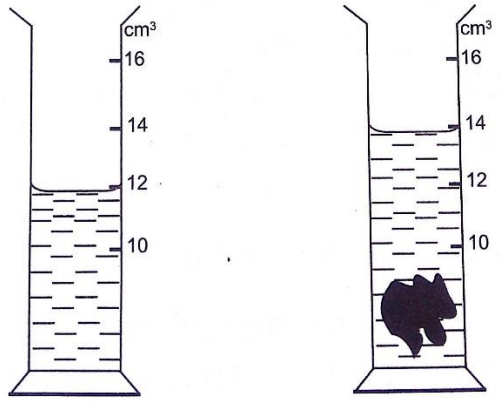


11. Safety symbols
    a.

Number	Safety	Meaning
1		Irritant/Harmful
2		Flammable
3		Poisonous/Toxic

    b. Place it away from an open flame
    c. Group 8
12. Four ways of data representation
    - Table
    - Bar graph
    - Pie chart
    - Line graph

13. To determine the volume of irregular solids, the displacement method is used



The difference in the levels of water in the above figure is the volume of water displaced. This is the volume of the irregular object. This is so because the irregular object occupies the exact volume that the displaced water occupied.

14. Five chemistry careers in the society

Most industries use chemistry to manufacture their products. Manufacturing industries vary in terms of products they make, therefore they need different specialized chemists. This means that people can study chemistry to become the future food chemists, agro chemists, chemical engineers and many more.

To begin with, food chemist is one of the careers. Food chemistry is the branch of chemistry associated with the chemical processes of all aspects of food. The majority of food chemistry bank on biochemistry

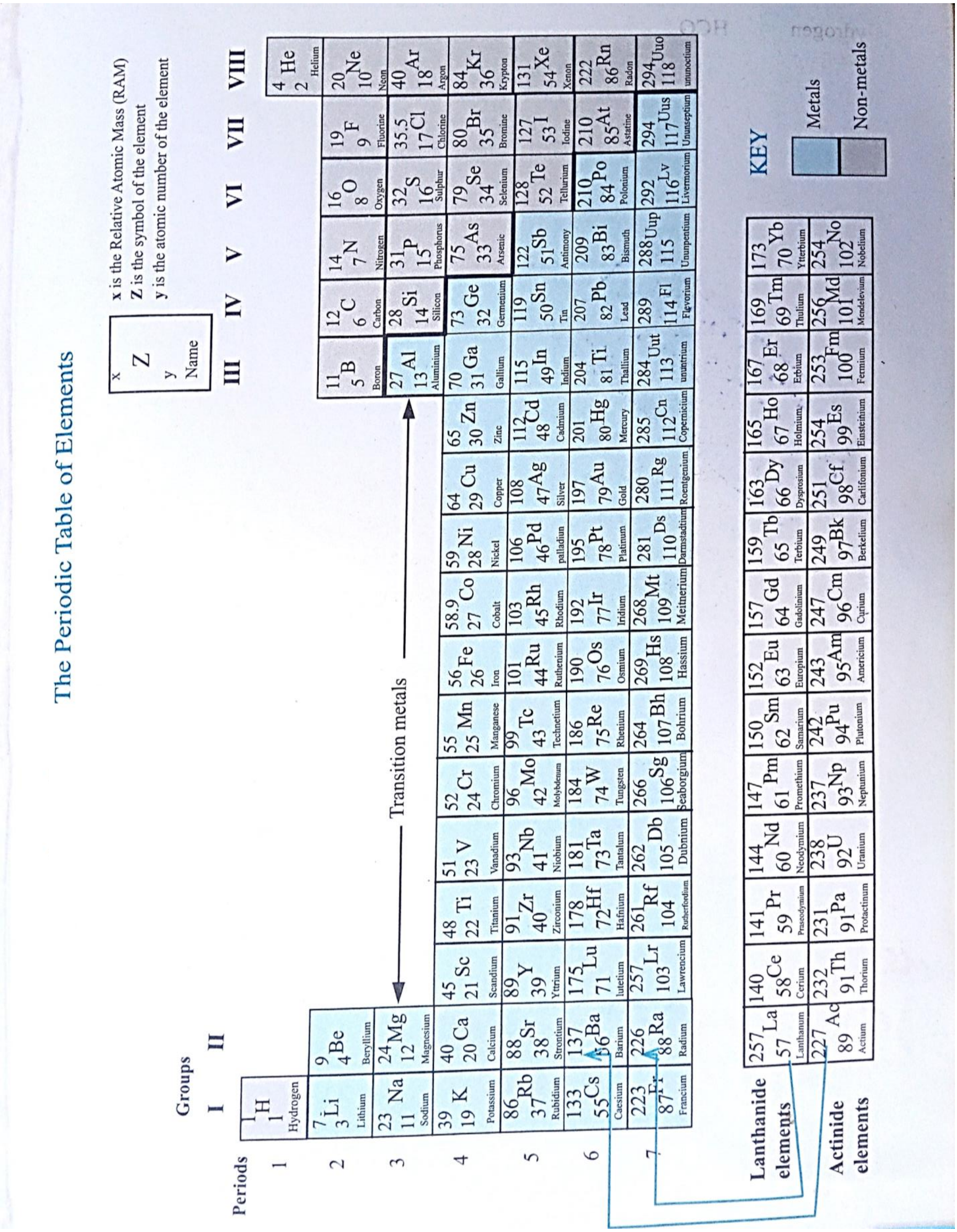
Secondly, Agro chemist. These deal with the application of chemistry for agricultural production, food processing and offering solutions to environmental problems.

Next is chemical engineer. In general engineers offer solutions to different problems in the world. Chemical engineering therefore involves the practical application of chemistry to solve problems.

Last but not least, chemistry teacher. For the whole world to have chemists in different fields, it needs some individuals to instil the knowledge in them. Therefore it is the chemistry teachers in schools who do that.

Lastly, pharmacologist. Pharmacologists study the chemical effects of drugs. These are under the branch of medicine and biology.

The Periodic Table



The Periodic Table of Elements

x Z y Name

x is the Relative Atomic Mass (RAM)
Z is the symbol of the element
y is the atomic number of the element

Periods	I	II											III	IV	V	VI	VII	VIII
1	1 H 1 Hydrogen																	4 He 2 Helium
2	7 Li 3 Lithium	9 Be 4 Beryllium											11 B 5 Boron	12 C 6 Carbon	14 N 7 Nitrogen	16 O 8 Oxygen	19 F 9 Fluorine	20 Ne 10 Neon
3	23 Na 11 Sodium	24 Mg 12 Magnesium	← Transition metals →										27 Al 13 Aluminium	28 Si 14 Silicon	31 P 15 Phosphorus	32 S 16 Sulphur	35.5 Cl 17 Chlorine	40 Ar 18 Argon
4	39 K 19 Potassium	40 Ca 20 Calcium	45 Sc 21 Scandium	48 Ti 22 Titanium	51 V 23 Vanadium	52 Cr 24 Chromium	55 Mn 25 Manganese	56 Fe 26 Iron	58.9 Co 27 Cobalt	59 Ni 28 Nickel	64 Cu 29 Copper	65 Zn 30 Zinc	70 Ga 31 Gallium	73 Ge 32 Germenium	75 As 33 Arsenic	79 Se 34 Selenium	80 Br 35 Bromine	84 Kr 36 Krypton
5	86 Rb 37 Rubidium	88 Sr 38 Strontium	89 Y 39 Yttrium	91 Zr 40 Zirconium	93 Nb 41 Niobium	96 Mo 42 Molybdenum	99 Tc 43 Technetium	101 Ru 44 Ruthenium	103 Rh 45 Rhodium	106 Pd 46 palladium	108 Ag 47 Silver	112 Cd 48 Cadmium	115 In 49 Indium	119 Sn 50 Tin	122 Sb 51 Antimony	128 Te 52 Tellurium	127 I 53 Iodine	131 Xe 54 Xenon
6	133 Cs 55 Caesium	137 Ba 56 Barium	175 Lu 71 lutetium	178 Hf 72 Hafnium	181 Ta 73 Tantalum	184 W 74 Tungsten	186 Re 75 Rhenium	190 Os 76 Osmium	192 Ir 77 Iridium	195 Pt 78 Platinum	197 Au 79 Gold	201 Hg 80 Mercury	204 Ti 81 Thallium	207 Pb 82 Lead	209 Bi 83 Bismuth	210 Po 84 Polonium	210 At 85 Astatine	222 Rn 86 Radon
7	223 Fr 87 Francium	226 Ra 88 Radium	257 Lr 103 Lawrencium	261 Rf 104 Rutherfordium	262 Db 105 Dubnium	266 Sg 106 Seaborgium	264 Bh 107 Bohrium	269 Hs 108 Hassium	268 Mt 109 Meitnerium	281 Ds 110 Darmstadtium	280 Rg 111 Roentgenium	285 Cn 112 Copernicium	284 Uut 113 ununtrium	289 Fl 114 Flevorium	288 Uup 115 Ununpentium	292 Lv 116 Livermorium	294 Uus 117 Ununseptium	294 Uuo 118 ununoctium

Lanthanide elements	257 La 57 Lanthanum	140 Ce 58 Cerium	141 Pr 59 Praseodymium	144 Nd 60 Neodymium	147 Pm 61 Promethium	150 Sm 62 Samarium	152 Eu 63 Europium	157 Gd 64 Gadolinium	159 Tb 65 Terbium	163 Dy 66 Dysprosium	165 Ho 67 Holmium	167 Er 68 Erbium	169 Tm 69 Thulium	173 Yb 70 Ytterbium
Actinide elements	227 Ac 89 Actium	232 Th 91 Thorium	231 Pa 91 Protactinum	238 U 92 Uranium	237 Np 93 Neptunium	242 Pu 94 Plutonium	243 Am 95 Americium	247 Cm 96 Curium	249 Bk 97 Berkelium	251 Cf 98 Carlifonium	254 Es 99 Einsteinium	253 Fm 100 Fermium	256 Md 101 Mendelevium	254 No 102 Nobelium

KEY
Metals
Non-metals