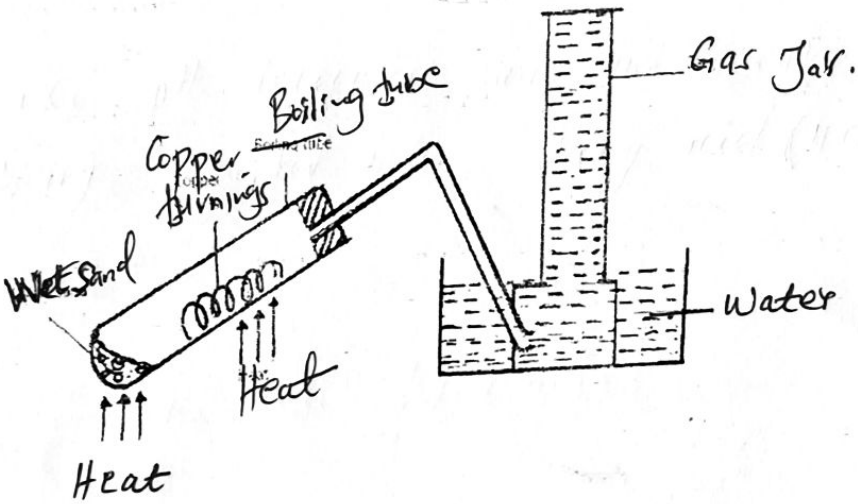
M.S

1. The set-up below was used to investigate the effect of steam on copper turnings.



(a) What was observed in the boiling tube? Explain (2mks)

No observable change. Copper remains brown .Copper is below hydrogen in the reactivity series hence cannot displace hydrogen from steam

(b) Suggest one other metal that would behave as copper turnings in the above set up if used. (1mk)

Gold, Silver. Mercury, platinum

2. (a) State Graham's law of diffusion. (1 mk)

Under the same conditions of temperature and pressure the rate of diffusion of a gas is inversely proportional to the square root of its density.

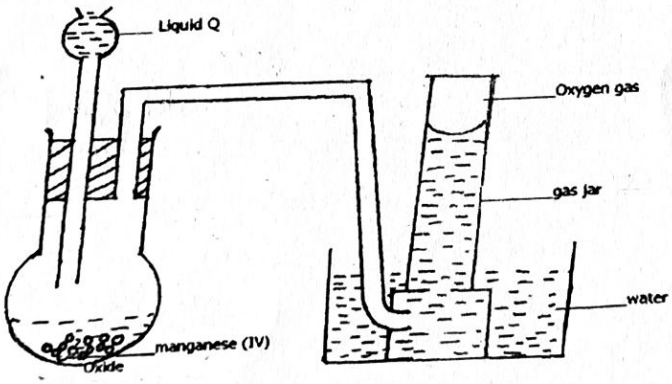
(b) A certain volume of gas S takes 180 seconds to diffuse through a porous plug. Molar mass of S is 18. Equal volume of gas Q takes 240 seconds to diffuse through the same plug.

Calculate the molar mass of Q. (2mks)

b)
$$\frac{T_S}{T_Q} = \frac{\sqrt{RMM_S}}{\sqrt{RMM_Q}} \Rightarrow \frac{180}{240} = \sqrt{\frac{18}{MQ}}$$

$$\frac{9}{16} = \frac{18}{MQ} \Rightarrow MQ = \frac{18 \times 16}{9} = 32$$

3. A student set-up the apparatus shown below attempting to collect oxygen gas.



(a) State one mistake the student made. (1 mk)

Thistle funnel should dip into the solutions in the flask

(b) Identify liquid Q. (1 mk)

Hydrogen peroxide

(c) What property enables the gas to be collected as shown above? (1 mk)

slightly soluble in water.

4. Sodium chloride is accidentally mixed with lead(II) sulphate. Explain how sodium chloride crystals can be obtained from the mixture. (3mks)

Add water to the mixture ¼ and stir to dissolve sodium chloride

Filter off' the lead II sulphate residue. √½ Heat the filtrate to dryness √½ to obtain sodium chloride crystals

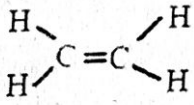
5. The molecular formula of a hydrocarbon is $C_{11}H_{24}$,

The hydrocarbon can be converted into other hydrocarbons as shown below.

$$C_{11}H_{24} \xrightarrow{\text{Process R}} Y + C_9H_{20}$$

(a)Name process R **Cracking** (½ mk)

(b) Draw the structural formula of Y and give its name. (1 ½ mks)

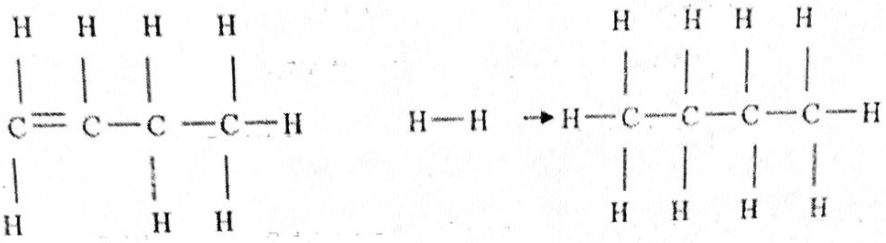


√1 Ethene √½

6. The third number of the alkenes is converted to its corresponding saturated hydrocarbon by hydrogenation. Using the bong energy values given below, answer the questions that follow.

Bond	Bond energy kJ/Mol
H-H	432
C=C	610
C-C	346
C-H	413

Determine the enthalpy change for the conversion of the third member of the alkenes to its corresponding saturated hydrocarbon by hydrogenation. (3mks)

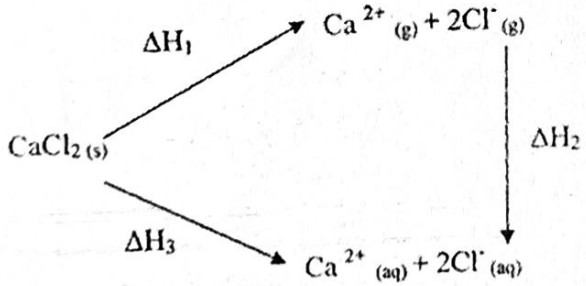


ΔH(2x346)+610+8xx413+432)—(10xx413+3x346)

=5038-5168

= -l30kjmol-1

7. Use the information in the energy cycle below to answer the questions that follow.



(i) What is the name given to the energy changes? (3mks)

H1. — **Lattice energy**

H2. **Hydration energy**

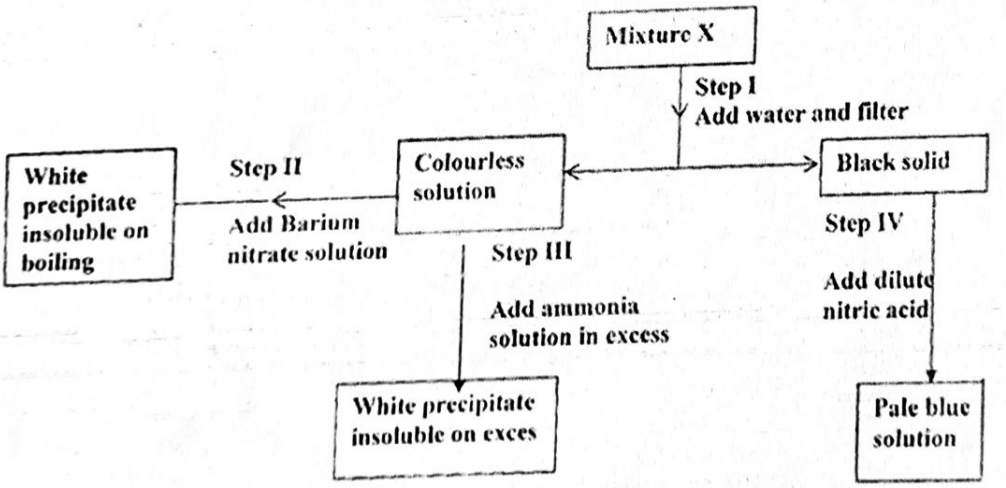
(ii) Given that Δ H1= 2237KJ/Mol and ΔH2=-2378KJ/Mol, calculate the value of ΔH3.
=2237+(-2378)

= -l4lKJmol-1 (1 mk)

8. When solid Zinc carbonate was added to a solution of hydrogen chloride in methylbenzene, there was no observable change. On addition of some water to the mixture there was effervescence. Explain these observations. (2mks)

Hydrogen chloride in methyl benzene is in molecular form. It allows no reaction with Zinc carbonate. /1 When water is added, the hydrogen chloride ionizes and the H ions react with Zinc carbonate producing carbon (VI) oxide.

9. Study the chart below and answer the questions that follow.



(a) Name:

(i) Cations present in mixture X. (1mk)

Cu^{2+} and Zn^{2+}

(ii) Anions present in the solution. (1mk)

SO_4^{2-}

(b) Write an equation to show how the white precipitate in step III dissolves. (1mk)

$Zn(OH)_2(s) + 4NH_3(aq) \rightarrow Zn(NH_3)_4^{2+}(aq) + 2OH^-(aq)$

(c) Name the process outlined in step IV above. (1mk)

Neutralization

10. An element X has two naturally occurring isotopes $^{22}X1$ and $^{20}X2$. If its relative atomic mass is 21.8, calculate the percentage abundance of the more stable isotope. (2mks)

Let y be % abundance of most abundant

$$\frac{22y + (100 - x)20}{100} = 218$$

Y = 90%

11. State two conditions that would make the boiling point of water to be higher than 100°C.

(2 marks)

Presence of impurities

At an altitude above sea-level//pressure above 1 atm (760 mmHg)

12. Study the following equilibrium equation.

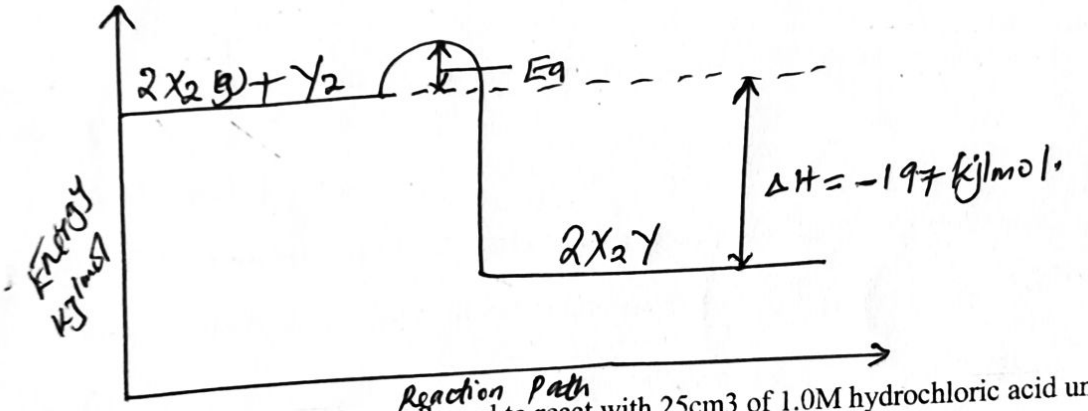
$$2X_2(g) + Y_2(g) \rightleftharpoons 2X_2Y(g) \qquad \Delta H = -197kJ/mol$$

(a) Suggest two ways of increasing the yield of X_2Y. (1 mark)

Lowering the temperature

Increasing pressure

(b) Draw the energy level diagram for the forward reaction. (2 marks)



13. 5.0g of calcium carbonate were allowed to react with 25cm3 of 1.0M hydrochloric acid until there was no further reaction. Calculate the mass of calcium carbonate that remained unreacted. (Ca = 40, C = 12, O = 16)

(3 marks)

$CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + CO_{2(g)} + H_2O_{(l)}$

5.0g | 1M, 25cm³ | 0.0125 moles = 5x/100 | 5 − 1.25 = 3.75g

1 mole – 1000cm³
x mole – 25cm³
= 0.025 moles

$\frac{0.025}{2} = 0.0125$

$= 1.25$

14. A student fetched water from a river in a limestone area. He used it for washing and realized that it did not lather easily.

(i) Name the two ions that prevent lathering. (1 mark)

magnesium ions

calcium ions

(ii) Given that the structure of soap is C17H35COONa.

Explain by means of ionic equations how the above ions prevent lathering. (2 marks)

$Ca^{2+}(aq) + C_{17}H_{35}COO^-(aq) \longrightarrow C_{17}H_{35}COOCa(s)$

$Mg^{2+}(aq) + C_{17}H_{35}COO^-(aq) \longrightarrow C17H35COOMg\ (aq)$

15. M grams of a radioactive isotope decayed to 5 grams in100 days. The half-life of the isotope is 25 days.

(a) What is meant by half life? (1 Mark)

Time taken for a given mass of a radioactive isotope to reduce to half its original mass.

(b) Calculate the initial mass M of the radioactive isotope. (2 Marks)

$\frac{100}{25} = 4$ half lifes.

$5 - 10 - 20 - 40 - 80 = 80g$

16. $20cm^3$ of a dibasic acid required $25cm^3$ of 0.1M NaOH for complete neutralization.

(a) How many moles of sodium hydroxide reacted with the dibasic acid? (1 mark)

$2NaOH(aq) + H_2X(aq) \longrightarrow Na_2X(aq) + H_2O(l)$

$25cm^3$ $0.1M$ | $20cm^3$

0.1 moles $- 1000cm^3$
x moles $- 25cm^3$

$x = \frac{0.1 \times 25}{1000} = 0.0025$ moles

(b) Calculate the concentration of the dibasic acid in moles per litre. (2 marks)

$\frac{0.0025}{2}$

$= 0.00125$ moles

0.00125 moles $= 20cm^3$
x moles $= 1000cm^3$

$x = \frac{0.00125 \times 1000}{20}$

$= 0.0625M$

17. When $25cm^3$ of 0.5M HCl is added to $25cm^3$ of 0.5M NaOH the temperature of the solution rose from 23 ℃ to 26 ℃. Given that the density of the solution is $1gcm^{-3}$ and its specific heat capacity is $4.2Jg^{-1}K^{-1}$.

(a) Determine the amount f heat evolved that caused the temperature rise. (1 mark)

$\Delta H = MC\Delta T$

$= 0.05 \times 4.2 \times 3$

$= 0.63 kJ$

(b) Work out the molar enthalpy of neutralization for this reaction. (2 marks)

0.5 moles $- 1000 cm^3$

x moles $- 25 cm^3$

$x = \frac{0.5 \times 25}{1000}$

$= 0.0125$ moles

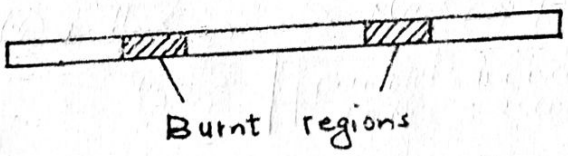
0.0125 moles $- 0.63 kJ$

1 mole $- x kJ$

$x = \frac{1 \times 0.63}{0.0125}$

$= -50.4 kJ$

18. The figure below shows a burning splint that was put across the middle of a non-luminous flame. Explain the results. (2 marks)



The middle part was not burnt because it was in the region of the unburnt gases. (1mk)

The ends were burnt because of complete combustion of the gas at the ends which were hot.

19. 3.22g of hydrated sodium sulphate, Na2SO4.XH2O were heated to a constant mass of 1.42g. Determine the value of X in the formula. (Na = 23.0, S = 32.0, O = 16.0, H = 1). (3 marks)

$Na_2SO_4 \cdot XH_2O \xrightarrow{heat} NaSO_4(s) + XH_2O_{(l)}$

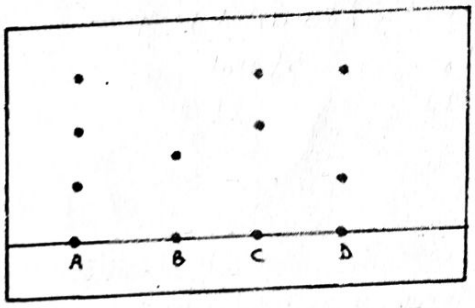
3.22g

Mass	1.42g	1.8
RAM	119	18
Moles	$\frac{1.42}{119} = 0.011$	$\frac{1.8}{18} = 0.1$
S.R	$\frac{0.011}{0.011} = 1$	$\frac{0.1}{0.011} = 10$
m R	1	10

$Na_2SO_4 \cdot 10H_2O$

$X = 10$

20. The following chromatogram was obtained in an experiment to investigate the components present in certain dyes.



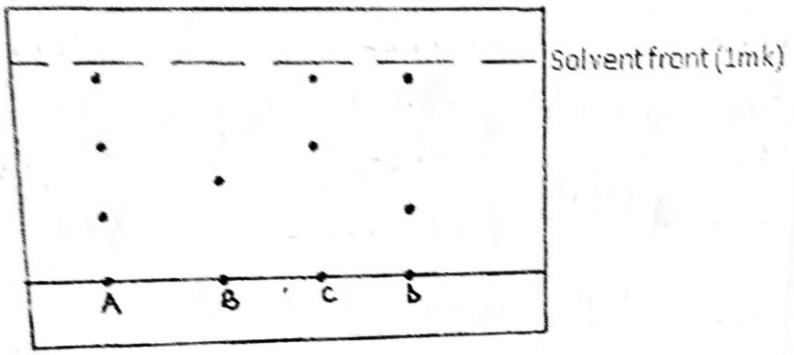
(a) Which two dyes when mixed would produce A? (1 mark)

C and D

(b) Which dye is pure? (1 mark)

B

(c) Indicate on the diagram the solvent front. (1 mark)



21. The following are electrode potentials of the half cells.

Half-cell	E® volts
M^{2+} (aq)/M(s)	-0.76
C^{2+} (aq)/C(s)	+0.34

a) Calculate the potential difference of the following cell. (1 mark)

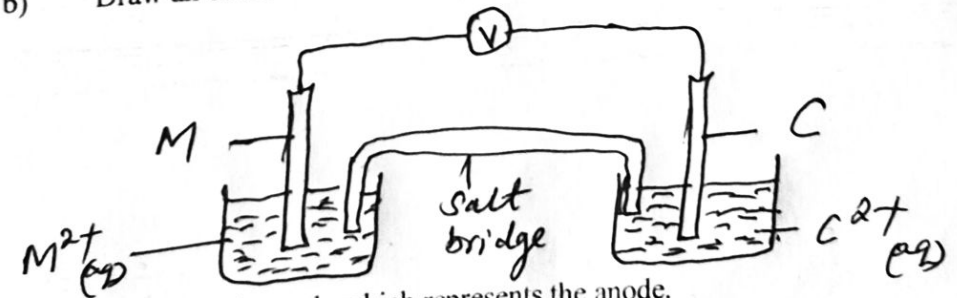
$M(s)/M^{2+}(aq)\ //C^{2+}(aq)\ /C(s)$

$E^{\theta} = E_{reduction} - E_{oxidation}$

$= (0.34) - (-0.76)$

$= +1.1V$

b) Draw an electrochemical cell for the cells in (a) above. (3 marks)

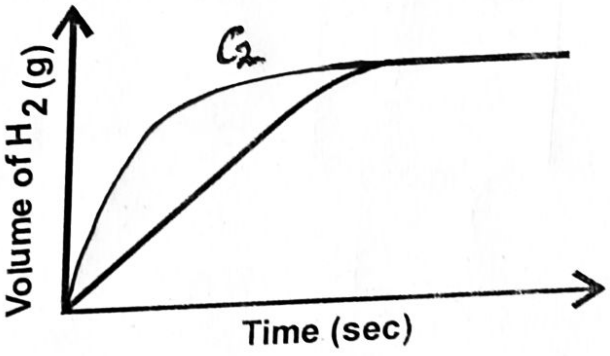


c) Show the electrode which represents the anode. (1 mark)

electrode C

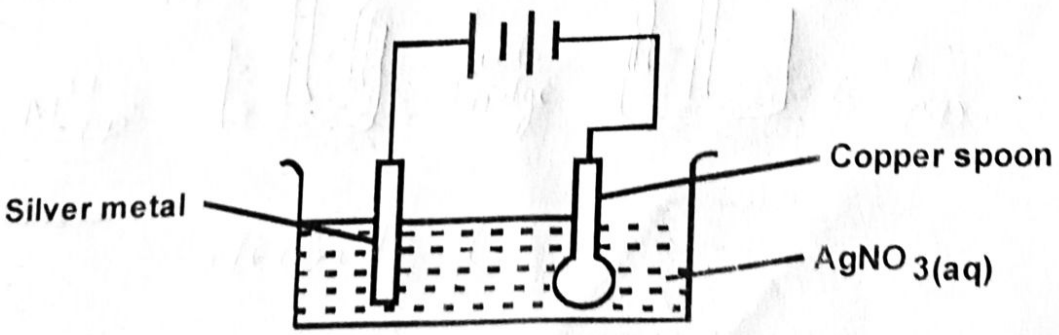
22. The diagram below shows the reaction of zinc granules with hydrochloric acid.

On the diagram sketch the graph that would be obtained if zinc powder of same quantity was used and label it C2. Explain. (2 marks)



* Powder has large surface area in contact with the Acid.

23. A copper spoon was coated with silver metal as shown below.



i) Write an equation for the reaction that occurs at the copper spoon cathode. (1 mark)

$Ag^+_{(aq)} + e^- \longrightarrow Ag_{(s)}$

ii) How many grams of silver would be deposited on the spoon in two hours using steady current of 0.03A? (1 F = 96500C, Ag = 108.0) (3 marks)

$Q = It$

$= 0.03 \times 2 \times 60 \times 60 = 216C$

96500C — 108g

21.6 C — xg

$x = \frac{216 \times 108}{96500}$

$= 0.242g$

24. Copper (II) sulphate solution was electrolyzed using graphite electrodes.

a. State the observations made at the electrodes. (2marks)

Anode pale blue colour of $CuSO_4$ fades

Cathode Red brown deposits of copper metal.

~~pale blue colour of copper (II) sulphate fades~~

$Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$

b. Write the equation for the anode reaction. (1mark)

$4OH^-_{(aq)} \longrightarrow 2H_2O_{(l)} + O_{2(g)} + 4e^-$

25. Write down a balanced equation to show the effect of heat on each of the following substances.

i) Anhydrous copper (II) sulphate (1mark)

$CuSO_{4(s)} \longrightarrow CuO_{(s)} + SO_{3(g)}$

ii) Potassium nitrate salt (1mark)

$2KNO_{3(s)} \longrightarrow 2KNO_{2(s)} + O_{2(g)}$

iii) Silver nitrate (1mark)

$2AgNO_{3(s)} \longrightarrow 2Ag_{(s)} + 2NO_{2(g)} + O_{2(g)}$

26. A compound with the formula X (OH)3(not its actual chemical formula) reacts as shown below

$X(OH)_3(s) + OH^-(aq) \longrightarrow X(OH)_4(aq)$

$X(OH)_3(s) + 3\ H^+(aq) \longrightarrow X^{3+}(aq) + 3H_2O(l)$

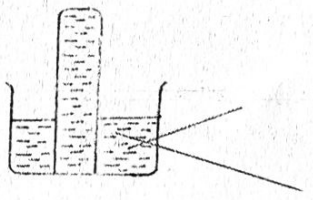
a) State the name of compounds that behave like X $(OH)_3$ in the two reactions above. (1mark)

Amphoteric hydroxides

b) Name two elements whose hydroxides behave like that of X. (2marks)

Lead (II) hydroxide
Aluminium hydroxide
Zinc (II) hydroxide.

27. Chlorine water was exposed to sunlight for one day using the set up below.



Chlorine water

After one day a gas was collected

a) Identify the gas that was collected. (1mark)

oxygen gas

b) State the observations made in the liquid. (2mark)

The yellow colour of the solution fades.

c) What will happen to the pH of the solution after one day? (1mark)

The pH decreases since the weak acid (HOCl) is being converted into strong acid (HCl)