The mole

1. In an experiment magnesium ribbon was heated in air. The product formed was found to be heavier than the original ribbon. Potassium manganate (VII) was on the other hand, heated in air and product formed was found to be lighter. Explain the differences on the observation made
2. In a filtration experiment $25cm^3$ of a solution of Sodium Hydroxide containing 8g per litre was required for complete neutralization of 0.245g of a dibasic acid. Calculate the relative molecular mass of the acid (Na = 23.0, O = 16, H= 1)
3. **D** grams of Potassium hydroxide were dissolved is distilled water to make $100cm^3$ of solution. $50cm^3$ of the solution required $50cm^3$ of 2.0M nitric acid for complete neutralization. Calculate the mass D of Potassium hydroxide (RFM of KOH = 56)

$$KOH_{(aq)} + HNO_{3(aq)} \longrightarrow KNO_{3(aq)} + H_2O_{(l)}$$

4. When excess dilute hydrochloric acid was added to sodium sulphite, $960cm^3$ of sulphuric (IV) Oxide gas was produced. Calculate the mass of sodium sulphate that was used. (Molar gas volume = $24000cm^3$ and Molar mass of sulphite = 126g)
5. The equation of the formation of iron (III) chloride is

$$2Fe_{(s)} + 3Cl_{2(g)} \longrightarrow 2FeCl_3$$

Calculate the volume of chlorine which will react with iron to form 0.5g of Iron (III) chloride. (Fe = 56 Cl=35.5). Molar gas volume at 298K = $24dm^3$)

6. $15.0cm^3$ of ethanoic acid (CH_3COOH) was dissolved in water to make $500cm^3$ of solution. Calculate the concentration of the solution in moles per litre [C=12, H = 1, O = 16, density of ethanoic acid is $1.05g/cm^3$]
7. When 1.675g of hydrated sodium carbonate was reacted with excess hydrochloric acid, the volume carbon (IV) oxide gas obtained at room temperature and pressure was $150cm^3$. Calculate the number of moles of water of crystallization in one mole of hydrated sodium carbonate:- (Na=23, H =1, C=12, O=16, MGV at R.T.P = $24000cm^3$)
8. How many chloride ions are present in 1.7g of magnesium chloride crystals? (Avogadro's constant = 6.0×10^{23}, Mg = 24, Cl = 35.5)

9. 0.84g of aluminium reacted completely with chlorine gas. Calculate the volume of chlorine gas used (Molar gas volume is $24dm^3$, Al = 27)

10. 6.4g of a mixture of sodium carbonate and sodium chloride was dissolved in water to make $50cm^3$ solution. $25cm^3$ of the solution was neutralized by $40cm^3$ of 0.1M $HCl_{(aq).}$ What is he percentage of sodium chloride in the solid mixture?

11 An unknown mass, **x,** of anhydrous potassium carbonate was dissolved in water and the solution made up to $200cm^3$. $25cm^3$ of this solution required $18cm^3$ of 0.22M nitric (V) acid for complete neutralization. Determine the value of **x.** (K=39.0, C =12.0, O =16.0)

12. Calculate the volume of oxygen gas used during the burning of magnesium (O = 16, molar gas volume = $24,000cm^3$ at room temperature)

f) Mass of O_2 = (40 – 24)= 16g

Moles of O_2 = $^{16}/_{16}$ = 01

If 1 mol O_2 ________ $24000cm^3$

01 Mol Mg = 05 mol $_{O2}$ = $1200cm^3$

OR

2mg	***:***	***O2***
2(24)		***24000***

$^{24}/_{2(24)} = {}^{x}/_{240000}$

$X = \dfrac{24 \times 24000}{2(24)} = 1200cm3$

13. A hydrated salt has the following composition by mass. Iron 20.2 %, oxygen 23.0%, sulphur 11.5%, water 45.3%

i) Determine the formula of the hydrated salt (Fe=56, S=32, O=16, H=11)

ii) 6.95g of the hydrated salt in **c(i)** above were dissolved in distilled water and the total volume made to 250cm^3 of solution. Calculate the concentration of the resulting salt solution in moles per litre. (Given that the molecula mass of the salt is 278)

13 i)

	Fe	S	O	H_2O
	$^{202}/_{56}$	$^{115}/_{32}$	$^{230}/_{16}$	$^{453}/_{18}$
	$^{036}/_{036}$	$^{036}/_{036}$	$^{144}/_{036}$	$^{252}/_{036}$
	1	***1***	***4***	***7***

Empirical formula: $FeSO_4 + H_2O$

ii) 695g = $^{695}/_{278}$ = 0025

$\therefore$ 005 moles in 250cm^3 = 0025 x $^{1000}/_{250}$ = 01

14. (i) Lead (II) ions react with iodide ions according to the equation;

$Pb^{2+}_{(aq)} + 2I^-_{(aq)} \longrightarrow PbI_{2(s)}$

300cm^3 of a 0.1m solution of iodide ions was added to a solution containing excess lead II ions. Calculate the mass in grams of lead II iodide formed

(ii) Identify the colour of the product formed in **(d) (i)**

14 RFM of pbI_2 = 207 + (127X2) = 461

2 moles of I^- ions produces I mole of pbI_2

Moles of I^- ions = $\frac{01 \text{ X } 300}{1000}$ = 003 mole

Mole ratio PbI_2: I^- mole of PbI2 formed = $\frac{003}{2}$ = 005

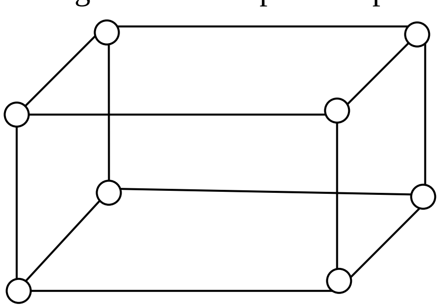
I : 2

Mass of pbI_2 formed = 0015 mole X 461

= 6915 g

d(i) Yellow precipitate Flow of elctrons

15. a) The diagram below represents part of the structure of sodium chloride crystal



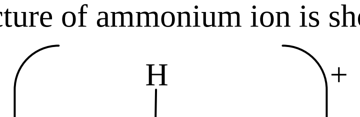
The position of one of the sodium ions in the crystal is shown as;

i) On the diagram, mark the positions of the other three sodium ions

ii) The melting and boiling points of sodium chloride are 801C and 1413C respectively. Explain why sodium chloride does not conduct electricity at 25C, but does not at temperatures between 801C and 1413C

b) Give a reason why ammonia gas is highly soluble in water

c) The structure of ammonium ion is shown below;



Name the type of bond represented in the diagram by N $\longrightarrow$ H

d) Carbon exists in different crystalline forms. Some of these forms were recently discovered in soot and are called fullerenes

i) What name is given to different crystalline forms of the same element

ii) Fullerenes dissolve in methylbenzene while the other forms of carbon do not. Given that soot is a mixture of fullerenes and other solid forms of carbon, describe how crystals of fullerenes can be obtained from soot

iii) The relative molecular mass of one of the fullerenes is 720. What is the molecular mass of this fullerene

15 a) i)

ii) At 25C, sodium chloride is in solid form Ions cannot move Between 801 and 1413C sodium chloride is in liquid state, ions are mobile

b) Both ammonia and water are polar moleculer and hydrogen bonds are formed

c) N _________ H // co-ordinate bond / Dative bond

d) i) Allotrope

ii) Add methylbenzene to soot in a beaker Shake and filter Warm the filtrate to concentrate it Allow the concentrate to cool for crystals to form Filter to obtain crystals of fullerene

iii) $^{720}/_{12}$ ***= 60***

16. Calculate the volume of oxygen gas used during the burning of magnesium (O = 16, molar gas volume = 24,000cm^3 at room temperature)

16 Mass of O_2 ***= (40 – 24)= 16g***

Moles of O_2 ***=*** $^{16}/_{16}$ ***= 01***

If 1 mol O_2 ***________ 24000cm3***

01 Mol Mg = 05 mol O2 = 1200cm3

OR

2mg : O_2

2(24) 24000

$^{24}/_{2(24)} = {}^{x}/_{240000}$

$X = \dfrac{24 \times 24000}{2(24)} = 1200cm3$

17. Study the information in the table below and answer the questions that follow

Number of carbon atoms per molecule	Relative molecular mass of the hydrocarbon
2	28
3	42
4	56

i) Write the general formula of the hydrocarbons in the table

ii) Predict the relative atomic mass of the hydrocarbons with 5 carbon atoms

iii) Determine the relative atomic mass of the hydrocarbon in **(ii)** above and draw its structural formula (H=1.0, C=12.0)

17 ***i) C_nH_{2n}, where n = No of carbon atoms***

ii) 70

iii) C_sH_{10}, $CH_3CH=CHCH_2CH_3$

OR $CH_3CH_2CHCH_2= CH_2$

18. A hydrated salt has the following composition by mass. Iron 20.2 %, oxygen 23.0%, sulphur 11.5%, water 45.3%

i) Determine the formula of the hydrated salt (Fe=56, S=32, O=16, H=11) (3 mks)

ii) 6.95g of the hydrated salt in **c(i)** above were dissolved in distilled water and the total volume made to 250cm^3 of solution. Calculate the concentration of the resulting salt solution in moles per litre. (Given that the molecula mass of the salt is 278)

18 ***i)***

Fe	S	O	H_2O
$^{202}/_{56}$	$^{115}/_{32}$	$^{230}/_{16}$	$^{453}/_{18}$
$^{036}/_{036}$	$^{036}/_{036}$	$^{144}/_{036}$	$^{252}/_{036}$
1	1	4	7

Empirical formula: $FeSO_4 + H_2O$

ii) 695g $= {}^{695}/_{278}$ ***= 0025***

$\therefore$ ***005 moles in 250cm^3 = 0025 x $^{1000}/_{250}$ = 01***

Concentration $= {}^{695}/_{278} \times {}^{1000}/_{250}$ ***= 01***

19. a) Galvanized iron sheets are made by dipping the sheets in molten Zinc.

i) Explain how zinc protects iron from rusting

ii) Name the process applied in galvanization of iron with zinc

20. Calculate the percentage of copper in 1.0g of the alloy

(Cu = 63.5 Mg = 24)

21. A factory uses nitric acid and ammonia gas as the only reactant for the preparation of the fertilizer if the daily production of the fertilizer is 4800kg. Calculate the mass of ammonia gas used daily

(N = 14.0, O= 16.0, H = 1.0)

22. Calculate the volume of sulphur (VI) oxide gas that would be required to produce 178kg of oleum in step 3 molar gas volume at s.t.p = 22.4 litres H = 1 O = 16 S = 32

23. Using the answer in **d (ii)** above, determine:

i) The volume of 1M nitric acid that would react completely with one mole of copper (Cu = 63.5)

ii) The volume of Nitrogen (IV) oxide gas produced when one mole of copper reacts with excess 1M nitric acid at room temperature

24. A sample of biogas contains 35.2% by mass of methane. A biogas cylinder contains 5.0kg of the gas. Calculate:

(i) Number of moles of methane in the cylinder (Molar mass of methane = 16)

(ii) Total volume of carbon (IV) oxide produced by the combustion of methane in the cylinder (Molar gas volume = 24.0dm^3 at room temperature and pressure)

25. 0.84g of aluminium were reacted completely with chlorine gas. Calculate the volume of chlorine gas used. (Molar gas volume is 24dm^3, Al = 27)

26. 3.52g of Carbon (IV) Oxide and 1.40g of water are produced when a mass of a hydrocarbon is completely burnt in oxygen. Determine the empirical formula of the hydrocarbon; (H = 1 , C= 12, O = 16)

27. Calculate the number of water molecules when 34.8g Na_2CO_3 xH_2O is heated and 15.9g of anhydrous Na_2CO_3 obtained (H=1, O=16, Na= 23, C = 12)

28. A weighed sample of crystallined sodium carbonate ($Na_2CO_3nH_2O$) was heated in a crucible until there was no further change in mass. The mass of the sample reduced by 14.5%. Calculate the number of moles (n) of water of crystallization (Na = 23, O = 16, C = 12, H = 1)

29. In a reaction $20cm^3$ of 0.1 M Sodium Carbonate completely reacted with $13cm^3$ of dilute sulphuric acid. Find the molarity of the sulphuric acid used.

30. An organic compound P contains 68.9% carbon, 13.5% hydrogen and 21.6% oxygen. The relative formula mass of **p** is 74. Determine its molecular formula. [C=12, H=1, 0=16]

31. Campers GAZ cylinder contains about $1.12dm^3$ of butane measured at 0^o and 1atm. Given that 25% of heat is lost, what is the maximum volume of water at room temperature which can be boiled to 100^oC in order to make some coffee?

$$C_4H_{10(g)} + 6\ ½\ O_{2(g)} \longrightarrow 4CO_{2(g)} + 5H_2O_{(l)};\ \Delta H^\theta = -3,000KJmol^{-1}$$

(Specific heat capacity of water = 4.2J $g^{-1}C^{-0c}$, density of water $1gcm^{-3}$ Molar gas volume 22.41 at s.t.p)

32. An aqueous solution containing anhydrous sodium carbonate was prepared by dissolving 19.6g of the salt in $250cm^3$ of distilled. Calculate the volume of **2M** of magnesium chloride solution required to precipitate all the carbonate ions in the solution.
(Na=23, C= 12; O = 16; Mg = 24; Cl =35.5)

33. 10.08g of ethanedioic acid ($H_2C_2O_4{\bullet}xH_2O$) crystals were dissolved in water and made to $1dm^3$ solution. $25.0cm^3$ of this solution was completely neutralized by $20cm^3$ of 0.2M sodium hydroxide solution.

Calculate

i) Molarity of the acid

ii)the value of **x** in $H_2C_2O_4\mathbf{x}H_2O$ acid

34. 1.6g of magnesium metal is reacted with excess hydrochloric acid. Calculate the volume of hydrogen gas produced
(Molar gas volume at stp = $22.4dm^3$ Mg=24)

35. 60 litres of sulphur(IV) oxide were made to react with 40 litres of oxygen.

a) Which reactant was in excess and by how much?

b) What is the volume of the product?

36. During welding of cracked railway lines by thermite 12.0g of oxide of iron is reduced by aluminium to 8.40g of iron. Determine the empirical formula of the oxide
(Fe= 56.0, O= 16.0)