FORM FOUR CLUSTER KCSE MODEL 3

CHEMISTRY PAPER 1 ANSWERS

1. (a) -Deflagrating spoon;

   - holding chemicals when they are being heated to burn;

   (b) Pipe clay triangle;

   - Support a crucible on a tripod stand when the crucible is being heated;

2. Add toluene // methylbenzene // organic solvent into the mixture and stir; sulphur dissolves unlike copper (II) sulphate; filter to obtain copper (II) sulphate as the residue; allow residue to dry;

3. (a)(i) Colour turns colourless; sulphuric (VI) acid adds more H+ // increases the concentration of H+ on the right causing the reversible reaction to proceed to the left hence colourless/equilibrium shifts to the left

   w.t.t.e

   (ii)Colour turns pink; Addition of sodium hydroxide introduces hydroxide ions (OH-) which reduces the concentration of hydrogen ions (H+) on the right of the equilibrium; favouring the forward reaction;/making equilibrium to shift to the right.

4. Experiment II; magnesium reacts with both oxygen and nitrogen

5. (a)(i) -Lead metal produces very little hydrogen due to formation of insoluble lead (II) chloride which coats the metal preventing further reaction;

   -The thistle funnel is hanging // does not dip into the reactants hence there would be sucking back;

   (ii) $Pb_{(s)} + 2HCl_{(aq)} \rightarrow PbCl_{2_{(s)}} + H_{2_{(g)}}$;

   (iii)- Slight effervescence in the conical flask;

   -White precipitate in the conical flask;

   (b) $3Fe_{(s)} + 4H_2O_{(g)} \rightarrow Fe_3O_{4(s)} + 4H_{2(g)}$;

6. Let mass number of one isotope be x;

   Thus mass number of second isotope:

   = (100-x);

   $$\text{Thus; } 20.2 = \frac{(20 \text{ x } (x)) + (22 \text{ x } (100\text{-}x))}{100}$$

   (20.2 x 100) = 20x +2200 - 22x

   2020 = 2200 -2x

   2x = 2200 - 2020

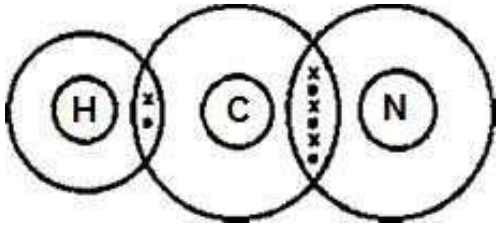
   2x= 180; thus x = 90.0%;

% age abundance of 1st isotope (20) = 90.0%

% age abundance of second isotope (22) =100-90 = 10%;

Note most abundant isotope is one whose RAM is closest to the RAM of the element;

7. Dot and cross diagram (HCN)



8. (a)First ionization energy is the minimum amount energy required to completely remove the first electron from an atom in gaseous state;

Owtte;

(b) $D^{2+} \rightarrow D^{3+} + e$;

(c) Group 4; it has 4 electrons in the outermost energy level; due to sudden large increase in ionization energy between the 4th and 5th ionization energies;

Owtte;

9. (a)(i) $2Na_2CO_3 \bullet NaHCO_3 \bullet 2H_2O_{(s)} \rightarrow 3Na_2CO_{3(s)} + CO_{2(g)} + 5H_2O_{(l)}$;

(ii)- Manufacture of glass;

- Softening hard water; Reject water alone;

10. (a)(i) Potassium;

(b) Anode: $2F^{-}{}_{(l)} \rightarrow F_{2(g)} + 2e^{-}$

11. (a)(i)To produce hydrogen chloride;

(ii) To oxidize $\dot{\underset{\cdot}{Cl}}^{-}$ from HCl, to form chlorine;

(b) Sodium hypochlorite;

12. Hint: in air only oxygen participates in the burning;

Volume of oxygen needed = 2 x 60 = 120dm3;

Percentage composition of oxygen = 21%;

Thus if 21% $\rightarrow$ 120 dm^3

Then 100% $\rightarrow \frac{100 \times 120}{21} = 571.428571\ dm^3$;

13. (i)The paper turns black; this is due to the precipitation of lead (II) sulphide which is black;

(ii) $H_{2(g)} + S_{(s)} \rightarrow H_2S_{(g)}$;

Then: $H_2S_{(g)} + Pb(NO_3)_{2_{(aq)}} \rightarrow PbS_{(aq)}2HNO_{3_{(aq)}}$

14.

(i). $Cu^{2+}{}_{(aq)} + OH^{-}{}_{(aq)} \rightarrow Cu(OH)_{2_{(s)}}$

(ii) With excess

$Cu^{2+}{}_{(aq)} + 4NH_{3_{(aq)}} \rightarrow Cu(NH_3)_4 \}^{2+}{}_{(aq)}$

15. Mass of oxygen : 16.72- 16.17=0.55 g

$$\frac{P1V1}{TI} = \frac{P2V2}{T2}$$

$$\frac{770 \times 400}{287} = \frac{760 \times V2}{273}$$

$$V2 = \frac{770 \times 400 \times 273}{760 \times 287}$$

$$V2 = 385.491 cm^3;$$

$$If\ 22400 cm^3 \rightarrow 1\ mole$$

$$Then\ 385.491 cm^3 \rightarrow \frac{385.495 \times 1}{22400}$$

$$= 0.0172\ moles\ of\ oxygen;$$

$$If\ 0.0172\ moles \rightarrow 0.55 g;$$

$$Then\ 1 mole \rightarrow \frac{1 \times 0.55}{0.0172} = 32 g;$$

$$Thus\ RMM\ of\ the oxygen = 32;$$

$$Penalize\ \tfrac{1}{2} mark if\ units included.$$

16. (a) Ethene;

(b) $C_2H_5OH \rightarrow CH_2CH_{2_{(g)}} + H_2O_{(l)}$;

Reject if Al_2O_3 ***does not appear on the arrow.***

(c) Sulphur (IV) oxide and carbon (IV) oxide; which are formed due to thermal decomposition of concentrated sulphuric (VI) acid and ethanol;

17. Pattern A; the positively charged alpha radiation bends less towards the negatively charged plate because they are heavier/ the negatively charged beta particle bends more towards the positive plate because they are lighter;

18. Electrolytic reactions will change; hydrogen will be released at the cathode in preference to

sodium and oxygen instead of chlorine at the anode; so no sodium would be extracted;

19. (a) Are lectrochemical cells that convert the chemical energy of a fuel directly into electrical energy;

(i) T - hydrogen; R - oxygen;

(ii) Catalyses the reactions at the electrodes to increase the output of the cell;

20.

(i) $L_{(s)} + M^{2+}{}_{(aq)} \rightarrow L^{2+}{}_{(aq)} + M_{(s)}$;

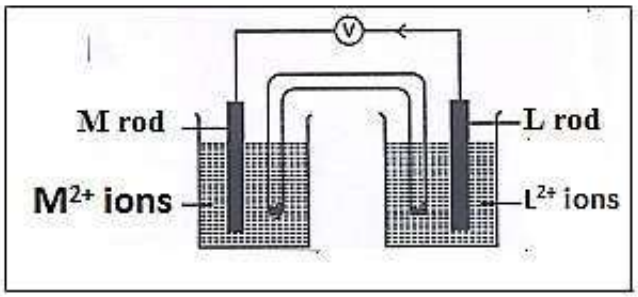
(ii) Calculating Emf of the cell.

$L_{(s)} \rightarrow L^{2+}{}_{(aq)} + 2e$; $\quad E^{\theta} = +0.82V$

$M^{2+}{}_{(aq)} + 2e \rightarrow M_{(s)}$; $\quad E^{\theta} = -0.13V$

$L_{(s)} + M^{2+}{}_{(aq)} \rightarrow L^{2+}{}_{(aq)} + M_{(s)}$; $\quad E^{\theta} = +0.69V$

(iii) Flow of electrons:



Must be on the external connecting wire, from L half-cell to the M half cell

21. The solution turn colourless // red colour fades; chlorine ionizes in the mixture to form chloride ions which react with hydrogen ions on the right of the equilibrium (to form hydrogen chloride gas); this lowers concentration of molecules on the product side causing the equilibrium to shift to the right//forward reaction;

Owtte;

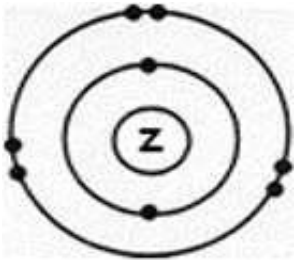
22. Heat copper metal in oxygen to form copper to oxide; Add excess copper (II) oxide to dilute hydrochloric acid; filter to remove excess copper (II) oxide; heat the filtrate until it is saturated; allow the saturated solution to cool and crystallize; pour off the mother liquor // water of crystallization; dry the crystals between absorbent // filterpapers;

Accept any correct alternative method;

23. (a) W andY;

(b) Group 3;

(c) Diagram: atomic structure of Z;



24. (a) The acid did not sink; since the test tube was not tilted;

(b) $FeSO_4 \bullet NO$;

25.

(a) $SiCl_{4(g)} + 2H_2O_{(l)} \rightarrow SiO_{2(s)} + 4HCl_{(aq)}$;

(b) Accept pH range between1-3;

26.

$(a) 2H_2O_{2(aq)} + SO_{2(g)} + H_2O_{(l)} \rightarrow 2H_2O_{(l)} + SO_4^{2-}{}_{(aq)} + 2H^+{}_{(aq)}$;

(b) Redox reaction//Reduction – oxidation reaction;

27.

(a) Bond breakage;

$= +641$ kJ; since heat is absorbed to break the ionic bond between the Mg^{2+} and Cl^- ions;

Bond formation:

$[(1 \times -467) + (2 \times -167)] = -801\ kJ$;

Heat change $= = 641 + (-801) = -160\ kJ$;

(b) Has a high enthalpy of solution//low lattice enthalpy;

28. (i) The yellow solid turns into a red solid during heating and final into a grey solid;

-Black particles in the mixture disappear;

(ii) $2CO_{(g)} + O_{2(g)} \rightarrow 2CO_{2(g)}$;

29. Saturated solution = 28 g;

Mass of salt only =7 g;

Mass of water //solvent; 28 – 7=19 g;

Thus 19g of water contains 7 g of salt;

Then 100 g of water will contain; =?

$$\frac{100 \times 7}{19} = 36.842105\ g$$

Solubility =38.842105 g/100 g of water;

Amounts of $NaCl$ and NH_4Cl

$$NH_4Cl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)} + NH_{3(g)}$$

$$Moles\ of\ NaOH = \frac{100}{1000}$$

$$Moles\ of\ HCl = \frac{30 \times 3}{1000}$$

$$= 0.09\ moles$$

$Thus\ 0.09\ moles\ remained\ to\ react\ with\ the\ HCl$

$Moles\ of\ NaOH\ that\ reacted\ with\ NH_4Cl : 0.1 - 0.09 = 0.01 moles$

$Moles\ of\ NH_4Cl = 0.01\ moles; by\ reaction\ ratio..$

$$Mass\ of\ NH_4Cl = 53.5 \times 0.01$$

$$= 0.535$$

$$Mass\ of\ NaCl = 1.535 - 0.53$$

$$= 1.0g$$