ELECTRO CHEMISTRY I AND II

1. a) Arrow from zinc to copper rod: zinc is more reactive than copper.

   Zinc donate electrons more readily.

   b) No deflection

2. $4OH_{(aq)} \rightarrow 4e + 2H_2O_{(l)} + O_{2(g)}$

3. i. Q= 0.6x 90 x 60 = 3240 columbs

   ii. $\frac{3240 \times 226}{3.8}$ = 192695 columbus

   iii. Charge = $\frac{192695}{96500}$ = 2

   Charge = +2

4. - Bulb will light since the current flow.

   - Grey metal of lead form at the cathode

   - Brown fumes of bromine at the anode.

5. Chloride ionizes in water since water is polar. The same chloride dissolve in methylbenzene as a molecule since the methylbenzene is non polar.

6. Cl ions will remove Pb^{2+} ions from electrolyte by farming insoluble $pcCL_2$

7. CL ions will remove Pb^{2+} ions from electrolyte by farming insoluble $PcCL_2$.

8. a) Cathode : Hydrogen

Anode: Oxygen

b) Increases: Since H_2O is decomposed

c) There would be an explosion because potassium is very reactive.

9. a) E reduced – Exudation = + 0.44 + 1.66 = + 1.22V

b) Aluminum is more electropositive than Zn: hence react by losing

electropositive than Zn; hence react by losing electron ready.

10. a) Because the concentration of Cu^{+2} ions is high at the beginning and

decreases as the ions are discharged during electrolysis.

(b) $CU^{2+}_{(aq)} + 2e \rightarrow CU_{(s)}$

11. a) $2Cr_{(s)} + 3Fe^{2+}_{(g)} \rightarrow 2Cr^{3+}_{(g)} + 3Fe_{(s)}$

b) 0.44 -E∝= 0.30v

EQ = -O.74v

12. a) Q= 1.5 x 15 x60 = 1350 ccolumbus

b) 1350c gives 0.6g a= m

3x96500C give $\frac{0.126 \times 3 \times 96500}{1350}$ = 55.76

13. T= 32x 60 + 10 = 1930sec

Q= 1930 x 0.5 = 965C

0.44g produced by 965C

88g = $\frac{965 \times 88}{0.44}$ = 193000C

Charge = $\frac{193000}{96500}$ = +2

14. a) $Ag_{(aq)} + +e^- \rightarrow Ag_{(g)}$

    b) Anode dissolves since it is active.

15. 63.5g requires 2x 96500C

    1.48g requires $\frac{1.48 \times 2 \times 96500}{63.5}$ = 4498.3C

    $Q = it \therefore 1 = \frac{Q}{T}$

    T= (2x60x60) + 30 x 60 = 9,000 see

    1 = $\frac{4498.3}{9000}$ = 0.4998A

16. a) The colour of solution fades and Q disappears .

    - Brown solid was deposited at the bottom.

    b) Metal Q is more reactive than copper, therefore it displaces copper from its solution.

17. i. Bulb did not light: No ions are present in water.

    ii. Bulb light bubbles of colourless gas H_2SO_4 is an electrolyte.

18. a) No heating

b) The solid melt, the ions become mobile.

19. Q = it = 0.82 x 5 x60 x 60 = 14760 columbus

No. of Faradays = $\frac{14760}{96500}$ = 0.15F

Moles of Z = $\frac{2.65}{52}$ = 0.05 moles

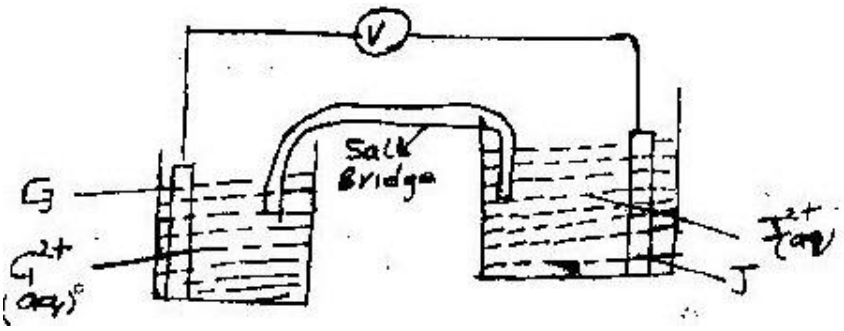
Change of Z = $\frac{0.15}{0.05}$ = +3

20. a) element "N" its more reactive

b) EMF = EQ reduced – Qoxidized.

= + 0.80 + 0.76 = + 1.57v

21.



b) E^0 cell $= E^0$ reduced - E^0 oxidezed.

$= -0.14V - -0.74V = + 0.6V$

22. a) Chloride ions in brime are in high concentration compare to oxide ions in solution

b) Hydrogen gas

23. a) $Ag_{(a)} + e^- \quad Ag_{(s)}$

b) $Ce = 1t = 5.0 \times 3 \times 60 \times 60 = 54000C$

Mass of silver deposited

$= \frac{108 \times 54000}{96500} = 60.44$

24. a) $Zn_{(s)} / Zn^{2+} // 2Ag^{+}_{(aq)} / 2A_{(s)}$

b) Greyish shinning solid deposited round copper. Copper being more reactive displaces Ag from Ag^{2+} blue solution formed due to presence of CU^{2+} in solution.

25. a) CU^{2+} migrate toward the cathode

CU^{2+} give solution a blue colour.

b) $4OH_{(aq)} \quad 4e \rightarrow 2H_2O_{(l)} + O_{2(g)}$

26. a) i. Copper: It is used as a standard electrode in this cell.

The two electrodes have the same reduction potential.

ii. "J" because it has the most negative reduction potential. Is easily oxidized.

iii. I. $K_{(s)} \rightarrow 2e_{(aq)} + K^{+2}$

$2m_{(aq)} + 2e \rightarrow 2M_{(s)}$

II. By allowing ions move into the two beakers. Na^{+} ions -pass into the metal M electrode beaker and NO_3 ions pass into metal K electrode beaker.

b) i. "D" Because oxygen gas is given out at electrode "C" thus "C" is an anode

ii. $4OH_{(aq)} \quad 4e^{-} \longrightarrow + \ 2H_2O_{(l)} \quad + \ O_{2(g)}$

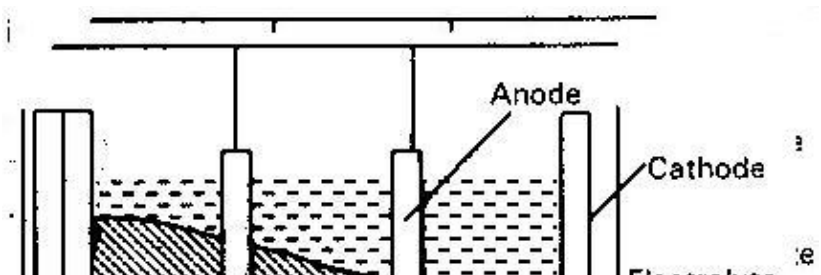
iii. I. Brown substance /solid at electrod "D" This is because CU^{2+} ions in solution gains electron at "d" to form $Cu_{(s)}$

II. The solution will remain blue since the electrodes used are copper and the anode will dissolve to replace the CU^{2+} ions which are discharged.

27 a) i. Bauxite $AL_2O_32H_2O$

ii. Iron (iii) oxide, silica

b) i.



I It is expensive / a lot of energy will be used

II. The ore is dissolve in cryolite ($NaALF_6$)

III. Its melting point is less than 800^0

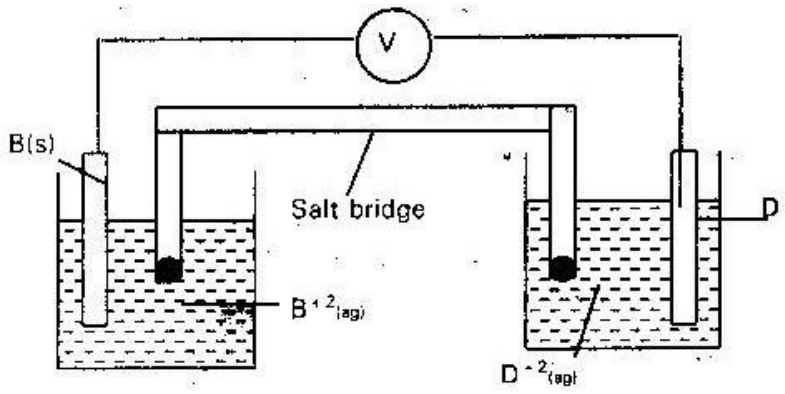
c) Q= 40,000 x 60 x 60 = 144, 000, 000C

Mass of AL = $\frac{144,000,000 \times 27}{3 \times 96500}$ = 13.43kg

28. i. C2: Hydrogen is used as a reference electrode whose E^0 value is 0.00v

ii. -240v

iii.



iv. EMF E^0 red- E^0 oxidized

= + 2.38 + 0.34 = + 2.27v

29. i) To lower the melting point from 800-600^{0}C . Hence reduce the cost of production.

ii) Steal will react with chlorine while graphite will not

iii) -Its melting point is lower than that of the electrolyte

-It is less dense than the electrolyte

iv) To prevent th products from coming into contact

v) i. Cathode $Na^+_{(aq)} + e \rightarrow Na_{(s)}$

ii. Anode $2Cl^-_{(aq)} \rightarrow 2e_{(g)} + Cl_2$

vi) -Manufacture of Na_2O_2/NaCN

-Liquid sodium is used as a coolant in nuclear reactor.

-Sodium vapour is used in street lamps

-Extraction of metals e.g Lithium and Aluminum in termite process.

30. i) Platinum /graphite/carbon

ii) Cation Mg^{2+} and H^+ anions $SO4^2$ and OH

iii) To the left

I. Anode: $4OH_{(aq)} \quad 4e \rightarrow 2H_2O_{(l)} + O_{2(g)}$

II. Cathode $2H_{(aq)} + +2e \quad H2_{(g)}\rightarrow$

iv) The concentration of a queous magnesium sulphate increase because water

molecules are broken down into hydrogen and oxygen.

31. i) I . Distilled water

II. Titanium /platinum

ii) Chlorine gas

iii) - Paper industry

- Glass industry
- Making soap/ detergents
- Extraction of aluminium
- Manufacture of drugs

b) i. I.. $Hg/Na^{+}_{(aq)} + e \longrightarrow Na/Hg_{(s)}$

II. $2Na/Hg_{(s)} + 2H_2O_{(l)} \longrightarrow 2NaOH_{(aq)} + H_{2(g)} + Hg_{(s)}$

ii. Q=it

= 100x 5x 60 x 60 = 1,800,000C

1 Faraday form 1 mode of Na

1, Mole of Na forms 1 mode NaOH

Rmm NaOH =40

180000C forms 40 x $\frac{1800000}{96500C}$ = 746.1(g)

32. i) "G" it has the highest +ve potential E^{o}value

ii) ½ $G_{(g)} + e \longrightarrow G_{(aq)}$ and

$M^{+}_{(aq)} + e \longrightarrow M_{(s)}$

iii) Reaction can not take place from left to right "M" cannot displace "N" from its solution. "M" is more electropositive or the E^0 value is –ve

b) i. $4OH_{(aq)} \longrightarrow 4e + 2H_2O_{(l)} + O_{2(g)}$

ii. Insert a burning split in gas jar of gas K. The gas burns with a pop sound to show it is hydrogen.

iii. a) Hydrogen is monovalent oxygen is divalent. The same amount of electricity liberate twice as much hydrogen.

b) The bulb is brigher with sulphuric acid. The acid is a strong acid which is fully ionized. Ethanoic acid is a weak acid partially ionized hence bulb will be dim.

33. a) E

b) i. $F^{2+}_{(aq)} + 2e \rightarrow F_{(s)}$

$G \rightarrow 2e + G^{2+}_{(g)}$

ii. $\rightarrow V \rightarrow$ From "G" to "F"

iii. -To complete the circuit

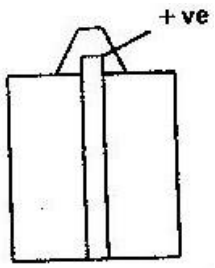
-To compensate for the ions used or added to the electrolyte.

c) i) Bluish/green blue colour of the solution fades CU^{2+} are removed from the solution.

ii) Chlorine gas and oxygen initially the concentration of chloride ions was high hence discharged. With time the concentration of CL^{-} ions decreased and [OH] ions were discharged in preference to CL^{-} ions.

iii) "J: The anions are –ve (negative) and are attracted at the anode.

34 i)



ii) $Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e$

iii) The cell would not produce any current ions are not mobile since the solid is a non electrolyte.

iv) <u>Advantage</u>

-Portable

-Cheap

Disadvantages

- Not rechargeable
- Cannot produce continous supply of electricity
- Causes environment pollution

b) i. Purple /violet fumes produced since iodine vapour is produced.

ii. Q = 0.5 x 2 x 60 x 60 = 3600c

Mass of Pb = $\frac{3600 \times 207}{2 \times 96500}$ = 3.86g

35. a) Add aqueous sodium carbonate to precipitate calcium carbonate and magnesium carbonate and filler.

b) i. Cathode: $2H^+_{(aq)} + 2e \rightarrow H_{2(g)}$

Anode : $2CL_{(aq)} \rightarrow 2e + CL_{2(g)}$

ii. U I. Sodium hydroxide

II. Graphite /platinum

III. Sodium chloride

iii. To prevent mixing of chlorine gas with sodium hydroxide but allow tree movement of ions

c) - In paper industries

- Manufacture of soap/detergents
- Making bleaching agents

- Purification of bauxite.

36. i) G

ii) $G_{(s)} + H^{2+}_{(aq)} \longrightarrow G^{2+}_{(aq)} + H_{(s)}$

iii) EMF = E^0 red – E oxide

$+ 0.34 + 0.44 = + 0.78_v$

b) i. H

ii. Pure water does not contain ions, acid is added to make water ionize.

iii. $HCl_{(aq)}$ is not used because the chloride ions will react with the electrodes due to its high reactivity.

c) 144750 Columbus = $\frac{144750}{96500}$ Taradays = 1.5F

2 faradays gives 64g of copper

1.5 faradays give $\frac{1.5 \times 64}{2}$ = 48g

37. i) Graphite/titanium: They do not react with chlorine.

ii) A steel diagram is suspended between the electrodes

iii) $2CL_{(aq)} \longrightarrow 2CL_{2(g)} + 2e$

b) i. Calcium chloride

ii. It is economical /reduce cost of production

c) Hydrogen is preferentially discharged at the expense of sodium at the cathode. At the anode OH will be discharge in expense of CL.

d) $Na2O_2$

Na2O

e) -Making NaCN (Sodium cyanide used in extraction of gold.

-Making sodium lead alloy used as antiknock in petol

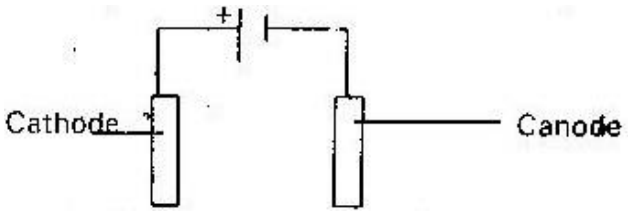
-Content in nuclear reactor.

38. a) Substamce which when molten fussed or in aqueous solution conduct electricity and is decomposed.

b) i. Conduct electricity when solution through the flow of the ions.

ii. Graphite has a decolorized electrons which conduct electricity.

c) ← ~~Elec~~tron flow



ii. Syringe 1: H+ ions are positively changed and are discharged at the cathode.

a) During the process the water molecules are decomposed to give hydrogen and water.

b) Q = 0.72 x 15 x 60 = 648 Columbs

1 mole of gas (O_2 requires 4 faraday i.e

$4OH_{(aq)} \longrightarrow 4e_{(g)} + 2H_{2(l)} + O_{2(g)}$

680 Columbus will liberate $\frac{648 \times 1}{4 \times 96500}$ = 0.001679 moles

Volume of O_2 = 2400 x 0.001679

= 40.29cm^3

39. a) (i) both SO_4^{2-} and OH migrate to the anode. OH being lower on the electrochemical series is preferentially discharged by losing electrons to form water and oxygen.

ii) The anode would dissolve in water and move to the cathode as copper(II) ions. This would discharge the products of the electrolysis.

b) i) - Copper pyrites

- Copper iron disulphide

- Basic copper carbonate

ii) $CU^{2+}_{(aq)} + 2e \longrightarrow CU_{(s)}$

iii) Q= It = 0.5 x 18 x 60 = 540C

96000C deposit 108g of Ag

540C deposit $\frac{108}{96500}$ x 540g of Ag

iv) - To prevent rusting/ carrion

- For beauty

40. a) Ce^{4+}

b) $Mg_{(s)}$

c) Ce^{+4} ions $Ce^{+4}{}_{(aq)} + Ag_{(s)} \longrightarrow Ag_{(aq)} + Ce^{+3}{}_{(aq)}$

d) i) $Mg_{(s)} / Mg^{2++} // Cd^{2-}{}_{(aq)}{}^{+} / Cd_{(s)}$

ii) $Mg_{(s)} + Cd^{2+}{}_{(aq)} \longrightarrow Mg^{2+}{}_{(aq)} / Cd_{(s)}$

iii) E value = E^0 oxidized

= -0.402 + 2.37 = + 1.968V

41. a) i) The bulb does not light since solid bromide is a non electrolyte

ii) Solid Lead (II) Bromide does not contain free ions

b) To provide mobile ions

c) Anode: Brown gas evalued (Br_2)

Cathode: Grey solid (Pb) deposited

d) Anode $2Br^-{}_{(g)} \quad 2e + Br_{2(g)}$

Cathode $Pb^{2+}{}_{(aq)} + 2\,e \quad Pb_{(s)} \longrightarrow$

42. i) Hydrogen ions are discharged in preference to potassium ion. H^+ are

below potassium in the preferential discharge series. ii)

Iodine is given off as a dark brown violet vapour.

iii) Q = 0.2 x 5788 = 1157.6 coulombs

0.208 g of or requires 1157.6 coulombs

$\therefore$ 52g = Cr requires $\frac{52 \times 1157.6}{0.208}$ = 289400 coulombs

Change of Cr = $\frac{289400}{96500}$ = $^{+}3$

43. Emf = $E^{(-)}$ produced – $E^{(-)}$ oxidized

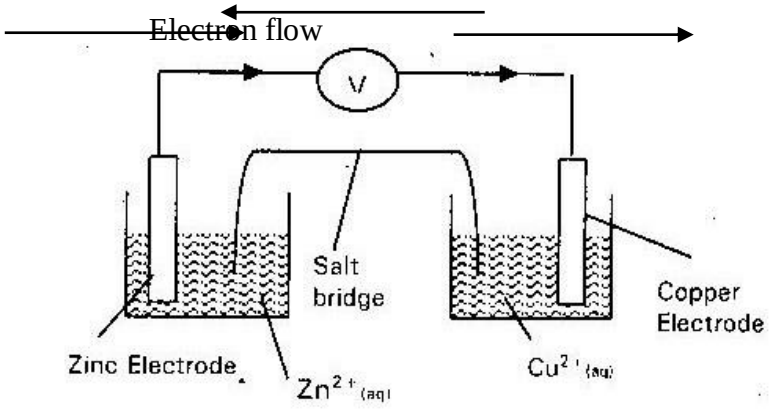
= -0.40 + 1.19 = + 0.79 V

44. $Zn_{(s)} + 2\ Fe^{3+}_{(aq)} \quad \cancel{Zn^{2+} + 2}\ Fe^{2+}_{(aq)}$

45. EQ value = E^0 reduced – E^0 oxidized

= + 1.36 + 0.76 = $^{+}$ 2.12 V

46. a) Current flow



b) Electron flow

Current flow

c) (see diagram)

d) $zn_{(s)} \rightarrow 2e + zn^{2+}_{(aq)}$

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

e) $zn^{(s)} + CU^{2+}_{(aq)} + CU_{(s)}$

f) 2 moles of electrons

g) 2 x 96500 = 19300 Coulombs

47. $Mg_{(s)} \rightarrow 2e + Mg^{2+}_{(aq)}$

$CU^{2+}_{(aq)} + 2e \rightarrow CU_{(s)}$

48. a) i) Oxygen gas evolved at anode Hydrogen gas evolved at the cathode

OH^- and H^+ ions are discharged in preference of Na^{++} ions SO_4^{-2} ions.

ii. Chlorine liberated at anode sodium discharged at the cathode to form sodium Amalgem. There is high concentration of Chloride ions in Brine.

High over voltage effect at the mercury cathode by hydrogen. This sodium is discharged instead of Hydrogen. The resulting solution is an alkali.

b) i) Copper ions were discharged and at the same time, the copper anode dissolves to form Copper (II) ions.

ii) To increase the concentration of OH ions (II) ions.

iii) Copper

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

v) Q= ie = 1.5 x 600 = 900 c

900 C gives 0.296g of = Cu

Hence 63.5 g of Cu produced by

$\frac{63.5 \times 900}{0.296} = 193074$ C

Farady constant = $\frac{193074}{2} = 96537$C

49. E.M.F = E^0 Reduced – E^0 Oxidised

= + 1.36 + 2.38 = + 3.74 v