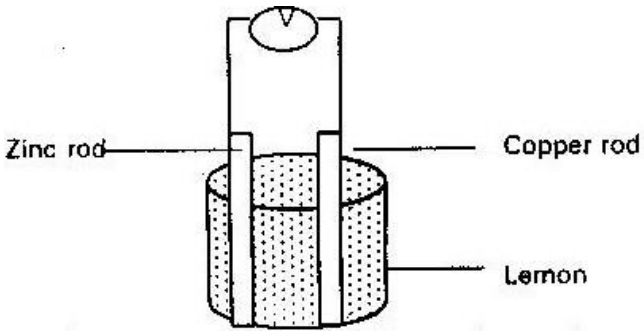
ELECTROCHEMISTRY 1 AND 2

1.

A student set up an experiment as shown in the diagram below



(a) Draw an arrow on the diagram to indicate the direction of the electron flow. Explain your answer (2 mks)

(b) What would be observed on the voltmeter (v) if both rods were Zinc rods?

2.

Write an equation for the process that takes place at the anode during electrolysis of aqueous sodium sulphate solution using platinum electrodes (1mk)

3.

3.8g of metal M were deposited when a molten salt of M was electrolyzed by passing a current of 0.6 amps for 90 minutes. Relative atomic mass of M= 226:

1. Faraday = 96500 coulombs)

(a) Calculate the amount of electricity in coulomb

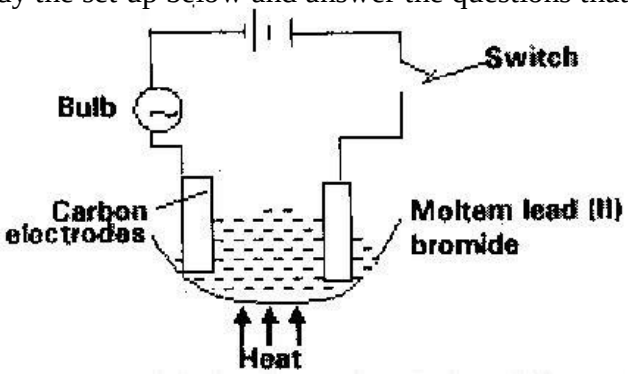
(i) Needed to deposit 3.8g of metal M (1mk)

(ii) Needed to deposit 3.8g of metal M (1mk)

(iii) Deduced the charge on the ion of M (1 mk)

4.

Study the set up below and answer the questions that flows



State and explain the observations that would be made when the circuit is completed (3 mks)

5.

Explain the following observation

A chloride dissolves in water to form an electrolyte while the same chloride dissolves in methyl benzene to form non- electrolyte (2 mks)

6.

Explain why it is not advisable to use aqueous sodium chloride solution as the salt bridge in electrochemical cell formed between half cells.

$Pb^{2+} / Pb^{q+} = 0.13V$ and $Cu^{2+}/ Cu\ E^{ce} = 0.34v$ (2 mks)

7.

Aqueous potassium sulphate was electrolyzed using platinum electrodes in a cell

(a) Name the products formed at the cathode and anode (1 mk)

(b) How does the concentration of electrolyte change during electrolysis?

(c) Why would it not be advisable to electrolyte aqueous potassium sulphate using metal electrodes?

8.

Use the information below to answer the questions that follows

$Zn^{2+} + 2e \rightarrow Zn\ (s) - 0.76$

$Al^{3+} + 3e \; Al \qquad -1.66$

$Fe^{2+} + 2e \rightarrow Fe(s) - 0.44$

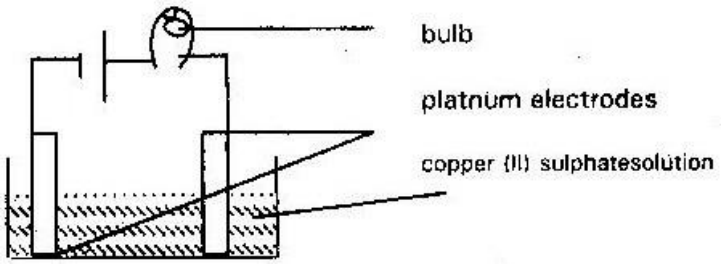
(a) Calculate the E^{Q} value for the electrochemical cell represented below

$Al(s)/Al^{3+} //Fe^{2+} (aq) / Fe + (s)$ (1 mk)

(b) Give a reason why aluminium metal would protect iron from rusting better than zinc metal (1 mk)

9.

The set up below was used to electrolyze aqueous copper (II) sulphate



(a) Explain why the bulb light brightly at the beginning of the experiment and become dim after sometime. (2 mks)

(b) Write an ionic equation for the reaction that took place at the cathode

(1 mk)

10.

Use the cell representation below to answer the questions that follow

(a) Write the equation for the cell reaction (1 mk)

(b) If the e.m.f of the cell is + 0.30v and Eq value of $Fe(a)^{2+}$ / Fe(s) is 0.44V. Calculate the E^{Q} value of $Cr(a)^{3+}$ /CV(s) (2 mks)

11.

When amount of 1.5 amperes was passed through a cell containing M^{3+} ions of metal M for minutes the mass of the cathode increased by 0.26g. (Faraday = 96500 coulombs)

(a) Calculate the quantity of electricity used (1 mk)

(b) Determine the relative atomic mass of metal "m" (2 mks)

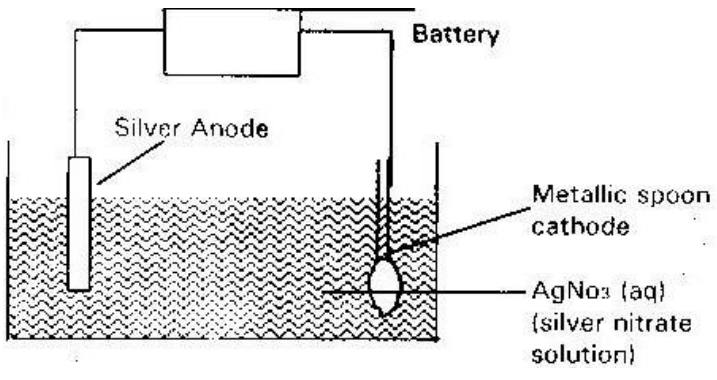
12.

An element "P" has a relative atomic mass of 88. When a current of "P" for 32 minutes and 10 seconds 0.44g of "p" were deposited at the cathode.

Determine the change on an ion of "p"

13.

The set up below was used to electroplate a metallic spoon. Study it and answer the question that follows



(a) Write an ionic equation for the reaction that occurred at the cathode(1 mk)

(b) State and explain what happen to the anode (1 mk)

14.

During purification of copper by electrolysis 1.48g of copper were deposited when a current was passed through aqueous for 2 ½ hrs

Calculate the amount of current that was passed (3 mks)

(CU = 63:5) (1 Faraday = 96,500 Coulombs)

15.

A strip of metal "Q" was dipped into a solution of copper (II) sulphate and allowed to stand overnight. Given that

$Cu^{2+} + 2s \rightarrow CuE^{Q} = + 0.34V$

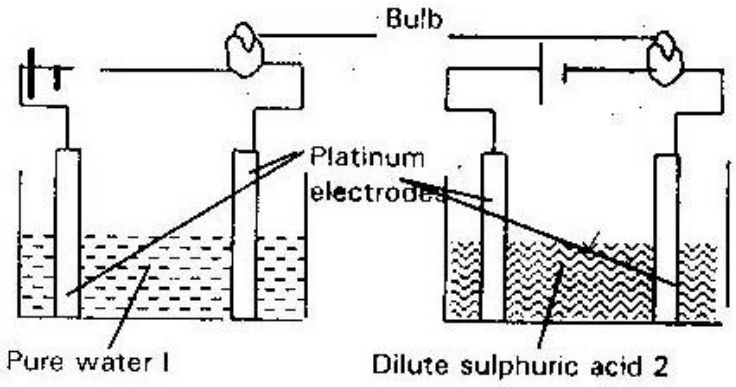
$Q^{2+}{}_{(aq)} + 2\ e \rightarrow Q_{(s)}\ E^{Q} = -0.13$

(a) State the observations which were made (2 mks)

(b) Give a reason for your answer in 19 (i) above (2 mks)

16.

The diagram below represent the set ups that were used to a study the effect of an electric current on pure water and dilute sulphuric acid.

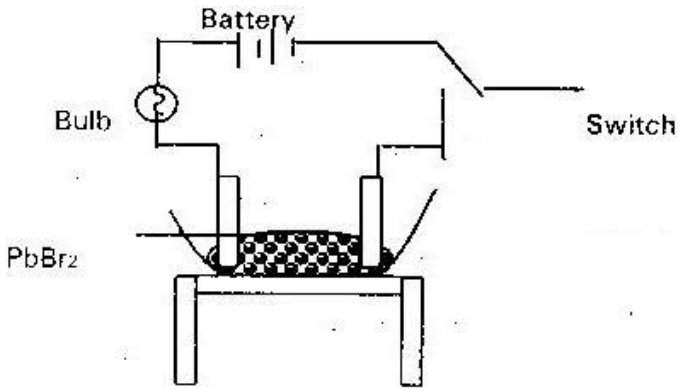


State and explain the observations made when each experiment was started

(3 mks

17.

In an experiment to investigate the conductivity of substance a student used the set up shown below



Student noted that the bulb did not light

(a) What had been omitted in the set up (1 mk)

(b) Explain why the bulb light when the omission is occurred (2 mks)

18.

When a current of 0.82A was passed for 5 hours through an aqueous solution of metal "Z" 2.65g of metal were deposited

Determine the change on the ions of metal (A faraday = 96,500 coulomb)

relative atomic mass of Z = 52 (2 mks)

19.

Study the standard reduction potential given below and answer the questions that follow. The letters are not actual symbols of the elements

Actual symbols of elements	EQ values
$M(aq)^{2+} + 2e \rightarrow M(s)$	-0.76V
$M(aq)^{2+} + 2e \rightarrow M(s)$	- 2.36V
$P(aq)^{+} + e \rightarrow P(s)$	-0.80V
$Q(aq)^{2+} + 2e \rightarrow Co + (s) \rightarrow$	- 0.14V

(a) The standard reduction potential for Fe^{2+} is 0.44V. Select the element which would best protect iron from rusting (1 mk)

(b) Calculate the E^{Q} value for the cell $M(s) / M^{2+}(a) // P^{+}(aq) P(s)$ (2mks)

20.

(a) Use the information given bellow to draw a labeled diagram of an electrochemical cell that can be constructed to measure the electromotive force between G and J.

$G^{2+}(aq) + +2e \rightarrow G(s)$; $E^{0} = -0.74v$ (2mks)

$J^{2+}(aq) + +2e \rightarrow J(s)$; E0 = - 0.14v

(b) Calculate the E^0 value for the cell constructed in (a) above. (1mk)

21.

(a) When brine is electrolyzed using inert electrodes, chlorine gas is liberated at the anode instead of oxygen. Explain this observation. (2mks)

(b) Name the product formed at the cathode. (1mk)

22.

During the electrolysis of aqueous silver nitrate, a current of 0.5A was passed through the electrolyte for 3 hours.

(a) Write the equation for the reaction which took place at the anode. (1mk)

(b) Calculate the mass of silver deposited (Ag = 108; 1F = 965000) (2mks)

23.

(a) The following are half-cell reaction and their reduction potentials,

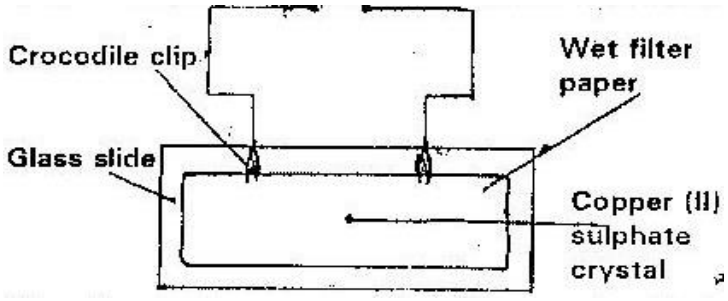
	E^0 (Volts)
$Zn^{2+}(aq) + 2e^- \rightarrow Zn_{(s)}$	-0.76
$Pb^{2+}(aq) + 2e^- \rightarrow Pb_{(s)}$	-0.13
$Ag^+(aq) + e^- \rightarrow Ag_{(s)}$	+0.80
$Cu^{2+}(aq) + 2e^- \rightarrow Cu_{(s)}$	+0.30

(b) Write the cell representation for the electrochemical cell that would give the highest E^θ (1mk)

(c) State and explain the observations made when a copper rod is placed in a beaker containing silver nitrate solution.
(2mks)

24.

The diagram below represents an experiment that was set up to investigate movement of ions during electrolysis.



When the circuit was completed, it was noticed that a blue colour spread towards the right

(a) Explain this observation (2mks)

(b) Write the equation for the reaction that occurred at the anode (1 mk)

25.

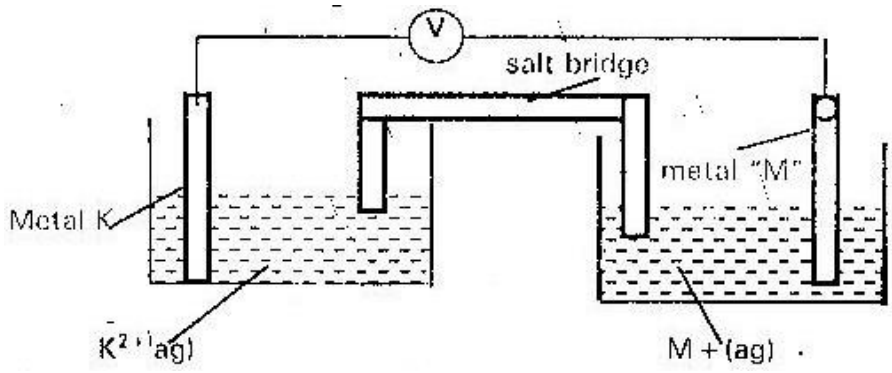
(a) The table below gives reduction potentials obtained when the half cells for each of the metals represented by J, K, L, M and N were connected to a copper half of cells as the reference electrodes.

Metals	Reduction potential (vol/s)
J	-1.10
K	-0.47
L	-0.00
M	+ 0.45
N	1.16

(i) What is the metal "L" likely to be? Give a reason (1 mk)

(ii) Which of the metals cannot be displaced from solution of its salt by any other metal in the table give a reason (2mks)

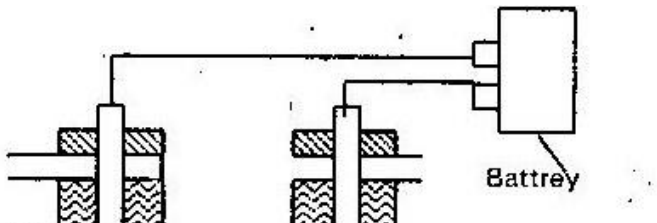
(iii) Metal "K" and "M" were connected to form a cell as shown the diagram below



(i) Write the equation for the half cell reaction that occur at metal K electrode (1 mk)

(ii) If the slat bridge is filled with saturated sodium nitrate solution, how does it help to complete the circuit (2mks)

(b) When electric current is passed through copper (II) sulphate solution for several hours as shown in the diagram, a gas that relights a glowing splint is produced at electrode "C"



(i) Which of the electrode is the cathode? Give a reason (2mks)

(ii) Write an equation for the formation of the gas at electrode "D"

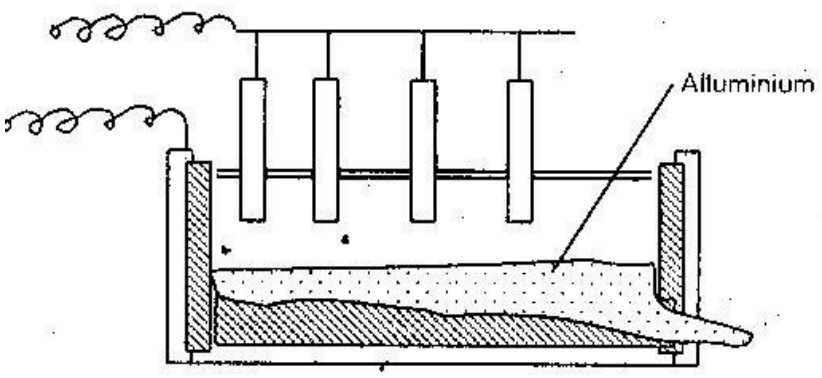
(iii) State and explain the observations that would be made

I. At electrode "D" (1 mk)

II. In the copper (II) sulphate solution (1 mk)

26.

The extraction of aluminium from its ore takes place in two stages, purification stage and electrolysis stage. Below shows the set up for the electrolysis stage



(a) (i) Name the ore from which aluminum is extracted (1 mk)

(ii) Name one impurity which is removed at the purification stage

(1 mk)

(b) (i) Label on the diagram each of the following

I. Anode

II. Cathode

III. Region containing electrolyte

(ii) The melting point of aluminium oxide is 20540C, but the electrolysis is carried out at between 800 C and 9000C

I. Why is not carried out at 20500C (2mks)

II. What is done to lower the temperature (1 mk)

(iii) The aluminium which is produced is tapped off as a liquid. What does this suggest about its melting point?

(c) A typical electrolysis cell uses a current of 40,000 amperes. Calculate the mass (in kg) of aluminium produced in one hour (Al = 27) Faraday = 96,500 coulombs) (3mks)

27.

Use the standard electrode potential for A, B, C, D and F given below to answer the questions that follows. The letters do not represent the actual symbols of the elements

E^Q volts

A $(aq)^{2+} + 2e \rightarrow A(s)$ - 2.90V

B $(aq)^{2+}$ $2e \rightarrow B(s)$ - 2.38V

C $(aq)^{+} + e \rightarrow ½ C_2$ - 0.00V

D $(aq)^{+2} + 2e \rightarrow D(s)$ + 0.34V

$½ Fe_2 + e \rightarrow F(aq)$ + 2.87V

(i) Which element is likely to be hydrogen? Give a reason for your answer (2 mks)

(ii) What is E^Q value for the strongest reducing agent? (1 mk)

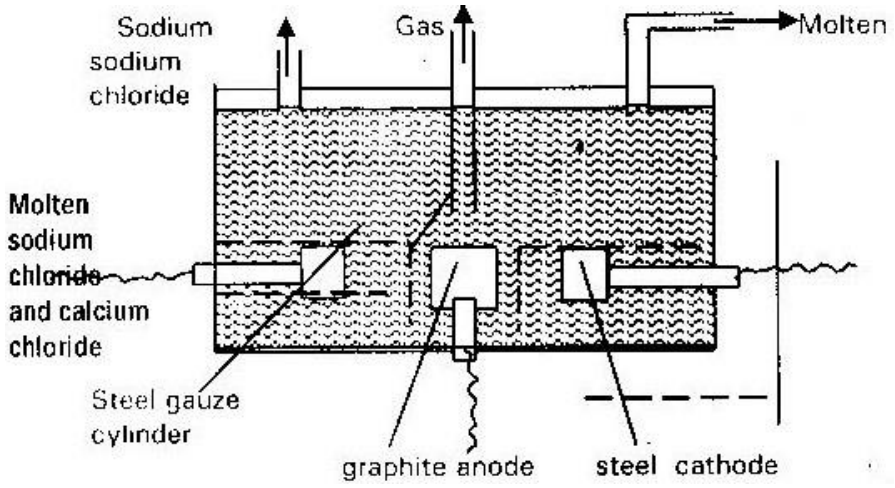
(iii) In the space provide, draw a labeled diagram of the electrochemical cell that would be obtained when a half cells of element "B" and "D are combined (3mks)

(iv) Calculate the EQ value of the electrochemical cell constructed in (iii) above (1 mk)

28.

The diagram below shows the extraction of sodium metal using the down cell

Study it and answer the questions that follows



(i) Explain why in this process the sodium chloride is mixed with calcium chloride (2 mks)

(ii) Why is the anode made of graphite and not steel? (1 mk)

(iii) State two properties of sodium metal that make it possible for it to be collected as shown in the diagram (2 mks)

(iv) What is the function of steel gauze cylinder? (1 mk

(v) Write ionic equation for the reactions which take place at

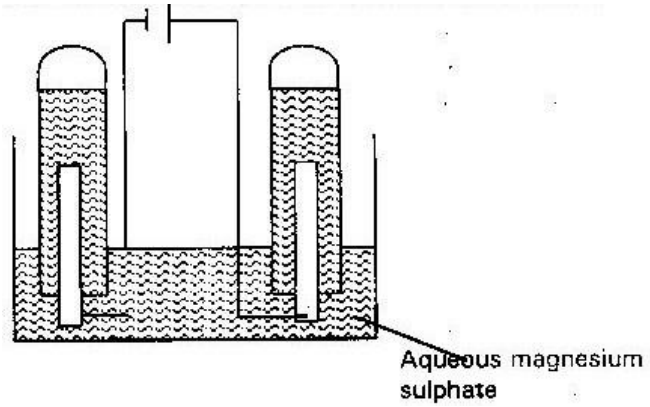
I. Cathode (1 mk)

II. Anode (1 mk)

(vi) Give one industrial use of sodium metal (1 mk)

29.

The set up below was used during the electrolysis of aqueous magnesium sulphate using inert electrodes



(i) Name a suitable pair of electrodes for this experiment (1 mk)

(ii) Identify the anions and cations present in the solution (2mks)

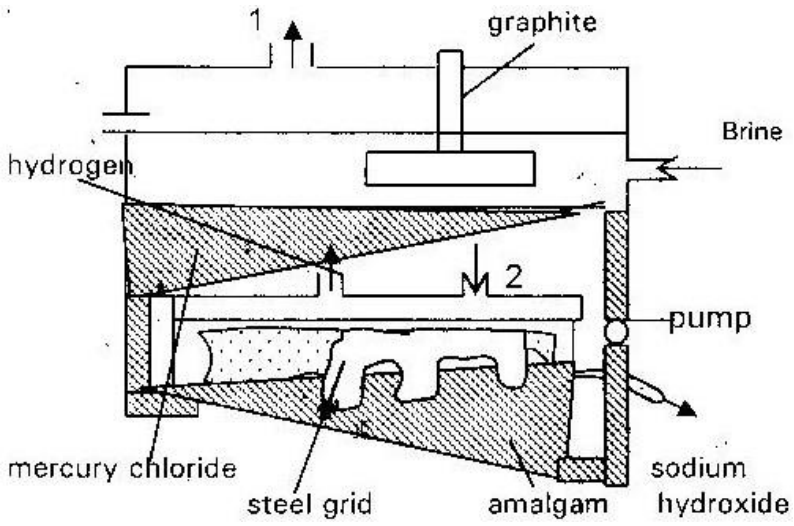
(iii) On the diagram label the cathode (1 mk)

(iv) Write ionic equation for the reaction that took place at the

I: Anode (1 mk)

II. Cathode (1 mk)

(a) The diagram below represents a mercury cathode cell that can be used in the industrial manufacture of sodium hydroxide. Study it and answer the question that follows



i. Name the

I: Raw material introduced at "2" (2mks)

II. Another substance, that can be used in the call instead of graphite (1mk)

ii. Identify the by products that come out at I (1 mk)

iii. Give

1. One use of sodium hydroxide (1 mk)

2. Two reasons why mercury recycled (1 mk)

(b) A current of 1000 amperes was passed through the cell for five (5) hours

i. Write equation for

I. The reaction that occurred at the mercury cathode (1 mk)

II. The reaction in which sodium hydroxide was produced (1 mk)

ii. Calculate the mass of sodium hydroxide that was produced (Na= 23) (O = 16) (H=1.0) Faraday = 96500 coulombs (4mks)

31.

(a) Study the standard electrode potentials for the half cells given below and answer the questions that follows. The letters do not represent the actual symbols of the elements

		E volts
$N^{+}_{(av)} + e^{-} \rightarrow$	N	-2.92
$J^{+}_{(av)} + e \rightarrow$	J	+0.52
$K^{+}(aq) + e \rightarrow$	½ Kg	0.00
½ G(g) + e →	$G^{-}(ag)$	+1.36
M^{2+} (g) + 2 e →	m(g)	-0.44

i. Identify the strongest oxidizing agent: Give a reason for your answer

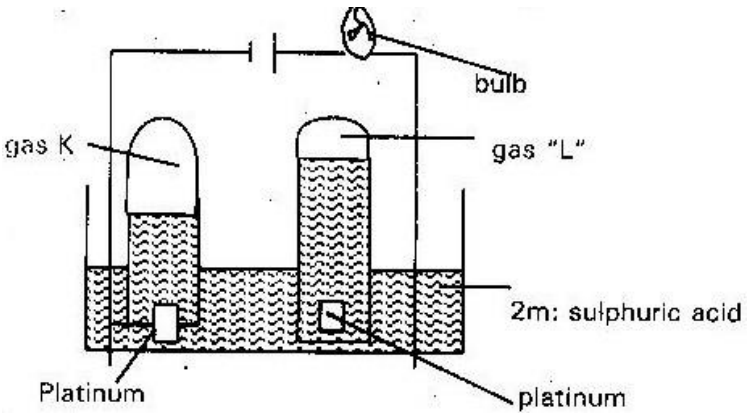
ii. Which two half cells would produce the highest potential differences when combined? (1 mk)

iii. Explain whether the reaction represents below can take place (2mks)

$2M^{-} + N \rightarrow 2N + M^{2+}$

(av) (s) (s) (aq)

(b) 100 cm^3 of 2m sulphuric acid was electrolyzed using the set up represented by the diagram below



i. Write an equation for the reaction that produce gas "L" (1 mk)

ii. Describe how gas "k" can be identified (1 mk)

iii. Explain the differences in

(a) The volume of gases produced at the electrodes

(b) Brightness of the bulb if 100 cm^3 of 2m ethanoic acid was used in place of sulphic acid (2mks)

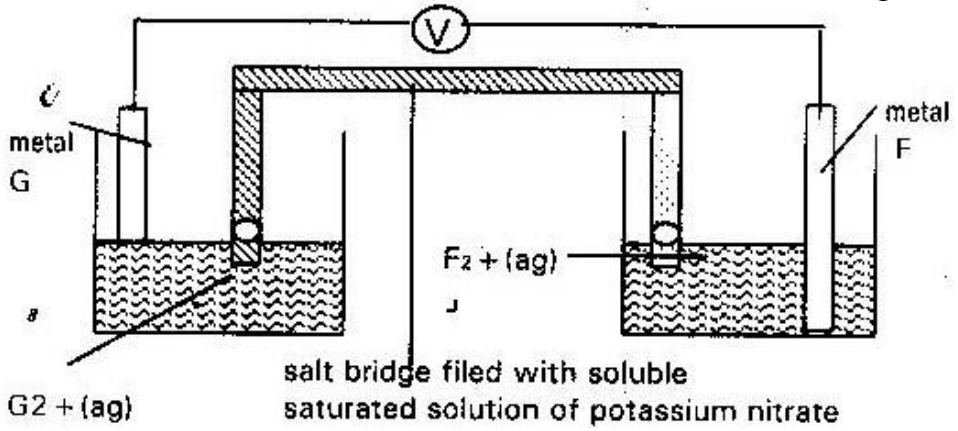
32.

The table below gives the standard electrode potentials for the metals represented by letters D, E, F & G. study it and answer the questions that follows

Metals	Standard electrical potential (volts)
D	-0.13
E	+ 0.85
F	+ 0. 34
G	- 0. 76

(a) Which metal can be displaced from a solution of its salt by all the other metals in the table? Give a reason

(b) Metal "F" and "G" was connected to form a cell as shown in the diagram

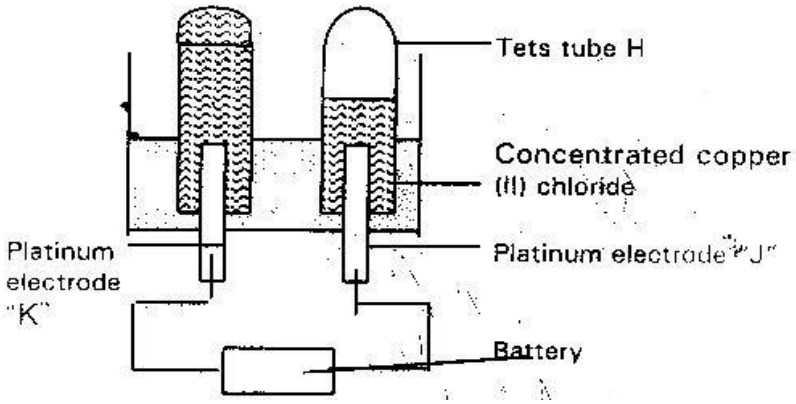


i. Write the equation for the reactions that occur at the electrode F and G

ii. On the diagram indicate with an arrow the direction in which electrons would flow

iii. What is the function of the salt bridge? (1 mk)

(c) An electric current was passed though concentrated solution of copper (ii) chloride as shown in the diagram below.



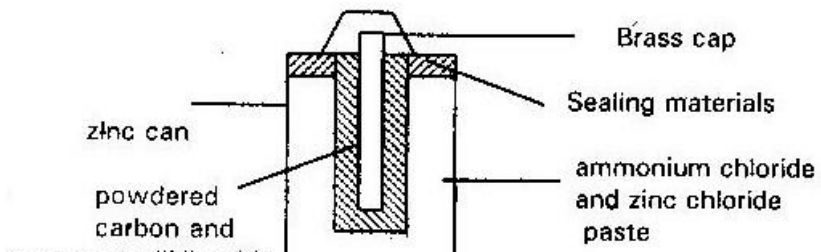
i. Explain the observation that would be made on the electrolyte as the experiment progress (2mks)

ii. After sometime test tube "H" was found to contain a mixture of two gases. Explain this observation (3mks)

iii. Which of the electrodes is the anode? Explain (2mks)

33.

The diagram below is a cross- section of a dry cell. Study it and answer the questions that follows



(i) On the diagram, show with a (+ve) sign the +ve (positive terminal) (1 mk)

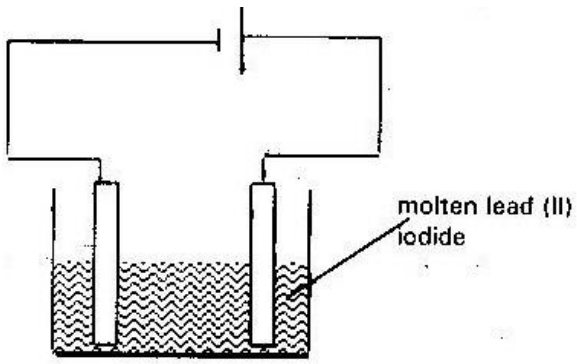
(ii) Write the equation for the reaction in which electrons are produced (1 mk)

(iii) The zinc can is line with ammonium chloride and zinc chloride paste. What would happen if the mixture was to become dry? Give a reason

(2 mks)

(iv) Give one advantage and one disadvantage of dry cell (2 mks)

(b) The setup up below was used to electrolyze molten lead (ii) Iodide



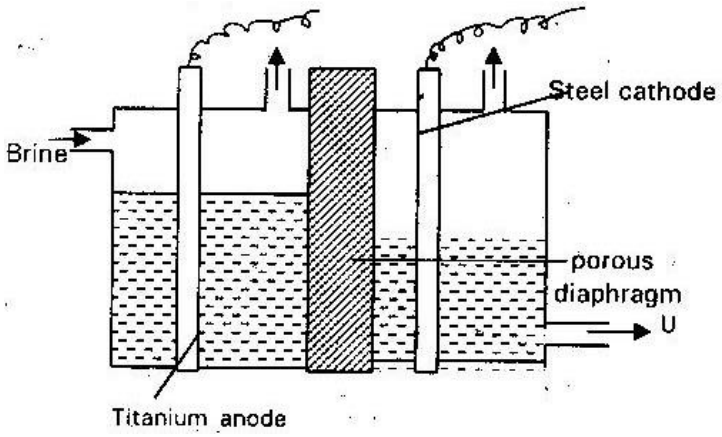
i. State the observation that was made at the anode during the electrolysis. Give a reason for your answer.

ii. A current of 0.5A was passed for two hours. Calculate the mass of load that was deposited (Pb= 207) (1 faraday = 96500c) (3mks)

34.

(a) Brine usually contains soluble calcium and magnesium salts. Explain how sodium carbonate is used to purify brine (2mks)

(b) The diagram below represents a diagram cell used to electrolyte pure brim



i. Write the equations for the reactions that take place at (2mks)

I. Cathode

II. Anode

ii. Name

I. Products U: (1 mk)

II. Another material that can be used instead of titanium (1 mk)

III. The impurity present in the product U (1 mk)

iii. State two functions of the porous diaphragm (2mks)

(c) Give one industrial use of the product "U" (1 mk)

35.

(a) The equations below shows the standard reduction potential for four half cell. Study it and answer the questions that follows. Letters are not actual symbols of the element.

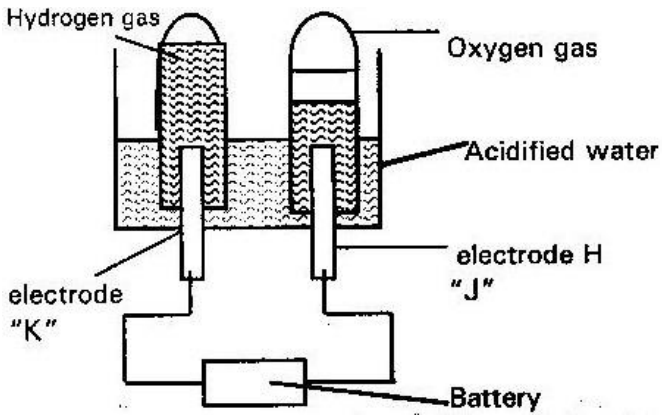
		E^{Q} Volts
F_2 (aq) + $2e^-$	$\rightarrow 2F^-$(av)	+ 0.54
G^{2+} + 2e	$\rightarrow$G(s)	-0.44
H^{+2} (aq) + 2 e	$\rightarrow$ H(s)	+ 0.34
$2J^+$ + 2eJ^2(g)	$\rightarrow$J2(g)	0.00

i. Identify the strongest reducing agent (1 mk)

ii. Write the equation for the reaction which takes place when solid "G" is added to a solution containing H^{2+} (ions) (2mks)

iii. Calculate the E^{Q} value for the reaction in (ii) above (1 mk)

(b) The diagram below shows the apparatus used to electrolyze acidified water to obtain hydrogen and oxygen gases. Study it and answer the questions that follows?



i. Identify the electrode at which oxidation takes place (1 mk)

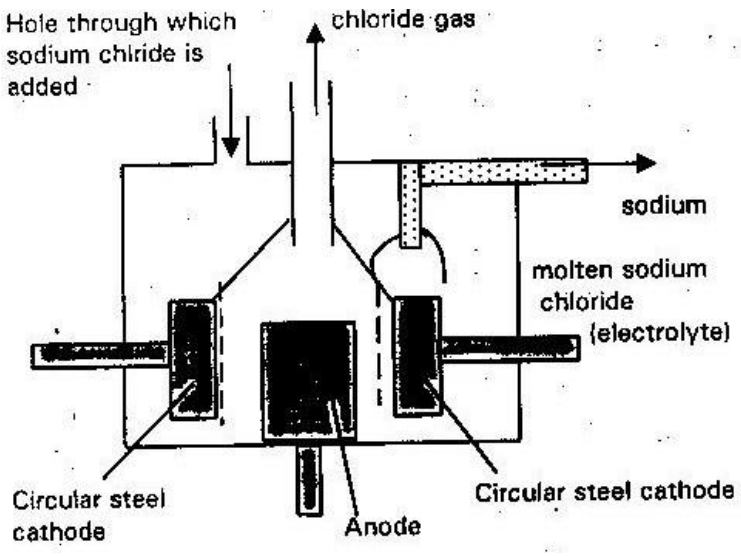
ii. Give a reason why it is necessary to acidify the water (1 mk)

iii. Explain why hydrochloric acid is not used to acidify the water (2mks)

(c) During electrolysis of aqueous copper (II) sulphate 144750 columbus of electricity were used. Calculate the mass of copper metal that was obtained (CU= 64) (1 Faraday = 96500 Columbus) (3mks)

36.

(a) Below is a simplified diagram of the down's cell used for the manufacture of sodium. Study it and answer the questions that follows.



i. What material is the anode made of? Give a reason (2mks)

ii. What precaution is taken to prevent chlorine and sodium from re- combining? (1 mk)

iii. Write an ionic equation for the reaction in which chlorine gas is formed (1 mk)

(b) In the down's cell (Used for manufacture of sodium) a certain salt is added to lower the melting point of sodium chloride from about 800^0C to 600^0C

i. Name the salt that is added

ii. State why is necessary to lower the temperature (1 mk)

(c) Explain why aqueous sodium chloride is not suitable as an electrolyte for the manufacture of sodium in the down's cell- process (2mks)

(d) Sodium metal reacts with air to form two oxides. Give the formula of the two oxides (2mks)

(e) State two uses of sodium metal (2mks)

37.

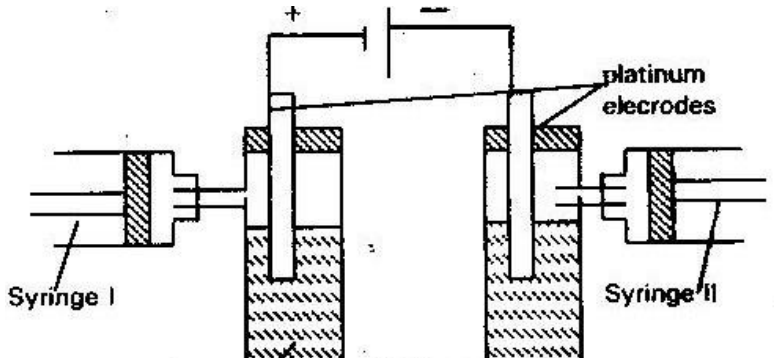
(a) What is an electrolyte (1 mk)

(b) State how the following substances conduct electricity

(i) Molten calcium chloride

(ii) Graphite

(c) The diagram below shows a set up that was used to electrolyze aqueous magnesium sulphate



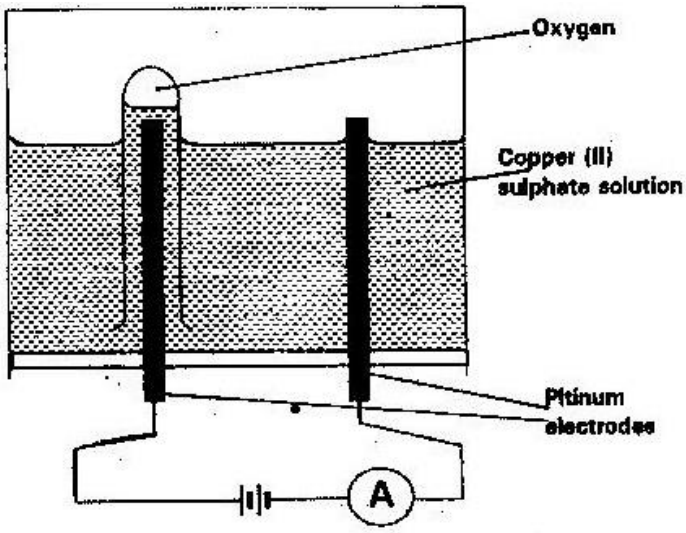
(i) On the diagram above, using an arrow, show the direction of the flow of electrons (1 mk)

(ii) Identify the syringe which hydrogen gas would be collected. Explain (1 mk)

(d) Explain why the concentration of magnesium sulphate was found to have increased at the end of the experiment. (2mks)

(e) During electrolysis a current of 0. 72A was passed through the electrolyte for 15 minutes. Calculate the volume of gas produced at the anode. I Faraday = 96500 Columbus. Molar gas volume is 24000 at room temperature (4mks)

The diagram below represents asset up that can be used to electrolyze aqueous copper (II) sulphate



(a) (i) Describe how oxygen gas is produced during the electrolysis (2mks)

(ii) Explain why copper electrodes are not suitable for this electrolysis (2 mks)

(b) Impure copper is purified by an electrolytic process

(i) Name one ore from which copper is obtained (1 mk)

(ii) Write the equation for the reaction that occurs at the cathode during the purification of copper (1 mk)

(iii) In an experiment to electroplate a copper spoon with silver, a current of 0.5A was passed for 18 minutes. Calculate the amount of silver deposited on the spoon. (1F = 96500 coulombs, Ag) = 108)

(iv) Give two reasons why some metals are electroplated (2mks)

39. The following tables give the standard electrode potential for a number of half reactions.

	E⁻volts
Mg^{2+} (aq) + 2e →mg(s)	-2.3
Mn^{2+} (aq) + 2e →mn (s)	-1.18
Cd^{2+} (aq) + 2e → Cd	-0.402
$2H^{+}$ (aq) + 2e → H2	0.00
Ag^{+} (aq) + e →Ag (s)	+0.799
Ce^{+4} + E → CC^{3+}	+1.61

(a) Which one of the substance is the strongest oxidizing agent (1 mk)

(b) Which one if the substance is the strongest reducing agent (1 mk)

(c) Select one of the substances from the table that could be used to oxidize silver ions and write the equation for the reaction.

(2mks)

(d) Given the two half reactions

$Cd^{2+}_{(aq)} + 2e^{-} \rightarrow Cd_{(s)}$

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

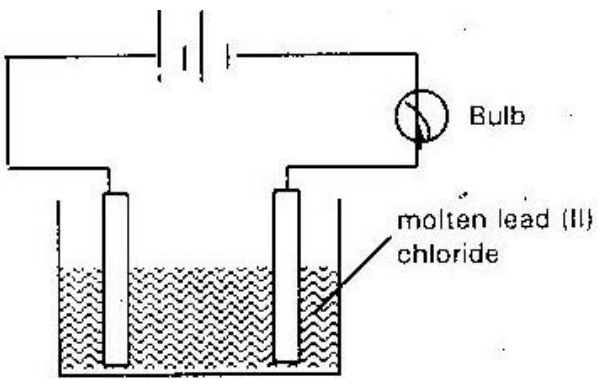
(i) Write the cell representation made up of these two half reactions

(2mks)

(ii) Write down the over all call reaction for the cell formed by these two half reactions (2mks)

(iii) Calculate the E^{Q} value of this cell (2mks)

40. The diagram below shows a setup used to pass to electric current on molten lead (ii) bromide



(a) (i) What does the bulb show before the solid lead bromide is heated? (1 mk)

(ii) Give a reason for your answer (1 mk)

(b) Why was lead (ii) bromide in the molten state? (1 mk)

(c) What observation is made at the cathode and anode respectively (2mks)

(d) Write equations for the reactions at both electrodes (2mk)

41. (i) If the same arrangement was used to electrolyze aqueous potassium iodide. Iodine vapor would be collected at the anode and hydrogen gas at the cathode instead of potassium. Explain why (2mks)

(ii) In an experiment chromium (iii) chloride is electrolyzed using the chromium electrodes. A current of 0.2A flows for 5788 seconds. The increase in mass of the electrode is 0.208g. Calculate the charge on the electrons. (Cr = 52) / Faraday = 96500C (3mks)

42. Consider the call

$Mn(s) / Mn^{2+}(aq) // Cd^{2+}(aq) / Cd(s)$

E^q for the manganese electrode is – 0.40v calculate the e.m.f of the cell (1 mk)

43. Write cell reaction for the following electrochemical

$ZN(s) / Zn^{z+} // Fe^{3+}(aq) / Fe / pt$ (2 mks)

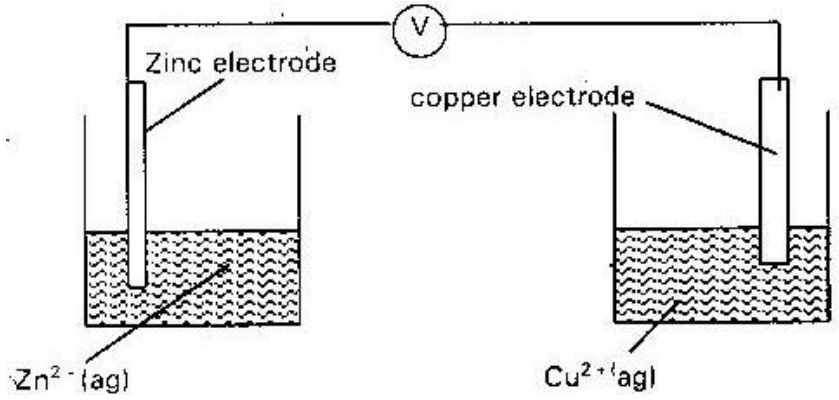
44. Given the following standard electrode potential, Eq = -0.76V

$Zn^{2+}(aq) + 2e \rightarrow Zn(s)$ $E^Q = 0.76v$

$Cl_2(g) + 2e \rightarrow 2Cl^-(aq)$ $E^Q = + 1.36V$

Calculate the EQ value for the cell (1 mk)

45. Two incomplete half cells are given below



(a) Complete the diagram to show how the two half cells are connected to give an electrochemical cell. (2mks)

(b) Using arrows show the direction of the electron flow (1 mk)

(c) Indicate the direction of current flow

(d) Write the equation for the half cell/ reaction taking place at the electrodes

(2mks)

(e) Write the overall cell reaction

(f) How many moles of electrons are transferred?

(g) Calculate the electronic charge transferred during reaction (F= 96,500 coulombs) (1 mk)

46. Magnesium reacts rapidly with copper (II) ions as follows

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

Give the half reaction for this reaction (1 mk)

47. (a) Explain the changes that takes place in solution and at the electrodes in the

electrolysis of

(i) Aqueous Sodium sulphate with invert electrodes (2mks)

(ii) Concentrated Sodium Chloride with carbon anode and mercury cathode (2mks)

(b) Two electrolytic cells for solutions in a (i) and (ii) respectively were connected in series. A current of 1.5 A was passed for 600 seconds. The first cell contained aqueous copper (II) sulphate and had copper electrodes. The anode showed a loss in mass of 0.296 g but there was no change in the appearance of the electrolyte. The sodium chloride with little sodium hydroxide had copper electrodes and a reddish brown precipitate formed.

(i) Why was there no change in the appearance of the electrolyte in the first cell

(ii) Why was a small amount of sodium hydroxide added to aqueous sodium chloride in the second cell?

(iii) Name the reddish- brown precipitate formed (1 mk)

(iv) Write an ionic equation for the formation of substance in (iii)

(v) Calculate the value of Faraday constant (1 mk)

48. Given that the standard electrode potential E^{Q} are

$Mg^{2+}(aq) + 2e \rightarrow Mg(s)$ $E^{Q} = -2.38V$

$Cl_2(g) + 2e \rightarrow 2Cl(aq)\ E^{Q} = +1.36V$

Find the e.m.f of the cell