

NAME \_\_\_\_\_ INDEX NUMBER \_\_\_\_\_

SCHOOL \_\_\_\_\_ DATE \_\_\_\_\_

## ELECTROCHEMISTRY

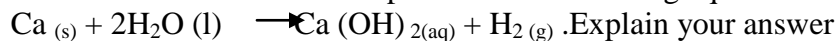
**1. 1989 Q2 P1**

Name the products at electrolysis of concentrated aqueous sodium chloride using inert electrodes.

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**2. 1989 Q 20**

State the oxidized and the reduced species in the following equation (2 marks)



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**3. 1990 P1A QUESTION 6**

When Zinc powder is added to an aqueous solution of copper II nitrate and warmed, the blue colour fades and a brown solid is deposited.

Write the two half equations and the overall equation for this reaction. (2 Marks)

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4. **1990 P1A QUESTION 17**

What mass of copper will be deposited from a solution of copper (II) chloride when a current of 3A is passed through the copper (II) chloride solution during electrolysis for 50 minutes (1 Mark)

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5. **1991 P1A QUESTION 9**

Write the equations for the reactions that take place during electrolysis of magnesium Sulphur solution using platinum electrodes at the:  
(i) Anode (1 Mark)

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(ii) Cathode (1 Mark)

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6. **1992 P1A QUESTION 16**

Study the standard electrode potential in the table below and answer the questions that follow:

	E (volts)
$\text{Cu}^{2+} + 2\text{e}^- \longrightarrow \text{Cu}$	+0.34
$\text{Mg}^{2+} + 2\text{e}^- \longrightarrow \text{Mg}$	-2.38
$\text{Ag}^+ + \text{e}^- \longrightarrow \text{Ag}$	+0.80
$\text{Ca}^{2+} + 2\text{e}^- \longrightarrow \text{Ca}$	-2.87

(a) Which is the strongest reducing agent (1 Mark)

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(b) (i) Write the ionic equation for the reaction that takes place when magnesium is dipped in a solution of silver nitrate (1 mark)

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7. **1993 Q 17**

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

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8. **1994 P1B QUESTION 3**

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

Metal	Reduction Potential (Volts)
J	-1.10
K	- 0.47
L	- 0.00
M	+0.45
N	+1.16

(i) What is metal L likely to be? Give a reason

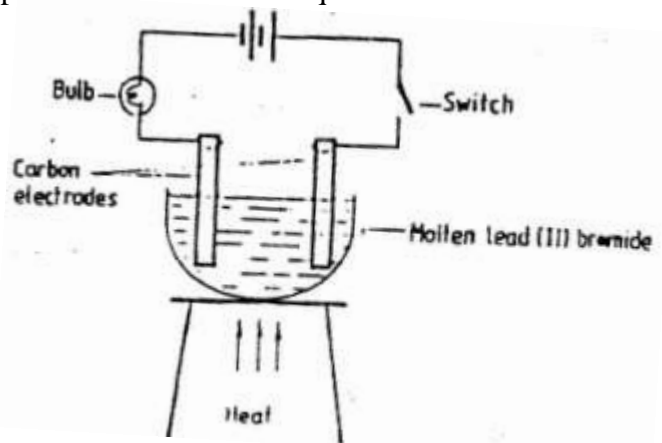
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(ii) Which of the metals cannot be displaced from the solution of its salt by any other metal in the table? Give a reason.

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9. **1995 Q 9**

Study the set – up below and answer the question that follows.



State and explain the observations that would be made when the circuit is completed.

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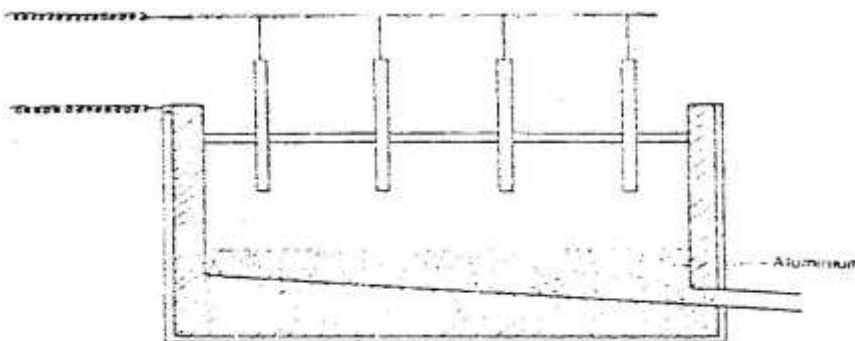
10. 1995 Q 23

Explain the following observation. A chloride dissolves in water to form an electrolyte while the same chloride dissolves in methylbenzene to form a non-electrolyte (2 Marks)

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11. 1996 Q 3 P2

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



a) i) Name the ore from which aluminium extracted. (1 mark)

ii) Name one impurity, which is removed at the purification stage. (1 mark)

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

- i) Anode
- ii) Cathode
- iii) Region containing the electrolyte.

ii) The melting point aluminium oxide is 2054°C, but electrolysis is carried out between 800 – 900°C.

i) Why is the electrolysis not carried out at 2054°C (1 mark)

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ii) What is done to lower the temperatures? (1 mark)

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iii) The aluminium which is produced is tapped off as a liquid. What does this suggest about its melting point? (1 mark)

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c) A typical electrolysis cell uses current of 40,000 amperes. Calculate the mass (in kilograms) of aluminium produced in one hour (3 marks)

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**12. 1997 Q 24**

Aqueous potassium sulphate was electrolysed using platinum electrodes in a cell.

a) Name the products formed at the cathode and anode.

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

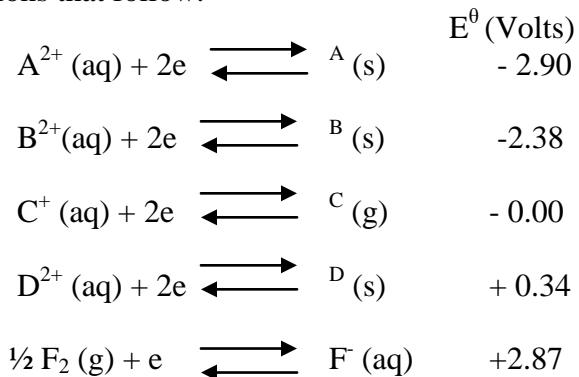
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c) Why would it not be advisable to electrolyse aqueous potassium sulphate using potassium metal electrodes.

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13. 1997 Q 1 P2

Use standard electric potentials for elements A, B,C, D and F given below to answer the questions that follow.



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

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(ii) What is the E<sup>θ</sup> value of the strongest reducing agent?

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(iii) In the space provided draw a labeled diagram of the electrochemical cell that would be obtained when half – cells of elements B and D are combined

(iv) Calculate the E<sup>θ</sup> value of the electrochemical cell constructed in (iii) above

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- (b) During the electrolysis of aqueous copper (II) sulphate using copper electrodes, a current of 0.2 amperes was passed through the cell for 5 hours
- (i) Write an ionic equation for the reaction that took place at the anode

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- (ii) Determine the change in mass of the anode which occurred as a result of the electrolysis process (Cu= 63.5, 1 Faraday = 96,500 coulombs.

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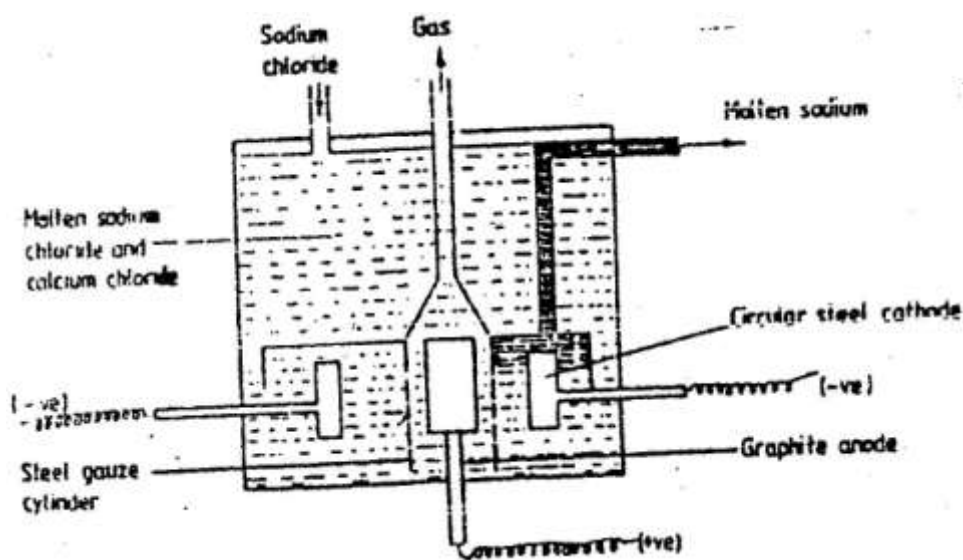
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14. 1997 Q 4

- (a) The diagram below shows the extraction of sodium metal using the Downs cell. Study it answer the questions that follow



- (i) Explain why in this process the sodium chloride is mixed with calcium chloride.

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

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

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

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(v) Write ionic equations for the reactions which take place at:  
I Cathode

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II Anode

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(vi) Give one industrial use of sodium metal

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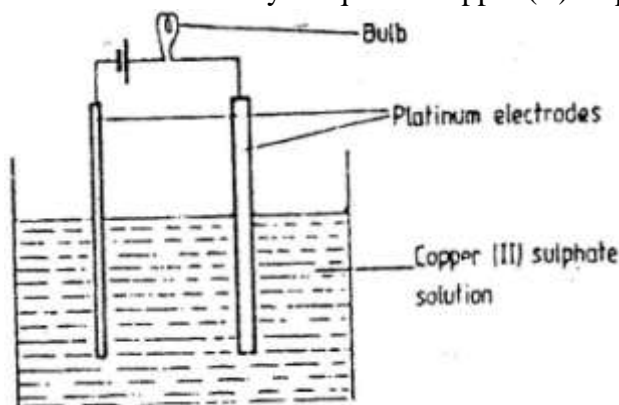
(b) Explain why the sodium metal is kept stored under kerosene

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15. 1998 Q 13

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



- a) Explain why the bulb light is brightly at the beginning of the experiment and becomes dim after sometime.

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- b) Write the ionic equation of the reaction that took place.

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16. 1998 Q 7e P2

Study the information given in the table below and answer the questions that follow.  
The letters do not represent the actual symbols of the elements

Element	Atomic number	Boiling point
S	3	1603
T	13	2743
U	16	718
V	18	87
W	19	1047

- (e) The aqueous sulphate of element W was electrolyzed using inert electrodes Name the products formed at the:

(i) Cathode

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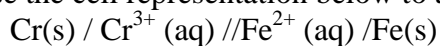
(ii) Anode

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17. 1999 Q 13, 2(P2)

13. Use the cell representation below to answer the questions that follow



(a) Write the equation for the cell reaction

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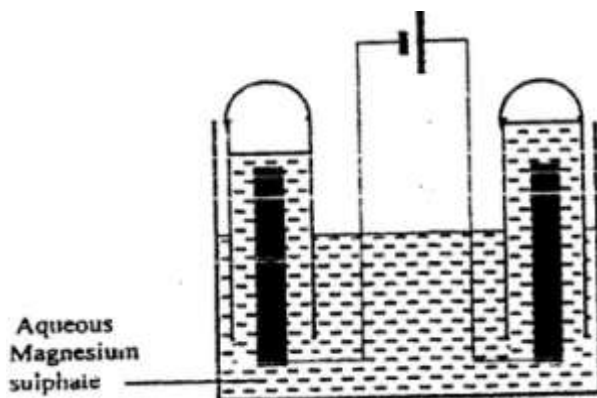
(b) If the E.M.F of the cell is 0.30 volts and the  $E^\theta$  value for  $\text{Cr}^{3+}(\text{aq}) / \text{Cr(s)}$

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2. 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

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ii) Identify the ions and cations in the solution

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iii) On the diagram label the cathode

iv) Write ionic equations for the reactions that took place at the anode.

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v) Explain the change that occurred to the concentration of magnesium sulphate solution during the experience.

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vi) During the electrolysis a current of 2 amperes was passed through the solution for

4 hours. Calculate the volume of the gas produced at the anode. (1 faraday 96500 coulombs and volume of a gas at room temperature is  $24000\text{cm}^3$ )

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vii) One of the uses of electrolysis is electroplating. What is meant by electroplating?

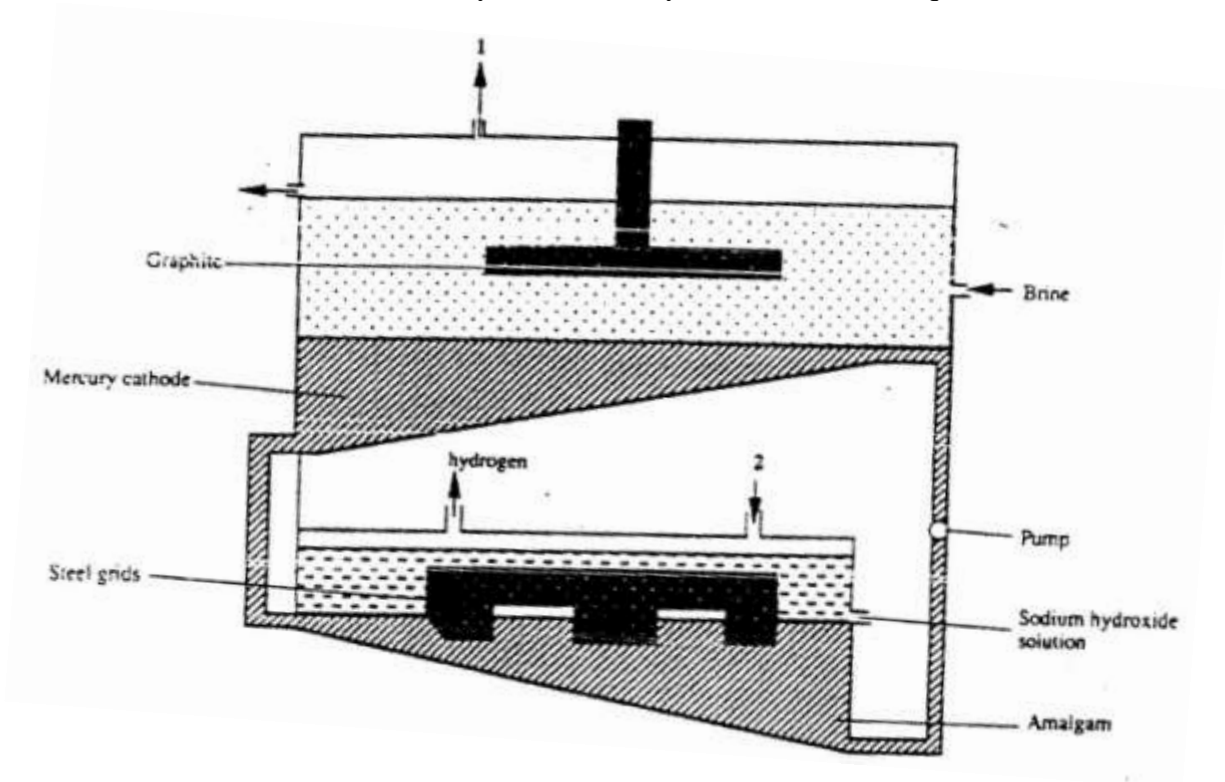
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Give two reasons why electroplating is necessary.

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**18. 2000 Q 2 P2**

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



(i) Name

I. the raw material introduced at 2

.....  
II. Another substance that can be used in the cell instead of graphite

.....  
(ii) Identify the by – product that comes out at I .....

(iii) Give

I. One use of sodium hydroxide

.....  
II. Two reasons why mercury is recycled

.....  
(b) A current of 100 amperes was passed through the cell of five ( 5) hours

(i) Write the equation for: The reaction that occurred at the mercury cathode

.....  
(ii) Calculate the mass of sodium hydroxide that was produced

(Na = 23.0, O = 16.0, H = 1.0, 1 Faraday = 96500 Coulombs)

19. **2001 Q 3 P2**

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

	<b>E°volts</b>
$N^+_{aq} + e^- \rightleftharpoons N(s);$	-2.92
$J^+_{(aq)} + e^- \rightleftharpoons J(s);$	+0.52
$K^+_{(aq)} + e^- \rightleftharpoons \frac{1}{2} K^2(g)$	0.00
$\frac{1}{2} G^2_{(g)} + e^- \rightleftharpoons G(aq);$	+1.36
$M^{2+}_{(aq)} + 2e^- \rightleftharpoons M(s);$	-0.44

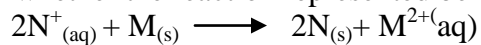
i) Identify the strongest oxidizing agent. Give a reason for your answer.

- .....
- ii) Which two half – cells would produce the highest potential difference when combined?

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- iii) Explain whether the reaction represented below can take place.



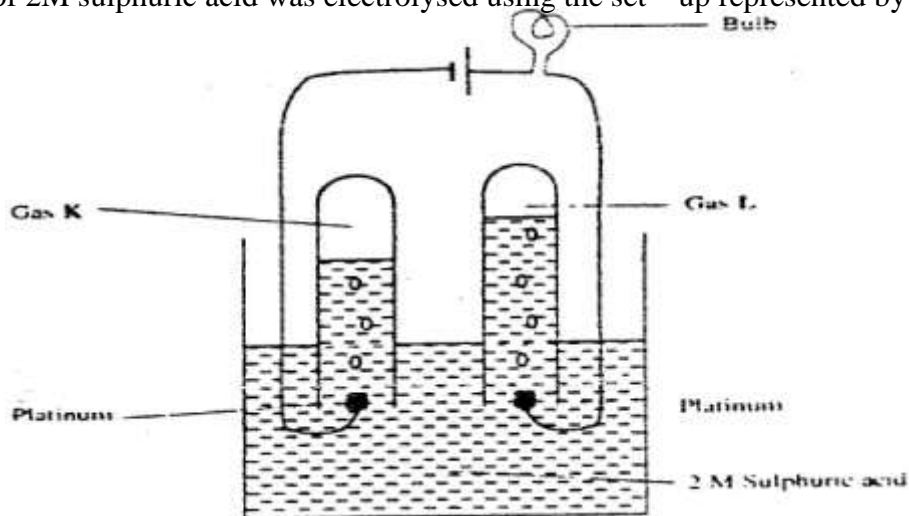
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- b) 100cm<sup>3</sup> of 2M sulphuric acid was electrolysed using the set – up represented by the diagram below.



- i) Write an equation for the reaction that produces gas L.

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- ii) Describe how gas K can be identified

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- iii) Explain the difference in :

I The volume of the gases produced at the electrodes.

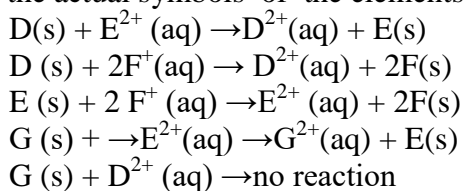
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II Brightness of the bulb if 100cm<sup>3</sup> of 2M ethanoic acid was used in place of sulphuric acid.

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20. 2002 Q 9

Use the reactions given below to answer the questions that follow. The letters do not represent the actual symbols of the elements

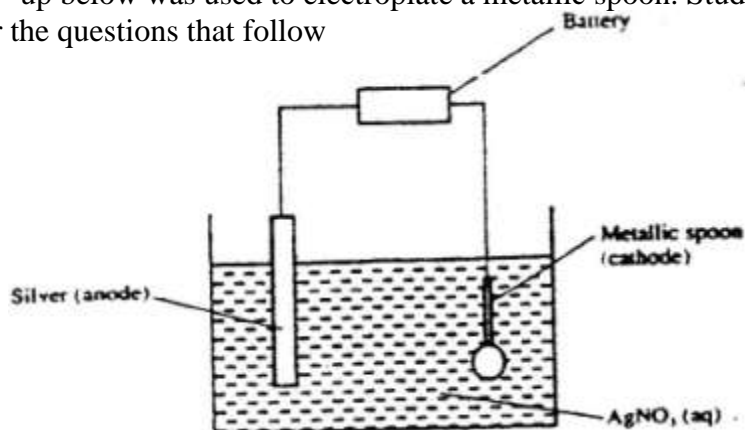


- (a) What name is given to the type of reaction given above?  
 .....
- (b) Arrange the elements D, E, F and G in the order of their reactivity starting with the most reactive  
 .....

- (c) Complete the equation below  
 $G(s) + 2F^+(aq) \rightarrow$

21. 2002 Q 26

The set – up below was used to electroplate a metallic spoon. Study it and answer the questions that follow



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

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(b) State and explain what happened to the anode

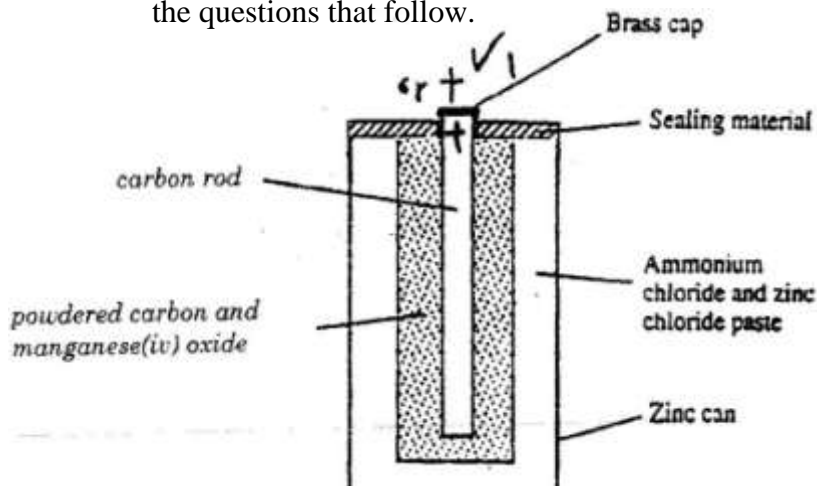
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22. 2003 Q27 (P1), 2 (P2)

27. During purification of copper by electrolysis, 1.48g of copper were deposited when current was passed through aqueous copper(II) sulphate for  $2\frac{1}{2}$  hours. Calculate (CU = 63.5, 1 Faraday = 96,500C).

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



- i) On the diagram, show with a (+) sign the positive terminal
- ii) Write the equation for the reaction in which electrons are produced

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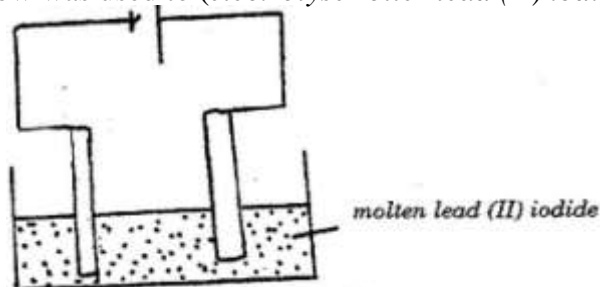
- iii) The zinc can is lined with ammonium chloride and zinc chloride paste. What would happen if the mixture was to become dry? Give a reason.

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- iv) Give one advantage and one disadvantage of dry cells.

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b) The set – up below was used to (*electrolyse roller lead (II) iodide*).



i) State the observation that was made at the anode during the electrolysis.  
Give a reason for your answer. (2 marks)

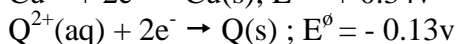
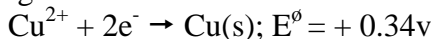
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ii) A current of 0.5 A was passed for two hours. Calculate the mass of lead  
that was deposited ( $Pb = 1F = 9,500C$ ) (3marks)

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**23. 2004 Q 19**

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



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

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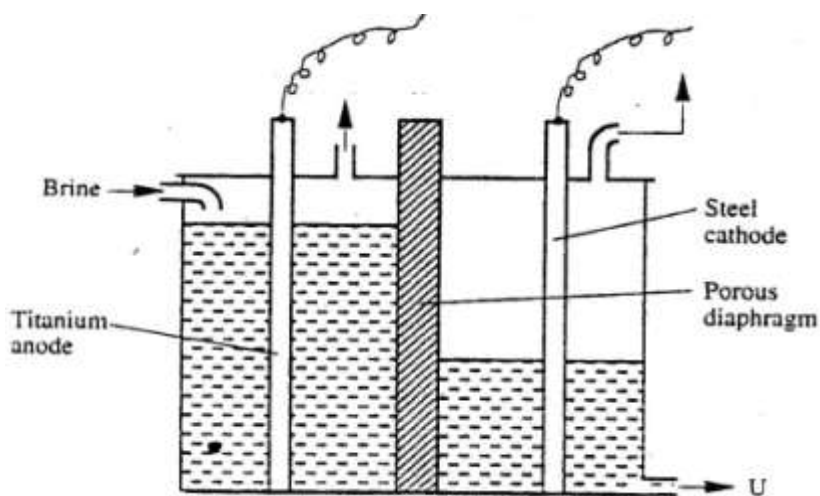
b) Give a reason for your answer in 19 (a) above. (1 mark)

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**24. 2004 Q 7b, c P2**



b) The diagram below represents a diaphragm cell used to electrolyse pure brine



i) Write the equations for the reactions that take place at  
 I Cathode (1 mark)

.....

II Anode (1 mark)

.....

ii) Name:  
 I Product at U (1mark)

.....

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

.....

III The impurity present in the product at U

.....

iii) State two functions of the diaphragm (2marks)

.....

.....

c) Give one industrial use of the product at U. (1 mark)

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- (a) The table below shows the standard reduction potentials for four half-cells. Study it and answer the questions that follow. (Letters are not the actual symbols of the elements)

	$E^\ominus$ (volts)
$F_2(aq) + 2e \rightarrow 2F^-(aq)$	; + 0.54
$G^{2+}(aq) + 2e \rightarrow G(s)$	; -0.44
$H^+(aq) + 2e \rightarrow H_2(g)$	; + 0.34
$2J^+(aq) + 2e \rightarrow J_2(s)$	; 0.00

- (i) Identify the strongest reducing agent (1 mark)

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- (ii) Write the equation for the reaction which takes place when solid G is added to a solution containing  $H^+$  ions (1 mark)

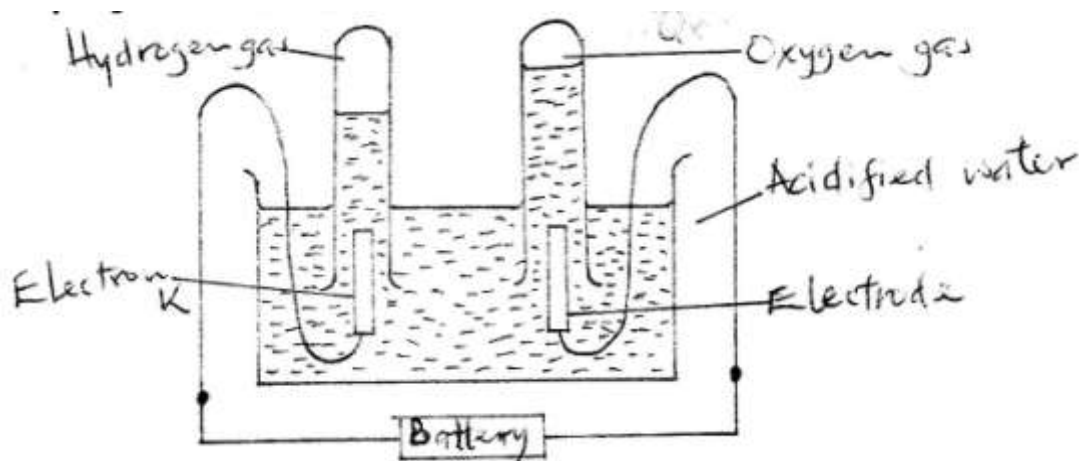
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- (iii) Calculate the  $E^\ominus$  value for the reaction in (ii) above (1 mark)

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



- (i) Identify the electrode at which oxidation takes place (1 mark)

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- (ii) Give a reason why it is necessary to acidify the water (1 mark)

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- (iii) Explain why hydrochloric acid is not used to acidify the water (2 marks)

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- (c) During electrolysis of aqueous copper (II) sulphate, 144750 coulombs of electricity were used. Calculate the mass of copper metal that was obtained  
(Cu = 64; 1 Faraday = 96500 coulombs) (3 marks)

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**26. 2006 Q 15**

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

	$E^\ominus$ (volts)
$M^{2+}_{(aq)} + 2e \rightarrow M_{(s)}$	-0.76
$N^{2+}_{(aq)} + 2e \rightarrow N_{(s)}$	-2.37
$P^{+}_{(aq)} + e \rightarrow P_{(s)}$	+0.80
$Q^{2+}_{(aq)} + 2e \rightarrow Q_{(s)}$	-0.14

- a) The standard reduction potential for  $Fe^{2+}_{(aq)}$  is -0.44 volts. Select the element which would best protect iron from rusting. (1 mark)

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- b) Calculate the  $E^\ominus$  value for the cell represented as  $M_{(s)} / M^{2+}_{(aq)} // P^{+}_{(aq)} / P_{(s)}$ . (2marks)

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**27. 2006 Q 1,2b P2**

1. a) What is an electrolyte? (1mark)

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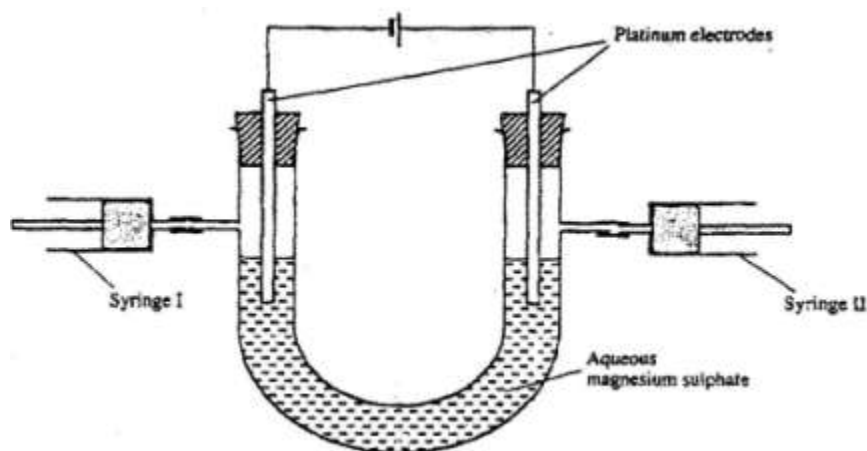
- b) State how the following substances conduct electricity. (1mark)  
 i) Molten calcium chloride

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- ii) Graphite. (1 mark)

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



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

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

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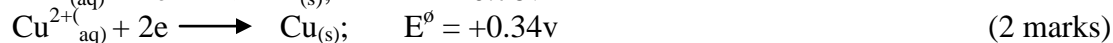
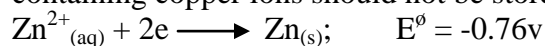
d) Explain why the concentration of magnesium sulphate was found to have increased at the end of the experiment. (2 marks)

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e) During the electrolysis, a current of 0.72A was passed through the electrolyte for 15 minutes. Calculate the volume of gas produced at the anode. (1 Faraday = 96500 coulombs; molar gas volume is 24000cm<sup>3</sup> at room temperature). (4 marks)

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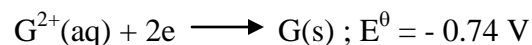
2b. Use the reduction potentials given below to explain why a solution containing copper ions should not be stored in a container made of zinc.



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28. 2007 Q 7

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



b) Calculate the  $E^\theta$  value for the cell constructed in (a) above. (1 mark)

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29. 2007 Q 21

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

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- b) Name the product formed at the cathode. (1 mark)

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**30. 2007 Q 28**

During the electrolysis of aqueous silver nitrate, a current of 5.0a was passed through the electrolysis for 3 hours.

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

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- b) Calculate the mass of silver deposited ( $A_g = 108$ ;  $IF=96500C$ ) (2 marks)

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**31. 2008 Q 19**

Select a letter which represents a mono atomic gas. (1 mark)

	$E^\ominus$ (Volts)
$Zn^{2+}(aq) + 2e^- \longrightarrow Zn(s)$	-0.76
$Pb^{2+}(aq) + 2e^- \longrightarrow Pb(s)$	-0.13
$Ag^+(aq) + e^- \longrightarrow Ag(s)$	+0.80
$Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$	+0.30

- a) Write the cell representation for the electrochemical cell that would give the highest E (1mark)

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

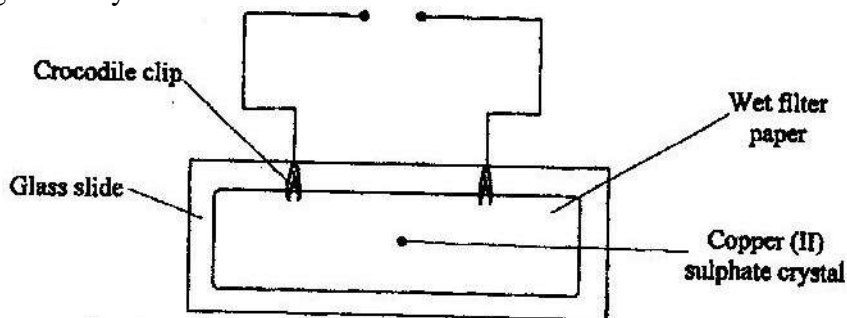
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**32. 2008 Q 21**

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 (2 marks)

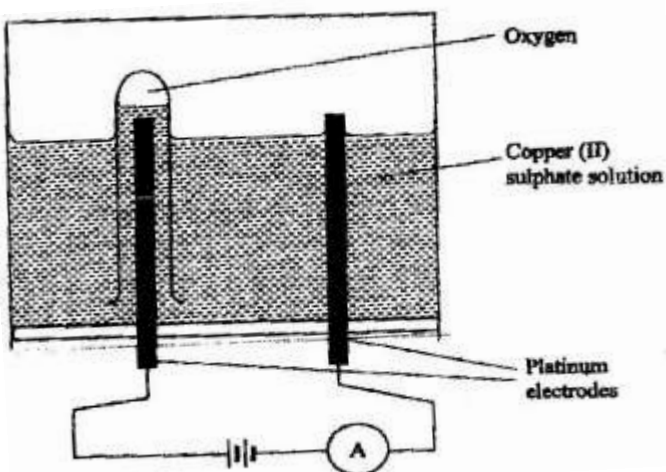
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b) Write the equation for the reaction that occurred at the anode. (1 mark)

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**33. 2008 Q 6 P2**

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



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

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

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(b) Impure copper is purified by an electrolytic process

(i) Name one ore from which copper is obtained

(1 mark)

.....

(ii) Write the equation for the reaction that occur at the cathode during the purification of copper

(1 mark)

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

(3 marks)

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(iv) Give two reasons why some metals are electroplated

(2 marks)

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**34. 2009 Q 7**

When aluminium oxide was electrolysed. 1800kg of aluminium metal obtained.

(a) Write an equation for the formation of aluminium metal.

(1 mark)

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(b) Calculate the quantity of electricity in faradays used ( $A_l = 27$ )

(2 marks)

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**35. 2009 Q 10**

Hydrogen and oxygen can be obtained by electrolysis of acidified water. Using equations for the reactions at the electrodes, explain why the volume of hydrogen obtained is twice that of oxygen.

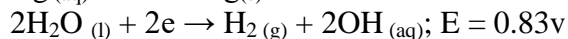
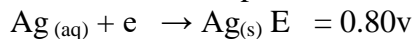
(2 marks)

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36. 2009 Q 12

The standard reduction potentials of two half cells are:



Draw a labelled diagram of an electrochemical cell that can be constructed using the two half cells.

37. 2009 Q 3 P2

The set-up below (figure 2) was used to electrolyse a bromide of metal D,  $\text{DBr}_2$

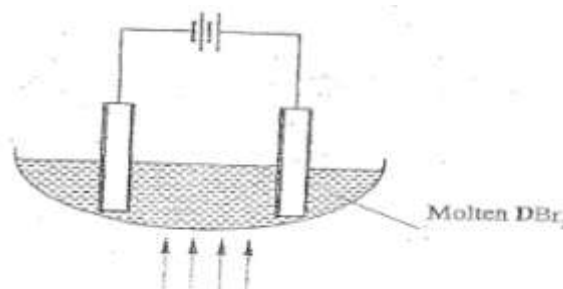


Figure 2

(i) Write the equation for the reaction at the :

(i) Cathode

(1 mark)

.....

(ii) Anode

(1 mark)

.....

(ii) The electrodes used in the experiment were made of carbon and metal D which of the two electrodes was used as the anode? Give a reason

(2 marks)

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(iii) Give a reason why this experiment is carried in a fume cupboard (1mark)

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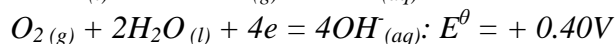
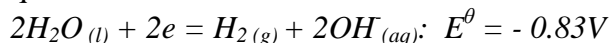
38. 2010 Q 7

Complete the table below by writing the product formed at the electrodes during the electrolysis of the electrolytes given in the table. (3 marks)

Electrolyte	Product at anode	Product at cathode
Aqueous sodium sulphate using inert electrodes	( $\frac{1}{2}$ mark)	( $\frac{1}{2}$ mark)
Aqueous copper(II) sulphate using copper electrodes	(1 mark)	(1 mark)

39. 2010 Q 19

The half equations involved in a cell are:



a) Write the overall equation for the electrochemical cell. (1 mark)

.....

b) Calculate the e.m.f. generated by a battery consisting of ten cells. (1 mark)

.....  
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c) State **one** environment advantage of using these cells in spacecrafts. (1 mark)

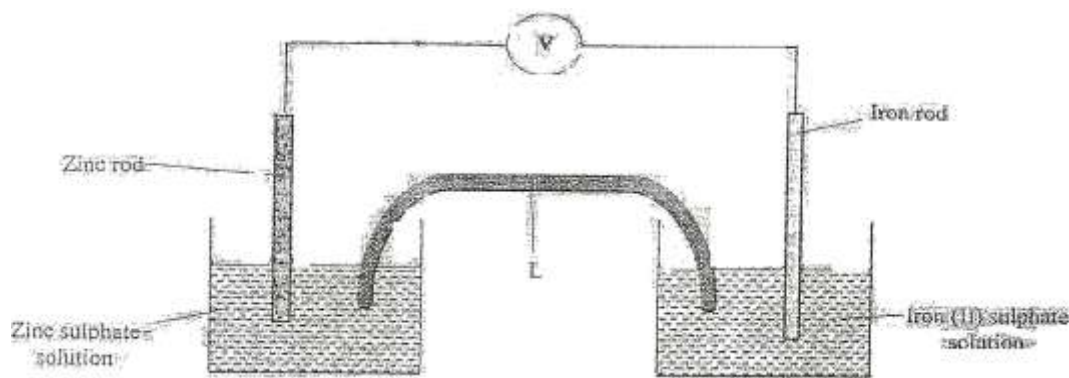
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40. 2010 Q 1 P2

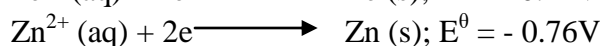
a) Which one of the following compounds; urea, ammonia, sugar and copper (II) chloride will conduct an electric current when dissolved in water? Give reasons. (2 marks)

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.....

b) The diagram below shows an electrochemical cell. Study it and answer the questions that follows.



Given the following



- i) Show on the diagram using an arrow, the direction of flow of electrons (1 mark)  
 ii) Name **two** substances that are used to fill the part labeled L (2 marks)

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c) In an experiment to electroplate iron with silver, a current of 0.5 amperes was passed through a solution of silver nitrate for an hour

- i) Give **two** reasons why it is necessary to electroplate iron with silver (2 marks)

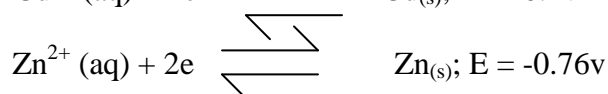
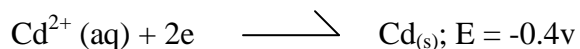
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- ii) Calculate the mass of silver that was deposited on iron ( $\text{Ag} = 108$ , 1 Faraday = 96,500 coulombs) (3marks)

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41. 2011 Q 2b

b) The electrode potentials for calcium and zinc are given below:

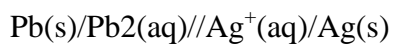


Explain why it is not advisable to store a solution of cadmium nitrate in a container made of zinc. (2 marks)

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**42. 2012 Q15 P1**

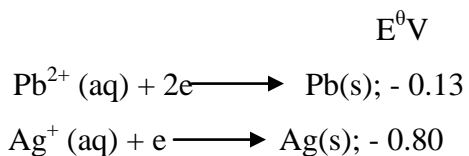
Below is a representation of an electrochemical cell.



(a) What does // represent? (1 mark)

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(b) Given the following:

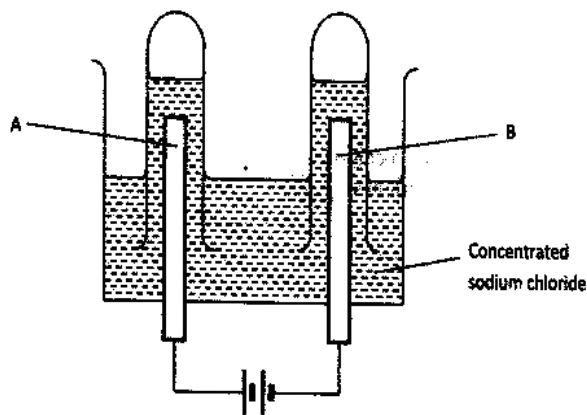


Calculate the E.M.F of the electrochemical cell. (2 marks)

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**43. 2012 Q28 P1**

The apparatus shown in the diagram below were used to investigate the products formed when concentrated sodium chloride was electrolysed using inert electrodes.



(a) Write the equation for the reaction that takes place at electrode A (1 mark)

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(b) If the concentrated sodium chloride was replaced with dilute sodium chloride, what product would be formed at electrode A? Explain. (2 marks)

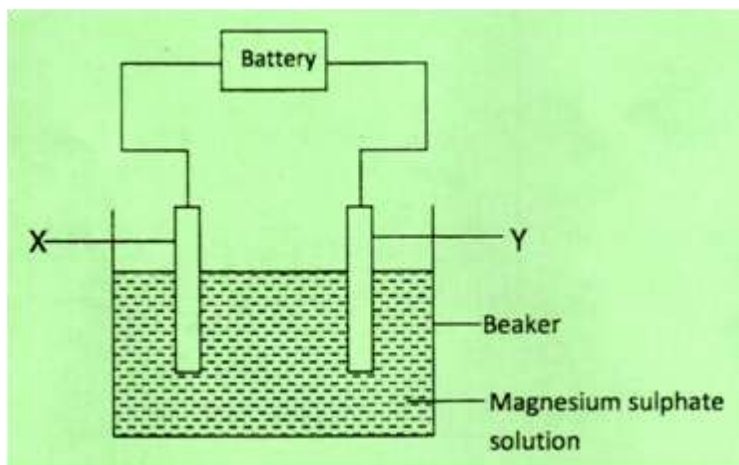
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**44. 2012 Q5 P2**

(a) The set up below was used to investigate the products formed at the electrodes during electrolysis of aqueous magnesium sulphate using inert electrodes. Use it to answer the questions that follow.



(i) During the electrolysis, hydrogen gas was formed at electrode Y. Identify the anode. Give a reason for your answer. (1 mark)

.....

.....

.....

(ii) Write the equation for the reaction which takes place at electrode X (1 mark)

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(iii) Why is the concentration of magnesium sulphate expected to increase during electrolysis? (2 marks)

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(iv) What will be observed if red and blue litmus papers were dipped into the solution after electrolysis? (2 marks)

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(b) During electrolysis of magnesium sulphate, a current of 0.3a was passed for 30 minutes. Calculate the volume of gas produced at the anode (Molar gas volume = 24dm<sup>3</sup>; 1 faraday = 96,500C) (3 marks)

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(c) State **two** applications of electrolysis (1 mark)

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