NAME: …………….…..………………………………………………………………..

SCHOOL:…………………………………………………………………………………

DATE: ....

ELECTROCHEMISTRY

INSTRUCTIONS TO CANDIDATES

*Answer **ALL** questions in this paper in the spaces provided.*

1.   Below is a table of reduction potentials and volts of some half cells. The letters are not actual symbols but use them to answer the questions which follow

Reaction		volts
$A^{2+}_{(aq)}$ + 2e $\longrightarrow$ $A_{(s)}$		-2.80
$B^{+}_{(aq)}$ + e $\longrightarrow$ $B_{(s)}$		-1.50
$2C^{+}_{(aq)}$ + 2e $\longrightarrow$ $C_{2(g)}$		0.00
$D_{2(g)}$ + 2e $\longrightarrow$ $2D^{-}_{(aq)}$		+3.20
$G^{+}_{(aq)}$ + e $\longrightarrow$ $G_{(s)}$		+1.80

(a)   Select the species with the largest

(i)   Oxidizing power   (1mk)

(ii)   Reducing power   (1mk)

1

(b)   Calculate the electrode potential (e.m.f) for a cell constructed using half-cells of A and B

(1mk)

2.   What is the oxidation number of

(i)   Chromium in $Cr_2O_7^{2-}$ (1mk)
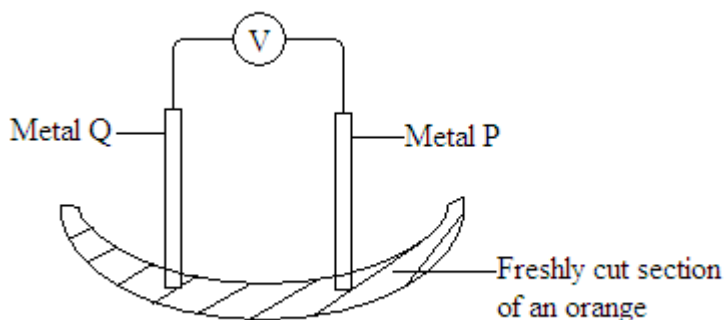
(ii)   Phosphorus in PO_4^{3-}

(1mk)

3. An element P has a relative atomic mass of 88. When a current of 0.5 amperes was passed through the fused chloride of P for 32 minutes and 10 seconds, 0.44g of P was deposited at the cathode. Determine the charge on an ion of P. (1 faraday = 96500 coulombs)

(3mks)

4. The setup below was used to show that metal P is more reactive than metal Q.

(a)   **Show** the direction of flow of electrons on the diagram using an arrow.
        (1mark)

2

(b) **Explain** your answer in (a) above.

(1mark)

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5.A dry cell is constructed using the following substances: Zinc metal, graphite rod, ammonium chloride paste and manganese (IV) oxide mixed with carbon powder.
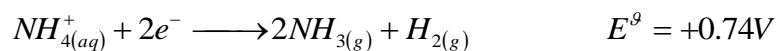
(a) (i) **State** the roles of (i) ammonium chloride paste (1mark)

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(ii) Manganese (IV) Oxide mixed with carbon powder (1mark)

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(b) Given that

$$NH_{4(aq)}^+ + 2e^- \longrightarrow 2NH_{3(g)} + H_{2(g)} \qquad E^\vartheta = +0.74V$$

$$\text{and} \quad Zn_{(aq)}^{2+} + 2e^- \longrightarrow Zn_{(s)} \qquad E^\vartheta = -0.76V$$

Calculate the e.m.f of the cell given Zinc forms the negative electrode.

(1mark)

6. (a) **Study** the table below and indicate with a tick (✔) where a reaction takes place or a cross (✘) where no reaction takes place.

(2marks)

Metal	Solution Containing Ions Of:	Reaction/ No Reaction
Cu	Zn^{2+}	
Zn	Ag^+	
Mg	Cu^{2+}	
Ag	Mg^{2+}	

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(b)   **Write** an ionic equation for one reaction that occurred.   (1mark)

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7. Fluorine can be obtained on large scale through electrolysis of potassium fluoride dissolved in liquid hydrogen fluoride but not by electrolysis of KF dissolved in water. **Explain.** (2marks)

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8.   a) Determine the oxidation state of sulphur in sodium thiosulphate, $Na_2S_2O_3$.   (1mk)

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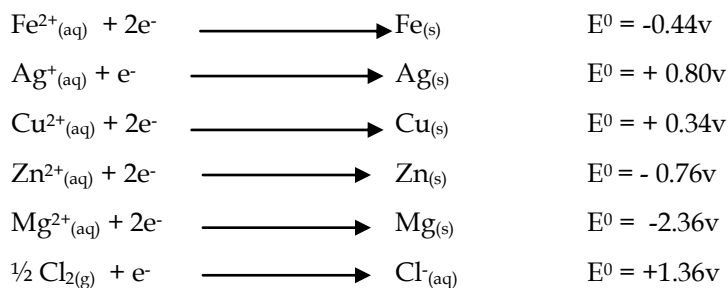
b) Write the equation for the reaction of sodium thiosulphate and dilute hydrochloric acid.   (1mk)

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c) Of what use is the reaction in (b) above in our school laboratory?   (1mk)

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9.   Study the following electrode potentials, E^0

$Fe^{2+}_{(aq)} + 2e^- \longrightarrow Fe_{(s)}$ $E^0 = -0.44v$

$Ag^+_{(aq)} + e^- \longrightarrow Ag_{(s)}$ $E^0 = + 0.80v$

$Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$ $E^0 = + 0.34v$

$Zn^{2+}_{(aq)} + 2e^- \longrightarrow Zn_{(s)}$ $E^0 = - 0.76v$

$Mg^{2+}_{(aq)} + 2e^- \longrightarrow Mg_{(s)}$ $E^0 = -2.36v$

$½ Cl_{2(g)} + e^- \longrightarrow Cl^-_{(aq)}$ $E^0 = +1.36v$

a)   Name:

(i) The strongest reducing agent.   (1mk)

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(ii) The strongest oxidizing agent. (1mk)

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b) Write the cell notation for combination of half-cells that would give the highest e.m.f.

(1mk)

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10. Metals zinc, copper and silver were placed in different solutions as shown in the table below.

| Metal	Solution containing ion of	Reaction / No reaction
Cu	Zn^{2+}	
Zn	Ag^+	
Ag	Pb^{2+}	

a) Indicate with a tick (✓) where a reason takes place or a cross (x) where no reaction takes place, in the table above. (1 ½ mks)

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b) Arrange the elements in their correct order of reactivity, starting with the least reactive. (½ mk)

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11. Chromium (IV) ion and chromium (III) ion exist in equilibrium as shown below.

$$Cr_2O_7^{2-} {}_{(aq)} + 14 H^+ {}_{(aq)} \rightleftharpoons 2Cr^{3+} {}_{(aq)} + 7H_2O {}_{(l)}$$
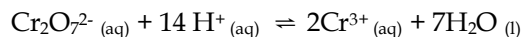
State and explain the observation that would be made when a few drops of hydrochloric acid   solution is added to the solution.

(2mks)

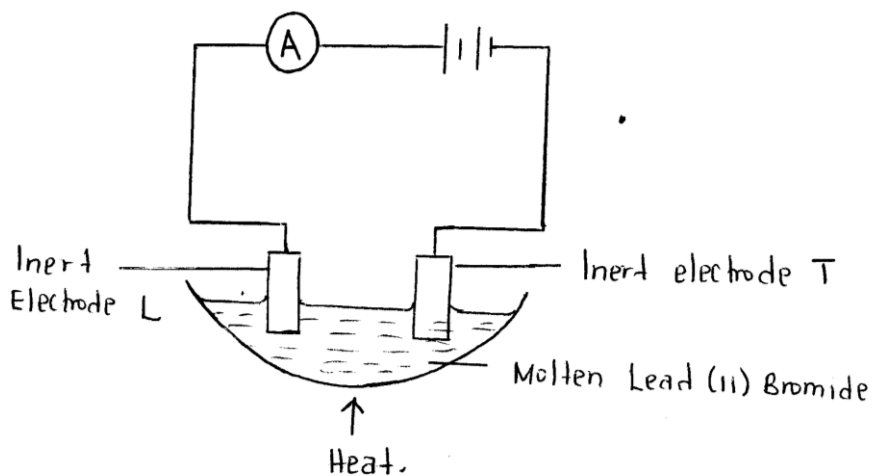..

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12. Study the set up below and answer the questions that follows

(a) **What** observations would be made at electrode L   (½ mk)

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(b) **Write an ionic** equation for the reaction at electrode. T.   (½ mk)

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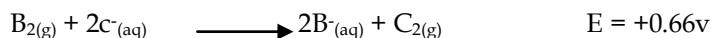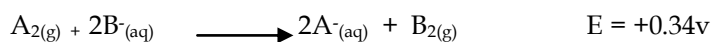
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(c) If a current of 2 amperes was passed through the molten lead (II) bromide for 15 minutes. **Calculate** the mass of product at electrode T. **(Pb = 207, Br = 80, If = 96500 coulombs)**

(1½mks)

13. Use the ionic equations below to answer the questions that follow. Letters used are not actual symbols of elements.

$A_{2(g)} + 2B^-_{(aq)} \longrightarrow 2A^-_{(aq)} + B_{2(g)}$ E = +0.34v

$B_{2(g)} + 2c^-_{(aq)} \longrightarrow 2B^-_{(aq)} + C_{2(g)}$ E = +0.66v

a) Identify the least reactive element.   (1mk)

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b) Calculate the standard reduction potential of B given that

$A_{2(g)} + 2e \longrightarrow 2A^-_{(aq)}$ E = + 1.42v

(2mks)

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14. Determine the oxidation number of

(a) Manganese in $KMnO_4$ (1mk)

(b) Sulphur in Na_2SO_3

(1mk)

15. During electrolysis of copper(II) Sulphate solution, a current of 4.0 Amperes was passed through the solution for Y minutes to deposit 2.39g of copper at the cathode. Determine the value of Y (Cu=64, 1F=96,500C). (2mks)

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16. The table below gives the standard reduction potentials of some elements represented by letters U,V,W,X and Z. (They are not the actual symbols)

Element	Standard electrode potentials (volts)
U	-2.36
V	+0.34
W	+0.79
X	0.00
Z	-0.76

a) (i) Identify the strongest reducing agent. Give a reason for your answer.   2mks

(ii)   Which two half cells would produce the highest e.m.f? Determine the e.m.f that would be produced.   2mks

(iii) What would element X represent?   1mk

b)   Elements V and Z were connected to form an electrochemical cell as shown in the diagram below.
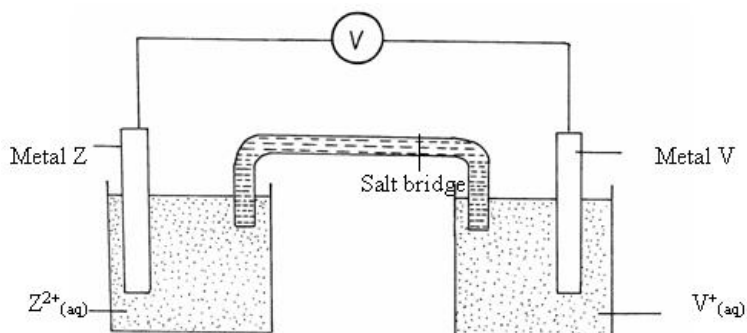
(i) Write the equation for the reaction that occurs at:
        Metal Z electrode   1mk

Metal V electrode   1mk

(ii) Write the cell representation for the above electrochemical cell.   1mk

(iii) Determine the e.m.f of the above cell.   1mk

iv) Write the overall cell reaction indicating the e.m.f   1mk

v) Give one use of electrochemical cells.   1mk

vi) State one use of a salt bridge, and name two salts that can be used in the salt bridge.

Use ……………………………………………………………………….. 1mk

Salts ……………………………………………………………………………2mks

17. The standard electrode potential of some half cells (in volts) are given below.

(i) $Zn^{2+}_{(aq)} + 2e \rightleftharpoons$ $Zn_{(s)}$ -0.76

(ii) $Cr^{3+}_{(aq)} + 3e \rightleftharpoons$ $Cr_{(s)}$ -0.74

(iii) $Sn^{2+}_{(aq)} + 2e \rightleftharpoons$ $Sn_{(s)}$ -0.14

(iv)$2B^{+}_{(aq)} + 2e \rightleftharpoons$ B_2 0.00

(v) $Cu^{2+}_{(aq)} + 2e \rightleftharpoons$ $Cu_{(s)}$ +0.34

(vi) $Fe^{3+}_{(aq)} + 2e \rightleftharpoons$ $Fe^{2+}_{(aq)}$ +0.77

(vii)$Br_{2(aq)} + 2e \rightleftharpoons$ $2Br^-$ +1.07

a) Which element is represented by letter B? Explain.   (1 mark)

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b) Identify the strongest reducing agent and strongest oxidizing agent.   (1 mark)
(i) Strongest reducing agent

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(ii) Strongest oxidizing agent

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c) Write the equation and calculate the e.m.f of the electrochemical cell constructed from half cells in b(i) and (ii) above.   (2 marks)

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d) Write the cell representation for the electrochemical cell made using half cells (v) and (vi).
            (1 mark)

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e) Draw the diagram for the cell represented in (d) above.   (3 marks)

f) A current of 1.8 A was passed through molten aluminium oxide for 3 hrs. Calculate

i) the number of faradays used.(F=96500C)   (2 marks)

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ii) The moles of aluminium deposited   (2 marks)

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iii) The mass of aluminium deposited (Al = 27)   (2 marks)

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18.   a) (i) Which of the following metals could be used as a sacrificial anode in order to prevent the corrosion of iron? Explain your answer.
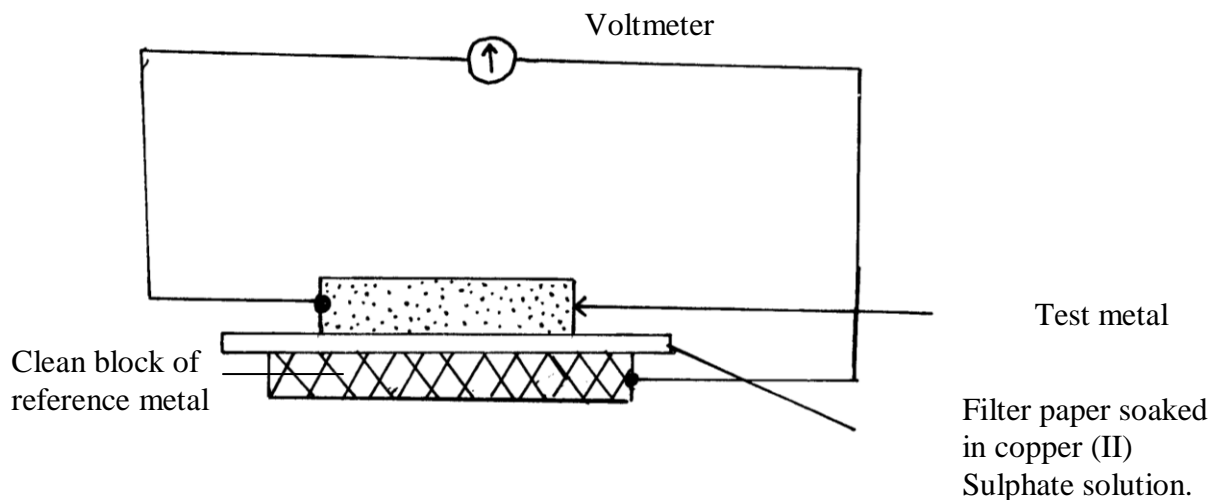
Magnesium, zinc, lead, copper.   (2mks)

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(ii) An iron becomes coated when placed in a solution of copper (II) sulphate, $CuSO_{4(aq)}$.
Write half equations for the oxidation / reduction reaction involved.   (2mks)

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b) Study the diagram and the data on the table to answer the questions that follow.

Voltmeter

Test metal

Clean block of
reference metal

Filter paper soaked
in copper (II)
Sulphate solution.

Using the above arrangement the results obtained were:-

Test metal	Voltmeter deflection units
Sodium	2.5 to the right
Magnesium	1.6 to the right
Metal X	0.8 to the right
Iron	0.6 to the right
Tin	0.4 to the right
Copper	0.0
Silver	0.4 to the left

(i) What was the reference metal for which the results were based?   (1mk)

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(ii) Identify two aqueous solutions in which an observable chemical change would occur

when metal X is added to them.   (1mk)

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(iii) When the reference metal is iron, what would be the test metal which could give a voltmeter deflection of 0.2 to the left. (1mk)

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c) What mass of copper is produced at a cathode by a current of 2 Amps flowing for 10 minutes? (Cu = 64, IF = 96500C). (2mks)

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d) Use the std electrode potentials below to answer the questions that follow.

Ion discharge reaction	$E^0(v)$
$X^+_{(aq)} + e \longrightarrow X_{(s)}$	- 2.92
$Y^{2+}_{(aq)} + 2e \longrightarrow Y_{s)}$	-2.34
$A^+_{(aq)} + e \longrightarrow A_{(s)}$	+ 0.80
$R^{2+}_{(aq)} + 2e \longrightarrow R_{(s)}$	+0.34

(i) Identify the letter representing the strongest reducing agent. Explain. (1mk)

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(ii) Is it appropriate to keep aqueous solution of the chloride of X in a container made of R? Explain. (1mk)

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(iii) Write down the cell representation for the pair that would give the largest e.m.f. showing the position of the salt bridge. (1 ½ mks)

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