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Name: Key
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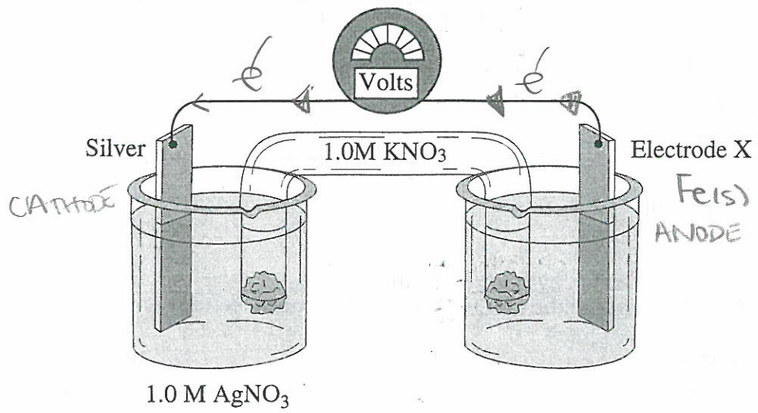
CHEMISTRY 12
WORKSHEET FOR ELECTROCHEMISTRY UNIT REVIEW

1. Consider the following electrochemical cell:



$Ag^+ + 1e \rightarrow Ag(s)$ $E^\circ = +0.8$

$Fe^{2+} + 2e \leftarrow Fe(s)$ $E^\circ = +0.45$

1.25

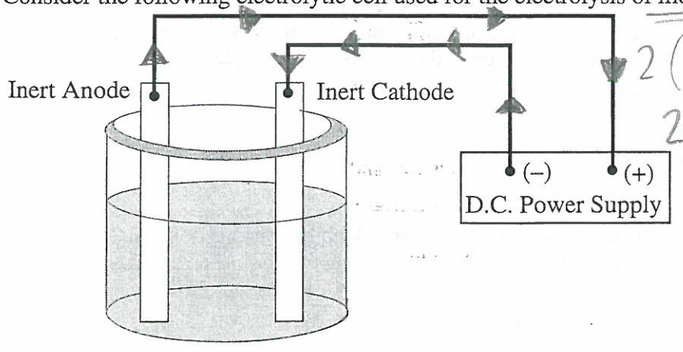
Fe(s) ∴ Fe(s)

1.25 - 0.80 = 0.45 V

a) The initial cell voltage in the diagram above is 1.25 V. Identify electrode X.
b) Towards which electrode will the K^+ ions migrate? Silver (cathode)
c) Write the equation for the reduction half-reaction that occurs. $Ag^+ + 1e \rightarrow Ag(s)$
d) On the diagram, indicate the direction of electron flow. (4 marks)

/4

2. Consider the following electrolytic cell used for the electrolysis of molten AgCl.



$2(Ag^+ + 1e \rightarrow Ag(s))$ $E^\circ = 0.80$ V

$2Cl^- \rightarrow Cl_2 + 2e$ $E^\circ = -1.36$ V

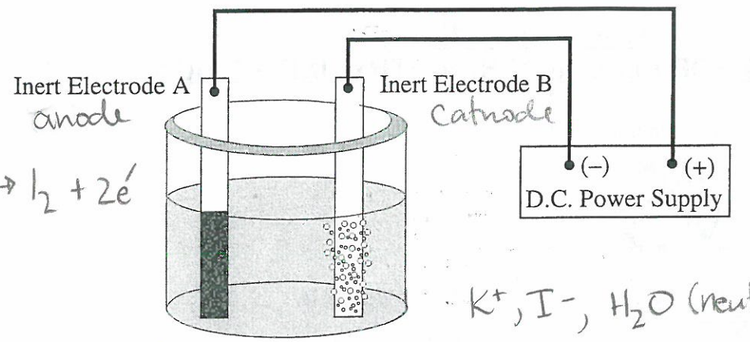
$E^\circ_{cell} = -0.56$

/4

a) Clearly indicate on the diagram above, the direction of the electron flow through the wire. Anode to Cathode
b) Write the equation for the half-reaction taking place at the anode. $2Cl^- \rightarrow Cl_2 + 2e$
c) Write the equation for the half-reaction taking place at the cathode. $Ag^+ + 1e \rightarrow Ag(s)$
d) Write the equation for the overall reaction. (4 marks)

$2Ag^+ + 2Cl^- \longrightarrow Cl_2 + Ag(s)$; $E^\circ = -0.56$ V

3. Consider the following cell used for the electrolysis of 1.0 M KI solution containing a few drops of phenolphthalein indicator.



$2I^- \rightarrow I_2 + 2e^-$

K^+, I^-, H_2O (neutral)

3

a) Write the equation for the half-reaction taking place at electrode A.
b) As the cell operates, gas bubbles form and the solution turns pink around electrode B.
   i) Identify the gas that forms. $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ (10^{-7} M)
   ii) Explain why the solution turns pink. (3 marks)

↳ production of OH^- → pink

2

4. An electrolytic cell can be used to plate a copper penny with a silver coating. Sketch a diagram of the electrolytic cell. Label the cathode and show the direction of electron flow. (2 marks)

$H_2 \rightleftharpoons 2H^+ + 2e^-$

5. The overall reaction in a fuel cell is:
$2H_2 + O_2 \rightarrow 2H_2O$ *basic*

2

a) Write the equation for the half-reaction at the anode. $H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$
b) Is the overall reaction spontaneous? Explain. (2 marks)

Yes → it generates electricity

OR $2H_2 + 4OH^- \rightarrow 4H_2O + 4e^-$

4

6. In a titration, a 1.00 mL sample of an antiseptic solution containing hydrogen peroxide required 17.6 mL of a 0.0200 M solution of $KMnO_4$ to reach the endpoint. The equation for the reaction is

$$5H_2O_{2(aq)} + 2MnO_4^- + 6H^+ \rightarrow 5O_2 + 2Mn^{2+} + 8H_2O$$

a) Identify the reducing agent. → H_2O_2
b) Calculate the concentration of H_2O_2 in the antiseptic solution. (4 marks)

0.0176 L × $\frac{0.0200 \text{ mol } MnO_4^-}{1 \text{ L}} \times \frac{5 \text{ mol } H_2O_2}{2 \text{ mol } MnO_4^-} = \frac{8.8 \times 10^{-4} \text{ mol } H_2O_2}{0.00100 \text{ L}} = 8.80 \times 10^{-1}$ M H_2O_2

7. A series of experiments is performed to measure the E° produced by various combinations of metals in 1.00 M solutions of their salts.

Anode	Cathode	E°(V)
Be	Cd	1.297
Be	Ga	1.180
Ti	Be	0.050

$Cd^{2+} \rightleftharpoons Cd(s)$ E° = 2.297
$Ga^{2+} \rightleftharpoons Ga(s)$ E° = 2.180
$Be^{2+} \rightleftharpoons Be(s)$ E° = 1.00 V
$Ti^{2+} \rightleftharpoons Ti(s)$ E° = 0.95 V

3

Based on the data above,
a) list the metals in order of their activity (strongest reducing agent first). Ti(s), Be(s), Ga(s), Cd(s)
b) predict the E° of a Ti /Cd cell. (3 marks)

1.2

OR Anode: Ti; Cathode: Cd; Cd^{2+}; $Ti_{(s)}$

1.297 V + 0.050 V = + 1.347 V

$E°_{cell} = 2.297 - 0.95\text{ V} = +1.347\text{ V}$

8. Consider the reaction:

$2Fe^{3+} + I_2 \rightarrow 2\,Fe^{2+} + 2I^-$

Is the reaction spontaneous? Explain. (2 marks)

This reaction is not spontaneous b/c both Fe^{3+} and I_2 can only undergo REDUCTION ∴ no redox rxn is possible

1/2

9. Balance the following redox reaction: (3 marks)

$Ni + ClO_4^- \rightarrow Ni^{2+} + Cl^-$ (acid)

1/3

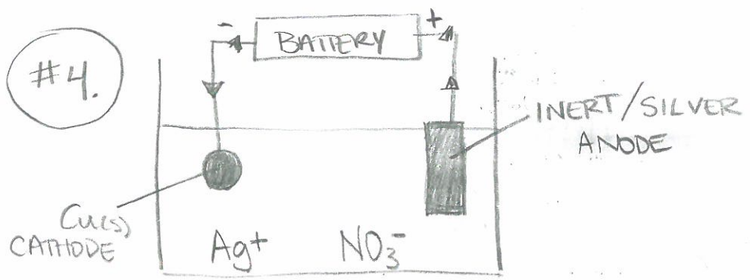
10. Balance the following half-reaction:

$Sb_2O_5 \rightarrow Sb_2O_3$ (basic)

and label as being an OXIDATION or a REDUCTION (3 marks)

1/3

#4.



#9. $(Ni \longrightarrow Ni^{2+} + 2e^-)4$

$8e^- + 8H^+ + ClO_4^- \longrightarrow Cl^- + 4H_2O$

$4Ni + 8H^+ + ClO_4^- \longrightarrow 4Ni^{2+} + Cl^- + 4H_2O$

+8 + -1 = +7 +8 + -1 = +7

#10.

$4e^- + 4H^+ + Sb_2O_5 \longrightarrow Sb_2O_3 + 2H_2O$

$2H_2O \rightleftharpoons 4H^+ + 4OH^-$

$4e^- + 2H_2O + Sb_2O_5 \longrightarrow Sb_2O_3 + 4OH^-$

↳ reduction (é gained)

#5 $2H_2 + O_2 \longrightarrow 2H_2O$ (Basic Conditions)

anode: $H_2 \longrightarrow 2H^+ + 2e^-$

$2OH^- + 2H^+ \rightleftharpoons 2H_2O$

$(H_2 + 2OH^- \longrightarrow 2H_2O + 2e^-)\,2$

Cathode: $4H^+ + O_2 + 4e^- \longrightarrow 2H_2O$

$4H_2O \rightleftharpoons 4H^+ + 4OH^-$

$O_2 + 4e^- + 2H_2O \longrightarrow 4OH^-$

Together: $2H_2 + 4OH^- \longrightarrow 4H_2O + 4e^-$ ○2

$2H_2O + O_2 + 4e^- \longrightarrow 4OH^-$

$2H_2 + O_2 \longrightarrow 2H_2O$