Name: _____ Class: _____ Date: _____ ID: A

Electrochemistry: Standard #10

Multiple Choice
Identify the letter of the choice that best completes the statement or answers the question.

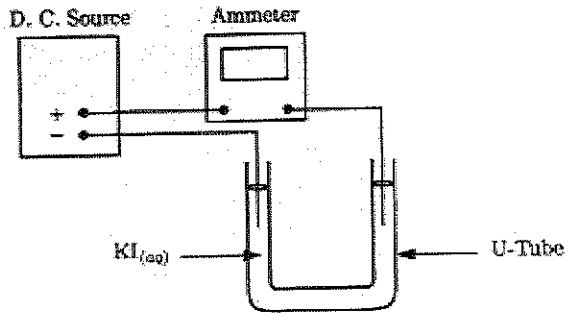
The diagram below represents apparatus that can be used in the laboratory for electrolysis of a 1.0M solution of KI. The terminals of the 12 V DC power supply have been labeled with the appropriate charges. The current is supplied at the rate of 2.5 amps. There is a brownish color being produced at the anode and bubbles are appearing at the cathode.

$$I_2 + 2e^- \Rightarrow 2I^- \quad E = 0.53$$

$$K^{+1} + 1e^{-1} \Rightarrow K \quad E = -2.92$$

$$O_2 + 4H^{+1} + 4e^{-1} \Rightarrow 2H_2O \; E = 1.23$$

$$2H_2O + 2e^{-1} \Rightarrow H_2 + 2OH^{-1} \; E = -0.83$$



$I = \frac{Q}{t}$

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

$.1 \times 2 = .2$ mol e^-

$.2 \text{ mol } e^- \cdot \frac{96500 \text{ C}}{1 \text{ mole}} =$

$\frac{Q}{I} = t$ ÷ 2.5

1. (#10-5)Which expression gives the time in hours needed to produce 0.10 mol I_2.
   a. 0.10 x 2/ 2.5 x 60
   b. (0.10 x 96500)/(2.5 x 60 x 60)
   c. .10 x 2/(2.5 x 60 x 96500)
   d. (.10 x 2 x 96500)/(2.5 x 60 x 60)
   e. (0.10 x 2 x 96500 x 60) /2.5

2. (#10-3) Which describes the behavior of $I^-_{(aq)}$ ions in this system?
   a. I^- ions migrate, as spectator ions, toward the anode.
   b. I^- ions migrates, toward the anode where they become oxidized to I_2
   c. I^- ions migrates, toward the anode where they become reduced to I_2
   d. I^- ions migrate toward the cathode where they become oxidized to I_2
   e. I^- ions migrate toward the cathode where they become oxidized to I_2

$2I^- \rightarrow I_2 + 2e^-$
Oxidize → anode

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They will or could be Reduced but water Reduces first

___ 3. (#10-3) Which describes the behavior of $K^+_{(aq)}$ ions in this system?

a. K^+ ions migrate, as spectator ions, toward the cathode.

b. K^+ ions migrate toward the anode where they become reduced to $K_{(s)}$

c. K^+ ions migrate toward the anode where they become oxidized to K solid

d. K^+ ions migrate toward the cathode where they become oxidized to $K_{(s)}$

e. K^+ ions migrate toward the cathode where they become reduced to $K_{(s)}$

___ 4. (#10-2) Which best describes the behavior in the chamber containing the electrode at which bubbles of gas are observed?

a. O_2 is produced as the pH of the solution increases.

b. O_2 is produced as the pH of the solution decreases.

c. H_2 is produced as the pH of the solution increases

d. H_2 is produced as the pH of the solution decreases

e. O_2 is produced as the pH of the solution remain the same

← Basic

$2e^- + H_2O \rightarrow H_2 + OH^-$ Check Reductions chart

Balance the following Redox reaction.

?? Zn + ??$H_2AsO_3^-$ + ??H^+ ⇒ ??AsH_3 + ??Zn^{2+} + ??H_2O

___ 5. (#10-6) When the overall equation is balanced using lowest integers as coefficients, what is the sum of those coefficients?

a. 10
b. 11
c. 16
d. 18
e. 20

___ 6. (#10-1) What is the oxidizing agent(who is being reduced?) in this reaction?

a. H^+
b. As^{3+}
c. Zn
d. $H_2AsO_3^-$
e. H_2O

* must pick a reactant

← oxidized

Not $Zn^0 \rightarrow Zn^{+2} + 2e$

So $H_2AsO_3^-$

___ 7.

Assign ox states

$$\overset{0}{H_2O} + \overset{0}{Br_2} \Rightarrow \overset{+1}{H}\overset{-2}{O}\overset{+1}{Br} + \overset{+1}{H}\overset{-1}{Br}$$

(#10-1) Which is the best description of the behavior of bromine in the reaction above?

a. oxidized, only
b. proton donor
c. proton acceptor
d. both oxidized and reduced
e. neither oxidized nor reduced

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___ 8. $6\,I^- + 2MnO_4^- + 4H_2O(l) \rightarrow 3I_2(s) + 2MnO_2(s) + OH^-$

(#10-1) Which of the following statements regarding the reaction represented by the equation above is correct?

a. Iodide ion is oxidized by hydroxide ion
b. MnO_4 is oxidized by iodide ion
c. The oxidation number of manganese changes from +7 to +2.
d. The oxidation number of manganese remains the same.
e. The oxidation number of iodine changes from -1 to 0

___ 9. (#10-1) What is the oxidation number of a monatomic ion?
a. 0
b. +1
c. its charge
d. its number of electrons

___ 10. (#10-1) In the reaction $O_2 + 4e^- \rightarrow 2O_2^-$, the species O_2 is
a. oxidized.
b. reduced.
c. electrolyzed.
d. autooxidized.

___ 11. (#10-1) In the reaction $Fe \rightarrow Fe^{3+} + 3e^-$, the species Fe is
a. oxidized.
b. reduced.
c. electrolyzed.
d. autooxidized.

___ 12. (#10-1) In the reaction $F_2 + Mg \rightarrow 2F^- + Mg^{2+}$, which species is oxidized?
a. F_2 only
b. Mg only
c. both Mg and F_2
d. neither Mg nor F_2

___ 13. Electrons in a voltaic cell normally flow
a. from cathode to anode.
b. through a porous barrier.
c. in both directions through the external circuit.
d. from anode to cathode.

___ 14. For electricity to flow in a voltaic cell, the two half-cells must be
a. connected by a wire and a porous barrier.
b. completely isolated from one another.
c. in the same solution.
d. connected to a dry cell.

___ 15. In which cell does a current drive a nonspontaneous redox reaction?
a. electrolytic cell
b. dry cell
c. electrochemical cell
d. voltaic cell

___ 16. Which process deposits metal onto a surface?
a. electrolysis
b. electroplating
c. autooxidation
d. oxidation

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Standard Reduction Potentials

Half-cell reaction	Standard electrode potential, E^0 (in volts)	Half-cell reaction	Standard electrode potential, E^0 (in volts)
$F_2 + 2e^- \rightleftharpoons F^-$	+2.87	$Fe^{3+} + 3e^- \rightleftharpoons Fe$	–0.04
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+1.50	$Pb^{2+} + 2e^- \rightleftharpoons Pb$	–0.13
$Au^{3+} + 3e^- \rightleftharpoons Au$	+1.50	$Sn^{2+} + 2e^- \rightleftharpoons Sn$	–0.14
$Cl_2 + 2e^- \rightleftharpoons 2Cl^-$	+1.36	$Ni^{2+} + 2e^- \rightleftharpoons Ni$	–0.26
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+1.23	$Co^{2+} + 2e^- \rightleftharpoons Co$	–0.28
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+1.22	$Cd^{2+} + 2e^- \rightleftharpoons Cd$	–0.40
$Br_2 + 2e^- \rightleftharpoons 2Br^-$	+1.07	$Fe^{2+} + 2e^- \rightleftharpoons Fe$	–0.45
$Hg^{2+} + 2e^- \rightleftharpoons Hg$	+0.85	$S^{2+} + 2e^- \rightleftharpoons S^{2-}$	–0.48
$Ag^+ + e^- \rightleftharpoons Ag$	+0.80	$Cr^{3+} + 3e^- \rightleftharpoons Cr$	–0.74
$Hg_2^{2+} + 2e^- \rightleftharpoons 2Hg$	+0.80	$Zn^{2+} + 2e^- \rightleftharpoons Zn$	–0.76
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+0.77	$Al^{3+} + 3e^- \rightleftharpoons Al$	–1.66
$MnO_4^- + e^- \rightleftharpoons MnO_4^{2-}$	+0.56	$Mg^{2+} + 2e^- \rightleftharpoons Mg$	–2.37
$I_2 + 2e^- \rightleftharpoons 2I^-$	+0.54	$Na^+ + e^- \rightleftharpoons Na$	–2.71
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+0.34	$Ca^{2+} + 2e^- \rightleftharpoons Ca$	–2.87
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+0.15	$Ba^{2+} + 2e^- \rightleftharpoons Ba$	–2.91
$S + 2H^{2+}(aq) + 2e^- \rightleftharpoons H_2S(aq)$	+0.14	$K^+ + e^- \rightleftharpoons K$	–2.93
$2H^+(aq) + 2e^- \rightleftharpoons H_2$	0.00	$Li^+ + e^- \rightleftharpoons Li$	–3.04

+.8 +.85

____ 17. Calculate E^0 for the spontaneous reaction when an Ag^+/Ag half-cell is joined to an Hg^{2+}/Hg half-cell. Name the neutral metal produced. (use chart above only... think about it)

a. +1.65 V; Ag
b. +1.65 V; Hg
c. +0.05 V; Ag
d. +0.05 V; Hg

+.05 $Hg^{2+} \rightarrow Hg^0$

____ 18. Calculate E^0 for the spontaneous reaction when a Co^{2+}/Co half-cell is joined to a Cu^{2+}/Cu half-cell. Name the neutral metal produced.(use chart above only... think about it)

a. +0.62 V; Cu
b. +0.62 Co
c. +0.06 V; Cu
d. +0.06 V; Co

-.28 +.34 +.28 .62 $Cu^+ \rightarrow Cu^0$

____ 19. Calculate E^0 for the reaction $3Ni^{2+} + 2Cr \rightarrow 3Ni + 2Cr^{3+}$. Is the reaction spontaneous?(use chart above only... think about it)

a. –1.00 V; yes
b. –0.48 V; no
c. +0.48 V; yes
d. +0.48 V; no

-.26 +.74

.74
-.26
+.48

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decreased ↓ increased ↑

$Q = \frac{[Zn^{2+}]}{[Cu^{+2}]}$

___ 20. $Zn(s) + Cu^{2+} \Rightarrow Zn^{2+} + Cu(s)$

An electrolytic cell based on the reaction represented above was constructed from zinc and copper half-cells. The observed voltage was found to be 1 .00 volt instead of the standard cell potential, E°, of 1.10 volts. Which of the following could correctly account for this observation?

a. The copper electrode was larger than the zinc electrode.
b. The Zn^{2+} electrolyte was $Zn(NO_3)_2$, while the Cu^{2+} electrolyte was $CuSO_4$.
c. The Zn^{2+} solution was more concentrated than the Cu^{2+} solution.
d. The solutions in the half-cells had different volumes
e. The salt bridge contained KCl as the electrolyte

(R) (P)

___ 21. (1984,20) $Mg(s) + NO_3^+(aq) + H^+ \Rightarrow Mg^{2+}(aq) + NH_4^+(aq) + H_2O(l)$

When the equation above is balanced and reduced to its lowest terms what is the coefficient for the H^+

a. 4
b. 6
c. 8
d. 9
e. 10

___ 22. (1984, 46) If 0.06 faraday is passed through an electrolytic cell containing a solution of In^{3+} ions, the maximum number of moles of In that could be deposited at the cathode is

a. 0.100 mole
b. 0.020 mole
c. 0.0300 mol
d. 0.060 mol
e. 0.18 mol

$In^{+3} + 3e^- \rightarrow In^0$

.06 faraday = .06 mole e⁻ .06

.06 · 1/3 = .02

___ 23. $Zn(s)$ is used to reduce other compounds in chemical reactions. If a chemist needs a substance that is more effective in its reducing ability, which of the following species would be the best choice?

must be metal

a. Na
b. H^+
c. K^+
d. Cl^-

___ 24. For the reaction above in a certain Daniell cell, the observed value for E is 0.90 volts.

Which applies to this cell?

I. Addition of more oxidizing agent will increased the value of E.
II. Addition of products will decrease the value of E°
III. As this reaction proceeds, the value of E decreased and the value of E° remained the same.

a. I only
b. II only
c. III only
d. I and III only
e. I, II, and III only

Electrochemistry: Standard #10
Answer Section

MULTIPLE CHOICE

1. ANS: D PTS: 1
2. ANS: B PTS: 1
3. ANS: A PTS: 1
4. ANS: C PTS: 1
5. ANS: D PTS: 1
6. ANS: D PTS: 1
7. ANS: D PTS: 1
8. ANS: E PTS: 1
9. ANS: C PTS: 1
10. ANS: B PTS: 1
11. ANS: A PTS: 1
12. ANS: B PTS: 1
13. ANS: D PTS: 1
14. ANS: A PTS: 1
15. ANS: A PTS: 1
16. ANS: B PTS: 1
17. ANS: D PTS: 1
18. ANS: A PTS: 1
19. ANS: C PTS: 1
20. ANS: C PTS: 1
21. ANS: E PTS: 1
22. ANS: B PTS: 1
23. ANS: A PTS: 1
24. ANS: C PTS: 1