Dougherty Valley • AP Chemistry Name_____

Electrochemistry

Period _____ Date _____

UNIT TEST – PRACTICE

Part 1 – Multiple Choice

You should allocate 15 minutes to finish this portion of the test. No calculator should be used. A periodic table and data table will be provided. Select the answer that best responds to each question.

Use the Table of Standard Reduction Potentials to respond to the questions in Part 1.

$O_2(g) + 4\ H^+ + 4\ e^- \rightarrow 2\ H_2O(l)$	$E°_{red} = +1.23$ V
$Ag^+ + e^- \rightarrow Ag(s)$	$E°_{red} = +0.80$ V
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	$E°_{red} = +0.77$ V
$Cu^{2+} + 2\ e^- \rightarrow Cu(s)$	$E°_{red} = +0.34$ V
$Pb^{2+} + 2\ e^- \rightarrow Pb(s)$	$E°_{red} = -0.13$ V
$Sn^{2+} + 2\ e^- \rightarrow Sn(s)$	$E°_{red} = -0.14$ V
$Ni^{2+} + 2\ e^- \rightarrow Ni(s)$	$E°_{red} = -0.25$ V
$Zn^{2+} + 2\ e^- \rightarrow Zn(s)$	$E°_{red} = -0.76$ V
$2\ H_2O(l) + 2\ e^- \rightarrow H_2(g) + 2\ OH^-$	$E°_{red} = -0.83$ V
$Mn^{2+} + 2\ e^- \rightarrow Mn(s)$	$E°_{red} = -1.18$ V
$Al^{3+} + 3\ e^- \rightarrow Al(s)$	$E°_{red} = -1.66$ V
$Na^+ + e^- \rightarrow Na$	$E°_{red} = -2.71$ V

1. A galvanic cell was constructed by placing Sn(s) in 1.0 M $SnCl_2$ and Zn(s) in 1.0 M $ZnCl_2$. Which of the following takes place at the anode?
   (A) $Sn(s) \rightarrow Sn^{2+} + 2\ e^-$
   (B) $Zn(s) \rightarrow Zn^{2+} + 2\ e^-$
   (C) $Sn^{2+} + 2\ e^- \rightarrow Sn(s)$
   (D) $Zn^{2+} + 2\ e^- \rightarrow Zn(s)$
   Since $E°_{red}$(Sn) > $E°_{red}$(Zn), Zn is oxidized.

2. What is the value of $E°_{cell}$ for a galvanic cell that undergoes the following reaction?
   $2\ Al(s) + 3\ Cu^{2+} \rightarrow 3\ Cu(s) + 2\ Al^{3+}$
   (A) +4.34 V
   (B) +2.00 V **(+0.34 V) + (+1.66 V) = +2.00 V**
   (C) −1.32 V
   (D) −2.30 V

3. A galvanic cell is constructed by placing unknown metal X in a solution of X^{2+} and Pb(s) in a solution of Pb^{2+}, and the $E°_{cell}$ was found to be +2.24 V. After some time, the mass of the X decreases while the mass of Pb increases. What is the $E°_{red}$ for the half reaction $X^{2+} + 2e^- \rightarrow X$?
   (A) +2.37 V
   (B) +2.11 V
   (C) −2.11 V
   (D) −2.37 V **X is oxidized**
   $(-E°_X) + (-0.13) = 2.24$; $E°_X = -2.37$ V

4. Strips of Pb and Zn metals are placed in a solution of $Ni(NO_3)_2$. On which metal would a change be observed?
   (A) Pb(s) only
   (B) Zn(s) only
   (C) Both Pb(s) and Zn(s)
   (D) Neither metal
   $E°_{red}$(Ni) < $E°_{red}$(Pb), so no reaction on Pb.
   $E°_{red}$(Ni) > $E°_{red}$(Zn), so reaction on Zn.

5. What is the value of ΔG° for the following reaction?
   $Mn^{2+} + 2\ Fe^{2+} \rightarrow Mn(s) + 2\ Fe^{3+}$
   (A) −79 kJ/mol
   (B) +69 kJ/mol
   (C) +376 kJ/mol
   (D) +525 kJ/mol
   $\Delta G = -(2)(96500)(^-1.18 + ^-0.77) = +376$ kJ

6. In a Ag/Cu Galvanic cell, Ag(s) and Cu(s) electrodes were placed in a solution with 0.50 M Ag^+ and 0.50 M Cu^{2+}. What can be concluded about the cell potential?
   (A) The cell potential is less than the standard cell potential.
   (B) The cell potential is the same as the standard cell potential.
   (C) The cell potential is greater than the standard cell potential.
   (D) Nothing can be concluded about the potential of this cell.
   $Cu + 2\ Ag^+ \rightarrow 2\ Ag + Cu^{2+}$
   $Q = \frac{[Cu^{2+}]}{[Ag^+]^2} = \frac{(0.50)}{(0.50)^2} = 2 > 1$
   Since Q > 1, E < E°

7. A solution of unknown pH is placed in the hydrogen compartment of a galvanic cell, with the H_2 pressure maintained at 1 atm. The other half-cell compartment consists of a Cu/Cu^{2+} electrode with $[Cu^{2+}] = 1.00$ M. If the overall cell potential at 25°C is +0.65 V, which describes the hydrogen component?
(A) Hydrogen is the anode with a $[H^+] > 1.0$ M.
(B) Hydrogen is the cathode with a $[H^+] > 1.0$ M.
(C) Hydrogen is the anode with a $[H^+] < 1.0$ M.
(D) Hydrogen is the cathode with a $[H^+] < 1.0$ M.

$Cu^{2+} + 2\ e^- \rightarrow Cu(s)$ $\quad E°_{red} = +0.34$ V

so $Cu^{2+} + H_2 \rightarrow Cu + 2\ H^+$ $\quad (H_2$ is anode)

$E > E°$, so $Q = \frac{[H^+]^2}{[Cu^{2+}]} < 1 \quad [H^+] < 1$

8. What is produced at the cathode when 1.0 M NaCl is electrolyzed?
(A) $Cl_2(g)$
(B) $H_2(g)$
(C) Na(s)
(D) $O_2(g)$

$2\ e^- + 2\ H_2O(\ell) \rightarrow H_2(g) + 2\ OH^-$

9. How long will it take to plate 0.100 g Cu from a $Cu(NO_3)_2$ solution if a current of 8.0 amp is used?
(A) 9.0 s
(B) 19 s
(C) 38 s
(D) 304 s

.1 g Cu $\left(\frac{\text{1 mol Cu}}{\text{63.5 g Cu}}\right)\left(\frac{\text{2 mol e}^-}{\text{1 mol Cu}}\right)\left(\frac{\text{96500 C}}{\text{1 mol e}^-}\right)\left(\frac{\text{1 s}}{\text{8 C}}\right)$

10. How many grams of Na will be deposited from molten NaCl by a current of 3.0 amp flowing for 4.0 hours?
(A) 1.1 g
(B) 10. g
(C) 13 g
(D) 22 g

4 h $\left(\frac{\text{3600 s}}{\text{1 h}}\right)\left(\frac{\text{3 C}}{\text{s}}\right)\left(\frac{\text{1 mol e}^-}{\text{96500 C}}\right)\left(\frac{\text{1 mol Na}}{\text{1 mol e}^-}\right)\left(\frac{\text{23 g Na}}{\text{1 mol Na}}\right)$