General Chemistry II
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Examination #6 Name____________________

(15) 1. Complete the following statements to make them correct:

a) An electrochemical cell in which an oxidation-reduction reaction is used to generate electricity is known as a(n) (electrolytic, galvanic) cell.

b) At the cathode of an electrochemical cell, the (oxidizing, reducing) agent undergoes a (loss, gain) of electrons.

c) As the tendency for a redox reaction to occur **increases**, the numerical value of the standard cell potential becomes more (positive, negative), and the numerical value of the standard free energy change becomes more (positive, negative).

Questions **2-6** are based on information found in the Table of Standard Reduction Potentials provided with the examination:

(4) 2. Which one of the following is the best **oxidizing** agent?

a) Mn^{+2} b) Ag^{+1} c) Cl_2 d) Pb^{+2} e) Na^{+1}

(4) 3. Which one of the following is the best **reducing** agent?

a) Pb^{o} b) Cl^{-1} c) Ag^{o} d) Cu^{o} e) Al^{o}

(4) 4. Which one of the following species is capable of spontaneously generating H_2 gas from a 1M HCl aqueous solution?

a) Ag^{o} b) Fe^{o} c) Zn^{+2} d) Pb^{+2} e) Cl_2

(4) 5. Which one of the following species is capable of spontaneously reducing Fe^{+3} to Fe^{+2} **but not** Fe^{+2} to metallic iron?

a) Zn^{o} b) Zn^{+2} c) Cl_2 d) Cu^{o} e) Ni^{+2}

(4) 6. The standard reduction potential for the conversion of Co^{+3} to metallic cobalt is:

a) +1.56V b) -1.56V c) +0.43V d) -0.43V e) +1.28V

(4) 7. In the electrolytic decomposition of molten KCl, chlorine gas is produced by:

a) oxidation at the cathode b) reduction at the cathode
c) oxidation at the anode d) reduction at the anode

(4) 8. What is the oxidation state of phosphorus in H_3PO_2?

a) -3 b) -1 c) +1 d) +3 e) +7

(4) 9. Which one of the following conversions requires an **oxidizing** agent?

a) $BrO_2^{-1} \longrightarrow BrO^{-1}$ b) $Cr_2O_7^{-2} \longrightarrow 2Cr^{+3}$

c) $NO_3^{-1} \longrightarrow NO_2$ d) $Sn(OH)_6^{-2} \longrightarrow HSnO_2^{-1}$

e) None of the above transformations requires an oxidizing agent.

(4) 10. Which one of the following statements is true for the redox reaction shown below?

$$H_2 + F_2 \longrightarrow 2HF$$

a) F_2 is the reducing agent b) F_2 is oxidized

c) H_2 undergoes reduction d) H_2 is the reducing agent

e) The above reaction is **not** an oxidation-reduction reaction

(5) 11. The following conversion occurs in acidic medium:

$$Sn + NO_3^{-1} \longrightarrow SnO_2 + NO_2 \qquad \text{(not balanced)}$$

In the **balanced overall** equation, for every mole of Sn that reacts, _____ mole(s) of NO_2 will be formed.

a) one b) two c) three d) four e) five

(8) 12. Consider the following redox reaction: $2Al^{o} + 3Pb^{+2} \longrightarrow 2Al^{+3} + 3Pb^{o}$

If a voltaic cell employing the above reaction produces 0.268 amps for one hour:

a) what mass, in grams, of aluminum metal will dissolve? Show all work in the space provided.

b) what mass, in grams, of metallic lead will plate out? Show all work in the space provided.

13. Consider the following unbalanced chemical equation:

$$Cr(OH)_3 + KOCl + KOH \longrightarrow K_2CrO_4 + KCl + H_2O$$

(8) a) Balance the above equation by the ion-electron method. Show all work in the space provided.

(4) b) Label the oxidation reaction and the reduction reaction.

(4) c) Identify the oxidizing agent and the reducing agent. Be specific.

14. Given the following voltaic cell:

$$Zn \,/\, Zn^{+2}\,(0.01M) \,/\,/\, Ag^{+1}\,(0.10M) \,/\, Ag$$

(4) a) Write the balanced chemical equation for the above cell in the direction of the spontaneous reaction.

(4) b) Determine the standard potential for the above cell. Show work in the space below.

(4) c) Determine the potential of the cell using the ionic concentrations indicated. Show work in the space below.

(4) d) Determine the equilibrium constant for the cell reaction. Show work in the space below.

(4) e) Circle/label the anode and the cathode in the above cell diagram.

Standard Reduction Potentials at 25°C

The format of this table is Ox. + ne^- $\rightleftharpoons$ Red., with all unsubscripted species having the 1 *M* aqueous solution as the standard state. The bracketed entries [ ] are not standard state values, but refer to neutral water at 25°C.

Half-reaction	$\mathcal{E}^0$, Volts
$Li^+ + e^- \rightleftharpoons Li_{(s)}$	−3.05
$K^+ + e^- \rightleftharpoons K_{(s)}$	−2.92
$Na^+ + e^- \rightleftharpoons Na_{(s)}$	−2.71
$Mg^{2+} + 2e^- \rightleftharpoons Mg_{(s)}$	−2.37
$Al^{3+} + 3e^- \rightleftharpoons Al_{(s)}$	−1.66
$Mn^{2+} + 2e^- \rightleftharpoons Mn_{(s)}$	−1.03
$2H_2O_{(\ell)} + 2e^- \rightleftharpoons H_{2(g)} + 2OH^-$	−0.83
$Zn^{2+} + 2e^- \rightleftharpoons Zn_{(s)}$	−0.76
$Fe^{2+} + 2e^- \rightleftharpoons Fe_{(s)}$	−0.44
[$2H_2O_{(\ell)} + 2e^- \rightleftharpoons H_{2(g)} + 2OH^-$ $(10^{-7}\ M)$]	[−0.41]
$Cd^{2+} + 2e^- \rightleftharpoons Cd_{(s)}$	−0.40
$PbSO_{4(s)} + 2e^- \rightleftharpoons Pb_{(s)} + SO_4^=$	−0.36
$Co^{2+} + 2e^- \rightleftharpoons Co_{(s)}$	−0.28
$Ni^{2+} + 2e^- \rightleftharpoons Ni_{(s)}$	−0.25
$Sn^{2+} + 2e^- \rightleftharpoons Sn_{(s)}$	−0.14
$Pb^{2+} + 2e^- \rightleftharpoons Pb_{(s)}$	−0.13
$2H^+ + 2e^- \rightleftharpoons H_{2(g)}$	Defined as 0.00
$AgCl_{(s)} + e^- \rightleftharpoons Ag_{(s)} + Cl^-$	+0.22
$Cu^{2+} + 2e^- \rightleftharpoons Cu_{(s)}$	+0.34
$O_{2(g)} + 2H_2O_{(\ell)} + 4e^- \rightleftharpoons 4OH^-$	+0.40
$I_{2(s)} + 2e^- \rightleftharpoons 2I^-$	+0.54
$O_{2(g)} + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+0.68
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+0.77
$Ag^+ + e^- \rightleftharpoons Ag_{(s)}$	+0.80
[$O_{2(g)} + 4H^+$ $(10^{-7}\ M)$ $+ 4e^- \rightleftharpoons 2H_2O_{(\ell)}$]	[+0.82]
$Hg^{2+} + 2e^- \rightleftharpoons Hg_{(\ell)}$	+0.85
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO_{(g)} + 2H_2O_{(\ell)}$	+0.96
$Br_{2(\ell)} + 2e^- \rightleftharpoons 2Br^-$	+1.09
$O_{2(g)} + 4H^+ + 4e^- \rightleftharpoons 2H_2O_{(\ell)}$	+1.23
$Cl_{2(g)} + 2e^- \rightleftharpoons 2Cl^-$	+1.36
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O_{(\ell)}$	+1.51
$PbO_{2(s)} + 4H^+ + SO_4^= + 2e^- \rightleftharpoons PbSO_{4(s)} + 2H_2O_{(\ell)}$	+1.69
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O_{(\ell)}$	+1.78
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	+1.84
$S_2O_8^= + 2e^- \rightleftharpoons 2SO_4^=$	+2.00
$F_{2(g)} + 2e^- \rightleftharpoons 2F^-$	+2.87