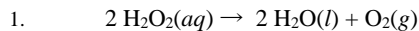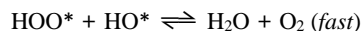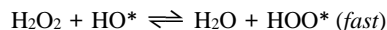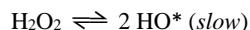**Name** _____   **AP Chemistry**

Chapter 17 HW 1: Due 3/16/20.   Complete all free response and multiple choice questions. All questions will be graded. Show all work. Box and clearly label all final free response answers.

1. $2 H_2O_2(aq) \rightarrow 2 H_2O(l) + O_2(g)$

The decomposition of hydrogen peroxide to form water and oxygen gas is represented by the equation above. A proposed mechanism for the reaction, which involves the free radicals HO* and HOO*, is represented by the three equations below.

$H_2O_2 \rightleftharpoons 2 HO*$ (*slow*)

$H_2O_2 + HO* \rightleftharpoons H_2O + HOO*$ (*fast*)

$HOO* + HO* \rightleftharpoons H_2O + O_2$ (*fast*)

(a) Write the rate law consistent with the proposed mechanism above.
(b) The rate of the decomposition reaction was studied in an experiment, and the resulting data were plotted in the graph to the right. Using the graph, determine the time, in hours, needed for the concentration of H_2O_2 to change from:
    (i) 1.50 *M* to 0.75 *M*
    (ii) 0.80 *M* to 0.40 *M*
(c) The experimental data are consistent with the proposed mechanism. Explain.
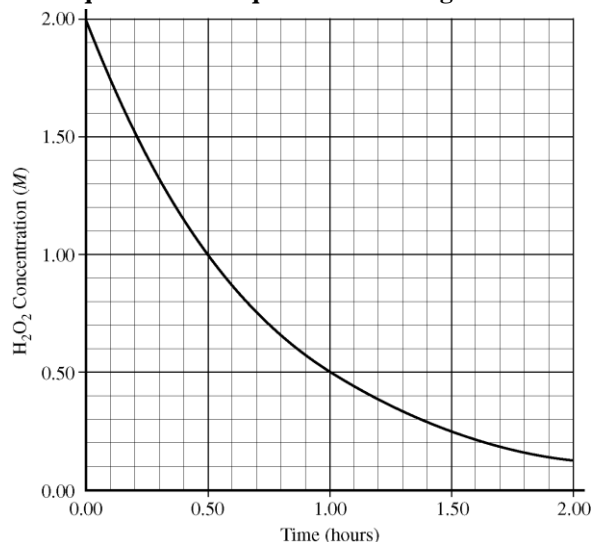
An electrochemical cell based on the decomposition of H_2O_2 can be constructed based on the half-reactions in the table below.

Half-Reaction	Standard Reduction Potential, $E°$
$H_2O_2 + 2 e^- \rightarrow 2 OH^-$	0.88 V
$O_2 + 2 H_2O + 2 e^- \rightarrow H_2O_2 + 2 OH^-$	−0.15 V

(d) Calculate the value of the standard cell potential, $E°$, for the cell.
(e) Indicate whether $\Delta G°$ for the decomposition reaction is greater than 0, less than 0, or equal to 0. Justify your answer.
(f) The decomposition of $H_2O_2(aq)$ is slow at 298 K, but a suitable catalyst greatly increases the rate of the decomposition reaction.
    (i) Draw a circle around each of the quantities below that has a different value for the catalyzed reaction than for the uncatalyzed reaction.
        K_{eq} $\Delta G°$ $\Delta H°$ E_a
    (ii) For any quantity that you circled above, indicate whether its value is greater or less for the catalyzed reaction than for the uncatalyzed reaction. Explain why.

Questions 1-5 use the answers below and the diagram to the right.
The spontaneous reaction that occurs when the cell to the right operates is:
$2Ag^+ + Cd(s) \rightarrow 2Ag(s) + Cd^{2+}$
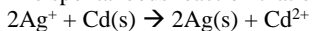
a. Voltage increases.
b. Voltage decreases but remains above zero.
c. Voltage becomes zero and remains at zero.
d. No change in voltage occurs.
e. Direction of voltage change cannot be predicted without additional information.

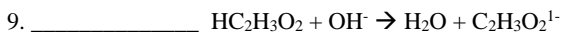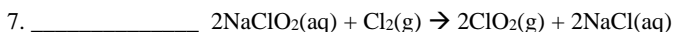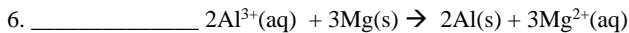Which of the above occurs for each of the following circumstances?

1._____ Current is allowed to flow for 17 minutes.

2. _____ Equal volumes of water are added to both cells.

3. _____ The salt bridge is replaced by a platinum wire

4. _____ 24.3 grams of solid sodium chloride is added to both cells.

5. _____ The silver electrode is made smaller.
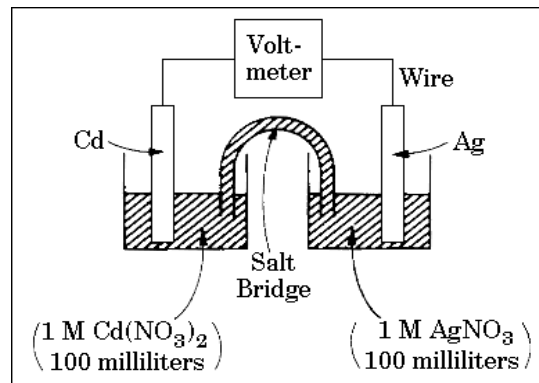
Questions 6-9 use the answers below.
The choices below refer to n, the number of moles of electrons transferred in a reaction.
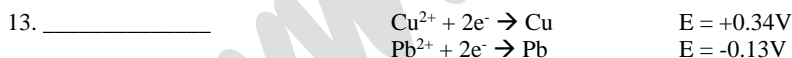
a. n=6   b. n=5   c. n=4   d. n=2   e. n=0

6. _____ $2Al^{3+}(aq) + 3Mg(s) \rightarrow 2Al(s) + 3Mg^{2+}(aq)$

7. _____ $2NaClO_2(aq) + Cl_2(g) \rightarrow 2ClO_2(g) + 2NaCl(aq)$

8. _____ $2VO_2^+ + 4H^+ + Zn \rightarrow 2VO^{2+} + 2H_2O + Zn^{2+}$

9. _____ $HC_2H_3O_2 + OH^- \rightarrow H_2O + C_2H_3O_2^{1-}$

10. _____ Reduction occurs at this electrode in a galvanic cell.
a. anode   b. cathode   c. electrode   d. salt bridge   e. voltmeter

Questions 11-12 refer to a galvanic cell constructed using two half-cells and based on the two half-reactions represented below.

$Zn^{2+}(aq) + 2\,e^- \rightarrow Zn(s)$ $E° = -0.76$ V
$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$ $E° = 0.77$ V
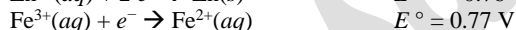
11. _____ As the cell operates, ionic species that are found in the half-cell containing the cathode include which of the following?
I. $Zn^{2+}(aq)$ II. $Fe^{2+}(aq)$ III. $Fe^{3+}(aq)$
a. I only   b. II only   c. III only   d. I and III   e. II and III

12. _____ What is the standard cell potential for the galvanic cell?
a. −0.01 V   b. 0.01 V   c. 0.78 V   d. 1.53 V   e. 2.31 V

13. _____ $Cu^{2+} + 2e^- \rightarrow Cu$ $E = +0.34V$
                             $Pb^{2+} + 2e^- \rightarrow Pb$ $E = -0.13V$
Based on the reduction potentials given above, what is the reaction potential for the following reaction?
$Cu + Pb^{2+} \rightarrow Cu^{2+} + Pb$
a. +0.21V   b. -0.47 V   c. +0.47 V   d. 0.42 V   e. -0.94 V

14. _____ By definition, the reduction potential for this species is equal to zero.
a. MnO_4^{1-} b. H^+ c. H_2 d. Li^+ e. F_2

15. _____ $2H_2O_2 \rightarrow 2H_2O + O_2$
Which of the following statements about the reaction shown above is true?
a. Oxygen is oxidized and hydrogen is reduced.   b. Oxygen is reduced and hydrogen is oxidized.
c. Oxygen is reduced and oxidized.   d. Hydrogen is reduced and oxidized.
e. Neither hydrogen nor oxygen changes oxidation state.

16. _____ $AlF_6^{3-} + 3\,e^- \rightarrow Al + 6F^-$
Which of the following occurs in the reaction?
a. AlF_6^{3-} is reduced at the cathode.   b. Al is oxidized at the anode.   c. F^- acts as a reducing agent.
d. F^- is reduced at the cathode.   e. Aluminum is converted from the -3 oxidation state to the 0 oxidation state.