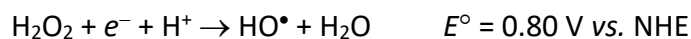
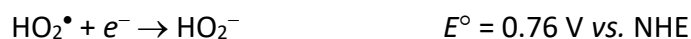


**Ch153a****Winter 2019****Due 25 January, 2019****Problem Set 3**

1. Construct a diagram illustrating the dependence of electrode potentials (vs. NHE) on pH (Pourbaix diagram) for the following redox couples:

- a.  $\text{O}_2 + e^- + \text{H}^+ \rightarrow \text{HO}_2^\bullet$
- b.  $\text{HO}_2^\bullet + e^- + \text{H}^+ \rightarrow \text{H}_2\text{O}_2$
- c.  $\text{H}_2\text{O}_2 + e^- + \text{H}^+ \rightarrow \text{HO}^\bullet + \text{H}_2\text{O}$
- d.  $\text{HO}^\bullet + e^- + \text{H}^+ \rightarrow \text{H}_2\text{O}$
- e.  $\text{O}_2 + 2e^- + 2\text{H}^+ \rightarrow \text{H}_2\text{O}_2$
- f.  $\text{H}_2\text{O}_2 + 2e^- + 2\text{H}^+ \rightarrow 2\text{H}_2\text{O}$
- g.  $\text{O}_2 + 4e^- + 4\text{H}^+ \rightarrow 2\text{H}_2\text{O}$

In constructing your diagram, use the following standard potentials:



and the following  $\text{p}K_a$  values:



The standard state for potentials is 25 °C, concentrations of 1 molal (1 *m*), partial gas pressures of 100 kPa, and the activity of water is taken to be unity. For the purposes of your diagram, assume the following conditions:

$$p\text{O}_2 = 100 \text{ kPa}$$

$$[\text{HO}_2^\bullet] + [\text{O}_2^{\bullet-}] = 1 \text{ } m$$

$$[\text{H}_2\text{O}_2] + [\text{HO}_2^-] = 1 \text{ } m$$

$$[\text{HO}^\bullet] + [\text{O}^{\bullet-}] = 1 \text{ } m$$

Your plot should span the range from pH 0 to pH 14.

2. Using the data from your Pourbaix diagram give the electrode potentials for the redox couples *a-g* at the following pH values:
  - a. pH 0
  - b. pH 7
  - c. pH 14
3. Using the data from your Pourbaix diagram determine the standard free energy change for the following reaction:

