

Chapter 18 Study Questions

- Calculate the oxidation number for nitrogen in the following substances:
a) NH_3 b) N_2 c) NO_2 d) NO_3^-
- In the oxidation-reduction reaction,
$$\text{Br}_2(l) + 2 \text{I}^-(aq) \rightarrow 2 \text{Br}^-(aq) + \text{I}_2(s),$$
 - which substance is being reduced?
 - which element is increasing in oxidation number?
 - which element is gaining electrons?
 - which substance is the oxidizing agent?
 - which substance is the reducing agent?
- Classify each of the following substances as an oxidizing agent, reducing agent or both. List the oxidizing agents in order of decreasing strength; list the reducing agents in order of decreasing strength (use E° Table):
 $\text{Ni}(s), \text{H}^+(aq), \text{Au}(s), \text{Cl}_2(g), \text{Sn}^{2+}(aq), \text{Mg}(s), \text{Fe}^{2+}(aq)$
- For each of the following reactions: 1) identify the oxidation and reduction half-equations, and 2) balance the equation (adding H^+ and H_2O as needed), 3) find E° (in volts) and 4) determine whether the reaction is spontaneous under standard conditions.
 - $\text{Ag}(s) + \text{Cu}^{2+}(aq) \rightarrow \text{Ag}^+(aq) + \text{Cu}(s)$
 - $\text{Ni}(s) + \text{MnO}_4^-(aq) \rightarrow \text{Ni}^{2+}(aq) + \text{Mn}^{2+}(aq)$
 - $\text{Mn}^{2+}(aq) + \text{NO}_3^-(aq) \rightarrow \text{MnO}_2(s) + \text{NO}(g)$
- For each of the following reactions: 1) find E° (in volts) and 2) determine whether the reaction is spontaneous under standard conditions.
 - the reaction between iron and iron(III) ions to give iron(II) ions.
 - the following cell: $\text{I}^- | \text{I}_2 || \text{Zn}^{2+} | \text{Zn}$
- Which of the following ions will oxidize Br^- ion to Br_2 ?
 - Pb^{2+}
 - H^+
 - Au^{3+}
 - MnO_4^-
- A voltaic cell has an aluminum electrode in $\text{Al}_2(\text{SO}_4)_3$ solution in one compartment and the other compartment has a lead electrode in PbSO_4 solution.
 - Which has a greater tendency to be oxidized, Al or Pb? Write a balanced equation for the spontaneous reaction.
 - Draw a diagram of the voltaic cell, including
 - the anode and cathode
 - the direction of flow of electrons, positive ions and negative ions
 - Which electrode will increase in mass?

8. The following table contains data obtained by measuring the voltage between two metals in an experiment like the one you did with a lemon:

Voltaic Cell	Anode (-)	Cathode (+)	Cell Voltage (v)
Pb/Ni	Ni	Pb	0.10 volts
Pb/Au	Pb	Au	0.80 volts
Pb/Fe	Fe	Pb	0.25 volts
Ni/Au	Ni	Au	0.90 volts
Ni/Fe	Fe	Ni	0.15 volts
Fe/Au	Fe	Au	1.05 volts

- a) From the data in the table above, which metal is the strongest reducing agent?
- b) From the data in the table above, which metal is the weakest reducing agent?
- c) Using the reduction of lead (Pb) as a reference, construct a half-cell voltage table from the experimental data above.

Summary of Chapter 18: Electrochemistry

definitions from Chapter 4

oxidation and reduction

oxidizing and reducing agents

oxidation number

oxidation-reduction reactions

balancing oxidation-reduction reactions

voltaic cells

anode and cathode

direction of electron and ion flow

porous barrier/salt bridge

standard voltages: E°_{ox} and E°_{red}

applications of values for E° :

calculation of cell voltage (E°)

reaction spontaneity

strength of oxidizing and reducing agents

electrolytic cells