Chemistry 125/126
Hourly 1 Review Notes and Questions to check your understanding.

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Experiment 3: Redox: Transferring Electrons
Major Concepts

A. Subtances can be ranked as oxidizing or reducing agents from experimental data.

- The stronger reducing and oxidizing agents are the reactants.
- The weaker reducing and oxidizing agents are the products.
- There is an inverse relationship between reducing and oxidizing agent strength of the species.

Example1: Observation: $Cu_{(s)} + 2Ag^{+}_{(aq)} \rightarrow Cu^{2+}_{(aq)} + 2Ag_{(s)}$
reducing agent strength: Cu > Ag
oxidizing agent strength: $Ag^{+} > Cu^{2+}$

Example2: Observation: $Cl_{2(aq)} + 2I^{-}_{(aq)} \rightarrow 2Cl^{-}_{(aq)} + I_{2(aq)}$
reducing agent strength: $I^{-} > Cl^{-}$
oxidizing agent strength: $Cl_2 > I_2$

B. Reaction vs. no reaction combos can be predicted from a given reaction or non-reaction.

- The products of a spontaneous rxn. will not react.

Example1: $Cu_{(s)} + 2Ag^{+}_{(aq)} \rightarrow Cu^{2+}_{(aq)} + 2Ag_{(s)}$
$\therefore$ $Cu^{2+}_{(aq)} + Ag_{(s)} \rightarrow$ no reaction

Example2: $Cl_{2(aq)} + 2I^{-}_{(aq)} \rightarrow 2Cl^{-}_{(aq)} + I_{2(aq)}$
$\therefore$ $Cl^{-}_{(aq)} + I_{2(aq)} \rightarrow$ no reaction

- Non-reactants are the stable products of a spontaneous rxn.

Example: $Cl^{-}_{(aq)} + I_{2(aq)} \rightarrow$ no reaction
$\therefore$ $Cl_{2(aq)} + 2I^{-}_{(aq)} \rightarrow$ reaction
(note: The latter rxn would constitute experimental proof of no rxn between Cl^{-} and I_2)

C. Reaction vs. no reaction can be predicted from relative strength.

Example1: Given the reducing agent strength: Zn > Cu > Ag

You can predict that Zn will react with metals ions of both Cu and Ag; Cu will only react with the metal ions of Ag; Ag will not react with the metals ions of either Zn or Cu.

Example2: Given the Oxidizing agent strength: $Cl_2 > Br_2 > I_2$

You can predict that Cl_2 will react with the halide ions Br- and I-; Br_2 will only react with the halide ion I-; I_2 will not react with either Br- or Cl-

D. **The halides (e.g., Cl^{-}, I^{-}, Br^{-})**

- are ionic species
- are colorless, soluble in water (due to polarity of water) and insoluble in hexane (nonpolar).
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E. The halogens (e.g., Cl_2, I_2, Br_2)

- are nonpolar
- have distinctive colors (yellow green, pink-violet, or yellow-orange) in hexane but are different to distinguish from one another in water (light yellow or yellow-green, brown, or brown)
- are more soluble in hexane than water.
- By tracking colors in hexane, it is possible to determine the identity of any halogen products.

Example: $Cl_{2(aq)} + 2I^-_{(aq)} \rightarrow 2Cl^-_{(aq)} + I_{2(a}$

Color changes occur as the yellow-green color of chlorine (Cl_2) disappears from the hexane phase upon reaction and the violet-pink color of iodine (I_2) appears in the hexane phase

Example: $NaCl_{aq)} + I_{2(aq)} \rightarrow$ no reaction

The hexane phase remains violet-pink indicating no reaction (i.e. if reaction occurred, the color would disappear since colorless I^- would form).

EXPERIMENT 3 (Redox: Transferring Electrons)

Part 1 Reactivity of Metals and Predicting Metal Reactivity

1. This questions deals with a study of redox reactions involving metals and aqueous solutions (0.1M nitrates) of the metal cations. Below are your recorded (incomplete) observations:

	Pb	Cd	Mn
$Pb(NO_3)_2$	**no** reaction	reaction	Reaction
$Cd(NO_3)_2$	**no** reaction	**no** reaction	
$Mn(NO_3)_2$	**no** reaction	**no** reaction	

A. Complete a **net equation** (do not include spectator ions) describing the reaction between Cd metal and $Pb(NO_3)_{2(aq)}$. Make sure you indicate correct **charge** and **state** of all products. Identify the oxidizing and reducing agent.

Completed Net Reaction for $Cd_{(s)} + Pb(NO_3)_{2(aq)}$	
$Cd_{(s)} + Pb^{2+}_{(aq)} \rightarrow$ _____ + _____	Oxidizing agent = _____ Reducing agent = _____

B. Based on the observations (above table) and your knowledge of redox reactions, will a reaction occur if manganese metal is added to 0.10 M $Cd(NO_3)_2$?

Circle "yes" or "no" to indicate if a Mn will react with 0.10 M $Cd(NO_3)_2$:

Yes. a reaction will occur No reaction will occur.

C. Based on the observations for reactions of Pb and Cd, it is possible to determine the relative strengths of three oxidizing agents: Mn^{2+}, Cd^{2+}, and Pb^{2+}. What are the relative strengths?

Strongest oxidizing agent:		*Weakest oxidizing agent:*
_____	> _____ >	_____

(now try March'08, 5; Nov.07, 4B, 4C, 6; March'07, 1D, 4; Nov.'06, 1C&D, 6; March'06 3D, 5; Nov.'05, 1A, 5)

Part 2 Halogens and Halides

2. This question involves a study of redox reactions where the observations given below were made. Hexane was added to all product mixtures:

A. $CrCl_2$ (aq) + I_2 (aq) → Product?
colored brown aqueous layer is colored; hexane layer is colorless

B. NaCl (aq) + I_2(aq) → Product?
colorless brown aqueous layer is colorless; hexane layer is pink

Based on test reaction **B,** what do you know about reaction **A**?

Conclusions regarding reaction **A**?

Based on the results, what are the relative strengths of Cr^{3+} and I_2 as oxidizing agents?

Strongest oxidizing agent		Weakest oxidizing agent:
_____	>	_____

(now try Nov. 07, 7; March'07, 1A(2-3),; Nov.'06, 5C; March'06, 3D; March'05, 1D, 3C)

Part 3 Analysis of Reactions

3. This questions deals with an investigation of redox reactions.

Information:

Cl_2, Br_2, Fe^{3+}, I_2 , Sn^{4+}, & K^+ are oxidizing agents (giving Cl^-, Br^- , Fe^{2+}, I^-, Sn^{2+}, & K).

Best oxidizing agent **Cl_2 > Br_2 > Fe^{3+} > I_2 > Sn^{4+}> K^+** *Worst* oxidizing agent

You add a few crystals of $FeCl_3$ to a test tube (**A**) with water and a few KBr crystals to another test tube (**B**). The crystals dissolve. Write a balanced equation for the dissociation of $FeCl_{3(s)}$.

Balanced equation for the dissociation of $FeCl_3$ into ions when placed in water:

$FeCl_{3(s)} \xrightarrow[\text{water}]{}$ _____ + _____

You now mix the contents of test tube **A** with the contents of test tube **B** and add hexane to the resulting mixture. Based on the oxidizing agent strengths (above), determine if a redox reaction occurs. Identify (circle) any species present in the hexane phase or indicate (circle) NONE.

NONE	Cl_2	Cl^-	Br_2	Br^-	Fe^{3+}	Fe^{2+}

Based solely on the relative oxidizing agent strengths indicated above, which reactions (below), if any, should occur? Put an X in the appropriate box.

	Will Occur	**Won't occur**
$Br_2 + Sn^{2+} \rightarrow 2\,Br^- + Sn^{4+}$		
$Fe^{3+} + 2I^- \rightarrow Fe^{2+} + I_2$		

(now try March '08, 4; Nov.'07, 7; March'07, 3D; Nov.'06, 5; March'06, 6; Nov.'05, 4)