Announcements – 9/27/00

- Chapter 10: Gases
  - -start on Friday
  - -assigned problems are now available
- Demos & Quiz: Friday

1

Oxidation #: examples

- **$SrBr_2$:** group II, group VII
  +2 -1
- **$Zn(OH)_4^{2-}$:** OH^- is -1, -2 charge for cmpd
  +2 -2 +1
- **$Cr_2O_7^{2-}$:** $-2 = 7(-2) + 2(x)$
  +6 -2 $x = +6$
- **MnO_4^-:** $-1 = 4(-2) + x$
  +7 -2 $x = +7$

2

Formal Charges

- Another way of looking at charge distribution in compounds:

  -whereas *oxidation numbers* assume complete transfer electrons between atoms (ionic model)

  -*formal charges* assumes complete **sharing** of electrons between atoms (covalent model)

Formal Charge =

#valence e^- -(#bonds + #nonbonding e^-)

3

Formal Charges: Example

- What is the structure of HCN?

Two choices:

H-C≡N| OR H-N≡C|

1) **H:** 1-(1+0) = *0*
   C: 4-(4+0) = *0*
   N: 5-(3+2) = *0*

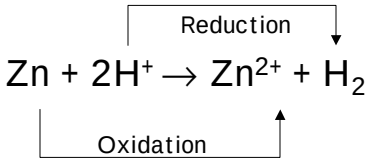
2) **H:** 1-(1+0) = *0*
   C: 4-(3+2) = *-1*
   N: 5-(4+0) = *+1*

Structure which minimizes formal charges is preferred

4

Back to Redox Reactions

- Redox reactions *change* the oxidation states of the reactants:



Zn: is *oxidized* (reducing agent)

H⁺: is *reduced* (oxidizing agent)

Reox movies

5

Redox Examples

- <u>Combustion</u>

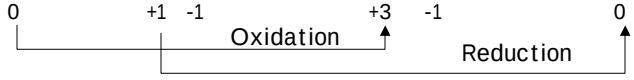
$$\underset{-4\ +1}{CH_4}\ (g) + 2\underset{0}{O_2}\ (g) \rightarrow \underset{+4\ -2}{CO_2}\ (g) + 2\underset{+1\ -2}{H_2O}\ (l)$$

<u>C:</u> oxidized (-4 → +4)

<u>O:</u> reduced (0 → -2)

- <u>Acid oxidation of a metal</u>

$$2Al\ (s) + 6HCl\ (aq) \rightarrow 2AlCl_3\ (aq) + 3H_2\ (g)$$



6

Solubility

- How do we know whether a compound is soluble in water?

  -we will address this from a *structural* point of view in Chem 36

NaCl dissolution movie

  -for now, we need to learn ***Solubility Rules:***

7

Solubility Rules: Goldberg

- ALL are Soluble:
  - **Nitrates** (NO_3^-)
  - **Chlorates** (ClO_3^-)
  - **Acetates** (CH_3COO^-)
  - **Sulfates** (SO_4^{2-})
    - **Except:** $BaSO_4$, $SrSO_4$, $PbSO_4$ <- *insoluble*
      $CaSO_4$, Ag_2SO_4, Hg_2SO_4 <- *slightly insoluble*
  - **Chlorides, Bromides and Iodides**
    - **Except:** Ag^+ and Hg^+ salts <- *insoluble*
      Pb^{2+} Salts <- *slightly insoluble*

8

Solubility Rules: Goldberg, Part II

- ALL are **IN**Soluble:
  - **Hydroxides** (OH^-)
    - **Except:** Group IA, NH_4^+ and Ba^{2+} salts <- *soluble*
      Sr^{2+} and Ca^{2+} salts <- *slightly soluble*
  - **Carbonates** (CO_3^{2-})
    - **Except:** Group IA and NH_4^+ salts <- *soluble*
  - **Phosphates** (PO_4^{3-})
    - **Except:** Group IA and NH_4^+ salts <- *soluble*
  - **Sulfides** (S^{2-})
    - **Except:** Group IA, IIA and NH_4^+ salts <- *soluble*

NEW RULE: **All Group IA and NH_4^+ salts are Soluble**

9

Precipitation Reactions

- When an *insoluble* compound is formed in a reaction:

Example: Silver Nitrate + Potassium Phosphate

$$3AgNO_3(aq) + K_3PO_4(aq) \rightarrow Ag_3PO_4(s) + 3KNO_3(aq)$$

ionic ionic precipitate ionic

$$3Ag^+(aq) + 3NO_3^-(aq) + 3K^+(aq) + PO_4^{3-}(aq) \rightarrow Ag_3PO_4(s) + 3K^+(aq) + 3NO_3^-(aq)$$

$$3Ag^+(aq) + 3NO_3^-(aq) + 3K^+(aq) + PO_4^{3-}(aq) \rightarrow Ag_3PO_4(s) + 3K^+(aq) + 3NO_3^-(aq)$$

spectator ions spectator ions

Net Ionic Eqn: $3Ag^+(aq) + PO_4^{3-}(aq) \rightarrow Ag_3PO_4(s)$

10

Acid/Base? Solubility? Both!

- Calcium Carbonate + Nitric Acid

$CaCO_3\ (s) + HNO_3\ (aq) \rightarrow H_2CO_3\ (aq) + Ca(NO_3)_2\ (aq)$

base — strong acid — weak acid — salt

Net Ionic:

$CaCO_3\ (s) + 2H^+\ (aq) \rightarrow Ca^{2+}\ (aq) + H_2CO_3\ (aq)$

But, also:

$H_2CO_3\ (aq) \rightarrow H_2O\ (l) + CO_2\ (g)$

11