Chem 111

Lecture 10

Announcements

- Oct 4th is your first exam. 1 week.

→ Bring a calculator (battery) and pencils (erasers)

- Practice Exams:

http://courses.umass.edu/chem111-bbotch/ExamInfo.html

- Friday Review

Help Sessions

Sunday, October 3rd Review Sessions

4:00-6:00 PM, ISB 135 Beatrice Botch (Instructor)
6:45-8:00 PM, ISB 221 Steven McPartland (SI)
7:00-9:00 PM, ISB 135 Breanne Holmes (TA)
8:15-9:30 PM, ISB 221 Nathaniel Kornet (SI)

SI sessions

Sunday
6:45 - 8:00 Steve McPartland - Library 1085
8:15 - 9:30 Nathaniel Kornet - Library 1049
Monday
5:45 - 7:00 Ankur Sheel - Library 1049
8:45 - 10:00 Kate Leidell - ISB 321
Tuesday
4:15 - 5:30 Nathaniel Kornet - Library 1049
5:45 - 7:00 Chris Gunderson - Library 1049
Wednesday
5:45 - 7:00 Ankur Sheel - Library 1049
7:15 - 8:30 Steve McPartland - ISB 329
Thursday
7:15 - 8:30 Chris Gunderson - Library 1085
8:45 - 10:00 Kate Leidell - ISB 321

Homework

- Read Chapter 4
- OWL online homework.

Recap

- Complete Ionic Equation
- Net Ionic Equation
- Acids
- Bases

$$NX_3$$

$$NH_3 + H_2O \Rightarrow NH_4^+ + OH^-$$

Strong/Weak Acids and Bases

Memorize

Strong acids or bases – completely ionize in solution (considered a good electrolyte)

TABLE 3.2 Common Acids and Bases

Strong Acids (Strong Electrolytes)		Soluble Strong Bases	
HCl (aq)	Hydrochloric acid	LiOH	Lithium hydroxide
HBr (aq)	Hydrobromic acid	NaOH	Sodium hydroxide
HI (aq)	Hydroiodic acid	KOH	Potassium hydroxide
HNO_3	Nitric acid	$Ba(OH)_2$	Barium hydroxide
$HClO_4$	Perchloric acid		
H_2SO_4	Sulfuric acid		
Weak Acids (Weak Electrolytes)*		**Weak Base (Weak Electrolyte)**	
H_3PO_4	Phosphoric acid	NH_3	Ammonia
H_2CO_3	Carbonic acid		
CH_3CO_2H	Acetic acid		
$H_2C_2O_4$	Oxalic acid		
$H_2C_4H_4O_6$	Tartaric acid		
$H_3C_6H_5O_7$	Citric acid		
$HC_9H_8O_4$	Aspirin		

* These are representative of hundreds of weak acids.

Table 3-2, p. 132

Weak acids or bases – partially ionize in solutions (weak electrolytes).

$HF \rightleftharpoons H^+ + F^-$

HF

$HCl \xrightarrow{H_2O} H^+(aq) + Cl^-(aq)$ 100%

$CH_3CO_2H \rightleftharpoons H^+(aq) + CH_3CO_2^-(aq)$ < 100%

CHO weak acid

Neutralization Reactions

Happen when a solution of an acid and that of a base are mixed.

$HCl(aq) + NaOH(aq) \rightarrow H_2O(l) + NaCl(aq)$

$H^+ + Cl^- + Na^+ + OH^- \rightarrow H_2O + Na^+ + Cl^-$

Neutralization reactions between an acid and a metal hydroxide produces water and a salt (an ionic compound).

Net Ionic Equation for strong acid + strong base:

$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

Weak Acid/Base Reactions

$CH_3CO_2H(aq) + NaOH(aq) \rightarrow H_2O(l) + NaCH_3CO_2(aq)$

$CH_3CO_2H(aq) \rightleftharpoons H^+(aq) + CH_3CO_2^-(aq)$

Net Ionic Equation for weak acid + strong base:

$CH_3CO_2H(aq) + OH^-(aq) \rightarrow H_2O(l) + CH_3CO_2^-(aq)$

0 −1 0 −1

$HCl(aq) + C_5H_5N(aq) \rightarrow C_5H_5NH^+(aq) + Cl^-(aq)$

$H^+(aq) + Cl^-(aq)$

Net Ionic Equation for strong acid + weak base:

$H^+(aq) + C_5H_5N(aq) \rightarrow C_5H_5NH^+(aq)$

+1 0 +1

Weak Acid/Base Reactions

$H_2CO_2(aq) + 2\,NaOH(aq) \rightarrow 2H_2O(l) + Na_2CO_3(aq)$

Net Ionic Equation for weak acid + strong base:

$H_2CO_2(aq) + 2OH^-(aq) \rightarrow 2H_2O(l) + CO_2^{2-}(aq)$

$H_2CO_2(aq) \rightleftharpoons H^+(aq) + HCO_2^-(aq)$

$HCO_2^-(aq) \rightleftharpoons H^+(aq) + CO_2^{2-}(aq)$

Oxides of Nonmetals and Metals

Sometimes not obvious.

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

$H_2CO_3 \rightleftharpoons 2H^+(aq) + CO_3^{2-}(aq)$

$2\ SO_2(g) + O_2(g) \rightarrow 2\ SO_3(g)$

$SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq)$

$H_2SO_4 \Rightarrow 2H^+(aq) + SO_4^{2-}(aq)$

$2\ NO_2(g) + H_2O(l) \rightarrow HNO_3(aq) + HNO_2(aq)$

$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$ ← slacked lime

lime

$Ca(OH)_2 \rightarrow Ca^{2+} + 2OH^-$

Gas Forming Reactions

$2HCl(aq) + Na_2S(aq) \rightarrow H_2S(g) + 2NaCl(aq)$

$2H^+ \; 2Cl^- \quad 2Na^+ \; S^{2-} \quad 2Na^+ \; 2Cl^-$

Net Ionic Equation:

$2H^+(aq) + S^{2-}(aq) \rightarrow H_2S(g)$ ✓

$HCl(aq) + NaHCO_3(aq) \rightarrow NaCl(aq) + H_2CO_3(aq)$

$H^+(aq) + HCO_3^- \rightarrow H_2CO_3(aq)$

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

Test

Oxidation-Reduction Reactions

$Mg(s) + 2HCl\,(aq) \rightarrow MgCl_2\,(aq) + H_2(g)$

$Mg(s) + 2H^+\,(aq) \rightarrow Mg^{2+}\,(aq) + H_2(g)$

Oxidation – when a substance loses electrons.
Reduction - when a substance gains electrons.

Oxidation-Reduction Reactions

$Cu(s) + 2Ag^{+}(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$

$Cu(s) \rightarrow Cu^{2+}(aq) + 2e^{-}$

$Ag^{+}(aq) + e^{-} \rightarrow Ag(s)$

Oxidation Numbers (144-145)

Table 2.2 The determination of oxidation number*

	Oxidation number
1. The sum of the oxidation numbers of all the atoms in the species is equal to its total charge	
2. For atoms in their elemental form	0
3. For atoms of Group 1	+1
For atoms of Group 2	+2
For atoms of Group 13 (except B)	$+3(EX_3)$, $+1(EX)$
For atoms of Group 14 (except C, Si)	$+4(EX_4)$, $+2(EX_2)$
4. For hydrogen	+1 in combination with nonmetals
	−1 in combination with metals
5. For fluorine	−1 in all its compounds
6. For oxygen	−2 unless combined with F
	-1 in peroxides (O_2^{2-})
	$-\frac{1}{2}$ in superoxides (O_2^-)
	$-\frac{1}{3}$ in ozonides (O_3^-)
7. Halogens	−1 in most compounds, unless the other elements include oxygen or more electronegative halogens