

Chem 2 AP Homework #4-3: Acids/Bases and Oxidation numbers/half reactions  
Problems pg. 153 #26, 27, 29, 30, 32, 34, 41, 44, 46, 48, 50, 142

4.26 Arrhenius and Bronsted definitions:

a) Give Arrhenius and Bronsted definitions of an acid and a base.

Arrhenius Acid: release $H^+$ ( $H_3O^+$ ) in water	Bronsted Acid: proton donor
Arrhenius Base: release $OH^-$ in water	Bronsted Base: proton acceptor

b) Why are Bronsted's definitions more useful in describing acid-base properties?

Bronsted definitions are broader because solutions do not have to be aqueous.

(All Arrhenius acids and bases are also Bronsted acids and bases, but not the converse).

4.27 Give an example of a monoprotic acid, a diprotic acid, and a triprotic acid.

Monoprotic acid: $HNO_3$ , $HCl$	Diprotic acid: $H_2SO_4$ , $H_2CO_3$	Triprotic acid: $H_3PO_4$ , $H_3AsO_4$
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4.29 Salts:

a) What factors qualify a compound as a salt?

To qualify as a salt, a compound must be an ionic compound that does not contain  $O^{2-}$  or  $OH^-$ .

(Salts are ionic compounds that are not acids or bases.)

A salt is a product of an acid-base reaction.

b) Specify which of the following compounds are salts:

$CH_4$ ,  $NaF$ ,  $NaOH$ ,  $CaO$ ,  $BaSO_4$ ,  $HNO_3$ ,  $NH_3$ ,  $KBr$ ?

Salts: $NaF$ , $BaSO_4$ , $KBr$
Not salts: $CH_4$ , $NaOH$ , $CaO$ , $HNO_3$ , $NH_3$

4.30 Identify the following substances as a weak or strong acid or base:

(a) $NH_3$ : weak base	(e) $H_2SO_4$ : strong acid
(b) $H_3PO_4$ : weak acid	(f) $HF$ : weak acid
(c) $LiOH$ : strong base	(g) $Ba(OH)_2$ : strong base
(d) $HCOOH$ : weak acid	(h) $CH_3NH_2$ : weak base

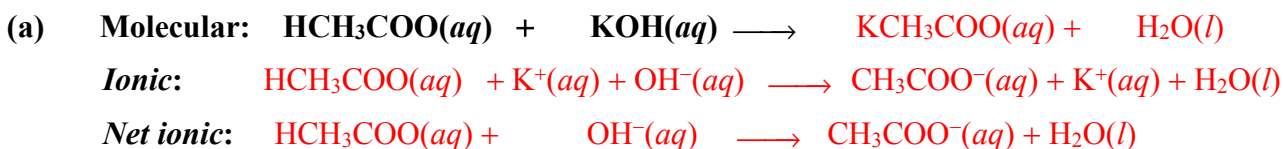
4.32 Identify each of the following species as a Bronsted acid, base, or both:

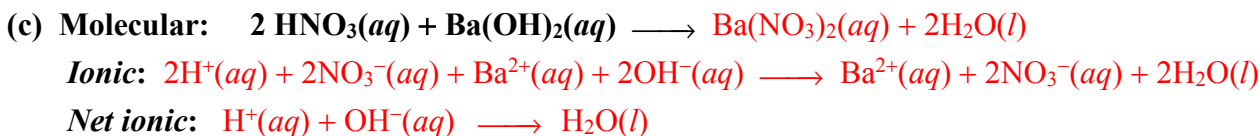
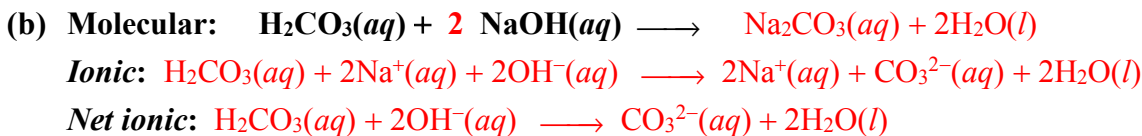
(a) $PO_4^{3-}$ in water can accept a proton to become $HPO_4^{2-}$ , and is thus a <b>Bronsted base</b> .
(b) $ClO_2^-$ in water can accept a proton to become $HClO_2$ , and is thus a <b>Bronsted base</b> .
(c) $NH_4^+$ dissolved in water can donate a proton $H^+$ , thus behaving as a <b>Bronsted acid</b> .
(d) $HCO_3^-$ can either accept a proton to become $H_2CO_3$ , thus behaving as a <b>Bronsted base</b> . Or, $HCO_3^-$ can donate a proton to yield $H^+$ and $CO_3^{2-}$ , thus behaving as a <b>Bronsted acid</b> . ( $HCO_3^-$ is said to be <b>amphoteric</b> because it possesses both acidic and basic properties.)

4.34 Determine the products of each of the following acid-base reactions. Balance the resulting molecular equations. Write the corresponding ionic and net ionic equations.

*Note:* All of these rxns involve a strong base; thus, all acidic hydrogens are removed from the acids.

*Remember:* All strong electrolytes (soluble ionics and strong bases) are dissociated into ions in the ionic equations, but weak electrolytes (weak acids and bases) are not!!!





4.41 **Is it possible to have a reaction in which oxidation occurs and reduction does not? Explain.**  
 No; a redox reaction must contain both a reduction and an oxidation. Electrons must come from and go to some species simultaneously.

4.44 **For the complete redox reactions given below, write the balanced half-reactions.**

(a) $4 \text{Fe} + 3 \text{O}_2 \rightarrow 2 \text{Fe}_2\text{O}_3$ <b>Ox:</b> $4 \text{Fe} \longrightarrow 4 \text{Fe}^{3+} + 12\text{e}^-$ <b>Red:</b> $3 \text{O}_2 + 12\text{e}^- \longrightarrow 6 \text{O}^{2-}$	(b) $\text{Cl}_2 + 2 \text{NaBr} \rightarrow 2 \text{NaCl} + \text{Br}_2$ <b>Ox:</b> $2 \text{Br}^- \longrightarrow \text{Br}_2 + 2\text{e}^-$ <b>Red:</b> $\text{Cl}_2 + 2\text{e}^- \longrightarrow 2 \text{Cl}^-$
(c) $\text{Si} + 2 \text{F}_2 \rightarrow \text{SiF}_4$ <i>Assume <math>\text{SiF}_4</math> is made up of <math>\text{Si}^{4+}</math> and <math>\text{F}^-</math>.</i> <b>Ox:</b> $\text{Si} \longrightarrow \text{Si}^{4+} + 4\text{e}^-$ <b>Red:</b> $2 \text{F}_2 + 4\text{e}^- \longrightarrow 4\text{F}^-$	(d) $\text{H}_2 + \text{Cl}_2 \rightarrow 2 \text{HCl}$ <i>Assume <math>\text{HCl}</math> is made up of <math>\text{H}^+</math> and <math>\text{Cl}^-</math>.</i> <b>Ox:</b> $\text{H}_2 \longrightarrow 2\text{H}^+ + 2\text{e}^-$ <b>Red:</b> $\text{Cl}_2 + 2\text{e}^- \longrightarrow 2\text{Cl}^-$

4.46 **Indicate the oxidation number of phosphorus in each of the following acids.**

(a) $\text{HPO}_3$ : <b>P +5</b>	(c) $\text{H}_3\text{PO}_3$ : <b>P +3</b>	(e) $\text{H}_4\text{P}_2\text{O}_7$ : <b>P +5</b>
(b) $\text{H}_3\text{PO}_2$ : <b>P +1</b>	(d) $\text{H}_3\text{PO}_4$ : <b>P +5</b>	(f) $\text{H}_5\text{P}_3\text{O}_{10}$ : <b>P +5</b>

4.47 **Give the oxidation number of the underlined atoms in the following molecules and ions.**

(a) <u>Cl</u> $\text{F}$ : <b>F -1, Cl +1</b>	(f) $\text{K}_2$ <u>Cr</u> $\text{O}_4$ : <b>K +1, O -2, Cr +6</b>	(k) $\text{Na}$ <u>I</u> $\text{O}_3$ : <b>Na +1, O -2, I +5</b>
(b) <u>I</u> $\text{F}_7$ : <b>F -1, I +7</b>	(g) $\text{K}_2$ <u>Cr</u> $_2\text{O}_7$ : <b>K +1, O -2, Cr +6</b>	(l) $\text{K}$ <u>O</u> $_2$ : <b>K +1, O -1/2</b>
(c) <u>C</u> $\text{H}_4$ : <b>H +1, C -4</b>	(h) $\text{K}$ <u>Mn</u> $\text{O}_4$ : <b>K +1, O -2, Mn +7</b>	(m) $\text{P}$ <u>F</u> $_6^-$ : <b>F -1, P +5</b>
(d) <u>C</u> $_2\text{H}_2$ : <b>H +, C -1</b>	(i) $\text{Na}$ <u>H</u> <u>C</u> $\text{O}_3$ : <b>Na +1, H +1, O -2, C +4</b>	(n) $\text{K}$ <u>Au</u> $\text{Cl}_4$ : <b>K +1, Cl -1, Au +3</b>
(e) <u>C</u> $_2\text{H}_4$ : <b>H +1, C -2</b>	(j) <u>Li</u> $_2$ : <b>Li 0</b>	

4.50 **Give the oxidation number of the underlined atoms in the following molecules and ions.**

(a) $\text{Mg}_3$ <u>N</u> $_2$ : <b>Mg +2, N -3</b>	(c) $\text{Ca}$ <u>C</u> $_2$ : <b>Ca +2, C -1</b>	(f) $\text{Zn}$ <u>O</u> $_2^{2-}$ : <b>Zn +2, O -2</b>
(b) $\text{Cs}$ <u>O</u> $_2$ : <b>Cs +1, O -1/2</b>	(d) $\text{C}$ <u>O</u> $_3^{2-}$ : <b>O -2, C +4</b>	(g) $\text{Na}$ <u>H</u> : <b>Na +1, H -1</b>

4.142 **What is oxidation number of O in HFO?**

H is +1, F is -1, so the oxidation number of O must be **zero**.