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 Brønsted 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 Brønsted's definitions more useful in describing acid-base properties?

Brønsted definitions are broader because solutions do not have to be aqueous.
(All Arrhenius acids and bases are also Brønsted 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

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 Brønsted acid, base, or both:

(a)	**PO_4^{3-}** in water can accept a proton to become HPO_4^{2-}, and is thus a **Brønsted base**.
(b)	**ClO_2^-** in water can accept a proton to become $HClO_2$, and is thus a **Brønsted base**.
(c)	**NH_4^+** dissolved in water can donate a proton H^+, thus behaving as a **Brønsted acid**.
(d)	**HCO_3^-** can either accept a proton to become H_2CO_3, thus behaving as a **Brønsted base**. Or, **HCO_3^-** can donate a proton to yield H^+ and CO_3^{2-}, thus behaving as a **Brønsted acid**. *(HCO_3^- is said to be **amphoteric** 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!!!***

(a) **Molecular:** $HCH_3COO(aq) + KOH(aq) \longrightarrow KCH_3COO(aq) + H_2O(l)$

***Ionic*:** $HCH_3COO(aq) + K^+(aq) + OH^-(aq) \longrightarrow CH_3COO^-(aq) + K^+(aq) + H_2O(l)$

***Net ionic*:** $HCH_3COO(aq) + OH^-(aq) \longrightarrow CH_3COO^-(aq) + H_2O(l)$

(b) **Molecular:** $H_2CO_3(aq) + 2\ NaOH(aq) \longrightarrow Na_2CO_3(aq) + 2H_2O(l)$

Ionic: $H_2CO_3(aq) + 2Na^+(aq) + 2OH^-(aq) \longrightarrow 2Na^+(aq) + CO_3^{2-}(aq) + 2H_2O(l)$

Net ionic: $H_2CO_3(aq) + 2OH^-(aq) \longrightarrow CO_3^{2-}(aq) + 2H_2O(l)$

(c) **Molecular:** $2\ HNO_3(aq) + Ba(OH)_2(aq) \longrightarrow Ba(NO_3)_2(aq) + 2H_2O(l)$

Ionic: $2H^+(aq) + 2NO_3^-(aq) + Ba^{2+}(aq) + 2OH^-(aq) \longrightarrow Ba^{2+}(aq) + 2NO_3^-(aq) + 2H_2O(l)$

Net ionic: $H^+(aq) + OH^-(aq) \longrightarrow H_2O(l)$

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) $4\ Fe + 3\ O_2 \rightarrow 2\ Fe_2O_3$ **Ox:** $4\ Fe \longrightarrow 4\ Fe^{3+} + 12e^-$ **Red:** $3\ O_2 + 12e^- \longrightarrow 6\ O^{2-}$	(b) $Cl_2 + 2\ NaBr \rightarrow 2\ NaCl + Br_2$ **Ox:** $2\ Br^- \longrightarrow Br_2 + 2e^-$ **Red:** $Cl_2 + 2e^- \longrightarrow 2\ Cl^-$
(c) $Si + 2\ F_2 \rightarrow SiF_4$ *Assume SiF_4 is made up of Si^{4+} and F^-.* **Ox:** $Si \longrightarrow Si^{4+} + 4e^-$ **Red:** $2\ F_2 + 4e^- \longrightarrow 4F^-$	(d) $H_2 + Cl_2 \rightarrow 2\ HCl$ *Assume HCl is made up of H^+ and Cl^-.* **Ox:** $H_2 \longrightarrow 2H^+ + 2e^-$ **Red:** $Cl_2 + 2e^- \longrightarrow 2Cl^-$

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

(a) HPO_3: **P +5**	(c) H_3PO_3: **P +3**	(e) $H_4P_2O_7$: **P +5**
(b) H_3PO_2: **P +1**	(d) H_3PO_4: **P +5**	(f) $H_5P_3O_{10}$: **P +5**

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

(a) **$\underline{Cl}F$:** F −1, **Cl +1**	(f) **$K_2\underline{Cr}O_4$:** K +1, O −2 **Cr +6**	(k) **$Na\underline{I}O_3$:** Na +1, O −2, **I +5**
(b) **$\underline{I}F_7$:** F −1, **I +7**	(g) **$K_2\underline{Cr_2}O_7$:** K +1, O −2, **Cr +6**	(l) **$K\underline{O}_2$:** K +1, **O −½**
(c) **$\underline{C}H_4$:** H +1, **C −4**	(h) **$K\underline{Mn}O_4$:** K +1, O −2, **Mn +7**	(m) **$\underline{P}F_6^-$:** F −1, **P +5**
(d) **$\underline{C}_2H_2$:** H +, **C −1**	(i) **$NaH\underline{C}O_3$:** Na +1, H +1, O −2, **C +4**	(n) **$K\underline{Au}Cl_4$:** K +1, Cl −1, **Au +3**
(e) **$\underline{C}_2H_4$:** H +1 **C −2**	(j) **$\underline{Li}_2$:** **Li 0**	

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

(a) **$Mg_3\underline{N}_2$:** Mg +2, **N −3**	(c) **$Ca\underline{C}_2$:** Ca +2, **C −1**	(f) **$Zn\underline{O}_2^{2-}$** Zn +2, **O −2**
(b) **$Cs\underline{O}_2$:** Cs +1, **O −½**	(d) **$\underline{C}O_3^{2-}$** O −2, **C+4**	(g) **$Na\underline{H}$:** Na +1, **H −1**

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**.