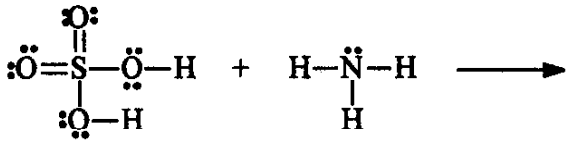
Chem 201

Extra Problems for Homework #3

Identify the reactants in the following reactions as strong acids, weak acids, strong bases, weak bases or neutral compounds and predict the products for any acid-base reaction that can take place. For reactants written as Lewis structures give the Lewis structure of the products. Assume that all reactants are aqueous solutions and only 1 H^+ is transferred in the acid-base reaction.

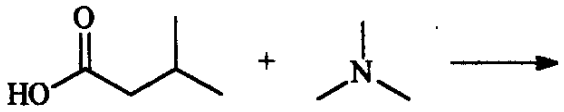
1. $KOH + HNO_3 \rightarrow$

2. 

3. $C_6H_5CH_2CO_2H + NaOH \rightarrow$

4. $Na_2CO_3 + HCl \rightarrow$

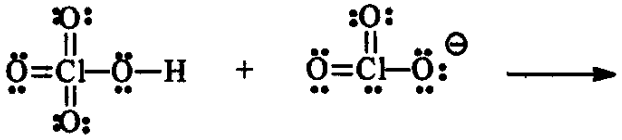
5. $NaCl + HBr \rightarrow$

6. 

7. $H_2CO_3 + KOH \rightarrow$

8. $KHCO_3 + KOH \rightarrow$

9. $[CH_3NH_3]Br + NaF \rightarrow$

10. 

11. $Cr(OH_2)_6^{+3} + H_2O \rightarrow$

12. $NH_4NO_3 + CH_3CO_2H \rightarrow$

Chem 201
Fall 2002

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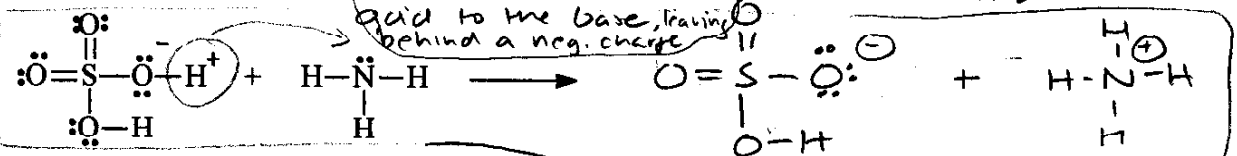
1. $KOH + HNO_3 \rightarrow H_2O + KNO_3$

ionic products written as complete ionic cmpds (cation + anion)

$K^+ + OH^- + H^+NO_3^- \rightarrow K^+ + H_2O + NO_3^-$

neutral — strong base — strong acid — ionic products written as individual ions

In the acid/base rxn, H^+ is transferred from the acid to the base, leaving behind a neg. charge

2. 

H_2SO_4 — strong acid — weak base

3. $C_6H_5CH_2CO_2H + NaOH \rightarrow Na[C_6H_5CO_2] + H_2O$ (or)

weak acid — $Na^+ + OH^-$ (neutral, strong base) $\rightarrow C_6H_5CH_2CO_2^- + Na^+ + H_2O$

4. $Na_2CO_3 + HCl \rightarrow NaHCO_3 + NaCl$

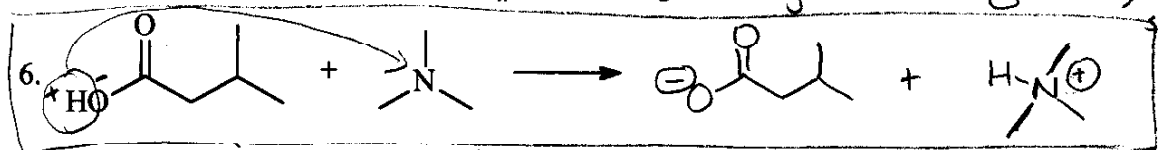
When writing out the complete ionic compounds, just remember the overall charge has to be zero

strong acid — $2Na^+ + HCO_3^- + Cl^-$

$2Na^+ + CO_3^{2-}$ — neutral — weak base - because CO_3^{2-} is the conj. base of HCO_3^-, which is a weak acid.

5. $NaCl + HBr \rightarrow$ NO REACTION (need both an acid and base)

$Na^+ + Cl^-$ — neutral — neutral - because Cl^- is the conj. base of HCl, which is a strong acid

6. 

weak acid (org. compound w/ HO_2C-) — weak base (org. compound w/ N)

7. $H_2CO_3 + KOH \rightarrow KHCO_3 + H_2O$

weak acid — only 1 H^+ transferred

$K^+ + OH^- \rightarrow HCO_3^- + K^+ + H_2O$

strong base

8. $KHCO_3 + KOH \rightarrow K_2CO_3 + H_2O$

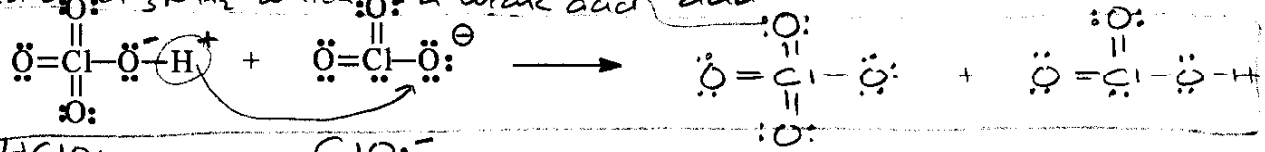
$K^+ + HCO_3^- + K^+ + OH^- \rightarrow K^+ + CO_3^{2-} + K^+ + H_2O$

neutral | weak acid | neutral | strong base

9. $[CH_3NH_3]Br + NaF \rightarrow CH_3NH_2 + HF + NaBr$

$CH_3NH_3^+ + Br^- + Na^+ + F^- \rightarrow CH_3NH_2 + Br^- + Na^+ + HF$

weak acid (because its the conj. acid of CH_3NH_2 which is a weak base) | neutral (because its the conj base of a strong acid) | weak base - because F^- is conj. base of HF, which is a weak acid

10. 

$HClO_4$ strong acid | ClO_3^- weak base - because its the conj base of a weak acid ($HClO_3$)

TYPO!

11. $Cr(OH_2)_6^{+3} + H_2O \rightarrow Cr(OH_2)_5(OH)^{+2} + H_3O^+$

weak acid

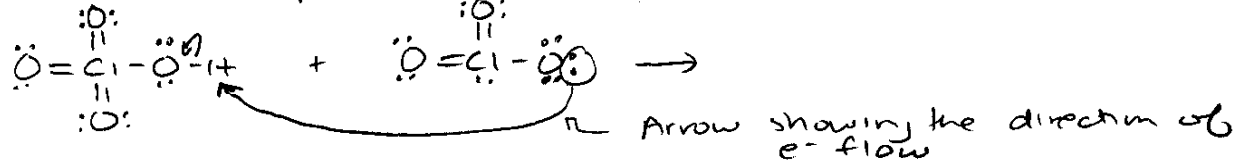
This is the "odd" case of acidic cations - small, highly charged (+2, +3) metal cations in water - the acidic H is on one of the water molecules bonded to the metal

12. $NH_4NO_3 + CH_3CO_2H \rightarrow$ NO REACTION

$NH_4^+ + NO_3^-$ | weak acid (organic compound w/ CO_2H)

weak acid (neutral) because its the conjugate acid of a weak base

NOTE: In order to emphasize that H^+ is transferred from the acid to the base I've put a circle around the acidic H and show it moving to the basic site. Don't confuse this presentation with the normal use of arrows showing the flow of electrons. In that case the arrows go in the opposite direction, from the lone pair on the base to the acidic H:



Arrow showing the direction of e^- flow