Writing Net Ionic Equations for AP Chemistry

When writing net ionic equations, keep the following in mind:

- Only atoms or ions that undergo a change are included
- Atoms/ions that are in the same state and form at the beginning and at the end of the reaction are not included (these are called **spectator ions**)
- Charges on ions must be included and correct
- Must be correctly balanced
- On the AP Exam, states/phases do not need to be included
    - HOWEVER – pay attention to them because they sometimes indicate which substances are changing
- Remember the following substances that fully dissociate in solution:
    - Ionic compounds that contain Na^+, K^+, NH_4^+ and NO_3^-
    - Compounds with K_{sp} values greater than 1
    - Strong acids (HCl, HBr, HI, $HClO_4$, H_2SO_4, HNO_3) and bases (group I and II hydroxides)

Types of Net Ionics

Dissociation:

$$AB \xrightarrow{H_2O} A^+(aq) + B^-(aq)$$

- General Formula: the coefficients in the products are derived from subscripts from the dissociated substance
- remember that subscripts in the dissociated substance are determined by the charges on the ions – these charges must be included in the products of the dissociation

Double Replacement/ Formation of Precipitate:

$$AB + CD \rightarrow AD + CB$$

- Net Ionic Format: Cation + Anion → Ionic Compound
- you will (generally) have 2 spectator ions – these are not included in net ionic
- Pay attention to the charges:
    - must be included on ions
    - solid formed is neutral (NO charge)
- treat as the opposite of a dissociation – write solid product first, then work backwards to write it's composite ions as the reactants

REDOX:

$$A(s) + B^{m+}(aq) \rightarrow A^{n+}(aq) + B(s)$$

- generally will be given a table of half-reactions to choose from
- coefficients come from the balancing of the electrons in the half reactions
- single-replacement is an application of REDOX

Acid-Base (including Buffers) Reactions:

$$HA(aq) + BOH(aq) \rightarrow H_2O(l) + BA(aq)$$

- Pay attention to strengths of acids and bases:
    - Strong will fully dissociate, creating spectator ion(s)
    - Weak will be written in associated form, since it only partially dissociates
- Strong acid + strong base net ionic:
  $H^+ + OH^- \rightarrow H_2O$
- Weak acid + strong base:
  $HA + OH^- \rightarrow H_2O + A^-$
- Strong acid + weak base:
  H+ + A- → HA

Practice:

For each of the following described situations, write a balanced net-ionic equation.

1) Under standard conditions at 25°C, Zn(*s*) reacts with $Co^{2+}(aq)$ to produce Co(*s*).

2) A volume of 50.0 mL of 0.20 M $NH_3(aq)$ is titrated with 0.50 M HCl(*aq*). The value of the K_b for NH_3 in water is 1.8×10^{-5} at 25°C. Write the balanced net ionic equation for the reaction of $NH_3(aq)$ with HCl(*aq*).

3) The addition of sulfurous acid (a weak acid) to barium hydroxide (a strong base) results in the formation of a precipitate.

4) $$CH_3NH_2(aq) + H_2O(l) \rightleftarrows CH_3NH_3^+(aq) + OH^-(aq) \qquad K_b = 4.4 \times 10^{-4}$$

Methylamine, CH_3NH_2, is a weak base that reacts with water according to the equation above. A 50.0 mL sample of the methylamine is titration with an HCl solution of unknown concentration. Write the net ionic equation that takes place during the titration.

5) $$Na_2CO_3(aq) + Ca(NO_3)_2(aq) \rightarrow 2\ NaNO_3(aq) + CaCO_3(s)$$

Write the net ionic equation for the reaction that occurs when the solutions of $Na_2CO_3(aq)$ and $Ca(NO_3)_2(aq)$ are mixed.

6) A solution is made by mixing 500. mL of 0.500 M $C_2H_5NH_2$ with 500. mL of 0.200 M HCl. Assume that volumes are additive. The pH of the resulting solution is found to be 10.93. Write the net-ionic equation that represents the reaction that occurs when the $C_2H_5NH_2$ solution is mixed with the HCl solution.

7) Potassium sorbate, $KC_6H_7O_2$ (molar mass 150. g/mol) is commonly added to diet soft drinks as a preservative. A stock solution of $KC_6H_7O_2$ (*aq*) of known concentration must be prepared. A student titrates 45.00 mL of the stock solution with 1.25 M HCl(*aq*) using both an indicator and a pH meter. The value of K_a for sorbic acid, $HC_6H_7O_2$, is 1.7×10^{-5}.

Compound	Melting Point (°C)
LiI	449
KI	686
LiF	845
NaF	993

8) Identify a compound from the table that can be dissolved in water to produce a basic solution. Write the net ionic equation for the reaction that occurs to cause the solution to be basic.

9) A student prepares a solution containing equimolar amounts of $HC_2H_3O_2$ and $NaC_2H_3O_2$. The pH of the solution is measured to be 4.7. The student adds two drops of 3.0 M HNO_3(*aq*) and stirs the sample, observing that the pH remains at 4.7. Write a balanced, net-ionic equation for the reaction between HNO_3(*aq*) and the chemical species that is responsible for the pH remaining at 4.7.

Half reaction	E° (V)
$S_4O_6^{2-}(aq) + 2\,e^- \rightarrow 2\,S_2O_3^{2-}(aq)$	0.08
$I_2(s) + 2\,e^- \rightarrow 2\,I^-(aq)$	0.54
$O_2(g) + 2\,H^+(aq) + 2\,e^- \rightarrow H_2O_2(aq)$	0.68

10) Which solution, of the choices above, should be added to I2(s) to reduce it to I-? Circle the answer below.

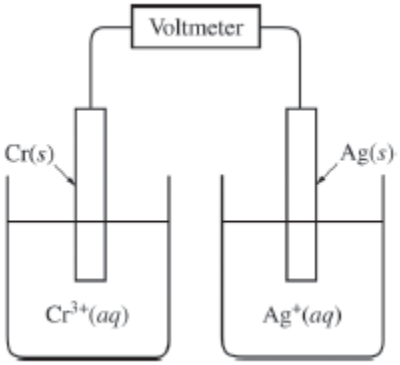
H_2O_2(*aq*) $Na_2S_2O_3$(*aq*) $Na_2S_4O_6$(*aq*)

Write a balanced, net-ionic equation for the reaction between I_2 and the solution you selected.

11) Explain why the addition of 0.100 M NaOH(*aq*) to 0.100 M HNO_2(*aq*) can result in the formation of a buffer solution. Include the net ionic equation for the reaction that occurs when the student adds the NaOH(*aq*) to the HNO_2(*aq*).

$$Na_2S_2O_3(aq) + 4\ NaOCl(aq) + 2\ NaOH(aq) \rightarrow 2\ Na_2SO_4(aq) + 4\ NaCl(aq) + H_2O(l)$$

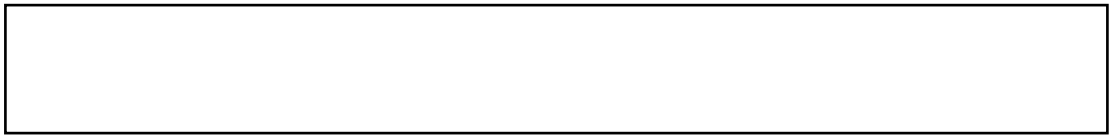
12) Write the balanced, net-ionic equation for the reaction shown above.



Half-Reaction	E° (V)
$Ag^+(aq) + e^- \rightarrow Ag(s)$	+ 0.80
$Cr^{3+}(aq) + 3\ e^- \rightarrow Cr(s)$	?

13) Given the picture of the cell above, and the table of half-reactions shown, write the balanced net-ionic equation for the overall equation that occurs as the cell operates.

14) Write the balanced, net ionic equation for the change that occurs when solid $CaCl_2$ is dissolved in water.



15) Sodium, when introduced into water, reacts violently. What is the net ionic for the reaction between sodium metal and water?

16) The addition of sulfurous acid (H_2SO_3 - a weak acid) to barium hydroxide ($Ba(OH)_2$ - a strong base) results in the formation of a precipitate. Write the net ionic equation for the reaction.

17) Aqueous ethylamine reacts with water according to the reaction below.

$$C_2H_5NH_2(aq) + H_2O(l) \rightleftarrows C_2H_5NH_3^+(aq) + OH^-(aq)$$

A solution is made by mixing 500. mL of 0.500 M $C_2H_5NH_2$ with 500. mL of 0.200 M HCl. Write the net ionic equation that represents the reaction that occurs.

18) Write the net ionic equation for the reaction between the weak acid HOCl(*aq*) and the strong base NaOH(*aq*).

19) Write the balanced net ionic equation for the galvanic cell that is constructed using to the two-half cells that are represented by the standard reduction potentials given below.

$$Zn^{2+}(aq) + 2\,e^- \rightarrow Zn(s) \qquad E° = -0.76\ V$$
$$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq) \qquad E° = 0.77\ V$$

20) A mixture of equimolar solutions of calcium chloride ($CaCl_2$) and barium chloride ($BaCl_2$) are present in a flask. A student adds a solution of calcium sulfate ($CaSO_4$) and notices a precipitate is formed. Write the net ionic equation for the formation of the precipitate.