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:	Double Replacement/ Formation of Precipitate:

$$AB \xrightarrow{H_2O} A^+(aq) + B^-(aq)$$
 • 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
	$$AB + CD \rightarrow AD + CB$$
	 • 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:
	    $H+ + A- \rightarrow HA$

Practice:

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

$$H_2NNH_2(aq) + H_2O(l) \rightleftharpoons H_2NNH_3{}^+(aq) + OH^-(aq) \qquad K_b = 1.3 \times 10^{-6}$$
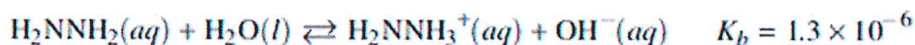
1) In aqueous solution, the compound H_2NNH_2 reacts according to the equation above. A 50.0 mL sample of 0.25 M $H_2NNH_2(aq)$ is combined with a 50.0 mL sample of 0.25 M HCOOH(aq). 2021 #1

$$H_2NNH_2 + HCOOH \longrightarrow H_2NNH_3{}^+ + HCOO^-$$

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).

$$NH_3 + H^+ \longrightarrow NH_4{}^+ \qquad \underline{OR}$$
$$NH_3 + H_3O^+ \longrightarrow NH_4{}^+ + H_2O$$

3) At high temperatures, SiH_4 decomposes to form solid silicon and hydrogen gas. Write a balanced equation for the reaction. 2021 #2

$$SiH_4 \longrightarrow Si + 2H_2$$

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

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. 2012 #1

$$CH_3NH_2 + H^+ \longrightarrow CH_3NH_3{}^+ \qquad \underline{OR}$$
$$CH_3NH_2 + H_3O^+ \longrightarrow CH_3NH_3{}^+ + H_2O$$
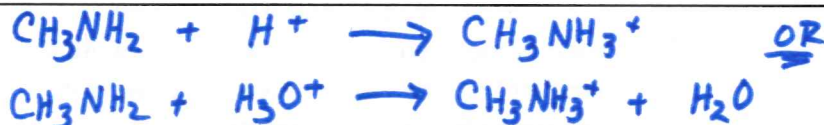
5)
$$Na_2CO_3(aq) + Ca(NO_3)_2(aq) \rightarrow 2\,NaNO_3(aq) + CaCO_3(s)$$

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. 2019 #3

$$Ca^{2+} + CO_3{}^{2-} \longrightarrow CaCO_3$$
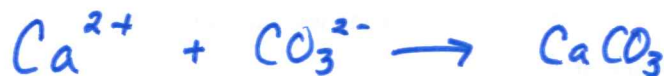
6) For the precipitation experiment, the student adds 20.0 mL of 0.200 M Ba(NO3)2 to 50.0 mL of the CuSO4(aq). The reaction goes to completion, and a white precipitate forms. The student filters the precipitate and dries it overnight. Write a balanced net ionic equation for the precipitation reaction. 2021 #3

$$Ba^{2+} + SO_4{}^{2-} \longrightarrow BaSO_4$$
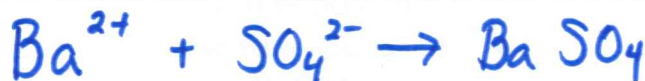
7) Potassium sorbate, $KC_6H_7O_2$ (molar mass 150. g/mol) is commonly added to diet soft drinks as a preservative. A stock solution of $KC_6H_7O_2$ (aq) of known concentration must be prepared. A student titrates 45.00 mL of the stock solution with 1.25 M HCl(aq) using both an indicator and a pH meter. The value of K_a for sorbic acid, $HC_6H_7O_2$, is 1.7×10^{-5}. *2015 #3*

$$H^+ + C_6H_7O_2^- \longrightarrow HC_6H_7O_2$$

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. *2015 #6*

Either LiF or NaF

$$F^- + H_2O \longrightarrow HF + OH^-$$

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. *2016 #2*

$$C_2H_3O_2^- + H_3O^+ \longrightarrow HC_2H_3O_2 + H_2O \quad \underline{OR}$$
$$C_2H_3O_2^- + H^+ \longrightarrow HC_2H_3O_2$$
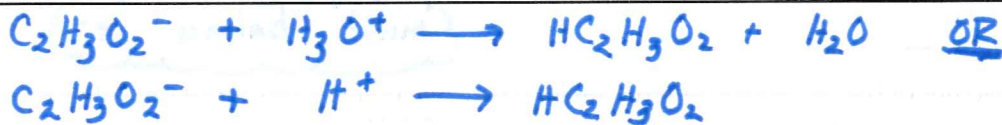
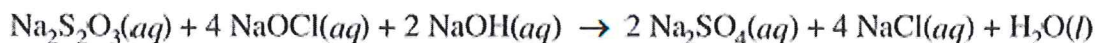| Half reaction	$E°$ (V)
$S_4O_6^{2-}(aq) + 2\,e^- \rightarrow 2\,S_2O_3^{2-}(aq)$	0.08
$I_2(s) + 2\,e^- \rightarrow 2\,I^-(aq)$	0.54
$O_2(g) + 2\,H^+(aq) + 2\,e^- \rightarrow H_2O_2(aq)$	0.68

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 I2 and the solution you selected. *2016 #3*

$$I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-}$$

11) Explain why the addition of 0.100 M NaOH(*aq*) to 0.100 M HNO₂(*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 HNO₂(*aq*). 2017 #3

$$HNO_2 + OH^- \longrightarrow NO_2^- + H_2O$$

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

12) Write the balanced, net-ionic equation for the reaction shown above. 2018 #1

$$S_2O_3^{2-} + 4\ OCl^- + 2\ OH^- \longrightarrow 2\ SO_4^{2-} + 4\ Cl^- + H_2O$$

Voltmeter

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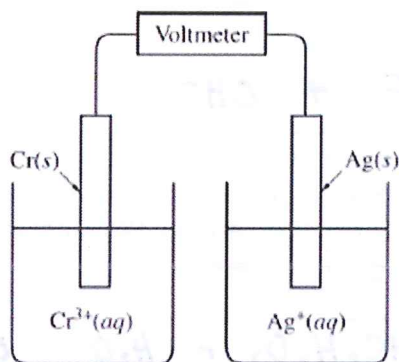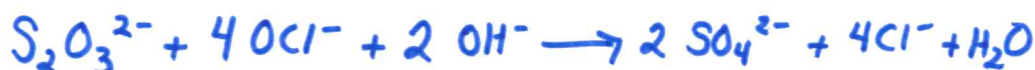
Half-Reaction	$E°$ (V)
$Ag^+(aq) + e^- \rightarrow Ag(s)$	+ 0.80
$Cr^{3+}(aq) + 3\ e^- \rightarrow Cr(s)$	?

Cr³⁺(aq)   Ag⁺(aq)

must balance e⁻

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. 2018 #6

$$3\ Ag^+ + Cr(s) \longrightarrow 3\ Ag(s) + Cr^{3+}$$

14) Write the balanced, net ionic equation for the change that occurs when solid CaCl₂ is dissolved in water.

$$CaCl_2 \longrightarrow Ca^{2+} + 2\ Cl^-$$

15) The color of another salt of silver, AgI(s), is yellow. A student adds a solution of NaI to a test tube containing a small amount of solid, cream-colored AgBr. After stirring the contents of the test tube, the student observes that the solid in the test tube changes color from cream to yellow. Write the net ionic equation for the reaction that occurred in the test tube. 2010 #1

$$AgBr(s) + I^- \longrightarrow AgI(s) + Br^-$$

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. *2012   MC #63*

$$H_2SO_3 + Ba^{2+} + 2OH^- \longrightarrow H_2O + BaSO_3$$

17) Aqueous ethylamine reacts with water according to the reaction below.
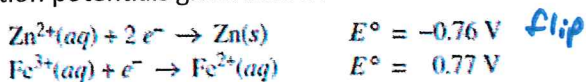
$$C_2H_5NH_2(aq) + H_2O(l) \rightleftarrows C_2H_5NH_3^+(aq) + OH^-(aq)$$
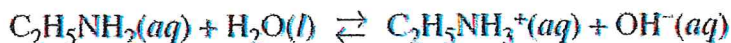
A solution is made by mixing 500. mL of 0.500 M $C_2H_5NH_2$ with 500. mL of 0.200 M HCl. Write the net ionic equation that represents the reaction that occurs. *2009 B   #1*

$$C_2H_5NH_2 + H^+ \longrightarrow C_2H_5NH_3^+ \qquad \underline{OR}$$
$$C_2H_5NH_2 + H_3O^+ \longrightarrow C_2H_5NH_3^+ + H_2O$$
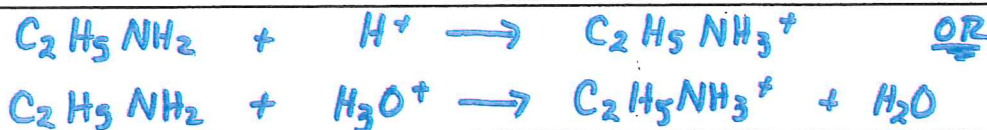
18) Write the net ionic equation for the reaction between the weak acid HOCl(aq) and the strong base NaOH(aq). *2005b   #1*

$$HOCl + OH^- \longrightarrow OCl^- + H_2O$$

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.

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

$$2Fe^{3+} + Zn \rightarrow 2Fe^{2+} + Zn^{2+}$$

20) Write the balanced equation for the combustion of $S_8(s)$ to form $SO_2(g)$
Course & Exam Description

$$S_8 + 8O_2 \longrightarrow 8SO_2$$