

# AP Chemistry

## Solution Chemistry Practice Problems

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

1. Consider a 1.00L solution containing 85.5g  $\text{Al}_2(\text{SO}_4)_3$  (FW = 342.15) and 21.3g  $\text{Na}_2\text{SO}_4$  (FW = 142.06). What are the molar concentrations of the aluminum, sodium and sulfate ions?

$$1. \text{ mol Al}_2(\text{SO}_4)_3 = 85.5\text{g}/(342.15\text{g/mol}) = .250\text{mol} \\ = 0.50\text{mol Al and } 0.75\text{mol SO}_4^{2-}$$

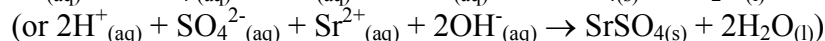
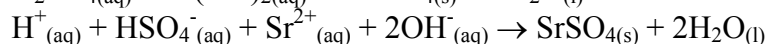
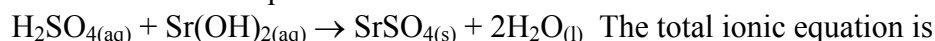
$$\text{mol Na}_2\text{SO}_4 = 21.3\text{g}/(142.06\text{g/mol}) = .150\text{mol} \\ = 0.300\text{mol Na and } 0.150\text{mol SO}_4^{2-}$$

$$[\text{Al}^{3+}] = 0.500\text{mol}/1.0\text{L} = \mathbf{0.500\text{M}}$$

$$[\text{Na}^+] = 0.300\text{mol}/1.0\text{L} = \mathbf{0.300\text{M}}$$

$$[\text{SO}_4^{2-}] = (0.750\text{mol} + 0.150\text{mol})/1.0\text{L} = \mathbf{0.900\text{M}}$$

2. The molecular equation is



Since there are no spectator ions, **the total and net ionic equations are the same.**

3. Which of the following substances is a strong electrolyte in aqueous solution?



NaCl. NaCl is a soluble ionic compound. The others either do not produce, or produce an extremely small number of ions (H<sub>2</sub>O).

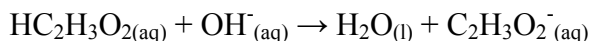
4. A 25.00mL sample of an aqueous solution of  $\text{Ba}(\text{OH})_2$  requires 18.45mL of 0.01500M  $\text{HCl}_{(\text{aq})}$  for its neutralization. What is the molarity of the  $\text{Ba}(\text{OH})_2$  solution?

$$\text{moles of HCl used} = .01845\text{L}(0.01500\text{mol/L}) = 2.77 \times 10^{-4} \text{ mol HCl} = \text{mol H}^+$$

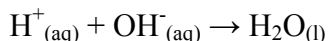
$$\text{This was able to neutralize } 2.77 \times 10^{-4} \text{ mol of OH}^-. \text{ Since each } \text{Ba}(\text{OH})_2 \text{ produces } 2\text{OH}^-, \text{ there were} \\ (2.77 \times 10^{-4})/2 = 1.385 \times 10^{-4} \text{ mol Ba}(\text{OH})_2. \text{ The molarity of the barium hydroxide is } (1.385 \times 10^{-4} \\ \text{mol})/(0.02500\text{L}) = \mathbf{5.54 \times 10^{-3}\text{M}}$$

5. Write net ionic equations for the following neutralization reactions:

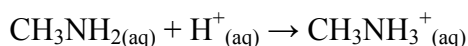
a. The strong base KOH and the weak acid  $\text{HC}_2\text{H}_3\text{O}_2$ .



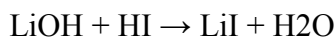
b. The strong base barium hydroxide and the strong acid perchloric acid.



c. The weak base methyl amine ( $\text{CH}_3\text{NH}_2$ ) and the strong acid hydrobromic acid (HBr).



6. What is the molarity of a solution of hydroiodic acid if exactly 35.0mL of .010M lithium hydroxide is required to titrate 30.0mL of the acid solution to the equivalence point?



$$\text{mol LiOH} = (.0350\text{L})(.010\text{M}) = .000350\text{mol}$$

$$.000350\text{mol LiOH} (1\text{mol HI} / 1\text{mol LiOH}) = .000350\text{mol HI} \quad \text{M} = .000350\text{mol}/.030\text{L} = \mathbf{.012\text{M}}$$

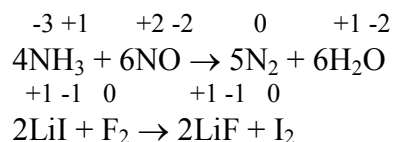
7. Classify each (unbalanced) reaction as precipitation, acid-base neutralization or oxidation-reduction. Write a net ionic equation where possible.

- $\text{Mg}_{(s)} + \text{Cl}_{2(g)} \rightarrow$
- $\text{Ba}(\text{OH})_{2(aq)} + \text{H}_2\text{SO}_{4(aq)} \rightarrow$
- $\text{Cu}(\text{NO}_3)_{2(aq)} + \text{Zn}_{(s)} \rightarrow$
- $\text{Na}_2\text{CO}_{3(aq)} + \text{Al}(\text{NO}_3)_{3(aq)} \rightarrow$

- $\text{Mg}_{(s)} + \text{Cl}_{2(g)} \rightarrow \text{MgCl}_{2(s)}$  oxidation/reduction (synthesis)
- $\text{Ba}^{2+}_{(aq)} + 2\text{OH}^{-}_{(aq)} + 2\text{H}^{+}_{(aq)} + \text{SO}_4^{2-}_{(aq)} \rightarrow 2\text{H}_2\text{O}_{(l)} + \text{BaSO}_{4(s)}$  neutralization.
- $\text{Cu}^{2+}_{(aq)} + \text{Zn}_{(s)} \rightarrow \text{Cu}_{(s)} + \text{Zn}^{2+}_{(aq)}$  oxidation/reduction (single replacement)
- $2\text{Al}^{3+}_{(aq)} + 3\text{CO}_3^{2-}_{(aq)} \rightarrow \text{Al}_2(\text{CO}_3)_3$  precipitation (metathesis, double displacement)

8. In each reaction determine: a) the oxidation number of each element, b) which element is oxidized and which is reduced, c) the oxidizing agent and the reducing agent.

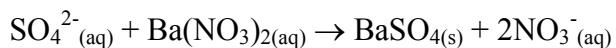
- $4\text{NH}_3 + 6\text{NO} \rightarrow 5\text{N}_2 + 6\text{H}_2\text{O}$
- $2\text{LiI} + \text{F}_2 \rightarrow 2\text{LiF} + \text{I}_2$



For the first equation, nitrogen is both oxidized and reduced. Ammonia is the reducing agent and nitrogen monoxide is the oxidizing agent.

In the second equation, iodine is oxidized and fluorine is reduced. Lithium iodide is the reducing agent and fluorine is the oxidizing agent.

9. A 100.g sample of an unknown alkali metal sulfate compound is dissolved in water. When excess barium nitrate is added, 164.31g of insoluble barium sulfate is produced. What is the identity of the original sulfate compound?



$$\text{Moles of BaSO}_4 = 164.31\text{g} / (233.39\text{g/mol}) = .704\text{mol}$$

$$.704\text{mol BaSO}_4 (1\text{mol SO}_4^{2-} / 1\text{mol BaSO}_4) = .704\text{mol SO}_4^{2-}$$

$$.704\text{mol SO}_4^{2-} (2\text{mol alkali metal} / 1\text{mol SO}_4^{2-}) = 1.41\text{mol alkali metal}$$

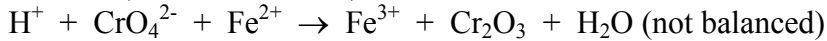
$$\text{mass of sulfate ion} = .704\text{mol SO}_4^{2-} (96.063\text{g/mol}) = 67.63\text{g sulfate}$$

$$\text{mass of alkali metal} = 100.\text{g} - 67.63\text{g} = 32.37\text{g alkali metal}$$

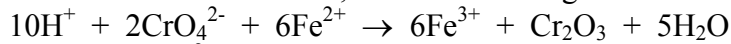
$$\text{molar mass of alkali metal} = 32.37\text{g} / 1.41\text{mol} = 22.98\text{g/mol}$$

This is the molar mass for sodium, so the compound is  $\mathbf{Na}_2\text{SO}_4$

10. How many milliliters of a 3.85M solution of  $\text{Fe}^{2+}$  are needed to titrate 250.0mL of a 0.125M  $\text{CrO}_4^{2-}$  solution (in acidic solution)?



Each iron loses 1 electron; each chromium gains 3 electrons so the balanced equation is

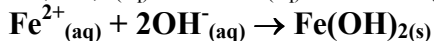
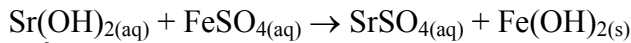


moles of  $\text{CrO}_4^{2-} = (0.125\text{M})(.250\text{L}) = .0313\text{mol}$

the mole ratio makes  $.0313\text{mol CrO}_4^{2-} (1\text{mol Fe}^{2+}/2\text{mol CrO}_4^{2-}) = .0157\text{mol Fe}^{2+}$

volume of  $\text{Fe}^{2+}$  needed =  $.0157\text{mol}/(3.85\text{mol/L}) = 0.0041\text{L} = \mathbf{4.1\text{mL}}$

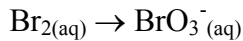
11. Determine the net ionic equation for the reaction between aqueous  $\text{Sr}(\text{OH})_2$  and  $\text{FeSO}_4$  solutions.



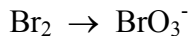
12. What is the oxidation number of iron in  $\text{Fe}_3\text{O}_7$ ?

Iron balances -14 from the oxygen. Since there are 3 iron atoms, 3 goes into 14  $\mathbf{4\ 2/3}$  times.

13. When the following half reaction (unbalanced) occurs, determine the total number of electrons transferred.



0      +5 -2



**10 electrons are transferred.**

14. **0.1621%  $\text{C}_2\text{H}_5\text{OH}$**

$.03546\text{L}(0.04961\text{M}) = .001759\text{mol dichromate}$

$.001759\text{mol dichromate} (1\text{mol ethanol} / 2\text{mol dichromate}) = 8.795 \times 10^{-4}\text{mol ethanol}$

$8.795 \times 10^{-4}\text{mol ethanol} (46.0684\text{g/mol}) = .040517\text{g}$

$.040517\text{g ethanol} / 25.00\text{g plasma} = .001621 = .1621\%$

15. Pb falls below Zn on the activity series of metals. Determine if there will be a reaction when a piece of solid zinc is placed into a solution of lead(II)nitrate.

Yes. Since Zn is higher on the activity series, it is able to reduce the lead so that the zinc can become the  $2+$  ion.