

PRACTICE TEST/AQ CHEM/FREE RESPONSE PROBLEMS/AP CHEMISTRY

In your text book, Chemistry the Central Science, there are three problems that are very similar to problems you will be expected to answer on your Aqueous Chemistry test. These problems are: 20.5, 20.9, and 20.10

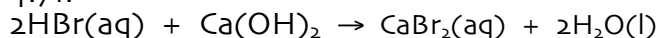
ANSWERS TO SUGGESTED BOOK PROBLEMS

- 20.5: a). $\text{TiCl}_4(\text{g}) + 2\text{Mg}(\text{l}) \rightarrow \text{Ti}(\text{s}) + 2\text{MgCl}_2(\text{l})$
b). titanium in TiCl_4 is the oxidant, magnesium is the reductant.
- 20.9: a). $8\text{H}^+(\text{aq}) + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow 2\text{Cr}^{3+}(\text{aq}) + 4\text{H}_2\text{O}(\text{l}) + \text{IO}_3^-(\text{aq})$
b). $12\text{H}^+(\text{aq}) + 4\text{MnO}_4^-(\text{aq}) + 5\text{CH}_3\text{OH}(\text{aq}) \rightarrow 4\text{Mn}^{2+}(\text{aq}) + 11\text{H}_2\text{O}(\text{l}) + 5\text{HCO}_2\text{H}(\text{aq})$
c). $\text{H}_2\text{O}(\text{l}) + \text{I}_2(\text{aq}) + 5\text{ClO}^-(\text{aq}) \rightarrow 2\text{IO}_3^-(\text{aq}) + 2\text{H}^+(\text{aq}) + 5\text{Cl}^-(\text{aq})$
d). $2\text{H}_2\text{O}(\text{l}) + \text{As}_2\text{O}_3(\text{s}) + \text{H}^+(\text{aq}) + 2\text{NO}_3^-(\text{aq}) \rightarrow 2\text{H}_3\text{AsO}_4(\text{aq}) + \text{N}_2\text{O}_3(\text{aq})$
e). $\text{H}_2\text{O}(\text{l}) + 2\text{MnO}_4^-(\text{aq}) + \text{Br}^-(\text{aq}) \rightarrow 2\text{MnO}_2(\text{s}) + \text{BrO}_3^-(\text{aq}) + 2\text{OH}^-(\text{aq})$
f). $\text{ClO}^-(\text{aq}) + \text{Pb}(\text{OH})_4^{2-}(\text{aq}) \rightarrow \text{Cl}^-(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{PbO}_2(\text{s}) + 2\text{OH}^-(\text{aq})$
- 20.10: a). $3\text{NO}_2^-(\text{aq}) + 8\text{H}^+(\text{aq}) + \text{Cr}_2\text{O}_7^{2-}(\text{aq}) \rightarrow 3\text{NO}_3^-(\text{aq}) + 2\text{Cr}^{3+}(\text{aq}) + 4\text{H}_2\text{O}(\text{l})$
b). $6\text{H}_2\text{O}(\text{l}) + 4\text{As}(\text{s}) + 3\text{H}^+(\text{aq}) + 3\text{ClO}_3^-(\text{aq}) \rightarrow 4\text{H}_3\text{AsO}_3(\text{aq}) + 3\text{HClO}(\text{aq})$

In addition to the above reaction writing problems, there are some calculation-based problems. These suggested problems are: 4.71, 4.72, and 4.73.

ANSWERS TO ADDITIONAL BOOK PROBLEMS:

4.71:



$$0.0488 \text{ L HBr soln} \times 5.00 \times 10^{-2} \text{ mol HBr}/1.0 \text{ L soln} \times 1 \text{ mol Ca}(\text{OH})_2/2 \text{ mol HBr}$$

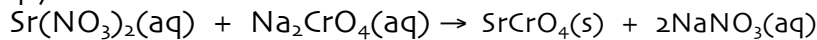
$$\times 1/0.100 \text{ L of Ca}(\text{OH})_2 = 1.220 \times 10^{-2} = 1.22 \times 10^{-2} \text{ M Ca}(\text{OH})_2$$

From the molarity of the saturated solution, we can calculate gram solubility of $\text{Ca}(\text{OH})_2$ in 100 mL of H_2O .

$$0.100 \text{ L soln} \times 1.220 \times 10^{-2} \text{ mol Ca}(\text{OH})_2/1.0 \text{ L soln} \times 74.10 \text{ g Ca}(\text{OH})_2/1 \text{ mol Ca}(\text{OH})_2 =$$

$$0.0904 \text{ g Ca}(\text{OH})_2 \text{ in } 100 \text{ mL of soln.}$$

4.72:

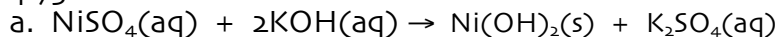


From a 100 mL sample we can:

$$0.100 \text{ L soln} \times 7.52 \text{ g Sr}(\text{NO}_3)_2/0.750 \text{ L soln} \times 1 \text{ mol Sr}(\text{NO}_3)_2/2.11.6 \text{ g Sr}(\text{NO}_3)_2 \times$$

$$1 \text{ mol Na}_2\text{CrO}_4/1 \text{ mol Sr}(\text{NO}_3)_2 \times 1 \text{ L soln}/0.0425 \text{ mol Na}_2\text{CrO}_4 = 0.111 \text{ L Na}_2\text{CrO}_4 \text{ soln}$$

4.73:



b. The precipitate is $\text{Ni}(\text{OH})_2$

$$\text{c. } 0.200 \text{ M KOH} \times 0.1000 \text{ L KOH} = 0.0200 \text{ mol KOH}$$

$$0.150 \text{ M NiSO}_4 \times 0.2000 \text{ L KOH} = 0.0300 \text{ mol NiSO}_4$$

1 mol NiSO_4 requires 2 mol KOH, so 0.0300 mol NiSO_4 requires 0.0600 mol KOH.

Since only 0.0200 mol KOH is available, KOH is the limiting reagent.

d. The amount of the limiting reagent (KOH) determines the amount of product, in this case $\text{Ni}(\text{OH})_2$

$$0.0200 \text{ mol KOH} \times \frac{1 \text{ mol Ni}(\text{OH})_2}{2 \text{ mol KOH}} \times \frac{92.71 \text{ g Ni}(\text{OH})_2}{1 \text{ mol Ni}(\text{OH})_2} = 0.927 \text{ g Ni}(\text{OH})_2$$

e. The limiting reagent is OH^- , no excess OH^- remains in solution.

Excess reactant: Ni^{2+} : $M \text{ Ni}^{2+} \text{ remaining} = \text{mol Ni}^{2+} \text{ remaining/liter of solution.}$

$$0.0300 \text{ mol Ni}^{2+} \text{ initial} - 0.0100 \text{ mol Ni}^{2+} \text{ reacted} = 0.0200 \text{ mol Ni}^{2+} \text{ remaining.}$$

$$0.0200 \text{ mol Ni}^{2+} / 0.3000 \text{ L} = 0.0667 \text{ M Ni}^{2+} \text{ (aq)}$$

Spectators: SO_4^{2-} and K^+ These ions do not react, so the only change in their M is due to dilution. The final volume is 0.3000 L

Dilution equation says $M_1V_1 = M_2V_2$

$$\text{So, } M_2 = M_1V_1/V_2 \text{ So, } 0.200 \text{ M K}^+ \times 0.1000 \text{ L} / 0.3000 \text{ L} = 0.0667 \text{ M K}^+ \text{ (aq)}$$

$$0.150 \text{ M SO}_4^{2-} \times 0.2000 \text{ L} / 0.3000 \text{ L} = 0.100 \text{ M SO}_4^{2-} \text{ (aq)}$$

OH WHAT THE HECK, TRY THIS PROBLEM TOO! HINT, HINT. TRY THIS ONE!!!!

A titration was performed:

73.2 ml of 0.143 M sulfuric acid solution are titrated with 109.4 mL of 0.317 M sodium hydroxide solution.

A. Show the balanced *ionic* equation.

B. What is the limiting reagent?

C. What are the remaining molarities of *all* of the remaining ions in solution? (There are three)

ANSWERS:



B. H_2SO_4 is the limit

C. 0.0575 M SO_4^{2-} , 0.190 M Na^+ , 0.0750 M OH^-