

ALL work must be shown to receive full credit. **Due at the end of laboratory.**

ICE3.1. What volume of 0.778 M sodium carbonate solution must be diluted to 150.0 mLs with water to reduce its concentration to 0.0234 M Na₂CO₃?

$$M_C \cdot V_C = M_D \cdot V_D$$

$$0.778 \text{ M} \cdot V_C = 0.0234 \text{ M} \cdot 150.0 \text{ mL}$$

$$V_C = \frac{0.0234 \text{ M} \cdot 150.0 \text{ mL}}{0.778 \text{ M}} \\ = 4.51 \text{ mL}$$

ICE3.2. A 0.0945 g sample of CuSO₄ · 5H₂O is dissolved and diluted to the mark in a 500.0 mL volumetric flask. A 2.00 mL sample of this solution is transferred to a second 5000.0 mL volumetric flask and diluted.

a) What is the molarity of the CuSO₄ in the final solution?

$$0.0945 \text{ g CuSO}_4 \cdot 5\text{H}_2\text{O} \left(\frac{1 \text{ mol CuSO}_4 \cdot 5\text{H}_2\text{O}}{250. \text{ g}} \right) = 3.78 \times 10^{-4} \text{ mol CuSO}_4 \cdot 5\text{H}_2\text{O} \\ \frac{3.78 \times 10^{-4} \text{ mol CuSO}_4 \cdot 5\text{H}_2\text{O}}{0.500 \text{ L}} = 7.56 \times 10^{-4} \text{ M CuSO}_4$$

$$M_C \cdot V_C = M_D \cdot V_D$$

$$7.56 \times 10^{-4} \text{ M CuSO}_4 \cdot 2.00 \text{ mLs} = M_D \cdot 5000.0 \text{ mL}$$

$$M_D = \frac{7.56 \times 10^{-4} \text{ M CuSO}_4 \cdot 2.00 \text{ mLs}}{5000.0 \text{ mLs}} \\ = 3.02 \times 10^{-7} \text{ M CuSO}_4$$

I meant to a second 500.0 mL volumetric flask

$$M_C \cdot V_C = M_D \cdot V_D$$

$$7.56 \times 10^{-4} \text{ M CuSO}_4 \cdot 2.00 \text{ mLs} = M_D \cdot 500.0 \text{ mL}$$

$$M_D = \frac{7.56 \times 10^{-4} \text{ M CuSO}_4 \cdot 2.00 \text{ mLs}}{500.0 \text{ mLs}} \\ = 3.02 \times 10^{-6} \text{ M CuSO}_4$$

b) To prepare the solution directly what mass of CuSO₄ · 5H₂O must be weighed out?

$$5.000 \text{ L} \left(\frac{3.02 \times 10^{-6} \text{ M CuSO}_4}{1 \text{ L}} \right) = 1.51 \times 10^{-6} \text{ mol CuSO}_4 \cdot 5\text{H}_2\text{O}$$

$$1.51 \times 10^{-6} \text{ mol CuSO}_4 \cdot 5\text{H}_2\text{O} \left(\frac{250. \text{ g}}{1 \text{ mol CuSO}_4 \cdot 5\text{H}_2\text{O}} \right) = 3.78 \times 10^{-4} \text{ g CuSO}_4 \cdot 5\text{H}_2\text{O}$$

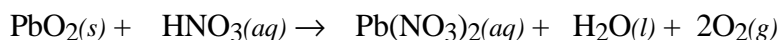
ICE3.3. Describe how you would prepare 250.0 mLs of a 0.0100 M solution of KMnO_4 .

$$.250 \text{ L} \left(\frac{0.0100 \text{ mol KMnO}_4}{1 \text{ L}} \right) = 2.50 \times 10^{-3} \text{ mol KMnO}_4$$

$$2.50 \times 10^{-3} \text{ mol KMnO}_4 \left(\frac{158 \text{ g KMnO}_4}{1 \text{ mol}} \right) = 0.395 \text{ g KMnO}_4$$

Weigh 0.395 g KMnO_4 on a balance. Measure out about 200 mL of water and add the 0.395 g of KMnO_4 to the 200 mL of water. After the KMnO_4 dissolves, add enough water so the final volume is 250 mL.

ICE3.4. Given the reaction



a) Balance the chemical equation.



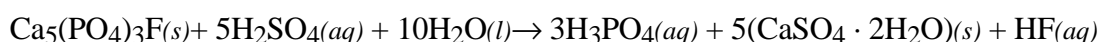
b) What volume of 1.23 M nitric acid is required to react with 15.0 g of lead(IV) oxide according to the equation?

$$15.0 \text{ g PbO}_2 \left(\frac{1 \text{ mol PbO}_2}{239 \text{ g PbO}_2} \right) = 6.28 \times 10^{-2} \text{ mol PbO}_2$$

$$6.28 \times 10^{-2} \text{ mol PbO}_2 \left(\frac{4 \text{ mol HNO}_3}{2 \text{ mol PbO}_2} \right) = 1.26 \times 10^{-1} \text{ mol HNO}_3$$

$$1.26 \times 10^{-1} \text{ mol HNO}_3 \left(\frac{1 \text{ L}}{1.23 \text{ mol HNO}_3} \right) = 0.102 \text{ L}$$

ICE3.5. Phosphoric acid can be produced according to the reaction



a) What volume of 2.50 M phosphoric acid is generated by the reaction of 500. g of $\text{Ca}_5(\text{PO}_4)_3\text{F}$ with excess sulfuric acid?

$$500.0 \text{ g Ca}_5(\text{PO}_4)_3\text{F} \left(\frac{1 \text{ mol Ca}_5(\text{PO}_4)_3\text{F}}{504 \text{ g Ca}_5(\text{PO}_4)_3\text{F}} \right) = 0.992 \text{ mol Ca}_5(\text{PO}_4)_3\text{F}$$

$$0.992 \text{ mol Ca}_5(\text{PO}_4)_3\text{F} \left(\frac{3 \text{ mol H}_3\text{PO}_4}{1 \text{ mol Ca}_5(\text{PO}_4)_3\text{F}} \right) = 2.98 \text{ mol H}_3\text{PO}_4$$

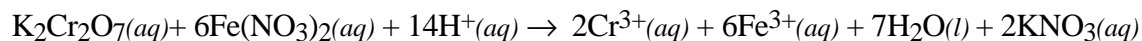
$$2.98 \text{ mol H}_3\text{PO}_4 \left(\frac{1 \text{ L}}{2.50 \text{ mol H}_3\text{PO}_4} \right) = 1.19 \text{ L of 2.50 M H}_3\text{PO}_4$$

b) What volume of 3.00 M sulfuric acid is required to react with amount of $\text{Ca}_5(\text{PO}_4)_3\text{F}$ in part a)?

$$0.992 \text{ mol Ca}_5(\text{PO}_4)_3\text{F} \left(\frac{5 \text{ mol H}_2\text{SO}_4}{1 \text{ mol Ca}_5(\text{PO}_4)_3\text{F}} \right) = 4.96 \text{ mol H}_2\text{SO}_4$$

$$4.96 \text{ mol H}_2\text{SO}_4 \left(\frac{1 \text{ L}}{3.00 \text{ mol H}_2\text{SO}_4} \right) = 1.65 \text{ L of 3.00 M H}_2\text{SO}_4$$

ICE3.6. Given the reaction



- a) A solution of $\text{Cr}_2\text{O}_7^{2-}$ is prepared by dissolving 9.34 g of $\text{K}_2\text{Cr}_2\text{O}_7$ in 400.0 mL of water. (Assume no significant change in volume when the solution is prepared.) A total 14.75 mL of this solution is required to reach the end-point in a titration of a 250.0 mL sample containing Fe(II). Determine the concentration of Fe(II) in the solution.

$$9.34 \text{ g of } \text{K}_2\text{Cr}_2\text{O}_7 \left(\frac{1 \text{ mol } \text{K}_2\text{Cr}_2\text{O}_7}{294.2 \text{ g}} \right) = 3.17 \times 10^{-2} \text{ mol } \text{K}_2\text{Cr}_2\text{O}_7$$

$$\frac{3.17 \times 10^{-2} \text{ mol}}{0.400 \text{ L}} = 7.94 \times 10^{-2} \text{ M } \text{K}_2\text{Cr}_2\text{O}_7$$

$$0.01475 \text{ L} \left(\frac{7.94 \times 10^{-2} \text{ mol}}{1 \text{ L}} \right) = 1.17 \times 10^{-3} \text{ mol } \text{K}_2\text{Cr}_2\text{O}_7$$

$$1.17 \times 10^{-3} \text{ mol } \text{K}_2\text{Cr}_2\text{O}_7 \left(\frac{6 \text{ mol } \text{Fe}^{2+}}{1 \text{ mol } \text{K}_2\text{Cr}_2\text{O}_7} \right) = 7.02 \times 10^{-3} \text{ mol } \text{Fe}^{2+}$$

$$\frac{7.02 \times 10^{-3} \text{ mol } \text{Fe}^{2+}}{0.250 \text{ L}} = 2.81 \times 10^{-2} \text{ M } \text{Fe}^{2+}$$

- b) Calculate the mols of H^+ required to react with the amount of $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$ and $\text{Fe}(\text{NO}_3)_2(\text{aq})$ used in part a.

$$1.17 \times 10^{-3} \text{ mol } \text{K}_2\text{Cr}_2\text{O}_7 \left(\frac{14 \text{ mol } \text{H}^+}{1 \text{ mol } \text{K}_2\text{Cr}_2\text{O}_7} \right) = 0.0164 \text{ mol } \text{H}^+$$

- c) If this number of mols of H^+ are dissolved in 300. mLs, calculate the concentration of H^+ .

$$\frac{0.0164 \text{ mol } \text{H}^+}{0.300 \text{ L}} = 5.46 \times 10^{-2} \text{ M } \text{H}^+$$

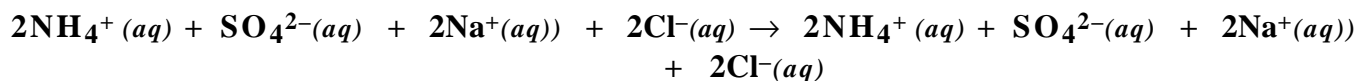
ICE3.7. Write the chemical formula(s) of the product(s) and balance the following reactions. Identify all products phases as either (g)as, (l)iquid, (s)olid or (aq)ueous. If no reaction occurs write NR.

- a) $2\text{Al}(s) + \text{Fe}_2\text{O}_3(s) \rightarrow \text{Al}_2\text{O}_3(s) + 2\text{Fe}(l)$
- b) $\text{Na}_2\text{SO}_4(aq) + 2\text{NH}_4\text{Cl}(aq) \rightarrow (\text{NH}_4)_2\text{SO}_4(aq) + 2\text{NaCl}(aq)$
- c) $\text{Mg}(s) + \text{Cu}^{2+}(aq) \rightarrow \text{Mg}^{2+}(aq) + \text{Cu}(s)$
- d) $3\text{Na}_2\text{CO}_3(aq) + 2\text{Fe}(\text{NO}_3)_3(aq) \rightarrow 6\text{NaNO}_3(aq) + \text{Fe}_2(\text{CO}_3)_3(s)$

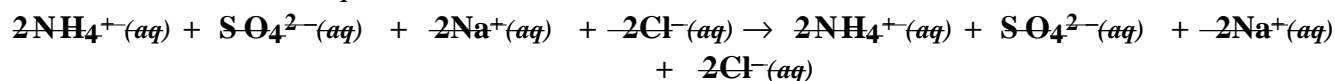
ICE3.8. Write the ionic and net ionic chemical equations for 1b) and 1d).

1b)

Ionic equation:



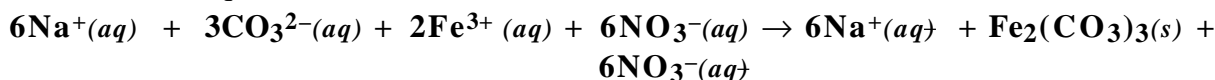
Net Ionic equation:



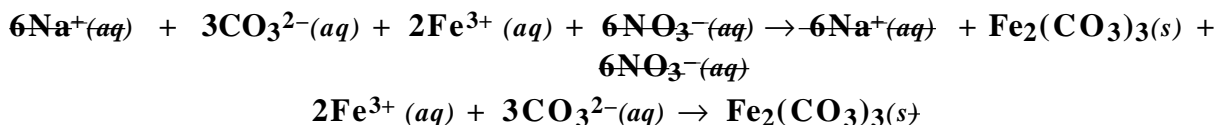
All ions cancel..no net ionic equation....no reaction.

1d)

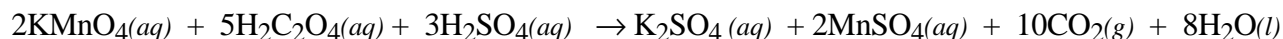
Ionic equation:



Net Ionic equation:



ICE3.9. Calculate the mass of manganese(II) sulfate that forms with 0.680 mLs of 2.44×10^{-3} M KMnO_4 react with 1.25 g of potassium permanganate in excess sulfuric acid. The equation which describes the reaction between oxalic acid, potassium permanganate and sulfuric acid is,



(moles KMnO_4) _o	(moles $\text{H}_2\text{C}_2\text{O}_4$) _{required}	(moles $\text{H}_2\text{C}_2\text{O}_4$) _o	Conclusion
1.66×10^{-6}	4.15×10^{-6}	1.39×10^{-2}	KMnO_4 limiting, $\text{H}_2\text{C}_2\text{O}_4$ excess

$$0.680 \text{ mLs} \left(\frac{1 \text{ L}}{1000 \text{ mLs}} \right) \left(\frac{2.44 \times 10^{-3} \text{ mol KMnO}_4}{1 \text{ L}} \right) = 1.66 \times 10^{-6} \text{ mol KMnO}_4$$

$$1.25 \text{ g H}_2\text{C}_2\text{O}_4 \left(\frac{1 \text{ mol H}_2\text{C}_2\text{O}_4}{90.0 \text{ g H}_2\text{C}_2\text{O}_4} \right) = 1.39 \times 10^{-2} \text{ mol H}_2\text{C}_2\text{O}_4$$

$$1.66 \times 10^{-6} \text{ mol KMnO}_4 \left(\frac{5 \text{ mol H}_2\text{C}_2\text{O}_4}{2 \text{ mol KMnO}_4} \right) = 4.15 \times 10^{-6} \text{ mol H}_2\text{C}_2\text{O}_4 \text{ required}$$

So KMnO_4 is the limiting reagent

$$1.66 \times 10^{-6} \text{ mol KMnO}_4 \left(\frac{2 \text{ mol MnSO}_4}{2 \text{ mol KMnO}_4} \right) \left(\frac{151 \text{ g}}{1 \text{ mol MnSO}_4} \right) = 2.51 \times 10^{-4} \text{ g of MnSO}_4$$