8.87   If sodium chloride has a solubility of 36.0 g of NaCl in 100 g of H_2O at 20 °C, how many grams of water are needed to prepare a saturated solution containing 80.0 g of NaCl?

8.88   If the solid NaCl in a saturated solution of NaCl continues to dissolve, why is there no change in the concentration of the NaCl solution?

8.89   Potassium nitrate has a solubility of 32 g of KNO_3 in 100 g of H_2O at 20°C. State if each of the following forms an unsaturated or saturated solution at 20°C:

    a.   32 g of KNO_3 and 200. g of H_2O

    b.   19 g of KNO_3 and 50. g of H_2O

    c.   68 g of KNO_3 and 150. g of H_2O

8.90   Potassium fluoride has a solubility of 92 g of KF in 100 g of H_2O at 18°C. State if each of the following forms an unsaturated or saturated solution at 18°C:

    a.   46 g of KF and 100. g of H_2O

    b.   46 g of KF and 50. g of H_2O

    c.   184 g of KF and 150. g of H_2O

8.91   Indicate whether each of the following ionic compounds is soluble or insoluble in water:

    a. $CuCO_3$

    b. $NaHCO_3$

    c. $Mg_3(PO_4)_2$

    d. $(NH_4)_2SO_4$

    e.   FeO

    f. $Ca(OH)_2$

8.92   Indicate whether each of the following ionic compounds is soluble or insoluble in water:

    a. Na_3PO_4

    b. $PbBr_2$

    c.   KCl

    d. $(NH_4)_2S$

    e. $MgCO_3$

    f. $FePO_4$

8.93   Write the net ionic equation to show the formation of a solid (insoluble salt) when the following solutions are mixed. Write *none* if there is no precipitate.

    a. $AgNO_{3(aq)}$ and $LiCl_{(aq)}$

    b. $NaCl_{(aq)}$ and $KNO_{3(aq)}$

    c. $Na_2SO_{4(aq)}$ and $BaCl_{2(aq)}$
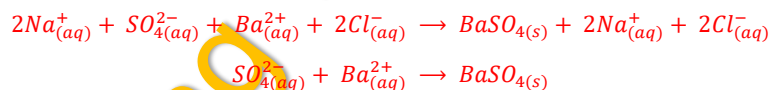
8.94   Write the net ionic equation to show the formation of a solid (insoluble salt) when the following solutions are mixed. Write *none* if there is no precipitate.

    a. $Ca(NO_3)_{2(aq)}$ and $Na_2S_{(aq)}$

    b. $Na_3PO_{4(aq)}$ and $Pb(NO_3)_{2(aq)}$

    c. $FeCl_{3(aq)}$ and $NH_4NO_{3(aq)}$

8.95   Calculate the mass percent (m/m) of a solution containing 15.5 g of Na_2SO_4 and 75.5 g of H_2O.

8.96   Calculate the mass percent (m/m) of a solution containing 26 g of K_2CO_3 and 724 g of H_2O.

8.97   What is the molarity of a solution containing 8.0 g of NaOH in 400. mL of NaOH solution?

8.98   What is the molarity of a solution containing 15.6 g of KCl in 274 mL of KCl solution?

8.99   How many grams of solute are in each of the following solutions?

      a.   2.20 L of a 3.00 M $Al(NO_3)_3$ solution

      b.   75.0 mL of a 0.500 M $C_6H_{12}O_6$ solution

      c.   0.150 L of a 0.320 M NH_4Cl solution

8.100   How many grams of solute are in each of the following solutions?

      a.   428 mL of a 0.450 M Na_2SO_4 solution

      b.   10.5 mL of a 2.50 M $AgNO_3$ solution

      c.   28.4 mL of a 6.00 M H_3PO_4 solution

8.101   A patient receives all her nutrition from fluids given through the vena cava. Every 12 h, 750 mL of a solution that is 4% (m/v) amino acids (protein) and 25% (m/v) glucose (carbohydrate) is given along with 500 mL of a 10% (m/v) lipid (fat) solution.

      a.   In 1 day, how many grams of amino acids, glucose, and lipid are given to the patient?

      b.   How many kilocalories does she obtain in 1 day?

8.102   A patient receives an intravenous solution of a 5.0% (m/v) glucose solution. How many liters of the glucose solution would the patient be given to obtain 75 g of glucose?

8.103   How many milliliters of a 12% (v/v) propyl alcohol solution would you need to obtain 4.5 mL of propyl alcohol?

8.104   An 80-proof brandy is 40.0% (v/v) ethyl alcohol. The "proof" is twice the percent concentration of alcohol in the beverage. How many milliliters of alcohol are present in 750 mL of brandy?

8.105   Calculate the concentration, percent or molarity, of the solution when water is added to prepare each of the following solutions:

      a.   25.0 mL of a 0.200 M NaBr solution diluted to 50.0 mL

      b.   15.0 mL of a 12.0% (m/v) K_2SO_4 solution diluted to 40.0 mL

      c.   75.0 mL of a 6.00 M NaOH solution diluted to 255 mL

8.106   Calculate the concentration, percent or molarity, of the solution when water is added to prepare each of the following solutions:

      a.   25.0 mL of an 18.0 M HCl solution diluted to 500. mL

      b.   50.0 mL of a 15.0% (m/v) NH_4Cl solution diluted to 125 mL

      c.   4.50 mL of an 8.50 M KOH solution diluted to 75.0 mL

8.107   What is the final volume, in milliliters, when 25.0 mL of each of the following solutions is diluted to provide the given concentration?

      a.   10.0% (m/v) HCl solution to give a 2.50% (m/v) HCl solution

      b.   5.00 M HCl solution to give a 1.00 M HCl solution

      c.   6.00 M HCl solution to give a 0.500 M HCl solution

8.108   What is the final volume, in milliliters, when 5.00 mL of each of the following solutions is diluted to provide the given concentration?

      a.   20.0% (m/v) NaOH solution to give a 4.00% (m/v) NaOH solution

      b.   0.600 M NaOH solution to give a 0.100 M NaOH solution

      c.   16.0% (m/v) NaOH solution to give a 2.00% (m/v) NaOH solution

Answers…

8.87   If sodium chloride has a solubility of 36.0 g of NaCl in 100. g of H_2O at 20 °C, how many grams of water are needed to prepare a saturated solution containing 80.0 g of NaCl?

$$Saturated\ Solution = \frac{36.0g\ NaCl}{100g\ H_2O} = \frac{80.0g\ NaCl}{xg\ H_2O}$$

$$x = \frac{80.0\ g\ NaCl * 100g\ H_2O}{36.0\ g\ NaCl}$$

$$x = 222\ g\ H_2O$$

8.88   If the solid NaCl in a saturated solution of NaCl continues to dissolve, why is there no change in the concentration of the NaCl solution?

Because all the NaCl that dissolves is balanced out by the precipitation of the NaCl in solution.

$$NaCl_s \rightleftharpoons Na^+_{(aq)} + Cl^-_{(aq)}$$

8.89   Potassium nitrate has a solubility of 32 g of KNO_3 in 100 g of H_2O at 20°C. State if each of the following forms an unsaturated or saturated solution at 20°C:

   a.   32 g of KNO_3 and 200. g of H_2O

        Unsaturated, 16g/100g – 16 is less than 32

   b.   19 g of KNO_3 and 50. g of H_2O

        Saturated, 38g/100g – 38 is greater than 32

   c.   68 g of KNO_3 and 150. g of H_2O

        Saturated, 45g/100g – 45 is greater than 32

8.90   Potassium fluoride has a solubility of 92 g of KF in 100 g of H_2O at 18°C. State if each of the following forms an unsaturated or saturated solution at 18°C:

   a.   46 g of KF and 100. g of H_2O

        Unsaturated 46g/100g – 46 is less than 92

   b.   46 g of KF and 50. g of H_2O

        Saturated 92g/100g – 92 is equal to 92

   c.   184 g of KF and 150. g of H_2O

        Saturated 123g/100g – 123 is greater than 92

8.91   Indicate whether each of the following ionic compounds is soluble or insoluble in water:

   a. $CuCO_3$

        Insoluble - From solubility rules, all CO_3^{2-} are insoluble

   b. $NaHCO_3$

        Soluble - From solubility rules, all Na^+ are soluble

   c. $Mg_3(PO_4)_2$

        Insoluble - From solubility rules, all PO_4^{3-} are insoluble

   d. $(NH_4)_2SO_4$

        Soluble - From solubility rules, all NH_4^+ are soluble

   e.   FeO

        Insoluble - Solubility rules to the right are useless for this question

   f. $Ca(OH)_2$

        Insoluble - From solubility rules, all OH^- are insoluble

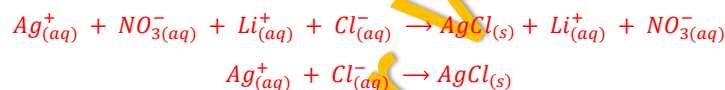| Rule	Applies to	Statement	Exceptions
1	Li^+, Na^+, K^+, NH_4^+	Group IA and ammonium compounds are soluble.	—
2	$C_2H_3O_2^-$, NO_3^-	Acetates and nitrates are soluble.	—
3	Cl^-, Br^-, I^-	Most chlorides, bromides, and iodides are soluble.	$AgCl$, Hg_2Cl_2, $PbCl_2$, $AgBr$, $HgBr_2$, Hg_2Br_2, $PbBr_2$, AgI, HgI_2, Hg_2I_2, PbI_2
4	SO_4^{2-}	Most sulfates are soluble.	$CaSO_4$, $SrSO_4$, $BaSO_4$, Ag_2SO_4, Hg_2SO_4, $PbSO_4$
5	CO_3^{2-}	Most carbonates are insoluble.	Group IA carbonates, $(NH_4)_2CO_3$
6	PO_4^{3-}	Most phosphates are insoluble.	Group IA phosphates, $(NH_4)_3PO_4$
7	S^{2-}	Most sulfides are insoluble.	Group IA sulfides, $(NH_4)_2S$
8	OH^-	Most hydroxides are insoluble	Group IA hydroxides, $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$

8.92   Indicate whether each of the following ionic compounds is soluble or insoluble in water:

a. Na_3PO_4

Soluble - From solubility rules, all Na^+ are soluble

b. $PbBr_2$

Insoluble - From solubility rules, all Pb^{2+} are insoluble

c.   KCl

Soluble - From solubility rules, all K^+ are soluble

d. $(NH_4)_2S$

Soluble - From solubility rules, all NH_4^+ are soluble

e. $MgCO_3$

Insoluble - From solubility rules, all CO_3^{2-} are insoluble

f. $FePO_4$

Insoluble - From solubility rules, all PO_4^{3-} are insoluble

Rule	Applies to	Statement	Exceptions
1	Li^+, Na^+, K^+, NH_4^+	Group IA and ammonium compounds are soluble.	—
2	$C_2H_3O_2^-$, NO_3^-	Acetates and nitrates are soluble.	—
3	Cl^-, Br^-, I^-	Most chlorides, bromides, and iodides are soluble.	$AgCl$, Hg_2Cl_2, $PbCl_2$, $AgBr$, $HgBr_2$, Hg_2Br_2, $PbBr_2$, AgI, HgI_2, Hg_2I_2, PbI_2
4	SO_4^{2-}	Most sulfates are soluble.	$CaSO_4$, $SrSO_4$, $BaSO_4$, Ag_2SO_4, Hg_2SO_4, $PbSO_4$
5	CO_3^{2-}	Most carbonates are insoluble.	Group IA carbonates, $(NH_4)_2CO_3$
6	PO_4^{3-}	Most phosphates are insoluble.	Group IA phosphates, $(NH_4)_3PO_4$
7	S^{2-}	Most sulfides are insoluble.	Group IA sulfides, $(NH_4)_2S$
8	OH^-	Most hydroxides are insoluble.	Group IA hydroxides, $Ca(OH)_2$, $Sr(OH)_2$, $Ba(OH)_2$

8.93   Write the net ionic equation to show the formation of a solid (insoluble salt) when the following solutions are mixed. Write *none* if there is no precipitate.
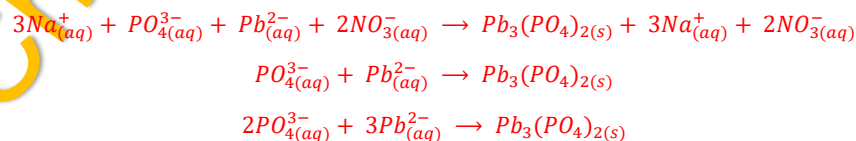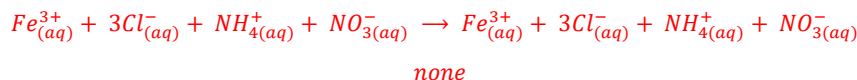
a. $AgNO_{3(aq)}$ and $LiCl_{(aq)}$

$$Ag^+_{(aq)} + NO^-_{3(aq)} + Li^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)} + Li^+_{(aq)} + NO^-_{3(aq)}$$

$$Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$$

b. $NaCl_{(aq)}$ and $KNO_{3(aq)}$

$$Na^+_{(aq)} + Cl^-_{(aq)} + K^+_{(aq)} + NO^-_{3(aq)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)} + K^+_{(aq)} + NO^-_{3(aq)}$$

none

c. $Na_2SO_{4(aq)}$ and $BaCl_{2(aq)}$

$$2Na^+_{(aq)} + SO^{2-}_{4(aq)} + Ba^{2+}_{(aq)} + 2Cl^-_{(aq)} \rightarrow BaSO_{4(s)} + 2Na^+_{(aq)} + 2Cl^-_{(aq)}$$

$$SO^{2-}_{4(aq)} + Ba^{2+}_{(aq)} \rightarrow BaSO_{4(s)}$$

8.94   Write the net ionic equation to show the formation of a solid (insoluble salt) when the following solutions are mixed. Write *none* if there is no precipitate.

a. $Ca(NO_3)_{2(aq)}$ and $Na_2S_{(aq)}$

$$Ca^{2+}_{(aq)} + 2NO^-_{3(aq)} + 2Na^+_{(aq)} + S^{2-}_{(aq)} \rightarrow CaS_{(s)} + 2Na^+_{(aq)} + 2NO^-_{3(aq)}$$

$$Ca^{2+}_{(aq)} + S^{2-}_{(aq)} \rightarrow CaS_{(s)}$$

b. $Na_3PO_{4(aq)}$ and $Pb(NO_3)_{2(aq)}$

$$3Na^+_{(aq)} + PO^{3-}_{4(aq)} + Pb^{2-}_{(aq)} + 2NO^-_{3(aq)} \rightarrow Pb_3(PO_4)_{2(s)} + 3Na^+_{(aq)} + 2NO^-_{3(aq)}$$

$$PO^{3-}_{4(aq)} + Pb^{2-}_{(aq)} \rightarrow Pb_3(PO_4)_{2(s)}$$

$$2PO^{3-}_{4(aq)} + 3Pb^{2-}_{(aq)} \rightarrow Pb_3(PO_4)_{2(s)}$$

c. $FeCl_{3(aq)}$ and $NH_4NO_{3(aq)}$

$$Fe^{3+}_{(aq)} + 3Cl^-_{(aq)} + NH^+_{4(aq)} + NO^-_{3(aq)} \rightarrow Fe^{3+}_{(aq)} + 3Cl^-_{(aq)} + NH^+_{4(aq)} + NO^-_{3(aq)}$$

none

8.95   Calculate the mass percent (m/m) of a solution containing 15.5 g of Na_2SO_4 and 75.5 g of H_2O.

$$Mass\ \% = \frac{Mass\ Solute}{Mass\ Solution} * 100\% = \frac{15.5g\ Na_2SO_4}{15.5g\ Na_2SO_4 + 75.5\ g\ H_2O} * 100\% = 17.0\%$$

8.96   Calculate the mass percent (m/m) of a solution containing 26 g of K_2CO_3 and 724 g of H_2O.

$$Mass\ \% = \frac{Mass\ Solute}{Mass\ Solution} * 100\% = \frac{26g\ K_2CO_3}{26g\ K_2CO_3 + 724\ g\ H_2O} * 100\% = 3.5\%$$

8.97   What is the molarity of a solution containing 8.0 g of NaOH in 400. mL of NaOH solution?

$$Molarity = M = \frac{moles\ solute}{volume\ solution} = \frac{8.0\ g\ NaOH}{400.\ mL} * \frac{1\ mole\ NaOH}{40.0\ g\ NaOH} * \frac{1,000\ mL}{1\ L} = 0.50\ M\ NaOH$$

8.98   What is the molarity of a solution containing 15.6 g of KCl in 274 mL of KCl solution?

$$Molarity = M = \frac{moles\ solute}{volume\ solution} = \frac{15.6\ g\ KCl}{274\ mL} * \frac{1\ mole\ KCl}{74.6\ g\ KCl} * \frac{1,000\ mL}{1\ L} = 0.763\ M\ KCl$$

8.99   How many grams of solute are in each of the following solutions?

$$Volume \xrightarrow{Molar\ Concentration} Moles \xrightarrow{Molecular\ Mass} Mass$$

a.   2.20 L of a 3.00 M $Al(NO_3)_3$ solution

$$2.20\ L\ solution * \frac{3.00\ moles\ Al(NO_3)_3}{1\ Liter\ Solution} * \frac{213\ g\ Al(NO_3)_3}{1\ mole\ Al(NO_3)_3} = 1,410\ g\ Al(NO_3)_3$$

b.   75.0 mL of a 0.500 M $C_6H_{12}O_6$ solution

$$75.0\ mL\ solution * \frac{0.500\ moles\ C_6H_{12}O_6}{1\ Liter\ Solution} * \frac{1\ L}{1,000\ mL} * \frac{180\ g\ C_6H_{12}O_6}{1\ mole\ C_6H_{12}O_6} = 6.75\ g\ C_6H_{12}O_6$$

c.   0.150 L of a 0.320 M NH_4Cl solution

$$0.150\ L\ solution * \frac{0.320\ moles\ NH_4Cl}{1\ Liter\ Solution} * \frac{53.5\ g\ NH_4Cl}{1\ mole\ NH_4Cl} = 2.57\ g\ NH_4Cl$$

8.100   How many grams of solute are in each of the following solutions?

$$Volume \xrightarrow{Molar\ Concentration} Moles \xrightarrow{Molecular\ Mass} Mass$$

a.   428 mL of a 0.450 M Na_2SO_4 solution

$$428\ mL\ solution * \frac{0.450\ moles\ Na_2SO_4}{1\ Liter\ Solution} * \frac{1\ L}{1,000\ mL} * \frac{142\ g\ Na_2SO_4}{1\ mole\ Na_2SO_4} = 27.3\ g\ Na_2SO_4$$

b.   10.5 mL of a 2.50 M $AgNO_3$ solution

$$10.5\ mL\ solution * \frac{2.50\ moles\ AgNO_3}{1\ Liter\ Solution} * \frac{1\ L}{1,000\ mL} * \frac{17\bar{0}\ g\ AgNO_3}{1\ mole\ AgNO_3} = 4.46\ g\ AgNO_3$$

c.   28.4 mL of a 6.00 M H_3PO_4 solution

$$28.4\ mL\ solution * \frac{6.00\ moles\ H_3PO_4}{1\ Liter\ Solution} * \frac{1\ L}{1,000\ mL} * \frac{98.0\ g\ H_3PO_4}{1\ mole\ H_3PO_4} = 16.7\ g\ H_3PO_4$$

8.101   A patient receives all her nutrition from fluids given through the vena cava. Every 12 h, 750 mL of a solution that is 4% (m/v) amino acids (protein) and 25% (m/v) glucose (carbohydrate) is given along with 500 mL of a 10% (m/v) lipid (fat) solution.

a.   In 1 day, how many grams of amino acids, glucose, and lipid are given to the patient?

$$\frac{0.04\ grams\ protein}{1\ ml\ solution} * \frac{750\ mL}{12\ hours} * 24\ hours = 60\ grams\ protein$$

$$\frac{0.25\ grams\ carbohydrates}{1\ ml\ solution} * \frac{750\ mL}{12\ hours} * 24\ hours = 380\ grams\ carbohydrates$$

$$\frac{0.10\ grams\ fat}{1\ ml\ solution} * \frac{500\ mL}{12\ hours} * 24\ hours = 1\bar{0}0\ grams\ fat$$

a. How many kilocalories does she obtain in 1 day? (Given that: Carbohydrate 4 kcal/g, Fat 9 kcal/g, Protein 4 kcal/g)

$$60g \; protien * \frac{4 \; kcal}{g \; protein} = 200 \; kcal$$

$$380g \; carbohydrate * \frac{4 \; kcal}{g \; carbohydrate} = 2000 \; kcal$$

$$1\bar{0}0 \; g \; fat * \frac{9 \; kcal}{g \; fat} = 900 \; kcal$$

$$\begin{array}{r} 200 \; kcal \\ 2000 \; kcal \\ + \quad 900 \; kcal \\ \hline 3000 \; kcal \end{array}$$

8.102 A patient receives an intravenous solution of a 5.0% (m/v) glucose solution. How many liters of the glucose solution would the patient be given to obtain 75 g of glucose?

$$75 \; g \; glucose * \frac{1 \; ml \; solution}{0.050 \; g \; glucose} * \frac{1 \; L}{1,000 \; ml} = 1.5 \; L \; glucose \; solution$$

8.103 How many milliliters of a 12% (v/v) propyl alcohol solution would you need to obtain 4.5 mL of propyl alcohol?

$$4.5 \; mL \; propyl \; alcohol * \frac{1 \; ml \; solution}{0.12 \; ml} = 38 \; ml \; solution$$

8.104 An 80-proof brandy is 40.0% (v/v) ethyl alcohol. The "proof" is twice the percent concentration of alcohol in the beverage. How many milliliters of alcohol are present in 750 mL of brandy?

$$750 \; mL \; brandy \; solution * \frac{0.400 \; ml \; ethyl \; alcohol}{1 \; ml \; solution} = 3\bar{0}0 \; ml \; solution$$

8.105 Calculate the concentration, percent or molarity, of the solution when water is added to prepare each of the following solutions:

a. 25.0 mL of a 0.200 M NaBr solution diluted to 50.0 mL

$$M = \frac{moles \; solute}{liters \; solution} * \frac{0.200 \; M \; NaBr * 25.0 \; mL * \; ^{1 \; L}/_{1,000 \; mL}}{50.0 \; mL \; * \; ^{1 \; L}/_{1,000 \; mL}} = 0.100 \; M \; NaBr$$

b. 15.0 mL of a 12.0% (m/v) K$_2$SO$_4$ solution diluted to 40.0 mL

$$\frac{0.120 \; g \; K_2SO_4}{1 \; ml \; solution} * \frac{15.0 \; ml}{40.0 \; ml} = 4.5\% \; K_2SO_4$$

c. 75.0 mL of a 6.00 M NaOH solution diluted to 255 mL

$$M = \frac{moles \; solute}{liters \; solution} * \frac{6.00 \; M \; NaOH * 75.0 \; mL * \; ^{1 \; L}/_{1,000 \; mL}}{255 \; mL \; * \; ^{1 \; L}/_{1,000 \; mL}} = 1.76 \; M \; NaOH$$

8.106 Calculate the concentration, percent or molarity, of the solution when water is added to prepare each of the following solutions:

a. 25.0 mL of an 18.0 M HCl solution diluted to 500. mL

$$M = \frac{moles \; solute}{liters \; solution} * \frac{18.0 \; M \; HCl * 25.0 \; mL * \; ^{1 \; L}/_{1,000 \; mL}}{5\overline{00} \; mL \; * \; ^{1 \; L}/_{1,000 \; mL}} = 0.900 \; M \; HCl$$

b. 50.0 mL of a 15.0% (m/v) NH$_4$Cl solution diluted to 125 mL

$$\frac{0.150 \; g \; NH_4Cl}{1 \; ml \; solution} * \frac{50.0 \; ml}{125 \; ml} = 6.00\% \; NH_4Cl$$

    c.   4.50 mL of an 8.50 M KOH solution diluted to 75.0 mL

$$M = \frac{moles\ solute}{liters\ solution} * \frac{8.50\ M\ KOH * 4.50\ mL * \frac{1\ L}{1,000\ mL}}{75.0\ mL\ * \frac{1\ L}{1,000\ mL}} = 0.510\ M\ KOH$$

8.107   What is the final volume, in milliliters, when 25.0 mL of each of the following solutions is diluted to provide the given concentration?

    a.   10.0% (m/v) HCl solution to give a 2.50% (m/v) HCl solution

$$M_1V_1 = M_2V_2$$

$$\frac{M_1V_1}{M_2} = V_2$$

$$\frac{0.100\ m/v}{0.0250\ m/v} * 25.0ml = 1\overline{00}\ ml$$

    b.   5.00 M HCl solution to give a 1.00 M HCl solution

$$\frac{5.00M}{1.00\ M} * 25.0ml = 125\ ml$$

    c.   6.00 M HCl solution to give a 0.500 M HCl solution

$$\frac{6.00\ M}{0.500\ M} * 25.0ml = 3\overline{00}\ ml$$

8.108   What is the final volume, in milliliters, when 5.00 mL of each of the following solutions is diluted to provide the given concentration?

    a.   20.0% (m/v) NaOH solution to give a 4.00% (m/v) NaOH solution

$$\frac{0.200\ m/v}{0.040\ m/v} * 5.00\ ml = 25.0\ ml$$

    b.   0.600 M NaOH solution to give a 0.100 M NaOH solution

$$\frac{0.600M}{0.100\ M} * 5.00\ ml = 30.0\ ml$$

    c.   16.0% (m/v) NaOH solution to give a 2.00% (m/v) NaOH solution

$$\frac{0.160\ m/v}{0.0200\ m/v} * 5.00ml = 40.0\ ml$$