Chemistry H

Exercise 12.3d(H)

Solution Dilution – Answers

Name: _____

Date: _____ Per: _____

While solutions are often made by dissolving a calculated mass (representing a certain number of moles) of solute in a solvent to create a desired volume of solution, another technique for making a solution involves taking a stock solution of higher concentration and diluting it to the desired concentration. The diluted solution is made by adding additional solvent to a measured amount of stock solution. This retains the original amount of solute but increases the solvent to create a concentration less than that of the original stock solution. *For example, 1 liter of 2 M solution contains 2 moles of solute in 1 L of solution. Adding an additional liter of solvent creates a solution where there are still 2 moles of solute, but there are now 2 L of solution creating a ratio of 2mol/ 2liter (reducing the fraction: 1mol/ 1liter or 1M).*

The calculation necessary to find the amount of stock solution needed for dilution is represented by:

$$\text{molarity}_1 \times \text{volume}_1 = \text{molarity}_2 \times \text{volume}_2 \quad \text{or} \quad \boldsymbol{M_1V_1 = M_2V_2}$$

Example: 560. mL of water is added to 340. mL of 0.500 M NaBr solution. What is the new concentration of the solution?

M_1 = 0.500 mol/liter
V_1 = 340. mL
M_2 = ?
V_2 = 900. mL = (560. mL + 340. mL)

$$\boldsymbol{M_1V_1 = M_2V_2}$$

$$\boldsymbol{M_2} = \frac{\boldsymbol{M_1V_1}}{\boldsymbol{V_2}} = \frac{0.500\ M \bullet 340.\ \text{mL}}{900.\ \text{mL}} = 0.1888\ M$$

0.0189*M*

DIRECTIONS: Answer the following in the space provided.

1. A stock solution of sodium sulfate, Na_2SO_4 has a concentration of 1.00 *M*. The volume of this solution is 50.0 mL. What volume of a 0.250 *M* solution could be made from the stock solution?

M_1 = 1.00 mol/liter
V_1 = 50.0 mL
M_2 = 0.250 mol/liter
V_2 = ?

$$\boldsymbol{M_1V_1 = M_2V_2}$$

$$\boldsymbol{V_2} = \frac{\boldsymbol{M_1V_1}}{\boldsymbol{M_2}} = \frac{1.00\ M \bullet 50.0\ \text{mL}}{0.250\ M} = 200.\ \text{mL}$$

200. mL

2. 2.00 mL of a 0.75 *M* solution of potassium permanganate, K_2MnO_4 solution is used to make a 500.00 mL solution. What is the concentration of the new solution?

M_1 = 0.75 mol/liter
V_1 = 2.00 mL
M_2 = ?
V_2 = 500.00 mL

$$\boldsymbol{M_1V_1 = M_2V_2}$$

$$\boldsymbol{M_2} = \frac{\boldsymbol{M_1V_1}}{\boldsymbol{V_2}} = \frac{0.75\ M \bullet 2.00\ \text{mL}}{500.00\ \text{mL}} = 3.0 \times 10^{-3}\ M$$

$3.0 \times 10^{-3}\ M$

3. A hydrochloric acid solution, HCl has a concentration of 12.1 *M*. A 41.2 mL sample is used to make a more dilute solution. If the new solution has a concentration of 0.5 *M*, determine the volume of the solution.

M_1 = 12.1 mol/liter
V_1 = 41.2 mL
M_2 = 0.5 mol/liter
V_2 = ?

$$\boldsymbol{M_1V_1 = M_2V_2}$$

$$\boldsymbol{V_2} = \frac{\boldsymbol{M_1V_1}}{\boldsymbol{M_2}} = \frac{12.1\ M \bullet 41.2\ \text{mL}}{0.5\ M} = 997.04\ mL$$

1000 mL

4. 250. mL of 0.10 *M* lithium acetate solution is diluted to a volume of 750 mL. What is the concentration of the diluted solution?

M_1 = 0.10 mol/liter
V_1 = 250. mL
M_2 = ?
V_2 = 750 mL

$$\boldsymbol{M_1V_1 = M_2V_2}$$

$$\boldsymbol{M_2} = \frac{\boldsymbol{M_1V_1}}{\boldsymbol{V_2}} = \frac{0.10\ M \bullet 250.\ \text{mL}}{750\ \text{mL}} = 0.03333\ M$$

0.033 *M*

5. 750. mL of 0.50 *M* sodium chloride solution is left uncovered on a windowsill and 150. mL of the solvent evaporates, what will the new concentration of the sodium chloride solution be?

M_1 = 0.50 mol/liter
V_1 = 750. mL
M_2 = ?
V_2 = 750. mL – 150. mL = 600. mL

$$\boldsymbol{M_1V_1 = M_2V_2}$$

$$\boldsymbol{M_2} = \frac{\boldsymbol{M_1V_1}}{\boldsymbol{V_2}} = \frac{0.50\ M \bullet 750.\ \text{mL}}{600.\ \text{mL}} = 0.625\ M$$

0.62 *M*

Answers: 1) 200. mL 2) 3.0×10^{-3} *M* 3) 1000 mL or 1 L 4) 0.033 *M* 5) 0.62 *M* 6) 900 mL 7) 0.050 *M* 8) 95 mL 9) 18 *M* 10) 6.2 mL $AgNO_3$

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6. How much water would have to be added to the concentrated solution in Problem 5 to produce a solution with a concentration of 0.25 *M* ?

M_1 = 0.62 mol/liter
V_1 = 600. mL
M_2 = 0.25 mol/liter
V_2 = ?

$M_1V_1 = M_2V_2$

$$V_2 = \frac{M_1V_1}{M_2} = \frac{0.625\ M \cdot 600.\ mL}{0.25\ M} = 1500\ mL$$

1500 mL (total volume) – 600. mL (starting volume) = 900 mL **900 mL**

7. A 0.50 *M* solution of sodium thiosulfate, $Na_2S_2O_3$ is used to create a more dilute solution. If 250 mL of the concentrated solution is diluted to a volume of 2.5 L, determine the concentration of the new solution.

M_1 = 0.50 mol/liter
V_1 = 250 mL
M_2 = ?
V_2 = 2.5 L (2500 mL)

$M_1V_1 = M_2V_2$

$$M_2 = \frac{M_1V_1}{V_2} = \frac{0.50\ M \cdot 250\ mL}{2500\ mL} = 0.050\ M$$

0.050 *M*

8. What volume of concentrated nitric acid, HNO_3 (15.8 *M*) should be added to water to form 500.0 mL of a 3.0 *M* nitric acid solution?

M_1 = 15.8 mol/liter
V_1 = ?
M_2 = 3.0 mol/liter
V_2 = 500.0 mL

$M_1V_1 = M_2V_2$

$$V_1 = \frac{M_2V_2}{M_1} = \frac{3.0\ M \cdot 500.0\ mL}{15.8\ M} = 94.93\ mL$$

95 mL

9. A sample of 7.0 mL of concentrated sulfuric acid, H_2SO_4 is used to make 250. mL of a 0.50 *M* sulfuric acid solution. What was the initial concentration of the sulfuric acid?

M_1 = ?
V_1 = 7.0 mL
M_2 = 0.50 *M*
V_2 = 250. mL

$M_1V_1 = M_2V_2$

$$M_1 = \frac{M_2V_2}{V_1} = \frac{0.50\ M \cdot 250.\ mL}{7.0\ mL} = 17.87\ M$$

18 *M*

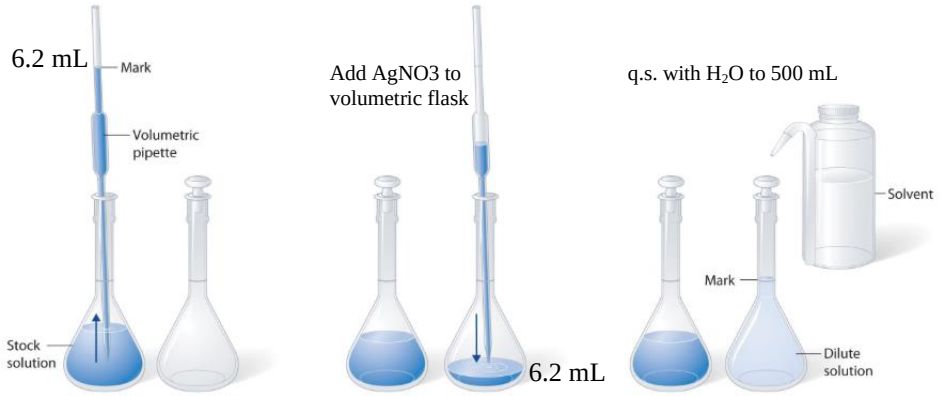
10. An instructor needs to make 500. mL of a silver nitrate solution that has a concentration of 0.010 *M* using a 0.80 *M* stock solution. *(Available equipment includes the stock bottle of $AgNO_3$, a 10 mL graduated pipet, a 500 mL volumetric flask and a wash bottle filled with distilled water.)* Perform the calculations required and draw a diagram representing the steps required to make this solution.

M_1 = 0.80 mol/liter
V_1 = ?
M_2 = 0.010 mol/liter
V_2 = 500.0 mL

$M_1V_1 = M_2V_2$

$$V_1 = \frac{M_2V_2}{M_1} = \frac{0.010\ M \cdot 500.0\ mL}{0.80\ M} = 6.25\ mL$$

6.2 mL



Answers: 1) 200. mL 2) 3.0 x 10^{-3} *M* 3) 1000 mL or 1 L 4) 0.033 *M* 5) 0.62 *M* 6) 900 mL 7) 0.050 *M* 8) 95 mL 9) 18 *M* 10) 6.2 mL $AgNO_3$