

*Practice Questions Section 2.4*

## Dilutions and Standard Solutions

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1. An experiment requires 2.00 L of 0.200 M hydrochloric acid (HCl) solution. What volume of concentrated hydrochloric acid, containing 11.9 M hydrogen chloride, is needed?
2. A chemist adds water to 120 mL of a 6.0 M solution of NaOH until the final volume is 2.0 L. What is the molarity of the resulting solution?
3. What concentration results when 150 mL of a 0.36 M solution of magnesium sulfate, MgSO<sub>4</sub>, are added to enough water to give a final solution volume of 750 mL?
4. What concentration results when 150 mL of a 0.36 M solution of magnesium sulfate, MgSO<sub>4</sub>, are added to 750 mL of water?
5. Describe how you would prepare 250.0 mL of a 1.00 M NaOH solution.

## Practice Questions Section 2.4

**Dilutions and Standard Solutions****Answers**

1. An experiment requires 2.00 L of 0.200 M hydrochloric acid (HCl) solution. What volume of concentrated hydrochloric acid, containing 11.9 M hydrogen chloride, is needed?

**Solution:**

Identify your variables:

$$M_1 = 11.9 \text{ M} \qquad M_2 = 0.200 \text{ M}$$

$$V_1 = ? \qquad V_2 = 2.00 \text{ L}$$

Set up and solve the equation for the unknown:

$$\begin{aligned} M_1 V_1 &= M_2 V_2 \\ 11.9 \times V_1 &= 0.200 \times 2.00 \\ V_1 &= \frac{0.200 \times 2.00}{11.9} \\ &= \mathbf{0.0336 \text{ L}} \\ &\text{or} \quad \mathbf{33.6 \text{ mL}} \end{aligned}$$

**Answer: 33.6 mL of concentrated HCl is required.**

2. A chemist adds water to 120 mL of a 6.0 M solution of NaOH until the final volume is 2.0 L. What is the molarity of the resulting solution?

**Solution:**

Once again we have a dilution question. Begin by identifying your variables.  
Be careful to convert mL to L so you are working with the same unit of volume!

$$M_1 = 6.0 \text{ M} \qquad M_2 = ?$$

$$V_1 = 120 \text{ mL} = 0.12 \text{ L} \qquad V_2 = 2.0 \text{ L}$$

Set up and solve the equation for the unknown:

$$\begin{aligned} M_1 V_1 &= M_2 V_2 \\ 6.0 \times 0.12 &= M_2 \times 2.0 \\ M_2 &= \frac{6.0 \times 0.12}{2.0} \\ &= \mathbf{0.36 \text{ M}} \end{aligned}$$

**Answer: The concentration of the final solution is 0.36 M.**

3. What concentration results when 150 mL of a 0.36 M solution of magnesium sulfate,  $\text{MgSO}_4$ , are added to enough water to give a final solution volume of 750 mL?

**Solution:**

Begin by identifying your variables. We can leave both volumes in mL, rather than convert both to L:

$$\begin{array}{ll} M_1 = 0.36 \text{ M} & M_2 = ? \\ V_1 = 150 \text{ mL} & V_2 = 750 \text{ mL} \end{array}$$

Set up and solve the equation for the unknown:

$$\begin{array}{rcl} M_1 V_1 & = & M_2 V_2 \\ 0.36 \times 150 & = & M_2 \times 750 \\ M_2 & = & \frac{0.36 \times 150}{750} \\ & = & \mathbf{0.072 \text{ M}} \end{array}$$

**Answer: The final concentration of the magnesium sulfate solution is 0.072 M**

4. What concentration results when 150 mL of a 0.36 M solution of magnesium sulfate,  $\text{MgSO}_4$ , are added to 750 mL of water?

**Solution:**

**BE CAREFUL!** Notice that this question seems to be the same as the previous question, but there is an important difference.

In this example, we have added 750 mL of water, not brought the total volume of the solution to 750 mL.

Adding the 750 mL of water to the existing 150 mL of solution will give us a total solution volume of  $750 + 150 = 900$  mL of solution. **THIS** is the value we will need to use in our dilution formula!

$$\begin{array}{ll} M_1 = 0.36 \text{ M} & M_2 = ? \\ V_1 = 150 \text{ mL} & V_2 = \mathbf{900 \text{ mL}} \end{array}$$

Set up and solve the equation for the unknown:

$$\begin{array}{rcl} M_1 V_1 & = & M_2 V_2 \\ 0.36 \times 150 & = & M_2 \times 900 \\ M_2 & = & \frac{0.36 \times 150}{900} \\ & = & \mathbf{0.060 \text{ M}} \end{array}$$

**Answer: The concentration of the magnesium sulfate solution will be 0.060 M.**

5. Describe how you would prepare 250.0 mL of a 1.00 M NaOH solution.

**Solution:**

We must first determine the mass of NaOH that will be needed to prepare 250.0 mL (0.250 L) of a 1.00 M solution. The molar mass of NaOH is  $40.0\text{g}\cdot\text{mol}^{-1}$ :

$$\text{g} = \frac{40.0\text{g}}{\text{mol}} \times \frac{1.00\text{mol}}{\text{L}} \times 0.250\text{L} = 10.0\text{g}$$

**Answer:** To prepare the standard solution we will carefully measure out 10.0 g of NaOH and dissolve it in some water (perhaps 100 mL of water). We pour this solution into a 250 mL volumetric flask and add just enough water to reach the calibration mark on the flask.