Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Student Exploration:** **Solubility and Temperature**

**Vocabulary:** concentration, dissolve, homogeneous mixture, solubility, solubility curve, solute, solution, solvent

**Prior Knowledge Questions** (Do these BEFORE using the Gizmo.)

1. What happens when you stir a spoonful of sugar into hot water? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

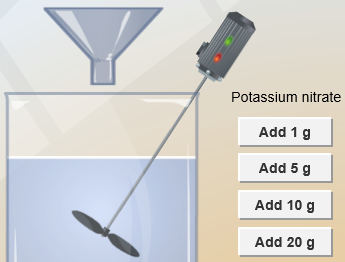
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1. When sugar or another substance is **dissolved** in water, it disappears from view and forms a **homogeneous mixture** with the water, also called a **solution**.

If you can’t see the sugar, how can you tell that it is there? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. Does sugar dissolve more easily in hot water or cold water? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



**Gizmo Warm-up**

A solution generally consists of two parts, a **solute** that is dissolved and a **solvent** that the solute is dissolved into. For example, sugar is a solute that is dissolved into the solvent water. In the *Solubility and Temperature* Gizmo, you will study how temperature affects how much solute will dissolve in a solution.

To begin, check that **Potassium nitrate** is selected and the **Temp.** of the water is 20 °C. Click **OK**.

1. In this solution, what is the solute? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ What is the solvent? \_\_\_\_\_\_\_\_\_\_\_
2. Click **Add 10 g** to mix 10 g of potassium nitrate into the water.
   1. Did all of the potassium nitrate dissolve? \_\_\_\_\_\_\_\_\_\_\_
   2. How can you tell? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| **Activity A:**  **Solubility** | Get the Gizmo ready:   * Click **Reset**. * Check that the **Temp.** is 20 °C and that **Potassium nitrate** is selected. | 384SE2 |

**Question: How do we find how much solute can be dissolved in a solvent?**

1. Observe: Click **OK**. Click **Add 20 g**, and observe the potassium nitrate being mixed into the solution. On the right, select the BAR CHART tab and turn on **Show numerical value**. The bars show how much solute has been added and how much has piled up on the bottom.

Did all of the solute dissolve? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Calculate: The **concentration** of a solution is equal to the mass of solute divided by the volume of solvent. Units of concentration are grams per 100 milliliters (g/100 mL, or g/dL).

What is the concentration of this solution? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Experiment: Click **Add 20 g** again.
   * 1. Did all of the solute dissolve? Explain how you can tell. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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* + 1. Based on the amount of solute added and the amount piled up on the bottom, how many grams of solute dissolved in the water? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    2. The **solubility** of the solution is equal to the maximum concentration of the solute.

What is the solubility of potassium nitrate in 20 °C water? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Experiment: Click **Reset**, and select **Sodium chloride**. With the **Temp.** still set to 20 °C, click **OK**. Add sodium chloride to the beaker until it starts piling up at the bottom.
   * 1. How much sodium chloride did you add? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     2. How much sodium chloride piled up at the bottom? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     3. How much sodium chloride dissolved in the water? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     4. What is the solubility of sodium chloride in 20 °C water? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Apply: At 20 °C, how much sodium chloride could be dissolved into 2 L of water? \_\_\_\_\_\_\_\_

How much potassium nitrate could be dissolved into the same amount of water? \_\_\_\_\_\_\_\_\_

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| **Activity B:**  **Solubility and temperature** | Get the Gizmo ready:   * Click **Reset**. * Set the **Temp.** to 10 °C. * Select **Potassium nitrate**, and click **OK**. | 384SE3 |

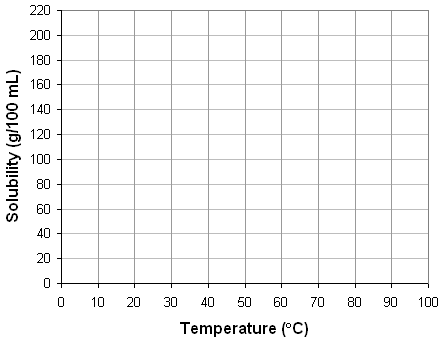
**Question: How does temperature of the solvent affect solubility?**

1. Predict: Based on your own experience, how do you expect temperature to affect solubility?

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1. Gather data: Use the Gizmo to measure the solubility of potassium nitrate at each temperature given in the table below. Then, graph the resulting **solubility curve** at right.



|  |  |
| --- | --- |
| **Temperature** | **Solubility  (g/100 mL)** |
| 10 °C |  |
| 20 °C |  |
| 30 °C |  |
| 40 °C |  |
| 50 °C |  |
| 60 °C |  |
| 70 °C |  |
| 80 °C |  |
| 90 °C |  |

1. Infer: Based on your graph, what would you predict is the solubility of potassium nitrate at a temperature of 5 °C? 95 °C? Check your 5 °C prediction with the Gizmo.

5 °C predicted solubility: \_\_\_\_\_\_\_\_\_\_\_\_ 5 °C actual solubility: \_\_\_\_\_\_\_\_\_\_\_\_

95 °C predicted solubility: \_\_\_\_\_\_\_\_\_\_ (Impossible to find actual solubility using Gizmo.)

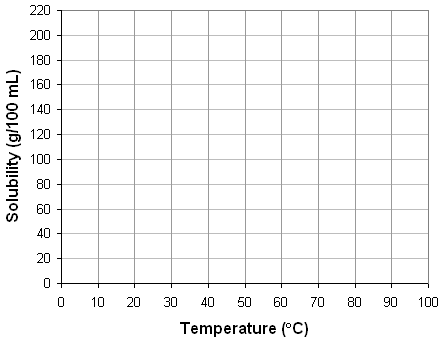
1. Explain: Potassium nitrate absorbs a large amount of heat energy from the water as it dissolves. How does this explain the solubility curve you graphed for potassium nitrate?

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**(Activity B continued on next page)Activity B (continued from previous page)**

1. Gather data: Now use the Gizmo to measure the solubility of sodium chloride at each temperature given in the table below. Then, graph the solubility curve of sodium chloride.



|  |  |
| --- | --- |
| **Temperature** | **Solubility  (g/100 mL)** |
| 10 °C |  |
| 20 °C |  |
| 30 °C |  |
| 40 °C |  |
| 50 °C |  |
| 60 °C |  |
| 70 °C |  |
| 80 °C |  |
| 90 °C |  |

1. Infer: Based on your graph, what would you predict is the solubility of sodium chloride at a temperature of 5 °C? 95 °C? Check your predictions with the Gizmo.

5 °C predicted solubility: \_\_\_\_\_\_\_\_\_\_\_\_ 5 °C actual solubility: \_\_\_\_\_\_\_\_\_\_\_\_\_\_

95 °C predicted solubility: \_\_\_\_\_\_\_\_\_\_\_\_ 95 °C actual solubility: \_\_\_\_\_\_\_\_\_\_\_\_\_

1. Compare: How does the solubility curve for sodium chloride compare with the solubility curve for potassium nitrate?

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1. Infer: Potassium nitrate absorbs a lot of heat from water as it dissolves. Based on its solubility curve, what can you infer about how much heat sodium chloride absorbs?

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1. Think and discuss: What do you think the solubility curve would look like for sugar? Explain.

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