Solubility

- Let the tap water run for two minutes in order to make sure that you get as cold a water temperature as possible. Add 250 mL of water to a glass. Add sugar to your water, ¼ teaspoon at a time. Record how much sugar you can add until it does not dissolve anymore. Repeat the experiment with the hottest possible water you can get from the hot water tap. Note the amount of sugar that dissolved. Now, predict how much sugar will dissolve if you use a solution of 125 mL of cold water mixed with 125 mL of hot water. Repeat the experiment with this lukewarm solution. According to your results, will the graph be linear or exponential?

Solubility is a characteristic of a solute that describes its ability to **dissolve** in a given solvent. Quantitatively, solubility describes the maximum amount of solute that will dissolve in a given quantity of solvent at a given temperature. Any extra solute that is added after the maximum is reached will no longer dissolve.

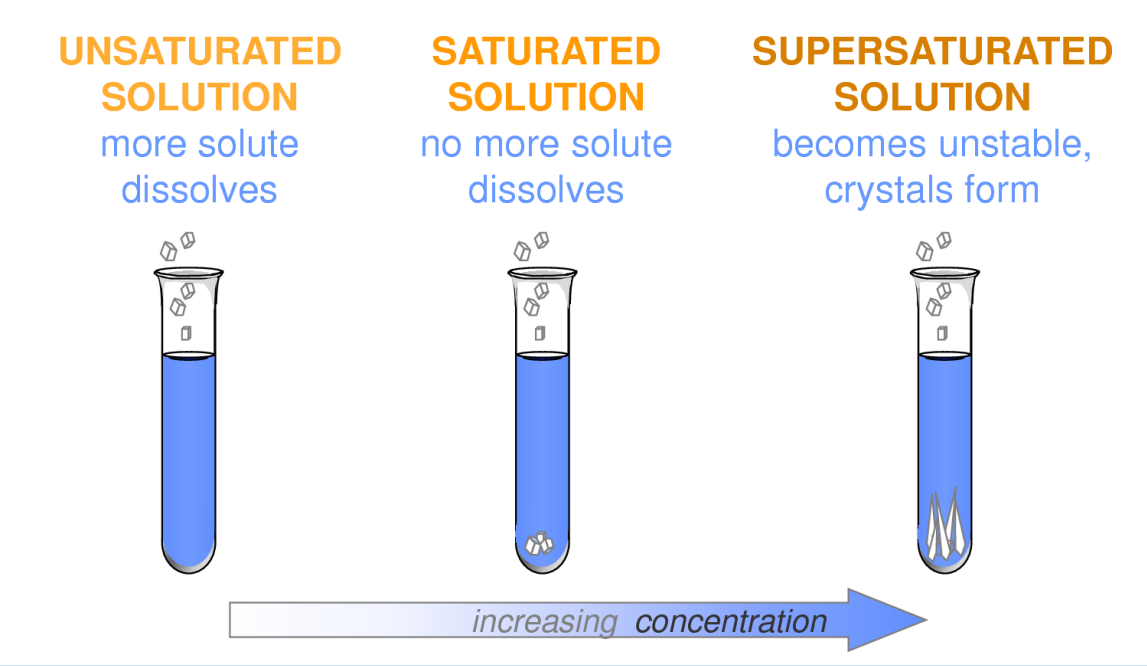
Typically, solubility is quantified as the maximum mass of solute that can be dissolved in 100 g of water at a given temperature.

Typically solubility is quantified as the maximum mass of solute that can be dissolved in 100 g of water at a given temperature.

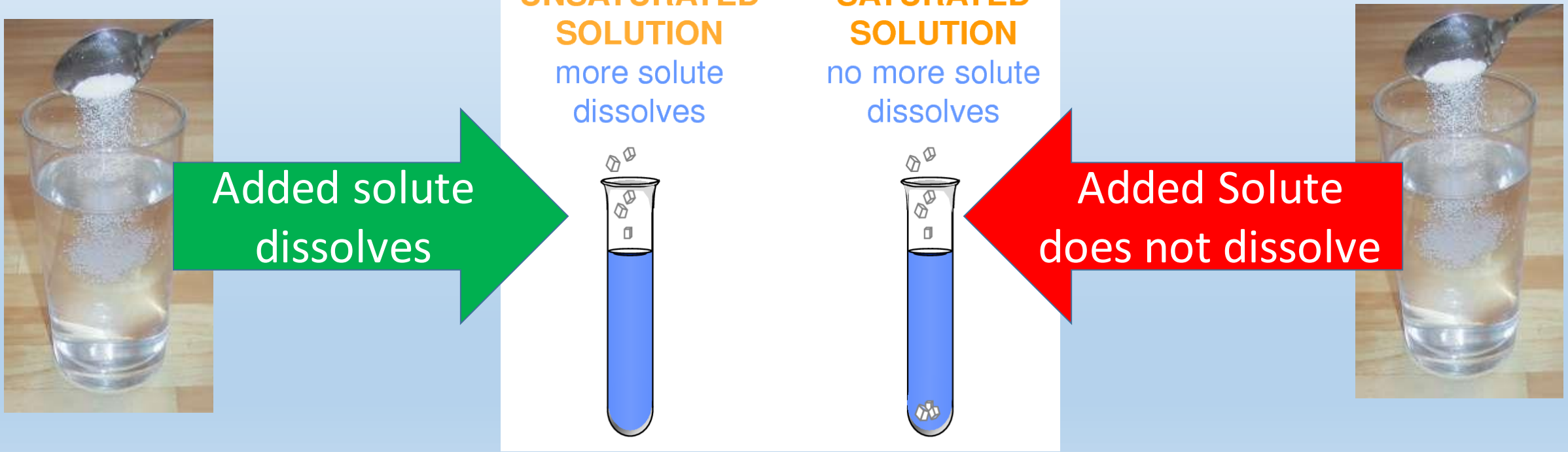
Compound	Solubility (g/100 g of H_2O at 20 ˚C)
Calcium Carbonate - $CaCO_3$	0.0
Sodium Chloride - NaCl	36.0
Sucrose - $C_{12}H_{22}O_{11}$	204.0

This table shows that calcium is insoluble (does not dissolve) in water at 20 ˚C, while sucrose is very soluble in water at 20 ˚C as a maximum of 204.0 g of sucrose will dissolve in 100 g of water at that temperature.

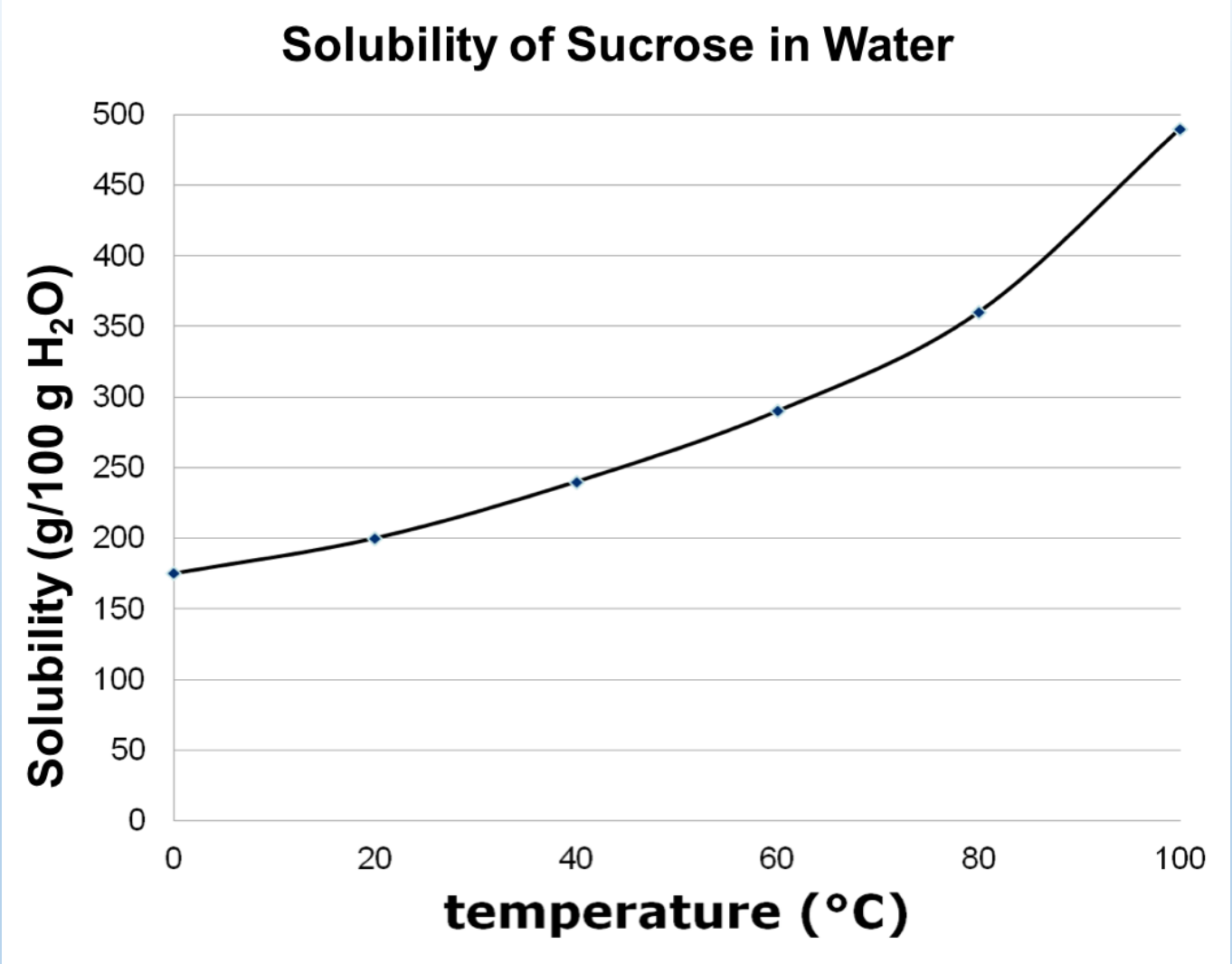
A solution that contains less than the maximum amount of solute that will dissolve is called an **unsaturated solution**. As more solute is added the solution approaches the maximum amount of solute that will dissolve. When the solution contains the maximum amount of solute in it that can dissolve is called a **saturated solution**. A solution with greater than the maximum amount of solute dissolved in it is called a supersaturated solution.



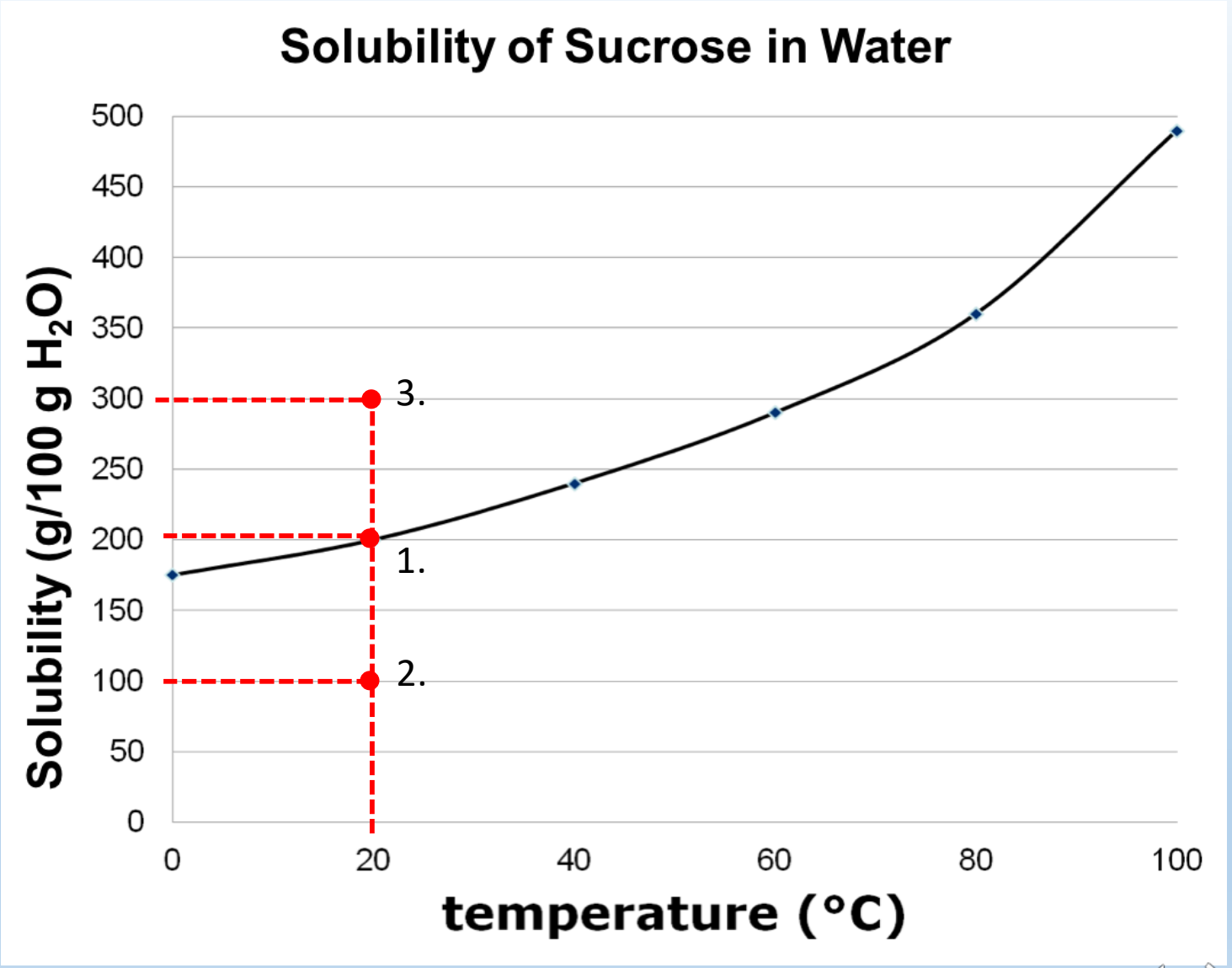
To test the saturation level of a solution, you can add more solute to the solvent. If the added solute dissolves then the solution is unsaturated. If the added solute does not dissolve then the solution is saturated.



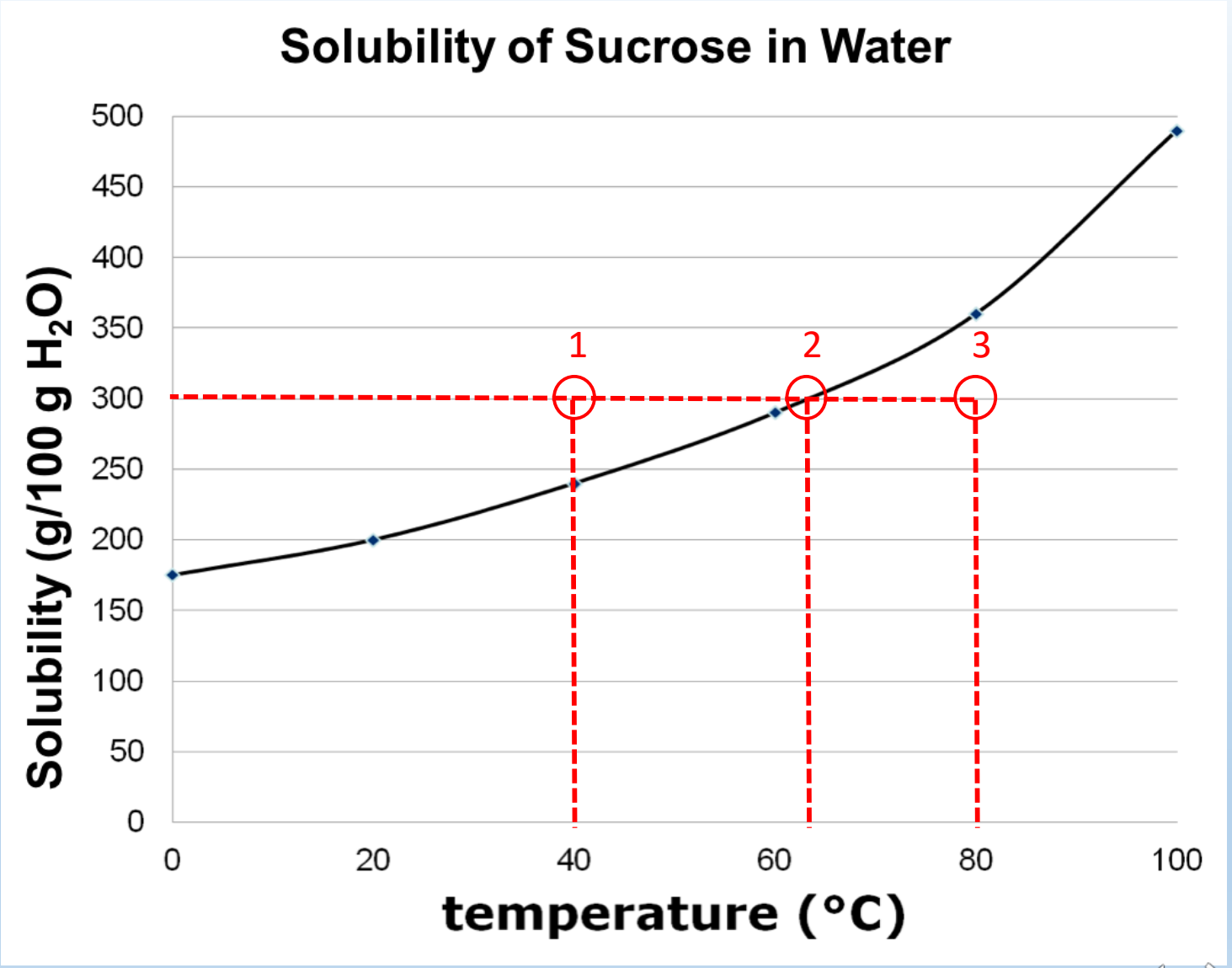
Solubility is a measure of the amount of solute that can be dissolved in a given solvent at a given temperature. As the temperature of the solvent changes, so does the ability of the solute to dissolve. This relationship can be represented graphically by using a **solubility curve.** In the graph the solubility of sucrose increases as the temperature of the water increases. Therefore, more sucrose will dissolve in 100 g of water as the temperature goes up.



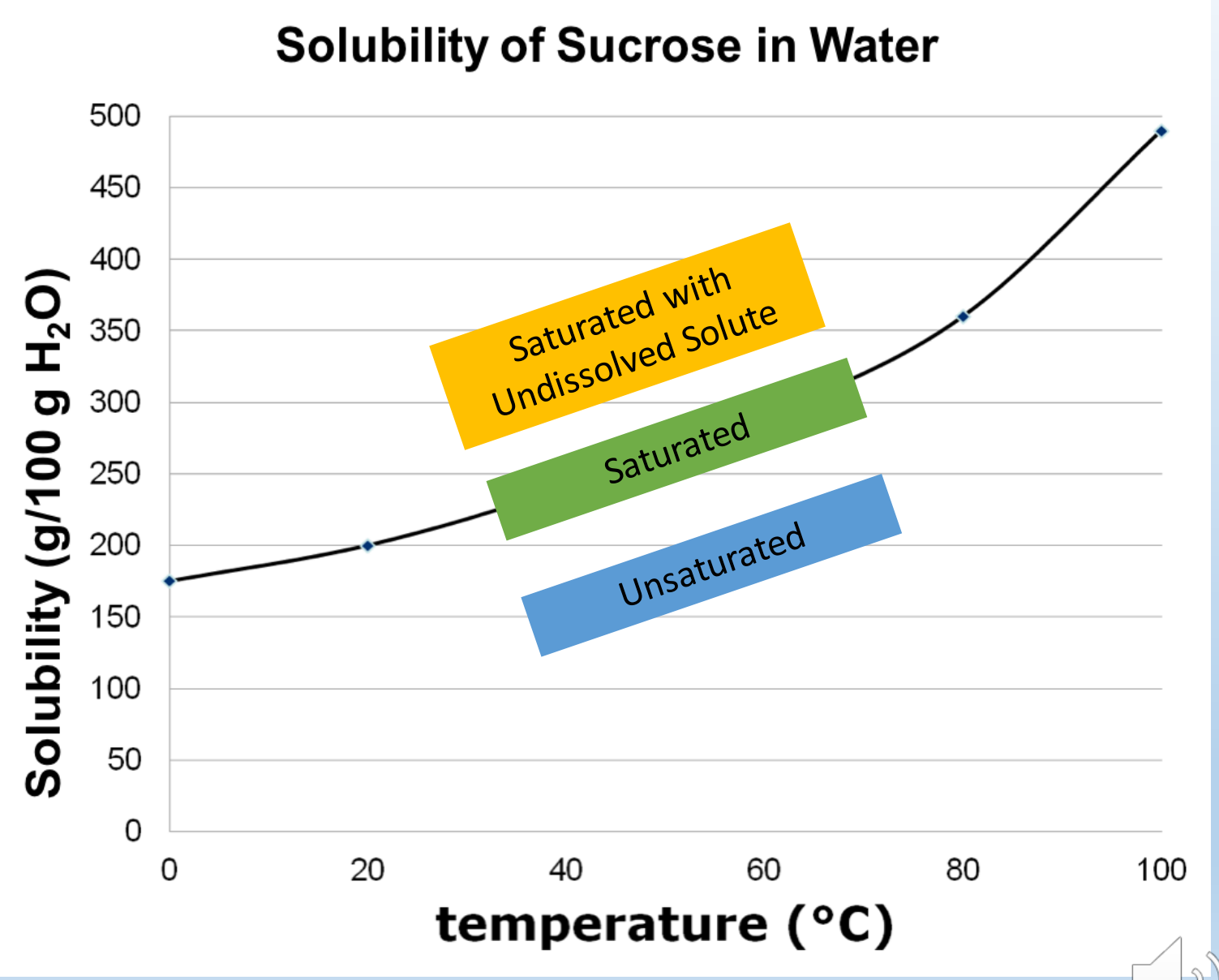
1. 200 g of sucrose will dissolve in 100 g of water at 20 ˚C. This solution will be saturated.
2. If 100 g of sucrose is added to 100 g of water at 20 ˚C, all of it will dissolve and the solution will be unsaturated.
3. If 300 g of sucrose are added to 100 g of water at at 20 ˚C not all of the solute will dissolve. The solution is saturated.



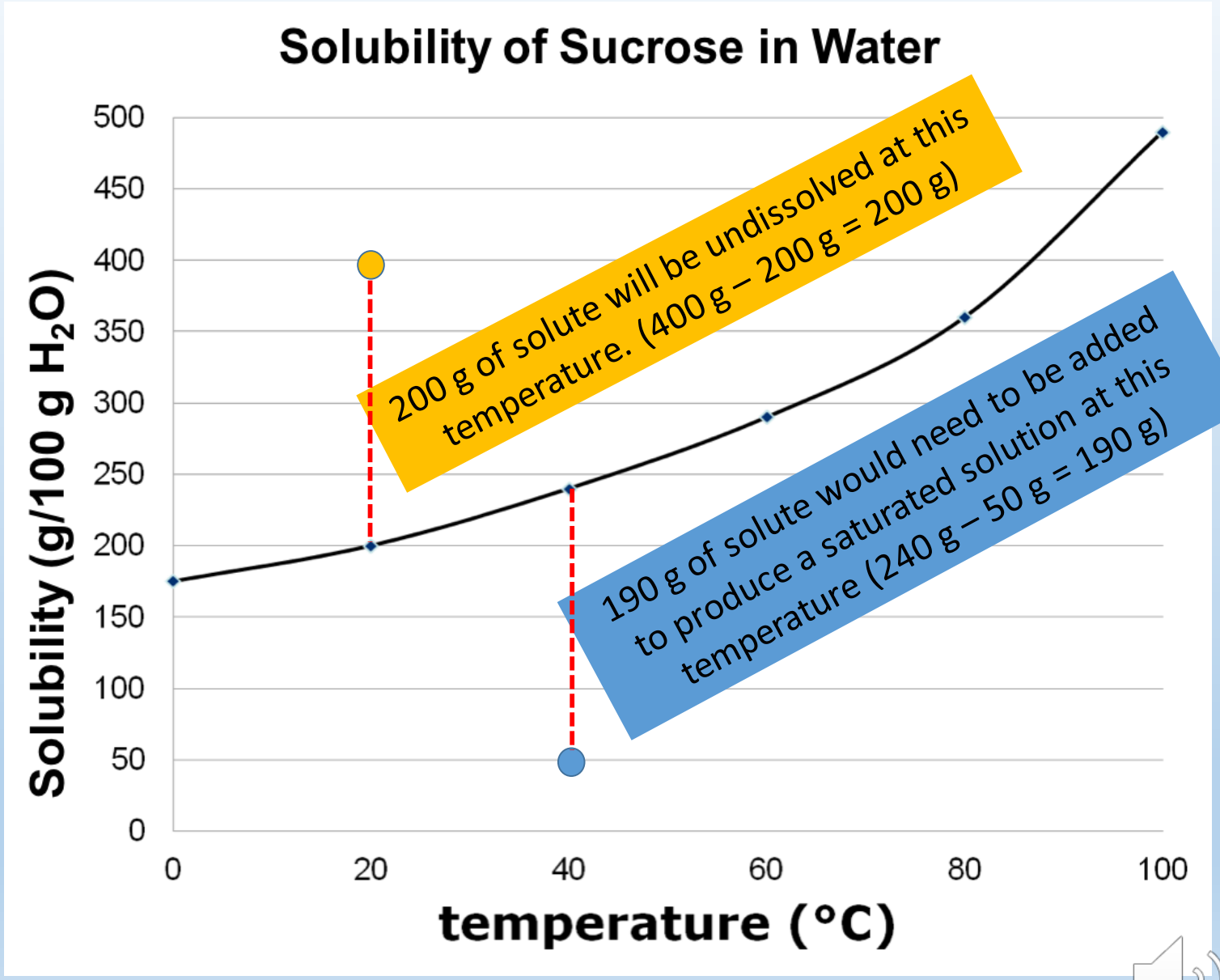
1. At 40 ˚C, a solution of 300 g of sucrose would be saturated with excess undissolved solute.
2. If the solution were heated up to 62˚C, the solution would become saturated.
3. If the solution were further heated to 80 ˚C, the solution would become unsaturated.



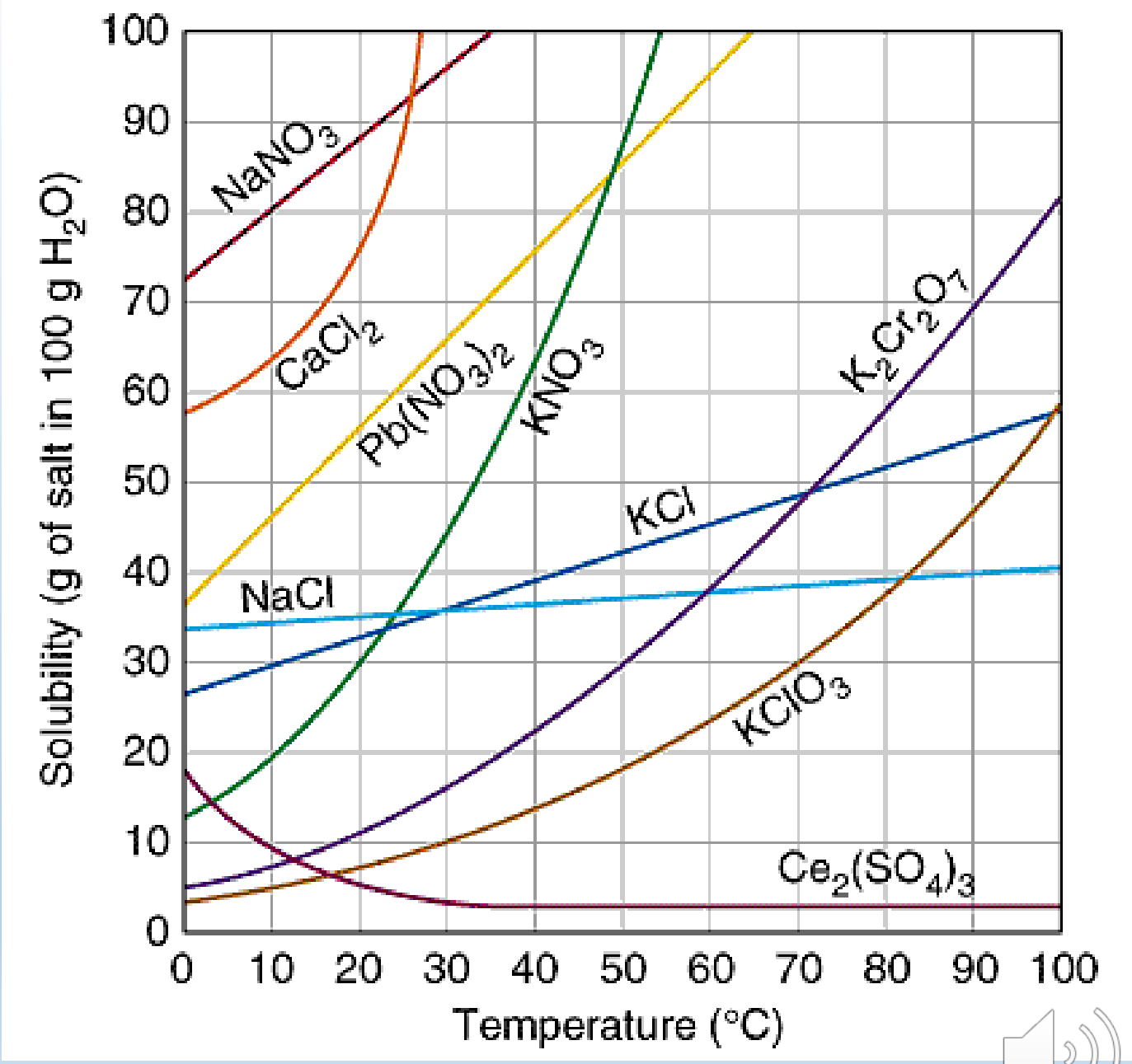
- Any point on the curve is a saturated solution.
- Any point above the curve represents a saturated solution with undissolved solute in it.
- Any point below the curve represents an unsaturated solution.



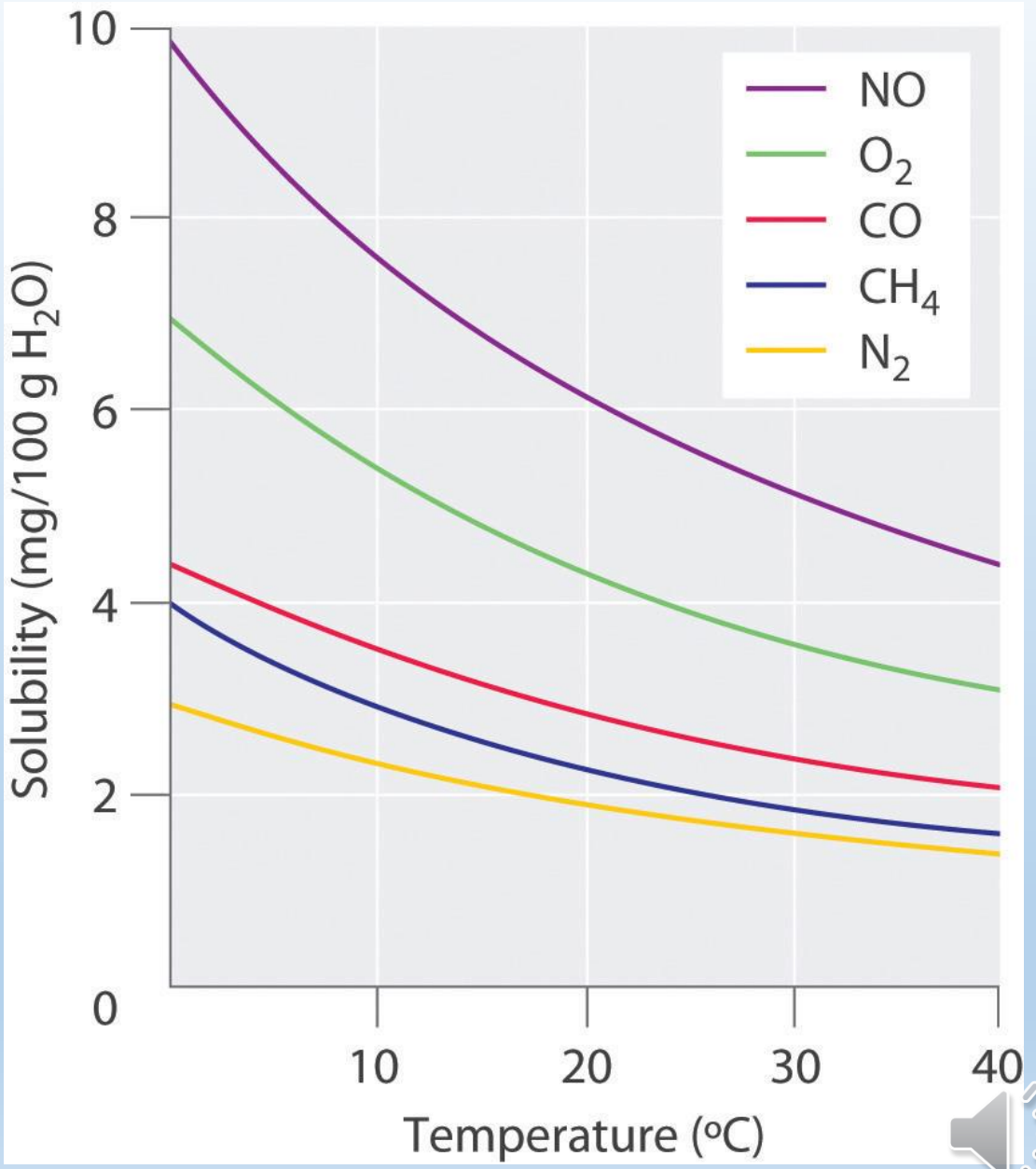
- The vertical difference between a point below the curve and a point on the curve represents the mass of solute that needs to be added to produce a saturated solution at that temperature.
- The vertical difference between a point above the curve and a point on the curve represents the mass of solute that will be undissolved at that temperature.



- The solubility for **most** ionic compounds increases as the temperature increases.
- Different ionic compounds have different responses to changes in temperature.



- The solubility of gases in liquids tends to decrease as the temperature rises.
- This has serious environmental implications. Oxygen dissolved in water is crucial for survival of aquatic life. If ocean temperatures increase → less oxygen dissolved in the water → suffocation



- Pressure affects the solubility of gases in liquids. Increased pressure increases the solubility.
- A sealed bottle of pop is under high pressure. CO_2 is soluble at this temperature and pressure so no bubbles are visible, indicating the gas is dissolved. When the bottle is opened, pressure reduces, CO_2 is less soluble and bubbles form as undissolved CO_2 is released.

Sealed Bottle: High Pressure = No bubbles. All CO_2 gas is dissolved.

Unsealed Bottle: Lower Pressure = Bubbles form as undissolved CO_2 is released from the liquid.

Test Your Understanding

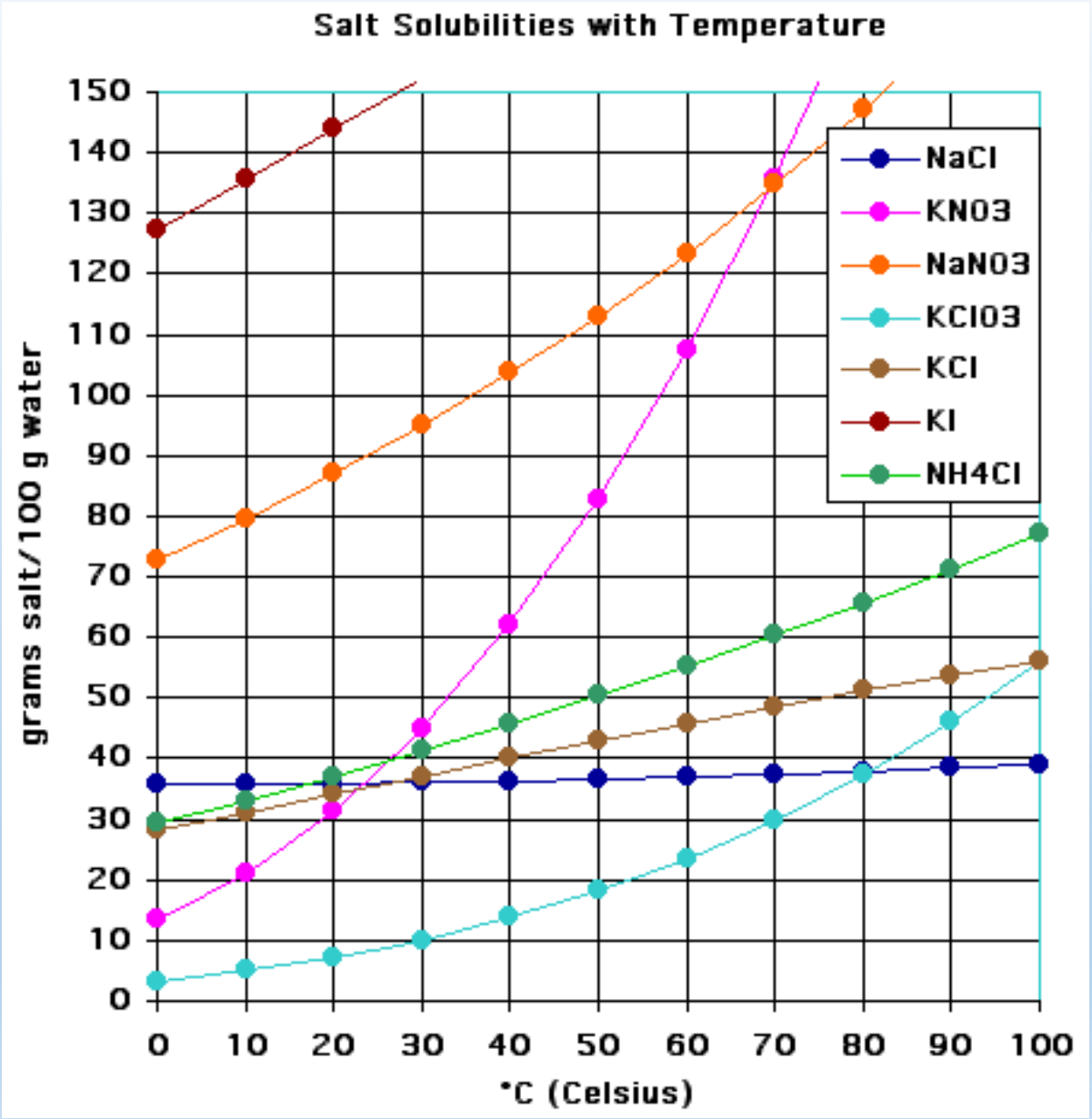
Given the following solubility curve, classify a solution that contains 10 g/ 100 g H_2O of potassium chloride (KCl) at 50 ˚C.

(Click the correct answer)

Saturated

Unsaturated

Super saturated



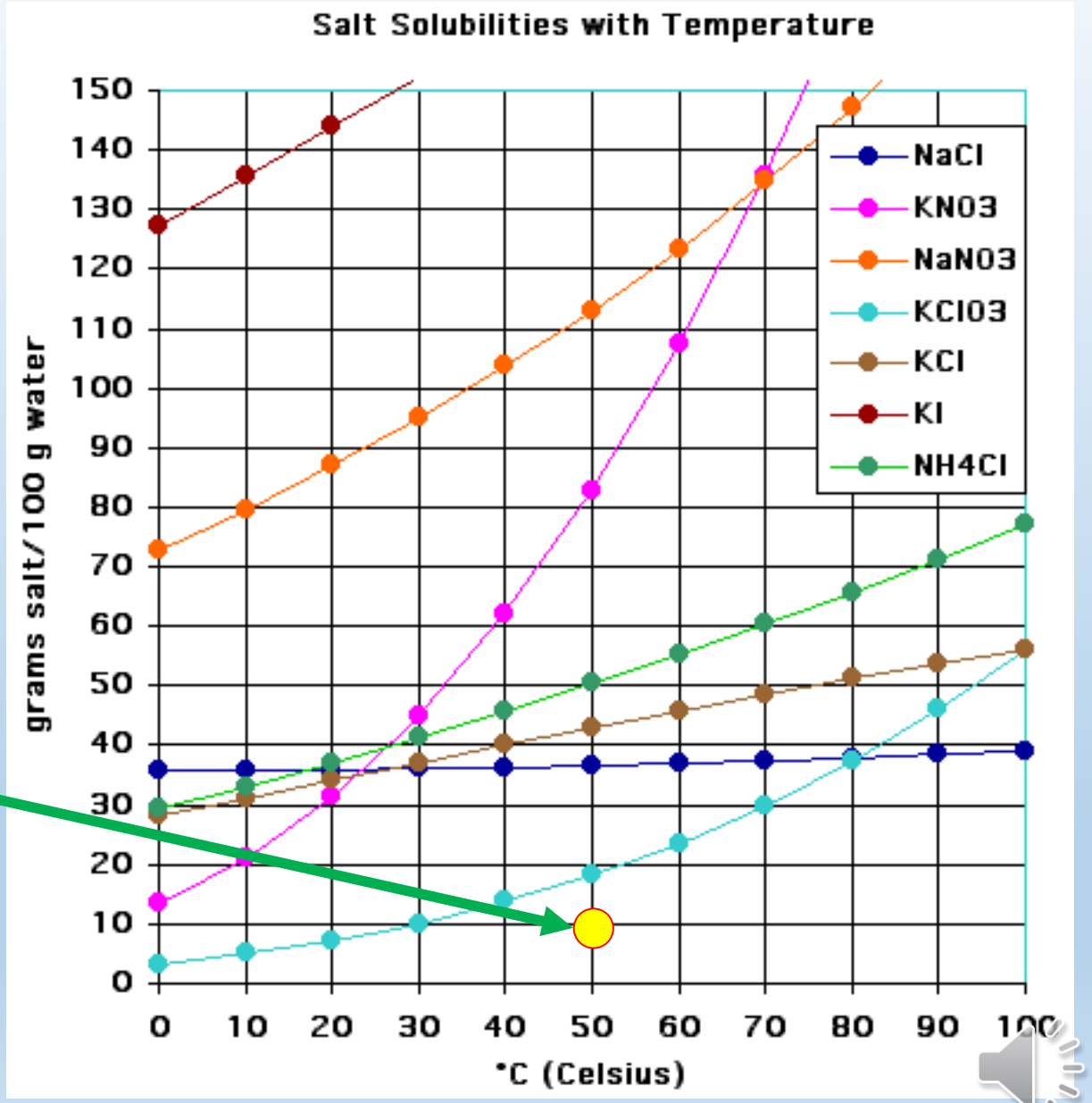
Test Your Understanding

The solution will be **unsaturated** at that temperature as the point is below the curve for KCl.

Saturated

Unsaturated

Super saturated



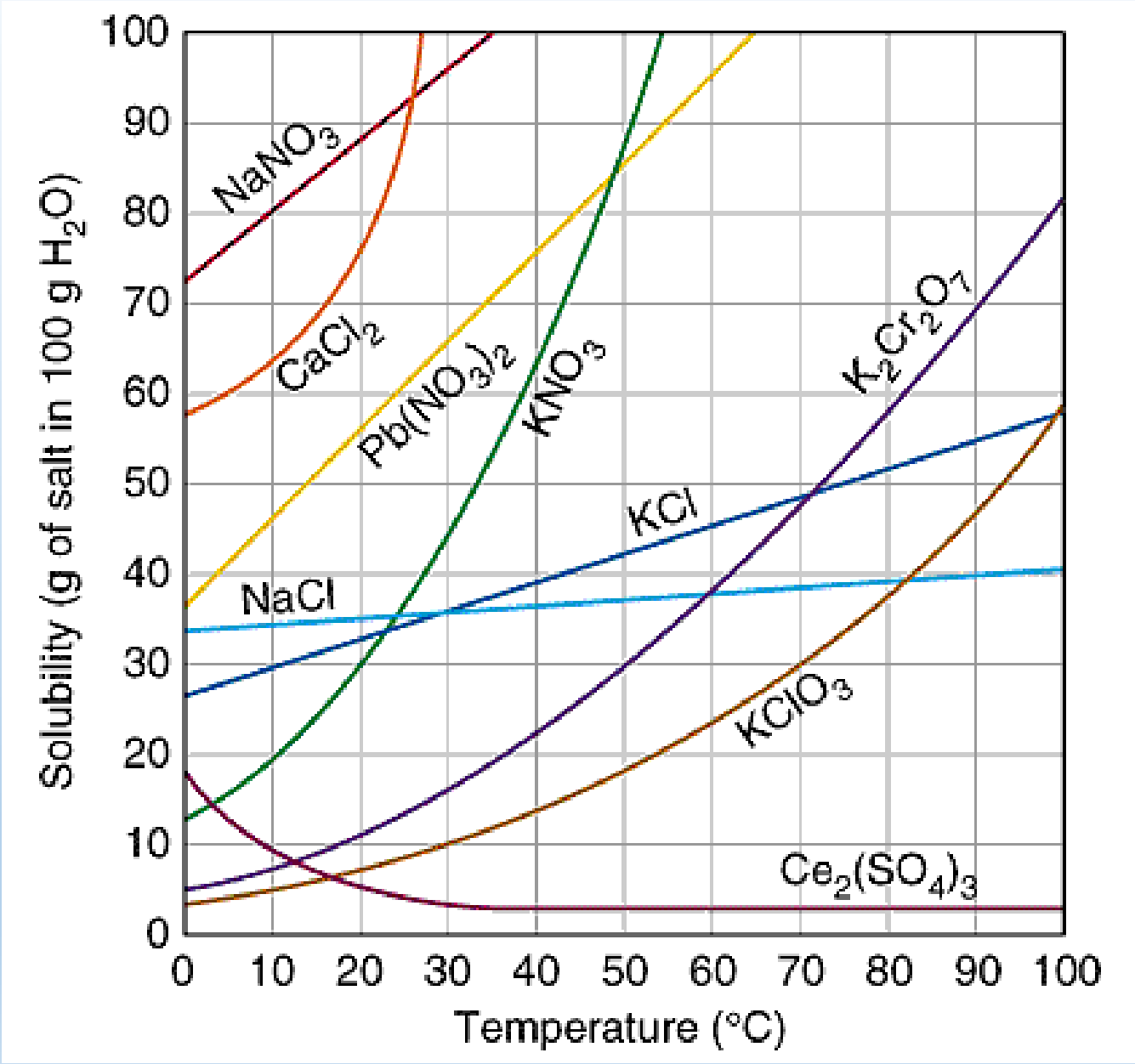
Test Your Understanding

What mass of solute is required to saturate a solution containing 50 g/100 g H_2O of $NaNO_3$ at 10 ˚C?

80 g/100 g H_2O

50 g/100 g H_2O

30 g/100 g H_2O



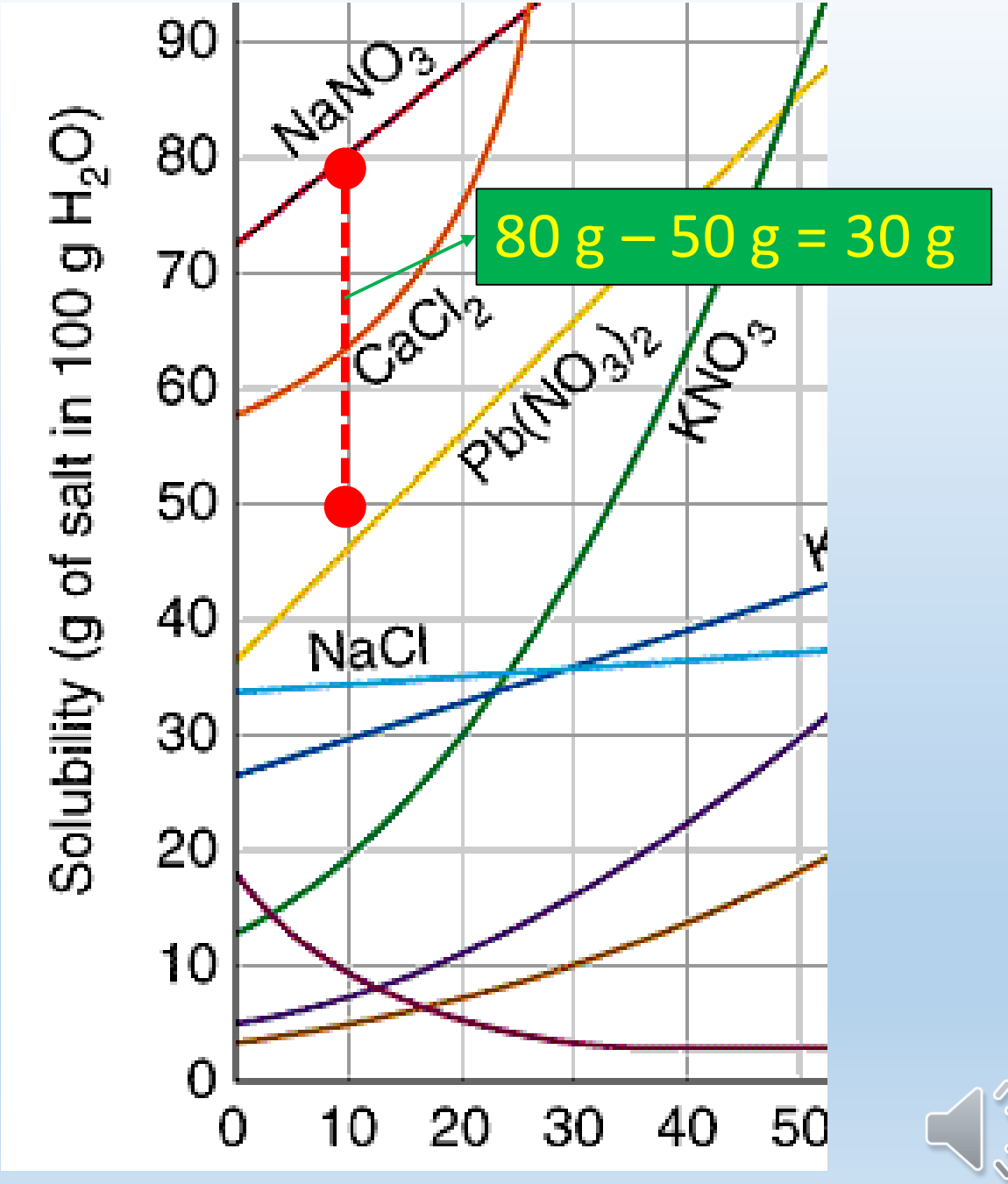
Test Your Understanding

30 g/100 g H_2O is required to saturate the solution.

80 g/100 g H_2O

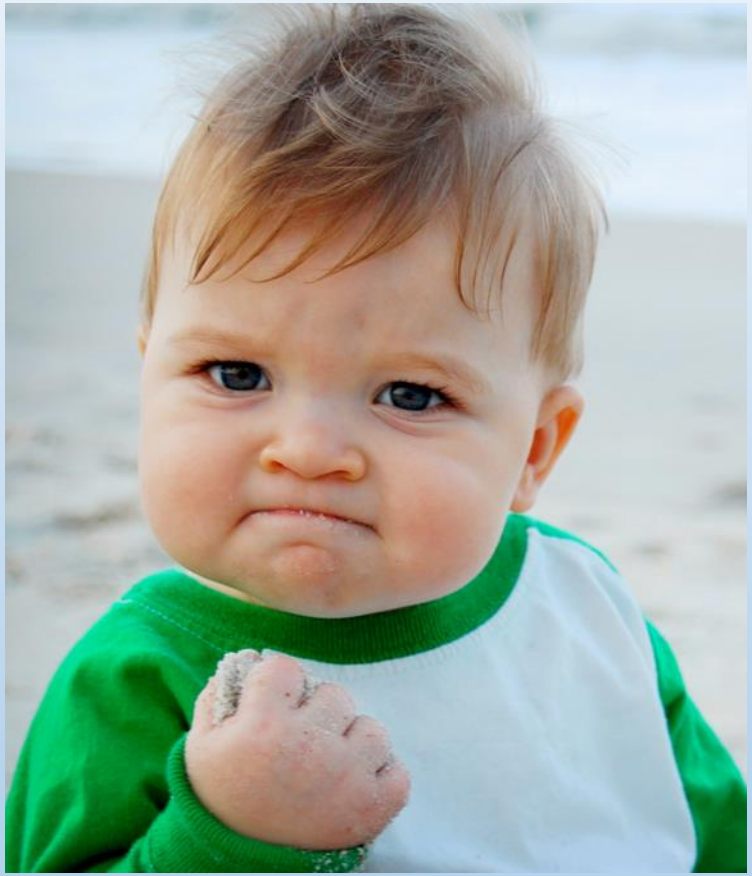
50 g/100 g H_2O

30 g/100 g H_2O



Success!

You have reached the end of this learning activity. You will know that you have achieved the goals for this activity when you can define solubility, describe the different categories of saturation and can read and interpret solubility curves.



Back to Start