# Saturated and Unsaturated Solutions

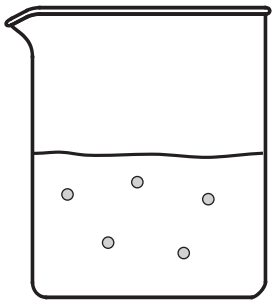
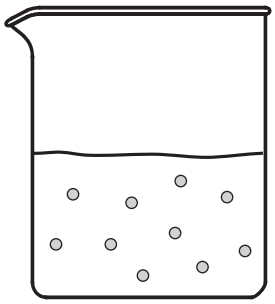
Is there a limit to the amount of solute that will dissolve in a solvent?

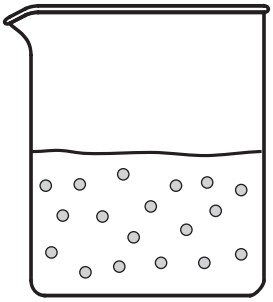
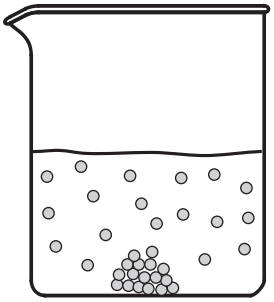
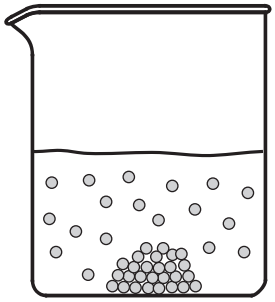
## Why?

We use solutions every day. People who wear contact lenses use "lens solution" to rinse their contacts and keep them wet. Athletes who consume sports drinks after exercising benefit from the electrolytes in those solutions. This activity will explore whether or not there is a limit to how much of one substance can dissolve in another.

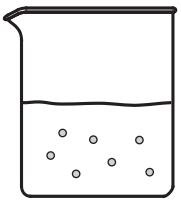
## Model 1 – Saturated and Unsaturated Solutions

- All beakers contain 10.0 g of water.
- All beakers are kept at 20 °C.
- All solutions are stirred for 2 hours.
- Solute is the same substance in all beakers.

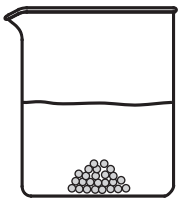
| | Unsaturated Solutions | |
|---|---|---|
| | Beaker A  1.0 g of solute added | Beaker B  2.0 g of solute added |
| Number of dissolved particles | 5 | |
| Number of solid particles | | 0 |

| Saturated Solutions | | |
|---|---|---|
| Beaker C  3.6 g of solute added | Beaker D  7.0 g of solute added | Beaker E  9.0 g of solute added |
| | | 18 |
| | 17 | |

1. Which illustration below represents
   *a.* solute particles in a solid state in water?
   *b.* solute particles in an aqueous state?



_____



_____

2. What variables are controlled in all five beakers of Model 1?

3. Count the particles present in each beaker of Model 1. Fill in the table to show the number of dissolved solute particles and the number of solid solute particles.
4. Consider the beakers in Model 1.
   *a.* Which beakers represent **unsaturated** solutions?

   *b.* Which beakers represent **saturated** solutions?

5. Beakers A–E in Model 1 are depicted as representing five different or separate solutions. They could also be considered as five "snapshots" of the same beaker over time. In other words, if additional measured quantities of solute were stirred into beaker A in small increments over time, then beakers B–E would result.
   *a.* When a small amount of additional solute is added to an unsaturated solution, what happens to the number of dissolved particles? Provide specific evidence from Model 1 to support your answer.

   *b.* When a small amount of additional solute is added to a saturated solution, what happens to the number of dissolved particles? Provide specific evidence from Model 1 to support your answer.

   *c.* Predict what would happen if a small amount of additional solute were stirred into beaker E in Model 1.

STOP

6. Have each person in your group provide an example of the word "saturated" as it is used in an everyday context. Summarize the meaning of the word in the space below.

7. Use a grammatically correct sentence to explain why beakers D and E in Model 1 are labeled as "saturated." Be sure to incorporate the words "solute" and "solvent" in your explanation, and reach a consensus within your group.

8. What feature in the beakers in Model 1 would typically enable a student to distinguish a saturated solution from an unsaturated one simply by looking at the beaker?

9. Beaker C in Model 1 is shown as "saturated." Explain why this is the correct category for beaker C even though the typical feature listed in Question 8 is not present.

10. If you were handed a beaker containing a clear solution (with no solid solute at the bottom), and asked to identify it as "saturated" or "unsaturated," what simple test could you perform to determine the answer.

STOP

## Model 2 – Solute Dissolved vs. Solute Added

The following data refer to an experiment in which a measured mass of solid is added to 10.0 g of 20 °C water. The mixture is stirred and allowed to sit for 3 hours. Ten separate trials are conducted for the experiment.

| Trial Number | Mass of solute added (grams) | Mass of solute dissolved (grams) |
|---|---|---|
| 1 | 1.0 | 1.0 |
| 2 | 2.0 | 2.0 |
| 3 | 3.0 | 3.0 |
| 4 | 4.0 | 3.6 |
| 5 | 5.0 | 3.6 |
| 6 | 6.0 | 3.6 |
| 7 | 7.0 | 3.6 |
| 8 | 8.0 | 3.6 |
| 9 | 9.0 | 3.6 |
| 10 | 10.0 | 3.6 |

11. Four of the trials in Model 2 correspond to beakers A, B, D, and E from Model 1. Write the letters for those beakers next to the corresponding trial numbers in Model 2.
12. Identify the following variables in the experiment in Model 2.

    Dependent variable  Independent variable  Controlled variable(s)

13. Sketch a graph of the data for the experiment in Model 2. A space has been provided next to the data table. Be sure to consider which variable belongs on each axis.
14. Consider the data in Model 2.
    *a.* Which trials represent solutions that are unsaturated?

    *b.* Which trial numbers represent solutions that are saturated?

    *c.* Describe the feature in the graph that can help you identify the saturated solutions. Explain.

STOP

15. Which trials in the experiment in Model 2 would have visible amounts of solid on the bottom of the beaker?

16. For Trial 8 in Model 2, determine the mass of solid solute remaining on the bottom of the beaker. Show your calculation.

17. Imagine that the contents of the beaker for Trial 8 in Model 2 are vigorously stirred and then poured into filter paper in a funnel.

    *a.* Is the liquid that drips from the filter (the filtrate) unsaturated or saturated? Explain.

    *b.* Which beaker in Model 1 best represents the filtrate that would be obtained?

## Extension Questions

18. Predict what would happen to the mass of solid solute sitting on the bottom of the beaker in Trial 8 in Model 2 when the following changes occur. Use complete sentences to support your predictions.

    *a.* More water is added to the beaker.

    *b.* The beaker is heated.

    *c.* The beaker is allowed to sit uncovered for two days and some water evaporates.