

## Frequently Asked Questions and Teacher Tips

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## 1. Teacher Facilitation

**How can I use this in my class?**

You can use the Concentration sim:

- **In class** by having your students work individually or in pairs at computers. Check out the sample activities for this simulation available in the Teacher Resources section (below where you download the sim).
- **As a demo** by projecting the simulation onto a screen. Now you have a way to dynamically change solution concentration and demonstrate the effects of adding and removing solute, solution, and water, and show the effects of evaporation in seconds. You can make the solutions, or you can select students to come up and make solutions for the class.
- **As homework** before introducing the dilution equation by asking students to explain the effects of adding and removing solute, solution, and solvent (water) on the concentration in units of moles per liter. You can also use the sim for homework problems related to making solutions of a certain concentration, determining the moles in a solution of set volume and known concentration, or calculating dilution volumes.
- **With clicker questions** by asking students what will happen to concentration if solute or solvent are added or removed, and then use the sim to see if they were correct.

For tips on using PhET sims with your students and for lesson plans written by the PhET team and other teachers, see our [For Teachers](#) page.

**What can students learn from playing with this sim?**

Students can:

- Describe the relationships between volume and amount of solute to solution concentration
- Explain qualitatively the relationship between solution color and concentration
- Predict and explain how solution concentration will change for adding or removing: water, solute, and/or solution
- Calculate the concentration of solutions in units of molarity (mol/L)
- Design a procedure for creating a solution of a given concentration
- Identify when a solution is saturated and predict how concentration will change for adding or removing: water, solute, and/or solution

Students can also:

- Compare saturation concentrations between different chemical solutions

### What are some things students might find difficult?

From interviews of undergraduate students using the Concentration sim:

- Students might not realize they need to click *and drag* the concentration meter probe into solution in order to get the numerical value.






## 2. Solutes

### What chemicals can I add to the beaker?

There are 8 solvents to choose from: Drink mix, and 7 different-colored inorganic salts. A table with information about each solute is in the section on Saturation.

### How do I select a different solute?

The solute menu drops to show all eight options. When you select a new solute, the beaker resets to 1/2 L of water.

	Drink mix
	Cobalt (II) nitrate
	Cobalt chloride
	Potassium dichromate
	Potassium chromate
	Nickel (II) chloride
	Copper sulfate
	Potassium permanganate

## 3. Solute Shaker and Dropper

### How do I add solute?




There are two ways to add solute to the beaker. You can shake in solid from the shaker, which comes out in small grains or crystals, or you can add a concentrated solution using the dropper in the simulation.

- Click and drag the shaker back and forth to shake out the solid solute.
- Push the red button on the dropper bulb to dispense solution.

The solution concentration in the dropper is less than the saturated concentration for each solvent. Adding solution from the dropper means you are adding both solute chemical and water to the beaker.

### The shaker / dropper is empty – what happened?

The maximum amount of solute that can be added to the beaker is 6 moles. This applies to all solutes. If the shaker or dropper is empty, some solute needs to be removed from the beaker before more can be added. You can remove some solute with the drain faucet; you can remove all of the solute by clicking the  button.

**Why isn't solution coming out of the dropper? Why can't I add water from the faucet?**

The maximum amount of solution that the beaker can hold is 1 liter. When the beaker is full, additional liquid (water from the faucet or solution from the dropper) cannot be added until some of the beaker volume is removed, either through the drain faucet or evaporation. The dropper button and faucet slider will turn grey when the beaker is full to show that they can't be used.

**Can I mix chemicals in the simulation?**

The Concentration sim lets you mix solute chemicals one at a time with water, but does not allow mixing of different solutes together.

**4. Faucets****Why are there two faucets? How do I use them?**

The faucet in the upper left lets in water. The faucet in the lower right drains the beaker of whatever solution it contains.

- Grab the blue slider knob and drag it to the right to open the faucet. Drag back to the left (or release the knob) to close the faucet. You can control how much water or solution is allowed out of the faucets using the slider.

**How do I add water to the beaker?**

There are two ways to add water to the beaker.

- To add only water, use the faucet in the upper left. Use the slider to control the flow.
- To add water and solute together, use the dropper from the solute tool box.

**How do I remove solution from the beaker?**

You can remove solution (solvent and solute together) using the drain faucet in the lower right part of the play area. Use the slider to control the flow. Note that the drain removes both solute chemical and solvent (water) together.

**Can I remove only water, without removing any solute, using the drain?**

Only if the beaker contains only water. If there is solute in your beaker, you can't remove water alone using the drain. See the next section on Evaporation.

**5. Evaporation****How do I remove only water, without removing any solute?**

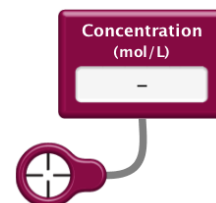
The Evaporation slider will evaporate just water from the beaker, leaving the moles of solute constant. Use the slider to control the evaporation rate: the farther to the right you move the slider, the faster

the water will evaporate from the solution. This control lets you evaporate much faster than you can in real life.

## 6. Concentration

### How do I measure the concentration of my solution?

The purple concentration meter on the right side of the beaker (under the solute controls) displays concentration in mol/L for whatever solution is inside the crosshairs of the probe. To use the probe, click and drag it into the solution whose concentration you want to measure. The probe shows concentration of solute, so when it is in pure water, it reads a concentration of 0.



### How do I change the concentration?

You can change the concentration in different ways using the sim, including:

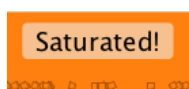
- Increase concentration: Add solute from the shaker or dropper, or remove water using evaporation.
- Decrease concentration: Add water from the upper left faucet, or click "Remove Solute".

Notice that the drain changes the volume of solution, but not the concentration.

### I can't tell how many moles I am adding. Where can I find this value?

Each grain of solid solute represents 0.0050 moles of solute. The sim does not have a read-out for moles in the beaker, but you can calculate this value by multiplying the Concentration (M) by the volume of the solution. For example, when the beaker is full to the 1 L mark, the concentration meter value is equal to the number of moles in the beaker.

## 7. Saturation



### How do I saturate the solution?

When the moles of solute per liter of water is above the saturation point, the solution will saturate and small crystals will form at the bottom of the beaker. This can be achieved by adding solid solute past the saturation point, or by evaporating the solution past the saturation point.

Solute	Formula	Molar mass (g/mol)	Color	Solubility in water (mol/L)	Dropper solution (mol/L)
Drink mix (sucrose)	$C_{12}H_{22}O_{11}$	342.296	red	5.96 @ 20 °C	5.50
Cobalt (II) nitrate	$Co(NO_3)_2$	182.942	red	5.64 @ 25 °C	5.00
Cobalt chloride	$CoCl_2$	129.839	pink	4.33 @ 25 °C	4.00
Potassium dichromate	$K_2Cr_2O_7$	294.185	orange	0.51 @ 25 °C	0.50
Potassium chromate	$K_2CrO_4$	194.191	yellow	3.35 @ 25 °C	3.00
Nickel (II) chloride	$NiCl_2$	129.599	green	5.21 @ 25 °C	5.00
Copper sulfate	$CuSO_4$	159.609	blue	1.38 @ 25 °C	1.00
Potassium permanganate	$KMnO_4$	158.034	purple	0.48 @ 25 °C	0.40

**Why are the saturation concentrations different from the values I get in lab?**

Saturation point depends on temperature in the lab. The solubility limit values used in the simulation are from the CRC Handbook of Chemistry and Physics 91<sup>st</sup> edition, online:

<http://www.hbcpnetbase.com/>

**8. Model****What is the underlying model used for the sim?**

**ALERT:** We used a simplified equation for concentration: Moles of Solute / Volume of Solvent, instead of volume of solution. This sim ignores the volume of the dissolved solutes for the following reasons:

- The effect is relatively small, since solute particles have small mass
- The different volumes of each solute chemical could be confusing to students
- It would be difficult to implement in terms of math and software design

In this simulation, the solvent is always pure water.