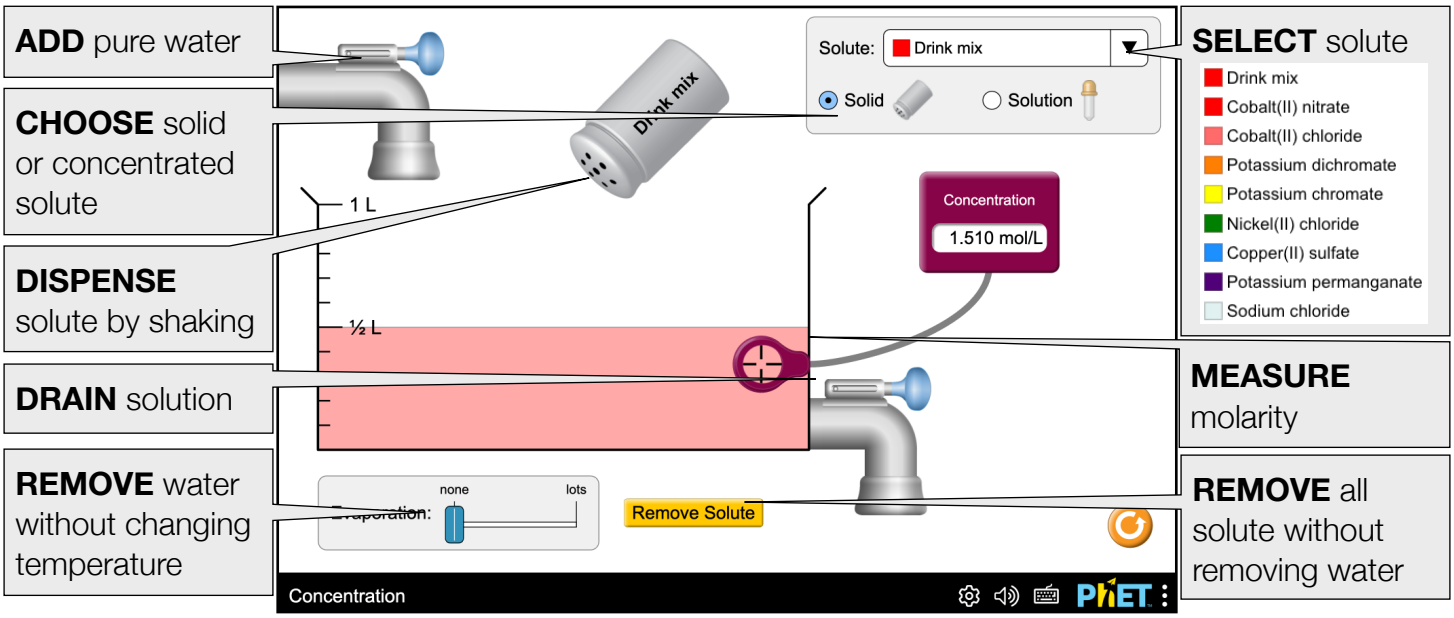
PhET Tips for Teachers — Concentration

Explore Screen

Students build an understanding of solution concentration by varying amounts of solute, solvent, and solution. Experimenting with several different chemicals in solid and concentrated solution form, students can develop qualitative and quantitative relationships.



Complex Controls

- The maximum amount of solute that can be added to the beaker is 7 moles; the shaker or dropper will not dispense any more solute. You can remove some solute with the drain faucet or you can remove all of the solute by clicking:

- The dropper will add concentrated solution of the solute. The concentration of the solution in the dropper can be measured by putting the probe below the dropper, then press the red button to read in the stream. See the table below for concentrations.

Customization Options

Query parameters allow for customization of the simulation, and can be added by appending a '`?`' to the sim URL, and separating each query parameter with a '`&`'. The general URL pattern is:

`...html?queryParameter1&queryParameter2&queryParameter3`

For example, in Concentration, if you want to show the solute amount (`showSoluteAmount`), with the ability to zoom turned off (`supportsPanAndZoom=false`) use:

https://phet.colorado.edu/sims/html/concentration/latest/concentration_all.html?showSoluteAmount&supportsPanAndZoom=false

To run this in Spanish (`locale=es`), the URL would become:

https://phet.colorado.edu/sims/html/concentration/latest/concentration_all.html?locale=es&showSoluteAmount&supportsPanAndZoom=false

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⚙ Indicates this customization can be accessed from the Preferences menu within the simulation.

Query Parameter and Description	Example Links
⚙ `showSoluteAmount` - displays the solute amount (in grams) below the beaker.	`showSoluteAmount`
⚙ `showSolutionVolume` - displays the solution volume inside of the beaker. Units will match beaker units.	`showSolutionVolume`
⚙ `beakerUnits` - specifies units used to label beaker tick marks, `milliliters` or `liters` (default)	`beakerUnits=milliliters`
⚙ `concentrationMeterUnits` - specifies units used to measure concentration, `percent` or `molesPerLiter` (default)	`concentrationMeterUnits=percent`
⚙ `locale` - specify the language of the simulation using ISO 639-1 codes. Available locales can be found on the simulation page on the Translations tab. Note: this only works if the simulation URL ends in "_all.html".	`locale=es` (Spanish) `locale=fr` (French)
⚙ `audio` - if muted, audio is muted by default. If disabled, all audio is permanently turned off.	`audio=muted` `audio=disabled`
`allowLinks` - when `false`, disables links that take students to an external URL. Default is `true`.	`allowLinks=false`
`supportsPanAndZoom` - when `false`, disables panning and zooming using pinch-to-zoom or browser zoom controls. Default is `true`.	`supportsPanAndZoom=false`

Model Simplifications

- The color intensity of a solution is used to indicate its concentration.
- Concentration is calculated as solute amount divided by *water* volume. The volume of dissolved solute has only a small effect on volume, and different volume changes for each solute could be confusing to students.
- Solute amount readout (available in the sim preferences) excludes precipitate/undissolved solutes.
- When represented as a percentage, concentration is calculated as a mass percent, mass solute/mass solution where mass solution = mass solute + mass water.
- The temperature of the solution is constant for each solute and dropper solution. All of the solutions are at 25°C except the drink mix, which is at 20°C.
- 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. The

solubility limit values used in the simulation are from the CRC Handbook of Chemistry and Physics 91st edition.

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

Suggestions for Use

Sample Challenge Prompts

- Describe the relationships between the amount of solute, volume of solution, solution color, and solution concentration.
- What happens to the concentration of a solution when the solution volume is decreased?
- Design a procedure for creating a solution of a given concentration.
- Predict how solution concentration will change for any action (or combination of actions) that adds or removes water, solute, or solution, and explain why.

See all published activities for Concentration here.
For more tips on using PhET sims with your students, see Tips for Using PhET.