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.

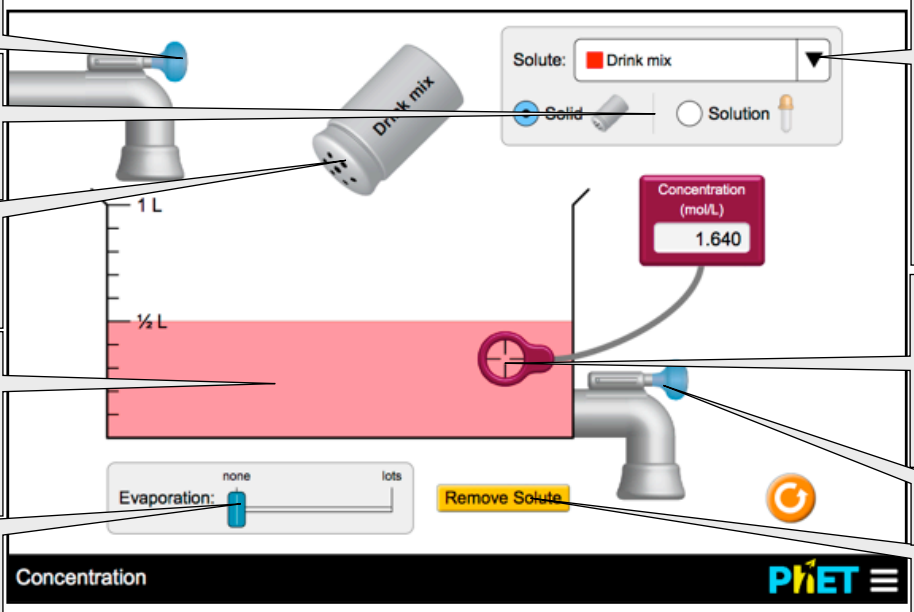
ADD pure water by pulling lever

CHOOSE solid or concentrated solute

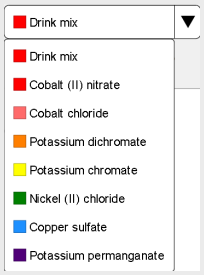
DISPENSE solute by shaking

Solution color darkness indicates concentration

REMOVE water without changing temperature



PICK your solute



READ molarity by dragging probe into beaker solution

DRAIN solution

REMOVE all solute without removing water

Complex Controls

- The maximum amount of solute that can be added to the beaker is 6 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.

Model Simplifications

- Simplified equation for concentration: Moles of Solute / Volume of Solvent, instead of volume of solution. This simplification is reasonable because the solute particles have small mass, variations in volume could lead to student confusion, and implementation complexity doesn't align with Html5.
- 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.

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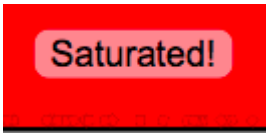
- When the moles of solute per liter of water is above the saturation point, the solution will saturate and small crystals will form at the bottom of the beaker. The solubility limit values used in the simulation are from the CRC Handbook of Chemistry and Physics 91st edition, online: http://www.hbcpnetbase.com



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

Customization Options

The following query parameters enable options in the "Concentration" and "Beer's Law Lab" sims:

- `showSoluteAmount` - shows the solute amount (in grams) below the beaker in the "Concentration" screen, does not require a value
- `beakerUnits=milliliters` - labels the beaker tick marks using mL (default is L)
- `concentrationMeterUnits=percent` - displays percent concentration in the concentration meter (default in mol/L)

Query parameters are added by appending a '?' to the sim URL, and separating each query parameter with a '&'. Here is an example with all 3 options enabled (this is a single line):
https://phet.colorado.edu/sims/html/concentration/latest/concentration_en.html?showSoluteAmount&beakerUnits=milliliters&concentrationMeterUnits=percent

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

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