



# Annotated Lecture Slides for *Concentration*

**AUTHORS:**

Robert Parson (University of Colorado Boulder)

Trish Loeblein (University of Colorado Boulder)

**COURSE:**

Introductory / Preparatory College Chemistry

**COPYRIGHT:** This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/).

# Learning goals

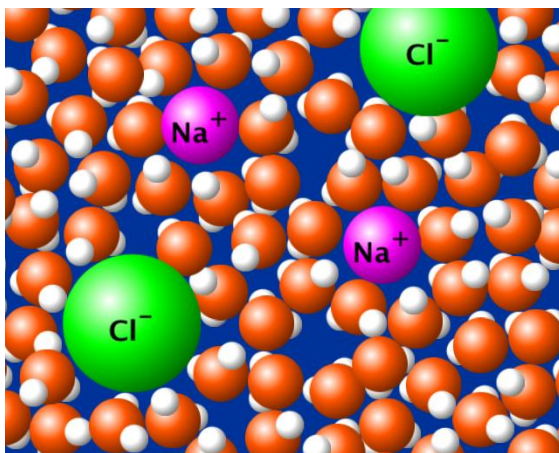
- Distinguish between dilute and concentrated solutions.
- Predict how various actions affect the concentration and number of moles of a solution.
- Use the molarity of a solution to calculate the moles of solute present in a given volume of the solution.
- Use the molarity of a solution to calculate the volume needed to provide a given number of solute moles.
- Calculate final volume or concentration of solutions prepared by dilution

# Solutions

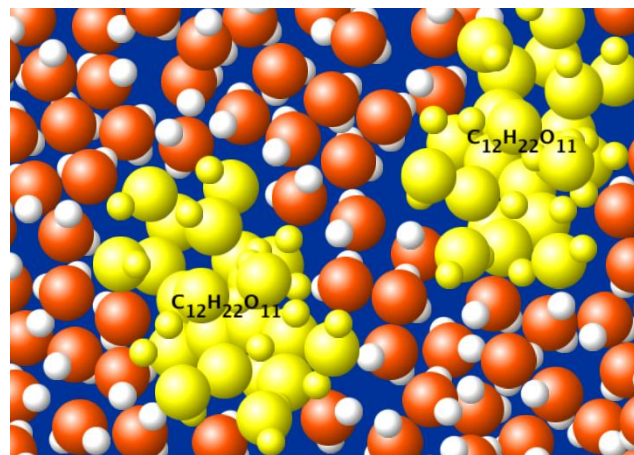
**Solute:** the substance that is dissolved.

**Solvent:** the substance that does the dissolving.

- When a solution forms, the solute molecules or ions become evenly dispersed throughout and surrounded by solvent molecules.



Ionic compound



Molecular compound

*Glucose  
highlighted  
in yellow  
for visibility*

# Concentration units: Molarity (M)

$$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{liters of solution}}$$

- If given mol and L, then can determine M.
- If given mol and M, can determine L.
- If given M and L, can determine mol.

Which action(s) will **increase** the concentration of the solution?

- ① Add more  $\text{Co}(\text{NO}_3)_2$
- ② Evaporate water
- ③ Drain solution

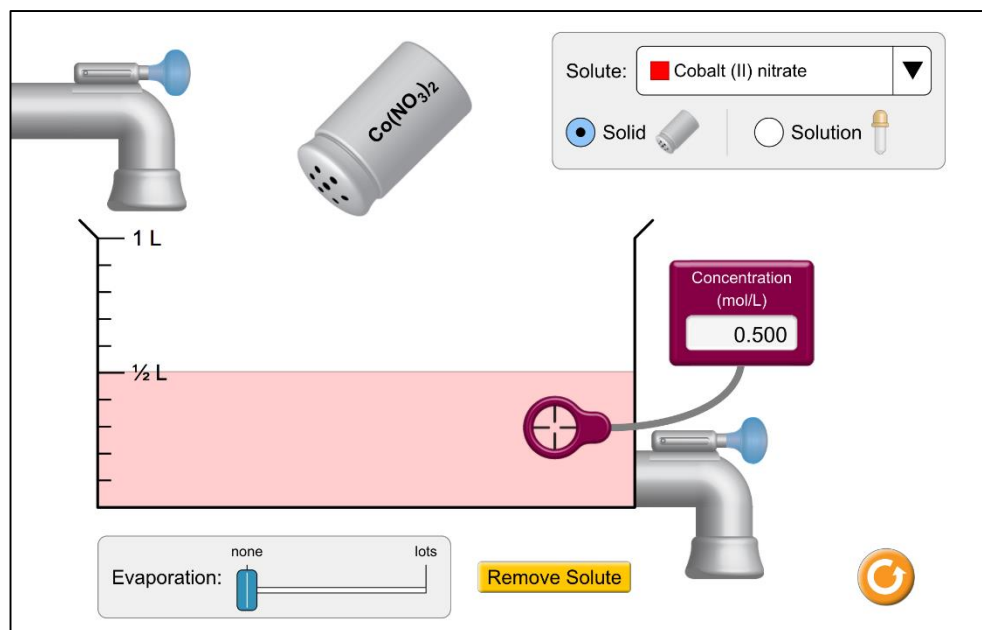
A. (1) only

B. (1) and (2)

C. (2) and (3)

D. (1) and (3)

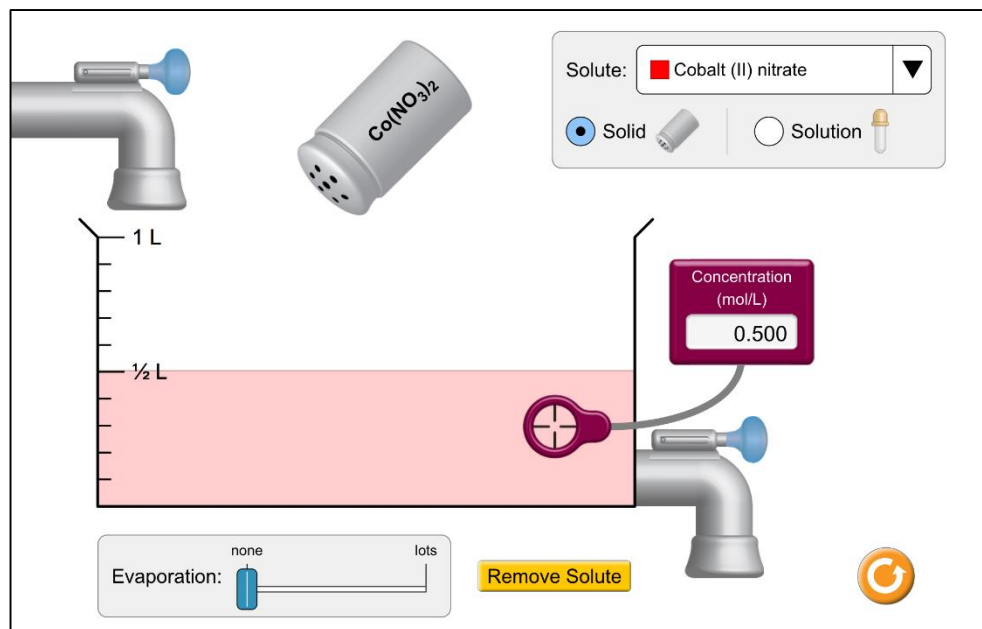
E. (1), (2), and (3)



Which action(s) will change the number of moles of solute in the container?

- ① Add water
- ② Evaporate water
- ③ Drain solution

- A. (1) only
- B. (2) only
- C. (3) only
- D. (1) and (2)
- E. (2) and (3)



Which action(s) will **increase** the concentration of the solution?

- ① Add more  $\text{Co}(\text{NO}_3)_2$
- ② Evaporate water
- ③ Drain solution

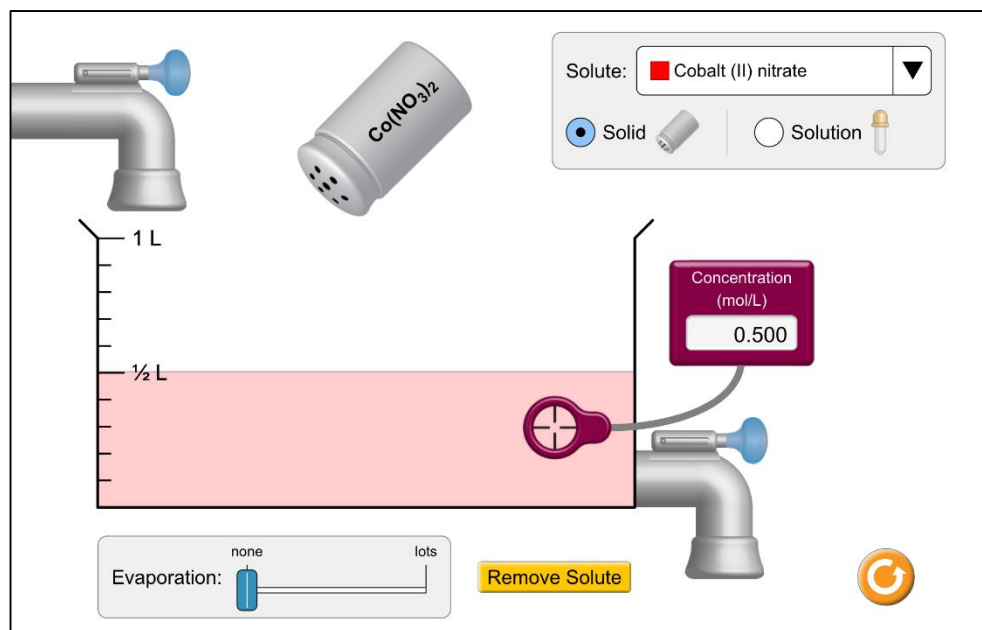
A. (1) only

B. (1) and (2)

C. (2) and (3)

D. (1) and (3)

E. (1), (2), and (3)



Which action(s) will change the number of moles of solute in the container?

- ① Add water
- ② Evaporate water
- ③ Drain solution

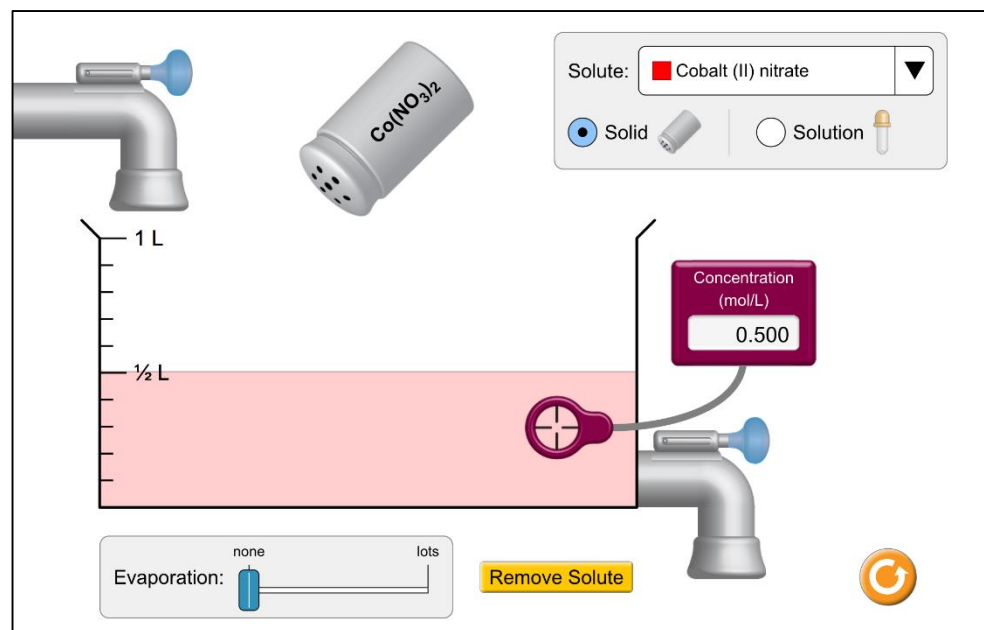
A. (1) only

B. (2) only

C. (3) only

D. (1) and (2)

E. (2) and (3)





# How many moles of solute are in the beaker?

Solute: ■ Cobalt (II) nitrate

Solid  Solution

Evaporation: none  lots

Concentration (mol/L): 0.500

Remove Solute

Co(NO3)2

a. 0.05 moles

b. 0.50 moles

c. 1.00 moles

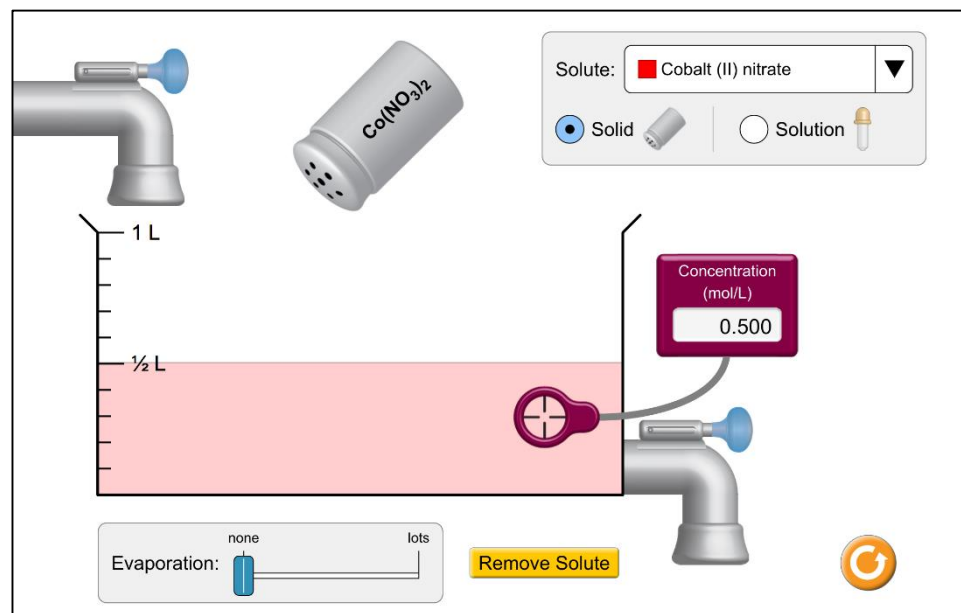
d. 1.50 moles

e. None of these

What will happen to the concentration and the number of moles when water is added?

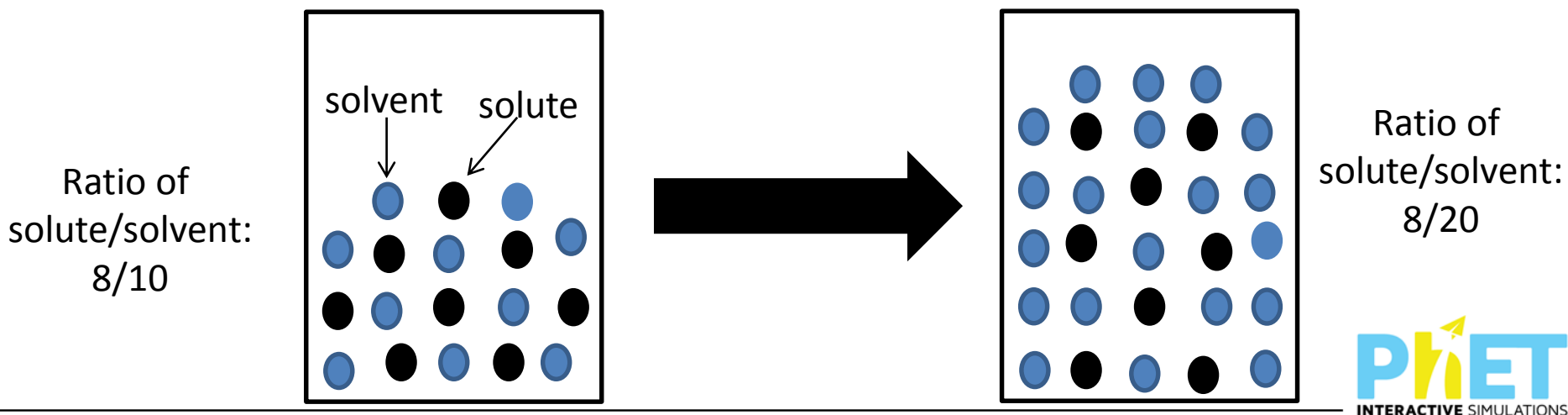
Concentration      Number of moles

- a.    Increase                  Decrease
- b.    Increase                  Increase
- c.    No change                No change
- d.    Decrease                  Decrease
- e.    Decrease                  No change



# Dilutions

- To decrease the concentration of a solution, add more solvent
  - The number of solute particles stay the same, but the number of solvent particles increases and the ratio of solute/solvent particles also changes
  - This means that the total volume also increases



# Dilutions

- Usually, a more concentrated solution is used to make the dilute solutions
- Equation: “moles equals moles”
- $M_{\text{dil}} V_{\text{dil}} = M_{\text{conc}} V_{\text{conc}}$
  
- $M_{\text{dil}}$  = Desired dilute molarity
- $V_{\text{dil}}$  = desired total volume
- $M_{\text{conc}}$  = Concentrated molarity (stock solution)
- $V_{\text{conc}}$  = Volume of concentrated solution

You start with 0.1 L of a 5.00 M solution of  $\text{NiCl}_2$ , and you plan to dilute it (by adding water) to make a solution with a concentration of 0.625 M. How far should you fill the beaker?

- a. 200 mL
- b. 400 mL
- c. 600 mL
- d. 800 mL**
- e. 1 L

The simulation interface includes the following elements:

- Beaker:** A graduated cylinder with markings for 1 L and 1/2 L. It contains a small amount of green liquid at the bottom.
- Faucets:** A faucet on the left and a faucet on the right, both with blue handles.
- Pipette:** A green pipette with a red stopper and a label  $\text{NiCl}_2$ .
- Control Panel (Right):**
  - Solute:** A dropdown menu showing "Nickel (II) chloride".
  - Form:** Radio buttons for "Solid" (unselected) and "Solution" (selected).
  - Concentration:** A purple box displaying "5.000 mol/L".
- Buttons:** A yellow "Remove Solute" button and an orange "Reset" button.
- Evaporation Slider (Bottom Left):** A slider labeled "Evaporation:" with "none" on the left and "lots" on the right. The slider is currently set to "none".