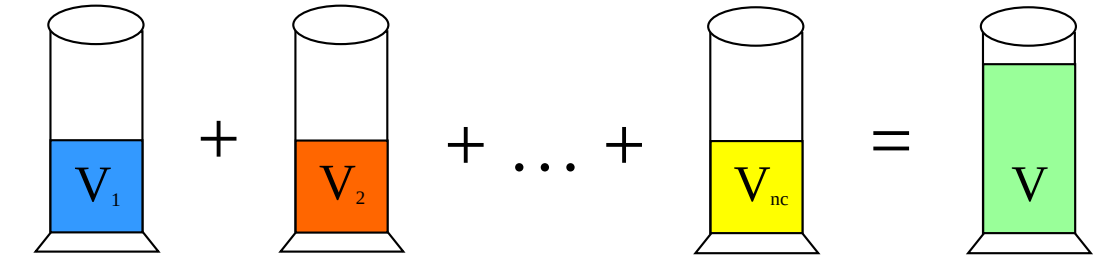
Volume Change of Mixing
An Investigation

ΔV of Mixing

- What happens when you mix two or more pure chemical compounds together to form a mixture?
- How do you mathematically model this mixing?
- What is meant by ideal and non-ideal solutions?

First Principle

Constant Temperature and Pressure



Component 1 Component 2 Component nc Mixture

$$\mathbf{V = V_1 + V_2 + \ldots + V_{nc} + \Delta V_{mixing}}$$

What are the mixing effects for the ΔV_{mixing}?

Mixing Effects

- ΔV_{mixing} can be = 0, Ideal Solution
- ΔV_{mixing} can be < 0, Non-Ideal Solution
- ΔV_{mixing} can be > 0, Non-Ideal Solution

ΔV_{mixing} can be zero, negative, or positive!

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Zero-Effect Observations

Click here to view a QuickTime movie of this effect. Turn the volume on.
(**Be patient, the file size is about 2 MB**)
When the movie is done, close the movie-viewing window to continue.

- Starting volumes are additive.
- Mixture volume is unchanged.
- Molecules look alike to one another.
- Mixture is an ideal solution.
- Common examples exist:
  - compounds with similar structures
  - benzene and toluene
  - n-hexane and n-octane

Negative-Effect Observations

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(**Be patient, the file size is about 2 MB**)
When the movie is done, close the movie-viewing window to continue.

- Starting volumes are **not** additive.
- Mixture volume contracts.
- Molecules attract each other.
- Mixture is a non-ideal solution.
- Common examples exist:
  - compounds with dissimilar structures
  - most alcohol's and water
  - ethanol and benzene

Volume Change of Mixing
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Positive-Effect Observations

Click here to view a QuickTime movie of this effect. Turn the volume on.
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When the movie is done, close the movie-viewing window to continue.

- Starting volumes are **not** additive.
- Mixture volume expands.
- Molecules repel each other.
- Mixture is a non-ideal solution.
- Rare examples exist:
  - compounds with dissimilar structures
  - carbon disulfide and ethyl acetate
  - dioxane and cyclohexane

Ideal and Non-Ideal Solutions

- ΔV_{mixing} for Ideal Solutions
  - it is what you think you would see, $\Delta V_{mixing} = 0$.
  - volumes of the pure components are additive.
- ΔV_{mixing} for Non-Ideal Solutions
  - it is **not** what you think you would see, $\Delta V_{mixing} \neq 0$.
  - volumes of the pure components are **not** additive.

Summary

- First principle is whole ≠ sum of its parts

$$\mathbf{V = V_1 + V_2 + \ldots + V_{nc} + \Delta V_{mixing}}$$

- The term ΔV_{mixing} can be neglected
  - ✓ when the mixture is an ideal gas or a real gas at most conditions.
  - ✓ when the chemical compounds of a liquid mixture are similar.
- Solid and liquid mixtures are
  - ✓ usually non-ideal solutions, but ideal for like molecules.
  - ✓ treated like ideal solutions, as a first approximation.

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Alisha M. Brown
Bucknell ChE 1998

Dr. Michael E. Hanyak, Jr.
Chemical Engineering Dept.
Bucknell University
Lewisburg, PA 17837

