



## Additive Volumes *Preparer's Version*

### Introduction

In this demonstration, equal volumes of two liquids – 50 mL of 200-proof ethanol and 50 mL of deionized water – are combined, yet the resulting solution measures less than 100 mL in total volume. This counterintuitive result exemplifies a fundamental physical phenomenon: volume contraction upon mixing, governed by intermolecular forces and non-ideal solution behavior. The principle at play here is that volumes are not necessarily additive when substances are mixed, especially when significant intermolecular interactions occur.

### Safety Hazards

- Personal Protective Equipment:
  - Safety glasses/goggles
  - Nitrile gloves
  - Chemical & flame retardant lab coat
- Physical Hazards
  - Ethanol is a highly volatile and flammable liquid/vapor
- Chemical Hazards
  - Ethanol causes serious eye irritation.

### Materials

- 2x 50mL graduated cylinders
- 100mL graduated cylinder
- 50mL of ethanol
- 50mL deionized water

### Safety Data Sheet(s)

- [Ethanol, 200 proof](#)



### **Procedure**

1. Carefully and precisely measure 50mL of deionized water.
2. Carefully and precisely measure 50mL of 200-proof ethanol.
3. Check that *exactly* 50mL was measured of each liquid.

### **Tips & Tricks**

- Have the performer measure the 50mL aliquots on stage in front of the class.
  - If the lecture hall is large, set up a camera or document camera to project the graduated cylinders onto the projectors.
- Have the students confirm that the measurements are correct before the performer combines the two liquids.

### **Clean-Up Procedures**

1. Rinse the graduated cylinders with deionized water three times.
2. Clean all labware and glassware with lab detergent thoroughly.
3. Hang the water jugs upside down to drain out all moisture.