

Exercise 33

The density (d) of a substance is an intensive property that is defined as the ratio of its mass (m) to its volume (V). $\text{density} = \frac{\text{mass}}{\text{volume}}$ $d = \frac{m}{V}$

Considering that mass and volume are both extensive properties, explain why their ratio, density, is intensive.

Solution

An extensive property is a property that is proportional to the amount of substance. Both mass and volume are extensive properties.

$$m \propto A \quad (\text{mass is proportional to the amount of substance})$$

$$V \propto A \quad (\text{volume is proportional to the amount of substance})$$

Change these proportionalities to equations by introducing proportionality constants, one for mass and one for volume.

$$m = k_m A$$

$$V = k_V A$$

Taking the ratio of mass and volume results in a quantity independent of the amount of substance.

$$d = \frac{m}{V} = \frac{k_m A}{k_V A} = \frac{k_m}{k_V}$$

This is the density, an intensive property.