

Density is an *intensive, characteristic* property. Characteristic properties are useful when trying to identify unknown materials. A characteristic property is always an intensive physical property - a property that does not vary regardless of whether you have a lot or a little of the material.

If you were going to carry something, you want to know about its

- mass (or weight)
- size
- ✓ probably it might be good to know about both

Density defined: The ratio comparison of an objects mass to its volume.

- Can something be heavy yet be small? Can something be light yet big?
 - ✓ yes, compare the small cylinder of lead with a very large block of foam.
 - ✓ the lead was much smaller, but had more mass, lead is much more dense than foam.
 - ✓ the block of foam is much larger than the cylinder of lead, yet it is much lighter in mass.
- Can something be the same size yet weigh different amounts?
 - ✓ yes recall the cylinder of lead and aluminum
 - ✓ assuming the metal atoms are packed in a similar way since they are both metals, this mass difference is likely to be caused by the fact that each of the copper atoms probably weighs more than each aluminum atom
 - ✓ yes recall the cube of oak and the cube of pine
 - ✓ assuming that they are both made of wood and therefore the same molecules, the wood must be packed tighter in the oak than the pine
- Can something be really heavy and still float?
 - ✓ How about that bowling ball!

What causes difference in densities?

So differences in density can be caused by one or both of two factors:

1. packing particles in tighter
2. packing in heavier items

Density Analogy – The Suitcase Analogy

A good analogy is to compare density to a hard suitcase – the case has a certain mass and a certain volume. The volume is constant since it is a hard case. I can change its mass by changing what or how much I put in the case.

1. put in a few underwear = more dense than empty suitcase, put in still more underwear = even more dense since more things are being stuffed in and packed more tightly.
2. put in a few books = more dense than a few under-wears since heavier things are being put in.

This model is meant to show that differenced in density may caused by packing of particles in a substance or the mass of each individual particle in the substance.

Density Formula

How shall we describe this property of a material’s mass compared to its volume?

$$\text{Density } D = \frac{m}{V} \quad \text{it's a ratio: mass over volume}$$

So in order to measure the density of a material, we need to measure the material’s mass and corresponding volume. Then make the calculation using the equation above.

Units?

What unit should we put on a density value?

$$\frac{\text{mass}}{\text{volume}} \quad \text{nothing cancels so the unit label will be g/ml or any version of mass/vol (kg/L, g/L, mg/ml, etc)}$$