TACTILE WARMTH

When you touch something, you can feel its **warmth**

Think of sitting at a **metal** table compared to a **wood** table

Which table feels “warmer”? **Why?**

What is Tactile Warmth?

It is actually a combination of multiple material properties!

1. Density, or how tightly packed atoms are in a material
2. Specific heat capacity, or how much energy does it take to heat up a material (remember, heat is a form of energy!)
3. Thermal conductivity, or how quickly heat flows in a material

All three of these factors can influence how warm or cold a material feels to the touch!

How does this property impact designing with materials?

Think back to the chairs

→ The metal table feels cold and industrial, which is a very specific design choice

→ The wood table feels warmer and may remind you of large holiday dinners, which makes you feel very different than sitting at the industrial metal table!

TOUCH

When you touch something, you notice if it is hard or soft

Think of sitting in a **metal** chair compared to a chair with **lots of cushion and fabric**.

Which chair feels “softer”? **Why?**

What do we mean by Touch?

Well we have two extremes for Touch: hard and soft.

For softness, this depends a lot on a material property called *Young’s modulus*, or how much it can stretch elastically, and surface texture. If a material is squishy (so it stretches really easily), it will feel softer than a material that doesn’t!

For hardness, this depends a lot on a material property called *Hardness*, or how easily you can make a mark on the surface of a material using a specific amount of force.

How does this property impact designing with materials?

Think back to the chairs

→ The metal chair feels cold and I already know it is going to be hard and uncomfortable. But it is very durable, will last a long time, and I am more likely to remind focused and alert.

→ The fabric covered chair feels soft and I already know it is going to be more comfortable to sit and relax in, which is a different purpose than the metal chair.

PITCH

Think of a xylophone

All of the bars are made of the same material,
but each bar makes a different sound when hit with the mallet

Why?

What do we mean by Pitch?

Pitch refers to the sound produced when a material is struck.

This depends on both the material and the size/shape. Tuning forks that are the same size will make different sounds when made from different materials.

Sound moves through materials via vibration waves → so the faster the frequency of the waves, the higher the pitch!

Properties such as *Young';s modulus* and *density* impact how the waves travel through a material.

How does this property impact designing with materials?

This is a crucial property to consider when designing a musical instrument!

→ A marimba, a xylophone, and a glockenspiel have very different sounds, even though they all look very similar → they are made of different materials and are different sizes too!

Property Definition

DENSITY

Touch & Feel

"What is heavier, a pound of feathers or a pound of bricks" is a common brain teaser*

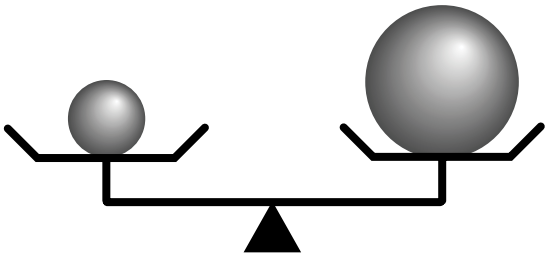
When we consider a single brick and a single feather, this riddle can become more complicated.

Which would be heavier? **Why?**

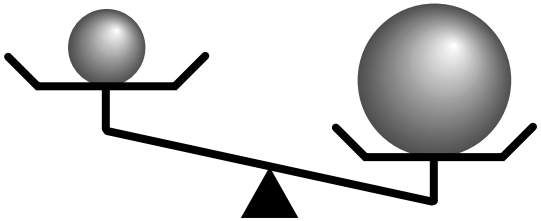
*The answer is they are the same weight- a pound!

This riddle is easy- if you understand density!

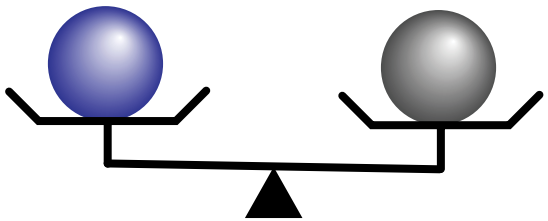
If the objects are the same *material*, ***size*** matters!



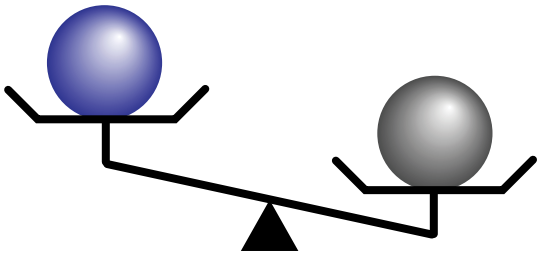
A larger steel ball is heavier than a smaller one



If the objects are the same *size*, then the material ***density*** matters!



The gray (steel) ball is heavier than the blue (plastic) one



this is the case for our bricks and feathers!

flip for more info

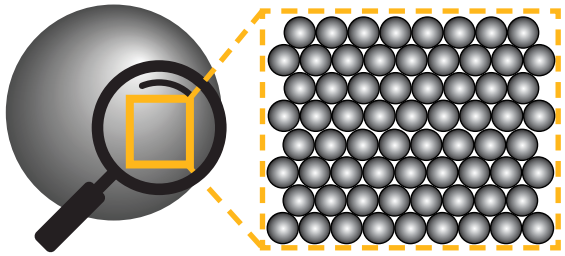
Property Definition

DENSITY

Touch & Feel

What causes materials to have different densities?

If we look inside a solid material, we will see that it is made of trillions of atoms.
There are ***two*** important details about these atoms that influence density.



1

Atomic Mass

All atoms on the Periodic Table of Elements have different atomic masses. For example, Copper has an atomic mass of 63.5 g/mol, while Titanium only has an atomic mass of 47.9 g/mol.

2

Atomic Packing

Different materials atoms "pack" or arrange themselves in different ways. ***Crystalline materials*** are highly organized with periodic, repeating 3D arrangement of atoms, ions, or molecules (*i.e.* metals). ***Amorphous materials*** lack this long-range periodic order (*i.e.* glass).

How does this property impact designing with materials?

Think of two toys: a boat and a diving ring

→ That boat needs to stay floating on the surface on the water, so we should pick materials that aren't too dense

→ That diving ring better sink to the bottom of the pool, so we can race to see who gets to the bottom and grabs it first! The diving ring will be much denser than the boat.

flip for more info