Thermal Expansion

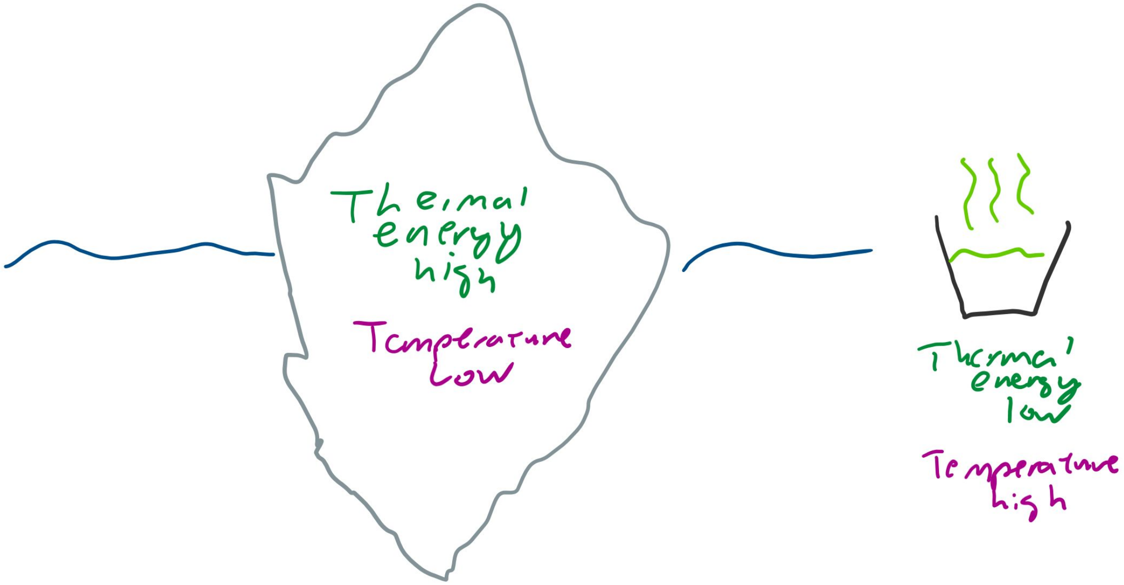
When the solid turn to solid but bigger

Review

Temperature

The average amount of energy the particles have

Opposed to thermal energy: the total amount of energy a sample has



Solids?

Structure

Strongly connected particles

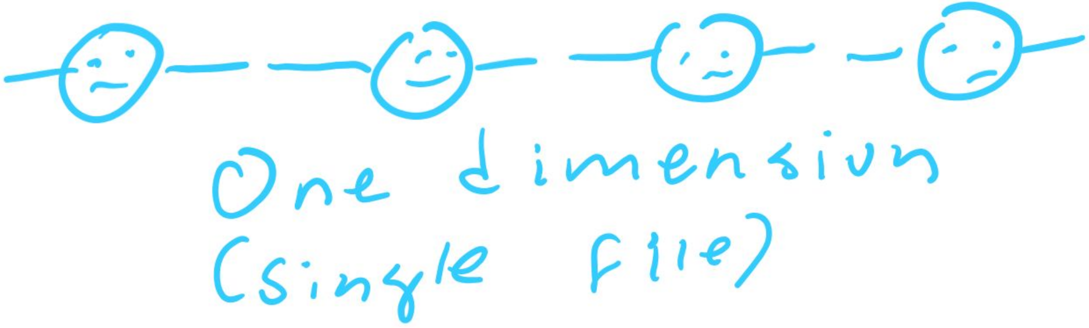
To weaken bonds, takes energy (like how it takes energy to pull apart two magnets)

When energy given, bonds stretch

Thermal Expansion

DIMENSIONS?

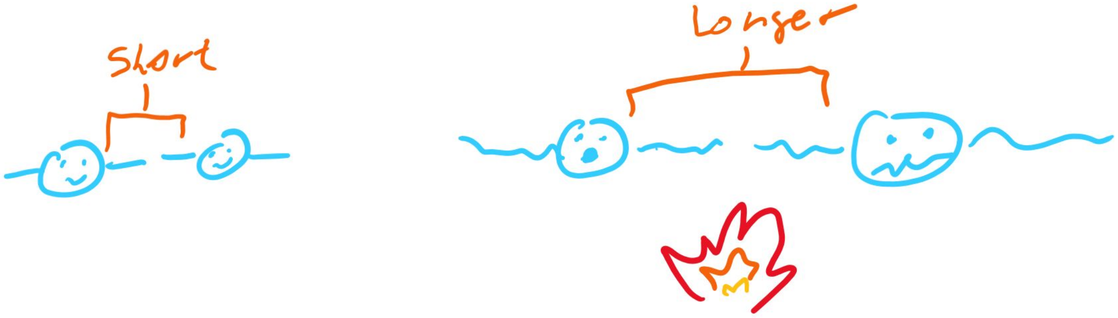
We will talk about 1D (one dimension) so the particles can only stretch in one direction



Expansion

Average amount of energy between bonds proportional to stretchy

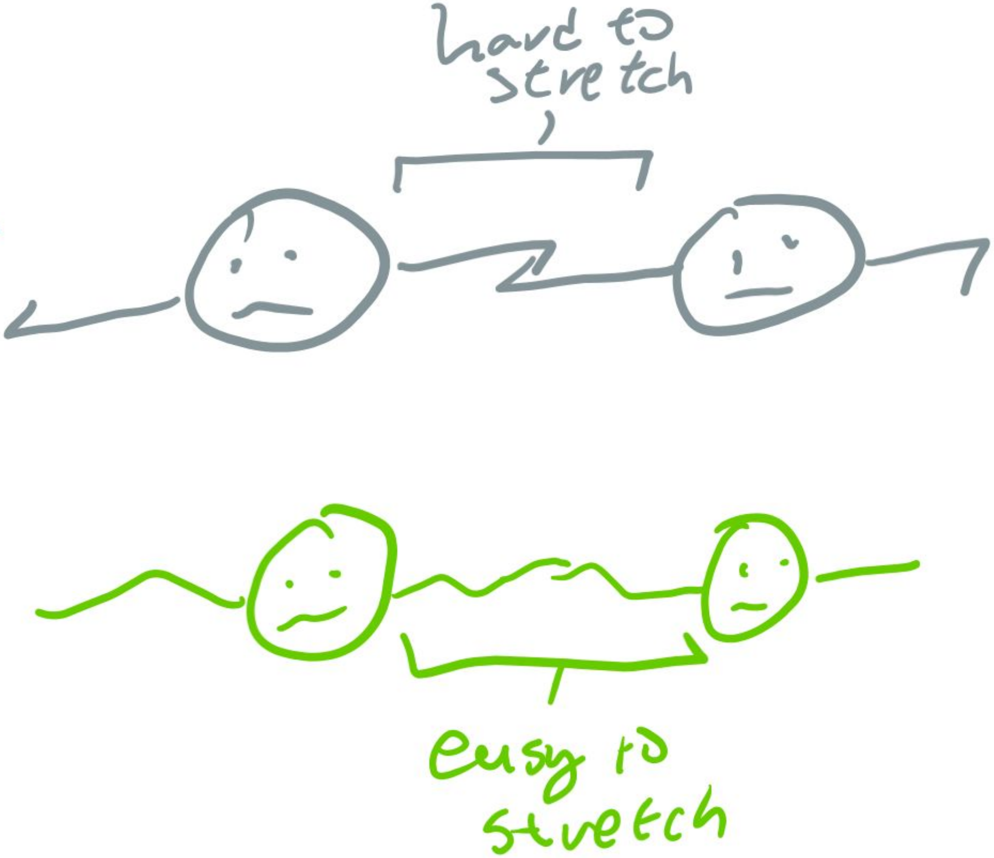
If temperature higher, distance between particles more



Stretchiness

Some substances stretch (or expand) more when temperature is added

The “stretchiness” of a substance is called the “thermal expansion coefficient”



How to remember?

Symbol: α (alpha)

Is a in Greek

If you stretch
someone out they’ll
scream aaaaaa

Ez claps

α

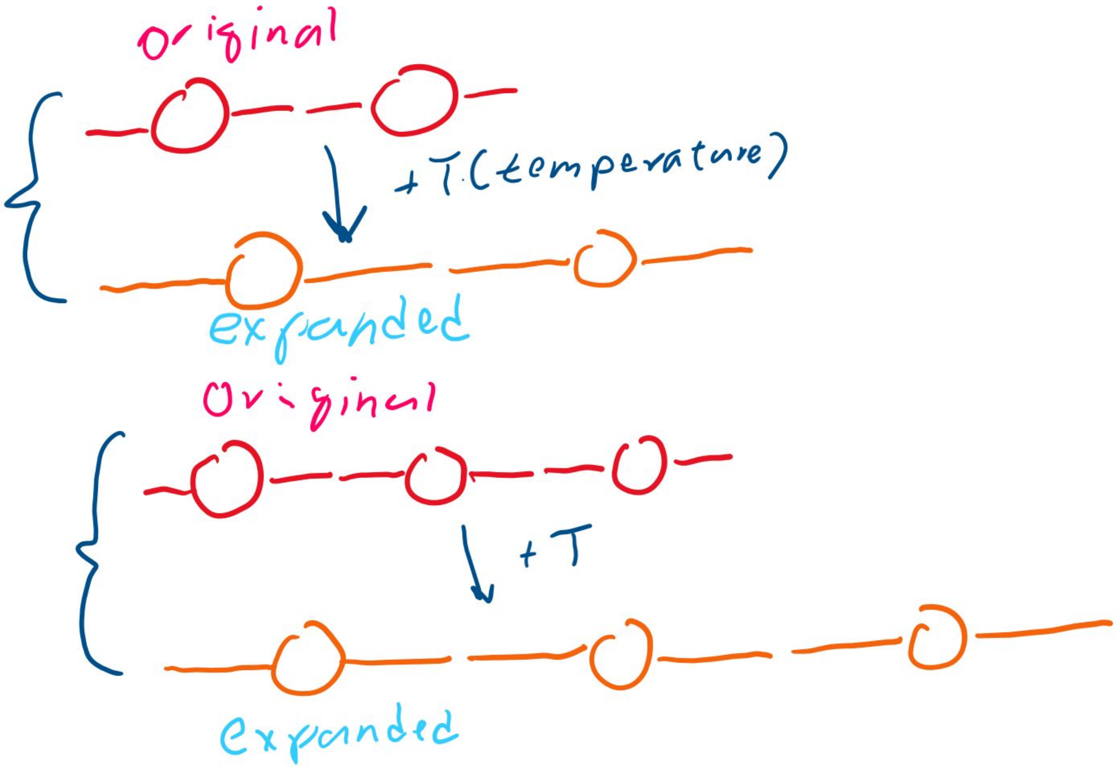
Name: alpha

Looks like: 

It's a fish!

Length and expansion

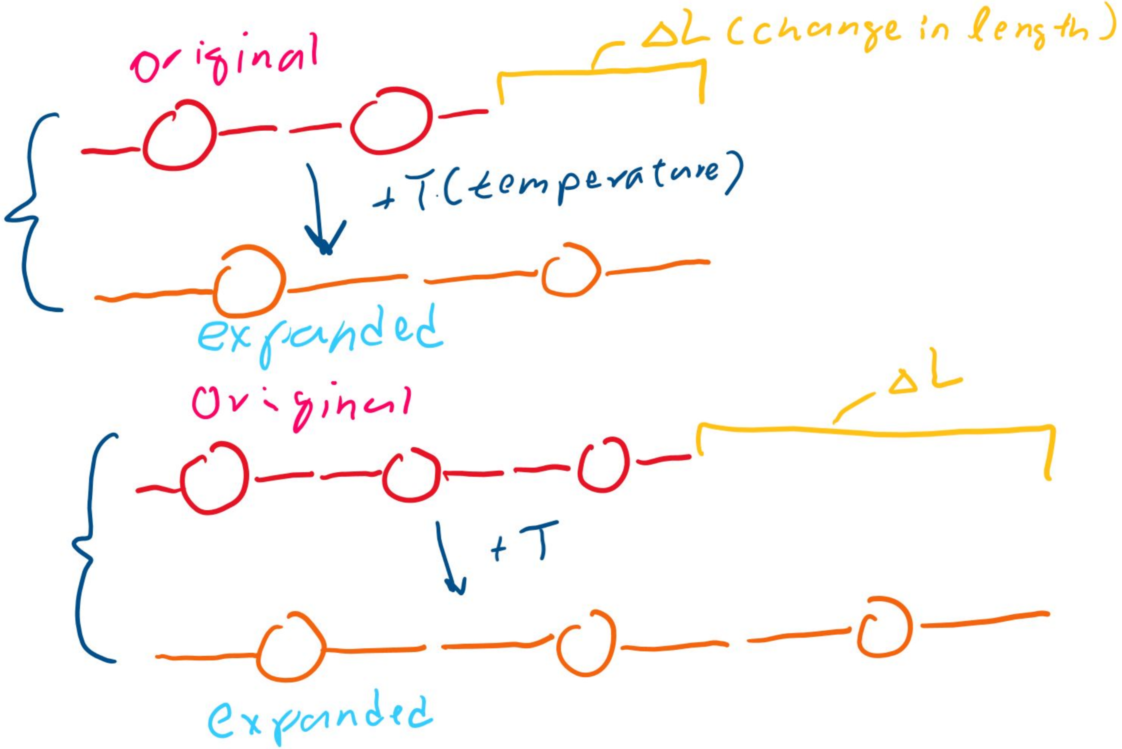
If the average length of bonds increases, which system on the right sees a longer change in length?



Original length

The bottom one!

It had a longer original length, so it was able to stretch a longer distance!



Equation

Change in Length

More change in temp means more change in length

More “stretchiness” means more change in length

Longer original length means more change in length

thermal expansion coefficient

original length

$$\Delta L = \alpha \Delta T L_0$$

Change in length

Change in temperature

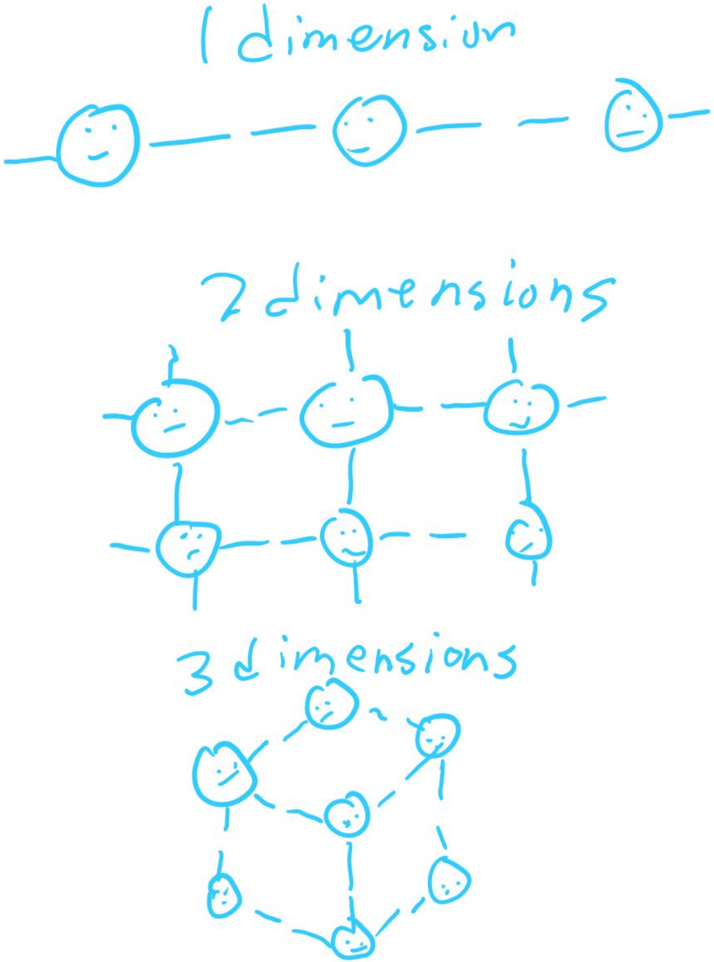
More dimension?

OTHER DIMENSIONS

1D is like a long rod (what we were using before)

2D is like a flat plate

3D is like a cube or any shape that is not flat



EQUATIONS

1 dimension

$\Delta L = 1\alpha \Delta T L_0$ → length

2 dimensions

$\Delta A = 2\alpha \Delta T A_0$ → area

3 dimensions

$\Delta V = 3\alpha \Delta T V_0$ → volume

Derivation to 2D (too hard, no need to memorize)

$$\Delta L = L_{final} - L_{original}$$

$$L_f - L_0 = \alpha \Delta T L_0$$

$$L_f = \alpha \Delta T L_0 + L_0$$

$$L_f^2 = A_f$$

$$A_f = (\alpha \Delta T L_0 + L_0)^2$$

$$A_f = L_0^2 + 2\alpha \Delta T L_0^2 + \underbrace{\alpha^2 \Delta T^2 L_0^2}_{\text{close enough to } 0}$$

$$A_f = A_0 + 2\alpha \Delta T A_0$$

$$A_f - A_0 = 2\alpha \Delta T A_0$$

$$\Delta A = 2\alpha \Delta T A_0$$

Derivation boring

Here's the conceptual way to remember it:

In 2D you can stretch in 2 directions

In 3D you can stretch in 3 directions

See? It's like 1D but in more directions!