Temperature

Temperature measures the average kinetic energy of molecules and atoms:

$$T \sim KE_{avg}$$

Average kinetic energy of N molecules of gas:

$$KE_{avg} = \frac{KE_1 + KE_2 + \cdots + KE_N}{N}$$

Higher temperature means higher kinetic energies:

$$T \uparrow \Rightarrow KE_{avg} \uparrow \quad \longrightarrow \quad T \downarrow \Rightarrow KE_{avg} \downarrow$$

Temperature

Different temperature scales:

$$t_F = 32 + \frac{9}{5} \cdot t_C$$

$$T_K = t_C + 273.15$$

The absolute zero temperature in Kelvins:

$$T_K = 0\ K \quad \Longrightarrow \quad KE_{avg} = 0$$

For ideal gases (we will use it for any gases):

$$KE_{avg} = \frac{3}{2} \cdot k \cdot T_K$$

$$k = 1.38 \cdot 10^{-23}\ \frac{J}{K}$$

Homework 18

Problem 1.
What is the temperature of a human body in the Kelvin scale?

Problem 2.
The temperature in the room is increased from 15℃ to 39℃. How many times did the average kinetic energy of the air molecules increase (use the formula for ideal gases)?

Problem 3.
Find the average speed of motion of oxygen molecules in the air at temperature 300 K (this is often taken as the value of typical room temperature because the number is nice). Mass of the oxygen molecule is $m_{O_2} = 2.7 \cdot 10^{-26} kg$.

Problem 4* (bonus problem).
Consider exactly one oxygen molecule (from the last problem) in a room, flying back and forth between two walls. Estimate the average force this molecule produces on the walls. Take the distance between the walls to be 1 meter. How many molecules of the same kind are needed to produce a force equal to 1 N?
Hint: You might want to refresh the relationships between momentum, impulse and force.