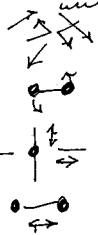
HEAT - WHAT IS IT?

We have seen that TEMPERATURE is a measure of the internal energy - random motions in a substance. We won't get embroiled in the 18th - 19th Century debate over caloric vs. kinetic theory (But read about the exploits of BENJAMIN THOMPSON a.k.a. COUNT RUMFORD who all but disproved the idea that heat is an indestructible fluid in favor of the idea that heat represents motion on the microscopic level

- HEAT IS DISORGANIZED (RANDOM) ENERGY

Up until now we've dealt with ordered motion of big objects - heat or thermal energy is the internal random motions of the microscopic particles (molecules, atoms, ions, free electrons - e.g. center of sun it was the p^+ = H nuclei + free e^-). This energy can be associated with translational motions - gas, liquid



rotational motion

vibrational motions

molecules in gas, liquid

molecules in gas, liquid

atoms in solid lattice

Temperature is fundamental - your book quantifies it but doesn't define it. Let's give it a shot

THERMAL EQUILIBRIUM (Thermodynamic) OR exists when there is no heat transfer between objects or different components of a system. In this case, many physical properties of a system can be characterized by a single number - the TEMPERATURE. Among these physical properties are:

DIST'N OF ATOMIC/MOLECULAR VELOCITIES
DIST'N OF ELECTRONIC ENERGY STATES OF ATOMS
IONIZATION STATE OF MATERIAL
AMOUNT AND SPECTRUM OF LIGHT PRODUCED
⋮

e.g. average kinetic energy in an ideal gas

$$\langle K \rangle = \frac{3}{2} kT$$

where k is a const known as the Boltzmann const.

Temperature scale SI K = Kelvin

We shall see that one fundamental way of looking at temperature is in terms of the internal energy of a substance

THERMAL ENERGY IS THE NET DISORDERED KINETIC ENERGY ASSOCIATED WITH THE BASIC PARTICLES WHICH MAKE UP A SUBSTANCE

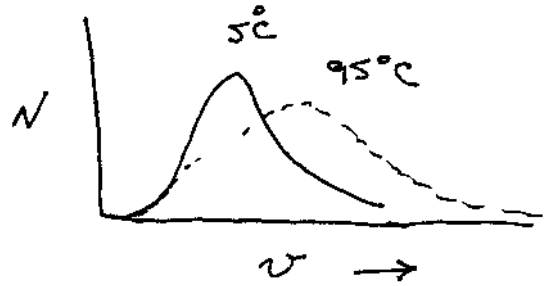
n.b. we can transform ordered energy into disordered energy

- Temperature is a measure of concentration of thermal energy

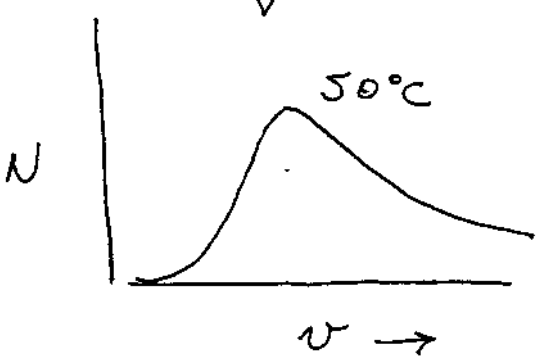
HEAT (Q) IS THE THERMAL ENERGY TRANSFERRED FROM A REGION OF HIGH TEMPERATURE TO LOW TEMPERATURE

Particles collide with one another + exchange energy (+ momentum)

e.g. mix a batch of water at 5°C with a batch at 95°C



High energy particles will exchange energy w/ lower energy particles



MECHANICAL EQUIVALENT OF HEAT

Heat Units - Since heat is thermal energy exchanged God's unit is

JOULES (J) = $1\ kg\ m^2/s^2 = 1\ N \cdot m$

(Erg = $1\ gram\ cm^2/s^2$)

In chemistry you will continue to see the

calorie = 4.1860 J originally the amount of heat to raise 1 gram H_2O from T = 14.5°C - 15.5°C

(lower case "c")

Those of you who dieting

Calorie = 1 kc (1 kilocalorie)

= $\frac{1}{145}$ the amount of heat generated by 1 oz of good chocolate

(UPPER CASE "C")

$= 10^3\ cal = 4186\ J$

Engineering

British Thermal Unit (BTU) = 1055 J

amount of heat needed to raise temperature of 1 lb of H_2O from T = 63 - 64°F

Most HEATING/AC systems are rated in BTU/hr.