Temperature Scales

Temperature is a measure of the average kinetic energy of particles in a system. There are three temperature scales we need to talk about:

a.) Celsius scale (same as Centigrade scale): Uses zero point as temperature water freezes; calibrated so that water boils at 100 degrees C.

b.) Fahrenheit scale: Uses water freezing at 32 degrees; water boils at 212 degrees F. (His rational for scaling as he did was REALLY obscure—it had to do with the freezing of brine water!)

c.) Kelvin scale: Used by scientists, its zero is at absolute zero (point where molecular kinetic energy is zero); water boils at 273 degrees K.

Notice that if you are talking generally about temperatures in the tens of thousands of degrees, it really doesn't matter what units you put on the value.

373° K	100° C	(water boiling)	212° F
273° K	0° C	(water freezing)	32° F
0° K	-273° C	(absolute zero)	-460° F

2.)

Energies in Joules

As a reminder, one joule is the amount of energy needed to raise a one-tenth of a kilogram of mass up one meter. In the language of us "mericans," that's the equivalent of raising a quarter-pounder three feet off the ground.

A piece of buttered toast contains   . . . .   315,000 joules

    With that energy, you could:
    a.) jog for 6 minutes
    b.) bicycle for 10 minutes
    c.) walk briskly for 15 minutes (that means you are looking at
        1.260,000 joules burnt per hour)
    d.) sleep for 1.5 hours
    e.) run a car at 50 mph for 7 seconds
    f.) lift a 5 lb sack of sugar a little over 2 ft 2100 times

Energy/Temperature Comparisons

One *electron-volt* is the amount of energy an electron picks up after being accelerated through a one volt electrical potential difference.

An *electron-volt* is numerically equal to 1.6×10^{-19} joules of energy.

It is not uncommon to characterize the amount of energy a single particle (i.e., a single atom or single molecule) has in electron-volts.

The abbreviation for the electron-volt is "eV."

Particle Energies in eV's

Temperature is related to energy as

$$E = n\,k\,T$$

where n is an integer between 1 and 3 (depending upon the substance), k is Boltzman's constant ($8.6\text{x}10^5$ eV/molecule^o K), and T is temperature in degrees Kelvin.

Particle Energies in eV's

Particle-energy/temperature summary:

    --1 keV is 1000 eV and corresponds to approximately 10^7 K.

        --this is approximately the particle energy at the core of the sun

    --1 MeV is 1,000,000 eV and corresponds to approximately 10^{10} K.

        --1000 times the particle energy at the core of the sun

Particle Energies in eV's

--1 GeV is 1,000,000,000 eV and corresponds to approximately 10^{13} K.

   --this is a million times more energetic than the atoms at the
   core of our star and corresponds to the particle energy of the
   universe at approximately 1 second after the Big Bang

--1 TeV is 1,000,000,000,000 eV and corresponds to 10^{16} K.

   --this is a billion times more energetic than the atoms at the
   core of our star

   --our most energetic particle accelerators can provide subatomic
   particles with energies in this range.

   --this corresponds to particle energies in the universe at
   approximately 10^{-12} seconds after the Big Bang.

Particle Energies in eV's

The binding energy of carbon is approximately 1 eV. That means that when you burn a piece of wood, you get out around 1 eV's worth of energy *per atom* from the reaction.

Temperature is a measure of the average kinetic energy of the atoms or molecules that make up a system.

> The molecules of the air in a room has approximately 1/40 of an eV's worth of energy.

> If the molecules of the air in a room had 1 eV's worth of energy, the room would glow and its temperature would be approximately 10,000 degrees kelvin (this is a little greater than the temperature of the sun's surface).

> At the core of the sun, the particle energy is around 1 keV. this corresponds to a temperature of approximately 10,000,000 $^{\circ}$K.