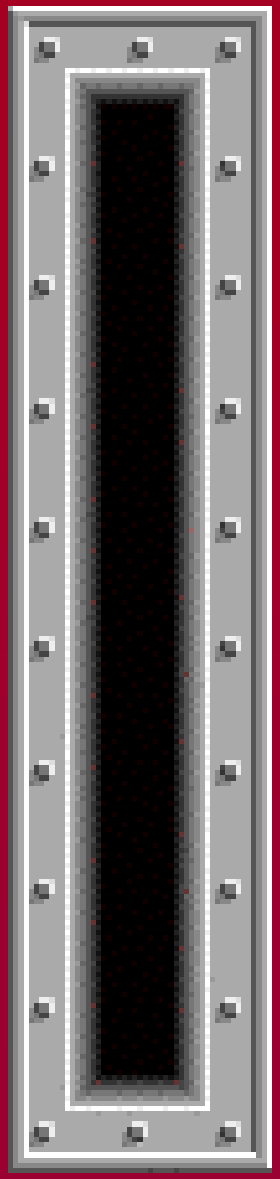
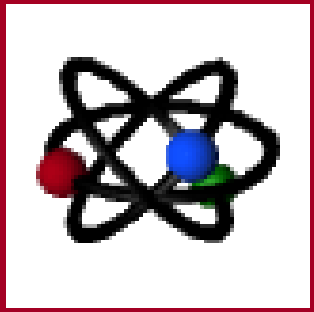


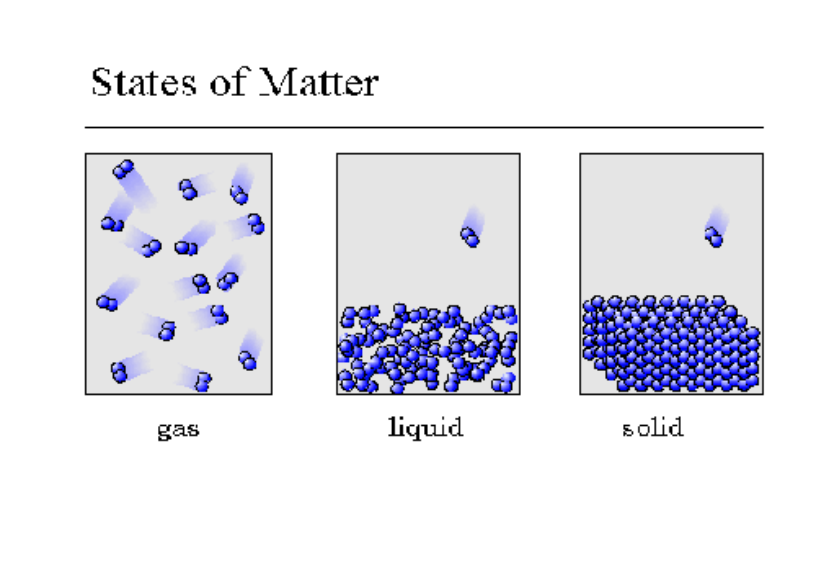
Ch 4 Temperature & Heat

Temperature Depends on Particle (atom) Movement



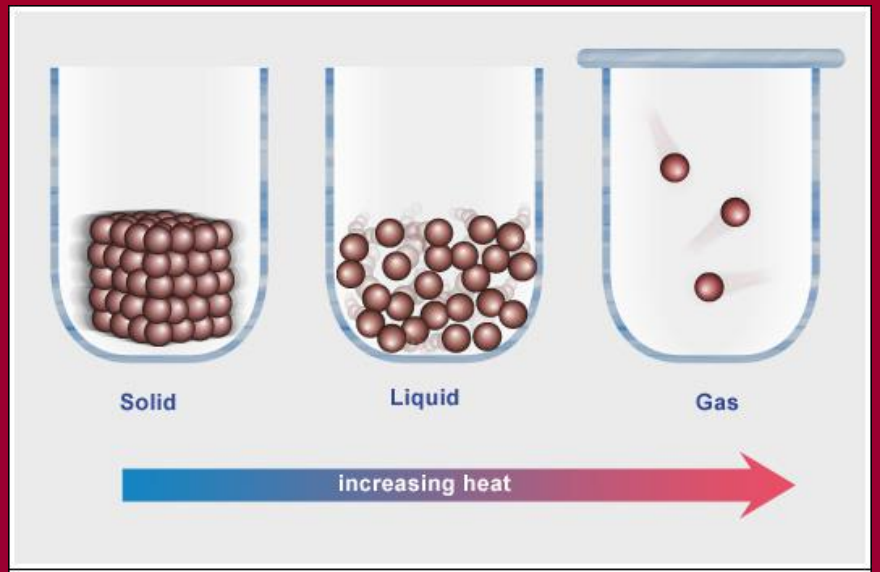
All matter is made of moving particles

Kinetic Theory of Matter—particles in matter are constantly moving (unless they are at absolute zero temperature); particles in solids, liquids, & gases move *differently*



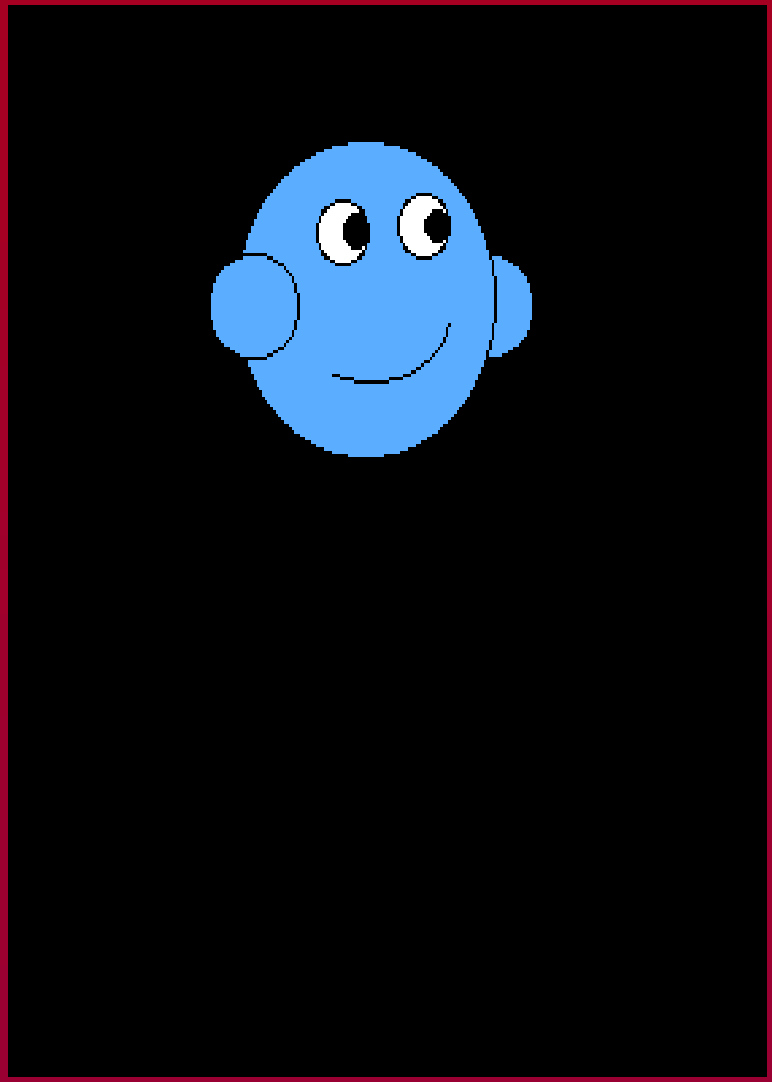
Particles do not move at the same speed!!

- Solid—particles vibrate in fixed positions but do not move past each other
- Liquid—particles slide past each other
- Gas—particles move freely



Solids are rigid because their particles can't overcome the attractive forces locking them in place. Particles in a liquid have enough energy to move more freely, so they can slosh about and need containing. Gas particles have enough energy to completely overcome the attractive Van der Waals forces – they need a container with a lid.

Temperature—
measurement of average kinetic energy of all particles in an object or location

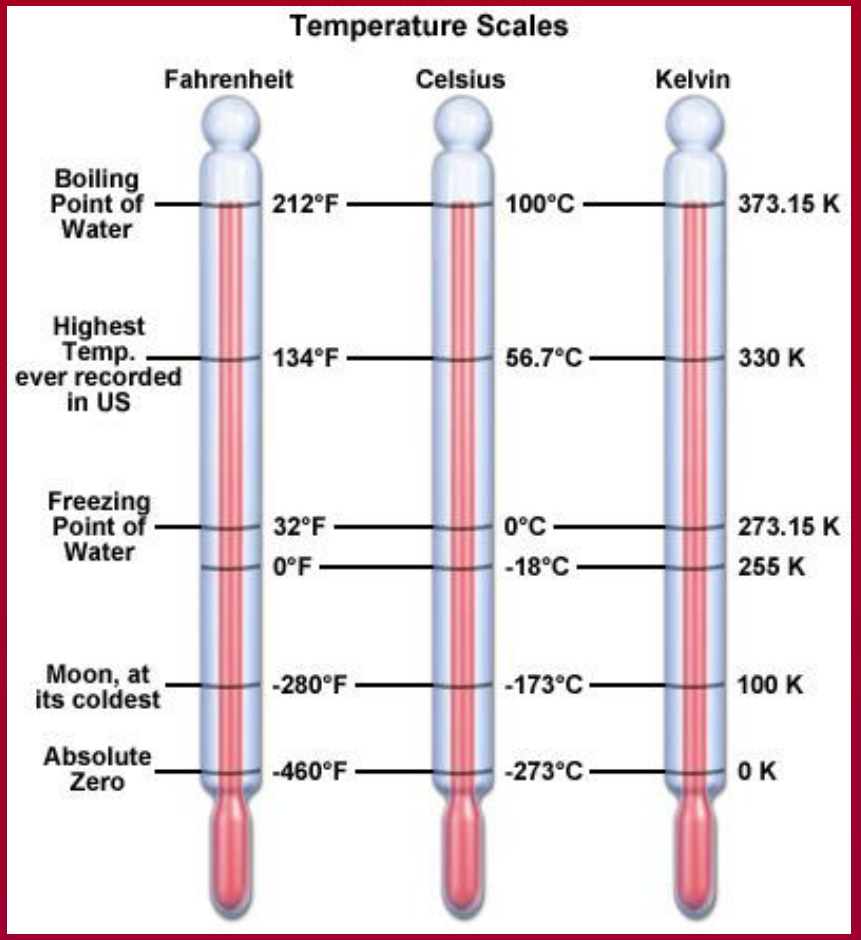


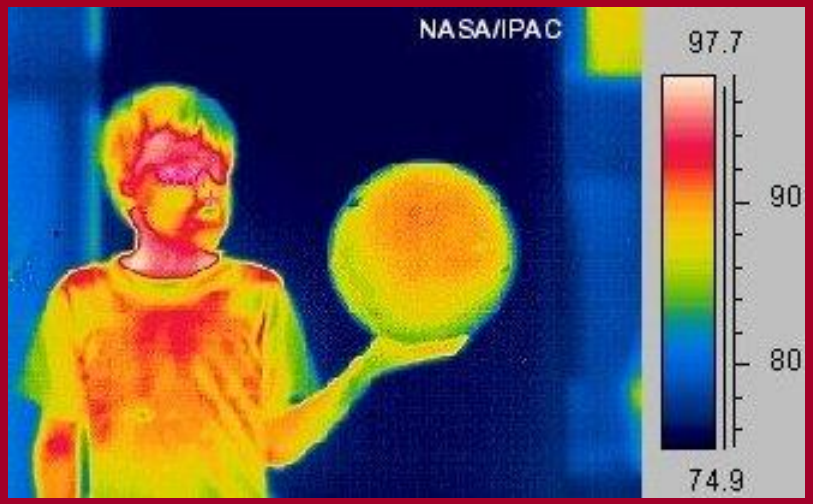
Temperature Scales

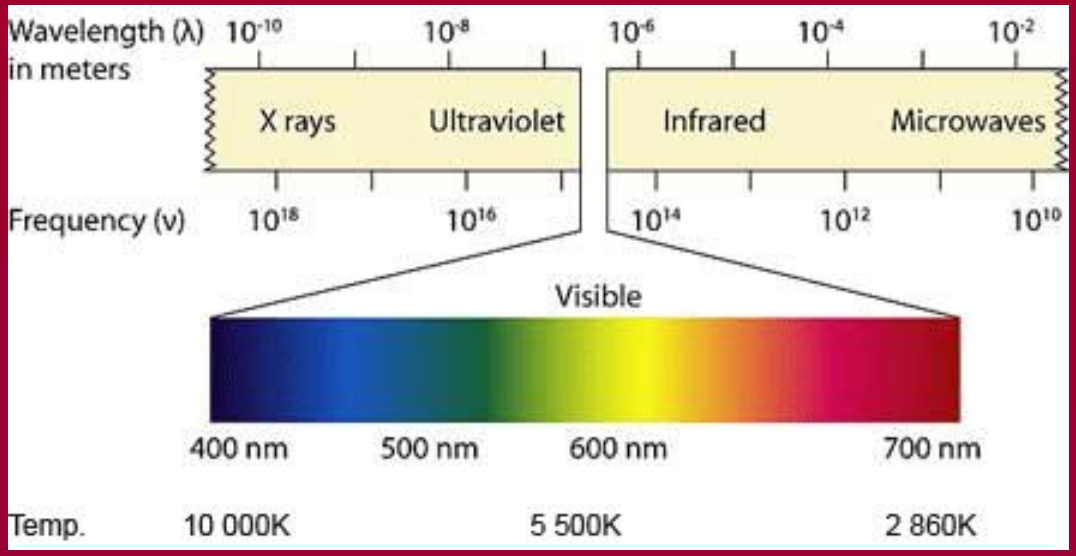
1. Fahrenheit
2. Celsius
3. Kelvin—zero point is absolute zero (no particle movement)

= -273.15 degrees Celsius

= -460 degrees Fahrenheit




NASA/IPAC
97.7
90
80
74.9


Wavelength (λ) in meters
10^{-10}
10^{-8}
10^{-6}
10^{-4}
10^{-2}
X rays
Ultraviolet
Infrared
Microwaves
Frequency (ν)
10^{18}
10^{16}
10^{14}
10^{12}
10^{10}
Visible
400 nm
500 nm
600 nm
700 nm
Temp.
10 000K
5 500K
2 860K

Thermometers

- those filled with alcohol or mercury measure through <u>uniform thermal expansion</u>
- Others measure through electrical resistance, infrared radiation, & differential expansion of materials

←*infrared radiation*

Copy the conversion formulas on p. 109…

Make the following conversions:

Convert to Celsius:

89 degrees F

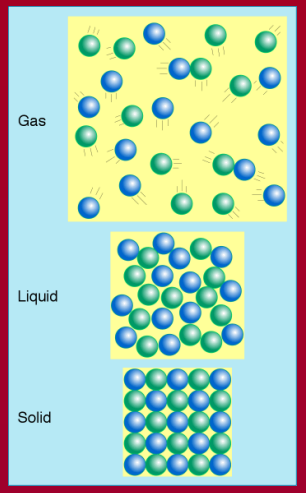
78 degrees F

Convert to Fahrenheit

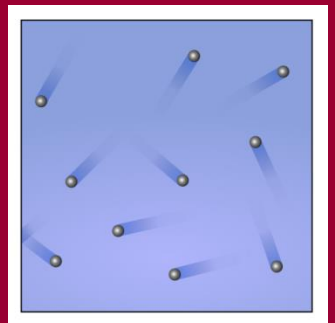
12 degrees C

30 degrees C

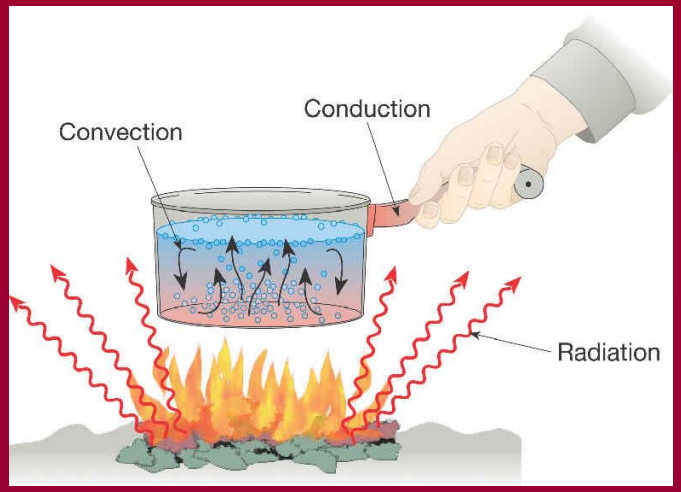
4.2 Energy flows from warmer to cooler objects



- Heat is different from temperature
  - Temp is a measurement
  - ***Heat is the flowing of energy
- Heat, temp., & thermal energy are closely related but not the same
  - Temperature—measurement of average kinetic energy of particles in an object or location

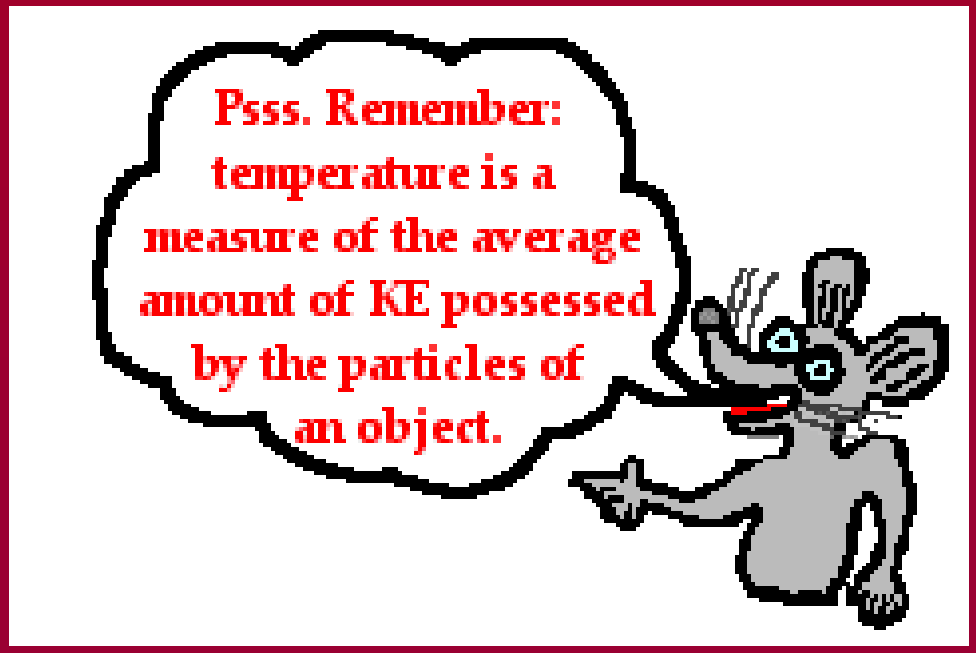


- Heat—flow of energy *from* an object or location of a higher *to* lower temp
  - Transfer of energy through heat continues as long as the temp difference exists (thermal energy of both objects change)



Temp = *average*
thermal=*total*

– Thermal energy—total kinetic energy of particles (atoms) in a substance or location



Units of Measurement for Heat

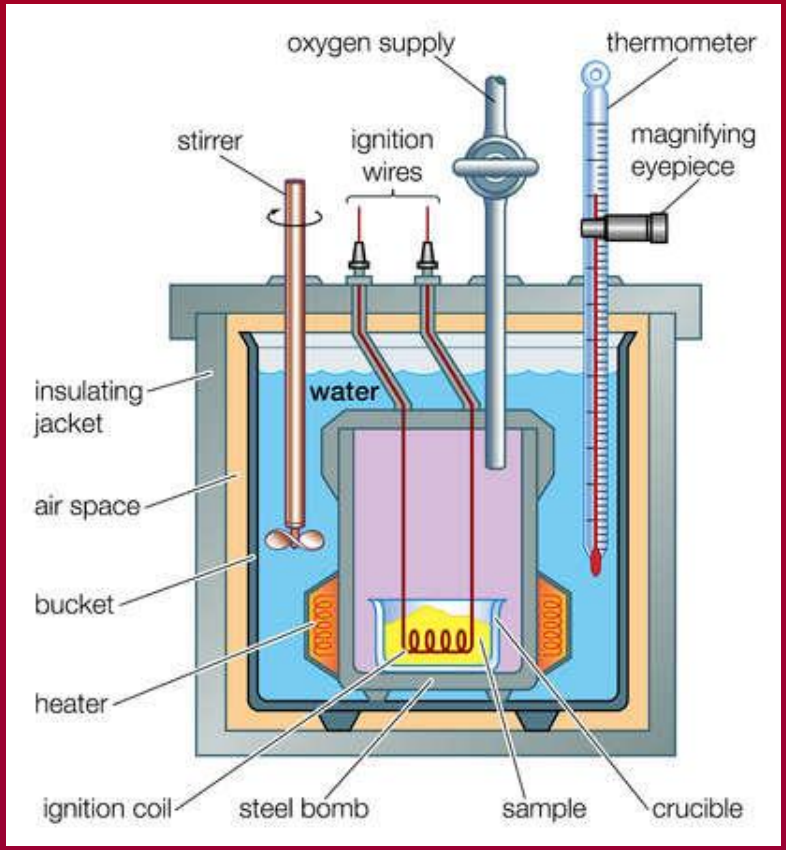
1. Calorie—amount of energy needed to raise the temperature of 1 gram of water 1 degree Celsius
   - A calorie with a capital C is a kilocalorie (1000 calories)
2. Joule—standard scientific unit for measuring energy
   - 1 calorie = 4.18 Joules

Calorimeter

Used to measure the

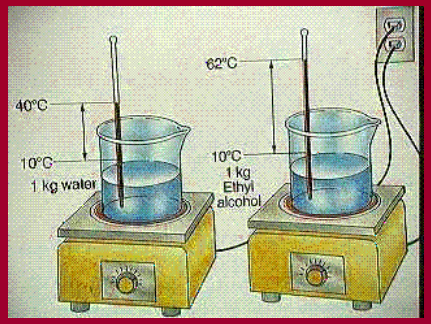
Amount of calories

In food



Some substances change temp more easily than others

- Specific heat—amount of energy needed to raise the temp of 1 gram of a substance 1 degree Celsius



*The higher the specific heat,

The slower it will heat up or cool down

  - The more mass an object has, the more energy required to produce an increase in temp, & the more energy that must be released to decrease the temp

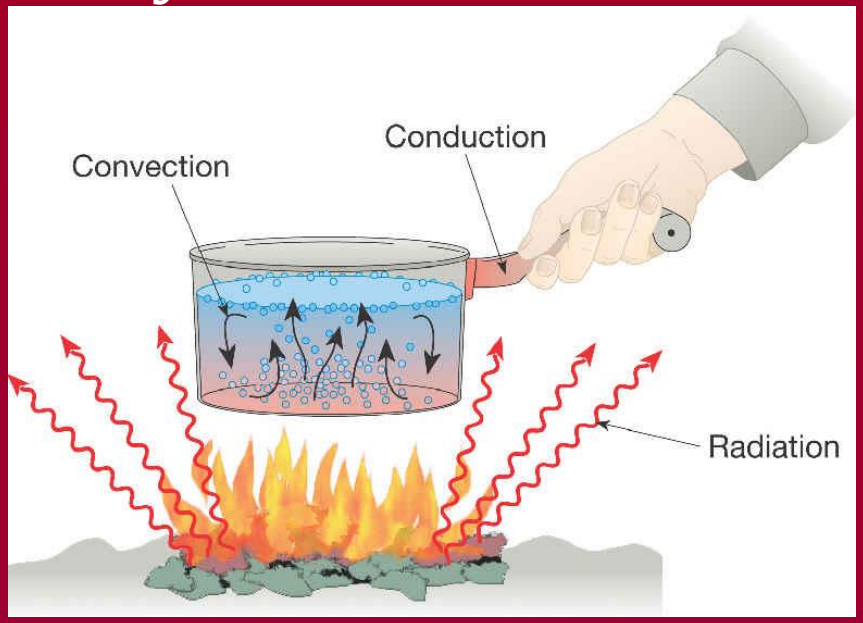
Table 6.1 Specific Heats for Various Common Substances, in Terms of How Many Calories of Heat are Required to Heat up 1 Gram by 1°C

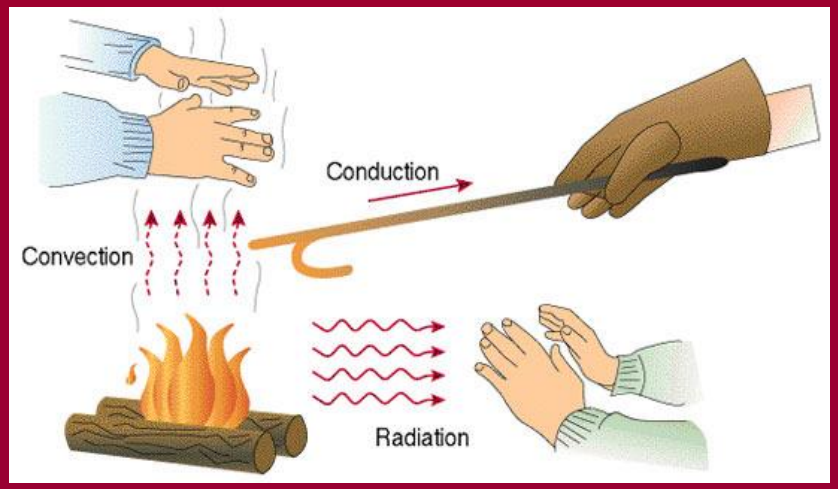
Substance	Specific Heat (cal/g/°C)
Alcohol	0.58
Aluminum	0.21
Copper	0.09
Gold	0.03
Leather	0.36
Marble	0.21
Salt	0.21
Sugar	0.27
Synthetic rubber	0.45
Water	**1.00**
Wood	0.42

4.3 The transfer of energy as heat can be controlled

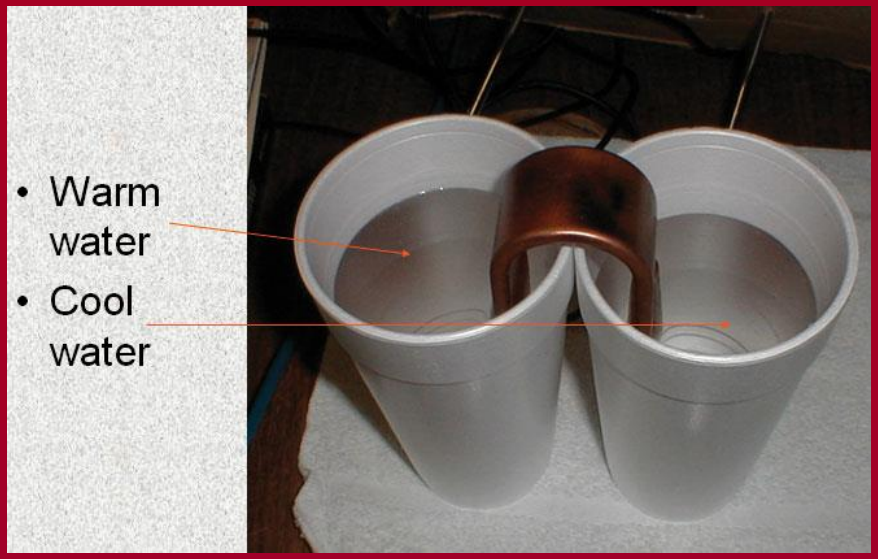
Energy moves as heat in 3 ways

1. Conduction
2. Convection
3. Radiation



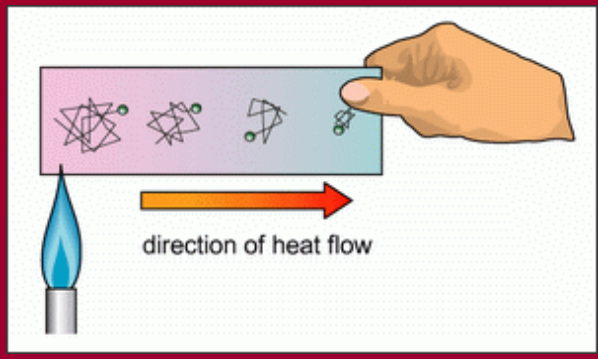


Conduction

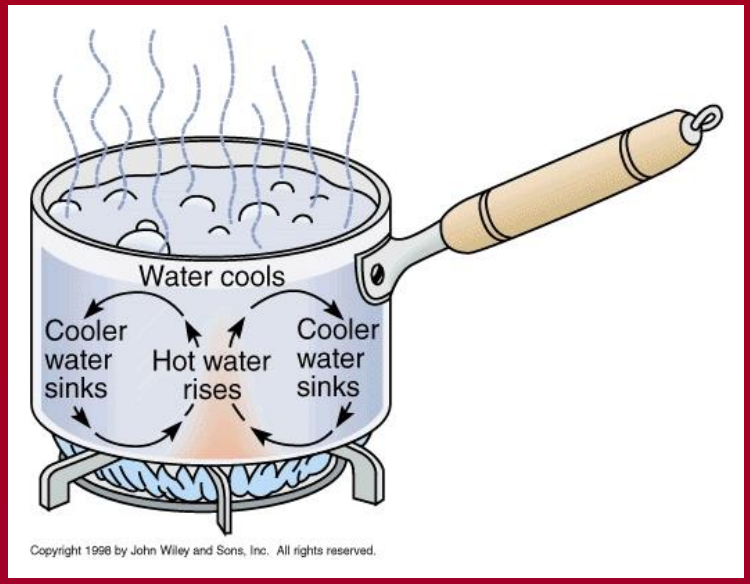


Energy is transferred through physical contact

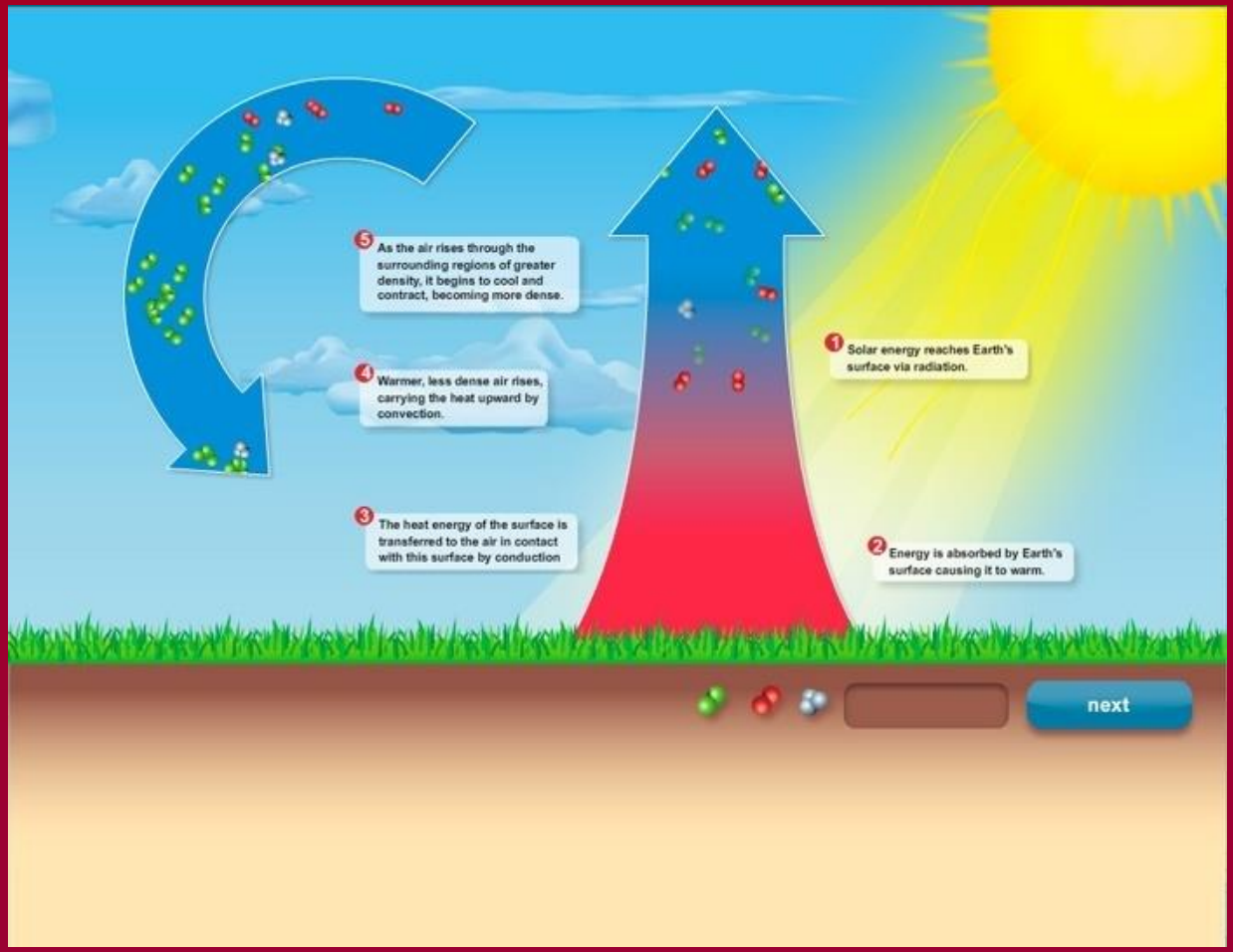
- Particles of a warmer substance collides with particles of a cooler substance
  - Conductors—materials that can easily transfer energy ***(low specific heat)***
  - Insulators—materials that do not transfer energy easily ***(high specific heat)***

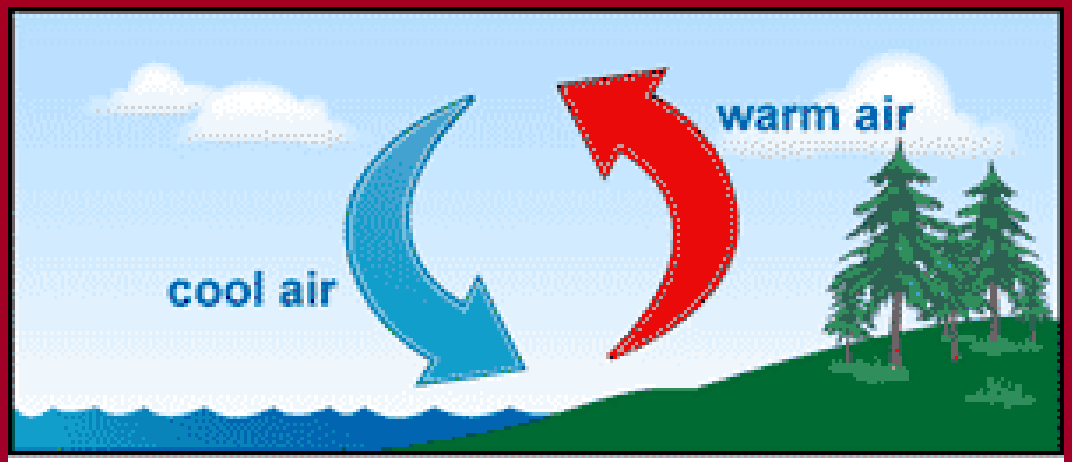


Convection

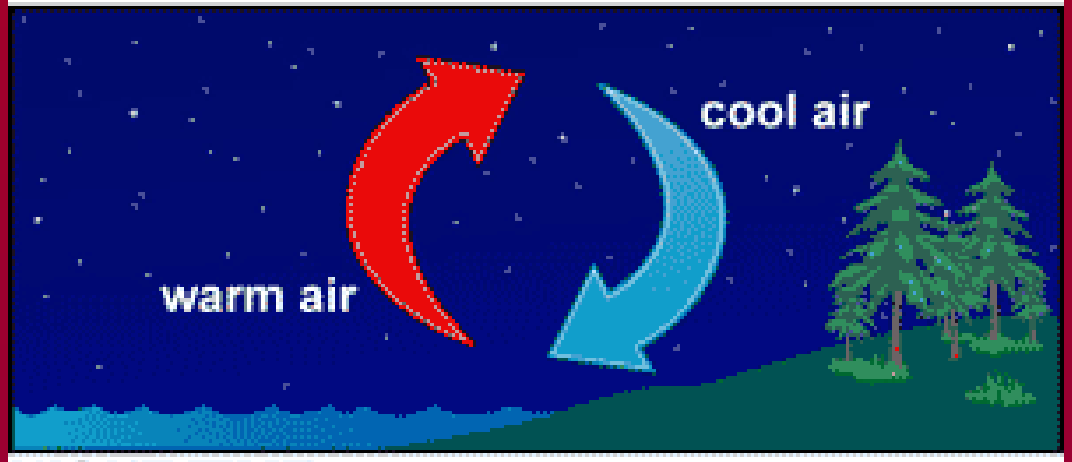


- Process that transfers energy in gases & liquids
  - Differences in densities between substances are produced by differences in temp
  - Creates currents
  - A warmer region of gas/liquid is less dense than a cooler region, due to thermal expansion
  - Warmer fluid rises & cooler fluids sink
  - Cycles of convection accounts for currents in bodies of water & winds in the atmosphere

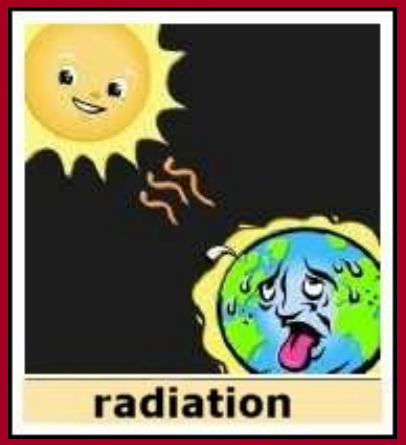

5 As the air rises through the surrounding regions of greater density, it begins to cool and contract, becoming more dense.
4 Warmer, less dense air rises, carrying the heat upward by convection.
3 The heat energy of the surface is transferred to the air in contact with this surface by conduction
1 Solar energy reaches Earth's surface via radiation.
2 Energy is absorbed by Earth's surface causing it to warm.
next

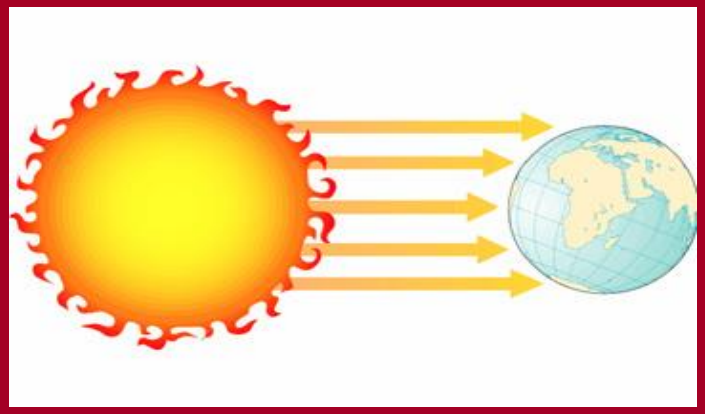


DAY TIME



NIGHT TIME



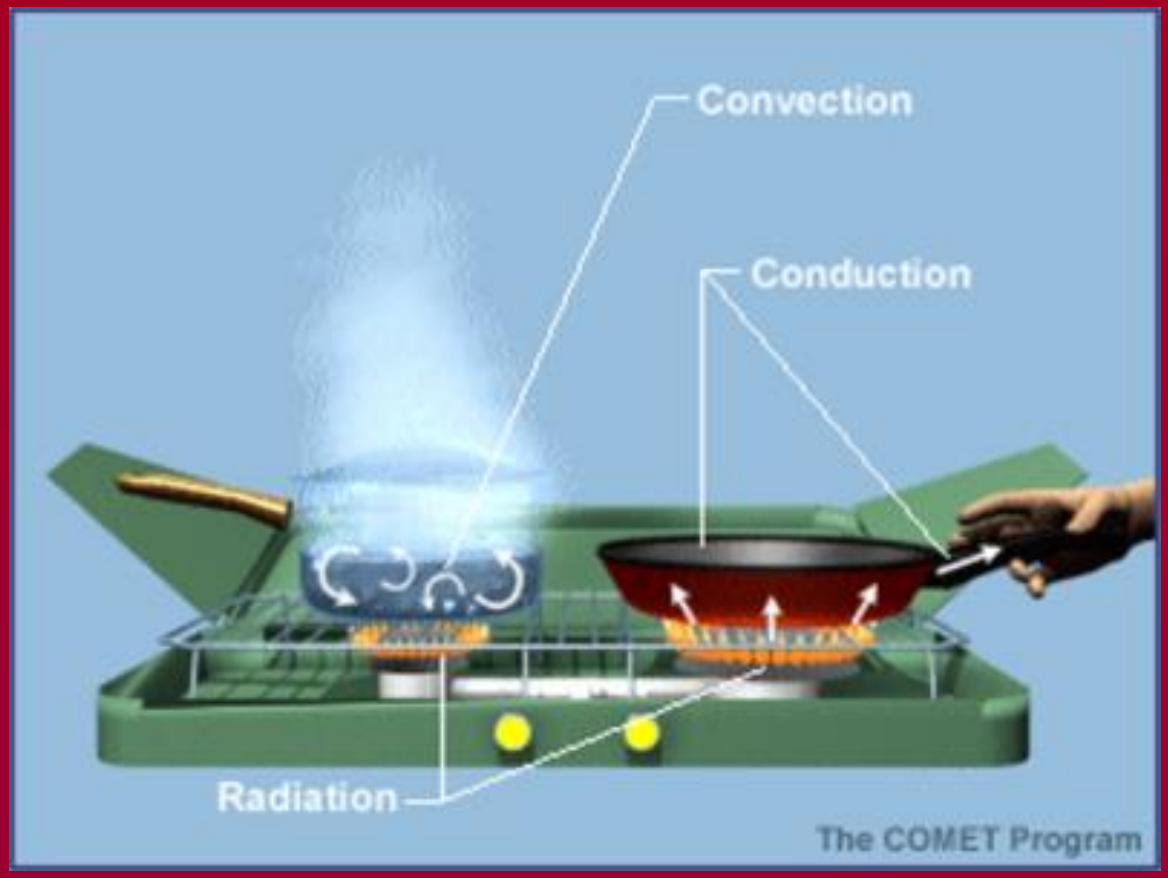


Radiation

Energy that travels as electromagnetic waves (visible light, infrared light, x-rays)

Travels through <u>SPACE</u>

- Energy can radiate through a vacuum (empty space)
- When radiation is absorbed by an object, the transfer of energy (as heat) occurs


Convection
Conduction
Radiation
The COMET Program

Different materials are used to control the transfer of energy

Materials are used for different purposes, depending on whether they are good or poor conductors of energy

- Many insulators contain or trap a layer of air, which is a poor conductor of heat