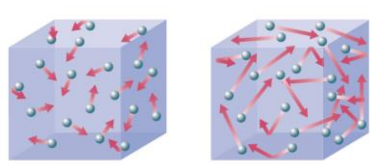
Physical Science
Chapter 6

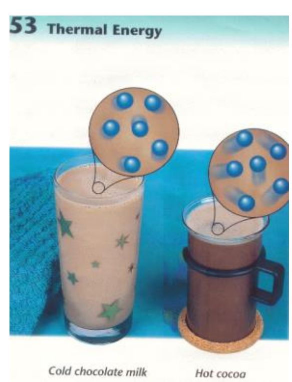
Thermal Energy
& Heat

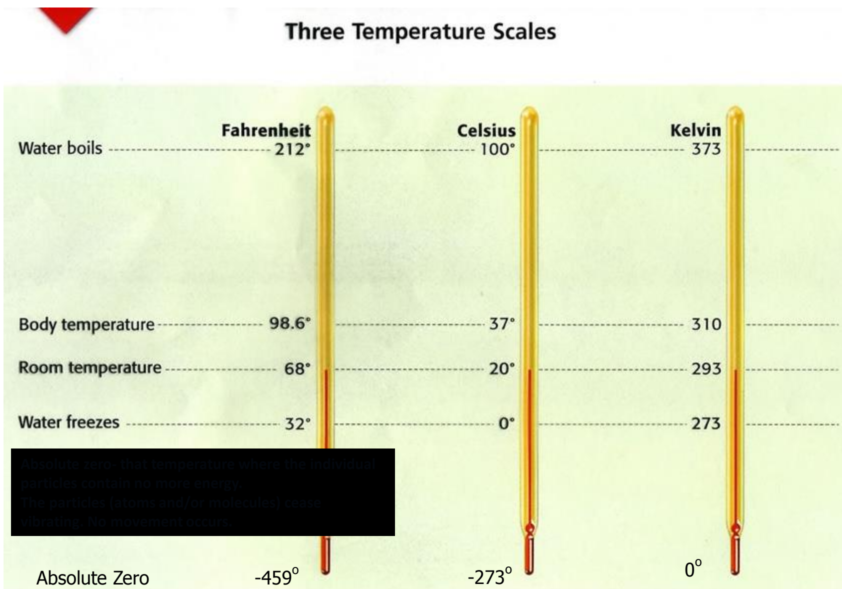
Thermal Energy and Heat

- **Temperature** – a measure of the AVERAGE kinetic energy of the individual particles of a substance.
- **Thermal energy** – TOTAL energy of all of the particles
- **Heat** – thermal energy moving from a warmer object to a cooler object, trying to reach thermodynamic equilibrium.



Longer arrows mean higher average speed.



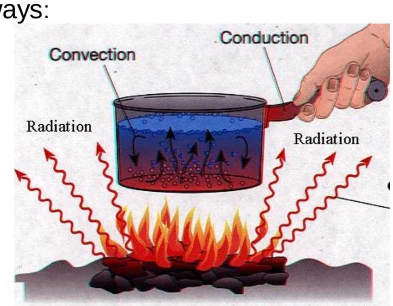


Heat Transfer

- Always trying to reach **Thermodynamic Equilibrium**
- Heat is transferred (moves) in only one direction: from a warmer object to a cooler object.
  - Hot coffee cools to room temp because the heat of the coffee is transferred to the cooler temperature of the room.
  - A cold glass of Iced tea soon warms up to the surrounding room temperature because the warmer temperature of the room's surroundings is transferred to the colder glass of iced tea thereby warming it up.
- Heat is transferred in one of three ways:
  - Conduction, Convection and Radiation

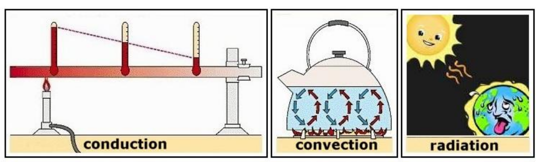
Conductor – a material that transfers heat well: metal, tile, glass

Insulator – a material that does not transfer heat well: air, carpet, wood



Conduction, Convection and Radiation

- **Conduction** – heat is transferred from one particle to the next particle w/out the particles actually moving or changing place.
  - Examples include: a metal spoon in hot water gets hot or a pot gets hot as it sits on an electric stove.
- **Convection** – movement that transfers heat by movement of currents within the particles. The particles actually are moving and thereby transferring the heat.
  - Examples include: a pot of boiling water sets up convection currents to move the hot water at the bottom of the pot being heated to the cooler water at the top of the pot and the convection zone in the sun.
- **Radiation Zone** – transfer of energy by electromagnetic waves.
  - Examples include: the Sun's energy traveling thru space and heating up the Earth w/out heating space itself, Heat lamps used at fast food restaurants, and the radiator of a car dissipating the heat of an engine.



Specific Heat

- the amount of energy required to raise the temperature of 1 kg of the object 1^0K.
- The unit is Joules/ Kg x ^{o} K
- Change in energy = Mass x Specific Heat x change in Temp
- How much heat is required to raise the temperature of 5Kg of water 10^oK? (Specific heat of water is 4,180 J/Kg^{o}K)

$$\Delta E = M x Sp x \Delta K$$

Change in Energy = 5 Kg x 4,180 J/Kg^{o}K x 10^oK

E = 209,000 J

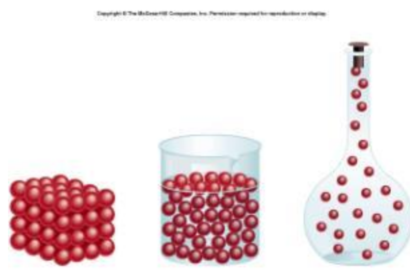
If the specific heat of iron = 0.46 J/g C°, how much heat is needed to warm 50 g of iron from 20° C to 100° C?

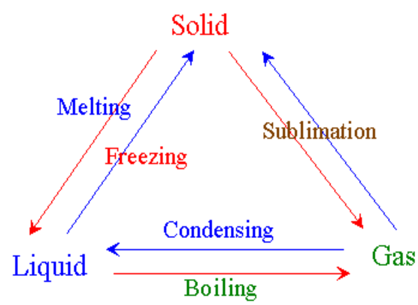
E = 50 g x .46 J / g ^{o}K x 80 ^{o}K = 1840 J

Answer: ___________

Thermal Energy & States of Matter

- Solid – atoms are in a fixed position, they only vibrate back and forth. Solids have both a definite shape and definite volume.
- Liquid – atoms are free to slide over and upon each other. Liquids have a definite volume but not a definite shape.
- Gas – atoms are free to move independently of other atoms of the substance. Gases have neither a definite shape or volume.





Heat & Phase Changes

- During a phase change, the temperature remains the same. The energy added to the system is used to change from one phase to the next….

For freezing and melting, heat = (mass in grams) (heat of fusion)
For boiling and condensation, heat = (mass in grams) (heat of vaporization)
The heat of fusion of water = 340 J/g
The heat of vaporization of water = 2,300 J/g

How many joules of heat are necessary to melt 500 g of ice at its freezing point?

heat = 500 g x 340 J / g = 170,000 J = 170 KJ

Answer: ________

If 57,500 joules of heat are given off when a sample of steam condenses, what is the mass of the steam?

57,500 J = Mass x 2,300 J / g = 57,500 J /2,300 J/g =
25 J/J/g = 25 g

Answer: ________

Nite … Nite….
All Done!