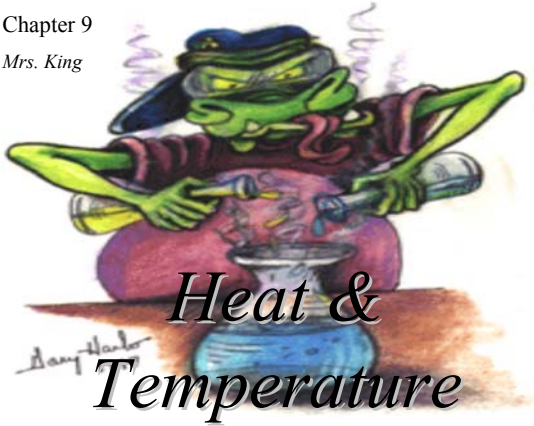


Chapter 9

Mrs. King



## Thermal Expansion

- Expansion and contraction is the result of energy exchange between the thermometer and its surroundings.

## Thermometers

- Rely on thermal expansion
- As the temperature rises, the particles in the liquid inside the thermometer gain kinetic energy and move faster.

## Measuring Temperature

- The thermometer in the backyard tells you how hot or cold it is outside.
- The meat and candy thermometers in the kitchen measure **food** temperatures.
- The thermometer in the furnace tells it when to turn on and off.
- The thermometer in the oven lets it keep a set temperature (hot).
- The thermometer in the **refrigerator** lets it keep a set temperature (cold).
- The **fever** thermometer in the medicine cabinet measures temperature accurately over a very small range.

Howstuffworks.com

## Galileo Thermometer

- With increased kinetic motion, the particles in the liquid move farther apart causing the glass bubbles to expand and rise up the narrow tube.



<http://science.howstuffworks.com/question663.htm>

## Bimetallic Strip Thermometers

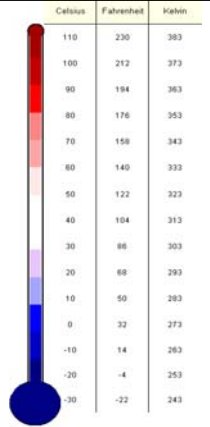


- Bonds two different metals together (bimetallic)
  - iron & copper
- Used for controlling temperature
- **Different metals expand at different rates as they warm up**
- Simple electric controller that can withstand fairly high temperatures
- Found in ovens and thermostats

## Measuring Temperature

- Celsius
- Fahrenheit
- Kelvin

– Average random kinetic energy,  $\frac{1}{2} mv^2$



## Absolute Zero

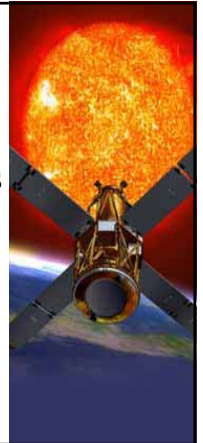
- The coldest temperature
- Kelvin scale begins at absolute zero, ( $-273.15^{\circ}\text{C}$ ).
- Temperature at which molecules (of any substance) have no more kinetic energy they can give up.

## Conversions

- Celsius to Fahrenheit
  - $F = (9/5 \times C) + 32$
- Fahrenheit to Celsius
  - $C = 5/9(F - 32)$
- Celsius to Kelvin
  - $K = C + 273$

## Heat

- *Heat* is the **transfer of energy** between objects with different temperatures.
- Energy is transferred as heat



- Some animals like, snakes, lizards and frogs, do not have an internal mechanism to regulate their body temperature.



- Reptiles bask in the sun to increase their body temp. by absorbing energy as heat
- **Conduction** from the rocks
- **Radiation** from the sun

- When it's cold outside reptiles become inactive
- They don't have extra energy to spend



## “Sunning”

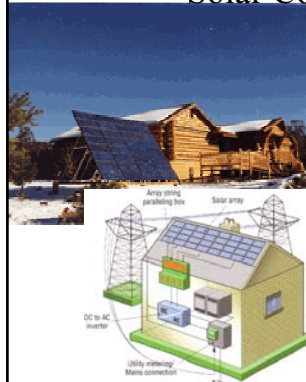


## Loggerhead Turtle



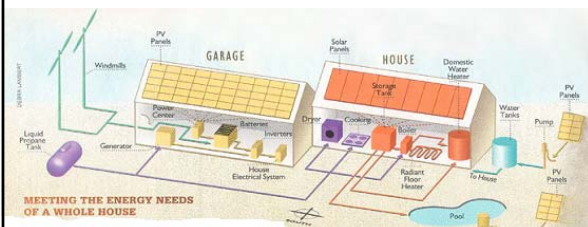
MSN Encanta

## Solar Collector



- Much like the reptile collecting the solar energy radiated from the sun
- Energy used to heat water
- Energy in a usable form
- Amount of usable energy always decreases when transferred or transformed
- Some energy lost to the surroundings
- Conservation of Energy

The Sol-Gen™ house from article in Sunset magazine - March '96



MEETING THE ENERGY NEEDS OF A WHOLE HOUSE

- **Conduction**
  - Involves direct contact
- **Convection** (Movement)
  - Cool air sinks
  - Warm air rises
- **Radiation**
  - Does not involve direct contact



## Convection & Conduction

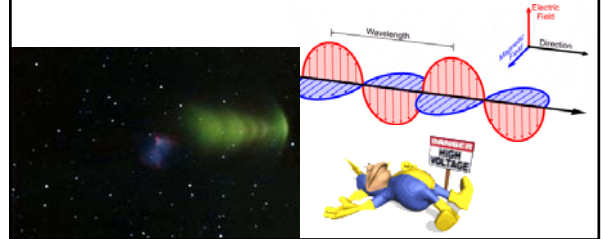
- Flames and **smoke** are carried upward by **convection**: Air around the fire heats up and rises
- The ground 3 feet beneath the fire will get hot, heated by **conduction**.



Bonfire

## RADIATION

The transfer of energy by electromagnetic waves



## RADIATION

- Another side effect of atomic motion is **vibration**, and vibration leads to the unexpected phenomenon of **infrared radiation**.
  - Infrared radiation is absorbed and emitted by the rotations and vibrations of chemically bonded atoms or groups of atoms
  - Infrared radiation is a form of **light**.
  - We can't see infrared, but our skin can feel it.

- When infrared is **absorbed** it results in atomic motion (i.e. a rise in temperature).
- Common examples:
  - Heat radiating from an electric heater
  - Heat from a red-hot piece of metal
  - Heat radiating from the bricks in a fireplace even if the fire has gone out
  - Heat radiating from a concrete wall after the sun has gone down

## Specific Heat (c)

- The amount of energy that must be transferred to the substance in order to raise the temperature of 1 kg of the substance by 1 K (or 1°C)
  - $\text{energy} = (\text{specific heat}) \times (\text{mass}) \times (\text{temperature change})$   
 $\text{energy} = cm \Delta t$

## Specific Heat is a ratio

- It can be used to predict the effects of larger temperature changes for masses other than 1 kg.

- If it takes **4186 J** to raise the temperature of 1 kg of water by 1 K ...
- Twice as much energy, **8372 J**, will be required to raise the temperature of 2 kg of water by 1 K.

## Specific Heat of H<sub>2</sub>O

- The ocean's temperature changes more slowly than the land's temperature.
- Water's specific heat is about **5 times as large as the specific heat of soil and sand.**

- Water stabilizes air temperatures by **absorbing** heat from warmer air and **releasing** heat to cooler air.
- Water can absorb or release relatively large amounts of heat with only a slight change in its own temperature.



## Impact of water's high specific heat

- **So, why are temperatures more moderate in Melbourne than in Orlando?**

- A large body of water can absorb a large amount of heat from the sun in daytime and during the summer, while warming only a few degrees.
- At night and during the winter, the warm water will warm cooler air.
- Therefore, ocean temperatures and coastal land areas have more stable temperatures than inland areas.



## Recap...

- For the same amount of absorbed sunlight, the temperature of a given mass of land increases up to 5x as much as the temperature of the same mass of water.
- If the land were to lose the same amount of heat at night as water does, its temperature would fall 5x as much.