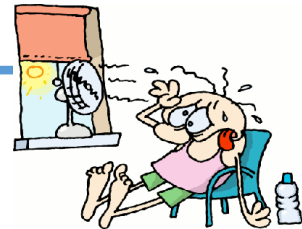
Intermediate Science 7

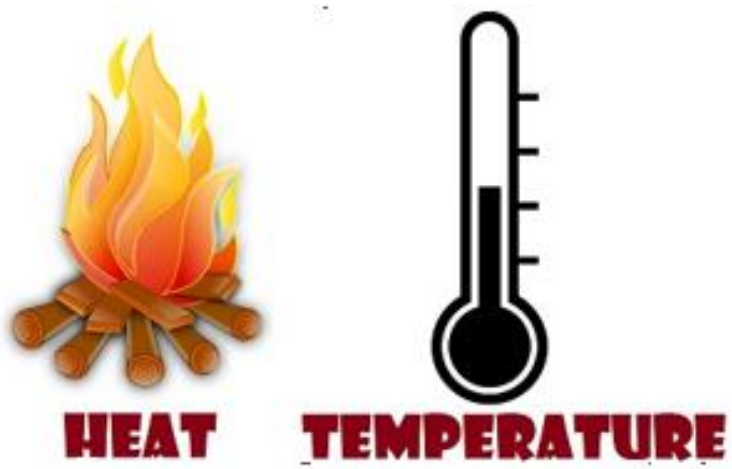
Unit 2: Heat

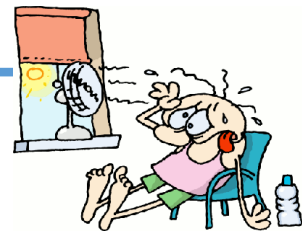


Intermediate Science 7

Unit 2: Heat

Topic 5: Heat and Temperature

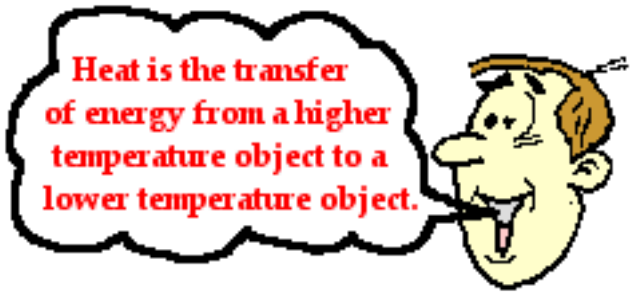




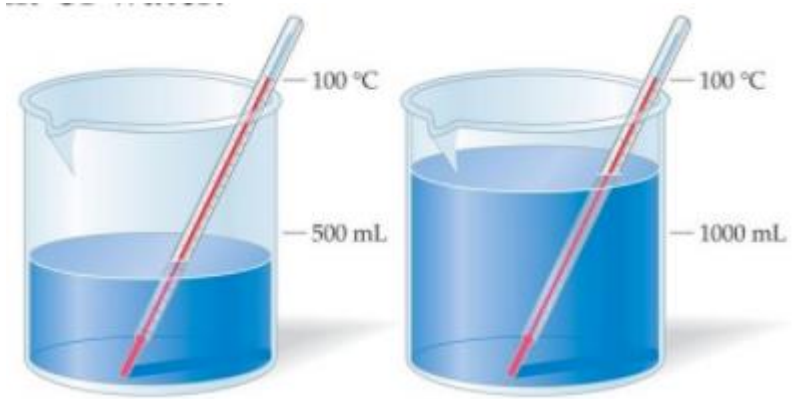
QUESTION?

Consider a very hot mug of coffee on the countertop of your kitchen. Imagine the cup of coffee has a temperature of 80°C and that the surroundings (countertop, air in the kitchen, etc.) has a temperature of 26°C. What do you suppose will happen in this situation?

WHAT IS HEAT?



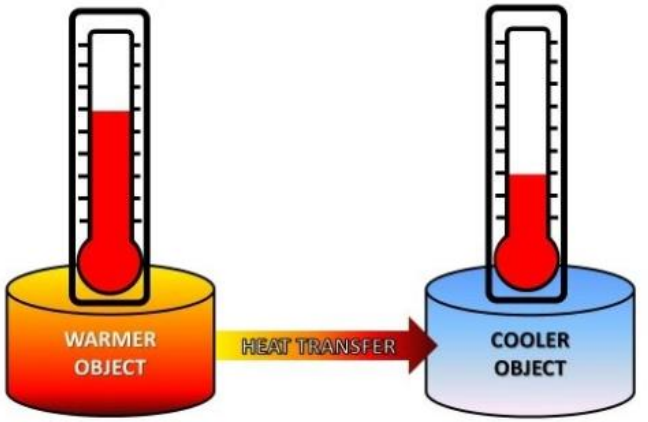
Heat is the total internal added together.

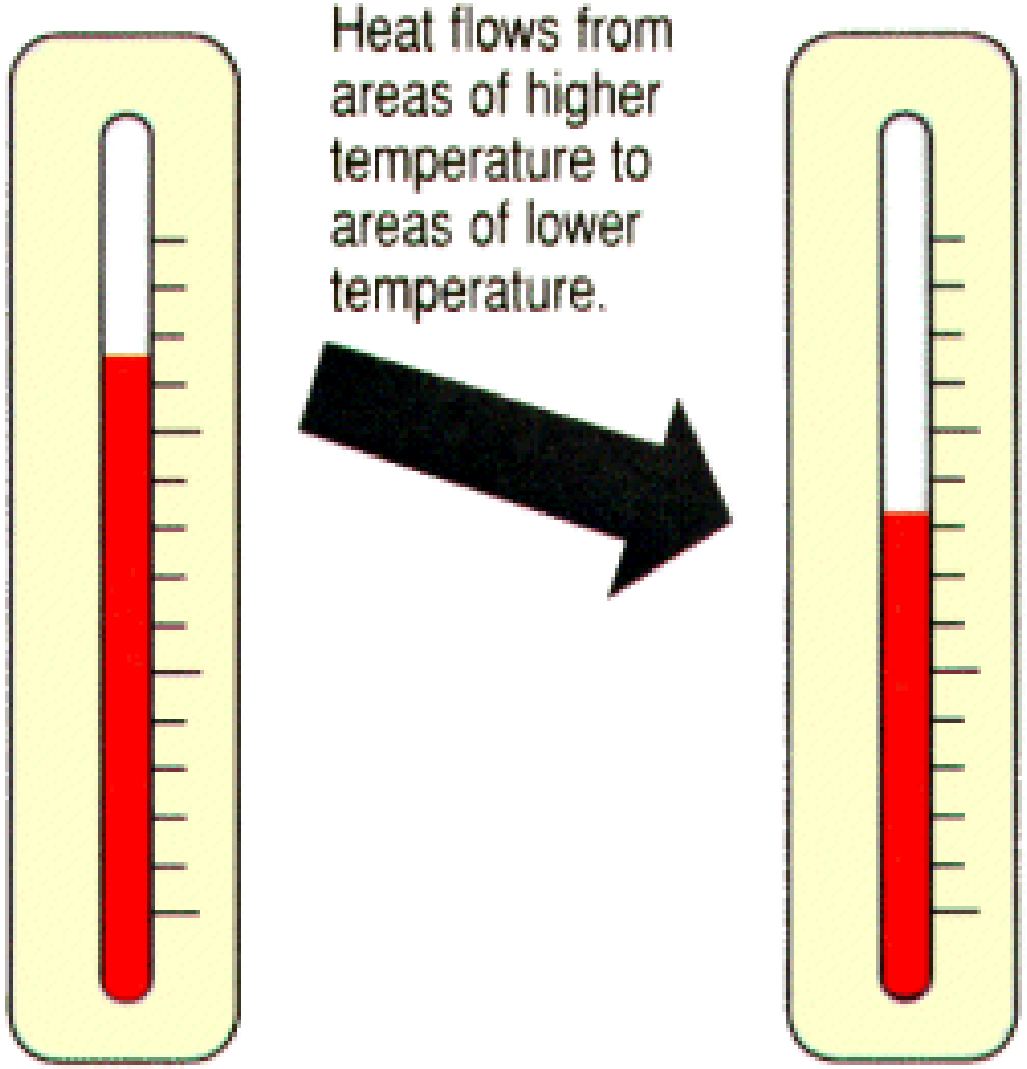


Although both beakers have the same temperature (100 ^{O}C), the beaker on the right has more energy because it has twice the amount of water

Heat is simply the transfer of energy from a hot object to a colder object.

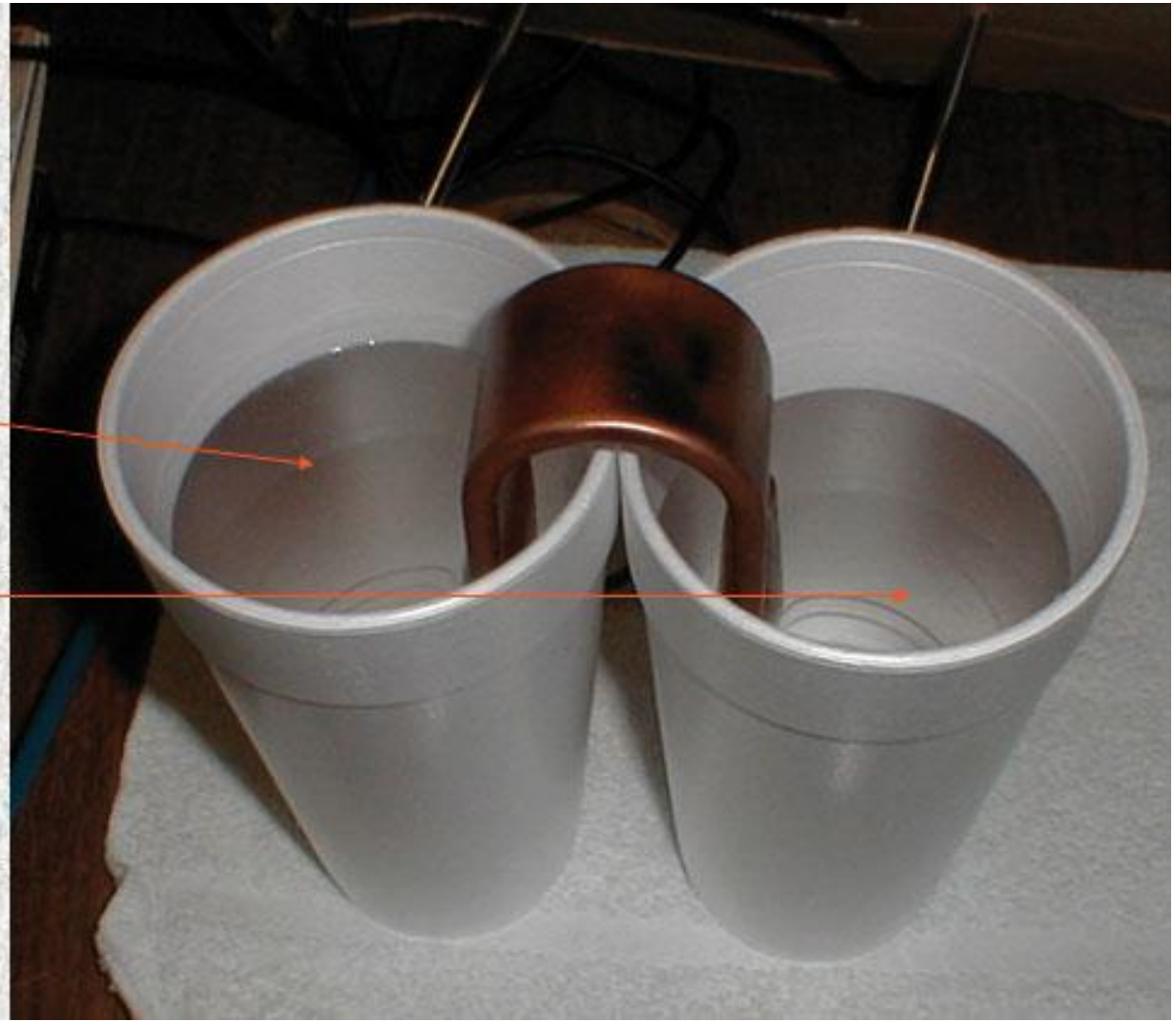
Heat is measured in Joules




Heat flows from areas of higher temperature to areas of lower temperature.

What Will Happen?

- Warm water
- Cool water



Absorbing and Losing heat

p.209

- Adding the same amount of heat to two different substances of the same mass will not cause both to increase to the sam temperature.
- The size of the temperature increase depends on the type of substance.

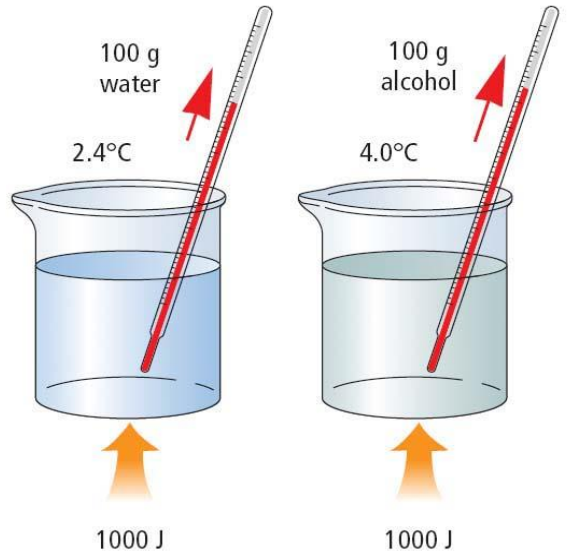
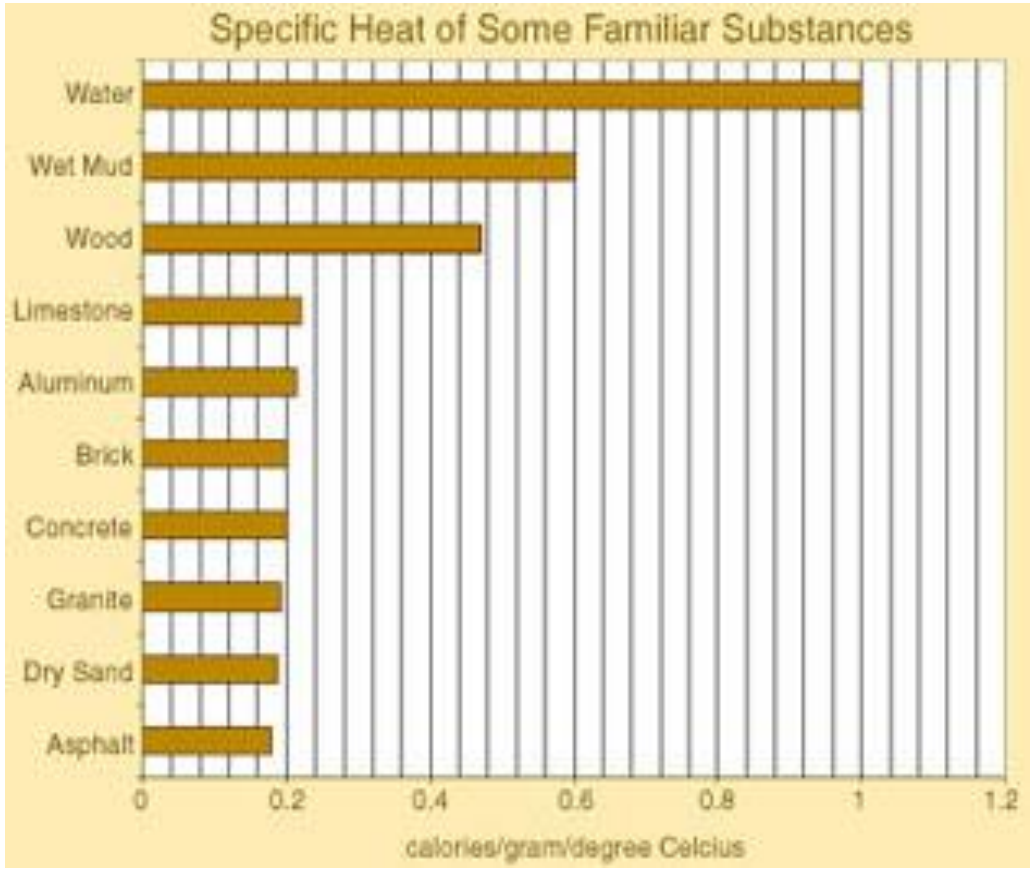


Figure 6.27 When you add 1000 J of heat to 100 g of water, the temperature of the water increases by 2.4°C. When you add 1000 J of heat to 100 g of alcohol, the temperature of the alcohol increases by 4.0°C.

Specific Heat

Some substances change temperature more easily than others

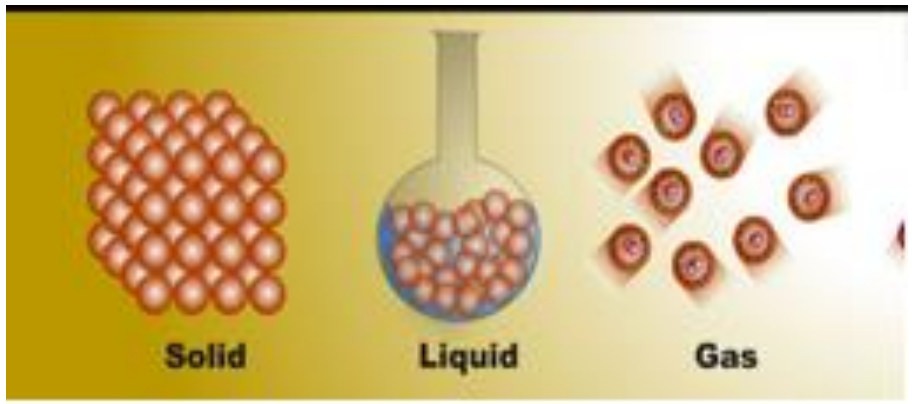
Specific Heat: the amount of energy required to raise the temperature of 1 gram of a substance by 1°C



The Kinetic Theory of Matter

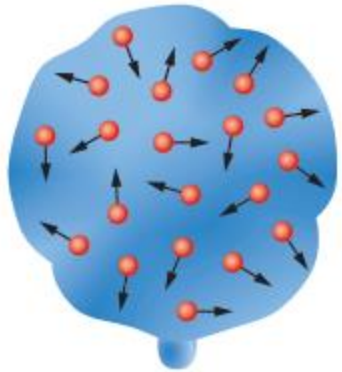
All of the particles that make up matter are constantly in motion

Solid= vibrating atoms
Liquid= flowing atoms
Gas= move freely



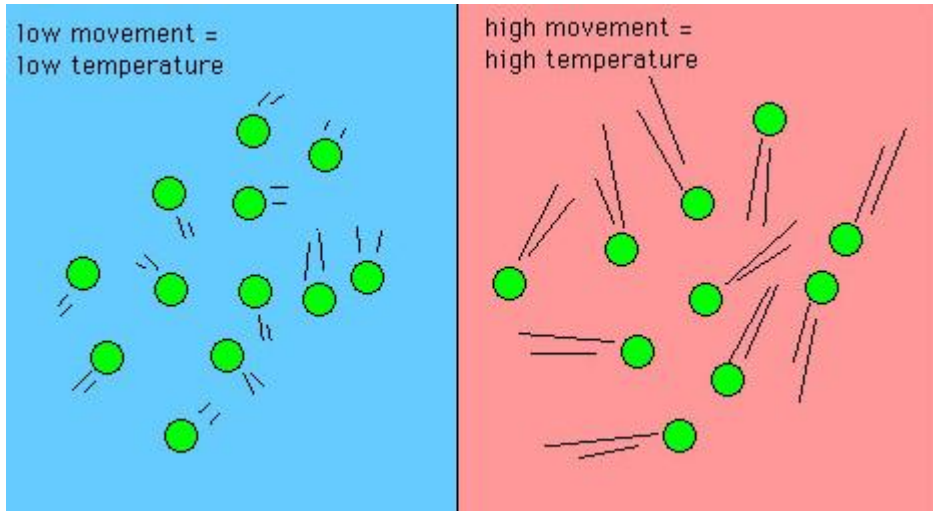
Kinetic energy refers to energy that all moving objects possess; a particle has more kinetic energy when moving faster and less kinetic energy when moving slower

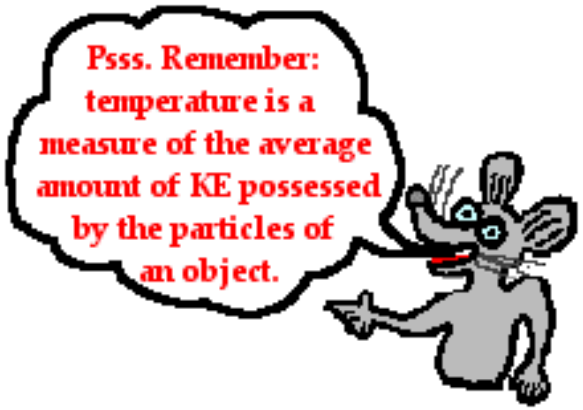
Temperature depends on particle movement!



What is Temperature?

Temperature refers to the measurement of the average kinetic energy of all the particles in the object

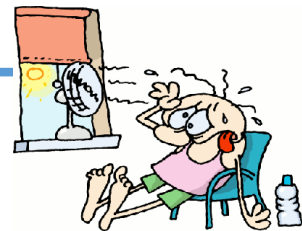




The motion of the particles increase as the temperature increase

The motion of the particles increase as the temperature increase

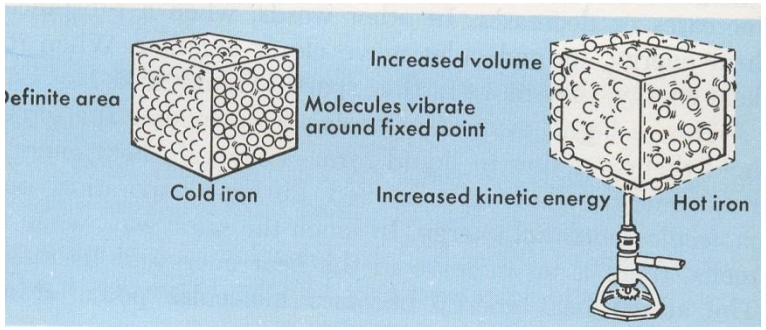
Temperature can be measured in Celsius, Fahrenheit, and Kelvin

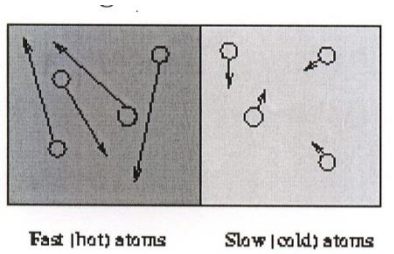


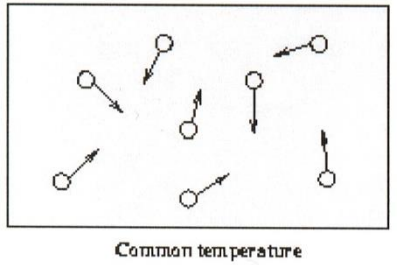
Temperature and Kinetic Energy

- As particles gain kinetic energy they move faster
- Temperature increases

- As particles lose kinetic energy they move slower
- Temperature decreases

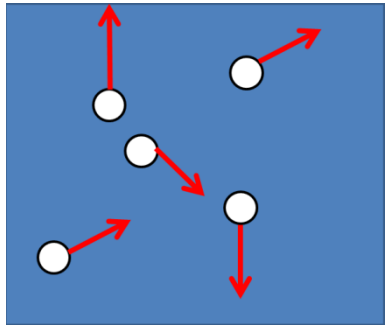


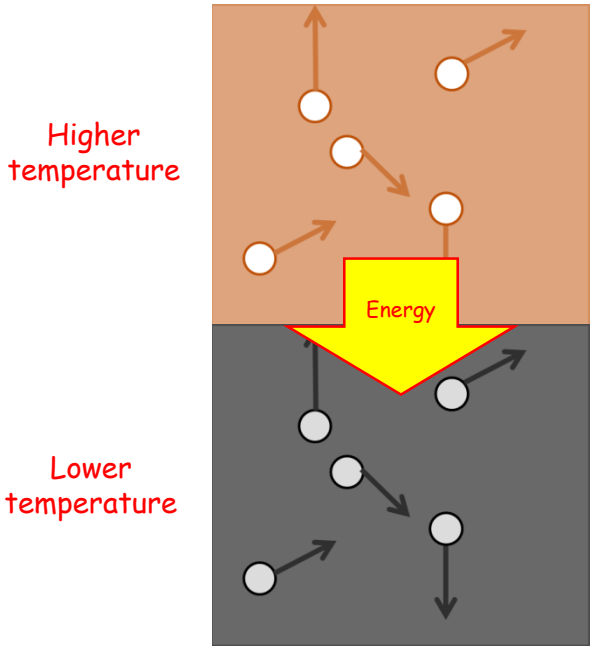




Temperature and Heat

Kinetic theory – particles are constantly moving and have kinetic energy. The higher the temperature, the faster they move, so the more kinetic energy they contain.



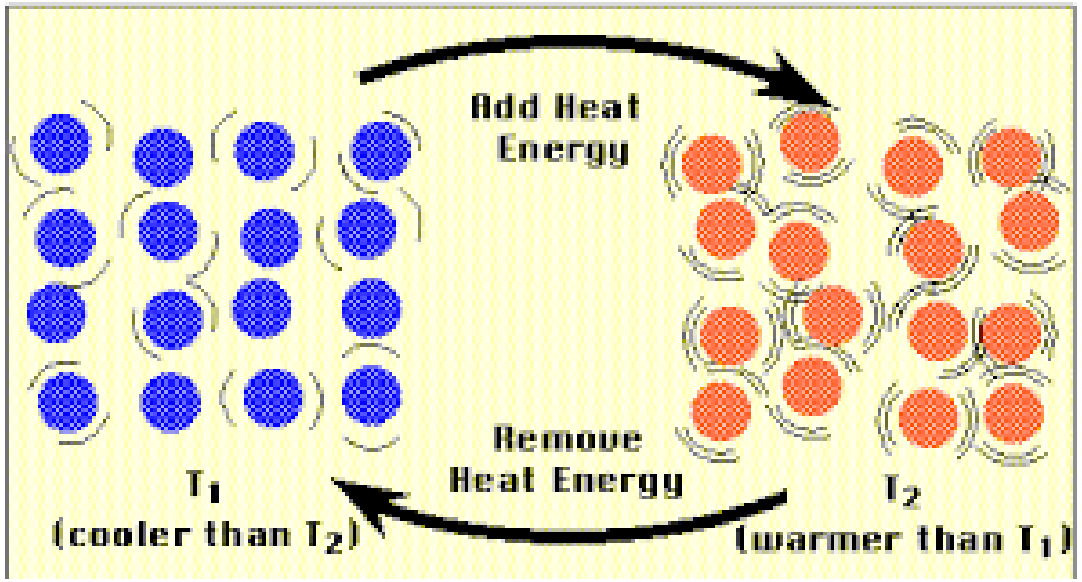


Energy will flow from a hotter object to a colder one. Particles in the hot object will lose kinetic energy, whereas particles in the cold object will gain energy.

Energy will continue to flow until both objects reach the same temperature. Objects at the same temperature will have the same average kinetic energy per particle.

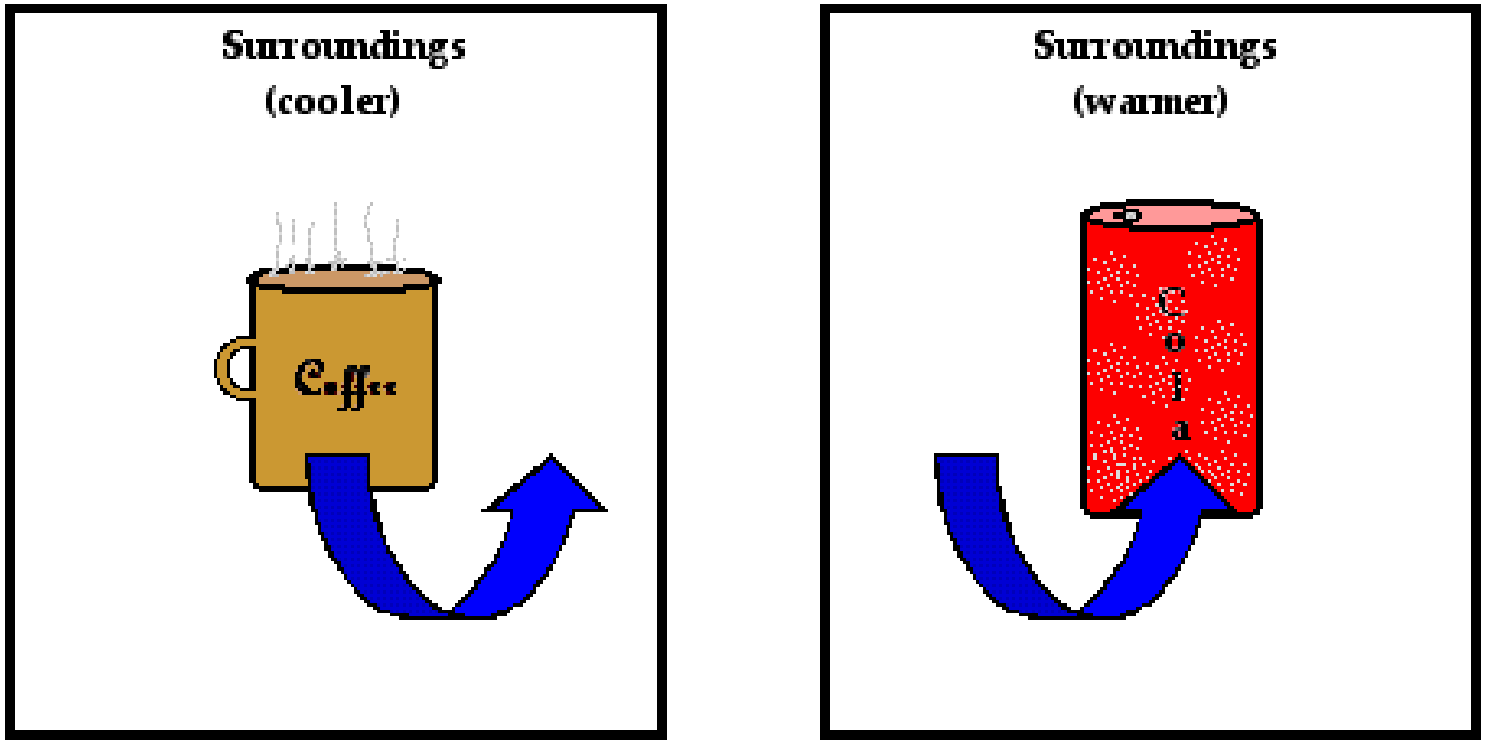
The ice tea on the left is cold, so the particles move slower. The herbal tea on the right is hot, so the particles move slower.

Add Heat = Particles Move Faster



Remove Heat = Particles Move Slower

The higher the temperature of an object is, the greater the tendency of that object to transfer heat.



Heat is the flow of energy from a high temperature location to a low temperature location

Summary for Heat vs. Temperature

Heat is the energy which is transferred from hotter substances to colder substances.

It is the sum total of the energies of the particles in a substance. (Thermal energy)

- Temperature is a measure of how hot or cold something is.
- The average kinetic energy of the particles in a substance.

http://www.youtube.com/watch?v=wTi3Hn09OBs

Heat

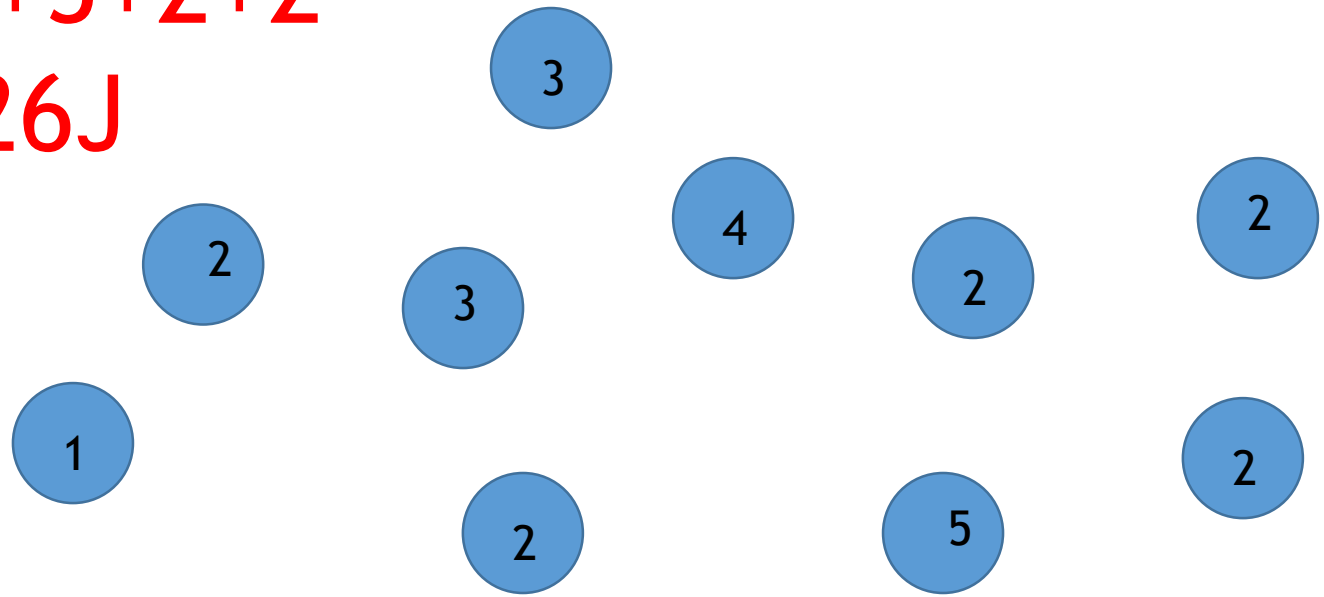
*Depends on the number or amount of particles present.

Temperature

* Depends on average kinetic energy. Not the amount of particles.

1+2+3+3+2+4
+2+5+2+2
= 26J

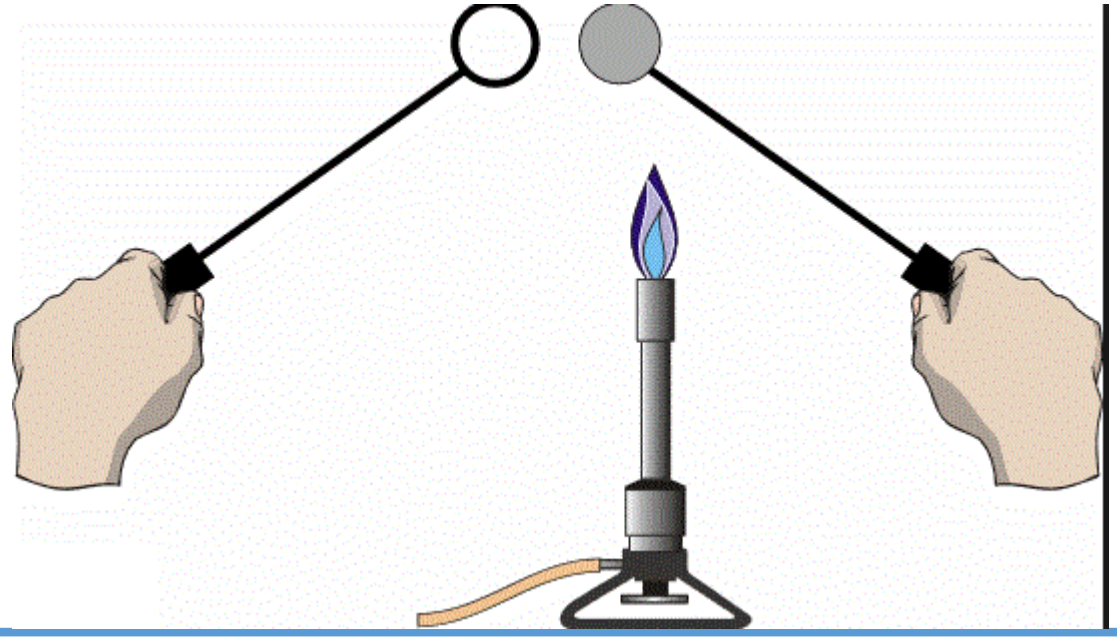
26 ÷ 10 = 2.6 ˚C

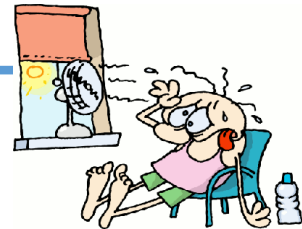


Intermediate Science 7

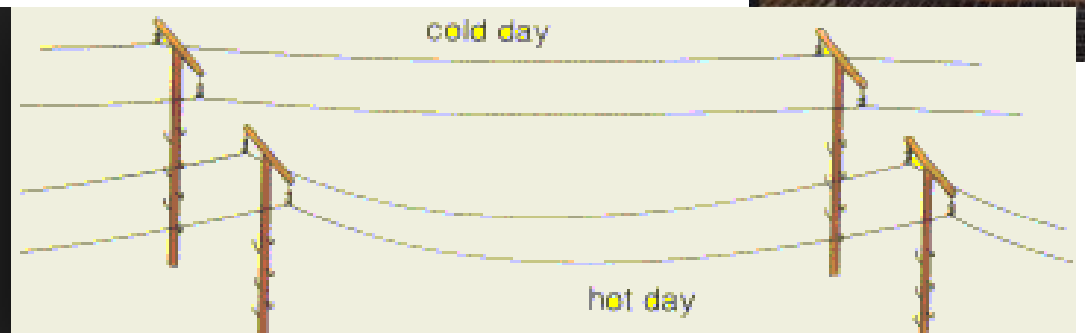
Unit 2: Heat

Topic 6: Expansion and Contraction





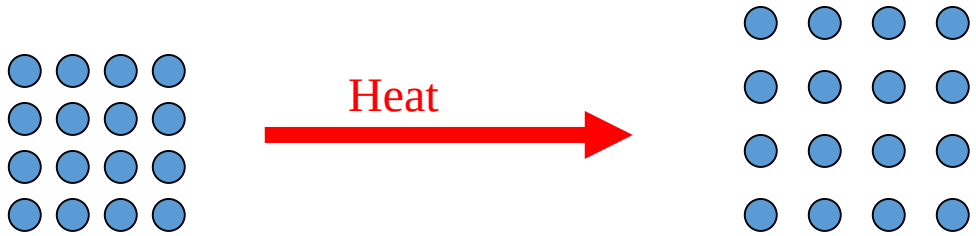
EXPANSION AND CONTRACTION OF MATTER



Expansion

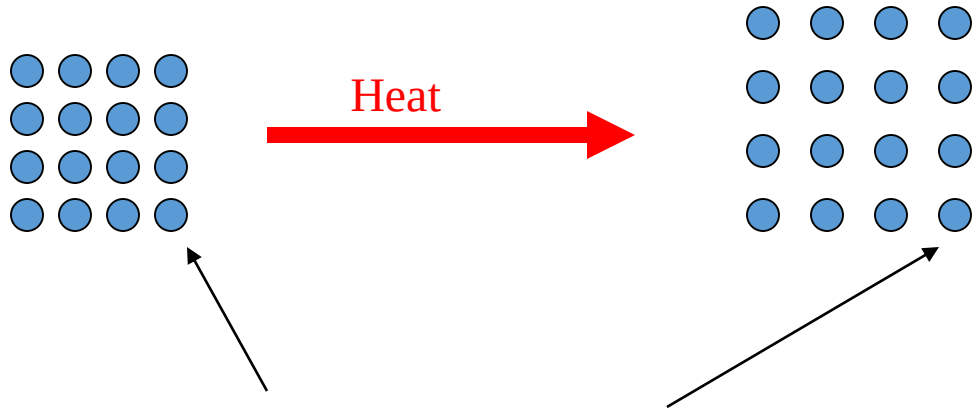
- When solids, liquids, and gases are heated, their volumes usually increase.
- Heating a substance speeds up its particles, so they have more kinetic energy.
- The faster-moving particles travel greater distances, so they occupy more space.

- So the substance expands

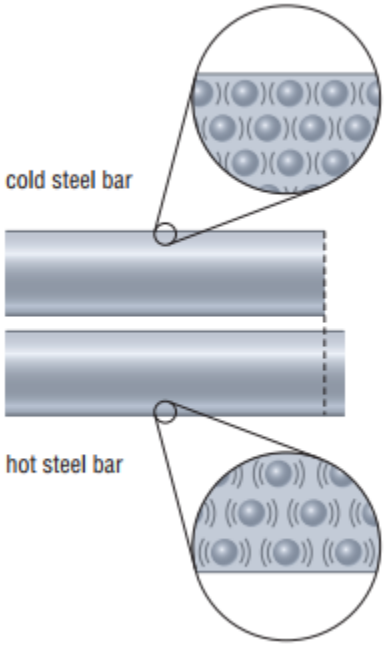


Important note!

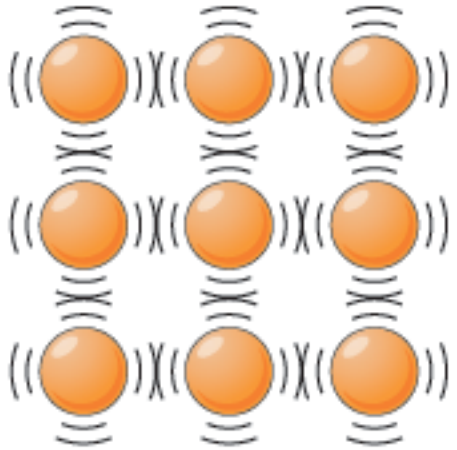
The particles in a substance do not expand themselves!



Particles are the same size



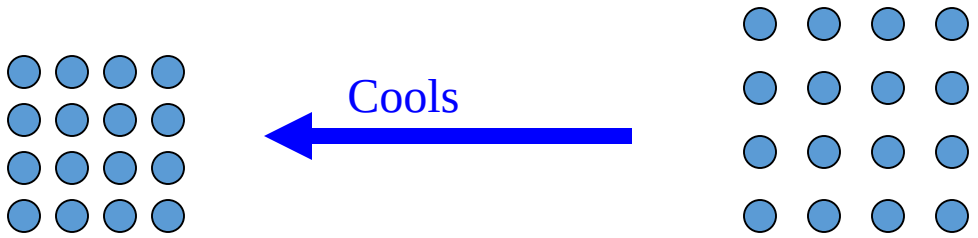
- When materials **warm up**, the particle model of matter says the particles **move faster** and **further apart**
  - It **expands**, and there is an **increase** in **volume** as temperature increases
  - Occurs when heat is transferred **to a solid**



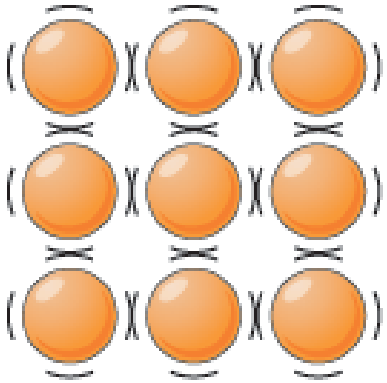
Hot

Contraction

- When solids, liquids, and gases are cooled, their volumes usually Decrease
- Cooling a substance slows down its particles, so that they have less kinetic energy.
- The slower-moving particles travel shorter distances, so they occupy less space.



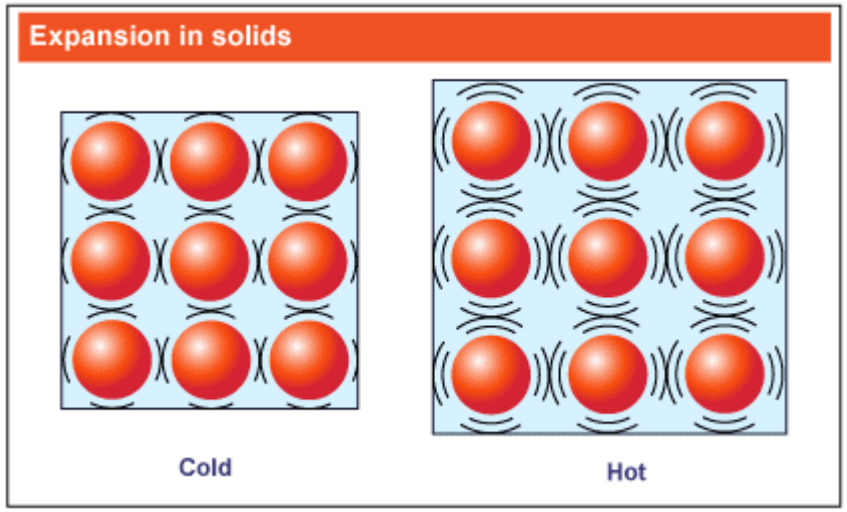
- When materials **cool down**, the particle motion is **slower**
  - Materials **contract**, or have a **decrease** in **volume**, as they cool
  - Happens when heat is transferred **from the warm object to the cooler one**



Cold

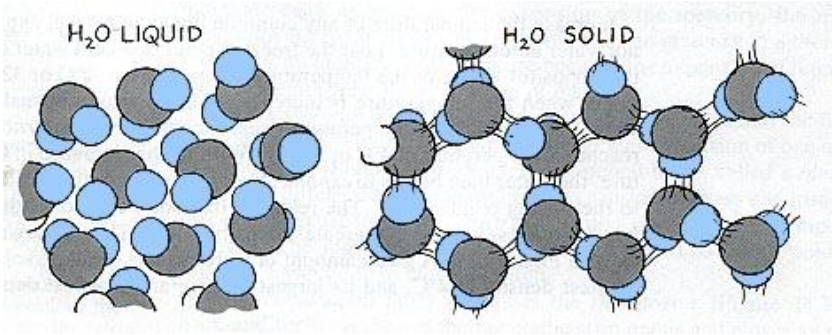
Expansion and Contraction of Solids

- Solids expand when heated
- Solids contract when cooled
- Solids expand at different rates



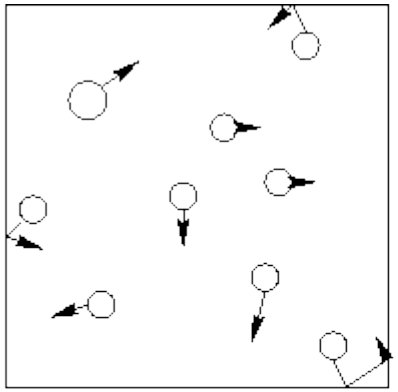
Expansion and Contraction of Liquids

- Liquids expand when heated and contract when cooled
- ONE EXCEPTION: WATER
- Water expands when cooled

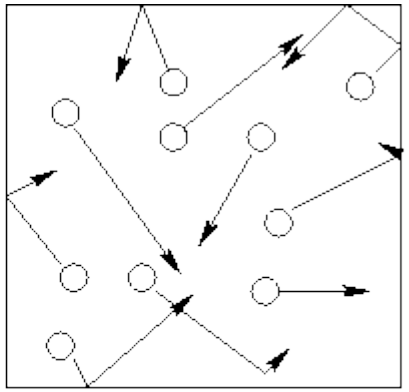


Expansion and Contraction of Gases

- Gases expand when heated and contract when cooled



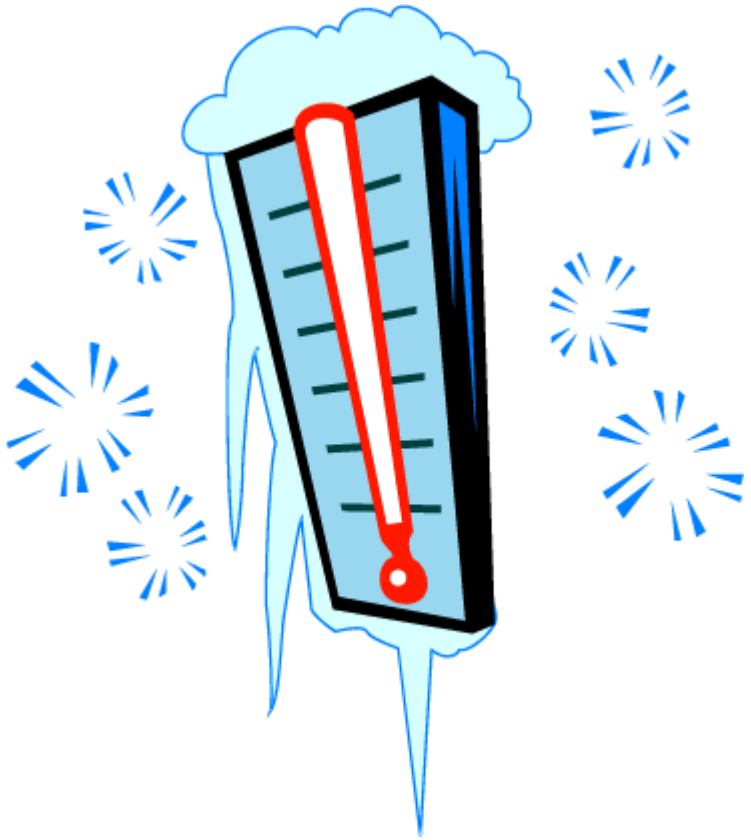
Cool gas, fewer and less energetic collisions



Hot gas, more and more energetic collision

Absolute zero ….. Brrr!

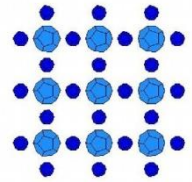
If the temperature of a gas is reduced, the particles have less energy and move more slowly. Eventually, at a particular temperature, the particles stop moving completely. This temperature is the lowest possible temperature, and is known as absolute zero.



SUMMARY OF Expansion and Contraction of Matter

- Expansion
- When matter is heated it expands
- As it expands it occupies more space and it’s volume increases

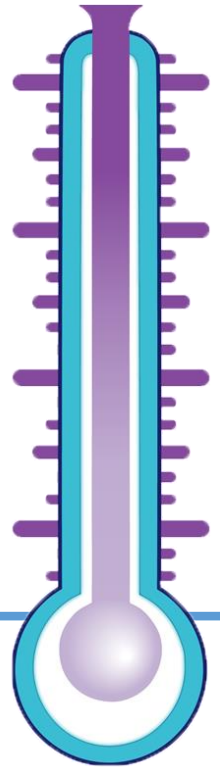
- Contraction
- When matter is cooled it contracts
- As it contracts it occupies less space and it’s volume decreases

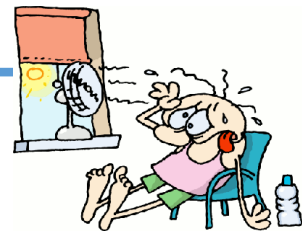


Intermediate Science 7

Unit 2: Heat

Topic 7: Applications of Expansion and Contraction





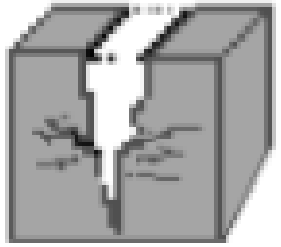
Observing The Effects Of Heat

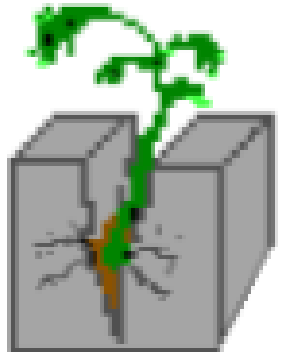
Cracks in rock, due to ice

Mechanical Weathering Includes:

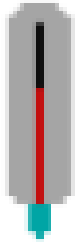
Unloading

Frost Action





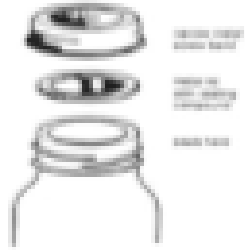
Root Wedging



Temperature Change

Fitting a nut to a bolt

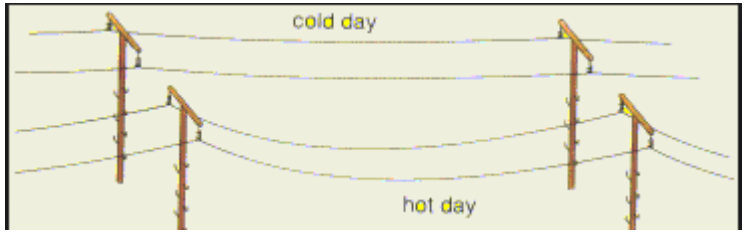
Hot water opens a jar lid



Boiling water cracks the cold mug

- Solids can become longer or shorter depending on the temperature (average energy of the particles

Telephone wires are hung up slack in the hot summer weather so that they do not pull the telegraph poles over when they contract in the winter

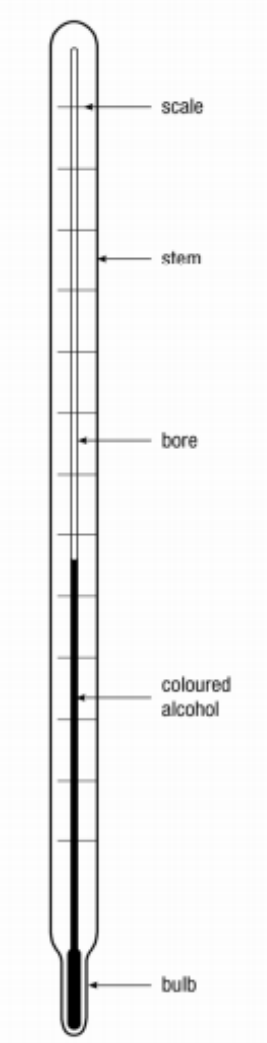


Railway lines are laid with small gaps to allow for expansion in hot weather

Girders in buildings and bridges are made with gaps at the ends

Bimetallic strip - this is made of two metals joined together that expand by different amounts when heated. It is used in thermostats and fire alarms

- When the particles in a liquid are heated, their average energy increases and they need more room, so they expand. When the particles in a liquid are cooled, the volume decreases, or contracts, because the particles need less room. This is demonstrated by the liquid used in a thermometer. As the liquid expands and contracts, it moves up and down the inside tubing (the bore) of the thermometer.



Scale refers to the series of lines that are etched into an area and allows the temperature to be read off in units of degrees. The type of degree unit depends upon the specific thermometer. Two commonly used temperature scales, are degrees Celsius and degrees Fahrenheit,

Stem: containing the scale that is measuring the temperature and a capillary through which the liquid can accordingly expand and contract

Bore refers to a thin open inside the stem which gives the liquid a route of travel as it expands and contracts.

Bulb: the lowest part of the thermometer, which has a spherical shape. It holds the liquid

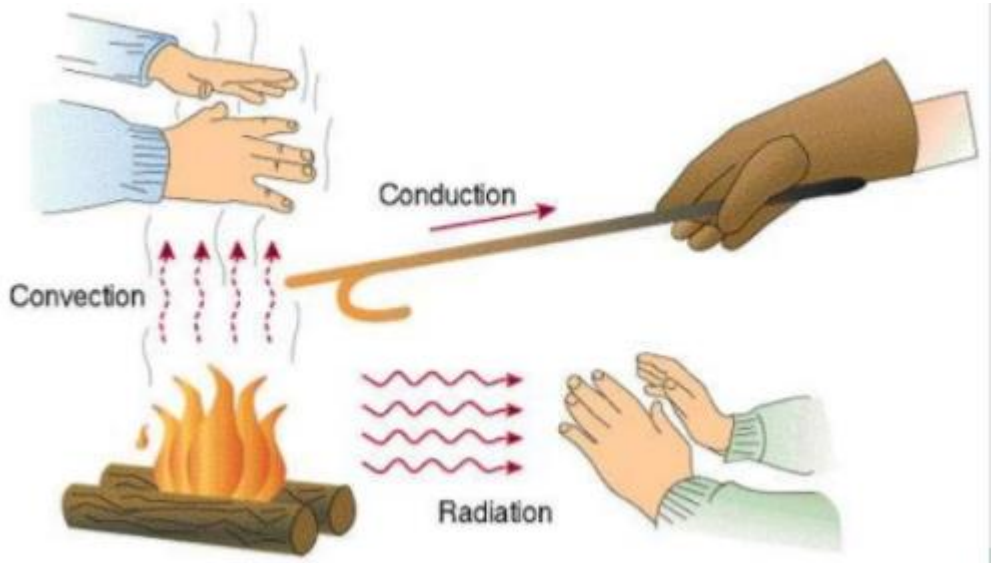
- When the particles in a gas are heated, their average energy increases and they need more room, so they expand. When the particles in a gas are cooled, the volume decreases, or contracts, because the particles need less room. Under extremely high temperature conditions (like the temperatures inside the Sun, particles can be split into what makes them up (electrons and ions). This creates a fourth state of matter called plasma.

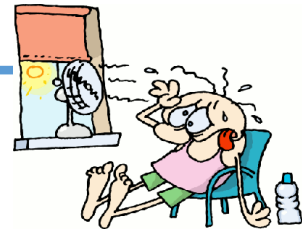
- A balloon is tied to the mouth of a bottle and placed in cold water. The balloon will shrink in size as the air inside contracts on cooling.

Intermediate Science 7

Unit 2: Heat

Topic 8: Types of Heat Transfer

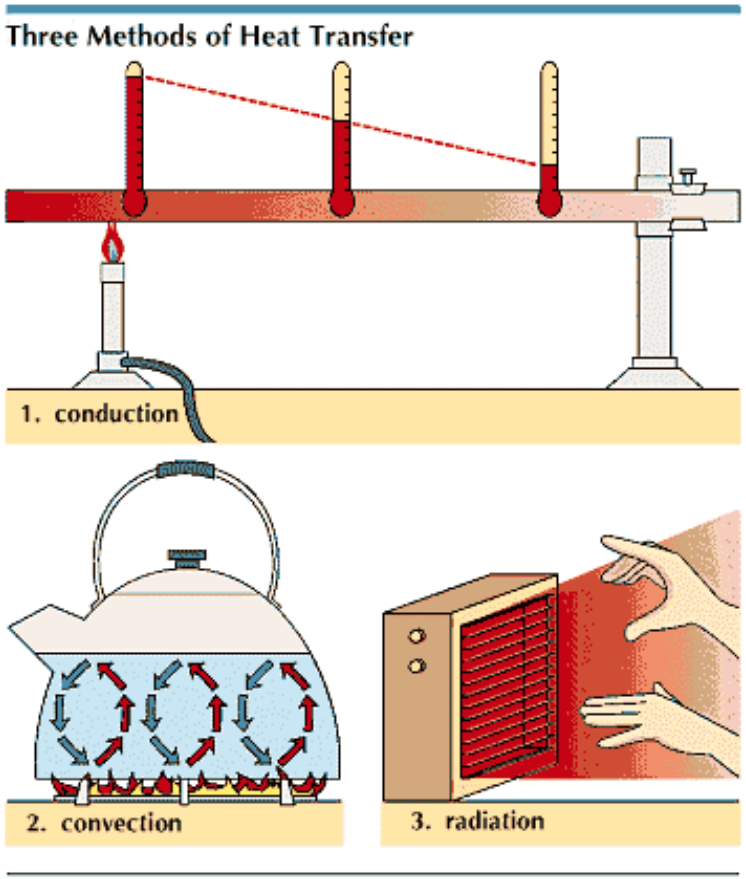




Transfer of Energy

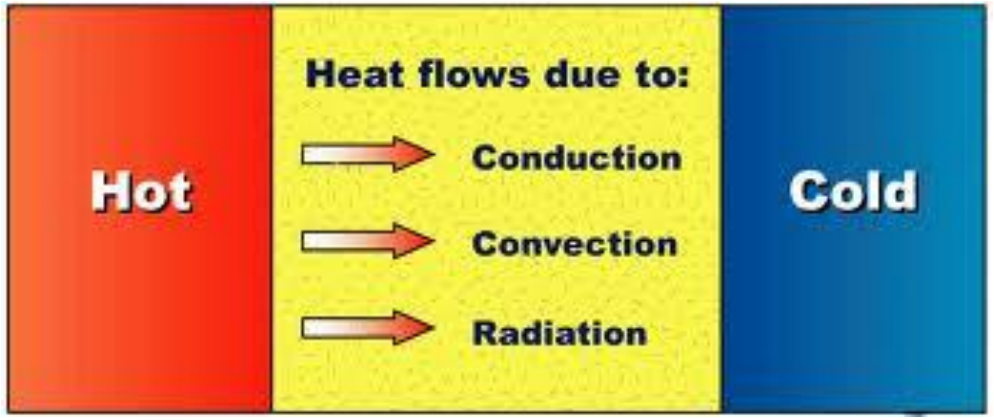
Energy can be transferred from one place to another by the following four methods.

1. Radiation
2. Conduction
3. Convection



Heat Transfer

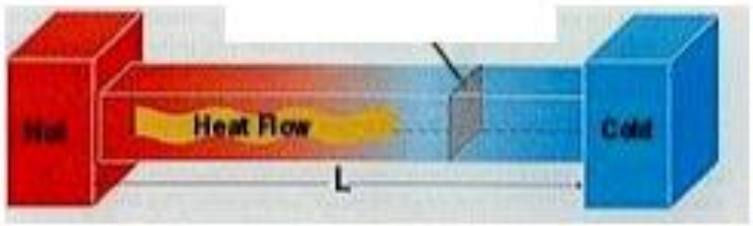
- Heat always moves from a warmer place to a cooler place.



- Hot objects in a cooler room will cool to room temperature after the hot object transfers some of their heat to the cold object.
- Cold objects in a warmer room will heat up to room temperature.

1. Conduction

- The transfer of thermal energy that occurs when warmer particles come in contact with cooler particles and transfer energy to the cooler particles.
- Examples: cook ware, ice pack



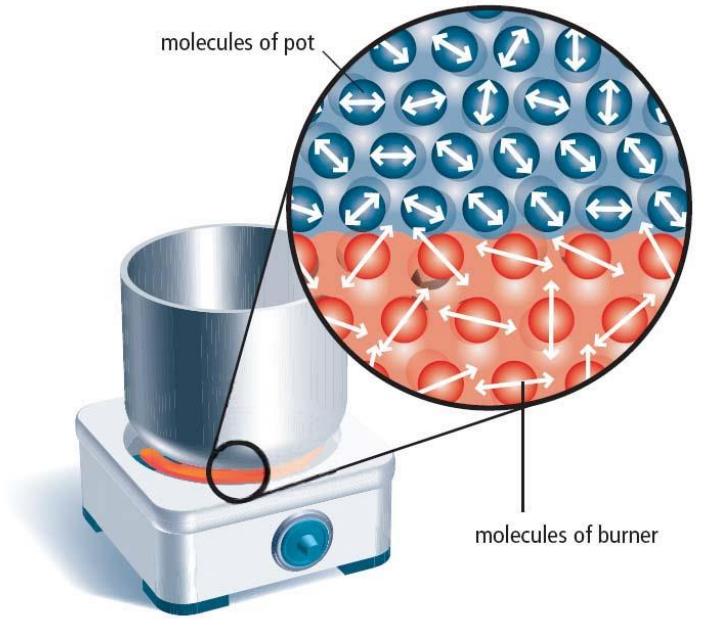


Figure 6.2 The length of the arrows on the particles in the stove burner and the bottom of the pan indicate the relative amount of kinetic energy that they have. The burner heats the pan by conduction caused by the collisions between particles in the burner and particles in the pan.

- Occurs when the particles in an object vibrate in place but collide with neighbouring particles passing kinetic energy to them.
  - The particles do not leave their original position.

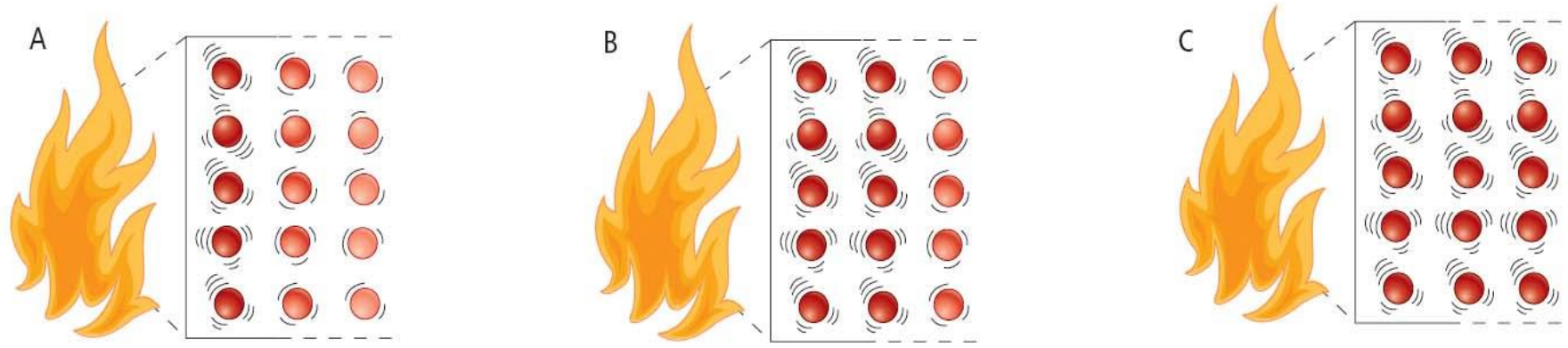
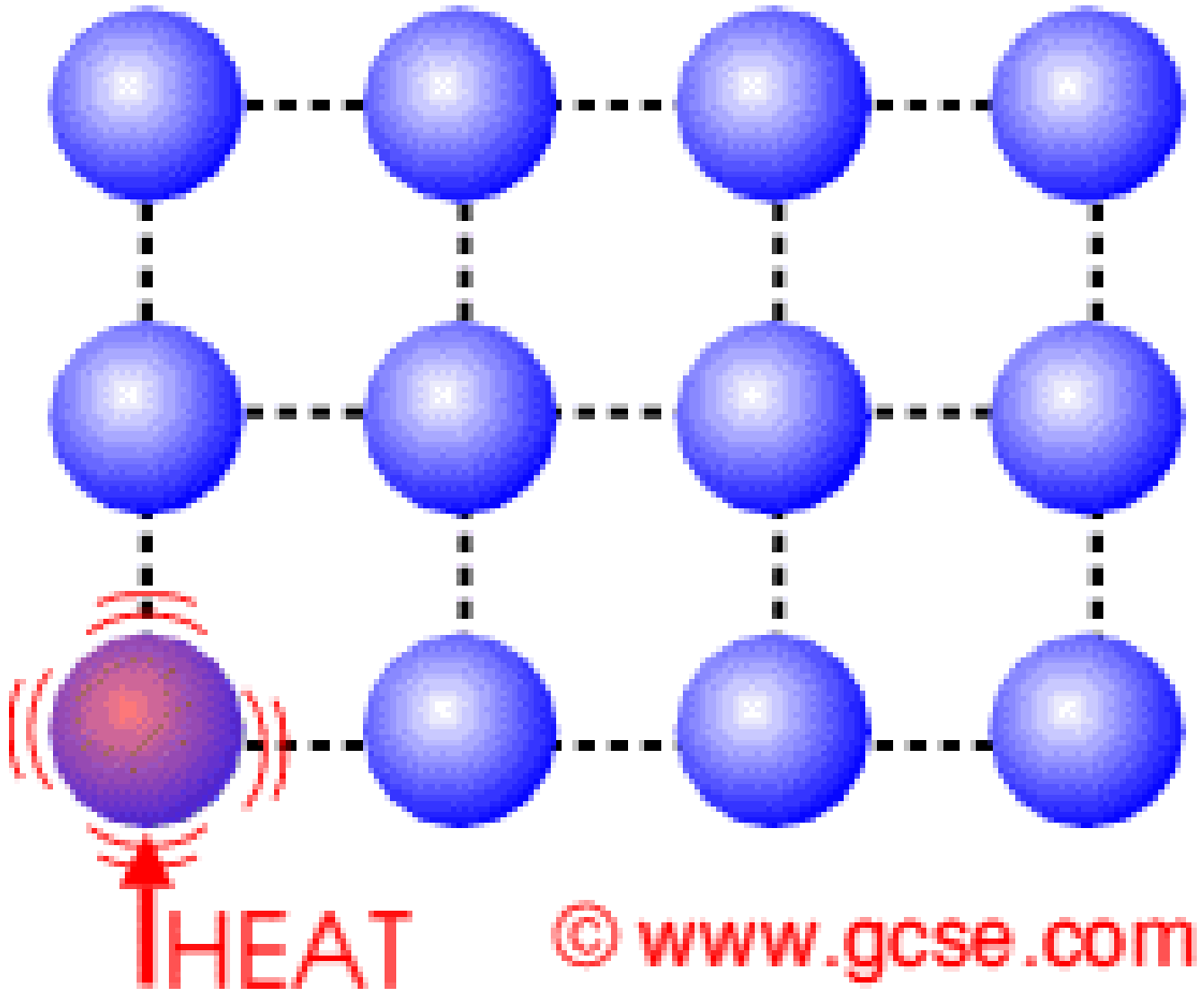


Figure 6.3 (A) Particles near a heat source absorb energy from the source and begin to move faster and, therefore, have more kinetic energy. (B) When the hot molecules on the surface collide with the neighbouring particles, they give some of their own kinetic energy to the nearby particles. (C) The collisions continue and heat is transferred throughout the object.


HEAT
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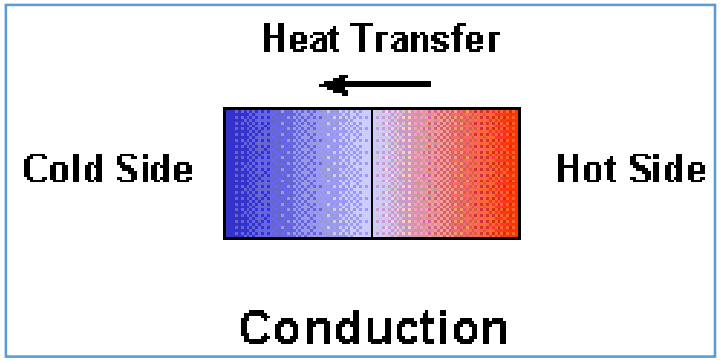
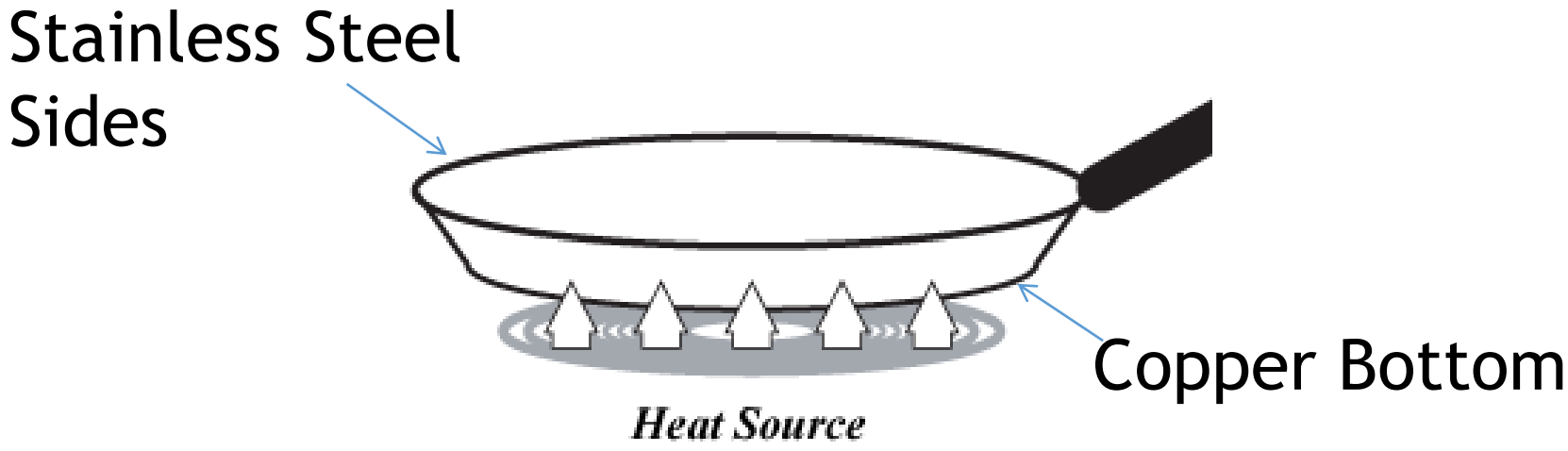
Ice Packs

- Conduction occurs in most solids.





COOKING BY CONDUCTION

- **Conductors** are materials that allow heat to move easily through them.

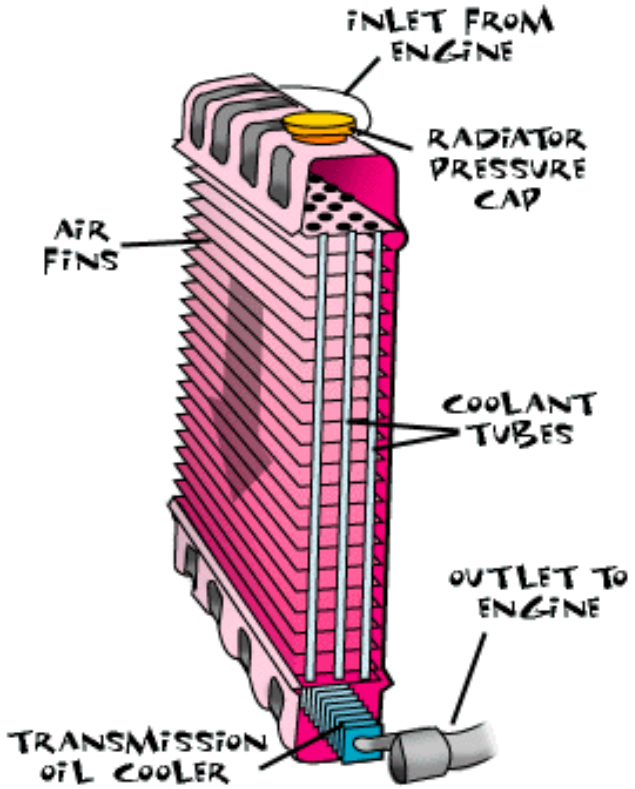
Examples of Conductors

- Metal

Uses of Conductors

Cookware

Car Radiator



What are Insulators?

- **Insulators** are materials that do not allow heat to move easily through them.

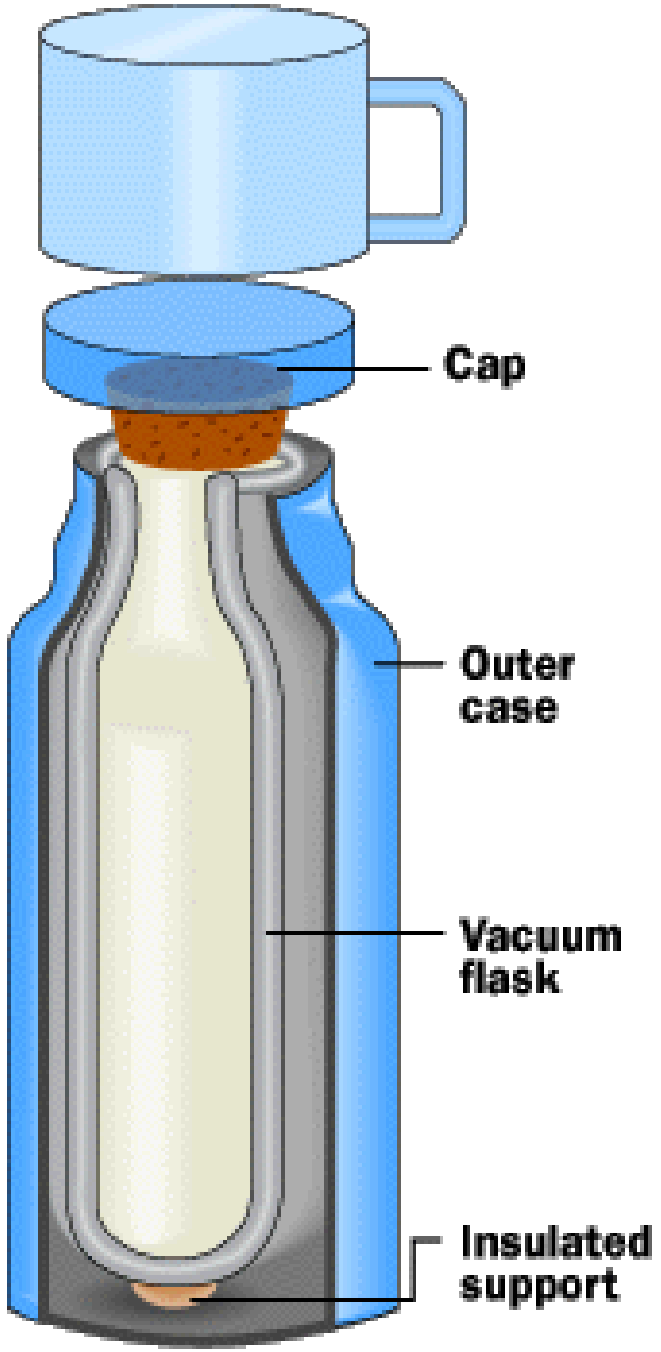
Use of insulators

Animal Fur

Sod

Fibreglass

Thermos



The vacuum layer has no particles which prevents heat transfer.

Note: It is impossible to create a perfect vacuum.

Conductors vs. Insulators

Conductors

- Allow heat transfer
- Ex. Metal *(some metal are better than others)*

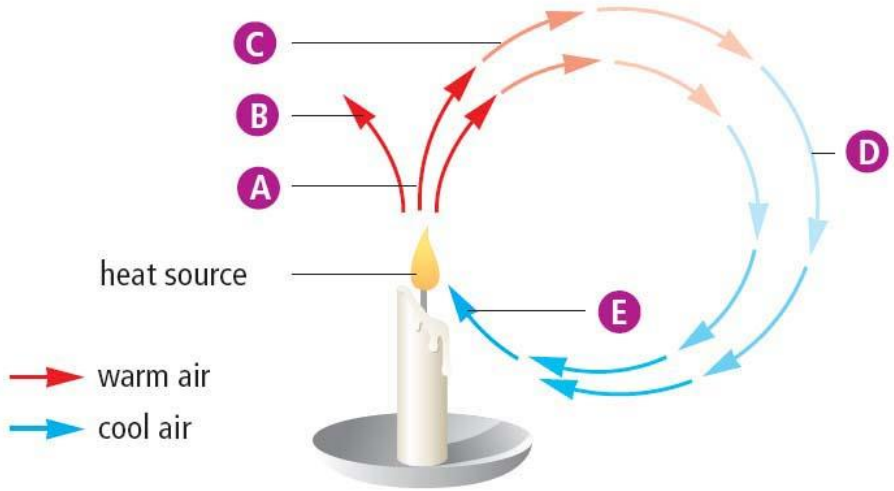
Insulators

- "Prevents" heat transfer
- Ex. Wood, plastic

2. Convection

- Occurs when warm fluids move from one place to another carrying heat.
- Occurs in liquids and gases.

- Examples: air currents, heating a liquid



A Warm air expands.

B Less dense, warmer air rises.

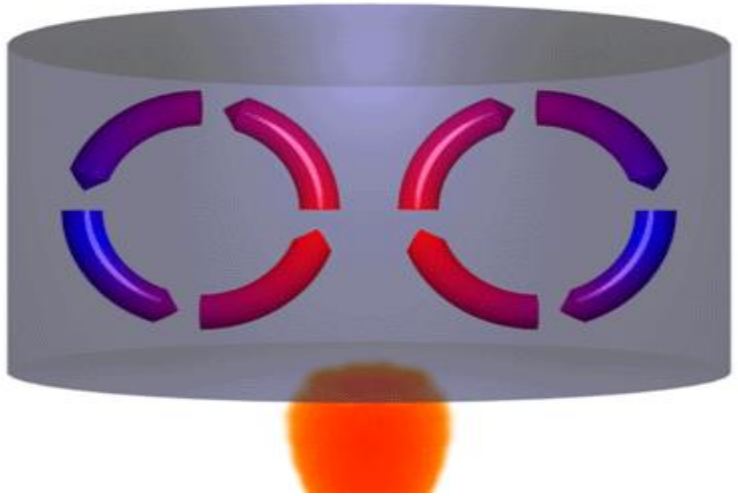
C The rising air cools and contracts.

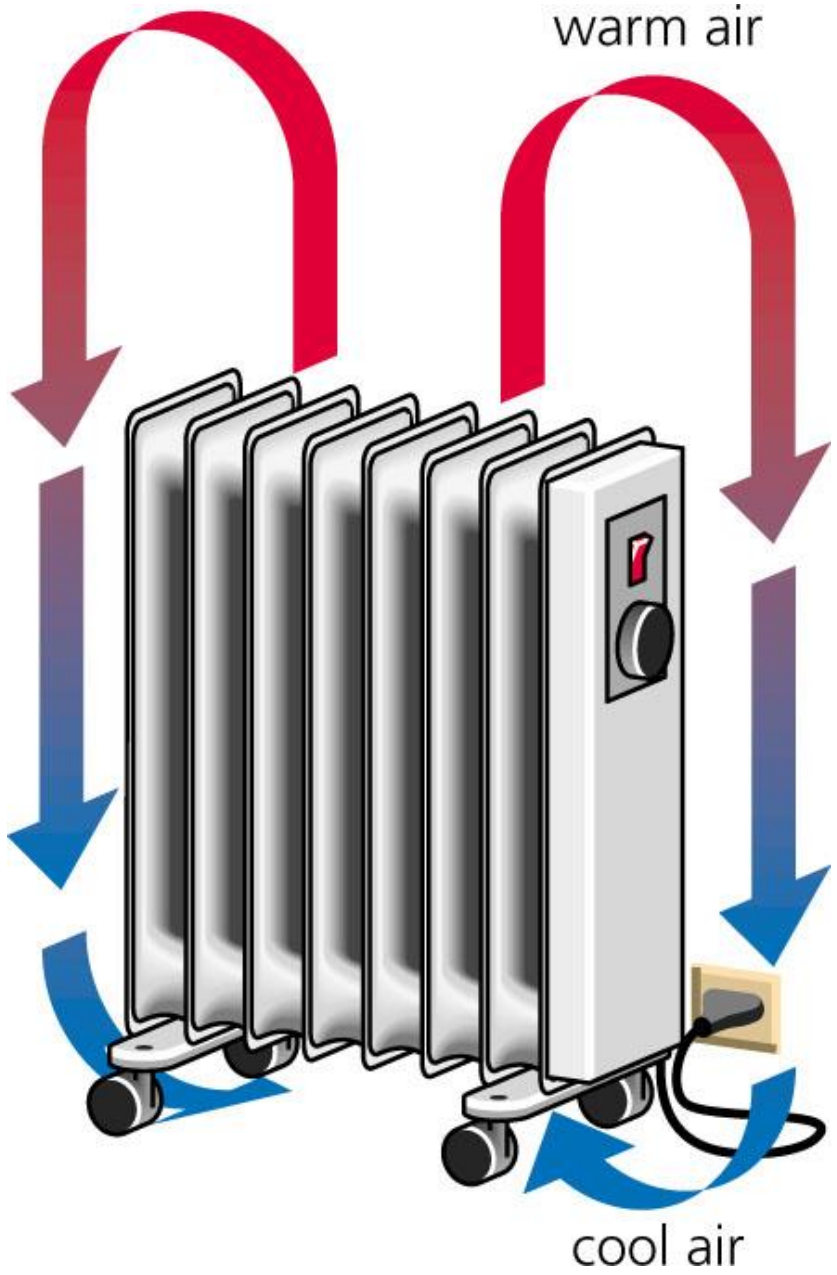
D The cool, denser air sinks.

E The cool air moves in to replace the rising warm air.

Figure 6.4 As the air near the flame becomes warmer, it rises, cools, and then drops back down again.

Convection: is the transfer of energy vertically by movement of particles in a fluid (water or atmosphere)





When air warms, the particles gain energy, spread out, become less dense and rise. As it cools, the particles lose energy, get closer together, become more dense and sink.

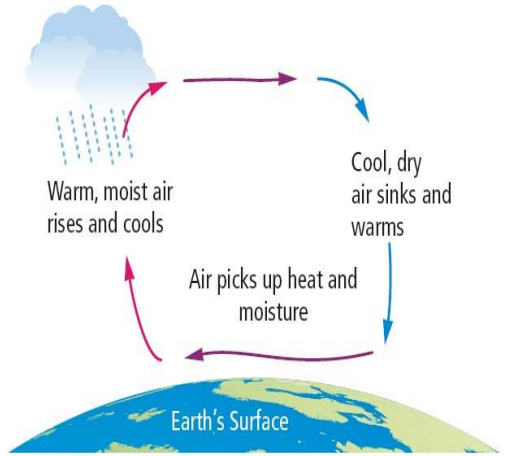


Figure 6.5 Wind is a type of convection current. You only feel the wind that is blowing along the surface of Earth. It appears to be blowing in one direction. However, the surface wind is part of a circular movement of air in the atmosphere.

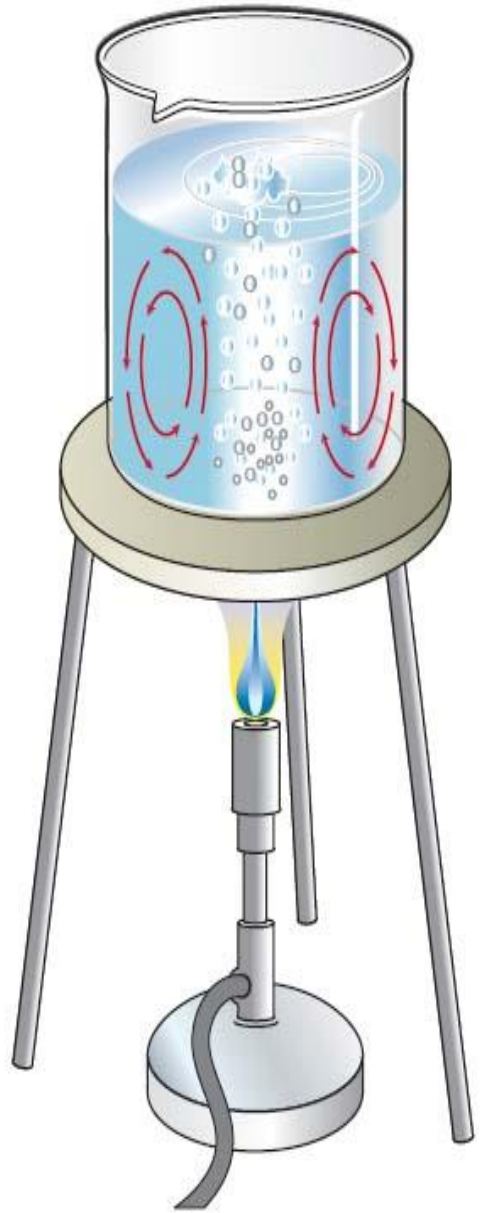
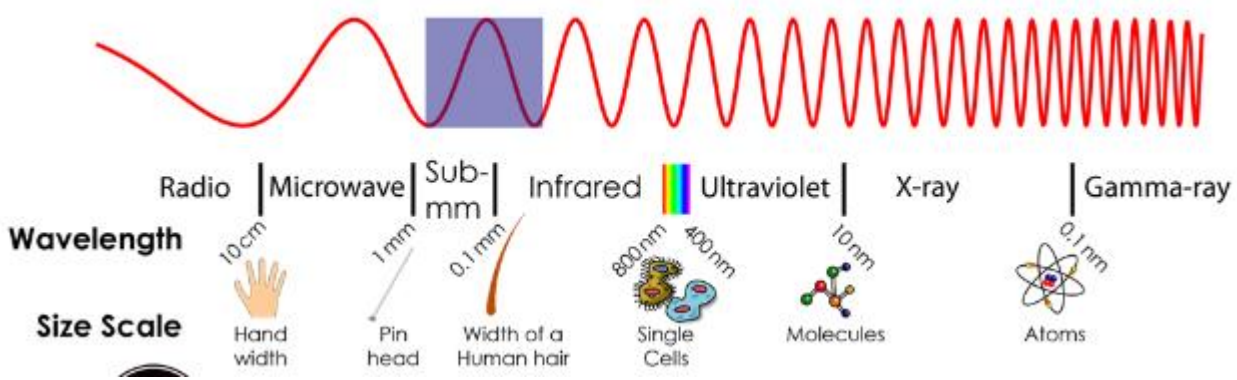


Figure 6.6 The arrows show the pattern followed by convection currents in the water.

1. Radiation

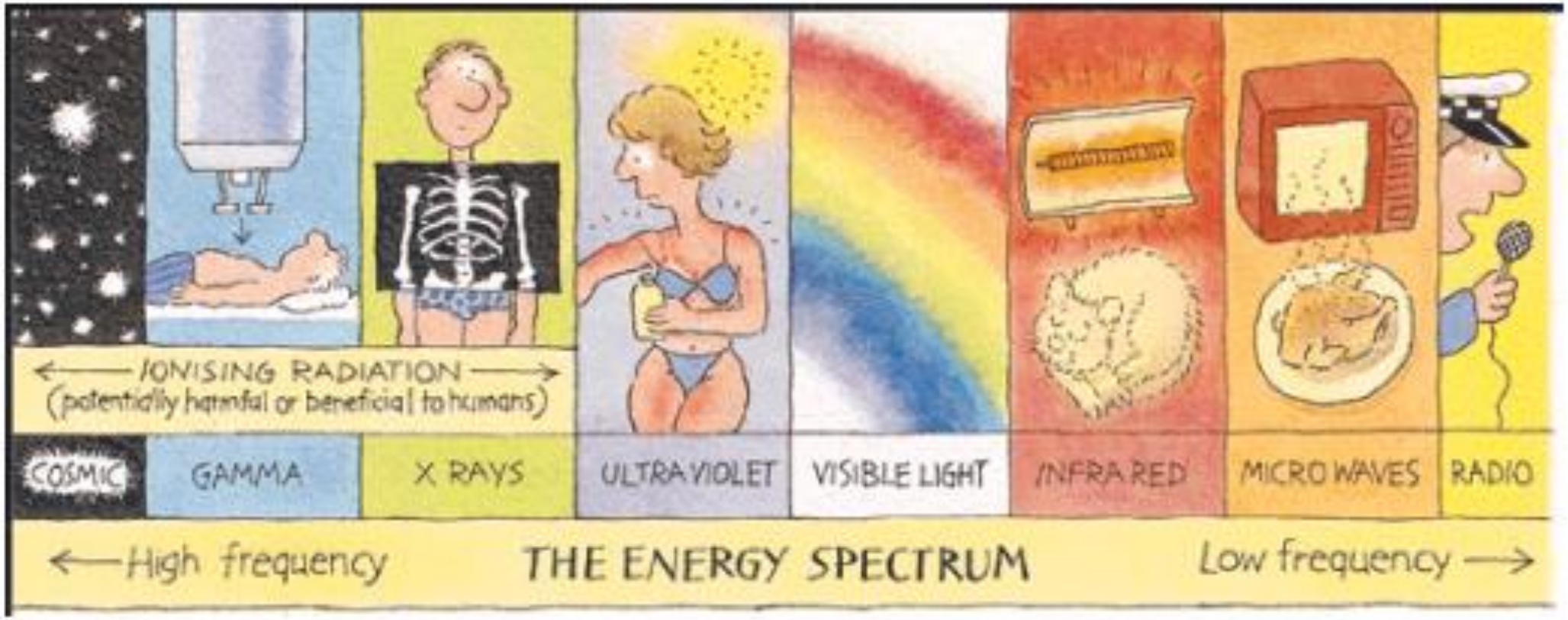
Energy can be transferred even though there are no particles to transfer the energy. This type of energy transfer is called radiation. Radiation is the transfer of energy without any movement of matter. Energy that is transferred in this way is called radiant energy or electromagnetic radiation (EMR for short). Radiant energy travels in waves.



Visible light is one form of radiation that reaches us from the sun via empty space.

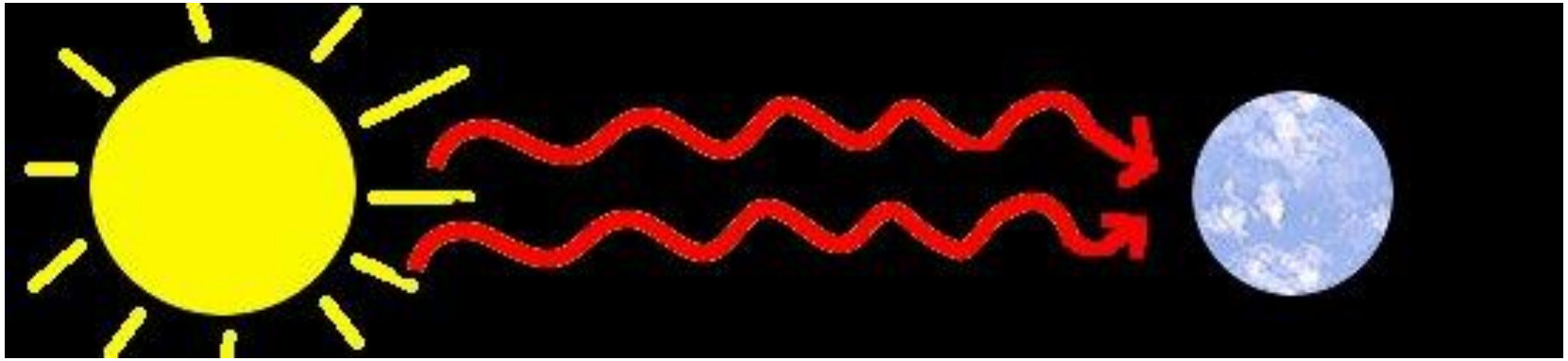
Examples fireplace, sunlight

Radiation is the transfer of energy by means of electromagnetic waves that can travel through a vacuum.



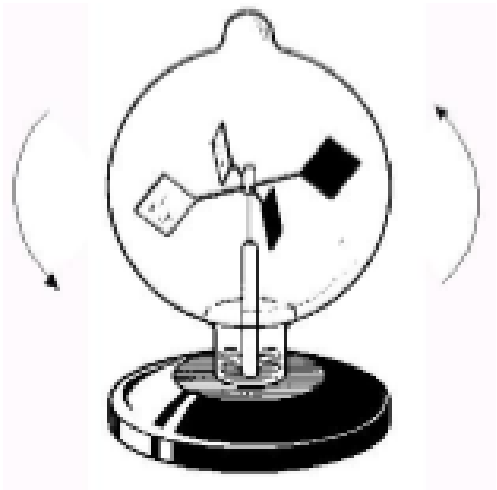
These waves can travel through space, air, glass and many other materials. There are different forms of EMR, including radio waves, microwaves, visible light and X-rays.

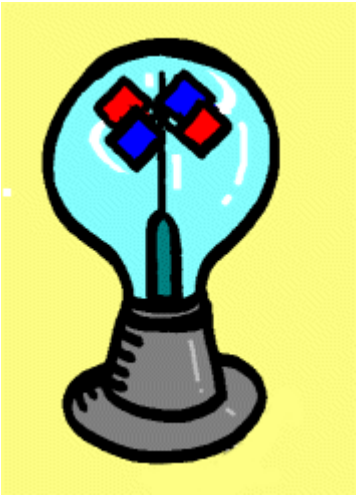
- There are no particles involved.
- The waves can travel in a vacuum.



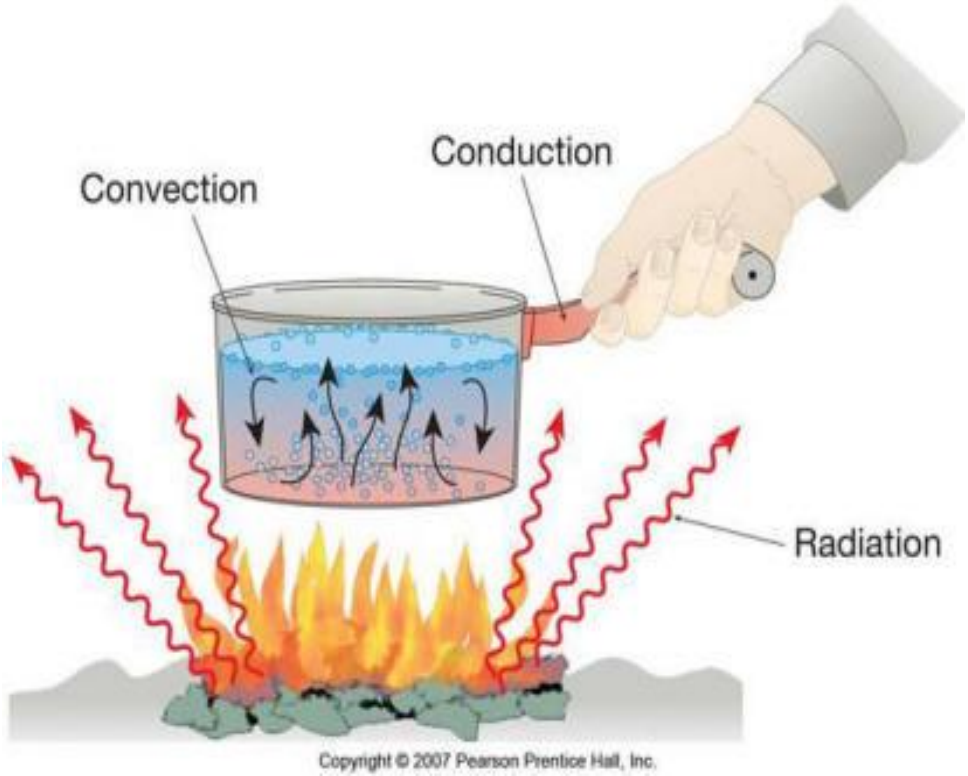
Pets understand radiation very well. They will lie near a window knowing the heat will radiate through the glass and warm them up during their nap.

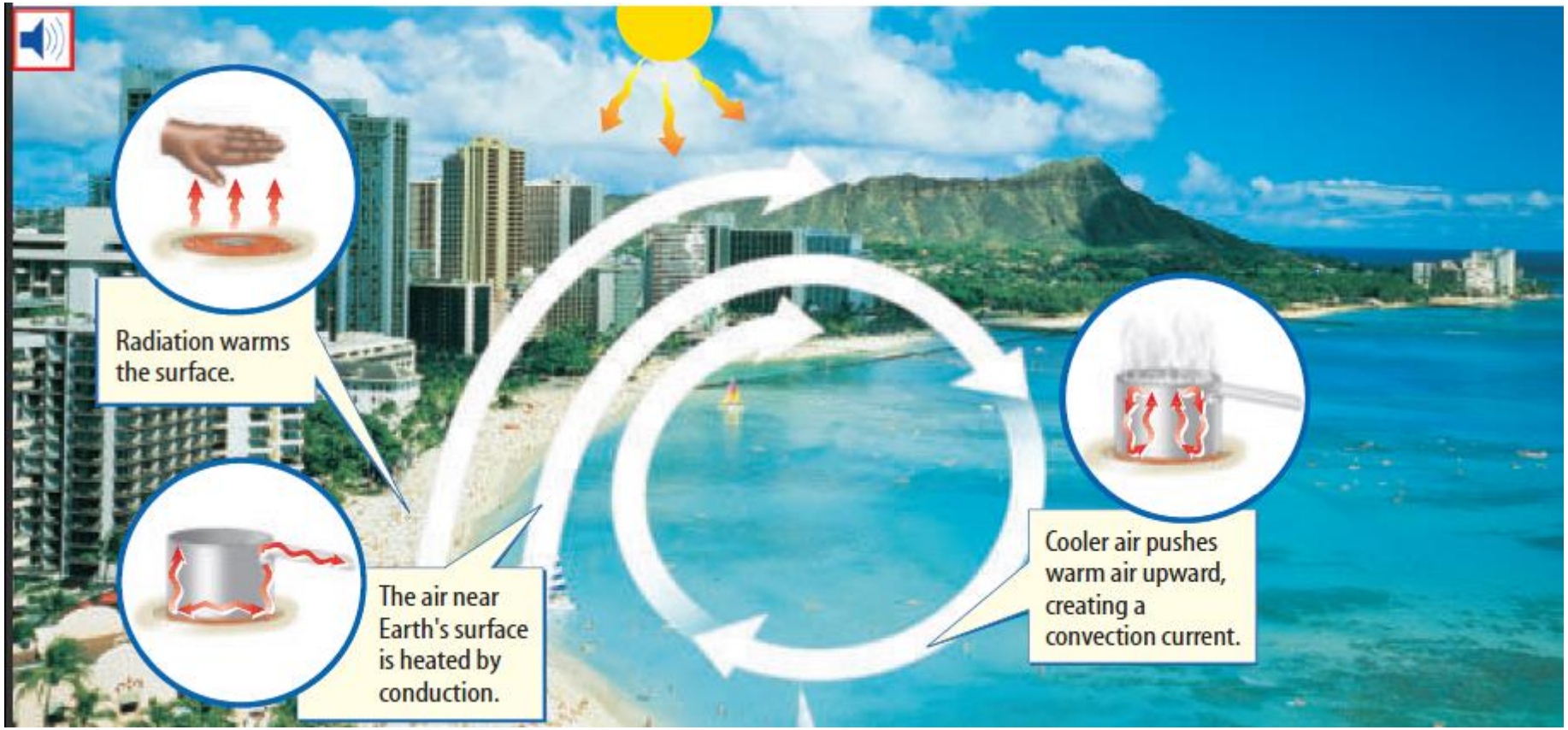
A Crookes' radiometer (or light mill) is a good example of how radiant energy works. It has four vanes suspended inside a glass bulb. Inside the bulb, there is a good vacuum. When you shine a light on the vanes in the radiometer, they spin -- in bright sunlight, they can spin at several thousand rotations per minute! This movement is caused by the black surface absorbing light energy and heating the gas near it. Hot gas particles move faster than cold ones and, by bumping onto the dark surface, they make it move toward the light surface





The three types of heat transfer, conduction, convection and radiation, can occur at the same time. The pan is made of a good conductor (metal) and the handle is made of an insulator (plastic). The shape of the pan allows a liquid to develop convection currents which help evenly heat what is being cooked. The stove burner (or the fire in this case) transfers heat by radiation from a high energy source to a low energy source



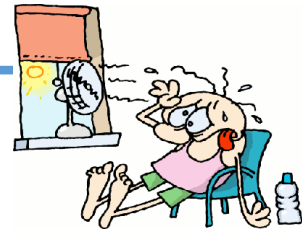

Radiation warms the surface.
The air near Earth's surface is heated by conduction.
Cooler air pushes warm air upward, creating a convection current.

Conduction	Convection	Radiation
• Energy transferred by direct contact • Energy flows directly from warmer to cooler objects • Continues until object temperatures are equal	• Occurs in gases and liquids • Movement of large number of particles in same direction • Cycle occurs while temperature differences exist	• Energy transferred by electromagnetic waves (visible light, microwaves, infrared) • All objects radiate energy • Can transfer energy through empty space

Intermediate Science 7

Unit 2: Heat

Topic 9: Heat Technologies



Development of Heat Technologies

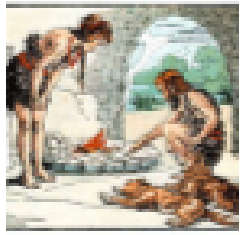
Heat Technologies refers to devices used to generate, transfer, control or remove heat

- Heat = Thermal energy

- Can you think of any examples of devices that generate, transfer, control or remove heat?

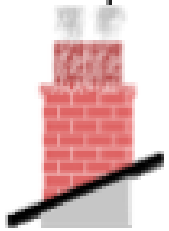
Early Heating Technology Timeline

7000 B.C. — Humans create fire



100 B.C. — Romans develop central heating – heat travels from one source to different areas of a building

A.D. 1200 — Chimneys first appear in Europe

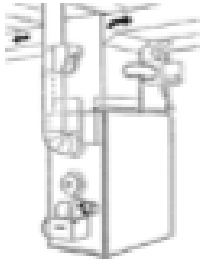


1300's — Fireplaces with chimneys are built into the walls of buildings

1700's — Cast-iron stoves heat rooms evenly: heat does not escape up the chimney

Late 1700's — Central heating reappears – using coal

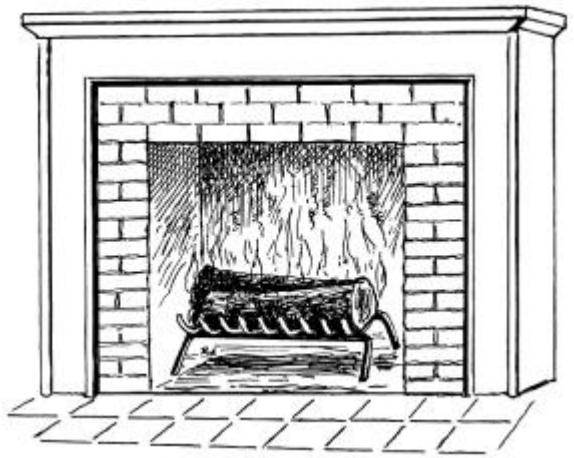
1800's — Forced-air heating



1906 — Electric heaters

1. Open Fireplace

Radiant heat from the fire and convection currents in the air spread the heat.



2. Wood Stove

- Efficient radiators due to the black color.

Figure 6.12 (A) On cold winter evenings, families would sometimes gather around the wood stove and talk about the day. (B) When it was time for bed, they would put hot coals from the stove into a bed warmer like this. They closed the lid and took the bed warmer to the bedrooms and slid it between the covers. When the bed covers were toasty warm, they would hop right into bed.

3. Electric Heaters: electrical device that converts electric current to heat.

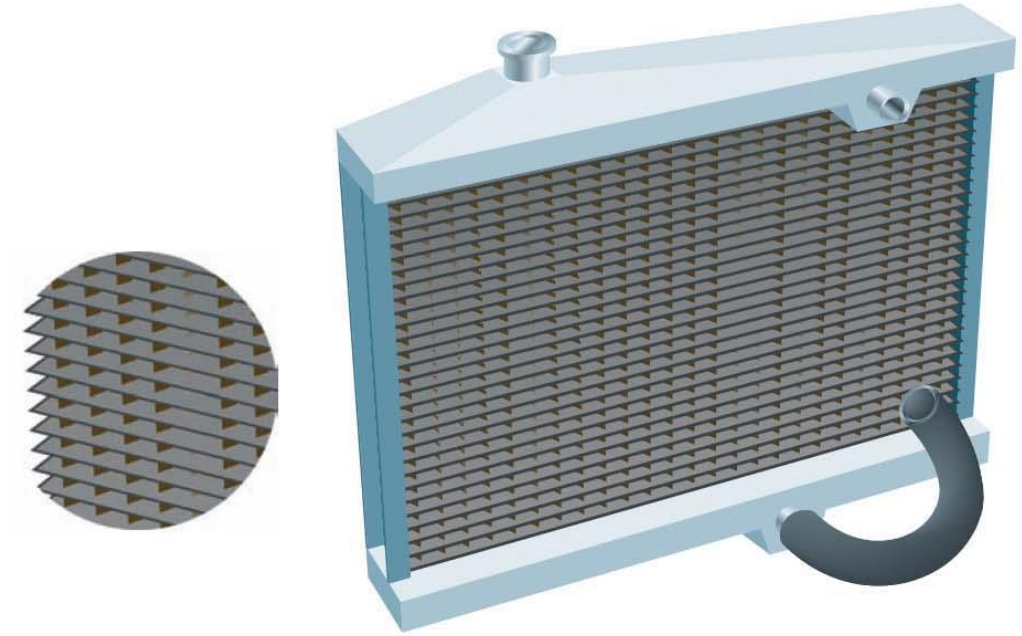
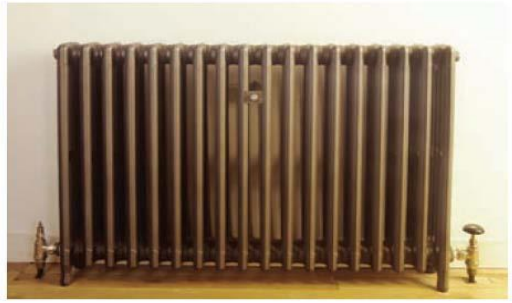


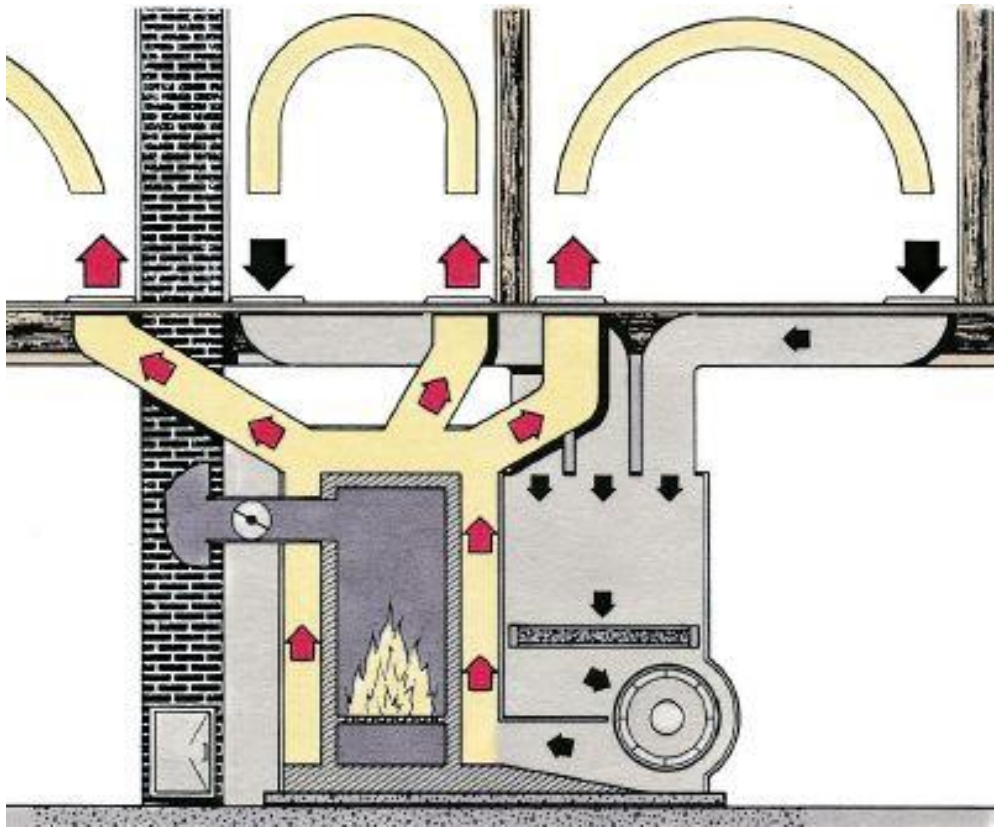
Figure 6.19 The honeycomb shape of the car radiator provides a very large metal surface area so that it can efficiently transfer heat from the engine to the outside air.

Figure 6.18 Baseboard heaters and radiators heat air by conduction with the air particles that come in contact with the metal surface. The hot air distributes the heat throughout the room by convection.

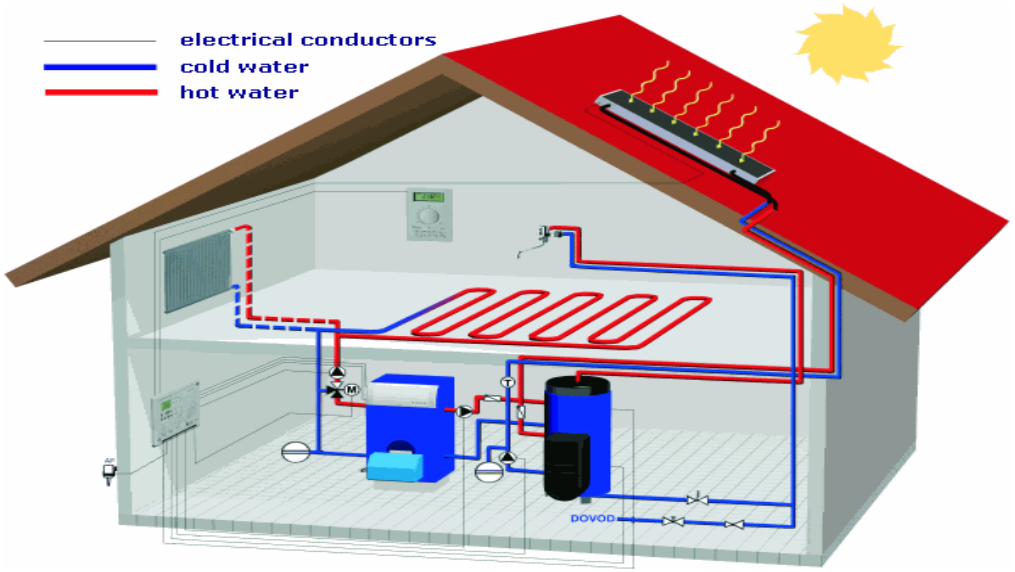


4. Oil Furnace

- Air is drawn into the furnace and heated and fans would blow the warm air through the ducts into the rooms.



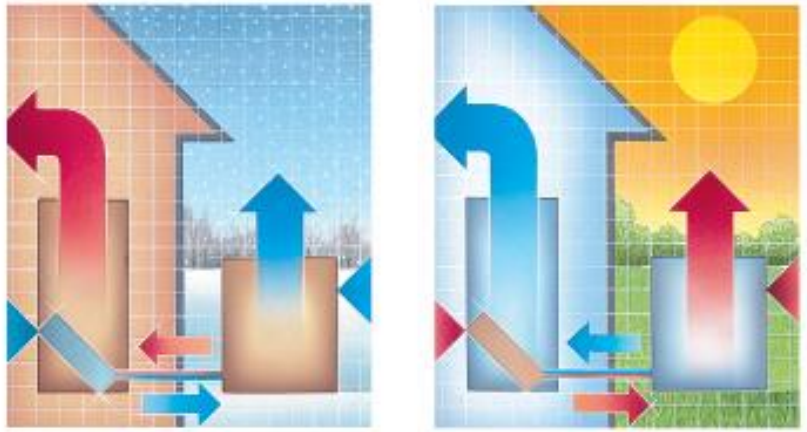
Water carried in a system of pipes can be used instead of air.
Hot Water Radiation



5. Air to Air Heat Pump

- Can be used to cool the home in the summer and heat the home in the winter.

Heat is exchanged with the outside air.

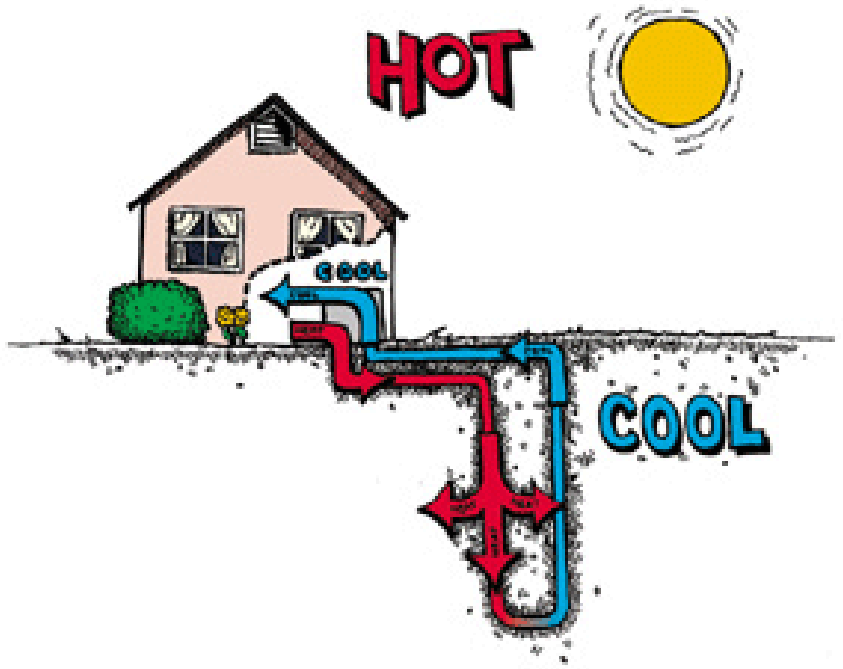


A heat pump heats your home in the winter...

and cools your home in the summer.

6. Geothermal

- Heat is exchanged with the ground.
- In the summer, heat is pumped into the ground andin winter it is pumped up from the ground.



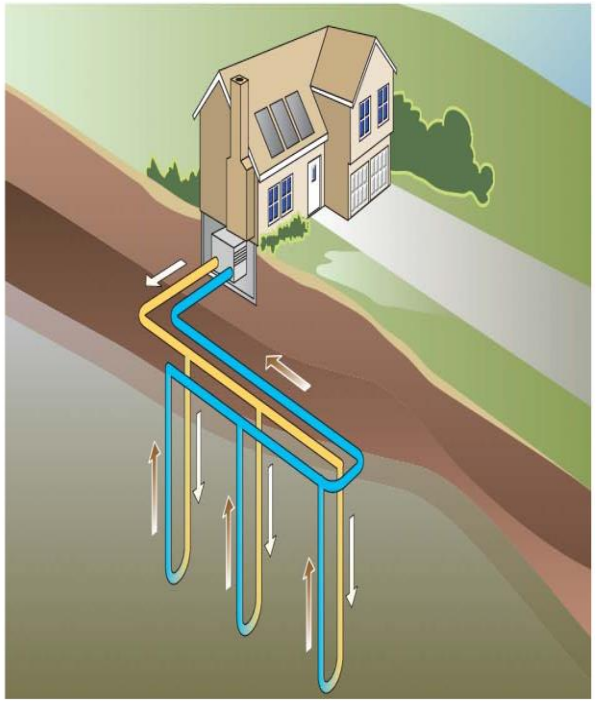


Figure 6.14 Pipes buried deep in the ground remove heat from the ground in the winter and pump it to the house. In summer, the heat pump takes heat from the house and deposits it in the ground.

7. Solar

- Converts light energy to electrical energy.

Using Energy from Heat

- What are some ways that we use heat?
  - Cook food
  - Warm buildings
  - Dry clothes

  - What are some ways Thermal Energy has been used throughout history?

Activity 6-1 C
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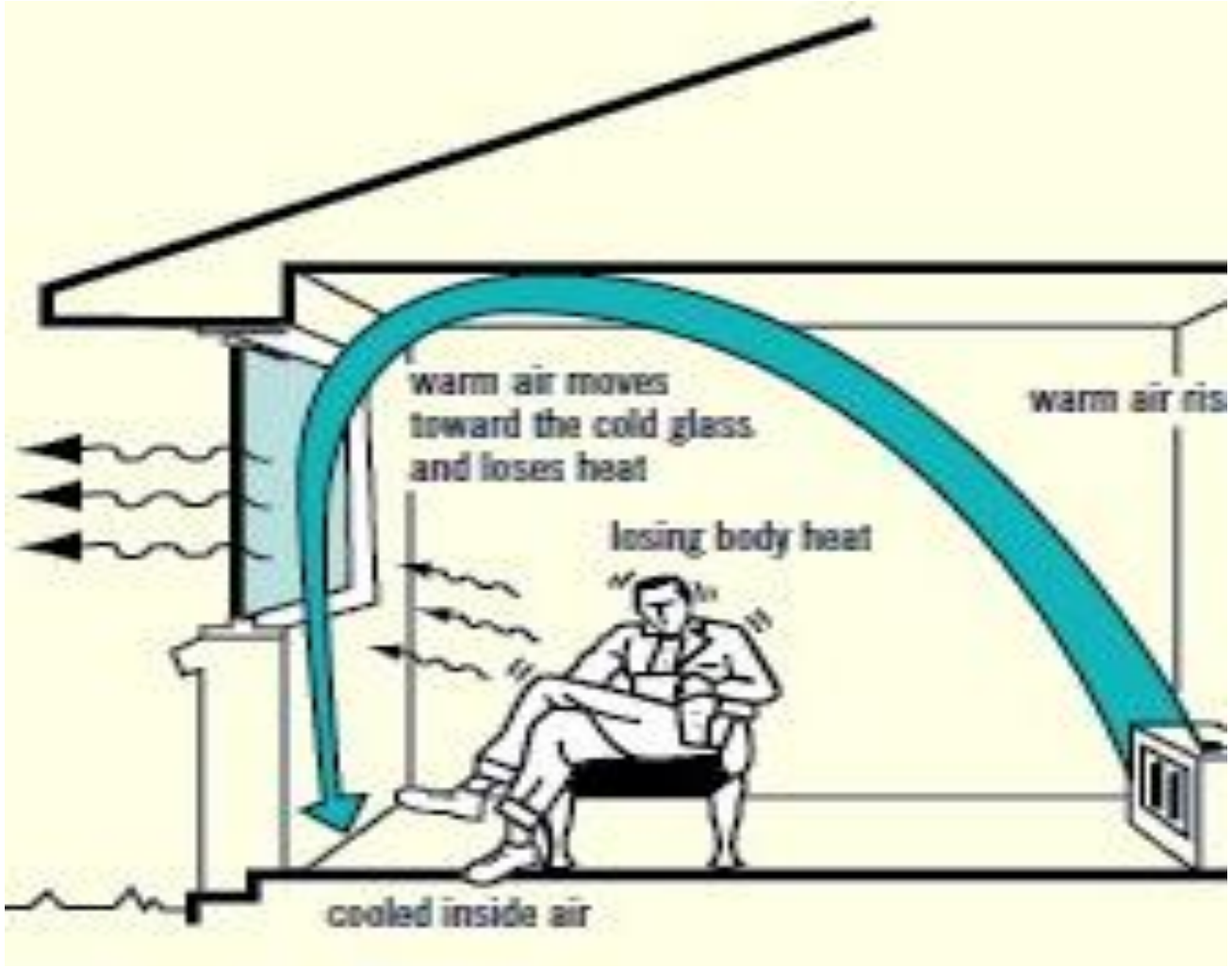
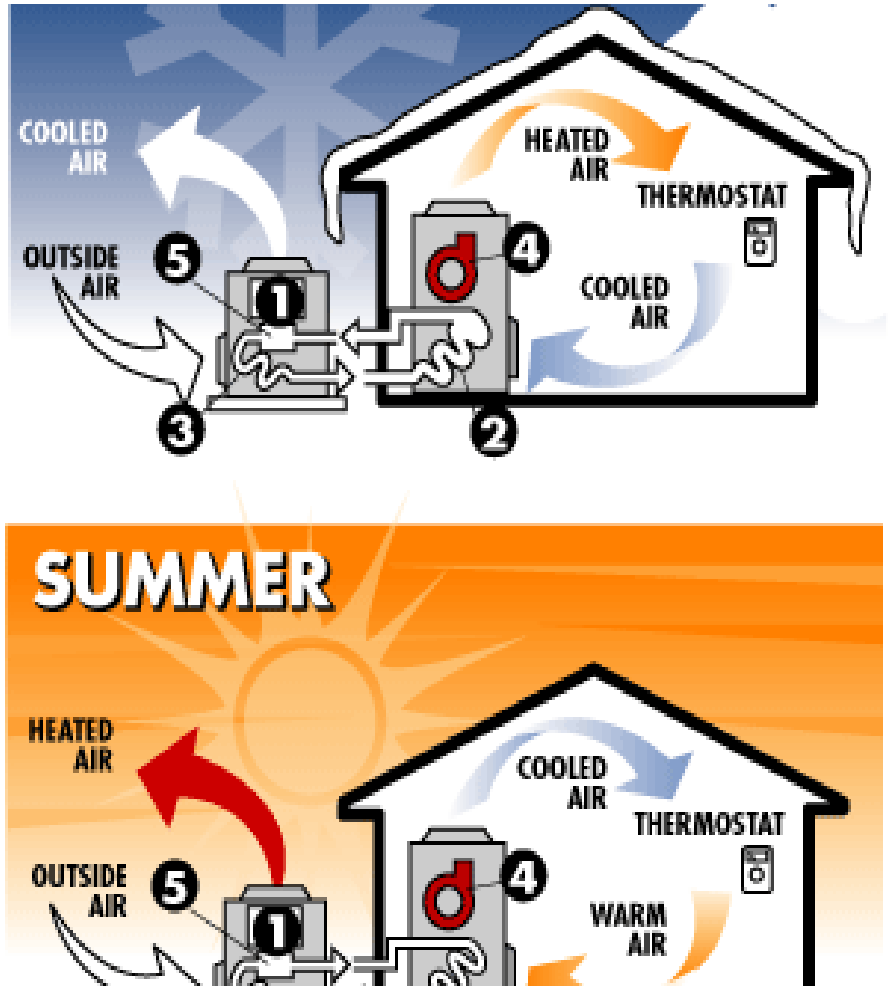


Energy Transfers and Home Heating Systems



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“Heat Pumps: An Alternative Way to Heat Homes”