Chapter 10: Heat

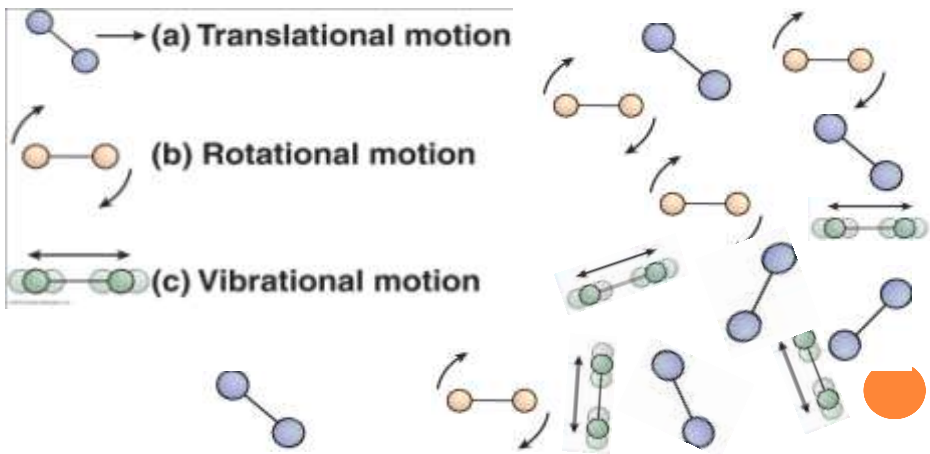
7th Physical Science

Introduction

- Worksheet Page 3. Do the QuickLab

Main ideas

- All objects are made of moving atoms and molecules



Main Ideas (worksheet Page 4)

- Thermal Energy:
  - Total KE from moving atoms and molecules
  - SI unit:
- Temperature:
  - Measure related to average KE of particles
  - Units:
- Heat:
  - Thermal energy transferred from hot object to cold object.
  - Example:
  - SI Unit:

10.1 Temperature
Bellringer

- The temperature of boiling water is 100° on the Celsius scale and 212° on the Fahrenheit scale. Look at each of the following temperatures and decide whether you think that it is hot or cold:

- 60°F 60°C 37°F 37°C 0°C 100°F 273K 70°F

10.1 Temperature (Worksheet Page 4)

- All object are made of atoms or molecules that are always moving randomly.
- Temperature = a measurement of the average kinetic energy of an object's particles.

10.1 Temperature

- Question: How does a thermometer work?

Thermal expansion:

The mercury or alcohol in a glass tube spreads out when it's hotter

Because the particles move faster.

10.1 Temperature

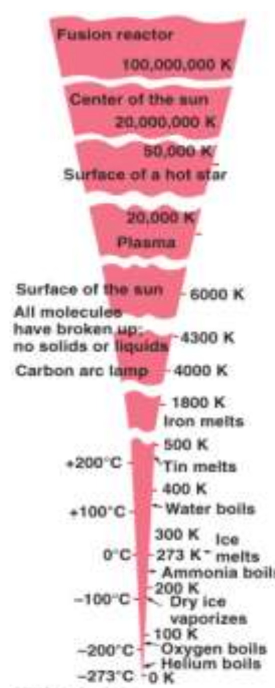
- Where do the temperature scales come from?

10.1 Temperature

- Why Kelvin scale?

10.1 Temperature (Worksheet Page 5)

- How cold is too cold?
- How hot is too hot?



10.1 Temperature

- Temperature Conversions. Write the equations.
  - Fahrenheit → Celsius

$$°F = \left(\frac{9}{5} \times °C\right) + 32$$

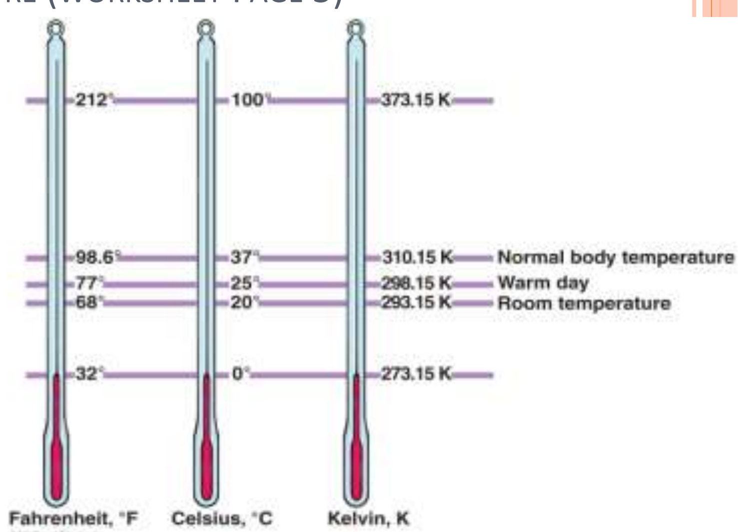
  - Celsius → Kelvin

$$K = °C + 273$$

  - Fahrenheit → Kelvin

10.1 Temperature (Worksheet Page 5)

- Label the temperatures in Fahrenheit, Celsius, Kelvin.
- Describe the tick marks.



10.1 Temperature (Worksheet Page 5)

- Math Practice
- 1. 373 K = _____________ °C
- 2. Which is colder 0 ° F or 200K?

10.1 Temperature (Worksheet Page 5)

- Most substances _______________ when cooled.
- Scientists use either the ___________ or ____________ temperature scale.
- An object's temperature decreases as the average kinetic energy of its particles _____________.

10.1 Temperature (Worksheet Page 5)

- Why does a bridge need expansion joints?

10.1 Temperature (Worksheet Page 5)

- How does a hot-air balloon work?

10.1 Temperature

- Homework:
  - Worksheet Page 1 (Section 10.1)
  - Prelab
    - Fill in Hypothesis -- and why?
    - Independent/ dependent variables

10.2 What's Heat? (Worksheet Page 5)

- A question:

  The temperature in the bathroom is 23°C. The tile floor feels very cold. The rug feels warmer.

Is the floor really colder than the rug? Why do they seem to be at different temperatures when your bare feet touch them?

10.2 What's Heat? (Worksheet Page 5)

- Heat =

    thermal energy transferred

        from an object with *higher* temperature

        to an object with *lower* temperature

- SI unit

    = Joule

- Question:
    - Why does an ice cube feel cold?

      Your hand lost energy to ice cube.

    - Why does a light bulb feet hot?

      Your hand picked up energy from light bulb.

10.2 What's Heat?

- Prediction: True or false?

    - Thermal energy depends partly on the temperature of a substance.

    - A cup of water at 283 K and a pot of water at 283 K have the same thermal energy.

    - True.
    - False

10.2 What's Heat? (Worksheet Page 6)

- Thermal energy =

  total kinetic energy of an object's particles.

- What is the difference between temperature and thermal energy?

  temperature = average KE (how fast does each particle run?)

  thermal energy = total KE (add up all the KE from all particles)

10.2 What's Heat? (Worksheet Page 6)

- Q) 2 bowls of soup are at the same temperature. The bigger bowl has less/more thermal energy than the smaller bowl.

- Q) A bigger ice cube has less/more thermal energy than a smaller ice cube because…

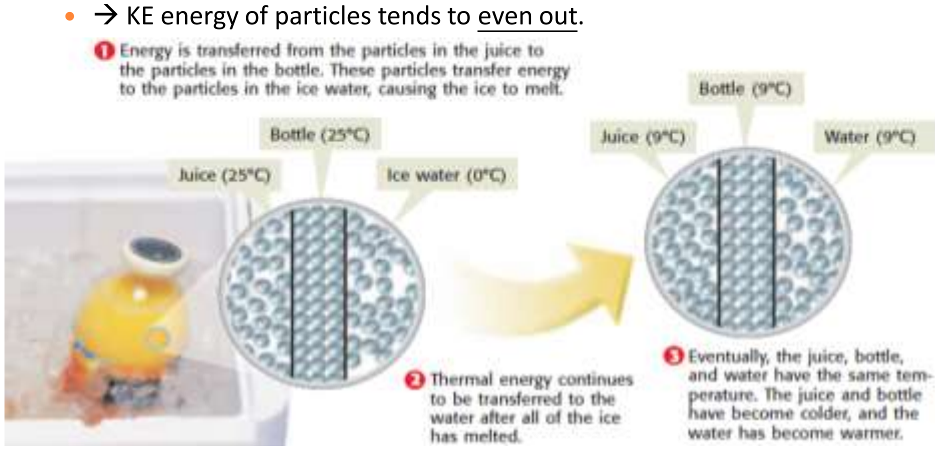
  particles move at about the same speed (temperature same) but there are more particles and their KE add up.

10.2 WHAT'S HEAT? (WORKSHEET PAGE 6)

Q	Which is higher temperature? Why?	Which has more thermal energy? Why?
Iceberg vs. Ice cube		
Bowl of hot soup vs. Lake		

10.2 WHAT'S HEAT? (WORKSHEET PAGE 6)

- When 2 objects at different temperatures come in contact, the cooler/warmer object gives energy to the cooler/warmer object until they are ___________________________
  - → KE energy of particles tends to even out.



10.2 WHAT'S HEAT?

- When energy has been transferred by heat, what happens to it?

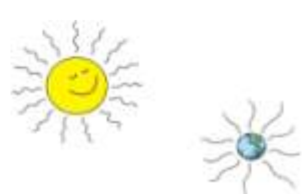
  Energy goes from high temperature object to cooler object.
  The high temperature object lost energy and decreases temperature.
  The cooler object gains energy and increases temperature.

10.2 HOW TO TRANSFER HEAT? (WORKSHEET PAGE 6)

- The 3 ways to transfer thermal energy (heat) are:
  - conduction

  - convection

  - radiation



10.2 Method #1: Conduction (Worksheet Page 6)

- Thermal conduction = transfer of thermal energy by direct contact.

Method #1: Conduction

- Example:

- Thermal conductors: ________________________
- Example: ___________________-

- Thermal Insulator: ________________________
- Example: ___________________________

Table 1 Conductors and Insulators

Conductors	Insulators
Curling iron	Flannel shirt
Cookie sheet	Oven mitt
Iron skillet	Plastic spatula
Copper pipe	Fiberglass insulation
Stove coil	Ceramic bowl

10.2 METHOD #1: CONDUCTION (WORKSHEET PAGE 6)

- A question:

  The temperature in the bathroom is 23°C. The tile floor feels very cold. The rug feels warmer.

Is the floor really colder than the rug? Why do they seem to be at different temperatures when your bare feet touch them?

10.2 METHOD #2: CONVECTION (WORKSHEET PAGE 6)

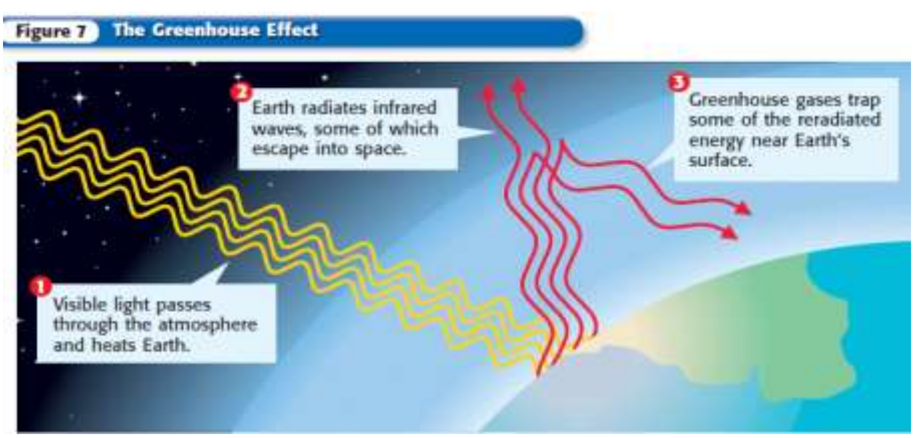
- Convection = transfer of thermal energy by movement of liquid or gas.

- One heater located in the deep end warms the entire swimming pool.
- Hot air/water is ____________ dense/_______________ than cold air/water, so the hot air/water will _____________ and the cold air/water will _______________.
- 2 examples:

10.2 METHOD #3: RADIATION (\

- Radiation = transfer of thermal energy by ____.
- This is different from conduction and convection since em waves can travel through matter *and* through _______________.
- The girl feels much warmer than the boy because ____________________________
- ____.
- What types of matter radiate em waves? ______________
- 3 Examples of radiation:  ______________________ _____________________________ _____
- Interesting fact: In ____________________, the surface of the earth absorbs enough energy to meet the world's energy needs for ______________________________.

RADIATION



10.2 Quick Lab #2: Worksheet Page 3

- Turn to Page 273 “Some Like it Hot”

10.2 Specific Heat(Worksheet Page 7)

- Put an empty metal pot on a stove and wait a 1 minute.
- Put a metal pot full of water on a stove and wait 1minute.
- Which one gets more energy?
- Which one is safe to touch?

- Which one needs more energy to increase the temperature?
- Which one has higher specific heat capacity?

10.2 Heat and Temperature Change (Worksheet Page 7)

- Specific heat capacity: thermal inertia.

  The harder it is to change the temperature, the higher the specific heat capacity is.

10.2 Heat and Temperature Change (Worksheet Page 7)

- Specific Heat = amount of ___energy____

  for _____1 kg of a substance______ to change ______temperature by $1^{o}C$___________.

Table 2 Specific Heat of Some Common Substances

Substance	Specific heat (J/kg·°C)	Substance	Specific heat (J/kg·°C)
Lead	128	Glass	837
Gold	129	Aluminum	899
Copper	387	Cloth of seat belt	1,340
Iron	448	Ice	2,090
Metal of seat belt	500	Water	4,184

- Metal has _____________ specific heat than cloth. A little energy (heat) makes metal a lot warmer.
- Water has _________________ specific heat than air. A lot of energy (heat) makes water a little warmer.

10.2 Heat and Temperature Change (Worksheet Page 7)

- **Q** On a summer day, the metal part of the seatbelt feels scalding hot, but the cloth just feels warm. Why?
- 1. Even if they were at the same temperature, metal feels hot because
- 2. Actually, the metal has a ___________ temperature than the cloth. The sun gives both metal and cloth the same amount of energy but metal _____________________

10.2 Heat and Temperature Change (Worksheet Page 7)

- **Q** Why does a swimming pool feel cool on a hot summer day?
- The Sun gives water and air about the ____________ energy, but the water temperature is _________ than air temperature because ____.

10.2 Heat and Temperature Change (Worksheet Page 7)

- Calculate Heat

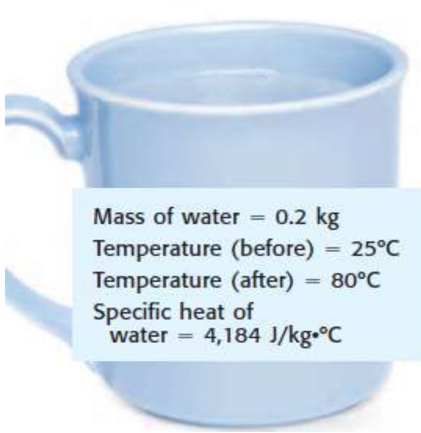
- Example:

- In the box:

- When energy is transferred out of / into water, the water becomes warmer.

10.2 Heat and Temperature Change (Worksheet Page 7)

- Calculate the heat (energy) transferred into the water.



10.2 Heat and Temperature Change (Worksheet Page 7)

- Calculate the heat (energy) transferred into the water.
- You heat 2.9 kg of water to make pasta. The temperature of the water before you heat it is 40°C, and the temperature after is 100°C. How much heat was transferred to the water?

10.2 Review – True or False?

- Heat is the transfer of energy between 2 objects with different temperatures.
- Convection currents result from temperature differences in liquids and gases.
- Radiation is the means by which the energy from the sun is transferred to Earth.
- Water stays warm or cool longer than land does because water has a lower specific heat than land does.

10.2 What's Heat?

- Homework – due Wednesday.
  Worksheet Page 1~2 (Section 10.2)

10.3 States and Heat (Worksheet Page 8)

- The 3 states of matter are:

Figure 1 Particles of a Solid, a Liquid, and a Gas

Particles of a gas, such as carbon dioxide, move fast enough to overcome nearly all of the attraction between them. The particles move independently of one another.

Particles of a liquid move fast enough to overcome some of the attraction between them. The particles are able to slide past one another.

Particles of a solid, such as ice, do not move fast enough to overcome the strong attraction between them, so they are held tightly together. The particles vibrate in place.

10.3 States and Heat (Worksheet Page 8)

- The state with fastest particles is ___________.
- The state with lowest kinetic energy is ___________.
- The state where particles vibrate in place is __________.
- The state where particles are sliding is __________.
- The state where particles are most strongly attracted is ________
- The state where particles have almost no attraction is _________.

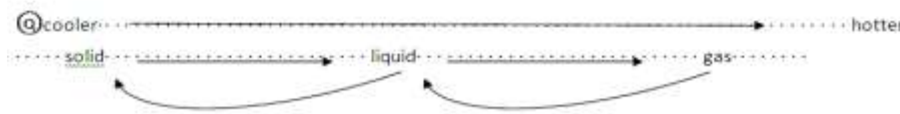
10.3 States and Heat (Worksheet Page 8)

- Change of state is a chemical/ physical change because the substance is still the same, just in a different form.
- H_2O is still H_2O even though it can be in the forms of __________________________________.

Figure 2 *When you melt cheese, you change the state of the cheese but not its identity.*

10.3 States and Heat (Worksheet Page 8)

- Changes of state



- When you add in thermal energy to an object, it could _______________, _____________, or _____________.
- When you take out thermal energy from an object, it could __________________, ___________, or___________.

10.3 Changes of State

- Freezing?
- Melting?
- Boiling?
- Condensing?

- Ice cubes turn to water
- Dew covers windshield
- Soup bubbles on the stove
- Winter road becomes slippery after sun goes down
- Water in pan on stove slowly disappears
- Bathroom mirror fogs up when shower

10.3 States and Heat (Worksheet Page 8)

- In the evening, why does dew tend to form?

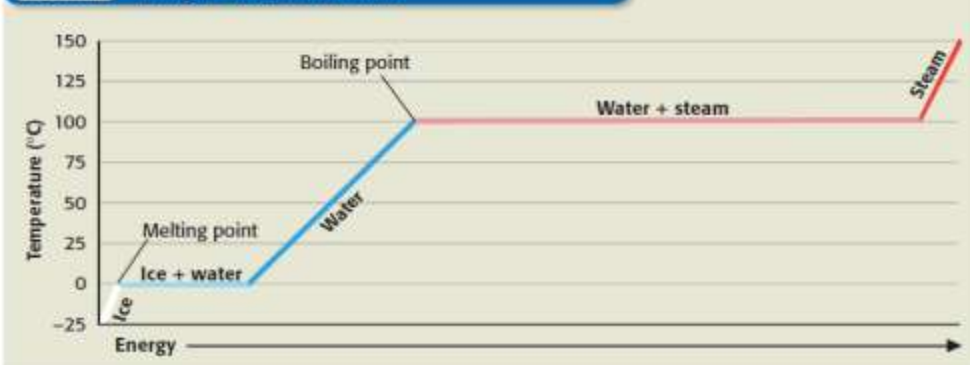
10.3 States and Heat (Worksheet Page 8)

- <u>During</u> a change of state, the temperature ______________________________ because…

10.3 States and Heat (Worksheet Page 8)

Reading Check What happens to the temperature of a substance while it is undergoing a change of state? *(See the Appendix for answers to Reading Checks.)*

Figure 3 Changes of State for Water



10.3 Changes and Heat

- Is this a physical or a chemical change?

- Chemical: oxygen in air and methane in natural gas form carbon dioxide and water and energy

- Chemical change: when the substance changes into another substance.
- Energy goes into breaking old bonds and creating new ones.

10.3 Food and Chemical energy (Page 8)

- 1 Calorie (on label) = 4184 J.
- Q. 502,080 J = __________calories

10.3 Calorimeter

- How to measure energy in food?
- Burn the food
- Energy is released, heat transfers to water.
- Water temperature rises
- Water's mass is known, specific heat is known. Calculate energy transferred to water. This is the energy of the food.

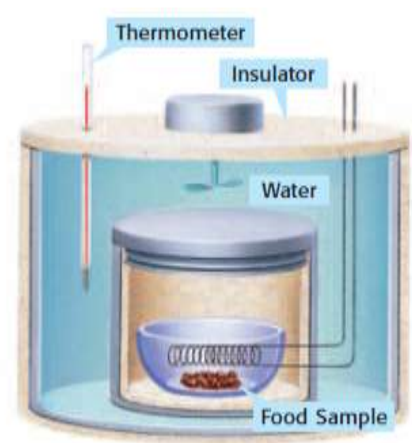


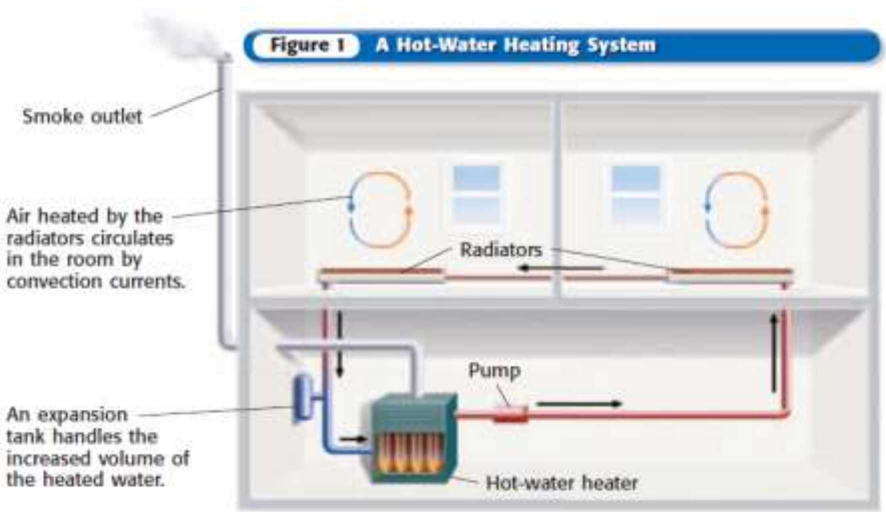
Figure 6 *A bomb calorimeter can measure energy content in food by measuring how much heat is given off by a food sample when it is burned.*

10.3 Matter and Heat Review

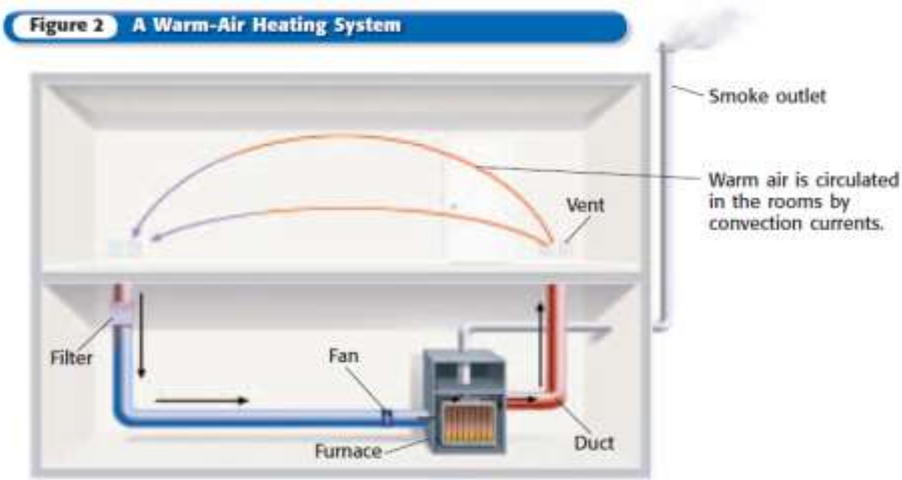
- True or false?

- 1. When ice changes to a liquid, it absorbs energy.
- 2. When a liquid evaporates, it absorbs energy.
- 3. When a vapor condenses to al liquid, energy is given off.
- 4. When a liquid boils, energy is absorbed.

10.4 Heat Technology



10.4 Heat Technology



10.4 Heat Technology

- Insulation: material that reduces the transfer of thermal energy.
- Helps maintain warmth in winter, cool in summer.
- Which parts of the roof are insulated?

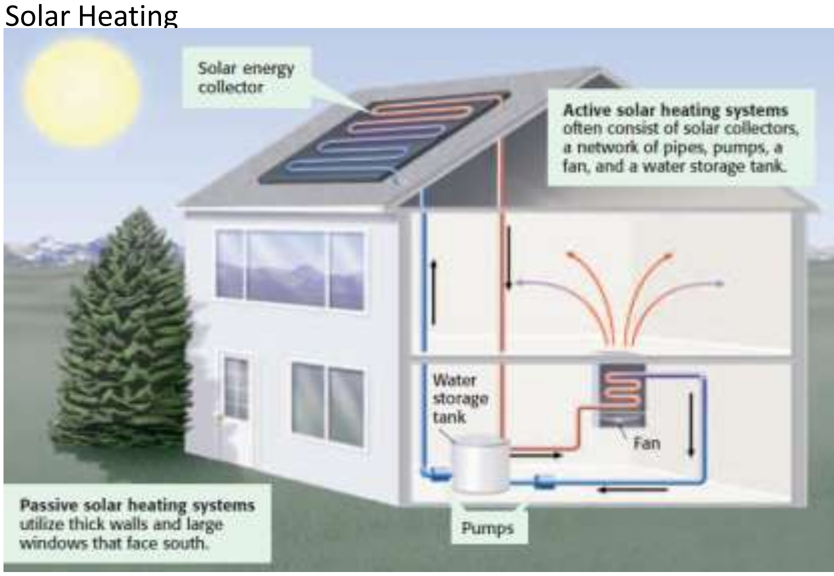
Figure 3 *Millions of tiny air pockets in this insulation help prevent thermal energy from flowing into or out of a building.*

10.4 Heat Technology

- Do blankets provide thermal energy?

10.4 Heat Technology

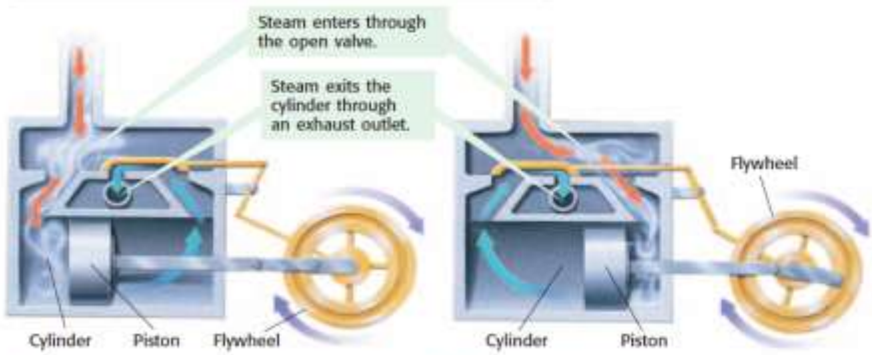
- Solar Heating



10.4 Heat Technology

- Heat engine: burn fuel to release heat (energy) to do work

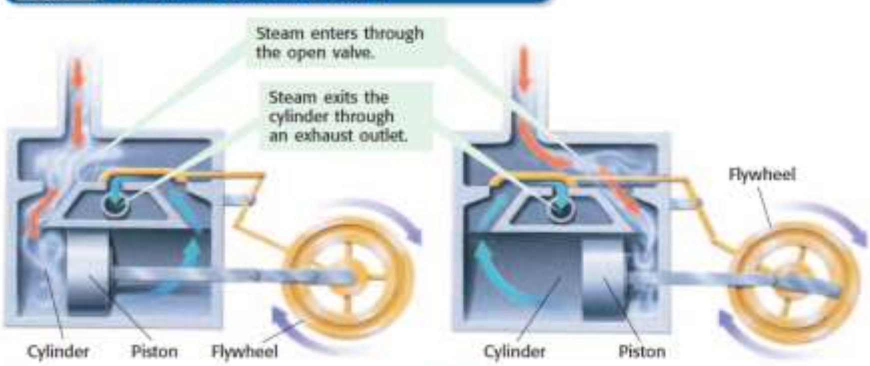
Figure 5 An External Combustion Engine



1. The expanding steam enters the cylinder from one side. The steam does work on the piston, forcing the piston to move.
2. As the piston moves to the other side, a second valve opens, and steam enters. The steam does work on the piston and moves it back. The motion of the piston turns a flywheel.

10.4 Heat Technology

Figure 5 An External Combustion Engine



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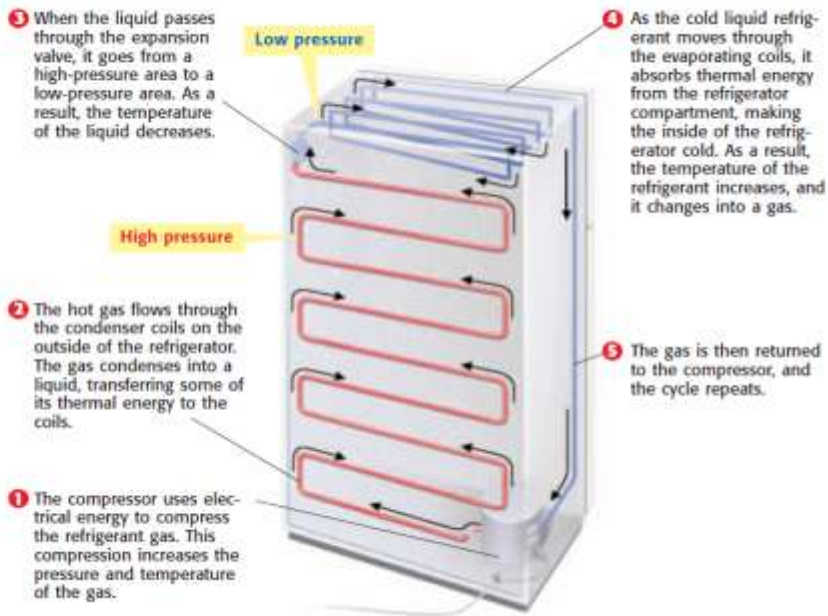

10.4 Heat Technology

- Thermal pollution