Chapter 4

Energy

Section 4.1: The Nature of Energy

- energy
  - the ability to cause change
- different forms of energy
  - electrical – making toast
  - chemical – stored in food
  - radiant – from the sun
  - thermal – warming of the atmosphere
- energy plays a role in every activity you do
- energy is measured in Joules (J)

Kinetic Energy

- Kinetic Energy (KE)
  - energy a moving object has because of its motion
  - depends on the mass and speed of the object
- Kinetic Energy Equation

$$KE = \frac{1}{2} mv^2$$

KE = kinetic energy (J)

m = mass (kg)

v = speed (m/s)

Practice: Page 102 #1-3

$KE = \frac{1}{2} mv^2$

1.

Potential Energy

- energy does not always include motion
- Potential Energy (PE)
  - stored energy an object has due to its position
  - Example
    - Apple in a tree due to its height
      - when it falls, potential energy transferred to kinetic
    - Electron excited into a higher orbital
      - when it falls, potential energy transferred light energy

Gravitational Potential Energy

- Gravitational Potential Energy (GPE)
  - energy stored by objects due to their position above Earth's surface
  - depends on distance above Earth's surface and the object's mass
- Gravitational Potential Energy Equation

$$GPE = mgh$$

GPE = gravitational potential energy (J)

m = mass (kg)

g = 9.8 m/s^2 (acceleration due to gravity)

h = height (m)

Practice Page 104 #1-3
GPE = mgh

1.

Changing GPE

- increasing the height above the ground increases the GPE
- if two objects are at the same height, the one with the larger mass has greater GPE
- What happens if an object falls?
  - amount of potential energy decreases as kinetic energy increases
  - Why?

Work - Change in Energy

- Work = Change in energy = Δ Energy
  - Whenever an objects energy changes, work is done.
  - If the object does work, it loses energy
  - If the object has work done on it, it gains energy

Work = Force * Displacement = Δ Energy

- Elastic Potential Energy
  - energy stored when an object is compressed or stretched
  - Example:
    - stretching a rubber band has stored elastic potential energy
    - when released, the potential energy changes to kinetic
- Chemical Potential Energy
  - energy stored in chemical bonds
  - Example
    - gasoline
    - food

Section 4.2: Conservation of Energy

- when energy changes form, it is always conserved
- a light transforms **electrical** energy to **light** and **thermal** energy
- other devices that make use of electrical energy

Conversions between Kinetic and Potential

ME = PE + KE

ME = Mechanical Energy
PE = Potential Energy
KE= Kinetic Energy

Section 6.1: Temperature and Heat

- temperature
  - measure of the average kinetic energy of all the particles in an object
- Kelvin (K)
  - SI unit of temperature
- a more commonly temperature scale used is Celsius (°C)
  - 1 K = 1°C
  - K=°C+273
  - °C=K – 273
- Convert 20°C to K
  - 20°C + 273 = 293 K

Thermal Energy

- thermal energy
  - sum of the kinetic and potential energy of the particles
  - is transferred by conduction, convection, and radiation
- when the temperature of an object increases, the average kinetic energy of the particles in the object increases
- as a result, the thermal energy increases

Water

- °C (Celsius)
  - boiling point – 100
  - freezing point – 0
- °F (Fahrenheit)
  - boiling point – 212
  - freezing point – 32
- K (Kelvin)
  - boiling point – 373
  - freezing point - 273

Heat

- **temperature** and **heat** are not the same, but they are related
- heat
  - thermal energy that flows from a warmer material to a cooler material
  - its unit is still in Joules (J)
- heat always flows from warmer to cooler materials
- heat depends on the amount of substance you have

Specific Heat

- specific heat
  - the amount of thermal energy needed to raise the temperature of 1 kg of a material 1°C
- specific heat is measured in joules per kilogram Celsius [J/(kg •°C)]

Specific Heat

Specific Heat of Some Common Materials	
Substance	Specific Heat [J/(kg/°C)]
Water	4,184
Wood	1,760
Carbon (graphite)	710
Glass	664
Iron	450

- water has the highest specific heat
- this means that it takes a lot of energy to heat up 1 kg of water 1 °C

Changes in Thermal Energy

- the thermal energy of an object changes when heat flows into or out of the object

$$Q=mc\Delta T$$

Q = change in thermal energy (J)
m = mass (kg)
c = specific heat (J/kg °C or J/kg K)
$\Delta T = T_f - T_i$ (change in temperature) (°C or K)

Pg 163 #6 and #7

6.)

Measuring Specific Heat

- **calorimeter**
  - used to measure specific heat
  - a heated sample transfers heat to a known mass of water
  - energy absorbed by the water can be calculated by measuring the water's temperature change
  - thermal energy released by the sample equals the thermal energy absorbed by the water

Section 6.2: Transferring Thermal Energy

- thermal energy can be transferred three ways
  - conduction
  - convection
  - radiation

Conduction

- Conduction
  - transfer of thermal energy by collisions between particles in matter
- conduction occurs because particles in matter are in constant motion
- best conductors of heat → metals
  - there are electrons that are not bound to individual atoms, but can move easily through the metal

Convection

- Convection
  - transfer of thermal energy in a fluid by the movement of warmer and cooler fluid from place to place
- fluid – liquid or a gas
- Convection current
  - transfer heat from warmer to cooler parts of the fluid

Radiation

- Radiation
  - transfer of energy by electromagnetic waves
- Energy transferred by radiation often is called radiant energy
- These waves can travel through space even when no matter is present

Radiant Energy and Matter

- materials that are light-colored reflect more radiant energy
- dark-colored materials absorb more radiant energy
- when radiant energy is absorbed by a material, the thermal energy of the material increases
- insulator
  - a material in which heat flows slowly
  - wood, plastic, fiberglass, air