Chapter 5 Part 1

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Energy

- Energy is the capacity to supply heat or do work
- Energy is not matter, as it does not have mass or occupy space

Two types of energy

Kinetic Energy

- The energy that an object possesses because of its motion

Potential Energy

- The energy that an object has because of its relative position

Law of conservation of energy

- Says that energy cannot be created or destroyed
- However, energy can be converted from one form to another
- All energy present before a change occurs always exists in some form after the change is completed

Thermal energy

- Kinetic energy associated with the random motion of atoms and molecules
- Thermal energy is an extensive property

Temperature

- Can be thought of as the average thermal energy of particles
- Is a quantitative measure of how hot or cold something is
  - We refer to things with a high average kinetic energy as hot
  - We refer to things with a low average kinetic energy as cold
- Temperature is an intensive property
- Changes in temperature often affect the volume of substances
  - Most substances expand as their temperature increases
  - Most substances contract as their temperature decreases

Temperature

- Temperature is the average kinetic energy of the particles in a substance
- Temperature is an intensive property
- There are 3 primary units of Temperature

Unit	Symbol
Kelvin	K
Celsius	°C
Fahrenheit	°F

Temperature Conversions

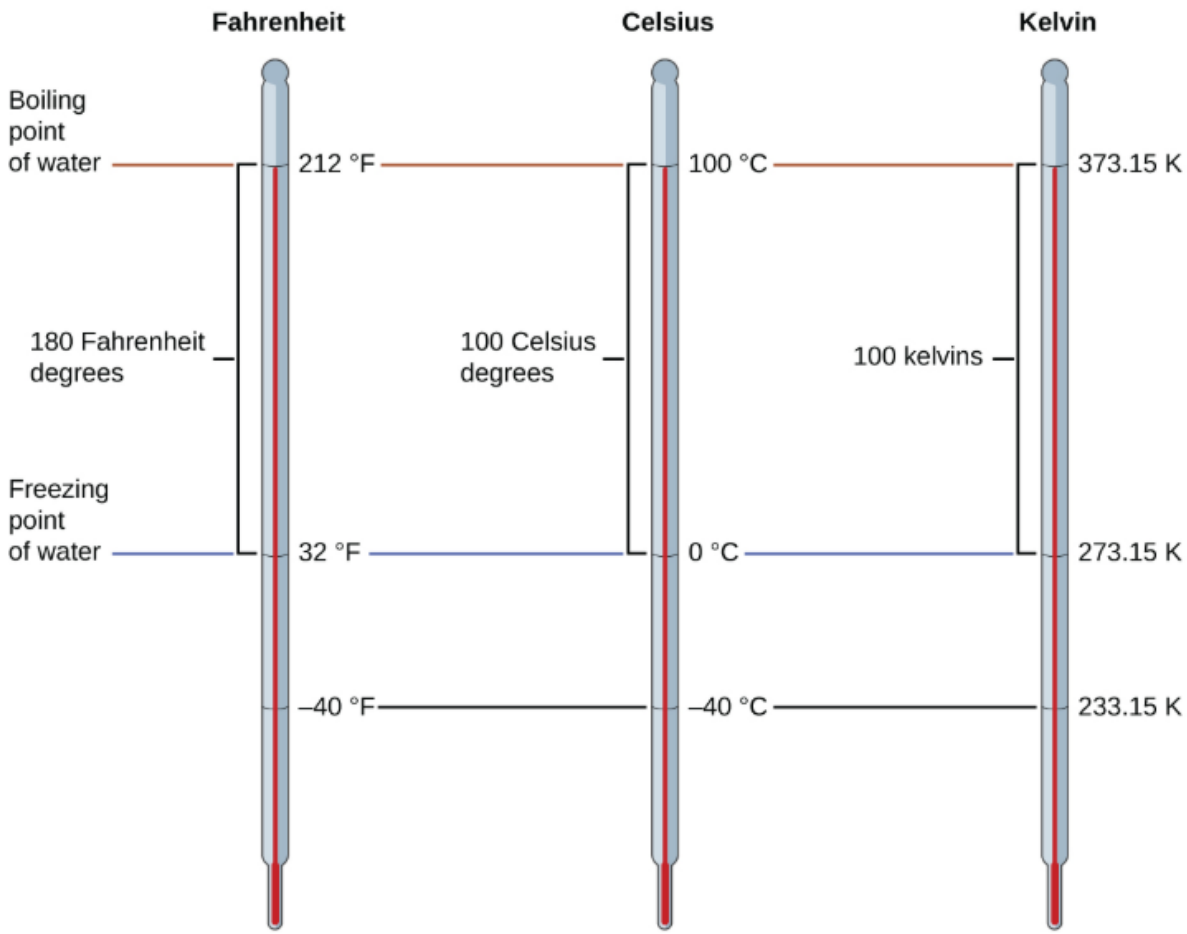
$$T_K = T_{\circ C} + 273.15$$

$$T_{\circ C} = \frac{5}{9}(T_{\circ F} - 32)$$

Some notes

- The interval between consecutive degrees Celsius is the same as the interval between consecutive Kelvins
- A degree Fahrenheit is $\frac{5}{9}$ the size of a degree Celsius or Kelvin
- 0 K (-273.15 °C) is the coldest possible temperature and is referred to as absolute zero

Temperature scales



Temperature Scales

A recipe calls for roasting a cut of meat at 350. °F. What is this temperature on the Celsius scale?

Temperature Scales

What is 316.15 Kelvin in units of Fahrenheit?

Heat

- Heat is the transfer (or flow) of thermal energy between two bodies at different temperatures
- Thermal energy flows from warmer things to colder things
- If a warm object comes into contact with a cooler object, thermal energy will flow from the warmer object to the cooler object until the two objects have the same temperature

Thermochemistry vocabulary

Define thermal energy, temperature, and heat in terms of the kinetic energy of the particles in a substance.

Heat changes in processes

$$\text{Heat} = \begin{matrix}\text{Energy of a system} \\ \text{after a process}\end{matrix} - \begin{matrix}\text{Energy of a system} \\ \text{before a process}\end{matrix}$$

- An exothermic process releases thermal energy (negative heat value)
- An endothermic process absorbs thermal energy (positive heat value)

Units of Energy

- Energy is measured in calories and Joules
- 4.184 Joules (J) = 1 calorie (cal)
- 1000 J = 1 kJ
- 1000 cal = 1 kcal
- 1 kcal = 1 Cal (Food calorie)

Heat absorbance

Maria and Keshia walk to their cars on a 102 °F summer day. Both women have leather steering wheels, but Keshia uses a sheepskin steering wheel cover. Which of the steering wheels would you expect to feel warmer to the touch? Why?

Measuring Heat (Heat capacity)

$$q = C\Delta T$$

- q is heat
- ΔT is the change in temperature in Kelvin or Celsius (final temperature − initial temperature)
- The heat capacity (C) is a measure of how easy or difficult it is raise or lower the energy of an object of constant mass

Measuring Heat (Specific heat capacity)

$$q = mc\Delta T$$

- q is heat
- m is the mass of the substance in grams
- ΔT is the change in temperature in Kelvin or Celsius (final temperature − initial temperature)
- c is the specific heat capacity
  - Qualitatively, this is a measure of how easy or difficult it is raise or lower the energy of an substance
  - Formally, this is the quantity of heat required to raise the temperature of 1 gram of a substance by 1 degree Celsius

Specific heat capacity

It takes more thermal energy to change the temperature of something with a large specific heat capacity

It takes less energy to raise the temperature of something with a small specific heat capacity

Specific heat capacity

Lead, aluminum, copper, and iron blocks of equal mass all have a temperature of 25 °C. They are then placed in a freezer for 5 minutes. Which block would you expect to be the coldest after 5 minutes. The specific heat of the block materials are given below.

A. Lead 0.128 J g^{-1} $°C^{-1}$
B. Aluminum 0.903 J g^{-1} $°C^{-1}$
C. Copper 0.385 J g^{-1} $°C^{-1}$
D. Iron 0.449 J g^{-1} $°C^{-1}$

Direct and Inverse Variation

Direct Variation

- Two things directly vary if an increase in one of them causes an increase in the other OR if a decrease in one causes a decrease in the other

Inverse Variation

- Two things inversely vary if an increase in one of them causes a decrease in the other OR if a decrease in one causes an increase in the other

Direct and Inverse Variation

Direct Variation

$$a = k \times b$$

- Here, a is directly related to b

Inverse Variation

$$a = \frac{k}{b} \quad \text{OR} \quad a \times b = k$$

- Here, a is inversely related to b

Direct and Inverse Variation

Given the ideal gas law equation below, which variables are directly related to P? Which variables are inversely related to P?

$$PV = nRT$$

Direct and Indirect Variation

If an empty iron pan is heated in an oven, which of the following is directly proportional to the temperature change of the iron?

A. The amount of heat added to the pan
B. The mass of the pan
C. The specific heat capacity of iron

Specific heat capacity

How much heat in joules is required to change the temperature of 7.35 g of water from 21.0 to 98.0°C? The specific heat of water is 4.184 J g^{-1} $°C^{-1}$.

Specific heat capacity

Calculate the final temperature that results when a 12.6 g sample of water at 22.9 °C absorbs 875 J of heat? The specific heat of water is 4.184 J g^{-1} $°C^{-1}$.

Specific heat capacity

Calculate the final temperature that results when a 1.59 kg sample of platinum at 78.2 °C gives off 1.05 kcal of heat (specific heat of Pt = 0.032 cal g^{-1} $°C^{-1}$).