IMPORTANT TERMS:

- **Absolute zero**
- **Bimetallic strip**
- **calorie**
- **Celsius scale**
- **Fahrenheit scale**
- **Heat**
- **Internal energy**
- **Kelvin scale**
- **Kilocalorie**
- **Specific heat capacity**
- **Temperature**
- **Thermal contact**
- **Thermal equilibrium**
- **thermostat**

EQUATIONS:

UNIT III: HEAT
Chapter 21-24

Chapter 21: Temperature, Heat, and Expansion

I. Temperature (21.1)

A. **Temperature**– the quantity that tells how _____ or _____ something is.

1. Expressed by a number that corresponds to a _____ mark on some chosen scale

2. **Thermometer**– device used to measure _____

a. Relies on fact that almost all matter _____when temperature increases and _____ when decreases

b. Usually use mercury or colored alcohol in a glass tube using a scale

B. **Celsius scale**

1. Most widely used temperature scale (International)

a. ____ at temperature of **water freezing**

b. _____ at **boiling point of water**

2. Gap between freezing (0) and boiling (100) divided into 100 equal parts, called _____**.**

C. **Fahrenheit Scale**

1. Common scale used in U.S.

a. _____ at **freezing point of water**

b. _____ at **boiling point of water**

2. This scale will become obsolete when U.S. goes metric.

D. **Kelvin Scale**

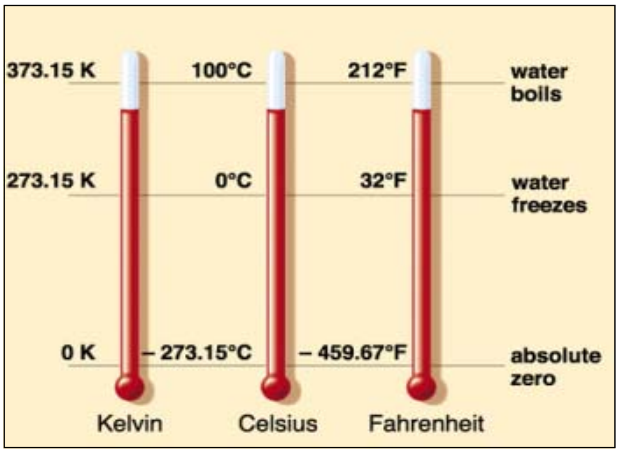
1. scale used in scientific research (SI scale)

2. Degrees same size as the Celsius degree and are called "**kelvins**".

a. ____ is assigned to the lowest possible temperature– _____

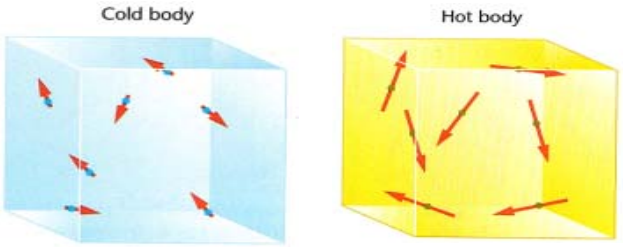
b. At absolute zero substance has no kinetic energy to give up

c. Corresponds to _____**C** on Celsius scale.



E. Temperature and Kinetic Energy

1. Temperature is related to the **random motions** of the _____ in a substance



2. **Ideal Gas**– proportional to average _____ energy of molecular translational motion (motion along straight or curved path)

3. **Solids and liquids**– more complicated but still related to average kinetic energy of molecules.

4. Temperature is _____ a **measure of total kinetic energy** *(i.e. There is twice as much kinetic energy in 2 liters of boiling water as 1 liter of boiling water)*

II. Heat (21.2)

A. **Heat**– The **energy** that is **transferred** from one object to another because of a **temperature difference** between them.

1. Matter contains _____ in many forms, but it does not contain _____.

2. Heat is energy transit from body of _____ temperature to one of _____ temperature

3. Energy resulting from heat flow called _____

I **energy**

B. **Thermal contact**– when heat flows from one object in _____ with another they are said to be in thermal contact.

1. Heat **flows from higher temp substance to lower**

a. Heat flows according to **temperature** _____

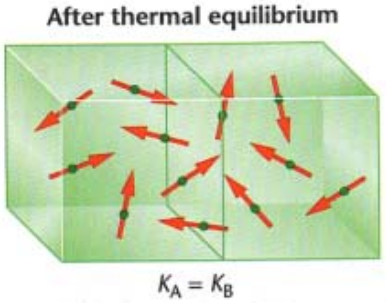
b. Heat does not necessarily flow from substance with more total molecular kinetic energy to one with less.

2. Heat _____ flows from _____ substance into a _____ substance

III. Thermal Equilibrium

A. **thermal equilibrium**– after objects in thermal contact reach the same temperature

B. Thermometer– heat flows between thermometer and substance until have same temp. (thermometer should be small enough so that it does not alter the temperature of substance being measured.



IV. Internal Energy (21.4)

A. _____ **Energy**– the grand total of all energies inside a substance.

1. includes _____ energy of molecules as well as _____ energy due to forces between molecules

2. A substance does **not** contain _____

B. When substance takes in or gives off heat, any of these energies may change.

V. Measurement of Heat (21.5)

A. The unit of heat is defined as the heat necessary to produce some standard, agreed-on temperature change for a specified mass of material

1. _____ (**c**)– most common unit for heat

a. Defined as: **amount of heat required to raise the temperature of 1 _____ of water by 1°C.**

b. **kilocalorie** (**C**) = _____ calories (Heat unit used to rate _____ (often called a **Calorie**)

B. The **SI system** (International System of Units) uses _____ to measure all forms of energy including heat (1 calorie = _____ J)

VI. Specific Heat Capacity (21.6)

A. Different substances have different capacities for storing internal energy.

1.Absorbed energy can affect substances in different ways.

2. may increase rotation of molecules, increase internal vibration, stretch intermolecular bonds and be stored as PE

B. _____ **Heat**– quantity of heat required to raise the temperature of a unit mass of the substance by __degree.

VII. The High Heat Capacity of Water (21.7)

A. _____ has much higher capacity for storing energy than most common materials.

1. Water often used as _____ agent (car radiator)

2. Water also takes a long time to _____.

B. This property of water affects _____ in many places

1. **West Coast Marine Climate**– water _____ in winter and _____ in the summer

2. Interior of large continents experience **extremes** in temperatures (due to _____ of large bodies of water)

VIII. Thermal Expansion (21.8)

A. When **temperature** of substance is <u>increased</u>, its **molecules jiggle faster and normally tend to move _____ apart.**

1. Fact used in **construction** of substances and devices of all kinds.

a. Concrete, fillings in teeth, bridge construction, etc.

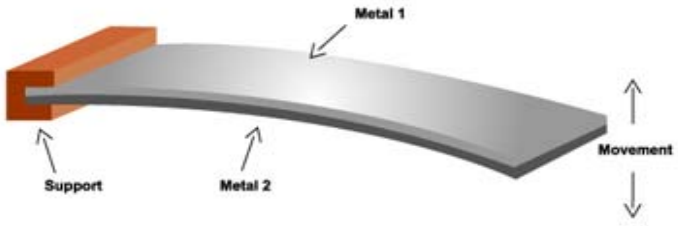
b. In most cases, expansion of _____ is greater than expansion of _____

B. Different materials _____ at different rates.

1. _____ **strip**– two strips of different metals (say one of brass and the other of iron)

a, When **heated**- different expansion causes strip to bend into a curve

b. When **cooled**– bends in opposite direction



2. _____-practical application of bimetallic strip

a. back and forth bending of bimetallic coil opens and closes an **electrical circuit**.

b. Used in number of applications (room thermostat, refrigerator, automatic chokes on cars, etc.)

IX. Expansion of Water (21.9)

A. Almost all _____ will expand when they are heated.

B. Water does the opposite (water expands when becomes ice– think: ice floats on water)

1. This is due to _____ structure of ice (due to shape of H_2O molecules)

2. This behavior has great importance to nature– it prevents lakes and ponds from freezing easier.

IMPORTANT TERMS:

- **Conduction**
- **Conductor**
- **Convection**
- **Greenhouse effect**
- **Insulator**
- **Newton's Law of cooling**
- **Radiant energy**
- **Radiation**
- **Terrestrial radiation**

EQUATIONS:

Chapter 22: Heat Transfer

I. Conduction (22.1)

A. _____– transfer of heat within and between materials that are in direct contact

1. **conductors**– materials that conduct _____ well

a. _____ are best conductors (of heat and electricity– because of "loose" outer electrons)

b. Silver is most, followed by copper, aluminum, and iron

2. Conduction explained by _____ between atoms or molecules and actions of loosely bound electrons.

3. Atoms vibrate against neighboring atoms and _____ vibration (energy)

B. _____– are poor conductors of heat (delay transfer of heat) reduces the rate at which heat penetrates.

1. Liquids and gasses are good _____

2. _____ materials are also good insulators (wool, fur, feathers)

C. **Cold**– simply the _____ of heat. Cold does not pass through a conductor or insulator, heat does.

II. Convection (22.2)

A. _____– transfer of energy by movement of hotter substance.

1. **Convection** occurs in all _____ (whether gas or liquid)

a. **When fluid is heated it _____ becomes less dense, and rises.**

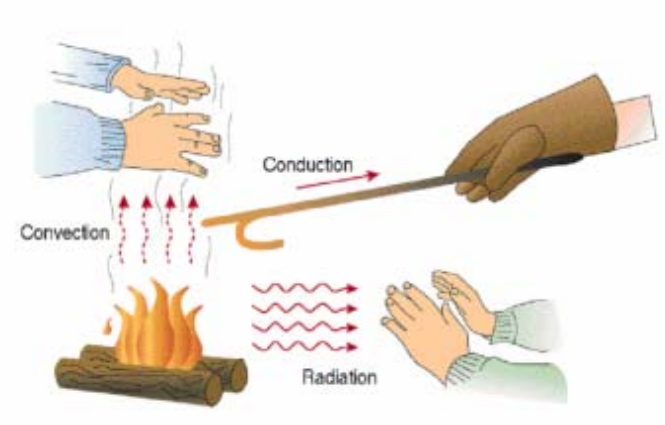
b. **Cooler** fluids moves to the _____

2. Creates **convection** _____

B. _____– Convection currents stirring the atmosphere produce winds.

1. Caused by uneven _____ of heat

2. This phenomenon is often evident at the seashore (results in sea breeze– onshore during day on offshore at night)



III. Radiation (22.3)

A. _____– the transfer of energy by **electromagnetic waves**

1. Any _____ (including heat) transmitted by radiation is called **radiant energy**

2. Includes radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays.

B. All objects continually emit radiant energy

1. objects at low temperatures emit _____ waves

2. Higher-energy objects emit waves of _____ length.

IV. Absorption of Radiant Energy (22.4)

A. Absorption and reflection are _____ processes.

1. Good absorber of radiant energy _____ very little radiant energy

2. Good absorber appears _____

B. Good reflectors are poor absorbers

1. _____ colored objects reflect more light and heat than dark colored ones.

2. In summer, light-colored clothing keeps people cooler

V. Emission of Radiant Energy (22.5)

A. Good absorbers are also good emitters; poor absorbers are poor emitters.

B. Whether a surface plays a role of net emitter or net absorber depends on whether its temperature is above or below the surroundings.

VI. Newton's Law of Cooling (22.6)

A. The rate of cooling of an object depends on how much _____ the object is than the surroundings.

B. **Newton's Law of Cooling**– rate of cooling of an object (whether by conduction, convection, or radiation) is approximately proportional to the temperature difference between the object and its surroundings

$$\textit{Rate of cooling} \sim \Delta T.$$

(E.g. Frozen food will warm up faster in a warm room than in a cold

room)

VII. Global Warming and Greenhouse Effect (22.7)

A. All things _____

1. Wavelength of radiation depends on the _____of the object emitting the radiation

a. High temperature objects (sun) radiate _____ waves

b. Low temperature objects (Earth) radiate _____ waves.

B. Transparency of things depend on _____ of radiation.

1. _____ is <u>transparent</u> to both **long and short**

2. **Greenhouse gasses** (CO_2, water vapor) don't allow **long wavelength** energy to escape back into space (reflected back to Earth).

3. This causes a warming of the Earth's atmosphere

IMPORTANT TERMS:

- **Boiling**
- **Condensation**
- **Equilibrium**
- **Evaporation**
- **Freezing**
- **Phase**
- **Relative humidity**
- **Saturated**

EQUATIONS:

Chapter 23: Change of Phase

I. Evaporation (23.1)

A. _____– change in phase from liquid to gas that takes place at the surface of a liquid.

1. Molecules on the surface of liquid that <u>gain</u> enough _____ **energy** to break free of the liquid.

2. Evaporation is a _____ process

a. Loss of kinetic energy lowers _____

b. Humans _____ to lower body temperature.

II. Condensation (23.2)

A. _____– process opposite to evaporation. The changing of a _____ to a _____.

1. Condensation is a _____ process.

a. **Kinetic energy** <u>lost</u> by condensing gas molecules **warms** the surface they strike.

b. This is why **steam** burns the skin <u>worse</u> than **boiling water** of the same temperature.

B. Condensation of the Atmosphere

1. _____– When limit or water vapor I n the atmosphere is reached

2. **relative humidity**- indicates the amount of _____ vapor in the air

3. Fog and Clouds

a. Warm air _____ and _____

b. As it expands it _____

c. As it cools, water-vapor molecules begin to stick together and form _____.

III. Evaporation and Condensation (23.3)

A. **Equilibrium**– when liquid is at a state of balance between evaporation and condensation (normally evaporation and condensation are taking place at the same time)

IV. Boiling (23.4)

A. _____– change in phase from a **liquid** to a **gas**

1. Gas that forms beneath the surface causes bubbles

2. Bubbles buoyed upward to the surface where they escape.

B. _____ pressure can effects the boiling point of a liquid

1. **High altitude** (lower pressure) _____ **boiling point**

2. Pressure cookers used to **increase** _____ and **increase the boiling point** (cooks food faster)

C. Boiling is a cooling process (like evaporation)

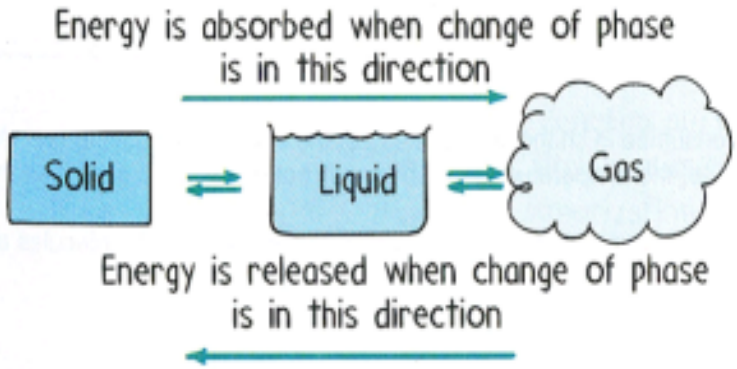
V. Freezing (23.5)– change of phase from _____ to a _____

VI. Energy and Changes of Phase (23.8)

A. **Energy** must be _____ to change solid to liquid or liquid to vapor

B. **Energy** must be _____ to change phase in direction from gas to liquid to solid.

C. This process is used in air conditioners and refrigerators.



IMPORTANT TERMS:

- **Absolute zero**
- **Efficiency**
- **Entropy**
- **First law of thermodynamics**
- **Heat engine**
- **Second law of thermodynamics**
- **Thermodyncamics**

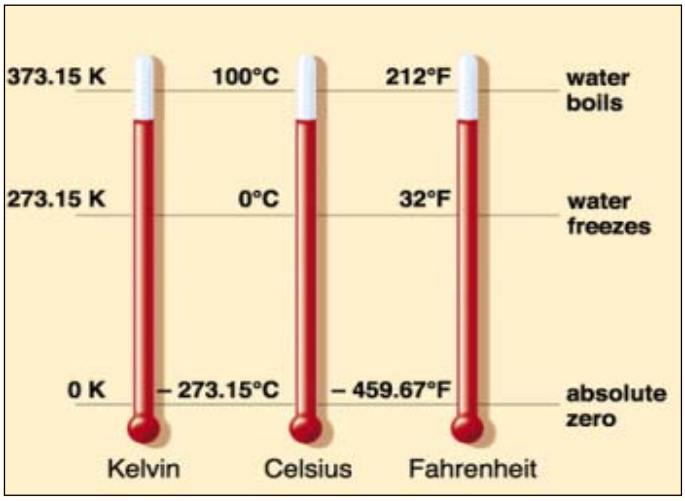
EQUATIONS:

Chapter 24: Thermodynamics

I. Absolute Zero (24.1)

A. _____– lowest temperature possible. No more energy can be extracted from a substance.

B. Corresponds to scales below.



II. First Law of Thermodynamic (24.2)

A. When the law of energy conservation is applied to thermal systems, called **First Law of Thermodynamics**

1. **When _____ is added to a system, it _____ to an equal amount of some other form of _____.**

2. This energy does one or both of these things:

a. **increases** the **internal energy** of the system if it remains in the system

b. **does external** _____ if it **leaves** the system

Heat Added = Increase in internal energy + external work done by system

III. Second Law of Thermodynamics (24.4)

A. **Second Law of Thermodynamics**– **heat** will _____ of itselfflow from a _____ **object to a** _____ **object**

B. Movement of heat from a cold object to a hot object would not violate the first law but does the second law

IV. Heat Engines and the Second Law (24.5)

A. **heat engine**– any device that _____ the **internal energy** into **mechanical work**

B. _____ of heat engines **never 100%**

1. The **greater** the _____ difference the **greater the efficiency** (operating temperature compared with exhaust temperature)

2. Only some of the heat input can be converted to _____ (even without friction)

V. Order Tends to Disorder (24.6)

A. First law of thermodynamics states that energy can be neither _____ or _____.

B. Second law of thermodynamics states that whenever energy transforms, some of it degenerates into _____

1. “Organized” (usable) energy degenerates into “disorganized (nonusable) energy

2. Useful energy that degenerates into non-useful forms is unavailable for doing the same work again.

3. _____ of energy is _____ with each transformation

C. Second Law of Thermodynamics can be stated another way:

1. **Natural systems tend to proceed toward a state of greater** _____

2. You would not expect the _____ to happen

3. Disordered energy can be changed by to ordered energy with input of _____.

4. Tendency of the universe tends to _____.

VI. Entropy (24.7)

A. _____– **the measure of the amount of disorder**

1. **Disorder increases; _____ increases**

2. Second law states that that for a natural process in the long run, entropy always _____

B. **First Law of thermodynamics** is a _____ for which no exceptions have been observed.

C. **Second Law of thermodynamics** is a _____