**Thermal Energy Notes**

**Intro** - **Kinetic theory of matter** – That the atoms/molecules of all states of matter are constantly in motion.

I. **Temperature** - the average kinetic energy of the atoms or molecules of a substance.

A. Temperature scales – have to be reproducible

1. Fahrenheit –

- 0º F the coldest temperature they could get salt water.

- 100º F was human body temperature

- **212**º F was the temperature at which water boiled

2. Celsius – (Centigrade)

- 0 ºC was the freezing point of water

- 100 ºC was the boiling point of water

- 100 degrees works well with decimals and metric system

3. Kelvin – no degrees

- 0 K is absolute zero (-273º C). Temperature at which there is no kinetic energy in the atoms.

1K = 1˚C

II. Thermal Energy

-The KE + the PE of the molecules of an object.

A. The closer atoms are, the less potential energy there is.

B. The farther apart atoms are, the more potential energy.

C. When heated, atoms move faster (↑KE) and move farther

apart (↑PE)

D. Mass & Thermal Energy

1. If 2 objects have the same mass and temperature they have

the same thermal energy.

2. If 2 objects have different masses and are the same temperature, the larger mass has more thermal energy.

E. **Heat** is thermal energy that flows from a higher temperature

to a lower temperature.

1. Measured in J or calories.

- one calorie is the amount of heat required to raise the temperature of one cm3 of water 1˚C.

1 cal = 4.18 J

1 food **C**alorie – 1kcal or 4,184 J

What is cold?

-absence of heat

III. Phases of Matter

A. Strong forces between molecules (intermolecular forces) are

solids at room temperature and have high melting points.

B. Weak intermolecular forces are liquids or gases at room temperatures and have low melting points and low boiling points.

IV. Do all things absorb heat equally?

A. Specific heat (cp)- amount of heat needed to raise the temperature of 1 kg of a material 1 ºC.

The ↑ the specific heat of an object, the slower an object heats up or cools off.

-The ↓ the specific heat of an object, the faster an object heats up or cools down.

- Measured in J/(kg x K) or calorie/(kg x ºC)

V. Calculating Changes in Thermal Energy

- Change in Thermal energy (Q) =

mass x change in temperature x specific heat

Q = m(Tfinal - Tinitial)cp or m(**ΔT)**cp

If the temperature of a 32g silver spoon increases from 21 °C

to 61 °C, and silver has a specific heat of 235J/(kg x °C), what is the change of thermal energy of a spoon?

VI. Transferring Heat Energy

A. **Conduction** - heat is transferred through matter by direct

contact of particles.

-occurs in all 3 phases, but fastest in solids b/c the atoms are close together and transfer kinetic energy easily.

B. **Convection** - heat is transferred by the movement of heated particles of a fluid, (any material that flows) such as liquids or gases.

- fluid heats up→ ↑KE and ↑PE → becomes less dense and rises→ fluid cools off→ ↓KE and ↓PE →becomes more dense and sinks.

This is called a convection current.

-wind currents are caused by convection currents in the atmosphere.

C. **Radiation** - transfer of heat by electromagnetic waves

-can pass through space where no matter is present.

-solids and liquids absorb most radiant energy

-gases transmit most of the radiant energy and let it pass through.

VII. Factors That Affect Heat Flow

A. **Temperature Difference** – The greater the difference in temperature on each side of a substance the faster the heat flows.

B. **Type of material** – that the heat is flowing through

-Different materials have different k-values (thermal conductivity).

-k-values are measured in W/m/oC.

-The higher the k-value the better thermal conductor a substance is (heat flows faster).

Metals are the highest, gases are the lowest.

C. **Surface area** of the substance

– the more surface area, the more heat flow there is

D. **Thickness** or distance of the substance

– the thicker the substance the longer it takes the heat to flow through it

-Formula for rate of heat flow:

**Rate of heat flow = k•A•(T1 - T2)**

**d**

Ex. - Calculate the rate of heat transfer on a cold day through a rectangular window that is 1.2 m wide and 1.8 m high, has a thickness of 6.2 mm, a thermal conductivity value of 0.27 W/m/°C. The temperature inside the home is 21°C and the temperature outside the home is -4°C.

**VIII. Controlling Heat Flow**

A. **Conductors** - materials that allow heat to flow through them easily.

B. **Insulators** - materials that do not allow heat to flow through them.

- R-values (thermal resistance) are used to measure how effective insulation works.