

## Note Packet #3

# Energy

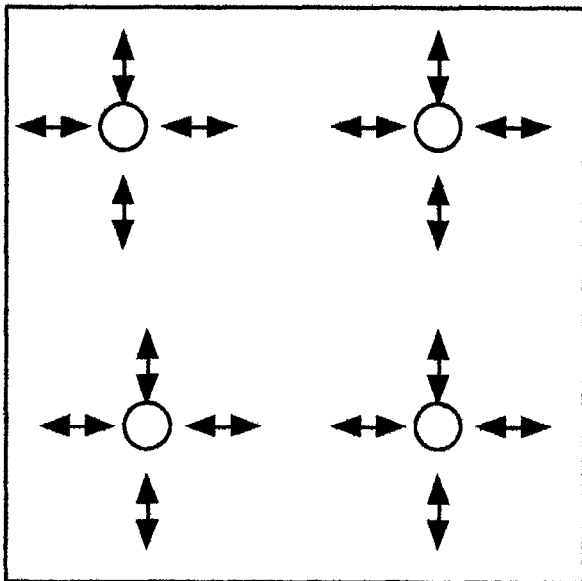
**Energy** - the ability to do work or transfer heat.

**Energy Units** - heat (thermal) energy is measured in **joules** (pronounced "jewles"). A kilojoule is 1000 joules.

**Potential Energy** - is stored energy. The energy stored in a battery is potential energy. The energy our bodies store as fat is potential energy. The energy stored in chemical bonds is potential energy. **Any stored energy is potential energy!**

**Kinetic Energy** - You may think of kinetic energy as the energy of motion. When you observe an object in motion, you are observing kinetic energy. Atoms and molecules vibrate in place according to their temperature. The higher the temperature of atoms and molecules the greater their motion.

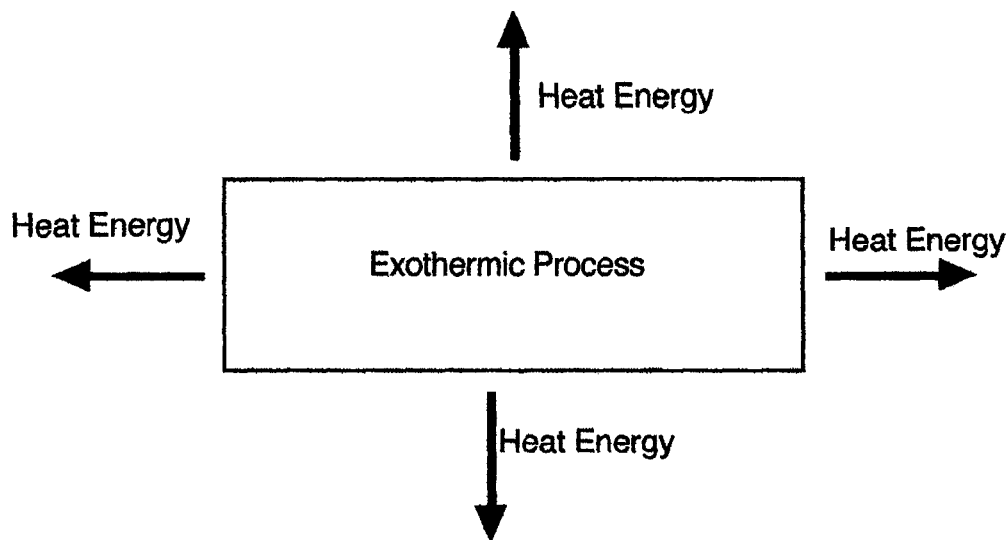
It is not obvious, but even a solid piece of metal sitting on a table has kinetic energy (energy of motion). How is that possible? The individual atoms (much too small to be seen) are vibrating in place.



Atoms or molecules vibrate fast when they are hot and vibrate slow when they are cold. Remember temperature is a measure of the average kinetic energy of material.

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**Exothermic** refers to any physical or chemical process that releases energy. A burning match is an example of an exothermic process. A container containing an exothermic process will feel hot as heat leaves the process and enters the container.



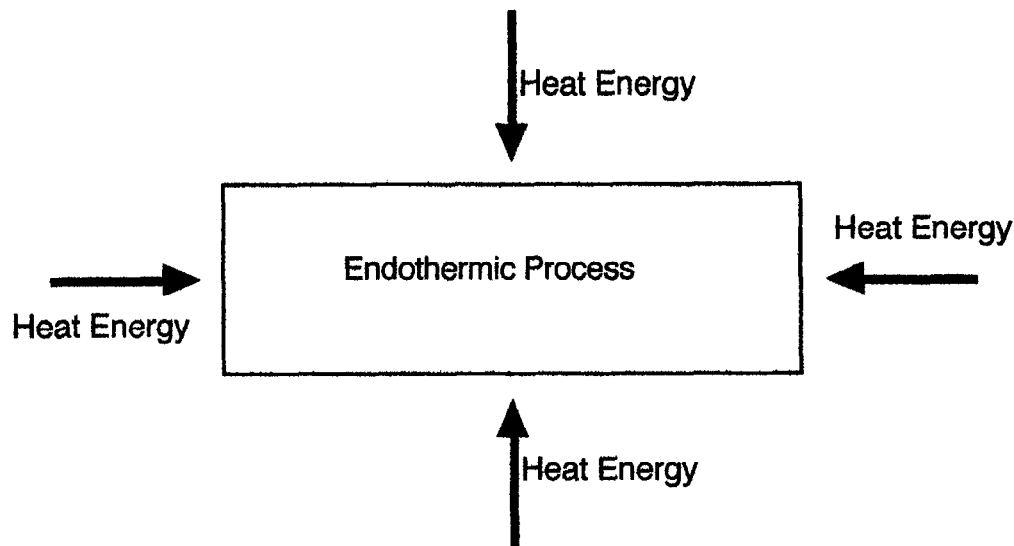
**Note:** If an exothermic process occurs in a beaker of water the water temperature will increase as the water absorbs energy released by the process.

If you held an exothermic process in your hand would it feel hot or cold?

Explain why?

**Note Packet #3**

**Endothermic** refers to any physical or chemical process that absorbs energy. A chemical cold-pack is an example of an endothermic process. A container containing an endothermic process will feel cold as heat leaves the container and enters the process.



**Note:** If an endothermic process occurs in a beaker of water the water temperature will decrease as the water loses energy absorbed by the process.

What will happen to the temperature of a beaker of water if an endothermic process occurs inside?

Why?

If you held an endothermic process in your hand would it feel hot or cold?

Explain why?

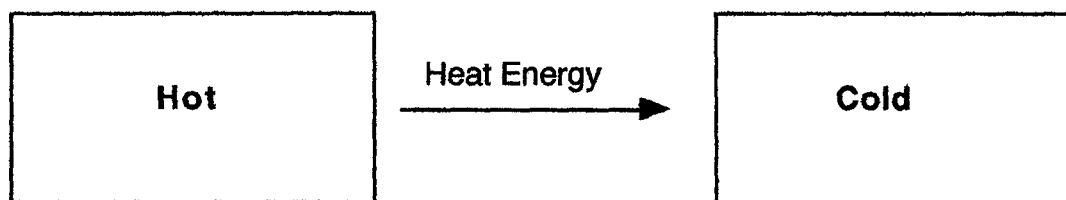
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**Forms of Energy** Energy exists in a variety of forms. They are: **C**hemical, **E**lectrical, **M**echanical, **E**lectromagnetic, **N**uclear, and **T**hermal. The acronym **CEMENT** may help you remember them.

Note: electromagnetic energy includes; radio waves, microwaves, infrared, visible light, ultraviolet, x-rays, and gamma rays.

The **Law of Conservation of Energy** states that in a closed system, energy can change from one form to another but the total remains the same.

**Temperature** is not heat. Heat is a thermal energy that travels from hot to cold. Temperature is a measure of the average kinetic energy (particle motion) of a material.



Temperature is measured in  $^{\circ}\text{C}$  (degrees Celcius) or Kelvins (not degrees Kelvin).  $1^{\circ}\text{C}$  is the same size as 1 Kelvin. Temperature must be expressed as Kelvin when using "Gas Law Formulas".

\*\*\* Important!

A Kelvin is the exact size as a  $^{\circ}\text{C}$ . Their positions are just in different locations on the temperature scale. If the temperature increases  $10^{\circ}\text{C}$  it has also increases 10 Kelvins.

To convert from  $^{\circ}\text{C}$  (degrees Celcius) to Kelvin use the formula:

$$^{\circ}\text{C} + 273 = \text{Kelvin}$$

Ex: What is  $100^{\circ}\text{C}$  equal to in Kelvin?

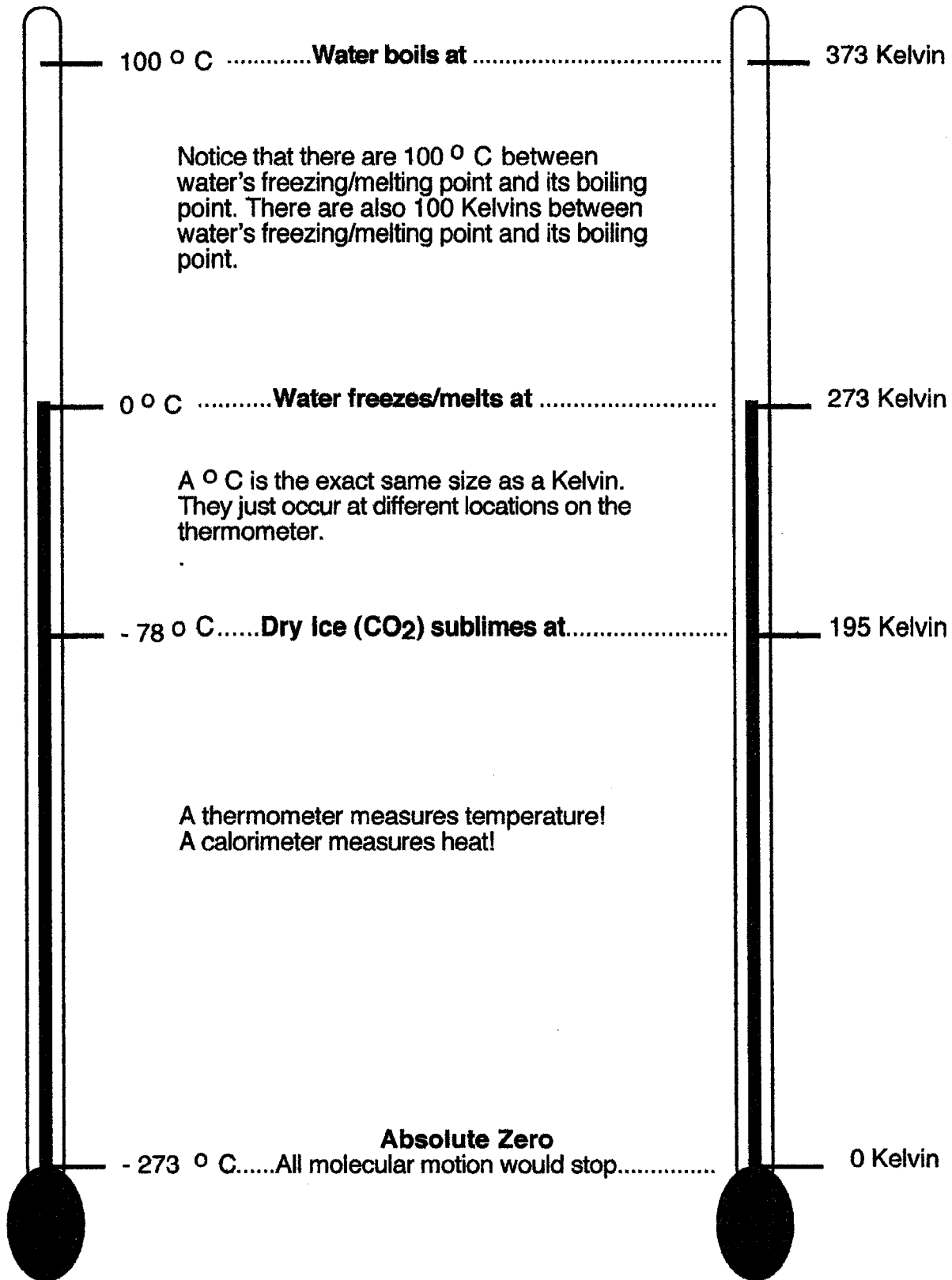
To solve: add 273  $100^{\circ}\text{C} + 273 = 373 \text{ Kelvin}$

Ex: What is  $0^{\circ}\text{C}$  equal to in Kelvin?

Ex: What is  $25^{\circ}\text{C}$  equal to in Kelvin?

Ex: What is  $-273^{\circ}\text{C}$  equal to in Kelvin?

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### Calorimeter

**A calorimeter measures heat energy.**  
A known mass of water is in the calorimeter. The initial and final water temperatures are recorded to determine the amount of heat added or removed from the insulated container (calorimeter).

A key assumption about a calorimeter is that the heat lost or gained by a calorimeter is equal to the heat lost or gained by the item added to the calorimeter.

The formula used to calculate the amount of heat gained or lost by the calorimeter is:

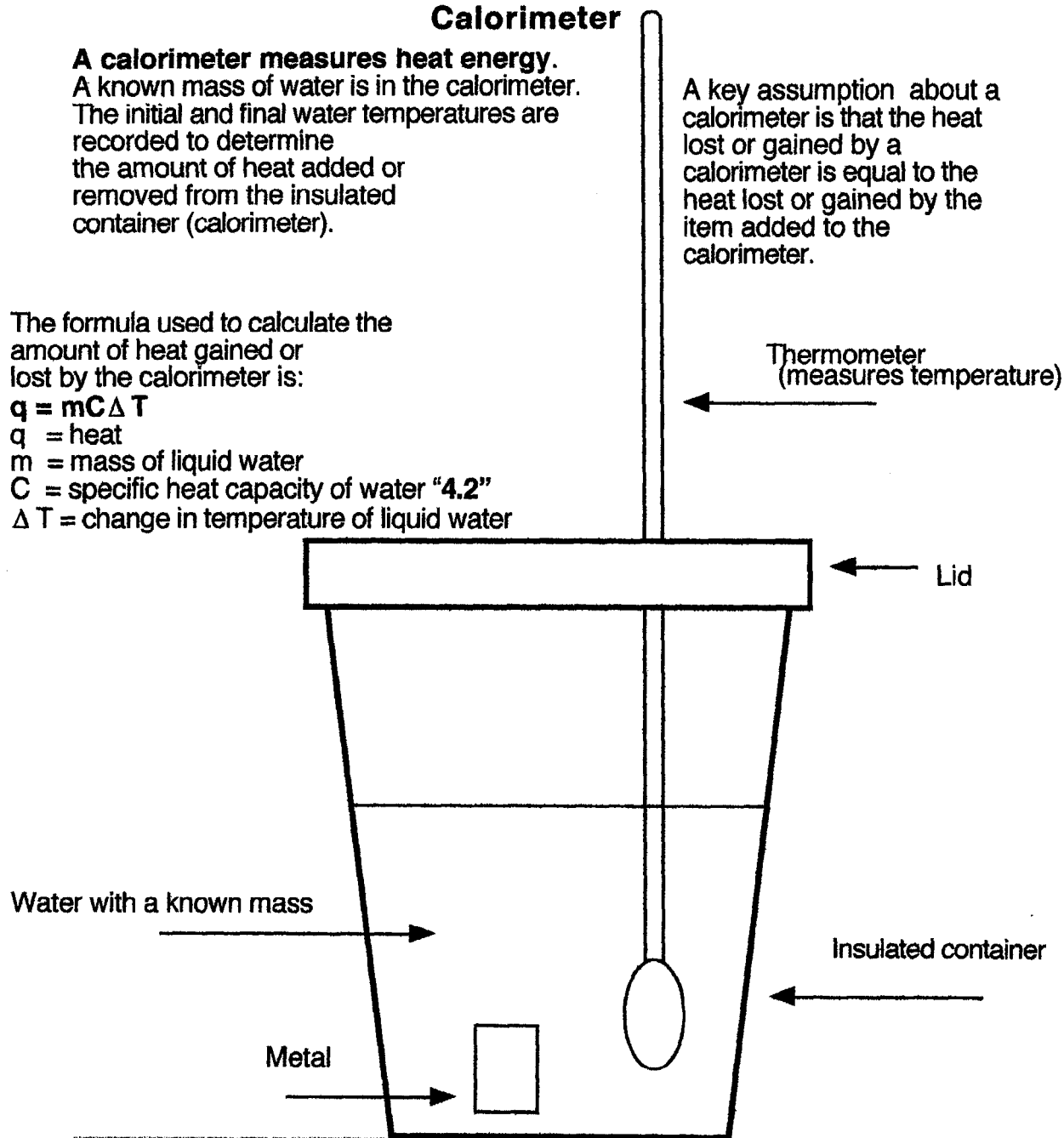
$$q = mC\Delta T$$

$q$  = heat

$m$  = mass of liquid water

$C$  = specific heat capacity of water "4.2"

$\Delta T$  = change in temperature of liquid water



**Ex:** A hot piece of metal was placed in the calorimeter containing 100 g of water.

The temperature of water in the calorimeter rose  $35^{\circ}\text{C}$ .

How much heat did the calorimeter absorb?

Where did the calorimeter gain the heat from?

To solve:

Substitute the given information into the formula:  $q = mC\Delta T$

$$q = 100\text{g} \times 4.2 \times 35^{\circ}\text{C}$$

$q = 14\,700\text{ J}$  of heat was transferred to the calorimeter from the metal.

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**Example Calorimeter Problems**  
**Show all work!**

1. A hot piece of metal was placed in a calorimeter containing 100 g of water. The temperature of water in the calorimeter rose  $25^{\circ}\text{C}$ . How much heat did the calorimeter absorb?

Where did the calorimeter gain the heat from?

2. A cold rock was placed in a calorimeter containing 100 g of water. The temperature of water in the calorimeter fell  $15^{\circ}\text{C}$ . How much heat was transferred?

Did the calorimeter gain or lose heat?

Did the rock gain or lose heat?

3. 150 g of  $30^{\circ}\text{C}$  water in a calorimeter changed temperature to  $60^{\circ}\text{C}$  after a hot piece of metal was added to it. How much heat did the calorimeter gain?

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4. If 200 g of water in a calorimeter at an initial temperature of  $25^{\circ}\text{C}$  absorbed 27720 joules of energy, what is the final temperature of water in the calorimeter?

**Absolute Zero** is the coldest theoretical temperature. At Absolute zero all molecular motion (vibrations) would stop. Its value is 0 Kelvin which is equal to  $-273^{\circ}\text{C}$ .

\* A thermometer measures temperature (average kinetic energy)!

\* A calorimeter measures heat (thermal) energy!