
DEALING WITH CHANGE
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by Mark Parisi
HOLD IT RIGHT THERE, YOUNG LADY...YOU'RE NOT LEAVING THIS TOMB DRESSED LIKE THAT!
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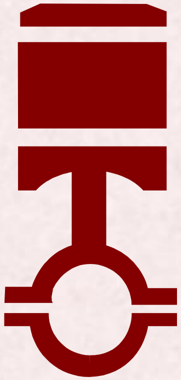
Monday, Oct. 21st: "A" Day
Tuesday, Oct. 22nd: "B" Day
Agenda

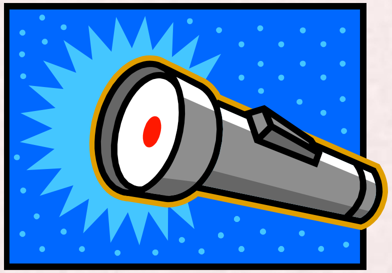
- Begin Chapter 10: Causes of Change
- 10.1: "Energy Transfer"
  - ✓ Heat, temperature, enthalpy, molar heat capacity, specific heat
- Homework
  - ✓ Sec 10.1 review, pg 344: #1-12, 14, 15
  - ✓ Concept Review: "Energy Transfer"

****Quiz next time over Section 10.1****

Section 10.1: "Energy Transfer"

- A sample can transfer energy to another sample.
  - ✓ Some examples of energy transfer are electric current in a wire, a beam of light, a moving piston, and a flame used by a welder.



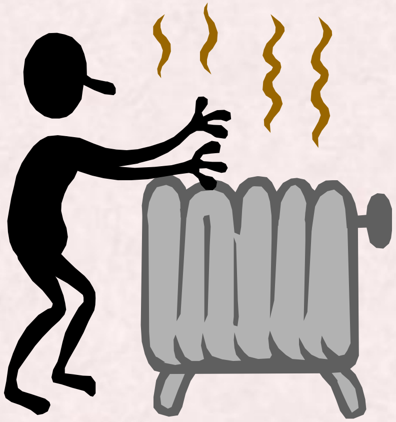



Energy as Heat

- One of the simplest ways energy is transferred is as heat.

- ***Heat:*** the energy transferred between objects that are at different temperatures.

- Energy is measured in joules (J).



Energy as Heat

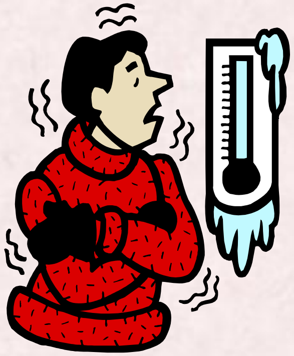
- The amount of energy transferred from one sample must be equal to the amount of energy received by a second sample.

- The total energy of the two samples remains exactly the same.

- Sounds like the Law of Conservation of Energy, doesn't it?

Temperature

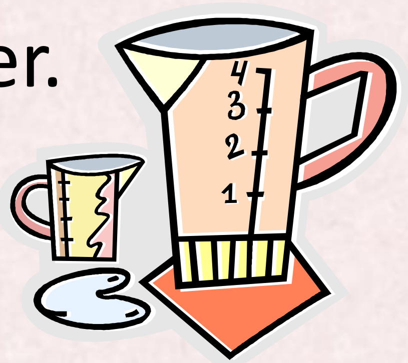
- ***Temperature:*** a measure of how hot (or cold) something is; specifically, a measure of the average kinetic energy of the particles in an object



- Energy is always transferred from the hotter sample to the colder sample.

Temperature

- The temperature of a sample depends on the average kinetic energy of the sample's particles.
- The higher the temperature of a sample is, the faster the sample's particles move.
- The temperature increase of a sample also depends on the mass of the sample.
  - ✓ If you add the same amount of energy, as heat, to different masses of water, the sample that has less mass will heat up faster.



Heat and Temperature are Different

- Temperature is an ***intensive property***
  - ✓ The temperature of the sample does not depend on the amount of the sample
- Heat is an ***extensive property***
  - ✓ The amount of energy transferred as heat by a sample depends on the amount of the sample

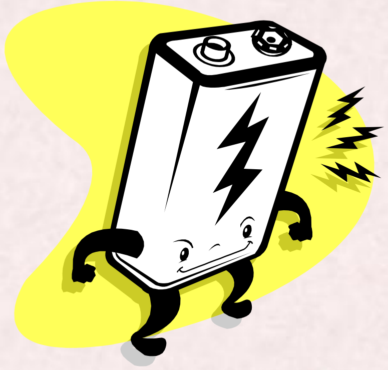
Ex: Both water in a glass and water in a pitcher can have the same temperature, but the water in the pitcher can transfer more energy as heat because it has more particles that the water in the glass.

Enthalpy

- ***Enthalpy:*** the total energy content of a sample.

- The symbol for enthalpy is: *H*

- The unit for enthalpy is the Joule, J.



Molar Heat Capacity

- ***Molar heat capacity:*** the energy, as heat, needed to increase the temperature of 1 mole of the substance by 1 K.

- Symbol: *C*
- Unit: J/ K·mol

- Molar heat capacity is accurately measured only if no other process, such as a chemical reaction, occurs. (you are just heating or cooling a sample)

Molar Heat Capacity

$$q = nC\,\Delta T$$

q = energy (J)

n = number of moles (mol)

C = molar heat capacity (J/K·mol)

ΔT = change in temperature (K)

(final temperature – initial temperature)

Energy=(# of moles)(molar heat cap.)(temp. change)

$$q = nC\,\Delta T$$

Calculating the Molar Heat Capacity Sample Problem A, pg. 342

Determine the energy as heat needed to increase the temperature of 10.0 mol of mercury by 7.5 K. The value of *C* for mercury is 27.8 J/K·mol.

$$q = nC\Delta T$$

n = 10.0 mol

C = 27.8 J/K·mol

ΔT = 7.5 K

q = (10.0 mol) (27.8 J/K·mol) (7.5 K) = **2,100 J**

(2 sig figs)

Calculating the Molar Heat Capacity, practice #3, pg. 342

Calculate the energy as heat needed to increase the temperature of 0.80 mol of nitrogen, N_2, by 9.5 K. The molar heat capacity of nitrogen is 29.1 J/K·mol.

$$q = nC\Delta T$$

n = 0.80 mol

C = 29.1 J/K·mol

ΔT = 9.5 K

q = (0.80 mol) (29.1 J/K·mol) (9.5 K) = **220 J**

(2 sig figs)

Calculating the Molar Heat Capacity, Additional Practice

Energy, 4.72 J, is needed to raise the temperature of 4.00 g of gold from 20.0˚C to 30.0˚C. What is the molar heat capacity for gold?

$$q = nC\Delta T$$

q = 4.72 J

- Use the molar mass of gold, Au, to convert 4.00 g of gold into moles of gold:

$$4.00 \text{ g Au} \times \frac{1 \text{ mol Au}}{196.97 \text{ g Au}} = 0.0203 \text{ mol Au}$$

(3 *sig figs*)

Calculating the Molar Heat Capacity, Additional Practice, cont.

- ΔT is the final temperature minus the initial temperature.
- When finding ΔT, you can leave the temperatures in ˚C because the temperature <u>interval</u> between the two scales is the same:

$$\Delta T = 30.0˚C – 20.0˚C = \mathbf{10.0˚C}$$

$$\Delta T = 303\ K – 293K = \mathbf{10\ K}$$

$$4.72\ J = (0.0203\ mol)\ C\ (10\ K)$$

C = 23.3 J/K·mol (3 sig figs)

"About 25 J Rule" 

- The molar heat capacities of all the metals are nearly the same.
- When 1 mol of ANY solid metal absorbs 25 J of energy as heat, the temperature increases by 1 K

- So for <u>metals</u>, C ≈ 25 J/K·mol

Molar Heat Capacity is Related to Specific Heat

- ***Specific heat:*** the energy, as heat, needed to raise the temperature of 1 g of a substance by 1 K.
- Symbol: c_p
- Unit: J/K·g

$$M \text{ (g/mol)} \times c_p \text{ (J/K·g)} = C \text{ (J/K·mol)}$$

(Molar Mass)(Specific Heat) = (Molar Heat Cap)

Molar Heat Capacity/Specific Heat Example

Use Table 1 on pg. 343 to determine the specific heat of mercury (Hg).

(Molar Mass) (Specific Heat) = Molar Heat Capacity

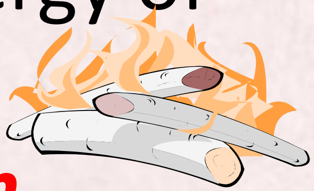
- (200.59 g/mol) (Specific Heat) = 27.8 J/K·mol

Specific Heat = 0.139 J/K·g

(3 sig figs)

Heat Results in Disorderly Particle Motion

- When a substance receives energy in the form of heat, its enthalpy and the kinetic energy of its particles both increase.



- The motion of these particles is ***random.***

- If you kick a ball across a field, the energy you supply causes the particles in the ball to move together in the same direction.

- The motion of these particles is ***concerted.***

Homework

- Section 10.1 Review, pg. 344: #1-12, 14, 15

- Concept Review: Energy Transfer

We will have a quiz next time over Section 10.1