CHEM 1305 - Chapter 10 - Handout

Memorize:
The conversion factor 1 cal = 4.184 J;
the specific heat for water;
the units for specific heat;
the formula $Q = m\ S\ \Delta T$

Define the following terms; explain the following concepts, and answer the following questions:

1) Define/explain the following:

   a) energy -- ability to perform work or transfer heat

   b) law of conservation of energy -- the total amount of energy is the same before and after a chemical or physical change. I.E., energy is neither created nor destroyed.

   c) state function -- a property whose change is independent of pathway.

   d) thermodynamics -- the study of energy.

   e) first law of thermodynamics -- the sum total of energy and matter in the universe is constant.

   f) enthalpy (ΔH_p) -- heat measured under condition of constant pressure. For example, as in an open pot (pressure on system is whatever atmospheric pressure is at the time) rather than pressure cooker (in which case the pressure increases as temperature increases..

2) What are two general classifications of energy? Describe each.

   a) Potential, energy due to position. Has the potential to do work. (e.g., water on the high side of a dam.)

   b) Kinetic, energy due to motion. Object is performing work. (eg, a baseball flying thru the air.)

3) Define/describe the terms TEMPERATURE and HEAT.

HEAT:
(a) flow of energy due to temperature difference.
(b) the ***TOTAL*** Kinetic Energy ($KE = 1/2\ mv^2$) of a system

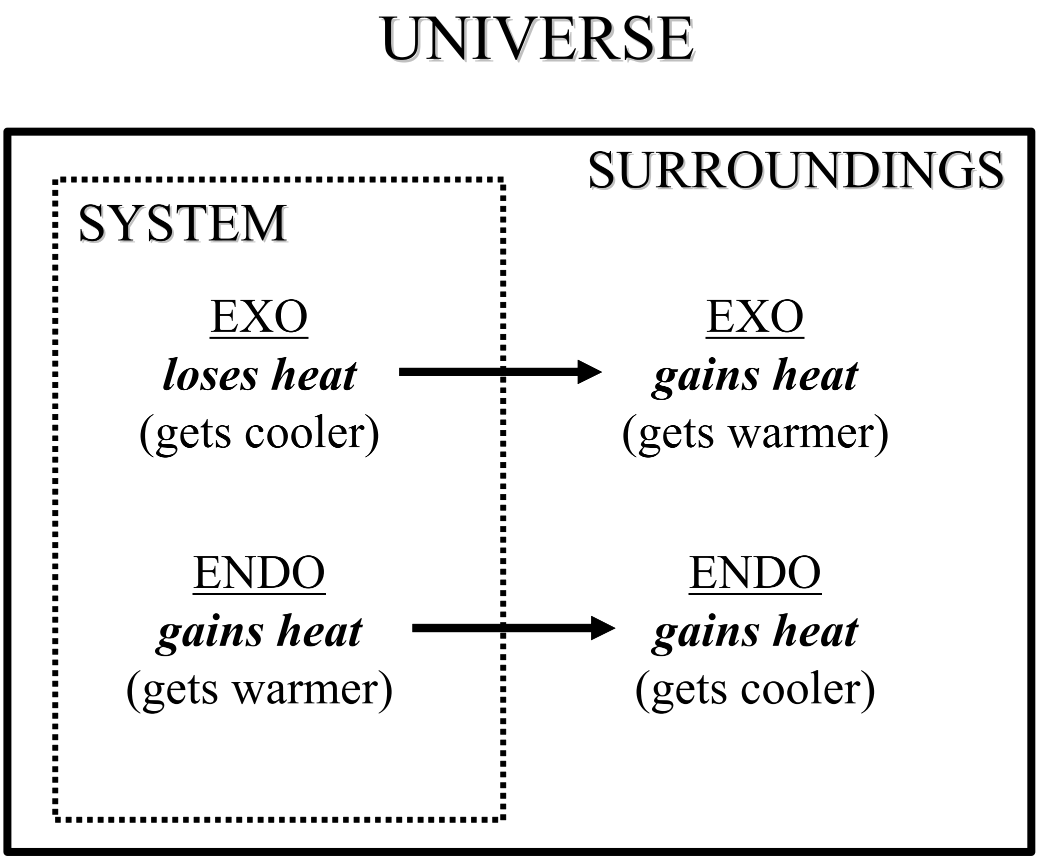
TEMPERATURE:
(a) a measure of heat.
(b) a measure of the ***AVERAGE*** Kinetic Energy of a system.

4) Define/describe the terms SYSTEM, SURROUNDINGS, and UNIVERSE.

a) UNIVERSE -- a (conceptual) device consisting of two parts: System and Surroundings.

b) SYSTEM -- the part of the universe where chemical interactions, reactions, and other changes occurs.

c) SURROUNDINGS -- the part of the universe that is not the System. Typically, the surroundings "feel" the impact of System changes.



5) Define/describe the terms EXOTHERMIC and ENDOTHERMIC.

EXOTHERMIC -- System gives heat to the Surroundings.

ENDOTHERMIC -- System takes heat from the Surroundings.

6) Do the following represent exothermic (EXO) or endothermic (ENDO) processes (Hint: consider your hand the 'system.')? After indicating the process, RATIONALIZE your answer.

   a) When you sweat on the back of your hand, you are cooled because the water vaporizes. Is the vaporization process EXO or ENDO?)

      ENDO: the water molecules (System) evaporate, which requires energy... which it takes from your hand (Surroundings). The removal of heat from your hand makes it feel colder.

   b) After dropping ice cream on your hand, it (your hand) gets cold.

      ENDO: the molecules comprising the ice cream (System) melt, which requires energy... which it takes from your hand (Surroundings). The removal of heat from your hand makes it feel colder.

7) The amount of heat needed to raise 1 g of water 1 °C is called a(n) calorie.

8) Express 38.4 cal of energy in joules.

$$? \, J = \frac{34.8 \, cal}{1} \bullet \frac{4.184 \, J}{cal} = 160.66 \, J = 161 \, J$$

9) Energy can be calculated from the equation: Q = m s Δt. Give the *typical* units for each of the following:

   a) Q --> J

   b) m --> g

   c) s --> $\frac{J}{g \, °C}$

   d) ΔT --> °C

10) Calculate the amount of energy needed to raise the temperature of a 10.0 g block of aluminum (molar mass = 26.98 g/mol) from 25 °C to 58 °C.

$$Q = m \bullet s \bullet \Delta T \qquad units: \quad J = \frac{g}{1} \cdot \frac{J}{g \cdot {}^\circ C} \cdot \frac{{}^\circ C}{1}$$

$$?\, J = \frac{10.0\ g}{1} \cdot \frac{4.184\ J}{g \cdot {}^\circ C} \cdot \frac{(58 - 25){}^\circ C}{1}$$

$$= 1380\ J$$

$$= 1.38\ kJ$$

11) If 294 J of heat is supplied to a 10.0 g silver medallion at 25 °C, to what temperature will the medallion raise?

$$Q = m \bullet s \bullet \Delta T = m \bullet s \bullet (T_{final} - T_{initial})$$

Rearranging the equation...

$$T_{final} = \frac{Q}{m \cdot s} + T_{initial}$$

Substituting...

$$?\ {}^\circ C = \frac{294\ J}{1} \cdot \frac{1}{10.0\ g} \cdot \frac{g \cdot {}^\circ C}{0.24\ J} + 25\ {}^\circ C$$

$$= 148\ {}^\circ C$$

12) You are given a gold nugget but you don't know its weight. The, you then discover that it applying 3.1 J of heat to the nugget raised its temperature from 19 °C to 27 °C. (Hint: you will need a datum from Table 10.1) (Recall: 1 kg = 2.205 lb).

a) What is the mass of gold?

$$Q = m \bullet s \bullet \Delta T \quad \Rightarrow \quad m = \frac{Q}{s \cdot \Delta T} = \frac{Q}{1} \cdot \frac{1}{s} \cdot \frac{1}{\Delta T}$$

Substituting...

$$? \, g = \frac{3.1 \, J}{1} \cdot \frac{g \cdot °C}{0.13 \, J} \cdot \frac{1}{(27 - 19)°C}$$
$$= 3.0288 \, g$$
$$= 3 \, g$$

b) [review question] On January 10, 2009, the price of gold was $855.30 per ounce. How much is the gold nugget worth?

$$? \, \$ = \frac{3 \, g}{1} \cdot \frac{1 \, kg}{1000 \, g} \cdot \frac{2.205 \, lb}{1 \, kg} \cdot \frac{16 \, oz}{1 \, lb} \cdot \frac{\$855.30}{oz}$$
$$= \$90.53$$
$$= \$90$$

c) [review question] What is the volume of gold nugget? (Hint: you will need Table 2.8)

$$? \, cm^3 = \frac{cm^3}{19.32 \, g} \cdot \frac{3 \, g}{1} = 0.1553 \, cm^3 = 0.2 \, cm^3$$

13) A device used to determine the heat associated with a chemical reaction is called a(n)

calorimeter.

14) Enthalpy is a form of energy that relates to heat. A form of energy that relates to

DISORDER or RANDOMNESS is called ENTROPY; and it is

represented by with the symbol S.

15) The SECOND LAW OF THERMODYNAMICS essentially states that …

The Entropy of the universe is always increasing. Or put another way, the energy in the universe is always becoming less usable. In short, the univerise is 'running down.'

16) In terms of enthalpy and entropy, the total energy of a 'chemical' system (represented here as ΔG) can be expressed by the equation:

$$\Delta G = \Delta H - T\Delta S$$

17) The process of dissolving salt in water is endothermic. Consider the situation in which a cook adds salt to water without applying any heat to 'drive' the dissolution process. Based strictly on a 'heat' argument, the salt should not dissolve . . . yet the cook observed that, indeed, it does. Explain why the endothermic proceeds in the absence of the cook heating the salt-water mixture.

Although the dissolution was NOT favorable in terms of heat (ΔH), it must have been very favorable in terms of entropy (ΔS). In other words, the favorable '$T\Delta S$' term more than offset the unfavorable 'ΔH' term.