THERMOCHEMISTRY

- **Thermochemistry** is the study of the transferring of energy between reacting chemicals and the world around them
- Whether a change is physical or chemical, energy is usually involved
  - **Kinetic energy** is energy due to motion of particles (vibrational, rotational or translational)
    - Temperature measures the average Ek of a substance
  - **Potential energy** is energy that is stored in the substance
    - By making and breaking chemical bonds, we can change the amount of potential energy a substance has
  - **Thermal energy** is a form of kinetic energy that results from the motion of particles
  - **System** is the area we are studying
  - **Surroundings** is all the matter around the system that is capable of absorbing or releasing thermal energy
  - **Heat** is the amount of energy transferred between substances
    - An object cannot possess heat; it possesses thermal energy
  - **Endothermic** reaction is one where heat (energy) is absorbed by the system
    - HEAT + $H_2O(l) \rightarrow H_2O(g)$
  - **Exothermic** reaction is one where heat (energy) is released by the system
    - $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ + HEAT
  - **open system** is one in which both matter and energy can move in and out
  - **closed system** is one in which energy can move in or out but not matter
  - **specific heat capacity** (c) is the amount of energy needed to raise the temperature of 1 g of a substance by 1°C
    - units are J/g°C or kJ/kg°C
  - **heat capacity** (C) is the amount of heat that must be absorbed or released by the system to change an object's temperature by 1°C
    - heat capacity = c X mass
  - **molar heat capacity** is the amount of heat needed to raise 1 mole of a substance by 1°C
    - units are J/mol°C or KJ/kmol°C
  - **enthalpy** (H) is the total energy in a system (Ep + Ek)
  - **law of conservation of energy** states that energy cannot be created or destroyed but only transferred or transformed into different forms of energy

Answer the following questions.

1. Identify each of the following as a physical, chemical or nuclear change. Be sure you are able to justify your answer.
    a. A gas barbecue operating
    b. An ice cube melting in someone's hand
    c. White gas burning in a camping lantern
    d. Wax melting on a hot stove
    e. Zinc metal added to an acidic solution in a beaker
    f. Ice applies to an athletic injury

2. Identify the system and surroundings in each of the examples in the previous questions.

3. Identify the following as examples of open or closed systems. Be sure you can justify your answer.
    a. Gasoline burning in an automobile engine
    b. Snow melting on a lawn in the spring
    c. A candle burning on a restaurant table
    d. The addition of baking soda to vinegar in a beaker
    e. A gas barbecue operating

4. A thimbleful of water at 100°C has a higher temperature than a swimming pool full of water at 20°C, but the pool has more thermal energy than the thimble. Explain this.

5. Identify each of the following as an exothermic or endothermic reaction:
    a. Hydrogen undergoes nuclear fusion in the Sun to produce helium atoms
    b. The butane in a lighter burns
    c. The metal on a safety sprinkler on the ceiling of an office building melts when a flame is brought near it