Homework #6-1: Energy, heat, work and state functions--KEY
From the text book, problems pg. 247-249 #2, 4, 7, 29, 30, 32−35

2.  a) What is heat?
Heat is the transfer of thermal energy between two materials at different temperatures.

b) How does heat differ from thermal energy?
It differs from thermal energy in that thermal energy is the energy of a material due to the motion of its particles, so heat is the change in this energy.

c) Under what conditions is heat transferred from one system to another?
Heat is transferred whenever there is a difference in thermal energy of two materials in contact with each other, from a region of high energy (high temperature) to a region of low energy (low temperature).

4. A truck initially traveling at 60 km per hour is brought to a complete stop at a traffic light. Does this change violate the law of conservation of energy? Explain
The loss of kinetic energy by the truck is balanced out by conversion of the energy to another form, most likely thermal energy as the braking mechanism, performing work on the truck, becomes hotter.

7. Define the following terms:
a) Thermochemistry: the study of heat change in chemical reactions.

b) Exothermic process: a chemical or physical process in which thermal energy is transferred from the system to the surroundings. Thus, the system loses energy.

c) Endothermic process: a chemical or physical process in which thermal energy is transferred from the surroundings to the system. Thus, the system gains energy.

11. The first law of thermodynamics can be represented by the equation, $\Delta E = q + w$.

a) On what law is the first law of thermodynamics based?
The first law of thermodynamics is based on the law of conservation of energy.

b) Explain the sign conventions for “$q$” and “$w$” in the equation, $\Delta E = q + w$.
- $+q$: heat is added to the system—ENDO (It’s positive because system gains energy)
- $-q$: heat is removed from the system—EXO (It’s negative because system loses energy)
- $+w$: work is performed on the system by the surroundings (System gains energy)
- $-w$: work is performed by the system on the surroundings. (System loses energy)

12. a) Explain what is meant by a state function.
A state function is one that only depends on the initial and final states of a system and not the path taken to get there

b) Give two examples of quantities that are state functions and two examples that are not.
Examples of state functions: $E, V, T, H, S, \text{height}$;
Examples of non-state functions: $q, w, \text{length}$.
For each of the reactions below, circle the correct answer in each of the parentheses.

(a) Hg (l) → Hg (g)

Moles of gas (increase, decrease, stay the same) * because liquid to gas
Volume of the system (increases, decreases, stays the same)
The system (must push outwards against the P_{ATM}, is pushed in by P_{ATM}, does neither)
Work is (done by the system, done on the system, not done)
Due to work, the system (gains energy, loses energy, has no change in energy)
For the system, work is ( +w, −w, equal to zero)

(b) 3 O_2 (g) → 2 O_3(g)

Moles of gas (increase, decrease, stay the same) * 3 moles of gas → 2 moles of gas
Volume of the system (increases, decreases, stays the same)
The system (must push outwards against the P_{ATM}, is pushed in by P_{ATM}, does neither)
Work is (done by the system, done on the system, not done)
Due to work, the system (gains energy, loses energy, has no change in energy)
For the system, work is ( +w, −w, equal to zero)

(c) CuSO_4•5 H_2O (s) → CuSO_4(s) + 5 H_2O (g)

Moles of gas (increase, decrease, stay the same) * 0 moles gas → 5 moles of gas
Volume of the system (increases, decreases, stays the same)
The system (must push outwards against the P_{ATM}, is pushed in by P_{ATM}, does neither)
Work is (done by the system, done on the system, not done)
Due to work, the system (gains energy, loses energy, has no change in energy)
For the system, work is ( +w, −w, equal to zero)

(d) H_2(g) + F_2(g) → 2 HF(g)

Moles of gas (increase, decrease, stay the same) * 2 moles of gas → 2 moles of gas
Volume of the system (increases, decreases, stays the same)
The system (must push outwards against the P_{ATM}, is pushed in by P_{ATM}, does neither)
Work is (done by the system, done on the system, not done)
Due to work, the system (gains energy, loses energy, has no change in energy)
For the system, work is ( +w, −w, equal to zero)