

**CH1020 Exercises (Worksheet 13)****(System, Surroundings, Internal energy, PV work)**

1. Suppose that a person eats a diet of 2387 Calories per day. Convert this energy into each unit:  
a. J                      b. kJ                      c. kWh
2. In a thermodynamic study a scientist focuses on the properties of a solution in a flask that is sealed with a stopper. A. What is the system in this study? B. What are the surroundings in this study? C. Is the system in this study a closed system?
3. What is meant by the internal energy of a system? By what means can the internal energy of a system increase?
4. Can we measure the internal energies of a system? Explain.
5. Under what conditions will the quantities  $q$  and  $w$  be negative numbers?
6. Identify each energy exchange as primarily heat or work and determine whether the sign of  $\Delta E$  is positive or negative for the system:
  - a. Sweat evaporates from skin, cooling the skin. (The evaporating sweat is the system)
  - b. A balloon expands against an external pressure. (The contents of the balloon is the system.)
  - c. An aqueous chemical reaction mixture is warmed with an external flame. (The reaction mixture is the system).
7. Calculate  $\Delta E$  and determine whether the process is endothermic or exothermic for the following cases:
  - a. a system absorbs 327 kJ of heat from the surroundings and does 430 kJ of work on the surroundings
  - b.  $q = -1.15 \text{ kJ}$  and  $w = -934 \text{ J}$
  - c. the system releases 245 J of heat while the surroundings does 97 J of work on it
  - d. a balloon is heated by adding 240 J of heat. It expands doing 135 J of work on the atmosphere.
  - e. A 50 g sample of iron metal is cooled from  $100^\circ\text{C}$  to  $90^\circ\text{C}$ , thereby losing approximately 225 J of heat.
  - f. A chemical reaction releases 5.75 kJ of heat and does no work on the surroundings.

8. What is meant by a state function? Is temperature a state function? Why or why not?
9. Indicate which of the following is independent of the path by which a change occurs?
  - a. the change in potential energy when a book is transferred from table to shelf
  - b. the heat evolved when a cube of sugar is oxidized to  $\text{CO}_2(\text{g})$  and  $\text{H}_2\text{O}(\text{g})$
  - c. the work accomplished in burning a gallon of gasoline
10. Predict the signs of  $q$  and  $w$  for the process of boiling water.
11. Calculate  $\Delta E$  for each of the following:
  - a.  $q = -47 \text{ kJ}$ ,  $w = +88 \text{ kJ}$
  - b.  $q = +82 \text{ kJ}$ ,  $w = +47 \text{ kJ}$
  - c.  $q = +47 \text{ kJ}$ ,  $w = 0$
  - d. In which of these cases do the surroundings do work on the system?
12. A system undergoes a process consisting of the following two steps:  
Step 1: The system absorbs 72 J of heat while 35 J of work is done on it  
Step 2: The system absorbs 35 J of heat while performing 72 J of work  
Calculate  $\Delta E$  for the overall process.
13. The volume of an ideal gas is decreased from 5.0 L to 5.0 mL at a constant pressure of 2.0 atm. Calculate the work associated with this process.
14. How much work (in J) is required to expand the volume of a pump from 0.0 L to 2.5 L against an external pressure of 1.1 atm?
15. Consider a mixture of air and gasoline vapor in a cylinder with a piston. The original volume is 40.  $\text{cm}^3$ . If the combustion of this mixture releases 950. J of energy, to what volume will the gases expand against a constant pressure of 650. torr if all the energy of combustion is converted into work to push back the piston?
16. To inflate a balloon pressure-volume work is done on the surroundings. If 177 J of work was used to inflate a balloon from an initial volume of 0.100 L against an external pressure of 1.00 atm, what is the final volume of the balloon?