CHEM 202 Accelerated General Chemistry I | TA: Alex Wang
Week 6 – Thermodynamics II | September 30, 2021
MERIT WS 6.2 | Section AQG

1. Please state the law of conservation of energy. What are the two major types of energy associated with daily life? Can you give examples of both? What are the two ways in which a system can either gain or lose energy?

2. What is the law of thermal equilibrium? State an example of when you may need to use principles of this law. Does this obey the Zeroth Law of Thermodynamics?

3. Compare and contrast what we mean by the “system” and the “surroundings.” Predict the signs of q and w for boiling water. Explain briefly. In the equation $w = -P\Delta V$, why is there a negative sign?

4. What are state functions? Which one of the following variables *H, E, q, w* are state functions? Why?

5. As a system increases in volume, it absorbs 52.5 J of energy in the form of heat from the surroundings. The piston is working against a pressure of 0.500 atm. The final volume of the system is 58.0 L. What was the initial volume of the system if the internal energy of the system decreased by 102.5 J?

6. Consider the combustion of propane:

$$C_3H_8\,(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$$

   Assume that all of the heat in Example 9.1 (Yes! You must look in the book!!) comes from the combustion of propane. What mass of propane must be burned to furnish this amount of energy, assuming the heat transfer process is 60 % efficient.

7. Explain how calorimetry works to calculate ΔH or ΔE for a reaction. Does the temperature of the calorimeter increase or decrease for an endothermic reaction? How about for an increase or decrease for an exothermic reaction? Explain why ΔH is directly obtained from a coffee cup calorimeter, whereas ΔE is obtained directly from a bomb calorimeter.

8. Objects placed together eventually reach the same temperature. When you go into a room and touch a piece of metal in that room, it feels colder than a piece of plastic. Explain.

9. Hydrogen gives off 120 J/g of energy when burned in oxygen, and methane gives off 50 J/g under the same circumstances. If a mixture of 5.0 g hydrogen and 10.0 g of methane is burned, and the heat released is transferred to 50.0 g water at 25.0^{o}C, what final temperature will be reached by the water?

10. It is a nice fall day and you decide to get a cup of coffee before class. You order a nice cup of piping hot coffee, but oh shucks, you have 10 am CHEM 202 Lecture and it is 9:58 am by the time you get your drink! You decide to run out of the coffee shop without a sleeve to put on the cup to make it to class on time. The paper cup is super thin and you can already feel your hand warming.

    The 250 mL cup of coffee that is 71.7°C. The specific heat of the human body is 3.5 kJ/kg-K and the normal body temperature is 37°C. If you are holding the coffee, will the heat transferred be dangerous enough to burn your hand? Here are some assumptions you can make:

    - Heat transfer is localized to your hand which is about 0.5 kg.
    - The density and specific hear capacity of coffee is the same as water.
    - In the time span you are traveling; burns will only occur at temperatures 60°C and above.

11. Living organisms excrete the excess nitrogen from the metabolism of amino acids in one of the following ways: ammonia, urea, or uric acid. Urea is synthesized in the liver by enzymes of the urea cycle, excreted into the bloodstream, and accumulated by the kidneys for excretion in urine. The urea cycle – the first known metabolic cycle – was elucidated in outline by Hans Krebs and Kurt Henseleit in 1932. Urea is a strong chemical denaturant that is used to study the structural stability of proteins. Solid urea combusts to liquid water and gaseous carbon dioxide and nitrogen according to the following reaction scheme:

$$CO(NH_2)_{2(8)}\ (s) + 1.5O_2\ (g) \rightarrow CO_2\ (g) + N_2\ (g) + 2H_2O\ (l)$$

According to bomb calorimetry measurements, at 25 ^{o}C this reaction results in the release of 152.3 kcal mol^{-1}. Calculate ΔH for this reaction.

12. A person weighing 60 kg drinks 0.25 kg of water. The latter has a temperature of 62 ^{o}C. Assume that body tissues have a specific heat capacity of 0.8 kcal kg^{-1} K^{-1}. The specific heat of water is 1.0 kcal kg^{-1} K^{-1}. By how many degrees will the hot drink raise the person's body temperature from 37^{o}C? Explain how arriving at the answer involves using the first law of thermodynamics.