

Physics 1320

Homework 3, Due Friday 2/11/22

This coming week we will be studying entropy S . Examples of calculations in this homework are in the latter part of my lecture notes, Lecture 8 (posted), as well as in the latter part of Lecture 9. We will be following these notes in class on Monday and Wednesday of next week.

Note on emailing of homework:

I received so many emailed homeworks this past week that my grader and I fear that we are becoming an official campus printing service! I realize that some of this was due to the storm. Nevertheless, this coming week, please bring your homework to class on Friday on paper. If you forget to bring it to class, please come to the department office at PAIS (must be before 5 pm on Friday) and place it in my mailbox. Thank you for your consideration.

Note on handwriting:

In some cases we are having trouble reading handwriting/printing, to the extent that it is not possible to record scores because we can't read their names.

Complete the following problems:

- 1) The average low temperature for Albuquerque for the month of April is 43 degrees F. Suppose that you heat your home to 70 degrees F using a heat pump when the outside temperature is 43 degrees F. For a reversible cycle, how many kJ of heat will be delivered to your home for every kJ of electrical work performed on the compressor? Compare this to the situation in Taos where the average low temperature is 33 degrees F. (DHD 2/6/22)
- 2) Ten moles of ideal gas (we don't know if it is diatomic or monatomic) is expanded reversibly and isothermally from an initial pressure of 5 atm to a final pressure of 1 atm. Calculate Q , Q_{surr} , ΔS , and ΔS_{surr} . The temperature is 350 K. (DHD 2/6/22)
- 3) A cup of rather dilute hot tea initially at 140 degrees F is served to a customer at Howard Johnson's. Unfortunately,  before they get around to drinking it, it has spontaneously cooled off to 100 degrees F. Calculate the change in entropy of the universe for this process. The temperature of the restaurant (the surroundings) is 70 degrees F. (DHD 2/6/22)
- 4) Repeat problem 2, but consider an expansion against a constant external pressure. (DHD 2/6/22)
- 5) Suppose that the heat has been turned off in the HoJo's in order to save money in the cold winter months, and the inside temperature is 32 degrees F. The hot tea cools from 140 degrees F to 32 degrees F, and then freezes, making it impossible to drink. What is the change in entropy of the universe in this case? (DHD 2/6/22)



- 6) Return to problem 3. Suppose that our customer complains about the cold tea and is given a second cup of hot tea. Feeling especially hungry (for tea?) they mix the hot tea and the cold tea together so that they will have twice as much tea (albeit luke warm). Assuming that the mixing occurs spontaneously and adiabatically, what is the final temperature of the tea, the change in entropy of the tea, and the change in entropy of the universe for the mixing process? (DHD 2/6/22)
- 7) Whenever a process takes place spontaneously, there is “free energy” available for the taking if you are clever enough to figure out how to extract it. What is the maximum amount of work you could extract from the cooling process in problem 3. (DHD 2/6/22)