**Entropy**

Prelab due: **Monday October 22nd,** as an upload to Gradescope

Background

The purpose of this lab is to complete two ‘mini-CGIs’ related to our discussion of entropy. In the first one, we will explore a surprising property of reversible processes. For a reversible expansion, a reversible process always does the most work (and any irreversible process does *less* work than a reversible process). For a reversible compression, it turns out that a reversible process always requires the *least* work. So in a sense, a reversible process is the most efficient way to do work on a system, or to get work out of a system.

We’ll also get a sense of how entropy varies with temperature, pressure, and volume, and relate this to what we know from class.

In-lab instructions

**Part 1: Multi-step work**

Before beginning to work on the computational exercise, answer the following questions in your lab notebook. You can discuss the questions with a partner or group of three.

* 1. Write an expression for the work required to compress the gas to a final volume Vf at constant temperature against a *constant external pressure* . Draw an indicator diagram for this process. Label Vf, Vi, and Pex.
  2. Write from part (a.) in terms of T and Vf.
  3. Suppose that instead you want to compress the gas to a final volume Vf in a *two equal steps* at constant temperature. That is, in the first step you compress to a volume halfway between Vf and Vi using a constant pressure, and in the second step you compress the rest of the way to Vf using a different (larger) constant external pressure. Draw an indicator diagram for this process, and derive expressions for the constant external pressure required for both steps. Your expressions should be in terms of Vf, Vi, and T.
  4. What if instead you want to compress the gas in three equal steps? Write expressions for the three pressures required and draw an indicator diagram.
  5. Suppose Vf = 1.0 m3, Vi = 2.5 m3, and T = 298K. What would be the work required (in J) to compress the gas in one step, two steps, and three steps?

Now, open the Multi-Step Work.ipynb notebook that you downloaded in your prelab. Follow the instructions in the notebook file.

**Part 2: Visualizing Entropy**

Your instructor will guide you through the Visualizing Entropy python notebook.

Pre-lab questions:

You do not need a procedure, any tables, or a purpose for this lab.

1. There are two Jupyter notebooks you will need for this lab, Multi-Step Work.ipynb and Visualizing Entropy.ipynb. Download both from Moodle and save them to your personal computer.
2. A 'for loop' in a programming language is a statement that allows code to be executed over and over. This is quite useful for many scientific applications! Watch [this Khan academy video](https://www.youtube.com/watch?v=9LgyKiq_hU0) about for loops,[[1]](#footnote-1) and answer the following questions about it.
3. What does the range() function do in Python?
4. Copy down the code that the video's creator used to sum the numbers from 0 to 9. Note that the print function is not necessary for the loop to function; Sal Khan puts it in so he can illustrate what the loop is doing.
5. In your lab notebook, write a for loop that calculates the **product** of all the numbers from 1 to 9.

1. Note that this video is from 2011 and the speaker is using an older version of Python. The only difference is that in the new version of python, you use the print function with parentheses, whereas in the old version there were no parenthesis. That is, in the new version of python we would type print(i), whereas in the old version the speaker types print i. This is just in case you were curious. [↑](#footnote-ref-1)