ECSE 310 Thermodynamics of Computer, Winter 2019

Homework 3

Assigned: March 3rd 2019

Due: March 15th 2019, 11:59 pm

Submission instructions: Please submit your assignment online via MyCourses assignment tool prior to the deadline. If your submission is handwritten please provide a high quality image (preferably scanned using uPrint or similar). Poor quality digital photos may be rejected. Include any workings and calculations that you performed in completing the assignment.

Late policy: 1% deduction per hour

Academic integrity reminder: In submitting this assignment on MyCourses you are attesting that it is the result of your own work.

Each question has the same weight

P1) Answer the following:

1. If you open a champagne slowly, can you see "white smoke", why?
2. Write down the state functions you have learned so far.
3. State 2nd law of thermodynamics using the language of entropy.
4. What's reversible process/irreversible process?
5. What's a degree of freedom?
6. State equipartition theorem, and describe the internal energy from equipartition point of view.
7. Rank average speed, most probable speed, rms speed from high to low.
8. What's equation engraved on Boltzmann's tombstone? Explain the equation.

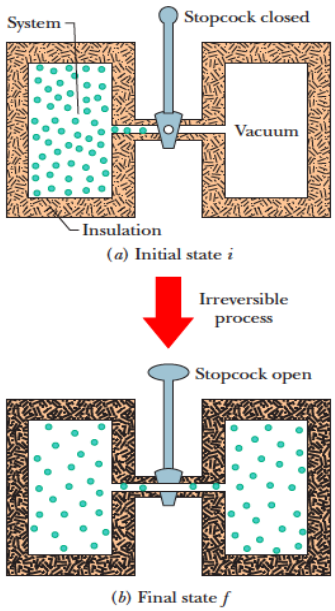
P2) The speeds of 22 particles are as follows (N_i represents the number of particles that have speed v_i):

N_i	2	4	6	8	2
v_i (cm/s)	1.0	2.0	3.0	4.0	5.0

What are (a) v_{avg}, (b) v_{rms} and (c) v_P?

P3) Suppose a container is full of oxygen gas and is kept at room temperature (300 K). Calculate the fraction of molecules that have speeds between 599 to 601 m/s? The molar mass M of oxygen is 0.0320 kg/mol.

P4) Assume that 1.0 mol of nitrogen gas is confined to the left side of the container of the figure shown. When the valve is opened, the volume of the gas doubles. For this irreversible process, what is the entropy change of the gas? Assume the gas is an ideal gas.



P5) Consider a Carnot cycle that fluctuates between the temperatures T_H = 850 K and T_L = 300 K. It performs 1.2 kJ of work each cycle. The duration of the cycle is 0.25 s. What is the entropy change of the working substance due to energy delivered from the high-temperature reservoir? And from the low-temperature reservoir?

P6) Construct a table like the table below for eight molecules.

Six Molecules in a Box

Configuration			Multiplicity W	Calculation of W	Entropy 10^{-23} J/K
Label	n_1	n_2	(number of microstates)	(Eq. 20-20)	(Eq. 20-21)
I	6	0	1	$6!/(6!\ 0!) = 1$	0
II	5	1	6	$6!/(5!\ 1!) = 6$	2.47
III	4	2	15	$6!/(4!\ 2!) = 15$	3.74
IV	3	3	20	$6!/(3!\ 3!) = 20$	4.13
V	2	4	15	$6!/(2!\ 4!) = 15$	3.74
VI	1	5	6	$6!/(1!\ 5!) = 6$	2.47
VII	0	6	1	$6!/(0!\ 6!) = 1$	0
			Total = 64		