

CHEM352: PHYSICAL CHEMISTRY I  
HOMEWORK SET V - DUE 14<sup>th</sup> OF DEC, 5.00 PM

Instructor: Dr. Mateusz Marianski

Room#: HN-1321B

email: [mmarians@hunter.cuny.edu](mailto:mmarians@hunter.cuny.edu)

Lecture: Tue, 2.10-3.25 pm & Fri 2.10-3.25 pm, **C111**

Office hours: Thu, 4-6 pm, **HB - 1321B**

### Problem 1

**CH29/5pts**

According to the latest basic rules of the PowerBall® lottery game (<https://en.wikipedia.org/wiki/Powerball>), winning the lottery requires selecting correctly both 5 of 69 (white balls) and 1 of 26 balls (red Powerball). The odds of winning the lottery are 1:292,201,338. Please:

1. Confirm the odds of winning.
2. Calculate the odds of having only 5 white balls.
3. Calculate the odds of having 3 white balls and 1 powerball.
4. If one bet is 2\$, what is a minimum prize pool that justifies playing the game? Disregard 'power-play'.

### Problem 2

**CH29/5pts**

Consider two probability distributions for molecular velocities in one dimension given by following equations:

$$P(v)dv = Ce^{-mv^2/2kT}dv \quad (1a)$$

$$P(v)dv = Cv^2e^{-mv^2/2kT}dv \quad (1b)$$

For each distribution, please:

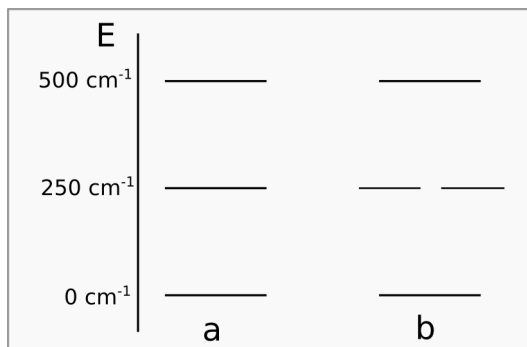
1. Determine the normalization constant  $C$
2. Determine  $\langle v \rangle$ ,  $\langle v^2 \rangle$  and the variance.
3. Determine the most probable velocity.

Solutions for respective integrals you can find in your favorite pchem or calculus books, web-search engine, or social-media channel.

### Problem 3

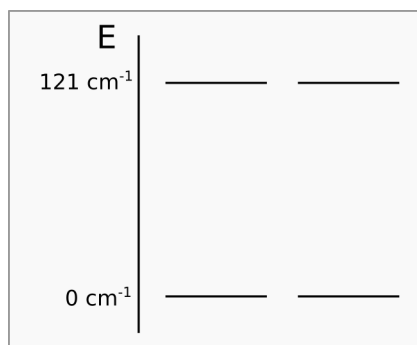
**CH30/5pts**

At what temperature will the probability of occupying the second energy level be 0.25 in the following two systems?



**Problem 4****CH30/5pts**

Below is simplified electronic energy diagram for radical  $\cdot\text{N}=\text{O}$  molecule. Determine the probability of electron to occupy one of the higher energy states at 100, 298 and 3000 K.

**Problem 5****CH30/5pts**

Calculate the contribution of each component (translational, rotational and vibrational, neglect electronic) to the partition energy function of  $\text{CO}_2$  at 1000K in volume of 1 nm<sup>3</sup>. The vibrations energies are 1388, 667.4 (doubly degenerate) and 2349 cm<sup>-1</sup>. The rotational constant is 0.39 cm<sup>-1</sup>.