

Problem Set 9
(Kinetic Theory of Gases)

1. Do problem 27-2 in McQuarrie and Simon.
2. Do problem 27-9 in McQuarrie and Simon.
3. Do problem 27-18 in McQuarrie and Simon.
4. Molecules all of mass m and speed v exert a pressure P on the walls of a vessel. If half the molecules are replaced by ones of another type all with mass $m/2$ and speed $2v$ will the pressure (a) increase, (b) decrease, or (c) remain constant?
5. By setting the derivative of the formula for the Maxwell-Boltzmann speed distribution to zero, find an expression for the most probable speed, i.e. the speed at which the distribution has a maximum value. From this, find an expression for the most probably kinetic energy for a molecule in the gas phase.
6. What is the ratio of the probability of finding a molecule moving with the average speed to the probability of finding a molecule moving with three times the average speed?
7. 10 point extra credit problem:
A Physical Chemistry student is caught without an umbrella in the rain and wishes to get to her dorm, 1 km away, in the driest possible condition. Should she walk or run? In order to answer this question, calculate the ratio of the rain drop collisions with the student's body under the two conditions. Assume that the cross section is independent of direction (i.e. that the student is spherical), that the student runs at 8 m/s, that she walks at 3 m/s, and that the rainfall is constant with a velocity of 15 m/s.

(Hint: Let N be the density of raindrops; let Z = number of collisions/unit time between the student and the raindrops; let v_s be the student's velocity (either $v_s = v_{walk}$ or $v_s = v_{run}$); let D be the distance to the dorm (=1 km); and note then that the number of collisions is given by Z , the number of collisions per unit time, times the time it takes to walk or run to the dorm, D/v_s : wetness $\propto ZD/v_s$)