PHYS2332-Modern Physics II
Winter 2020 Assignment #1

Due on Monday January 20, 2020.

Question 1

Consider a simple harmonic oscillator (section 6.6) in an arbitrary quantum state, $\psi_a = \sqrt{\frac{2}{5}}\psi_1 + \sqrt{\frac{1}{5}}\psi_2 + \sqrt{\frac{2}{5}}\psi_4$, where the ψ_n is the wavefunction solution of equation (6.57). In class I explained that $\psi_n$is stationary quantum state, with energy $E_n = \left(n + \frac{1}{2}\right)\hbar\omega$, of equation (6.58). **A)** What is the probability that a measurement of the arbitrary state ψ_a find that the system has energy $\frac{3\hbar\omega}{2}$? ; **B)** What is the probability that a measurement of the arbitrary state ψ_a find that the system has energy $\frac{7\hbar\omega}{2}$?; **C)** What is the **average energy** of this arbitrary state ψ_a? **Note:** You must justify your answers?

Question 2 Consider an ideal gas in 2D. In 2D the speed distribution becomes $f_{2D}(v) = \beta m v \exp\left(-\beta\frac{mv^2}{2}\right)$ with $v^2 = v_x^2 + v_y^2$, and $f_{2D}dv$ is the probability that the speed is in the range v to $v+dv$. A) By direct integration verify that the distribution is normalized (i.e. $\int_0^\infty dv f_{2D}(v) = 1$). B) Find the average speed in 2D $\overline{v} = \int_0^\infty dv v f_{2D}(v)$, the mean square speed $\overline{v^2} = \int_0^\infty dv v^2 f_{2D}(v)$, and most probable speed, v^* , found by $df_{2D}/dv = 0$. Compare your answers to the 3D ideal gas in the textbook, equation 9.15, 9.17, and 9.20. C) The probability that the speed of a 2D ideal gas particle has speed with values from $v = v_1$ to $v = v_2$ is $P_{12} = \int_{v_1}^{v_2} dv f_{2D}(v)$. Find the probability that a 2D gas particle has speed greater than the 0.1 the speed of light $v > 0.1c$ at temperature, T = 290 K. Briefly comment on the value you calculated. In part C, sssume that the gas is **argon**.

Do problem 7 of Chapter 9. Note that since the answer is in the back you must show work in order to receive marks for this question

Do problem 17 of Chapter 9. Note that since the answer is in the back you must show work in order to receive marks for this question

Do problem 18 of Chapter 9.