PHYS 2210 Homework assignments – Problems 1 to 8.

When handing in assignments, please clearly label each problem solution by the Problem Number given here.

Each Problem is graded on a ten point basis unless noted otherwise.

In order to earn full credit, you must clearly describe every important logical step. Do not just write an equation and an answer. Answers that are unclear or difficult to read may have point deductions, even if they are correct.

Problem Number	
1	Townsend 1.12 Townsend 1.12. The photoelectrons ejected in the photoelectric effect seem to appear instantaneously. In particular, no time delay has been observed, even with light of very low intensity. In classical physics. the energy of the electromagnetic wave is spread out uniformly over the surface of the metal. In this picture. calculate the amount of time it would require for 1 eV of energy (a typical binding energy) to be absorbed by an atom in a metal located 1 m away from a 1-walt bulb. Take the area of the atom to be 10^{-20} m^2. *Suggestion:* What fraction of the incident flux is absorbed by the atom?
2	Townsend 1.13 Townsend 1.13. The maximum kinetic energy for electrons ejected from sodium is 1.85 eV for radiation of 300 nm and 0.82 eV for radiation of wavelength 400 nm. Use this data to determine Planck's constant and the work function of sodium.
3	Townsend1.15 Townsend 1.15. Suppose a photon with a wavelength equal to the Compton wavelength makes a collision with a free electron initially at rest. What is the energy of the final photon if it is backscattered at 180 degrees? How much kinetic energy is transferred to the electron?
4	Townsend 1.18 Townsend 1.18. *(a)* Suppose that the probability amplitude for a photon to arrive at a detector is $1/(1+i)$. What is the probability that the detector records a photon? *(b)* What is the probability of· detecting a photon if the probability amplitude equals i? *(c)* Determine the probability of detecting a photon if the probability amplitude is $$\frac{1}{1+i}+i$$ *(d)* Show that $$\frac{1}{(1+i)}-i$$ is not a valid probability amplitude. *Suggestion:* What would be the probability of detecting a photon for this amplitude?
5	Townsend 1.20 Townsend 1.20. Rewrite each of the following complex numbers in each of the forms $z-x+iy$ and $re^{i\phi}$, where $x, y, r, and\ \phi$ are real numbers. State logic and/or show work. a) $(1+2i)^2$

	b) $\frac{1}{1+i}$ c) $\sqrt{3-4i}$ d) $e^{\frac{i\pi}{4}}$
6	Townsend 1.32 Townsend 1.32. Add the two complex numbers $z_1 = 1$ and $z_2 = e^{\frac{i\pi}{3}}$ by (a) adding the real and imaginary pieces together and (b) using geometry to "add the arrows" representing each of these complex numbers. Check that your results for the magnitude and phase of the complex number $z_1 + z_2$ agree.
7	Townsend 1.38 Townsend 1.38. For a grating with *N* equally spaced narrow slits, the amplitude for detecting a photon with a photomultiplier centered al point P in the detection plane is given by $$z_P = re^{ikd_1}[1 + e^{i\phi} + e^{i2\phi} + e^{i3\phi} \ldots + e^{i(N-1)\phi}]$$ Notice that each term in this series of terms can be obtained from the one preceding it by multiplying by$e^{i\phi}$. Thus, it is a geometric series that can be summed. Show that the probability of detecting a photon is given by $$r^2\left((\sin^2\left(\frac{N\phi}{2}\right))/(\sin^2\frac{\phi}{2})\right)$$ Verify that this res ult reduces to the double-slit result (1.60) for *N* = 2.
8	Townsend 2.01 Townsend 2.01. What is the speed of helium atoms with a de Broglie wavelength of 1.03 angstroms?