Physics 214: Introduction to Quantum Mechanics
Spring 2016

Problems for Recitation Section, Week 3

Problems:

1. **Probability amplitudes for reflection and transmission** (Townsend 1.23). One photodetector is located in front of a thick piece of glass and another photodetector is located within the glass. At normal incidence, the glass reflects 4% of the light. A photon is incident on the glass, as indicated in Fig. 1. (a) What is the magnitude of the probability amplitude for reflection of the photon? (b) What is the magnitude of the probability amplitude for transmission of the photon? Add a part (c): Is the reflection from the air→glass interface a hard or soft reflection, and what does this imply about the relative phase of the reflected and transmitted amplitudes?

![Figure 1: Partial reflection of light by a single surface of glass.](image)

2. **Algebraic and geometric methods of adding complex numbers** (Townsend 1.32). Add the two complex numbers \( z_1 = 1 \) and \( z_2 = e^{i\pi/3} \) 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.

3. **Geometric derivation of N slit diffraction.** By geometrically “adding the arrows” rather than algebraically summing the series, compute the magnitude of the sum

\[
z_p = r + re^{i\delta} + re^{2i\delta} + \cdots + re^{(N-1)i\delta}.
\]

This is the sum that arises in computing the probability amplitude for \( N \)-slit diffraction, where \( \delta = ka \sin \theta \) is the difference in phase of adjacent paths and \( a \) is the separation distance between neighboring slits.