

University of Calgary
Winter semester 2007

PHYS 443: Quantum Mechanics I

Homework assignment 1

Due January 23, 2007

Problem 1.1.

- Decompose the linear polarization states $|\theta\rangle$ and $|\frac{\pi}{2} + \theta\rangle$ (where θ is an arbitrary angle) into the canonical basis. Write the decomposition in the matrix form.
- Show that these states form an orthonormal basis.
- Decompose the right circular polarization state $|R\rangle$ into this basis. Discuss the physics behind the observed dependence on θ .
- Decompose the state $|\psi\rangle = (3|H\rangle + 4i|V\rangle)/5$ in this basis.
- Find the inner product $\langle\psi|R\rangle$ using Eq. (1.13) from the lecture notes both in the canonical basis and in the basis $\{|\theta\rangle, |\frac{\pi}{2} + \theta\rangle\}$. Show that the results are identical.

Problem 1.2.

- Propose an experimental apparatus for measuring the polarization of the photon in the basis $\{|\theta\rangle, |\frac{\pi}{2} + \theta\rangle\}$.
- What are the probabilities of each outcome if this apparatus is used to measure a photon with a linear polarization at angle $|\varphi\rangle$ to horizontal?
- The same question for photons with circular polarizations.

Problem 1.3. Perform the Gram-Schmidt procedure for three 3D vectors: $\vec{w}_1 = (1, 1, 1)$, $\vec{w}_2 = (1, 2, 3)$, $\vec{w}_3 = (1, -1, 2)$. Verify that the basis obtained is indeed orthonormal.