PHYS 4380 Quantum Mechanics I

Homework Assignment 01

Due date: September 06, 2018

Instructor: Dr. Daniel Erenso   Name: —————————————————

Mandatory problems: 1 & 2

Student signature:_____

Student Comment:_____
_____
_____

P #	1	2	3	4	5	Score	F. Score
Score	/	/	/	/	/	/100	/100

1. Consider the following two vectors in a complex Cartesian vector space

$$\vec{A} = 3\hat{x} - 4i\hat{y}, \vec{B} = 6i\hat{x} + 8\hat{z}$$

Suppose the unit vectors $\hat{x}, \hat{y}$, and $\hat{z}$ can be represented by $|e_1\rangle, |e_2\rangle$, and $|e_3\rangle$

(a) Express these vectors $\vec{A}$ and $\vec{B}$ using Dirac notation (i.e. $|A\rangle$ and $|A\rangle$)

(b) Find components of these vectors using Dirac notation

$$A_i = \langle e_i | A \rangle, B_i = \langle e_i | B \rangle$$

   for $i = 1, 2$, and 3

(c) Find the component of vector $\vec{A}$ along the direction of vector $\vec{B}$ using Dirac notation.

2. Consider the ket vector
$$|\psi\rangle = \frac{1}{\sqrt{2}} [|a_1\rangle + i |a_2\rangle]$$

where the vectors $\{|a_1\rangle, |a_2\rangle\}$ form an orthonormal set of vectors

(a) Find the bra vector

(b) Find $\langle a_1 | \psi \rangle$ and $\langle \psi | a_1 \rangle$

(c) Find the probability amplitude $\langle a_2 | \psi \rangle$ and $\langle \psi | a_2 \rangle$

(d) What is the resulting value for k given by

$$k = \langle a_1 | \psi \rangle \langle \psi | a_1 \rangle + \langle a_2 | \psi \rangle \langle \psi | a_2 \rangle$$

3. Consider the a photon described by its polarization state

$$|\psi\rangle = \frac{e^{i\theta}}{\sqrt{2}} [|\uparrow\rangle + i |\longrightarrow\rangle]$$

where vectors $|\uparrow\rangle$ and $|\longrightarrow\rangle$ represent vertical and horizontal polarization states and form an orthonormal set of vectors

(a) Find the bra vector

(b) Find $\langle \uparrow | \psi \rangle$ and $\langle \psi | \uparrow \rangle$

(c) Find the probability amplitude $\langle \longrightarrow | \psi \rangle$ and $\langle \psi | \longrightarrow \rangle$

(d) What is the resulting value for k given by

$$k = \langle \uparrow | \psi \rangle \langle \psi | \uparrow \rangle + \langle \longrightarrow | \psi \rangle \langle \psi | \longrightarrow \rangle$$

4. **Townsend 1.1**

5. **Townsend 1.2**