**Post-Test: Dirac Notation Warm-Up**

For all of the following questions:

* Assume that form one orthonormal basis and , , and form another orthonormal basis for the same three dimensional vector space.
* and are vectors in a three dimensional vector space.

1. For vector :
   1. Write the components in Dirac notation.
   2. Write as a column matrix (vector) in the given basis.
2. a. Write the outer product of “ket” vector with “bra” vector .

b. Is this a scalar (number), column vector, row vector, or an operator?

1. Write the identity operator in terms of which form a complete set of basis vectors for a three dimensional vector space.
2. Consider the following statement:

* The components of the vector have fixed values even if we change the basis such that the unit vectors are , , and .

Explain why you agree or disagree with this statement.

1. Choose all of the correct statements about the identity operator (assume three dimensional vector space):
2. In general, given an orthogonal basis , if we compute the outer product of each unit vector with itself and then add them up, we obtain the identity operator.
3. If we change the basis we have chosen to a different orthogonal basis , , and , if we compute the outer product of each new basis vector with itself then add them up, we will still obtain the identity operator .
4. The completeness relation refers to writing the identity operator in terms of a complete set of basis vectors.
5. (I) only
6. (II) only
7. (III) only
8. (I) and (III) only
9. All of the above
10. For the vector
    1. Write down the projection operator that projects vector along the direction of the unit vector .
    2. Using the projection operator from 6.a, show what happens to the vector when the projection operator acts on it.
    3. Summarize your result in part 6.b in one sentence.
11. Consider the following statement made by Student A about vector :

* Student A: is a vector which points along the z-direction.

Do you agree with Student A? Explain your reasoning.