Feedback for Problem Sheet 2

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Question 1

Some students did the entire question with vector/matrix notation instead of Dirac notation.

a. A few were confused by "diagonal form", many missed the final bit about verifying equality to the previous expression
b. Very few students realised that $|y_+\rangle$, $|y_-\rangle$ also formed a basis so could be used for an arbitrary state, but most managed in the standard basis. Some students quoted the resolution of the identity for any basis, somewhat defeating the point of the question, while others took $|0\rangle\langle 0| + |1\rangle\langle 1|$ to be the definition of the identity and didn't check it
c. Many expanded U in the standard basis making the algebra harder for themselves. A majority also checked both $U^\dagger U = I$ and $UU^\dagger = I$ when just one would suffice

Question 2

a. Answered well by most, a few stated unitarity with little working
b. Some were confused by this, perhaps those less familiar with roots of unity

Question 3

a. Most students recalled the orthogonality condition, although a few just thought they needed to be distinct states. Some were confused by "measurement operator", instead just listing projectors, or combined the projectors with the same eigenvalues e.g. $|0\rangle\langle 0| + |1\rangle\langle 1|$
b. Sign errors were quite frequent here, often from not checking that $\langle v_1^\perp | v_2^\perp \rangle = \langle v_1 | v_2 \rangle$
c. Some were confused by what this question was asking. A few tried to make arguments based on probabilities rather than what we can say with certainty

Question 4

a. Answered well
b. Many students did the same method as part a, found no contradiction, and stopped there, without actually finding a product state form

Question 5

Definitely the hardest question on the sheet, the number of fully correct answers to this could be counted on one hand. Most managed the forward direction, but either didn't realise there was a reverse, or thought their proof sufficed for it despite assuming the existence of a product state factorisation to begin with. One student used the phrase "is this a proof, idk I do physics 😊" which sums up many of the attempts to this question.

Question 6

a. Done well for the most part
b. Showing this identity proved trickier but most managed it, however a significant number of students failed to do induction, with some missing it entirely, and others implying it but not doing it in full
c. Done well if they made it this far