Feedback for Problem Sheet 3

Markers: James Byrne, Amari Jaconelli, Sohyun Park

Question 1

Mostly done well by all students. Many forgot that α and β were complex and missed the modulus signs, some simplifying using $\alpha^2 + \beta^2 = 1$ erroneously. Some failed to normalise correctly, others were confused about the post-measurement state when the outcome has probability zero

Question 2

Most proved equivalence with respect to product states, but very few justified why this meant the operators were the same (e.g. due to linearity, by choosing a basis of product states, etc.). Some students forgot the Hermitian part, but the unitary part was done well

Question 3

Few if any mistakes from all students in this question, some missed the final verification

Question 4

Most were able to show that the final state was entangled, but didn't fully justify why that meant the operator was non-local, as they didn't emphasise the fact that the initial state was a product state. Some attempted to prove it was a product state despite it already being written as one, while others attempted to prove the operator was non-local by contradiction, but this was usually logically flawed

Question 5

Many students managed this well, most mistakes came from not applying the identity on the unmeasured system, meaning that they got confused about which system was being measured. This resulted in them effectively measuring the first system twice and getting the wrong answer

Some students also tried to use the computational basis form of Y as projectors, rather than the diagonal form. This obviously led them astray immediately

Question 6

a. Most were able to find unitary matrices to transform states into one another, but very few fully justified that any state could be transformed into any other, by composing and inverting unitaries appropriately
b. Again, finding the transformations was not challenging, although many didn't prove that the transformations they defined were actually unitary. Some students missed the orthonormality check, others thought that because they were related by unitary operations they must form an orthonormal basis, misunderstanding the condition about unitaries taking orthonormal bases to orthonormal bases
c. Very few students managed this in its entirety. The most common approach was along the lines of proving that given any two states there exists a unitary map between them, but this proved difficult to justify fully. Some found appropriate transformations between arbitrary states, but they weren't unitary in general