Welcome to Homework 18!

Instructions:

The homework assignment you need to submit on Canvas this week asks conceptual questions about content covered in lecture and lab. This week's jupyter notebook provides a practice exercise about quantum teleportation. You do not need to complete the jupyter notebook in order to submit the Canvas assignment. However, we encourage you to use the notebook for practice, which may help you build intuition to answer these questions.

1. In quantum teleportation, if Bob receives the classical bit pair "01", what gate combination should Bob apply to his qubit?

A) X Gate then Z Gate
B) Z Gate then X Gate
C) X Gate
D) Z Gate

2. Qiskit allows us to use a function called "snapshot" while running the statevector simulator to look at the qubit states at different points in the circuit. Snapshot returns the exact statevector of the qubit state at a desired point in the circuit.

For simulating quantum teleportation, we can use statevector-simulator snapshots to look at the quantum state during the protocol. Why is this impossible to do on a real quantum device?

A) A we haven't yet solved the electron snapshot conjecture
B) A snapshot involves a measurement of quantum states which would destroy the entangled pair.
C) There is so much noise involved in taking snapshots that it is not possible on NISQ computers.
D) It is too expensive to build a snapshot machine.

3. What does the no-cloning theorem prevent us from doing?

Hint: As a reminder, the no-cloning theorem states that it is impossible to create an independent and identical copy of an arbitrary unknown quantum state.

A) Teleporting more than one qubit.
B) Swapping the state of two qubits across each other.
C) Measuring a qubit mid-teleportation.
D) Copying a state from one qubit onto another without destroying the first state.

4. What is the role of the third person, Charlie, in the first step of quantum teleportation and superdense coding?

Reminder: Charlie refers to the person mentioned in Fran's lecture and this week's lab.

A) Charlie provides an entangled pair for Alice and Bob
B) Charlie is trying to eavesdrop on the secret message sent from Alice to Bob
C) Charlie measures Alice and Bob's qubits
D) Charlie tells Bob which gates to apply

5. Imagine Alice wants to send a 1000-character document to Bob. Alice and Bob also happen to have 2500 shared entangled states between them. Assuming that each character can take one of 32 different character values e.g. (a,b, … ,!, -), and that we are only able to send one qubit at a time:

How many classic bits would you need to send the document? Now using superdense coding, what is the minimum number of qubits required to send the document?

A) 1000 Classical Bits, 2500 Quantum Bits
B) 2500 Classical Bits, 5000 Quantum Bits
C) 5000 Classical Bits, 2500 Quantum Bits
D) 5000 Classical Bits, 1000 Quantum Bits