

# Quantum Teleportation Solutions

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## 1 Quantum Teleportation

The task is to teleport an arbitrary qubit state  $|\psi\rangle = \alpha|0\rangle + \beta|1\rangle$  from Alice to Bob with the help of only classical communication and a previously shared EPR state  $|\Phi^+\rangle = \frac{1}{\sqrt{2}}(|00\rangle + |11\rangle)$  (each having one qubit). The teleportation protocol consists of four main steps:

1. Alice applies a CNOT gate on her two qubits, with  $|\psi\rangle$  as the control qubit and her half of the entangled pair as the target qubit. She then applies a Hadamard gate to the control qubit.
2. Alice measures both qubits that she owns. She sends the measurement results to Bob.
3. Depending on the measurement results, Bob applies  $X$  and  $Z$  gates to his qubit.
4. The qubit in Bob's possession is now in the state  $|\psi\rangle$ .

## 2 Teleporting a Mixed State