

1. Reconcile the no-cloning theorem with the copying action of the CNOT gate. i.e. if the control qubit is $b \in \{0, 1\}$ and the target qubit is 0, then the CNOT gate copies the control qubit into the target.
2. Consider a CNOT gate whose second input is $|0\rangle - |1\rangle$. Describe the action of the CNOT gate on the first qubit.

Now show that if the CNOT gate is applied in the Hadamard basis - i.e. apply the Hadamard gate to the inputs and outputs of the CNOT gate - then the result is a CNOT gate with the control and target qubit swapped.

3. Consider the unitary operation U resulting from applying the Hadamard gate to each of n qubits. Describe U by giving a formula for its $(x,y)^{th}$ entry.
4. Show that if U and V are unitary, then so is $U \otimes V$.
5. Write the 4×4 matrix of the unitary operation on two qubits resulting from performing a Hadamard transform on the first qubit and a phase flip on the second qubit.