Problem Set 2: Introduction to Quantum Circuits

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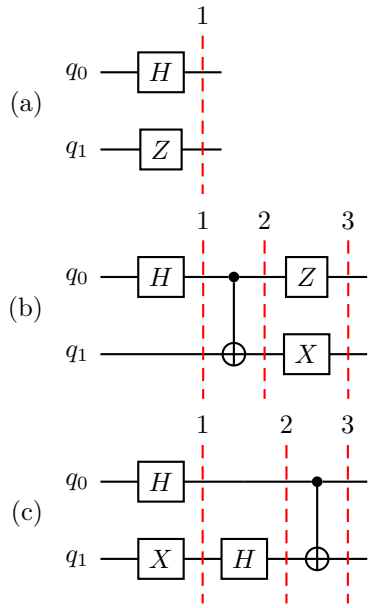
1 Theory Exercises

1. Calculate the statevector of the following quantum circuits at each step. Remember that all qubits start in the $|0\rangle$ state.



2. Measure $|0\rangle$ in basis $B = |+\rangle\langle+|, |-\rangle\langle-|$
   (a) What are the probabilities of outcomes + and −, respectively?
   (b) What are the post-measurement states if one obtains outcome + or −, respectively?
3. Construct a H gate using only $R_y(\theta)$ and $R_x(\phi)$ gates
4. The density matrix of a single qubit state can be found using the Bloch Sphere using the following relation:

$$\rho = \frac{1}{2}(I + \vec{r} \cdot \vec{\sigma})$$

where r is the 3D Bloch position vector, σ are the Pauli matrices, and I is the identity matrix. Use this identity to calculate the density matrix of a qubit initialized at $|0\rangle$ with an H gate applied on it. Refer to *Lecture Notes 1* if needed.

2 Qiskit Excercise + Bonus

The Qiskit problems can be found this jupyter notebook.