

**Problem Set 4**  
CPSC 489/689 Quantum Algorithms  
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**The assignment is due next Monday, before class.**

Find an implementation of a the half-adder, as specified in Challenge problem 2, with at most 15 controlled-not and single qubit gates. Try to find the most efficient solution!

- Derive your solution step by step. For example, replace the Toffoli gate by controlled- $U$  gates, then realize the controlled- $U$  gates by controlled-not gates and single qubit gates.
- Prove all simplifications, which you use to replace a circuit by an equivalent one. Be careful here, this is a common source of error.