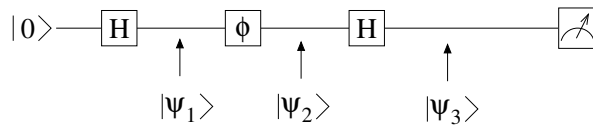


## Nanophysics — Fall 2017

### Exercise 2

(1) **Interferometers**

The circuit below shows a single qubit model of an interferometer.

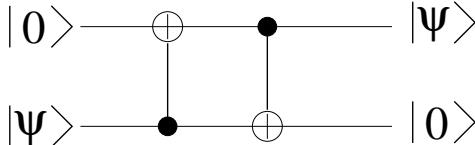


Let the gate  $\phi$  map  $|0\rangle \rightarrow |0\rangle$  and  $|1\rangle \rightarrow e^{i\phi}|1\rangle$

- (a) What are the states  $|\psi_1\rangle$ ,  $|\psi_2\rangle$  and  $|\psi_3\rangle$  ?
- (b) What is the probability of measuring the final qubit to be one ?

(2) **Swap circuit**

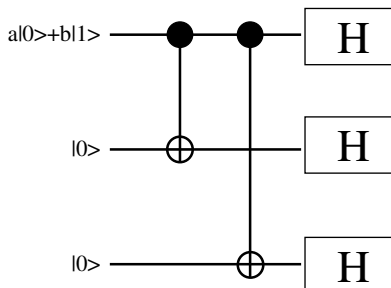
Show that the circuit below swaps the the first qubit in state  $|0\rangle$  with an arbitrary qubit  $|\psi\rangle$ .



Note that this circuit only uses CNOT gates.

(3) **Bit flip error correction code**

Consider the circuit shown below.



- (a) What is the final three-qubit state ?
- (b) Express the state obtained in (a) in  $|+\rangle$  and  $|-\rangle$  basis.