Homework 5

Due Nov 25 at 4am **Points** 100 **Questions** 10
Available until Nov 25 at 4am **Time Limit** 60 Minutes
Allowed Attempts 3

Instructions

We use the **conventions in the QBook101**.

The default programming language for coding is Python. You may write pieces of code during this quiz.

When the qubits are enumerated as $q_0, q_1, \ldots, q_n$, *we combine them as* $q_n \otimes q_{n-1} \otimes \cdots \otimes q_0$ *and then read in the order* $q_n, q_{n-1}, \ldots, q_0$

Controlled-NOT operator takes its parameters as $CNOT(q_{controller}, q_{target})$

Attempt History

	Attempt	Time	Score
KEPT	Attempt 3	6 minutes	50 out of 100
LATEST	Attempt 3	6 minutes	50 out of 100
	Attempt 2	11 minutes	30 out of 100
	Attempt 1	29 minutes	10 out of 100

Last Attempt Details:

Time:	6 minutes
Current Score:	50 out of 100
Kept Score:	50 out of 100

3 Attempts so far
View Previous Attempts
No More Attempts available

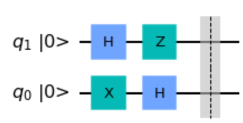
Correct answers are hidden.

Score for this attempt: **50** out of 100
Submitted Nov 24 at 8:24pm
This attempt took 6 minutes.

Incorrect

Question 1 — 0 / 10 pts

What is the state at the barrier?

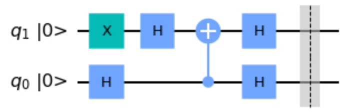


- $|-\rangle|-\rangle$
- $\frac{1}{\sqrt{2}}(|00\rangle + |11\rangle)$
- $|+\rangle|-\rangle$ (selected)
- $|-\rangle|+\rangle$
- $|+\rangle|+\rangle$

Question 2

10 / 10 pts

What is the state at the barrier?



Hint: You may execute the circuit and guess the result from the collected statistics.

- $|01\rangle$
- $|00\rangle$
- $\frac{1}{\sqrt{2}}(|00\rangle + |11\rangle)$
- $|11\rangle$
- $|10\rangle$

Question 3

10 / 10 pts

We have two qubits as $q_1 \otimes q_0$ in state

$\sqrt{\frac{1}{10}}|00\rangle - \sqrt{\frac{2}{10}}|01\rangle - \sqrt{\frac{3}{10}}|10\rangle - \sqrt{\frac{4}{10}}|11\rangle$.

If we measure only q_0, what is the probability of observing $|1\rangle$?

- 6/10
- 3/10
- 4/10
- 1/10
- 2/10

Incorrect

Question 4

0 / 10 pts

We have two qubits as $q_1 \otimes q_0$ in state

$\sqrt{\frac{1}{10}}|00\rangle - \sqrt{\frac{2}{10}}|01\rangle - \sqrt{\frac{3}{10}}|10\rangle - \sqrt{\frac{4}{10}}|11\rangle$.

If we measure only q_0 and observe $|0\rangle$,

what is the new state of the qubits?

- $\sqrt{\frac{1}{10}}|00\rangle - \sqrt{\frac{2}{10}}|01\rangle$
- $\sqrt{\frac{1}{10}}|00\rangle - \sqrt{\frac{3}{10}}|10\rangle$

- $\sqrt{\frac{1}{4}}|00\rangle - \sqrt{\frac{3}{4}}|10\rangle$
- $|00\rangle$
- $\sqrt{\frac{1}{3}}|00\rangle - \sqrt{\frac{2}{3}}|01\rangle$

Question 5

10 / 10 pts

We have two qubits as $q_1 \otimes q_0$ in state

$$\sqrt{\frac{1}{10}}|00\rangle - \sqrt{\frac{2}{10}}|01\rangle - \sqrt{\frac{3}{10}}|10\rangle - \sqrt{\frac{4}{10}}|11\rangle .$$

If we measure only q_1 , which one of the following mixtures is obtained?

- $\left\{\left(pr = \frac{4}{10},\ \sqrt{\frac{1}{10}}|00\rangle - \sqrt{\frac{3}{10}}|10\rangle\right), \left(pr = \frac{6}{10},\ -\sqrt{\frac{2}{10}}|01\rangle - \sqrt{\frac{4}{10}}|11\rangle\right)\right\}$
- $\{(pr = \frac{4}{10},\ |00\rangle), (pr = \frac{6}{10},\ |11\rangle)\}$
- $\left\{\left(pr = \frac{3}{10},\ \sqrt{\frac{1}{3}}|00\rangle - \sqrt{\frac{2}{3}}|01\rangle\right), \left(pr = \frac{7}{10},\ \sqrt{\frac{3}{7}}|10\rangle + \sqrt{\frac{4}{7}}|11\rangle\right)\right\}$
- $\left\{\left(pr = \frac{3}{10},\ \sqrt{\frac{1}{10}}|00\rangle - \sqrt{\frac{2}{10}}|01\rangle\right), \left(pr = \frac{7}{10},\ -\sqrt{\frac{3}{10}}|10\rangle - \sqrt{\frac{4}{10}}|11\rangle\right)\right\}$
- $\left\{\left(pr = \frac{4}{10},\ \sqrt{\frac{1}{4}}|00\rangle - \sqrt{\frac{3}{4}}|10\rangle\right), \left(pr = \frac{6}{10},\ \sqrt{\frac{2}{6}}|01\rangle + \sqrt{\frac{4}{6}}|11\rangle\right)\right\}$

Question 6

10 / 10 pts

We have two qubits as $q_1 \otimes q_0$ in $|0\rangle \otimes. |0\rangle$

Which one of the following operators leads the composite system to

$$\frac{1}{\sqrt{2}}|01\rangle + \frac{1}{\sqrt{2}}|10\rangle$$

- $H(q_1), X(q_0), CNOT(q_0, q_1)$
- $X(q_0), H(q_1), CNOT(q_1, q_0)$
- $H(q_1), H(q_0), X(q_1)$
- $H(q_1), X(q_1), H(q_0)$
- $H(q_1), X(q_0), H(q_0)$

Question 7

10 / 10 pts

In which one of the following states, the qubits are not entangled?

Hint: One may find it easier to work with the state vector.

- $\frac{1}{2}(|00\rangle - |01\rangle - |10\rangle - |11\rangle)$
- $\frac{1}{2}(|00\rangle - |01\rangle - |10\rangle + |11\rangle)$
- $\frac{1}{2}(|00\rangle - |01\rangle + |10\rangle + |11\rangle)$
- $\frac{1}{2}(|00\rangle + |01\rangle + |10\rangle - |11\rangle)$
- $\frac{1}{2}(-|00\rangle - |01\rangle - |10\rangle + |11\rangle)$

Incorrect

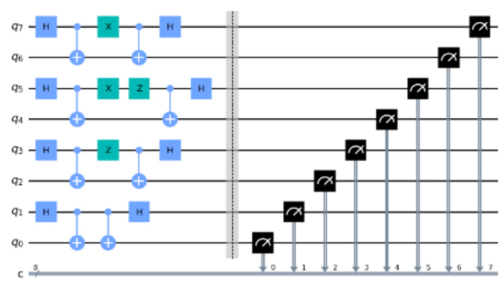
Question 8

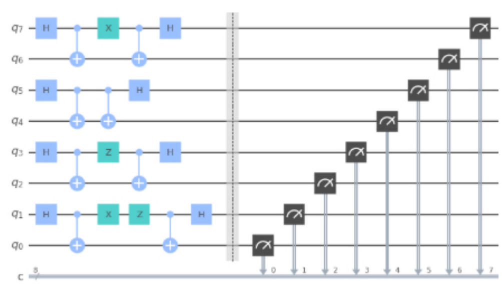
0 / 10 pts

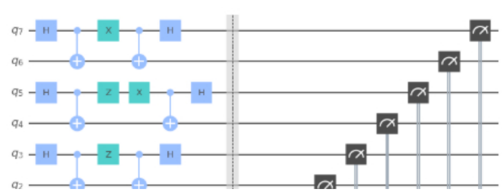
Asja will send the classical message '10000111' to Balvis by using superdense coding protocol as described in our notebooks.

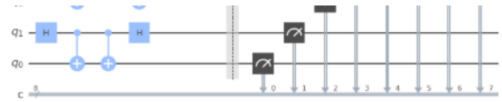
Which one of the circuits represent this communication?

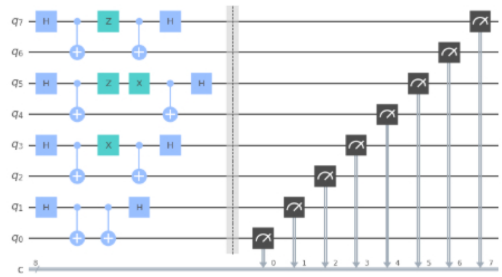
Remark that the outcome of the circuit should be the classical message above.

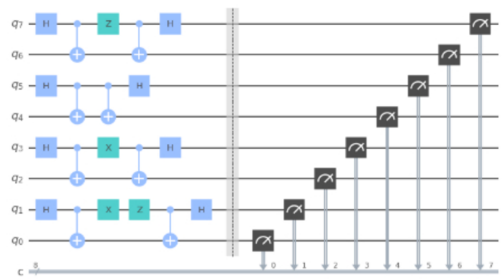












Incorrect

Question 9

0 / 10 pts

By using the quantum teleportation protocol given our notebooks, Asja is teleporting the state $\begin{pmatrix}\alpha \\ \beta\end{pmatrix} \in \mathbb{R}^2$ to Balvis.

Immediately after Asja's measurement, Balvis qubit will be in a mixture of pure states (before post-processing).

If this measurement result is '01' or '10', what is this mixture?

- $\alpha|1\rangle + \beta|0\rangle$ with probability $1/4$
- $\alpha|1\rangle - \beta|0\rangle$ with probability $1/4$

- $\alpha|0\rangle + \beta|1\rangle$ with probability $1/2$
- $\alpha|1\rangle + \beta|0\rangle$ with probability $1/2$

- $\alpha|1\rangle + \beta|0\rangle$ with probability $1/2$
- $\alpha|1\rangle - \beta|0\rangle$ with probability $1/2$

- $\alpha|0\rangle - \beta|1\rangle$ with probability $1/2$
- $\alpha|1\rangle + \beta|0\rangle$ with probability $1/2$

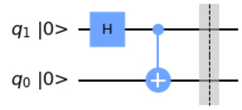
- $\alpha|0\rangle - \beta|1\rangle$ with probability $1/4$
- $\alpha|0\rangle + \beta|1\rangle$ with probability $1/4$
- $\alpha|1\rangle - \beta|0\rangle$ with probability $1/4$
- $\alpha|1\rangle + \beta|0\rangle$ with probability $1/4$

Incorrect

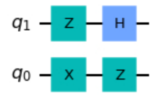
Question 10

0 / 10 pts

We entangle two qubits as given below.



After that, we apply the following operators to this entangled state:



What is the final state?

Hint: You may use Qiskit's StatevectorSimulator.

- ○ $\frac{1}{2}(|00\rangle + |01\rangle + |10\rangle - |11\rangle)$
- ○ $\frac{1}{2}(-|00\rangle - |01\rangle + |10\rangle - |11\rangle)$
- ○ $\frac{1}{2}(|00\rangle - |01\rangle - |10\rangle - |11\rangle)$
- ○ $\frac{1}{2}(|00\rangle + |01\rangle + |10\rangle + |11\rangle)$
- ◉ $\frac{1}{2}(|00\rangle - |01\rangle + |10\rangle + |11\rangle)$

Quiz Score: **50** out of 100