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# Homework 6

Due Dec 9 at 3:59am

Points 100

Questions 10

Available Nov 12 at 9:23pm - Dec 9 at 3:59am 26 days

Time Limit 60 Minutes

Allowed Attempts 3

## Instructions

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

The default programming language for coding is **Python**.

The default quantum programming framework is **Cirq**.

You may write pieces of code during this quiz.

Take the Quiz Again

## Attempt History

	Attempt	Time	Score
KEPT	<a href="#">Attempt 2</a>	10 minutes	70 out of 100
LATEST	<a href="#">Attempt 2</a>	10 minutes	70 out of 100
	<a href="#">Attempt 1</a>	21 minutes	40 out of 100

① Correct answers are hidden.

Score for this attempt: **70** out of 100

Submitted Dec 9 at 1:09am

This attempt took 10 minutes.

### Last Attempt Details:

Time:	10 minutes
Current Score:	70 out of 100
Kept Score:	70 out of 100

2 Attempts so far

[⌚ View Previous Attempts](#)

1 More Attempt available

[Take the Quiz Again](#)

(Will keep the highest of all your scores)

Question 110 / 10 pts

Let  $z_1 = \frac{1+i}{2}$  and  $z_2 = \frac{1-i}{2}$ .

Which one of the following is a unitary matrix?

- ☐  $\begin{pmatrix} z_1 & z_2 \\ z_1 & z_2 \end{pmatrix}$
- ☐  $\begin{pmatrix} z_1 & z_1 \\ z_1 & z_1 \end{pmatrix}$
- ☐  $\begin{pmatrix} z_1 & z_1 \\ z_2 & z_2 \end{pmatrix}$
- ☒  $\begin{pmatrix} z_1 & z_2 \\ z_2 & z_1 \end{pmatrix}$
- ☐  $\begin{pmatrix} z_2 & z_2 \\ z_2 & z_2 \end{pmatrix}$

Question 210 / 10 pts

For a given vector  $|u\rangle = \begin{pmatrix} \frac{1}{3} - \frac{4i}{3} \\ -\frac{1}{3} + \frac{i}{3} \\ -\frac{5}{3} - \frac{i}{3} \end{pmatrix}$

what is  $\langle u|u\rangle$

- ☐  $5 + \sqrt{5}i$
- ☐  $\sqrt{5} + \sqrt{5}i$
- ☐  $\sqrt{5}$
- ☒ 5
- ☐  $-\sqrt{5}i$

Incorrect

### Question 3

0 / 10 pts

Let  $|a\rangle = \begin{pmatrix} 1 \\ -i \end{pmatrix}$  and  $|b\rangle = \begin{pmatrix} i \\ -1 \end{pmatrix}$

What is  $\frac{1}{2}(|a\rangle\langle a| + |b\rangle\langle b|)$

- ☒  $\frac{1}{2}(X - I)$
- ☐  $X$
- ☐  $I$
- ☐  $\frac{1}{2}(I + X)$
- ☐  $\frac{1}{2}(I - X)$

### Question 4

10 / 10 pts

For the given quantum state  $|v\rangle = \cos \frac{\theta}{2} |0\rangle + e^{i\phi} \sin \frac{\theta}{2} |1\rangle$   
 $\theta = \pi$  and  $\phi = \frac{\pi}{4}$

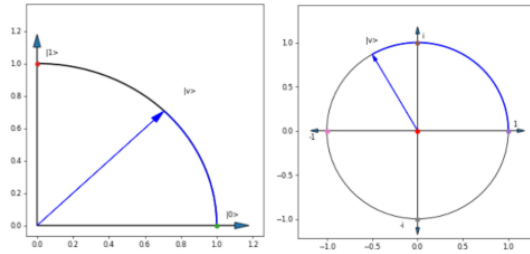
what are the probabilities of observing states  $|0\rangle$  and  $|1\rangle$ ?

- ☐  $\frac{1}{4}$  and  $\frac{3}{4}$
- ☒ 0 and 1
- ☐ 1 and 0
- ☐  $\frac{3}{4}$  and  $\frac{1}{4}$
- ☐  $\frac{1}{2}$  and  $\frac{1}{2}$

### Question 5

10 / 10 pts

Which one of the following states is demonstrated on the following images?



- ☐  $|v\rangle = \cos\frac{\pi}{2}|0\rangle + e^{i\frac{2\pi}{3}}\sin\frac{\pi}{2}|1\rangle$
- ☐  $|v\rangle = \cos\frac{\pi}{4}|0\rangle + e^{i\frac{\pi}{3}}\sin\frac{\pi}{4}|1\rangle$
- ☐  $|v\rangle = \cos\frac{\pi}{2}|0\rangle + e^{i\frac{3\pi}{4}}\sin\frac{\pi}{2}|1\rangle$
- ☒  $|v\rangle = \cos\frac{\pi}{4}|0\rangle + e^{i\frac{2\pi}{3}}\sin\frac{\pi}{4}|1\rangle$
- ☐  $|v\rangle = \cos\frac{\pi}{8}|0\rangle + e^{i\frac{\pi}{3}}\sin\frac{\pi}{8}|1\rangle$

### Question 6

10 / 10 pts

Each quantum state below is in the form of  $\cos\frac{\theta}{2}|0\rangle + e^{i\phi}\sin\frac{\theta}{2}|1\rangle$

Which one the following pairs of states locates at the opposite side of the Bloch sphere?

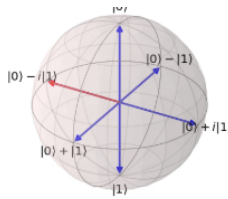
- ☐  $\cos\frac{\pi}{8}|0\rangle + e^{i\pi}\sin\frac{\pi}{8}|1\rangle$  and  $\cos\frac{\pi}{8}|0\rangle - e^{i\pi}\sin\frac{\pi}{8}|1\rangle$
- ☒  $\cos\frac{\pi}{8}|0\rangle + e^{i2\pi}\sin\frac{\pi}{8}|1\rangle$  and  $\cos\frac{3\pi}{8}|0\rangle - e^{i2\pi}\sin\frac{3\pi}{8}|1\rangle$
- ☐  $\cos\frac{\pi}{8}|0\rangle + e^{i\pi}\sin\frac{\pi}{8}|1\rangle$  and  $\cos\frac{3\pi}{8}|0\rangle + e^{i\pi}\sin\frac{3\pi}{8}|1\rangle$
- ☐  $\cos\frac{\pi}{8}|0\rangle + e^{i2\pi}\sin\frac{\pi}{8}|1\rangle$  and  $\cos\frac{\pi}{8}|0\rangle - e^{i2\pi}\sin\frac{\pi}{8}|1\rangle$
- ☐  $\cos\frac{\pi}{8}|0\rangle + e^{i\pi}\sin\frac{\pi}{8}|1\rangle$  and  $\cos\frac{3\pi}{8}|0\rangle - e^{i2\pi}\sin\frac{3\pi}{8}|1\rangle$

Incorrect

### Question 7

0 / 10 pts

What are the angles  $\theta$  and  $\phi$  on Bloch sphere for the depicted state?



- ☐  $\frac{\pi}{4}$  and  $\frac{3\pi}{2}$
- ☒  $\pi$  and  $\frac{\pi}{2}$
- ☐  $\frac{\pi}{2}$  and  $\frac{\pi}{2}$
- ☐  $\frac{\pi}{2}$  and  $\frac{3\pi}{2}$
- ☐  $\frac{\pi}{4}$  and  $\frac{\pi}{2}$

Incorrect

### Question 8

0 / 10 pts

We have a circuit with a single qubit.

```
circuit = cirq.Circuit()
q = cirq.LineQubit(0)
```

As a continuation of the previous question:

Which one of the following programs can you use in Cirq to get the state shown in the Bloch sphere when started in state  $|0\rangle$ ?

- ☐

```
circuit.append(H.on(q))
circuit.append(Y.on(q))
circuit.append(rz(3*pi/2).on(q))
```
- ☐

```
circuit.append(X.on(q))
circuit.append(Y.on(q))
```
- ☒

```
circuit.append(rz(pi/2).on(q))
circuit.append(Y.on(q))
```
- ☐

```
circuit.append(H.on(q))
circuit.append(rz(3*pi/2).on(q))
```
- ☐

```
circuit.append(Z.on(q))
circuit.append(Y.on(q))
circuit.append(X.on(q))
```

### Question 9

10 / 10 pts

$\theta: \text{---} \text{Rz}(\theta, 333\pi) \text{---} \text{Ry}(\theta, 4\pi) \text{---} \text{Rx}(1, 5\pi) \text{---} \text{Rz}(-\theta, 333\pi) \text{---} \text{Ry}(-\theta, 4\pi) \text{---} \text{Rx}(-1, 5\pi) \text{---}$

If we read the state of the above circuit in Cirq simulator, what will the imaginary part of the amplitude of  $|1\rangle$  be?

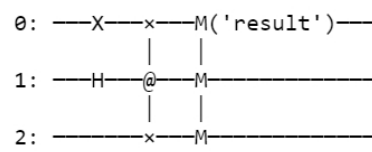
Remark that we should not put the quantum state in the unique representation form.

- ☐ 0
- ☒ -0.835
- ☐ 0.405
- ☐ 0.372
- ☐ 0.043

### Question 10

10 / 10 pts

If we execute the following circuit 1000 times, which one the following binary outcomes is more likely?



- ☐ {'110': 486, '001': 514}
- ☒ {'100': 486, '011': 514}
- ☐ {'000': 486, '111': 514}
- ☐ {'001': 486, '101': 514}
- ☐ {'010': 486, '101': 514}

Quiz Score: **70** out of 100

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