Exercises 3B

Due No due date **Points** 100 **Questions** 10 **Time Limit** 60 Minutes
Allowed Attempts 3

Instructions

We use the conventions in Bronze-Qiskit.

The default programming language for coding is python.

You may write pieces of code during the exam.

Take the Quiz Again

Attempt History

	Attempt	Time	Score
KEPT	Attempt 2	4 minutes	100 out of 100
LATEST	Attempt 2	4 minutes	100 out of 100
	Attempt 1	41 minutes	90 out of 100

Correct answers are hidden.

Score for this attempt: **100** out of 100
Submitted Sep 25 at 11:55am
This attempt took 4 minutes.

Question 1

10 / 10 pts

The rotation on the unit circle with angle θ is denoted $R(\theta)$.

What is the matrix form of $R(-\theta)$?

(Hint: Apply each candidate matrix to states $|0\rangle$ and $|1\rangle$ to verify whether the result is the rotated state.)

Typesetting math: 100%

- $\begin{pmatrix} \sin\theta & \cos\theta \\ -\cos\theta & \sin\theta \end{pmatrix}$
- $\begin{pmatrix} \cos\theta & \sin\theta \\ \sin\theta & -\cos\theta \end{pmatrix}$
- $\begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$
- **(selected)** $\begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix}$
- $\begin{pmatrix} \sin\theta & -\cos\theta \\ \cos\theta & \sin\theta \end{pmatrix}$

Question 2

10 / 10 pts

If $R(\theta)$ is applied to a qubit initially in state $|1\rangle$ twice,

what is the final state?

- **(selected)** $\begin{pmatrix} -\sin(2\theta) \\ \cos(2\theta) \end{pmatrix}$
- $\begin{pmatrix} \cos(2\theta) \\ \sin(2\theta) \end{pmatrix}$
- $\begin{pmatrix} \sin(2\theta) \\ -\cos(2\theta) \end{pmatrix}$
- $\begin{pmatrix} \sin(2\theta) \\ \cos(2\theta) \end{pmatrix}$
- $\begin{pmatrix} \cos(2\theta) \\ -\sin(2\theta) \end{pmatrix}$

Question 3

10 / 10 pts

We have a qubit in state $|0\rangle$.

The rotations $R\left(\frac{\pi}{3}\right)$ and $R\left(-\frac{\pi}{6}\right)$ are applied m and n times, respectively.

If the final state is $-|1\rangle$, what can be the values of (m,n)?

- (20,7)
- (20,5)
- (20,11)
- (20,3)
- (20,9)

Question 4

10 / 10 pts

What is $Ref(\theta_1) \cdot \begin{pmatrix} \cos\theta_2 \\ \sin\theta_2 \end{pmatrix}$?

- $\begin{pmatrix} \cos(\theta_1+\theta_2) \\ \sin(\theta_1+\theta_2) \end{pmatrix}$
- $\begin{pmatrix} \cos(\theta_1-\theta_2) \\ \sin(\theta_1-\theta_2) \end{pmatrix}$
- $\begin{pmatrix} \cos(2\theta_2-\theta_1) \\ \sin(2\theta_2-\theta_1) \end{pmatrix}$
- $\begin{pmatrix} \cos(2\theta_1-\theta_2) \\ \sin(2\theta_1-\theta_2) \end{pmatrix}$
- $\begin{pmatrix} \cos(\theta_2-\theta_1) \\ \sin(\theta_2-\theta_1) \end{pmatrix}$

Question 5

10 / 10 pts

We start in state $|0\rangle$.

Then, we apply $Ref(\theta)$ and then $Ref(-\theta)$.

What is the angle of the final state?

- 4θ
- 0
- 2θ
- -2θ
- -4θ

Question 6

10 / 10 pts

Let $|u\rangle$ be a quantum state on the unit circle with angle θ.

We apply $Ref(\theta_1)$ and then $Ref(\theta_2)$.

What is the angle of the final state?

- $\theta_1 + \theta_2 - \theta$
- $-2\theta_1 - 2\theta_2 + \theta$
- $-2\theta_1 + 2\theta_2 + \theta$
- $2\theta_1 + 2\theta_2 + \theta$

- $2\theta_1 + 2\theta_2 - \theta$

Question 7

10 / 10 pts

Which one of the following pairs of quantum states cannot be distinguishable?

- $|+\rangle$ and $|-\rangle$
- $-|+\rangle$ and $|-\rangle$
- $|1\rangle$ and $-|1\rangle$
- $|0\rangle$ and $|1\rangle$
- $|0\rangle$ and $-|1\rangle$

Question 8

10 / 10 pts

Which one of the following pairs of quantum states is perfectly distinguishable?

- $\left(\sqrt{\frac{5}{7}}|0\rangle + \sqrt{\frac{2}{7}}|1\rangle, -\sqrt{\frac{2}{7}}|0\rangle - \sqrt{\frac{5}{7}}|1\rangle\right)$
- $\left(\sqrt{\frac{5}{7}}|0\rangle + \sqrt{\frac{2}{7}}|1\rangle, -\sqrt{\frac{5}{7}}|0\rangle - \sqrt{\frac{2}{7}}|1\rangle\right)$
- $\left(\sqrt{\frac{5}{7}}|0\rangle + \sqrt{\frac{2}{7}}|1\rangle, \sqrt{\frac{5}{7}}|0\rangle - \sqrt{\frac{2}{7}}|1\rangle\right)$

- $\left(\sqrt{\frac{5}{7}}|0\rangle - \sqrt{\frac{2}{7}}|1\rangle, -\sqrt{\frac{5}{7}}|0\rangle - \sqrt{\frac{2}{7}}|1\rangle\right)$
- $\left(\sqrt{\frac{5}{7}}|0\rangle - \sqrt{\frac{2}{7}}|1\rangle, -\sqrt{\frac{2}{7}}|0\rangle - \sqrt{\frac{5}{7}}|1\rangle\right)$

Question 9

10 / 10 pts

We have 1000 copies of the identical qubit in state $\begin{pmatrix} \cos\theta \\ \sin\theta \end{pmatrix}$,

where $\theta \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$.

After measuring 1000 copies, we observe $|0\rangle$ 201 times and state $|1\rangle$ 799 times.

Which one of the followings can be more likely a value of θ in degree?

- 15
- 30
- -45
- -80
- -63

Question 10

10 / 10 pts

We have 2000 copies of the identical qubit in state $\begin{pmatrix} \cos\theta \\ \sin\theta \end{pmatrix}$,

where $\theta \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$.

After measuring 1000 copies, we observe $|0\rangle$ 671 times and state $|1\rangle$ 329 times.

Then, we apply Hadamard to each of the remaining 1000 copies.

After that, we measure these remaining copies and observe $|0\rangle$955 times and $|1\rangle$ 45 times.

Which one of the followings is the value of θ in degree more likely?

- 55
- 35
- 70
- -35
- -55

Quiz Score: **100** out of 100