Quiz 2

Name: ____________________________ Date: _____________________ I participated today: _____

1. Which of the following are possible single-qubit gates? Circle all that apply. (Hint: Consider how each matrix would transform the state vectors $\begin{bmatrix}1\\0\end{bmatrix}$ and $\begin{bmatrix}0\\1\end{bmatrix}$. Is the result a valid single-qubit state?)

   a. $\begin{bmatrix}1\\0\end{bmatrix}$

   b. $\begin{bmatrix}0 & 1\end{bmatrix}$

   c. $\begin{bmatrix}\mathbf{1} & \mathbf{0}\\ \mathbf{0} & \mathbf{-1}\end{bmatrix}$

   d. $\begin{bmatrix}0 & 2\\ 2 & 0\end{bmatrix}$

   e. $\frac{1}{\sqrt{2}}\begin{bmatrix}\mathbf{1} & \mathbf{1}\\ \mathbf{1} & \mathbf{-1}\end{bmatrix}$

   f. $\begin{bmatrix}\mathbf{0} & \boldsymbol{-i}\\ \boldsymbol{i} & \mathbf{0}\end{bmatrix}$

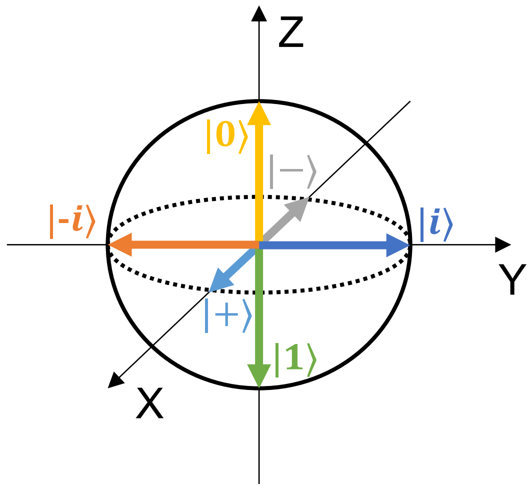
2. What is the difference between relative and global phase?

   Relative phase refers to phase terms (complex arguments) of various amplitudes in a superposition that are different relative to each other; states with different relative phase patterns are distinguishable. Global phase refers to a phase term which is common to all amplitudes in a superposition and can be factored out; states with different global phases are indistinguishable.

3. True or False: Two qubits could have different relative phases but the same measurement probabilities.

   True. For example, $|+\rangle$ *and* $|-\rangle$

4. Label the vectors $|0\rangle = \begin{bmatrix}1\\0\end{bmatrix}$, $|1\rangle = \begin{bmatrix}0\\1\end{bmatrix}$, $|+\rangle = \begin{bmatrix}\frac{1}{\sqrt{2}}\\\frac{1}{\sqrt{2}}\end{bmatrix}$, $|-\rangle = \begin{bmatrix}\frac{1}{\sqrt{2}}\\-\frac{1}{\sqrt{2}}\end{bmatrix}$, $|i\rangle = \begin{bmatrix}\frac{1}{\sqrt{2}}\\\frac{i}{\sqrt{2}}\end{bmatrix}$, and $|\text{-}i\rangle = \begin{bmatrix}\frac{1}{\sqrt{2}}\\-\frac{i}{\sqrt{2}}\end{bmatrix}$ on the Bloch sphere shown below. (Recall that the spherical coordinates (θ, φ) on the Bloch sphere map to the state vector $|\psi\rangle = \begin{bmatrix}\cos\left(\frac{\theta}{2}\right)\\e^{i\varphi}\sin\left(\frac{\theta}{2}\right)\end{bmatrix}$.)



5. How might you prepare the state $\frac{\sqrt{3}}{2}|0\rangle + \frac{1}{2}|1\rangle$?

Assuming a starting state of $|0\rangle$*, apply* $R_y\left(\frac{\pi}{3}\right)$*. This rotates the qubit* $\frac{\pi}{3}$ *radians about the Y-axis, producing the state* $\cos\left(\frac{\pi}{6}\right) \cdot |0\rangle + \sin\left(\frac{\pi}{6}\right) \cdot |1\rangle = \frac{\sqrt{3}}{2}|0\rangle + \frac{1}{2}|1\rangle$*.*