1. If a qubit is in the state $\begin{bmatrix}1\\0\end{bmatrix}$, what is the result of applying the Hadamard gate to it?
    a. $\boxed{|+\rangle}$
    b. $|-\rangle$
    c. $|-+\rangle$
    d. $\begin{bmatrix}-\\+\end{bmatrix}$
    e. $\begin{bmatrix}0\\0\end{bmatrix}$

2. Is the tensor product of $\begin{bmatrix}0\\1\end{bmatrix}$ and $\begin{bmatrix}0\\1\end{bmatrix}$ the same as the tensor product of $\begin{bmatrix}0\\1\end{bmatrix}$ and $\begin{bmatrix}1\\0\end{bmatrix}$?
    a. Yes, because the qubits are the same.
    b. No, because the qubits are different.
    c. No, because the qubits are in a different state.
    d. Yes, because even though the qubits are different, they will give the same result.
    e. No, because this is an entangled state and the tensor product cannot be used here.

3. What is the tensor product of these two qubit states :$\begin{bmatrix}\frac{1}{\sqrt{2}}\\\frac{1}{\sqrt{2}}\end{bmatrix}$ and $\begin{bmatrix}\frac{1}{\sqrt{2}}\\\frac{1}{\sqrt{2}}\end{bmatrix}$?
    a. $\frac{\mathbf{1}}{\sqrt{\mathbf{2}}}\begin{bmatrix}1\\1\\1\\1\end{bmatrix}$
    b. $\boxed{\frac{\mathbf{1}}{\mathbf{2}}\begin{bmatrix}1\\1\\1\\1\end{bmatrix}}$
    c. $\frac{\mathbf{1}}{\mathbf{4}}\begin{bmatrix}1\\1\\1\\1\end{bmatrix}$
    d. $\begin{bmatrix}1\\0\\1\\0\end{bmatrix}$

e. These two states are entangled, so we cannot represent them using tensor products.

4. What is the probability of measuring $|\mathbf{01}\rangle$ in this quantum system: $\begin{bmatrix} \frac{\sqrt{3}}{2} \\ 0 \\ \frac{1}{2} \\ 0 \end{bmatrix}$?

a. $\frac{\sqrt{\mathbf{3}}}{\mathbf{2}}$
b. $\frac{\mathbf{3}}{\mathbf{4}}$
c. $\mathbf{0}$
d. $\frac{\mathbf{1}}{\mathbf{2}}$
e. $\frac{\mathbf{3}}{\mathbf{4}}$

5. What is the probability of measuring $|\mathbf{00}\rangle$ in this quantum system:
$\sqrt{\frac{\mathbf{1}}{\mathbf{3}}}|\mathbf{00}\rangle + \sqrt{\frac{\mathbf{1}}{\mathbf{6}}}|\mathbf{01}\rangle + \sqrt{\frac{\mathbf{1}}{\mathbf{3}}}|\mathbf{10}\rangle + \sqrt{\frac{\mathbf{1}}{\mathbf{6}}}|\mathbf{11}\rangle\rangle$?

a. $\sqrt{\frac{\mathbf{1}}{\mathbf{3}}}$
b. $\frac{\mathbf{1}}{\mathbf{3}}$
c. $\sqrt{\frac{\mathbf{1}}{\mathbf{6}}}$
d. $\frac{\mathbf{1}}{\mathbf{6}}$
e. $\frac{\mathbf{2}}{\mathbf{3}}$

6. What is the tensor product of these two qubit states: $\begin{bmatrix} \sqrt{\frac{2}{3}} \\ \sqrt{\frac{1}{3}} \end{bmatrix}$ and $\begin{bmatrix} \sqrt{\frac{1}{3}} \\ \sqrt{\frac{2}{3}} \end{bmatrix}$?

a. $\begin{bmatrix} \sqrt{\frac{2}{3}} \\ \frac{2}{3} \\ \frac{1}{3} \\ \frac{2}{3} \end{bmatrix}$

b. $\begin{bmatrix} \sqrt{\frac{\sqrt{2}}{3}} \\ \frac{1}{3} \\ \frac{2}{3} \\ \frac{\sqrt{2}}{3} \end{bmatrix}$

c. $\begin{bmatrix} \sqrt{\frac{2}{9}} \\ \frac{4}{9} \\ \frac{1}{3} \\ \frac{2}{9} \end{bmatrix}$

d. $\begin{bmatrix} \frac{\sqrt{2}}{3} \\ \frac{2}{3} \\ \frac{1}{3} \\ \frac{\sqrt{2}}{3} \end{bmatrix}$

e. These two states are entangled, so we cannot represent them using tensor products.

7. Given the quantum state $\begin{bmatrix} 0 \\ \frac{1}{\sqrt{2}} \\ 0 \\ -\frac{1}{\sqrt{2}} \end{bmatrix}$, if we apply the X gate to the second qubit, what is the new state?

a. $\begin{bmatrix} \frac{1}{\sqrt{2}} \\ 0 \\ \frac{-1}{\sqrt{2}} \\ 0 \end{bmatrix}$

b. $\begin{bmatrix} \frac{1}{\sqrt{2}} \\ 0 \\ 0 \\ \frac{-1}{\sqrt{2}} \end{bmatrix}$

c. $\begin{bmatrix} \frac{1}{\sqrt{2}} \\ 0 \\ 0 \\ \frac{1}{\sqrt{2}} \end{bmatrix}$

d. $\begin{bmatrix} 0 \\ 0 \\ -1 \\ 0 \end{bmatrix}$

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

8. Consider the quantum state $|\mathbf{101}\rangle$. If we apply the CNOT gate to the first (leftmost) qubit (control) and the second (middle) qubit (target), what is the resulting state?

   a. $|\mathbf{101}\rangle$
   b. $\boxed{|\mathbf{111}\rangle}$
   c. $|\mathbf{100}\rangle$
   d. $|\mathbf{001}\rangle$
   e. $|\mathbf{110}\rangle$

9. If a collection of qubits are in the state below, how many qubits are there?

$$\begin{bmatrix} 0 \\ 0 \\ 0 \\ \frac{1}{\sqrt{3}} \\ 0 \\ 0 \\ \frac{1}{\sqrt{3}} \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ \frac{1}{\sqrt{3}} \end{bmatrix}$$

a. 3
b. 4
c. 5
d. 6
e. Impossible to tell