QUANTUM STATES FOR TWO QUBIT SYSTEMS

Question 1

We define a state $|\psi>= \alpha|00> +\beta|01> +\gamma|10> +\delta|11>$ to be a valid quantum state if $|\alpha|^2 + |\beta|^2 + |\gamma|^2 + |\delta|^2 = 1$. Which of the following equations describe a valid quantum state?

(a) Example: $\frac{1}{2}|00> +\frac{1}{2}|01> +\frac{1}{2}|10> +\frac{1}{2}|11>$

$$\alpha = \frac{1}{2}, \beta = \frac{1}{2}, \gamma = \frac{1}{2}, \delta = \frac{1}{2}$$

$$\alpha^2 + \beta^2 + \gamma^2 + \delta^2 = (\frac{1}{2})^2 + (\frac{1}{2})^2 + (\frac{1}{2})^2 + (\frac{1}{2})^2 = 1$$

Since $\alpha^2 + \beta^2 + \gamma^2 + \delta^2 = 1$, $|\psi>$ is a valid quantum state.

(b) $|\psi>= \frac{\sqrt{7}}{5}|00> +\frac{\sqrt{7}}{\sqrt{5}}|01> +\frac{3}{5}|10> +\frac{\sqrt{2}}{5}|11>$

(c) $|\psi>= |00>$

(d) $|\psi>= |00> +|01> +|10> +|11>$

(e) $|\psi>= \frac{3}{5}|00> + \frac{4}{5}|01>$

MEASUREMENT

Question 2

For the following, quantum states, what would the qubits most likely collapse to?

(a) Example: $\frac{1}{2}|00> + \frac{1}{2}|01> + \frac{1}{2}|10> + \frac{1}{2}|11>$

This state is in an equal superposition of the four states |00>, |01>, |10>, |11>. Therefore, we can equally expect the states to be:
First Qubit: 0, Second Qubit: 0
First Qubit: 0, Second Qubit: 1
First Qubit: 1, Second Qubit: 0
First Qubit: 1, Second Qubit: 1

(b) $|\psi>= |00>$

(c) $|\psi>= \frac{1}{\sqrt{2}}|0> + \frac{1}{\sqrt{2}}|1>$

(d) $|\psi>= \frac{1}{\sqrt{2}}|00> + \frac{1}{\sqrt{2}}|11>$

(e) For $|\psi>= \frac{1}{\sqrt{2}}|00> + \frac{1}{\sqrt{2}}|11>$*, if we measure the first qubit to result in 0, what can we say about the second qubit?*

(f) For $|\psi>= \frac{1}{\sqrt{2}}|01> + \frac{1}{\sqrt{2}}|10>$*, if we measure the first qubit to result in 0, what can we say about the second qubit?*

(g) For $|\psi>= \frac{1}{\sqrt{2}}|00> + \frac{1}{\sqrt{2}}|11>$*, if we measure the first qubit to result in 1, what can we say about the second qubit?*

(h) For $|\psi>= \frac{1}{\sqrt{2}}|00> + \frac{1}{\sqrt{2}}|01>$*, if we measure the first qubit to result in 0, what can we say about the second qubit?*

ENTANGLEMENT: BELL STATES

Question 3

Prepare bell states starting with the states |00>, |01>, |10>, |11>. What is the resulting state?