

Question

Consider a quantum system made of one qubit. The system is in the initial state $|\psi\rangle = |1\rangle$. The quantum gate Pauli X is applied on $|\psi\rangle$. Can you describe the action of this gate on the system? Can you give a graphical representation of the circuit? What is the final state of the system?

Answer 1

The Pauli X gate, also known as the "bit-flip" gate, is a fundamental quantum gate that acts on a single qubit. It flips the state of the qubit from $|0\rangle$ to $|1\rangle$ and vice versa.

When the Pauli X gate is applied to the initial state $|1\rangle$, the final state of the system is obtained by applying the matrix representation of the gate to the initial state:

$$|\psi\rangle = |1\rangle$$

$$X|\psi\rangle = X|1\rangle = |0\rangle$$

So, the final state of the system after applying the Pauli X gate is the state $|0\rangle$.

A graphical representation of this circuit can be drawn using the standard notation for quantum circuits. The circuit consists of a single qubit, and the Pauli X gate is applied to it. The circuit can be represented as:

$$|1\rangle \text{ --- } X \text{ --- } |0\rangle$$

In this representation, the initial state of the qubit is denoted by the input $|1\rangle$, and the final state of the qubit is denoted by the output $|0\rangle$. The X gate is represented by the letter X.

So, the action of the Pauli X gate on the system flips the state of the qubit from $|1\rangle$ to $|0\rangle$.

Answer 2

The Pauli X gate, also known as the NOT gate, is a single-qubit gate that flips the state of the qubit from $|0\rangle$ to $|1\rangle$, and vice versa. In the case of your system, the gate is applied on the initial state $|\psi\rangle = |1\rangle$, which means that the qubit is initially in the state $|1\rangle$.

The action of the Pauli X gate on the state $|1\rangle$ is to flip the state to $|0\rangle$, which can be represented mathematically as:

$$X|1\rangle = |0\rangle$$

To represent this operation graphically, we can use a quantum circuit diagram, where the qubit is represented by a vertical line and the gate is represented by a box with the letter X inside. The circuit for applying the Pauli X gate to a qubit in state $|1\rangle$ is shown below:

$$|1\rangle \xrightarrow{X} |0\rangle$$

The final state of the system after the application of the Pauli X gate is $|0\rangle$.

Answer 3

The Pauli X gate, also known as the NOT gate, is a basic quantum gate that acts on a single qubit. It flips the state of the qubit, transforming the state $|0\rangle$ into $|1\rangle$ and vice versa. Therefore, when the Pauli X gate is applied to the initial state $|1\rangle$, it will flip the state to $|0\rangle$.

Graphically, the circuit representation of this operation would look as follows:

$$|1\rangle \xrightarrow{[X]} |0\rangle$$

Here, the initial state $|1\rangle$ is represented as an input wire, and the Pauli X gate is denoted by the "X" symbol. The final state $|0\rangle$ is shown as an output wire.

In summary, the action of the Pauli X gate on the initial state $|1\rangle$ is to flip the state, resulting in the final state $|0\rangle$.