

### Question

Consider a quantum system made of one qubit. The system is in the initial state  $|\psi\rangle = |0\rangle$ . 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

Yes, I can certainly help you with that!

The Pauli X gate is also known as the NOT gate, and it is one of the most fundamental quantum gates. It is a single-qubit gate that flips the state of a qubit from  $|0\rangle$  to  $|1\rangle$ , or vice versa. So, if the Pauli X gate is applied to the initial state  $|\psi\rangle = |0\rangle$ , the final state of the system will be  $|1\rangle$ .

Graphically, the circuit for the Pauli X gate looks like:

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

where the  $|0\rangle$  represents the initial state, X represents the Pauli X gate, and  $|1\rangle$  represents the final state.

To summarize, the action of the Pauli X gate on the initial state  $|0\rangle$  is to flip it to the final state  $|1\rangle$ .

### Answer 2

The Pauli X gate is a single-qubit gate that performs a bit-flip operation, effectively exchanging the  $|0\rangle$  and  $|1\rangle$  states. In the computational basis, the action of the Pauli X gate is described as follows:

$|0\rangle \rightarrow |1\rangle$

$|1\rangle \rightarrow |0\rangle$

Thus, applying the Pauli X gate on the initial state  $|0\rangle$ , we get:

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

Graphically, the circuit for this operation can be represented as:

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

Therefore, the final state of the system after applying the Pauli X gate is  $|1\rangle$ .

### **Answer 3**

The Pauli X gate, also known as the NOT gate, is a fundamental quantum gate that operates on a single qubit. It flips the state of the qubit, effectively interchanging the basis states  $|0\rangle$  and  $|1\rangle$ .

In this case, the initial state of the system is  $|\psi\rangle = |0\rangle$ . When the Pauli X gate is applied to this state, it transforms the qubit as follows:

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

Graphically, the circuit representation of the operation would be as follows:

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

Here, the qubit state  $|0\rangle$  is input to the Pauli X gate, and the resulting state  $|1\rangle$  is output.

Therefore, the final state of the system after applying the Pauli X gate to the initial state  $|\psi\rangle = |0\rangle$  is  $|\psi\rangle = |1\rangle$ .