Question

Consider a quantum system made of one qubit. The system is in the initial state |ψ⟩ = |0⟩ and the quantum gate Identity is applied. 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 Identity gate, denoted as I, is a quantum gate that has no effect on the state of a qubit. It essentially leaves the qubit in the same state as it was before the gate was applied. In mathematical notation, we can represent the action of the Identity gate as:

I|ψ⟩ = |ψ⟩

where |ψ⟩ is the initial state of the qubit, in this case, |0⟩.

The graphical representation of the circuit for this scenario would be a single qubit circuit with the Identity gate applied to it. This circuit would be represented by the following diagram:

|0⟩ --I---> |0⟩

The final state of the system after the application of the Identity gate would be the same as the initial state, i.e., the qubit would still be in the state |0⟩. Thus, the final state of the system would be:

|ψ⟩ = |0⟩

Answer 2

The Identity gate, denoted as I, is a quantum gate that does not change the state of the qubit it acts upon. In other words, if the qubit is in state |0⟩, applying the Identity gate leaves it in the same state |0⟩. Mathematically, we can represent the Identity gate as a 2x2 unitary matrix:

I = | 1 0 |
   | 0 1 |

The graphical representation of the circuit for this operation is as follows:

|0⟩ ----[I]----> |0⟩

Here, the state $|0\rangle$ represents the initial state of the qubit, $[I]$ represents the Identity gate, and the final state of the qubit is also $|0\rangle$.

Therefore, the final state of the system after applying the Identity gate on the initial state $|\psi\rangle = |0\rangle$ is also $|\psi\rangle = |0\rangle$.

Answer 3

The Identity gate, denoted as I, is a quantum gate that leaves the state of a qubit unchanged. It is often represented as a square matrix:

$I = |1\ 0|$
$|0\ 1|$

When the Identity gate is applied to the initial state $|0\rangle$, the resulting state is still $|0\rangle$. Mathematically, we can represent this as:

$I|0\rangle = |0\rangle$

Graphically, the circuit representation of this operation is as follows:

$|0\rangle$ ----[I]----

The $|0\rangle$ state is represented as a horizontal line, and the Identity gate (I) is depicted as a box. The arrow indicates the direction of the qubit's flow through the circuit.

The final state of the system remains $|0\rangle$.