**1: "Introduction to Quantum Computing: Qubits and Gates on the Bloch Sphere"**

**Key Learning:** Unlike classical bits, a qubit can exist in a **superposition** of both 0 and 1 states. Quantum gates are represented by **unitary matrices** that correspond to rotations on the Bloch sphere, which serves as a visual tool for understanding qubit states and operations.

* **Summary:** The video compares classical bits and logic gates to their quantum counterparts. It explains that a qubit can be in a superposition of |0⟩ and |1⟩ states. It shows that quantum logic gates are matrices that transform a qubit's state and that these operations can be visualized as rotations on the Bloch sphere. For instance, the Pauli X gate corresponds to a 180-degree rotation, while the Hadamard gate creates a superposition state.

**2: "Quantum Gates"**

**Key Learning:** Quantum gates must be **unitary**, which means they preserve the total probability of a qubit's state. Many gates are also **Hermitian** (their own conjugate transpose), which means they are their own inverse.

* **Summary:** The video explains the mathematical properties of quantum gates, emphasizing the importance of unitarity and Hermiticity. It then explores common single-qubit gates like the **Pauli-X, Y, and Z gates**, and the **Hadamard gate**, describing their matrix representations and effects on a qubit. It also introduces two-qubit gates, such as the **Controlled-NOT (CNOT)** gate and the **SWAP gate**, which are represented by 4x4 matrices and are crucial for multi-qubit operations.

**3: "Introduction to Quantum Gates - Quantum Computing in 10 minutes"**

**Key Learning:** Quantum gates manipulate the state of a qubit. Single-qubit gates are 2x2 matrices, while two-qubit gates are 4x4 matrices.

* **Summary:** The video provides a quick rundown of common quantum gates. For single-qubit gates, it covers the **Pauli-X (NOT)**, **Pauli-Y**, **Pauli-Z**, and **Hadamard gates**, briefly mentioning their matrix forms and effects. For two-qubit gates, it introduces the **Controlled-NOT (CNOT)**, **Controlled-Z (C-Z)**, and **Swap gates**, explaining their roles in a multi-qubit system. The video highlights how gates like the CNOT are conditional, applying an operation to one qubit based on the state of another.