**1: "The Bloch Sphere: From First Principles"**

**Key Learning:** The state of a qubit can be represented as a point on the Bloch sphere, and its state formula, cos(θ/2)∣0⟩+eiϕsin(θ/2)∣1⟩, can be derived from the principles of quantum mechanics, specifically spin angular momentum.

* **Summary:** The video explains that a global phase has no effect on a quantum state. It then uses the Pauli matrices to represent spin angular momentum along the X, Y, and Z axes. By finding the eigenvectors for a measurement in an arbitrary direction, the video shows how the well-known Bloch sphere formula is derived. It also clarifies that opposite points on the sphere represent eigenstates for opposite spin measurements.

**2: "What is a Qubit? Visualizing with a Bloch Sphere"**

**Key Learning:** The Bloch sphere is a visual tool for understanding qubit states and the probability of measurement.

* **Summary:** A qubit’s state can be visualized on a sphere, where the North Pole is the |0⟩ state and the South Pole is the |1⟩ state. The position of the qubit on the sphere indicates the probability of it being measured as either a 0 or a 1. A qubit on the equator has an equal chance of being measured as 0 or 1, while a qubit closer to the North or South Pole has a higher probability of being measured as that state. The video also introduces the concept of phase, which is a rotation around the sphere.

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

**Key Learning:** A qubit can exist in a superposition of both 0 and 1, and quantum logic gates are represented by matrices that perform rotations on the Bloch sphere.

* **Summary:** Unlike classical bits (0 or 1), qubits can exist in a superposition of both states. This superposition is represented mathematically by a linear combination of |0⟩ and |1⟩. Quantum gates like the Pauli X and Hadamard gates are shown to be unitary matrices that act on the qubit vector. On the Bloch sphere, these gate operations correspond to specific rotations, such as a 180-degree rotation for the Pauli X gate or a rotation that creates a superposition state for the Hadamard gate. This video demonstrates that these gates are essentially operators that change the state of a qubit by rotating it on the sphere.