Week	Topic	Scientist Spotlight (English Comprehension)	Math Focus	Physics/Science Focus	Tier 1 (Grade 6–8) Conceptual Focus	Tier 2 (Grade 9–11) Intermediate Math & Visuals	Tier 3 (Undergrad) Qiskit Developer Focus	Tier 4 (Adv. Encryption) Qiskit Advocate Focus
1	Qubits & Measurement (Lab 1)	Erwin Schrödinger: Biography & philosophical context of the quantum state.	Basic Probability & Fractions. Normalization: p0+p1=1.	Superposition: The "both states at once" idea. Measurement: Wave function collapse.	* Qubit States & H Gates (Functions). * Analogy: Flipping a coin in the air. * Visualization: Histogram focus.	* State Vectors (α, β). * Probability: Calculating from amplitudes. * Introduction: 2×1 vector notation.	* Formal State Vector & Born Rule. * Dirac Notation & 2×2 matrices. * Noise: Density Matrix (ρ).	* Quantum Postulates. * Security: Formal proof of the No-Cloning Theorem.
2	Single-Qubit Rotations	Paul Dirac: Biography & necessity of Dirac Notation.	Geometry: 3D coordinates. Trigonometry: Sine and Cosine functions.	Spin: Qubits as two-level systems. State Space: The Bloch Sphere concept.	* Analogy: Direction/Spin. * Rotations: Simple flips (X,Z). * Visualization: States on the Bloch Sphere.	* Bloch Sphere Map: Mapping C2 to 3D. * Pauli Gates: X,Y,Z as π rotations. * Qiskit: Using plot_bloch_vector.	* Linear Algebra: Unitary Evolution & Ry,Rz matrices. * Decomposition: Euler Angles.	* Basis Transformation. * Derivation: Switching between Z and X measurement bases.
3	Entanglement & Bell States (Lab 2)	John Bell: Biography & the proof concept for non-local reality.	Multiplication: Simple probability rules. Linear Algebra: Tensor Product for 4×4 matrices.	Entanglement: Non-classical correlation. Local Hidden Variables: The idea Bell's Theorem disproves.	* Analogy: Magic Dice & Perfect Link. * Correlation: Outcomes are always 00 or 11.	* CNOT Gate: Truth table and function. * State Composition: Building the 4-component state vector. * Visualization: Unpolarized individual qubit on Bloch Sphere.	* Tensor Product & Non-Separability. * Proof: Algebraic factorization proof. * Test: Implement the CHSH Game/Inequality.	* EPR Pairs for QKD (E91). * Resource: Entanglement as a secure key source. * Detection: Security relies on correlation check.
4	Mini-project: Teleportation	Charles H. Bennett: Biography and the conceptual leap of teleporting information.	Logic: Conditional IF/THEN statements. Matrix Operations: Simple basis change.	Information Transfer: Classical vs. Quantum communication channels.	* Analogy: "Un-Flip" Game. * Function: Using the perfect link to transmit a state perfectly.	* Teleportation Circuit Logic: Roles of Bell State and measurement. * Derivation: Formal math showing measurement results determine corrections.	* Conditional Logic: Applying X/Z gates based on classical bits. * Derivation: Formal Teleportation circuit math.	* Superdense Coding vs. Teleportation. * Analysis: Limitations of the classical channel requirement.

5	Multi-qubit Circuits & Noise (Lab 3)	Peter Shor: Biography and the threat of his algorithm.	Vector Space: Increased dimensionality (N qubits →2N dimensions). Error Rates: Simple percentage calculations.	Decoherence: Environmental interaction. Gate Set: Concept of universal gates.	* Complexity: Recognizing 3+ qubit circuits. * Noise: Conceptual idea of "static" on the signal.	* SWAP Gate & Toffoli Gate: Introduction to matrix representations. * Noise: Defining "Error Rate."	* Controlled Gates (Cn(U)) & OpenQASM. * Noise Modeling: Using ρ for simple channels.	* Quantum Error Correction (Conceptual). * Formalism: Introduction to the Stabilizer Formalism. * Implementation: 3-qubit bit-flip code.
6	QAOA (Intuitive) (Lab 4)	Edward Farhi: Biography and the groundwork for Variational Algorithms (AQC).	Optimization: Finding minimum values. Graph Theory: Nodes and edges (MaxCut problem).	Energy Landscape: Finding the minimum energy state. Hybrid Computing: Classical optimizer + Quantum computer loop.	* Analogy: Optimization as Pathfinding. * Goal: Guided search for the lowest point in a network.	* Cost Function & Parameterization. * Structure: Two-gate ansatz (Mixer and Cost).	* Variational Algorithms & Primitives. * Ansatz: Formal structure. * Estimator: Using Qiskit's Estimator primitive.	* Optimization for Cryptography. * Application: Optimization problems relevant to secure routing.
7	VQE (Intuitive) (Lab 5)	Alan Aspuru-Guzik: Biography and the early work in quantum chemistry.	Linear Algebra: Eigenvectors/Eigenvalues. Expectation Value calculation.	Chemistry: Molecular structure (Hamiltonian). Ground State Energy: The most stable configuration.	* Analogy: Finding the Lowest Energy (ball in a bowl). * Goal: Find the most stable state.	* Hamiltonian & Energy Minimization. * Concept: Minimizing the expected value of the Hamiltonian.	* Hamiltonian Mapping (Jordan-Wigner). * Expectation Value: Formal calculation of ⟨H⟩. * Qiskit: Using the Estimator.	* VQE for Material Science/Chemistry. * Application: Simulating the LiH molecule. * Analysis: Resource estimation and NISQ limitations.
8	Quantum Encryption (BB84) (Lab 6)	Bennett & Brassard: Biographies and the conceptual genesis of QKD.	Statistics: Error rate calculation. Set Theory: Sifting and reconciliation process.	Photon Polarization: The physical carriers of quantum information. Eavesdropping: The inevitability of detection due to measurement.	* Analogy: Secret Code Game. * Protocol: "Send, check, discard" logic.	* Two Measurement Bases: Role of Rectilinear (Z) and Diagonal (X). * Security: Detection of Eve by wrong basis choice.	* BB84 Formalism & Security Proof. * Protocol: Formal description using basis rotation matrices. * Security: Proof of Eve's inevitable disturbance.	* QKD Post-Processing. * Simulation: Implementing Sifting, Reconciliation, and Privacy Amplification. * Analysis: Final secure key rate vs. noise.