PHYS 220 B: Quantum Mechanics for Everyone

Lecture 0: Course Overview



Anderson Academy — Extracurricular: Physics

Anderson Academy

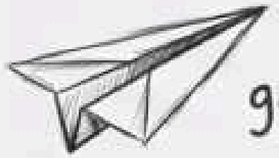
Paragraph 0.1

Pay it forward. Be of service to humanity.

Tell us what you learned and how you did it.







garyanderson@mail.grokbot.com | X: @garyanderson

Overview

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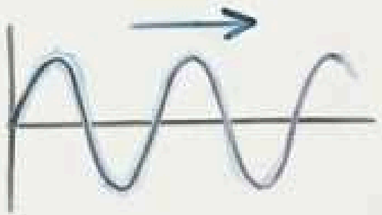
(6 Lectures × ~10 mins)

= ~1 Hour Total.

Target Level: High School.

Prerequisites

- A little algebra $x+y=z$
- The idea of a wave

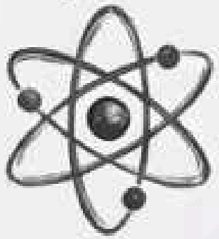


Paragraph 0.3

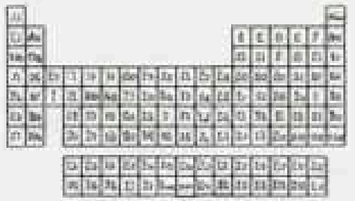
Most successful theory in science
Astonishing precision

Quantum Mechanics:
Physics of the
Very Small

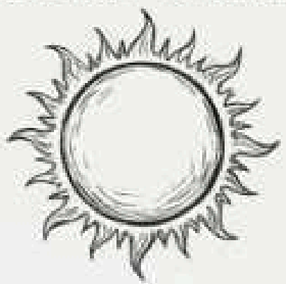
Stability of Atoms



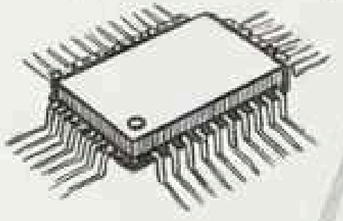
The Periodic Table



The Sun Shining



Computer Chips



Paragraph 0.4

Famously Strange (Plainly & Correctly Explained)

Light = Wave
yet arrives in
separate lumps.

Electrons = Particles
yet interfere like
waves.

Position & Momentum
cannot both be
sharply defined at
once.



Linked particles:
Measuring one tells
you about the other,
regardless of distance.



Paragraph 0.5

1

Discovery of the Quantum, 1900-1905

Max Planck
(Lumps of energy)

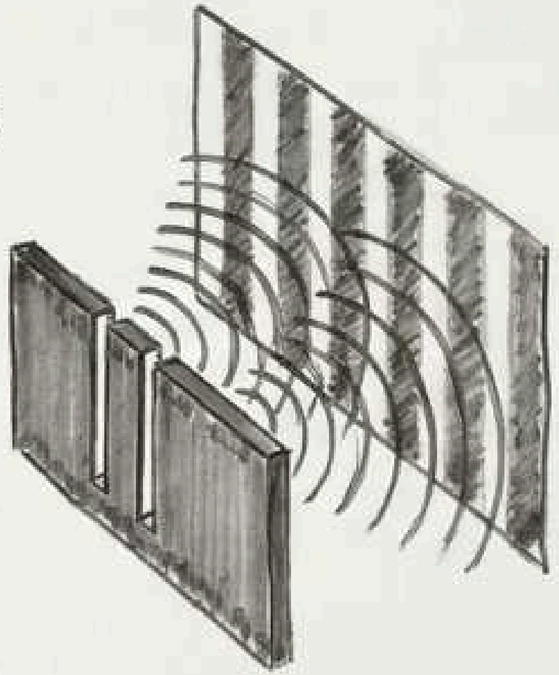
↳ Albert Einstein
(Photons)

2

Matter Waves

Louis de Broglie
(Matter has waves)

The Double Slit Experiment: The clearest window onto quantum behaviour.



Paragraph 0.6

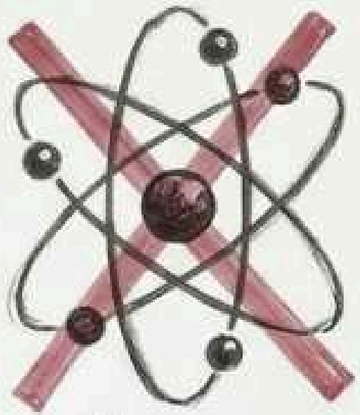
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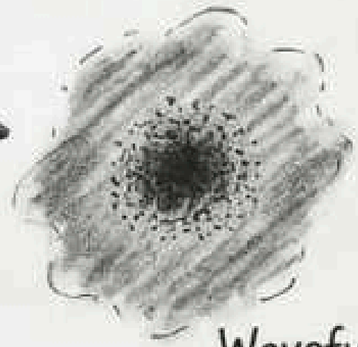
The Atom

Niels Bohr
(1913 model)

Erwin Schrödinger
(Wavefunction)

Core Insight: Confinement
= fixed energy levels.





Wavefunction

4

The Strange Rules

Werner Heisenberg
(Uncertainty Principle)

Superposition + The
Puzzle of Measurement
(and its main interpretations).

Paragraph 0.7

5

Spin & Entanglement

John Bell's Theorem:
Nature cannot be explained by hidden, local instructions.

6

Quantum Tunneling & Tech

Quantum Tunneling → Real-world technology

- Lasers,
- Transistors,
- LEDs,
- MRI scanners,
- Atomic Clocks,
- Quantum Computers

Paragraph 0.8

Mathematics is kept light.
Explained in words. No solving required.

$$E = hf$$

Links energy of a photon to its frequency.

$$\lambda = \frac{h}{p}$$

Links a wavelength to a momentum.

$$\Delta x \cdot \Delta p \geq \frac{\hbar}{2}$$

The Uncertainty Principle.

Paragraph 0.9

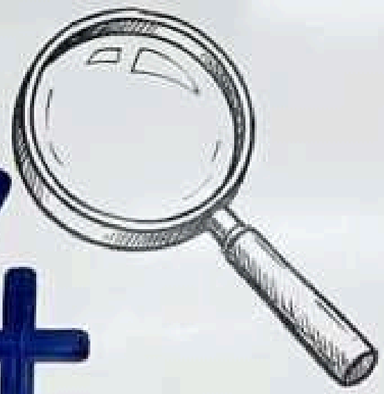
10^{-34} = a decimal point, 33 zeros, and a 1.

0.000000000000000000000000000000001

Planck's constant (h) $\approx 6.63 \times 10^{-34}$ joule-seconds.

Its tiny size is the reason quantum effects stay hidden in everyday life.

Paragraph 0.10



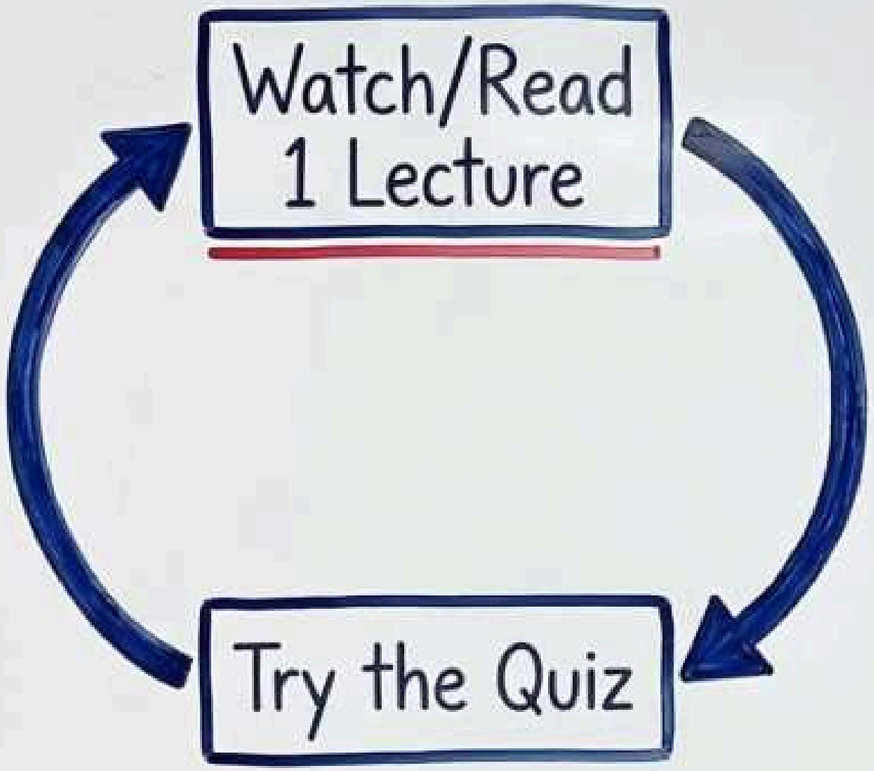
3.4

Lecture 3

4 Paragraph 4

- Assessments: Quizzes, Final Exam, and Tripos Paper point back to these numbers.
- References: Citations (Author Year) point to the Bibliography.
- Going Deeper: Check the Further Reading list for popular introductions to university texts.

Paragraph 0.11



Let us begin with a hot stove and a puzzle about light...



Do not worry if it feels uncomfortable. The physicists who built it felt the same way, and arguments still continue. What is not in doubt is that it works.