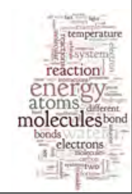
Spectra, Bohr Model, Heisenberg, Schrodinger and Orbitals

Electrons are waves

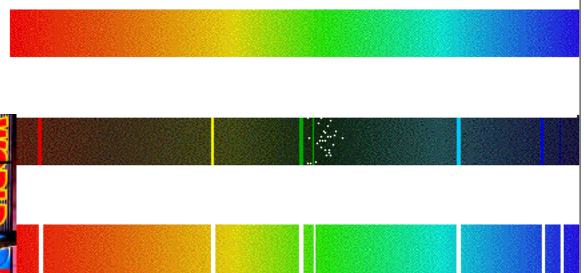


CLUE: Chemistry, Life, the Universe & Everything

Where does light come from?
And why is it different colors?

How do we see things?
Why are they different colors?

Where do those photons come from? **Why** is light different colors?



Visible spectrum

Light from the sun (white light) can be separated by a prism (Isaac Newton did this first)

Only a very small part of the full e/m spectrum

Light from one particular element does not contain all the colors of the spectrum – it has only a few wavelengths!

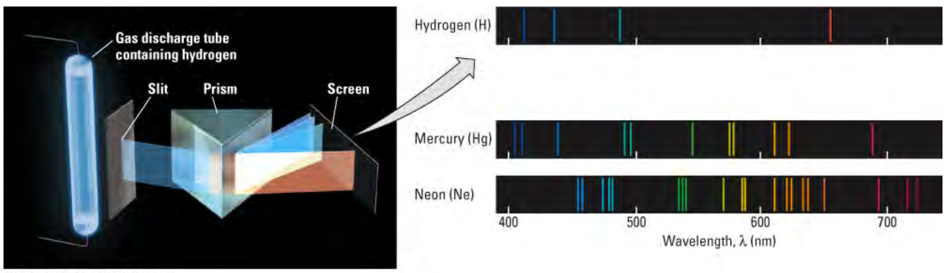
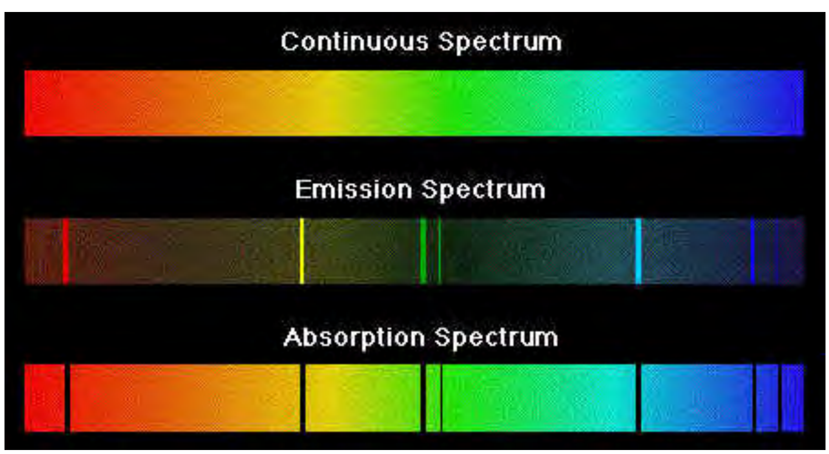


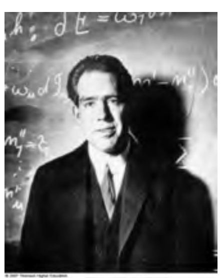
Fig. 7-7, p. 281



The wavelengths of light emitted by a hydrogen atom can be calculated – using the Rydberg Equation – which requires that integers (whole numbers, n) be used for each line in the spectrum – but no theoretical basis

Spectra show light only of specific wavelengths/energies - the **spectrum** of an **element** is the same whether that element is on Earth, in the Sun, or in a galaxy light years away.

Niels Bohr



Explained emission and absorption spectra by invoking discrete energy levels - characterized by quantum numbers (n)

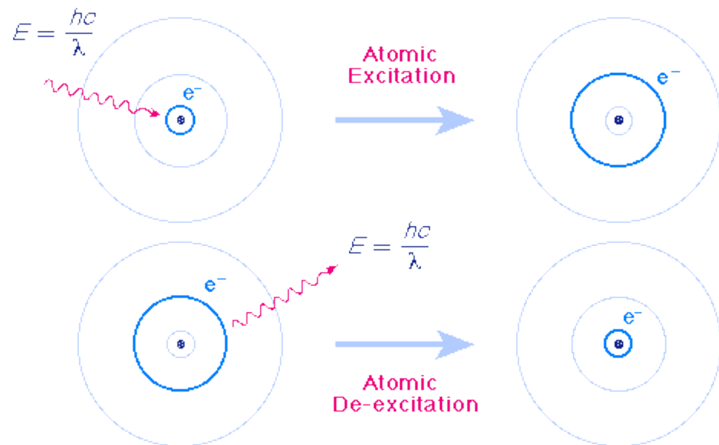
Electrons move in ORBITS around nucleus

These orbits have definite energies

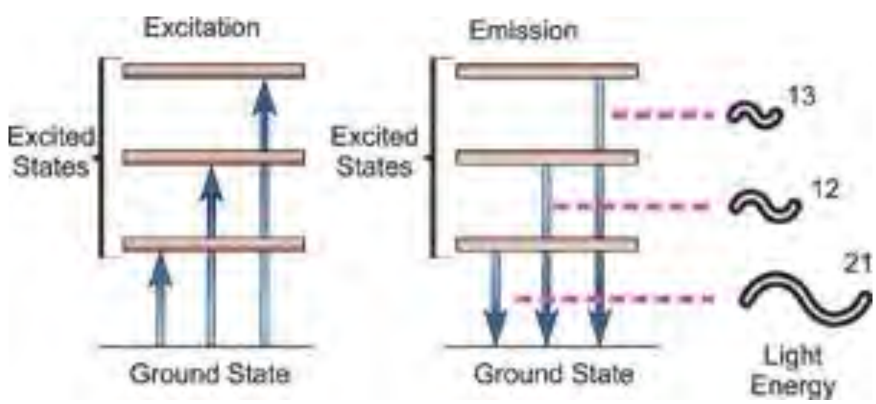
So - the energies of electrons in atoms are **quantized**

Photons of electromagnetic energy are emitted from atoms as electrons move from one energy level to another.

Bohr Model

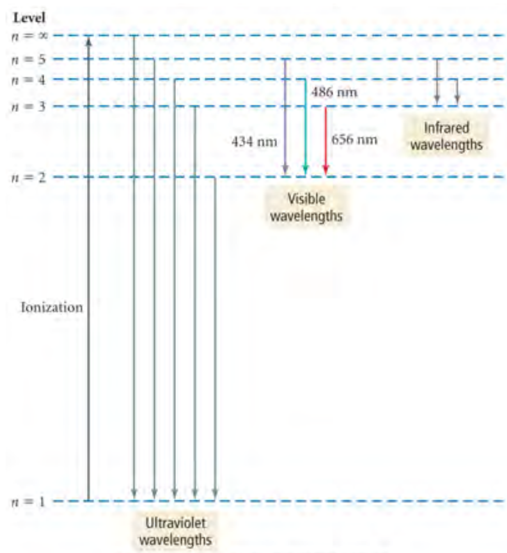


Absorption and emission



Which of the following transitions for an electron in a hydrogen atom would ***release*** the largest quantum of energy?

A. $n = 3 \rightarrow n = 1$
B. $n = 4 \rightarrow n = 3$
C. $n = 1 \rightarrow n = 4$
D. $n = 2 \rightarrow n = 1$



Problem

- Bohrs model (electrons moving in defined orbits around nucleus at known energy levels only works for hydrogen) – and there are a lot more elements than that!

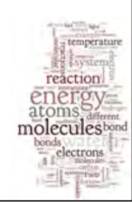
Matter is a wave (and a particle)

- **DeBroglie** all matter has wave properties - can calculate wavelength λ
- $\lambda = h/mv$
- Not important for macroscopic objects
- Electrons - wavelength λ about the size of atom - affects properties

Q1. What is the wavelength of an electron moving at 2.65×10^6 m/s
$\lambda = h/mv$

•Note: Mass of an electron is 9.1×10^{-31} kg
• $h = 6.626 \times 10^{-34}$ J.s
•$1J = 1 Kg.m^2/s^2$

What is the wavelength of a baseball (mass 150 g) travelling at ~ 45 m/s? (~ 100 mph)



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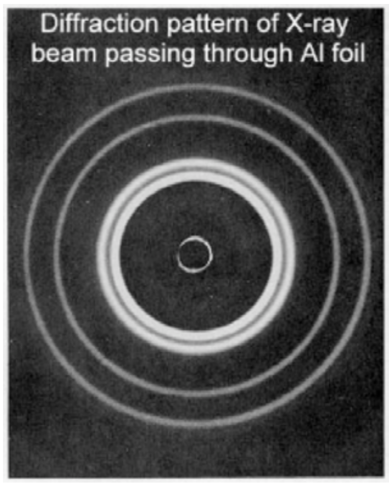
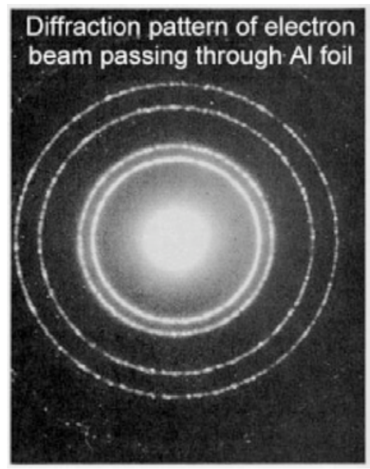
E/m radiation is a wave



Electrons are waves



Quantum Mechanics

- Heisenberg Uncertainty Principle
  - Can't measure accurately both the position and the momentum (or energy or velocity) of a small particle (electron)
- Schrodinger - Quantum Mechanics

Wave equation - Wave function Ψ - Probability Ψ^2

double slit experiment

Models of Hydrogen atom and
interactions with light

Quantum numbers and atomic orbitals