PHYS 2D
DISCUSSION SECTION

2012/5/02

Topics

- Faraday's Electrolysis
- Thomson's Cathode Ray
- Millikan's Oil Drop
- Rutherford Scattering

- Bohr's Atomic model

Faraday's Electrolysis

- Electrolysis of molten NaCl
- Exactly 96500 C of charge transferred to generate 1 mol Na & ½ mol Cl_2

- Explanation:
  - Matter is composed of molecules, which are composed of atoms
  - Molecules are broken apart into ions (atoms with charge)
  - All ions carry the same charge

Thomson's Cathode Ray

- "Cathode ray" is a beam of charged particles
- Ions from gas discharge hit cathode & generate CR
- With perpendicular E & B fields the charge to mass ratio (q/m) of the particles is measured

- Different gases & cathode metals yield cathode ray with same q/m
- Cathode ray is the same as photoelectrons

- Cathode ray are actually electrons
- Electrons are part of all atoms

Millikan's Oil Drop

- Oil drops carrying charges are generated
- Measure the terminal speed of a drop falling under gravity to find its mass using $a = \sqrt{\frac{9\eta v}{2\rho g}}$ (a: radius)
- Apply E field and measure new terminal speed
- $q_1 = \frac{mg}{E}\left(\frac{v + v'_1}{v}\right)$
- Can find charge q of the drop

- All drops carry integer multiples of a unit charge
- Amount of charge is quantized, not continuous
- This unit charge is the charge of an electron

Rutherford Scattering

- Shoot α-particles at gold foil
- Find back-scattering
- Only happens if it hits something massive
- Even a large mass would not suffice

- Rutherford's guess:
  - Matter are composed of atoms, an atom contains a massive "nucleus"
  - The nucleus also carries positive charge
- Matches experiment

What the experiments tell you

- Faraday: Idea of atoms, atom carries charge
- Thomson: Electrons are present in all atoms
- Millikan: Charge is quantized, unit=electron charge
- Rutherford: Model of structure of atom, + charged massive nucleus & - charged electrons

- Unanswered questions:
  - How are electrons distributed in an atom?
  - How is the nucleus held together if it's all positive?

Bohr's Atomic Model

- Bohr's model of the atom explains spectra for H
- Model:
  - Electrons move in orbits around nucleus
  - In certain stationary states they do not radiate
  - These states have quantized angular momentum
- Quantization condition:
  - $L_e = m_e v r = n\hbar$
  - Explained more intuitively with waves by de Broglie
  - Electrons are waves that form closed orbits
- Energy level for H: $E_n = \frac{-ke^2}{2a_0 n^2} = -\frac{13.6}{n^2} eV,\ n = 1, 2, 3..\infty$
- Emission spectra comes from transition between states

- Questions