Federal University of Santa Catarina (UFSC)
Joinville Technological Center (CTJ)
Graduate Program in Engineering and Mechanical Sciences (Pós-ECM)

Course: Plasmas and Electrical Discharges in Gases (ECM410054)
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Ionization (List 3)

1. A photon of wavelength 10 nm is incident upon a hydrogen atom at rest. The photon gives essentially all of its energy to the bound electron; thus, releasing it from the atom (binding energy = 13.6 eV). Find the kinetic energy (eV) and velocity of the photoelectron.

2. What is the maximum wavelength of electromagnetic radiation which permits the dissociation of a carbon-monoxide molecule into a carbon atom and an oxygen atom? The dissociation energy between carbon and oxygen atoms is 11.0 eV.

3. A beam of radiation has a photon energy of 0.10 MeV. When it is incident on the surface of water its intensity is reduced to ⅛ at 10 cm from the surface. Find μ of water for this wavelength.

4. A beam of photons is incident on a gas, passes through a thin glass wall of negligible absorption and then goes through a second gas. If the two gases have absorption coefficients μ_1 and μ_2 and if their chambers are identical, what is the ratio of the emerging beam intensities when the beam is first incident to gas 1 and when it is first incident to gas 2?

5. Two materials have absorption coefficients 58 and 0.44 cm^{-1} for a monochromatic beam of 0.1 MeV photons. Find the ratio of their thickness so that the beam intensity is reduced equally in both materials.

6. Find the degree of ionization of mercury vapor at atmospheric pressure if heated to 6300 K. The ionization energy of Hg is 10.38 eV.

7. The longest wavelength of electromagnetic radiation to cause the dissociation of a carbon-monoxide atom was found experimentally to be 113 nm. What is the binding energy of CO?

8. An electron was found to make an average of 85 collisions per cm in Krypton at 1 torr and 0°C. Determine the corresponding value of the diameter of the Kr atom.

9. If the ionization cross section of mercury for a monoenergetic beam of electrons is 5 Å^2, find the ionization efficiency and the ionizing collision frequency at (a) 1 torr and 0°C, (b) and at 760 torr and 25°C.

10. If the normalized elastic collision frequency, ν/N, in N_2 is 10^{-9} cm^3/s at an electron energy of 1 eV, determine the atomic diameter of N_2.

11. Calculate the radius, a_0, of the hydrogen atom H and the cross section πa_0^2 at 2, 4, 6 and 10 eV electron energy as derived from elastic collisions by electron impact of figure below. How do these values compare with Bohr's radius for the H-atom?

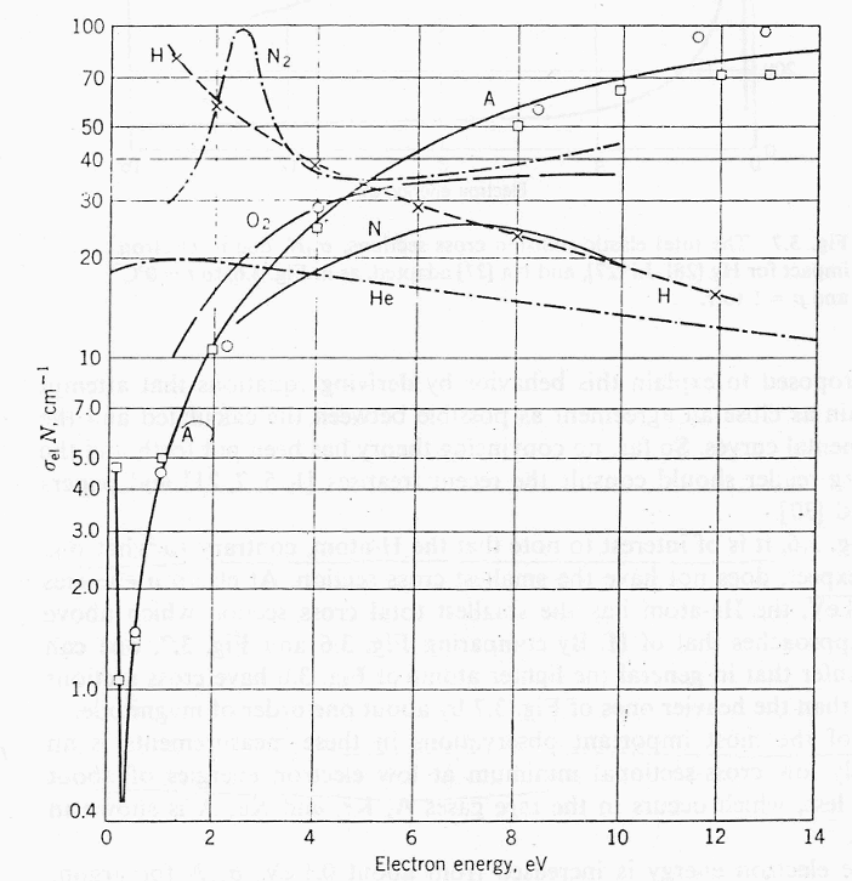

Fig. 3.6 The total elastic-collision cross sections, $\sigma_{el}N$, due to electron impact for some gases according to recent accurate measurements, plotted here to the same scale at $t = 0$ C and $P = 1$ torr (i.e., $N = 3.56 \times 10^{22}$ molecules/m^3) from A [22] and [23], 0_2 and N_2 [20] and [23], He [24], N [25], and H [26].

12. If the ionization efficiency at normalized conditions is 1.8 cm^{-1}, and the total cross section is 9.0 cm^{-1}, what is the ionization probability?

13. In an experiment to determine σ_{ion} due to photoionization (figure below), it was found that the ratio between the currents collected at the first and third electrodes was 0.9885. If the pressure in the chamber was 5×10^{-4} torr and the distance between the electrodes is 25 cm, calculate (a) the absorption coefficient μ, (b) the ionization cross section σ_{ion}.

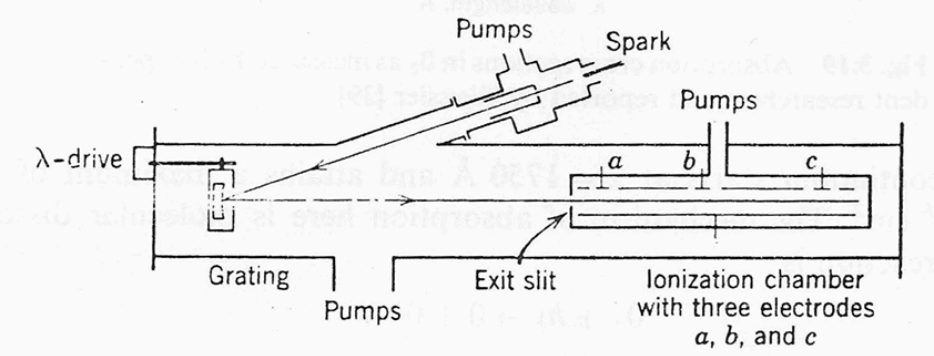

Fig. 3.18 Apparatus for measuring photoabsorption and photoionization cross sections. Photomultipliers can be placed at the location of the electrodes to measure the light beam intensity at the three locations [39, 40, and 41].