



Problem Set 1

Physical Chemistry I

Fall 2005

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This problem set is due in class on Friday, September 2. Read Chapter 1, sections 6, 7 and 9 of McQuarrie and Simon, do the selection of problems from Chapter 1, complete and hand in the "micro test" problem.

Problems You may (and are in fact *encouraged*) to work with other members of the class on these problems. Solutions can be found in the manual on reserve in the Collier Science Library, but you should only consult these to check your work or *in extremis*. If you use Mathematica, please leave the notebook in the dropbox on BlackBoard using a file name **PS1YourName.nb**

Ch. 1: 13, 14, 29, 36, 37, 38

Micro Test When completing the problem below, you may not consult anyone. You may use the text and any notes or problems sets written in your own hand. If you use Mathematica, please leave the notebook in the dropbox on BlackBoard using a file name **MT1YourName.nb**

Biological specimens are often examined by microscopy. However, microscopy with visible light is limited to viewing details of a specimen on the order of the wavelength of light (400 nm). The macromolecules that make up the cell are much smaller, often about 2-10 nm in size, and the interatomic bonds that make up the molecular structures are about 0.2 nm in length. One method that can be used to reveal the atomic-level details of biological molecules is electron microscopy, in which a beam of electrons is focused onto a biological sample. Modern electron microscopes can emit a beam of electrons with a velocity of $1.5 \times 10^8 \text{ m sec}^{-1}$.

- What is the wavelength of an electron particle in this beam? Is the wavelength short enough to reveal molecular details at the atomic level?
- The wavelength of the particle determines the resolution of the microscopy that can be performed. Assume that you desire minimum uncertainty in the position of the electron of 1.0 \AA ($1 \text{ \AA} = 10^{-10} \text{ m}$). Using the uncertainty principle, what is the maximum uncertainty that is acceptable in the momentum of the particle?

The Culture of Chemistry



Winning the prize wasn't half as exciting as doing the work itself.

Maria Goeppert Mayer,
Nobel Prize winner in physics (1963)

Goeppert Mayer is one of the few women to have won the Nobel prize in physics or chemistry (trivia question - who are the others?). She was cited for her work on the structure of the nucleus. Though she received her Ph.D. from the University of Goettingen in 1930 and worked on the Manhattan Project during World War II, her first full time paid position was at the University of San Diego in 1960! She had often worked at the same institution as her husband (a chemist), and hiring rules at the time forbade spouses from having faculty positions at the same place. At the beginning of her career, many places considered her a "nuisance". Her early work in chemical physics was with Herzfeld on the colors of organic molecules.

Physics

1903, Marie Curie

1963, Maria Goeppert-Mayer

Chemistry

1911, Marie Curie

1935, Irène Joliot-Curie

1964, Dorothy Crowfoot Hodgkin