NS 546 Concepts in Modern Physics I: Quantum Physics
Course Schedule

N.B.: The schedule below has not yet been adapted to the blended schedule of online and in-class meetings. Course readings may vary between course offerings.

Reading assignment for first session:

- Niaz, M. & Rodrigues, M.A. (2002) Improving learning by discussing controversies in 20th century physics. *Physics Education* 37(1) 59 – 63.

Session 1: The Electron; Blackbody Radiation.

Active Physics CoreSelect: Atoms on Display 2 – Tiny and Indivisible
Sections from Cutnell & Johnson: 29.1 – 29.2
Laboratory experiment: "The Millikan oil-drop experiment"
Philosophy/History/Education Research: Overview of scientific revolutions. Overview of the conundrums facing physicists in 1900.
Reading assignment for next Friday:

- Toulmin, S. and Goodfield, J. (1962). Entering the Quantum World (Ch. 12) and Sharpening the Focus (Ch. 13). *The architecture of matter*. Chicago: University of Chicago Press.
- Holton, G. (1978). *The scientific imagination: case studies.* (pp. 25-83). Cambridge: Cambridge University Press.

Session 2: Rutherford and the Nucleus.

Active Physics CoreSelect: Atoms on Display 3 – How Big is Small?
Sections from Cutnell & Johnson: 30.1
Web assignment 1

Session 3: Atomic Spectra; Models of the Atom.

Active Physics: Atoms on Display 4 – Hydrogen Spectra/Bohr's Model
Sections from Cutnell & Johnson: 30.2 – 30.3
Applications: Spectroscopy.

Session 4: Atomic Spectra lab experiment

Sections from Cutnell & Johnson: 30.2 – 30.3
Laboratory experiment: "Atomic Spectra"
Web assignment 2
Philosophy/History/Education Research: Millikan and Ehrenfast controversy.
Reading assignment for next Friday:

- Bohr, N. (1913). On the Constitution of Atoms and Molecules. *Philosophical Magazine*, 26, 1-25.
- Romer, A. (1997). Proton or prouton?: Rutherford and the depths of the atom. *American Journal of Physics, 65,* 707-716.

Session 5: Test 1; Matter Waves; Photoelectric effect.

Active Physics: Atoms on Display 5 – Extending and Amending the Model

Sections from Cutnell & Johnson: 29.3, 29.5.
Test 1: 1-hour test on sessions 1 – 4.

Session 6: Photoelectric effect lab experiment.
Sections from Cutnell & Johnson: 29.3, 29.7
Laboratory experiment: "Photoelectric Effect"
Web assignment 3
Reading assignment for next Friday:
- L. Bao and E. Redish (2002) Understanding Probabilistic Interpretations of Physical Systems: A Prerequisite to Learning Quantum Physics. *Am. J. Phys, 70,* 210-217.

Session 7: Classical and Quantum-mechanical Probability.
Chapter 6 from *Physlet Quantum Physics*
Sections from Cutnell & Johnson: 29.6
Philosophy/History/Education Research: Bohr's development of a quantum atom model and Rutherford's experimental verification of the structure of the nucleus.
Reading assignment for next Friday:
- Articles from Selections from Physics Education Research Literature as listed in the bibliography.

Session 8: The Schrödinger Equation
Chapter 7 from *Physlet Quantum Physics*
Web assignment 4
Sections from Cutnell & Johnson: 30.5 – 30.6

Session 9: The Strong Nuclear Force.
Active Physics CoreSelect: Atoms on Display 6 – Inside the Nucleus
Sections from Cutnell & Johnson: 31.1 – 31.3
Philosophy/History/Education Research: Group work to discuss and prepare students' projects.

Session 10: Test 2; Nuclear Decay and Radioactivity.
Test2: 1-hour test on sessions 5 – 9.
Active Physics: Atoms on Display 7 – Radioactive Decay and the Nucleus
Web assignment 5
Sections from Cutnell & Johnson: 31.4 – 31.7

Session 11: Nuclear Binding Energy.
Active Physics: Atoms on Display 8 – Holding the Nucleus Together
Sections from Cutnell & Johnson: 32.5
Philosophy/History/Education Research: The pedagogical development of the *Exploring Quantum Concepts* curriculum.

Session 12: Nuclear Fission.

Active Physics: Atoms on Display 9 – Breaking Up Is Hard to Do
Web assignment 6
Sections from Cutnell & Johnson: 32.3 – 32.4

Session 13: Presentations.

Philosophy/History/Education Research: Students' presentations
Test 3: Take-home test.

Bibliography

Selections from primary sources

Bohr, N. (1913). On the Constitution of Atoms and Molecules. *Philosophical Magazine, 26,* 1-25.

Selections from secondary sources

Toulmin, S. and Goodfield, J. (1962). Entering the Quantum World (Ch. 12) and Sharpening the Focus (Ch. 13). *The architecture of matter*. Chicago: University of Chicago Press.

Holton, G. (1978). *The scientific imagination: case studies.* (pp. 25-83). Cambridge: Cambridge University Press.

Romer, A. (1997). Proton or prouton? Rutherford and the depths of the atom. *American Journal of Physics, 65,* 707-716.

Selections from Physics Education Research Literature

Niaz, M. & Rodrigues, M.A. (2002) Improving learning by discussing controversies in 20th century physics. *Physics Education 37(1)* 59 – 63.

Bao, L. and Redish, E.F. (2002). Understanding probabilistic interpretations of physical systems: A prerequisite to learning quantum physics. *American Journal of Physics, 70,* 210-217.

Budde, M., Niedderer, H., Scott, P., and Leach, J. (2002). 'Electronium'**:** a quantum atomic teaching model. *Phys. Educ, 37,* 197-203.

Budde, M., Niedderer, H., Scott, P., and Leach, J. (2002). The quantum atomic model 'Electronium'**:** a successful teaching tool. *Phys. Educ. 37,* 204-210

Gillespie, R.J., Spencer, J.N., and Moog, R.S. (1996). Demsytifying Introductory Chemistry. *Journal of Chemical Education, 73,* 617-622.

Niedderer, H., Bethge, Th., and Cassens, H. (1990). A simplified quantum model: A teaching approach and evaluation of understanding In P. L. Lijuse et al. (Eds.), *Relating Macroscopic Phenomena to Microscopic Particles - A Central Problem in Secondary Science Education* (pp. 67-80) Utrecht: CD-§ Press.

Petri, J. and Niedderer, H. (1998). A learning pathway in high-school level quantum atomic physics. *International Journal of Science Education, 20,* 1075-1088.