

University of Vermont  
Physics 128

*Waves and Quanta*

**Prerequisites:** Physics 42, Mathematics 121

Lecturer: Prof. Junru Wu

Office: A526 Cook Building

Office Hour: Mon 3:30-4:30 PM, Thurs 3:30 – 4:30 PM or by appointment

Telephone: 656-8357

**E-Mail:** [Jun-ru.wu@uvm.edu](mailto:Jun-ru.wu@uvm.edu)

**Website:** [www.uvm.edu/~jwu/Wu.html](http://www.uvm.edu/~jwu/Wu.html)

**Lectures:** Mon, Wed, and Fri: 9:35-10:25 AM, Room A402 Cook Building

**Textbook:** *Concepts of Modern Physics (6th edition)* by Arthur Beiser, McGraw-Hill (2003).

**References:**

1. "Modern Physics" by Frank Blatt, McGraw-Hill, 1992.
2. "Modern Physics" 2nd Edition by Kenneth Krane, John Wiley & Sons Inc. 1996.

**Subjects:** Relativity (Chapter 1), Particle Properties of Waves (Chapter 2), Wave Properties of Particles (Chapter 3), Atomic Structure (Chapter 4), Quantum Mechanics (Chapter 5), Quantum Theory of the Hydrogen Atom (Chapter 6), Many-Electron Atoms (Chapter 7), Molecules (Chapter 8), Statistical Mechanics (Chapter 9), The Solid States (Chapter 10).

**HomeWork:** Several problems will be assigned as homework every chapter. The answers to those problems will be given.

**Tests:** There will be three tests during the semester. An accumulative final two-hour exam will be given in the end of the semester.

**Evaluation:** Each hour-test counts 20 %, and the final exam (08:00 AM - 10:00 AM, Friday, May, 08 2009) counts 40 % in total.

**Religious Holidays:** *Students have the right to practice the religion of their choice. Each semester students should submit in writing to their instructors by the end of the second full week of classes their documented religious holiday schedule for the semester. Faculty must permit students who miss work for the purpose of religious observance to make up this work.*

## **Homework Assignment**

Chapter 1: 6, 9, 10, 11, 17, 18, 21, 24, 26, 27, 28, 29, 30, 32, 40, 41, 42, 46, 49

Chapter 2: 7, 8, 9, 13, 15, 16, 19, 21, 23, 25, 27, 30, 32, 38, 39, 40, 43, 51, 54

Chapter 3: 1, 2, 3, 6, 10, 11, 12, 13, 15, 16, 19, 21, 22, 24, 26, 27, 29, 31

Chapter 4: 2, 3, 4, 8, 10, 14, 16, 21, 23, 27, 28

Chapter 5: 4, 5, 6, 9, 10, 14, 15, 18, 21, 22, 23, 25, 26, 29, 30, 32

Chapter 6: 2, 4, 5, 6, 7, 9, 10, 12, 15, 16, 19, 21, 25, 29, 31

Chapter 7: 1, 3, 4, 5, 6, 22, 23, 41

Chapter 8: 2, 3, 4, 6, 9, 18

Chapter 9: 1, 2, 3, 4, 10, 11, 12, 15, 17, 19, 20, 22, 37, 38, 39.

Chapter 10: 3, 4, 10, 11, 23, 24

## **Answers to Even Problems**

Chapter 1

6:  $2 \times 10^{12}$  s; 10:  $1.23 \times 10^3$ ; 18: 1.6 m; 24: 2.14, 3.06; 28:  $2.69 \times 10^{11}$  kg; 30:  $1.17 \times 10^{17}$  J/kg;  
40:  $1.78 \times 10^{-30}$  kg,  $5.344 \times 10^{-22}$  kg m/s; 42: 137 MeV

Chapter 2

8: 3; 16: 0.6 V,  $4.6 \times 10^5$  m/s; 30:  $2 \times 10^{-19}$  J; 32: 141 keV (hint: Use Eq. 2-20); 38:  
 $E/(E_0/(2E)+1)$ ; 40: 2.740 MeV, 0.282 MeV

Chapter 3

2: 6.9 pm, 2.7 pm; 6:  $2.86 \times 10^{-14}$  m; 12:  $\lambda = hc / \sqrt{qV(qV + 2mc^2)}$ ,  $\lambda = h / \sqrt{2eVmc}$ ; 16:  
1.5 v<sub>p</sub>; 24: 32.5°, 100°, 142.6°; 26: 3.0 pm;

Chapter 4

2:  $f = 6.6 \times 10^{15}$  Hz; 4:  $6.6 \times 10^{15}$  Hz,  $\lambda = c/f = 45.4$  nm; 10:  $2.35 \times 10^{-10}$  m, 13.6 eV; 14:  
Lyman series; 16: The Lyman, Balmer and Paschen series with  $n_i \leq 4$ .

Chapter 5

4:  $(4/\pi)^{(1/4)}$ ; 10:  $-n^2$ ; 14:  $\sqrt{\frac{2}{L}} \sin \frac{n\pi x}{L}$ ; 18:  $\frac{1}{\sqrt{L}}$ ; 22:  $7.5 \times 10^{-4}$ ,  $1/8$ ; 30:  $\sqrt{\frac{2\pi V}{\hbar}} dx$ ,

$\sqrt{\frac{2\pi V}{\hbar e^2}} dx$ ; 32:  $E_0/2$

#### Chapter 6

10: 45 degree, 90 degree and 135 degree; 35.3 degree, 65.9 degree, 90 degree, 114.1 degree and 144.7 degree. 28:  $\mu = n \frac{\hbar e}{2m}$

#### Chapter 7

6: 13.1 eV.

#### Chapter 8

2: -0.299e. 6:  $2.04 \times 10^{11}$  Hz,  $3.05 \times 10^{11}$  Hz. 18: a. 0.272 eV, 4.09 eV. b. 8.

#### Chapter 9

2: The relative numbers of H atoms in the different states are 1 (n=1),  $2.9 \times 10^{-10}$  (n=2),  $5.9 \times 10^{-12}$  (n=3) and  $2.3 \times 10^{-12}$  (n=4). 4: a) 1:0.282:7.94x10-2:2.24x10-2:6.30x10-3; b) Not at any finite temperature. 20: 55%. 22:  $1.4 \times 10^{11}$  years. 38: 4.22 eV and  $3.75 \times 10^{-2}$  eV.

#### Chapter 10

4: n = 8.14. 10: 41.2 nm. 24:  $2.19 \times 10^{-3}$  eV,  $6.60 \times 10^{11}$  Hz