

**Quantum Mechanics**  
**Physics 237**

Frank L. H. Wolfs  
Department of Physics and Astronomy  
University of Rochester

Frank L. H. Wolfs      Department of Physics and Astronomy, University of Rochester, Lecture 8, Page 1

---

---

---

---

---

---

---

---

1

**Course information**

- Midterm Exam # 1 will take place on Thursday February 10, 2022, between 8 am and 9.30 am. Location: B&L 109.
- The material covered are Chapters 1 – 4.
- The material will be reviewed during a review session on Tuesday February 8, between 3:00 pm and 5:30 pm in B&L 480.
- Office hours:
  - Margaret Porcelli: Tuesday 8 – 10 pm, POA.
  - Frank Wolfs: Wednesday 9 – 11 am, B&L 203A.
  - Navya Uberoi: Wednesdays 1 - 3 pm, POA.

Frank L. H. Wolfs      Department of Physics and Astronomy, University of Rochester, Lecture 8, Page 2

---

---

---

---

---

---

---

---

2

**Time management on exams**

- Work no more than 10 – 15 minutes on each problem.
- Even if not finished, move on to the next problem.
- This will leave 30 minutes at the end to finish your problems and/or make correction.
- We can only give credit for what you write (not what you think).
- We can only give credit for what we can read (write neatly).

Frank L. H. Wolfs      Department of Physics and Astronomy, University of Rochester, Lecture 8, Page 3

---

---

---

---

---

---

---

---

3

### Final Remarks about Exam # 1.

- Make sure you really understand the solutions to the homework assignments.
- Make sure you understand the material discussed in the textbook. I cannot cover everything during lecture. If I skip a specific topic, do not assume you can skip it to when you prepare for exam # 1.
- Make sure you pay attention to the correspondence principle discussed in Section 4.11. This makes an important connection between the classical world (large  $n$ ) and the quantum world (small  $n$ ).
- Your TAs will not see the exam until you see it.

Frank L. H. Wolfs Department of Physics and Astronomy, University of Rochester, Lecture 8, Page 4

4

---

---

---

---

---

---

---

---

### Extra credit HW # 3

- Based on looking at the solutions to the extra credit problem of HW # 3, I need to make the following comments:
  - Check your answers for proper orders of magnitude results.
  - Relativistic effects start to become important when the velocities approach the speed of light ( $v/c > 0.1$ ) or the kinetic energy is similar (1% – 10%) to the rest energy of the particles involved.
  - Make sure that you realize that the 0.511 MeV is the rest energy of the electron, not the rest mass. When you calculate the classical momentum of the electron as  $\sqrt{2mK}$ ,  $m$  is the rest mass, not the rest energy. This expression can be rewritten as  $(1/c)\sqrt{2mc^2K}$ . **Note: if you use 0.511 MeV for the rest energy, make sure that  $K$  is also in units of MeV.**

Frank L. H. Wolfs Department of Physics and Astronomy, University of Rochester, Lecture 8, Page 5

5

---

---

---

---

---

---

---

---

Do not worry.  
I did not forget the airplane picture.



Frank L. H. Wolfs Department of Physics and Astronomy, University of Rochester, Lecture 8, Page 6

6

---

---

---

---

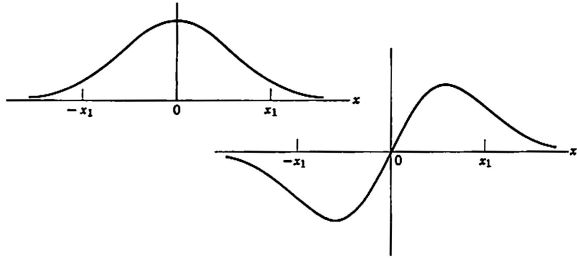
---

---

---

---

## Wavefunctions. Even and odd functions.



Frank L. H. Wolfs Department of Physics and Astronomy, University of Rochester, Lecture 8, Page 7

7

---

---

---

---

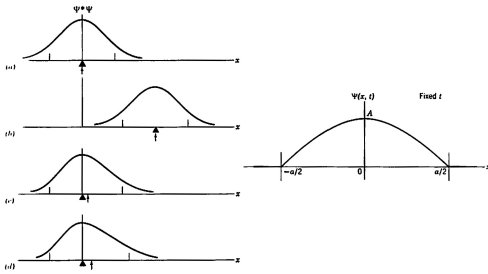
---

---

---

---

## Wavefunctions and particle location.



Frank L. H. Wolfs Department of Physics and Astronomy, University of Rochester, Lecture 8, Page 8

8

---

---

---

---

---

---

---

---



## 3 Minute 38 Second Intermission.

- Since paying attention for 1 hour and 15 minutes is hard when the topic is physics, let's take a 3 minute 38 second intermission.

- You can:
  - Stretch out.
  - Talk to your neighbors.
  - Ask me a quick question.
  - Enjoy the fantastic music.



Frank L. H. Wolfs Department of Physics and Astronomy, University of Rochester, Lecture 8, Page 9

9

---

---

---

---

---

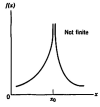
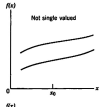

---

---

---

### Requirements of wavefunctions.

- Wavefunctions must satisfy the following requirements:
  - Must be finite everywhere.
  - Must be single valued.
  - Must be continuous.

Frank L. H. Wolfs      Department of Physics and Astronomy, University of Rochester, Lecture 8, Page 10

---

---

---

---

---

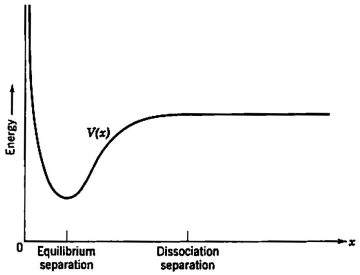
---

---

---

10

### A typical potential.



Frank L. H. Wolfs      Department of Physics and Astronomy, University of Rochester, Lecture 8, Page 11

---

---

---

---

---

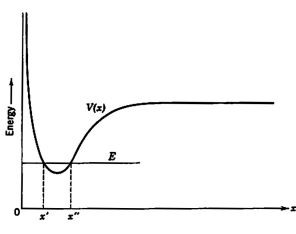
---

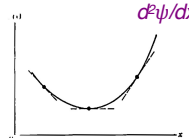
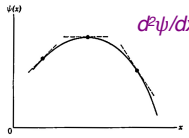
---

---

11

### Properties of the wavefunction.



Frank L. H. Wolfs      Department of Physics and Astronomy, University of Rochester, Lecture 8, Page 12

---

---

---

---

---

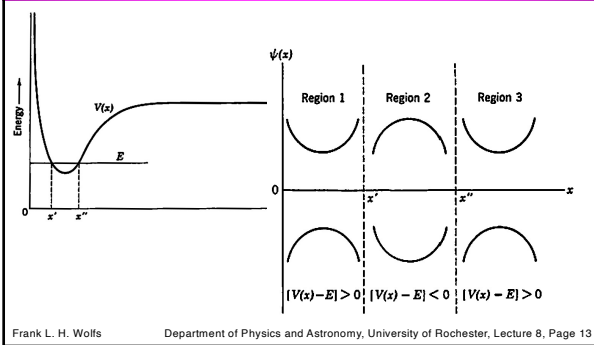
---

---

---

12

### Understanding the shape of the wavefunction.



13

---

---

---

---

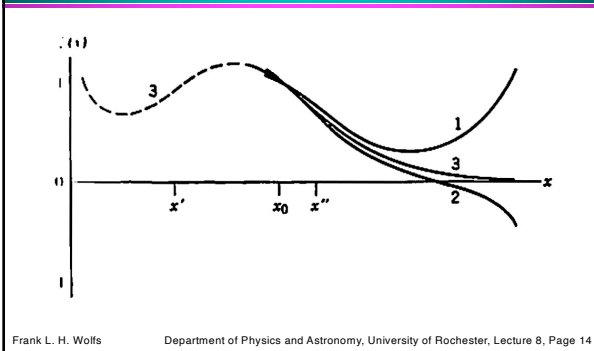
---

---

---

---

### The shape of the wavefunction. What happens at large $x$ ?



14

---

---

---

---

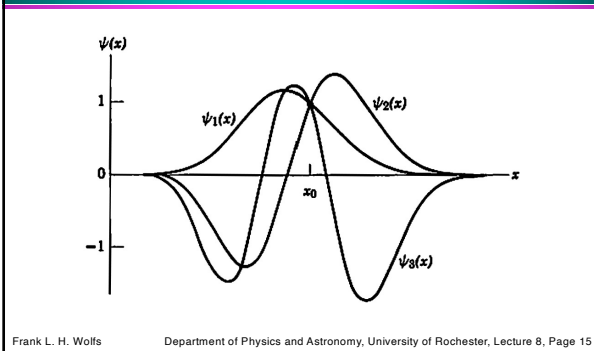
---

---

---

---

### Different wavefunctions. Different energies.



15

---

---

---

---

---

---

---

---

**ENOUGH FOR TODAY?**

Frank L. H. Wolfs      Department of Physics and Astronomy, University of Rochester, Lecture 8, Page 16

---

---

---

---

---

---

---

---