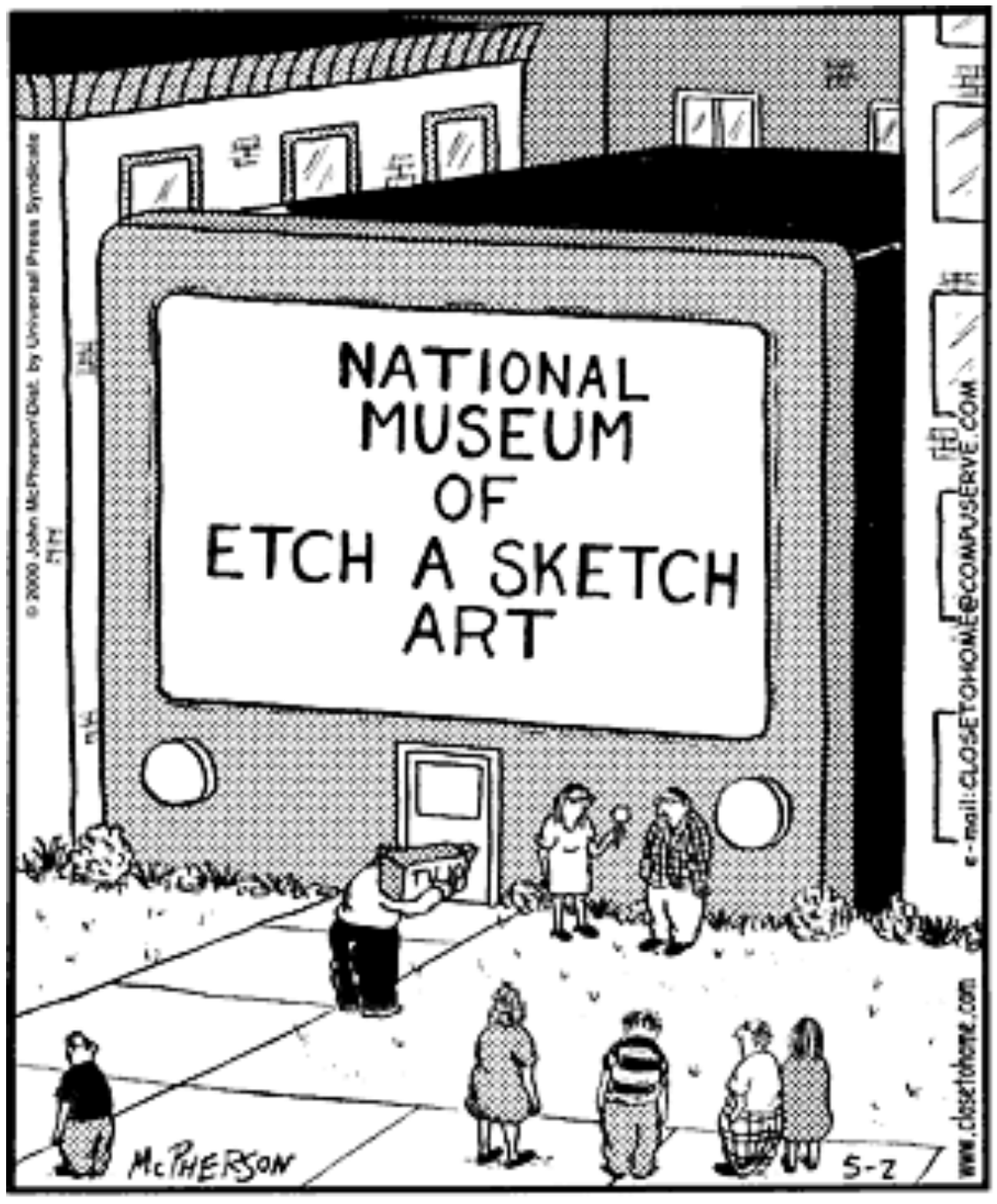
Physics 323 - Solid State Physics

On the 3 x 5 card, please write

1. Preferred name
2. Your hometown
3. Interests, hobbies, major
4. Some interesting/funny facts about yourself that you don't mind sharing with the class.

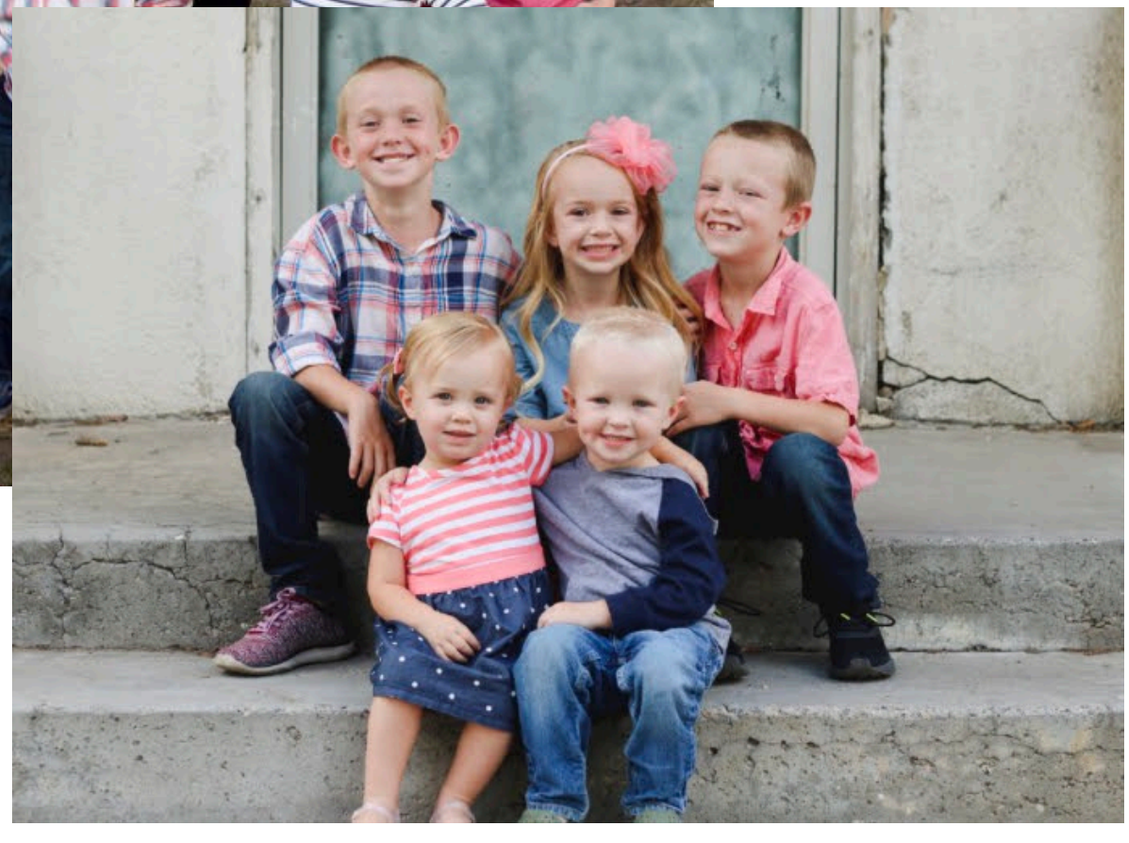
Share what you wrote with someone around you. In a moment, I'll ask you to introduce someone else.

Hand in your card before you leave today.



"Structurally, the building is fine. But sadly, the earthquake destroyed all of our art pieces."

Physics 323: Solid State Physics



<u>Who am I?</u>

Lance Nelson

Rigby, Idaho

Computational Physics
Materials Physics

I like to play handball
but I'm not very good.

What's handball?

The "what to do" of this course...

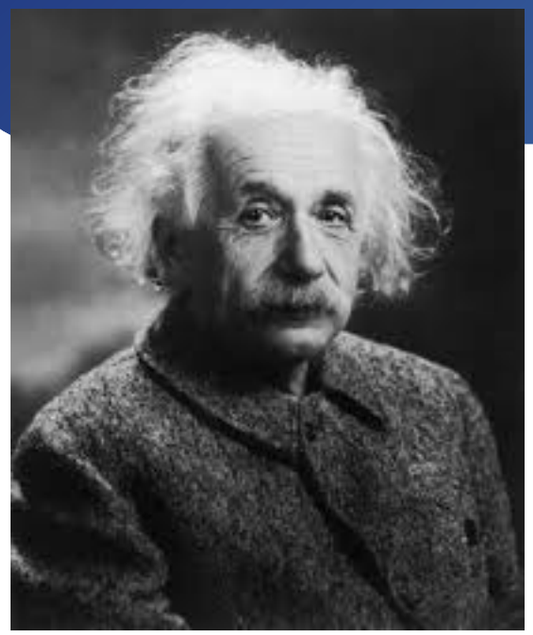
Syllabus

https://lancejnelson.github.io/PH323

Participation
Homework
Exams
Python
Mathematica

The spirit will teach you.

Historical Review



Einstein
Photoelectric Effect

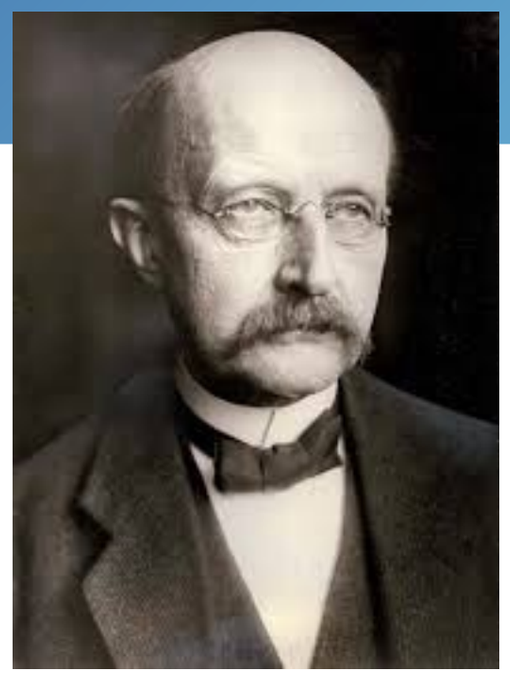
1905

1921 Nobel Prize

Luis de Broglie
wave nature of particles

1925

1929 Nobel Prize



Max Planck
Blackbody Radiation

1901

1918 Nobel Prize

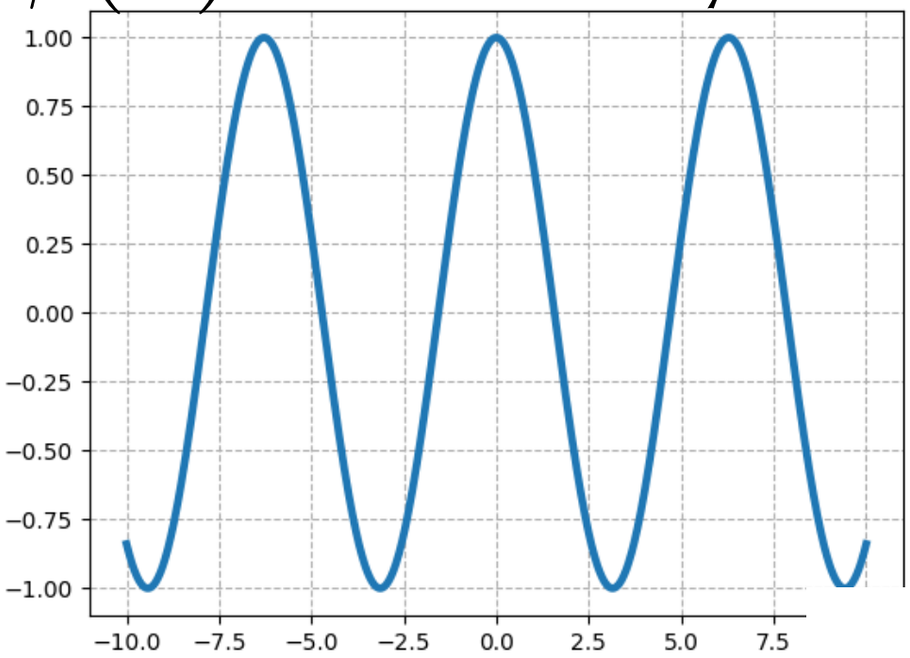
WaveFunctions

Postulate 1: The state of a particle/system is completely specified by the wave function.

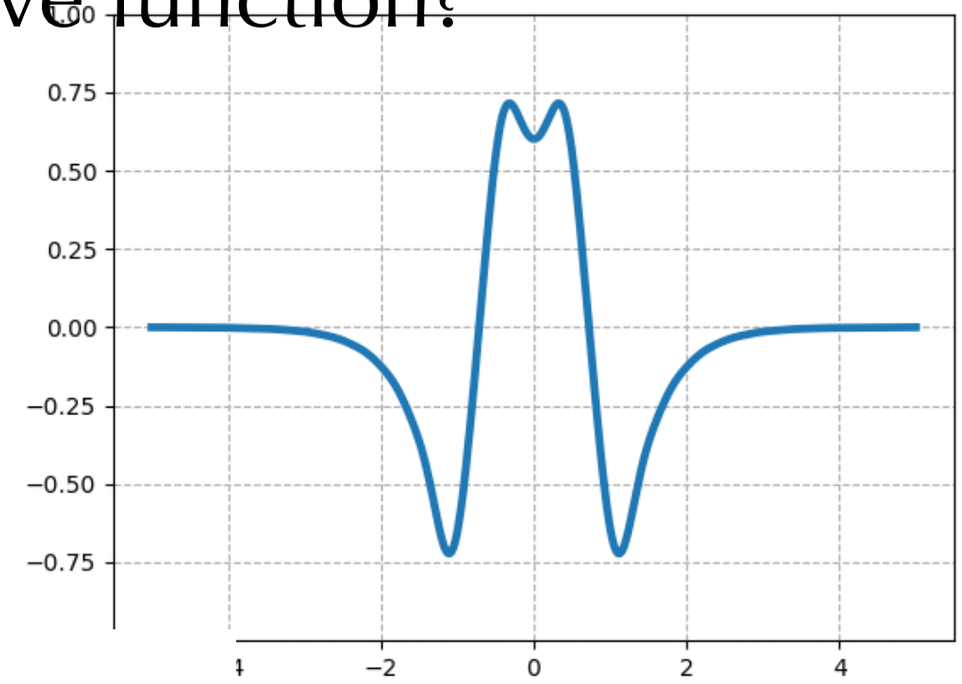
Is it possible to observe a wave function?

Is any function a valid wave function?

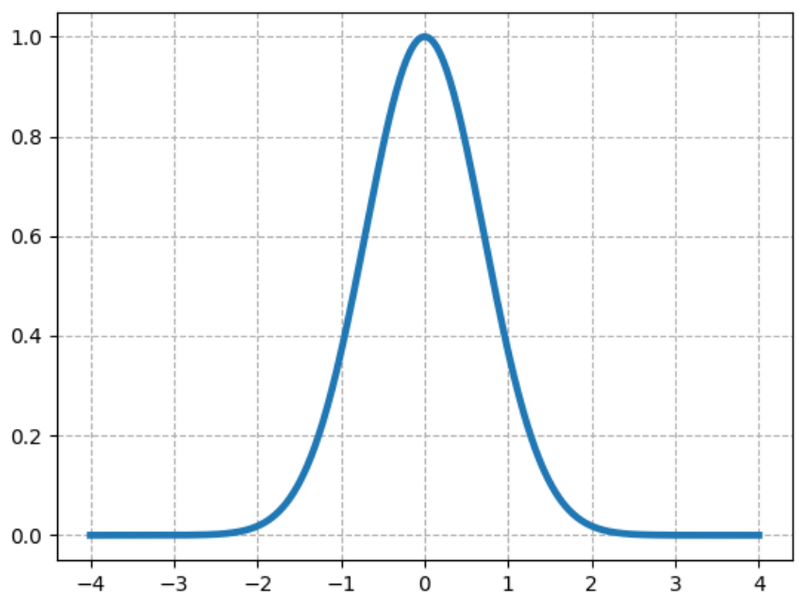
$\psi(x)$



$\psi(x)$



$\psi(x)$



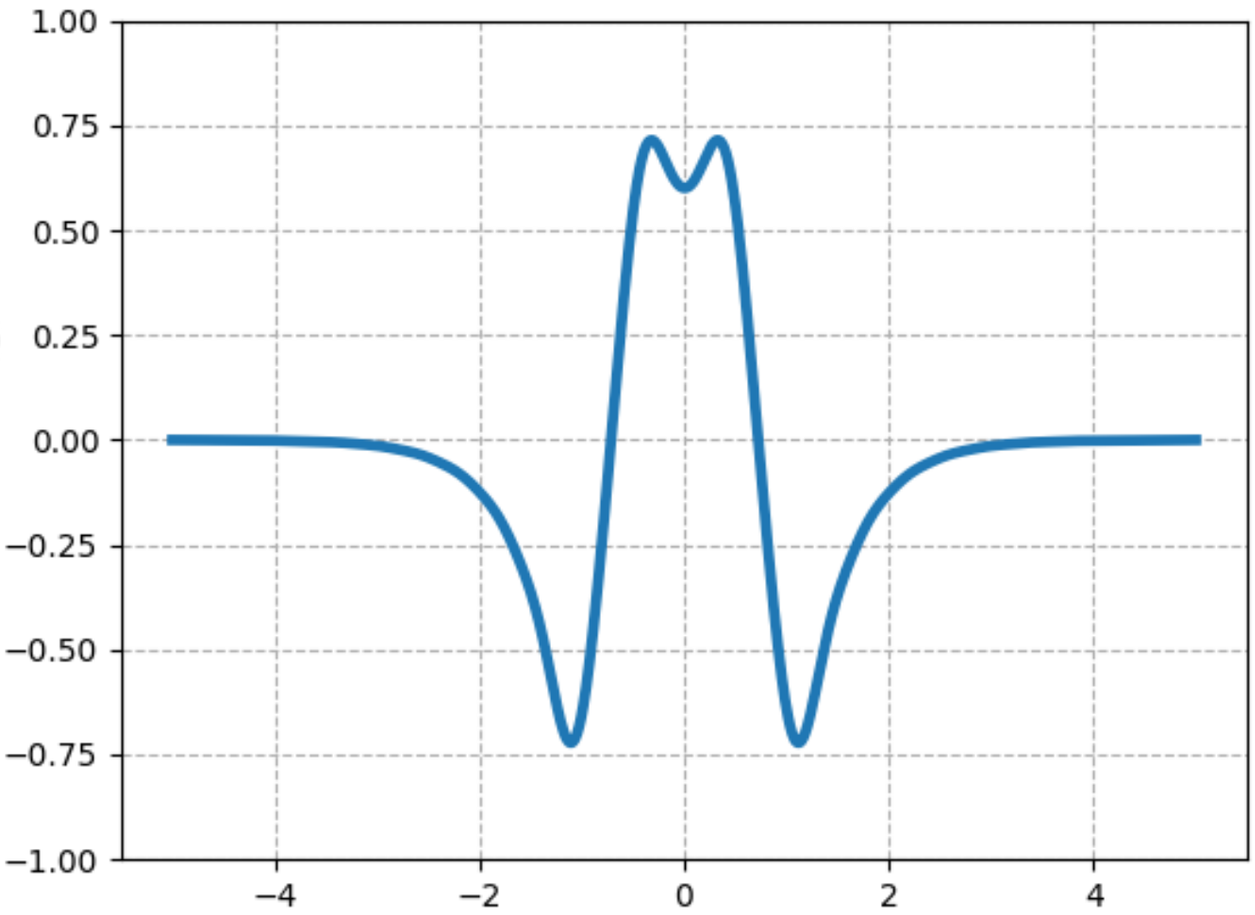
WaveFunctions

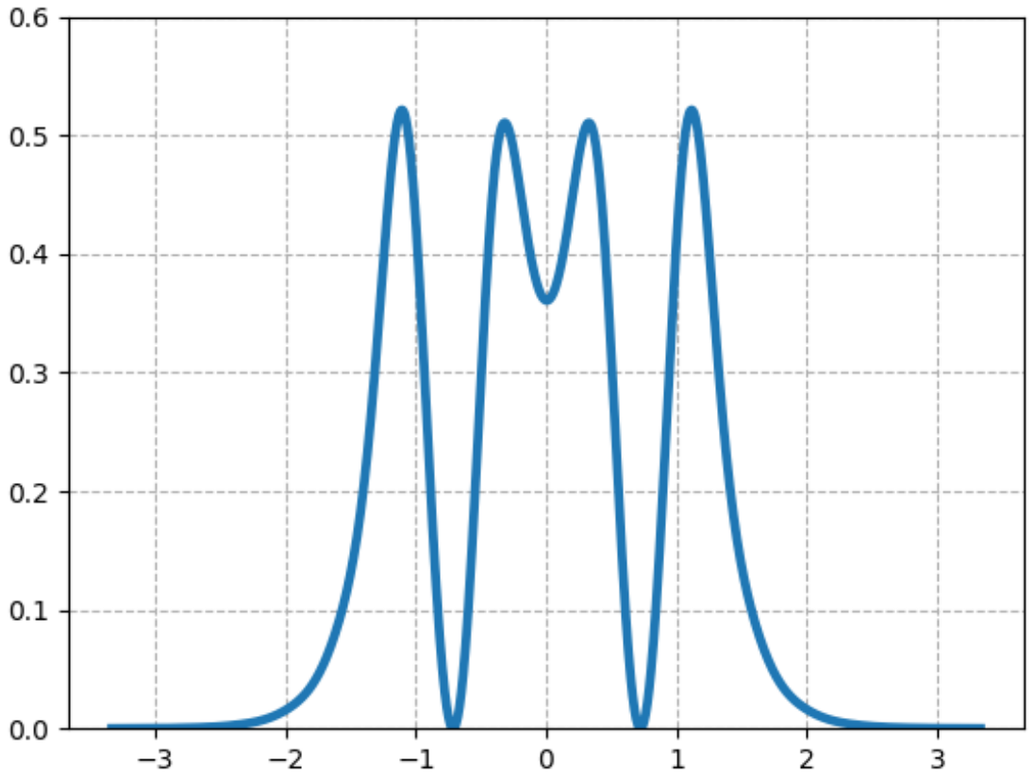
In order to correspond to a real physical situation, the wave function must be normalizable!!

(Otherwise you lose the statistical interpretation that was intended to begin with.)

$$\int \psi^*(x)\psi(x)dx = 1$$

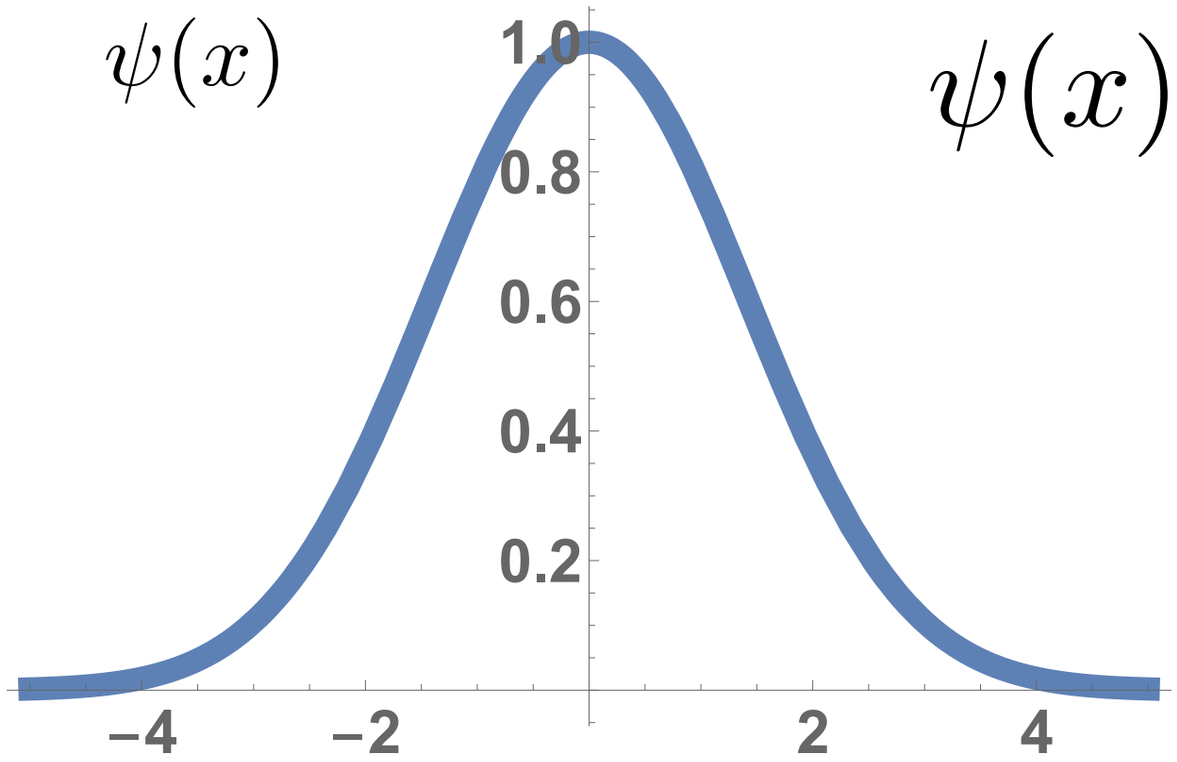
$\psi(x)$





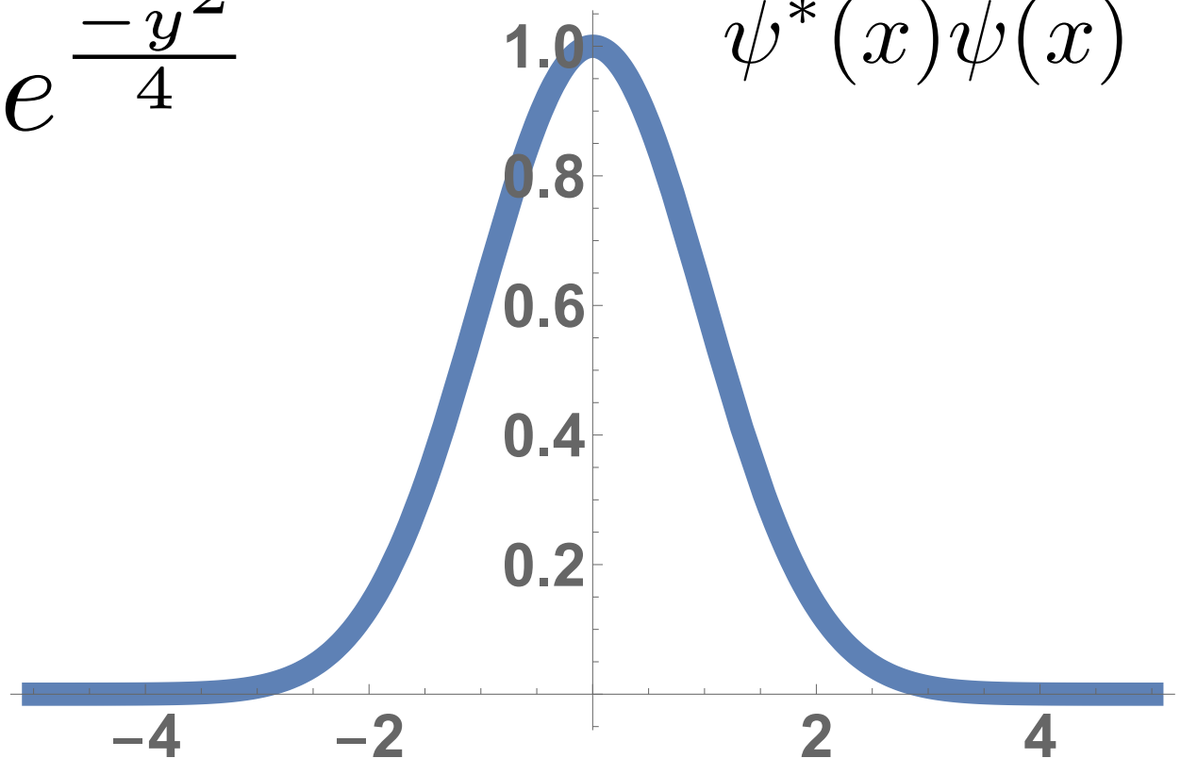
WaveFunctions

$\psi(x)$



$$\psi(x) = e^{\frac{-y^2}{4}}$$

$\psi^*(x)\psi(x)$



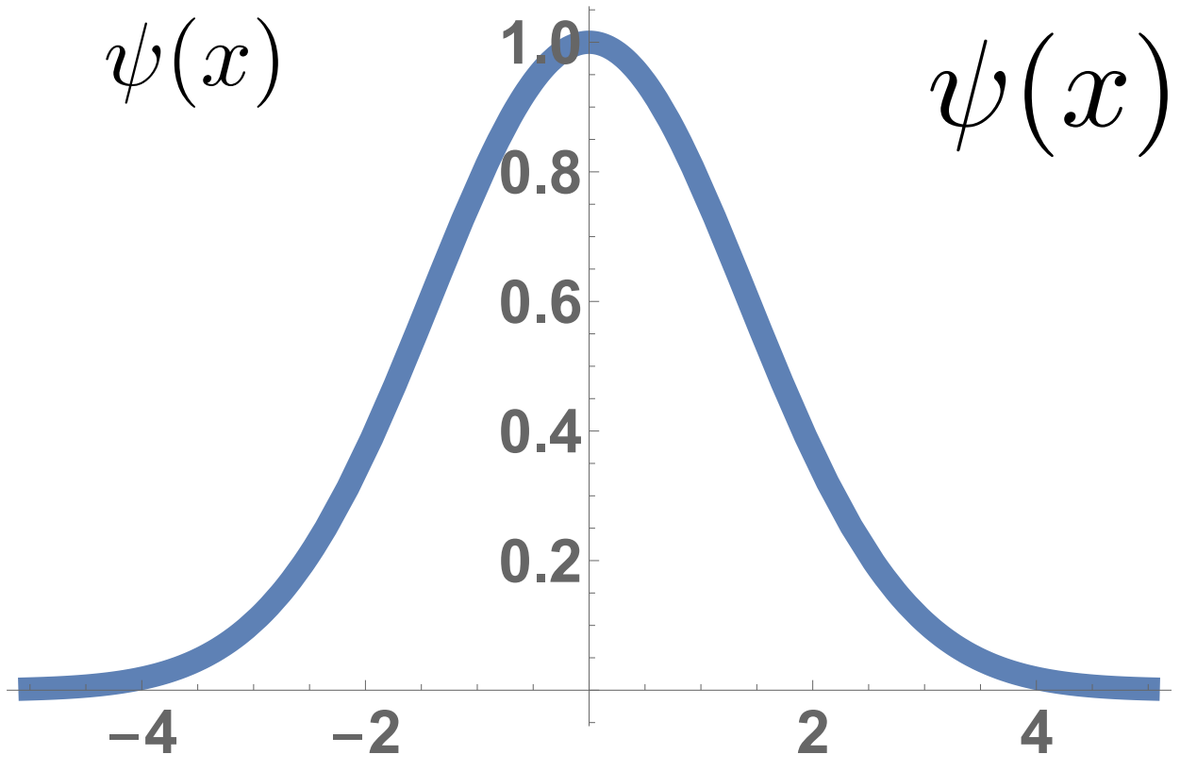
$$\int \psi^*(x)\psi(x)dx = 1$$

What should I multiply this function by so that it is normalized?

$\frac{1}{\sqrt{2.5}}$ $\frac{1}{2.5}$ $\frac{1}{\sqrt{2.24}}$ $\frac{1}{2.24}$

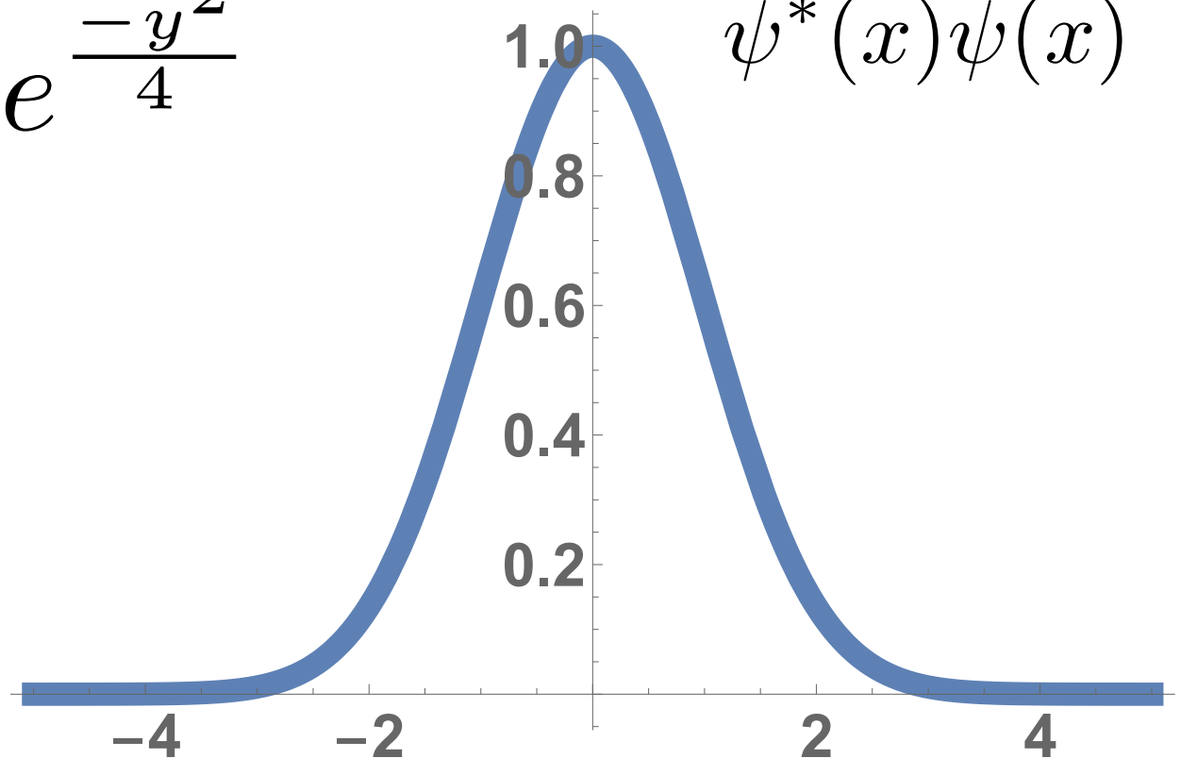
WaveFunctions

$\psi(x)$



$$\psi(x) = e^{\frac{-y^2}{4}}$$

$\psi^*(x)\psi(x)$



What is the probability of finding the particle between 0 and 1?

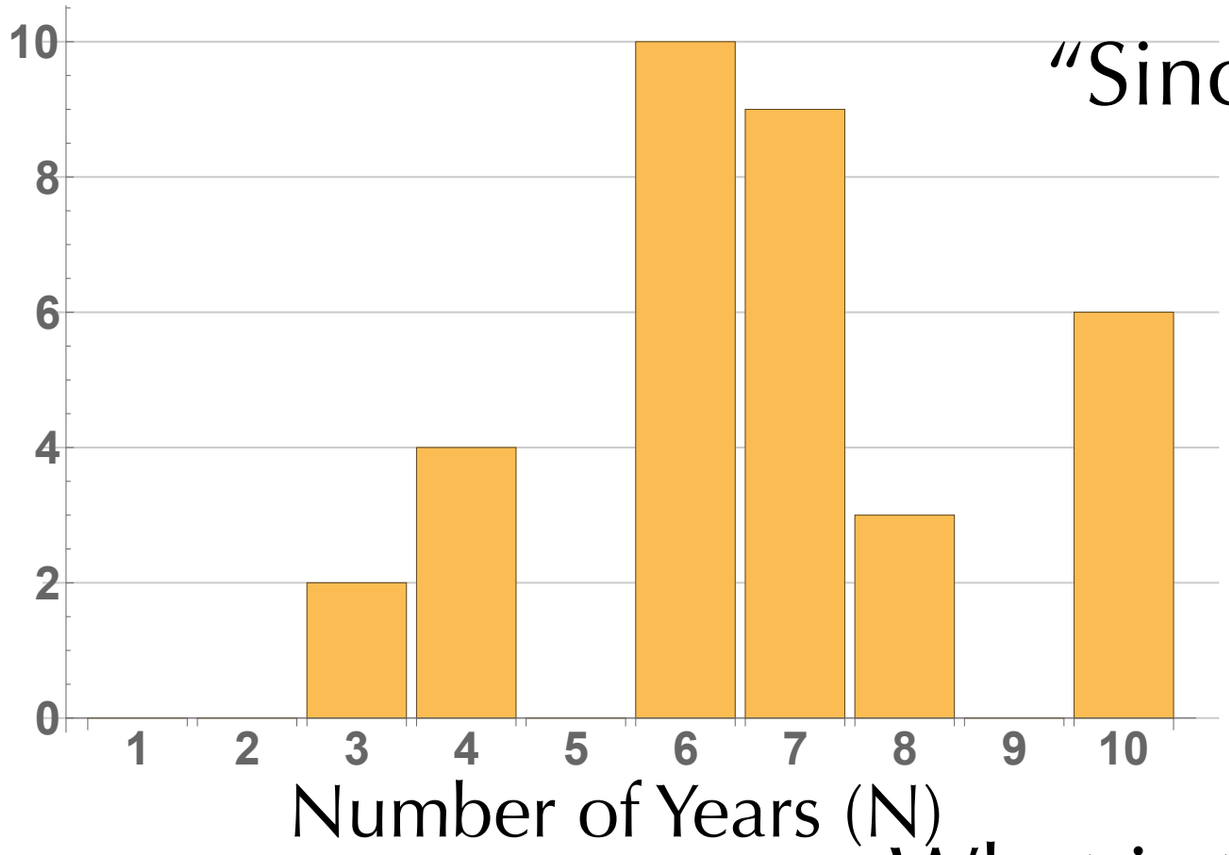
34%

58%

66%

25%

Average (Expectation) Values



"Since high school how many years have you been in school?

34 total people

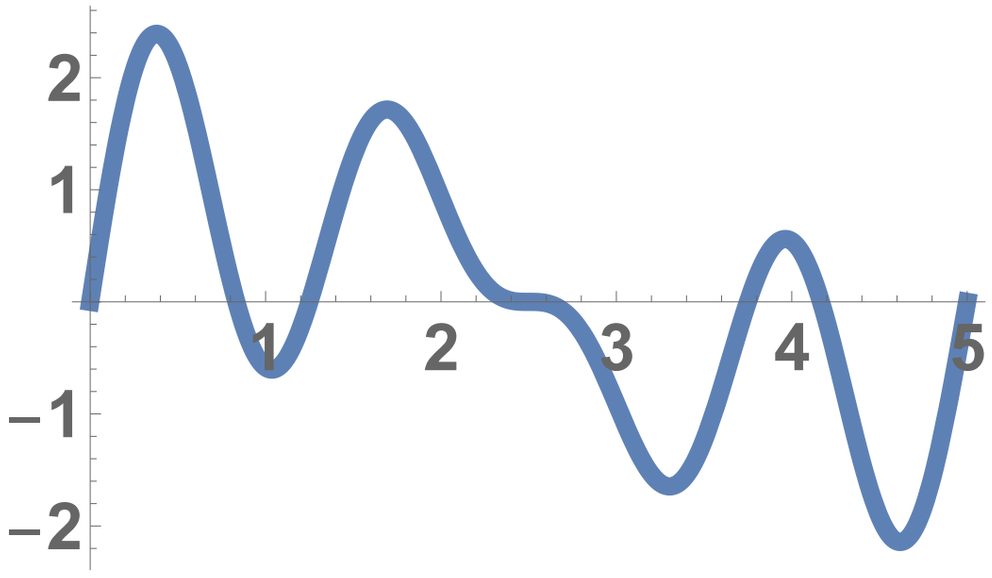
What is the **<u>average</u>** number of post-high-school years in school?

$$\langle N \rangle = \sum_i N_i P(N_i)$$

a) 6.74
b) 6.23
c) 7.26
d) 6.52
e) 6.85

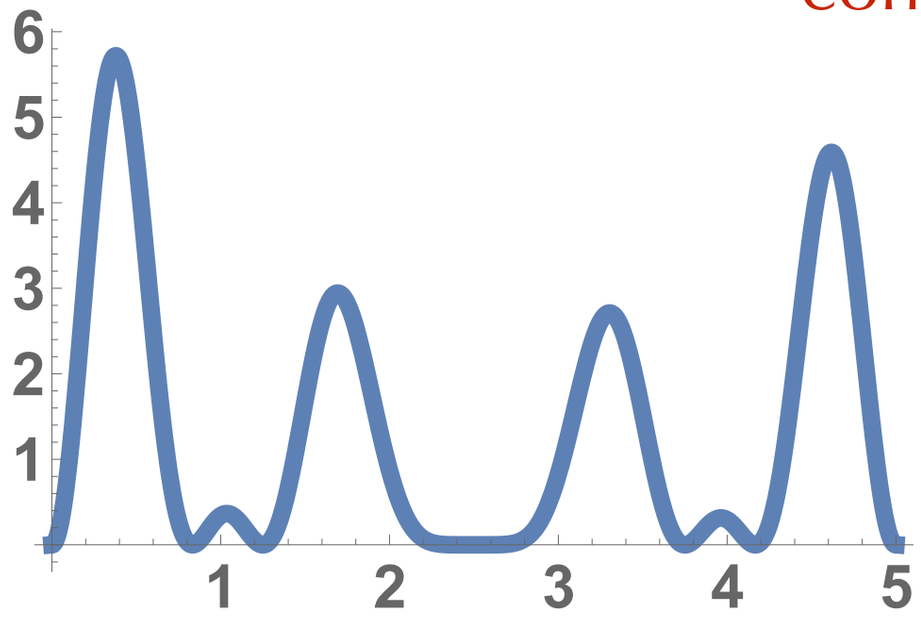
Continuous Probability Distributions

$$\psi(x) = \frac{1}{\sqrt{6.84592}} \cos(\frac{x}{10}) \left(\sin(\frac{2\pi x}{a}) + \sin(\frac{6\pi x}{a}) + \sin(\frac{8\pi x}{a}) \right)$$



discrete $\langle N \rangle = \sum_i N_i P(N_i)$

continuous $\langle x \rangle = \int x \psi^*(x) \psi(x) dx$



a) 2.35
b) 2.65
c) 0.56
d) 4.53
e) 1.5

Postulates of Quantum Mechanics

Postulate 1

For every observable quantity, there is an operator and an associated eigenvalue equation.

$$\hat{A}\psi = a\psi \qquad \text{(Eigenvalue equation)}$$

Example

Momentum Operator

$$\hat{A}\psi = a\psi \qquad \text{(Eigenvalue equation)}$$