

Extra Credit

Mathematical operators:

An operator is a symbol that tells you to do something to whatever follows the symbol. Typically the operator will have a hat or caret symbol, ^, over it. An example of an operator is the following:

$$\hat{A} = \frac{d}{dx}$$

The operation it performs is the derivative with respect to x. If we use it to operate on the function:

$$f(x) = x,$$

then:

$$\hat{A}f(x) = \frac{d}{dx} f(x) = \frac{d}{dx} x = 1$$

Pretty simple. Operators can also be complex. For instance, we can have the following:

$$\hat{P}_x = -i\hbar \frac{\partial}{\partial x}$$

For the function:

$$f(x) = e^{-ikx}$$

then:

$$\hat{P}_x f(x) = -i\hbar \frac{\partial}{\partial x} f(x) = -i\hbar ke^{-ikx} = \hbar ke^{-ikx}$$

- Your assignment is the following. I will give you a list of operators and a list of functions. I want you to **use each operator and operate on each and every function**. You will do so using Mathematica. Please use the Style Sheet ArticleModern and use various Styles to allow ease of reading your work.

List of Operators	List of Functions
1. $\hat{P}_x = -i\hbar \frac{\partial}{\partial x}$	1. $\psi(x) = Be^{ikx}$
2. $\hat{H}_x = \frac{\hbar^2}{2m} \nabla_x^2 = \frac{\hbar^2}{2m} \frac{\partial^2}{\partial x^2}$	2. $\phi(x) = Ax(a-x)$
3. $\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$	3. $\Phi(x) = A \sin\left(\frac{\pi x}{a}\right)$
4. $\hat{L}_x = -i\hbar \left(y \frac{\partial}{\partial z} - z \frac{\partial}{\partial y} \right)$	4. $\varphi(x) = axe^{-\frac{ax^2}{2}}$
5. \hat{C} Take complex conjugate $C =$	5. $\Psi(x, y, z) = x^2 + y^2 + z^2$
	6. $\Gamma(x, y, z) = x^2 yz + xy^2 z + xyz^2$

For help, see the file: *Operators Complex Conjugates & Rules.pdf*

2. Given the function: $\phi(x) = Ax(a - x)$

and the following integral: $b \int_0^a \phi(x)\phi(x)dx = 1$

use Mathematica and solve for the constant b .