Schrödinger equation in position-space representation (for AP Physics 2⁺)

According to		so
Classical	$E = K + U$	
Quantum	$E = hf$	
		$hf = K + U$
Classical	$K = \frac{1}{2}mv^2$ $K = \frac{m^2v^2}{2m}$ $p = mv$ $K = \frac{p^2}{2m}$	
		$hf = \frac{p^2}{2m} + U$
Quantum	$p = \frac{h}{\lambda}$	
		$hf = \frac{\frac{h}{\lambda} \cdot \frac{h}{\lambda}}{2m} + U$
Quantum	All information about a system can be represented in the wavefunction $\psi(x,t)$. For example, the probability of a point-like observation at time t in a spatial interval from x to $x + \Delta x$ is approximated by $\lvert\psi(x,t)\rvert^2 \Delta x$.	
		$hf\psi(x,t) = \frac{\frac{h}{\lambda} \cdot \frac{h}{\lambda}}{2m}\psi(x,t) + U(x)\psi(x,t)$
Classical	Classical plane waves propagating in free-space can be represented using complex exponentials that look like $\psi(x,t) = e^{-i\omega t}e^{ikx} = e^{-i\cdot 2\pi f t}e^{i\cdot\frac{2\pi}{\lambda}x}$	
		Use complex exponential representations of classical plane waves to explore mathematical behavior of expressions containing the quantum

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constant h and wavefunction $\psi(x,t)$

$$hf\;\psi(x,t) = hf e^{-i\cdot 2\pi f t} e^{i\cdot\frac{2\pi}{\lambda}x}$$

$$hf\;\psi(x,t) = \frac{h}{2\pi}\cdot\frac{-i\cdot 2\pi f}{-i} e^{-i\cdot 2\pi f t} e^{i\cdot\frac{2\pi}{\lambda}x}$$

Housekeeping: Let $\hbar = \frac{h}{2\pi}$

$$hf\;\psi(x,t) = i\hbar\cdot -i\cdot 2\pi f e^{-i\cdot 2\pi f t} e^{i\cdot\frac{2\pi}{\lambda}x}$$

$$hf\;\psi(x,t) = i\hbar\frac{\partial}{\partial t}\, e^{-i\cdot 2\pi f t} e^{i\cdot\frac{2\pi}{\lambda}x}$$

$$hf\;\psi(x,t) = i\hbar\frac{\partial}{\partial t}\psi(x,t)$$

$$\frac{h}{\lambda}\;\psi(x,t) = \frac{h}{\lambda} e^{-i\cdot 2\pi f t} e^{i\cdot\frac{2\pi}{\lambda}x}$$

$$\frac{h}{\lambda}\;\psi(x,t) = \frac{1}{i}\frac{h}{2\pi}\frac{i\cdot 2\pi}{\lambda} e^{-i\cdot 2\pi f t} e^{i\cdot\frac{2\pi}{\lambda}x}$$

$$\frac{h}{\lambda}\;\psi(x,t) = \frac{\hbar}{i}\frac{\partial}{\partial x} e^{-i\cdot 2\pi f t} e^{i\cdot\frac{2\pi}{\lambda}x}$$

$$\frac{h}{\lambda}\;\psi(x,t) = \frac{\hbar}{i}\frac{\partial}{\partial x} e^{-i\cdot 2\pi f t} e^{i\cdot\frac{2\pi}{\lambda}x}$$

$$\frac{h}{\lambda}\frac{h}{\lambda}\;\psi(x,t) = \frac{\hbar}{i}\frac{\partial}{\partial x}\left(\frac{\hbar}{i}\frac{\partial}{\partial x} e^{-i\cdot 2\pi f t} e^{i\cdot\frac{2\pi}{\lambda}x}\right)$$

$$\frac{h}{\lambda}\frac{h}{\lambda}\;\psi(x,t) = -\hbar^2\frac{\partial^2}{\partial x^2} e^{-i\cdot 2\pi f t} e^{i\cdot\frac{2\pi}{\lambda}x}$$

$$\frac{h}{\lambda}\frac{h}{\lambda}\;\psi(x,t) = -\hbar^2\frac{\partial^2}{\partial x^2}\psi(x,t)$$

$$i\hbar\frac{\partial}{\partial t}\psi(x,t) = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}\psi(x,t) + U(x)\psi(x,t)$$

Play with simulations at Professor Schroeder's website: https://physics.weber.edu/schroeder/software/SquareWell.html

The stationary solutions (amplitude distribution does not change with time) to the time-dependent Schrödinger equation for a Coulombic potential are the hydrogenic orbitals of chemistry.

