# Practice Quiz KEY

① State wether or not the following wavefunctions are valid. Take all space to be $0 \le x < \infty$

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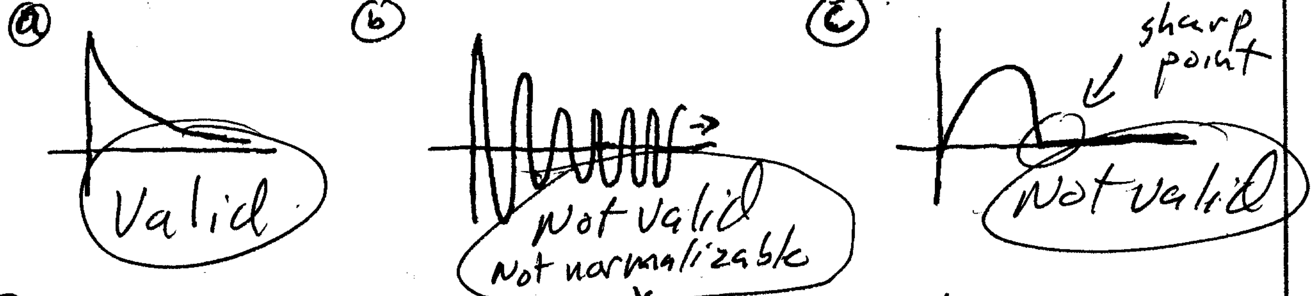


② Normalize $\psi(x) = e^{-x}$. Take all space to be $0 \le x < \infty$

$$N = \sqrt{\int_0^\infty (e^{-x})^2 \, dx} = \sqrt{\int_0^\infty e^{-2x}} = \sqrt{\frac{1}{-2} e^{-2x} \Big|_0^\infty}$$

$$N = \sqrt{\frac{1}{2}}$$

So $\boxed{\psi_{norm} = \sqrt{2}\, e^{-x}}$

③ Write down the 1D Schrödinger equation for $V(x) = \frac{1}{2}kx^2$

$\hat{H}\psi = E\psi \qquad \hat{H} = \hat{T} + \hat{V} \qquad \hat{T} = \frac{-\hbar^2}{2m}\frac{d^2}{dx^2}$

$\hat{V} = \frac{1}{2}kx^2$

$$\left(\frac{-\hbar^2}{2m}\frac{d^2}{dx^2} + \frac{1}{2}kx^2\right)\psi = E\psi$$

$$\Longrightarrow \boxed{\frac{-\hbar^2}{2m}\frac{d^2\psi}{dx^2} + \left(\frac{1}{2}kx^2 - E\right)\psi = 0}$$

④ write out the integral that you would need to do to evaluate $\langle \hat{p}_x \rangle$ for ~~the~~ a system described by the wavefunction in problem 2 above.

$$\langle \hat{p}_x \rangle = \int_0^\infty \sqrt{2}\, e^{-x} \left(-i\hbar \frac{d}{dx}\right) \sqrt{2}\, e^{-x} \, dx$$

$\sqrt{2}$