CHEM 3322: Physical Chemistry II Jonathan Riezman
Meeting 4 Quick Problems 1/29/21

1a) 9.41581980041211 x 10^{-33} m

b) 0.000165382337316 m

2a-i) $\frac{d(\sin(3x))}{dx} = -3\cos(3x)$ so (i) is not an eigenfunction of (a) because the operator does not return a scalar multiple of the input function.

a-ii) $\frac{d(e^{-3x})}{dx} = -3e^{-3x}$ so (ii) is an eigenfunction of (a) with eigenvalue -3.

b-i) $\frac{d^2(\sin(3x))}{dx^2} = -9\sin(3x)$ so (i) is an eigenfunction of (b) with eigenvalue -9.

b-ii) $\frac{d^2(e^{-3x})}{dx^2} = 9e^{-3x}$ so (ii) is an eigenfunction of (b) with eigenvalue 9.

3) Consider a particle in a 1D box of length a. Since the particle exists, we know that the probably of finding the particle in the interval x = (0, a) is 1. Thus $|\psi(x)|^2 = \int_0^a \psi*(x)\psi(x)dx = 1$ where the wave function is given as $\psi(x) = Nsin(\frac{\pi}{a}x)$ thus $1 = N^2\int_0^a \sin^2(\frac{\pi}{a}x)dx = \frac{N^2}{2}\int_0^a 1\,dx - \int_0^a \cos(\frac{2\pi}{a}x)dx$

$= N^2 \frac{a}{2} + \frac{a}{2\pi}\sin(\frac{2\pi}{a}[a]) - \frac{a}{2\pi}\sin(\frac{2\pi}{a}[0]) = \frac{N^2 a}{2} \Rightarrow N = \sqrt{\frac{2}{a}}$ for the particle.

4) (1.7320508075689, 45° = 0.785398163 radians, 54.735610327° = 0.955316618 radians)