

Homework 2

Due in class Sept. 10

From Shankar: Exercises 1.7.2, 1.8.2, 1.8.3, 1.8.7, 1.8.10, and

6. Given the following Hamiltonians in 3D space, state the conserved quantities (if any):

$$H = -\frac{\hbar^2}{2m}\nabla^2 \quad (1)$$

$$H = -\frac{\hbar^2}{2m}\nabla^2 + eEz \quad (2)$$

$$H = -\frac{\hbar^2}{2m}\nabla^2 - \frac{1}{4\pi\epsilon_0} \frac{Ze^2}{r} \quad (3)$$

$$H = -\frac{\hbar^2}{2m}\nabla^2 + \frac{1}{2}m\omega^2(x^2 + y^2 + z^2) \quad (4)$$

$$H = -\frac{\hbar^2}{2m}\nabla^2 + \alpha \sin(\omega t)r^2 \quad (5)$$

where m , e , E , Z , ω , and α are constants.

Extra credit: What quantities are conserved for the following Hamiltonian

$$H = -\frac{\hbar^2}{2m_1}\nabla_1^2 - \frac{\hbar^2}{2m_2}\nabla_2^2 + \frac{1}{2}m\omega^2|\mathbf{r}_1 - \mathbf{r}_2|^2$$

with m_i and ω constants?

Supplemental reading:

Review Chap. 2, especially Hamiltonians and Sec. 2.8.

Review Chap. 3 — motivation for quantum mechanics.