

**Recitation #6**  
**Quantum 521**

1. Consider a particle of mass  $m$  in a 1-D box,  $0 < x < a$ . Suppose that at time  $t = 0$  the particle is in the properly normalized state,

$$\psi(x, 0) = \sqrt{\frac{2}{a}} \left[ \frac{3}{5} \sin\left(\frac{\pi x}{a}\right) + \frac{4i}{5} \sin\left(\frac{3\pi x}{a}\right) \right]$$

- a) Determine the probabilities  $P_1$ ,  $P_2$  and  $P_3$  to measure the ground state energy  $E_1$ , the first excited state energy  $E_2$  and the third excited state energy  $E_3$ .
- b) What is the ground state energy  $E_1$ ? In the following questions, express all energies in terms of the ground state energy  $E_1$ .
- c) What is the expectation value  $\langle E \rangle$  ?
2. Consider a particle of mass  $m$  in a 1-D box,  $0 < x < a$ . Suppose that at time  $t = 0$  the particle is in the properly normalized state,

$$\psi(x, 0) = \frac{1}{\sqrt{2}} \sqrt{\frac{2}{a}} \left[ \sin\left(\frac{\pi x}{a}\right) + \sin\left(\frac{2\pi x}{a}\right) \right]$$

Find  $\langle x(t) \rangle$ . Use the integral

$$\int_0^\pi \theta \sin(\theta) \sin(2\theta) d\theta = -\frac{8}{9}$$