

Homework I - PHYS652

1. shankar: 12.6.9
2. Various measurements: Given following two operators, \hat{H} and \hat{B} with ϵ, β real:

$$\hat{H} = \epsilon \begin{pmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 3 \end{pmatrix} \quad \hat{B} = \beta \begin{pmatrix} 0 & -i & 0 \\ i & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

- a (2pts)** Why can these operators represent physical observables ?
 - b (5pts)** Given a particle state, $\psi = c \begin{pmatrix} 1+i \\ 2 \\ 2i \end{pmatrix}$. Determine c
 - c (5pts)** Assume that the particle is in the state ψ (in the basis of \hat{H}): If you measure the physical observable H what values can you get and with what probability ?
 - d (10pts)** Assume that your particle is in the state ψ (in the basis of \hat{H}): If you measure the physical observable B what values can you get and with what probability ?
 - e (5pts)** Assume that your particle is in the state ψ (in the basis of \hat{H}) and you do a sequence of measurements: First you measure H and find 3ϵ and then you measure B and find what value? What is the probability for this measurement route ?
 - f (13pts)** Assume that your particle is in the state ψ (in the basis of \hat{H}) and you do a sequence of measurements: First you measure B and find β and then you measure H ? What outcome can you get and with what probability. Don't worry if numbers get a bit ugly.
 - g (5pts)** If you assume that \hat{H} is a Hamilton operator, calculate the propagator.
3. Given an infinite square well potential with a Dirac delta-function barrier at $x = 0$ ($\lambda > 0$):

$$V(x) = \begin{cases} \infty & \text{for } x < -a \\ \lambda\delta(x) & \text{for } -a < x < b \\ \infty & \text{for } x > b \end{cases}$$

- a Determine the transcendental equation that determines the energy eigenvalues.
- b Discuss the energies for the limiting case $\lambda \rightarrow 0$ and interpret the result.
- c Discuss the energies for the limiting case $\lambda \rightarrow \infty$ and interpret the result.
- d Discuss the energies for the special case, $a = b$ and interpret the result.