Physics 462 Midterm I

Name:

You may use your homework portfolio as a reference with this exam.

Question	Points	Score
1	25	
2	25	
3	25	
4	25	
Total:	100	

1. **Expectation Values**

   (a) (9 points) Compute $\langle T \rangle$ (Kinetic energy; transmission coefficient wouldn't make sense in this context) for the second excited state of the infinite square well.

   (b) (9 points) Compute $\langle T \rangle$ for the second excited state of the harmonic oscillator.

   (c) (7 points) Draw a potential for which $\langle x \rangle \neq 0$.

2. **Downward step potential** Consider the downward step potential (as in problem 2.35).

   (a) (5 points) Compute the reflectance coefficient R for an energy just slightly above the top of the step. That is, $E = \epsilon$, where ϵ is some very small number, and the step goes from $V = 0$ on the left down to $V = -V_0$ on the right.

   (b) (7 points) Give a physical justification for your answer in part (a).

   (c) (5 points) Compute the reflectance coefficient R for $E \gg V_0$.

   (d) (8 points) Give a physical justification for your answer in part (c).

3. **Triple delta function potential** Note that in this problem I am not asking you to perform an entirely new calculation; rather, I would like you to generalize a result you obtained in homework.

   (a) (15 points) Based on your results for the double delta function potential, sketch the wave functions for the bound states of the triple delta function potential $V = -\alpha\left(\delta(x+a) + \delta(x) + \delta(x-a)\right)$.

   (b) (5 points) Which of these is the ground state, and why?

   (c) (5 points) Explain the parity (evenness or oddness) of these solutions.

4. **Linear combination** A particle in a harmonic oscillator potential has as its initial wave function a mixture of the first two stationary states:

$$\Psi(x,0) = A\left[\psi_0(x) + \psi_1(x)\right]$$

(a) (8 points) Normalize $\Psi(x,0)$.

(b) (8 points) Find $\Psi(x,t)$ and $|\Psi(x,t)|^2$.

(c) (9 points) Compute $\langle x \rangle$. (Remember that there is a trick to make this easy)