For Monday 9/24, read Griffiths section 2.5.1 and turn in by 9:30 am:

1. Conceptual: Compare Griffith's definition of a bound state with Q7.1.
2. Conceptual: Compare Griffith's definition of tunneling with Q11.3.
3. Easy Math: Let $y = \sqrt{a}[x + (b/2a)]$. Write out the equivalent for $(ax^2 + bx)$ in terms of y instead of x. What is the advantage of this change of variables?
4. Real math: The Gaussian wave packet. A free particle has the initial wave function $\Psi(x,0) = Ae^{-ax^2}$, where *A* and *a* are constants (*a* is real and positive).
   a. Normalize $\Psi(x,0)$.
   b. Find $\Psi(x,t)$.
   c. Find $|\Psi(x,t)|^2$. Express your answer in terms of the quantity $w \equiv \sqrt{\frac{a}{1+(2\hbar at/m)^2}}$.

      Sketch $|\Psi|^2$ (as a function of *x*) at *t*=0, and again for some very large *t*. Qualitatively, what happens to $|\Psi|^2$ as time goes on?
   d. Find $\langle x \rangle$, $\langle p \rangle$, $\langle x^2 \rangle$, $\langle p^2 \rangle$, σ_x, and σ_p.
   e. Does the uncertainty principle hold? At what time *t* does the system come closest to the uncertainty limit?

"For realz" weekly homework due 9:30 am on Wednesday 9/26 is math problems from 9/19, 9/21, and 9/24.

For Wednesday 9/26, read Griffiths' section 2.5 and Q11 and turn in by 9:30 am:

1. Conceptual: Are possible energy levels quantized only for bound states? Why or why not?
2. Conceptual: State the rules from Q11.4 in terms of mathematical equations. Can you match the rules to equations in Griffiths? If you can, give equation numbers.
3. Math: Evaluate the following integrals:
   a. $\int_{-3}^{+1} (x^3 - 4x^2 + 3x - 2)\delta(x+1)dx$
   b. $\int_{0}^{\infty} [\cos(2x) + 5]\delta(x-\pi)dx$
   c. $\int_{-3}^{+1} e^{(|x|+6)}\delta(x-4)dx$
4. Math: Consider the double delta-function potential $V(x) = -\alpha[\delta(x+a) + \delta(x-a)]$, where α and *a* are positive constants.
   a. Sketch this potential.
   b. Write the schrodinger equation in each of the three regions.
   c. What is the solution to each of these differential equations?
   d. What are the boundary conditions?
   e. Does problem 2.1(c) apply here? Does it help?
   f. Write the possible solutions for $\psi(x)$.
   g. How many bound states are there?

For Friday 9/28, read Griffiths' section 2.6 and Q11.2 turn in by 9:30 am:

5. Conceptual: What physical properties determine the number of bound states in a finite well?
6. Conceptual: How do we determine the number of scattering states?
7. Fill in: Derive equations 2.167 and 2.168. Show all steps. Hints:
    a. First use 2.165 and 2.166 to write C and D in term of F (without A or B).
    b. Solve for $Ae^{-ika}+Be^{ika}$ and $Ae^{-ika}-Be^{ika}$ in terms of $\sin(2la)$ and $\cos(2la)$ using the double angle formulas in trig.
    c. Add the equations you get in the previous section to get rid of B and then solve for F in terms of A (eq. 2.168).
    d. Now subtract the equations to get rid of A and solve for B in terms of F (eq. 2.167).
8. Math: Consider the "step" potential: $V(x)=\begin{cases}0, & \text{if } x\le 0\\ V_0, & \text{if } x>0\end{cases}$ and $V(x)=\begin{cases}V_o, & \text{if } x\le 0\\ 0, & \text{if } x>0\end{cases}$
    a. Sketch both functions. (This is due with conceptual questions.)
    b. Show that the reflection coefficients for the two cases are equal when $E > V_0$.
        i. Start by doing the first case. How many regions are you using? What are your boundary conditions?
        ii. Write the schrodinger equation in each region and solve. Solutions should be exponentials, not sines and cosines. You should be using k from equation 2.130 and l similar to (but not exactly) equation 2.148. Careful when defining these in terms of E and V_0.
        iii. Label your diagrams in part (h) with coefficients like in figure 2.15. Assume wave enters from left. What goes to zero?
        iv. Apply boundary conditions and calculate the reflection coefficient. (Hint: write as something over $(k^2-l^2)^2$.) Finally, plug back in for k and l to get reflection in terms of E and V_0 and simplify. You should get something ugly over V_0^2.
        v. Repeat above for other case.
    c. What happens when $E < V_0$? Show calculation and comment on solution. Do only for the first case.