

Subject and Problems on Second Exam

1. Understand solid angles and how they are used when describing scattering. The Rutherford experiment is a prototype. You should know how to integrate over a sphere. PT1.3, PT2.3, HW5: 4.8, 2, 3, 4
2. Use and derive the Bohr model and generalization. Especially important for estimates: PT1.1, PT2.1, HW6: all – for example 2,3,4
3. Debroglie waves, wave packets, and the uncertainty principle. HW7: 1 , HW7 3.19, 3.28, 3.30, Complex quizzes
4. Skills with wave functions PT1.2,PT2.2:
 - (a) Determine probabilities to find an electron in a region of space given the wave function HW7: 5.7
 - (b) Determine the most likely position of finding an electron. HW7: 5.2
 - (c) Normalize the wave function HW7: 5.10
 - (d) Compute the average position, variance in position, average momentum and the variance in momentum. Determine the average kinetic energy and potential energy many examples from HW7 and HW8
 - (e) Show that this or that function obeys the time dependent or time independent Shrödinger equation and determine the energy in the time independent case. HW7:5.10, HW8:2, PT1.2, PT2.2 EX5.9
5. Qualitative features of the wave function:
 - (a) Understand that the ground state is a balance between the kinetic and potential energies and that this provides an order of magnitude for the size HW8: 2, HW9 5.22, Additional Problems on Estimates
 - (b) Understand that in the classically allowed region the local wavelength is determined by the available kinetic energy, $k^2 \propto (E - V)$. HW9: 5.25, 5.27, 5.30, PT1.4
 - (c) Understand that in the classically forbidden region one decreases exponentially as one goes deeper into the forbidden region, and increases exponentially as one goes out of the forbidden region. The rate is governed by $\Psi \propto e^{\pm\kappa(x-x_o)}$ where x_o is the classical turning radius, $\kappa^2 \propto (V - E)$ HW9: 5.25, 5.27, 5.30, PT1.4.
 - (d) Understand that it is requiring that the wave function $\psi \rightarrow 0$ at $x \rightarrow \pm\infty$ that leads to discrete energies. see Lecture L20, Isho
 - (e) Describe qualitatively the $n - th$ excited state of a given potential. HW9: 5.22
6. Specific solutions to the Shrödinger Equation:
 - (a) Know and the particle in the box wave functions and energies. e.g. PT1.2, PT2.2, HW9.3

- (b) Know the energies associated with the harmonic oscillator and be able to use the table (see website) of harmonic oscillator wave functions given in class and on the web. If this table of wave functions is needed it will be provided. HW8: 2, HW9: 6.32

7. Calculate the effect of a perturbing potential on the energies. HW9: 3, PT2.2

Specific Mathematical Skills we have developed:

1. Know a few Taylor series and how to use. For this test $\sin(x)$, $\cos(x)$, $\exp(x)$, $(1+x)^\alpha$ should do it. This will appear in some (probably minor) way. HW9.3a
2. Know that products of sin's and cos's can be written as sums of sin's and cos's. Complex Quizzes. We used this in several ways analyzing beats. HW7: 1
3. Understand complex numbers: Complex Quizzes , HW7: 2