

Modern Physics

Problem Set 10

JC-45) Thermal Behavior of Air

(10 points) Air is mostly composed of diatomic nitrogen, N_2 . Assume that we can model the gas as an oscillator with an effective spring constant of 2.3×10^3 N/m and an effective oscillating mass of half the atomic mass. For what temperatures should vibration contribute to the heat capacity of air?

JC-46) Oscillating Block

A 2.0 kg block oscillates with an amplitude of 10 cm on a spring of force constant 120 N/m.

- (10 points) In which quantum state is the block?
- (10 points) The block has a slight electric charge and drops to a lower energy level generating a photon. What is the minimum energy decrease possible?

JC-47) Classical Particle in a Box

Classically, if a particle is not observed, the probability per unit length of finding it in a box is $1/L$ along the entire length of the box. Use this information to answer the following questions.

- (10 points) What is the expectation value of the position?
- (10 points) What is the expectation value of the square of the position?
- (10 points) Using parts a and b, calculate the uncertainty in the particle's position.

JC-48) Harmonic Oscillator Revisited

(30 points) Compute the uncertainty in position for the ground state of a harmonic oscillator using expectation values. You should work all integrals out by hand and show your work! The integrals are solvable using standard integration techniques. You may use a computer program such as Wolfram Alpha, MatLab or Mathematica to check your answer, but ***to receive credit, you must solve the problem by hand and turn in your written work.***

Talk 1) First Draft of Slides

(10 points) Turn in a complete first draft of your slides in pdf format. Email your pdf to cooley@physics.smu.edu.