

Chem 361
Quantum Chemistry
Midterm Exam
October 18, 2006



Name _____

**Full credit will be given to correct answers only when ALL the necessary steps are shown.
DO NOT GUESS THE ANSWER.**

This is a closed book and closed notes exam, and you are responsible to be sure that your exam has no missing pages (6 pages).

If you consider that there is not enough information to solve a problem, you have to specify the missing information and describe the problem solving procedure.

No one can make you feel inferior without your consent

- Eleanor Roosevelt -

Honor Statement

I have neither give nor received aid in this examination.

Full signature _____

Problem 1 (15 points)

Sirus, one of the hottest known stars, has approximate blackbody radiation with $\lambda_{\text{max}} = 2600 \text{ \AA}$. Estimate the surface temperature of Sirus.

Problem 2 (15 points)

A muon is an unstable elementary particle whose mass is $207 m_e$, and whose charge is either $+e$ or $-e$. A negative muon (μ^-) can be captured by a nucleus to form a muonic atom.

- a) A proton captures a μ^- . Find the radius of the first orbit of this atom.
- b) Find the ionization energy of the atom.

Problem 3 (30 points)

A particle limited to the x axis has the wave function $\Psi(x) = ax$ between $x = 0$ and $x = 1$; $\Psi = 0$ elsewhere.

- a) Find the probability that the particle can be found between $x = 0.45$ and $x = 0.55$.
- b) Find the expectation value $\langle x \rangle$ of the particle's position.

Problem 4 (30 points)

For a particle in a box, find the probability that the particle can be found between $0,45L$, and $0.55 L$ for the ground state and the first excited state.

Problem 5 (10 points)

Prove that for a Hermitian operator \hat{O} its eigenfunctions are orthogonal.