

Chem 155  
Quantum Chemistry  
Midterm Exam  
November 13, 2002



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(5 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.**

*But surely this is an old tale you tell, they say;  
But surely this is a new tale you tell, other say.  
Tell it once again, they say;  
Or, do not tell it yet again, others say.  
But I have heard all this before, say some;  
Or, but this is not how it was before, say the rest*

Naqshbandi recital, from The Way of the Sufi, by Idries Shah

**Honor Statement**

**I have neither give nor received aid in this examination.**

**Full signature \_\_\_\_\_**

**Problem 1 (20 points)**

Light with a wavelength of 400 nm strikes the surfaces of cesium in a photocell, and the maximum kinetic energy of the electron ejected is  $1.54 \times 10^{-19}$  J. Calculate the longest wavelength of light in nanometers that is capable of ejecting electrons from that metal.

**Problem 2 (20 points)**

Give an argument and predict which atom or ion in each of the following pairs should be larger:

- Kr or Rb
- Y or Cd
- $F^-$  or  $Br^-$

**Problem 3 (20 points)**

The motion of an electron in a carbon-carbon double bond  $C=C$  can be treated very crudely as a motion in a one-dimensional box of length 1.34 Å. Calculate the wavelength in nm of light necessary to excite the electron from the ground state to the first excited state.

**Problem 4 (20 points)**

Predict the structure of hydrazine ( $H_2NNH_2$ ) by writing down its Lewis structure first and using VSEPR theory. What is the hybridization of the two nitrogen atoms?

**Problem 5 (20 points)**

Using MO theory, determine why the dissociation energy of  $N_2$  is greater than  $N_2^+$  but for  $O_2^+$  the dissociation energy is greater than  $O_2$ .

**Problem 6 (20 points)**

Using our discussion of triatomic nonhydrated molecules, discuss the differences between  $NO_2^+$  and  $NO_2$ . Also discuss if their Lewis structures are or are not consistent with our MO analysis?