Exam I, Chemistry 4610/5560, Fall 2002
Department of Chemistry, University of North Texas, Dr. Mohammad Omary

Student name: ____________________________________

1) a. Fill the following table with the appropriate n_l and n_h values that correspond to the indicated emission lines in the atomic spectrum of hydrogen. (9 points)

Series	Line	n_l	n_h
Lyman	Lowest energy		
	2^{nd} lowest energy		
	3^{rd} lowest energy		
Balmer	Lowest energy		
	2^{nd} lowest energy		
	3^{rd} lowest energy		
Paschen	Longest wavelength		
	2^{nd} longest wavelength		
	3^{rd} longest wavelength		

b. Determine the wavenumber (<u>in cm^{-1}</u>), wavelength (<u>in nm</u>), and energy (<u>in J</u>) for the lowest-energy line in the Lyman series of the hydrogen spectrum and determine whether it lies in the visible, infrared, or ultraviolet region of the electromagnetic radiation.
Useful constants: Planck constant (h) = 6.626 ? 10^{-34} J s; Speed of light (c) = 2.998 ? 10^{8} m s^{-1}; Rydberg constant (R_H) = 1.097 ? 10^{7} m^{-1}.

(16 points)

2) a. Write down the electronic configuration for a neutral Ti atom (show the Noble gas configuration followed by the valence electrons). (2 points)

b. Calculate the n, l, m_l, and m_s values *<u>for each valence electron</u>* in part a. (4 points)

Electron	n	l	m_l	m_s

c. Explain how your answers illustrate: (4 points)

- The Pauli exclusion principle

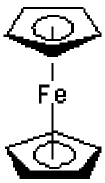
- Hund's rule

3) Ferrocene, an organometallic iron complex, is this week's "molecule of the week" according to web site of the American Chemical Society. In addition to its many scientific applications, ferrocene is used today as a fuel additive, a catalyst, and it also has current and potential biomedical, nanotechnology, and electronics applications. The structure of ferrocene is shown.

a. Iron in ferrocene has a +2 oxidation state. Write down the electronic configuration for Fe^{2+}. (2 points)

b. Label the point group of the ferrocene on the structure shown (staggered). (2 points)

c. Draw the eclipsed isomer of ferrocene and also label its point group. (2 points)



4) Answer the following questions for each of the three following molecules or ions:

$[COS_2]^{2-}$ (C is central) PCl_3Br_2 $[TeF_4]^{2-}$

a. Write the electronic configuration for the central atom. (6 points)

b. Draw the Lewis dot structure. (9 points)

c. Determine the geometry of the atoms comprising the molecule or ion (draw the structure and give its name). (6 points)

d. Determine whether each compound is polar or non-polar. (6 points)

e. Determine the point group for each. (6 points)

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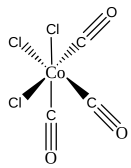
5) The octahedral complex $[Co(CO)_3Cl_3]$ has two geometrical isomers: *fac*- and *mer*- as shown below.
a. Write down the electronic configuration for the Co^{3+} ion.

(2 points)

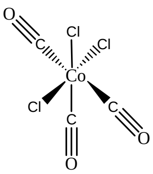
b. Determine the point group for both the *fac*- and *mer*- isomers of $[Co(CO)_3Cl_3]$. (4 points)

c. Show how group theory can be used to distinguish between the two isomers based on differences in the $\nu_{C\text{-}O}$ infrared and Raman bands. That is, determine the irreducible representations that correspond to the C-O stretching vibrations in each isomer, then determine whether each mode is IR or Raman active, and finally conclude how many $\nu_{C\text{-}O}$ bands are expected in the IR and Raman spectrum of each isomer.

(20 points)



fac-isomer



mer-isomer