Chemistry 341

Exam 1
September 26, 2000

Dr. McMahon

This exam consists of 10 questions on 8 pages.

In addition, a periodic table is included at the end of the exam.

Print Name ___________________________ Grading Key

Circle your TA's name

Wendy deProphetis
Melissa Feenstra
Gina Gencarelli
Lisa Jungbauer

Sarah Maifeld
Meg Schmitt
John Stevens

Grading

1. ___ / 8
2. ___ / 6
3. ___ / 12
4. ___ / 15
5. ___ / 15

Circle the day and time of your Discussion Session

Tue 3:30 pm
4:35 pm
5:40 pm

Wed 3:30 pm
4:35 pm

6. ___ / 9
7. ___ / 12
8. ___ / 9
9. ___ / 12
10. ___ / 12

Total ___ / 100
(8 pts) 1. Complete the Lewis Dot structures for each of the following compounds, showing any π bonds, lone pairs, and formal charges. All atoms should have fully satisfied valences.

(a) ![Lewis Dot Structure](image_a)

(b) ![Lewis Dot Structure](image_b)

(c) ![Lewis Dot Structure](image_c)

(d) ![Lewis Dot Structure](image_d)

(6 pts) 2. Wyerone - a natural product produced by the broad bean plant - is one type of Phytoalexin. These natural antibiotics help protect the plant against fungal infections. For each atom indicated with an arrow, specify the hybridization (sp, sp², or sp³) and approximate bond angle.

- Hybridization = sp³, Bond Angle = 109°
- Hybridization = sp², Bond Angle = 120°
- Hybridization = sp, Bond Angle = 180°
3. For the following reaction:
Label the Lewis Acid and the Lewis Base.
Label the Nucleophile and the Electrophile.
Use the curved arrow formalism to illustrate the reaction between these species.
Draw the structure of the first-formed product of the reaction.

\[ \text{CH}_3\text{C}_-\text{-} \rightarrow \text{CH}_3\text{C}_-\text{-} \]

-3 pts for correct curved arrow
-1 pt (2/3)
-3 pts + Lewis Acid Lewis Base +3 pts +3 pts for structure

Electrophile Nucleophile +3 pts

4. Chlorophyll is green. What is the color of light that Chlorophyll absorbs?

Chlorophyll appears green
It must absorb the complementary color ⇒ RED

+5 pts
5. Draw structures for the major organic products of the following reactions. (It is not necessary to write a balanced reaction with respect to reagents and inorganic products.)

(a) \( \text{hv, Br}_2 \rightarrow \text{Br} + \text{Br} \) give mono-bromination product(s) only

(b) \( \text{H}^+ \rightarrow \text{Br} \) Markovnikov addition; don't need to say this

(c) \( \text{BH}_3 \rightarrow \text{OH} \) anti-Markovnikov addition

(d) \( \text{H}_2 \rightarrow \text{Pt} \)

(e) \( \text{H}^+ \rightarrow \text{H}_2 \text{O} \rightarrow \text{OH} \) +2 pts for each product

6. Tetrafluoroethylene, \( \text{CF}_2=\text{CF}_2 \), is the monomer that is used to produce the polymer TEFlon.

Consider tetrafluoroethylene and the related molecule, 1,1-difluoroethylene, \( \text{CH}_2=\text{CF}_2 \). Indicate whether or not each molecule possesses a dipole moment. If it does, illustrate the direction of the dipole moment.

Dipole moment? (circle) YES \( \bigcirc \) NO +3pts

\( \text{CF} = \text{CF} \) up-down

\( \text{CF} = \text{CF} \) left-right

\( \text{CF} = \text{CF} \) not just individual bonds
(12 pts) 7. In the TV episode of *Poirot* shown on the A&E Series *Mysteries to Die For* this past Friday, *Poirot* investigates the murder of the chief executive of a British chemical company that has developed a new form of synthetic rubber.

Consider the structure of the following synthetic rubber:

\[
\text{[\text{Structure Image]}}
\]

(a) Are the alkene units CONJUGATED or NON-CONJUGATED? (circle) [3 pts]

(b) What color do you predict for the pure polymer? (refer to question 4, if necessary)
Colorless, Clear, White [3 pts for any of these non-conjugated double bonds absorb only UV light (they are colorless)]

(c) Draw the structure of the product(s) that you would expect upon degradation of this synthetic rubber in the smoggy, ozone-containing atmosphere of Los Angeles. (i.e. what product(s) are formed upon treatment of the polymer with O$_3$ followed by Zn / H$^+$?)

\[
\text{[Structure Image]}
\]

[3 pts for each structure]

(FYI - *Poirot* identified the murderer as a chemist who feared losing his patent royalties if the chief executive licensed the patent for the production of synthetic rubber to the Nazi-controlled German chemical company I. G. Farben.)
(9 pts) 8. Identify the following pairs of molecules as structural isomers or conformational isomers.

(a) \[ \text{conformational isomers (interconverted by chair-chair inversion)} \]

(b) \[ \text{conformational isomers} \]

(c) \[ \text{structural (constitutional) isomers} \]
(12 pts) 9. (a) Write a detailed mechanism for the following reaction.

\[ \text{Cyclic ring} + HBr \rightarrow \text{Product} \]

+6: correct (or nearly so), 1 mistake
+4: OK, but some mistakes
+2: problems [radical mechanism, fishhook arrows]
+0: blank or completely wrong

(b) Draw a free energy vs. reaction coordinate diagram for the reaction. Label any transition states or intermediates that may be involved.

\[ \Delta G \]

- 1 hump: 2 pts
- 1 pt: exothermic

For full credit:
1) Rxn is exothermic
2) TS for step 1 is rate determining

Note: Answer to part (b) must be consistent with mechanism proposed in part (a). If part (a) is wrong, a consistent answer for part (b) merits full credit.
(12 pts) 10. Draw (clearly) two chair conformations of cis-1-methyl-4-tert-butylcyclohexane. It is not necessary to show all of the hydrogen atoms, but you should show the hydrogen atoms at a carbon bearing another substituent. Identify each substituent as axial or equatorial.

Indicate the lowest-energy (most stable) conformation with an asterisk *. Briefly explain the basis for your choice.

\[ +3 \text{pts} \text{(including labels)} \]

\[ \text{CH}_3 \text{ (axial)} \]

\[ (\text{equatorial}) \]

\[ +3 \text{pts} \]

[most stable]

methyl group axial is much better than

\[ +3 \text{pts} \]

tert-butyl group axial (less severe 1,3-diaxial interactions)