

1. (32 points) Circle the letter *on the right* which corresponds to the answer to each question. There is only one correct answer for each question.

(i) Which of the following species has a negative charge *but NO lone pair of valence shell non-bonding electrons*? [all atoms have complete valence shell of electrons, but lone pairs are not shown]

A. NH_4 B. CH_3 C. HO D. BH_4 A
B
C
D

(ii) Which functional groups and structural features are present in the following molecule (strychnine)?

i. 2° amine

ii. ester

iii. ether

iv. ketone

v. amide

vi. sp carbon

vii. carbonyl

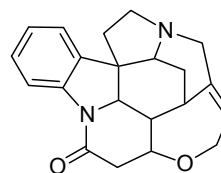
viii. methyl group

E. i, ii and vi only

F. iii, v and vii only

G. ii, iii, iv, and vii only

H. i, ii, vii and viii only

E
F
G
H

(iii) How many 1° alcohols with the molecular formula $\text{C}_6\text{H}_{14}\text{O}$ are possible?

I. five

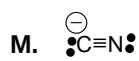
J. six

K. seven

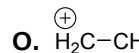
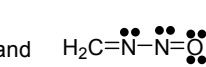
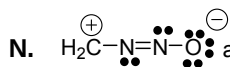
L. eight

I
J
K
L

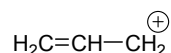
(iv) Which of the following pairs are *not* valid resonance structures?



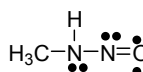
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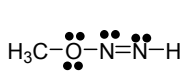
and



P.



and

M
N
O
P

(v) Which of the following molecules has an sp hybridized carbon atom?

Q. CH_3I R. CO_2 S. CH_3CHO T. $\text{CH}_3\text{CH}_2\text{OH}$ Q
R
S
T

(vi) Which of the following have approximately tetrahedral geometries? [nonbonded electrons not shown]

i. methyl anion, CH_3^- ii. boron trichloride, BCl_3 iii. tetrachloroaluminate, AlCl_4^- iv. amide anion, NH_2^-

U. only i and iv

V. only i and iii

W. only i, iii and iv

X. i, ii, iii and iv

U
V
W
X

(vii) In which of the following compounds is hydrogen bonding absent?

Y. 2° amine

Z alcohol.

AA. aldehyde

BB. carboxylic acid

Y
Z
AA
BB

(viii) What is the shape of a p orbital of nitrogen in $\text{H}_2\text{C}=\text{NH}$ which overlaps with the p orbital on carbon to form a π -bond?



CC



DD



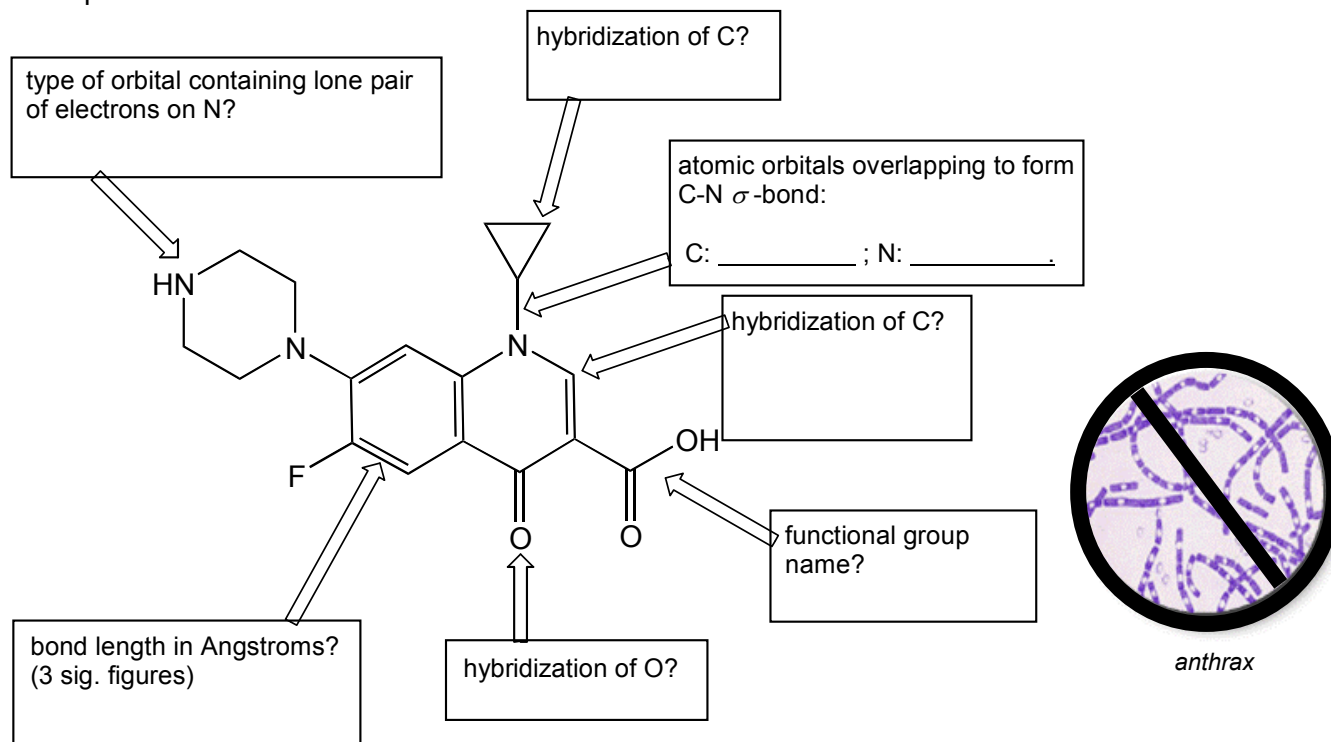
EE



FF

CC
DD
EE
FF

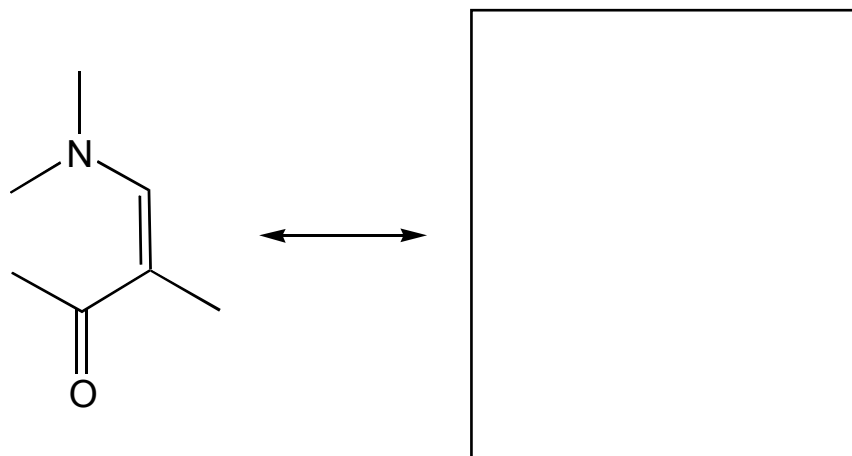
2. (34 points) (a) The structure of ciprofloxacin (Cipro®) is shown below. Provide appropriate descriptions of the molecular features in the boxes.



(b) How many lone pairs of non-bonding valence shell electrons does Cipro possess? (these are omitted from the structure shown above)

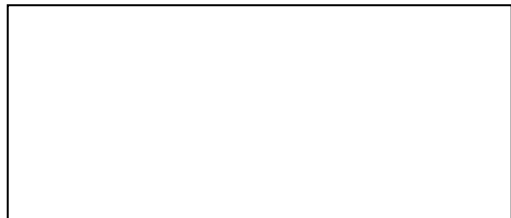
(c) What is the molecular formula of Cipro?

(d) The C=O bond of the ketone of Cipro (shown below in a simplified fragment of the molecule) is slightly *longer* than the C=O bond of a simple ketone. Draw a resonance structure of this fragment that explains this observation.



3. (24 points) Provide a single *line-bond* structure in each of the following boxes.

(a) An alcohol with the molecular formula $C_7H_{16}O$ which has methyl groups and methine groups, but no methylene groups.



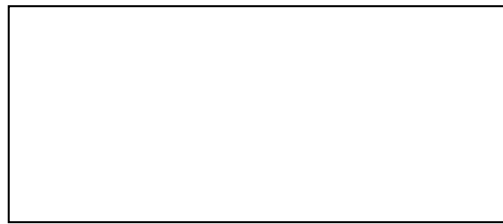
(c) *sec*-butyl phenyl ether



(b) The isomer of $C_2H_2Cl_2$ which has no net molecular dipole

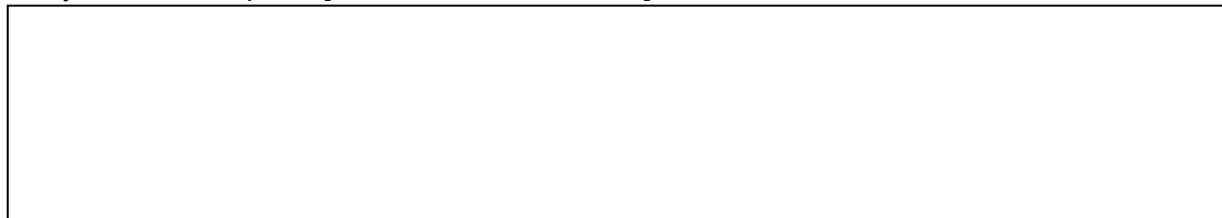


(d) The lowest boiling constitutional isomer of C_3H_8O

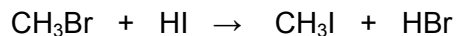


4. (10 points)

(a) Fluorine is more electronegative than chlorine. However, methyl chloride is *more* polar than methyl fluoride. Explain. [*Answer in one sentence*]



(b) What is the value of ΔH for the following reaction? Indicate whether this reaction is exothermic or endothermic.



$\Delta H = \underline{\hspace{2cm}}$ kcal/mol

(circle one)

Exothermic

Endothermic

Bond Strengths
(kcal/mol)

H-H	104
H-Br	87
H-I	71
C-H	99
C-C	88
C-Br	67
C-I	57