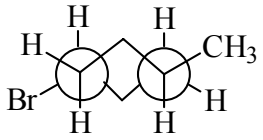
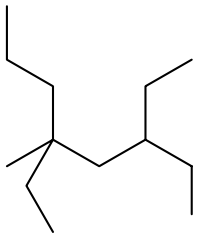
Answer questions in the blue book provided. Start new questions on a separate page.

1.(20) Give the names for the following compounds using I.U.P.A.C. nomenclature. Be sure to denote stereochemistry if appropriate (*cis*, *trans*).

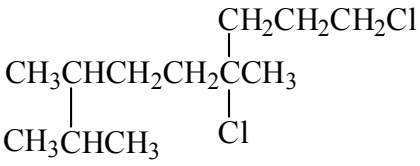
a)



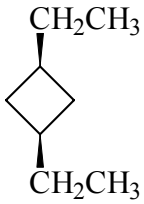
b)



c)



d)

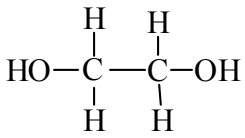


2.(15) Using Kekulé structures (zig-zag), draw 8 unique structural isomers with the formula of $C_5H_{11}Cl$.

3.(15) Consider the molecule **3-methylpentane** citing along **C_2-C_3**. Construct all six rotational conformers using Newman projections. **Also**, identify the *highest* and *lowest* energy conformations and determine the energy difference (KJ/mol) between the two. *Please be sure to draw the correct molecule (not cyclopentane)!*

Interaction	Energy cost (KJ/mol)
methyl-methyl *gauche*	3.8
methyl-ethyl *gauche*	4.0
methyl-H *eclipse*	6.0
ethyl-H *eclipse*	6.2
methyl-methyl *eclipse*	11.0
methyl-ethyl *eclipse*	12.0
H-H *eclipse*	4.0

4.(15) The molecule ethane 1,2-diol (ethylene glycol) can exist in 2 different *staggered* conformations. One conformation is nonpolar ($\mu = 0D$) whereas the other conformation has a considerable dipole moment.



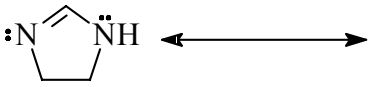
The molecule actually adopts a conformation that has a nearly identical dipole moment to the theoretical value for the polar conformation.

a) Draw the two conformations with Newman projections (focus down C-C bond).
b) Identify the polar and nonpolar conformations by showing the direction of the dipole moment in the polar conformation and label them as *anti* or *gauche*.
c) Explain why ethylene glycol "prefers" to exist almost entirely in the polar conformation even though it appears to be somewhat sterically hindered. Feel free to use a well-drawn picture to enhance your explanation.

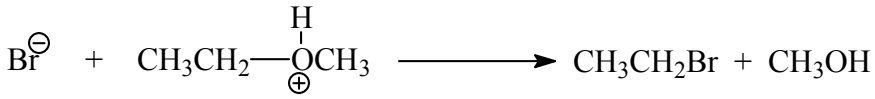
5.(10) Draw the Lewis-dot representations of $[PO_2]^+$ and $[PO_2]^-$.

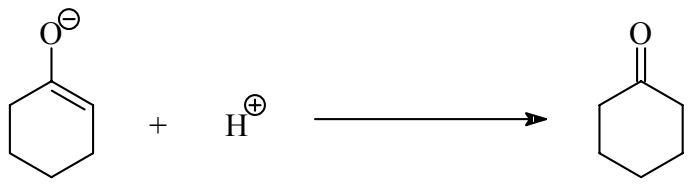
a) Which one of these is bent and which is linear (OPO bond angles)? How do you know?
b) Which one has a resonance structure that contributes to the overall structure. Draw the resonance structure.

6.(10) The molecule shown below reacts quickly as a Bronsted base with HCl. Which nitrogen atom is more basic (i.e. which nitrogen atom will be protonated)? Draw a resonance structure of the molecule that shows why only one nitrogen reacts.

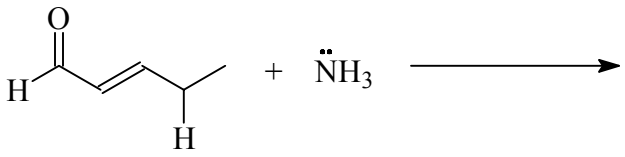


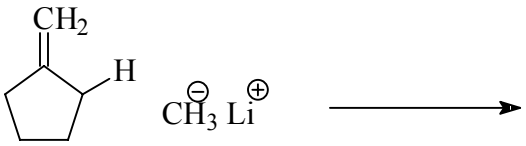
7.(10) Provide arrows to indicate the electron flow for the following reactions.

a) 

b) 

8.(10) Give the products of the following reactions using the given arrow formalism.

a) 

b) 

9.(15) The molecule ***trans*1-methyl-3-propylcyclohexane** can exist in two conformations that have a **difference in energy of only 1.0 KJ/mol**. Draw the two chair conformations of this molecule and **label the alkyl groups** as axial-up, axial-down, equatorial-up, or equatorial-down. If the energy value of a 1,3-diaxial interaction between a methyl group and a hydrogen is 3.8 KJ/mol, what is the value of a 1,3-diaxial interaction between a propyl group and a hydrogen.

10.(20) Consider the free radical halogenation (X_2) of **methane** with both **fluorine (F_2)** and **bromine (Br_2)**. Use the information below and the data table provided to answer the following questions. $CH_4 + X_2 \dashrightarrow CH_3X + HX$

X_2 ----------> $X^{\cdot} + X^{\cdot}$ **X= F Br**

i) $X^{\cdot} + CH_4$ ----------> $HX + CH_3^{\cdot}$ **ΔH_i** _____ _____

ii) $CH_3^{\cdot} + X_2$ ----------> $CH_3X + X^{\cdot}$ **ΔH_{ii}** _____ _____

ΔH_{rxn}_____ _____

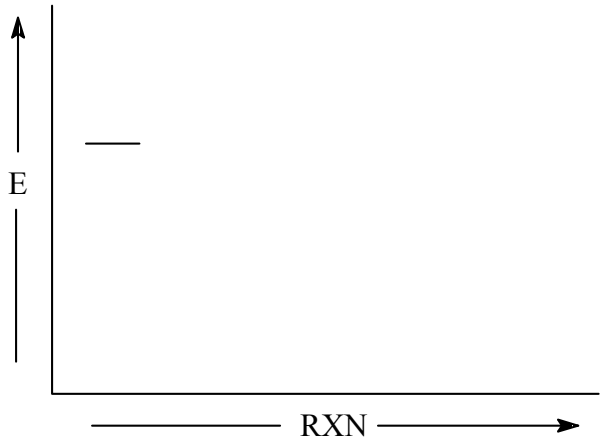
a) Using the two propagation steps shown above (i and ii), calculate ΔH_i and ΔH_{ii}. and ΔH_{rxn} for the reaction with both F_2 and Br_2 (see BDE values on next page).

b) Are the reactions endo- or exothermic overall? _____

c) Which step is the rate determining step in the **bromination** reaction?

d) Which reaction is likely *not* a safe reaction to carry out in the lab? Why?

e) On the axes below, construct a reaction profile for the **bromination** propagation steps. Keep your profile roughly to scale. With vertical arrows, **Label ΔH^o** for step i, ii, and for the overall reaction.



Bond	**Bond Dissociation Energy (KJ/mol)**
CH_3-H	438
CH_3-Br	293
CH_3-F	456
H-Br	366
H-F	569
Br-Br	193
F-F	157