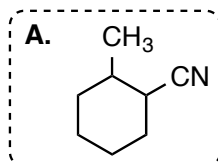


Name: _____

Consider the following: each 1,3-diaxial strain interaction between CH₃ and H is 1 kcal/mol; each 1,3-diaxial strain interaction between CN and H is 0.1 kcal/mol; each gauche strain interaction between CH₃ and CN is 0.1 kcal/mol; and the gauche strain interaction between CH₃ and CH₃ is 1 kcal/mol.

1a. 11 pts. Focus on the **cis** and **trans** stereoisomers of the molecule in box **A**. In **B** and **C**, draw the most stable **chair** conformer, as specified in the respective box (cis and trans). In boxes **D** and **E**, draw the least stable chair conformer.

Then, calculate ΔG_0 for the **chair-flip process** in **F** and **G**.



B. Trans, Most stable chair

D. Trans, Least stable chair

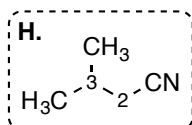


C. Cis, Most stable chair

E. Cis, Least stable chair

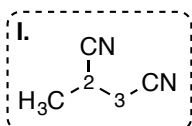


1b. 10 pts. Consider compounds **H** and **I**. Draw the **most** and **least** stable Newman projection of each molecule, putting carbon number 2 in the front. Note: exact strain energy values are not necessary to answer this question.



J. Most Stable
Newman Projection

L. Least Stable
Newman Projection



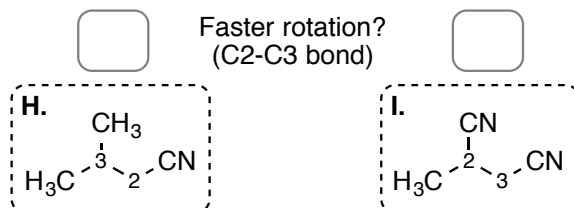
K. Most Stable
Newman Projection

M. Least Stable
Newman Projection

pts. this pg.

Continued from the previous page.

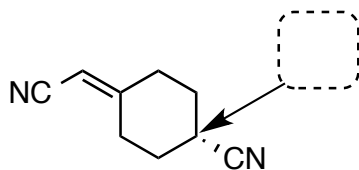
1c. 4 pts. Which compound would you expect to rotate faster about the C2-C3 bond? Mark an **X** in the box above the structure of the molecule that you expect to have a faster rotation.



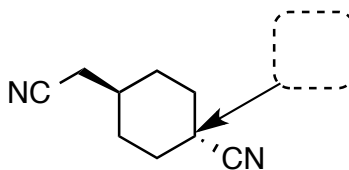
Briefly explain your answer in the box below:

2. 18 pts. In the **dashed boxes**, label the **R/S** specific configuration of the carbon center indicated by the arrows. If the carbon is not a chiral center, enter the letter **N** (for “no chiral center”).

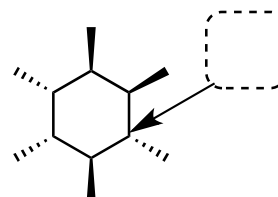
In the solid boxes, put a check mark (✓) in the appropriate space if the **molecule is chiral or achiral**.



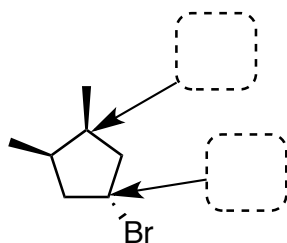
☐ Chiral
☐ Achiral



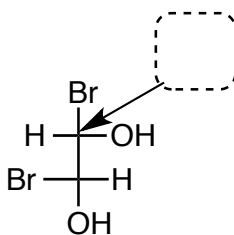
☐ Chiral
☐ Achiral



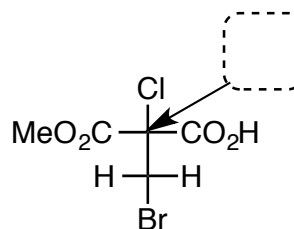
☐ Chiral
☐ Achiral



☐ Chiral
☐ Achiral



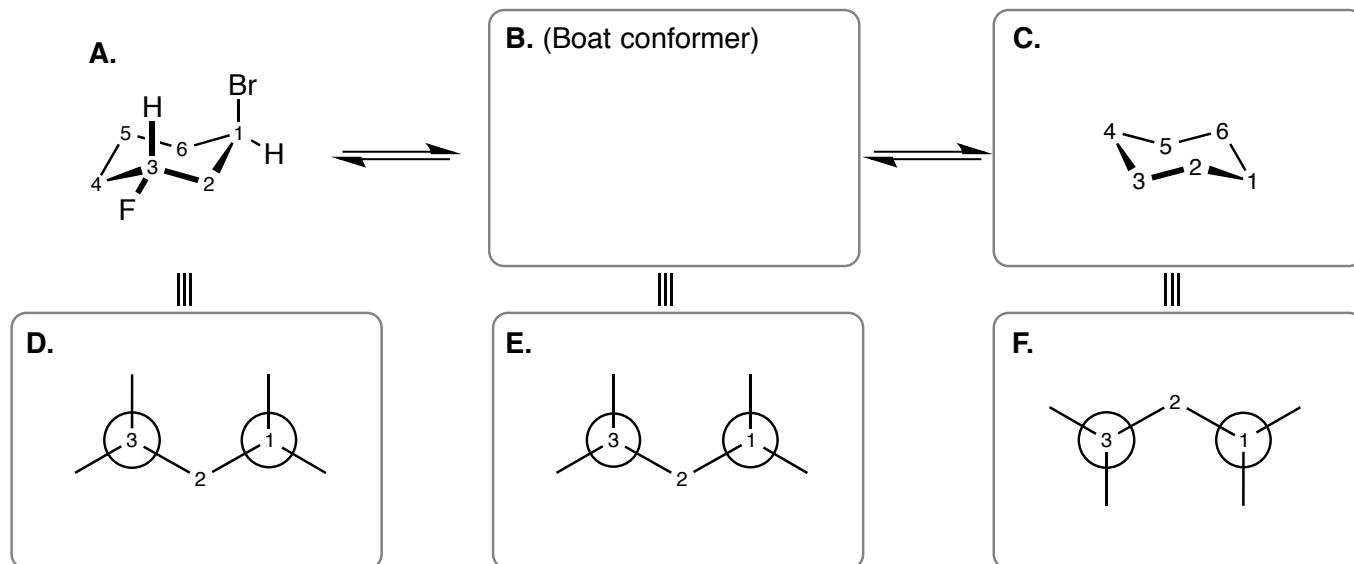
☐ Chiral
☐ Achiral



☐ Chiral
☐ Achiral

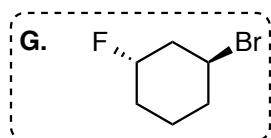
Name: _____

3a. 11 pts. The cyclohexane molecule containing two functional groups in box **A** is drawn as a chair, showing the carbons as numbers for easy labeling and tracking during the chair-flip process. In box **B**, draw the boat conformer, and in **C**, add the missing bonds and atoms that show the ring-flipped conformer. In boxes **D**, **E**, and **F**, complete the corresponding Newman projections **with all missing bonds and atoms** (C, H, Br, F).



Comparing **A**, **B**, and **C**, which conformer would you *expect* to be the most stable? Answer: enter A, B or C

3b. 2 pts. What is the name of the molecule in box **G**. (Answer in the space provided).



Name:

3c. 2 pts. Now consider the molecules in boxes **A** and **G**. What is their relationship? Mark an **X** in the boxes below. Check all that apply.

A and **G** are:

☐

same molecule

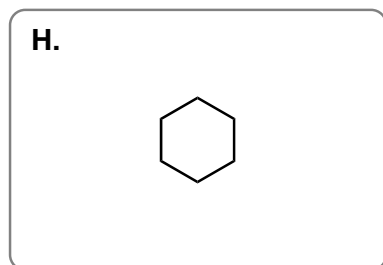
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enantiomers

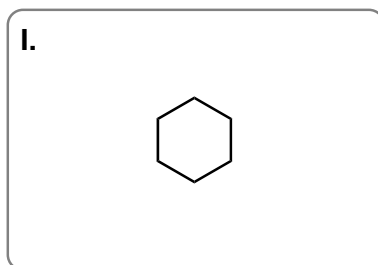
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diastereomers

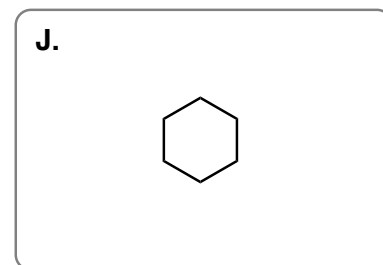
3d. 6 pts. In boxes **H**, **I**, and **J**, there may be more than one correct answer. Therefore, provide **one structure**, as specified by the following instructions: In box **H**, draw a **diastereomer** of **A**. In box **I**, draw a **chiral constitutional isomer** of $C_6H_{10}BrF$, where there's still a 6-membered ring (other than the ones shown above). In box **J**, draw an **achiral constitutional isomer** of $C_6H_{10}BrF$, where there's still a 6-membered ring.



Diastereomer



Chiral constitutional isomer



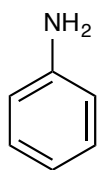
Achiral constitutional isomer

pts. this pg.

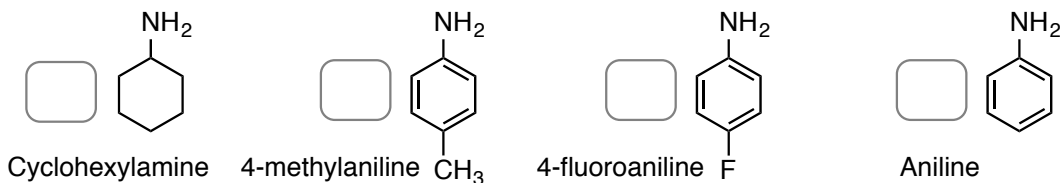
Name: _____

4a. 5 pts. Draw *all* resonance structures for aniline (*i.e.* only the structures with full octets). Be sure to include lone pairs and arrow pushing to show the movement of electrons in the structure on the left and the ones within the box.

Aniline:



4b. 6 pts. Put an **X** in the box to indicate which one is the **weakest Brønsted base** below.



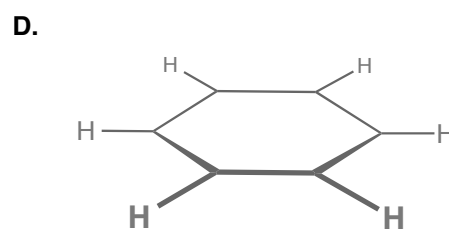
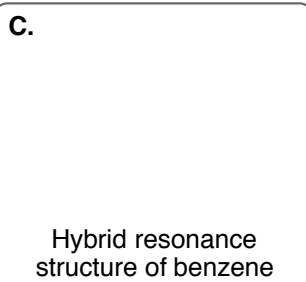
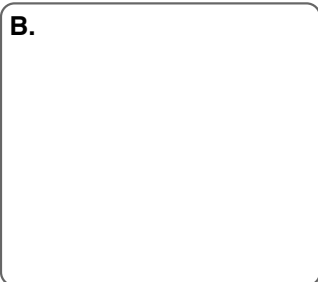
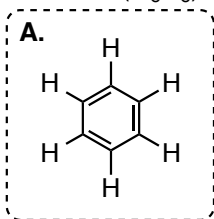
Briefly explain your answer, comparing and contrasting the different compounds, and include structures that are relevant to your explanation.

Be concise! Adding superfluous statements that are wrong will result in deduction of points, even if you have already written the correct explanation.

Name: _____

5a. 5 pts. In box **B**, draw the best resonance structure of benzene (full octets, no formal charge), including the arrows that show the interconversion between *both* structures. In box **C**, draw the *hybrid* resonance structure of benzene. In the σ -bond skeleton of benzene (**D**, side view), draw the atomic orbitals and clearly label any π bonds. **NOTE:** exclude the *s* and *sp*² atomic orbitals and σ -bonds.

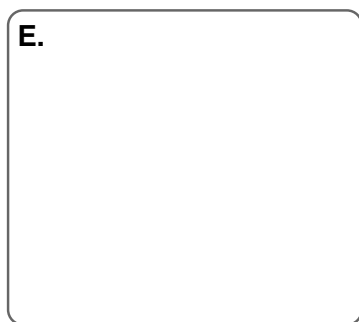
Benzene (C₆H₆)



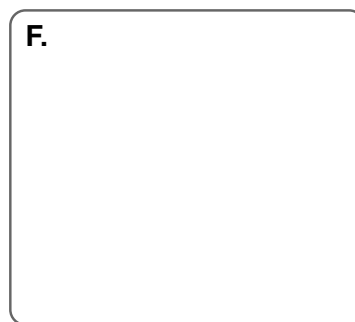
5b. 3 pts. The benzene structure in box **A** shows that benzene has alternating double bonds and single bonds in a cyclic fashion. A typical C-C **single** bond length is **1.54 Å**. A typical C=C **double** bond length is **1.34 Å**. However, the actual C-C bond distances in benzene are all equal (the C-C bonds in benzene are **1.40 Å**). Briefly explain why:

5c. 5 pts. In 1865, Kekulé proposed the structure of benzene (box **A**), which is one of the 217 constitutional isomers of the molecular formula C₆H₆. Kekulé's structure contains each carbon bonded to one hydrogen. In boxes **E** and **F**, draw two other **constitutional isomers** of C₆H₆ that **also** have **each carbon bonded to one hydrogen** (excluding resonance structures of box **A**). Hint: Multicyclic structures are possible.

Constitutional isomer 1



Constitutional isomer 2



5d. 3 pts. Out of all the structures in boxes **A**, **E**, and **F**, which constitutional isomer do you expect to be the most stable (lower energy structure)? (Consider all factors contributing to the stability of the structure).

☐ Most stable constitutional isomer

Briefly explain your answer:

pts. this pg.