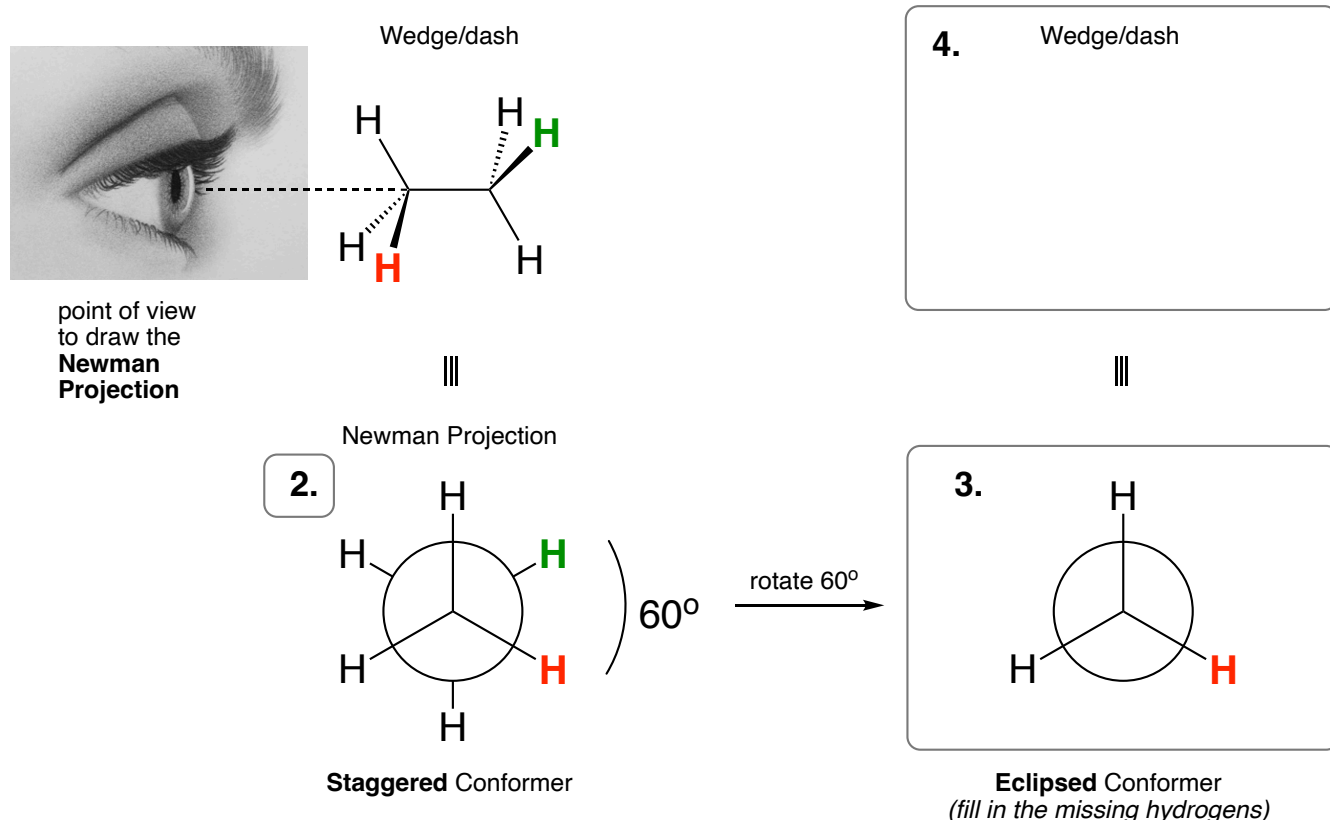


Consider the **staggered** Newman Projection of ethane. Using your model kit, build ethane.

1. What does the big circle represent in the Newman Projection?

2. Circle the three hydrogens in the back of the **staggered** conformer (see diagram below).



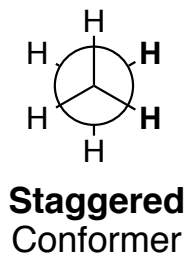
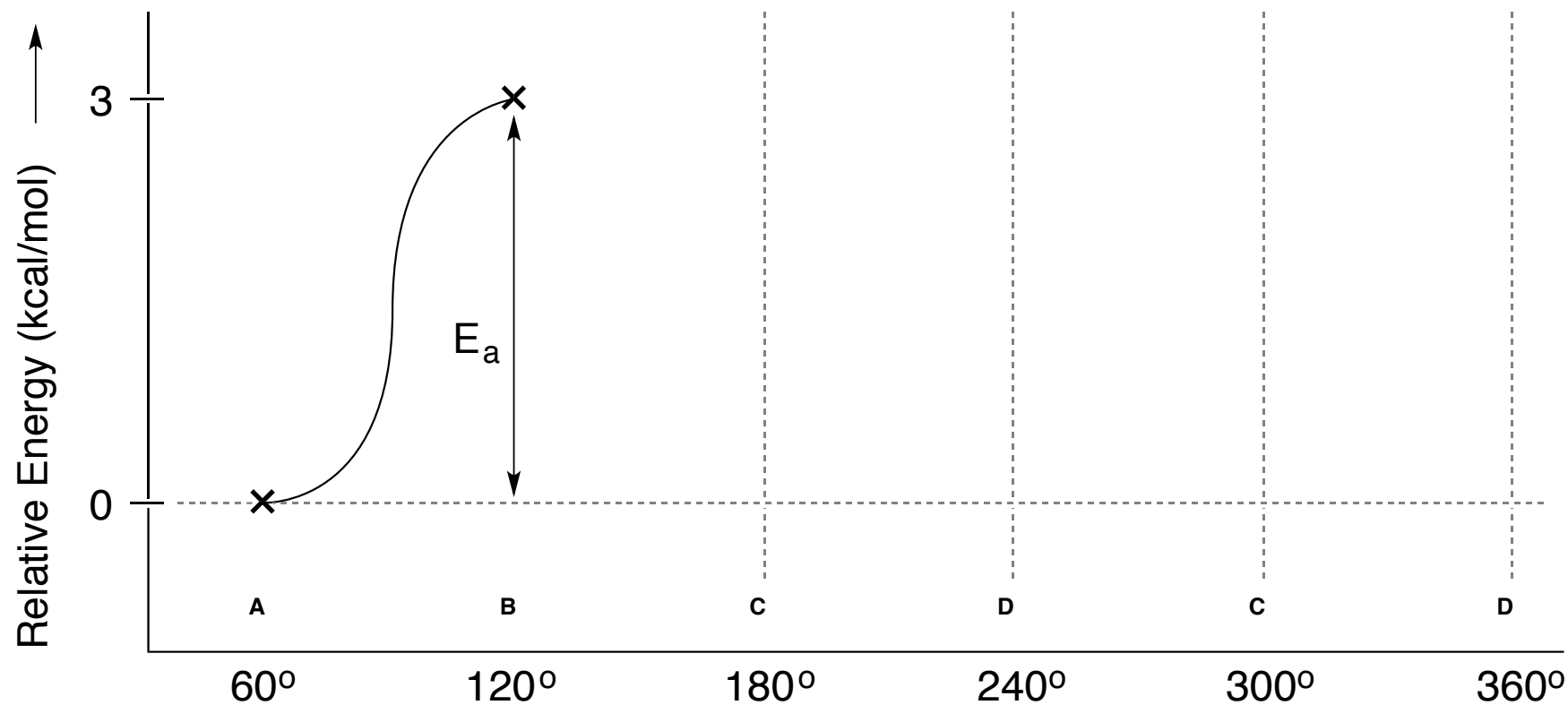
3. Rotate the **bold hydrogen** in the back carbon by 60° and *finish drawing* the Newman projection of the **Eclipsed** Conformer.

4. In the blank box provided above, draw the wedge/dash structure of the missing conformational isomer.

5. Explain the names **staggered** and **eclipsed** in Ethane: _____

6. The **staggered** Newman projection is more stable than the **eclipsed** rotational isomer. Propose an explanation (3 sentences or less): _____

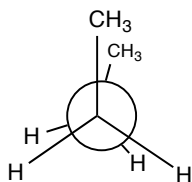
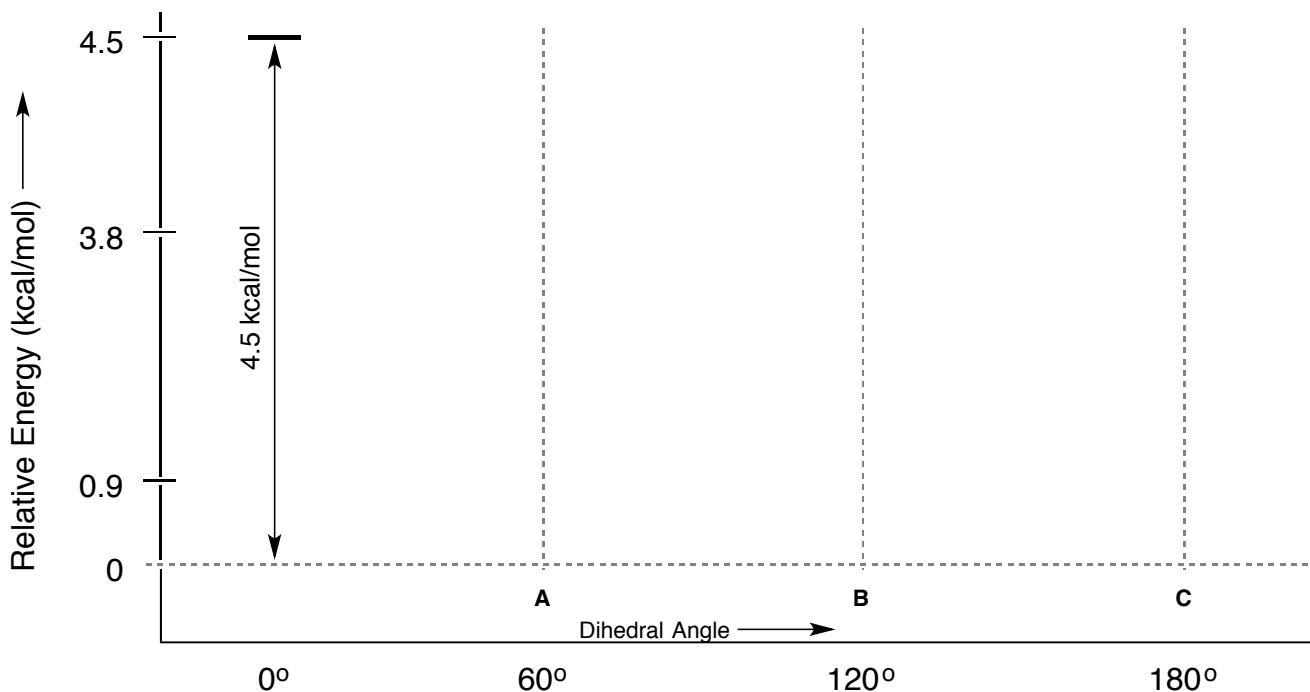
7. In a free energy diagram for the rotation about the C-C bond in ethane, the **eclipsed** conformer is higher in energy by 3 kcal/mol than the **staggered** conformer. Complete the free energy diagram for the rotation about the C-C σ -bond (hint: rotate the carbon in the back). Put an "X" where you expect the free energy value for the rest of the conformers and connect the X's with a line, as initially shown.



Note: E_a is the **activation energy**, *i.e.* the energy required to overcome the barrier to rotate from 60 to 180 degrees.

Using your model kit, build **Butane**.

1. Considering the energy interactions written on the board (at various dihedral angles of $R_1-C_A-C_B-R_2$), complete the free energy diagram for the rotation of the σ -bond between the second and third carbons of butane. (the numbers are also written on the back of this sheet).



Name of
Conformer

Put an "X" in
the box for the
lowest energy
conformer

☐
☐
☐
☐

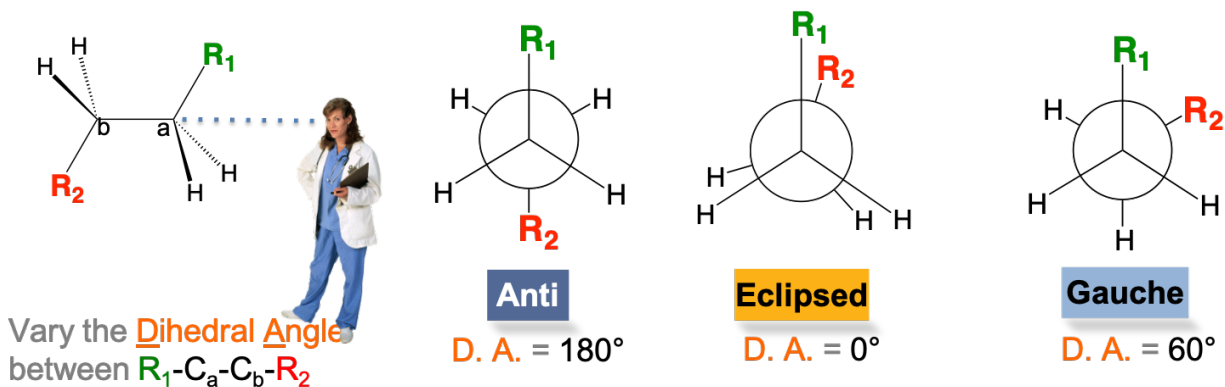
2. What is the activation energy for the rotation:

from 60° to 180°? _____

from 180° to 60°? _____

from 60° to -60°? _____

4. Explain why is the gauche conformer higher in energy than the anti conformer (3 sentences or less):



Anti is the lowest energy rotational isomer.

Compare the repulsive energy interactions of R_1 and R_2 as viewed through C_a-C_b

R_1	R_2	Interaction	Energy cost, each (kcal/mol)	Overall energy of conformer	
H	H	Eclipsed	1	3	There are 3 eclipsed H-H interactions in ethane One H-CH ₃ eclipsed Two H-H eclipsed One CH ₃ -CH ₃ eclipsed Two H-H eclipsed
H	CH ₃	Eclipsed	1.4	3.4	
CH ₃	CH ₃	Eclipsed	2.5	4.5	
H	H	Gauche	0		Only One CH ₃ -CH ₃ gauche interaction
CH ₃	H	Gauche	0		
CH ₃	CH ₃	Gauche	0.9	0.9	