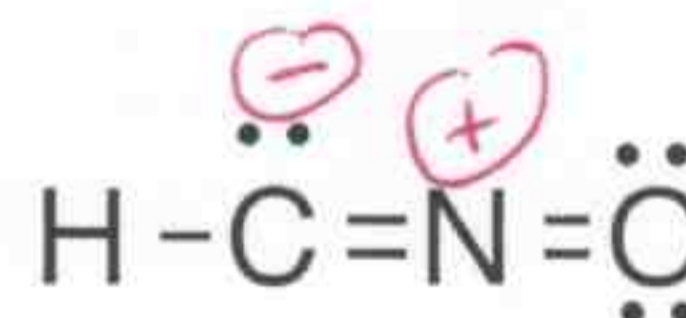
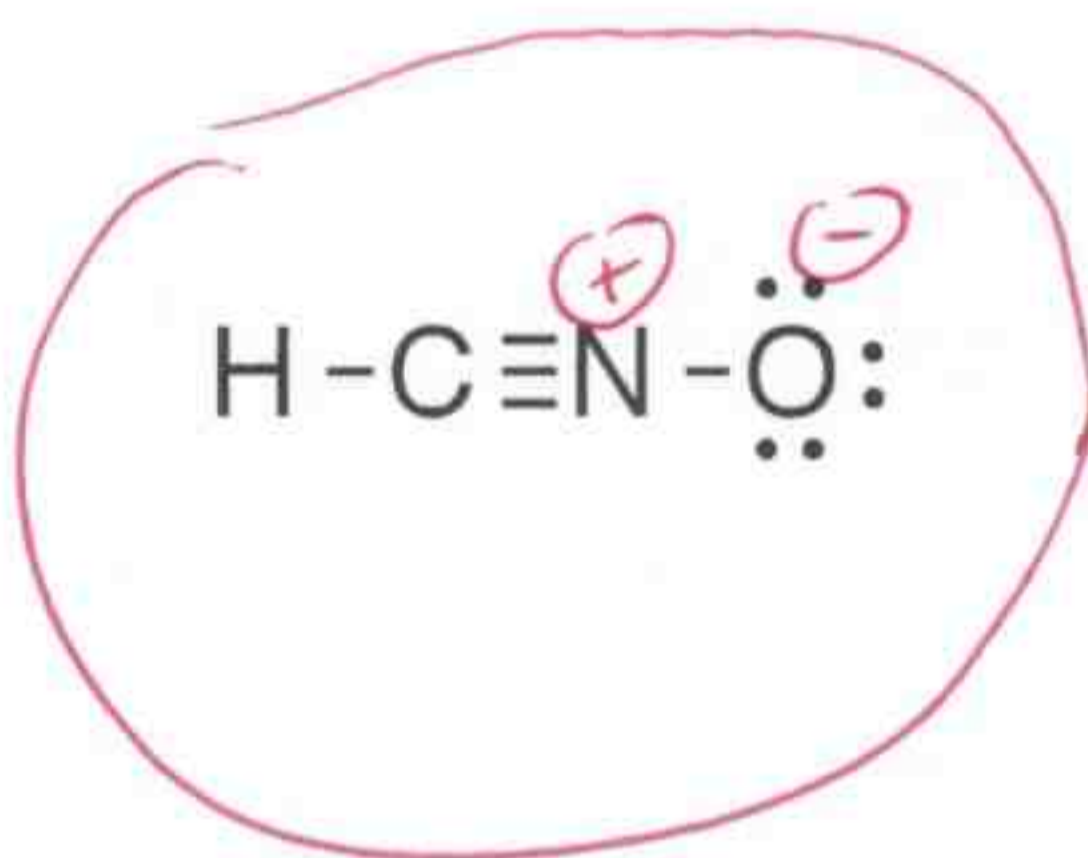
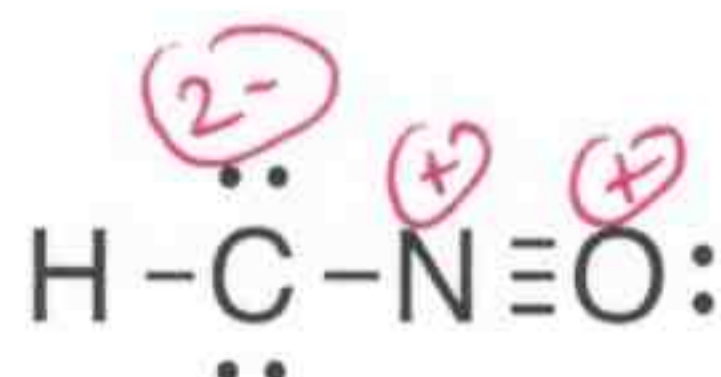




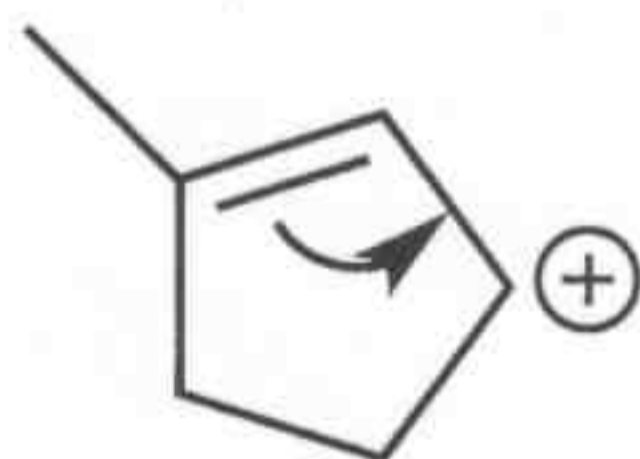
1. A) Provide the best Lewis structure for the azide anion,  $\text{N}_3^-$ , show the valence electrons for each atom and indicate the formal charge and the atom that bears the formal charge (6 pts).



B) Add formal charges to each resonance structure of HCNO (3 pts). Circle the structure that is the most stable (3 pts).



C) Draw the resonance structure indicated by the arrow (6 pts).





2. A) Match the pKa values with the corresponding acids (6 pts).

HCl

NH<sub>3</sub>CH<sub>3</sub>CH<sub>3</sub>CH<sub>3</sub>CO<sub>2</sub>HNH<sub>4</sub><sup>+</sup>CH<sub>3</sub>OHpKa = 50 is CH<sub>3</sub>CH<sub>3</sub>pKa = 35 is NH<sub>3</sub>pKa = 15 is CH<sub>3</sub>OHpKa = 9 is NH<sub>4</sub><sup>+</sup>pKa = 4 is CH<sub>3</sub>CO<sub>2</sub>H

pKa = -6 is HCl

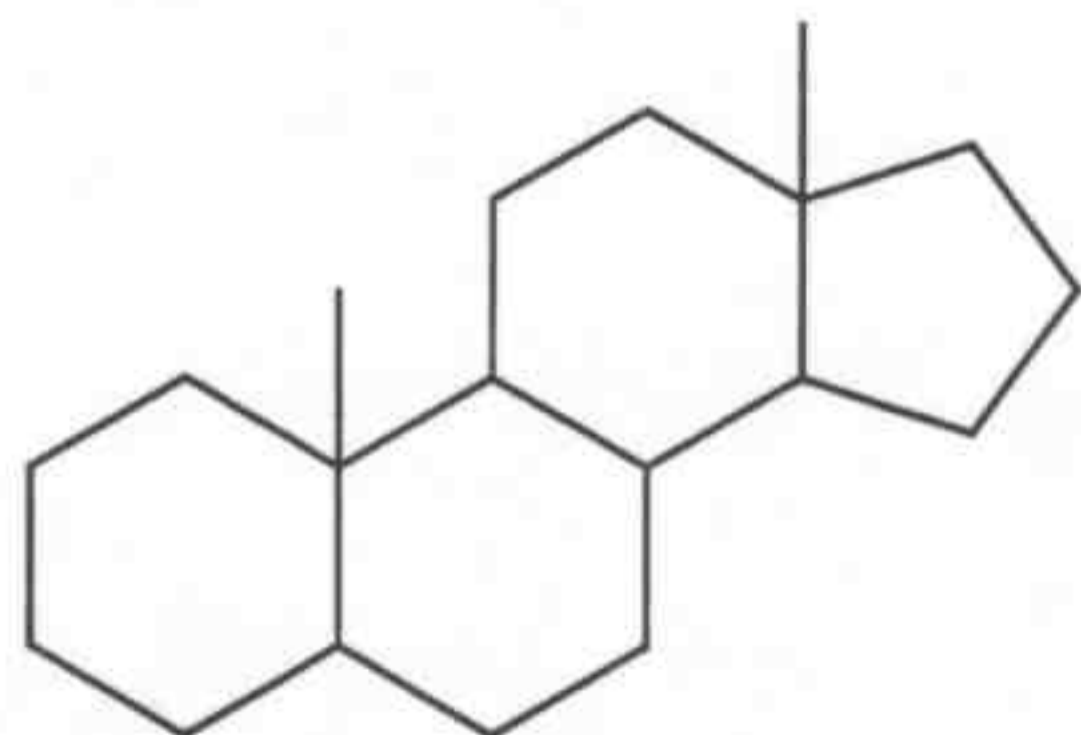
B) Rank the following acids in strength from weakest acid to strongest acid (3 pts)

HCl, H<sub>3</sub>P, H<sub>4</sub>Si, H<sub>2</sub>S*weak**strong*

C) Rank the following bases in strength from weakest base to strongest base (3 pts)

(CH<sub>3</sub>)<sub>3</sub>CCO<sub>2</sub><sup>-</sup>, CBr<sub>3</sub>CH<sub>2</sub>CO<sub>2</sub><sup>-</sup>, CF<sub>3</sub>CO<sub>2</sub><sup>-</sup>, CBr<sub>3</sub>CO<sub>2</sub><sup>-</sup>*weak**strong*

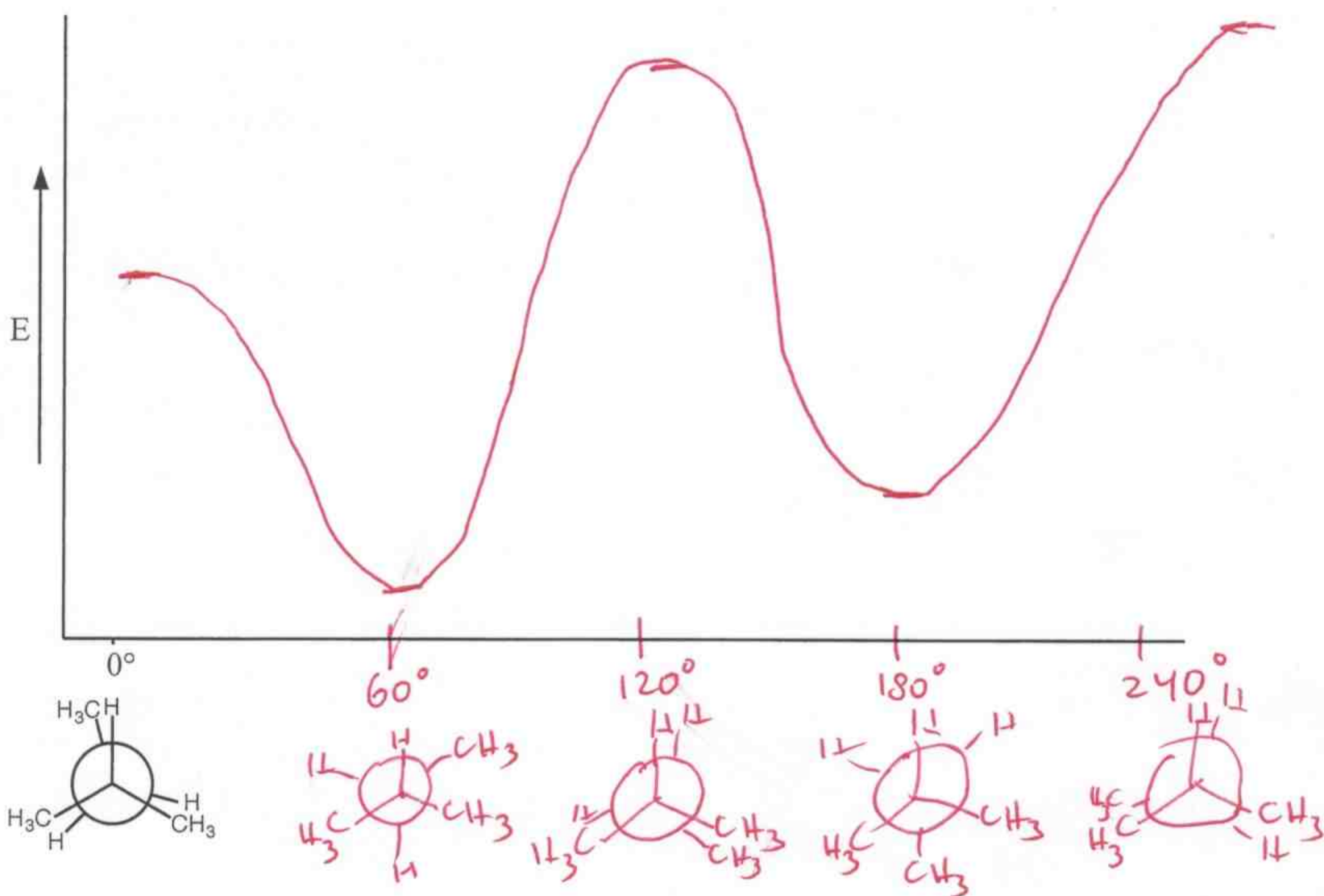
3. How many primary, secondary, tertiary, and quaternary carbons does the following compound have (8 pts).



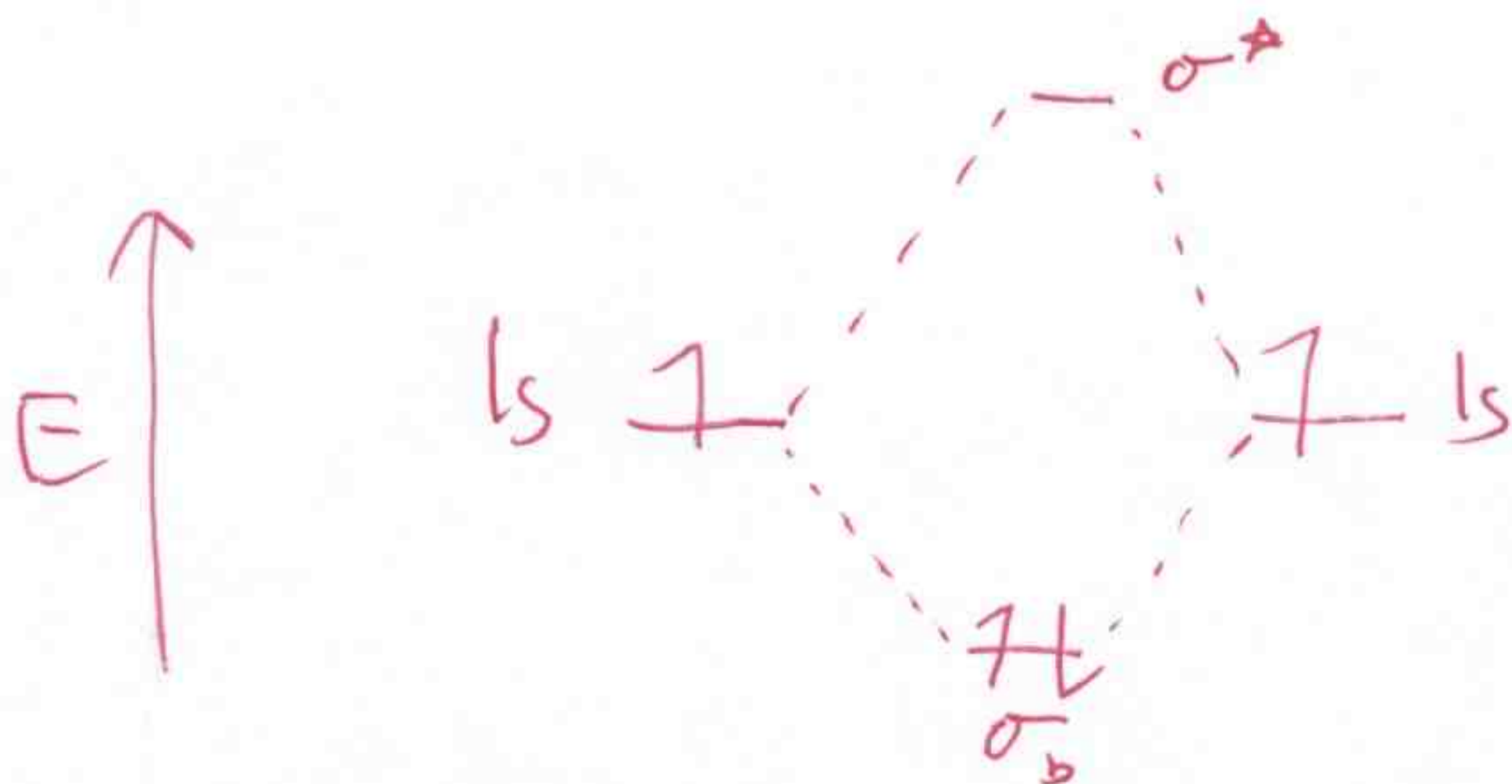
1° - 2  
2° - 11  
3° - 4  
4° - 2



4. Draw a potential energy diagram for rotation about the C2—C3 bond in 2-methylbutane. Draw the Newman projections for the dihedral angles  $60^\circ$ ,  $120^\circ$ ,  $180^\circ$ , and  $240^\circ$  (18 pts).

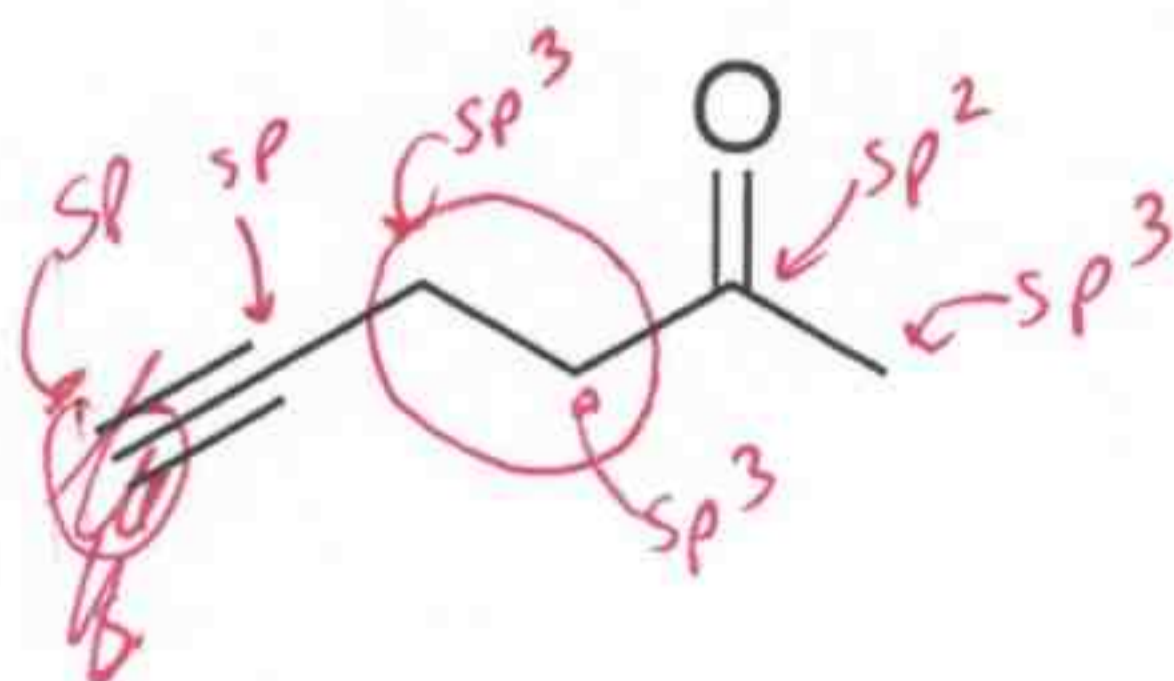


5. Draw the molecular orbital diagram of H-H. Be sure to pay attention to the starting energies of your atoms, and to the energy of the resulting orbitals. (8 pts)

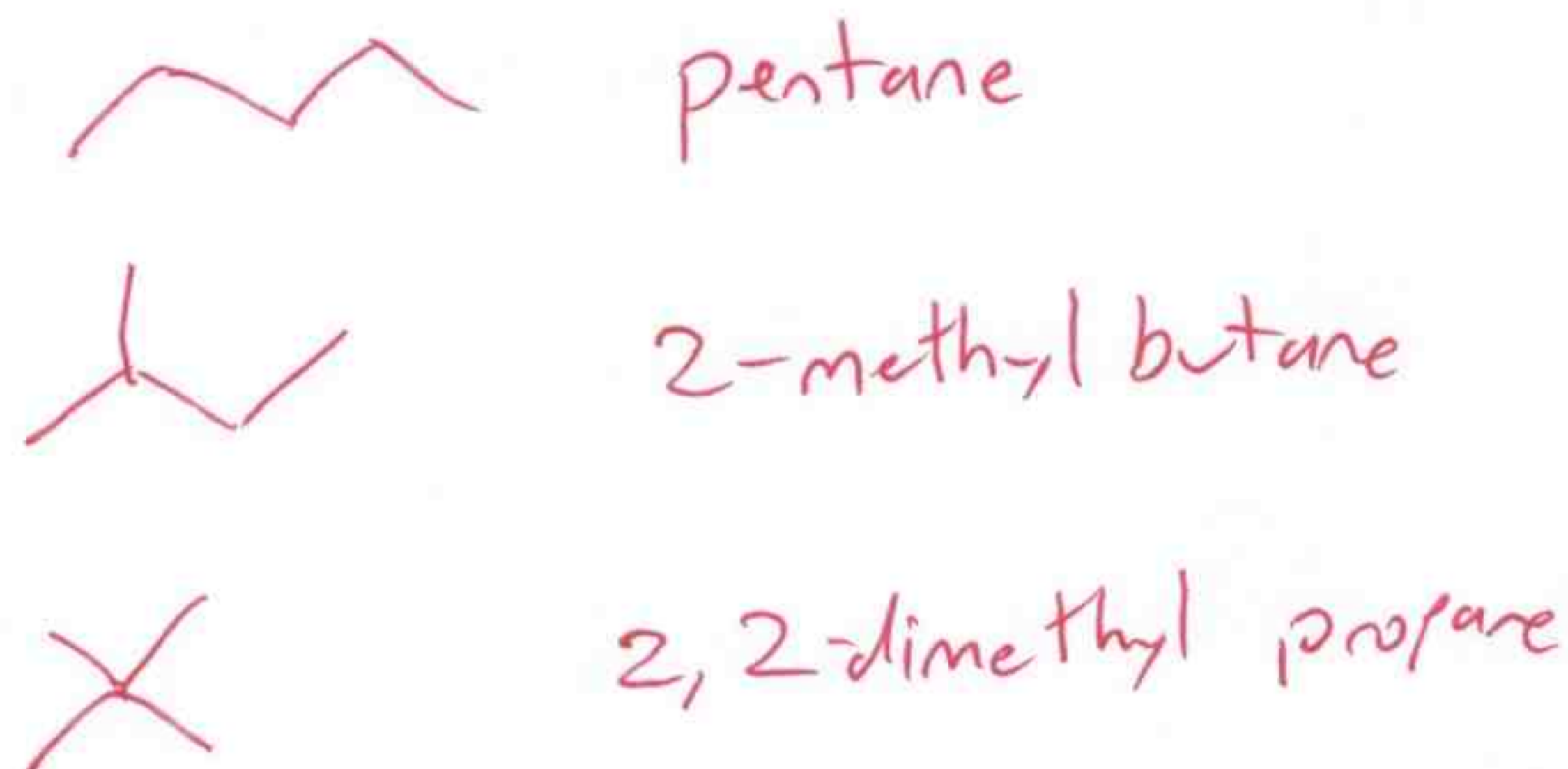




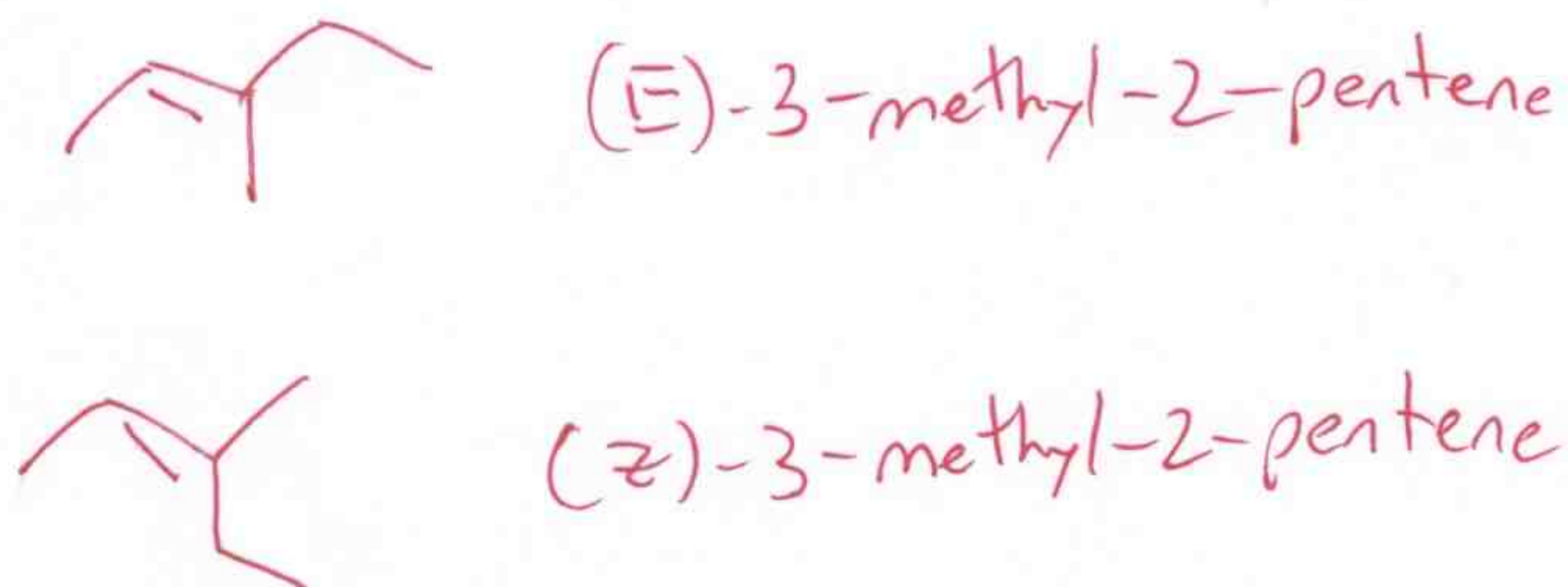
6. What is the hybridization of each carbon atom in the following molecule? (3 pts) Circle the longest C-C bond (3 pts).



7. A) Draw the structures for all the constitutional isomers of the molecular formula  $C_5H_{12}$  and give their IUPAC names (6 pts).



B) Draw the structures for all the stereoisomers of 3-methyl-2-pentene and give their IUPAC names (6 pts).



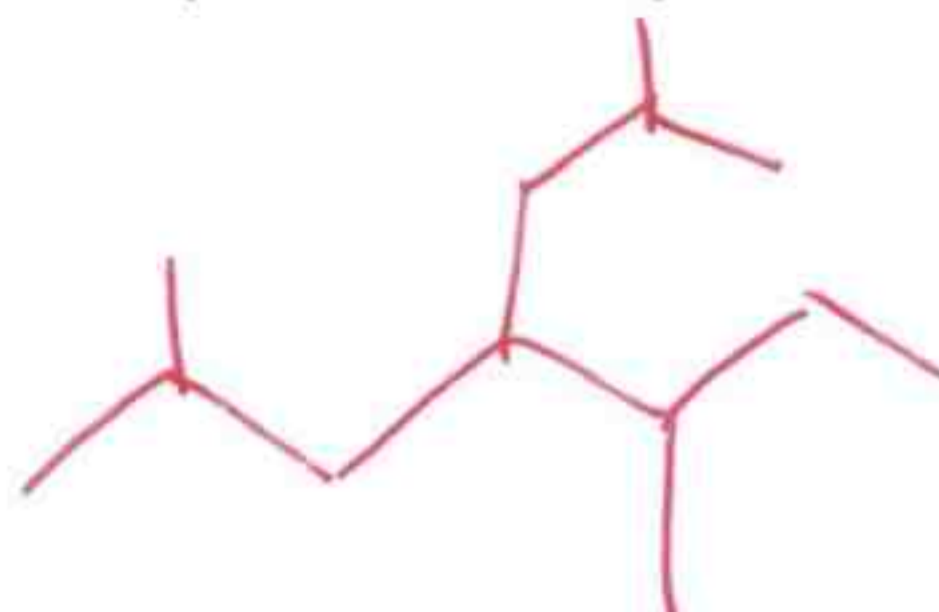
C) Draw the skeletal structures that correspond to the following names: (6 pts)

(1) 4-isobutyl-2,5-dimethylheptane

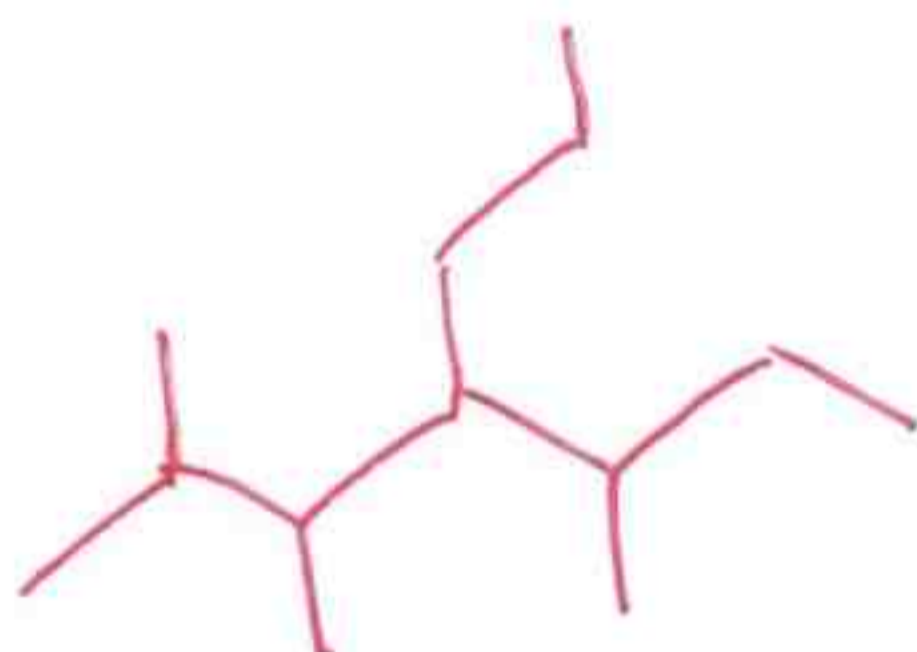
(2) 2,3,5-trimethyl-4-propylheptane

(3) 5-*sec*-butyl-6-*tert*-butyl-2,2-dimethylnonane

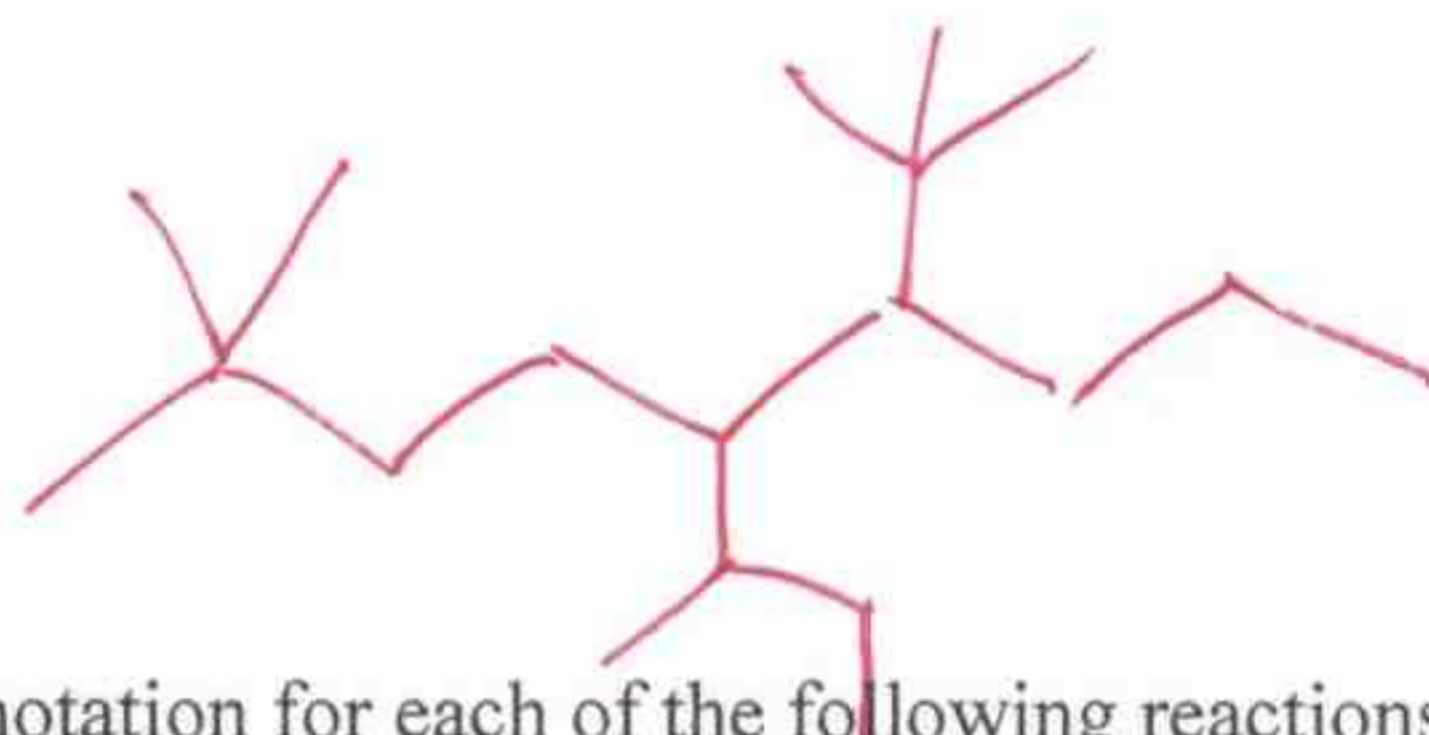
1)



2)



3)



8. Provide a curved-arrow notation for each of the following reactions in the left-to-right direction. (3 pts each)

