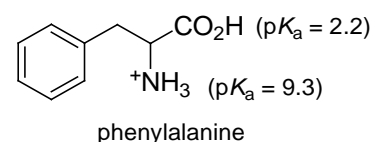


1. Draw as many **skeletal structures of the isomers (constitutional isomers or stereoisomers)** for a compound with the molecular formula C_5H_{10} as possible and **name each isomer** according to the IUPAC nomenclature. You may use the condensed formula to draw the structure if you want.

2. One of the essential amino acids, phenylalanine shown on the right, has both a carboxylic acid and an amino group. The pK_a values of the two groups are indicated with its structure.



- (a) Draw the structure of phenylalanine in a solution at $pH = 5.2$. Explain.

- (b) At what pH will alanine be neutral, that is, have no net charge? Explain, of course, your answer.

3. Answer the questions related to the following three covalent compounds with the molecular formula; CH_5N , CH_3N , and CHN .

(a) Write the condensed structural formulas satisfying the octet rule for each.

(b) Arrange them in the increasing order of the bond lengths between the carbon and nitrogen atoms and explain why.

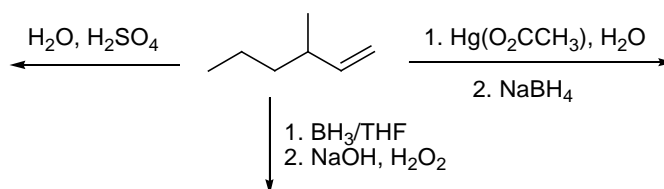
(c) Arrange the nitrogen atoms in the increasing order of basicity and explain why.

(d) Which has the higher boiling point between methanol (CH_4O) and CH_5N ? Explain why.

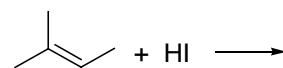
(e) Write a chemical equation when the CH_5N compound reacts with a strong base, BuLi , and explain.

4. There are two sets of two isomeric alkenes as follows; (a) 1-butene and 2-butene, (b) 2-butene and 2-methyl-1-propene. Suggest **two different experimental ways** to compare the relative stability of the two alkenes in each set and explain your answer.

5. The following alkene shown below yields **three different products** depending on the reagents shown with the reaction arrow. Draw the structure of the expected **major** product for each reaction and explain.



6. Answer the questions related to the following reaction of the alkene shown on the right.



(a) Write the structure of the two possible products and indicate which one is a major product.

(b) Explain why one product is the major isomer based on their reaction coordinate diagrams that show the two different reaction progresses (or pathways) to give the two different products, the major and the minor products. Explain the reaction results using the Hammond postulate.

(c) The same product as the major isomer in (a) can be produced from the reaction of HI with 3-methyl-1-butene. Explain why based on the reaction mechanism.