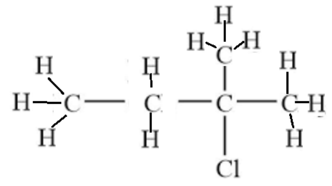
1. Structural and Semistructural Formulas (Hydrocarbons with Halides and Methyl Groups)

Question 1: Write the structural formula for 2-chloro-3-methylbutane.



2-chloro-2-methylbutane

Question 2: Write the semistructural formula for 1-bromo-2,2-dimethylpropane.

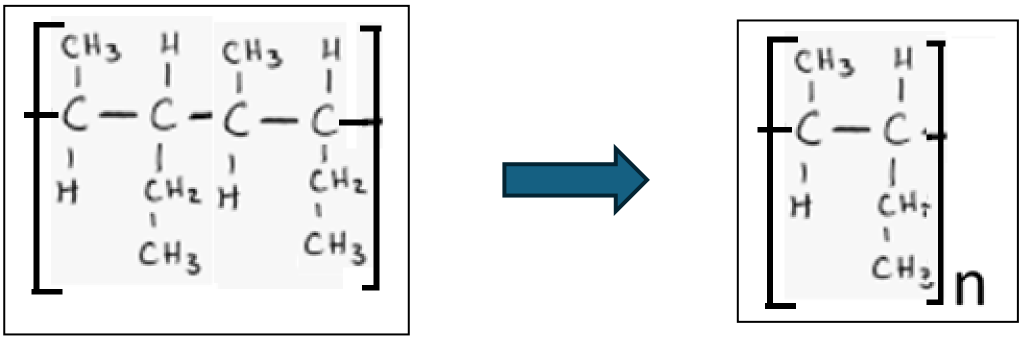
______________________________*$CH_2BrC(CH_3)_3$*____

Question 3: Write the name of the hydrocarbon with the semistructural formula $CH_3CHBrCH(CH_3)CH_3$.

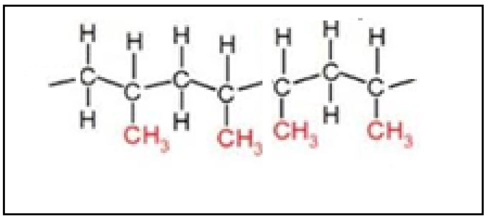
2-bromo-3-methylbutane

2. Addition Polymerisation

Question 1: Given the monomer pent-2-ene (C_5H_{10}), draw the repeating unit of the polymer formed by addition polymerisation.



Question 2: Consider the polymer chain shown on the right.
Give the IUPAC name of the monomer.



Propene

Question 3: Explain the general process of addition polymerisation and what happens to the double bond during polymer formation. 3 marks

1-----mark for mentioning the underlined text in some way in the response.

Addition polymerisation is a process where many small unsaturated monomer molecules (with carbon-to-carbon double bonds) join together to form a long chain polymer without the loss of any atoms.

1-----mark The double bond (C=C) in each monomer opens up (breaks) during the reaction.

1-----mark for mentioning the underlined text. The opened bonds link with other monomers, forming a continuous carbon-carbon single bond backbone of the polymer chain.

3. Naming Alcohols and Carboxylic Acids; Alkanes and Alkenes from Semistructural Formulas

Question 1: Name the alcohol with the semistructural formula shown below

$CH_3CH(OH)CH_2\ CH_3$.

____________________*butan-2-ol*____________________

Question 2: Write the name of the carboxylic acid with the formula

$CH_3CH(CH_3)COOH$.

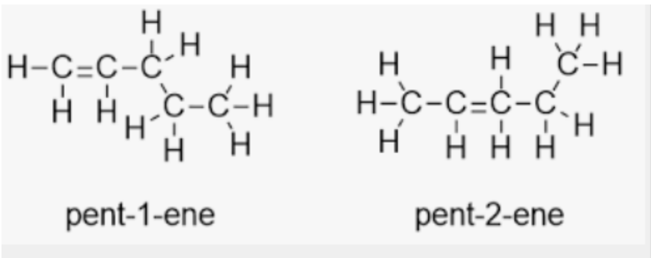
____________________*2-methylpropanoic acid*____________________

Question 3: Given the semistructural formula $CH_3CHCHCH_3$, name the alkene.

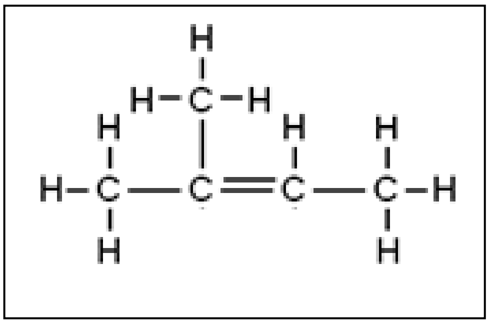
But-2-ene

4. Isomers of Pentene

Question 1: Draw the structural formula of the two possible unbranched isomers of pentene (C_5H_{10}).



Question 2: Draw one possible branched isomer of pentene.



Question 3: Explain briefly why these isomers have different physical properties, such as MP and BP.

Branched molecules tend to pack poorly in the solid state. This prevents molecules getting close to each other where dispersion forces can have a greater impact hence branched hydrocarbon molecules have lower MP than their straight carbon chain isomers.

5. Amino Acids and Chromatography

Question 1: Draw the structures of glycine and alanine.

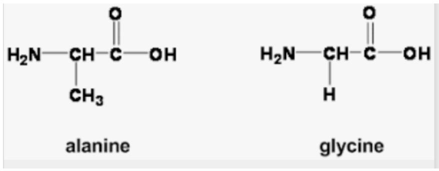
Question 2: Explain why glycine and alanine would have different Rf values when run on a chromatogram using water as the solvent.

Polarity difference: Glycine has a smaller, simpler side chain (a hydrogen atom), making it more polar than alanine, which has a methyl (–CH_3) group that is less polar.

Solubility and mobility: Water is a polar solvent, so more polar molecules like glycine tend to interact strongly with the solvent and move more with it, giving a higher Rf value.

Interaction with stationary phase: The stationary phase (often polar, like silica gel) interacts more strongly with polar compounds, which may slow their movement. However, in this case, since both compounds are fairly polar, their balance between stationary phase retention and solvent mobility is affected by their polarity difference.

Question 3: Predict which amino acid (glycine or alanine) would travel further on the chromatogram, and justify your answer.



Glycine has the simplest side chain: a hydrogen atom (–H). This small, non-bulky side chain is more polar relative to alanine's methyl (-CH_3) side chain which reduces the polarity of alanine. The more polar molecule will dissolve readily in water hence will move up the chromatogram further..

6. Empirical Formula Experiment

A metal Y (molar mass 9.19 g/mol) is burned in oxygen to form an oxide.

Question 1: Given the masses before and after burning, calculate the empirical formula of the oxide formed.

- Mass of empty crucible = 25.000 g
- Mass of crucible + metal Y before burning = 26.780 g
- Mass of crucible + oxide after burning = 28.640 g

Step 1: Calculate mass of metal Y

Mass of metal Y = (Mass of crucible + metal Y) - (Mass of crucible)
= 26.780 g - 25.000 g = 1.780 g

Step 2: Calculate mass of oxide

Mass of oxide = (Mass of crucible + oxide after burning) - (Mass of crucible)
= 28.640 g - 25.000 g = 3.640 g

Step 3: Calculate mass of oxygen combined

Mass of oxygen = Mass of oxide - Mass of metal Y
= 3.640 g - 1.780 g = 1.860 g

Now, you need molar masses of metal Y and oxygen to proceed.

Step 4: Calculate moles of metal Y and oxygen

- *Moles of metal Y = Mass of metal Y / Molar mass of metal Y*
  = 1.780 g / 9.19 g/mol ≈ 0.1937 mol
- *Moles of oxygen = Mass of oxygen / Molar mass of oxygen*
  = 1.860 g / 16.00 g/mol = 0.1163 mol

Step 5: Determine mole ratio

Divide both mole values by the smaller number (0.1163):

- *Metal Y: 0.1937 / 0.1163 ≈ 1.666*
- *Oxygen: 0.1163 / 0.1163 = 1*

To get whole numbers, multiply both by 3:

- *Metal Y: 1.666 × 3 ≈ 5*
- *Oxygen: 1 × 3 = 3*

Y_5O_3

Question 2: Why is it important to keep the crucible lid slightly open during the experiment?
To allow oxygen to enter the crucible and react with the metal and ensure complete oxidation.

Question 3: List two possible sources of error in this empirical formula experiment and how they might affect the result.

1. *Incomplete combustion or oxidation of the metal:*
   If the metal does not fully react with oxygen, the oxide formed will have less oxygen than expected, leading to an empirical formula with a lower oxygen ratio.
2. *Some oxide or metal might be lost if the crucible is overheated or handled roughly, reducing the mass of oxide and affecting the mass of oxygen calculation, which results in an inaccurate empirical formula.*

7. Isotopic Mass and Percentage Abundance

Question 1: An element has two isotopes: isotope A (mass 10 amu, abundance 20%) and isotope B (mass 11 au, abundance 80%). Calculate the average atomic mass.

10 X 0.20 + 11 X 0.80 = 10.8 amu

Question 2: If the abundance of isotope A changed to 25%, how would the average atomic mass change?

The average atomic mass decreases slightly from 10.8 amu to 10.75 amu.

Question 3: Explain why the average atomic mass is usually not a whole number.

The average atomic mass is not a whole number because it is a weighted average of all the naturally occurring isotopes of an element, each having different masses and abundances.