Question

An hydrocarbon of relative molecular mass 70 was found to contain 85.7% carbon.

Determine :

(a) The molecular formula

(b) The structural formula

Solution

$M(C_xH_y) = 70$.

$Ar(C) = 12$

$Ar(H) = 1$

$12 \cdot x + 1 \cdot y = 70$

If carbon content is 85.7, hydrogen content is (100 - 85.7) = 14.3

$C_x / H_y = 85.7/14.3$

$12 \cdot x / 1 \cdot y = 85.7/14.3$

Thus we have system of two equations with two unknown quantities:

$$\begin{cases} 12 \cdot x + 1 \cdot y = 70 \\ 12 \cdot x / 1 \cdot y = 85.7/14.3, \end{cases}$$

Whence

$12 \cdot x \cdot 14.3 = 1 \cdot y \cdot 85.7$,

$171.6 \cdot x = 85.7 \cdot y$,

$y = 171.6 \cdot x/85.7$,

$y = 2 \cdot x$

$12 \cdot x + 2 \cdot x = 70$

$14 \cdot x = 70$

$x = 5$

$y = 2 \cdot x = 10$

Answer

a) Molecular formula – C_5H_{10}

b) Ten structural isomers are possible: three linear, three branched and four cyclic.

So, ten versions of structural formula are possible:

pent-1-ene   (2*E*)-pent-2-ene   (2*Z*)-pent-2-ene

2-methylbut-1-ene   2-methylbut-2-ene   3-methylbut-1-ene

cyclopentane   methylcyclobutane   1,2-dimethylcyclopropane   ethylcyclopropane