Example 2. *28 g of ethene was polymerised by radical polymerization process and the average degree of polymerization of polythene was found to be 1,000. Calculate : (i) the number of molecules of ethene in original sample, (ii) the number of molecules of polythene produced.*

Solution. (*i*) No. of molecules of ethene in 28 g

$$= 28 \text{ g} \times (6.02 \times 10^{23} \text{ molecules}/28 \text{ g}) = \mathbf{6.02 \times 10^{23}\ molecules.}$$

(*ii*) No. of molecules of polythene formed

$$= \frac{\text{No. of ethene molecules}}{\text{Degree of polymerization}} = \frac{6.02 \times 10^{23}}{1{,}000} = \mathbf{6.02 \times 10^{20}\ molecules.}$$

Example 3. *Calculate the maximum percentage of sulphur that can be present in vulcanized rubber.*

Solution. 2 monomer units of isoprene require = 2 S atoms for cross-links

$\therefore$ 2×68 g of isoprene requires $= 2 \times 32$ g sulphur

or 68 g of isoprene requires $= 32$ g of sulphur

or (68 + 32) g of vulcanized rubber contains $= 32$ g of sulphur

Hence, maximum percentage of S in vulcanized rubber

$$= \frac{32 \text{ g}}{100 \text{ g}} \times 100\% = \mathbf{32\%}$$

Example 4. *216 g butadiene is copolymerized with 104 g of styrene. What is the molecular formula of the copolymer ?*

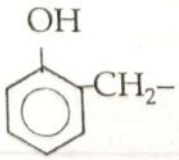
Solution. 216 g of butadiene = 216 g/54 g mol^{-1} = 4 mol

104 g of styrene = 104 g/104 g mol^{-1} = 1 mol

$\therefore$ Molecular formula of copolymer is :

$$[\ CH_2{-}CH{=}CH{-}CH_2\ ]_{4n}\ [\ CH_2{-}CH\ ]_n$$

Example 5. *100 g of novolac is to cross-linked by one $-CH_2-$ group of each benzene ring. What weight of formaldehyde is required for achieving this ?*

Solution. 2 molecules of  unit of novolac require

= 1 molecule of HCHO

$\therefore$ 2×96 g of novolac requires = 30 g HCHO

or 100 g of novolac requires $= \dfrac{30 \text{ g} \times 100 \text{ g}}{2 \times 96 \text{ g}}$ HCHO = **15.625 g HCHO.**

Example 6. *28 g of ethylene was polymerized and average degree of polymerization of polyethylene (PE) so-produced was found to be 500. Calculate the number of PE molecules formed.*

Solution. $\overline{DP} = \dfrac{\text{No. of ethylene molecules}}{\text{No. of PE molecules formed}}$

$\therefore$ No. of PE molecules formed

$$= \frac{\text{No. of ethylene molecules}}{\overline{DP}} = \frac{28 \text{ g} \times (6.023 \times 10^{23} \text{ molecules}/28}{500}$$

$$= 6.023 \times 10^{23} \text{ molecules}/500 = \mathbf{1.2046 \times 10^{20}\ molecules.}$$

Example 7. *A polymer sample contains :*

Polymer of DP	400	500	600	800	1,000
Percentage	10	15	35	15	25

Calculate its average degree of polymerization.

Solution. $\overline{DP} = \dfrac{10 \times 400 + 15 \times 500 + 35 \times 600 + 15 \times 800 + 25 \times 1000}{10 + 15 + 35 + 15 + 35} = 100$

$= 40 + 75 + 210 + 120 + 250 = \mathbf{695}$

Example 8. *Calculate the number average and weight average molecular masses of polypropylene polymer with the following composition :*

$$\left[-CH_2 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - \right]_{400} \text{ is 25\% ; } \left[-CH_2 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - \right]_{800} \text{ is 35\% ; } \left[-CH_2 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - \right]_{600} \text{ is 40\%}$$

Given that at. mass of C = 12 and H = 1.] [VT, Aug. 2K]

Solution. Mol. mass of repeat unit, $-CH_2 - CH(CH_3) -$ is 42.

No. of repeat unit (n) in polymer	***400 in I***	***800 in II***	***600 in III***
Mol. mass (M_i) (= 42 n)	16,300	32,600	25,200
No. of molecules in 100	25	35	40

$$\therefore \quad \overline{M_n} = \frac{\Sigma N_i M_i}{\Sigma N_i} = \frac{25 \times 16{,}300 + 35 \times 32{,}600 + 40 \times 25{,}200}{100} = \mathbf{25{,}565}$$

and $$\overline{M_w} = \frac{\Sigma N_i M_i^2}{\Sigma N_i M_i} = \frac{25\,(16{,}300)^2 + 35\,(32{,}600)^2 + 40\,(25{,}200)^2}{25 \times 16{,}300 + 35 \times 32{,}600 + 40\,(25{,}200)}$$

$$= \frac{69{,}24045 \times 10^4}{25{,}56{,}500} = \mathbf{27{,}084}$$