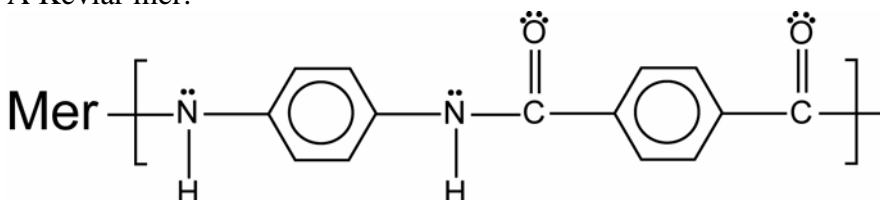


In-Class Exercise
Kevlar Molecular Weight
SOLUTIONS

Kevlar® is used in the core of skis. Below is some data from a Kevlar sample. Is it possible to have a Kevlar® polymer with the following molecular weight data and a weight-average degree of polymerization of 246? Why or why not?

A Kevlar mer:



Molecular Weight Range (g/mol)	x_i	w_i
8,000 – 20,000	0.04	0.01
20,000 – 32,000	0.10	0.05
32,000 – 44,000	0.16	0.12
44,000 – 56,000	0.26	0.25
56,000 – 68,000	0.23	0.27
68,000 – 80,000	0.15	0.21
80,000 – 92,000	0.06	0.09

$$\begin{aligned}
 A_{\text{Kevlar}^\circledR} &= 2A_{\text{N}} + 10A_{\text{H}} + 2A_{\text{O}} + 14A_{\text{C}} = \\
 &= 2 (14.0067 \text{ g/mol}) + 10 (1.00794 \text{ g/mol}) + 2 (15.9994 \text{ g/mol}) + \\
 &+ 14 (12.0107 \text{ g/mol}) = 238.241 \text{ g/mol}
 \end{aligned}$$

The appropriate data are given below along with a computation of the weight-average molecular weight.

Molecular Weight Range (g/mol)	Mean M_i	w_i	$w_i M_i$
8,000 – 20,000	14,000	0.01	140
20,000 – 32,000	26,000	0.05	1300
32,000 – 44,000	38,000	0.12	4560
44,000 – 56,000	50,000	0.25	12,500
56,000 – 68,000	62,000	0.27	16,740

68,000 – 80,000	74,000	0.21	15,540
80,000 – 92,000	86,000	0.09	7740

$$M_w = \sum w_i M_i = 58,520 \text{ g/mol}$$

Now we can compute n_w :

$$n_w = \frac{M_w}{A_{\text{Kevlar}^\circledR}} = \frac{58,520 \text{ g/mol}}{238.241 \text{ g/mol}} = 245.6$$

Thus, such a polymer is possible, since the calculated n_w is 246.