

Chapter 10: Homework solutions

10.7. The mass of acrylonitrile mer is $M_a = 53$ g/mol; the mass of butadiene mer is $M_b = 54$ g/mol; the mass of styrene mer is $M_s = 104$ g/mol.

Assume we have 100 g of ABS, then the mole # of acrylonitrile mer is $25\text{g}/53\text{g/mol} = 0.47$ mol, the mole # of butadiene mer is $30/54$ g/mol = 0.56 mol, the mole # of styrene mer is $45/104$ g/mol = 0.43 mol.

The mole fraction of polyacrylonitrile is $0.47 \text{ mol}/(0.47 \text{ mol} + 0.56 \text{ mol} + 0.43 \text{ mol}) = 0.322$

The mole fraction of polybutadiene is $0.56 \text{ mol}/(0.47 \text{ mol} + 0.56 \text{ mol} + 0.43 \text{ mol}) = 0.384$

The mole fraction of polystyrene is $0.43 \text{ mol}/(0.47 \text{ mol} + 0.56 \text{ mol} + 0.43 \text{ mol}) = 0.294$

10.9. The mass of butadiene mer is $M_b = 54$ g/mol. The mass of sulfur is 32 g/mol.

Each sulfur atom can cross-link one mer, the mole # needed is $70\text{g}/54\text{g} \times 3\% = 0.0389$ mole

The weight S needed = $0.0389 \times 32 = 1.2444$ g

10.13. The mass of butadiene mer is $M_b = 54$ g/mol. The mass of sulfur is 32 g/mol.

The mole # of S is $300\text{g}/32 \text{ g/mol} = 9.375$ mole

The mole # of mers is $300000 \text{ g}/54 \text{ g/mol} = 5555.556$ mol

The fraction is $9.375/5555.556 = 0.17\%$

10.14. The mass of butadiene mer is $M_b = 54$ g/mol. the mass of styrene mer is $M_s = 104$ g/mol. The mass of sulfur is 32 g/mol.

The weight fraction of butadiene before cross-linking is $7 \times 54 / (7 \times 54 + 104) = 78.4$

Assume 100 g co-polymer. The butadiene is 78.4 g, which has 1.45 mol of monomer

Mole # of S = $1.45 \times 20\% = 0.29$ mol = 9.29 g

The weight fraction of S = $9.29 / (100 + 9.29) = 8.5\%$.

10.20. From $\sigma = \sigma_0 e^{-t/\tau}$, we have $1/\tau = (1/t) \ln(\sigma_0/\sigma)$.

At $T_1 = 27^\circ\text{C} = 300$ K, $1/\tau_1$ can be calculated as 0.0115 /day, $\tau_1 = 86.9$ day.

At $T_2 = 50^\circ\text{C} = 323$ K, $1/\tau_2$ can be calculated as 0.03372 /day, $\tau_2 = 29.7$ day

From $1/\tau = C e^{-Q/RT}$, we have $Q = R \ln(\tau_1/\tau_2) / (1/T_1 - 1/T_2) = 122$ kJ/mol