15.25 We are asked what weight percent of sulfur must be added to polyisoprene in order to ensure that 10% of possible sites are crosslinked, assuming that, on the average, 3.5 sulfur atoms are associated with each crosslink. Table 14.5 shows the chemical repeat unit for isoprene. For each of these units there are two possible crosslink sites; one site is associated with each of the two carbon atoms that are involved in the chain double bond. Since 10% of the possible sites are crosslinked, for each 100 isoprene repeat units 10 of them are crosslinked; actually there are two crosslink sites per repeat unit, but each crosslink is shared by two chains. Furthermore, on the average we assume that each crosslink is composed of 3.5 sulfur atoms; thus, there must be 3.5 x 10 or 35 sulfur atoms added for every 100 isoprene repeat units. In terms of moles, it is necessary to add 35 moles of sulfur to 100 moles of isoprene. The atomic weight of sulfur is 32.06 g/mol, while the molecular weight of isoprene is

$$A(\text{isoprene}) = 5(A_C) + 8(A_H)$$

$$= (5)(12.01 \text{ g/mol}) + (8)(1.008 \text{ g/mol}) = 68.11 \text{ g/mol}$$

The mass of sulfur added (m_S) is

$$m_S = (35 \text{ mol})(32.06 \text{ g/mol}) = 1122 \text{ g}$$

While for isoprene

$$m_{ip} = (100 \text{ mol})(68.11 \text{ g/mol}) = 6811 \text{ g}$$

Or, the concentration of sulfur in weight percent (Equation 4.3) is just

$$C_S = \frac{m_S}{m_S + m_{ip}} \times 100 = \frac{1122 \text{ g}}{1122 \text{ g} + 6811 \text{ g}} \times 100 = 14.1 \text{ wt\%}$$