

40. (a) *n*-type, since each phosphorous atom has one more valence electron than a silicon atom.
- (b) The added charge carrier density is $n_P = 10^{-7} n_{Si} = 10^{-7} (5 \times 10^{28} \text{ m}^{-3}) = 5 \times 10^{21} \text{ m}^{-3}$.
- (c) The ratio is $(5 \times 10^{21} \text{ m}^{-3}) / [2(5 \times 10^{15} \text{ m}^{-3})] = 5 \times 10^5$. Here the factor of 2 in the denominator reflects the contribution to the charge carrier density from *both* the electrons in the conduction band *and* the holes in the valence band.