Example 2.4 Calculate the effective densities of states in the conduction and valence bands of germanium, silicon and gallium arsenide at 300 K.

Solution The effective density of states in the conduction band of germanium equals:

$$N_c = 2(\frac{2p\, m_e^* kT}{h^2})^{3/2}$$

$$= 2(\frac{2p\ 0.55 \times 9.11 \times 10^{-31} \times 1.38 \times 10^{-23} \times 300}{(6.626 \times 10^{-34})^2})^{3/2}$$

$$= 1.02 \times 10^{25}\ \text{m}^{-3} = 1.02 \times 10^{19}\ \text{cm}^{-3}$$

where the effective mass for density of states was used (see appendix 3 or section 2.3.6). Similarly one finds the effective density of states in the conduction band for other semiconductors and the effective density of states in the valence band:

	Germanium	Silicon	Gallium Arsenide
N_c (cm^{-3})	1.02×10^{19}	2.81×10^{19}	4.35×10^{17}
N_v (cm^{-3})	5.64×10^{18}	1.83×10^{19}	7.57×10^{18}

Note that the effective density of states is temperature dependent and can be obtain from:

$$N_c(T) = N_c(300\,\text{K})(\frac{T}{300})^{3/2}$$

where N_c(300 K) is the effective density of states at 300 K.