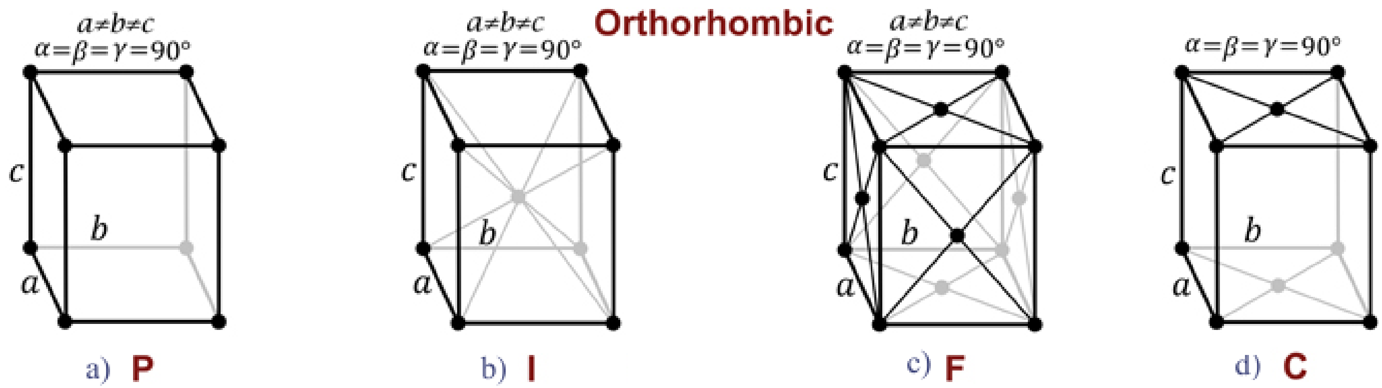
For the four orthorhombic Bravais lattices: a) simple, b) body-centered, c) face-centered, and d) side-/end-centered, compute how many atoms are contained within each of the unit cells and the volume density when a = 4.6 Å, b = 5.6 Å, and c = 6.8 Å. Treat each atom as a sphere and count only that portion of the sphere that actually resides within the cube.



a) Simple orthorhombic

$$\# \text{ atoms/unit cell} = 8 \text{ corners} \left(\frac{1/8 \text{ atom}}{\text{corner}}\right) = \underline{\underline{1 \text{ atom}}}$$

$$\text{atomic vol. density} = \frac{1 \text{ atom}}{abc} = \frac{1}{(4.6\times10^{-10})(5.6\times10^{-10})(6.8\times10^{-10})}$$

$$\underline{\underline{N_P = 5.7088\times10^{27}\ \frac{\text{atoms}}{\text{m}^3} = 5.7088\times10^{21}\ \frac{\text{atoms}}{\text{cm}^3}}}$$

b) Body-centered orthorhombic

$$\# \text{ atoms/unit cell} = 8 \text{ corners} \left(\frac{1/8 \text{ atom}}{\text{corner}}\right) + 1 \text{ atom inside}$$

$$= \underline{\underline{2 \text{ atoms}}}$$

$$\text{atomic vol. density} = \frac{2 \text{ atoms}}{abc} = 2(5.7088\times10^{27})$$

$$\underline{\underline{N_I = 1.1418\times10^{28}\ \frac{\text{atoms}}{\text{m}^3} = 1.1418\times10^{22}\ \frac{\text{atoms}}{\text{cm}^3}}}$$

c) Face-centered orthorhombic

$$\#\text{atoms/unit cell} = 8\text{ corners}\left(\frac{1/8\text{ atom}}{\text{corner}}\right) + 6\text{ faces}\left(\frac{1/2\text{ atom}}{\text{face}}\right)$$

$$= \underline{\underline{4\text{ atoms}}}$$

$$\text{atomic vol. density} = \frac{4\text{ atoms}}{abc} = 4(5.7088\times10^{27})$$

$$\underline{\underline{N_F = 2.2835\times10^{28}\,\frac{\text{atoms}}{\text{m}^3} = 2.2835\times10^{22}\,\frac{\text{atoms}}{\text{cm}^3}}}$$

d) End-centered orthorhombic

$$\#\text{atoms/unit cell} = 8\text{ corners}\left(\frac{1/8\text{ atom}}{\text{corner}}\right) + 2\text{ faces}\left(\frac{1/2\text{ atom}}{\text{face}}\right)$$

$$= \underline{\underline{2\text{ atoms}}}$$

$$\text{atomic vol. density} = \frac{2\text{ atoms}}{abc} = N_I$$

$$\underline{\underline{N_C = N_I = 1.1418\times10^{28}\,\frac{\text{atoms}}{\text{m}^3} = 1.1418\times10^{22}\,\frac{\text{atoms}}{\text{cm}^3}}}$$