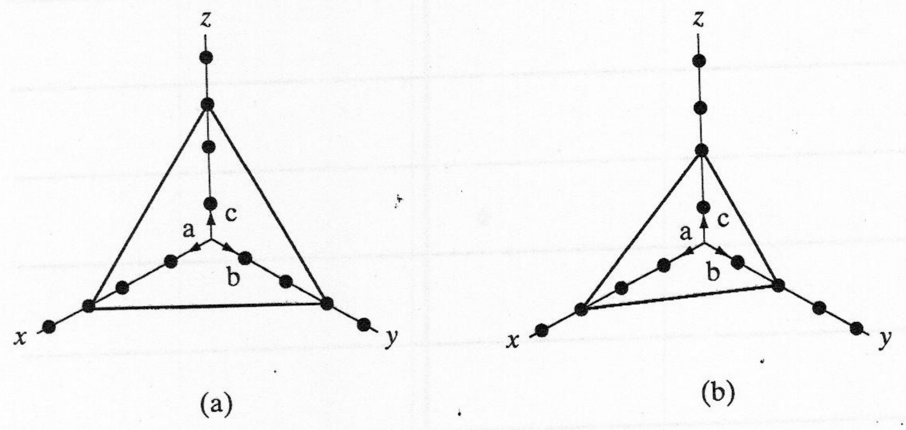
1.1 Using Appendix III, which of the listed semiconductors in Table 1–1 has the largest band gap? The smallest? What are the corresponding wavelengths if light is emitted at the energy E_g? Is there a noticeable pattern in the band gap energy of III–V compounds related to the column III element?

1.2 For a bcc lattice of identical atoms with a lattice constant of 5Å, calculate the maximum packing fraction and the radius of the atoms treated as hard spheres with nearest neighbors touching.

1.3 (a) Label the planes illustrated in Fig. P1–3.



(b) Draw equivalent ⟨111⟩, ⟨100⟩, ⟨110⟩ directions in a cubic lattice; use a unit cube for illustrating each set of equivalent directions.

1.4 Calculate the volume density of Si atoms (number of atoms/cm^3) given that the lattice constant of Si is 5.43 Å. Calculate the areal density of atoms (number/cm^2) on the (110) plane. Calculate the distance between two adjacent (111) planes in Si passing through nearest-neighbor atoms.

1.5 The atomic radii of In and Sb atoms are approximately 1.44 Å and 1.36 Å, respectively. Using the hard-sphere approximation, find the lattice constant of InSb (zincblende structure), and the volume of the primitive cell. What is the atomic density on the (110) planes? (Hint: The volume of the primitive cell is $^1/_4$ the fcc unit cell volume.)

1.6 Sodium chloride (NaCl) is a cubic crystal that differs from a sc in that alternating atoms are different; each Na is surrounded by six Cl nearest neighbors and vice versa in the three-dimensional lattice. Draw a two-dimensional NaCl lattice looking down a ⟨100⟩ direction and indicate a unit cell. Remember the unit cell must be repetitive upon displacement by the basis vectors.

1.7 Sketch a view down a ⟨110⟩ direction of a diamond lattice, using Fig. 1–9 as a guide. Include lines connecting nearest neighbors.

1.8 Show by a sketch that the bcc lattice can be represented by two interpenetrating sc lattices. To simplify the sketch, show a ⟨100⟩ view of the lattice.

1.9 (a) Find the number of atoms/cm^2 on the (100) surface of a Si wafer.

(b) What is the distance (in Å) between nearest In neighbors in InP?

1.10 The ionic radii of Na^+ (atomic weight 23) and Cl^- (atomic weight 35.5) are 1.0 and 1.8 Å, respectively. Treating the ions as hard spheres, calculate the density of NaCl. Compare this with the measured density of 2.17 g/cm^3.

1.11 The atoms seen in Fig. 1–8b along a ⟨100⟩ direction of the diamond lattice are not all coplanar. Taking the top plane of colored atoms in Fig. 1–8a to be (0), the parallel plane $a/4$ down to be ($\frac{1}{4}$), the plane through the center to be ($\frac{1}{2}$), and the second plane of black atoms to be ($\frac{3}{4}$), label the plane of each atom in Fig. 1–8b.

1.12 How many atoms are found inside a unit cell of a simple cubic, body-centered cubic, and face-centered cubic crystal? How far apart in terms of lattice constant a are nearest-neighbor atoms in each case, measured from center to center?

1.13 Draw a cube such as Fig. 1–7 and show four {111} planes with different orientations. Repeat for {110} planes.

1.14 Find the maximum fractions of the unit cell volume that can be filled by hard spheres in the sc, bcc, and diamond lattices.

1.15 Calculate the densities of Ge and InP from the lattice constants (Appendix III), atomic weights, and Avogadro's number. Compare the results with the densities given in Appendix III.

1.16 Beginning with a sketch of an fcc lattice, add atoms at ($\frac{1}{4}, \frac{1}{4}, \frac{1}{4}$) from each fcc atom to obtain the diamond lattice. Show that only the four added atoms in Fig. 1-8a appear in the diamond unit cell.

1.17 Assuming the lattice constant varies linearly with composition x for a ternary alloy (e.g., see the variation for InGaAs in Fig. 1–13), what composition of $AlSb_xAs_{1-x}$ is lattice matched to InP? What composition of $In_xGa_{1-x}P$ is lattice-matched to GaAs? What is the band gap energy in each case?