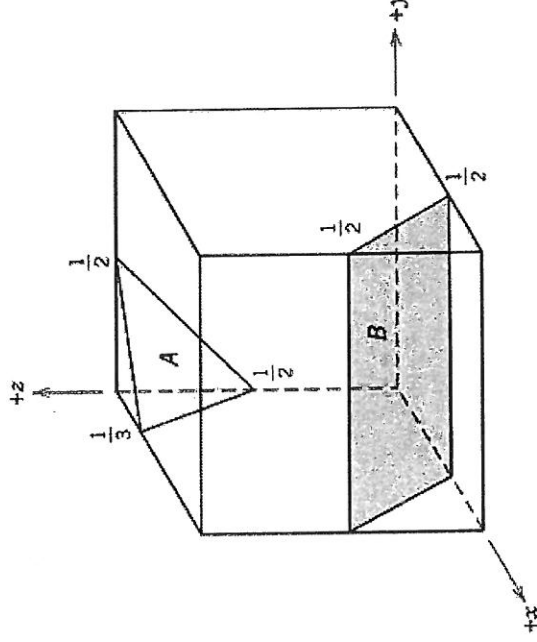
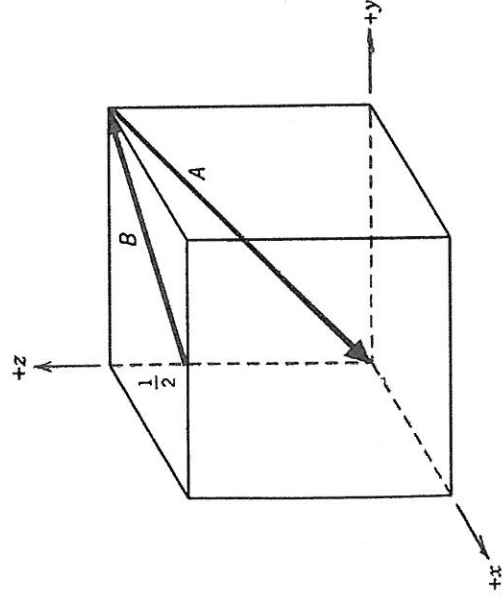


- List (a) six categories of material properties (4%) and (b) four basic types of solid materials (6%)
- (a) Sketch within a cubic unit cell the directions $[\bar{1}10]$, $[0\bar{1}2]$ and planes $(11\bar{2})$, $(\bar{1}31)$. (8%)
 (b) Determine the indices for the directions A and B and the Miller indices for plans A and B shown below. (8%)



- Solid solution. Atomic radius, crystal structure, electronegativity, and the most common valence, are tabulated on the right for several elements; for those that are nonmetals, only radii are indicated. Which of these elements would you expect to form the following with copper and justify your answers. (12%)
 (a) a substitutional solid solution having complete solubility,
 (b) a substitutional solid solution of incomplete solubility, and
 (c) an interstitial solid solution.

Element	Atomic Radius (nm)	Crystal Structure	Electronegativity	Valence
Cu	0.1278	FCC	1.9	+2
C	0.071			
H	0.046			
O	0.060			
Ag	0.1445	FCC	1.9	+1
Al	0.1431	FCC	1.5	+3
Co	0.1253	HCP	1.8	+2
Cr	0.1249	BCC	1.6	+3
Fe	0.1241	BCC	1.8	+2
Ni	0.1246	FCC	1.8	+2
Pd	0.1376	FCC	2.2	+2
Zn	0.1332	HCP	1.6	+2

- Define (a) diffusion flux, (b) Fick's first law of diffusion and (c) Fick's second law of diffusion, and explain each term of the equations. (12%)
- Please describe the extrinsic semiconductor, intrinsic semiconductor, n-type semiconductor, and p-type semiconductor. (20%)
- For an intrinsic semiconductor, the room-temperature electrical conductivity is $8 \times 10^4 (\Omega\text{-m})^{-1}$; the electron and hole mobilities are, respectively, 0.1 and $0.05 \text{ m}^2/\text{V-s}$. Compute the electron and hole concentrations at room temperature. (15%)
- For BCC crystal, compute (a) the interplanar spacing, and (b) the diffraction angle for the (110) set of planes. (15%)
 The lattice parameter of this crystal is 0.4 nm.
 The monochromatic radiation has a wavelength of 0.1790 nm.

$$d_{hkl} = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$$