

I. (12) Define the following terms:

A. Index of refraction

The index of refraction is the ratio of the speed of light in vacuum to the speed of light in the medium.

B. Diffraction

Diffraction is the coherent scattering of waves by a periodic array of scatterers.

C. Pleochroism

Pleochroism is the phenomenon of absorption being a function of direction in an anisotropic medium

II. (10) Kamacite is the mineral name for pure iron metal (atomic weight = 55.847). It has a cubic unit cell edge of 2.867Å with $Z = 2$. Calculate the density of kamacite.

$$\rho = Z \cdot FW / A \cdot V$$

$$\rho = 2(55.847) / 0.6024 (2.867)^3$$

$$\rho = 7.869 \text{ g/cm}^3$$

III. A. (10) Kamacite has space group $Im\bar{3}m$ with cell edge 2.867\AA . The first two allowed diffractions have Miller indices (1 1 0), and (2 0 0). Calculate 2θ for these diffractions using Cu $k\alpha$ radiation ($\lambda = 1.5405\text{\AA}$).

$$D = a / (h^2 + k^2 + l^2)^{0.5}$$

$$D_{110} = 2.867/1.414$$

$$D_{110} = 2.0276$$

$$D = a / (h^2 + k^2 + l^2)^{0.5}$$

$$D_{200} = 2.867/2$$

$$D_{200} = 1.434$$

$$2\theta = 2 \sin^{-1} \lambda/2d$$

$$2\theta = 2 \times 22.33 = 44.65^\circ$$

$$2\theta = 2 \sin^{-1} \lambda/2d$$

$$2\theta = 2 \times 32.50 = 65.00^\circ$$

IV (8) Brilliant cut diamonds are designed so that all of the light entering the table face (the large top facet) comes back out this face. This is because the light cannot strike the side facets at an angle less than the critical angle. Diamond has an index of refraction of 2.42. Calculate the critical angle for diamond.

$$N_i \sin \omega_i = N_r \sin \omega_r$$

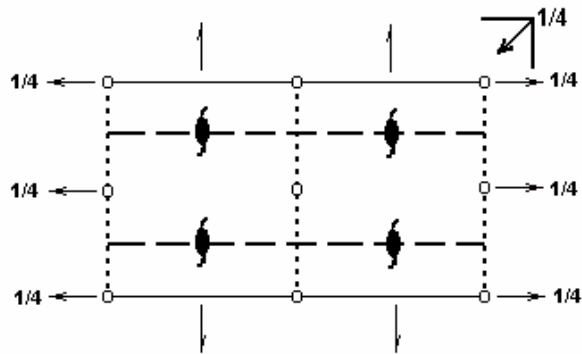
$$2.42 \sin \omega_i = 1.0$$

$$\sin \omega_i = 1.0 / 2.42$$

$$\omega_i = 24.40^\circ$$

- V. (10) Shown below is a symmetry diagram for a primitive orthorhombic space group in standard orientation (a -vertical, b horizontal, and c normal to page). Give the Hermann-Mauguin symbol for this space group and for the crystal class (point group) to which it belongs.

	axis	plane
a	_____	_____
b	_____	_____
c	_____	_____
H-Msymbol	_____	_____
Point Group	_____	_____



Space Group $P 2_1/b 2/c 2_1/n = Pbcn$
 Point Group $2/m 2/m 2/m$