**Tutorial Sheet**

**Crystal Geometry and Structure Determination**

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1. Draw a (111) plane and a (222) plane in the unit cell of a cubic lattice with lattice parameter *a*. Determine their distances from a parallel plane through the origin.
2. Find the Miller indices of a plane that makes an intercept of 1 on the a-axis and 2 on the b-axis and is parallel to the c-axis.
3. Determine the Miller indices for the plane shown in the accompanying sketch (a).



1. For BCC iron, compute (a) the interplanar spacing and (b) the diffraction angle for the (220) set of planes. The lattice parameter for Fe is 0.2866 nm. Assume that monochromatic radiation having a wavelength of 0.1790 nm is used, and the order of reflection is 1.
2. Calculate the atomic packing factor for Simple cubic, BCC and FCC crystal structure.
3. Niobium has a BCC crystal structure, an atomic radius of 0.143 nm and an atomic weight of 92.91 g/mol. Calculate the theoretical density for Nb.
4. Calculate the radius of a vanadium atom, given that V has a BCC crystal structure, a density of 5.96 g/cm3, and an atomic weight of 50.9 g/mol.
5. Within a cubic unit cell, sketch the following directions:



1. Sketch within a cubic unit cell the following planes:



1. Determine the Miller indices for the planes shown in the following unit cell:



1. (a) Derive linear density expressions for FCC [100] and [111] directions in terms of the atomic radius R.

(b) Compute and compare linear density values for these same two directions for silver.

1. (a) Derive linear density expressions for BCC [110] and [111] directions in terms of the atomic radius R.

(b) Compute and compare linear density values for these same two directions for tungsten.

1. (a) Derive planar density expressions for BCC (100) and (110) planes in terms of the atomic radius R.

(b) Compute and compare planar density values for these same two planes for vanadium.

1. Explain why the properties of polycrystalline materials are most often isotropic.
2. Determine the expected diffraction angle for the first-order reflection from the (113) set of planes for FCC platinum when monochromatic radiation of wavelength 0.1542 nm is used.
3. The metal rubidium has a BCC crystal structure. If the angle of diffraction for the (321) set of planes occurs at 27.00° (first-order reflection) when monochromatic x-radiation having a wavelength of 0.0711 nm is used, compute (a) the interplanar spacing for this set of planes, and (b) the atomic radius for the rubidium atom.
4. The metal iridium has an FCC crystal structure. If the angle of diffraction for the (220) set of planes occurs at 69.22° (first-order reflection) when monochromatic x-radiation having a wavelength of 0.1542 nm is used, compute (a) the interplanar spacing for this set of planes, and (b) the atomic radius for an iridium atom.
5. For which set of crystallographic planes will a first-order diffraction peak occur at a diffraction angle of 46.21° for BCC iron when monochromatic radiation having a wavelength of 0.0711 nm is used?