

Homework 04

Read: Ch 3 & Ch 5 (again!)

Due date: not collected (I recommend completing this before the exam!)

Work problems 2.14, 2.17, 2.18, 2.19, 5.1, 5.2, 5.3 in the text.

AQ 1: Polonium was discovered in 1898 by Marie and Pierre Curie. All the isotopes of Po are radioactive and Po has a solid form that crystallizes into the simple cubic (SC) structure (the only pure element to do so!).

Suppose an electron beam is accelerated from rest to a speed v_f by a potential difference of $V_A = 2500\text{ V}$ such that it is incident on a single crystal thin film of polonium oriented with the (100) planes perpendicular to the incident beam.

- (a) Find the speed and wavelength of the electrons.
- (b) If the diffracted electrons hit a phosphorescent screen that is 150 mm away from the target, how far are the first order diffraction spots associated with the (100) planes from the central maximum?
- (c) If the single crystal sample was produced such that the (110) planes were perpendicular to the electron beam how far would the first order diffraction spots associated with the (110) planes be from the central maximum?

AQ 2: Describe how X-rays are produced for an X-ray source that might be used for diffraction experiments. What are the wavelengths of K_α and K_β X-rays from a copper source? What specific energy transitions levels are involved to create these photons?

AQ 3: Using the basis vectors for the tetragonal P crystal system and matrix representations of symmetry operations, find which, if any, four-fold rotation operations about the Cartesian axes are possible. Use sketches to explain each of the three results. Repeat for reflection in the x - y , x - z , and y - z planes.