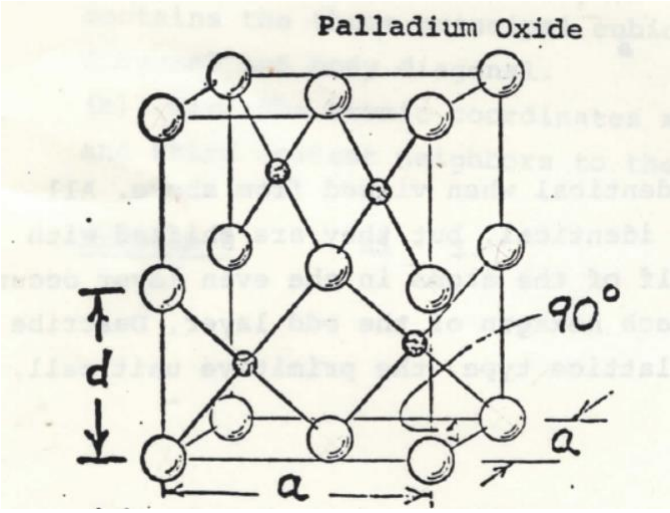
NORTHERN ILLINOIS UNIVERSITY

PHYSICS DEPARTMENT

Physics 580 – Solid State Physics Fall 2024

Problem Set #4

Problem Set Due: Thurs, Sept. 26, 2024
Read Kittel: Chapter 2, peruse paper on "Palladium Oxide"



1. The figure above shows the structure of PdO. The small circles represent palladium atoms and the large circles oxygen atoms. The PdO_4 groups are planar.

   (a) Use Vesta to draw a model of this structure above. You may use the paper on "Palladium Oxide" in Blackboard and the websites for WebElements and the Materials Project for help.

   (b) What is the lattice type?

   (c) Draw the primitive unit cell using either Vesta or by hand.

   (d) Give a set of primitive translation vectors for both the lattice shown above and for the primitive unit cell.

   (e) How many atoms are in the primitive unit cell? Give the coordinates of the basis atoms for the lattice shown above and for the primitive unit cell.

   (f) Give the Miller indices for a plane which contains planar PdO_4 groups for the lattice shown above and for the primitive unit cell.

2. Kittel: **Problem 5** (see below)

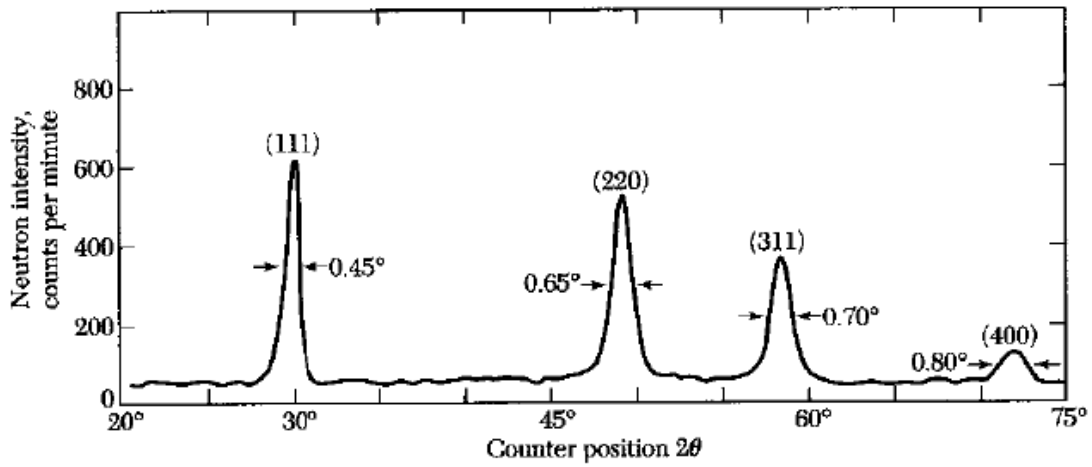


Figure 18 Neutron diffraction pattern for powdered diamond. (After C. Bacon.)

5. ***Structure factor of diamond.*** The crystal structure of diamond is described in Chapter 1. The basis consists of eight atoms if the cell is taken as the conventional cube. (a) Find the structure factor S of this basis. (b) Find the zeros of S and show that the allowed reflections of the diamond structure satisfy $v_1 + v_2 + v_3 = 4n$, where all indices are even and n is any integer, or else all indices are odd (Fig. 18). (Notice that h, k, l may be written for v_1, v_2, v_3 and this is often done.)

You may find the relations below useful for the case where $h + k + l$ = an integer:

$$e^{-i\pi(h+k+l)} = \cos[\pi(h+k+l)] - i\sin[\pi(h+k+l)] = (-1)^{h+k+l}$$

$$e^{-i\frac{\pi}{2}(h+k+l)} = \cos[\frac{\pi}{2}(h+k+l)] - i\sin[\frac{\pi}{2}(h+k+l)] = (-i)^{h+k+l}$$