NAME: _____

33-448 Solid State Physics Midterm #3 Wednesday, April 26, 2017

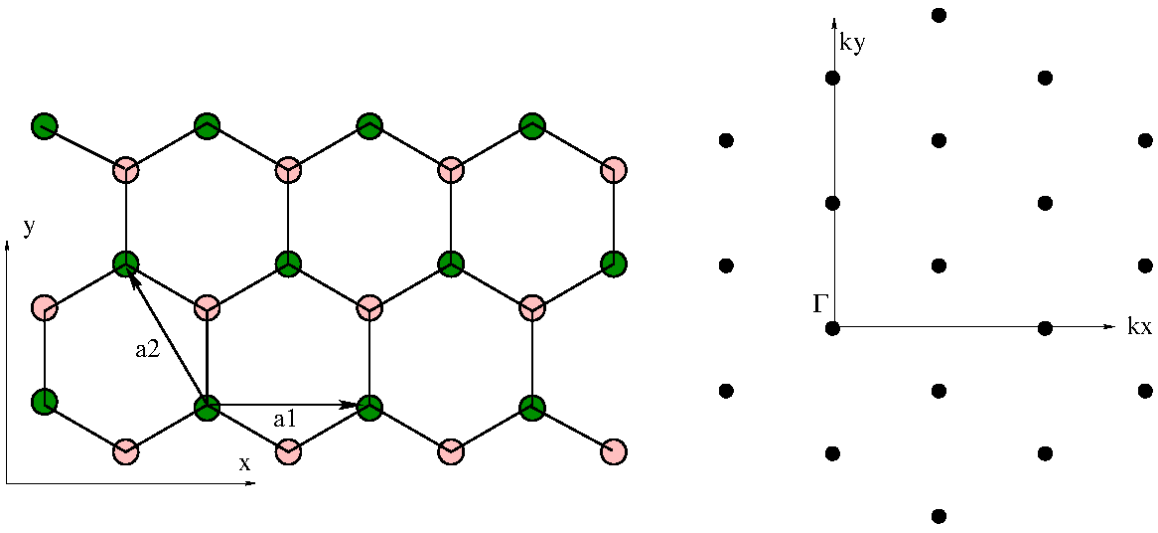
This exam contains two questions, each with several parts.

1. The figure below illustrates the real-space structure and diffraction pattern of hexagonal boron nitride. The translation vectors are

$$\mathbf{a}_1 = a\hat{x} \qquad \mathbf{a}_2 = a(-\hat{x}/2 + \sqrt{3}\hat{y}/2)$$

and the reciprocal lattice vectors are

$$\mathbf{b}_1 = \frac{2\pi}{a}(\hat{x} + \frac{1}{\sqrt{3}})\hat{y} \qquad \mathbf{b}_2 = \frac{4\pi}{\sqrt{3}a}\hat{y}.$$



Sketch on the figure and clearly label:

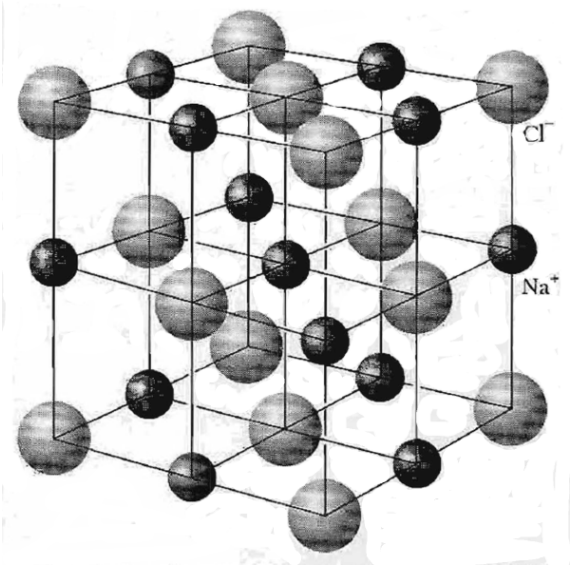
i. A conventional unit cell

ii. Lattice planes of Miller indices (10), (01), (11) and (21)

iii. Reciprocal lattice points of Miller indices (10), (01), (11) and (21)

iv. The first and second Brillouin zone boundaries.

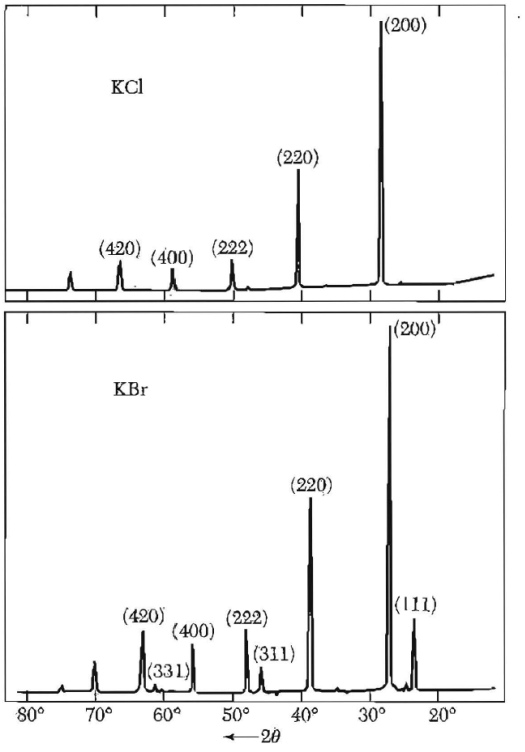
2. Potassium Bromide (KBr) takes the rocksalt (NaCl) structure (shown below). K and Br atoms sit at alternating sites of a simple cubic lattice, leading to two interpenetrating FCC lattices.



(a) Given that the atomic numbers of K and Br are $Z = 19$ and 35, respectively, calculate the structure factor $S(hkl)$ for peaks of Miller index (hkl).

(b) Briefly explain the origin of any extinctions (missing peaks), and the pattern of large and small structure factors.

(c) The figure below compares the diffraction patterns of KBr with KCl, which also takes the rocksalt structure. Explain the extinctions of the (111), (311) and (331) peaks. Hint, Cl is Chlorine, with atomic number $Z = 17$, and KCl is strongly ionic, K^+Cl^-.



(d) If you were given the diffraction pattern of KCl with the peak indexing omitted, and were told nothing about the material under study, what would you conclude about its crystal structure, and why?

ADDITIONAL SPACE IF NEEDED