First Midterm Exam

P555

February 25, 2021

SHOW ALL WORK TO GET FULL CREDIT!

Problem 1: Consider the array of atoms shown in Fig. 1.

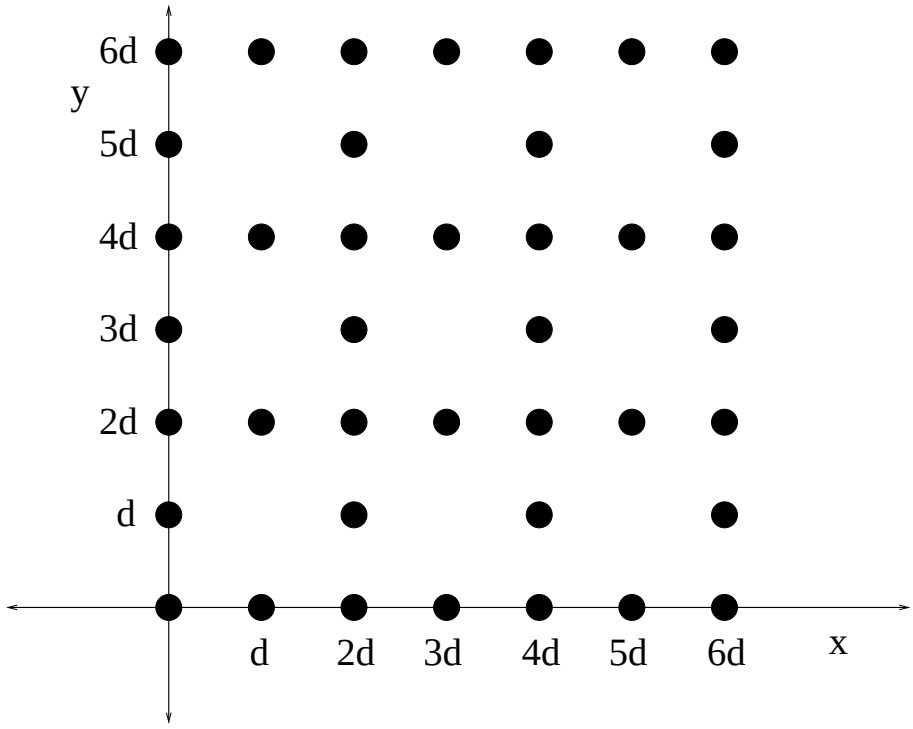

FIG. 1:

a) Draw a unit cell indicating and indicate two primitive lattice vectors in this plane.(5 points)

b) Provide an expression for the primitive vectors $\mathbf{a}_1$ and $\mathbf{a}_2$ that you drew in part (a), in cartesian coordinates in terms of the distance d indicated in Fig. 1. (5 points)

c) How many atoms are in the unit cell? (5 points)

d) How many points of the Bravais lattice are in the unit cell? (5 points)

e) Name the Bravais lattice. (5 points)

f) Does the system have a basis? If there is a basis provide an expression for the basis vectors in terms of the distance d indicated in the figure.(10 points)

g) Find the primitive vectors $\mathbf{b}_1$ and $\mathbf{b}_2$ in the reciprocal lattice. (5 points)

h) Calculate the modulation factor $F_{\mathbf{K}}$. (10 points)

i) Find the posible values of $F_{\mathbf{K}}$ and say if it describes an interference pattern from a Bravais lattice or from a Bravais lattice with a basis. Explain. (5 points)

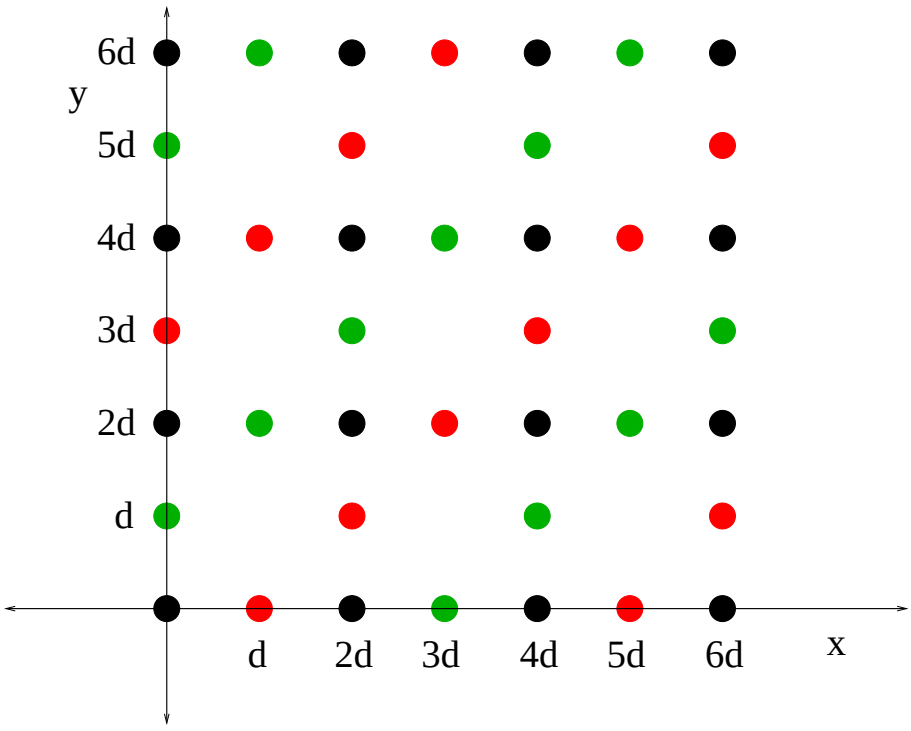

FIG. 2:

j) Now some of the black atoms are replaced by two different kind of atoms, red and green as shown in Fig. 2. Draw the unit cell in this new situation.(5 points)

k) Provide an expression for the primitive vectors $\mathbf{a}_1$ and $\mathbf{a}_2$ in cartesian coordinates in terms of the distance d indicated in Fig. 2. (5 points)

l) How many atoms are in the unit cell? (5 points)

m) How many points of the Bravais lattice are in the unit cell? (5 points)

n) Name the Bravais lattice. (5 points)

o) Does the system have a basis? If there is a basis provide an expression for the basis vectors in terms of the distance d indicated in the figure.(10 points)

p) Find the primitive vectors $\mathbf{b}_1$ and $\mathbf{b}_2$ in the reciprocal lattice. (5 points)

q) Name one symmetry present in the monoatomic system shown in Fig. 1 that is lost when red and green atoms are introduced as in Fig. 2. (5 points)