University of M'sila
Faculty of Science **June 2022**
Physics department

English Exam

Exercise 1: Read the text carefully then answer the questions

Translational symmetry

An ideally perfect single crystal is an infinite three–dimensional repetition of identical building blocks, each of the identical orientation. Each building block, called a basis, is an atom, a molecule, or a group of atoms or molecules. The basis is the quality of matter contained in the unit cell, a volume of space in the shape of a

3-D parallelepiped, which may be translated discrete distances in three dimensions to fill all of the space.

The most obvious symmetry requirement of a crystalline solid that of translational symmetry. This requires that three translational vectors **a**, **b**, and **c** can be chosen such that the translational operation (where n1, n2, and n3 are arbitrary integers)

$$T = n_1 a + n_2 b + n_3 c$$

Connect two locations in the crystal having identical atomic environments. The translation vectors **a**, **b**, and **c** lie along three adjacent edges of the unit cell parallelepiped. However, translational Symmetry means much more than that the atomic environment must look the same at one corner of the unit cell as at the opposite corner; it means that if any location in the crystal (which may or may not coincide with the position of an atom) is designated as the point **r**, then the local arrangement of atoms must be the same about **r** as it is about any of the set of points

$$r' = r + T$$

The set of operations **T** defines a space lattice or Bravais lattice, a purely geometric concept. A real crystal lattice results when a basis is placed around each geometric point of the Bravais lattice.

Five different Bravais lattices can be envisaged for a hypothetical two dimensional solid, and we shall find it convenient to illustrate some features of 2-D situations before proceeding to real three-dimensional materials. Fourteen Bravais lattices are possible in three dimensions.

Only for certain kinds of lattices can the vectors a, b, and c be chosen to be equal in length, and only for certain simple lattices are they mutually perpendicular .The lattice of points **r'** ,and the translation vectors a, b, and c are said to be primitive if every point equivalent to **r** is included in the set **r'**. The primitive basis is the minimum number of atoms or molecules which suffices to characterize the crystal structure, and is the amount of matter contained within the primitive (smallest) unit cell. For some kinds of crystalline array, there is more than one logical way in which a set of primitive vectors can be chosen (as well as an infinite number of ways in which sets can be chosen for larger, non-primitive unit cells).

Exercise 1. Put "T" for true and "F" for false statements. Justify your answers. (6 points)

T 1-Three translational vectors of a, b, and c connect three adjacent edges of the unit cell.

T 2 -Translational Symmetry must look the same at all of the corners of the unit cell.

T.3- The arrangement of atoms around a point in a perfect crystal is the same as all other points.

T 4- There are five different space lattices in two dimensional solids.

T 5- Three translational vectors a, b, and C have equal length in few cases.

T 6-The minimum amount of molecules required to characterize a single crystal is called the primitive basis.

Exercise 2: Complete these sentences with the most suitable word or phrase from those given (3 points)

quarter , plane waves, energy gap, first Brillouin zone, forbidden, Bravais Lattice.

1) The wigner_seitz primitive cell of the reciprocal lattice is known as first Brillowin zone

2) When the periodic potential is zero, the solution to schrodinger's equation are plane waves

3) In an insulator there is a region of forbidden.energies separating the highest occupied and lowest unoccupied levels

4) We can characterize insulators by energy gap between the top of the highest filled bands and the bottom of the lowest empty bands.

5) The diamond lattice consists of two interpenetrating face centered cubic Bravais Lattice.

displaced along the body diagonal of the cubic cell by one quarter the length of the diagonal.

Exercise 3: Put the following sentences in the right order to from a paragraph. Write the corresponding letters in the boxes provided(6 points)

a- However, in the early years of the twentieth century, theoretical and experimental investigations established that light sometimes has particle properties.

b- According to the view of classical physics, light is a wave consisting of electric and magnetic fields with a smooth distribution of energy.

c- According to this new view, light acts like a stream of particle like energy packets.

d-Further investigations soon established that energy quantization is a pervasive feature of the microscopic world – the energy of atoms and the energy of electrons and other subatomic particles is packaged in energy quanta.

e- The interference and diffraction phenomena give direct experimental evidence for the wave properties of light.

f- These energy packets are called quanta of light, or photons.

1	2	3	4	5	6
e	b	a	d	c	f

Good luck

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