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Head of the Department

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Dear students -

Wishing best alway, please use the following on-line education of NPTEL during stay home orders.

1. Solid state Physics by Prof. A. K Das
2. Solid state Devices by Prof. S. Kamilla
3. Electronics by Prof. D. C. Dube
4. Basic Electronics and lab by T. S. Natarajan
5. Fundamentals of Semiconductors by Prof. D. N. Nath

Being Co-ordinator and observer of Conducting NPTEL examination in Kashmir region, I know these are number of courses worth to record & listen.

Asmat Shah
NIT Srinagar

These groups are called bands because in a sample of any practical size there are so many atoms that the splitting is much too fine to detect experimentally. These groups are essentially continuous in their energy span.

If there are about 10^{19} atoms in a crystal, for example, a band may contain a few times this number of energy states. Since a typical band may be 1 eV wide, the individual energy levels are about 10^{-19} eV apart. This is a very small amount of energy.

→ The valence band is that group of states containing the valence electrons of the atomic solid.

This band like the one above, is shared by the crystal as a whole.

what appears as doubling of the energy states. Fig ↑.

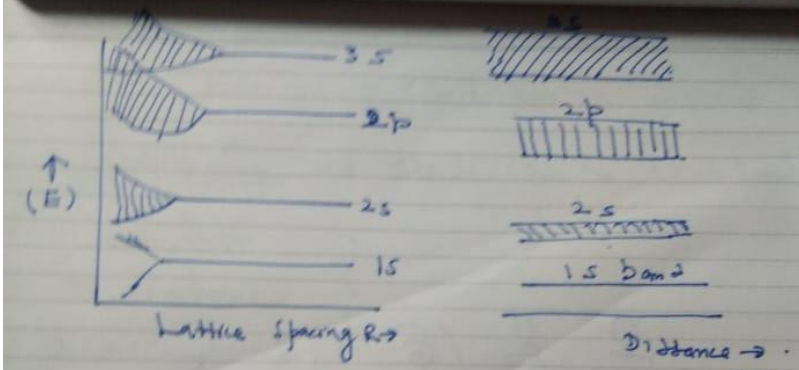
SI

the actual number of states in each atom available to the electrons does not change, but the states in each atom shift slightly in energy.

✓ When we consider the pair of atoms from the outside we see that the effect to obtain two closely spaced levels near the same energy as the original levels in the isolated atoms.

The outermost electrons share the two ~~the~~ levels. This corresponds to the well known covalent binding of germanium-type atoms.

An empty excitation level is known above a valence electron level. This level is normally empty but could have an electron in it if the electron gained enough energy to jump this level by absorbing a photon or phonon



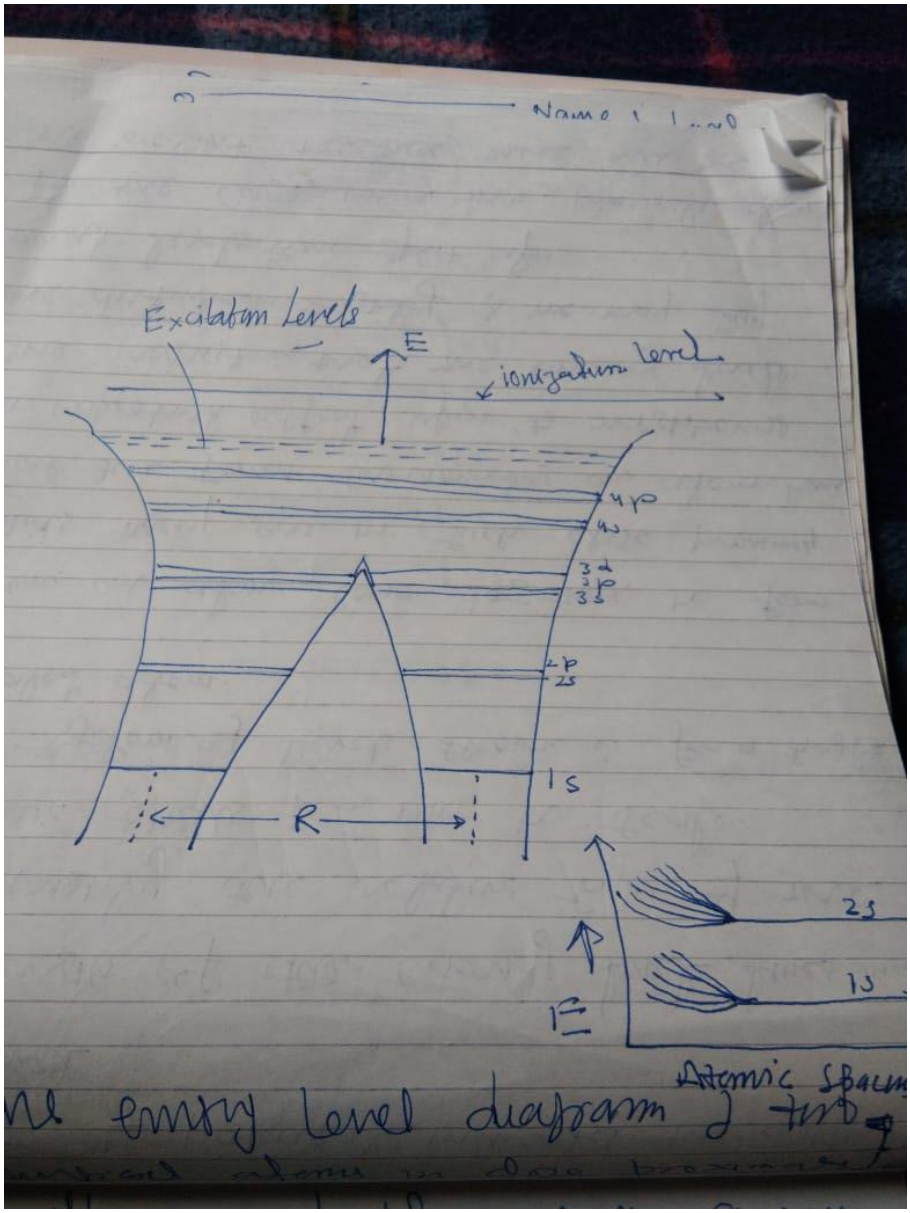
The energy levels for a hypothetical substance as a function of lattice spacing.

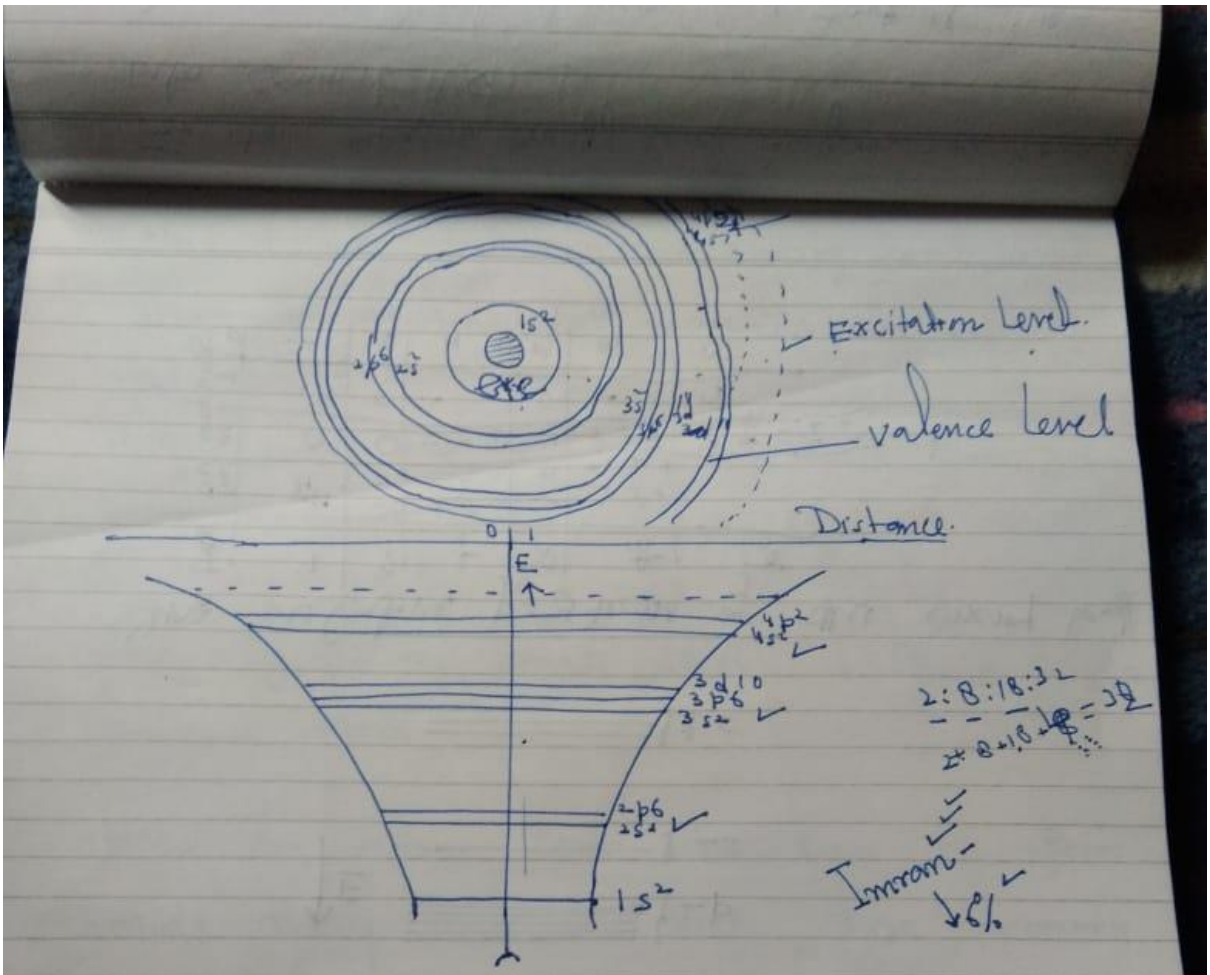
Suppose we have a hypothetical substance for which we can calculate the energy levels as a function of atomic spacing.

↓

The distance between an energy level and the zero of potential indicates the depth of the level.
The length of the energy level lines indicates very roughly the relative sizes of the electronic shells & is not to scale.
The system of levels shown is for a single isolated atom.

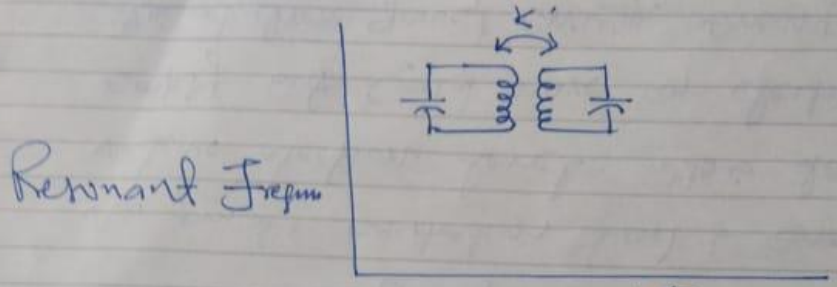
When an atom come together to form solids they are in such close proximity that the forces surrounding an atom an important effect upon its neighbours. The result is that the energy levels are disturbed slightly, & we may say that levels tend split up.
For the case, where two identical are brought together, there will be

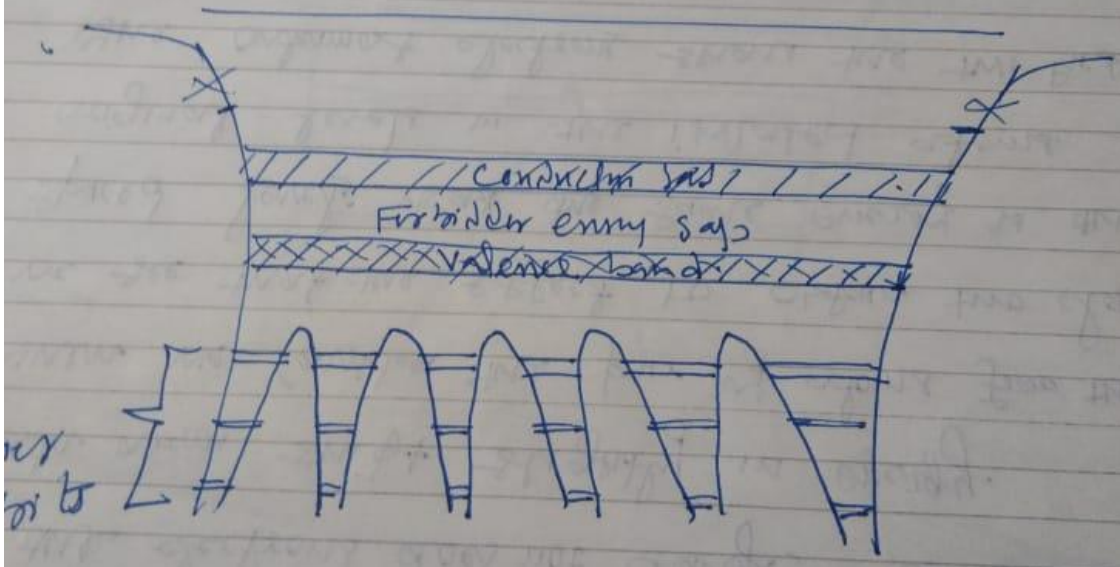

Excitation Levels
E
ionization level
4p
4s
3d
3p
3s
2p
2s
1s
R
2s
1s
Atomic Spacing



Energy level diagram

The shells and sub-shells are shown in their respective in their relative positions and contain the allowed number of electrons. The 4s and 4p levels are shown with a total of 4 electrons.





Energy level diagram for a crystal containing several atoms

contains several atoms.

The phenomenon of energy-level splitting is very much like that which takes place between two tuned circuits ↑.

The amount of spreading of energy levels in atoms depends upon how close the atoms are to each other when they form the solid or in other-words how strong the coupling is between energy levels.

As the atoms are brought closer together the spreading increases. This situation is again analogous to the tuned circuits. There the frequency shift is increased as the coupling is increased.

The one dimensional energy level diagram for a similar group of atoms is shown in figure ↑

The group of neighbouring levels

For this reason, energy level diagram has come into common use.

An energy-level diagram is a sort of one-dimensional scale of energy along which we may locate each electron according to its energy state.

The electron scale is usually measured in electr volts and is so oriented that electrons tend to move downward on the scale to a to be in the lowest possible energy state This means that region of positive potent electrically will be lower on the energy scale than a region of negatively electr potential.

A Schematic representation of an atom a the energy level diagram of the same atom is shown —

The energy gap directly above the valence band is called the forbidden-energy band, the forbidden gap — or simply energy gap because electrons may not exist in the crystal with these energies.

The band of allowed energies directly above the forbidden band is called the conduction band.

The band corresponds to the first excited states & is normally almost empty.

The inner bands or core bands are not shared by all atoms.

They are infact not important in determining the electrical properties of solids.

Just as it is the valence electrons which determine the chemical properties of atoms, it is the valence electron band therefore also which determine the electrical properties

Lecture Notes for M. Sc II Sem. 27-03-2020

Electrons in atoms Lecture-1

The Energy-Band Structure of Solids :- When atoms come together to form molecules, they exert an influence on one another and allowed energy-states are perturbed, or split into closely spaced states. A similar situation exists when many atoms come together to form a solid, except now there are a multitude of states, because of large number of atoms in the solid. These energy-states form essentially continuous bands of allowed energy which the electrons may occupy. Since the motion of the electrons in the solid is confined by the energy states, which they may occupy, the exact nature of these energy bands is of primary interest in determining the electrical properties of solids.