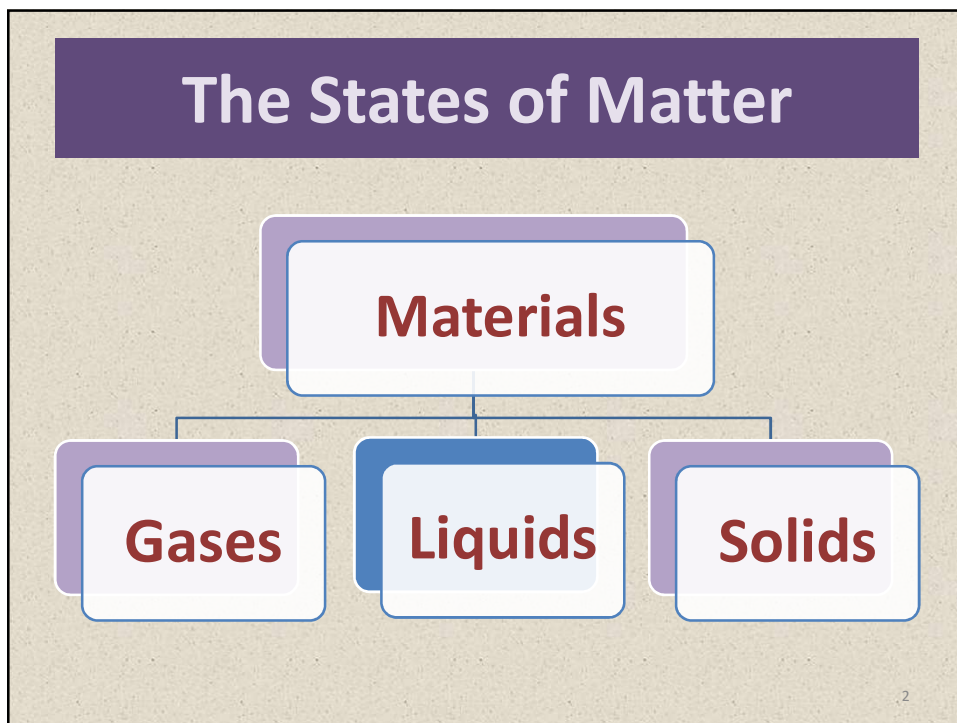



Structure of Solids

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March 2020
أ.د/ كمال محمد سيد خليل



Why to study solids?

- 1. All compounds are solids under suitable conditions of temperature and pressure.**
- 2. Most of useful materials are solids.**
- 3. Solids are very important for many applications.**

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Why to study solids?

Examples of Solids Applications

1 Technological Applications

Metals/Alloys	e.g. Titanium for aircraft
Ceramics	e.g., BN, SiC
Lubricants	e.g. Graphite

2 Electrical Applications

Metallic Conductors	e.g. Cu, Ag
Semiconductors	e.g. Si, GaAs
Superconductors	e.g. Nb ₃ Sn, YBa ₂ Cu ₃ O ₇
Electrolytes,	e.g. LiI in pacemaker batteries

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Why to study solids?

Other Examples of Solids Applications

Optical Applications

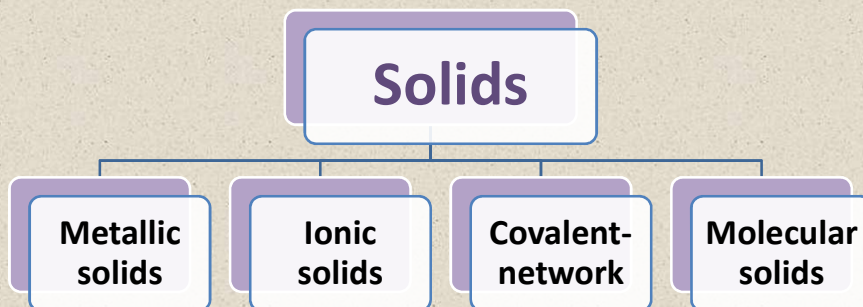
Appearance	e.g. Precious stone
Pigments	e.g. TiO_2 in paints
Phosphors	e.g. Eu^{3+} in Y_2O_3 is red on TV

Physical/Chemical Applications

Catalysts	Zeolite ZSM-5 (an aluminosilicate) for Oil refining
Sensors	Oxygen sensor, e.g. ZrO_2/CaO solid solution
Magnetic	CrO_2 , Fe_3O_4 for recording technology

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1.2 Classification of Solids

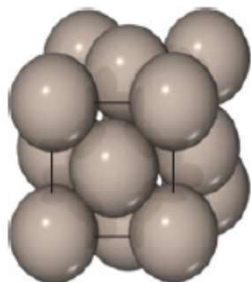


This course is concerned mostly with the structures of metals, ionic solids, and extended covalent structures.

Structures which do not contain discrete molecules as such, but which comprise extended arrays of atoms or ions.

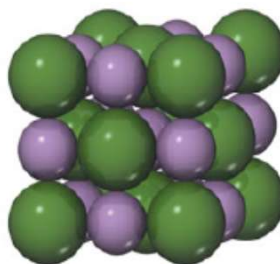
6

1.2 Classification of Solids



Metallic solids

Extended networks of atoms held together by metallic bonding (Cu, Fe)

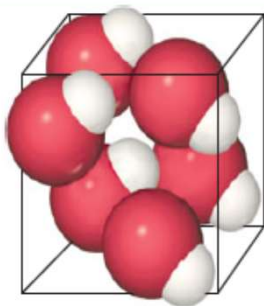


Ionic solids

Extended networks of ions held together by ion-ion interactions (NaCl, MgO)

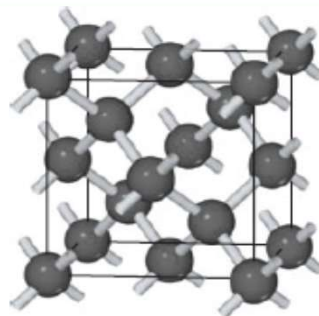
7

1.2 Classification of Solids



Molecular solids

Discrete molecules held together by intermolecular forces (HBr, H₂O)



Covalent-network solids

Extended networks of atoms held together by covalent bonds (C, Si)

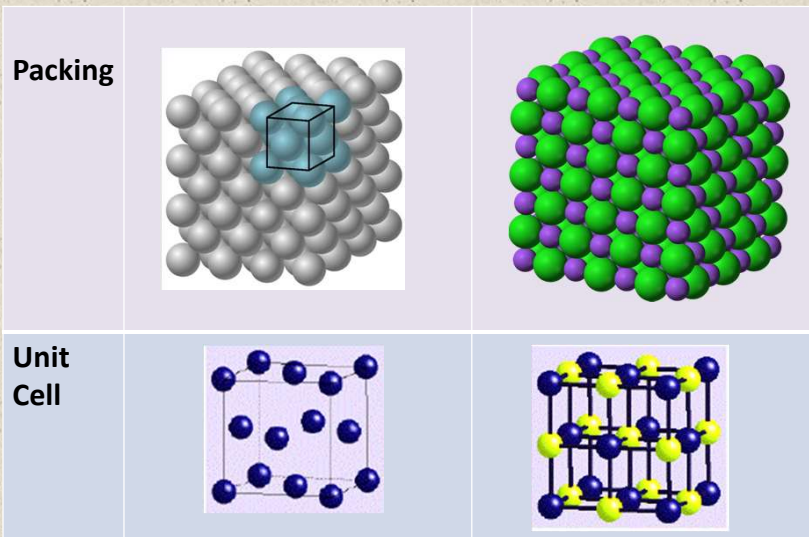
8

1.3 CLOSE-PACKING

- The structures of many inorganic crystal structures can be discussed in terms of the simple packing of spheres.
- *So we will consider the problem of simple packing of spheres, before moving on to the more formal classification of crystals.*

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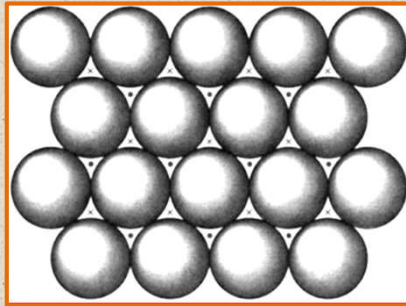
1.3 CLOSE-PACKING



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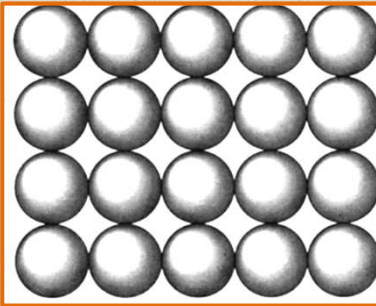
1.3 CLOSE-PACKING

A close-packed



A close-packed layer of spheres

A square array

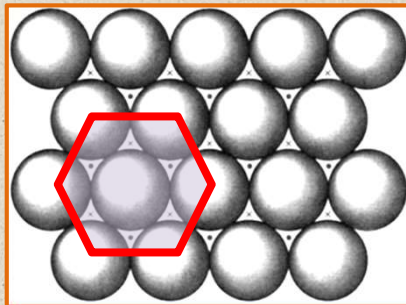


A square array of spheres

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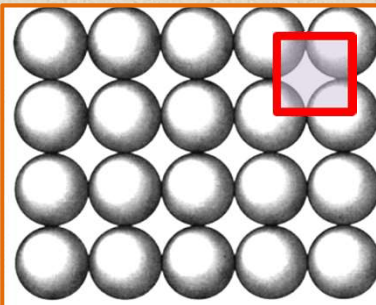
1.3 CLOSE-PACKING

A close-packed



A close-packed layer of spheres

A square array

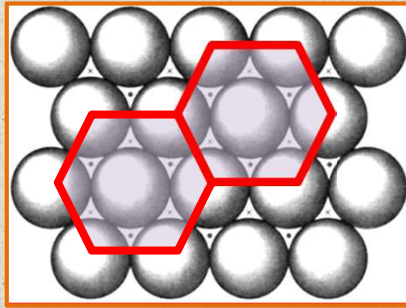


A square array of spheres

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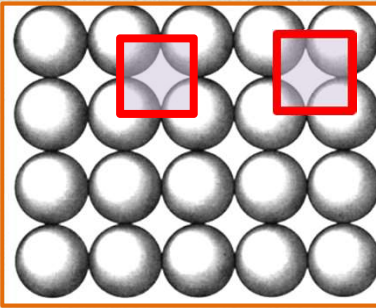
1.3 CLOSE-PACKING

A close-packed



A close-packed layer of spheres

A square array



A square array of spheres

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1.3 CLOSE-PACKING

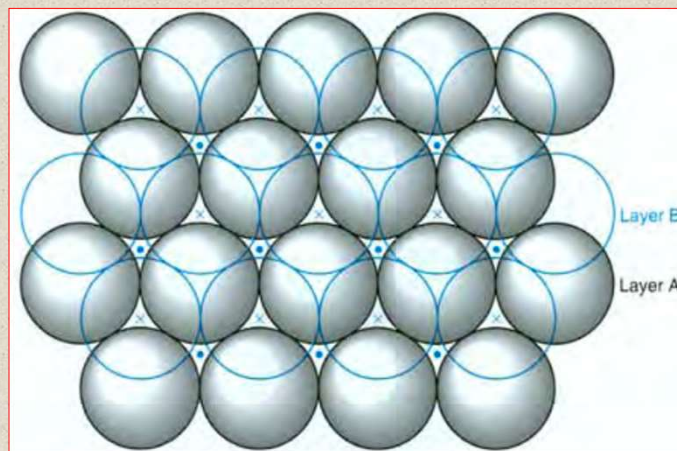
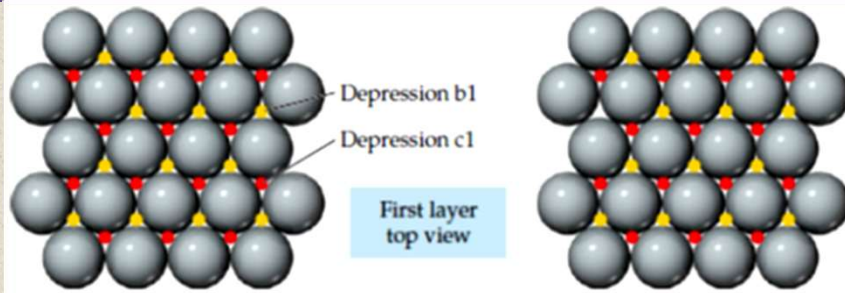


Figure 2 Two layers of close-packed spheres.

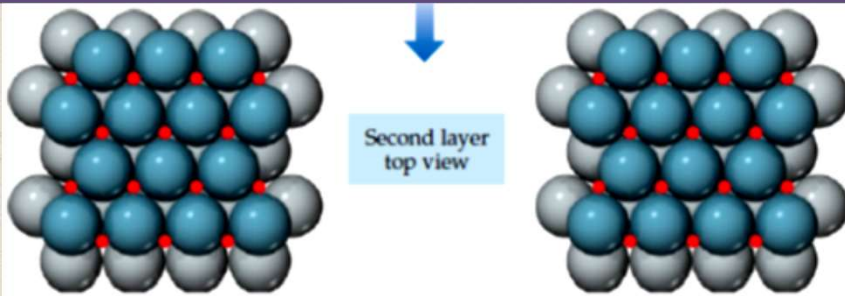
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1.3 CLOSE-PACKING



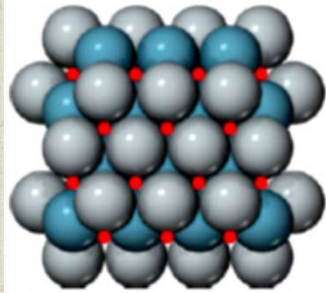
15

1.3 CLOSE-PACKING

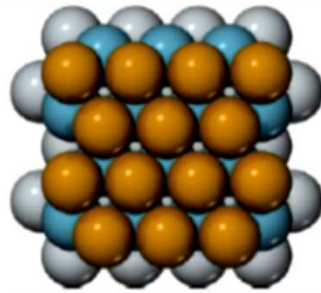


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1.3 CLOSE-PACKING

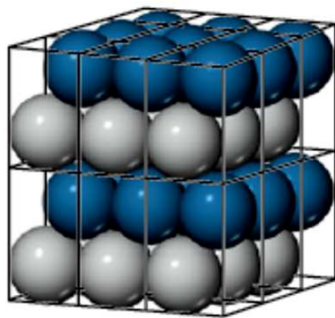


Third layer
top view

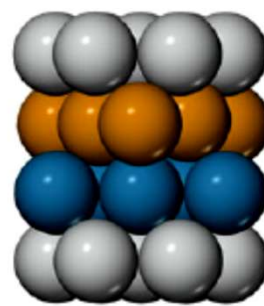


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1.3 CLOSE-PACKING



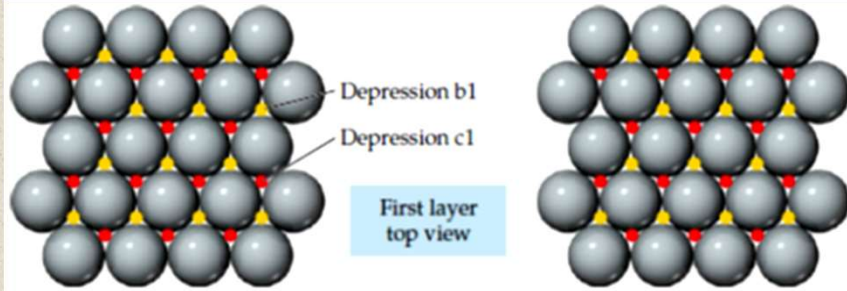
Side view



Side view

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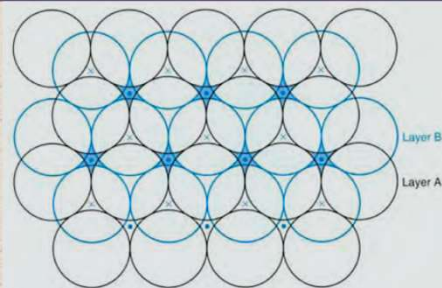
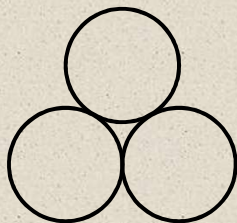
1.3 CLOSE-PACKING



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1.4 Formation of Octahedral Holes

- (a) *Two layers of close-packed spheres with the enclosed octahedral holes shaded;*
(b) *a computer representation of an octahedral hole.*



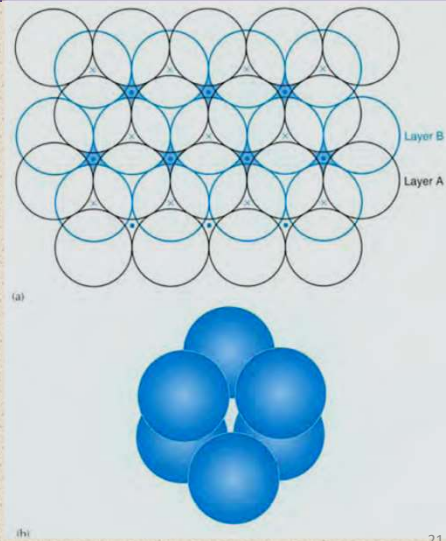
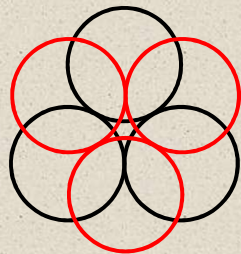
(a)

(b)

20

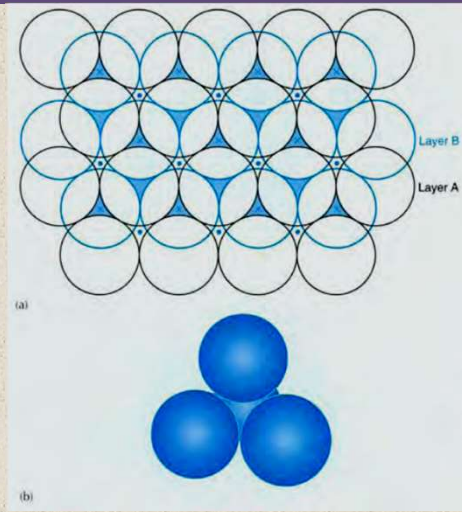
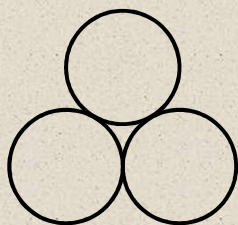
1.4 Formation of Octahedral Holes

- (a) *Two layers of close-packed spheres with the enclosed octahedral holes shaded;*
(b) *a computer representation of an octahedral hole.*



1.4 Formation of Tetrahedral Holes

- (a) *Two layers of close-packed spheres with the tetrahedral holes shaded;*
(b) *a computer representation of a tetrahedral hole.*



1.4 Formation of Tetrahedral Holes

(a) *Two layers of close-packed spheres with the tetrahedral holes shaded;*

(b) *a computer representation of a tetrahedral hole.*

