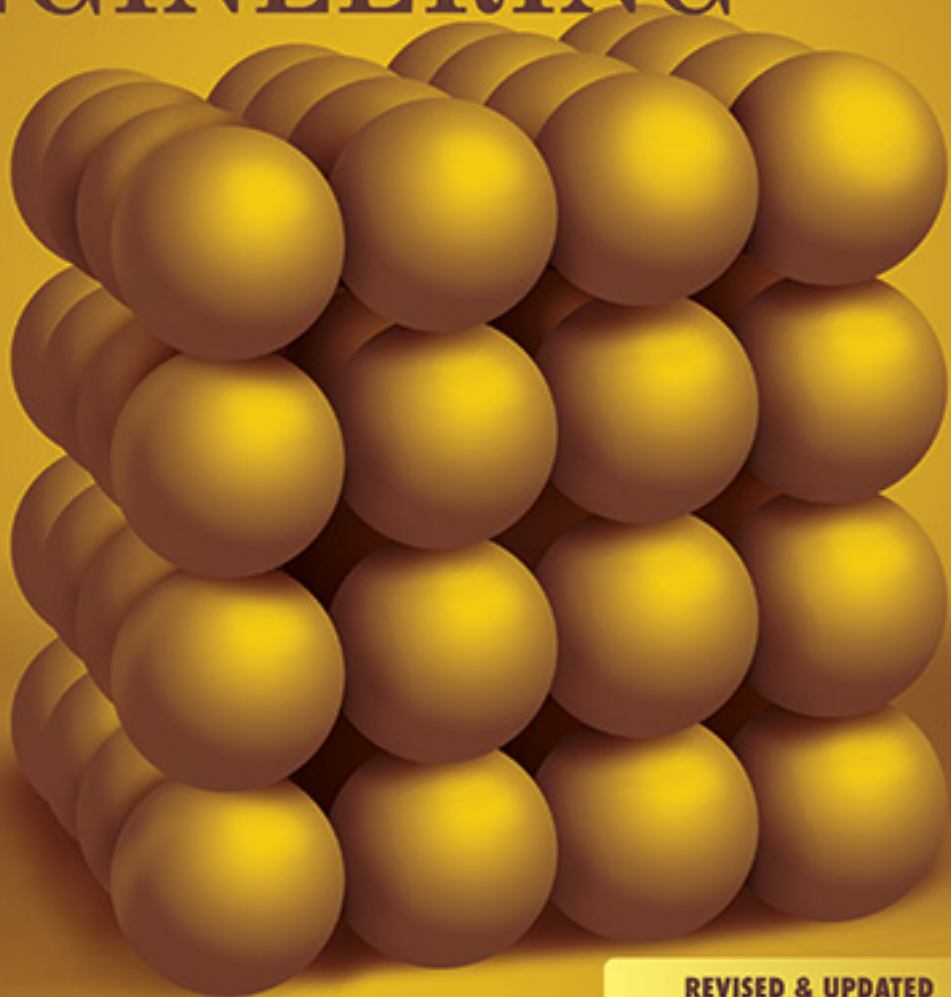


ESE 2018
Prelims Paper - I



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Basics of
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PREFACE

Materials are the spinal chord of technology. An Engineer, regardless of which discipline he/she belongs to, must have sound understanding of basic concept of Material Science.

This understanding of materials enables the engineers to select the most appropriate materials and use them with greatest efficiency whilst causing minimum pollution in their extraction, refinement and manufacturing.

Favourable and warm reception which the first edition got from the student is a matter of great satisfaction for me. In present second addition I have tried to use simple and lucid language to explain the fundamental. As per the latest paper of ESE and by brainstorming over it, I have included some new topics in each chapter of first addition along with Annexure I & II.

This book primarily aimed at explaining the basic concept of "Material Science" for student preparing for ESE. The treatment of each chapter is such as to start from the fundamentals and build up to the level of ESE.

This book is divided into "Eleven Chapters" plus Two Annexure-I & II. The first two chapter deal with the basic concept of atom, chemical bonding, Various Related Theories to Bonding and Crystal Structure. The Chapter 3 and 4 describes the phase diagram, Heat treatment and mechanical properties of material. Chapter 5 discusses the various type of alloy. Chapter 6 discusses the semiconductor and its related terms. Chapter 7, 8, 9 describes the magnetic and dielectric properties, conductivity and superconductivity, optical and thermal properties of material. Chapter 10 deals with modern material which include polymer, ceramic and composite. Chapter 11 includes Miscellaneous and advance material. The Annexures given at end serves as a ready reckoner, covering short and brief description of properties of various important material in the periodic table, for a distraction free learning.

This book contains several student friendly features. No prior knowledge is expected of the student except school level physics and chemistry. Important points, which are important from examination point of view, are highlighted in the chapters and at the end of the chapter these are given as **Point to be Remembered**. Good number of practice questions are provided at the end of every chapter. So, as a topic is finished, students test their understanding in the language asked in the UPSC exam. The spin given to the concepts, tests the ability of the students to derive the correct answer, which facilitate the students to acquire necessary confidence. Apart from the aforesaid, UPSC sample Paper Questions and Questions asked in ESE-2017 paper are discussed after the completion of relevant topics.

All care has been taken to make the understanding of this subject more clear and interesting. My special thanks to the entire IES MASTER Team for their continuous support in bringing out this book. Hope this will suffice the need of students who are preparing for Engineering Services Examination. All comments and suggestions for function improvement of the book are welcome and will be appreciated.

Bipin Thakur
IES Master Publication
New Delhi, 2017

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1. According to Thomson's plum pudding model, an atom consists of
 - (a) A nucleus of negative charge with protons around
 - (b) A sphere of negative charge seasoned with enough number of proton plums.
 - (c) A heavy sphere of positive charge seasoned with enough number of electron plums to make it electrically neutral
 - (d) None of these
2. Rutherford's experiment of Bombardment of α -particles by striking on a thin gold foil showed that
 - (a) All the α -particles passed straight through the foil
 - (b) All the α -particles were deflected back
 - (c) Some particles passed through the foil and some were deflected back.
 - (d) Most of the α -particles went straight through the foil while very few were deflected by various angles
3. Hydrogen bonds are stronger than
 - (a) Van der Waals bonds
 - (b) Metallic bonds
 - (c) Ionic bonds
 - (d) Covalent
4. The atomic number of a certain element is 83. An atom of this element must contain
 - (a) 42 protons and 41 electrons
 - (b) 83 neutrons
 - (c) 1 neutron, 41 electrons and 41 protons
 - (d) 83 electrons
5. Avogadro number, N
 - (a) 6.023×10^{23}
 - (b) 6.02×10^{21}
 - (c) 6.023×10^{-26}
 - (d) 6.023×10^{-29}
6. Particles that most effects material propertis
 - (a) Nuetrons
 - (b) Protons
 - (c) Electrons
 - (d) Valence electrons
7. Which one of the following is not a strong bond?
 - (a) Van der Waals bond
 - (b) Covalent bond
 - (c) Metallic bond
 - (d) Ionic bond
8. Electron sea exists in
 - (a) Polar bonds
 - (b) Ionic bond
 - (c) Covalent bond
 - (d) Metallic bond
9. The mole is
 - (a) The molecular weight of a substance in grams
 - (b) The amount of a substance whose mass is numerically equal to its molecular weight
 - (c) The amount of a substance whose volume is equal to that of 1 gram of hydrogen gas at standard temperature and pressure
 - (d) None of the above
10. Avogadro's number is
 - (a) The number of atoms in a gram-atom
 - (b) The number of molecules in a gram-molecule
 - (c) Both (a) and (b)
 - (d) None of the above
11. Rutherford's α -particle scattering experiment showed that
 - (a) the nuclear charge is proportional to atomic number
 - (b) electrons are small compared with the atom
 - (c) the nucleus is small compared with the atom
 - (d) None of the above
12. The total energy of the electron is
 - (a) the difference between its kinetic and potential energies
 - (b) the sum of its kinetic and potential energies

- (c) the product of its kinetic and potential energies
(d) None of the above
13. How many quantum numbers are needed to define the wave function of an electron moving in two dimensions (excluding spin)?
(a) one (b) two
(c) three (d) four
14. The principal quantum number n may have only the values
(a) 0, 1, 2, ... (b) 0, ± 1 , ± 2 , ± 3 , ...
(c) 1, 2, 3, ... (d) None of the above
15. The angular momentum quantum number l may take only the values
(a) 0, 1, 2, ..., $(n - 1)$ (b) 0, 1, 2, 3, ..., n
(c) 1, 2, 3, ..., n (d) 1, 2, 3, ..., $(n - 1)$
16. The magnetic quantum number m may have only the values
(a) 0, ± 1 , ± 2 , ..., $\pm l$
(b) 0, ± 1 , ± 2 , ..., $\pm n$
(c) 0, ± 1 , ± 2 , ..., $\pm (l - 1)$
(d) 0, ± 1 , ± 2 , ..., $\pm (n - 1)$
17. When an electron 'jumps' from an energy level to a lower one, the energy released is usually
(a) absorbed by the nucleus
(b) emitted as a photon
(c) emitted as light
(d) emitted as a continuous electromagnetic wave
18. The frequency (ν) and wavelength (λ) of the emitted radiation can be found from which two equations?
(a) $\lambda = h/p$ (b) $E = h/\nu$
(c) $E = \frac{1}{2}mc^2$ (d) $c = \nu\lambda$
19. The radiation emitted by a heated gas of hydrogen atoms contains
(a) all wavelengths
(b) one specific wavelength
(c) a set of discrete values of wavelength
(d) None of the above
20. The emission of radiation from a gas of atoms occurs when
(a) an electron is spiralling towards the nucleus
(b) an electron jumps between two energy levels
(c) the wavelength of an electron changes
(d) None of the above
21. If the atomic number of an element is Z and its atomic weight is A , the number of protons in the nucleus is
(a) Z (b) $A - Z$
(c) A (d) $Z - A$
22. The difference between A and Z is a result of the presence in the nucleus of
(a) electrons (b) protons
(c) photons (d) neutrons
23. Pauli's exclusion principle states that, within one atom
(a) no more than two electrons may have the same energy
(b) the spins of the electrons interact so as to become parallel if possible
(c) no two electrons may have the same four quantum numbers
(d) there are only two values for the quantum number m_s
24. The maximum number of electrons in the L shell ($n = 2$) is
(a) 4 (b) 6
(c) 8 (d) 14
25. The maximum number of electrons allowed in the 4d subshell is
(a) 14 (b) 10
(c) 8 (d) 4
26. The lithium atom, which contains three electrons, has the structure
(a) $1s^2 2s^1$ (b) $1s^2 2p^1$
(c) $1s^1 2p^2$ (d) $2s^2 2p^1$
27. The atomic number of the element whose outermost electron fills the 3s subshell exactly is
(a) 13 (b) 8
(c) 10 (d) 12

18 Material Science

<p>52. Assertion : The electronic structure $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^5 4d^2$ does not normally occur in a real atom.</p> <p>Reason : The subshells have been filled in the wrong order.</p>	<p>55. Assertion : Bonding in diamond is covalent.</p> <p>Reason : Carbon lies in Group 14 of the periodic table.</p>
<p>53. Assertion : The elements in any one group of the periodic table are chemically similar.</p> <p>Reason : They all contain the same number of electrons in the outermost subshell.</p>	<p>56. Assertion : van der Waals bonding is weak.</p> <p>Reason : It bonds only molecules together.</p>
<p>54. Assertion : Magnesium oxide is bonded ionically.</p>	<p>57. Assertion : Liquid carbon tetrachloride cannot conduct electrically.</p> <p>Reason : it contains neither C^+ ions nor Cl^- ions.</p>

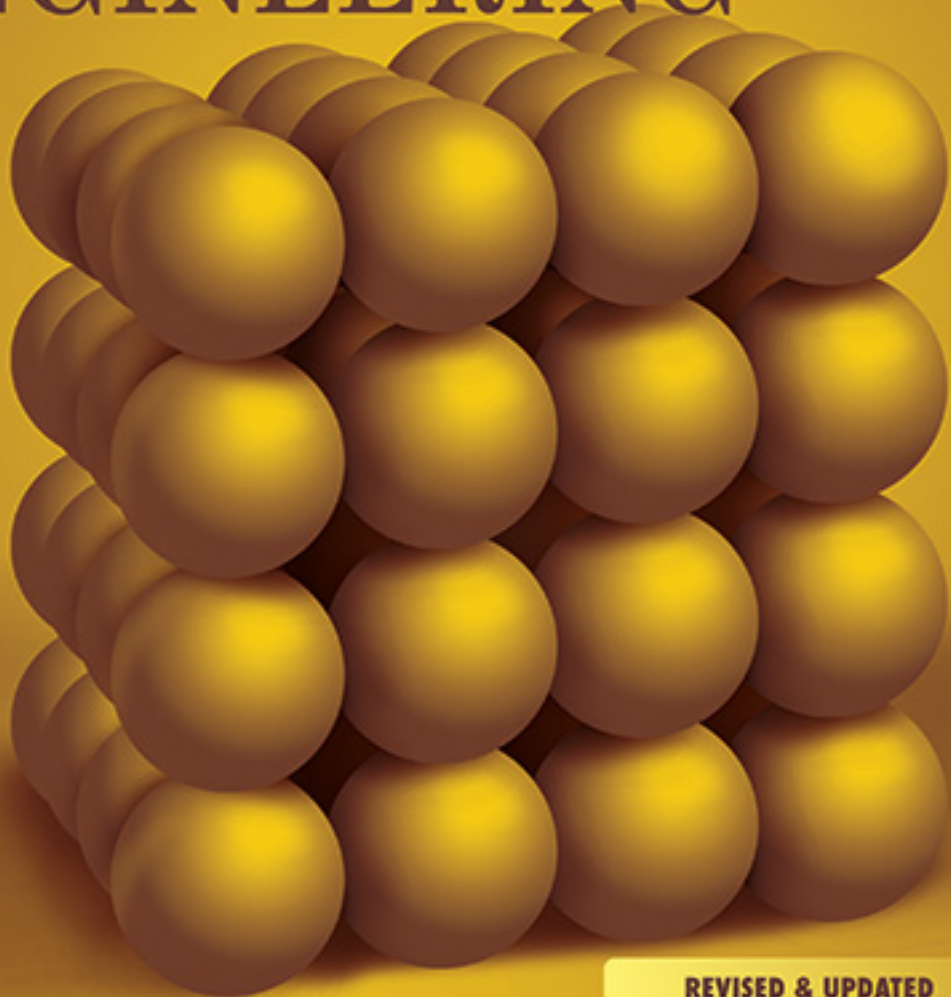
ANSWER KEY

1. (c)	13. (b)	25. (b)	37. (b)	49. (b)
2. (d)	14. (c)	26. (a)	38. (c)	50. (b)
3. (a)	15. (a)	27. (d)	39. (c)	51. (b)
4. (d)	16. (a)	28. (d)	40. (a)	52. (a)
5. (a)	17. (b)	29. (b)	41. (a)	53. (a)
6. (d)	18. (a, d)	30. (d)	42. (c)	54. (b)
7. (a)	19. (c)	31. (a)	43. (b)	55. (a)
8. (d)	20. (b)	32. (a)	44. (c)	56. (c)
9. (b)	21. (a)	33. (c)	45. (d)	57. (a)
10. (c)	22. (d)	34. (a)	46. (d)	
11. (c)	23. (c)	35. (b)	47. (a)	
12. (b)	24. (c)	36. (b)	48. (d)	

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