ESE-2019 PRELIMS TEST SERIES

Date: 17th November, 2018

GS PAPER-I (TEST-07) OBJECTIVE SOLUTION...

ANSWERS

1. (b)	18. (d)	35. (b)	52. (b)	69. (d)	86. (c)
2. (b)	19. (d)	36. (c)	53. (b)	70. (c)	87. (b)
3. (d)	20. (c)	37. (c)	54. (c)	71. (d)	88. (b)
4. (a)	21. (d)	38. (c)	55. (d)	72. (b)	89. (c)
5. (a)	22. (b)	39. (a)	56. (c)	73. (b)	90. (a)
6. (c)	23. (a)	40. (d)	57. (a)	74. (b)	91. (a)
7. (c)	24. (d)	41. (a)	58. (c)	75. (a)	92. (c)
8. (b)	25. (b)	42. (d)	59. (c)	76. (b)	93. (c)
9. (b)	26. (c)	43. (c)	60. (b)	77. (c)	94. (a)
10. (d)	27. (a)	44. (c)	61. (c)	78. (c)	95. (a)
11. (c)	28. (c)	45. (b)	62. (c)	79. (c)	96. (a)
12. (d)	29. (a)	46. (b)	63. (c)	80. (a)	97. (c)
13. (c)	30. (d)	47. (b)	64. (b)	81. (c)	98. (d)
14. (b)	31. (b)	48. (d)	65. (a)	82. (c)	99. (a)
15. (a)	32. (d)	49. (d)	66. (c)	83. (b)	100. (a)
16. (d)	33. (d)	50. (b)	67. (d)	84. (c)	
17. (a)	34. (a)	51. (c)	68. (b)	85. (b)	

1. **(b)**

2. **(b)**

3. **(d)**

4. **(a)**

5. **(a)**

6. **(c)**

7. **(c)**

Fe^{3+} form soluble complex with oxalic acid.

8. **(b)**

9. **(b)**

10. **(d)**

11. **(c)**

12. **(d)**

13. **(c)**

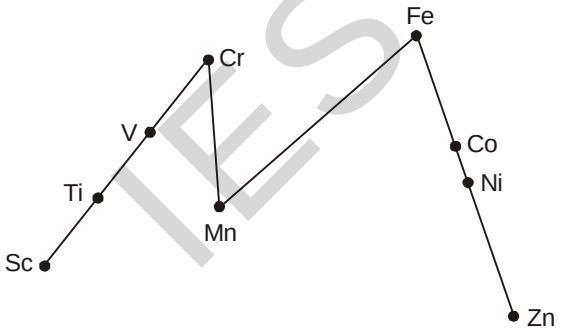
Fe has 4 unpaired electrons.

14. **(b)**

15. **(a)**

16. **(d)**

Transition metals have high melting point is due to atoms in these elements are held together by strong metallic bonds that present in molten state as well. Greater the number of valence shell, stronger is bonding, melting point rise to maximum and fall as atomic number increases except in Mn where melting point is minimum.



17. **(a)**

Polyvinyl chloride (PVC) resembles polyethylene (PE) except that one of the four hydrogens is replaced by a chlorine, $-(C_2H_3Cl)-vs-(C_2H_4)-$. The mass of each mer is [2(12) + 3(1) + 35.5 amu].

18. **(d)**

There are two types of dislocations:

1. An edge dislocation may be described as an edge of a missing half-plane of atoms
2. A screw dislocation is the core of a helix.

19. **(d)**

Unless special efforts are made to grow single crystals, many crystals are nucleated and grow until they encounter neighboring crystals. Each grain in individually oriented.

20. **(c)**

Zinc is sufficiently near copper in size and electrical behavior to proxy for copper in the crystal structure. It is too big for the interstices.

21. **(d)**

Some glass products are called “crystal” because they can be shaped to give refracted colors, as do transparent gem crystals. Actually, glasses are amorphous, supercooled liquids.

22. **(b)**

The 7.5% copper replaces silver atoms. If it is cooled rapidly, the copper is retained in solid solution. The copper atoms interfere with electron movements within the silver.

23. **(a)**

FCC metals have a higher packing factor than do bcc metals; therefore, with other factors equal, diffusion is reduced.

24. **(d)**

Metallic crystals are not ionic and do not have discrete ions.

25. **(b)**

The elastic strains between atoms along the boundary follow the same relationships as the strains among atoms within the grains.

26. **(c)**

Solid solution increases strength (solution hardening). It also decreases conductivity (and increases resistivity). Sterling silver is 92.5 Ag – 7.5 Cu.

27. **(a)**

Phase diagrams can not be used to predict crystalline properties.

28. **(c)**

Group III elements have a shortage of an electron compared to Si and Ge. As examples, B and Al readily accept an electron from the valence band, thereby leaving an electron hole. These are positive in response, and they become the majority charge

carriers. The silicon becomes p-type.

Group V elements have an extra electron per atom, which can be donated to the conduction band of silicon (or Ge). These electrons serve as the majority carriers. Being negative, the semiconductor is n-type.

29. (a)

Thermal agitation overcomes spontaneous magnetism at elevated temperatures, vanishing completely at the Curie temperature. Atomic magnetism occurs mainly from unbalanced electron spins in the 3d orbitals.

30. (d)

A III-V compound averages four valence electrons per atom, completely filling two energy bands. InP is a III-V compound.

31. (b)

Structural disorder in metals scatters electrons and decreases the electrical conductivity.

32. (d)

Thermal energy is transferred through solids by elastic waves (phonons) and by delocalized electrons, as they are in metals.

33. (d)

Cations, electron holes, and anion vacancies are all positive carriers that migrate toward the negative electrode.

34. (a)

Group III elements accept electrons from the valence band of silicon to produce electron holes and p-type majority carriers. Group V elements donate electrons to the conduction band of silicon to produce n-type majority carriers. Thus, the symmetry across the energy gap does not hold, and the Fermi energy level is shifted.

35. (b)

The movement of domain boundaries (block walls) is resisted by structural imperfections and variations.

36. (c)

Internal boundaries reflect and refract light. Imperfections within a phase absorb light.

37. (c)

As the temperature is increases, the atoms gain additional energy and can relocate, eliminating the strain energy that accompanies dislocations. Less time is required at higher temperature. Less time is also required for a highly cold-worked material because there is additional stored energy present.

38. (c)

Strength and hardness are increased at the expense of ductility and toughness (opposite of brittleness). The increase is facilitated by microstructures that interfere with dislocation movements. These include a high density of dislocations from plastic deformation, and the presence of many fine, hard particles. Annealing removes dislocations and permits the agglomeration of particles into fewer large particles.

39. (a)

Annealing removes the hardness that was introduced by cold work. Quenched and tempered steels are harder with higher carbon contents, because more hard carbide particles are present. Alloying elements perform several hardening functions: They solution-harden the ferrite matrix; they slow down grain growth; and they delay the formation of pearlite, thus permitting more martensite with slower cooling rates (in turn, more tempered martensite may be realized farther below the quenched surface).

40. (d)

The processing step of rapid cooling, such as quenching, retains the structures that existed at higher temperatures, even though a solubility limit is exceeded.

41. (a)

Alloying elements can dissolve substitutionally in austenite which remains fcc.

42. (d)

Dozens of steels are available with yield strengths over 1575 MPa. Any steel with a yield strength over 1120 MPa is considered to be an ultra-high strength steel.

43. (c)

Although fatigue strength is not sensitive to temperature or loading rates, it is very sensitive to surface imperfections from which cracks originate and propagate.

44. (c)

Corrosion commonly occurs in the combined presence of oxygen and water. Protection may

be obtained by making a cathode out of the critical part or avoiding air.

45. (b)

In crystal lattice, the vacancy created by absence of certain atom is called Schottky defect.

46. (b)

Aluminium has FCC crystal structure

$a = 2\sqrt{2}r$

Volume of unit cell = a^3

$= (2\sqrt{2}r)^3$

$= 8\times 2\times \sqrt{2}r^3 = 16\sqrt{2}r^3$

or $\left(\frac{4r}{\sqrt{2}}\right)^3$

47. (b)

Generally, non-ferrous metals like aluminium, copper etc. are hardened by precipitation hardening heat treatment (also called age hardening). Ferrous metals are hardened by other hardening process.

48. (d)

An isotropic material have same physical properties irrespective of the crystallographic direction in which they are measured. Anisotropic materials show direction dependent properties.

49. (d)

Fine grain size has higher yield strength and are more succeptible to corrosion because of residual stresses present in it due to cold working.

50. (b)

In cold working no heating is required and better surface finish is obtained but higher forces are required as compared to hot working process.

51. (c)

Ni-Zn Ferrite : It is a soft ferrites and can be magnetized and demagnetized very easily hence used in audio and TV transformers core.

Co-Sm Alloy : Hard ferric hence used in permanent magnets.

Yttrium Iron Garnet : This ferrite can be used at microwave frequencies in circulators and isolators.

Mg-Zn Ferrite : This ferrite shows rectangular hysteresis loop used in magnetic memory cores.

52. (b)

- The magnetic field required to reduce the residual magnetisation to zero is called "coercivity".
- The value of the residual magnetisation is called.
- The process of magnetisation 'and demagnetisation' of the ferromagnetic material is called 'hysteresis'.

53. (b)

As χ_m (susceptibility) $\propto \frac{1}{T}$.

54. (c)

Electro magnet's hysteresis loop should be narrow, so low coercive field is main requirement.

55. (d)

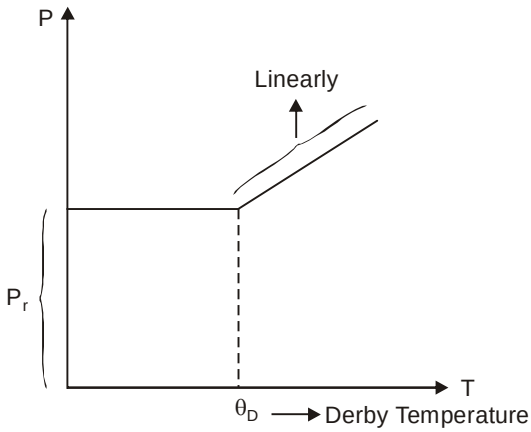
Fuse has very low meeting point. When high current flows, heat is produced in fuse and it melts. Hence circuit breaks.

56. (c)

57. (a)

Localised strains produced by mechanical treatment of copper increases its resistivity. Hence, a hard drawn copper wire has higher resistivity than annealed copper, i.e., the resistivity of annealed copper compared to hard drawn copper is lesser.

58. (c)



59. (c)

We know that weight of an electron = 9.1×10^{-31} kg

$= 9.1 \times 10^{-31} \times 10^3$ (gram)

Total number of electron

$= \frac{1\,(gm)}{9.1\times10^{-31}\times10^3\ (gram)}$

$= 1.1 \times 10^{27}$

60. (b)

Secondary bond is basically a dipole interaction between molecules or atoms and have lesser binding energy compares to primary bonds hence weaker than primary bonds.

Ionic bond is a primary bond.

61. (c)

Since atomic number = number of protons in an atom = 30

Electronic configuration is

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}$

Given, number of electrons in outermost shell = 2

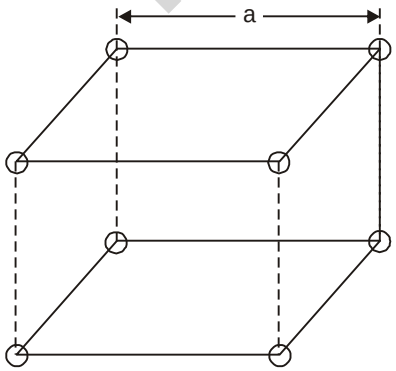
The elements having small number of valence electrons, which are loosely held, forms metallic bond. However a valence electron of a metal atom has a small ionization energy, and in the solid state this valence electron is relatively free to leave one atom in order to associate with another nearby. Such a free electrons can be moved under the influence of an electric field, and it is responsible for the electrical conductivity of the metal. Hence, the material made of such atom is a conductor.

62. (c)

Energy band structure is used to distinguish the behavior of conductors semiconductors and insulators. For conductors band gap does not exist. For semiconductors, it is very low and for insulator, it is very high.

63. (c)

The void is an octahedral void. The largest radius that can kept in it



$$R_{octahedral} = \frac{a}{2} - R$$

For BCC, $a = \frac{4}{\sqrt{3}}R$

$$R_{octa} = \frac{2}{\sqrt{3}}R - R = 0.158R$$

$$(diameter)_{octa} = 0.158 \times 2R = 0.316R$$

64. (b)

Tempering $\rightarrow$ Both hardness and brittleness are reduced.

Austempering $\rightarrow$ Austenite is converted into bainite.

Martempering $\rightarrow$ Austenite is converted into martensite.

65. (a)

At eutectoid point, solid decomposes to two different solids on cooling and vice-versa on heating. Eutectoid reaction in iron carbon diagram takes place at temperature of 725°C percentage of carbon at eutectoid point = 0.83.

66. (c)

At triple point degree of freedom becomes 'zero', there is no possible moment in any plane at triple point of any substance.

67. (d)

Toughness is the ability of the material to absorb energy and plastically deform upto fracture point. In other words, it is material's resistance to fracture when stressed.

68. (b)

Viskers hardness number of a given material depends on applied load but independent of the size of diamond indenter. This test uses a pyramid shaped diamond tool with an angle of 136° between opposite faces.

69. (d)

Understressing is a phenomenon where endurance limit of a material improves when material is subjected to stress below its fatigue strength.

Understressing improves the fatigue strength of metallic material.

70. (c)

Carburizing is one of the most widely used surface hardening process. It has been used for a long time. The process involves diffusing carbon into a low carbon steel to form a high carbon steel surface. Carburising process is also referred to

as case hardening or case carburizing process. It is a heat treatment process that produces a surface which is resistant to wear, while maintaining toughness and strength of the core.

71. (d)

Strain aging is a phenomenon where strength of metal increases and ductility decreases when metal are heated in temperature range 300° F to 700° F. When metals are subjected to plastic deformation. Increase in strength is attributed to diffusion of carbon or nitrogen atoms from interstitial sites alongside dislocations, hindering these movement.

72. (b)

Creep in the concrete is considered to be an isolated rheological phenomenon and this is associated with the gel structure of cement paste. Creep increases when temperature increases.

73. (b)

Cast iron has excellent vibration damping properties due to graphite flakes. Its compressive strength is higher compared to that of steel. Cast iron being a brittle material dues undergo large plastic deformation and fracture at much lower strains.

74. (b)

75. (a)

76. (b)

Cast Iron (CI) is brittle in nature. So, its torsional (shear) strength is less hence can not used as shaft. Cast iron is strong in compression but weak under tension.

77. (c)

The Hall voltage is given as

$$V_H = \frac{BI}{\rho W}$$

$\because \quad V_H \propto I$

where, V_H = Hall Voltage

B = Magnetic field

W = Width of specimen

ρ = Charge density

78. (c)

The current flow in a semiconductor is due to :

(i) **Drift Current :** This current is due to the movement of charge carries under the influence of applied electric field.

(ii) **Diffusion Current :** This current is due to the movement of carriers due to concentration gradient.

79. (c)

Properties of soft iron :

* Low retentivity
* Low coercivity-earthing
* High saturation magnetization

80. (a)

Ionic core and electron distribution are distorted, when an electric field is applied to dielectric material. This distribution appears as strain and is proportional to square of electric field. This effect is called electrostriction.

81. (c)

A composite material is a combination of two or more chemically distinct and insoluble phases; its properties and structural performance are superior to those of the constituents acting independently.

82. (c)

Ceramic can be used within temperature range from 1000°C to 1600°C, as these are made to withstand high temperatures.

Silicon carbide is not an exception, as all carbides are used for high temperatures. SiC is used as refractory material also.

83. (b)

Cobalt occurs as two crystallographic structures hexagonal close packed (hcp) structure and face-centred cubic (fcc), structure. The ideal transition temperature between the hcp and fcc structure is 420°C, but in practice, the energy difference is so small that random intergrowth of the two is common.

84. (c)

Polarization means orientation and depends on applied electric field and magnetic field. With change in frequency its orientations can not be changed. It change either electric field change, magnetic field change or both change.

85. (b)

Cold working increases the strength of material but decreases its ductility and electrical conductivity. To recover the electrical properties,

material has to be annealed.

86. (c)

Abrasive ceramics should have high wear resistance, high degree of toughness so that they do not shatter during cutting and refractoriness to withstand high temperature during cutting.

87. (b)

88. (b)

89. (c)

The lattice structure of diamond consists of two intercepting FCC structure displaced along the body diagonal of cubic cell by (1/4)th the length of the diagram. Hence, it has low packing density.

90. (a)

Rock salt is a polar molecule and due to centre of symmetric structure half of the moment is cancelled by opposite half of the moments.

91. (a)

When electric field applied to dielectric material it gets polarized because due to electric field +ve and –ve change centre created which effectively creates a dipole.

92. (c)

Alnico has high hysteresis loss.

93. (c)

94. (a)

Electron is a negatively charged particle and it is in motion. Any moving charged particle will create a magnetic field around its path of travel. So electron in every atom is a tiny magnet.

95. (a)

$$\lambda = \frac{h}{P} = \frac{h}{mV}; \text{ m is more}$$

$$\boxed{\lambda \approx 0}$$

$\because$ $h = 6.67 \times 10^{-34}$

96. (a)

Co-ordination number for covalent bonded atoms are controlled by the radii ratio, also covalent bond are highly directional in nature in space.

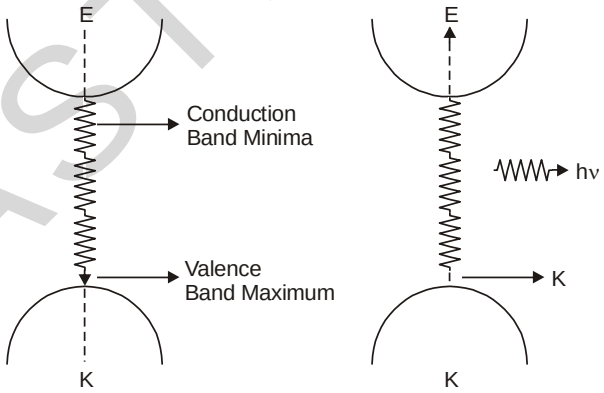
97. (c)

In impact testing of materials, whether by Charpy test or Izod test, a notched specimen is used to gauge notch toughness of material. A notch is a stress raiser which introduces triaxial tensile stresses causing brittle failure.

98. (d)

Hardness test is not a slow, expensive methods to assess mechanical properties of materials. However, hardness is a function of yield stress and work hardening rate of material.

99. (a)



- E–K diagram for direct band gap semiconductor.
- In direct band gap semiconductor when charge carrier recombines it emits energy in the form of light.

100. (a)