

BPUT Question Bank For Material Science

SHORT QUESTIONS

1. Write down the expression for Lorentz no.
2. Why does conductivity of metals decrease at higher temp?
3. In two materials the energy gap between the conduction band & valence band is ≈ 1 eV & ≈ 5 eV. Classify the materials electrically.
4. According to Drude-Lorentz theory of metals, write down mathematical expression for Wiedmann-Franz law.
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6. What is Hall Effect?
7. Write down the expression for critical fiber length.
8. Find the transition temp for isotope of mercury with mass no. 200. The transition temp for mass no. 202 is 4.2 K.
9. Explain why silicate materials have relatively low densities.
10. What is optical pumping?
11. What are hard directions?
12. How is cathodic protection of iron different from its galvanization?
13. Which type of corrosion occurs in the following cases :
 - * Steel pipe connected to copper plumbing
 - * Stainless steel in FeCl_3 solution
 - * α - Brass in ammonia solution
11. The density of an amorphous polyethylene is 920 kg m^{-3} & that of totally crystalline poly-ethylene is 961.97 kg m^{-3} . What is the density of 44 % crystalline polyethylene?
12. Find out which is more likely to crystallize easily from the following pairs of polymers:
 - Linear & syndiotactic PVC or linear atactic polystyrene
 - Linear polyethylene or branched polyethylene.
13. In an continuous & aligned carbon fiber re-enforced nylon 6:6 composition, the fibers are to carry 97 % of the longitudinal load applied.
 - (i) Determine the volume fraction of fiber.
 - (ii) What will be the modulus of elasticity & tensile strength of the composite?
(E: fiber 260 GPa, E: nylon 6,6=2.8 G Pa, TS :fiber=1700 M Pa, TS: nylon 6,6= 76 M Pa)
 1. 14. Give reason for use of carbon as a fiber in fiber reinforced composite.
15. Calculate the polarization produced in BaTiO_3 crystal if Ti^{74} ions at the body center shifts by 0.06 \AA , oxygen anions at side faces by 0.04 \AA & oxygen anions at top & bottom by 0.08 \AA , all in a direction opposite to the displacement of Ti ions. The lattice parameters are $a=4.03 \text{ \AA}$, $b=c=3.98 \text{ \AA}$.
16. Find out the temp at which there is 1 % probability that an electron in a solid will have an energy 0.5 eV above the Fermi energy. ($|e|=1.6 \times 10^{-19} \text{ C}$, $K_B=1.38 \times 10^{-23} \text{ J/K}$)
17. Phosphorous is added to high purity silicon to give a concentration of 10^{23} m^{-3} of charge carriers at room temp. Calculate the conductivity at room temp. What type of semiconductor is this material?
18. Calculate the wavelength of light if a material has band gap 2.4 eV.
19. Why is a coating of tin preferred to zinc on a steel food can?
20. Why are whiskers stronger than ordinary crystals?
21. Why is the slope for intrinsic semiconductor steeper than for n-type extrinsic semiconductor in σ Vs $1/T$ curve?
22. Distinguish between di-electric
23. What is Josephson effect?
24. What is the net spin magnetic moment for Fe^{+3} ions?
25. Determine the frequency difference between the cavity modes of a laser which is 1 m long & contain a gas of refractive index of 1.0204.
26. A rod of Aluminium is 0.35 m long & its ends are maintained rigid. It is heated from 15°C to 85°C . Calculate the magnitude of stress developed. (Thermal expansion co-efficient = $23.6 \times 10^{-6} \text{ K}$, Young's modulus = 69 G Pa)
27. Calculate Fermi energy of Iron at 0 k.
(Density = $7.87 \times 10^3 \text{ kg/m}^3$, atomic weight = 55.85)
28. Differentiate between intrinsic and extrinsic semiconductor.
29. Differentiate between thermosetting and thermoplastic plastics.
30. Calculate the temperature at which polystyrene will have a viscosity of 106 Pa.S ($T_g = 90^\circ\text{C}$).
31. The density of 67.3 % crystalline and 43.7 % crystalline polymer are 1188 Kg/ m³ respectively. Calculate the density of polymer with 55.4 % crystalline.
32. What are the limitations of fiber glass reinforced composites?
33. A 10 cm cube is made by laminating alternate sheets of 0.25mm thick rubber and 0.75 mm thick aluminium. Calculate the thermal conductivity of the laminate in (I) perpendicular and (II) parallel directions ($K_{ai} = 0.22 \text{ W mm}^{-1} \text{ K}$, $K_{ru} = 0.00012 \text{ W/ mm K}$)
34. Why is corrosion accelerated when anode is smaller than the cathode but not when the situation is reversed.
35. Distinguish between soft & hard magnetic materials.
36. A rare earth metal is ferromagnetic with 7.1 β /atom. Calculate its saturation magnetization (at. Wt. =157.26 amu, density= $7.8 \times 10^3 \text{ kg/m}^3$).
37. Light is attenuated by 0.15 db/km. How long can an optical fiber be used so that it can retain 10% of its initial intensity?
38. Mention two go-no-go parameters in material selection.
39. Prove that the probability of occupancy of an energy level by the electron below Fermi level at 0 k is 1.
40. Distinguish between di-electric constant & dielectric strength.
41. Give two medical applications of superconductivity.
- 42.
43. How is nitrile rubber made?
44. Briefly write down the advantages of composite materials.
45. What is Portland cement concrete? State its applications.
46. How passivity is carried out for corrosion protection?
47. Enumerate the failure criteria of members in service.

48. Is Hall effect affected by sign of the charge carrier? Justify your answer.
49. A current of 200 ampere is established in a rectangular slab of copper of width 2 cm & 1 mm thickness' magnetic field of induction 1.5 Tesla is applied perpendicular to both current & the plane of the slab. The concentration of free electrons in copper is $8.4 \times 10^{28} \text{ m}^{-3}$. Calculate the hall voltage across the slab.
50. Show that electric field inside a superconductor is zero.
51. Calculate the Fermi energy in Zinc at 0k. The density and atomic mass of Zinc is 7.14 g/cm^3 and 65.38amu.
52. When an electric field 300 Volt/cm is applied to Benzene it is polarized to an extent of $3.398 \times 10^{-7} \text{ Coul/m}^2$. Calculate the local field acting on the benzene molecule.
53. Distinguish between type-1 & type-2 superconductors.
54. What is cooper pairs?
55. Find the number average molecular weight of a sample of polytetrafluoroethylene for which the number average degree of polymerisation is 296.
56. Discuss the fabrication of plastics by injection moulding method.
57. What are non-linear materials?
58. Mention one similarity & one dissimilarity between energy level band diagram of silicon & diamond?
59. The concentration of free electrons in copper is $8.4 \times 10^{28} \text{ m}^{-3}$. Calculate the Hall co-efficient.
60. Write an expression for the magnetic susceptibility of antiferromaterials at temp more than Neel temp.
61. In a step index Fibre the refractive indices of Core and cladding are 1.53 and 1.5 respectively. Calculate the numerical aperture of the fibre.
62. A PVC sample was found to have 26,000 units of monomers. Calculate the molecular mass of the PVC.
63. What is the difference between fibre and filament ?
64. Give two examples of Ceramics showing magnetism.
65. What are the factors on which the rate of corrosion of iron in atmosphere depends?
66. What is the requirement of the coating metal to act as the sacrificial anode for iron ?
67. What type of magnetism is developed in a superconductor when its temp is lowered below its critical temp ?
68. HCL vapour having concentration $10^{27} \text{ molecules/m}^3$ & permanent dipole moment 1.04 Debye, at room temp is subjected to an electric field of 10^5 volt/meter . Determine the orientation polarisation of HCL from the above data .
69. Write two applications of long fiber composites of aramide.
70. 108 gm of butadiene was co-polymerised with 52 gm of styrene . What is the molecular formula of the co-polymer ? The molecular weights of butadiene & styrene 54 & 104 respectively.
71. Explain how lasers are useful in computer system ?
72. Stainless steel is not used to build ships . Explain why ?
73. The refractive index of the material is 1.54 and the transmission of a di-electric material is 15mm thick to normally incident light is 0.80. Calculate the thickness of material that will yield a transmissivity of 0.70. All the reflection losses are to be included.
74. Given density of iron is 7.85 gm/cm^3 and its atomic molar mass is 55.85gm. The dipole moment of iron atom in an iron bar of 5cm long and 1 cm^2 cross-section area is $1.8 \times 10^{-23} \text{ Amp.m}^2$. Assume that all the atoms in the bar have their dipole moments aligned. What is the dipole moment of the bar?
75. Show the variation of resistance versus the temperature of a superconductor & normal conductor.
76. Why aluminium kitchen utensils corrode less readily than do iron ones?
77. In a material transition occurs between a meta-stable state & an energy level of 0.25 eV & the wave length of radiation emitted is 1100 nm. Calculate the energy of the meta-stable state.
78. The radius of an indium wire is 6 mm. The critical temp is 3.4 k & the critical magnetic field is $29.3 \times 10^{-3} \text{ Tesla}$ at 0 k for indium . Calculate the critical current density in the wire at 2 k.
79. Mention four electrical properties of materials.
80. Show that unit of polarizability is Farad $\times \text{ m}^2$.
81. Write down at least four engineering properties of materials.
82. According to Drude-Lorentz theory of metals, write down mathematical expression for Wiedmann-Franz law.
83. Distinguish between Di-electric constant & dielectric strength.
84. Show figuratively the nature of light ray propagating in graded index optical fiber.
85. The number average molecular mass of a polymerized sample is 7000. Calculate the degree of polymerization, if the molecular mass of the monomer is 35.
86. How is nitrile rubber made?
87. What is the harm of having two parts of a tool with dissimilar metals, put in contact with each other used in a corrosive medium ?
88. Mention few structural deformations encountered while working at high temp.
89. what are the factors on which the rate of corrosion of iron in atmosphere depends ?
90. What do you mean by electrical properties of a material? What are different types of engineering properties of those materials?
91. Distinguish between soft & hard superconductor.
92. When an electric field 300volt/cm is applied to benzene, it is polarised to an extent of $3.398 \times 10^{-2} \text{ coul/met}^2$. Calculate the local field acting on the benzene molecule.
93. The magnetic susceptibility of a material at room temp is 0.82×10^{-8} . Calculate its magnetization under the action of magnetic induction of 0.25 Tesla.
94. It is found experimentally that superconducting critical temp of certain material is 8.93 k & critical magnetic induction at 0k is $80.3 \times 10^{-3} \text{ Tesla}$. What will be the critical current density?
95. Derive the units of (Di-electric polarization)/(Electric permittivity) .
96. A material attains the magnetization of 2500 Amp/meter under the action of magnetic induction 0.008 wb/met² . Calculate the magnetizing field, magnetic susceptibility and relative permeability of the material.
97. In a certain intrinsic semiconductor the mobility of electrons is $0.3 \text{ xmet}^2 \text{ v}^{-1} \text{ s}^{-1}$, the mobility of holes is $0.2 \text{ xmet}^2 \text{ v}^{-1} \text{ s}^{-1}$ and forbidden energy gap/band is 0.7ev. Calculate the intrinsic carrier concentration in semiconductor if effective mass of electrons and holes are respectively 0.55 and 0.37 times the rest mass of an electron.
98. The polarizability of argon is $1.818 \times 10^{-40} \text{ coul}^2 \text{ met/Newton}$. Calculate the di-electric constant and electric susceptibility of argon at NTP.
99. What do you mean by optical properties of materials?
100. Show graphically the variation of resistivity of a pure metal with temperature according to classical free electron theory of metals.
101. What type of magnetism is developed in a superconducting material below its critical temperature ?

102. Determine the orientation polarization of HCl vapour at room temp (300K) when it is subjected to an electric field of 10^6 volt/m. Given that concentration of HCl molecule = 10^{27} molecules/m³, permanent dipole moment of HCl molecule = 3.35×10^{-30} coul m.
103. Give statement of the basic principle involved in the functioning of an optical fiber.
104. What are the monomers of Nylon 6, 6? Write their structures.
105. Why most ceramics materials have lower spalling resistance than metals?
106. Why does impure metals corrode faster than pure metal under identical conditions?
107. What is an isotropic composite?
108. Why fine grain structures have higher hardness than coarse grain structures?
109. Why copper equipment should not possess a small steel bolt?
110. Draw the cross sectional views of an optical fiber & show the different components of the optical fiber in it.
111. Write an expression for the smallest value of the magnetic moment, electrons can possess & calculate its value.
112. It is found experimentally that superconducting critical temp of indium is 3.4k & critical magnetic induction at 0k is 29.3×10^{-3} Tesla. What will be the critical current density of indium wire of radius 5 mm at 4k?
113. Give the band diagram of insulator, conductor & semi conductor.
114. What do you mean by smart material?
115. Show that all the energy levels of a material below the Fermi level at 0k are filled up by electrons.
116. What type of semiconducting material is produced when an alloy of aluminum & germanium in the ratio 1: 10^6 is prepared?
117. Out of MB, FD & BE statistics which type of statistics is applicable to the cooper pairs?
118. In a material, electron transition occurs between a metastable state & an energy level of 0.35 eV. The wave length of radiation emitted in the process is 4200Å. Calculate the energy of the meta-stable state.
119. What is meant by vulcanization of rubber?
120. What type of glaze should be chosen for pottery?
121. State pilling- Bed worth rule.
122. What is a hybrid composite?
123. Mention the results of creep test.
124. London's penetration depth in certain superconducting material is 390 Å at 0k. Calculate the magnitude of magnetic induction at a depth of 400 Å at 0k when a magnetic induction of 0.75T is applied.
125. Draw an expression for the average energy of an electron in metal at 0k in terms of Fermi energy of an electron at 0k.
126. How can you find out the direction of magnetic moment of a current carrying loop?
127. Mention few applications of inverse piezo-electric effect.
128. Distinguish between step index multimode fiber & graded index multimode fiber.
129. Show that superconducting material exhibits perfect diamagnetism in superconducting state.
130. A paramagnetic material contains 7.8×10^{27} ions /m³ with magnetic moment $0.3\mu_B$. Calculate the magnetization under the action of magnetic induction of 0.75 Tesla at 300 k. Here Bohr magneton = $\mu_B = e\hbar/(2m_e)$.
131. The number average molecular weight of a poly propylene sample is 1000000 gm/mol. Find the number – average degree of polymerization.
132. Mention two go-no-go parameters in material selection for engineering purposes.
133. Distinguish between superconductor & perfect conductor.
134. Out of MB, FD & BE statistics which type of statistics is applicable to identical, indistinguishable particle that obey Pauli exclusion principle?
135. Why optical fibers are not affected by electromagnetic radiation?
136. Briefly write-down the advantages of composite material.
137. A metallic wire of length 0.6m & diameter 0.4 mm has a resistance 0.10Ω at 300k. Using the above data calculate the Lorentz number according to classical free electron theory of metals if the thermal conductivity of the metal at 300k is 380 w/mk.
138. In certain intrinsic semiconductor, the mobility of electrons is $0.3 \text{ m}^2 \text{ v}^{-1} \text{ s}^{-1}$, the mobility of holes is $0.2 \text{ m}^2 \text{ v}^{-1} \text{ s}^{-1}$ & the forbidden energy band is 0.7 eV. Calculate the intrinsic carrier concentration in semiconductor if effective mass of electrons & holes are respectively 0.55 & 0.37 times the rest mass of an electron.
139. A material attains the magnetization of 3400 A/m. Under the action of magnetic induction 0.006 wb/m². Calculate the magnetizing field, magnetic susceptibility & relative permeability of the material.
140. It is found experimentally that the superconducting critical temp of lead is 7.193k & critical magnetic induction at 0k is 80.3×10^{-3} Tesla. What will be the critical current density of lead wire of radius 5 mm at 4 k?
141. Write down the expression for the dielectric constant of a dielectric in terms of its density & molar mass.
142. Find the number average molecular weight of a sample of polytetrafluoroethylene for which the number average degree of polymerization is 296.
143. What are the importances of composite materials in modern days?
144. What is corrosion?
145. What is polarization?

LONG QUESTIONS

1. What is LASER? Explain the principle of operation of He-Ne laser.
2. What are optical fibers? Discuss its principle of operation.
3. Discuss about the performance of metals & ceramics at high temp.
4. Differentiate between addition & condensation polymerization.
5. What are ferroelectric materials? Discuss about different types of ferro-electric materials.
6. What are the functions of matrix phase in a fiber- reinforced composite?
7. Derive an expression for electric polarization of dielectric in an electric field.
8. Explain the Ferro-electric phenomena w.r.t BaTiO₃.
9. Explain the methods of preventions of following types of corrosion:
 - a. dezincification
 - b. season cracking
 - c. caustic embrittlement of boilers
 - d. intergranular corrosion of steel.
10. Discuss about silicate structures.
11. Differentiate between type-1 & type-2 superconductors with examples.

12. Explain the principle of operation of Ruby laser.
13. Discuss the various applications of optical fiber.
14. Assume that electron is a small sphere of radius R , its charge & mass being distributed uniformly through out its volume. Derive an expression for its spin magnetic moment. [This model of the electron is too mechanistic to be in the spirit of quantum physics view of this particle].
15. Discuss the advantages & dis-advantages of classical free electron theory.
16. Explain how a four level laser system works?
17. Derive an expression for the electronic polarizability in terms of atomic radius.
18. Draw the polymer structure for polymethyl methacrylate & polyhexamethylene adipamide. Indicate whether they are thermoplastic or thermosetting polymers. Mention one application of each polymer.
19. Compare & describe the properties of GFRP & CFRP composites.
20. What is post tensioning in re-inforced concrete? How is it carried out? State at least two applications of this material.
21. State the mechanical properties of ceramics.
22. What is corrosion? How is it prevented for metallic materials?
23. How optical fibers are in use to improve the living conditions in the world?
24. Explain how failure models help the manufacturer to manufacture a product?
25. Derive an expression for the concentration of holes in the valence band of an intrinsic semiconductor.
26. Explain the mechanism of differential aeration of metals. Give two examples where differential aeration effects are seen.
27. What are the functions of the dispersed phase & matrix phase in composites?
28. What are the postulates of Drude –Lorentz theory of metals?
29. Give the mechanism of addition and condensation polymerization. What is the minimum functionality required for a monomer to form a cross-linked polymer?
30. Describe the steps to be adopted in the production of bricks for
 - (a) Civil construction work
 - (b) Refractory linings.
31. Give the comparison between ferromagnetic, ferromagnetic and ant ferromagnetic substance.
32. Enumerate the potential use of composite materials.
33. Mention few examples to highlight the applications of Ceramics in medical science, interior decoration and in electronic gadgets.
34. Derive an expression for the numerical aperture of a step index optical fibre in terms of refractive indices of core and cladding.
35. Enumerate the different methods to control or to prevent the corrosion of metals.
36. Discuss various characteristics of ceramics of ceramic white ware products and their industrial applications.
37. Derive an expression for the thermal conductivity of a material in terms of mean free path average speed of electrons.
38. What are the advantages and dis-advantages of plastics?
39. What is R.C.C? Give its composition and strength. How can you make it water proof?
40. Compare and describe the properties of GFRP and CFRP composites.
41. Give a comparison between hard and soft ferromagnetic substance.
42. Differentiate between addition and condensation polymerization. Why does natural rubber need vulcanization? What is injection moulding of plastics?
43. Calculate the maximum percentage of sulphur that can be present vulcanized rubber.
44. Explain pitting corrosion. Discuss important methods for corrosion control.
45. Mention mechanical properties of ceramics. What are its important applications?
46. Find the number-average molecular weight of a sample of PTEE for which the number average degree of polymerization is 296.
47. What is Hall Effect? How you will determine the mobility of electrons in germanium knowing only the resistivity & Hall-coefficient of it.
48. The fermi energy in copper at 0k on the assumption that each copper atom contributes one electron to the electron gas is 7.04 eV. Calculate the Fermi energy & average energy of an electron in the metal at 300k.
49. Explain how failure analysis of material selection helps the manufacturer to manufacture a better product.
50. What is acceptance angle in optical fiber? Derive an expression for the numerical aperture of a step-index optical fiber in terms of its refractive indices of core & cladding.
51. Mention the basic property of paramagnetic materials. Applying Langevin's classical theory of paramagnetism; derive an expression for the average value of paramagnetic dipole moment.
52. Mention few applications of ferrites.
53. Distinguish between spontaneous emission, induced absorption & induced emission.
54. What are the factors affecting the selection of materials for technological purposes? Explain in detail the economic factor.
55. Distinguish between dielectric constant & dielectric strength of a material.
56. Discuss the fabrication of plastics by injection moulding method.
57. Explain condensation polymerisation & co-polymerisation. Write the structures of the following polymers & give two important applications of each (i) PET, (ii) SBR.
58. How is corrosion controlled by use of protective coatings?
59. What are the special characteristics that make the fiber reinforced composites very useful?
60. Which are the materials included under ceramics? Discuss the structure of ceramics.
61. What is transfer moulding of plastics? Mention its advantages.
62. What are the factors affect the selection of materials for technological purpose? Explain in detail the reliability factor.
63. Distinguish between hard ferromagnetic material and soft ferromagnetic materials.
64. Mention few applications of ferroelectric materials.
65. Draw the polymer structures for polymethyl methacrylate & poly-hexamethylene adipamide. Indicate whether they are thermoplastic or thermosetting polymers. Mention one application of each polymer.
66. What is corrosion? How is it prevented for metallic materials?
67. How is corrosion controlled by cathodic protection?
68. Discuss briefly the different types of fiber-reinforced composites.
69. What are ceramics? What are its types? Discuss its mechanical properties & important applications.