

Questions for offset / exam of “Material Science” discipline

The theoretical questions demanding the complete answer

1. Structure of metal materials. Crystalline structure of metals.
2. Concept about a crystalline lattice cell. Cell parameters.
3. Main types of crystalline lattices of metals: BCC, FCC, HCP. Their parameters.
4. Polymorphism: phenomenon essence, examples. Value of polymorphism in forming of steels properties.
5. Defects of a crystal structure of real metals: dot, linear, surface and volume defects. Their role in forming of properties of metals.
6. Crystallization of metals: driving force of crystallization, overcooling ration, their role in forming of structure.
7. Crystallization of metals: not spontaneous crystallization, structure of cast metal. Ways of management of crystallization process.
8. Structure of metal alloys. Concepts: alloy, thermodynamic system, component, phase.
9. Solid solutions of substitution: definition, types of SS of substitution, condition of their formation, examples.
10. Solid solutions of interstitial: formation conditions, examples.
11. Chemical mixtures: definition, formation conditions, examples.
12. Phase rule of Gibbs. State diagram of two-component systems. Liquidus and solidus.
13. State diagram of system which components have unlimited solubility in liquid, and in solid state. Types of the formed structures.
14. The chart of phase balance with insolubility of components in a solid state and an eutectic. Types of the formed structures.
15. State diagram of alloys with limited solubility of components in a solid state and an eutectic. Extreme solubility, solvus line. Types of the formed structures.
16. State diagram of system with formation of steady chemical compound.
17. Properties of iron, carbon, polymorphism, critical points. Interaction of iron with carbon.
18. Phases and structural components of Fe-C (Fe_3C) alloys: definitions, characteristics, properties.
19. Chart of phase balance iron-carbon: reactions of balance in system.
20. State diagram of iron-carbon: forming of steels structure during crystallization and cooling. Types of structures of steels.
21. Chart “iron-carbon”: forming of structure of white cast-iron during crystallization and cooling. Types of structures of white cast-iron.
22. Chart iron-carbon. Forming of structure of gray cast-iron during crystallization and cooling. Types of structures of gray cast-iron.

23. Heat treatment of metals and alloys. Classification of types of heat treatment.

24. Ways of annealing of steel: complete and incomplete annealing, normalization.

25. Ways of annealing of steel: the homogenizing and spheroidizing annealing. Essence, technological modes.

26. Heat treatment of the alloys which do not have phase changes and with variable solubility of components in a solid state.

27. The transformations happening when heating steel to an austenitic state. A concept about critical points steel A_{C1} , A_{C3} , A_{Cm} , A_{r1} , A_{r3} , A_{rm} .

28. Quenching of steel - full and incomplete. A concept about the critical speed of quenching. Quenching of steel for martensite.

29. The transformations happening when cooling steel: intermediate (bainite) transformation, features, structure.

30. The transformations happening at drawing of hardened steel. Low, average and high drawing: the modes, structure after drawing.

31. Chemical heat treatment. General patterns of CHT.

32. Cementation of steel: the essence, temperature conditions, structure of steels after cementation.

33. Nitriding of steel: the essence, temperature conditions, a surface structure of steels after nitriding.

34. Nitrocementation: the essence, temperature conditions, a surface structure of steels after nitrocementation.

35. Carbon steels. Influence of carbon content and impurities on properties of steel.

36. Classification of steels depends on a total carbon, assignment and quality.

37. Constructional carbon steels of normal quality: classification, marking, application.

38. Qualitative constructional carbon steels: classification, marking, application.

39. Cast-irons. Marking of cast-irons.

40. Classification depends on assignment and marking of alloy steels. Examples.

41. Alloy steels. Influence of alloying elements on structure and property of steel. Carbides in alloy steels.

42. Alloy steels: bearing steels: principle of alloying, marking, heat treatment.

43. Alloy steels: high-strength alloy steels: principles of alloying, heat treatment.

44. Alloy steels: steel for building constructions, principle of alloying, marking, heat treatment.

45. Alloy steels: toughened steels, the principle of alloying, marking, heat treatment.

The questions demanding the brief answer

1. What phases are available in the equilibrium Fe-Fe₃C (Fe-C) system?
2. What phases are present at Fe-Fe₃C system alloys at the room temperature?
3. By what principle the alloys of the Fe-Fe₃C (Fe-C) system are subdivided on steels and cast-irons?
4. What is the general and what are the distinctions at solid solutions of substitution and introduction?
5. What phases compose the eutectoid steel?
6. What is the difference between white cast-iron and gray cast-iron?
7. Give the definition of a phase.
8. What elements surely are presented at chemical composition of any steel?
9. What impurities in steels are harmful and what is their adverse effect?
10. What is the difference between rimmed steel, capped (semikilled) steel and dead-melted steel?
11. What differs steel of normal quality and qualitative steels in?
12. Give definition of austenite, ferrite, perlite, ledeburite, bainite, martensite, cement carbide.
13. What differs the perlite, sorbite and troostite received when cooling steel in?
14. Give definition of solid solution of substitution, solid solution of introduction.
15. Why in structure of alloys of the Fe-Fe₃C system (Fe - C) at the room temperature an austenite does not observed?
16. To what phases does the martensite break down at drawing?
17. What does the structure of sorbite of cooling and sorbite of drawing differ in?
18. What is the essence of the heat treatment called toughening? What final structure of steel after such heat treatment?
19. If steel contains 0,5% of carbon what total carbon in martensite after quenching?
20. For steel the recommended temperature of normalization and quenching – $A_{C3}+(30\div 50)^{\circ}C$. What do these types of heat treatment essentially differ in if the temperature is identical?
21. What do the modes of annealing and steel hardening essentially differ in?
22. To what king of heat treatment steels should be subjected after cementation?
23. What does the structure of troostite of the drawing and troostite received at disintegration of austenite when cooling steel differ in?
24. What is the general and what is the difference between drawing and aging?

25. What does the structure of sorbite of cooling and sorbite of drawing differ in?