

**Part 2**

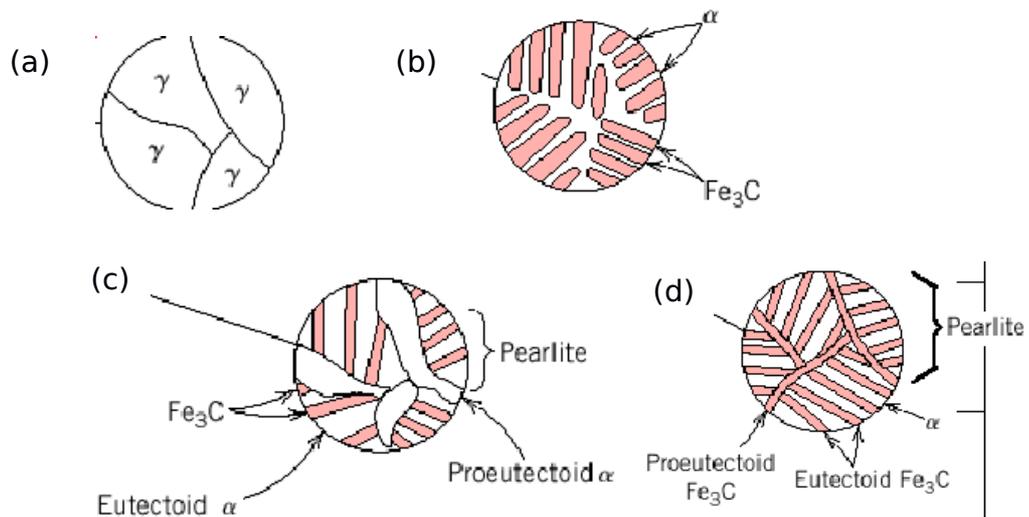
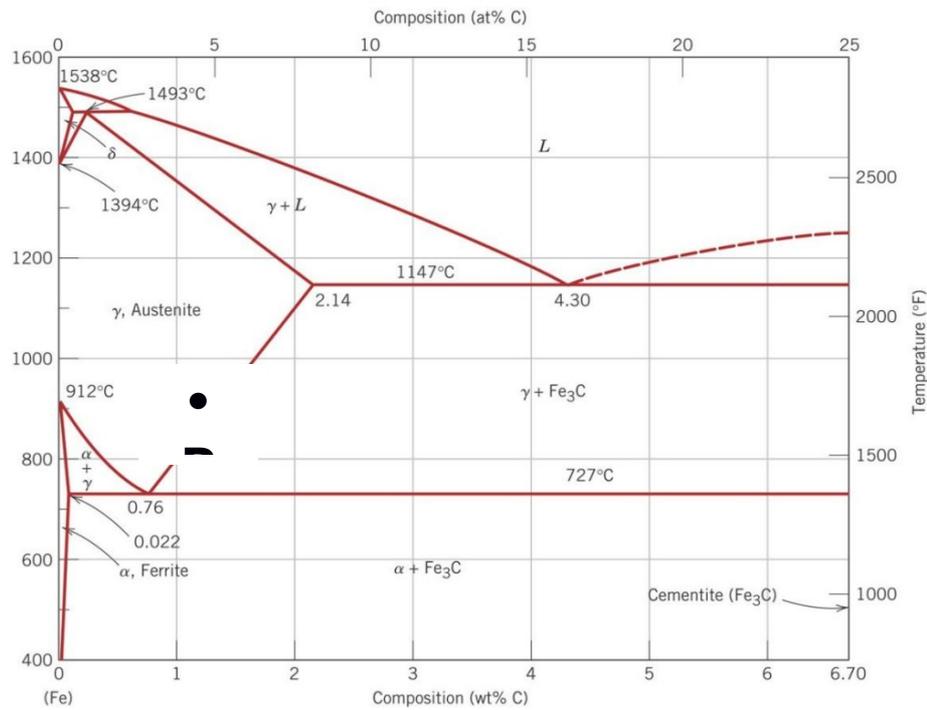
1. In a crystalline solid, which of the following diffusion paths would have the highest activation energy?
  - a. Grain boundary diffusion
  - b. Surface diffusion
  - c. Lattice diffusion
  - d. Dislocation pipe diffusion
  
2. Identify the correct statement:
  - a. All piezoelectric materials are also paraelectric, and have non-centrosymmetric crystal structures
  - b. All piezoelectric materials are also ferroelectric, and have centrosymmetric crystal structures
  - c. Ferroelectric materials may or may not be piezoelectric, but must have centrosymmetric crystal structures.
  - d. All ferroelectric materials are also piezoelectric, and have non-centrosymmetric crystal structures
  
3. The reaction,  $\text{Liquid}_1 \rightarrow \text{Liquid}_2 + \text{Solid}_1$  is a
  - a. Eutectic reaction
  - b. Monotectic reaction
  - c. Eutectoid reaction
  - d. Non-existent reaction
  
4. Which of the following pairs of crystal structures have the same packing fraction?
  - a. FCC and BCC
  - b. HCP and BCC
  - c. FCC and HCP
  - d. BCC and BCT
  
5. Which part of the sand casting mould acts as a reservoir of molten metal?
  - a. Riser
  - b. Sprue
  - c. Gate
  - d. Runner
  
6. Which strengthening mechanism can operate in pure aluminium?
  - a. Precipitate strengthening
  - b. Cold working
  - c. Solid solution strengthening
  - d. None of these

7. Which of the following is a position of an octahedral void in FCC?
- $0, \frac{1}{4}, 0$
  - $0, 0, \frac{1}{2}$
  - $\frac{1}{4}, \frac{1}{4}, \frac{1}{4}$
  - $1, \frac{1}{4}, \frac{3}{4}$
8. Which of the following is not a Miller index?
- $(2\ 1\ 1)$
  - $(10\ 2\ 4)$
  - $(1\ 2\ \frac{1}{4})$
  - $(\bar{1}\bar{1}\ 4)$
9. What is passivation?
- Decrease in corrosion rate due to lowered standard electrode potential of a metal
  - Decrease in the corrosion rate without change in the standard electrode potential
  - Decrease in corrosion rate due to a sacrificial anode
  - Decrease in corrosion rate by applying a coating of an inert material
10. Stainless steels have excellent corrosion resistance due to the formation of
- $\text{Cr}_2\text{O}_3$  scale
  - $\text{NiO}$  scale
  - $\text{Fe}_2\text{O}_3$  scale
  - $\text{Al}_2\text{O}_3$  scale
11. Which of the following is not a surface hardening technique?
- Carburizing
  - Nitriding
  - Shot peening
  - Galvanizing
12. Consider steady-state diffusion of a species from the inner surface to the outer surface of an infinitely long hollow cylindrical pipe with inner radius  $r_1$  and outer radius  $r_2$ . The flux of this species at steady state will:
- Remain constant throughout the cross-section
  - Vary as  $1/r$  with the radius of the cross-section
  - Vary as  $r^2$  with the radius of the cross-section
  - Vary as  $r^3$  with the radius of the cross-section

13. An insect floating on the surface of a lake sinks when its waters are polluted by an industrial detergent because,
- Addition of the detergent reduces the dissolved oxygen in the water thus significantly affecting the survival of the insect
  - Addition of the detergent decreases the surface tension of water as a result of which the water surface can no longer support the weight of the insect
  - Addition of the detergent increases the surface tension of the water which results in a strong downward pulling force on the insect legs
  - Addition of the detergent leads to formation of micellar phases which displace water molecules from the water surface
14. A cosmetic company which makes UV block sun tan lotion decides to use nanotechnology in its lotion. In doing so, it replaces 1  $\mu\text{m}$  sized spherical particles by 10 nm sized spherical particles. In addition, the number of 10 nm sized particles is  $10^6$  times the number of 1  $\mu\text{m}$  sized particles. Assuming that there are no agglomerates, and that the UV absorbing capacity of the lotion depends only on the particle surface area, the UV absorbing capacity:
- Increases by a factor of  $10^6$
  - Increases by a factor of  $10^2$
  - Increases by a factor of  $10^1$
  - Decreases by a factor of  $10^4$
15. A polymer latex is generally made via:
- Condensation polymerization
  - Emulsion polymerization
  - Addition polymerization
  - Anionic polymerization
16. A water soluble polymer displays a Lower Critical Solution Temperature at  $37^\circ\text{C}$ . What happens when the polymer solution is heated to  $40^\circ\text{C}$ ?
- The polymer solution is more homogeneous at the higher temperature
  - The polymer forms large single crystals
  - Some polymer precipitates from the solution
  - More polymer now goes into the vapour phase
17. A glass slide can support an average weight of 50 grams before it fractures in a four-point bend test. However, after etching the surface of the glass slide, it is found that it can support an average weight of 75 grams. This happens because:
- The etchant reacts with the glass surface and forms a tough film
  - The etchant forms a large number of cross-links on the glass surface
  - The etchant reduces the average flaw size on the glass surface
  - The etchant introduces critical flaws which deflect propagating cracks

18. An n-type Si sample is illuminated with visible light. Which of the following statements is true:
- Electrons are generated in excess
  - Both electrons and holes are generated in equal numbers
  - Holes are generated in excess
  - Si vacancies are created throughout the sample
19. Two materials A and B are heated and their conductivities are recorded as functions of temperature. The conductivity of A increases with temperature and that of B decreases with temperature. Then:
- A is a semiconductor and B is a metal
  - A is a metal and B is a semiconductor
  - A is an n-type semiconductor and B is a p-type semiconductor
  - A is a p-type semiconductor and B is an n-type semiconductor
20. A charged particle is moving in an electromagnetic field. The force acting on the particle is:
- Parallel to Electric field and Parallel to magnetic field
  - Perpendicular to Electric field and Parallel to magnetic field
  - Perpendicular to Electric field and Perpendicular to magnetic field
  - Parallel to Electric field and Perpendicular to magnetic field
21. Which optical property of liquid crystals is exploited in Liquid crystal displays:
- Refraction
  - Reflection
  - Polarization
  - Dispersion
22. A tensile stress is applied along the long axis of a cylindrical rod that has a diameter of 10 mm. As a result a reduction in diameter of  $2.5 \times 10^{-3}$  mm is observed. If the Poisson ratio for the material is 0.25, determine the strain along the long axis,
- $10^{-3}$
  - $-10^{-4}$
  - $-10^{-3}$
  - $6.25 \times 10^{-4}$
23. Bubbles forming on a plastic straw inserted into a carbonated drink (e.g. Coke/Pepsi) bottle is a result of
- Reaction of acidic carbonated drink with the plastic surface of the straw
  - Heterogeneous nucleation of bubbles from the supersaturated solution
  - Transfer of bubbles from the bulk to the lower surface energy straw surface
  - Entrained air from the atmosphere appearing on the straw surface

24. What is the correct microstructure at point P in the phase diagram shown below:



25. As a precipitate grows, the precipitate-matrix interface:

- is likely to change from coherent to incoherent at a critical size
- is likely to change from incoherent to coherent at a critical size
- will never change its character
- is likely to change from coherent to incoherent in some systems and incoherent to coherent in other systems

26. A colloidal crystal is made up of 500 nm sized monodisperse spheres arranging themselves in a FCC lattice. Which of the following light sources can be used to produce a diffraction pattern from such a crystal?
- X-ray
  - Microwaves
  - Red laser pointer
  - Electron beam
27. Which of the following is the case of heat transfer primarily by conduction
- Heating of the earth by sunlight
  - Cooling of a hot liquid under a fan
  - Heat received by a person from a fireplace
  - Copper cooling blocks used during casting
28. The number of degrees of freedom available to a two-component system at the eutectic point (at atmospheric pressure) is:
- 2
  - 1
  - 0
  - 1
29. The rate of oxide growth in a system is known to follow Arrhenius kinetics. If the temperature is increased, the growth rate:
- Increases linearly with temperature
  - Decreases linearly with temperature
  - Increases exponentially with temperature
  - Increases logarithmically with temperature
30. During the doping of a silicon wafer with phosphorus, the required doping concentration of  $1.0 \times 10^{16} \text{ cm}^{-3}$  is achieved at a depth of 1 micron after 30 minutes. In order to achieve the same concentration at a depth of 2 microns, the doping time will be;
- 1 hour
  - 1.5 hours
  - 2 hours
  - 2.5 hours

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