

※ 考生請注意：本試題可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。材料科學導論共 50 題選擇題，每題答對得 2 分，答錯倒扣 0.5 分；滿分 100 分，倒扣至 0 分為止。

1. The blue brittle phenomenon is associated with

- (a) dynamic recovery
- (b) dynamic recrystallization
- (c) dynamic strain aging
- (d) work hardening

2. The growth rate of a fatigue crack is described by the relationship

- (a) $dc/dN = A \ln(\sigma c^{1/2})$
- (b) $dc/dN = A \exp(\sigma c^{1/2})$
- (c) $dc/dN = A (\sigma c^{1/2})^n$
- (d) $dc/dN = A (\sigma/c^{1/2})^n$

where A and n are constants, σ is the peak gross stress, c is the half crack length for a double-ended crack, and N is the number of cycles.

3. The Coffin-Manson equation for low cycle fatigue is

- (a) $\Delta\varepsilon = C \ln(N)$
- (b) $\Delta\varepsilon = C \exp(N)$
- (c) $\Delta\varepsilon = C \exp(N^\beta)$
- (d) $\Delta\varepsilon = C (N)^\beta$

where $\Delta\varepsilon$ is the plastic strain range, N is the number of cycles to failure, and C and β are materials constants

4. Dislocation velocity is proportional to

- (a) $\ln(1/T)$
- (b) $\ln(1/T^2)$
- (c) $\exp(1/T)$
- (d) $\exp(1/T^2)$

5. Shear strain rate is proportional to

- (a) $(\rho b v)^{1/2}$
- (b) $(\rho b v)^{1/3}$
- (c) $(\rho b v)^2$
- (d) $\rho b v$

where ρ is dislocation density, b is Burgers vector, and v is average dislocation density

6. For most alloys, the dendrite arm spacing (DAS) is related to the cooling rate, r , by

- (a) $DAS = k \exp(1/r)$
- (b) $DAS = k \log(1/r)$
- (c) $\log(DAS) = k(1/r)$
- (d) $DAS = k r^{-n}$

7. The primary mechanism involved in dynamic recovery is

- (a) dislocation cross-slip
- (b) dislocation slip
- (c) dislocation climb
- (d) twinning

8. In terms of weight percent, the most abundant element in the earth's crust is

- (a) silicon
- (b) oxygen
- (c) iron
- (d) carbon

9. The potential energy of two adjacent ions in an ionic crystal is equal to $-(A/r) + (B/r^n)$, where A , B and n are positive constants, and r is the spacing between the two ions. What is the equilibrium spacing of the two ions?

- (a) $(nB/A)^{n+1}$
- (b) $(nA/B)^{n+1}$
- (c) $(nB/A)^{1/(n-1)}$
- (d) $(nA/B)^{1/(n-1)}$

10. Which of the following electron configurations belongs to some alkali metal?

- (a) $1s^2 2s^2$
- (b) $1s^2 2s^2 2p^5$
- (c) $1s^2 2s^2 2p^6 3s^1$
- (d) $1s^2 2s^2 2p^6 3s^2 3p^1$

11. Which of the following statements is wrong?

- (a) The packing efficiency (percent volume of a crystal occupied by atoms) for a simple cubic crystal is $\pi/6$ (assuming the hard-sphere model).
- (b) Since hexagonal close packed (hcp) crystal structure and face-centered cubic (fcc) crystal structure are both close packed, the packing efficiency of pure cobalt will remain unchanged when its crystal structure changes from hcp (α -Co) to fcc (β -Co).

- (c) In fcc crystals there exist four close-packed lattice planes of different orientations, each having three different close-packed directions.
- (d) The most densely packed directions of a body-centered cubic crystal are along $\langle 111 \rangle$ (in terms of Miller indices).
12. Using an incident beam of wavelength λ , the X-ray diffraction of a cubic crystal shows a diffraction peak of $\{111\}$ planes at the diffraction angle $2\theta = 60^\circ$. Which of the following descriptions is correct?
- (a) The distance between two adjacent $\{111\}$ planes $d_{111} = 0.5\lambda$ if the diffraction is first order.
- (b) $d_{111} = \lambda$ if the diffraction is first order.
- (c) $d_{111} = 0.5\lambda$ if the diffraction is second order.
- (d) $d_{111} = \lambda$ if the diffraction is second order.
13. Carburization treatment of a low carbon steel for 4 hours gives rise to 0.4 wt% carbon in the depth region of 0.2 mm below surface. What is the time needed for the depth region of 0.5 mm to reach the same carbon concentration?
- (a) 30 hours
- (b) 25 hours
- (c) 20 hours
- (d) 15 hours
14. Which of the following statement is correct?
- (a) Magnetic metallic glasses are not easily magnetized and demagnetized because they have no grain boundaries and no long-range anisotropy.
- (b) The basic composition of the cubic soft ferrites is $MO \cdot 6Fe_2O_3$ where M represents a divalent metal ion such as Fe_{2+} , Mn_{2+} , or Zn_{2+} .
- (c) As the domain size is decreased, the domain wall energy increases.
- (d) none of above.
15. Which of the following statement is correct?
- (a) The magnetic field strength H has SI units of A/m^2 and cgs units of Oe/m^2 .
- (b) Only iron, cobalt, and nickel are strongly ferromagnetic at room temperature.
- (c) The magnetic permeability of a ferromagnetic material is a constant.
- (d) none of above.
16. The austenite will transform to
- (a) Martensite
- (b) Bainite

(c) coarse pearlite

(d) fine pearlite

after continuous and slow cooling (full annealing).

17. What is the characteristic of polymer material that can be used as elastomers?

(a) they are generally thermoplastic

(b) they have highly degree of crystallinity before the tension stress apply

(c) the chains will be more rigid and have some limitation to rotation that can avoid plastic deformation

(d) it has crosslinking chains due to the vulcanization.

18. Which of the following statement is correct?

(a) Phonons are elastic waves that exist within solid materials.

(b) Photons are electromagnetic energy packets that may exist in solid materials, as well as in other media.

(c) For a phonon, its velocity is that of sound.

(d) all of above.

19. Which of the following statement is correct?

(a) From the classical perspective, electromagnetic radiation is wave-like in character.

(b) From the classical perspective, the possible energies of the electromagnetic radiation are continuous.

(c) From the quantum-mechanical perspective, electromagnetic radiation is dual-like in character (being both wave-like and particle-like).

(d) all of above.

20. Which of the following statement is correct?

(a) Both spinel and inverse spinel crystal structures consist of FCC close-packed stackings of anions (O^{2-} ions).

(b) Two types of sites, tetrahedral and octahedral, exist among the anions which may be occupied by the cations.

(c) The divalent cations (e.g., Fe^{2+}) occupy tetrahedral positions for both structures.

(d) All of above.

21. Polycrystalline alloys and metals are used for engineering applications and determine which one of crystal defects acts as barriers to dislocations.

(a) Grain boundaries

(b) dislocations

(c) solute atoms

(d) precipitation phases

22. Predict the theoretical strength for metals, assuming G is shear modulus.

- (a) $G/100$
- (b) $G/10$
- (c) G
- (d) $10G$

23. Recovery is controlled by thermal activation. Predict the most possible metal to carry out the recovery process.

- (a) Ag
- (b) Au
- (c) Al
- (d) Cu

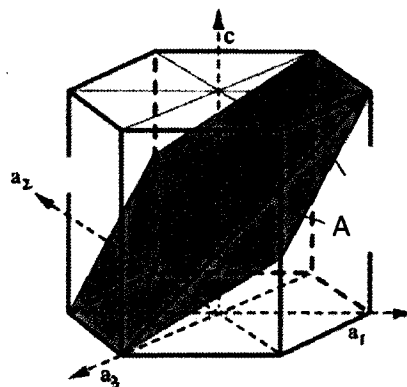
24. In hcp the Burgers vector is of the type $\frac{a}{3}\langle 11-20 \rangle$, assuming a as the lattice constant of metals.

Determine the value of this Burgers vector.

- (a) $\frac{1}{\sqrt{3}}a$
- (b) a
- (c) $\frac{\sqrt{8}}{3}a$
- (d) $\frac{a}{3}$

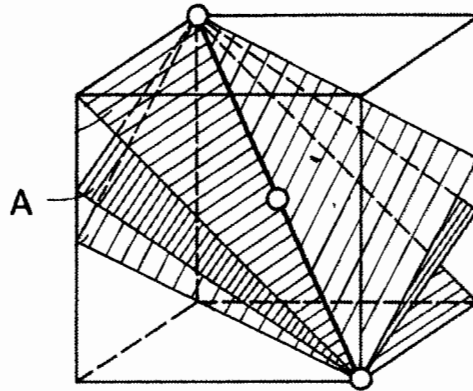
25. Index the Miller indices of the following plane A in a HCP lattice.

- (a) $(-1\ 0\ 1\ 2)$ (b) $(1\ 0\ -1\ 1)$ (c) $(-1\ -1\ 2\ 0)$ (d) $(1\ 1\ -2\ 2)$



26. Show the Miller indices of the following plane A in a cubic lattice.

- (a) $\{112\}$ (b) $\{122\}$ (c) $\{123\}$ (d) $\{113\}$



27. Which metal shows a brittle fracture after plastic deformation at room temperature?

- (a) Mg
- (b) Mo
- (c) W
- (d) Fe

28. Calculate the hardness value in which of method the contact surface is applied?

- (a) Rockwell
- (b) Knoop
- (c) Meyer hardness
- (d) Vickers

29. Determine the resolved shear stress on $(-111)[101]$ slip system in an copper single crystal, assuming applied stress of 20 MPa in the $[324]$ direction.

- (a) -16MPa
- (b) -6MPa
- (c) 6MPa
- (d) 16MPa

30. Which of the following statement about GP zone is correct ?

- (a) increasing strength
- (b) decreasing strength
- (c) causing brittleness
- (d) increasing conductivity

31. Which of the following statement is not support about the eutectic composition?

- (a) the lowest solidification temperature

- (b) lamella structural feature
 - (c) precipitations
 - (d) solidificational phase
32. Which of the following statement is support about the eutectoid composition?
- (a) Aluminum alloy
 - (b) low carbon steel
 - (c) high carbon steel
 - (d) stainless steel
33. Which of the following statement is support about the diffusionless transformation
- (a) cementite
 - (b) pearlite
 - (c) bainite
 - (d) martensite
34. Which of the following statement is not support about the diffusionless transformation ?
- (a) strain induced transformation
 - (b) martensite
 - (c) stress induced transformation
 - (d) GP zone
35. Which of the following statement is support about the step of polygonization phenomenon during static recrystallization process
- (a) over-aging
 - (b) recovery
 - (c) as quenched
 - (d) under-ageing
36. Which of the following statement is not support about the static recrystallization structure?
- (a) higher hardness
 - (b) higher ductility
 - (c) higher formability
 - (d) higher conductivity
37. Which metal has the lowest density?
- (a) aluminum

(b) magnesium

(c) copper

(d) titanium

38. Which manufacturing process is most commonly employed when a metallic component with complex shape is to be produced?

(a) forging

(b) rolling

(c) powder metallurgy

(d) casting

39. Which material has the best combination of mechanical strength and ductility

(a) steel

(b) plastics

(c) ceramics

(d) wood

40. Which material is characterized by its low density and its use as insulators both thermal and electrical

(a) metal

(b) plastics

(c) ceramics

(d) concrete

41. Which metal has the lowest melting point

(a) iron

(b) copper

(c) aluminum

(d) tin

42. Which metal has the highest melting point

(a) iron

(b) copper

(c) aluminum

(d) tin

43. Which is the crystal structure of a silicon wafer

(a) single crystal

- (b) poly-crystal with columnar structure
 - (c) poly-crystal with equiaxed grain
 - (d) poly-crystal with hybrid structure
44. What is the main structure for a soda (Na) glass?
- (a) crystalline
 - (b) amorphous
 - (c) polymer
 - (d) metal
45. Which defect has larger energy ?
- (a) dislocation
 - (b) grain boundary
 - (c) interface energy
 - (d) vacuum energy
46. Interface fractures of multilayer films are induced by ?
- (a) tensile stress
 - (b) compressive stress
 - (c) vibration
 - (d) fatigue
47. Catalyst can change ?
- (a) free energy
 - (b) activation energy
 - (c) strength
 - (d) hardness
48. Can a crystalline polymer be detected by XRD?
- (a) Yes
 - (b) No
 - (c) look at the surface property to decide
 - (d) no correlation
49. Nano-flowers and nano-wires, they only can be used in:
- (a) upper layer
 - (b) bottom layer

(c) sub-surface

(d) interface

50. Why do the milling powders possess the alloying?

(a) water

(b) frictional heat

(c) particle size

(d) air