

※ 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. Which material has the best combination of mechanical strength and ductility  
(a) steel (b) plastics (c) ceramics (d) wood
2. 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
3. Which one of the following materials has the lowest thermal expansion of coefficient  
(a) Al (b) W (c) stainless steel (d) Invar
4. Which metal has the lowest melting point  
(a) iron (b) copper (c) aluminum (d) tin
5. Which metal has the highest melting point  
(a) iron (b) copper (c) aluminum (d) tin
6. What conditions are required for rusting to take place?  
(a) water only (b) Oxygen only (c) Water and Oxygen (d) Water and Carbon dioxide
7. Which of the following metals would protect iron by electrons flowing to the iron?  
(a) Ag (b) Sn (c) Cu (d) Mg
8. When objects (gates) are galvanised, what metal is used to protect the iron  
(a) Al (b) Cu (c) Ni (d) Zn
9. The outer Helmholtz plane is defined as  
(a) the line passing through the center of the absorbed water molecule  
(b) the line passing through the center of the cations in the electrolyte  
(c) the line passing through the center of the hydrated cations in the electrolyte  
(d) the line passing through the center of the anions and cations in the inner Helmholtz layer
10. Which one of the following metal would have the least tendency to corrode?  
(a)  $\text{Cr}^{3+} + 3\text{e} = \text{Cr}$   $E^\circ = -0.741$  (b)  $\text{Sn}^{2+} + 2\text{e} = \text{Sn}$   $E^\circ = -0.138$   
(c)  $2\text{H}^+ + 2\text{e} = \text{H}_2$   $E^\circ = 0.000$  (d)  $\text{Cu}^{2+} + 2\text{e} = \text{Cu}$   $E^\circ = 0.342$

11. Annealing twins form during annealing heat treatments, most often in  
 (a) simple cubic metals (b) face-centered cubic metals  
 (c) body-centered cubic metals (d) HCP metals
12. For the following stacking sequences found in FCC metals, cite the type of planar defect that exists: ...  
 ABCBACBA...:  
 (a) a subgrain boundary (b) a twin boundary (c) a domain wall (d) a stacking fault.
13. For each of the following stacking sequences found in FCC metals, cite the type of planar defect that exists: ... ABCABCBCABC...  
 (a) a subgrain boundary (b) a twin boundary (c) a domain wall (d) a stacking fault.
14. The number of kilograms of hydrogen that pass per hour through a 5-mm-thick sheet of palladium having an area of  $0.25 \text{ m}^2$  at  $500^\circ\text{C}$  (Assume a diffusion coefficient of  $1.0 \times 10^{-8} \text{ m}^2/\text{s}$ , that the concentrations at the high- and low-pressure sides of the plate are 2.4 and 0.6 kg of hydrogen per cubic meter of palladium, and that steady-state conditions have been attained) is  
 (a)  $2.5 \times 10^{-4} \text{ kg/h}$  (b)  $4.8 \times 10^{-3} \text{ kg/h}$  (c)  $3.2 \times 10^{-3} \text{ kg/h}$  (d)  $2.4 \times 10^{-4} \text{ kg/h}$
15. A sheet of steel 1.8 mm thick has nitrogen atmospheres on both sides at  $1200^\circ\text{C}$  and is permitted to achieve a steady-state diffusion condition. The diffusion coefficient for nitrogen in steel at this temperature is  $6 \times 10^{-11} \text{ m}^2/\text{s}$ , and the diffusion flux is found to be  $1.2 \times 10^{-7} \text{ kg/m}^2\text{s}$ . Also, it is known that the concentration of nitrogen in the steel at the high-pressure surface is  $4 \text{ kg/m}^3$ . How far into the sheet from this high-pressure side will the concentration be  $2.0 \text{ kg/m}^3$ ? (Assume a linear concentration profile)  
 (a)  $1 \times 10^{-3} \text{ m}$  (b)  $1.5 \times 10^{-3} \text{ m}$  (c)  $3 \times 10^{-3} \text{ m}$  (d)  $3.5 \times 10^{-3} \text{ m}$
16. Transgranular damage reveals:  
 (a) elasticity fracture (b) corrosive fracture (c) brittle fracture (d) ductile fracture
17. How to decrease the ductile-to-brittle transition temperature (DBTT) of materials?  
 (a) increase hardness (b) decrease surface area (c) increase strength (d) control grain size
18. Which test to get S-N curve of materials?  
 (a) Fatigue (b) Creep (c) Tensile (d) Impact
19. For metal materials, which of the following is correct ( $\nu$  is poisson's ratio)?  
 (a)  $\nu=1$  (b)  $\nu=0.3$  (c)  $\nu=-0.5$  (d)  $\nu=-1$

20. Elastic shear modulus= $G$ ; Modulus of Elasticity= $E$ , which of the following is correct?  
(a)  $G > E$                       (b)  $G = E$                       (c)  $G < E$                       (d)  $E = 2G$
21. (a) Diamond                      (b) graphite                      (c) carbon nanotube                      (d) graphene  
has the smallest modulus of elasticity.
22. For the  $\text{SiO}_2\text{-Al}_2\text{O}_3$  system, what is the maximum temperature that is possible without the formation of a liquid phase?  
(a)  $1600^\circ\text{C} \pm 10^\circ\text{C}$                       (b)  $1700^\circ\text{C} \pm 10^\circ\text{C}$                       (c)  $1890^\circ\text{C} \pm 10^\circ\text{C}$                       (d)  $2010^\circ\text{C} \pm 10^\circ\text{C}$
23. Plastic deformation occurs by  
(a) dislocation motion                      (b) slip systems                      (c) volume diffusion                      (d) viscous flow  
for noncrystalline ceramics.
24. The cation-anion radius ratio is 0.550 for  $\text{FeO}$ . The coordination number for the  $\text{O}^{2-}$  ion is  
(a) 8                      (b) 6                      (c) 4                      (d) 2
25.  $\text{FeAl}_2\text{O}_4$  has a  
(a) perovskite                      (b) zinc blende                      (c) spinel                      (d) rock salt                      crystal structure.
26. (a) Forsterite                      (b) Kaolinite                      (c) Cristobalite                      (d) Mica  
has the formula  $\text{Al}_2(\text{Si}_2\text{O}_5)_2(\text{OH})_2$ .
27. Indicate the trend of the lattice dimension of a and c axis in the martensite of Fe-C alloys, as increasing the amount of carbon.  
(a) a and c increased                      (b) a and c decreased  
(c) a decreased and c increased                      (d) a increased and c decreased.
28. What is NOT typical phase in hypereutectic plain carbon steel?  
(a) Primary ferrite                      (b) primary cementite                      (c) perlite                      (d) austenite.
29. Determine the annealing temperature T of hypoeutectoid steels in order to obtain homogeneous microstructure.  
(a)  $\text{Ac}_1 < T < \text{Ac}_3$                       (b)  $\text{Ac}_3 < T$                       (c)  $T < \text{Ac}_1$                       (d)  $\text{Ac}_1 < T < \text{Ac}_m$ .

30. Give the austenitizing temperature  $T$  for heat treatment of hypereutectoid steels.  
 (a)  $Ac_1 < T < Ac_3$                       (b)  $Ac_3 < T$                       (c)  $Ac_m < T$                       (d)  $Ac_1 < T < Ac_m$ .
31. Which one is correct for the transformation temperature of martensite ( $T_m$ ), pearlite ( $T_p$ ), bainite ( $T_b$ ) and ferrite ( $T_f$ )?  
 (a)  $T_m > T_p > T_b > T_f$               (b)  $T_p > T_b > T_f > T_m$               (c)  $T_f > T_b > T_p > T_m$               (d)  $T_f > T_p > T_b > T_m$ .
32. The Al-4%Cu alloy is heated at  $515^\circ\text{C}$ , quenched in water and then heated at  $130^\circ\text{C}$ . Give the state of the solid solution after quenching:  
 (a) Supersaturated solution                      (b) preprecipitation  
 (c) metastable precipitate                      (d) intermediate precipitate.
33. A parallel-plate capacitor having an area of  $6.45 \times 10^{-4} \text{ m}^2$  and a plate separation of  $2 \times 10^{-3} \text{ m}$  across which a potential of  $10 \text{ V}$  is applied. If the capacitor is measured to have capacitance of  $1.71 \times 10^{-11} \text{ F}$ , what is dielectric constant of the material positioned within the region between the plates?  
 (a) 5.0                      (b) 6.0                      (c) 7.0                      (d) 8.0
34. Which kind of material has highest thermal expansion coefficient?  
 (a) 1025 Steel                      (b) Alumina                      (c) Nylon 6,6                      (d) Brass
35. Which kind of material has highest heat capacity ( $C_p$ )?  
 (a) Fused silica                      (b) Iron                      (c) Polypropylene                      (d) Magnesia
36. A brass rod is assumed stress free at room temperature ( $20^\circ\text{C}$ ). The modulus of elasticity and the linear coefficient of thermal expansion of brass is, respectively,  $100 \times 10^3 \text{ MPa}$  and  $20 \times 10^{-6} (\text{ }^\circ\text{C})^{-1}$ . What is the thermal stress of the rod if it is heated to  $106^\circ\text{C}$ ?  
 (a) Compressive stress of 172 MPa                      (b) Tensile stress of 172 MPa  
 (c) Compressive stress of 50 MPa                      (d) Tensile stress of 50 MPa
37. Which one is NOT the origin of magnetic properties of materials?  
 (a) magnetic moment                      (b) flow of electron  
 (c) orbital motion of electron around nucleus                      (d) spin of electron
38. The saturate magnetization for  $\text{Fe}_3\text{O}_4$  given that each cubic unit cell contains 8  $\text{Fe}^{2+}$  and 16  $\text{Fe}^{3+}$  ions, and that the unit cell edge length is 0.839 nm. The net spin magnetic moment of  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  is 4 and 5 Born magnetons. What is the saturation magnetization of  $\text{Fe}_3\text{O}_4$ ?  
 (a)  $5.0 \times 10^5 \text{ A/m}$                       (b)  $10.0 \times 10^5 \text{ A/m}$                       (c)  $15.0 \times 10^5 \text{ A/m}$                       (d)  $20.0 \times 10^5 \text{ A/m}$

39. What is the velocity of light in calcium fluoride ( $\text{CaF}_2$ ), which has a dielectric constant of 2.056 and a magnetic susceptibility of  $-1.43 \times 10^{-5}$ ?
- (a)  $2.09 \times 10^8$  m/s      (b)  $3.00 \times 10^8$  m/s      (c)  $2.98 \times 10^8$  m/s      (d)  $2.59 \times 10^8$  m/s
40. Which of the following statement about GP zone is correct ?
- (a) increasing strength      (b) decreasing strength      (c) causing brittleness      (d) increasing conductivity
41. 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
42. 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
43. Which of the following statement is support about the diffusionless transformation
- (a) cementite      (b) pearlite      (c) bainite      (d) martensite
44. 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
45. About elastomers (rubber) and polymer adhesives, which descript is INCORRECT?
- (a) both have the glass transition temperatures far below the room temperature  
(b) elastomers have lower molecular weight than polymer adhesives  
(c) polymer adhesives is liquid from physical point of view  
(d) elastomers require certain crosslinking
46. Which man-made polymer has the highest tensile strength?
- (a) Kevlar      (b) Nylon      (c) Teflon      (d) Chitin
47. Which material processing is NOT suitable to polymers?
- (a) Extrusion      (b) Spin-coating      (c) Calcination      (d) Injection molding
48. You frequently find the number inside the triangle in the plastic products. These recycling numbers are from 1 to 7. For number 6, it indicates the plastic product is made of:
- (a) PET      (b) Polypropylene (PP)      (c) HDPE      (d) Polystyrene (PS)

49. Which physical response stores the energy in the deformation of an elastomer?

- (a) Enthalpy                      (b) Entropy                      (c) Heat capacity                      (d) covalent bond length

50. Which polymer has the same linkage as Proteins

- (a) Nylon 6                      (b) Polyethylene                      (c) Polyurethane                      (d) Polyester