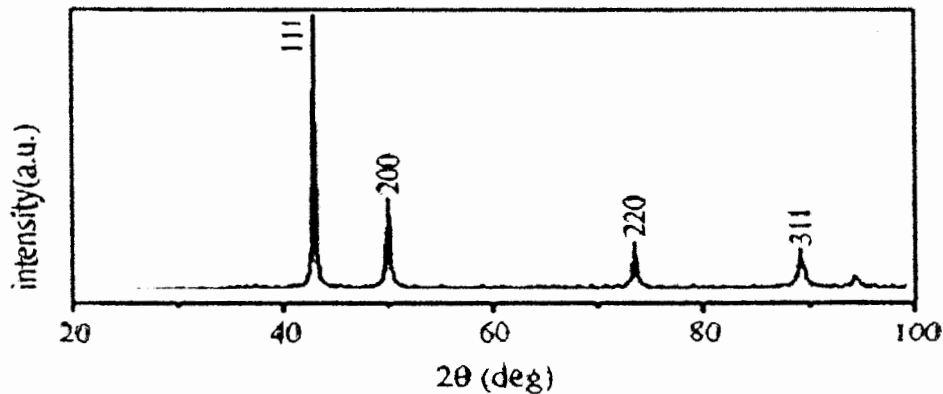※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

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. Determine the Miller indices of the cubic crystal plane with the intersection position coordinates of

    (1, 1/4, 0), (1, 1, 1/2) and (3/4, 1, 1/4).　Ⓐ(-4 4 6)　Ⓑ(3 4 1)　Ⓒ(2 4 -6)　Ⓓ(-6 -4 6).

2. Determine the material from the XRD diffraction pattern.　ⒶFe　ⒷCo　ⒸCu　ⒹCr.

3. What kind of structure is for the atomic coordinates of (0, 0, 0) and (1/2, 1/2, 1/2)?

    Ⓐbcc　Ⓑfcc　Ⓒhcp　Ⓓnone of the above.

4. Determine which direction of the Al single crystal has the largest yielding strength using the Schmid's factor

    as a function of the tensile direction, assuming the direction in the figure parallel to the tensile direction.

    Ⓐ[123]　Ⓑ[111]　Ⓒ[100]　Ⓓ[110].
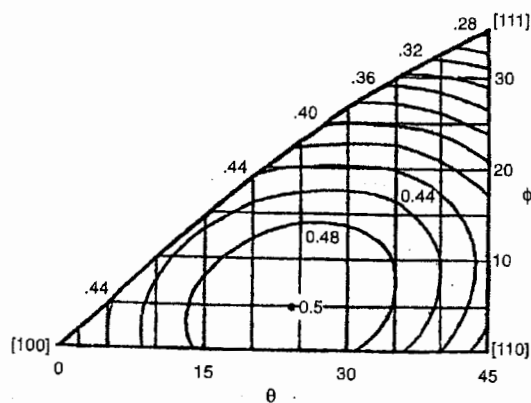
5. Which criterion can be applied to predict the failure of brittle materials?

    ⒶMaximum shear stress Ⓑmaximum distortion energy ⒸTresca criterion　Ⓓmaximum normal stress.

6. Atomic packing factor (APF) is lower, atomic radius is?

    Ⓐ high　Ⓑ low　Ⓒ look at the structure before deciding　Ⓓ no correlation

7. What is the biggest difference between the ionic compounds and the covalent compounds?

    Ⓐ atomic radius　Ⓑ stacking　Ⓒ atomic number　Ⓓ shared electron

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8. For XRD analysis, the reflection must need to comply with ?

　Ⓐ Law of conservation of mass　Ⓑ Law of refraction　Ⓒ Bragg's Law　Ⓓ Law of inertia

9. For interface diffusion of Solid / Liquid, which mechanism is the main process?

　Ⓐ mixed　Ⓑ dopped　Ⓒ coated　Ⓓ dipped

10. For thin film thermal effect, $\delta_T = \alpha (\Delta T) L$, which is larger parameter to affect the thermal strain:

　Ⓐα　ⒷΔT　ⒸL　ⒹT

11. The atomic packing factor for hexagonal close-packed structure is

　Ⓐ 0.74　Ⓑ 0.60　Ⓒ 0.64　Ⓓ 0.78

12. In an FCC structure, the number of tetrahedral sites is

　Ⓐ 2　Ⓑ 4　Ⓒ 6　Ⓓ 8

13. In the thin film solution for diffusion in a single crystal, the concentration profile has a linear relation for

　Ⓐ C vs x　Ⓑ lnC vs x　Ⓒ lnC vs x^2　Ⓓ lnC vs lnx, where C is concentration, x is distance.

14. The capacity of a material to absorb energy when it is deformed elastically and then, upon unloading, to have this energy recovered is called　Ⓐtensile strength　Ⓑfracture strength　Ⓒductility　Ⓓresilience.

15. The slip system for face-centered cubic metals is

　Ⓐ $\{110\}<1\bar{1}1>$　Ⓑ $\{111\}<1\bar{1}0>$　Ⓒ $\{211\}<\bar{1}11>$　Ⓓ $\{321\}<\bar{1}11>$

16. An A-B binary alloy is composed of two solid phases, namely α and β. The weight content of α relative to that of β is three to one at 500 °C, where the concentration of B in α and β are 20 wt% and 60 wt%, respectively. What is the bulk concentration (average concentration) of B in the alloy?

　Ⓐ 30 wt%;　Ⓑ 40 wt%;　Ⓒ 50 wt%;　Ⓓ 55 wt%.

17. Which of the following descriptions regarding a binary eutectic alloy of eutectic composition might not be correct?

　ⒶIn the eutectic transformation upon cooling, the alloy transforms from liquid into two eutectic phases.

　ⒷWhen equilibrium is reached at eutectic temperature, the two eutectic phases and the liquid phase are all present.

　ⒸThe two eutectic phases are two solid phases of different chemical compositions.

　ⒹThe two eutectic phases are two solid phases of different crystal structures.

系所組別：材料科學及工程學系
考試科目：材料科學導論　　　　　　　　　　　　　　　　考試日期：0222，節次：3

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18. At room temperature a cylindrical metal rod of 0.5-m length is fixed at its two ends on rigid walls. What is the axial stress of the rod if it remains straight but the surrounding temperature is raised to 100 °C?
Ⓐtensile;　Ⓑzero;　Ⓒcompressive;　Ⓓshear.

19. Which of the following statements is the most improper?
Ⓐ A concrete is less stiff than the steel bars inside it.
Ⓑ Diamond crystal possesses larger Young's modulus (modulus of elasticity) than Al_2O_3 crystal.
Ⓒ Compared to stainless steels, titanium alloys are better frame materials of eye glasses since they are lighter in mass density and easier to be bended elastically.
Ⓓ Higher elastic constants are a major concern of using steels rather than aluminum alloys to make a spring.

20. The contraction ratio of an isotropic solid is the magnitude of its lateral contraction strain/longitudinal tensile strain upon tensile loading. Which of the following statements is not correct?
Ⓐ The contraction ratio is 1.0 if the deformation results in no volume change.
Ⓑ The contraction ratio is less than 0.5 if the solid is deformed elastically.
Ⓒ The contraction ratio is also called Poisson's ratio if the solid is deformed in elastic regime.
Ⓓ When an elastic solid is strained in tension, its volume will be enlarged.

21. A thin plate normally fractures at later stage by
Ⓐ Mode I　Ⓑ Mode II　Ⓒ Mode III　Ⓓ Mode IV

22. The Paris Equation describing the relationship between the stress intensity factor range Kr and the crack growth rate (r) is
Ⓐ $Kr = C\, r^n$　Ⓑ $r = C\, Kr^n$　Ⓒ $Kr = C \exp(Kr)$　Ⓓ $r = C \log(Kr)$

23. Which of the following materials has the smallest yield strength sensitivity
Ⓐ Ionic Solids　Ⓑ Covalent Solids　Ⓒ FCC metals　Ⓓ BCC metals

24. Appreciable quantities of a solute may be accommodated in the substitutional type of solid solution only when the difference in atomic radii between the two atom types is less than about:
Ⓐ ±5 %　Ⓑ ±10 %　Ⓒ ±15 %　Ⓓ ±20 %

25. Which of the following materials has the highest frictional stress for dislocation
Ⓐ Ionic Solids　Ⓑ Covalent Solids　Ⓒ FCC metals　Ⓓ BCC metals

(背面仍有題目，請繼續作答)

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26. In the following figures: (a) is the geometry of surface and internal creaks and (b) the stress profile along the line x-x' in (a). Which position generates the most stress?

　Ⓐ Away from x or x'　Ⓑ σ_m increases with the decrease of the radius of curvature of the creak tip, ρ_t

　Ⓒ between the tip position x and x'　Ⓓ σ_m increases with the decrease of the length of a surface creak, a.

(a)　　　　　　　　(b)
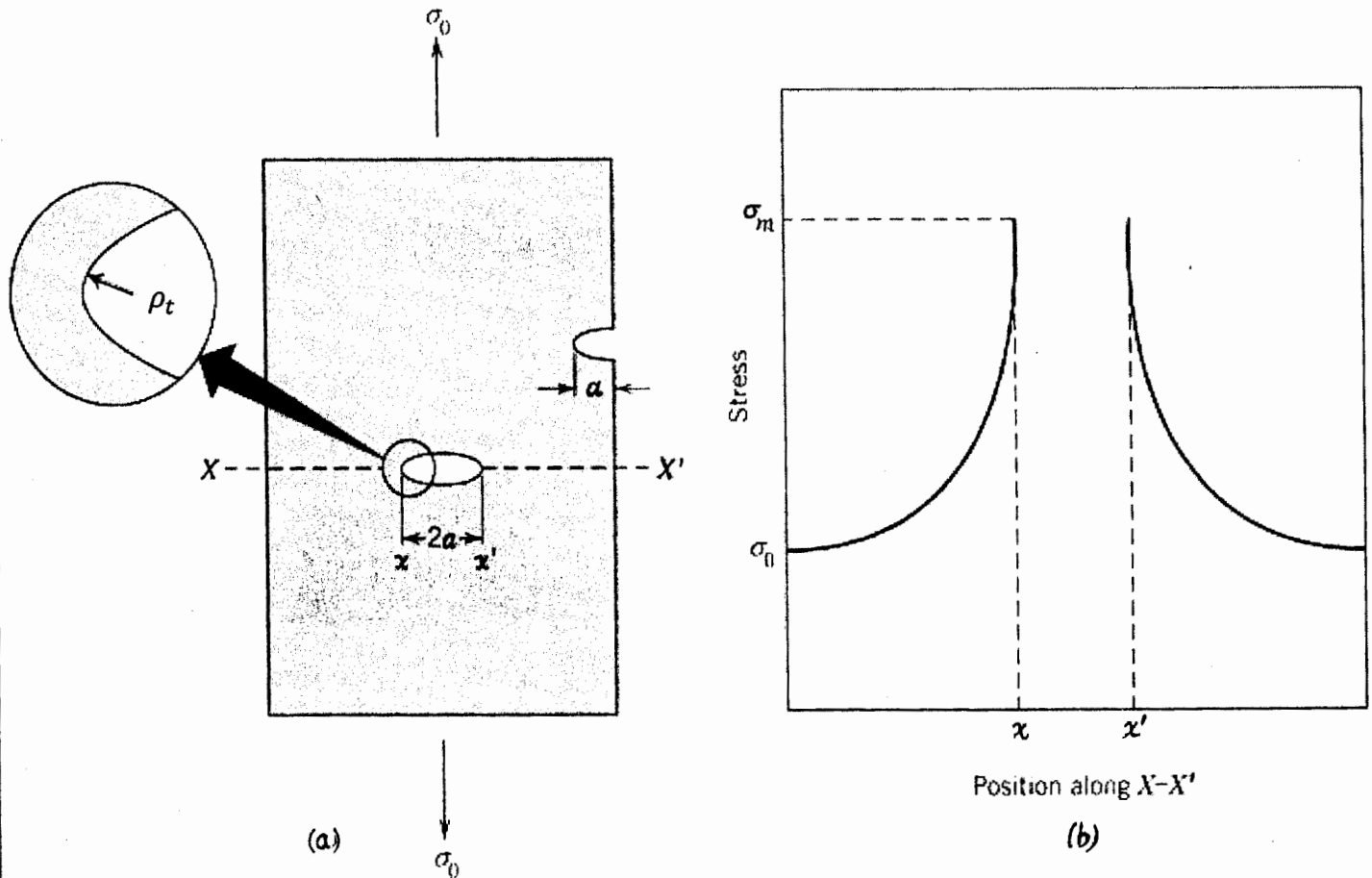
27. (figure below) For most nonferrous alloys (e.g., Al, Cu, Mg), their S-N curves continue their downward trend at increasingly greater N values. Thus, fatigue will ultimately occur regardless of the magnitude of the stress. For these materials, the fatigue response for some specified number of cycles (e.g., 10^7 cycles) at a stress level can be defined as

　Ⓐ fatigue limit　　　Ⓑ fatigue strength　　　Ⓒ fatigue life cycle　　　Ⓓ Repeated stress cycle.

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(a)

(b)
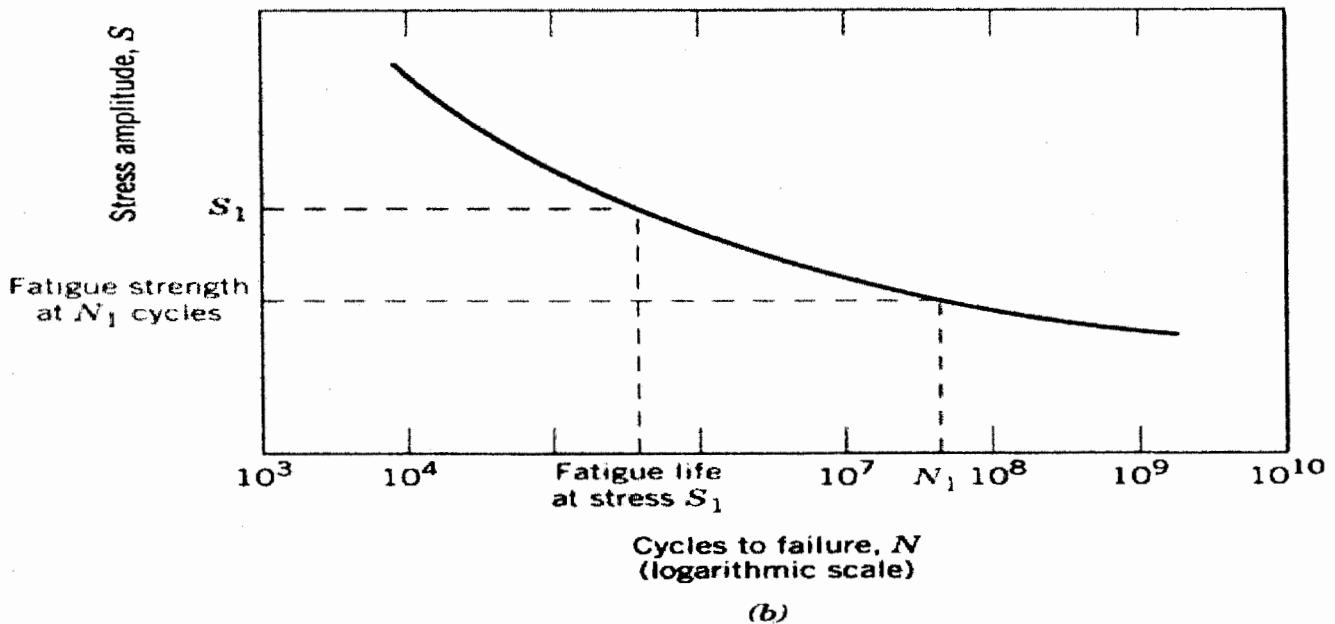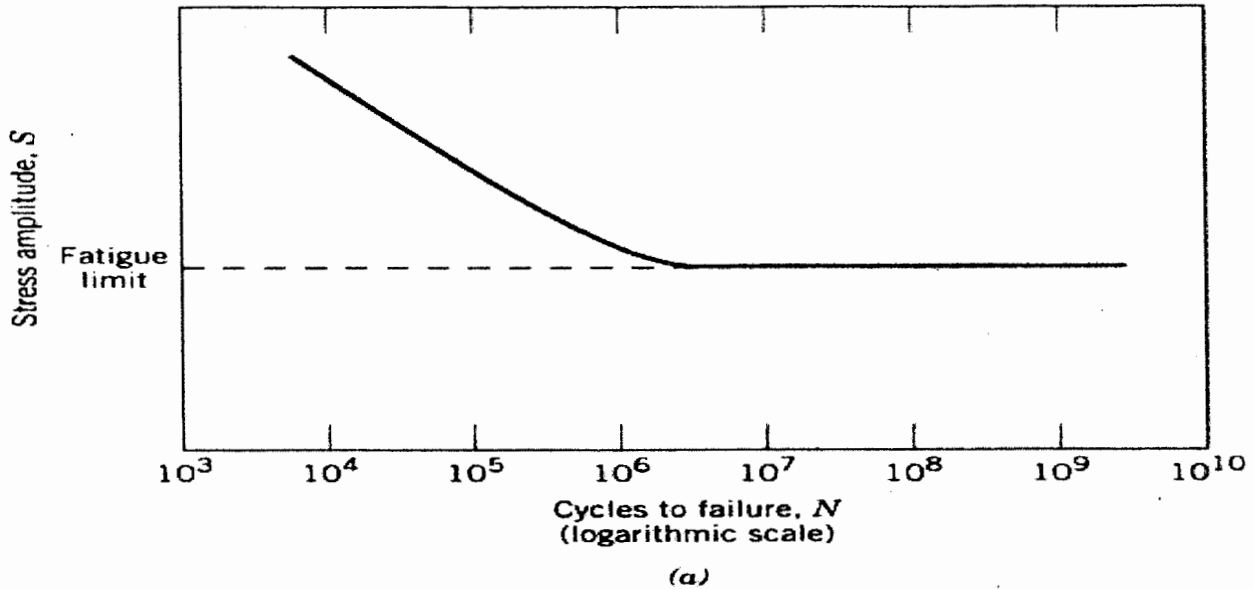
28. Which one of the following materials is NOT a good electrical conductor?

Ⓐcarbon nanotubes Ⓑgraphene layers　Ⓒpure Cu　Ⓓpolished diamond

29. Which one of the following factors will NOT improve a metallic material's fatigue life?

ⒶA design to reduce stress amplification　Ⓑshot peened on a ductile metal

Ⓒcase hardened on a Fe-C alloy　　Ⓓ Knoop indentation on a metal.

30. In a typical creep test, which behavior of metal is usually NOT observed?

ⒶA continuously increasing creep rate at the first stage

Ⓑa steady-state creep (the rate is constant) at the second stage with the longest duration

Ⓒan acceleration of the creep rate and ultimate failure at the third stage.

ⒹThe rupture may be resulted from microstructural and/or metallurgical changes.

(背面仍有題目，請繼續作答)

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31. Which of the following statement is correct?
   (A)The thermal conductivity of a stainless steel is greater than for a plain carbon steel.
   (B)The thermal conductivity of a polycrystalline ceramic specimen is slightly greater than a single-crystal one of the same material
   (C)The linear polyethylene will have a larger conductivity than the lightly branched polyethylene.
   (D)none of above.

32. Which of the following statement is correct?
   (A)Metals are more corrosion resistant than Ceramic materials in most environments.
   (B)Corrosion of ceramic materials is normally just a electrochemical, whereas for metals it is usually chemical dissolution process.
   (C)Metals are more corrosion resistant than ceramics at elevated temperatures.
   (D)none of above.

33. For BCC iron, what is the diffraction angle for (220) set of planes? The lattice parameter for Fe is 0.2866 nm. Assume that monochromatic radiation having the wavelength of 0.1790 nm is used, and the order of reflection is 1.
   (A)62.13°　　　(B)124.26°　　　(C)53.13°　　　(D)106.26°.

34. For intrinsic gallium arsenide, the room temperature electrical conductivity is $10^{-6}(\Omega m)^{-1}$, the electron and hole mobilities are, respectively, 0.85 and 0.04 $m^2/v \cdot s$. Compute the intrinsic carrier concentration n_i at room temperature.
   (A) $7.02*10^{12}$　　(B) $7.35*10^{11}$　　(C) $7.71*10^{13}$　　(D) $1.56*10^{14}$　m^{-3}

35. What is the minimum cation-anion radius ratio for coordination number 4?
   (A)0.732　　　(B)0.414　　　(C)0.225　　　(D)0.155

36. Which of the following statement about microsegregation could be caused ?
   (A)dislocations　　(B)stress concentration　　(C)solidification　　(D)heat-treatment

37. Which of the following statement about microsegregation is correct ?
   (A)dendritic spacing　　(B)ingot center　　(C)rolling structure　　(D)recrystallization

38. Which of the following statement about Hall-Petch equation is correct?
   (A)conductivity　　(B)tensile ductility　　(C)tensile deformation resistance　　(D)formability

39. Which of the following statement about kirkendal effect is correct ?
   (A)diffusion　　(B)grain size　　(C)recovery　　(D)strain aging

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40. Which of the following statement about GP zone could be caused ?

    Ⓐcasting　　　Ⓑforging　　　Ⓒrolling　　　Ⓓheat-treatment

41. Which one of the following materials can be used at very high temperature

    Ⓐcopper　　　Ⓑplastics　　　ⒸMgO　　　Ⓓgraphite.

42. Fe_3C is also called　Ⓐcementite　　Ⓑpearlite　　Ⓒaustenite　Ⓓperitectoid.

43. Which one of the following materials has the lowest thermal expansion of coefficient

    ⒶAl　　　ⒷW　　　Ⓒstainless steel　　　ⒹInvar.

44. A fabrication process whereby molten metal is poured into a mold cavity having the desired shape is called

    Ⓐcasting　　Ⓑrolling　　Ⓒsintering　　Ⓓannealing.

45. When subjected to a stress, the crystal exhibits electrical polarity. This is called

    Ⓐpyroelectric effect　　Ⓑpiezoelectric effect　　Ⓒferromagnetic effect　　Ⓓferroelectric effect.

46. The region of Spinodal decomposition can decompose a phase into two different coherent phase, which of the following statement is support about overcoming an activation energy barrier

    Ⓐsmall　　　Ⓑlarge　　　Ⓒwithout　　　Ⓓmust

47. Which of the following statement is support about minimizing the free energy barrier for nucleation

    Ⓐgrain refinement　　　Ⓑalloying　　　Ⓒpreheating　　　Ⓓundercooling

48. Which of the following statement is support about PFZ

    Ⓐprecipitation free zone　　Ⓑprecipitation focus zone　　Ⓒprestrain free zone　　Ⓓpenetration free zone

49. Which of the following statement is support about the problem of DBTT

    Ⓐsuperplasticity　　　Ⓑtensile strength　　　Ⓒtensile ductility　　　Ⓓformability

50. Which of the following statement is not support about the dominant factor of increasing hardness and strength of an oversaturated solid solution aluminum alloy pertaining to artificial aging

    Ⓐdiffusional phenomenon　　ⒷGP zone　　Ⓒstrain induced phenomenon　　Ⓓprecipitation hardening