1. Solve $y' = (x + e^y - 1)e^{-y}$ (10%)

2. Solve $x^2 y'' + 5xy' + (x + 4) = 0$ by series solution (20%)

3. Prove that Fourier coefficient $a_m = \dfrac{\int_a^b p(x)f(x)y_m(x)dx}{\int_a^b p(x)y_m^2(x)dx}$, n=0, 1, 2, 3…..where $p(x)$ is a weight

   function and $f(x) = \sum_{m=0}^{\infty} a_m y_m(x)$ expanded by a generalized Fourier series. (15%)

4. Solve $ty'' + (1-t)y' + ny = 0$, $n = 0, 1, 2, 3\cdots$ by Laplace transform. (15%)

5. Show that a solution of the Laplace equation $\dfrac{\partial^2 u}{\partial r^2} + \dfrac{1}{r}\dfrac{\partial u}{\partial r} + \dfrac{1}{r^2}\dfrac{\partial^2 u}{\partial \theta^2} = 0$ in the disk $r < R$ and $u_r(R,\theta) = f(\theta)$ ($u_r = \dfrac{\partial u}{\partial r}$ is the directional derivative in the direction of the outer normal) is

$$u(r,\theta) = A_0 + \sum_{n=1}^{\infty} r^n [A_n \cos n\theta + B_n \sin n\theta]$$

   with arbitary A_0 and $A_n = \dfrac{1}{\pi n R^{n-1}} \int_{-\pi}^{\pi} f(\theta)\cos n\theta\, d\theta$, $B_n = \dfrac{1}{\pi n R^{n-1}} \int_{-\pi}^{\pi} f(\theta)\sin n\theta\, d\theta$ (20%)

6. Find the Fourier half-range sine expansion of $u(x) = \begin{cases} 50x & , \ 0 < x < 1 \\ 100 - 50x & , \ 1 < x < 2 \end{cases}$ (10%)

7. Find an eigenbasis (a baisi of eigenvectors) and diagonalize. Show the details.
$$\begin{bmatrix} 7.3 & 0.2 & -3.7 \\ -11.5 & 1.0 & 5.5 \\ 17.7 & 1.8 & -9.3 \end{bmatrix}$$
(10%)

1. A point charge q is brought to a position α with distance d away from an infinite plane conductor held at zero potential. Using the method of electrostatic images would be helpful. Please find:

   (a) The surface-charge density induced on the plane. (5%)

   (b) The force between the plane and the charge by using Coulomb's law for the force between the charge and its image. (5%)

   (c) The work necessary to remove the charge q from its position to infinity. (5%)

   (d) The potential energy between the charge q and its image. (5%)

   (e) What is the work (in electron volts) needed to remove for an electron originally one angstrom from the surface to infinity? (5%)

2. The microscopic theory of Ohmic conduction depends on the existence of a linear retarding force that acts on free charges in the medium. While the drift velocity is the average velocity that the free charge, such as an electron, attains due to an electric field. It can also be referred to as axial drift velocity since particles defined are assumed to be moving along a plane. In general, an electron will 'rattle around' in a conductor at the Fermi velocity randomly. An applied electric field will give this random motion a small net velocity in one direction. The maximum rated current for a copper wire, with radius $= 0.5$ mm, is 3 A.

   (a) What is the corresponding current density in A/m^2 ? (5%)

   (b) Assuming that each copper atom contributes one conduction electron. Calculate the density of the free electrons in the copper wire. (5%)

   (c) Estimate the electronic drift velocity corresponding to the current density. (5%)

   (Avogadro's number $N_A = 6.02 \times 10^{23}$ atoms per mole; atomic weight of copper is 63.55; density of copper is 8.94 g/cm^3)

3. A blade of grass standing 5.0 mm tall is 150 mm in front of a thin positive lens having a 100 mm focal length; 250 mm behind that first lens is a thin negative lens with a focal length of -75.0 mm.

   (a) Show that the first lens forms an image 300 mm behind it. (4%)

   (b) Describe that image. (4%)

   (c) What is the magnification? (4%)

   (d) Prove that the final image formed by both lenses is located 150 mm behind the negative lens. (4%)

   (e) What is the total magnification of the combination? (4%)
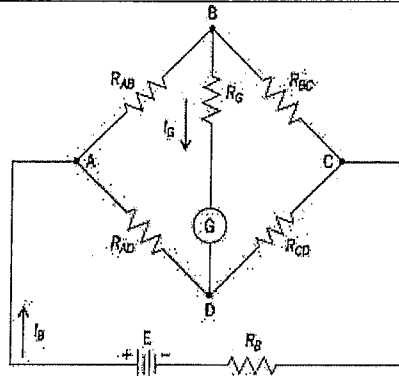
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Figure 1:

4. A Wheatstone bridge is an electrical circuit used to measure an unknown electrical resistance by balancing two legs of a bridge circuit, one leg of which includes the unknown component. Its operation is similar to the original potentiometer. It was invented by Samuel Hunter Christie in 1833 and improved and popularized by Sir Charles Wheatstone in 1843. Fig.1 shows the structure of a Wheatstone-bridge circuit.

(a) Find the current through the galvanometer when the bridge is off balance. (10%)

(b) Assuming the bridge can be balanced by adjusting R_{CD}. The sensitivity of the bridge is defined by

$$S = C \cdot R_{CD} \cdot \left(\frac{\partial I_G}{\partial R_{CD}} \right) \Bigg|_{ZERO}$$, where C is the galvanometer deflection per unit current, and the

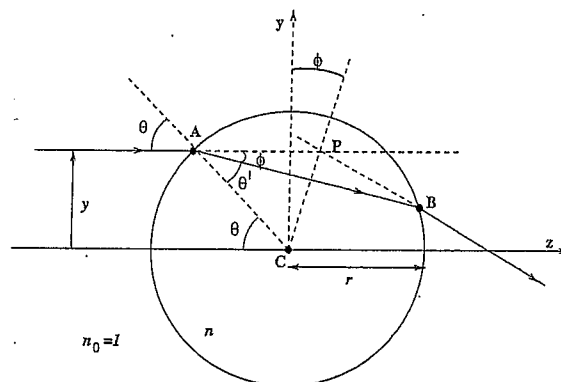subscript "$ZERO$" means that the derivation is to be evaluate at balance. Derive $S = ?$ (10%)

Figure 2:

5. Consider a glass sphere with radius r and refractive index n, concentric with the origin of the (y, z) coordinate system (Figure 2). A light, with y = constant, is incident on the sphere from the negative z direction, where $|y|/r \ll 1$, and passes completely through the sphere. Show that the ingoing and outgoing rays intersect on a parabola at $P(y, z)$ with approximate relation: $z \cong (n-1) \cdot y^2 / (n \cdot r)$.

(20%)

1. 選擇題 (單選, Total: 40%, each 2%)

1) (　) How many resonance forms can be drawn for the NO_3^- ion? a) 1, b) 2, c) 3, d) 4.

2) (　) Which of the following alkanes would have the highest boiling point? a) heptane; b) 2-methylpentane; c) 2,3-dimethylbutane; d) 2,2,3-trimethylbutane; e) All have the same molar mass and would have about the same boiling point.

3) (　) In cyclopropane, which of the following strain types would be the least important in determining the overall energy? a) angle; b) torsional; c) steric; d) all make a significant contribution.

4) (　) Which of the following compounds can be used to prepare Grignard reagents by reacting with Mg in ether?. (I) $CH_3CH=CH-CH_3$, (II) $CH_3CH_2CH(Br)-CH_3$; (III) $HO-CH_2CH_2CH_2-CH_2Br$; (IV) $HOOC-CH_2CH_2CH_2-CH_2Br$; (V) C_6H_5-Cl. (a) I, III; (b) II, V; (c) III. IV; (d) II, III.

5) (　) Which ion is the strongest base? a) $CH_3CH_2O^-$, b) $CH_3CH_2C(=O)O^-$, c) Cl^-, d) $CH_3CH_2^-$.

6) (　) Arrange the following groups in the order of decreasing priority: (I) $-CH_3CH_2$, (II) $-CH_3NH_2$, (III) $-CH_2Br$, (IV) $-CH_2OH$. (highest first). a) I, II, IV, III; b) III, IV, II, I; c) I, IV, II, III; d) IV, II, III, I.

7) (　) Which molecules are polar? (I) NH_3, (II) CO_2, (III) H_2O, (IV) Br_2. a) I, IV; b) I, III; c) II, III, IV; d) III, IV, V.

8) (　) Dehydrohalogenation of 2-bromobutane in the presence of a strong base proceeds via which of the following mechanistic pathways? a) SN1, b) SN2, c) E1, d) E2, e) none of the above.

9) (　) Arrange the leaving groups in order of decreasing leaving group ability: (I) CH_3COO^-, (II) CH_3O^-, (III) Br^-, (IV) HO^-. (strongest first) a) I, III, II, IV; b) III, I, IV, II; c) VI, II, I, III; d) IV, III, II, I.

10) (　) How many isomers, including stereoisomers, can be formed from the hydroxylation of 4-methylcyclohexene using osmium tetroxide (OsO_4)? a) 2; b) 4; c) 6; d) 8.

11) (　) The compound shown below is best classified as an $(CH_3)_2CCH_2CH=NCH_3$: (a) carbonolamine, (b) enamine, (c) hydrazone, (d) imine, (e) oxime.

12) (　) Hydroboration of alkenes is an example of: a) a rearrangement reaction, b) a substitution reaction, c) an elimination reaction, d) an addition reaction.

13) (　) The term retrosynthesis refers to syntheses developed: a) starting with simple molecules; b) devised by examining the product; c) working forward and backward from intermediates; d) beginning by examining the reactant available.

14) (　) Which of the following compound will have the M and M+2 peaks of equal intensity in its Mass spectrum? (a) $CH_3CH_2CH=CH_2$, b) $CH_3CH_2C=OCH_3$, c) $CH_3CH_2CH_2CH_2Br$; d) $CH_3CH_2CH_2CH_2Cl$.

(To be continued)

15) ( ) Consider the following reaction: ～～～～～～ - HBr ⟶ ～～～～～(Br)
a) is an oxidation; b) is a reduction; c) neither an oxidation or a reduction.

16) ( ) Which of the following compounds will not undergo acid-catalyzed bromination reaction? a) acetone, b) Ethyl acetate, c) benzophenone, d) acetaldehyde.

17) ( ) In order to produce a carboxylic acid as a product of the Grignard reaction, the Grignard reagent reacts with:
a) CO_2, b) a methyl ketone, c) a methyl ester, d) an aldehyde, e) either or CO_2 a methyl ketone.

18) ( ) What is the IR absorption of $CH_3C(=O)OCH_3$ will appear at? a) 3300 cm^{-1}; b) 1735 cm^{-1}; c) 2210 cm^{-1}; d) 1600 cm^{-1}.

19) ( ) Treatment of cyclopentene with m-chloroperoxybenzoic acid (MCPBA): a) results in oxidative cleavage of the ring to produce an acyclic compound. b) yields a meso epoxide. c) yields an equimolar mixture of enantiomeric epoxides. d) none of the above.

20) ( ) How many distinct alkene products are possible when the alkyl iodide below undergoes E2 elimination? a) 1, b) 2, c) 3, d) 4, e) 5. (p.s. including geometry isomers)
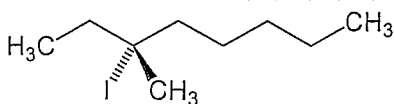

2. (Total: 15%) Friedel-Crafts acylation involves the electrophilic substitution of aromatic molecules. By reacting with acyl chloride in the presence of catalytic Lewis acid (e.g. $AlCl_3$), aromatic molecules will undergo Friedel-Crafts acylation to produce aromatic ketones. Besides intermolecular acylation, intramolecular acylation is also possible if aromatic molecules with appropriate chemical structure are available. The following questions from a) to c) relate to the intramolecular acylation of aromatic molecules:
a) Predict the product of the following reaction: (5%)
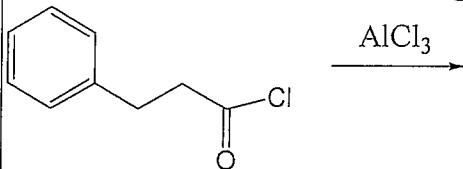
b) Explain why $AlCl_3$ can be catalyst in activating the reaction above? (5%)

c) Give the reason why the reaction in a) proceeds exclusively through intramolecular pathway but for the reaction below, the possibility for intramolecular reaction is low? (5%)
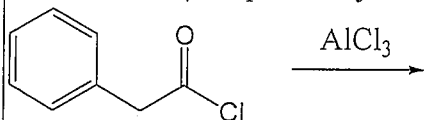
(To be continued)

3. (Total: 15%, each 5%) Acidity of organic carboxylic acids (R-COOH) refers to their ability to release proton and to generate the conjugated base of carboxylate anion (R-COO⁻). Conceptually, we may say that more acidic organic acid tends to form stable conjugated base, whose stability is closely related to the acid strength of the carboxylic acid. Rank the members of each of the following sets of three carboxylic acids in decrease order of strength (strongest first, weakest last)
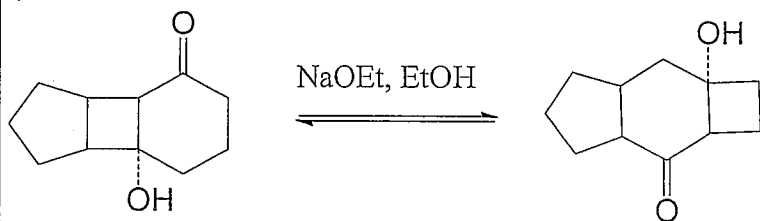
a) CF_3-CO_2H, F_2CH-CO_2H, CH_3CO_2H. (5%)

b) F-CH_2CO_2H, CH_3-O-CH_2CO_2H, CH_3CO_2H. (5%)

c) CH_3-S-CH_2-CO_2H, $^+NH_3$-CH_2CO_2H, $N{\equiv}C{-}CH_2{-}CO_2H$ (5%)

4. (Total: 30%, each 6%) Write down the mechanistic steps involved in each of the following reactions.

a)
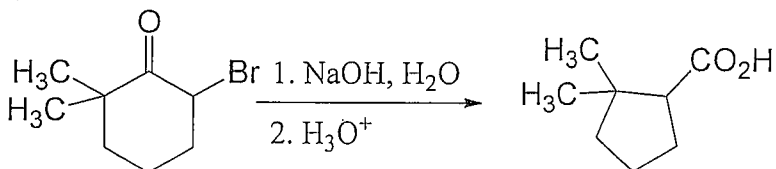
NaOEt, EtOH
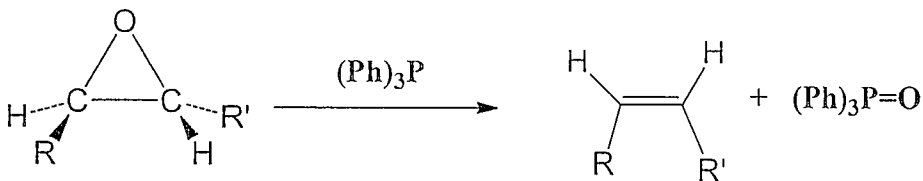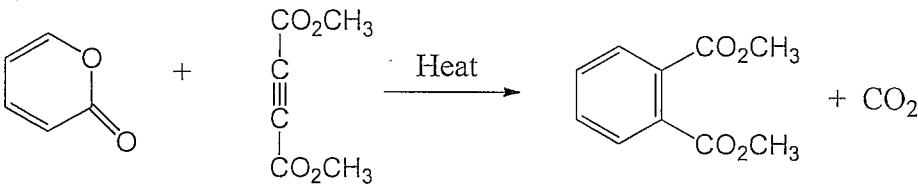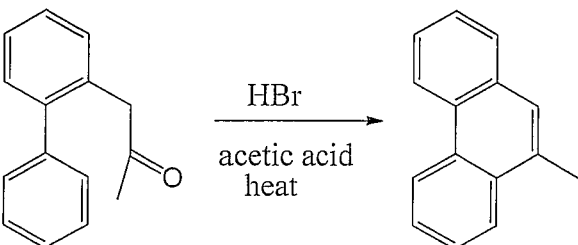
b)

1. NaOH, H₂O
2. H₃O⁺

c)

(Ph)₃P → + (Ph)₃P=O

d)

+ Heat → + CO₂

e)

HBr
acetic acid
heat

#1 to #30 題 每題 1 分；#31 to #50 題 每題 2 分　(選擇題 總計 70 分)

1. What are the three main categories of materials in classic definition? (a) semiconductors, polymers, composites, (b) ceramics, polymers, metals, (c) metals, semiconductors, nano-materials, (d) bio-materials, nano-materials, smart-materials.

2. What is the English name for 鎂? (a) magnesium, (b) manganese, (c) maglasium, (d) mergersium.

3. What is potassium in Chinese? (a) 銫, (b) 鈉, (c) 鉀, (d) 鍶.

4. What is the electron configuration for Mn (25)? (a) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^5$, (b) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^2$, (c) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7$, (d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^6$.

5. The L shell orbital will possess a principal quantum number of (a) 1, (b) 2, (c) 3, (d) 4.

6. What is isotope? (a) with the same protons but different neutrons, (b) with the same electron but different protons, (c) with the same neutrons but different electrons, (d) with the same neutrons but different protons.

7. What is the standard SI unit (not extension)? (a) nm, (b) min, (c) kcal, (d) kg.

8. What is this crystal system on the right side? (a) monoclinic, (b) rhombohedral, (c) orthorhombic, (d) triclinic.
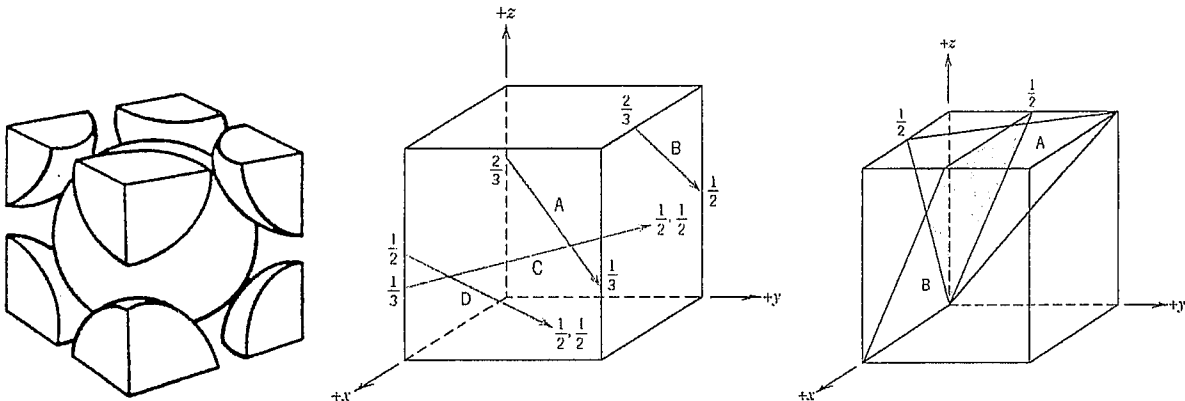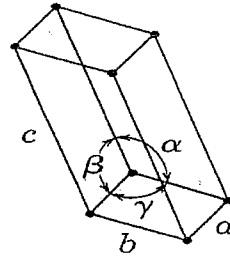
9. What is the packing density of the crystal structure on the above left side? (a) 0.61, (b) 0.68, (c) 0.74, (d) 0.79.

10. The coordination number for this structure in question 9 is (a) 6, (b) 8, (c) 10, (d) 12.

11. What is the direction for line D on the above center? (a) [-33-1], (b) [-22-1], (c) [-11-1], (d) [-40-3].

12. What is the plane index for plane B on the above right side? (a) (021), (b) (012), (c) (02-1), (d) (0-12).

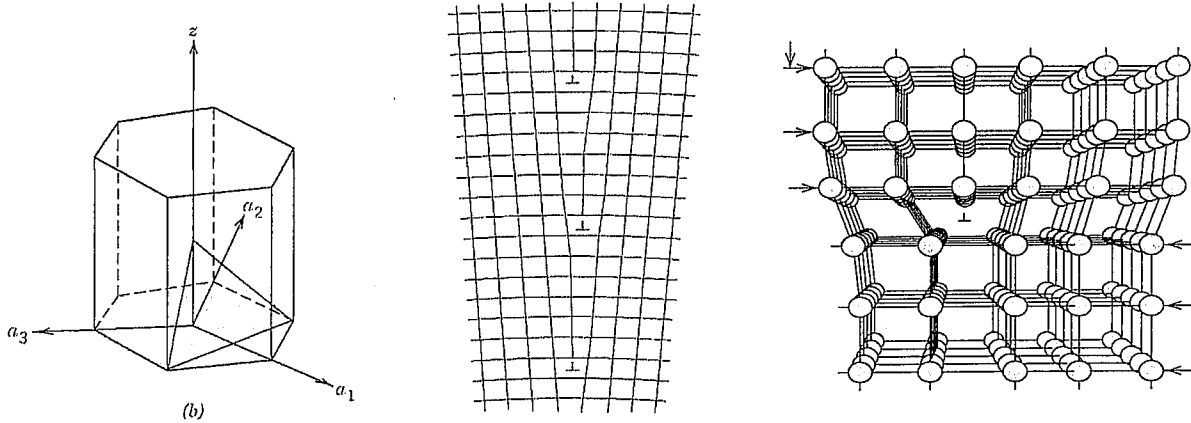13. What is the plane index for the plane on the above left side? (a) (2-1-12), (b) (1-211), (c) (11-22), (d) (11-21).

14. What is the direction index for a_2 in the HCP crystal? (a) <2-1-11>, (b) [1-2-20], (c) <211-1>, (d) [1-210].

15. What is the direction index for the direction of $[a_1-a_2]$? (a) <10-11>, (b) [1-100], (c) <10-12>, (d) [10-10].

16. Based on the figure on the above center, the misorientation, $\sin\theta$, of the tilt boundary should be around (a) 0.02, (b) 0.14, (c) 0.28, (d) 0.04.

17. Based on the figure on the above right side, which one is incorrect? (a) dislocation line direction l is pointing to the screen, (b) Burger's vector direction b is pointing to the right, (c) dislocation sliding direction v is pointing to the right, (d) dislocation line direction l is pointing to the right.

18. For an alloy of Ag-30wt%Cu, what is the alloy composition in wt%, give that the atomic weight of Ag is 108 and that of Cu is 64? (a) Ag-42at%Cu, (b) Ag-20at%Cu, (c) Ag-58at%Cu, (d) Ag-80at%Cu.

19. Which statement is correct? (a) a dislocation will not end inside a perfect single crystal, (b) there would be no vacancy in a perfect single crystal, (c) forming a self vacancy needs a higher energy than forming a self interstitial, (d) grain boundaries have a higher energy than the free surface.

20. Which activation energy Q for diffusion is the highest? (a) Ni, (b) W, (c) Al, (d) Cu.

21. Which activation energy Q for diffusion is the lowest? (a) lattice, (b) grain boundary, (c) dislocation pipe, (d) surface diffusion.

22. If the growth mechanism of a precipitate is a diffusional process, then the precipitate size would become 3 times when the growth time is increased by ? times. (a) 1, (b) 1.73, (c) 3, (d) 9.

23. If a material follows the Hall-Petch relationship, the material strength would be roughly ? times when the grain size is refined to 1/3 times. (a) 1/3, (b) 1.73, (c) 3, (d) 1/9.

24. It is known that the HCP crystals have the slip systems of the type of {0001}<11-20>. How many slip systems in this type? (a) 3, (b) 6, (c) 12, (d) 24.

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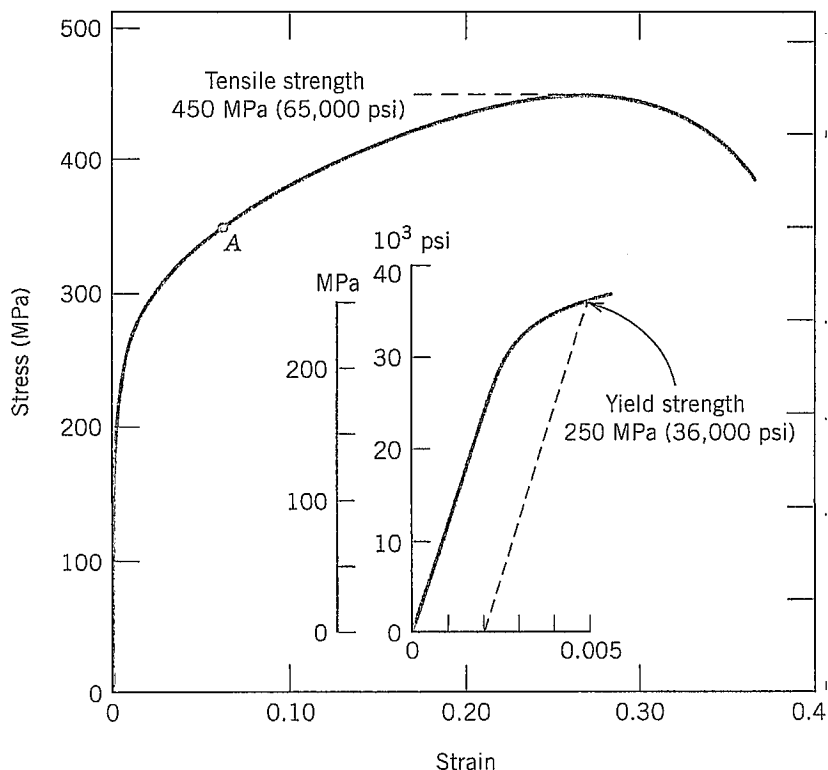25. Based on the curve above, estimate the elastic modulus: (a) ~63 GPa, (b) ~83 GPa, (c) ~103 GPa, (d) ~123 GPa.

26. Based on the above curve, necking would occur when strain = (a) ~0.002, (b) ~0.17, (c) ~0.27, (d) ~0.37.

27. What is the true strain ε for the above necking? (a) ~0.002, (b) ~0.20, (c) ~0.24, (d) ~0.35.

28. Based on the above curve and the power law for the plastic deformation, $\sigma_T = K \varepsilon_T^n$, estimate the work hardening exponent n value. (a) ~0, (b) ~0.1, (c) ~0.5, (d) ~1.

29. For a BCC iron specimen under tensile testing, with the tensile loading direction parallel to its [010] direction, what is the CRSS on (110) along [-111] if the tensile normal stress is 52 MPa? (a) ~11 MPa, (b) ~21 MPa, (c) ~31 MPa, (d) ~41 MPa.
(α=45°, and β=54.7°) (sinα=cosα=0.71; sinβ=0.82, cosβ=0.58)

30. What is the cup-and-cone typed fracture representing? (a) ductile, (b) brittle, (c) cleavage, (d) intergranular.

31. What is the reaction in the left plot (i)?
(a) peritectoid, (b) isomorphous,
(c) monotectoid, (d) monotectic.

32. What is the reaction in the left plot (ii)?
(a) peritectic, (b) monotectic,
(c) syntectic, (d) eutectic.
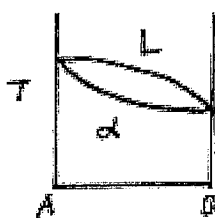
(i)
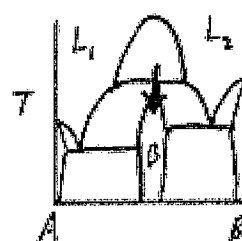
(ii)

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33. How do we define the recrystallization temperature? It is the temperature that recrystallization will complete within (a) 1 second, (b) 1 min, (c) 1 h, (d) 1 day.

34. For an alloy of Ag-50wt%Cu below, what is the approximate weight fraction of this β phase at 800°C? (a) 26%, (b), 44%, (c) 56%, (d) 74%.

35. For an alloy of Ag-50wt%Cu below, what is the β phase chemical composition at 800°C? (a) Ag-28wt%Cu, (b) Ag-50wt%Cu, (c) Ag-73wt%Cu, (d) Ag-93wt%Cu.

36. For an alloy of Ag-50wt%Cu below, what is the α phase chemical composition at 500°C? (a) Ag-2wt%Cu, (b) Ag-28wt%Cu, (c) Ag-50wt%Cu, (d) Ag-99wt%Cu.
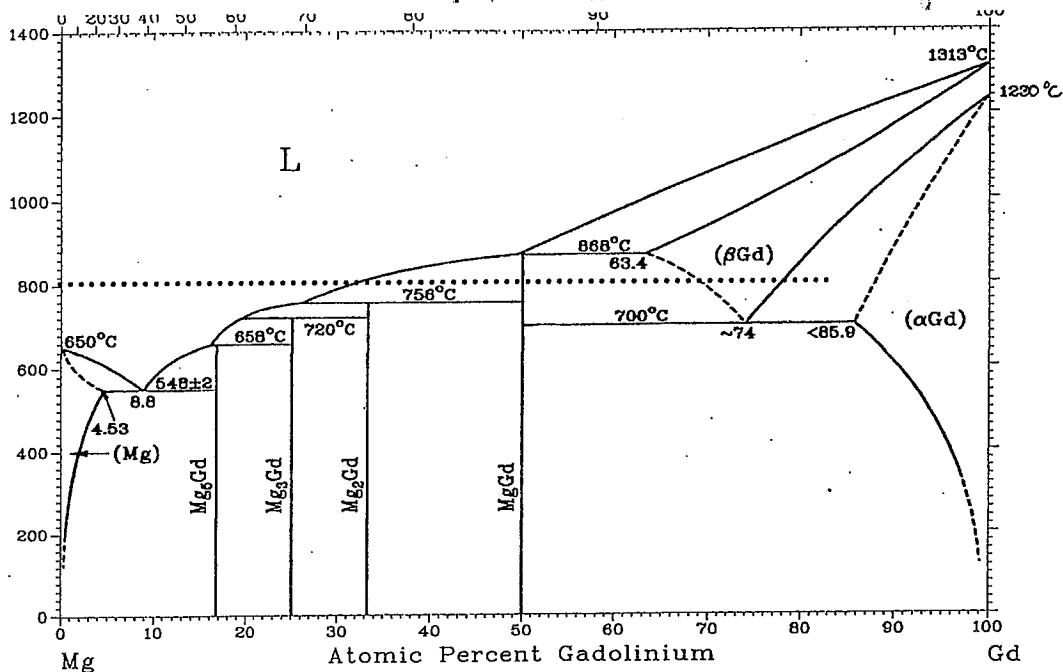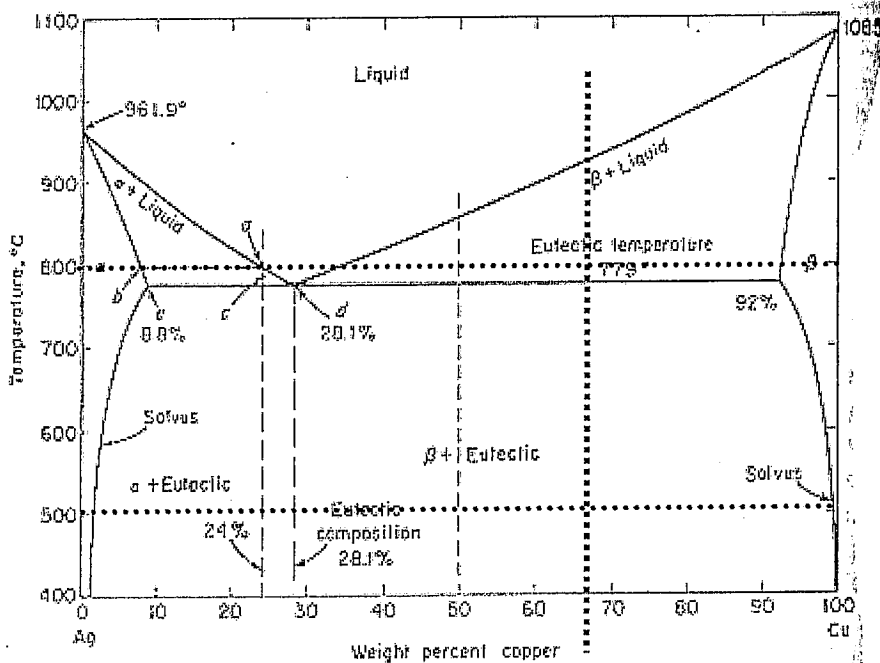
37. What phases are there in the phase region at 800°C and Mg-40at%Gd? (a) Mg$_2$Gd + MgGd, (b) MgGd + αGd, (c) MgGd + βGd, (d) L + MgGd.

38. What is the reaction at 756°C and Mg-33.3at%Gd? (a) peritectoid, (b) peritectic, (c) monotectoid, (d) monotectic.
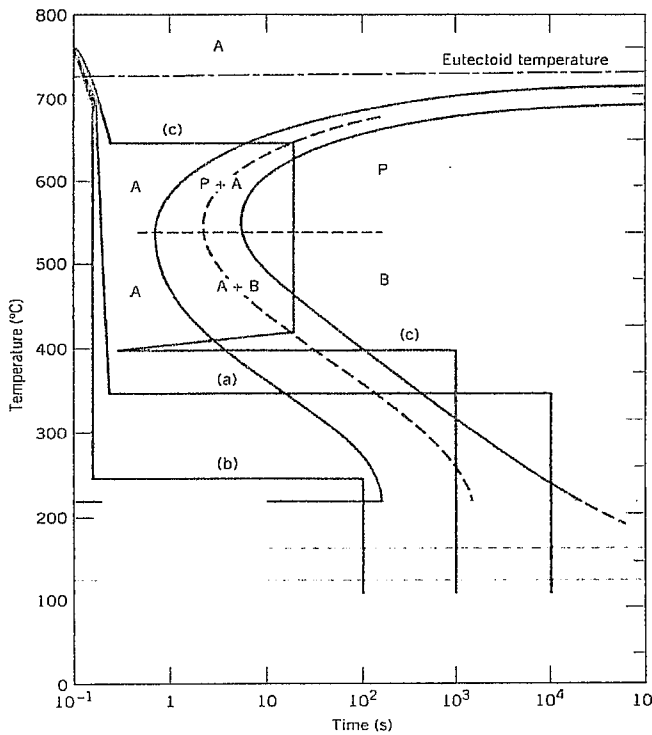
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39. The phase transformation evolution can be presented as an S curve, and described by the Avrami equation, which is (a) $r = A \exp(-Q/RT)$, (b) $r = A \exp(Q/RT)$, (c) $y = 1 - \exp(-kt^n)$, (d) $y = 1 + \exp(kt^n)$.

40. What will be the phase(s) for path (a)? (a) 50% Martensite+50%Bainite, (b) 100% Bainite, (c) 100% Pearlite, (d) 50% Pearlite+50%Martensite.

41. What will be the phase(s) for path (c)? (a) 50% Pearlite+50% Bainite, (b) 100% Pearlite, (c) 50% Martensite+50%Bainite, (d) 50% Pearlite+50%Martensite.

42. What is the phase(s) for path (b)? (a) 50% Martensite+50%Bainite, (b) 100% Bainite, (c) 100% Pearlite, (d) 100% Martensite.

43. And what would this phase change to when it is subject to a follow-up tempering for 2 h at 400°C? (a) Pearlite, (b) Bainite, (c) Spheroidite, (d) Austenite.

(i)　　　　(ii)　　　　(iii)
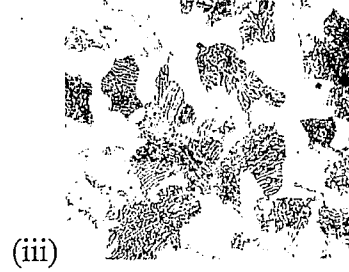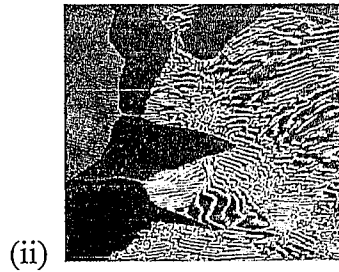
44. The dark color is referred to Cementite and the light color is referred to Ferrite. Estimate the approximate steel compositions for the steel that would exhibit the (i) microstructures. (a) Fe-0.1wt%C, (b) Fe-0.4wt%C, (c) Fe-0.8wt%C, (d) Fe-1.2wt%C.

45. Estimate the approximate steel compositions for the steel that would exhibit the (ii) microstructures. (a) Fe-0.1wt%C, (b) Fe-0.4wt%C, (c) Fe-0.8wt%C, (d) Fe-1.2wt%C.

46. Estimate the approximate steel compositions for the steel that would exhibit the (iii) microstructures. (a) Fe-0.1wt%C, (b) Fe-0.4wt%C, (c) Fe-0.8wt%C, (d) Fe-1.2wt%C.

47. How do we call the steel in (ii). (a) eutectoid steel, (b) hypereutectoid steel, (c) hypoeutectic steel, (d) primary steel.

48. Which material has the lowest electricity resistivity? (a) Al, (b) Cu, (c) Ag, (d) Au.

49. Many ceramics have the NaCl crystal structure. What is their coordination number? (a) 2, (b) 4, (c) 6, (d) 8.

50. Which one is the thermoplastic polymer? (a) polyethylene, (b) rubber, (c) epoxy, (d) polyester resin.

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51. A cylindrical rod with length of 400 mm and diameter of 10 mm, is deformed under a tensile load of 24,500 N. The deformation is limited within either elastic regime or within an elongation less than 0.9 mm. Of the materials listed below, which are possible candidates? Need to justify your choice(s). (本題 10 分)

Material	Modulus E (GPa)	Yield stress (MPa)	Tensile strength (MPa)
Al alloy	70	255	420
Brass alloy	100	345	420
Cu	110	250	290
Steel	207	450	550

52. Based on the following information, answer the questions.
   (i) What would this crystal structure be called? (ii) If the density of this metal is 8 g/cm^3, determine its atomic weight.
   (本題 10 分)
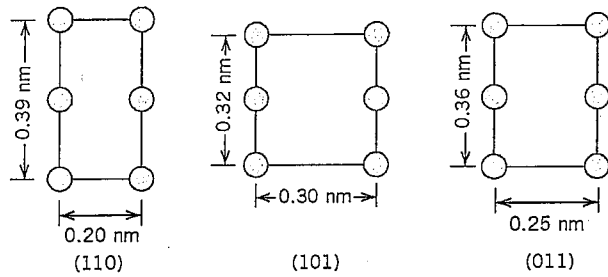
53. Based on your materials knowledge, write down your choices.
   (i)   Which material (not necessarily metallic) has the highest thermal conductivity?
   (ii)   Which metallic material has the highest melting point?
   (iii) Which metallic material has the lowest electricity resistivity?
   (iv)   Which metallic material has the highest toughness?
   (v)   Which material (not necessarily metallic) has the highest elastic modulus?
   (本題 10 分)

1. At 300 K and 20 atm, the compression factor of a gas is 0.86. Calculate (a) the volume occupied by 8.2 mmol of the gas under these conditions and (b) an approximate value of the second Virial coefficient B at 300 K. (each 10%, 20%)

2. Consider the following mechanism for renaturation of a double helix from its strands A and B

   (1) $A + B \underset{k_{-1}}{\overset{k_1}{\Longleftrightarrow}}$ unstable helix　　　　(fast)

   (2) Unstable helix $\xrightarrow{k_2}$ stable helix (slow)

   Derive the rate equation for the formation of the double helix and express the rate constant of renaturation reaction in terms of the rate constants of the individual steps. (20%)

3. Consider a system consisting of 2 mol $CO_2(g)$, initially at 25 °C and 10 atm and confined to a cylinder of 10 cm^2 cross-section. It is allowed to expand adiabatically against an external pressure of 1 atm until the piston has moved outwards through 20 cm. Assume that carbon dioxide may be considered a ideal gas with $C_{v,m} = 28.8$ J/K.mol and calculate (a) q, (b) w, (c) ΔU, (d) ΔT, and (e) ΔS. (each 4%, 20%)

4. Consider the thermodynamic description of stretching rubber. The observables are the tension t and length l (like p and V for gases). Since $dw = tdl$, the basic equation is $dU = TdS + tdl$ (pdV terms are supposed negligible throughout). If $G = U - TS - tl$, find expression for dG and dA and deduce the Maxwell relations

   $$\left(\frac{\partial S}{\partial l}\right)_T = -\left(\frac{\partial t}{\partial T}\right)_l \qquad \left(\frac{\partial S}{\partial t}\right)_T = \left(\frac{\partial l}{\partial T}\right)_t$$

   Go on to deduce the equation of state for rubber

   $$\left(\frac{\partial U}{\partial l}\right)_T = t - T\left(\frac{\partial t}{\partial T}\right)_l$$

   (20%)

5. From their atomic numbers and mass numbers, decide whether the following nuclei are likely to have zero, half-integral or integral spin: (a) ^{10}B, (b) ^{14}N, (c) ^{18}O, (d) ^{19}F, and (e) ^{31}P. (each 4%, 20%)

（請依序作答，標示題號，並注意單位）

1. Thermodynamics deals with equilibrium states. The word equilibrium implies a state of balance. There are many types of equilibrium, and a system is not in thermodynamic equilibrium unless the conditions of all the relevant types of equilibrium are satisfied. Please describe four important types of equilibrium related with the materials field. (20%)

2. 10 liters of gas at atmospheric pressure is compressed isothermally to a volume of 1 liter and then allowed to expand adiabatically to 10 liters. (a) Sketch the processes on a pV diagram for an ideal gas.(10%) (b) Is a net work done on or by the system? (10%)

3. According to the following figure, (a) what is the meaning of the isobars slopes in liquid Ag and solid Ag phase field, (10%) and (b) describe the meaning of "A" point based on the phase rule. (10%)
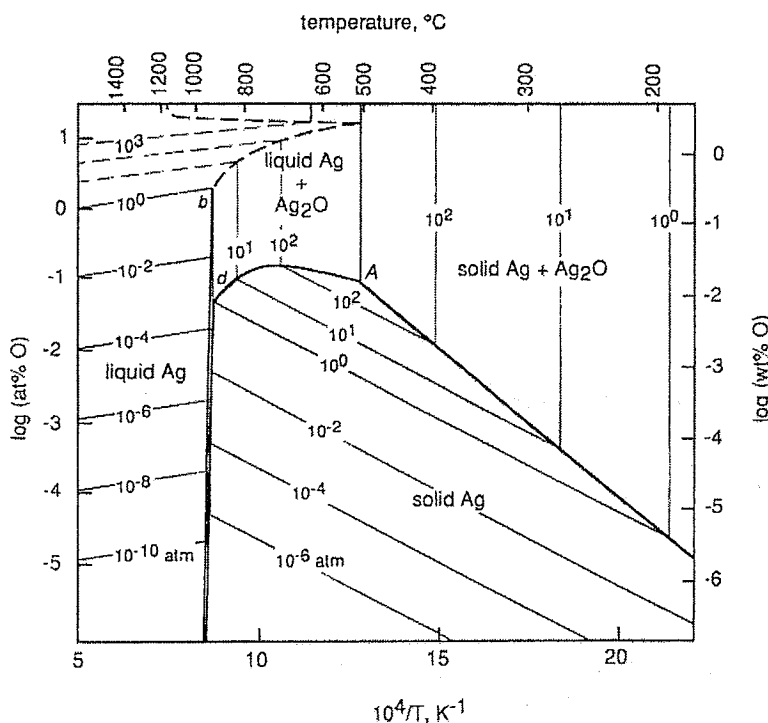

Figure 13.30   The solubility of oxygen in silver as a function of oxygen pressure and temperature

4. (a) How much heat is required to raise the temperature of 1000 grams of nitrogen from $-20\,^{\circ}C$ to $100\,^{\circ}C$ at constant pressure? (5%)
(b) How much has the internal energy of the nitrogen increased? (5%)
(c) How much external work was done? (5%)
(d)How much heat is required if the volume is kept constant? (5%)
Take the specific heat at constant volume Cv = 5 cal/mole.$^{\circ}C$ and R =2 cal/mole.$^{\circ}C$

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5. Plot the molar Gibbs free energy of mixing (ΔGmix) of each phase and show their relationships with equilibrium phase compositions at temperature 1400 °C and 800 °C, according to the following diagram. (20%)

Au-Pt