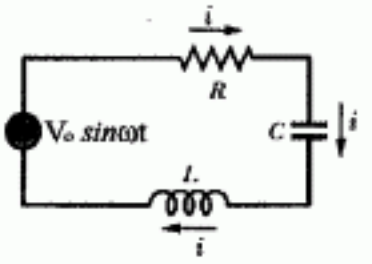
國　立　清　華　大　學　命　題　紙

九十三學年度 材料科學工程 系（所） _____ 組碩士班入學考試

科目 論工學力測驗三 科號 1303 共 14 頁第 1 頁 *請在試卷【答案卷】內作答

普通物理

1. 如下的 RLC 串聯電路, 何者敘述錯誤? (a) i 與 R 的電壓沒有相位差. (b) i 的相位落後(lags)L 的電壓 90 度. (c)設電路的總阻抗(impedance)爲 Z,則平均功率 $P_{av} = \frac{V_0^2 R}{2Z^2}$. (d)$Z = \sqrt{R^2 + (\omega C - \frac{1}{\omega L})^2}$. (e)電路的共振(resonance)頻率爲 $\frac{1}{\sqrt{LC}}$.



2. 彗星有 2 個尾巴最主要的原因是 (a)彗星噴射 2 種折射係數的物質. (b)受到星際間星球引力的作用. (c)彗星噴射不同速度的物質. (d)受太陽風的作用. (e)宇宙輻射背景造成.

3. 平面電磁波的磁場 $\vec{B} = B_0 \vec{j}$, $B_0 = 2 \times 10^{-7}\ sin(0.5 \times 10^3 x + 1.5 \times 10^{11} t)$ T, 則 (a)電場平行 $+z$ 方向, (b)電磁波往 $+x$ 方向行進, (c)玻印廷(Poynting)向量平行 $-x$ 方向, (d)電場振幅爲 6 V/m, (e)波長爲 2×10^{-3} m.

4. 楊格(Young)雙狹縫實驗中,置於雙狹縫前的單狹縫主要的作用是
(a)衰減入射光強度, (b) 增加干涉條紋的空間解析度(spatial resolution),
(c)形成同調(coherent)光源, (d)用於形成繞射條紋, (e)提高鑑別率(resoling power).

5. 哪一種波的能量最大? (a)紅光, (b)黃光, (c)無線電波, (d)紅外光, (e)紫外光.

6. 光具有粒子與波動雙重性質,下列何項與光的粒子性質無關?
(a)黑體輻射, (b)康普敦(Compton)效應, (c)拉瑟福(Rutherford)散射實驗,
(d)光電效應, (e)普朗克(Planck)輻射定律.

7. 電子也有波動性質,有類似 X 光繞射功能,可用於決定晶體表面結構. 哪一種波長的電子適用於這項研究?
(a) 200 nm, (b) 20 nm, (c) 2 nm, (d) 0.2 nm, (e) 0.02 nm.

8. 下列哪種現象與量子侷限 (quantum confinement) 效應無關?
(a)超導體現象, (b)零點(zero-point)能量, (c) α粒子衰減, (d)場電子發射, (e)氫原子能階.

9. 有關電容器的描述, 哪個不對?

(a)兩個並聯的電容器 C_1 與 C_2,它們的等效電容是 C_1+C_2.

(b)平行板電容器的電容 $C = \varepsilon_0 A/d$, A 是電板面積, d 是板間距離.

(c)介電(dielectric)常數 K 的介電質放入電容器中,會使電容增加 K 倍.

(d)介電質置於外電場中,內部電場比外電場小.

(e)儲存在電容器 C 的電能 $U = \frac{q^2}{2C} = \frac{\varepsilon_0 E^2}{2}$, 其中 q 是電板上的電荷,E 是板間的電場.

10. 以波長 400 nm 的光波爲準, 用雷利 (Rayleigh) 準則 $\theta = 1.2\frac{\lambda}{d}$, 估計在 500 公里高空中裝設有 40 公分孔徑相機的間碟衛星, 它的最小可解析距離是

(a) 60 公尺, (b) 6 公尺, (c) 60 公分, (d) 6 公分, (e) 0.6 公分.

普通化學

11. Predict the molecular geometry of XeF_4

(a) tetrahedral (b) square planar (c) trigonal pyramidal (d) octahedral (e) trigonal bipyramidal

12. Without doing detailed calculation, arrange aqueous solutions with the following concentrations in the order of increasing mass percent of solute. (a) 1% by mass; (b) 1 mg solute/dL solution; (c) 1 ppb; (d) 1 ppm; (e) 1 ppt.

(a) b<c<a<e<d (b) e<c<d< a<b (c) c<d<a<b<e (d) a<b<c<d<e (e) e<c<d<b<a

13. Arrange the set of the following aqueous solutions in order of the increasing freezing points.

(a) 0.1 m glucose ($C_6H_{12}O_6$) (b) 0.1 m $CaCl_2$ (c) 0.1 m CH_3COOH (d) 0.1 m KI

(a) d<b<c<a (b) b<d<a<c (c) b<d<c<a (d) a<b<c<d (e) a<c<d<b

14. The following is the proposed as a plausible reaction mechanism

$A + B \rightarrow I$ (slow)

$I + B \rightarrow C + D$ (fast)

What is a plausible rate law for the reaction

(a) Rate = $k[A][B]$ (b) Rate = $k[A][B]^2$ (c) Rate = $k[A][2B]$

(d) Rate = $k[B][I]$ (e) R = $k[A][B]/[C][D]$

15. In the reaction $C(s) + S_{2(g)} \rightleftharpoons CS_{2(g)}$, Kp=5.6 at 1009℃. If, at equilibrium, P_{CS2}=0.152 atm, what must be P_{S2}.

(a) 36.84 (b) 0.85 (c) 5.752 (d) 0.0271 (e) 0.672

16. Arrange the set of the following aqueous solutions in order of the increasing pH values (a) 0.0025 M HCl (b) 0.055M NaOH (c) 0.015 M $Ba(OH)_2$ (d) $1.6*10^{-3}$ M HBr

(a) a<d<b<c (b) a<d<c<b (c) d<a<c<b (d) d<a<b<c (e) a<b<c<d

17. Which of the following solids are likely to be more soluble in acidic solution?

(a) $LiNO_3$ (b) $BaCO_3$ (c) $CaCl_2$ (d) CaC_2O_4 (e) $Sr(OH)_2$

18. The following reaction is nonspontaneous under standard state condition at room temperature.

$COCl_2(g) \rightarrow CO(g) + Cl_2(g)$

How to make it a spontaneous reaction?

(a) raise the temperature (b) lower the temperature (c) increase pressure (d) reduce pressure (d) increase reaction time

19. The azide ion, N_3^-, is isoelectronic with which of the following?

(a) NO_2^- (b) NO_2 (c) CO_2 (d) SO_2 (e) O_3

20. Which of the following is true for the element xenon?

(a) It does not form chemical compounds

(b) It exists as the diatomic molecule Xe_2

(c) It has a lower first ionization energy than Na

(d) It has an extensive chemistry

(e) It forms compounds with some electronegative elements.

工程數學

21. A vector field $\mathbf{A}(x,y,z) = xy\hat{\mathbf{i}} - yz\hat{\mathbf{j}}$, $\nabla \times \mathbf{A}$ is equal to

(a) $y\hat{\mathbf{i}} - x\hat{\mathbf{k}}$ (b) $y\hat{\mathbf{j}} - x\hat{\mathbf{k}}$ (c) $x\hat{\mathbf{i}} - y\hat{\mathbf{k}}$ (d) $x\hat{\mathbf{i}} - y\hat{\mathbf{j}}$ (e) $y\hat{\mathbf{i}} - x\hat{\mathbf{j}}$

22. If P and Q are scalar fields, $\mathbf{A}, \mathbf{B}$ are vector fields, $d\mathbf{s}$ the line element vector, $d\mathbf{a}$ the area element vector, and dv the volume element, which of the following equations is INCORRECT?

(a) $\nabla \cdot (P\nabla Q) = \nabla P \cdot \nabla Q + P\nabla^2 Q$ (b) $\nabla \times (P\mathbf{A}) = \nabla P \times \mathbf{A} + P\nabla \times \mathbf{A}$

(c) $\nabla \times (\nabla \times \mathbf{A}) = \nabla(\nabla \cdot \mathbf{A}) - \nabla^2 \mathbf{A}$ (d) $\int_{\mathbf{x}_1}^{\mathbf{x}_2} \nabla P \cdot d\mathbf{s} = P(\mathbf{x}_2) - P(\mathbf{x}_1)$

(e) $\int (P\nabla^2 Q + Q\nabla^2 P)\, dv = \oint (P\nabla Q + Q\nabla P) \cdot d\mathbf{a}$

23. A function $f(x)$ defined in $0 < x < L$ has a Fourier half range cosine expansion

$f(x) = a_0 + \sum_{n=1}^{\infty} a_n \cos\frac{n\pi x}{L}$. Which of the following is correct?

(a) $a_0 = \frac{2}{L}\int_0^L f(x)dx$ (b) $a_n = \frac{2}{L}\int_0^L f(x)\cos\frac{n\pi x}{L}dx$ (c) $a_n = \frac{1}{L}\int_0^L f(x)\cos\frac{n\pi x}{L}dx$

(d) $a_n = \frac{2}{L}\int_0^L f(x)\sin\frac{n\pi x}{L}dx$ (e) $a_n = \frac{1}{L}\int_0^L f(x)\sin\frac{n\pi x}{L}dx$

24. For the eigenvalue problem $y'' + \lambda y = 0, (0 < x < L), y(0) = 0, y'(L) = 0$, the eigenvalues are λ_n and the eigenfunctions are ϕ_n, $n = 1, 2, \ldots$. Which of the following is correct?

(a) $\lambda_n < 0$. (b) $\lambda_n = \dfrac{n^2\pi^2}{L^2}$ (c) $\phi_n = \cos\dfrac{n\pi x}{L}$ (d) $\phi_n = \sin\dfrac{n\pi x}{L}$

(e) A function $f(x)$ can be expanded as $f(x) = \sum_{n=1}^{\infty} \dfrac{\int_0^L f(x)\phi_n(x)\,dx}{\int_0^L \phi_n^2\,dx}\phi_n(x)$

25. The Fourier transform of a function *f(x)* is defined by $F\{f(x)\} = \int_{-\infty}^{\infty} f(x)e^{-i\omega x}\,dx$.

If $f^{(n)}(x)$ is the *n*th derivative, $F\{f^{(n)}(x)\}$ is equal to

(a) $\omega^n F\{f(x)\}$ (b) $(i\omega)^n F\{f(x)\}$ (c) $(-\omega)^n F\{f(x)\}$ (d) $(-i\omega)^n F\{f(x)\}$

(e) none of the above.

26. Consider the wave equation $c^2 u_{xx} = u_{tt}$, $u(0,t) = u(L,t) = 0$, $u(x,0) = f(x), u_t(x,0) = g(x)$ for $0 \le x \le L$, $0 \le t$. By the method of separation of variables, we have $u(x,t) = \sum_{n=1}^{\infty} X_n(x)T_n(t)$, Then $X_n(x)$ is equal to (a) $\sin\dfrac{n\pi x}{L}$ (b) $\sin\dfrac{2n\pi x}{L}$ (c) $\cos\dfrac{n\pi x}{L}$ (d) $\cos\dfrac{2n\pi x}{L}$ (e) $\cos\dfrac{n\pi x}{2L}$

27. Following the above problem, it is known that $T_n(t) = A_n\cos\dfrac{n\pi ct}{L} + B_n\sin\dfrac{n\pi ct}{L}$. Then

(a) $A_n = \dfrac{2}{L}\int_0^L f(x)\sin\dfrac{n\pi x}{L}dx$ (b) $A_n = \dfrac{2}{L}\int_0^L f(x)\sin\dfrac{2n\pi x}{L}dx$

(c) $A_n = \dfrac{2}{L}\int_0^L f(x)\cos\dfrac{n\pi x}{L}dx$ (d) $A_n = \dfrac{2}{L}\int_0^L f(x)\cos\dfrac{2n\pi x}{L}dx$

(e) $A_n = \dfrac{2}{L}\int_0^L f(x)\cos\dfrac{n\pi x}{2L}dx$

28. The complex function $f(z) = \dfrac{1}{z(z-2)}$ can NOT be expanded into a unique Laurent series about $z = i$ in the region

(a) $|z-i| < \dfrac{1}{2}$ (b) $|z-i| < 1$ (c) $|z-i| < 2$ (d) $1 < |z-i| < \sqrt{5}$ (e) $|z-i| > \sqrt{5}$

29. On the complex z plane, let C be a closed circle centered at $z = 0$ with a radius of 2 and oriented counterclockwise, then $\oint_C \frac{e^{tz}}{z^2+1} dz$ is equal to

(a) 0 (b) $2\pi i \sin t$ (c) $-2\pi i \sin t$ (d) $2\pi i \cos t$ (e) $-2\pi i \cos t$

30. On the complex z plane, let C be the square contour $0 \to 2 \to 2+2i \to 2i \to 0$. The integral $\oint_C \frac{1}{z^2-2iz-1} dz$ is equal to

(a) 0 (b) πi (c) $2\pi i$ (d) $-\pi i$ (e) $-2\pi i$

應用電子學

31. For the circuit shown in Fig. A, let the transistor have $\beta = 100$ and neglect the effect of r_o. Use $V_{BE} \doteq 0.7$ V and assume all capacitances are infinite. What is the dc Q-point collector current I_{CQ}?

(a) 4.3 mA (b) 4.8 mA (c) 5.0 mA (d) 7.5 mA (e) 4.1 mA

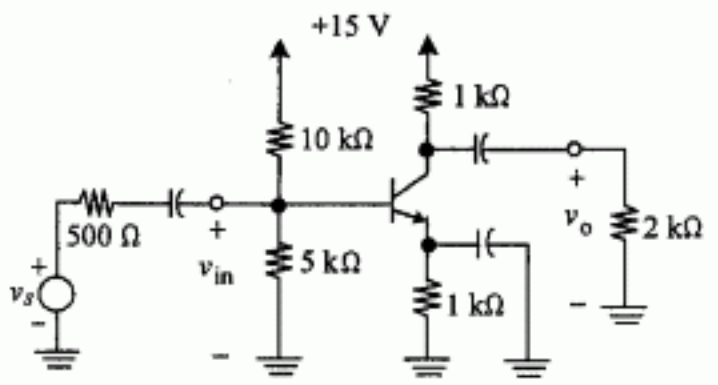


Fig.A

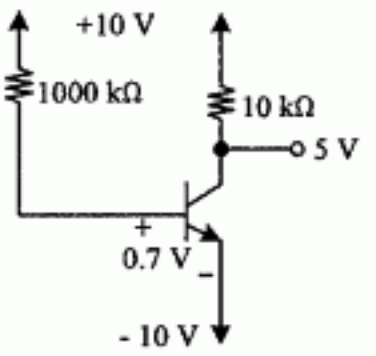


Fig. B

32. Find the midband value of voltage gain A_v ($= v_o/v_{in}$) for the circuit shown in Fig. A.

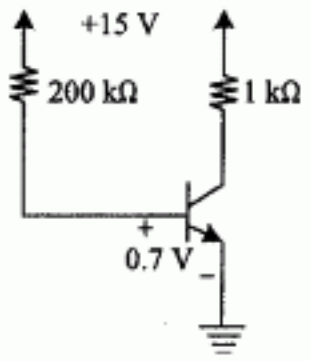
(a) -105 (b) -315 (c) -127 (d) -385 (e) 2

33. Find the value of β for the transistor of Fig. B.

(a) 78 (b) 54 (c) 100 (d) 26 (e) 161

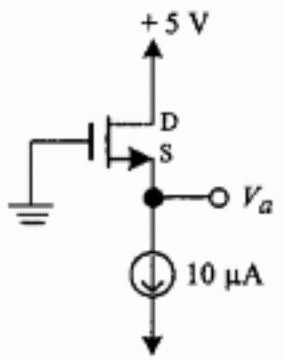
34. The transistor shown in Fig. 8 has $\beta = 10$. Find the value of collector current.

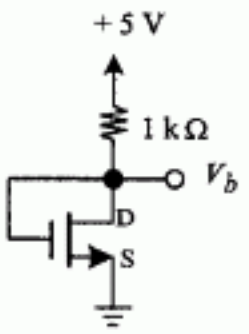
(a) 71.5 μA (b) 14.8 mA (c) 0.715 mA (d) 14.3 mA (e) 15 mA



35. Find the labeled node voltage V_a in the circuit of Fig. C.

(a) 2.14 V (b) –2.14 V (c) 2.45 V (d) –2.45 V (e) 5 V





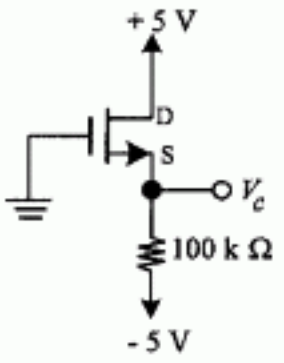


Fig. C Fig. D Fig. E

Note: All n-MOSFETs in the circuits of Figs. C-E are identical and have $V_{th} = 2$ V and $k = 0.5$ mA/V^2.

36. Find the labeled node voltage V_b in the circuit of Fig. D.

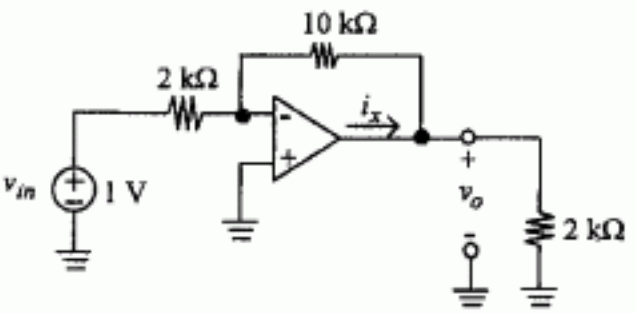
(a) 3 V (b) 2 V (c) 3.65 V (d) 5 V (e) –1.65 V.

37. Find the labeled node voltage V_c in the circuit of Fig.E.

(a) –2.24 V (b) –1.74 V (c) –5 V (d) 5 V (e) 0 V

38. Find the voltage and current labeled in the circuit of Fig. F, assuming an ideal op-amp.

(a) 0.14 V, 0.07 mA (b) 1 V, 0 mA (c) -5 V, 0 mA (d) –5 V, -3 mA (e) 5 V, 2 mA



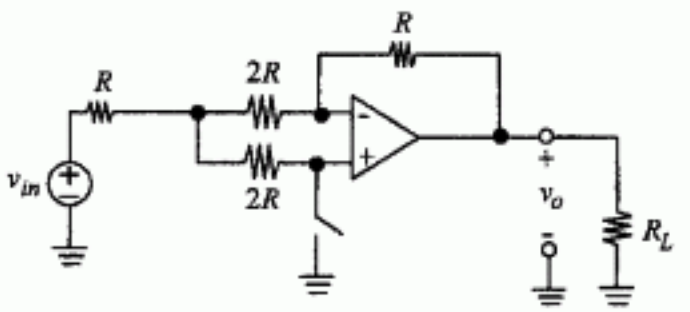


Fig. F Fig. G

39. Find the voltage gain $A_v = v_o/v_{in}$ and input impedance of the circuit shown in Fig. G with the switch closed.
(a) $A_v = -0.5$, $R_{in} = 2R$ (b) $A_v = 1$, $R_{in} = \infty$ (c) $A_v = -1$, $R_{in} = \infty$ (d) $A_v = 1$, $R_{in} = 2R$ (e) $A_v = -0.5$, $R_{in} = 3R$

40. Find the voltage gain $A_v = v_o/v_{in}$ and input impedance of the circuit shown in Fig. G with the switch open.
(a) $A_v = -0.5$, $R_{in} = 2R$ (b) $A_v = 1$, $R_{in} = \infty$ (c) $A_v = -1$, $R_{in} = \infty$ (d) $A_v = 1$, $R_{in} = 2R$
(e) $A_v = -0.5$, $R_{in} = 3R$

熱力學

41. For a pure homogeneous substance, as T→0 K, which of the following statement is true? (a) $\left(\frac{\partial G}{\partial P}\right)_T < 0$,
(b) $\left(\frac{\partial G}{\partial P}\right)_T = 0$, (c) $\left(\frac{\partial G}{\partial T}\right)_p < 0$, (d) $\left(\frac{\partial G}{\partial T}\right)_p = 0$, (e) none of above is correct.

42. Consider a binary eutectic phase diagram. The ΔH_s and ΔH_ℓ are the heat of mixing of solid solution and liquid solution, respectively. Assume that phase diagram is constructed with the ideal liquid solution and the regular solid solution, then, (a) $\Delta H_s<0$, (b) $\Delta H_s>0$, (c) $\Delta H_\ell<0$, (d) $\Delta H_\ell>0$, (e) none of above is correct.

43. Consider the oxidation of copper, $4\ Cu_{(s)} + O_2 = 2Cu_2O_{(s)}$. Then,
(a) as the temperature increases, ΔG^0 also increases,
(b) as the oxygen pressure increases, ΔG^0 also increases,
(c) as the temperature increases, the amount of Cu2O increases,
(d) ΔG^0 is independent of oxygen pressure,
(e) none of above is correct.

44. For the reaction $M_{(s)} + 2NO_{(s)} = 2N_{(s)} + MO_{2(s)}$, $\Delta G^0 = A + BT$, where $A<0$, $B>0$ and at $T = T_E$, $\Delta G^0 = 0$. Then,
(a) at $T>T_E$, M is more resistant to oxidation than N,
(b) at $T>T_E$, N is more resistant to oxidation than M,
(c) oxidation of M by NO is endothermic,
(d) the entropy change of the reaction is positive,
(e) none of above is correct.

45. Consider the gas phase reaction $a\ A + b\ B = c\ C + d\ D$. Given $\Delta H^o > 0$, then
(a) as temperature increases, the equilibrium constant K_p increases,
(b) as temperature increases, the equilibrium constant K_p decreases,
(c) as total pressure increases, the equilibrium constant K_p increases,
(d) as total pressure increases, the equilibrium constant K_p decreases,
(e) the effect of temperature or pressure on K_p cannot be determined.

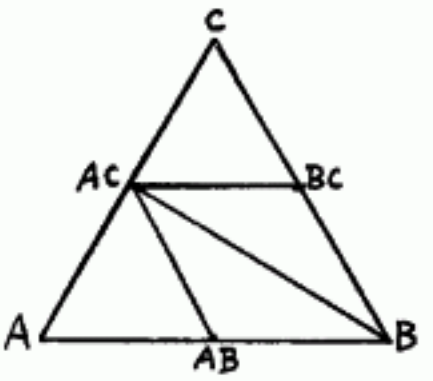
46. Consider the gas phase reaction a A + b B = c C + d D. Given $\Delta H^o > 0$, then
(a) as temperature increases, the equilibrium constant K_X increases,
(b) as temperature increases, the equilibrium constant K_X decreases,
(c) as total pressure increases, the equilibrium constant K_X increases,
(d) as total pressure increases, the equilibrium constant K_X decreases,
(e) the effect of temperature or pressure on K_X cannot be determined.

47. For a regular solid solution, the critical temperature of the miscibility gap is T_c, then
(a) $\Omega=0.25RT_c$, (b) $\Omega=0.5RT_c$, (c) $\Omega=RT_c$, (d) $\Omega=2RT_c$, (e) $\Omega=4RT_c$.

48. Supposed that a solution can be described with both the simplest regular solution model, i.e. $\Delta H^M = a_0 X_A X_B$, and the quasichemical solution model. If the solution exhibits a tendency toward clustering, which of the following statement is not true?
(a) $a_0>0$, (b) $[E_{AB} - 1/2(E_{AA}+E_{BB})]>0$, (c) $(d\gamma_A/dT)>0$, (d) $\gamma_A>1$, (e) $\gamma_B>1$.

49. For an ideal A-B solid solution, which of the following statement is not true?
(a) $\Delta G^M = RT(X_A \ln a_A + X_B \ln a_B)$
(b) $\Delta \overline{G}_A = RT \ln X_A$
(c) $\Delta \overline{H}_A = 0$
(d) $\Delta \overline{S}_A = R \ln X_A$
(e) $\Delta V^M = 0$

50. The ternary phase diagram at constant T, P, is shown as below, then
(a) for AC +BC = AB + 2C, $\Delta G^o < 0$;
(b) for AC + AB = 2A + BC, $\Delta G^o < 0$;
(c) for AC + B = AB + C, $\Delta G^o > 0$;
(d) for A + BC = B + AC, $\Delta G^o > 0$;
(e) for AB + BC = AC + 2B, $\Delta G^o > 0$;



物理冶金

51. 一個鑄錠在凝固過程時樹枝晶(dendrite)延伸很長，最後凝固熔湯中有壓力，且模壁與鑄錠間因爲鑄錠收縮而生縫隙，則容易產生
(a)內偏析(coring) (b)重力偏析(gravity-induced segregation) (c)樹枝間孔隙(interdendritic porosity) (d)逆偏析(inverse segregation) (e)胞室結構(cellular structure)

52. 界面(interface)控制的成長速率比擴散(diffusion)控制的成長速率
(a)快 (b)慢 (c)相等 (d)不一定 (e)無法判定

53. 下列哪一資料不是析出強化(precipitation hardening)所必需？
(a)固體之溶質溶解度隨溫度上升而變小 (b)先固溶處理(solution treatment)
(c)固溶處理後需快速冷卻 (d)時效(aging)處理 (e)以上皆非

54. 下列何者不是麻田相變化(martensitic transformation)必有的特徵？
(a)非恆溫(athermal)相變化 (b)無理數晶癖面(habit plane) (c)硬度變大
(d)剪移應變 (e)應變促進相變化

55. 形狀記憶合金的超彈性(superelasticity)現象是因爲？
(a)沃斯田相具有極大彈性變形能力 (b)麻田相具有極大彈性變形能力 (c) 應力引發沃斯田相變化
(d)應力引發麻田相變化 (e)以上皆非

56. 下列哪一特性不是屬於波來鐵(pearlite)相變化所有
(a)經由擴散產生 (b)層狀雙相結構 (c)置換型合金元素重新分配
(d)碳元素重新分配 (e)無理數晶癖面(habit plane)

57. 四種鋼鐵分別是 A:Fe-0.40%C ； B:Fe-0.40%C-0.40%Mn ； C:Fe-0.40%C -0.40%Ni ；
D:Fe-0.40%C-0.40%Cr。其硬化能(hardenability)大小依序爲
(a) D>B>A>C (b) D>B>C>A (c) B>D>C>A (d) B>D>A>C (e) A>B>C>D

58. 常見鋁合金中，下列哪一元素不是添加的合金元素？
(a)鐵 (b)矽 (c)鎂 (d)銅 (e)鋅

59. 下列哪一因素不會促進脆性斷裂？
(a)增加強度 (b)雙軸向應力 (c)降低溫度 (d)減少厚度 (e)增加雜質含量

60. 固定負荷、恆溫下的潛變(creep)應變量，隨時間增加而變曲線之變化是
(a)先較大斜率，變成固定斜率一段範圍，再變成較小斜率
(b)先較大斜率，變成固定斜率一段範圍，再變成較大斜率
(c)先較小斜率，變成固定斜率一段範圍，再變成較小斜率
(d)先較小斜率，變成固定斜率一段範圍，再變成較大斜率
(e)先較小斜率，變成固定斜率直到斷裂

近代物理

61. When 546 nm light illuminates a surface, the stopping potential is 0.42 volts. What will it be for 492nm light? (a) 0.67 V (b) 0.83 V (c) 0.58 V (d) 0.47 V (e) none of the above

62. An electron and a proton have the same velocity. Comparing the wavelengths and the phase and group velocities of their de Broglie waves, which of the following statements is incorrect?
(a) The electron has the longer wavelength
(b) The electron has the same phase and group velocities
(c) The proton has the same phase and group velocities
(d) The electron has higher phase velocity than the group velocity
(e) none of the above

63. The uncertainty in the position of a certain particle is equal to twice its de Broglie wavelength. What is the minimum percentage of uncertainty in its momentum in the same direction?
(a) 50% (b) 10% (c) 5% (d) 1% (e) none of the above

64. The lowest energy possible for a certain particle trapped in a certain box is 1.00 eV. What are the next two higher energies the particle can have?
(a) 2 eV, 3 eV, (b) 4 eV, 6 eV, (c) 4 eV, 9 eV, (d) 2 eV, 4 eV (e) none of the above

65. Which excited state of hydrogen has an excitation energy of 12.09 eV?
(a) 1st (b) 2nd (c) 3rd (d) 4th (e) none of the above

66. Of the following quantities, which increases in the Bohr model as quantum number n increases?
(a) frequency of revolution (b) electron speed (c) kinetic energy
(d) electron wavelength (e) none of the above

67. Which of the following wave functions can be solution of Schrödinger's equation for all values of x?
(a) $\psi = A \sec x$ (b) $\psi = A \exp(x^2)$ (c) $\psi = A \exp(-x^4)$ (d) $\psi = A \cot x$ (e) none of the above

68. A particle is in a box with infinitely rigid walls. Suppose the walls are in $x = -L/2$ and $x = +L/2$.
If $\psi_n = A \cos k_n x$ is a possible solution, what must k_n equal?
(a) $k_n = 3n\pi/L$ (n is an interger) (b) $k_n = 2n\pi/L$ (n is an interger) (c) $k_n = n\pi/L$ (n is an interger)
(d) $k_n = n\pi/L$ (n is an odd interger) (e) none of the above

69. The wave function $(1/\sqrt{8})(\alpha/\pi)^{1/4}(4\alpha x^2-2)\exp(-\alpha x^2/2)$ is that of a harmonic oscillator with $E_n = (n+\frac{1}{2})h\nu_c$, where h is the Planck's constant, ν_c is the oscillator's frequency, and E_n is the eigenvalue. What the quantum number n is to be?
(a) 1 (b) 2 (c) 3 (d) 4 (e) none of the above

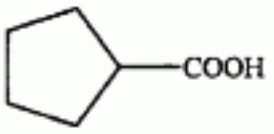
70. What is the probability that a particle in a box L wide can be found between $x = 0$ and $x = L/n$ when it is in the nth state?
(a) $1/n$ (b) $1/2n$ (c) $2/n$ (d) $1/4n$ (e) none of the above

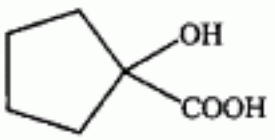
有機化學

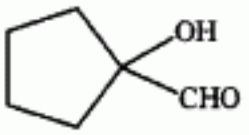
71. In the ^{1}H NMR of benzaldehyde (C_6H_5CHO) the signal from aldehyde proton will appear as:

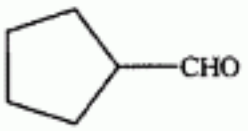
(a) a singlet at about 11.6 ppm
(b) a singlet at about 9.8 ppm
(c) a triplet between 7 and 8 ppm
(d) a doublet at about 12.0 ppm
(e) none of the above are correct

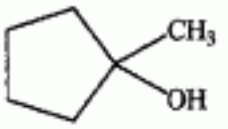
72. What is the product of the synthetic sequence below?

(a) 

(b) 

(c) 

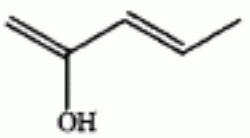
(d) 

(e) 

73. To convert a nitrile to primary amine you must:

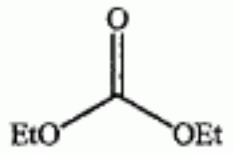
(a) hydrolyze it with water
(b)reduce it with hydrogen or $LiAlH_4$
(c) oxidize it with chromic acid
(d)substitute it with an alkyl halide
(e)none of the above are correct

74. Identify the keto form of the following enol.



(a) 1-penten-3-one
(b) (*E*)-3-penten-2-one
(c) 2-pentanone
(d) (*E*)-pentenal
(e) none of the above are correct

75. Reaction of excess Grignard reagent with diethyl carbonate, shown below, gives a(n):



(a) ester (b) ketone (c) secondary alcohol (d) tertiary alcohol (e) none of the above

76. Which is the least reactive toward nucleophiles?

(a) ketone (b) ester (c) amide (d) acyl halide (e) aldehyde

77. Which can be reduced by catalytic hydrogenation?

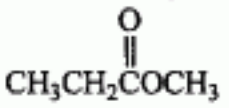
(a) carboxylic acid
(b) ester
(c) amide
(d) alkyne
(e) all of the above

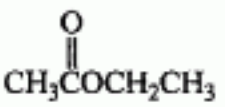
78. Which of these bonds would have the most intense stretching vibration?

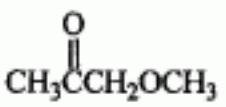
(a) H–H
(b) H–O
(c) H–N
(d) H–C
(e) H–B

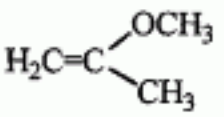
79. Which compound below fits the following ^{1}H NMR data?

triplet δ 1.22 ppm (3H)
singlet δ 1.98 ppm (3H)
quartet δ 4.07 ppm (2H)

(a) 

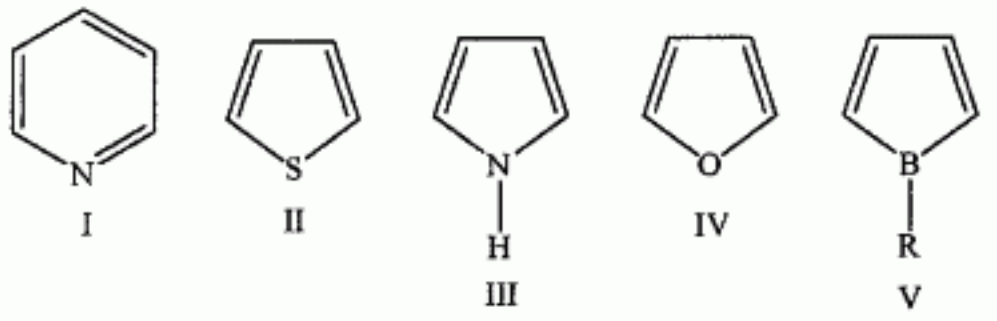
(b) 

(c) 

(d) 

(e) none of the above

80. Which compound would you not except to be aromatic?



I II III IV V

(a) I (b) II (c) III (d) IV (e) V

工程力學

81-82. A circular hollow steel bar has outer diameter d_o= 2 in, inside diameter d_i=1 in, length L=3 ft, and shear modulus of elasticity G=12x10^6 psi. The bar is subjected to a torque of T=100 ft-lb at the ends.

81. The polar moment of inertia of the cross section I_p (in^4) is

(a) 15/32 (b) 15 π /32 (c) 7/32 (d) 7π/32 (e) π/32

82. The maximum shear stress in the bar is

(a) Td_i/I_p (b) $Td_i/(2I_p)$ (c) Td_o/I_p (d) $Td_o/(2I_p)$ (e) $Td_o/(4I_p)$

83. The torsion failure of a brittle chalk is

(a) by tension cracking along a 30° helical surface

(b) by compression cracking along a 30° helical surface

(c) by tension cracking along a 60° helical surface

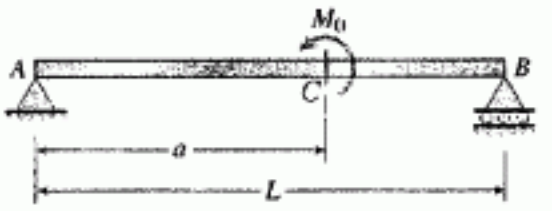
(d) by compression cracking along a 45° helical surface

(e) by tension cracking along a 45° helical surface

84.The relationship between modulus of elasticity E and shear modulus G is (ν is the Poisson's ratio)

(a) $G=\frac{E}{2(1+\nu)}$ (b) $G=\frac{E}{(1+\nu)}$ (c) $E=\frac{2G}{(1+\nu)}$ (d) $E=\frac{G}{2(1+\nu)}$ (e) $E=\frac{G}{(1+\nu)}$

85-86. A simple beam *AB* is subjected to a counterclockwise couple of moment M_o acting at distance *a* from the left-hand support.



85. The shear force at support *A* is

(a) $2M_o$/L (b) M_o/L (c) M_o/(2L) (d) $4M_o$/L (e) M_o/(4L)

86. The maximum bending moment at point *C* is

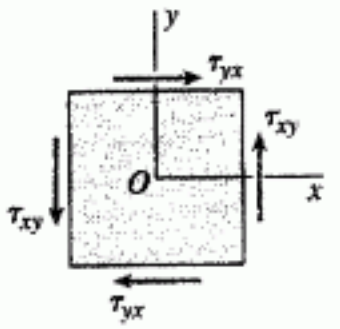
(a) $2aM_o$/L (b) aM_o/L (c) aM_o/(2L) (d) $4aM_o$/L (e) aM_o/(4L)

87. For a beam of rectangular cross section with width b and height $2h$, the moment of inertia I and the section modulus S are

(a) $I=\frac{bh^3}{12}, S=\frac{bh^2}{6}$ (b) $I=\frac{2bh^3}{3}, S=\frac{bh^2}{6}$ (c) $I=\frac{bh^3}{12}, S=\frac{2bh^2}{3}$

(d) $I=\frac{bh^3}{3}, S=\frac{bh^2}{3}$ (e) $I=\frac{2bh^3}{3}, S=\frac{2bh^2}{3}$

88. A stress element is at a state of pure shear τ_{xy},



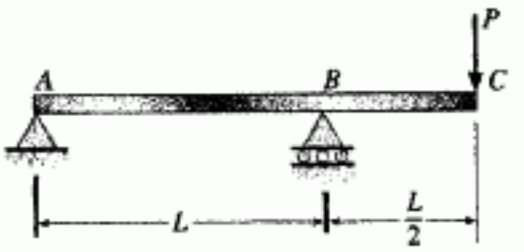
this stress state can be transformed into a state of maximum normal stress σ_x at an inclined angle θ, then

(a) $\sigma_x=\tau_{xy}, \theta=45°$ (b) $\sigma_x=2\tau_{xy}, \theta=45°$ (c) $\sigma_x=\tau_{xy}, \theta=30°$

(d) $\sigma_x=2\tau_{xy}, \theta=30°$ (e) $\sigma_x=\tau_{xy}, \theta=60°$

89-90. A simple beam AB with an overhang BC supports a concentrated load P at the end of the overhang. When solving the differential equation of the deflection curve v(x),

89. which of the following conditions is wrong?



(a) v(0)=0 (b)v'(0)=0 (c) v"(0)=0 (d) v(L)=0 (e)v"(1.5L)=0

90. Which of the following reaction at supports is true?

(a) $R_A=1.5P\downarrow$ (b) $R_A=P\uparrow$ (c) $R_A=0.5P\downarrow$ (d) $R_B=P\uparrow$ (e) $R_B=1.5P\downarrow$