九十二學年度材料科學工程學系碩士班研究生招生考試

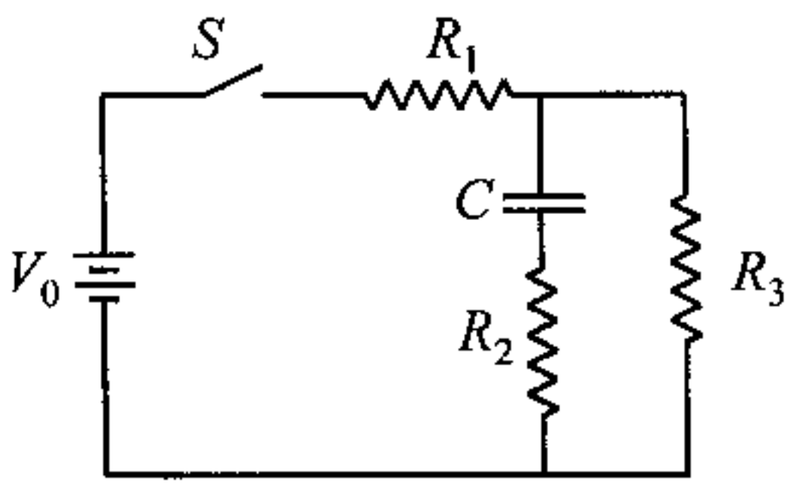
科目 理工學力測驗三 科號 1103 共 11 頁第 1 頁

單選題，以 2B 鉛筆劃在答案卡上；答對一題得 1 分，答錯一題倒扣 0.25 分，未答不計分。

## 普通物理

1. 5μF 和 3μF 的電容器並聯後再和一個 2μF 的電容器串聯，若此電路用一個等效電容器取代，則此等效電容器的電容大小是多少？（答案僅要求二位有效數字的準確度。）
(A) 10μF (B) 3.9μF (C) 2.5μF (D) 1.6μF (E) 0.97μF。

2. 右圖所示的電路中，$V_0$ 爲 12V 的直流電壓源，$R_1$、$R_2$ 和 $R_3$ 分別爲 2Ω、4Ω及 4Ω 的電阻，$C$ 爲 0.1F 的電容器。在開關 $S$ 關上前，整個電路無任何電流，且電容未儲存電荷。請問當 $S$ 關上後的瞬間，$R_3$ 兩端的電壓是多少？
(A) 0 (B) 2V (C) 4V (D) 6V (E) 8V




3. 續前題，將 $S$ 關上足夠久之後，整個電路達到穩定狀態，$R_1$ 兩端的電壓是多少？
(A) 0 (B) 2V (C) 4V (D) 6V (E) 8V

4. 二條長直且平行電線的電流皆爲 2A，電流方向相同，電線間距爲 2cm。電線的單位長度受力是多少？（$\mu_0$ 爲 permeability constant。）

(A) $\frac{\mu_0}{4\pi}$ N/cm 排斥力 (B) $2\times\frac{\mu_0}{4\pi}$ N/cm 吸引力 (C) $4\times\frac{\mu_0}{4\pi}$ N/cm 排斥力 (D) $8\times\frac{\mu_0}{4\pi}$ N/cm 吸引力

(E) $16\times\frac{\mu_0}{4\pi}$ N/cm 吸引力

5. 將一條電線彎成半徑爲 30cm 的圓環並置於 $xy$ 平面上，電線的電流爲 2A，圓環的圓心位於原點，請計算座標（0,0,40cm）處的磁場大小？
(A) $1.44\mu_0$ T (B) $1.20\mu_0$ T (C) $0.720\mu_0$ T (D) $0.432\mu_0$ T (E) $0.360\mu_0$ T

6. 真空中波長爲 600nm 的光進入折射率爲 1.5 的介質，其於介質中的波長及頻率分別是多少？
(A) 400nm，$5.0\times10^{14}$Hz (B) 400nm，$7.5\times10^{14}$Hz (C) 600nm，$3.3\times10^{14}$Hz (D) 900nm，$5.0\times10^{14}$Hz
(E) 900nm，$7.5\times10^{14}$Hz

7. 某種型式照相機之鏡頭焦距爲 50mm，被拍攝物體置於鏡頭前 30cm 處，請問成像之效果如何？
(A) 5 倍放大率之正像 (B) 2 倍放大率之倒像 (C) 1 倍放大率之正像 (D) 0.2 倍放大率之倒像 (E) 0.1 倍放大率之正像

8. 一台 50mW 雷射的波長爲 400nm，此雷射每秒鐘大約釋放出多少顆光子？普郎克常數（Plank constant）爲 $6.6\times10^{-34}$ J×s。
(A) $10^{19}$ (B) $10^{17}$ (C) $10^{15}$ (D) $10^{13}$ (E) $10^{11}$

9. 請問下面那一種儀器的功能與物質波有關：
(A)質譜儀 (B)電子顯微鏡 (C)雷射 (D)磁共振造影(MRI) (E)以上皆非

10. 尺寸大小約 10nm 的盒子內有個氫原子，盒子的溫度非常接近絕對零度，此氫原子的動能大概是多少？
(A) 0 (B) $10^{-32}$ J (C) $10^{-28}$ J (D) $10^{-24}$ J (E) $10^{-20}$ J

單選題，以 2B 鉛筆劃在答案卡上；答對一題得 1 分，答錯一題倒扣 0.25 分，未答不計分。

## 普通化學

11. For the reaction $2A + B \rightarrow C$

the following mechanism is proposed:

| | | |
|---|---|---|
| Step 1: | $A + B = D$ | fast equilibrium |
| Step 2: | $D + B \rightarrow E$ | |
| Step 3: | $E + A \rightarrow C + B$ | |

If step 2 is the rate-determining step, the rate of formation of C should equal

(A) $k[A]$ (B) $k[A]^2[B]$ (C) $k[A]^2[B]^2$ (D) $k[A][B]$ (E) $k[A][B]^2$

12. Two rate constants $k_1$ and $k_2$ have exactly the same value at 300.0 K. The activation energy for $k_1$ is 50.0 kJ/mol and for $k_2$ is 100.0 kJ/mol. What is the ratio of the frequency factors $A_1$ to $A_2$ for the two rate constants? (A)1.02 (B) 0.980 (C) $5.05 \times 10^8$ (D) $1.97 \times 10^{-9}$ (E) none of above

13. Which statement regarding water is TRUE?

(A) Energy must be given off to break down the crystal lattice of ice to a liquid.

(B) Hydrogen bonds are stronger than covalent bonds.

(C) Liquid water is less dense than solid water.

(D) Only covalent bonds are broken when ice melts.

(E) none of above

14. Which statement is FALSE?

(A) The binding forces in a molecular solid include London dispersion forces.

(B) Molecular solids have high melting points.

(C) Ionic solids are insulators.

(D) Ionic solids have high melting points.

(E) None of above

15. To calculate the freezing point of an ideal dilute solution of a single , nondissociating solute in a solvent, the minimum information is

(A) the molality (of the solute).

(B) the molality (of the solute) and the freezing point depression constant of the solvent.

(C) the quantities in (B) and the freezing point of pure solvent.

(D) the quantities in (C) and the molecular weight of the solute.

(E) the quantities in (C) and the weight of the sovent.

16. Choose the species with the greatest bond strength.

(A) $F_2$ (B) $Cl_2$ (C) $Br_2$ (D) $I_2$ (E) all the same

17. The complex ions of $Zn^{2+}$ are all colorless. Which is the most likely explanation?

(A) $Zn^{2+}$ is not a transition metal ion.

(B) $Zn^{2+}$ is paramagnetic.

(C) $Zn^{2+}$ exhibits *d* orbital splittings in its complexes that absorb all wavelengths in the visible region.

(D) Since $Zn^{2+}$ is a $d^{10}$ ion, it does not absorb visible light even though *d* orbital splitting are correct for absorbing visible wavelengths.

(E) none of above.

單選題，以 2B 鉛筆劃在答案卡上；答對一題得 1 分，答錯一題倒扣 0.25 分，未答不計分。

18. The half-life of the Cs-131 nuclide is 30 years. After 90 years, about 6 *g* remains. The original mass of the Cs-131 sample is closest to (A) 80 *g* (B) 70 *g* (C) 60 *g* (D) 50 *g* (E) 40 *g*
19. Substances with the same molecular formula but with different structures are
(A) polymers. (B) esters. (C) isomers. (D) isotoples. (E) dimers.
20. Nylon is a (A) copolymer. (B) Homopolymer. (C) dimer. (D) two of these. (E) none of these.

## 工程數學

$A=\begin{pmatrix}1 & 1\\ 1 & 0\end{pmatrix}$ (21-23)

21. A 之 eigenvalue 是

(A) 0 (B) 1 (C) $\frac{1-\sqrt{5}}{2}$ (D) $\frac{-1-\sqrt{5}}{2}$ (E) $\frac{-1-\sqrt{5}}{3}$

22. 對應之 eigenvector 爲

(A) $\begin{pmatrix}1\\0\end{pmatrix}$ (B) $\begin{pmatrix}0\\1\end{pmatrix}$ (C) $\begin{pmatrix}-1\\ \frac{-1-\sqrt{5}}{2}\end{pmatrix}$ (D) $\begin{pmatrix}-1\\ \frac{1+\sqrt{5}}{2}\end{pmatrix}$ (E) $\begin{pmatrix}1\\ \frac{1-\sqrt{5}}{2}\end{pmatrix}$

23. 另一個 eigenvector 爲

(A) $\begin{pmatrix}1\\0\end{pmatrix}$ (B) $\begin{pmatrix}0\\1\end{pmatrix}$ (C) $\begin{pmatrix}1\\ \frac{-1+\sqrt{5}}{2}\end{pmatrix}$ (D) $\begin{pmatrix}-1\\ \frac{-1+\sqrt{5}}{2}\end{pmatrix}$ (E) $\begin{pmatrix}1\\ \frac{-1-\sqrt{5}}{2}\end{pmatrix}$

24. $F(x,y,z)=\begin{pmatrix}yz^2-1\\ xz^2+e^y\\ 2xyz+1\end{pmatrix}$，其 potential function 是

(A) $x^2y^2z-x+e^y+z$ (B) $xyz^2-x+e^{-y}-z$ (C) $x^2yz-x+e^y+z$ (D) $x^2yz-x+e^{-y}+z$ (E) $xyz^2-x+e^y+z$

25. 承前題，$\nabla \cdot F=?$

(A) $x^2y^2z-x+e^y+z$ (B) $xyz^2-x+e^{-y}-z$ (C) $e^y+2yz$ (D) $e^x+2xz$ (E) $e^z+2xy$

26.球座標 $x=r\sin\theta\cos\phi$， $y=r\sin\theta\sin\varphi$， $z=r\cos\theta$，若是距離之公式是：
$d\ell^2=h_1^2dr^2+h_2^2d\theta^2+h_3^2d\varphi^2$，則$(h_1,h_2,h_3)$爲

(A) $\begin{pmatrix}r\\-1\\r\sin\theta\end{pmatrix}$ (B) $\begin{pmatrix}r^2\\1\\\sin\theta\end{pmatrix}$ (C) $\begin{pmatrix}1\\r\\r\sin\theta\end{pmatrix}$ (D) $\begin{pmatrix}-r\\1\\r\sin\theta\end{pmatrix}$ (E) $\begin{pmatrix}1\\r^2\\\sin\theta\end{pmatrix}$

27.熱傳方程式 $\frac{\partial u}{\partial t}=a^2\frac{\partial^2 u}{\partial x^2}$，$0\leqq x\leqq\pi$；$t>0$，$u(0,t)=u(\pi,t)=0$；$u(x,0)=2$，$0<x<\pi$；則 $t\to\infty$時，$u(x,t)=?$

(A) $\frac{8}{\pi}\sin 2xe^{-2a^2t}$ (B) $\frac{8}{\pi}\sin xe^{-a^2t}$ (C) $\frac{8}{\pi}\sin 2xe^{2a^2t}$ (D) $\frac{8}{\pi}\cos xe^{-2a^2t}$

(E) $\frac{8}{\pi}\sin xe^{2a^2t}$

單選題，以 2B 鉛筆劃在答案卡上；答對一題得 1 分，答錯一題倒扣 0.25 分，未答不計分。

28. $V=\iiint_M \frac{1}{x^2+y^2+z^2}dxdydz$ ，M 是一個三度空間範圍，它的點(x,y,z)符合：$3<\sqrt{x^2+y^2+z^2}<6$，則 V=？ (A) 10π (B) 11π (C) 12π (D) 13π (E) 14π

29. $z^4=1-i$， z 爲複數， z=？

(A) $2^{1/8}\left[\cos\frac{-\pi}{16}+i\sin\frac{-\pi}{16}\right]$ (B) $2^{1/8}\left[\cos\frac{7\pi}{16}+i\sin\frac{8\pi}{16}\right]$ (C) $2^{1/8}\left[\cos\frac{15\pi}{16}+i\sin\frac{16\pi}{16}\right]$

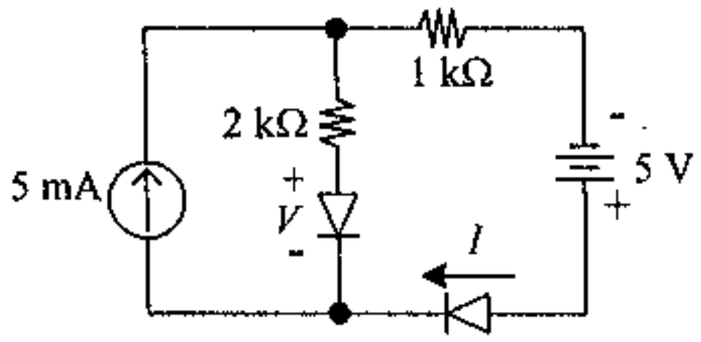
(D) $2^{1/8}\left[\cos\frac{23\pi}{16}+i\sin\frac{24\pi}{16}\right]$ (E) $2^{1/4}\left[\cos\frac{23\pi}{16}+i\sin\frac{23\pi}{16}\right]$

30. $\oint_c \frac{dz}{(z-2i)\sin z}$ c ： $|z-8i|=1$

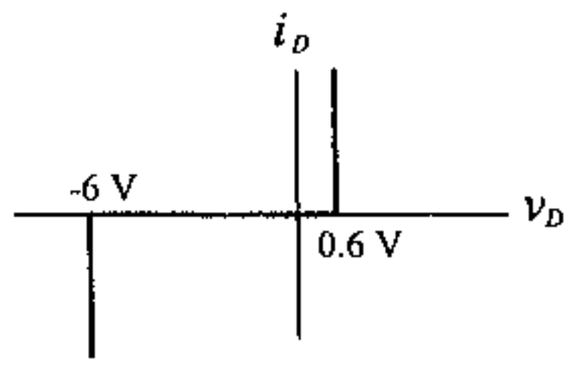
(A) $\frac{\pi}{15}$(12-i) (B) −4πi (C)2πi (D) $\frac{2\pi i}{e}$ (E)0

## 應用電子學

31. Find the values of $I$ (in mA) and $V$ (in volts) for the circuit shown in Fig. 31(a). Assume that both diodes are identical and their volt-ampere characteristic is shown in Fig. 31(b).
(A) 1.67; 3.93 (B) 4.4; −5 (C) 5; 0.6 (D) 5; −10 (E) 5; 0




(a)




(b)

Fig. 31

32. Find the value of $I$ for the circuit shown in Fig. 32, assuming both Zener diodes are ideal with the breakdown voltages shown. (A) 3 (B) 5 (C) 0 (D) 3.33 (E) 2

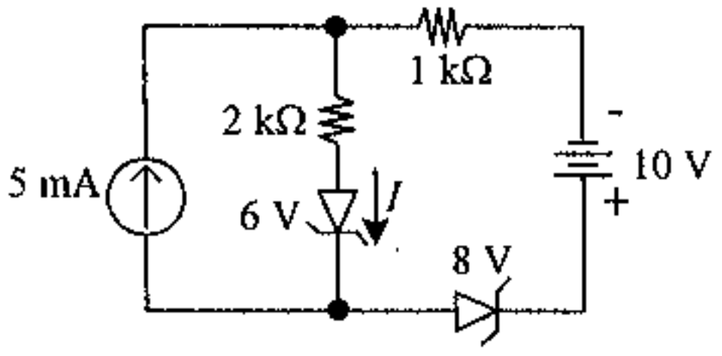



Fig. 32

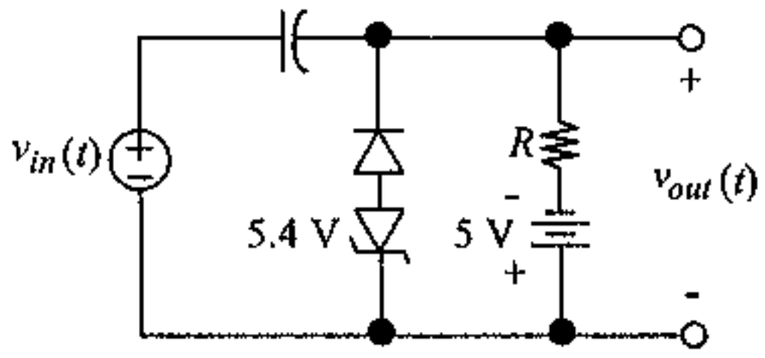



Fig. 33

33. Consider the circuit shown in Fig. 33. Assume the capacitor is large enough so that the voltage across it does not discharge through R appreciably during one cycle of input. What is the steady-state output voltage $v_{out}(t)$ if $v_{in}(t) = 4\sin(\omega t)$. Allow a 0.6-V forward drop for the diodes.
(A) −6 (B) $4\sin(\omega t) - 6$ (C) $4\sin(\omega t)$ (D) $4\sin(\omega t) + 2$ (E) −5

單選題，以 2B 鉛筆劃在答案卡上；答對一題得 1 分，答錯一題倒扣 0.25 分，未答不計分。

34. For the circuit shown in Fig. 34, find the value of $v_o$ for $v_i \geq 4.65$ V. Allow a 0.7-V forward drop for each conducting diode. (A) 5 V (B) 10 V (C) 0 V (D) 4.65 V (E) 9.3 V

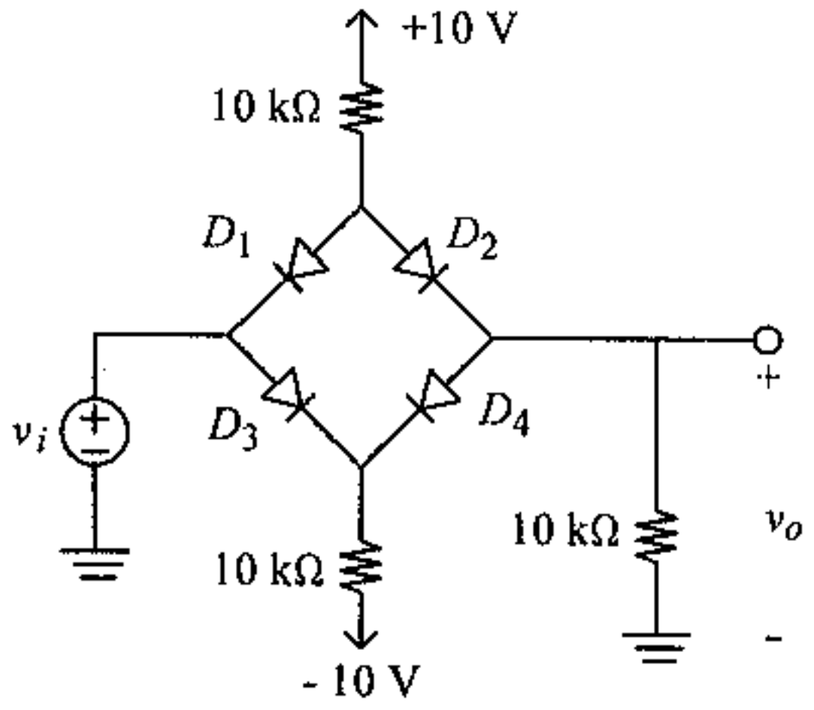
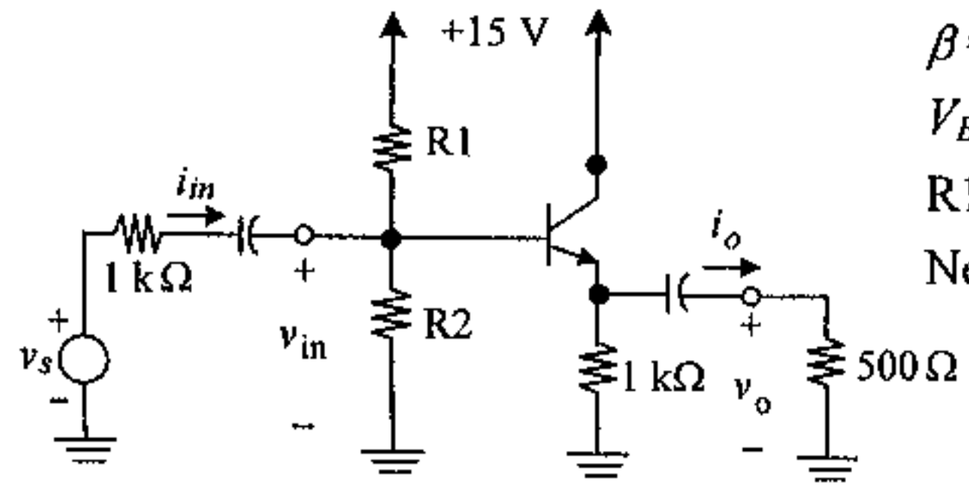



Fig. 34

35. Find the dc Q-point collector current $I_{CQ}$ for the circuit shown in Fig. 35-37.
(A) 5 mA (B) 15 mA (C) 7.07 mA (D) 1.3 mA (E) 6.41 mA




$\beta = 100$
$V_{BE} = 0.7$ V
R1 = R2 = 10 kΩ
Neglect $r_o$, and assume all

Fig. 35-37

36. Find the voltage gain $A_v = v_o/v_{in}$ for the amplifier shown in Fig. 35-37.
(A) 1 (B) –82.22 (C) 0.988 (D) 0.996 (E) 82.22

37. If the resister R2 is removed from the circuit of Fig. 35-37, find the dc Q-point collector current $I_{CQ}$ again.
(A) 15 mA (B) 12.88 mA (C) 1.3 mA (D) 14.3 mA (E) 1.37 mA

38. Assume the OP amps in the circuit of Fig. 38 are ideal. Analyze the circuits to find the values of $v_{o1}$ and $v_{o2}$ (both in volts).
(A) –12; –4 (B) 2; –2 (C) –2; –4 (D) 2; –4 (E) –2; 2

單選題，以 2B 鉛筆劃在答案卡上；答對一題得 1 分，答錯一題倒扣 0.25 分，未答不計分。

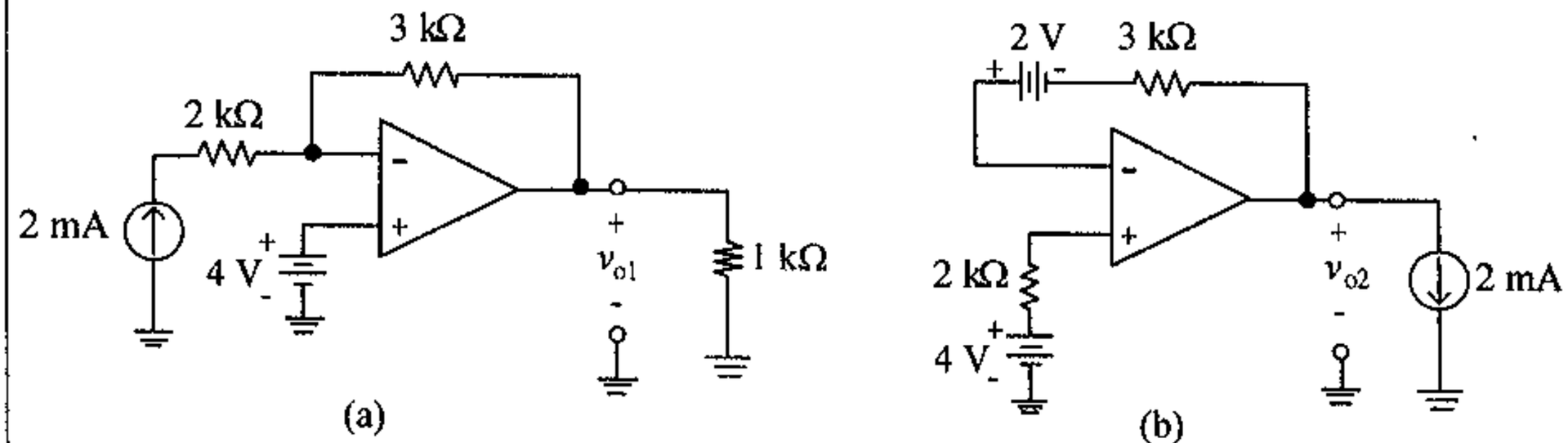



Fig. 38

39. Determine the minimum SOP expression for the logic function

$F = A\overline{B} + ABCD + AC\overline{D} + AB\overline{C} + AB + ABC + B\overline{C}\,\overline{D} + \overline{A}\,\overline{B}\,\overline{C}\,\overline{D}$.

(A) $B + \overline{B}C + B\overline{C}$ (B) $A + \overline{C}\,\overline{D}$ (C) 1 (D) $\overline{C}\,\overline{D} + AD$ (E) $A + \overline{A}\,\overline{C}\,\overline{D}$

40. Find the minimum SOP expression for the output of the logic circuit of Fig. 40.

(A) A (B) B (C) C (D) ABC (E) AB + C

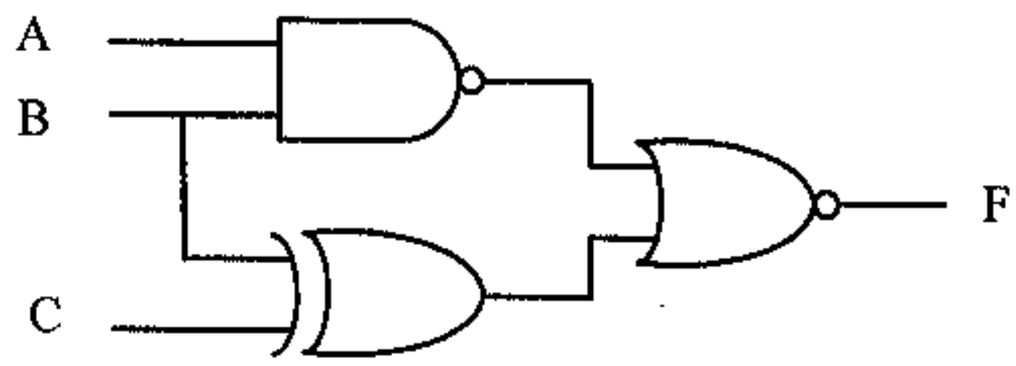



Fig. 40

## 熱力學

41. In reversible, adiabatic expansion of an ideal gas

(A) $\Delta H > 0$ (B) $\Delta H < 0$ (C) $\Delta S > 0$ (D) $\Delta G > 0$ (E) $\Delta G < 0$

42. Pure solid metal is melted isothermally and isobarically at 1 atm, and at its equilibrium melting temperature. Which of the statement is right

(A) $\Delta H = 0$ (B) $\Delta H > 0$ (C) $\Delta S < 0$ (D) $\Delta G < 0$ (E) $\Delta G > 0$

43. For supercooled pure liquid metal frozen isothermally and isobarically at a temperature 25℃ below its equilibrium melting point, which of the statement is right?

(A) $\Delta H > 0$ (B) $\Delta H < 0$ (C) $\Delta S > 0$ (D) $\Delta G = 0$ (E) $\Delta G > 0$

44. A block of solid metal initially at 900℃ is quenched in cold water at constant P=1 atm. The change of entropy is (A) $\Delta S = 0$ (B) $\Delta S < 0$ (C) $\Delta S > 0$ (D) $\Delta S \geqq 0$ (E) Impossible to tell

45. An endothermic chemical reaction occurs spontaneously within an adiabatic, isobaric system. The change of Gibbs free energy is

(A) $\Delta G > 0$ (B) $\Delta G < 0$ (C) $\Delta G = 0$ (D) $\Delta G \leqq 0$ (E) Impossible to tell

46. A 10 at.% solution of carbon in iron at 1560℃ has an activity of 0.178 referred to the graphite standard state. The activity coefficient referred to graphite standard state is

(A) 0.178 (B) 1 (C) 37.8 (D) 0.568 (E) 1.78

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47. Consider a simplified Pb-O-C system with the following possible solid phase: Pb, $PbCO_3$, PbO, $Pb_3O_2CO_3$ and a gas phase containing CO and $CO_2$ at 400 K, the degree of freedom for an area (one solid + gas) in the phase stability is (A) 1 (B) 0 (C) 4 (D) 3 (E) 2

48. For Au: $C_p = 23.7 + 5.19 \times 10^{-3}$ T J/ mole.K, $\alpha = 4.26 \times 10^{-5}$ /K, $\rho = 19.3$ g/cm$^3$, M.W. = 197. For an initial state of T = 298K, p = 1 atm, the pressure you have to apply to gold at constant temperature in order to increase its molar enthalpy by 1 J is
(A) ≈400 atm (B) ≈2000 atm (C) $1.98 \times 10^5$ atm (D) 198 atm (E) 1.98 atm

49. Use the same parameters in Prob. #48, to what temperature would you have to heat gold at constant pressure in order to raise its molar enthalpy by 1 J
(A) ≈1724K (B) ≈1035K (C) 273K (D) 297.21K (E) 298.04K

50. Same as Prob.#49, what pressure would you have to apply to Au at 298K in order to decrease its molar entropy by 1 J/K?
(A) 1 atm (B) 10 atm (C) 106 atm (D) 213 atm (E) 22715 atm

## 物理冶金

51. 高強度低合金鋼(high-strength low-alloy steel)的相界析出(interphase precipitation)現象，主要是來自
(A)fcc 鐵的碳溶解量隨溫度降低而下降 (B)fcc 鐵的碳溶解量比 bcc 鐵來得小(C)fcc 鐵的碳溶解量比 bcc 鐵來得大 (D)bcc 鐵的碳溶解量隨溫度降低而下降
(E)以上皆非

52. 鋅與鎂晶體都是 hcp 結構，但鋅受拉伸時，易產生變形雙晶化(deformation twinning)；而鎂則是受壓縮時容易產生，其原因是
(A)hcp 鋅晶體的 c/a 比值較大 (B)hcp 鋅晶體的 c/a 比值較小
(C)鋅晶體較耐拉伸 (D)鋅晶體較耐壓縮 (E)鎂晶體較耐拉伸

53. 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)應變促進相變化 (D)剪移應變 (E)硬度變大

54. 下列哪一特性是屬於變韌鐵(bainite)相變化與波來鐵(pearlite)相變化所共有
(A)針狀外形 (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) 以上皆非

55. 三種合金的強度與比重分別是 A:572MPa, 2.8；T:900MPa, 4.5；S:1400MPa, 8.0。則三者之比強度(specific strength)大小爲
(A)A>T>S (B)A>S>T (C)T>A>S (D) T>S>A (E)S>T>A

56. 下列疲勞(fatigue)斷裂面特徵中，哪一項不是由往復應力所造成？
(A)磨亮(polished)區 (B)粒狀(granular)區 (C)蛤殼(clamshell)痕跡
(D)擠出與擠入(extrusion and intrusion) (E)永存滑移帶(persistent slip bands)

57. 哪一因素不一定能使鋼料的疲勞(fatigue)性質變好？
(A)減少非金屬介在物(inclusion) (B)增加試片表面的光滑度 (C)表面殘留壓縮應力 (D)得到最多的麻田鐵(martensite)再回火(tempering) (E)增加強度

單選題，以 2B 鉛筆劃在答案卡上；答對一題得 1 分，答錯一題倒扣 0.25 分，未答不計分。

58. 以精緻拉伸試樣(compact tensile specimen)測量斷裂韌性(fracture toughness)，得到負荷隨裂口拉開位移(crack opening displacement)而變情形，先直線上升到 500N，之後開始彎曲，到 580N 突然下降，再達到 560N 的最低點，然後再彎曲上升，到 650N 達最高點，而後便一直下降；若以初期直線斜率的 95%畫另一直線，發覺交於 580N 到 560N 這段曲線間。則應以哪一負荷代入斷裂韌性的計算公式中？

(A)500N (B)560N (C)570N (D)580N (E)650N

59. 疲勞裂隙成長速率(log da/dN)，隨應力強度因子增量(stress-intensity factor increment, log ΔK)的增加而變情形一般爲

(A)先較小斜率，變成較大固定斜率一段範圍，再變成較小斜率
(B)先較小斜率，變成較大固定斜率一段範圍，再變成更大斜率
(C)先較大斜率，變成較小固定斜率一段範圍，再變成更小斜率
(D)先較大斜率，變成較小固定斜率一段範圍，再變成較大斜率
(E)不一定

60. 在純鋁單晶，{111}<1$\bar{1}$0>單一滑動(simple glide)的潛變(creep)活化能隨溫度而變情形，發現在 0-400 K 爲 14.2 kJ；650-750 K 爲 117 kJ；800-900 K 爲 149 kJ。則三種活化能對應的潛變機制最可能是

(A)低溫是差排交叉滑移(cross-slip)；中溫是差排交錯(intersection)；高溫是差排爬升(climb)
(B)低溫是差排交叉滑移；中溫是差排爬升；高溫是差排交錯
(C)低溫是差排爬升；中溫是差排交叉滑移；高溫是差排交錯
(D)低溫是差排交錯；中溫是差排爬升；高溫是差排交叉滑移
(E)低溫是差排交錯；中溫是差排交叉滑移；高溫是差排爬升

## 近代物理

61 Which statement is **NOT** correct? (A)Phonons obey Bose-Einstein distribution (B) free electrons in a metal obey Fermi-Dirac distribution (C) Molecules of a gas obey Maxwell-Boltzmann distribution (D)Photons obey Fermi-Dirac distribution (E) liquid helium at low temperature obey Bose-Einstein distribution

62 Which statement is **NOT** correct for the specific heat at constant volume?
(A) $C_v$=3R for Pb at room temperature (B) $C_v$<3R for diamond at room temperature (C) electrons in metal contribute significantly to $C_v$ at room temperature (D) At low temperatures, $C_v$ decreases with decreasing temperature. (E) Einstein's formula of specific heat approaches 3R when $h\nu >> kT$.

63 What is the average electron energy at T=0K in metals? (A)0.3 $\varepsilon_f$ (B) 0.5 $\varepsilon_f$ (C)0.6 $\varepsilon_f$ (D) 0.8 $\varepsilon_f$ (E) $\varepsilon_f$ ($\varepsilon_f$ is the Fermi energy)

64 Which metal has the highest Fermi energy? (A) Li (B) Na (C) K (D) Al (E) Cs

65 The structure of a tunneling junction is metal/insulator/metal. Which statement is correct for the tunneling current I ? (A) I increases with increasing the barrier height of insulator. (B) I only depends on the resistivity of metals. (C) I increases with increasing the thickness of metals. (D) I decreases with the thickness of metal. (E) I decreases with increasing the thickness of insulator.

66 What is the relationship between the electron energy E and its density of state Z(E)? Z(E) is proportional to (A) $E^{1/2}$ (B) E (C) $E^{-1}$ (D) $E^2$ (E) $E^{-2}$.

單選題，以 2B 鉛筆劃在答案卡上；答對一題得 1 分，答錯一題倒扣 0.25 分，未答不計分。

67 Consider a system with Fermi energy $E_F$. For what temperature is the number of electrons at 0.5 $E_F$ equal to 90% of the zero-temperature number at 0.5 $E_F$? (hint: ln(0.11) = –2.2, k: Boltzmann constant)
(A) 0.46 $E_F$ /k (B) 0.23 $E_F$ /k (C) 2 $E_F$ /k (D) 5 $E_F$ /k (E) $E_F$ /k

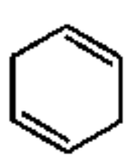
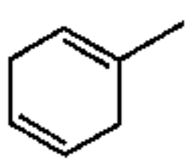
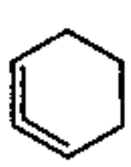
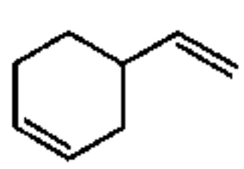
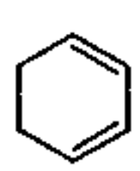
68 When a particle is confined in a 1-D box with the dimension L, what is the expected value of the momentum. (A) $8L^2$ (B)4L (C) $9\ L^3$ (D) 0 (E) 27L

69 The resistivity of Cu is $1.72\times10^{-8}$. Estimate the mean free path *l* between collisions of the free electrons in Cu. (the free electron density in Cu = $8.48\times10^{28}\ m^{-3}$, and the Fermi velocity is $1.57\times10^6$ m/s, electron mass = $9.11\times10^{-31}$ kg and its charge = $1.6\times10^{-19}$ C) (A)38 nm (B) 380nm (C) 3nm (D)3000nm (E) 0.38 nm

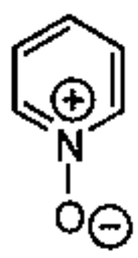
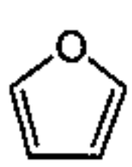
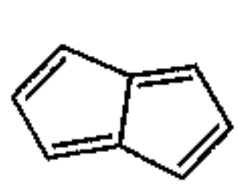
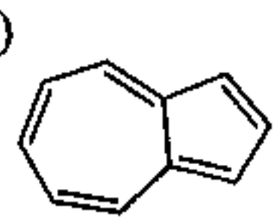
70 The boundary of the first Brillouin zone of a two-dimensional square lattice with dimension a occurs at k =
(A) π/3a (B) π/2a (C) π/a (D) π/4a (E) π

## 有機化學

71. Which of the following compounds is the most stable diene?

a)  b)  c)  d)  e) 

72. Which of the following is not an aromatic compound?

a)  b)  c)  d)  e) 

73. Which of the following is the best method for preparing $CH_3Br$?
(A) $CH_3OH + HBr$ (B) $CH_3OH + NaBr$ (C) $CH_3OH + Br_2$ (D) $CH_3OH + Br^-$ (E) $CH_3OH + Br^+$

74. Absorption of UV-visible energy by a molecule results in:
(A) vibrational transitions (B) electronic transitions (C) rotational transitions
(D) electron spin transitions (E) nuclear spin transitions

75. What m/z value would you predict for the most stable fragment peak in the mass spectrum of 4-ethylheptane? (A) 128 (B) 127 (C) 113 (D) 99 (E) 85

76. Which of the following compounds gives the highest chemical shift in the $^1H$ NMR spectrum?

a)  b)  c) $(CH_3)_3N$ d) $(CH_3)_4C$ e) $(CH_3)_4Si$

77. Which is the best method for carrying out the following reaction?




(A) $^+COOH$; then $HNO_3/H_2SO_4$
(B) $CH_3Cl/AlCl_3$; then $HNO_3/H_2SO_4$; then $KMnO_4/H^+$, heat
(C) $CH_3Cl/AlCl_3$; then $KMnO_4/H^+$, heat; then $HNO_3/H_2SO_4$

單選題，以 2B 鉛筆劃在答案卡上；答對一題得 1 分，答錯一題倒扣 0.25 分，未答不計分。

(D) $HNO_3/H_2SO_4$; then $CH_3Cl/AlCl_3$; then $KMnO_4/H^+$, heat

(E) $CO/AlCl_3$; then NaOH, heat; then $HNO_3/H_2SO_4$

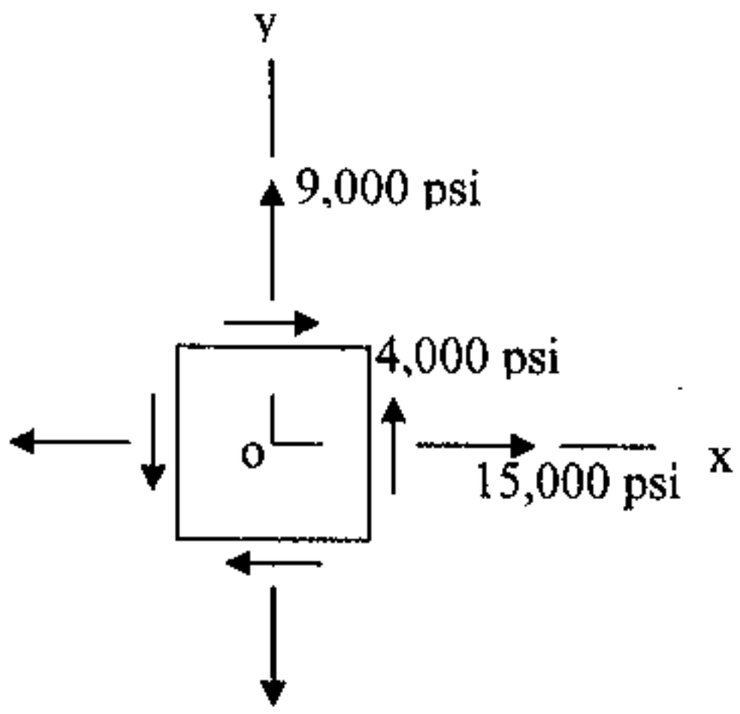
78. Which of the following monomers is least likely to undergo cationic polymerization?
(A) Propylene (B) Isobutylene (C) Styrene (D) Vinyl acetate (E) Methyl acrylate

79. When (R)-2-butanol is treated with toluenesulfonyl chloride in pyridine, the product will be
(A) an achiral compound (B) a mixture of diastereomers (C) a racemic mixture
(D) a single enantiomer (E) an epimer

80. When dipentyl ether is treated with excess HI, through what type of mechanism does the major product result? (A) $S_N1$ (B) $S_N2$ (C) $S_Ni$ (D) E1 (E) E2

## 工程力學

An element in plane stress at the surface of a large machine is subjected to stresses $\sigma_x$ = 15,000 psi, $\sigma_y$ = 9,000 psi, $\tau_{xy}$ = 4,000 psi. Using Mohr's circle to solve the problem. The Mohr's circle is defined as $\tau_{x1y1}$ is positive downward and the angle 2θ is positive counterclockwise. (81-83)

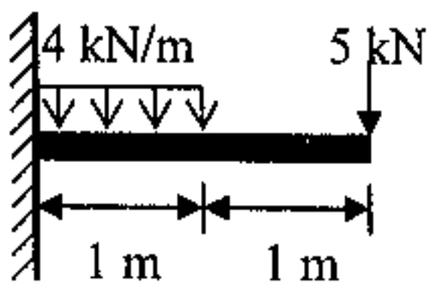



81. The coordinate of center of Mohr's circle is (A) (0 psi, 12,000 psi), (B) (12,000 psi, 0 psi),
(C) (12,000 psi, 4,000 psi), (D) (6,000 psi, 4,000 psi), (E) (3,000 psi, 4,000 psi),

82. The radius of the circle is (A) 3,000 psi, (B) 4,000 psi, (C) 5,000 psi, (D) 6,000 psi, (E) 9,000 psi.

83. The maximum normal stress in the element is (A) 14,000 psi, (B)15,000 psi, (C) 16,000 psi,
(D) 17,000 psi, (E) 18,000 psi,

A cantilever beam is subjected to a distributed load and a concentrated load, as shown in the figure. (84-85)




84. The maximum shear-force in the beam is (A) 4 kN, (B) 9 kN, (C) 14 kN, (D) 19 kN, (E) 24 kN

85. The maximum bending-moment in the beam is (A) 9 kN-m, counterclockwise, (B) 10 kN-m,
counterclockwise, (C) 10 kN-m, clockwise, (D) 12 kN-m, counterclockwise, (E) 12 kN-m, clockwise

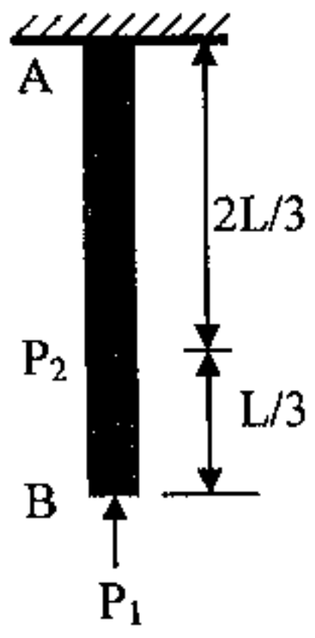
單選題，以 2B 鉛筆劃在答案卡上；答對一題得 1 分，答錯一題倒扣 0.25 分，未答不計分。

A prismatic bar AB, fixed at one end and free at the other. The bar with the length of L, shear modulus of elasticity G, and radius of r, is subjected to pure torsion under the action of a torque 2T. When the load is applied statically, the bar twists and the free end rotates through an angle $\phi$. (86-87)

86. The strain energy of the bar is (A) $4T^2L/(G\pi r^4)$, (B) $2T^2L/(G\pi r^4)$, (C) $T^2L/(G\pi r^4)$, (D) $2T^2L^2/(G\pi r^4)$, (E) $4T^2L^2/(G\pi r^4)$

87. The angle of twist is (A) $4TL/(G\pi r^4)$, (B) $2TL/(G\pi r^4)$, (C) $TL/(G\pi r^4)$, (D) $TL/(G\pi r^3)$, (E) $4TL/(G\pi r^2)$

A prismatic bar of length L and cross-sectional area A supports two concentrated loads $P_1$ and $P_2$, as shown in the figure. The material of the bar is a homogeneous material with isotropic property. (88-89)




88. The displacement $\delta_B$ of the lower end of the bar under the load $P_2$ alone is (A) $2P_2L/(EA)$, (B) $P_2L/(3EA)$, (C) $3P_2L/(2EA)$, (D) $P_2L/(EA)$, (E) $2P_2L/(3EA)$

89. In order to maintain its original length, what the relationship between $P_1$ and $P_2$
(A) $2P_1 = P_2$, (B) $P_1 = 2P_2$, (C) $P_1 = 3P_2$, (D) $3P_1 = P_2$, (E) $P_1 = P_2$

90. Which statement listed in the following is wrong for a homogeneous and isotropic material
(A) allowable stress is yield strength divided by factor of safety,
(B) factor of safety is defined as actual strength divided by required strength,
(C) no thermal stresses will develop when the temperature change is uniform throughout the structure,
(D) in order to have uniform tension or compression in a prismatic bar, the axial force must act through the centroid of the cross-sectional area,
(E) Poisson's ratio is defined as the ratio of lateral strain to the axial strain and it is always positive.