九十一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。

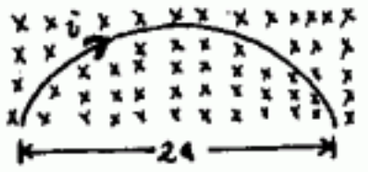
普通物理

1. 二同心金屬球殼，內外球半徑分別爲 a 及 $2a$，若 k 爲庫倫定律比例常數，內外球上各帶有電量 Q 及 $-Q$，則二球殼之間電場中之靜電位能爲(A) $\frac{kQ^2}{4a}$ (B) $\frac{kQ^2}{2a}$ (C) $\frac{3kQ^2}{4a}$ (D) $\frac{kQ^2}{a}$ (E) $\frac{2kQ^2}{a}$。

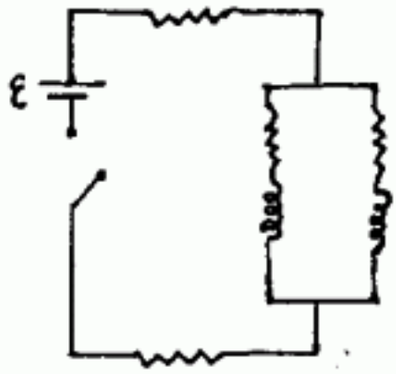
2. 一電偶極位於原點，此電偶極之兩點電荷相距 d，在遠方離電偶極中心 r 處一點(r>>d) 之電位與 r 的幾次方成反比? (A) 1(B)3/2 (C)2 (D)5/2 (E)3。

3. 一電池之電動勢爲 ε，內電阻爲 r，今將此電池串聯一外電阻 R 後接通，則在下列之 R 值中，何者會使電阻 R 消耗之熱功率爲極大? (A) R=$\frac{r}{2}$ (B) R=r (C) R=$\frac{3}{2}$r (D) R=2r (E) R=$\frac{5}{2}$r。

4. 一帶有電流之導體被彎成半個橢圓的形狀，設此橢圓的半長軸爲 a，半短軸爲 b；若此導線被放入垂直於橢圓面的均勻磁場 B 中(如附圖所示)，則此段導線所受之磁力量值爲(A) 2iaB (B) 2ibB (C) i(a+b)B (D) 2i(a-b)B (E)0。

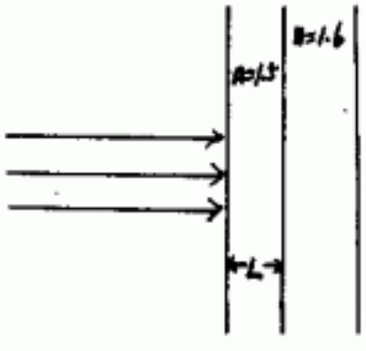


5. 在附圖所示之電路中，每一電阻之值均爲 R，每一電感之值均爲 L，當按下開關，接通電路經很長的時間 t，(t>>$\frac{L}{R}$)，則流過電池的電流趨近於(A)0 (B) $\frac{2\varepsilon}{5R}$ (C) $\frac{\varepsilon}{2R}$ (D) $\frac{\varepsilon}{3R}$ (E) $\frac{\varepsilon}{4R}$。



6. 在單狹縫繞射圖紋中，中央主極大之旁第 1 個極大的強度 I_1 與第 4 個極大強度 I_4 之比約爲(A)6.0 (B)7.5 (C)9.0(D)10 (E)12。

7. 有兩層薄膜其折射率分別爲 1.5 及 1.6，其中折射率爲 1.5 之薄膜其厚度 L 爲 200nm；今以光線自空氣中正射二薄膜(如附圖所示)，則在反射光中能被肉眼看到之最強光波長爲(A) 450nm (B) 500nm (C) 550nm (D) 600nm(E) 650nm。



8. 以波長爲 600 及 610nm 的光照射刻線間距爲 2080nm 的繞射光柵，其第 3 階極大之偏向角約爲 60°，此二波長之光偏向角之差 Δθ 約爲(A)0.55 (B)1.05 (C)1.65 (D)2.30 (E)2.85 度。

9. 動能皆爲 1kev 的電子與質子，其物質波波長 λ_e 及 λ_p 的比值(λ_e/λ_p)約爲(A)18 (B)35 (C)43 (D)52 (E)65。

10. 在寬度爲 L 的無限深位阱中，若一質點處於基態，則其波函數可寫爲 $\psi(x)=\sqrt{\frac{2}{L}}\sin\frac{\pi x}{L}$。在 x=0 到 x=$\frac{L}{4}$ 之間找到此質點之機率約爲(A)0.08 (B)0.09 (C)0.10 (D)0.11 (E)0.12。

普通化學

11 Which of the following is a molecular solid?

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。

12 Which of the following molecules exhibits the largest dipole moment?
(A) HF (B) KF (C) HBr (D) LiF (E) HCl.

13 Which of the following is the strongest double bond?
(A) C=C (B) C=N (C) C=O (D) N=O (E) O=O.

14 According to the periodic table, when element 118 is made (or discovered), this element will be (A) a noble gas (B) an alkali metal (C) similar in atomic structure to fluorine (D) inert (E) none of the above.

15 How many electron pairs surround the Xe atom in xenon tetrafluoride (A) six (B) four (C) two (D) one (E) none.

16 How many valence electrons are in the NO_3^- group?(A) 18 (B) 20 (C) 22 (D) 24 (E) 25.

17 What two monomers have been co-polymerized to make an excellent synthetic rubber? (A) styrene and ethylene (B) styrene and butadiene (C) ethylene and butadiene (D) ethylene and vinyl chloride (E) vinyl chloride and styrene.

18 What is the most basic medium? (A) milk of magnesia (B) milk (C) bleach (D) blood (E) vinegar.

19 What is the ultimate radioactive decay product of the uranium-238 series?
(A) radon gas (B) lead (C) uranium-235 (D) alpha particles (E) neutron.

20 What is the compound nucleus produced when beryllium-9 reacts with helium-4? (A) oxygen-17 (B) nitrogen-15 (C) carbon-14 (D) carbon-13 (E) carbon-12

工程數學

21 A vector field $\mathbf{V}(x,y,z) = xyz\,\hat{\mathbf{i}} - 2y^2\,\hat{\mathbf{k}}$, then curl $\mathbf{V}$ is equal to (A) $-4y\hat{\mathbf{i}} + xy\hat{\mathbf{j}} + xz\hat{\mathbf{k}}$
(B) $4y\hat{\mathbf{i}} + xy\hat{\mathbf{j}} - xz\hat{\mathbf{k}}$ (C) $-4y\hat{\mathbf{i}} + xy\hat{\mathbf{j}} - xz\hat{\mathbf{k}}$ (D) $4y\hat{\mathbf{i}} - xy\hat{\mathbf{j}} + xz\hat{\mathbf{k}}$ (E) $-4y\hat{\mathbf{i}} - xy\hat{\mathbf{j}} + xz\hat{\mathbf{k}}$.

22 If Φ is a scalar field and $\mathbf{A}, \mathbf{B}$ are vector fields, which of the following equations is INCORRECT?
(A) $\nabla\cdot(\Phi\mathbf{A}) = \nabla\Phi\cdot\mathbf{A} + \Phi\nabla\cdot\mathbf{A}$ (B) $\nabla\times(\Phi\mathbf{A}) = \nabla\Phi\times\mathbf{A} + \Phi\nabla\times\mathbf{A}$ (C) $\nabla\cdot(\nabla\times\mathbf{A}) = 0$
(D) $\nabla\times(\nabla\times\mathbf{A}) = \nabla(\nabla\cdot\mathbf{A}) - \nabla^2\mathbf{A}$ (E) none of the above.

23 The polar coordinates (r, θ) and the Cartesian coordinates (x, y) are related by $x = r\cos\theta$, and $y = r\sin\theta$.
The integral $\int_0^\infty e^{-x^2}dx$ is equal to (A) $\int_0^{2\pi}\int_0^\infty e^{-r^2}rdrd\theta$ (B) $\frac{1}{2}\int_0^{2\pi}\int_0^\infty e^{-r^2}rdrd\theta$
(C) $\{\int_0^{2\pi}\int_0^\infty e^{-r^2}rdrd\theta\}^{1/2}$ (D) $\{\frac{1}{2}\int_0^{2\pi}\int_0^\infty e^{-r^2}rdrd\theta\}^{1/2}$ (E) $\frac{1}{2}\{\int_0^{2\pi}\int_0^\infty e^{-r^2}rdrd\theta\}^{1/2}$.

24 The Fourier transform of $f(x)$ is defined by $F\{f(x)\} = \int_{-\infty}^{\infty} f(x)e^{-i\omega x}dx$. If $f^{(n)}(x)$ is the nth 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.

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25 Following the above problem, $F\{e^{-x^2}\}$ is equal to

(A) $\sqrt{\pi}e^{-\omega^2}$ (B) $\sqrt{\pi}e^{-\omega^2/2}$ (C) $\sqrt{\pi}e^{-\omega^2/4}$ (D) $\sqrt{\pi}e^{-2\omega^2}$ (E) $\sqrt{\pi}e^{-4\omega^2}$.

26 Consider the diffusion equation $\alpha^2 u_{xx} = u_t, u(0,t) = u(L,t) = 0, u(x,0) = f(x)$ for $0 \le x \le L, 0 \le t$. By the method of separation of variables, we have $u(x,t) = X(x)T(t)$ and $\frac{X''}{X} = \frac{T'}{\alpha^2 T} = \text{constant} = -\kappa^2$, $\kappa > 0$. If $n = 1,2,3\ldots$, κ is equal to (A) $\frac{n\pi}{L}$ (B) $\frac{n\pi}{2L}$ (C) $\frac{2n\pi}{L}$ (D) $\frac{(2n-1)\pi}{2L}$ (E) $\frac{(2n-1)\pi}{L}$.

27 Following the above problem, *u(x,t)* is the superposition of the possible *X(x)T(t)* and has the form $u(x,t) = \sum_{n=1}^{\infty} A_n X_n(x) T_n(t)$. Then $X_n(x)$ is equal to (A) $\sin\frac{n\pi}{L}x$ (B) $\cos\frac{n\pi}{2L}x$ (C) $\sin\frac{2n\pi}{L}x$ (D) $\cos\frac{(2n-1)\pi}{2L}x$ (E) $\sin\frac{(2n-1)\pi}{L}x$.

28 $(1+i)^5$ is equal to (A) $2^{5/2}(1-i)$ (B) $2^{5/2}(1+i)$ (C) $-2^{5/2}(1-i)$ (D) $-2^{5/2}(1+i)$ (E) none of the above.

29 Let $f(z) = M(x,y) + i\,N(x,y)$ be a complex function, and *M* and *N* are the real and imaginary parts. If f is differentiable, df/dz is equal to (A) $\frac{\partial N}{\partial x} - i\frac{\partial N}{\partial y}$ (B) $\frac{\partial N}{\partial y} - i\frac{\partial N}{\partial x}$ (C) $\frac{\partial M}{\partial y} - i\frac{\partial M}{\partial x}$ (D) $\frac{\partial M}{\partial x} - i\frac{\partial M}{\partial y}$ (E) $\frac{\partial M}{\partial x} - i\frac{\partial N}{\partial y}$.

30 On the complex *z* plane, let *C* be a closed circle centered at *z* = 1 with a radius of 2 and oriented counterclockwise. Then $\oint \frac{dz}{z^2 - 2}$ is equal to (A) 0 (B) $\frac{\pi}{\sqrt{2}}i$ (C) πi (D) $-\frac{\pi}{\sqrt{2}}i$ (E) $-\pi i$.

應用電子學

31 The transistor shown in Fig. 31 has $\beta = 300$. Find the value of collector current.
(A) 21.45 mA (B) 14.8 mA (C) 14.3 mA (D) 7.15 mA (E) 9 mA.

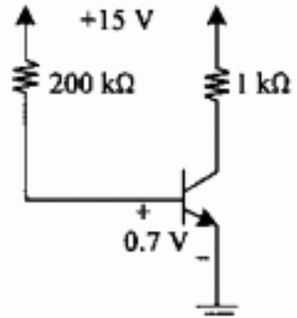

Figure 31

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。

32 Find the labeled node voltage V_7 in the circuit of Fig. 32.
(A) 2.45 V (B) –2.45 V (C) –2.14 V (D) 2.14 V (E) 5 V.

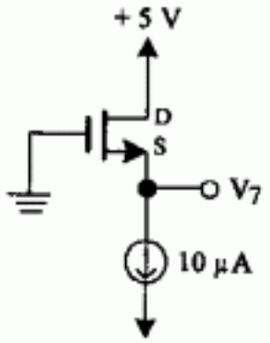

Fig. 32

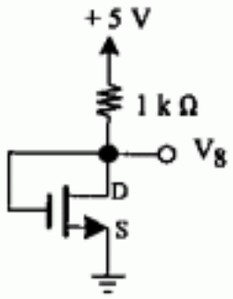

Fig. 33

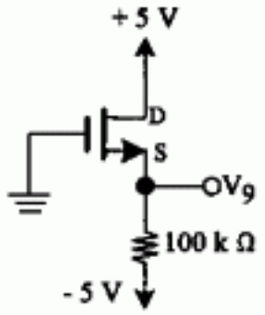

Fig. 34

Note: All *n*-MOSFETs in the circuits of Figs. 32-34 are identical and have $V_{th} = 2$ V and $k = 0.5$ mA/V^2.

33 Find the labeled node voltage V_8 in the circuit of Fig. 33.
(A) 3 V (B) 2 V (C) 5 V (D) 3.65 V (E) –1.65 V.

34 Find the labeled node voltage V_9 in the circuit of Fig. 34.
(A) –2.24 V (B) –1.74 V (C) –5 V (D) 5 V (E) 0 V.

35 An amplifier has an input resistance of 100 Ω, an output resistance of 5 Ω, and a short-circuit current gain of 500. What is its open-circuit voltage gain? (A) 500 (B) 10000 (C) 25 (D) 5 (E) 100.

36 Two amplifiers with the following characteristics are cascaded in the order of 2, 1.
Amplifier 1: $A_{vo1} = 12$, $R_{i1} = 1$ kΩ, $R_{o1} = 100$ Ω; Amplifier 2: $A_{vo2} = 20$, $R_{i2} = 2$ kΩ, $R_{o2} = 200$ Ω
Find the open-circuit voltage gain of the overall cascaded connection.
(A) 240 (B) 32 (C) 229 (D) 160 (E) 200.

37 Find the voltage and current labeled in the circuit of Fig. 37, assuming an ideal op-amp.
(A) 10 V, 9 mA (B) –10 V, -11 mA (C) 10 V, 0 mA (D) –10 V, 0 mA (E) 0.083 V, 0 mA.

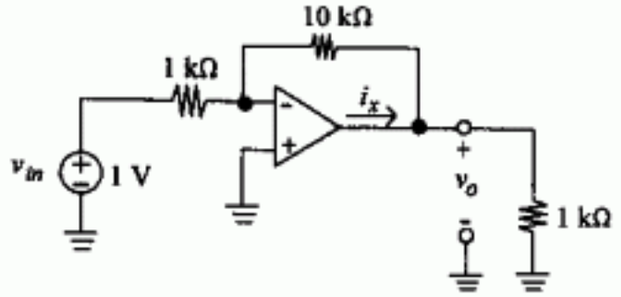

Fig. 37

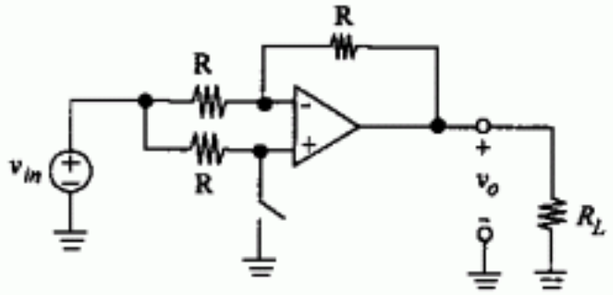

Fig. 38

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。

38 Find the voltage gain $A_v = v_o/v_{in}$ and input impedance of the circuit shown in Fig. 38 with the switch open.
(A)$A_v = 1, R_{in} = \infty$ (B) $A_v = -1, R_{in} = 0$ (C) $A_v = 1, R_{in} = R$ (D) $A_v = -1, R_{in} = R/2$ (E) $A_v = 1, R_{in} = 0$.

39 Find the voltage gain $A_v = v_o/v_{in}$ and input impedance of the circuit shown in Fig. 38 with the switch closed.
(A) $A_v = 1, R_{in} = \infty$ (B) $A_v = -1, R_{in} = 0$ (C) $A_v = 1, R_{in} = R$ (D) $A_v = -1, R_{in} = R/2$ (E) $A_v = 1, R_{in} = 0$.

40 Given a logic function $F = (\overline{A} + \overline{B} + C)(A + B + \overline{C})(A + \overline{B} + C)$ determine its minimum Sum of Product (SOP) expression.
(A) $A + \overline{A}B$ (B) $A + B + C$ (C) $B\overline{C} + \overline{A}\overline{B}C$ (D) $\overline{B}\overline{C} + BC + AC$ (E) $\overline{A} + B + C$.

熱力學

41 About non-ideal solutions: (A) The thermodynamic behavior of non-ideal solutions is dealt with by introducing the activity coefficient, γ, which for the component i is defined as $\gamma_i = a_i / X_i$, (B) The coefficient γ_i can have values of greater or less than unity, (C) If $d\gamma_i / dT$ is positive, $\Delta\overline{H_i}$ is negative and vice versa, (D) The above items are all correct, (E) Only two items listed above are correct.

42 About ideal gas: (A) An ideal gas is an assemblage of volumeless noninteracting particles which obeys the ideal gas law, PV = RT. (B) The internal energy of an ideal gas arises solely from the translational motions of the gas particles and hence is a function only of temperature, (C) The enthalpy of an ideal gas is a function only of temperature, (D) The internal energy U is constant with respect to the gas volume, i.e. $(dU/dV) = 0$, hence the pressure P can be expressed as $P = (dS/dV)$, (E) The above are all correct.

43 Which is the correct statement of the Gibbs' phase rule, with f, ϕ, r being respectively the degree of freedom of the system, the number of the phases, and the number of the components presented in the system: (A) At all conditions, $f = \phi - r - 2$, (B) At constant pressure, $f = \phi - r - 2$, (C) At constant temperature, $f = \phi - r - 1$, (D) At constant pressure, $f = r\phi - 2$, (E) At constant temperature, $f = r - \phi - 2$.

44 The Gibbs-Duhem relation is : (A) $\sum_i X_i d\overline{Q_i} = 0$ at constant temperature and pressure where $\overline{Q_i}$ is the partial molar value of the extensive thermodynamic function Q of the solution component i, (B) $\sum_i X_i d\overline{Q_i} = 0$ at constant temperature and composition where $\overline{Q_i}$ is the partial molar value of the extensive thermodynamic function Q of the solution component i, (C) Equally, we have $G^{ex} = RT\sum X_i \ln\gamma_i$, (D) $\sum_i X_i d\overline{Q_i} = 0$ at constant temperature and pressure for an ideal solution where $\overline{Q_i}$ is the partial molar value of the extensive thermodynamic function Q of the solution component i, (E) More than one items listed above are correct.

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45 For a solid solution, the critical temperature of the miscibility gap T_c is (A) $T_C = \Omega/2R$, (B) where the first order derivative of the free energy of mixing equal to zero, (C) where the second order derivative of the free energy of mixing equal to zero, (D) where the third order derivative of the free energy of mixing equal to zero. (E) A through D are correct.

46 The Clapeyron equation is a thermodynamic conclusion about (A) the effect of pressure on a second order transition temperature, (B) the effect of temperature on a first order ductile-brittle transition, (C) the effect of applied field on the paramagnetic-ferromagnetic transition temperature, (D) the effect of pressure on the first order transition temperature including the superconduction transition. (E) None are correct.

47 For an endothermic reaction, (A) the volume change ΔV is negative, (B) The magnitude of the volume change correlates well with the scale of the enthalpy change ΔH, (C) The entropy change should be positive, (D) The resulted product are more thermally stable, (E) The above are all correct.

48 In a binary system A-B which forms ideal liquid solutions, the liquidus line is given by

(A) $X_{A(l)} = \dfrac{[1-\exp(-\Delta G^0_{m(B)}/RT)]\exp(-\Delta G^0_{m(A)}/RT)}{\exp(-\Delta G^0_{m(A)}/RT)-\exp(-\Delta G^0_{m(B)}/RT)}$,

(B) $X_{A(l)} = \dfrac{\exp(-\Delta G^0_{m(B)}/RT)}{\exp(-\Delta G^0_{m(A)}/RT)-\exp(-\Delta G^0_{m(B)}/RT)}$,

(C) $X_{A(l)} = \dfrac{1-\exp(-\Delta G^0_{m(B)}/RT)}{\exp(-\Delta G^0_{m(A)}/RT)-\exp(-\Delta G^0_{m(B)}/RT)}$,

(D) $X_{A(l)} = \dfrac{1-\exp(-\Delta G^0_{m(A)}/RT)}{\exp(-\Delta G^0_{m(A)}/RT)-\exp(-\Delta G^0_{m(B)}/RT)}$,

(E) None are correct.

49 In a binary system A-B which forms ideal solid solution, the solidus is given by

(A) $X_{A(S)} = \dfrac{1-\exp(-\Delta G^0_{m(B)}/RT)}{\exp[-(\Delta G^0_{m(A)}-\Delta G^0_{m(B)})/RT]}$,

(B) $X_{A(S)} = \dfrac{\exp(-\Delta G^0_{m(B)}/RT)}{\exp(-\Delta G^0_{m(A)}/RT)-\exp(-\Delta G^0_{m(B)}/RT)}$,

(C) $X_{A(S)} = \dfrac{1-\exp(-\Delta G^0_{m(B)}/RT)}{\exp(-\Delta G^0_{m(A)}/RT)-\exp(-\Delta G^0_{m(B)}/RT)}$,

(D) $X_{A(S)} = \dfrac{1-\exp(-\Delta G^0_{m(A)}/RT)}{\exp(-\Delta G^0_{m(A)}/RT)-\exp(-\Delta G^0_{m(B)}/RT)}$,

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50 Ellingham Diagram: (A) 所謂 Ellingham Diagram 是化學反應之ΔG 和平衡 P_{O2} 對溫度之數據圖, (B) 利用 Ellingham diagram 可得氧化物和氮化物的ΔG_0和平衡之 P_{O2}, (C) 在 Ellingham 圖中,上方曲線的氧化反應之反應物可以還原其下方曲線之反應的生成物, (D)在 Ellingham diagram 中,所有的反應曲線都幾乎平行, (E)以上皆對.

物理冶金

51 金屬熔湯之冷卻在何階段放出最多氣體？（A）液相冷卻階段（B）液相變態爲固相階段（C）固相冷卻階段（D）脫模階段（E）以上皆非。

52 第二相(second phase)由基地(matrix)析出時，若與基地不整合(incoherent)且應變很大，則傾向以何種形狀析出？（A）圓片狀(disc)（B）球狀(sphere)（C）棒狀(rod)（D）針狀(needle)（E）立方體狀(cuboid)。

53 Al-4wt%Cu 合金經固溶處理(solution treatment)後在 100℃時效(aging)，其初期的析出物應爲（A）θ（B）θ'（C）θ''（D）GP zone（E）α。

54 擴散型相變態的相變化量與時間的關係曲線應成（A）C 曲線（B）倒 C 曲線（C）S 曲線（D）wave 曲線（E）parabolic 曲線。

55 在高溫下的析出反應，其析出物主要分佈於（A）晶界（B）差排（C）基地（D）孔缺(vacancy)（E）疊差(stacking fault)。

56 過共析鋼(hypereutectoid steel)由奧斯田鐵相區作空氣冷卻，其微結構應爲（A）初析雪明碳鐵加波來鐵（B）初析肥粒鐵加波來鐵（C）波來鐵（D）變韌鐵（E）麻田散鐵。

57 Fe-0.78wt%C 普通碳鋼經 600℃等溫變態成波來鐵後水淬至冰水中，所得微結構應爲（A）波來鐵（B）變韌鐵（C）麻田散鐵（D）肥粒鐵（E）奧斯田鐵。

58 下列何項因素不利於鋼的淬火硬化深度：（A）奧斯田相的晶粒愈大（B）冷卻速率愈快（C）添加合金元素如 Cr、Mo（D）奧斯田化時間愈長（E）愈大的物件尺寸。

59 高速鋼(high-speed steel)能在高速切削下保持高硬度，是因爲（A）形成麻田鐵相（B）高度加工硬化（C）二次硬化現象（D）形成相間析出(interphase precipitation)（E）形成非晶質相。

60 何種相形成時具有擴散及剪移的雙重機制？（A）麻田鐵（B）奧斯田鐵（C）雪明碳鐵（D）變韌鐵（E）波來鐵。

近代物理

61 Stern and Gerlach 的實驗觀察到 (A)原子電子的能量是不連續的, (B)軌道角動量量子化, (C)電子具有量子化的自旋, (D)電子具有波動性, (E)以上皆非。

62 定義位能井：$V(x)=\begin{cases}-V_0, & 0\le x\le L\\ 0, & \text{elsewhere}\end{cases}$，如果 L 不變，但是把井變淺（即把正數 V_0 變小），則基態能量會 (A)降低, (B)升高, (C)不變, (D)要看 V_0 變得多小，因爲有可能基態根本就變得不存在了, (E)以上皆非。

63 He^+ 氦離子的電子從 $n=3$ 躍遷到 $n=1$ 態時，會放出多大能量（以 $13.6ev$ 作單位）的光子？
(A)$\frac{8}{9}$, (B)$\frac{16}{9}$, (C)$\frac{32}{9}$, (D)$\frac{8}{3}$, (E)以上皆非。

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。

64 在三維的金屬中，費米能量(Fermi energy)和電子密度 n 的幾次冪成正比？ (A)$\sqrt{n}$， (B)n， (C)$n^{3/2}$，(D)有關的應該是電子數目，不是密度， (E)以上皆非。

65 在 DeBroglie 的假說裡，粒子性（動量）和波性（波長）只是一體的兩面，那爲什麼大象在走路時，一點都不像波？ (A)波長太長， (B)波長太短， (C)如果你看對地方（例如肚子附近），波性其實很顯著， (D)DeBroglie 的假說不適用於大型哺乳類動物， (E)以上皆非。

66 如果要求簡諧位能 $\frac{1}{2}Kx^2$ 的 x 不能小於零（相當於在 $x=0$ 擺一個無窮高的位能障），電子質量用 m 表示，請問第一激發態的能量是 $\hbar\sqrt{\frac{K}{m}}$ 的幾倍？ (A)$\frac{3}{2}$， (B)$\frac{5}{2}$， (C)$\frac{7}{2}$， (D)$\frac{9}{2}$， (E)問題會變得很難解，答案沒那麼簡單。

67 兩個不可區分的波色子(Bosons)，需滿足 (A) Pauli exclusion principle， (B)總自旋仍應和電子一樣，分成 singlet 和 triplets 兩類， (C)如果自旋空間的波函數在粒子身份對調時變號，則空間波函數得是 antisymmetric， (D)空間波函數永遠是 symmetric， (E)以上皆非。

68 電子在垂直磁場的二維平面上運動時，從量子力學可以證明它的能階能量相當於 (A)二維的簡協運動， (B)一維的簡協運動， (C)有限位能井，而井的深度和磁場大小有關， (D)能階能量會和磁場大小成根號正比， (E)以上皆非。

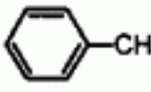
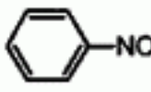
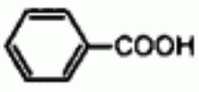
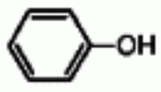
69 Aharonov-Bohm effect 描述的是 (A)由於 vector potential, $\hat{A}$,的取法有無窮多種，以前的人總認爲它不像磁場$\left(\vec{B}=\nabla\times\vec{A}\right)$，沒有真正的物理意義,這裡問的 AB effect 推翻這種想法 (B)推廣 Zeeman effect，把有 spin-orbit interaction 的情況也考慮進來， (C)該不會是和混沌有關吧？ (D)Bohm 和 Bohr 有點像，大概和原子的電子模型有點關係， (E)上面都在亂講。

70 如果位能只跟位置 $\vec{r}$ 的大小有關，則三維的波函數在球形座標下，可以利用變數分離法拆成徑向和兩個角度的部份，以氫原子電子爲例，最後波函數的標記會有 n,ℓ,m 三個（高中理化課本分別叫它們主、角動量和磁量子數），請問在當把 $\vec{r}$ 變成 $-\vec{r}$ 時，決定波函數會不會變號的是 (A)哪那麼簡單，在一般情況下，n,ℓ,m 三個都需要扯進來，才能知道， (B)n， (C)ℓ， (D)m， (E)以上皆非。

有機化學

71 When cyclopentadiene reactes with CH_2=CHCN which term below best describes the product mixture?
(A) two diastereomers (B) single compound (C) optically active (D) two enantiomers (E) meso compounds.

72 Which of the following compounds is the most reactive toward Br_2/NaOH?

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

73 Among the following dimethylcyclohexane derivatives which is the most stable isomer?
(A) *cis*-1,2-dimetyl (B) *cis*-1,3-dimethyl (C) *cis*-1,4-dimethyl (D) *trans*-1,2-dimethyl (E)

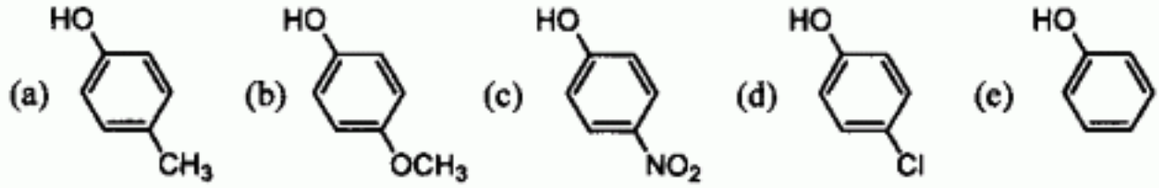
單選題，以 2B 鉛筆劃在答案卡上；答對一題得 1 分，答錯一題倒扣 0.25 分，未答不計分。

74 One compound has mass peak intensity ratio M^+:$M+2^+$:$M+4^+$=1:2:1 in its mass spectrum. This compound should contain (A) 1 Cl (B) 1Br (C) 1 I (D) 2 Cl (E) 2 Br.

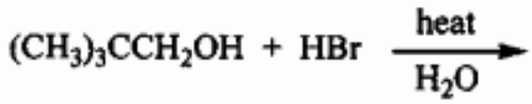
75 Which of the following chemical tests can be applied to distinguish primary, secondary, and tertiary alcohols? (A) Lucas test (B) Tollen's reagent (C) Iodoform test (D) permanganate test (E) Fehling's reagent.

76 Which of the following reagents is the best choice for the oxidation of a primary alcohol to an aldehyde? (A) $KMnO_4$ (B) H_2CrO_4 (C) Tollen's reagent (D) pyridinium chlorochromate (E) $FeCl_3$.

77 Which of the following compounds is the most acidic?



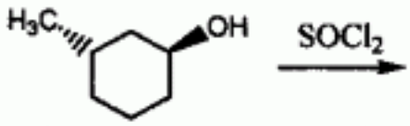
78 Which is the most unlikely product for the following reaction?

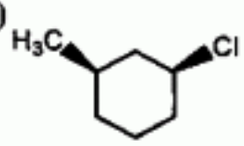


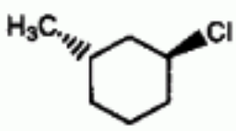
(a) $(CH_3)_3CCH_2Br$ (b) $(CH_3)_2C{=}CHCH_3$ (c) $CH_3\text{-}C(CH_2CH_3){=}CH_2$

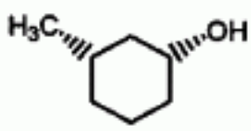
(d) $CH_3\text{-}C(Br)(CH_2CH_3)\text{-}CH_3$ (e) $CH_3\text{-}C(OH)(CH_2CH_3)\text{-}CH_3$

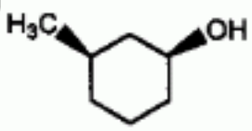
79 Which compound is product of the following reaction?

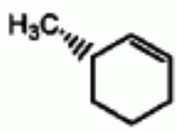


(a) 

(b) 

(c) 

(d) 

(e) 

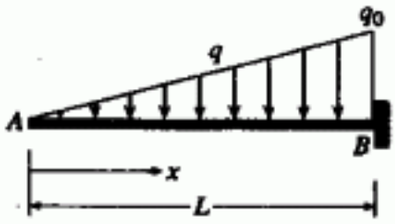
80 Which of the following species is not a nucleophile? (A) $^-OCH_3$ (B) NH_3 (C) BF_3 (D) $HSCH_3$ (E) I^-.

工程力學

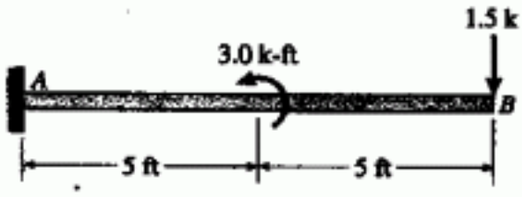
81 A circular tube with an outside diameter of 80 mm and an inside diameter of 60 mm is subjected to a torque T = 4.0 kN.m. The shear modulus of elasticity G = 27 Gpa. The maximum shear stress is 58.2 Mpa. Which one listed in the following is wrong (A)maximum tensile stress = 58.2 Mpa, (B) maximum compressive stresses = -58.2 Mpa, (C) maximum shear strain = 0.0022, (D) maximum normal strain = 0.0022, (E) The maximum tensile stress act on planes at 45^0 to the axis.

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。

82 A cantilever beam that is free at end A and fixed at end B is subjected to a distributed load of linearly varying intensity q. The maximum intensity of the load occurs at the fixed support and is equal to q_0. Which one listed in the following is wrong (A)maximum shear force is $-(q_0L)/2$, (B)maximum bending moment is $-(q_0L^2)/6$, (C) maximum shear stress occurs at the fixed end B, (D) maximum bending moment occurs at the mid-point of the beam, (E) bending moment is a function of x with an order of 3.



83 The cantilever beam AB supports a concentrated load and a couple as shown. Which one listed in the following is wrong (A) shear force keeps constant through the beam, (B) maximum shear force occurs at mid-point of the beam, (C) maximum bending moment occurs at point A, (D) bending moment at mid-point is –7.5 k ft, (E) shear force at point B is 1.5 k.



84 On a beam subjected to pure bending, find the wrong statement listed in the following. (A) the only stress resultants are the bending moment and the only stresses are the normal stresses acting on the cross sections, (B) vertical shear stress vanish at the upper surface, (C) the maximum normal stresses occur at top and bottom surfaces, (D) The maximum shear stress occurs at the neutral axis, (E) The maximum shear stress is proportional to cross-sectional area of the beam.

85 A high-strength steel wire the diameter of d and modulus of E is bent around a cylindrical drum of radius R_0. What is the bending moment in the wire. (A) $\pi Ed^4/(32(R_0+d))$, (B) $\pi Ed^4/(16(2R_0+d))$, (C) $\pi Ed^4/(32(2R_0+d))$, (D) $\pi Ed^6/(18(2R_0+d))$, (E) $\pi Ed^2/(32(2R_0+d))$.

86 In a Mohr's circle, let the stresses σ_x, σ_y, and τ_{xy} acting on the x and y planes of an element in plane stress, which statement is wrong: (A) the x coordinate of the circle center is $(\sigma_x+\sigma_y)/2$, (B) the stresses at the points where the circle intersects with the σ_{x1} abscissa is called principal stresses, (C) we plot the normal stress σ_{x1} positive to the right and the shear stress τ_{x1y1} positive downward, (D) an angle 2θ on Mohr's circle corresponds to an angle θ on a stress element, (E) the maximum shear stresses are numerically equal to the diameter of the circle.

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。

87 For the beam loaded and supported as shown, the shear force in the beam is (A) $q_0(L-x)^2/(2L)$, (B) $q_0(L-x)^2/(4L)$, (C) $q_0(L-x)^3/(2L)$, (D) $q_0(L-x)^3/(4L)$, (E) $q_0(L-x)^2/(8L)$.

88 For the same beam loaded and supported as shown in the previous problem, the bending moment is (A) $-q_0(L-x)^3/(3L)$, (B) $-q_0(L-x)^3/(4L)$, (C) $-q_0(L-x)^3/(6L)$, (D) $-q_0(L-x)^4/(4L)$, (E) $-q_0(L-x)^4/(8L)$.

89 For a bar subjected to load P as shown, σ_θ and τ_θ represent to the normal and shear stresses, respectively, which one listed in the following is right (A) $\sigma_\theta = P\cos^2\theta/A$, (B) $P = \sigma_\theta \cos\theta/A$, (C) $\tau_\theta = -P A \sin\theta\cos\theta$, (D) $\tau_0 = P A \sin\theta\cos\theta$, (E) $\sigma_\theta = P\sin^2\theta/A$

90 The stress-strain diagram for a typical structural steel in tension (not to scale) is shown in figure. which statement is wrong (A) region BC represents perfect plasticity, (B) region CD represents strain hardening, (C) region DE represents Necking, (D) Both points E and E' represent fracture, (E) E' represent ultimate stress.