

編號：F 121 系所：材料科學及工程學系

科目：B 科目

本試題是否可以使用計算機： 可使用， 不可使用（請命題老師勾選）

## 成功大學材料系 95 學年度碩士班入學考試試題

B 卷：普通化學、材料熱力學、有機化學。共 90 題，滿分 90 分。倒扣至零分為止。

科目名稱：普通化學

每題為 4 選 1，每一題答對得 1 分，答錯倒扣 0.25 分。

- Predict the shift in equilibrium position if the volume is reduced for the reaction:  $P_4(s) + 6Cl_2(g) \rightleftharpoons 4PCl_3(l)$   
 (A) right (B) left (C) no effect (D) none of the above.
- In which direction will the position of the equilibrium  $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$  be shifted if some Ar is added?  
 (A) right (B) left (C) no effect (D) all of the above.
- The pH of the  $7.0 \times 10^{-7}$  M HCl solution is  
 (A) 6.15 (B) 7.0 (C) 7.85 (D) 8.15.
- When 2.00 mole of  $SO_2(g)$  reacts completely with 1.00 mole of  $O_2(g)$  to form 2.00 moles of  $SO_3(g)$  at  $25^\circ C$  and a constant pressure 1.00 atm, 198 kJ of energy is released as heat. What is the enthalpy change ( $\Delta H$ ) of the reaction?  
 (A) 198 kJ (B) -198 kJ (C) 99 kJ (D) -99 kJ.
- Which of the following processes require energy as they occur?  
 (A) Salt dissolves in water. (B) Iron rusts  
 (C) A house is built. (D) A satellite falls back to earth.
- Which of the following half-cell reactions has the highest standard reduction potential?  
 (A)  $Mg^{2+} + 2e^- \rightarrow Mg$  (B)  $Zn^{2+} + 2e^- \rightarrow Zn$   
 (C)  $Fe^{2+} + 2e^- \rightarrow Fe$  (D)  $Cu^{2+} + 2e^- \rightarrow Cu$ .
- A fuel cell use  $H_2(g)$  as the fuel and  $O_2(g)$  as the oxidant. What is the half cell reaction at cathode?  
 (A)  $2H_2 + O_2 = 2H_2O$  (B)  $H_2 \rightarrow 2H^+ + 2e^-$   
 (C)  $2H^+ + 2e^- \rightarrow H_2$  (D)  $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$
- A galvanic cell is based on the half-cell reactions of  $Cl_2 + 2e^- \rightarrow 2Cl^-$  and  $Br_2 + 2e^- \rightarrow 2Br^-$ . The respective standard half-cell potentials are 1.36 and 1.09V. What is the free energy change of the galvanic cell reaction?  
 (A) -26 kJ (B) -52 kJ (C) -236kJ (D) -472kJ.

(請面仍有題目,請繼續作答)

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9. Is  $\text{H}_2(\text{g})$  capable of reducing  $\text{Ag}^+(\text{aq})$ ?  
Ⓐ yes      Ⓑ no      Ⓒ both      Ⓓ none of the above.
10. What mass of hydrogen can be produced in  $\text{HCl}$  solution if 15A of current is passed for 1.0 h?  
Ⓐ 36.5 g      Ⓑ 18.3 g      Ⓒ 0.56 g      Ⓓ 0.28g
11. Which one of the following descriptions on heat capacity is correct?  
Ⓐ The concept of heat capacity is used when a phase change is involved.  
Ⓑ The concept of heat capacity is only used when the addition of heat to or withdrawal of heat from the system produces a temperature change, without considering the change of volume or pressure.  
Ⓒ The heat capacity, being depending on the size of the system is an extensive property.  
Ⓓ The heat capacity of a substance is zero at low temperature.
12. Consider a system of water and water vapor at the uniform temperature  $T$  contained in a cylinder fitted with a frictionless piston, and let the cylinder be placed in thermal contact with a heat reservoir which is also at the constant temperature  $T$ . When the compression of the water vapor is performed,  
Ⓐ spontaneous evaporation of water occurs;  
Ⓑ an endothermic process from the heat reservoir occurs;  
Ⓒ the temperature gradient between the heat reservoir and the cylinder remains constant.  
Ⓓ A complete reversibility is approached, the process becomes infinitely slow.
13. Which one of the following descriptions on entropy is incorrect?  
Ⓐ Entropy is an intensive property.  
Ⓑ The entropy of a system increases when the system undergoes an irreversible process.  
Ⓒ Entropy is not created when a system undergoes a reversible process.  
Ⓓ Entropy is independent of reaction paths when the system conducted reversibly.
14. Methane,  $\text{CH}_4$ , has a tetrahedral geometry with bond angles around  
Ⓐ 109.5      Ⓑ 112      Ⓒ 120      Ⓓ 97.5.
15. Which one of the following descriptions on the types of bonds is incorrect?  
Ⓐ All single bonds are  $\pi$  bonds.  
Ⓑ A double bond is made up of a  $\sigma$  and a  $\pi$  bond.  
Ⓒ A triple bond is a  $\sigma$  and two  $\pi$  bonds.  
Ⓓ Bond strength and bond length are correlated with the types of bonds.
16. Which one of the following carbon-carbon bond energy is the highest?  
Ⓐ  $\text{C}_2\text{H}_2$       Ⓑ  $\text{C}_2\text{H}_4$       Ⓒ  $\text{C}_2\text{H}_6$       Ⓓ in free radical form.

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17. A compound composed of carbon and hydrogen and at least one double bond is called  
Ⓐ saturated compound Ⓑ alkene Ⓒ alkyne Ⓓ alkane.
18. The name of the saturated hydrocarbon,  $\text{CH}_3(\text{CH}_2)_6\text{CH}_3$  is  
Ⓐ Pentane Ⓑ Hexane Ⓒ Heptane Ⓓ Octane.
19. Which one of the following melting points of alkanes is the highest?  
Ⓐ Pentane Ⓑ Hexane Ⓒ Heptane Ⓓ Octane.
20. The functional group of carboxylic acid is  
Ⓐ  $-\text{C}=\text{C}-$  Ⓑ  $\text{O}=\text{C}-\text{OH}$  Ⓒ  $\text{O}=\text{C}-\text{H}$  Ⓓ  $\text{O}=\text{C}-\text{NH}_2$ .
21. A hard working graduate student always remember that a  $\text{NaOH}_{(\text{aq})}$  does not help if someone was hurt by a  $\text{HCl}_{(\text{aq})}$ . What is the hard working graduate student thinking?  
Ⓐ I won't have time to calculate and prepared the right  $\text{HCl}$  aqueous solution  
Ⓑ The mixture of  $\text{NaOH}_{(\text{aq})}$  and  $\text{HCl}_{(\text{aq})}$  generates  $\text{NaCl}$  salt. And,  $\text{NaCl}$  salt is really bad for someone's wound, according to the old saying.  
Ⓒ The mixture of  $\text{NaOH}_{(\text{aq})}$  and  $\text{HCl}_{(\text{aq})}$  generates heat. Also, both  $\text{NaOH}_{(\text{aq})}$  and  $\text{HCl}_{(\text{aq})}$  hurt people.  
Ⓓ None of above.
22. In terms of chemical thermodynamics, which following description is correct:  
Ⓐ Gibbs free energy depends on enthalpy and entropy.  
Ⓑ Gibbs free energy is independent from the temperature and pressure.  
Ⓒ The change in an equilibrium constant with temperature is nothing to do with the change in standard molar enthalpy.  
Ⓓ None of above.
23. For a catalyst in a chemical reaction, which following description is incorrect?  
Ⓐ A catalyst can act by modifying the electronic structure of the reactants.  
Ⓑ The reaction rate increases linearly with the catalyst concentration.  
Ⓒ A catalyst can act in both homogeneous and heterogeneous systems.  
Ⓓ A catalyst is a substance that increases the reaction rate without itself undergoing change.
24. What is the contribution of R.A. Millikan in his famous oil-drop experiment?  
Ⓐ Oil and water become soluble under high pressure.  
Ⓑ Determine the radius of a single electron.  
Ⓒ Determine the Boltzmann constant.  
Ⓓ All electric charges are multiples of one definite elementary unit.

(背面仍有題目,請繼續作答)

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25. According to the collision theory of reactions, which description listed below is correct?
- Ⓐ Kinetic energies of all molecules are the same.
  - Ⓑ All collisions result to the desired reactions.
  - Ⓒ Higher temperature leads to more molecules above the activation energy.
  - Ⓓ None of above.
26. Which following description about carbon is incorrect?
- Ⓐ Graphite is  $SP^2$  carbon.
  - Ⓑ Diamond is  $SP^3$  carbon.
  - Ⓒ Single-wall carbon nanotube is  $SP^2$  carbon.
  - Ⓓ Polyethylene contains  $SP^2$  carbons.
27. Please compare the bonding strength of ionic bonding (I), covalent bonding (C), hydrogen bonding (H), and van der Waals bonding (v):
- Ⓐ  $I > C > H > v$
  - Ⓑ  $C > I > H > v$
  - Ⓒ  $C > I > v > H$
  - Ⓓ  $I > C > v > H$
28. Copper were used to re-build the roof of the National Museum of Taiwanese Literature, a historic building in Tainan City. Several years later, the color of the copper roof will expected to be?
- Ⓐ Red
  - Ⓑ Yellow
  - Ⓒ Green
  - Ⓓ White
29. How do you define "electron affinities"?
- Ⓐ the minimum amount of energy required to remove a bound electron from an anion to produce a neutral atom
  - Ⓑ the minimum amount of energy required to remove a bound electron from a cation to produce a neutral atom
  - Ⓒ the minimum amount of energy required to remove a bound electron from a neutral atom to produce an anion
  - Ⓓ the minimum amount of energy required to remove a bound electron from a neutral atom to produce a cation
30. Which following description is incorrect?
- Ⓐ Electronegativity:  $F > Cl > Br > I$
  - Ⓑ Atom size:  $F < Cl < Be < I$
  - Ⓒ Acidity:  $HF > HCl > HBr > HI$
  - Ⓓ Boiling points:  $F_2 > Cl_2 > Br_2 > I_2$

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科目名稱：材料熱力學

每題為 4 選 1，每一題答對得 1 分，答錯倒扣 0.25 分。

[請注意：(1)有幾個題目是連鎖題；(2)某些題目須利用計算機計算  $\ln(x)$  or  $\exp(x)$ ]

31. Which of the following statements is NOT correct for the molar entropy of melting?

- A  $\Delta S_m$  is zero at  $T=0$  K;                       B  $\Delta S_m = \Delta H_m / T_m$ ;  
 C  $\Delta S_m$  is about a constant for all FCC metals;                       D  $\Delta S_m$  is always positive.

32. The enthalpy of PbO is -219 kJ/mole at 298 K.  $\Delta C_p$  of the reaction  $\text{Pb} + 0.5\text{O}_2 \rightarrow \text{PbO}$  is 10 J/mol-K for  $T=298 - 500$  K. What is  $\Delta H$  for the reaction at 398 K?

- A -218 kJ;                       B  $-10 \ln(398/298)$  J;  
 C 1000 J;                       D not available from the provided data.

33. The change of Gibbs free energy from solid to liquid phase at constant pressure will

- A always be negative;                       B increase with increasing temperature;  
 C decrease with increasing temperature;                       D be independent of temperature.

34. Regarding the P-T diagram of one-component systems, which one of the following statements is NOT correct?

- A  $dP/dT$  for the solid-vapor phase boundary must be positive.  
 B For a constant-temperature line passing the triple point, the possible phases along this line must be liquid and vapor.  
 C For a constant-pressure line passing the triple point, the possible phases along this line must be solid and vapor.  
 D The maximum number of phases which can coexist at equilibrium is three.

35. When  $\alpha$ -phase and  $\beta$ -phase are in equilibrium,

- A  $\Delta H_{\alpha \rightarrow \beta}$  is at the minimum;                       B  $\Delta S_{\alpha \rightarrow \beta}$  is at the maximum;  
 C  $\Delta G_{\alpha \rightarrow \beta}$  is at the minimum;                       D  $\Delta G_{\alpha \rightarrow \beta} = \text{zero}$ .

36. The molar Gibbs free energy of mixing of ideal gases is  $\Delta G'^{mix}$ .  $p_i$  is the partial pressure of gas  $i$  in the mixture,  $P_i$  is the pressure of the pure gas  $i$  before mixing, and  $X_i$  is the molar fraction of  $i$  in the gas mixture. Then,

- A  $\Delta G'^{mix} = \sum_i X_i RT \ln \left( \frac{P_i}{P} \right)$ ;                       B  $\Delta G'^{mix} = \sum_i X_i R \ln \left( \frac{P_i}{P} \right)$ ;  
 C  $\Delta G'^{mix} = - \sum_i X_i RT \ln \left( \frac{P_i}{P} \right)$ ;                       D  $\Delta G'^{mix} = \sum_i RT \ln X_i$ .

(背面仍有題目,請繼續作答)

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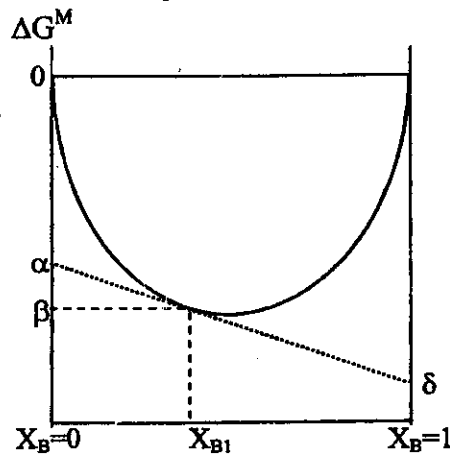
37. The partial molar enthalpy of an ideal gas  $i$ ,  $\bar{H}_i$ , in a mixture of ideal gases is

- Ⓐ dependent on pressure;                      Ⓑ dependent on composition;  
 Ⓒ dependent on temperature;                Ⓓ all of the above statements are correct.

38. Above the critical temperature,

- Ⓐ the pressure of gas will always be higher than the critical pressure;  
 Ⓑ the gaseous state cannot be condensed by isothermal compression;  
 Ⓒ the volume of gas will always be smaller than the critical volume;  
 Ⓓ none of the above statements is correct.

[Prob. 39 and 40] The molar Gibbs free energy of mixing,  $\Delta G^M$ , for an A-B binary solution at the temperature T is shown as the figure.



39.  $\Delta G^M(X_{B1}) =$

- Ⓐ  $\alpha$ ;                      Ⓑ  $\beta$ ;                      Ⓒ  $\delta$ ;                      Ⓓ  $X_{B1}\alpha + (1-X_{B1})\delta$

40. If A-B binary solution is an ideal solution, then

- Ⓐ  $\alpha = RT \ln X_{B1}$ ;                      Ⓑ  $\alpha = X_{B1} RT \ln X_{B1}$ ;  
 Ⓒ  $\delta = RT \ln X_{B1}$ ;                      Ⓓ  $\delta = X_{B1} RT \ln X_{B1}$ .

41.  $C_p$  is equal to  $C_v$  at

- Ⓐ 0 °K;                      Ⓑ 15 °K;                      Ⓒ 298 °K;                      Ⓓ 398 °K.

42. Chemical potential is a direct measure of

- Ⓐ activity;                      Ⓑ density;                      Ⓒ activation energy; Ⓓ thermal conductivity.

43.  $(\partial G / \partial P)_T = ?$

- Ⓐ V;                      Ⓑ -S;                      Ⓒ H;                      Ⓓ U

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44.  $(\partial G/\partial T)_P = ?$   
① V;                      ② - S;                      ③ H;                      ④ U
45. A process of a system completely surrounded by a diathermic wall may be considered as an  
① isobaric process;                      ② isothermal process;  
③ isometric process;                      ④ isentropic process.
46. Which substance has lowest absolute entropy?  
① liquid Al;                      ② liquid Cu;                      ③ solid Fe;                      ④ diamond.
47. Which substance has lowest absolute entropy?  
① solid Cu;                      ② solid Au;                      ③ solid Fe;                      ④ solid Si.
48. The standard-state Gibbs energy change in a chemical reaction is equivalent to  $-RT \ln K$ , where K is  
① Boltzmann's constant;                      ② equilibrium constant;  
③ gas constant;                      ④ Faraday's constant.
49. The Van't Hoff equation can be used to determine  
① entropy;                      ② enthalpy;                      ③ internal energy;                      ④ volume.
50. Which property is not a thermodynamic property?  
① volume;                      ② pressure;                      ③ strain energy;                      ④ activity.
51. Compare the oxidation of metal A, as the temperature increases and passes the melting point of  $AO_2$ , the Ellingham lines should look like  
① elbow downward                      ② elbow upward  
③ curve up                      ④ no change
52. Which of the following condition will cause the biggest slope change in the Ellingham line of a metal oxidation  
① the melting of metal                      ② the boiling of metal  
③ the melting of oxide                      ④ the phase transformation of solid metal
53. In an equilibrium mixture of metal A and oxide  $AO_2$ , you want to obtain more metal A in the mixture, you will  
① adding more  $AO_2$ ,                      ② increase  $p_{O_2}$   
③ increase the temperature                      ④ decrease the temperature

(背面仍有題目,請繼續作答)

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54. In a Ellingham diagram, what information you cannot determine
- Ⓐ entropy change                      Ⓑ equilibrium  $p_{O_2}$   
Ⓒ volume change                        Ⓓ Gibbs free energy change
55. In the process control some we need to fixed a desired CO/CO<sub>2</sub> ratio, the purpose may be to
- Ⓐ to fix the amount of CO<sub>2</sub>            Ⓑ to obtain desired  $p_{O_2}$   
Ⓒ to form carbonate                    Ⓓ to fix the amount of CO
56. Considering the oxidation of Cu and Al, the position of Ellingham lines for the these two reactions
- Ⓐ Al/Al<sub>2</sub>O<sub>3</sub> is higher                    Ⓑ Cu/CuO is higher  
Ⓒ depending on the temperature      Ⓓ none of above is correct
57. Considering the reaction of carbon and carbon dioxide into carbon monoxide, the precipitation of carbon powder can be controlled by increasing the ratio of
- Ⓐ  $p_{O_2}/p_{CO}$             Ⓑ  $p_{CO_2}/p_{CO}$             Ⓒ  $p_{CO}/p_{CO_2}$             Ⓓ  $p_{O_2}/p_{CO_2}$
58. Considering two reactions Mn/MnO and Co/CoO, the position of Co/CoO Ellingham line is much higher than the other one, thus we may say
- Ⓐ CoO is more stable than MnO            Ⓑ less oxygen is needed to oxidize Co  
Ⓒ MnO is more stable than CoO            Ⓓ both oxides are stable
59. Through the chlorination of Fe combining the phase change of FeCl<sub>2</sub> what causes the slope change from positive to negative in Ellingham lines
- Ⓐ the melting of FeCl<sub>2</sub>                    Ⓑ the solidification of FeCl<sub>2</sub>  
Ⓒ the large entropy change of FeCl<sub>2</sub>      Ⓓ transformation of Fe
60. Two metals shows different equilibrium  $p_{O_2}$ , compared to the other metal, the metal with lower  $p_{O_2}$  indicates that
- Ⓐ its oxide is more stable                    Ⓑ its melting point is lower  
Ⓒ this metal cannot be oxidized easily      Ⓓ none of above is correct



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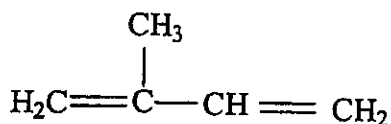
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61. What is the IUPAC name of the following compound?



- (A) 3-methyl-1,4-butadiene      (B) 2-methyl-1,3-butadiene  
(C) 2-methyl-1,4-butadiene      (D) 3-methyl-1,3-butadiene

62. A process involving symmetrical bond breaking and bond making is

- (A) radical reaction      (B) elimination reaction  
(C) addition reaction      (D) substitution reaction

63. When a primary substrate reacts with a good nucleophile, which reaction will occur?

- (A) S<sub>N</sub>1      (B) S<sub>N</sub>2      (C) E1      (D) E2

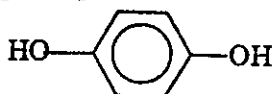
64. Grignard reagents reacts with water will give which compound?

- (A) alkyl halide      (B) hydrocarbons      (C) esters      (D) ethers

65. When an alkyl halide react with a base, what is the product?

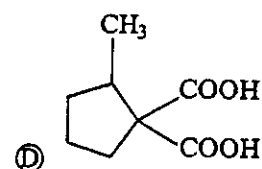
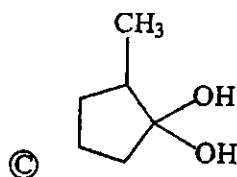
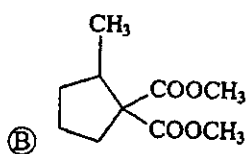
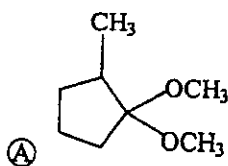
- (A) alcohol      (B) alkyne      (C) alkene      (D) alkane

66. What is the name of the following compound?



- (A) m-cresol      (B) anisole      (C) hydroquinone      (D) benzophenone

67. What product would you obtain from the acid catalyzed reaction of 2-methylcyclopentanone with methanol?



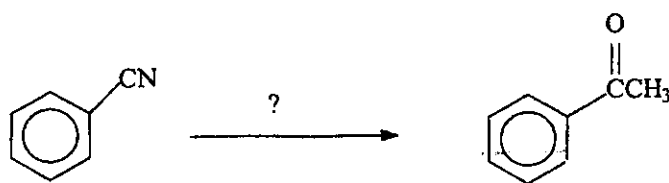
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68. What reagents should be used in the following reaction??



- (A) 1.  $\text{CH}_3\text{MgBr}$ , ether 2.  $\text{H}_3\text{O}^+$       (B)  $\text{CH}_3\text{COCl}$   
 (C)  $\text{CH}_3\text{OH}$ , acid, heat                      (D) all of the above work

69. Reduction of esters with  $\text{LiAlH}_4$  will give which compound?

- (A) primary alcohols      (B) secondary alcohols      (C) ketone      (D) aldehyde

70. The Claisen condensation will give which compound?

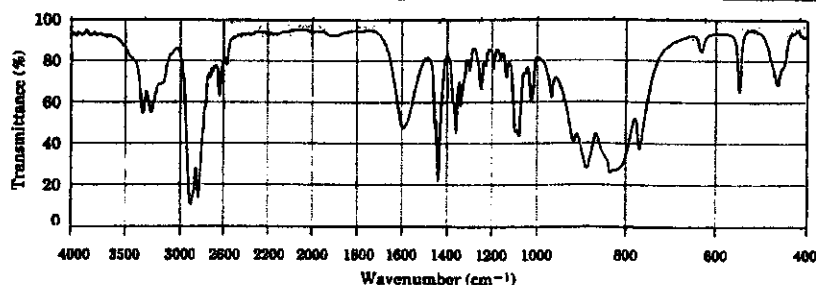
- (A) conjugated enone      (B) malonic acid      (C) enolate      (D)  $\beta$ -keto ester

71. What description about Lewis acid/base is **incorrect**?

- (A) A Lewis acid: a substance that has a vacant valence orbital and can thus accept an electron pair.  
 (B) The donated electron pairs between Lewis acid and base can not form a new new covalent bond.  
 (C) A Lewis acid is an electrophile.  
 (D) The Lewis acid/base definition is nothing to do with protons.

72. Which description below is **correct**?

- (A) An infrared spectrum is good for the qualitative analysis.  
 (B)  $^{12}\text{C}$  is invisible in NMR measurement.  
 (C) Proton NMR measurement is not good for the qualitative analysis.  
 (D) The wavelength of visible light is from 200 nm to 400 nm..

73. Which description about the spectrum shown below is **incorrect**?

- (A) This is an infrared spectrum.  
 (B) Twin-peak centered at  $3300\text{cm}^{-1}$  suggests the existing of  $-\text{OH}$   
 (C) Strong absorption at  $2900\text{cm}^{-1}$  shows the existing of  $\text{CH}$   
 (D) Strong peak at  $1600\text{cm}^{-1}$  indicates the existing of  $\text{C}=\text{O}$ .

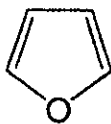
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科目: B 科目

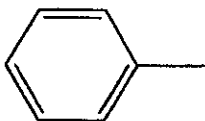
本試題是否可以使用計算機:  可使用,  不可使用 (請命題老師勾選)74. Which one is incorrect?

Ⓐ Thio —SH

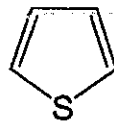
Ⓑ Pyridine



Ⓒ Toluene



Ⓓ Thiophene



75. Which following organic compounds is aromatic?

Ⓐ Cyclohexene

Ⓑ Chloroform

Ⓒ Aniline

Ⓓ Acetone

76. Emily, an outstanding student in NCKU, found the grape she purchased two weeks ago has "decomposed" and turned sour. What kind of chemical reaction can explain this tragedy?

Ⓐ Oxidation reactions of sugar's amine groups

Ⓑ Oxidation reactions of sugar's hydroxyl groups

Ⓒ Reduction reactions of sugar's hydroxyl groups

Ⓓ Reduction reactions of sugar's amine groups

77. How do you purify an amine compound from other impurities?

Ⓐ dissolve it in low pH water, followed by the precipitation from base addition

Ⓑ dissolve it in high pH water, followed by the precipitation from acid addition

Ⓒ dissolve in low pH water, followed by filtration

Ⓓ dissolve in high pH water, followed by filtration

78. Oxidation reaction of a secondary alcohol generates:

Ⓐ aldehyde

Ⓑ ketone

Ⓒ carboxylic acid

Ⓓ ether

79. Arrows frequently used in the organic reaction mechanism mean:

Ⓐ the direction of groups' relocation

Ⓑ the direction of atoms' relocation

Ⓒ the direction of electrons' relocation

Ⓓ the direction of protons' relocation

80. A plastic container marked with a triangle and number 6 in the center is made of:

Ⓐ polystyrene (PS)

Ⓑ poly(ethylene terephthalate) (PET)

Ⓒ poly(vinyl chloride) (PVC)

Ⓓ polyethylene (PE)

81. What is the reaction product of an acid chloride and an alcohol?

Ⓐ imide

Ⓑ ester

Ⓒ amino acid

Ⓓ amide

(背面仍有題目, 請繼續作答)

本試題是否可以使用計算機： 可使用， 不可使用（請命題老師勾選）

82. What is the reaction product of a dianhydride and a diamine?  
 (A) polyamide (B) polyimide (C) polyester (D) polyether
83. What is the IR absorption range of carbonyl compound  
 (A)  $4000\sim 2500\text{ cm}^{-1}$  (B)  $2500\sim 2000\text{ cm}^{-1}$   
 (C)  $2000\sim 1500\text{ cm}^{-1}$  (D) below  $1500\text{ cm}^{-1}$
84. Which polymer can be prepared by a free radical polymerization reaction?  
 (A) polystyrene (B) polycarbonate  
 (C) polyester (D) polyimide
85. Which kind of polymers have the highest modulus?  
 (A) rubbers (B) plastics (C) fibers (D) paints
86. The product of the following reaction is:
- Cc1ccccc1
 $\xrightarrow[\text{H}_3\text{O}^+]{\text{KMnO}_4}$ 
 $\xrightarrow[\text{FeBr}_3]{\text{Br}_2}$ 
 ?
- (A) o-bromo-benzoic acid (B) n-bromo-benzoic acid  
 (C) p-bromo-benzoic acid (D) m-bromo-benzoic acid
87. Which stereoisomers have identical physical properties?  
 (A) Diastereomers (B) Meso compounds (C) Racemic compounds (D) Enantiomers
88. When a primary or secondary alkyl halide is treated with a strong base, which reaction will occur?  
 (A)  $\text{S}_{\text{N}}1$  (B)  $\text{S}_{\text{N}}2$  (C) E1 (D) E2
89. Which polymer can be prepared by a free radical polymerization reaction?  
 (A) polystyrene (B) polycarbonate  
 (C) polyester (D) polyimide
90. Which kind of polymers have the highest modulus?  
 (A) rubbers (B) plastics (C) fibers (D) paints