

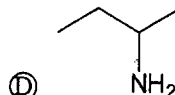
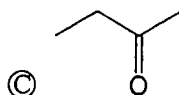
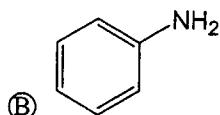
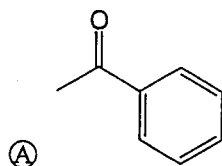
成功大學材料系 94 學年度碩士班入學考試試題

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

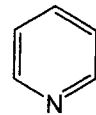
科目名稱：普通化學

每題為 4 選 1，每一題答對得 1 分，答錯倒扣 0.25 分。

- The units used in IR and UV-vis-NIR spectra are cm^{-1} and nm, respectively. Since both of them are electromagnetic waves. IR absorption at 4000 cm^{-1} is equal to:
 (A) 1250 nm (B) 2500 nm (C) 3750 nm (D) 5000 nm
- John was analyzing an unknown sample. He found an intense absorption centered at 1715 cm^{-1} in its IR spectrum, and several peaks located at 6.5 ~ 7.5 ppm in its proton NMR spectrum. Which compound shown below is the possible answer for John?



- Pyridine is frequently used as an organic base. According to its chemical structure, what kind of amine it is?



- (A) primary amine (B) secondary amine (C) tertiary amine (D) quaternary amine
- Oxidation reaction of primary alcohol generates:
 (A) aldehyde (B) ketone (C) carboxylic acid (D) ether
 - What metal reacts with an alkyl halide and forms a Grignard reagent?
 (A) Germanium (B) Gallium (C) Manganese (D) Magnesium
 - Which following reaction can NOT give you polyamide (Nylon)?
 (A) diamine + dicarboxylic acid (B) diamine + dichloride
 (C) diol + diisocyanate (D) open-ring polymerization of caprolactam
 - Which solvent has the highest density?
 (A) methylene chloride (B) benzene (C) chloroform (D) hexane

(背面仍有題目,請繼續作答)

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科目：B科目

8. The water-solubility of amino compounds is dependent on the H^+ concentration of the aqueous solution. Why?
- (A) at high pH, the amino group is protonated
(B) at low pH, the amino group is protonated
(C) at high pH, the amino group is hydrolyzed
(D) at low pH, the amino group is hydrolyzed
9. A plastic container marked with a triangle and number 5 in the center is made of:
- (A) PET (B) PP (C) HDPE (D) PVC
10. Nature gas is mainly:
- (A) methane (B) ethane (C) propane (D) butane
11. How many chlorine atoms are in 0.1 moles of $C_2H_3Cl_3O_2$?
- (A) 0.1 mole (B) 1 mole (C) 6.022×10^{22} (D) 1.807×10^{23} .
12. A substance X_2Z has the composition (by mass) of 40.0% X and 60.0% Z. What is the composition of (by mass) of the compound XZ_2 ?
- (A) 60.0% X and 40.0% Z, (B) 33.3% X and 66.7% Z
(C) 14.3% X and 85.7% Z (D) 40.0% X and 60.0% Z.
13. Pure carbon was burned in an excess of oxygen. The gaseous products were 72.0 mol% CO_2 , 16.0 mol% CO and 12.0 mol% O_2 . How many moles of O_2 were present in the initial reaction mixture for every mole of carbon?
- (A) 1 mole, (B) 0.92 mole, (C) 1.05 mole, (D) 1.12 mole.
14. The number of moles of Cl^- ions in 1.75 L of 1.0×10^{-3} M $AlCl_3$ is
- (A) 1.75×10^{-3} moles, (B) 1.0×10^{-3} moles,
(C) 5.25×10^{-3} moles, (D) 0.57×10^{-3} moles.
15. What volume of a 0.100 M solution of $NaHCO_3$ contains 0.350 g of $NaHCO_3$?
- (A) 35.0 ml, (B) 41.7 ml, (C) 84 ml, (D) 168 ml.
16. Compare the kinetic energies of CH_4 , CO_2 and N_2 at 273 K. Which one has the highest kinetic energy?
- (A) CH_4 , (B) CO_2 , (C) N_2 , (D) the same.

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17. Which of the following gases has the lowest root mean square velocity at 500 K?
Ⓐ O₂, Ⓑ CO₂, Ⓒ CO, Ⓓ CH₄.
18. At a particular temperature, 12.0 mol of SO₃ is placed into a 3.0-L container, and the SO₃ dissociates by the reaction: $2\text{SO}_3(\text{g}) = 2\text{SO}_2(\text{g}) + \text{O}_2(\text{g})$. At equilibrium, 3.0 mol of SO₂ is present. What is the equilibrium constant of the above reaction?
Ⓐ 6 mol/L, Ⓑ 1.5 mol/L, Ⓒ 0.056 mol/L, Ⓓ 0.032 mol/L.
19. In which direction will the position of equilibrium $2\text{HI}(\text{g}) = \text{H}_2(\text{g}) + \text{I}_2(\text{g})$ be shifted if I₂(g) is removed?
Ⓐ left, Ⓑ right, Ⓒ no effect, Ⓓ none of the above.
20. The solution pH of the strong acid of 5.0 M HClO₄ in water is
Ⓐ 5, Ⓑ 0.7, Ⓒ -0.7, Ⓓ 1.6.
21. Which description to the mass and charge of the electron, proton, and neutron is **incorrect**?
Ⓐ The mass of electron is lighter than that of proton.
Ⓑ The charge of neutron is none.
Ⓒ The charge of electron plus proton is equal to that of neutron.
Ⓓ The mass of proton is usually higher than that of neutron.
22. What is the compound of Lithium nitride?
Ⓐ LiN Ⓑ Li₂N Ⓒ Li₃N Ⓓ Li₃N₂.
23. What is the chemical formula of Gallium oxide?
Ⓐ GaO₂ Ⓑ Ga₂O₃ Ⓒ GaO Ⓓ Ga₂O.
24. The balanced equation for the reaction is $(\text{A})\text{NH}_3(\text{g}) + (\text{B})\text{O}_2(\text{g}) \rightarrow (\text{C})\text{NO}(\text{g}) + (\text{D})\text{H}_2\text{O}(\text{g})$. Which numbers for A, B, C, and D are **correct**?
Ⓐ 4, 4, 5, 6 Ⓑ 4, 6, 4, 6 Ⓒ 6, 5, 6, 4 Ⓓ 4, 5, 4, 6.
25. The mixed solution, $\text{K}_2\text{CrO}_4(\text{aq}) + \text{Ba}(\text{NO}_3)_2(\text{aq}) \rightarrow$ products. What kinds of ions contain in the solution?
Ⓐ K⁺, Ⓑ Ba²⁺, Ⓒ CrO₄²⁻ or NO₃⁻. Ⓓ All of the Ⓐ, Ⓑ, and Ⓒ are correct.
26. An adiabatic process means
Ⓐ No external work, Ⓑ No internal energy changed
Ⓒ No heat absorbed, Ⓓ No entropy changed.

(背面仍有題目,請繼續作答)

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27. For the following electromagnetic radiations, which wavelength is the shortest?
Ⓐ Infrared, Ⓑ Radio waves, Ⓒ Ultraviolet, Ⓓ X rays.
28. The first ionization energy for phosphorous is A, and that for sulfur is B. Which expression is **correct**?
Ⓐ $A > B$, Ⓑ $A \approx B$, Ⓒ $A < B$, Ⓓ All of the Ⓐ, Ⓑ, and Ⓒ are possible.
29. Compare the following bonds according to polarity. Which one is **incorrect** on the electronegativity difference?
Ⓐ $S-H > Cl-H$, Ⓑ $O-H > Cl-H$, Ⓒ $F-H > O-H$, Ⓓ $S-H > H-H$.
30. Compare the following sizes of ions. Which one is **incorrect**?
Ⓐ $I^- > Cs^+$, Ⓑ $Cs^+ > Ba^{2+}$, Ⓒ $Cs^+ > Te^{2-}$, Ⓓ $Te^{2-} > I^-$.

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科目：B 科目

科目名稱：熱力學。

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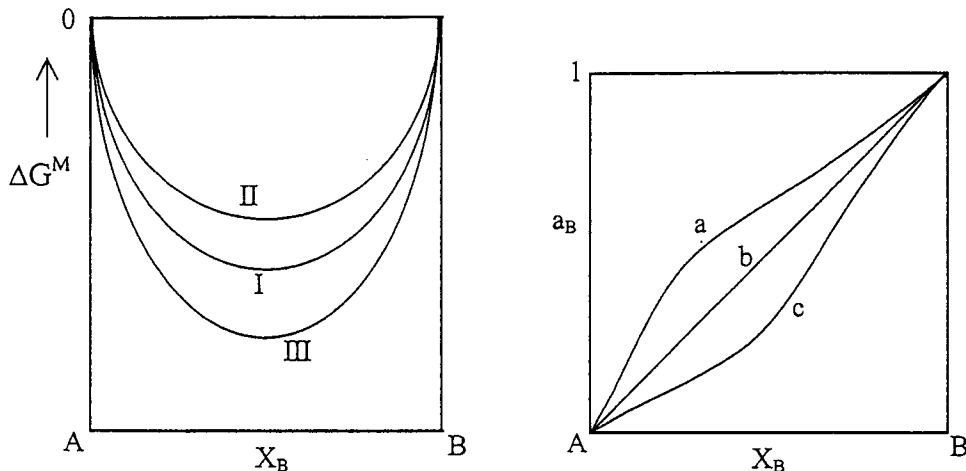
[請注意：(1)有幾個題目是連鎖題；(2)某些題目須利用計算機計算 $\ln(x)$ or $\exp(x)$]

31. The slope of Ellingham line for oxidation of metals will
- Ⓐ become larger when the metal transforms from solid to liquid.
 - Ⓑ become larger when the oxide transforms from solid to liquid.
 - Ⓒ become larger when the metal is replaced by its alloy.
 - Ⓓ stay constant upon phase transformation.
32. The Ellingham line for the oxidation of silver ($2\text{Ag}_{(s)} + \text{O}_{2(g)} = 2\text{Ag}_2\text{O}_{(s)}$) follows the equation of $\Delta G^\circ = A + BT$ (B is positive) and $\Delta G^\circ = 0$ at $T = 462\text{K}$.
- Ⓐ The standard entropy change of for the reaction, ΔS° is positive.
 - Ⓑ Silver will not be oxidized at temperatures below 462K.
 - Ⓒ Silver will not be oxidized at temperatures above 462K.
 - Ⓓ The pressure of oxygen gas which is in equilibrium with pure silver at 462K, $p_{\text{O}_2(\text{eq. } 462\text{K})} = 1$ atm.
33. The partial pressure of oxygen in equilibrium with pure liquid Pb and pure liquid PbO at 1200K is 2.16×10^{-9} atm. When SiO_2 is added into the liquid PbO to form a lead silicate melt, the oxygen pressure in equilibrium with the pure liquid Pb and the lead silicate melt at is
- Ⓐ smaller than 2.16×10^{-9} atm;
 - Ⓑ larger than 2.16×10^{-9} atm;
 - Ⓒ equal to 2.16×10^{-9} atm;
 - Ⓓ not able to be determined.
- [Prob. 34-35] An Fe-Mn solid solution is in equilibrium with an FeO-MnO solid solution and O_2 gas.
34. According to the phase rule, how many degrees of freedom does the equilibrium have?
- Ⓐ 1;
 - Ⓑ 2;
 - Ⓒ 3;
 - Ⓓ 4.
35. At equilibrium,
- Ⓐ the activities of FeO and MnO in the FeO-MnO solid solution, $a_{\text{FeO}} = a_{\text{MnO}}$;
 - Ⓑ the activity of Fe in the Fe-Mn solution and the activity of Fe in the FeO-MnO solution, $a_{\text{Fe}(\text{Fe-Mn})} = a_{\text{Fe}(\text{FeO-MnO})}$;
 - Ⓒ at given temperature and oxygen partial pressure, the compositions of Fe-Mn and FeO-MnO solutions are both determined;
 - Ⓓ none of above is correct.

(背面仍有題目,請繼續作答)

36. The left figure shows the molar Gibbs free energies of mixing in binary systems exhibiting ideal behavior (I), positive deviation from ideal behavior (II), and negative deviation from ideal behavior (III). The right figure shows the activities of component B obtained from line I, II, III in the left figure. Which of the following relation is correct?

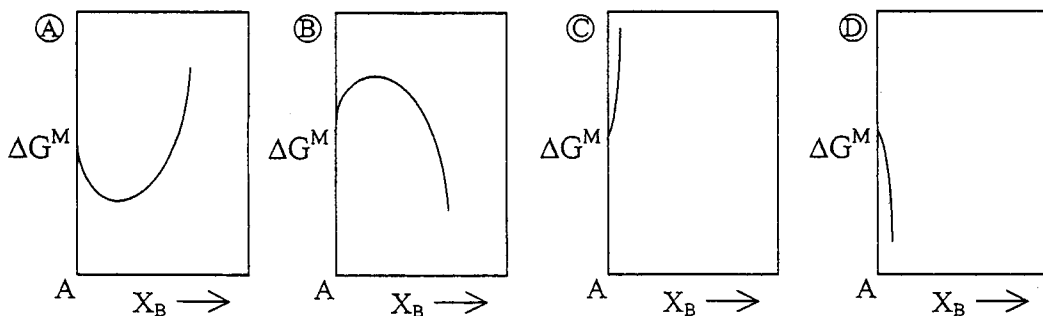
- Ⓐ $a \rightarrow \text{I}, b \rightarrow \text{II}, c \rightarrow \text{III};$ Ⓑ $a \rightarrow \text{II}, b \rightarrow \text{I}, c \rightarrow \text{III};$
 Ⓒ $a \rightarrow \text{III}, b \rightarrow \text{I}, c \rightarrow \text{II};$ Ⓓ none of above is correct.



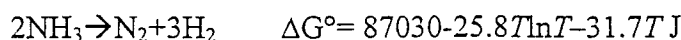
37. A binary A - B solution behaves ideally both in liquid and solid and exhibits complete mutual solid/liquid solubility. At a temperature which is between melting point of A and melting point of B , the activities of component B will be

- Ⓐ $a_B = X_A;$ Ⓑ $a_B = X_B;$ Ⓒ $a_B = \text{constant};$ Ⓓ a_B may have two values for each of X_B .

38. If component B has a negligible solid solubility in component A , which of the following will be the possible molar Gibbs free energy of mixing curve?



[Prob. 39-40] Consider the cracking of ammonia gas according to the reaction



39. What is the equilibrium constant for the NH_3 decomposition reaction at 300°C ?

- Ⓐ 5.25; Ⓑ 191; Ⓒ 13.37; Ⓓ 1.56

40. At what pressure is the molar fraction of N_2 in the equilibrium gas mixture equal to 0.1?

- Ⓐ 159 atm; Ⓑ 0.6 atm; Ⓒ 18 atm; Ⓓ 71 atm.

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41. At what temperature can changes in Gibbs free energy and enthalpy of a system be equal?
Ⓐ 0°C ; Ⓑ 25°C ; Ⓒ 100°C ; Ⓓ 0°K
42. Gibbs free energy is a direct measure of
Ⓐ heat capacity; Ⓑ temperature; Ⓒ thermal conductivity; Ⓓ activity.
43. Activity is a direct measure of
Ⓐ work done by a system; Ⓑ partial pressure;
Ⓒ heat generated in a chemical reaction; Ⓓ thermal conductivity.
44. Which property has an inexact differential?
Ⓐ volume; Ⓑ temperature; Ⓒ internal energy; Ⓓ heat.
45. A process of a system completely surrounded by an adiabatic envelope (wall) may be considered as an
Ⓐ isobaric process; Ⓑ isothermal process;
Ⓒ isometric process; Ⓓ isentropic process.
46. Enthalpy is equivalent to heat when
Ⓐ thermal conductivity is constant; Ⓑ volume is constant;
Ⓒ pressure is constant; Ⓓ entropy is constant.
47. Which substance has lowest absolute entropy?
Ⓐ solid B; Ⓑ solid Au; Ⓒ solid Fe; Ⓓ oxygen gas
48. Which substance has lowest absolute entropy?
Ⓐ liquid Cu; Ⓑ liquid Au Ⓒ solid Fe; Ⓓ solid graphite.
49. Which substance has highest absolute entropy?
Ⓐ solid Si; Ⓑ water vapor; Ⓒ solid iron; Ⓓ diamond.
50. Which substance has highest absolute entropy?
Ⓐ nitrogen gas; Ⓑ solid Fe; Ⓒ solid Sn; Ⓓ solid B.
51. The enthalpy of oxides are usually lower than that of its metallic counterpart and oxygen. The reason is
Ⓐ the melting point of oxide is usually higher than that of metals
Ⓑ The heat capacity of oxides is smaller than that of metal
Ⓒ The oxidation reaction gives away heat
Ⓓ none of above is true.

(背面仍有題目,請繼續作答)

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科目：B科目

52. In the plot of enthalpy vs temperature for metals A and B, if the slope of A is less than B, which of the following is true
- Ⓐ the entropy of A is less than B
 - Ⓑ melting point of metal A is higher than that of metal B
 - Ⓒ more heat is needed to heat up metal B than A when the equal moles of A and B are used
 - Ⓓ Heat will flow from B to A when they are in direct contact
53. In the plot of enthalpy vs temperature for metals A, the enthalpy difference between liquid phase and solid phase results from the
- Ⓐ difference of heat capacity between liquid phase and solid phase
 - Ⓑ the heat of fusion
 - Ⓒ difference of volume between liquid phase and solid phase
 - Ⓓ difference of entropy between liquid phase and solid phase
54. In a phase diagram (pressure vs temperature) of one component system containing vapor, liquid, and solid phases, which one the phase boundary is nearly a straight line
- Ⓐ solid/vapor
 - Ⓑ liquid/vapor
 - Ⓒ solid/liquid
 - Ⓓ none of above is true
55. The melting point of a substance decreases when the pressure increases is because
- Ⓐ melting of the substance releases heat
 - Ⓑ melting of the substance requires heat
 - Ⓒ the density of liquid phase is less than that of solid phase
 - Ⓓ the volume change is negative after melting
56. In a phase diagram (pressure vs temperature) of one component system containing vapor, liquid, and solid phases, the value of dP/dT for the boundary line of vapor/liquid
- Ⓐ always negative,
 - Ⓑ always positive,
 - Ⓒ may be positive or negative,
 - Ⓓ must be zero
57. In the diagram of molar Gibbs free energies of solid and liquid with temperature (G vs T) under constant pressure, the value of slopes for the liquid and solid phases
- Ⓐ always negative, its absolute value for liquid phase is greater than solid phase
 - Ⓑ always positive, its absolute value for liquid phase is greater than solid phase
 - Ⓒ always negative, its absolute value for liquid phase is less than solid phase
 - Ⓓ always negative, its absolute value may vary

58. In the diagram of molar Gibbs free energies of solid and liquid with pressure (G vs P) under constant temperature, the value of slopes for the liquid and solid phases
- Ⓐ always negative, its absolute value for liquid phase is greater than solid phase
 - Ⓑ always positive, its absolute value for liquid phase is greater than solid phase
 - Ⓒ always negative, its absolute value for liquid phase is less than solid phase
 - Ⓓ always positive, its absolute value may vary depending upon the system
59. There are three phases present in a phase diagram of metal A (pressure vs temperature). The low (α phase) and high (δ phase) temperature phases exhibit body-center cubic structure. The phase in the intermediate temperature (γ phase) belongs to face-centered cubic structure. The values of phase boundary for (α/γ phases) and (γ/δ phases) are respectively
- Ⓐ negative, positive
 - Ⓑ positive, negative,
 - Ⓒ positive, positive
 - Ⓓ negative, positive
60. In the isothermal PV diagram of a gas based on the van der Waals equation, there are one maximum, one minimum, and one inflexion point, the unrealistic region is present in the region
- Ⓐ above the inflexion point
 - Ⓑ below the inflexion point
 - Ⓒ between the maximum and minimum
 - Ⓓ none of above is true

(背面仍有題目,請繼續作答)

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科目: B科目

科目名稱: 有機化學。

每題為 4 選 1, 每一題答對得 1 分, 答錯倒扣 0.25 分。

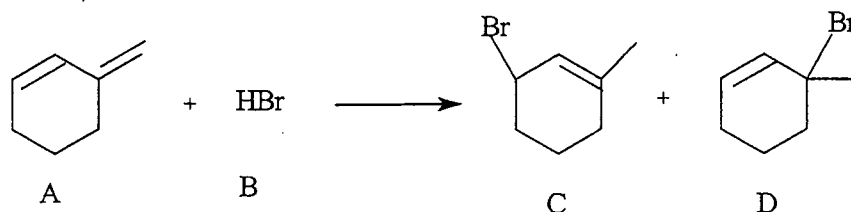
61. A compound of formula C_9H_{14} contains no rings or triple bonds. How many double bonds does it have?

- (A) 2 (B) 3 (C) 4 (D) 5

62. Since the two bromine atoms add to opposite faces of the cyclohexene double bond, we say that the reaction occurs with

- (A) syn stereochemistry (B) cis stereochemistry
(C) anti stereochemistry (D) retention of stereochemistry

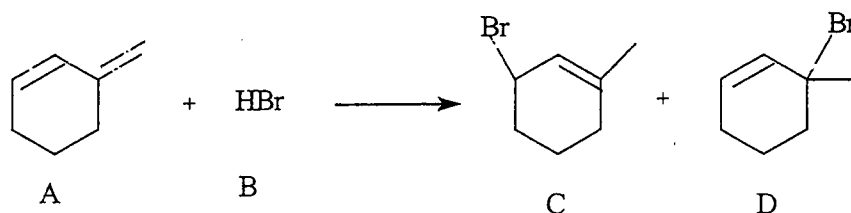
63. Consider the reaction below :



The nucleophile in the reaction is

- (A) A (B) B (C) C (D) D

64. Consider the reaction below :



The electrophile in the reaction is

- (A) A (B) B (C) C (D) D

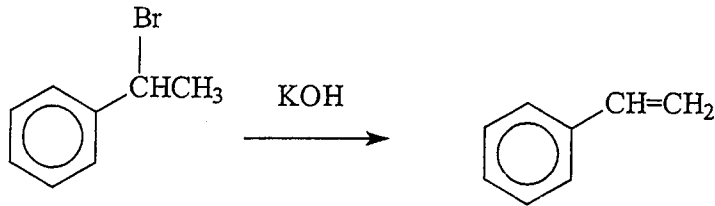
65. Which substituent in an aromatic compound is an ortho and para-directing activator

- (A) CN (B) NO_2 (C) CHO (D) OCH_3

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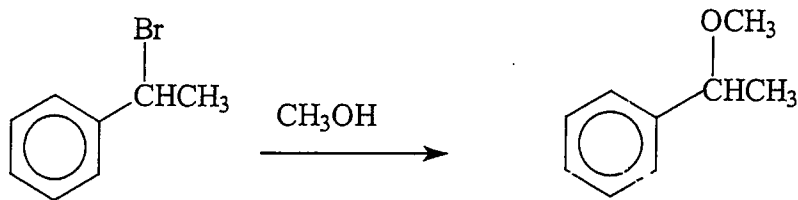
科目: B科目

66. What kind of reaction is the following reaction?



- (A) E1 (B) E2 (C) $\text{S}_{\text{N}}1$ (D) $\text{S}_{\text{N}}2$

67. What kind of reaction is the following reaction?

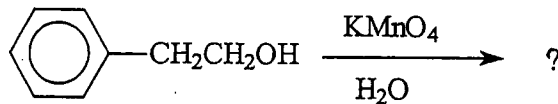


- (A) E1 (B) E2 (C) $\text{S}_{\text{N}}1$ (D) $\text{S}_{\text{N}}2$

68. Mechanistically, the Williamson ether synthesis is

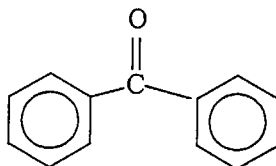
- (A) an E1 process (B) an E2 process (C) an $\text{S}_{\text{N}}1$ process (D) an $\text{S}_{\text{N}}2$ process

69. What is the product of the following reaction?



- (A) (B)
- (C) (D)

70. What is the name of the following compound?



- (A) acetophenone (B) benzaldehyde (C) acetaldehyde (D) benzophenone

(背面仍有題目,請繼續作答)

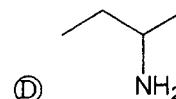
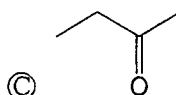
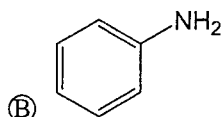
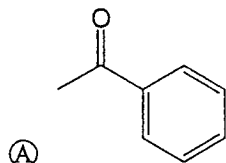
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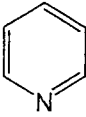
科目：B科目

71. The units used in IR and UV-vis-NIR spectra are cm^{-1} and nm, respectively. Since both of them are electromagnetic waves. IR absorption at 4000 cm^{-1} is equal to:

- (A) 1250 nm (B) 2500 nm (C) 3750 nm (D) 5000 nm

72. John was analyzing an unknown sample. He found an intense absorption centered at 1715 cm^{-1} in its IR spectrum, and several peaks located at $6.5 \sim 7.5 \text{ ppm}$ in its proton NMR spectrum. Which compound shown below is the possible answer for John?



73. Pyridine is frequently used as an organic base. According to its chemical structure, , what kind of amine it is?

- (A) primary amine (B) secondary amine (C) tertiary amine (D) quaternary amine

74. Oxidation reaction of primary alcohol generates:

- (A) aldehyde (B) ketone (C) carboxylic acid (D) ether

75. What metal reacts with an alkyl halide and forms a Grignard reagent?

- (A) Germanium (B) Gallium (C) Manganese (D) Magnesium

76. Which following reaction can NOT give you polyamide (Nylon)?

- (A) diamine + dicarboxylic acid (B) diamine + dichloride
(C) diol + diisocyanate (D) open-ring polymerization of caprolactam

77. Which solvent has the highest density?

- (A) methylene chloride (B) benzene (C) chloroform (D) hexane

78. The water-solubility of amino compounds is dependent on the H^+ concentration of the aqueous solution. Why?

- (A) at high pH, the amino group is protonated
(B) at low pH, the amino group is protonated
(C) at high pH, the amino group is hydrolyzed
(D) at low pH, the amino group is hydrolyzed

79. A plastic container marked with a triangle and number 5 in the center is made of:

- (A) PET (B) PP (C) HDPE (D) PVC

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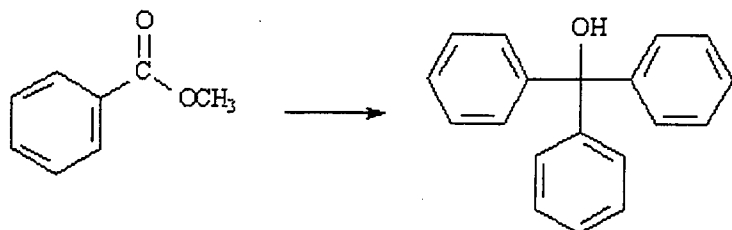
科目：B科目

80. Nature gas is mainly:

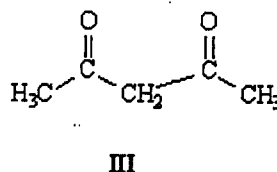
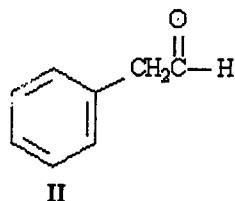
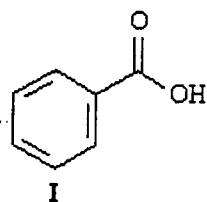
- Ⓐ methane Ⓑ ethane Ⓒ propane Ⓓ butane

81. Which are the best reagent for carrying out the following reaction:

- Ⓐ 1. $(\text{Ph})_2\text{MgBr}$, ether 2. H_3O^+ Ⓑ 1. $(\text{Ph})_2\text{CHMgBr}$, ether 2. H_3O^+
 Ⓒ 1. 2 PhMgBr , ether 2. H_3O^{++} Ⓓ all of the above work

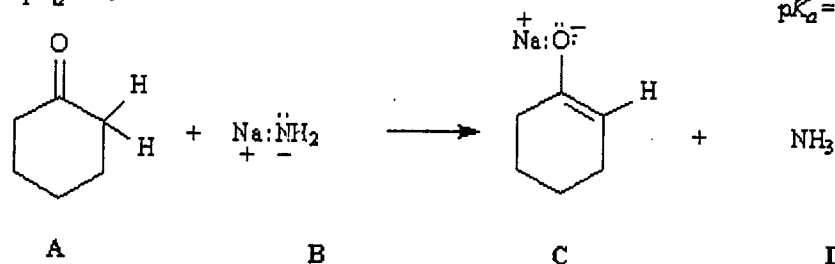
82. Rank the molecules below in order of *increasing* acidity (least acidic to most acidic).

- Ⓐ III, II, I Ⓑ II, III, I Ⓒ I, II, III Ⓓ II, I, III



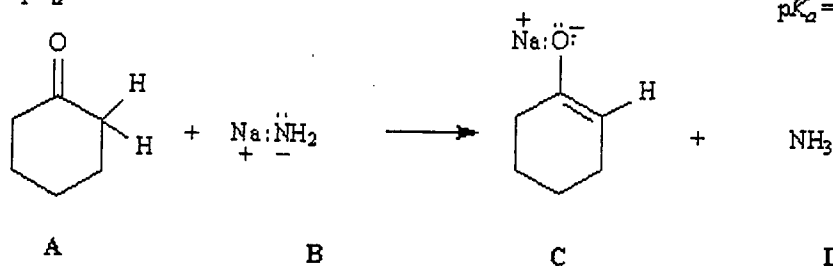
83. The strongest base in the following reaction is

- Ⓐ A Ⓑ B Ⓒ C Ⓓ D
 $\text{p}K_a = 16$ $\text{p}K_a = 36$



84. The enolate ion in the following reaction is

- Ⓐ A Ⓑ B Ⓒ C Ⓓ D
 $\text{p}K_a = 16$ $\text{p}K_a = 36$



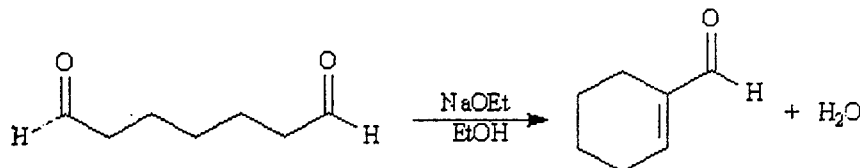
(背面仍有題目,請繼續作答)

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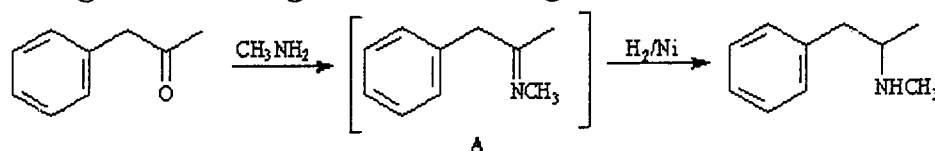
科目：B 科目

85. The following reaction is an example of:

- (A) an intramolecular Claisen condensation (B) an intramolecular aldol condensation
 (C) a Robinson annulation (D) a Michael reaction

86. Methamphetamine can be synthesized by reacting phenyl-2-propanone with methylamine in the presence of H_2/Ni as shown in the following. The intermediate A is an example of an

- (A) imine (B) enamine (C) iminium ion (D) imide



87. Which of the following IR spectrum region corresponds to C=O, C=N, and C=C bond absorptions

- (A) 4000 to 2500 cm^{-1} (B) 2500 to 2000 cm^{-1}
 (C) 2000 to 1500 cm^{-1} (D) below 1500 cm^{-1}

88. The amount of energy in infrared light corresponds to:

- (A) the amount of energy needed to promote one electron from a bonding to an antibonding molecular orbital
 (B) the amount of energy needed to "flip" the spin of a ^{13}C or 1H nucleus
 (C) the amount of energy needed to strip a molecule of one electron to generate a cation radical
 (D) the amount of energy needed to increase certain molecular motions, such as bond vibrations, in organic molecules

89. Examining the infrared spectrum of a compound allows us to:

- (A) determine the types of functional groups present in the compound
 (B) determine the carbon-hydrogen framework of the compound
 (C) determine the molecular weight of the compound
 (D) determine the nature of the conjugated pi electron system in the compound

90. Nuclear magnetic resonance spectroscopy provides information about a molecule's:

- (A) conjugated pi electron system
 (B) size and formula.
 (C) carbon-hydrogen framework.
 (D) functional groups.