

系所組別： 材料科學及工程學系

考試科目： B科目

考試日期：0219，節次：2

※ 考生請注意：本試題 可 不可 使用計算機

B 卷：普通化學(30 題[1-30]，每題 1 分)、材料熱力學(20 題[31-50]，每題 1.5 分)、有機化學(30 題[51-80]，每題 1 分)。滿分 90 分。倒扣至零分為止。

※本卷全部皆為選擇題，請以 2B 鉛筆劃卡作答。

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。

- Which of the following reactions are balanced? (A) $\text{Al} + \text{Fe}_2\text{O}_3 = \text{Al}_2\text{O}_3 + \text{Fe}$, (B) $6 \text{CO}_2 + 6\text{H}_2\text{O} = \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$, (C) $\text{Au} + 2\text{NaCN} + \text{O}_2 + \text{H}_2\text{O} = \text{NaAu}(\text{CN})_2 + 3 \text{NaOH}$ (D) $\text{CaC}_2 + \text{H}_2\text{O} = \text{Ca}(\text{OH})_2 + \text{C}_2\text{H}$
- In a hydrogen-oxygen fuel cell, which of the followings is the anodic reaction in the cell? (A) $2\text{H}_2(\text{g}) + 4\text{OH}^-(\text{aq}) \rightarrow 4\text{H}_2\text{O}(\text{l}) + 4\text{e}^-$ (B) $\text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) + 4\text{e}^- \rightarrow 4\text{OH}^-$ (C) $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l})$ (D) $2\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{H}_2(\text{g}) + \text{O}_2(\text{g})$
- For the reaction $\text{A} + \text{B} \rightleftharpoons \text{C} + \text{D}$, the rate of forward reaction = $k_f[\text{A}][\text{B}]$, the rate for reverse reaction = $k_r[\text{C}][\text{D}]$. What is the equilibrium constant of the above reaction? (A) k_f+k_r , (B) k_f-k_r , (C) k_r-k_f , (D) k_f/k_r .
- Which of the following materials is not a ceramic? (A) Al_2O_3 , (B) SiC, (C) Si_3N_4 , (D) polyethylene.
- Which of the following reactions would you expect to be endothermic at room temperature? (A) $\text{H}_2(\text{g}) \rightarrow 2 \text{H}(\text{g})$, (B) $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$, (C) $\text{H}_2\text{O}(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$, (D) $\text{HCl}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$.
- Which of the following sets of orbitals is arranged in order of increasing energy? (A) $3d < 4s < 4p < 5s < 4d$, (B) $3d < 4s < 4p < 4d < 5s$, (C) $4s < 3d < 4p < 5s < 4d$, (D) $4s < 3d < 4p < 4d < 5s$.
- Which of the following elements should not be able to reduce Cu^{2+} ions to copper metal? (A) Mg, (B) Al, (C) Zn, (D) Ag
- Which of the following elements of the most electronegative? (A) S, (B) P, (C) Cl, (D) Br

(背面仍有題目,請繼續作答)

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9. Which of the reactions with the following values of ΔH and ΔS is non-spontaneous? (A) $\Delta H = -128 \text{ kJ}$; $\Delta S = +35 \text{ J/K}$ at 500K (B) $\Delta H = +67 \text{ kJ}$; $\Delta S = -140 \text{ J/K}$ at 250K. (C) $\Delta H = +75 \text{ kJ}$; $\Delta S = +95 \text{ J/K}$ at 800K (D) $\Delta H = -48 \text{ kJ}$; $\Delta S = +135 \text{ J/K}$ at 400K.
10. Consider the following chemical reaction: $2\text{NO}_2(\text{g}) = \text{N}_2\text{O}_4(\text{g})$. If 25 mL of NO_2 gas is completely converted to N_2O_4 gas under the same condition, what volume will N_2O_4 occupy? (A) 12.5 mL (B) 25 mL (C) 37.5 mL (D) 50 mL
11. The landmark banyan tree at the Kuang-Fu Campus might convert about 88 g of CO_2 per day into carbohydrate at its greatest rate of photosynthesis. How many grams of oxygen does the tree produce in 1 day at this rate?
Hint: photosynthesis: $6\text{CO}_2 + 6\text{H}_2\text{O} \xrightarrow{h\nu} \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$ (A) 64 g (B) 50 g (C) 128 g (D) 32 g
12. Please indicate the number of protons and neutrons in the oxygen-17 nucleus. (A) 8 electrons, 8 neutrons (B) 9 protons, 8 neutrons (C) 8 protons, 9 neutrons (D) 10 protons, 7 neutrons.
13. Please name the electron-pair geometry for the CF_4 molecule. (A) cubic (B) trigonal pyramidal (C) octahedral (D) tetragonal
14. A $\text{Zn}^{2+}(\text{aq})$ solution is electrolyzed ($\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightarrow \text{Zn}(\text{s})$) using a current of 1.6 A. What mass of Zn is plated out after 6 min? Elementary charge: 1.6×10^{-19} coulomb, Avogadro constant: $6.02 \times 10^{23}/\text{mole}$, Zn: 65.4 g/mole. (A) ~ 2 g (B) ~ 0.4 g (C) ~ 0.2 g (D) ~ 0.04 g
15. Please calculate the pH value corresponding to 10^{-5} M (mole/liter) OH^- . (A) 9 (B) 5 (C) 3 (D) 11
16. Please write the chemical formula for xenon trioxide and indicate the oxidation state of xenon. (A) XeO_3 , +3 (B) SeO_3 , +3 (C) NeO_3 , +6 (D) XeO_3 , +6
17. The alloying of metals is of great importance because it is one of the primary ways of modifying the properties of the pure metallic elements. One of the famous examples is that iron containing less than 3% carbon is much harder than pure iron. Such alloying system is classified as (A) substitutional alloy (B) interstitial alloy (C) heterogeneous alloy (D) intermetallic compound.
18. Which of the following compounds are ionic? (A) N_2O (B) CaO (C) CO (D) P_2O_5

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19. What is the maximum number of electrons that can occupy each of the following subshells: 4d, 4f, and 2p? (A) 10, 10, 2 (B) 4, 4, 2 (C) 10, 14, 6 (D) 14, 10, 6
20. Please arrange the size of the following ions: S^{2-} , Cl^- , K^+ , and Ca^{2+} . Hint: atomic numbers of the ions are S (16), Cl (17), K (19) and Ca (20). (A) $Cl^- > S^{2-} > K^+ > Ca^{2+}$ (B) $Ca^{2+} > K^+ > Cl^- > S^{2-}$ (C) $S^{2-} > Cl^- > K^+ > Ca^{2+}$ (D) $Ca^{2+} > Cl^- > S^{2-} > K^+$.
21. A chemical reaction occurring in a stainless steel vessel results in an appearance of water droplets on the outside wall of the vessel. The reaction is (A) combustion (B) endothermic (C) exothermic (D) oxidation
22. Which of the following involves a chemical change? (A) ice skating (B) melting of butter (C) brewing of coffee (D) rusting of steel
23. Which of the following statements is correct? (A) the neutron is positively charged (B) the neutron is negatively charged (C) the mass of a neutron is about the same as that of a proton (D) the neutron has no mass
24. Which of the following statement is correct? (A) Potassium has low second ionization energy (B) He has low first ionization energy (C) Ca has low first and high second ionization energy (D) Ar has high first ionization energy
25. The electronic structure of Na in NaCl and Mg in $MgCl_2$ are: (A) the same (B) Mg has one more electron than Na (C) Na has one more electron than Mg (D) Mg has two more electrons than Na
26. Carbon will form compound with Chlorine to form CCl_4 . The type of bonding in this compound is (A) ionic bonding (B) metallic bonding (C) covalent bonding (D) mechanical bonding
27. Brass is an alloy of zinc and copper. Treatment of 1.500 g of brass with sulfuric acid in apparatus for collecting hydrogen as it forms gave a total of 175 ml of hydrogen (the density of hydrogen is 0.0899g/l). The atomic weight of Zn is 65.37 and of Cu is 63.55. The percentage composition of the brass is, (A) 15%Zn (B) 26%Zn (C) 34%Zn (D) 45%Zn
28. The behavior that C can crystallize in graphite and diamond is said to be, (A) isomorphous (B) polymorphous (C) isotope (D) amorphous

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29. The freezing point of a solution differs from those of the pure solvent by amounts that are directly proportional to, (A) the molal concentration of the solute (B) the electronegativity of the solute (C) the melting point of the solute (D) the electrical conductivity of the solute
30. The boiling temperature of pure water is 100°C at 1 atm. The boiling point of the water solution of sugar should be, (A) $>100^{\circ}\text{C}$ (B) $=100^{\circ}\text{C}$ (C) $<100^{\circ}\text{C}$ (D) no basis for judgement

科目名稱： 材料熱力學

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31. Indicate the wrong statement for the properties of ideal gas (A) internal energy depends only on the temperature (B) internal energy does not depend on volume (C) internal energy does not depend on pressure (D) no heat needed in an isothermal reversible expansion process
32. In a real gas system, when the van der Waals equation, $PV^3 - (Pb + RT)V^2 + aV - ab = 0$, b is to correct (A) the finite volume of the particles (B) the interaction occurring between particles (C) the weight of the particles (D) the temperature of the gas
33. Enthalpy is equivalent to heat when which of the following is constant (A) thermal conductivity (B) pressure (C) volume (D) entropy
34. As an ideal gas undergoes an adiabatic process, which one in the following is correct? ($\gamma = C_p/C_v$, R is the gas constant) (A) $TV^\gamma = \text{constant}$ (B) $PV^\gamma = \text{constant}$ (C) $PV^R = \text{constant}$ (D) none of the above
35. An ideal gas at 300K has a volume of 15 liters at a pressure of 15 atm. Calculate the change in the enthalpy when the gas undergoes for a reversible isothermal expansion to a pressure of 10 atm (A) 0 (B) -8251 J (C) -4235 J (D) 254 J
36. The initial state of one mole of a monatomic ideal gas is $P=10$ atm and $T=300\text{K}$. Calculate the change in the entropy of the gas for a reversible adiabatic expansion to a pressure of 5 atm (A) 0 (B) 1.53J/K (C) 5.76J/K (D) 22.8J/K

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37. The melting point of silver is 1234K and the heat of fusion is 11.2 kJ/mole. For the case of freezing of super-cooled liquid silver at 1073 K, how much heat is released? (A) -109 J (B) -11091 J (C) -1109 J (D) -2350 J
38. Which thermodynamic function has an absolute value? (A) internal energy (B) entropy (C) enthalpy (D) none of the above
39. Evaluate the entropy change of mixing 1 mole of gas A at $P = 1$ atm with 2 moles of A at $P = 2$ atm if the mixing is carried out at constant total volume. (A) 1.14 J (B) 2.28 J (C) 3.42 J (D) 4.56 J
40. 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) impossible to tell
41. For an ideal solution between components A and B, which one of the following characteristics is correct: (A) $\Delta G^M = RT(X_A \ln X_A + X_B \ln X_B)$ (B) entropy change is zero (C) enthalpy change is zero (D) ΔG is zero
42. For a regular solution, which statement is correct: (A) there is no entropy change when solution is formed (B) ΔH is proportional to the volume fraction product of A and B (C) enthalpy change is the same as the ideal solutions (D) enthalpy change is different from ideal solution
43. For a regular solution consisting of A and B, consider the entropy change of formation: (A) $\Delta S =$ can be positive or negative (B) $\Delta S = 0$ (C) $\Delta S = -R(X_A \ln X_A + X_B \ln X_B)$ (D) none of above is correct
44. van der Waals equation and the equation for regular solution have the following characteristics (A) entropy is the same as the ideal condition (B) atoms/molecules exhibit the same interaction (C) behavior deviated from the ideal gas/ideal solution (D) none of above is correct
45. In a regular solution, the parabolic function is used to express (A) entropy (B) volume (C) enthalpy (D) Gibbs free energy.

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46. In a binary solution, the thermodynamic properties of one component may be derived from the experimentally obtained thermodynamic properties of another component based on ① Gibbs-Duhem equation ② Dalton's law ③ Hess law ④ Clapeyron equation
47. In the Ellingham diagram, the oxidation of carbon into carbon monoxide will get ① positive slope ② negative slope ③ nearly horizontal slope ④ nearly vertical slope
48. The slope of Ellingham line is related to what thermodynamic function for that specific reaction? ① equilibrium constant ② entropy ③ enthalpy ④ internal energy
49. After adding metallic impurity into a metal A, in order to see the formation of AO_2 in this alloy at the same temperature compared with the pure metal A, ① equilibrium pO_2 reduced ② equilibrium pO_2 increased ③ alloy will not be oxidized ④ no change in equilibrium pO_2
50. Two Ellingham lines with same slope represent these two reactions have similar thermodynamic property of ① Gibbs free energy change ② entropy change ③ enthalpy change ④ volume change

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。

51. Which compound is more basic? ① alkylamine ② arylamine ③ amide ④ ether
52. Which compound does not undergo nucleophilic acyl substitution reaction? ① amide ② ester ③ aldehyde ④ acid chloride
53. Which compound is more reactive? ① ester ② amide ③ acid chloride ④ acid anhydride
54. Which of the following has the highest boiling point? ① ether ② butan-2-ol ③ hexanoic acid ④ heptan-3-one

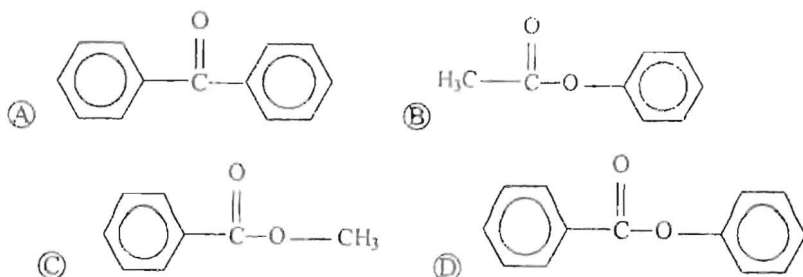
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55. What is the structure for phenylbenzoate ?



56. The common feature of α -substitution and condensation reactions of carbonyl group: (A) involve two carbonyl partners (B) involve the formation of an enol or enolate ion (C) involve a nucleophile (D) produce a new carbon to carbon bond

57. Which of the following does not involve the interaction of molecules with electromagnetic energy? (A) mass spectroscopy (B) infrared spectroscopy (C) ultraviolet spectroscopy (D) nuclear magnetic resonance spectroscopy

58. Which of the following polymers is not synthesized by a condensation polymerization reaction? (A) PE (B) epoxy resin (C) PET (D) polyimide

59. Which of the following polymers is a thermosetting plastic? (A) PVC (B) epoxy resin (C) PC (D) PMMA

60. Which of the following polymers has a lowest T_g ? (A) polycarbonate (B) silicone rubber (C) PVC (D) PMMA

61. Which of the following compounds can be classified as the amine compound? (A) CH_3CN (B) $\text{CH}_3\text{-CNH-CH}_3$ (C) CH_3CONH_2 (D) CH_3NH_2

62. Which is the carbonyl group? (A) C=S (B) C=O (C) C=NH (D) C-OH

63. For the stability of carbocation, which of the following descriptions is correct? (A) Increasing alkyl substitution makes the carbocations more stable. (B) Primary cation is more stable than the secondary cation. (C) The electron donation from substitutive groups decreases the stability of cation. (D) The stability of cation is not related to the substitutive groups.

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64. For the hydroxylation of an alkene, propose the possible alkene that yields the product of $(\text{CH}_3)_2\text{C}=\text{O} + \text{CO}$ on treatment with acidic KMnO_4 (A) Hex-3-ene (B) 1-Propene (C) 2-Methylpropene (D) 1-Butene
65. For the hydrogenation of alkenes, (A) it proceeds as a homogeneous process. (B) the KMnO_4 is used as the catalyst. (C) it occurs in solution. (D) the double bond is reduced.
66. While cyclohexane adopts chair conformation, (A) the ring strain can be reduced. (B) the C-H eclipsing interaction increases. (C) the C-C-C bond angles are close to 102.9° . (D) the molecule becomes flat.
67. The behavior of cycloalkanes is similar to that of open chains in many aspects, for example, (A) both have the same chemical reactivity. (B) both are planar molecules. (C) both are nonpolar. (D) both are able to rotate freely around C-C bond.
68. Which of the following compounds is not the isomers of C_5H_{12} ? (A) Pentane (B) 2,2-Dimethylpropane (C) 2-Methylbutane (D) 2-Methylpropane
69. How many carbon atoms in Undecane, which is a straight-chain alkane? (A) 12 (B) 11 (C) 10 (D) 9
70. Regarding to these different conformations of cyclohexane, (A) they are equally stable. (B) the conversion between these conformations are more or less forbidden. (C) the so-called 1,3-diaxial interaction can be responsible for the involved steric strain. (D) the involved amounts of ring strain are equal.
71. The specific rotation $[\alpha]_D$ in a polarimeter measurement is NOT related to: (A) the intensity of incident light (B) the solution concentration (C) the observed rotation (D) the light path length
72. Stereoisomers do NOT describe: (A) (+)-Limonene vs. (-)-Limonene. (B) *n*-Butane vs. Isobutane (C) (*R*)-(+)-Lactic acid vs. (*S*)-(-)-Lactic acid (D) *cis*-2-Butene vs. *trans*-2-Butene

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73. Which description below is INCORRECT? (A) S_N reactions mean "Nucleophilic Substitution Reactions". (B) Steric effects in S_N2 Reactions are crucial. (C) S_N2 reaction rate depends on the concentration of the nucleophilic only. (D) S_N2 reactions are relatively slower than S_N1 reactions.
74. Name the compound $CH_3CH_2CH_2-Br$: (A) 1-Brominepropane (B) Isopropyl bromide (C) 3-Bromopropane (D) 1-bromicpropane
75. Phenols can directly react with NaOH, but Methanol can not. Why? (A) Phenol is aromatic alcohol. Its boiling point is much lower than other alcohols. (B) Phenol is aromatic alcohol. Its pKa is much lower than other alcohols. (C) Phenol molecules easily crystallize. (D) Methanol is more hydrophilic than phenol.
76. Ethylene Glycol (EG) is one of the important reagents for chemical/plastics industrials. What is its chemical structure? (A) $HO-CH_2CH_2-OH$ (B) $HO-CH_2CH_2-SH$ (C) $HO-CH=CH-OH$ (D) $HO-CH=CH-SH$
77. Linear glucoses undergo the polymerization to form the cellulose or the starch. Which of the following groups involve in this particular reaction: (A) hemiacetals and acetals (B) esters (C) enolates and aldehydes (D) ethers
78. Regarding to the nucleophilic (Nu) addition reactions to the carbonyl groups, which descript is INCORRECT: (A) The reaction can be carried out under basic or acidic conditions. (B) Nu must be negatively charged nucleophiles. (C) Nu approaches 45° to the plane of $C=O$ (D) Nu approaches and adds to carbon
79. The addition of Grignard reagents to aldehydes generates: (A) Esters (B) Ketones (C) primary alcohols (D) secondary alcohols
80. A carbonyl group usually gives a strong infrared absorption at about: (A) $2850 - 3000\text{ cm}^{-1}$ (B) $1670 - 1780\text{ cm}^{-1}$ (C) $1050 - 1150\text{ cm}^{-1}$ (D) $600 - 800\text{ cm}^{-1}$