

系所組別：材料科學及工程學系

考試科目：B科目

考試日期：0307 · 節次：2

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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(20 題[51-70]，每題 1.5 分)。滿分 90 分。倒扣至零分為止。

科目名稱：普通化學

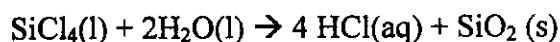
每題為 4 選 1，每一題答對得 1 分，答錯倒扣 0.25 分。

1. Which substance of the following reaction is oxidizing agent?



- Ⓐ $\text{H}_2\text{O}(\text{l})$ Ⓑ $\text{O}_2(\text{g})$ Ⓒ $\text{H}_2\text{O}_2(\text{l})$ Ⓓ none of the above

2. Which substance of the following reaction is reducing agent?



- Ⓐ $\text{SiCl}_4(\text{l})$ Ⓑ $\text{H}_2\text{O}(\text{l})$ Ⓒ $\text{HCl}(\text{aq})$ Ⓓ none of the above

3. A piece of Cu metal (1.06g) is placed in 250ml of 0.20M AgNO_3 solution. What would you expect to happen?

- Ⓐ No reaction Ⓑ produce brown precipitate
Ⓒ the Cu metal disappears Ⓓ produce yellow gas

4. Rust stains (Fe_2O_3) can be removed by washing the surface with a dilute solution of oxalic acid ($\text{H}_2\text{C}_2\text{O}_4$). Which of the following statements is correct?

- Ⓐ This reaction is an oxidation-reduction reaction
Ⓑ The rust stains are reduced
Ⓒ The oxalic acid is oxidized
Ⓓ There is no change in oxidation number of any element

5. The correlation between the equilibrium constant and the reaction rate is,

- Ⓐ larger equilibrium constant gives rise to higher reaction rate
Ⓑ higher equilibrium constant gives rise to slower reaction rate
Ⓒ equilibrium constant and reaction rate are irrelevant
Ⓓ reaction rate is influenced by the equilibrium constant only at high temperature

6. The K_a values are given in parenthesis for the following acids. HF (7.2×10^{-4}), HNO_2 (4.0×10^{-4}), HCN (6.2×10^{-10}), NH_4^+ (5.6×10^{-10}). Which of the following sequence is correct?

- Ⓐ Base strength $\text{F}^- < \text{NO}_2^- < \text{H}_2\text{O} < \text{CN}^-$

(背面仍有題目,請繼續作答)

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- (B) Base strength $F^- > NO_2^- > H_2O > CN^-$
 (C) Base strength $H_2O < F^- < NO_2^- < CN^- < NH_3$
 (D) Base strength $F^- < NO_2^- < H_2O < CN^- < NH_3$

7. Which of the following electron configurations is correct?

- (A) Cr: $[Ar]4s^23d^4$ (B) Cu^+ : $[Ar]4s^23d^8$ (C) Cu^{2+} : $[Ar]3d^9$ (D) V: $[Ar]4s^13d^4$

8. Given that $K_a(NH_4^+) = 5.6 \times 10^{-10}$, $K_a(HCN) = 6.2 \times 10^{-10}$, the aqueous solution of NH_4CN will be,

- (A) basic (B) neutral (C) acidic (D) not known

9. Considering the reaction, $CH_3CO_2H(aq) + H_2O(l) = CH_3CO_2^-(aq) + H_3O^+(aq)$ $K_a = 1.8 \times 10^{-5}$

Which of the following statements is incorrect?

- (A) H_2O and $CH_3CO_2^-$ are competing for proton
 (B) H_2O is the stronger base than $CH_3CO_2^-$
 (C) H_2O is the weaker base than $CH_3CO_2^-$
 (D) CH_3CO_2H is not competing for proton.

10. Which of the following orbital designs is incorrect?

- (A) 1s (B) 1p (C) 3d (D) 4f

11. Regarding the chemical bonding, which of the following statements is incorrect?

- (A) covalent bond involves sharing of electron pairs
 (B) ionic bond involves sharing of electron pairs
 (C) electronegativity is the ability of an atom in a molecule to attract electron
 (D) polar covalent bond involves unequal sharing of electron pair

12. Which of the followings is disproportional to intermolecular force?

- (A) surface tension (B) viscosity (C) boiling point (D) vapor pressure

13. The glucose solution in water may exhibit

- (A) higher boiling point than water
 (B) lower boiling point than water
 (C) same boiling point as water
 (D) lower boiling point than water at $< 1\%$ concentration

14. The balanced equation for the reaction of gaseous nitrogen dioxide and fluorine is: $2NO_{2(g)} +$

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$F_{2(g)} \rightarrow 2NO_2F_{(g)}$. The experimentally determined rate law is: $Rate = k[NO_2][F_2]$. Which of the following suggestion mechanism for this reaction is acceptable?

- (A) $NO_2 + F_2 \rightarrow NO_2F + F$ (slow); $F + NO_2 \rightarrow NO_2F$ (fast)
 (B) $NO_2 + F_2 \rightarrow NO_2F + F$ (fast); $F + NO_2 \rightarrow NO_2F$ (slow)
 (C) $NO_2 + F_2 \rightarrow NOF + OF$ (fast); $NOF + OF + NO_2 \rightarrow 2NO_2F$ (slow)
 (D) $NO_2 + F_2 \rightarrow NF_2 + O_2$ (slow); $NF_2 + O_2 + NO_2 \rightarrow 2NO_2F$ (fast)

15. Which one of the following descriptions is CORRECT?

- (A) $AgNO_{3(aq)} + KCl_{(aq)} \rightarrow AgCl_{(s)} + KNO_{3(aq)}$ is a precipitate reaction
 (B) $NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O$ is a oxidation-reduction reaction
 (C) $2Na_{(s)} + Cl_{2(g)} \rightarrow 2NaCl_{(s)}$ is an precipitate reaction
 (D) $CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(g)}$ is an acid-base reaction

16. Which one of the following descriptions about chemical bonds is CORRECT?

- (A) Bonds are defined as forces that hold groups of molecules together and make the molecules functions as a unit.
 (B) The energy that are required to break the bond is called the ionization energy.
 (C) Ionic bond are formed when an atom that loses electrons relatively easily reacts with an atom that has low affinity for electrons.
 (D) Covalent bond are formed in the hydrogen molecule and in many other molecules in which electrons are shared by nuclei.

17. Which one of the following hybrid orbital is NOT possible for carbon atom in a molecule?

- (A) sp hybridization
 (B) sp^2 hybridization
 (C) sp^3 hybridization
 (D) dsp^3 hybridization

18. The infrared spectrum of gaseous CH_4 , CO_2 , C_2H_2 and H_2O shows the $v=0$ to $v=1$ transition at 2850 cm^{-1} , 1690 cm^{-1} , 1640 cm^{-1} and 3610 cm^{-1} , respectively. Which one of the following sequence of force constant for the corresponding bond is CORRECT?

- (A) $C-H > C=O > C=C > O-H$
 (B) $C=C > C=O > C-H > O-H$
 (C) $C=C > C-O > C-H > O-H$
 (D) $C=C > C-O > O-H > C-H$

19. Consider the following elements, which one of the following sequences of first ionization energy is NOT correct?

- (A) $He > Ne > Ar > Kr$
 (B) $N > C > B > Be$
 (C) $Ne > Mg > Na$
 (D) $H > Li > Na > K$

(背面仍有題目,請繼續作答)

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20. Which one of the following molecule is expected to have a dipole moment?

- Ⓐ CCl₄ Ⓑ SO₂ Ⓒ CO₂ Ⓓ CH₄

21. In the reaction: CH₄ (g) + 2O₂ (g) → CO₂ (g) + 2H₂O (g), which of the following statement is **incorrect**?

- Ⓐ The oxidation state of O changed from 0 to -2
Ⓑ The oxidation state of C changed from -4 to +4
Ⓒ CH₄ is the oxidizing agent
Ⓓ Oxygen is reduced

22. About the properties of H₂O, which of the following is **incorrect**?

- Ⓐ It is amphoteric Ⓑ The H-O bonds forms an angle of 120°
Ⓒ Its IUPAC name is oxidane Ⓓ It's a polar molecule

23. The pH value of a 2.0 M solution of CH₃NH₂ is (K_b = 4.38 × 10⁻⁴):

- Ⓐ 12.17 Ⓑ 13.56 Ⓒ 10.28 Ⓓ 1.68

24. About atomic radius, which of the following is true?

- Ⓐ Be < C Ⓑ Si > Na Ⓒ Mg > Ca Ⓓ Al > Cl

25. Which one of the following descriptions on the galvanic cells is **correct**?

- Ⓐ The oxidation involves a gain of electrons or a decrease in oxidation number.
Ⓑ Electrons are transferred from the oxidizing agent to the reducing agent.
Ⓒ A galvanic cell is a device in which chemical energy is changed to electrical energy.
Ⓓ Oxidation occurs at the cathode.

26. Which one of the following descriptions on acids and bases is **correct**?

- Ⓐ Bases produce hydrogen ions in aqueous solution, and acids produce hydroxides ions.
Ⓑ The conjugate acid is everything that remains of the acid molecule after a proton is lost.
Ⓒ The H⁺ is simply expressed as it is hydrated in aqueous solutions.
Ⓓ A strong acid is obtained when the acid dissociation at equilibrium is low.

27. Which one of the following descriptions on acid strength (for a weak acid HA and its conjugate base A⁻) is **correct**?

- Ⓐ For weak acid, K_a is large.
Ⓑ For weak acid, equilibrium concentration of H⁺ is comparable with original concentration of HA.

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Ⓓ B has larger volume and lower temperature

37. When a piece of steel A with temperature of 30 °C and a piece of aluminum B with temperature of 50 °C were put in contact side by side, which of the following is true

- Ⓐ the Al atom will diffuse into steel A
- Ⓑ configuration entropy will not increase
- Ⓒ total entropy will not be affected
- Ⓓ thermal entropy will not increase

38. In the diagram of enthalpy versus temperature, the discontinuity at certain temperature usually means

- Ⓐ overheating
- Ⓑ the phase change
- Ⓒ supercooled state
- Ⓓ oxidation

39. When pressure is constant, enthalpy is equivalent to

- Ⓐ heat
- Ⓑ internal energy
- Ⓒ entropy
- Ⓓ work

40. Which activity coefficient is an indication of a eutectoid solid solution?

- Ⓐ 0
- Ⓑ 0.5
- Ⓒ 1.0
- Ⓓ 1.5

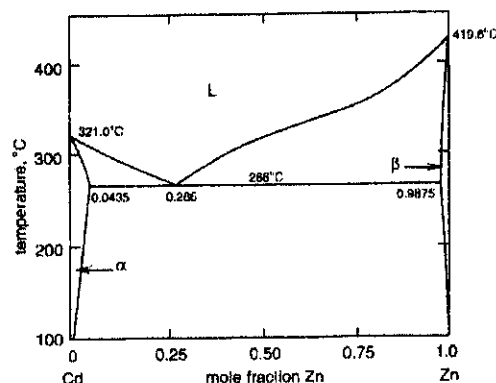
41. Which property cannot be derived from the first law of thermodynamics alone?

- Ⓐ free energy
- Ⓑ work
- Ⓒ internal energy
- Ⓓ heat

42. At constant pressure, when temperature increases, Gibbs free energy

- Ⓐ always increases
- Ⓑ always decreases
- Ⓒ does not change
- Ⓓ increases following by decreasing

Consider the phase diagram for the system Cd-Zn at 1 atm pressure, answer the following questions (Q43-Q45)



(背面仍有題目,請繼續作答)

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- (A) The molar Gibb's free energy of formation is $\Delta G^M = RT(X_B \ln a_A + X_A \ln a_B)$
- (B) For equilibrium between phase α and phase β : $a_A(\text{in } \alpha) = a_B(\text{in } \beta)$
- (C) In a regular solution, when $\alpha = 2$, immiscibility is likely to happen
- (D) The A-liquidus composition are given by $-\Delta G_{m(A)}^0 = RT \ln X_A$

47. Consider a system of water and 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,

- (A) spontaneous evaporation of water occurs
- (B) entropy remains unchanged in the water-vapor system;
- (C) heat is transferred from the heat reservoir to the water-vapor system.
- (D) When a complete reversibility is approached, the process becomes infinitely slow.

48. Which one of the following descriptions on entropy is correct?

- (A) Entropy is a not state function.
- (B) The entropy of a system increases when the system undergoes a reversible process.
- (C) The entropy change decreases when a process of phase change is completed.
- (D) Entropy is independent of reaction paths when the system conducted reversibly.

49. Which one of the following descriptions on the reversible heat transfer is correct?

- (A) Reversible heat flow is degraded as a maximum work performed in a system.
- (B) The heat transfer is so fast that the system remains in equilibrium throughout the process.
- (C) The process from an initial state to a final state can be returned when a maximum work is performed.
- (D) The system or the surroundings suffer an overall change.

50. Which one of the following descriptions on the heat of fusion and vaporization at normal melting and boiling temperatures is correct?

- (A) The temperatures correspond to low temperature.
- (B) For fusion, the volume change is much higher than for vaporization.
- (C) The difference between the change of internal energy and the change of enthalpy is very small.
- (D) A vapor pressure is attained when the rates of evaporation and condensation are not equal.

(背面仍有題目,請繼續作答)

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每題為 4 選 1，每一題答對得 1.5 分，答錯倒扣 0.375 分。

51. Which group is ortho- and para-directing activator in electrophilic aromatic substitution?

- (A) -Cl (B) -CN (C) -NO₂ (D) -OH

52. The molecules which contain chirality centers and a plane of symmetry are:

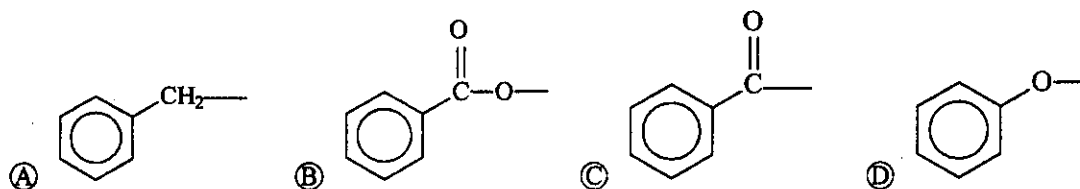
- (A) meso compound (B) racemates (C) enantiomers (D) diastereomers

53. What is the structure of tetrahydrofuran (THF)?

54. Which one is the poorer leaving group in S_N2 reaction?

- (A) F⁻ (B) I⁻ (C) Cl⁻ (D) OH⁻

55. What is the benzoyl group?



56. What is the most common reaction of carboxylic acids ?

- (A) nucleophilic addition (B) nucleophilic substitution
(C) electrophilic addition (D) electrophilic substitution

57. Acid chlorides react with amines to yield:

- (A) ester (B) acetal (C) nitrile (D) amide

58. Aldehydes and ketones are easily reduced to yield:

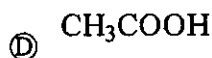
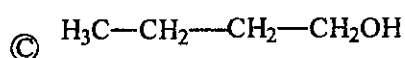
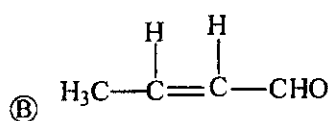
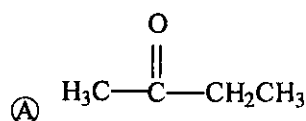
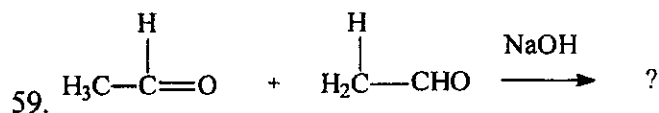
- (A) alcohols (B) esters (C) acid (D) alkane

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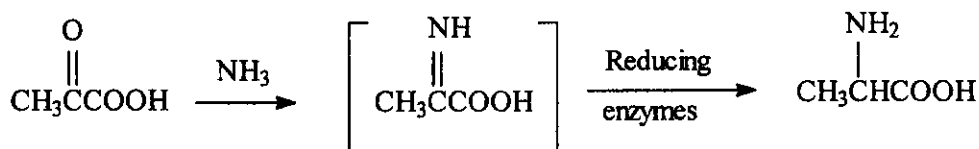
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60. The intermediate in the reaction is :



(A) imine

(B) enamine

(C) imide

(D) iminium ion

61. The configuration of each chiral carbon in a molecule can be designated in terms of the symbol *R* and *S*. Which of the following description is **not** correct?

(A) There must be four different ligands covalently bonded to this chiral carbon atom.

(B) The configuration of *R* can be switched to configuration *S* by consecutive rotation around single bonds.

(C) *R* configuration can not superimpose with the *S* configuration.

(D) This difference in configurations can cause the molecular behavior and reactivity to be very different.

62. Compare physical and chemical properties of enantiomers, which of the following description is correct?

(A) Their chemical properties are the same toward achiral solvent

(B) Enantiomers are not optical active

(C) The racemic form is optical active

(D) The melting point of enantiomers usually is different.

63. Which of the following description is **not** considered as the aromatic characters of benzene molecules?.

(A) Thermal stability

(B) Substitution rather than addition reactions with polar reagents

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- © Easy to be oxidized by KMnO_4 and HNO_3
© Unique nuclear magnetic resonance spectra.
64. About the name and molecular formula, which of the following pairs is **not** proper?
① ethyl alcohol: $\text{CH}_3\text{CH}_2\text{OH}$ ② Ethyl dihalide: $\text{CH}_3\text{CH}_2\text{X}$
③ Borane: H_2BH ④ Sulfuric acid: HOSO_3OH
65. Considering the reversible reaction, $\text{RCH}_2\text{CH}_2\text{OH} \rightleftharpoons \text{RCH}=\text{CH}_2 + \text{H}_2\text{O}$ which of the following description is **not** correct?
① High H_2O concentration and temperature favor alkene formation by dehydration.
② Hydration of alkene occurs at low temperature and with dilute acid which provides a high concentration of H_2O .
③ The reverse process proceeds through the same intermediates and transition states, but in the opposite order.
④ This is a reaction about the dehydration of alcohols and hydration of alkenes.
66. Comparing the relative reactivities of HX to alkene, which of the following description is **not** correct?
① The relative reaction rate depends on the ability of HX to donate an H^+ to form an R^+ in the rate controlling step
② HI is a stronger acid than HBr
③ The reactivity of HBr is lower than the HCl
④ The reactivities are directly related to the stabilities of the intermediate R^+
67. Comparing the solubility and boiling point of alkane with those of corresponding alkene, which of the following description is **not** correct?
① Both of them are nonpolar compounds.
② Both of them are not soluble in water.
③ The π bond of alkene is stronger and less reactive than the σ bond.
④ Boiling points of alkenes are close to those of alkanes and similarly have 20°C increments per carbon atom.
68. Which of the following compound is **NOT** nucleophile?
① NH_3 ② OH^- ③ Cl^- ④ Br_2
69. Which of the following description regarding Markovnikov's rule is **NOT** correct?

