

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）

考試日期：0301，節次：2

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。

- If an electron is added to neutral chlorine atom (Cl), which one of the following description is **correct**?
 - The chloride ion contains 16 electrons.
 - The chloride ion is a cation.
 - The solid sodium chloride packs together with a covalent bonding.
 - The chlorine gas is a green gas composed of Cl_2 molecules.
- The electron configuration for Fe is
 - $[\text{Ar}]4s^23d^6$
 - $[\text{Ar}]4s^23d^7$
 - $[\text{Ar}]4s^23d^8$
 - $[\text{Ar}]4s^23d^0$
- Which part of the metal surfaces is much resistant to corrosion?
 - The deformed site;
 - the sharpened site;
 - the defective site;
 - the smooth surface.
- Which one of the following charges in polyatomic ions is **incorrect**?
 - SO_4^{2-} ,
 - CrO_4^{2-} ,
 - NH_4^+ ,
 - MnO_4^{2-}
- Which one of the following descriptions on the buffered solutions, $\text{OH}^- + \text{HA} \rightarrow \text{A}^- + \text{H}_2\text{O}$, is **correct**?
 - A buffered solution is one that gives a change in pH when either hydroxide ions or protons are removed.
 - A buffered solution with a constant pH for blood is vital, because cells can survive only in a very narrow pH range.
 - Buffered solutions are simply solutions of strong acids or bases containing a common ion.
 - The net result of buffering is that the equilibrium concentration OH^- and thus the pH are determined by the ratio $[\text{HA}]/[\text{A}^-]$ (for a weak acid HA and its conjugate base A^-).
- The number of electrons in outer shell of the group V is
 - 3
 - 4
 - 5
 - 6.

(背面仍有題目,請繼續作答)

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13. What compound is formed by combining 1 g of oxygen with 1.750 g of nitrogen?
Ⓐ N_2O , Ⓑ NO , Ⓒ NO_2 , Ⓓ N_2O_3 .
14. The mass of proton is:
Ⓐ 9.11×10^{-31} kg, Ⓑ 1.67×10^{-27} kg, Ⓒ 1.602×10^{-19} kg, Ⓓ 1 g.
15. What is the charge of a neutron?
Ⓐ $+1.6 \times 10^{-19}$ C, Ⓑ -1.6×10^{-19} C, Ⓒ $\pm 1.6 \times 10^{-19}$ C, Ⓓ none.
16. How many neutrons are in a carbon atom?
Ⓐ 12, Ⓑ 6, Ⓒ 4, Ⓓ 1.
17. Which of the following element does not belong to halogen group?
Ⓐ Br, Ⓑ Cl, Ⓒ S, Ⓓ I.
18. Give the name of the Na_2SO_3 compound.
Ⓐ nickel sulfate, Ⓑ sodium sulfite, Ⓒ sodium sulfate, Ⓓ nickel sulfide.
19. What volume of 0.200 M HCl will react completely with 50.00 ml of 0.100 M NaOH?
Ⓐ 100 ml, Ⓑ 50 ml, Ⓒ 25 ml, Ⓓ 12.5 ml.
20. A methane gas that has a volume of 3.8 L at $5^\circ C$ is heated to $86^\circ C$ at constant pressure. What is its new volume?
Ⓐ 2.9 L, Ⓑ 3.8 L, Ⓒ 4.3 L, Ⓓ 4.9 L.
21. The has pressure in an evacuated vessel is 0.01 torr. What is the pressure inside this vessel in terms of standard atmosphere (atm)?
Ⓐ 7.6, Ⓑ 0.01, Ⓒ 0.0013, Ⓓ 1.13×10^{-5} .
22. What is the pH value of a solution containing 1.0×10^{-5} M of OH^- ions?
Ⓐ -5, Ⓑ 5, Ⓒ -9, Ⓓ 9.
23. Which of the following is relatively a weak acid?
Ⓐ CH_3COOH , Ⓑ HCl, Ⓒ H_2SO_4 , Ⓓ HF.
24. Consider the reaction of acetic acid in water: $CH_3COOH_{(aq)} + H_2O_{(l)} = CH_3COO^-_{(aq)} + H_3O^+_{(aq)}$. Which two bases are competing for the proton?

(背面仍有題目,請繼續作答)

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Acronyms: R=gas constant, T=temperature, V=volume, P=pressure, U=internal energy, H=enthalpy; G=Gibbs free energy; A=Helmholtz free energy; S=entropy, q=heat, w=work, C_p =heat capacity at constant pressure; C_v =heat capacity at constant volume
Gas constant: $R=8.314 \text{ J/mol-K}=0.082 \text{ l-atm/mol-K}$

31. Compare the entropy change for the oxidation reaction of Mg (I), and the oxidation reaction of Al(II),
- Ⓐ the entropy change for the reaction I will be close to reaction II;
 - Ⓑ the entropy change for the reaction I will be positive and 50% more than the reaction II;
 - Ⓒ the entropy change for the reaction I will be 50% more negative than the reaction II;
 - Ⓓ the entropy change for the reaction II will be 50% more negative than the reaction I.
32. In the phase diagram of one component system, pressure is plotted as a function of temperature. During the transition from liquid state to vapor state, which of the following is true?
- Ⓐ dP/dT is positive;
 - Ⓑ it is endothermic reaction;
 - Ⓒ the volume change from solid to vapor is increasing;
 - Ⓓ all of above are correct.
33. When we plot Gibbs free energy, G vs pressure, P at constant temperature, generally, G of the solid phase looks like
- Ⓐ a curve with increasing slope;
 - Ⓑ a straight line with positive slope;
 - Ⓒ a curve with decreasing slope;
 - Ⓓ a straight line with negative slope.
34. The relationship between the variations of temperature and pressure which is require for the maintenance of equilibrium between two different phases may be expressed by the
- Ⓐ van der Waals equation;
 - Ⓑ Ellingham line;
 - Ⓒ Gibbs Duhem equation;
 - Ⓓ Clapeyron equation.
35. Assume $P_A^0=0.04\text{atm}$ and $P_B^0=0.05 \text{ atm}$, for an ideal solution of 40% of A and 60% of B, the partial pressures of A and B are:
- Ⓐ 0.016atm and 0.03atm;
 - Ⓑ 0.02 atm and 0.024 atm;
 - Ⓒ 0.024atm and 0.02atm;
 - Ⓓ 0.036 atm and 0.054atm.

(背面仍有題目,請繼續作答)

36. When A and B forms Henrian solution behavior with very strong negative deviation, which one of the following statement is correct:

- Ⓐ the partial pressure of each component is much smaller than the Raoultian solution;
- Ⓑ there is no interaction between A and B;
- Ⓒ there is strong repulsion force between A and B;
- Ⓓ none of above is correct.

37. Which substance has the lowest absolute entropy?

- Ⓐ liquid gold;
- Ⓑ solid gold;
- Ⓒ liquid silicon;
- Ⓓ solid silicon.

38. At 100°C,

- Ⓐ $C_p > C_v$;
- Ⓑ $C_p = C_v$;
- Ⓒ $C_p < C_v$;
- Ⓓ all above answers are possible.

39. Internal energy is constant when

- Ⓐ entropy and volume are constant;
- Ⓑ entropy or volume is constant;
- Ⓒ volume and temperature are constant;
- Ⓓ volume or temperature is constant.

40. $(a + bT + cT^2)$ is often a description of

- Ⓐ entropy
- Ⓑ heat capacity
- Ⓒ heat conductivity
- Ⓓ activity

41. It is most reasonable for a gas engine to have an efficiency of

- Ⓐ 0.3;
- Ⓑ 1.0;
- Ⓒ 10;
- Ⓓ 100.

42. Which remains unchanged during free expansion of an ideal gas?

- Ⓐ pressure;
- Ⓑ Gibbs free energy;
- Ⓒ entropy;
- Ⓓ internal energy.

43. Which one of the following statements is related with the zeroth law of thermodynamics?

- Ⓐ At $T=zero$, $V=P=zero$.
- Ⓑ For A, B, C three systems, if $T_A=T_C$ and $T_B=T_C$, then $T_A=T_B$.
- Ⓒ As $T \rightarrow zero$, free energy $\rightarrow zero$.
- Ⓓ None of above.

44. Regarding the work, heat and energy, which of the following statements correct?

- Ⓐ The work done on an adiabatic system can be converted to internal energy completely.
- Ⓑ The mechanical work done on a system will become the kinetic energy and dissipated heat.
- Ⓒ The work done on an adiabatic system is not a state function.

Ⓓ Heat can be converted to the performed work completely.

45. If the volume of a system is maintained constant ($=V_0$) during a process and the mechanical work is the only source of work, then

- Ⓐ work performed $= \Delta PV_0$; Ⓑ the absorbed heat $= \Delta PV_0$;
 Ⓒ the work performed $= \Delta U$; Ⓓ the absorbed heat $= \Delta U$.

46. Regarding the molar heat capacity of at constant volume, c_v ,

- Ⓐ $c_v = \delta q_v / dT$; Ⓑ $c_v = dU / dT$;
 Ⓒ $c_v = R$ for ideal gas; Ⓓ $c_v = 2R$ for diatomic gases (e.g. $H_2, O_2 \dots$).

47. For an ideal gas undergoing a reversible process,

- Ⓐ $\delta w = \text{zero}$ when the process is adiabatic; Ⓑ $\delta q = \delta w$ when the process is adiabatic;
 Ⓒ $\delta q = \text{zero}$ when the process is isothermal; Ⓓ $dU = \text{zero}$ when the process is isothermal.

48. Let $\alpha = \frac{1}{V} \left(\frac{\partial V}{\partial T} \right)_P$ and $\beta = -\frac{1}{V} \left(\frac{\partial V}{\partial P} \right)_T$, then $C_p - C_v = ?$

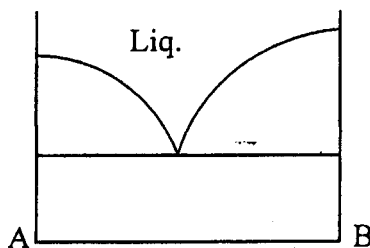
- Ⓐ $PV\alpha\beta$; Ⓑ $V(1 - T\alpha)$; Ⓒ $\frac{TV\alpha^2}{\beta}$; Ⓓ $\frac{TV\alpha}{\beta}$.

49. According to Maxwell's equations, which one of the follows is NOT correct?

- Ⓐ $\left(\frac{\partial T}{\partial V} \right)_S = - \left(\frac{\partial P}{\partial S} \right)_T$; Ⓑ $\left(\frac{\partial S}{\partial V} \right)_T = \left(\frac{\partial P}{\partial T} \right)_V$;
 Ⓒ $\left(\frac{\partial S}{\partial P} \right)_T = - \left(\frac{\partial V}{\partial T} \right)_P$; Ⓓ $\left(\frac{\partial T}{\partial P} \right)_S = \left(\frac{\partial V}{\partial S} \right)_P$.

50. The phase diagram of a binary A-B system with regular solid and liquid solutions is shown below. Then,

- Ⓐ $\Omega_l \gg 0$ and $\Omega_s \ll 0$; Ⓑ $\Omega_l \ll 0$ and $\Omega_s \gg 0$;
 Ⓒ $\Omega_l \approx 0$ and $\Omega_s \ll 0$; Ⓓ $\Omega_l \approx 0$ and $\Omega_s \gg 0$.



(背面仍有題目,請繼續作答)

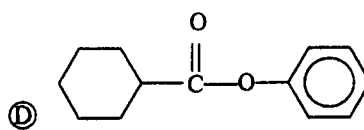
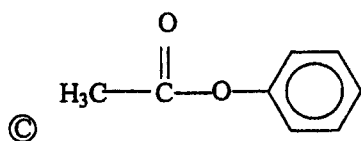
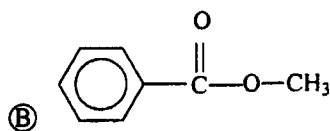
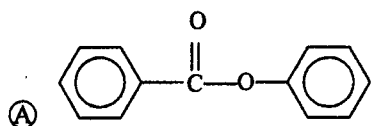
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科目名稱：有機化學

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51. What is the structure of phenylbenzoate?



52. Which reaction is not an electrophilic aromatic substitution?

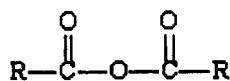
(A) Friedel-Crafts alkylation

(B) nitration

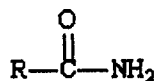
(C) sulfonation

(D) aldol reaction

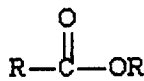
53. What is the order of *decreasing* reactivity towards nucleophilic acyl substitution for the carboxylic acid derivatives? (most reactive first)



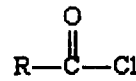
I



II



III



IV

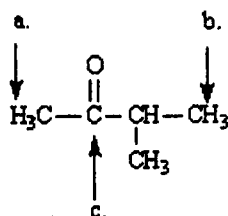
(A) I, III, II, IV

(B) II, III, I, IV

(C) III, II, I, IV

(D) IV, I, III, II

54. What is the splitting pattern for the hydrogens in 3-methyl-2-butanone labeled b.?



(A) septet

(B) quartet

(C) doublet

(D) singlet

55. Which substituent in an aromatic compound is a meta-directing Activator:

(A) Br

(B) OH

(C) COOH

(D) OCH₃

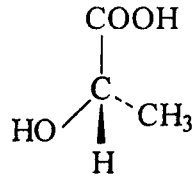
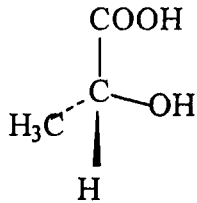
56. Which compound has the highest reactivity toward Friedel-Craft acylation?

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- Ⓐ Anisole Ⓑ Toluene Ⓒ Nitrobenzene Ⓓ Bromobenzene

57. The following two compounds are:

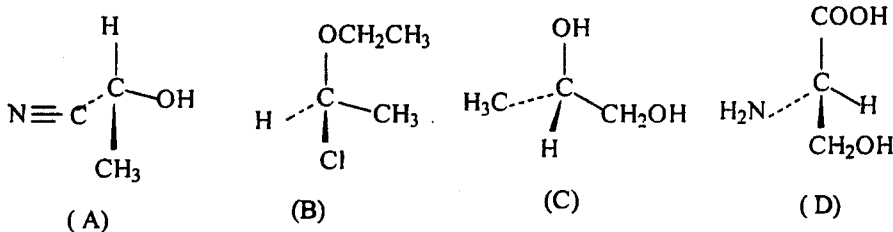


- Ⓐ Diastereomers Ⓑ Meso compounds
 Ⓒ Constitutional isomers Ⓓ Enantiomers

58. Which of the following compound is chiral?

- Ⓐ 5-ethyl-3,3-dimethylheptane Ⓑ 2,4-Dimethylheptane
 Ⓒ cis-1,3-Dimethylcyclohexane Ⓓ none of them

59. Which of the following compound is S configuration ?

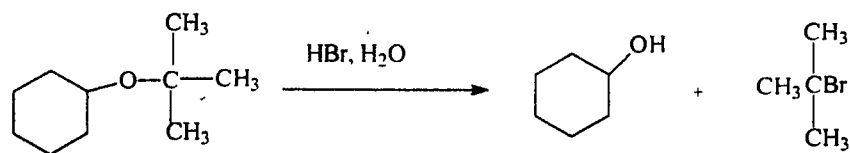


- Ⓐ (A) Ⓑ (B) Ⓒ (C) Ⓓ (D)

60. Which leaving group is more reactive in Sn2 reaction ?

- Ⓐ OH⁻ Ⓑ NH₂⁻ Ⓒ Cl⁻ Ⓓ I⁻

61. What kind of reaction is the following reaction?



- Ⓐ E1 Ⓑ E2 Ⓒ S_N1 Ⓓ S_N2

62. Many nucleophilic addition reactions of aldehydes and ketones are catalyzed by acid or base.

Bases catalyze hydration by:

- Ⓐ making the carbonyl group more electrophilic
 Ⓑ shift the equilibrium of the reaction

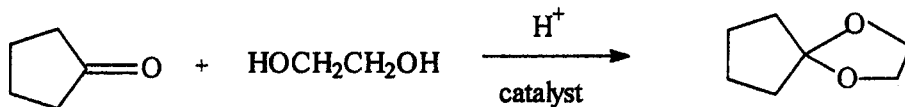
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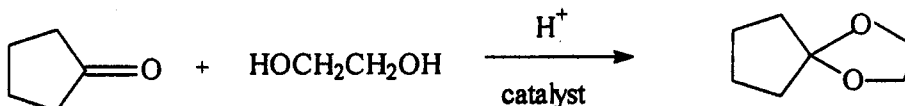
- making the carbonyl group less electrophilic
 converting the water to hydroxide ion, a much better nucleophile

63. The product of the reaction is called:



- an acetal an ylide a gem diol a hydrate

64. The nucleophile of the reaction is?



- C1CCCC1=O HOCH2CH2OH H^+ catalyst

65. Acetals are valuable to organic chemists because they can serve as:

- nucleophiles electrophiles protecting groups leaving group

66. Which type of excitation can be caused by infrared light?

- electronic spin
 nuclear spin
 electronic excitation from ground state to excited state
 excitation of molecular vibration.

67. Which of the following electronic transitions detectable by UV spectrophotometers requires largest ΔE ?

- $\sigma^* \rightarrow n$ $\pi \rightarrow \pi^*$ $n \rightarrow \pi^*$ $\pi \rightarrow n$

68. Considering the relationship between the molecular structure and the maximum wavelength of absorbed light, which of the following description is **not** correct?

- Cyclic polyenes absorb at higher wavelengths than do acyclic polyenes.
 Substitution of alkyl group on $\text{C}=\text{C}$ cause a shift to shorter wavelength.
 Conjugation of π bonds causes molecules to absorb at longer wavelengths.
 As the number of conjugated π bonds increases, absorption wavelength decreases.

69. Considering the IR spectrum, which of the following description is **not** correct?

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- Ⓐ The more s character in the C-H bond, the stiffer the bond and absorption frequency become higher.
- Ⓑ Stretching frequency increases with the mass of the bonded atoms.
- Ⓒ H-bonding causes a shift to lower frequencies.
- Ⓓ H-bonding causes a broad absorption band.

70. Which of the following description about the alkene is **not** correct?

- Ⓐ The reactivity of π bond imparts the unsaturation to alkenes.
- Ⓑ The π bond prevent the free rotation about C=C
- Ⓒ The isomers of alkenes are stereoisomers
- Ⓓ The geometric isomers of alkenes have similar physical properties (m.p, b.p., etc.).