編號：　120　系所：材料科學及工程學系　　科目：B科目

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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 of the followings is the correct name for $FeCl_2$?

Ⓐ ferric chloride, Ⓑ ironous chloride, Ⓒ ferrous chloride, Ⓓ ironic chloride

2. Which of the followings belongs to ionic compound?

Ⓐ NO, Ⓑ O=C=O, Ⓒ HCHO, Ⓓ $Li_3N$

3. The formula for ammonium sulfate is,

Ⓐ $(NH_3)_2SO_4$, Ⓑ $(NH_4)_2SO_3$, Ⓒ $(NH_4)_2SO_4$, Ⓓ $(NH_3)_2SO_4$

4. The name for $HClO_2$ is

Ⓐperchloric acid, Ⓑ chlorous acid, Ⓒ perchlorate acid, Ⓓhypochlorous acid

5. The systematic name for $N_2O$ is,

Ⓐ nitrogen monoxide, Ⓑ dinitrogen monoxide,
Ⓒ nitrogen oxide, Ⓓ dinitrogen oxide

6. Which of the following solution will most likely give rise to a precipitate?

Ⓐ water solution of (NaCl + Sucrose), Ⓑ water solution of ($KNO_3$ + $BaCl_2$),
Ⓒ water solution of $Na_2SO_4$ + $Pb(NO_3)_2$, Ⓓ water solution of (KCl + soda powder)

7. Which of the following statements is incorrect?

Ⓐ the nitrate salts of alkali metals are soluble in water,
Ⓑ ammonium hydroxide is soluble in water, while ammonium chloride is not,
Ⓒ the aqueous mixture of $AgNO_3$, KCl, and $Na_2SO_4$ will give rise to a precipitate,
Ⓓ the solubility of the following chemicals in water is in the decreasing sequence: NaCl > NaOH > $Ca(OH)_2$

8. The most soluble salt in water of the following chemicals is,

Ⓐ $CaSO_4$, Ⓑ $Ca(OH)_2$, Ⓒ $Hg_2Cl_2$, Ⓓ KOH

9. Which of the following aqueous solutions could be treated by selective precipitation process to

（背面仍有題目，請繼續作答）

separate the cation constituents?

Ⓐ $AgNO_3$, $NaNO_3$, $FeNO_3$,　Ⓑ $NaNO_3$, $KNO_3$, $LiNO_3$,
Ⓒ KCl, $NH_4OH$, NaCl,　Ⓓ none of the above

10. The ability of attracting electron in a molecule is highest for,

Ⓐ Cr,　Ⓑ Zn,　Ⓒ F,　Ⓓ Si

11. What type of solution will be produced for a 0.010 M $AlCl_3$ in water? Knowing that the $K_a$ value for $Al(H_2O)_6^{3+}$ is $1.4\times10^{-5}$.

Ⓐ acidic,　Ⓑ basic,　Ⓒ neutral,　Ⓓ not able to predict

12. Regarding to the two buffering solutions,
(A) 5.0M acetic acid + 3.0M sodium acetate
(B) 0.5M acetic acid + 0.30M sodium acetate
which of the following statements is correct?

Ⓐ pH of (A )> pH of (B),　Ⓑ pH of (A )< pH of (B),
Ⓒ pH of (A ) = pH of (B),　Ⓓ not able to predict

13. The Ksp of $Bi_2S_3$ which has a solubility of $1.0\times10^{-15}$ mol/L at 25°C is,

Ⓐ $1.1\times10^{-20}$,　Ⓑ $1.1\times10^{-40}$,　Ⓒ $1.1\times10^{-73}$,　Ⓓ unable to calculate

14. The Hess's Law may allow one to compute,

Ⓐ diffusivity of gas,　Ⓑ activation energy of gaseous reaction,
Ⓒ enthalpy of a gaseous reaction,　Ⓓ heat capacity of an alloy

15. Which of the following expression is correct? (in water)

Ⓐ $I_{2(aq)} + I_{2(aq)} \rightarrow I_3^-{}_{(aq)} + I^-_{(aq)}$
Ⓑ $I_{2(aq)} + I_{2(aq)} \rightarrow 4I^-_{(aq)}$
Ⓒ $I_{2(aq)} + I^-_{(aq)} \rightarrow 1/3\ I_3^-{}_{(aq)} + I_{2(aq)}$
Ⓓ $I^-_{(aq)} + I_{2(aq)} \rightarrow I_3^-{}_{(aq)}$

16. Which of the following is a weak base in aqueous solution?

Ⓐ $HNO_2$,　Ⓑ $HNO_3$,　Ⓒ $NH_3$,　Ⓓ $Ca(OH)_2$.

17. Which of the following reaction could do work of expansion on its surroundings?

Ⓐ $CaO(s) + SO_2(g) \rightarrow CaSO_3(s)$　Ⓑ $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

Ⓒ $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$　　Ⓓ $2Al(s) + 3/2O_2(g) \rightarrow Al_2O_3(s)$.

18. Which of the following is not at standard state?
Ⓐ a gas at a pressure of exactly 1 atm,
Ⓑ a substance with a concentration of exactly 1M in a solution at an applied pressure of 1 atm,
Ⓒ a pure liquid,
Ⓓ all of above.

19. The enthalpy change of a specific reaction is -890 kJ. This reaction is a process of
Ⓐ endothermic,　Ⓑ exothermic,　Ⓒ at equilibrium,　Ⓓ none of the above.

20. Which of the following atoms or ions has the smallest radius?
Ⓐ K,　Ⓑ Ca,　Ⓒ $K^+$,　Ⓓ $Ca^{2+}$.

21. Which one of the following descriptions on heat capacity is **incorrect**?
Ⓐ The concept of heat capacity cannot be used when a phase change is involved.
Ⓑ The concept of heat capacity is used when the addition of heat to or withdrawal of heat from the system produces a temperature change, with considering the change of volume or pressure.
Ⓒ The heat capacity, being depending on the size of the system is an intensive property.
Ⓓ The heat capacity of a substance is not zero even at low temperature.

22. Which one of the following descriptions on entropy is **correct**?
Ⓐ Entropy is not a state function.
Ⓑ The entropy of a system increases when the system undergoes a reversible process.
Ⓒ The entropy change increases when a process of phase change is completed.
Ⓓ Entropy is dependent of reaction paths when the system conducted reversibly.

23. Which one of the following descriptions on the heat of fusion and vaporization at normal melting and boiling temperatures is **incorrect**?
Ⓐ The temperatures correspond to 1 atm.
Ⓑ For fusion, the volume change is much smaller than for vaporization.
Ⓒ The difference between the change of internal energy and the change of enthalpy is very small.
Ⓓ 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）

24. Which one of the following descriptions on acids and bases is **incorrect**?
    Ⓐ Acids produce hydrogen ions in aqueous solution, and bases produce hydroxides ions.
    Ⓑ The conjugate base 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.

25. Which one of the following charges in polyatomic ions is **incorrect**?
    Ⓐ $SO_4^{2-}$,　Ⓑ $MnO_4^{2-}$,　Ⓒ $CrO_4^{2-}$,　Ⓓ $NH_4^+$.

26. Which one of the following electronegativity differences is the highest?
    Ⓐ O-H,　Ⓑ S-H,　Ⓒ H-H,　Ⓓ Cl-H.

27. Which one of the following descriptions on the buffered solutions, $OH^- + HA \rightarrow A^- + H_2O$, is **incorrect**?
    Ⓐ 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 weak acids or bases containing a common ion.
    Ⓓ The net result of buffering is that the equilibrium concentration $H^+$ and thus the pH are determined by the ratio [HA]/[ $A^-$] (for a weak acid HA and its conjugate base $A^-$)

28. Which one of the following descriptions on the types of bonds is **incorrect**?
    Ⓐ All single bonds are π bonds.
    Ⓑ A double bond is made up of a σ and a π bond.
    Ⓒ A triple bond is a σ and two π bonds.
    Ⓓ Bond strength and bond length are correlated with the types of bonds

29. Which one of the following electromagnetic radiations has the shortest wavelength?
    Ⓐ X-ray,　Ⓑ microwaves,　Ⓒ radio waves,　Ⓓ ultraviolet.

30. A species with an unpaired electron is called
    Ⓐ a dissociated ion,　Ⓑ a free radical,
    Ⓒ a covalently bonded species,　Ⓓ a negatively charged particle.

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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 1.5 分，答錯倒扣 0.375 分。**

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 J/mol-K=0.082 *l*-atm/mol-K

31. Which substance has highest absolute entropy?
Ⓐ solid diamond; Ⓑ solid boron; Ⓒsolid graphite; Ⓓ solid gold.

32. Which substance has lowest absolute entropy?
Ⓐ liquid copper; Ⓑ oxygen gas; Ⓒ solid graphite; Ⓓ solid iron.

33. Which property is not a thermodynamic property?
Ⓐ heat capacity; Ⓑ diffusivity; Ⓒ temperature; Ⓓ volume.

34. At 0°C,
Ⓐ $C_p > C_v$; Ⓑ $C_p = C_v$;
Ⓒ $C_p < C_v$; Ⓓ all above answers are possible.

35. A process of a system completely surrounded by an adiabatic wall may be considered as an
Ⓐ isobaric process; Ⓑ isothermal process;
Ⓒ isometric process; Ⓓ isentropic process.

36. At constant pressure,
Ⓐ enthalpy is equivalent to work; Ⓑ enthalpy is equivalent to heat;
Ⓒ enthalpy is equivalent to entropy; Ⓓ enthalpy is equivalent to heat capacity.

37. Helmholtz free energy is constant when
Ⓐ volume and pressure are constant; Ⓑ volume or pressure is constant;
Ⓒ volume and temperature are constant; Ⓓ volume or temperature is constant.

38. For a chemical reaction to take place, it must
Ⓐ absorb heat;
Ⓑ release heat;
Ⓒ reduce in heat capacity;
Ⓓ reduce in chemical potential during the reaction.

（背面仍有題目，請繼續作答）

39. Kelvin-Planck statement describes work-heat relationship of
Ⓐ an oven; Ⓑ a refrigerator; Ⓒ an engine; Ⓓ a vacuum furnace.

40. The molar heat capacity of most elements at room temperature is
Ⓐ 24.9 J/K Ⓑ 24.9 kJ/K Ⓒ 2.49 J/K Ⓓ 249 J/K

41. During the oxidation reaction of alkaline earth metal, e.g. Mg, the entropy change after the reaction will be
Ⓐ positive and close to entropy of oxygen molecules
Ⓑ negative and close to entropy change due to consuming oxygen molecules
Ⓒ the entropy of metal oxide
Ⓓ none of above is correct

42. When we plot Gibbs free energy, G, vs temperature T, at constant pressure for one-component system, the physical meaning for the slope is
Ⓐ negative volume Ⓑ the entropy Ⓒ volume Ⓓ negative entropy

43. $P_A^O$ and $P_B^O$ represent the vapor pressures of pure A and B respectively. When A and B forms Henrian solution behavior with positive deviation, then the partial pressure of A, $P_A$, we will find
Ⓐ $P_A^O / P_A = X_A$
Ⓑ $P_A / P_A^O = kX_A$, k>1
Ⓒ $P_A / P_A^O = X_A$
Ⓓ $P_A / P_A^O = kX_A$, k<1

44. When an binary ideal solution with $X_A$ =0.4 $X_B$ =0.6, assuming $P_A^O$ =0.04atm and $P_B^O$=0.06 atm, which of the following is total vapor pressure ($P_A$+$P_B$):
Ⓐ 0.05atm, Ⓑ 0.051atm, Ⓒ 0.048atm, Ⓓ 0.052atm

45. In a binary solution, the thermodynamic properties of one component may be derived from the experimentally obtained thermodynamic properties of another component based on
Ⓐ Gibbs-Duhem equation
Ⓑ Dalton's law
Ⓒ Hess law
Ⓓ Clapeyron equation

46. For a steam engine, steam enters at 500 °C and is exhausted at 120 °C. What is the maximum efficiency of this engine?
Ⓐ 0.76 Ⓑ 0.49 Ⓒ 0.51 Ⓓ 0.63

Problems 47-50　5 moles of ideal gas initially at state 1 ($P_1$=50 atm, $T_1$=300K) expands

adiabatically to state 2 ($P_2$= 10 atm) and performs a work of 4000 J.

47. What is $T_2$?

Ⓐ 300K;　Ⓑ 236K;　Ⓒ 204K;　Ⓓ 261K.

48. What is $V_2$?

Ⓐ 9.68 liters;　Ⓑ 8.364 liters;　Ⓒ 848 liters;　Ⓓ 981 liters.

49. What is ΔS?

Ⓐ zero;　Ⓑ 57.8 J/K;
Ⓒ 42 J/K;　Ⓓ cannot be determined.

50. What is Δq?

Ⓐ zero;　Ⓑ 4000 J;
Ⓒ 345 J;　Ⓓ cannot be determined.

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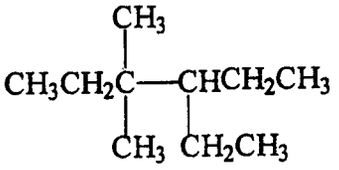
科目名稱：　有機化學

每題為 4 選 1，每一題答對得 1.5 分，答錯倒扣 0.375 分。

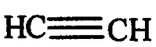
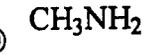
51. What is the IUPAC name of the following compound?



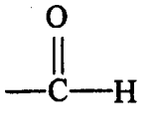
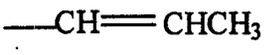
Ⓐ 3-Ethyl-2-methylhexane　　Ⓑ 3-Ethyl-4,4-dimethylhexane

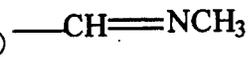
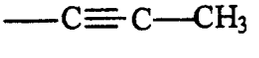
Ⓒ 3-methyl-4,4-dimethylhexane　　Ⓓ 4-Ethyl-3,3-dimethylhexane

52. Which one is an electrophile?

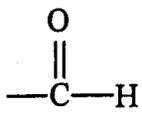
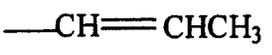
Ⓐ  　Ⓑ  　Ⓒ  　Ⓓ 

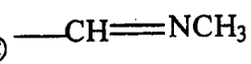
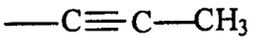
53. According to the Cahn-Ingold-Prelog sequence rules, which one has the highest priority?

Ⓐ  　Ⓑ 

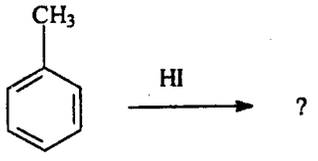
Ⓒ  　Ⓓ 

54. According to the Cahn-Ingold-Prelog sequence rules, which one has the lowest priority?

Ⓐ  　Ⓑ 

Ⓒ  　Ⓓ 

55. Predict the major product in the following reaction



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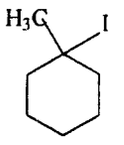
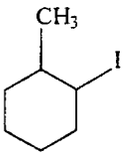
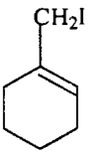
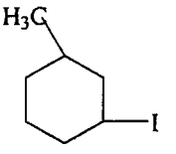
Ⓐ 


Ⓑ 


Ⓒ 


Ⓓ 


56. Which compound is more reactive toward $S_N2$ reaction?
Ⓐ 2-mromobutane　Ⓑ 1-bromobutane
Ⓒ 1-mromo-2-methyl-propane　Ⓓ 2-mromo-2-methyl-propane

57. Which reaction can be used to prepare conjugated enones ?
Ⓐ Claisen condensation　Ⓑ The aldol reaction
Ⓒ Williamson synthesis　Ⓓ Malonic ester synthesis

58. Nucleophilic addition of Grignard reagents to aldehydes and ketones to yield
Ⓐ alcohols　Ⓑ alkane　Ⓒ ester　Ⓓ acid

59. What is the reaction product of a diacid and a diamine?
Ⓐ polyamide　Ⓑ polyimide　Ⓒ polyester　Ⓓ polyether

60. Nuclear magnetic resonance spectroscopy provides information about a molecule's:
Ⓐ conjugated pi electron system　Ⓑ size and formula.
Ⓒ carbon-hydrogen framework.　Ⓓ functional groups.

61. Constitutional isomers are isomers that differ in
Ⓐ how their atoms are oriented in space
Ⓑ their bonding sequence
Ⓒ their conformations
Ⓓ the chemical bond number.

62. Please find out the alcohol that possesses strongest acid
Ⓐ cyclohexanol　Ⓑ secondary alcohol
Ⓒ tertiary alcohol　Ⓓ ethanol

63. For a nonpolar solute mixing with nonpolar solvent,
Ⓐ usually large amount of heat will be released, which greatly help the mixing process
Ⓑ large increase in entropy will be obtained, which greatly help the mixing process
Ⓒ the contribution from enthalpy and entropy are roughly the same

（背面仍有題目，請繼續作答）

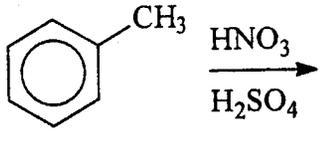
Ⓓ forces between permanent dipole moment have important influence.

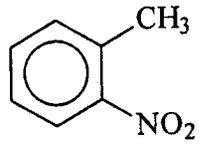
64. About a carboxylic acid
Ⓐ dissociation of a carboxylic acid to a carboxylate ion is more endothermic than dissociation of an alcohol to an alkoxide ion
Ⓑ a substituent that stabilizes the negatively charge carboxylate ion reduces the acidity of carboxylic acid
Ⓒ the most obvious feature in infrared spectrum of a carboxylic acid is the intense carbonyl stretching absorption
Ⓓ an aromatic acid can not also be a carboxylic acid.

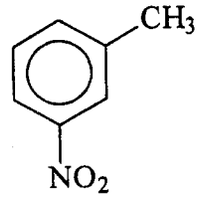
65. Based on electronegativity of halogen, which of the following carbon-halogen bond has largest length
Ⓐ CF　　Ⓑ CCl　　Ⓒ CBr　　Ⓓ CI

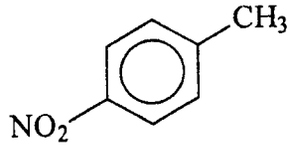
66. For the comparison between $S_N1$ and $S_N2$, which of the following statement is correct
Ⓐ Nucleophilie strength is unimportant for $S_N1$
Ⓑ good ionizing solvent is not required for $S_N1$
Ⓒ mixtures of retention and inversion are obtained by $S_N2$
Ⓓ rearrangement is impossible for $S_N1$.

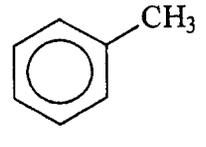
67. Toluene reacts about 25 times faster than benzene under the same condition, however, what will be the most preferred product resulting from the following reactions?




Ⓐ 


Ⓑ 

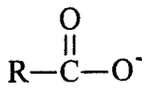
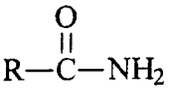
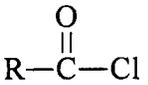
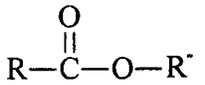

Ⓒ 


Ⓓ 


68. About the nucleophilicity, which of the following statements is correct?
Ⓐnucleophilicity is defined by the equilibrium constant for abstracting a proton

Ⓑ nucleophilicity is defined by the rate of attack on an electrophilic carbon atom
Ⓒ all the nucleophiles are also strong bases
Ⓓ the steric hindrance will reduce the basicity, but not nucleophilicity.

69. For the interconversion of acid derivatives by nucleophilic acyl substitution, which of the following compound has highest reactivity?

Ⓐ 
Ⓑ 
Ⓒ 
Ⓓ 

70. For the Diels-Alder reaction, which of the following statement is true?
Ⓐ totally there are two pi electrons coming from diene as the reaction is finished
Ⓑ alkene in this reaction is considered as dienophile
Ⓒ totally two pi bonds are converted into one sigma bone as the reaction is finished
Ⓓ the electron-drawing group can reduce the reactivity of dienophiles in the Diels-Alder reaction.