※ 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(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　How many $\sigma$ and $\pi$ bonds are in the molecule, tetracyanoethylene?

 Ⓐ5 $\sigma$ and 9 $\pi$  Ⓑ6 $\sigma$ and 8 $\pi$  Ⓒ9 $\sigma$ and 9 $\pi$  Ⓓ9 $\sigma$ and 7 $\pi$

2. For a particle in a cubic box, how many degenerate energy levels have energy equal to $14h^2/8mL^2$?

 Ⓐ 3  Ⓑ6  Ⓒ 8  Ⓓ 12

3　In the best Lewis structure for $ICl_3$, the formal charge on I is

 Ⓐ-1  Ⓑ0  Ⓒ+1  Ⓓ+2

4. As $K_2O$ is added to water, the solution is basic because it contains a significant concentration of

 Ⓐ$K^+$  Ⓑ$K_2O$  Ⓒ $O^{2-}$  Ⓓ$OH^-$

5　Consider the reaction, A+B→products, which has the rate equation, rate=k[A]. The concentration of A falls from 0.050 M to 0.015 M after a period of 10 minutes. What is the value of the rate constant, k, for this reaction?

 Ⓐ17 min⁻¹  Ⓑ0.12 min⁻¹  Ⓒ380 min⁻¹  Ⓓ2.6x10⁻⁶ min⁻¹

6. The atomic number of titanium is

 Ⓐ 8  Ⓑ 13  Ⓒ 22  Ⓓ 40.

7　Calculate the number of moles of $Cl^-$ ions in 1.75 L of $1.0 \times 10^{-3}$ M $AlCl_3$.

 Ⓐ $1.0 \times 10^{-3}$ moles  Ⓑ $1.75 \times 10^{-3}$ moles  Ⓒ $3.0 \times 10^{-3}$ moles  Ⓓ $5.25 \times 10^{-3}$ mole

8　Predict the shift in equilibrium position that will occur for the following process when the volume is reduced. $PCl_{3(g)} + Cl_{2(g)} \rightleftharpoons PCl_{5(g)}$

 Ⓐ to the right  Ⓑ to the left  Ⓒ unchanged  Ⓓ all correct.

9. Calculate the $K_{sp}$ value for bismuth sulfide ($Bi_2S_3$), which has a solubility of $1.0 \times 10^{-15}$ mol/L at 25 °C.  Ⓐ $1.0 \times 10^{-15}$  Ⓑ $1.0 \times 10^{-30}$  Ⓒ $1.1 \times 10^{-73}$  Ⓓ $1.1 \times 10^{-75}$

**（背面仍有題目,請繼續作答）**

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10. Which of the following substance has the highest positional probability at a given temperature:
solid $CO_2$, liquid $CO_2$, gaseous $CO_2$, and $CO_2$ dissolved in water?

  Ⓐ solid $CO_2$             Ⓑ liquid $CO_2$

  Ⓒ gaseous $CO_2$         Ⓓ $CO_2$ dissolved in water.

11 Which substance of the following reaction is reducing agent? (the equation is not balanced)

  $Na_2H_2PO_2 + NiSO_4 \rightarrow$ P +  Ni +  H+  +  $HPO_3^{2-}$ + $H_2$
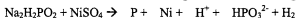
  Ⓐ$Na_2H_2PO_2$      Ⓑ $NiSO_4$        Ⓒ $HPO_3^{2-}$        Ⓓ none of the above

12. Which of the followings will you apply for neutralizing 25.0 ml of a 0.350 M NaOH solution?

  Ⓐ $1.0 \times 10^{-2}$ L of $H_2SO_4$        Ⓑ $1.0 \times 10^{-3}$ L of $HNO_3$

  Ⓒ $8.75 \times 10^{-3}$ L of $CH_3COOH$     Ⓓ $8.75 \times 10^{-2}$ L of 0.1 M HCl

13. The $K_a$ values are given in parenthesis for the following acids.

  HF ($7.2 \times 10^{-4}$), $HNO_2$ ($4.0 \times 10^{-4}$), HCN ($6.2 \times 10^{-10}$), $NH^{4+}$ ($5.6 \times 10^{-10}$)
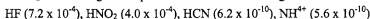
  Which of the following sequence is correct?

  Ⓐ Base strength $F^- < NO_2^- < H_2O < CN^-$

  Ⓑ Base strength $F^- > NO_2^- > H_2O > CN^- > Cl^-$

  Ⓒ Base strength $Cl^- < F^- < NO_2^- < H_2O < CN^- < NH_3$

  Ⓓ Base strength $Cl^- < H_2O < F^- < NO_2^- < CN^- < NH_3$

14. The Dalton's law of partial pressure can be expressed as

  Ⓐ$P_{Total} = (P_1 + P_2 + P_3)/3$        Ⓑ $P_{Total} = P_1 + P_2^2 + P_3^3$

  Ⓒ $P_{Total} = (P_1 \times P_2 \times P_3)^{1/2}$        Ⓓ $P_{Total} = P_1 + P_2 + P_3$

15 Which of the following has the highest first ionization constant?

  Ⓐ $H_2S$       Ⓑ $H_2Se$       Ⓒ $H_2Te$       Ⓓ all are the same

16. Which compound is in solid state at room temperature?

  Ⓐ$SiCl_4$       Ⓑ$PCl_3$       Ⓒ$S_2Cl_2$       Ⓓ$AlCl_3$

17 A sample of hydrogen gas has a volume of 8.56 L at a temperature of 0 °C and a pressure of 1.5 atm. Calculate the moles of $H_2$ present in this gas sample.

  Ⓐ 0.38 mole       Ⓑ 0.52 mole       Ⓒ 0.57 mole       Ⓓ 1 14 mole

18. Most transition metals have more than one oxidation state. Which of the following elements has

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the most number of different oxidation states?

 Ⓐ Cr,     Ⓑ Co,     Ⓒ Mn,     Ⓓ Ni.

19. Regarding to the titration curve, which of the following statements is incorrect.
 Ⓐthe equivalence point of a strong acid-strong base titration is pH 7
 Ⓑthe equivalence point of a titration of a weak acid with a strong base is pH 7
 Ⓒthe equivalence point of a titration of a weak acid with a strong base is greater than pH 7
 Ⓓthe equivalence point of a titration of a weak acid with a strong acid is less than pH 7

20. In which of the following molecules is the "rule of eight" violated?
 Ⓐ CaO   Ⓑ $NH_4F$   Ⓒ $SF_6$   Ⓓ $Na_2SO_4$

21 As cerium (Ⅲ) carbonate pentahydrate is heated strongly, it decomposes to yield carbon dioxide,
 cerium (Ⅲ) oxide, and water vapor. How many moles of carbon dioxide can be obtained by
 completely decomposing 2 moles of cerium (Ⅲ) carbonate pentahydrate?
 Ⓐ1.50   Ⓑ3.00   Ⓒ4.50   Ⓓ6.00

22. Which of the following best describes the hybrids used by S in the sulfite ion, $SO_3^{2-}$?
 Ⓐsp   Ⓑ$sp^2$   Ⓒ$sp^3$   Ⓓ$dsp^2$

23. The Bohr radius for n=1 is $a_o$, therefore the radius for n=3 is
 Ⓐ$3a_o$   Ⓑ$9a_o$   Ⓒ$6a_o$   Ⓓ$12a_o$

24. A buffered solution contains 0.50 M acetic acid ($HC_2H_3O_2$, $K_a$ = 1.8 x $10^{-5}$) and 0.5 M sodium
 acetate ($NaC_2H_3O_2$). Calculate the pH of the solution.
 Ⓐ 4.74   Ⓑ 2.37   Ⓒ 1.8   Ⓓ 0.9

25. In the electroplating of Cu in $CuSO_4$ solution, how many moles of Cu is reduced when 1.93 x
 $10^5$ coulombs of electric charges are passed through the electrolytic cell?
 Ⓐ 0.5,   Ⓑ 1.0,   Ⓒ 2.0,   Ⓓ 4.0.

26. Which of the following half-cell reactions has the highest standard reduction potential?
 Ⓐ $Ag^+ + e^- \rightarrow Ag$ Ⓑ $Zn^{2+} + 2e^- \rightarrow Zn$ Ⓒ $Fe^{2+} + 2e^- \rightarrow Fe$ Ⓓ $Cu^{2+} + 2e^- \rightarrow Cu$.

27 Precipitation may be observed in which of the following solution?
 Ⓐ $Pb(NO_3)_2$ + water + $Na_2SO_4$   Ⓑ $NH_4Cl$ + water + NaOH
 Ⓒ $NaNO_3$ + water + NaCl   Ⓓ $CH_3COONa$ + water + Sucrose

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28. Which of the followings has the greatest dipole moment?

    Ⓐ HF     Ⓑ Tolune     © cyclohexane     Ⓓ HCl
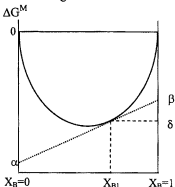
29. Which of the followings is the correct name for $CuCl_2$?

    Ⓐcuprous chloride Ⓑ copper dichloride © cupric chloride Ⓓ Choro-copper

30. Which of the following electrolytes is commonly used for automotive battery?

    Ⓐ $Li_2SO_4$     Ⓑ $K_2MnO_4$     © $PbSO_4$     Ⓓ NaCl

(31-33) The molar Gibbs free energy of mixing, $\Delta G^M$, for an A-B binary regular solution at the temperature T is shown as the figure.



31 For such a solution, the solid solubility of A in B at temperature T is

    Ⓐ 1,     Ⓑ $1-X_{B1}$,     © $X_{B1}$,     Ⓓ none of above is correct.

32. $\Delta G^M(X_{B1}) =$

    Ⓐ $X_{B1}\alpha + (1-X_{B1})\beta$,     Ⓑ $\beta$,     © $\delta$;     Ⓓ none of above is correct.

33 If the activity coefficients, $\gamma_A$ and $\gamma_B$, are both smaller than 1, then

    Ⓐ $|\alpha|=(1-X_{B1})RT\ln(1-X_{B1})$;     Ⓑ $|\alpha|<(1-X_{B1})RT\ln(1-X_{B1})$;

    © $|\beta|=RT\ln X_{B1}$,     Ⓓ$|\beta|>RT\ln X_{B1}$

(34-35) The molar excess Gibbs free energy of formation of solid solutions in the system Ga-Cd can be represented by $G^{XS}=10,800X_{Ga}X_{Cd}$ J

34. Calculate the activity coefficient of Ga in the solution of $X_{Ga}=0.6$ at 700K.

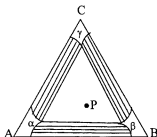    Ⓐ 1.95,     Ⓑ 1.35,     © 1 75,     Ⓓ 1.56.

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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35 Calculate the activity of Ga in the solution of $X_{Ga}$=0.6 at 700K.

    Ⓐ 0.66;        Ⓑ 0.78,        Ⓒ 0.81,        Ⓓ 0.94.

(36-38) A ternary phase diagram of system A-B-C at temperature $T$ is shown below.



36. Which of the following compositions is the closest to the composition of point P?

    Ⓐ10%A+20%B+70%C,        Ⓑ 50%A+30%B+20%C;

    Ⓒ 35%A+20%B+45%C,        Ⓓ 30%A+45%B+25%C.

37 The point P

    Ⓐ is a homogeneous solution,        Ⓑ contains two phases;

    Ⓒ contains three phases;        Ⓓ is an eutectic composition.

38. About this phase diagram, which of the following statement is NOT correct?

    Ⓐ A-B, B-C, C-A all have a complete range of solutions at temperature $T$;

    Ⓑ the end compositions of tie lines are dependent on the temperature;

    Ⓒ it is possible that A-B-C may form a homogeneous liquid solution;

    Ⓓ A, B, C all exhibit a limited solubility in the other components at temperature $T$

39. The fugacity of pure $i$ is denoted as $f_i^o$ and the fugacity of component $i$ in a condensed solution is denoted as $f_i$. Which one of the following statements is NOT correct?

    Ⓐ If the vapor $i$ is an ideal gas, then $f_i$ =$p_i$. ($p_i$ is the partial pressure of vapor $i$ over the solution.)

    Ⓑ $f_i^o$ =$P_i^o$ ($P_i^o$ is the pressure of pure vapor $i$.)

    Ⓒ The activity of component $i$ in the condensed solution is $a_i$=$f_i/f_i^o$

    Ⓓ $a_i$=$X_i$ ($X_i$: the molar fraction of component $i$) if the solution is an ideal solution.

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40. The heat capacity (cₚ) of copper is 23 J/mol-K at 1 atm. What is the enthalpy of 1 mole iron at 598K, 1 atm?

    Ⓐ $23ln(598/298)$ J,　　　　　　　　　Ⓑ 6.9 kJ,

    Ⓒ 13.754 kJ,　　　　　　　　　　　　Ⓓ not enough information for calculation.

41 In reality, the entropy of compound or elements at 0 K

    Ⓐ will be zero due to immobile atoms;

    Ⓑ may be positive due to the presence of isotopes or glassy phase;

    Ⓒ will be negative due to completely ordered state;

    Ⓓ all of above are possible.

42. Pressure is usually plotted as a function of temperature in the phase diagram of one component system, when dP/dT is positive during the transition from liquid state to solid state, which of the following is true

    Ⓐ the volume change from liquid to solid is decreasing

    Ⓑ it is endothermic reaction

    Ⓒ the density change from liquid to solid is decreasing

    Ⓓ none of above is correct

43 In the phase diagram of $H_2O$ system, pressure is plotted as a function of temperature, the relationship between dP/dT and the volume change/latent heat may be derived from,

    Ⓐ van der Waals equation,　　　　　　Ⓑ Laws of thermodynamics,

    Ⓒ Clausius-clapeyron equation,　　　　Ⓓ Gibbs-Duhem equation.

44. In a one-component system, when Gibbs free energy is plotted as a function of pressure, at constant temperature, generally, for vapor phases, you will see

    Ⓐ a straight line with negative slope;　　Ⓑ a straight line with positive slope;

    Ⓒ a curve with positive slopes,　　　　Ⓓ none of above is correct.

45. On a P-V diagram of a real gas, what does the curve look like in a region showing gas/liquid two phase mixture?

    Ⓐ The curve shows negative slope.

    Ⓑ The curve shows positive slope.

    Ⓒ The curve is parallel (horizontal) to the axis of volume.

    Ⓓ None of above is correct.

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46. If the component A and component B in a binary solution A-B obey Henry's law when the molar fraction of solute is less than 0.1  The partial pressure of A in the Herrian solution can be expressed as $P_A = 0.06X_A$ atm and the partial pressure of B in the Herrian solution can be expressed as $P_B = 0.06X_B$ atm at 298K. Assume $P_A^O = 0.04$ atm and $P_B^O = 0.05$ atm, where $P_A^O$ and $P_B^O$ represent the vapor pressures of pure A and B respectively.　When the Henry's law is applicable, the activity coefficients of A and B are

　　Ⓐ 0.66 and 0.833　　Ⓑ 1.5 and 1.2　　　Ⓒ 1.5 and 1.2　　　Ⓓ 0.024 and 0.03B

47 When a negative-deviated solution consists 95% of A and 5% of B, assuming $P_A^O = 0.06$ atm and $P_B^O = 0.04$ atm, which of the following partial pressure of A and B may be true:

　　Ⓐ 0.057 atm and 0.002 atm　　　　　Ⓑ 0.072 atm and 0.01 atm

　　Ⓒ 0.018 atm and 0.0025 atm　　　　　Ⓓ 0.057 atm and 0.0015 atm

48. Regarding the definition of enthalpy (H) and enthalpy change (ΔH), which one of the following statements is true:

　　Ⓐ H does not have an absolute value　　　Ⓑ negative ΔH represent an endothermic reaction
　　Ⓒ H=0 for elements in their stable state at 0°C　　Ⓓ none of above is correct.

49 Which one of the following thermodynamic relations is correct (without considering the chemical potential)?

　　Ⓐ $S = (\partial G/\partial T)_P$,　　Ⓑ $V = (\partial H/\partial P)_S$,　　　Ⓒ $P = -(\partial A/\partial V)_T$,　　Ⓓ $T = (\partial H/\partial S)_V$.

50. Which one of the following properties (or state variables) is **intensive** (that depends on the size of the system)?

　　Ⓐ $10^3$ cm$^3$/mole,　　Ⓑ entropy,　　　Ⓒ enthalpy,　　　Ⓓ internal energy.

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考試科目　B科目

考試日期　0307　節次　2

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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. Which of the following descriptions regarding to enantiomers is correct
   Ⓐ Enantiomers have the same configuration, but different conformations
   Ⓑ Configuration of enantiomers can change by breaking chemical bonds
   Ⓒ A mixture of unequal numbers of molecules of each enantiomer is a racemic form
   Ⓓ The mirror images of enantiomers is superimposable.

52. For cyclic hydrocarbon, which of the following description is WRONG
   Ⓐ Since the ring C's are $sp^3$-hybridized, they may be chiral centers
   Ⓑ The ring strain can influence the stability of molecules
   Ⓒ The twist-boat form of cyclohexane is less stable than the chair form
   Ⓓ Cyclohexane minimizes its ring strain by being flat rather than puckered.

53. Which of the following atoms has the highest electronegativity
   Ⓐ F　　　　　　Ⓑ Cl　　　　　　Ⓒ Br　　　　　　Ⓓ I

54. The dipole moment of the bond
   Ⓐ is generated in the electric field　　　Ⓑ decreases during crystallization
   Ⓒ is related to bond polarity　　　　　　Ⓓ increases with bond strength.

55. Which of the following molecules does not form hydrogen bond
   Ⓐ Polylactide　　Ⓑ Toluene　　　Ⓒ HF　　　　Ⓓ HCl

56. The preparation of Grignard reagents <u>does not</u> need.
   Ⓐ Alkyl Halide　　Ⓑ Magnesium　　Ⓒ Germanium　　Ⓓ Organic solvent

57. Which following description about the alcohol oxidation is ***incorrect***?
   Ⓐ Oxidation of a primary alcohol results in an aldehyde.
   Ⓑ Oxidation of a secondary alcohol creates a ketone.
   Ⓒ Oxidation of a tertiary alcohol gives a peroxide.
   Ⓓ Oxidation of a primary alcohol produces a carboxylic acid.

58. UV-vis Spectroscopy provides the information of:
   Ⓐ molecular formula　　　　　　　　Ⓑ conjugated electron system

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  © carbon-hydrogen framework     ① molecular functional group

59. In the $S_N2$ reaction, the leaving group:
  Ⓐ is from a direction 120° away from the attacking nucleophilic
  Ⓑ is displaced by the attacking nucleophilic
  © prefers to be a less stable anion
  ① prefers to be a weak acid

60. Ketone is difficult to be oxidized. However, if a strong oxidation agent is utilized, ketone can be converted to:
  Ⓐ alcohol    Ⓑ two carboxylic acids   © aldehydes    ① ether

61 Nitrogen molecules ($N_2$) can not be detected in the Infrared Spectroscopy. Why?
  Ⓐ its molecular weight is not large enough   Ⓑ it contains two atoms only
  © it has seven protons     ① its heat capacity is over 25 J/K mol

62. Which following organic compound is not aromatic?
  Ⓐ Aniline    Ⓑ Phenol      © Toluene      ① Cyclopentene

63. The common name of the following group is

$$CH_3CH_2CH-$$
$$|$$
$$CH_3$$

 Ⓐ $n$-butyl     Ⓑ $sec$-butyl      © isobutyl      ① $tert$-butyl

64. The correct IUPAC name of the following compound is



 Ⓐ 4-ethyl-2-methylhexane       Ⓑ 3-ethyl-5-methylhexane
 © 2-methyl-4-ethylhexane       ① 5-methyl-3-ethylhexane

65. Which of the following sets of conditions most favors the E1 mechanism
  Ⓐ When the alkyl halide is tertiary and the base is weak base

**（背面仍有題目,請繼續作答）**

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        Ⓑ When the alkyl halide is tertiary and the base is strong base

        Ⓒ When the alkyl halide is primary or secondary and the base is weak base

        Ⓓ When the alkyl halide is primary or secondary and the base is strong base

66. Which of the following polymers is a thermosetting plastic?

    Ⓐ PVC        Ⓑ epoxy resin        Ⓒ PC        Ⓓ PMMA

67 Which of the following polymers is not a conductive polymer?

    Ⓐ polyaniline    Ⓑ Polythiophene    Ⓒ poly(p-phenylenevinylene)    Ⓓ polycarbonate

68. Which of the following has a meso stereoisomer? (1) 2,4-dichloropentane, (2) 1,3-dimethylcyclopentane (3) 2,3-dichloropentane?

    Ⓐ only (1)        Ⓑ only (2)        Ⓒ (1) and (3)        Ⓓ (1) and (2)

69. The name of the following compound is



    Ⓐ meta-bromoanisole        Ⓑ meta-mromonitrobenzene

    Ⓒ meta-bromoaniline        Ⓓ meta-bromophenol

70. Rank the following three carboxylic acids in order of increasing acidity (1) 4-chlorobutanoic acid (2) 3-chlorobutanoic acid (3) 2-chlorobutanoic acid

    Ⓐ (1)< (2)< (3)    Ⓑ (2)< (1)< (3)    Ⓒ (3)< (2)< (1)    Ⓓ (3)< (1)< (3)