中原大學 104 學年度碩士班考試入學

104/3/4 8:00 AM~9:30 AM

誠實是我們珍視的美德，
我們喜愛「拒絕作弊，堅守正直」的你！

化學系

科目：物化、分析（滿分150分）

（共5頁，第1頁）
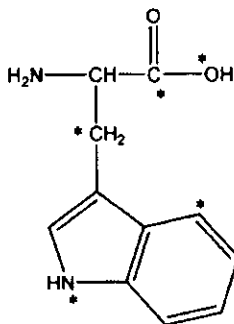
■可使用計算機(僅限於四則運算、三角函數及對數等基本功能，可程式之功能不可使用)
□不可使用計算機
----------------- (不可直接作答於試題，請作答於答案卷) -----------------

1. Choose the right answer for the following question(single choice),(單選題)(40 分)

(1) Below is the line structure for the amino acid tryptophan.　Determine the type of hybridization and number of each type for the starred atoms.

(a) 1 sp, 2 sp^2, 2 sp^3; (b) 1 sp, 3 sp^2, 1 sp^3; (c) 2 sp^2, 3 sp^3; (d) 3 sp^2, 2 sp^3

(2) Which of the following compounds would be expected to absorb the longest wavelength light?
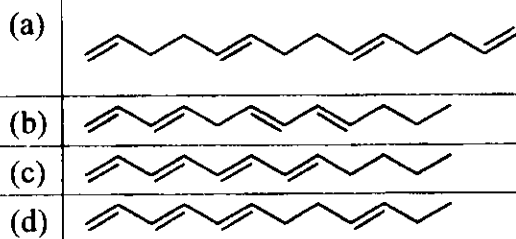
(3) Which of the following elements would be added to germanium to produce an *n*-type semiconductor?
(a) Gallium; (b) Silicon; (c) Aluminum; (d) Arsenic

(4) The relative size of the Van der Waals constant, *a*, correlates well with boiling point; that is, the larger *a* is, the higher the boiling point. The reason for this correlation is:
(a) The *a* constant is a measure of molecular size;
(b) The boiling point is directly proportional to *a*
(c) The *a* constant varies with temperature
(d) The *a* constant is a measure of intermolecular force strength

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化學系

科目：物化、分析（滿分150分）　　　　　　（共 5 頁，第 2 頁）
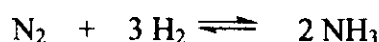
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(5) What are **the signs for the entropy change of the system and surroundings,** respectively, for water evaporating at 370 K, when the system is defined as water?

(a) <0, <0; (b) <0, >0; (c) 0, 0; (d) >0, <0

(6) Which way will the Haber Process shift if a container at equilibrium has its volume decreased?

$$N_2 \ + \ 3\,H_2 \rightleftharpoons \ 2\,NH_3$$

(a) shift to the reactants

(b) shift to the products

(c) there will be no change

(d) the temperature will increase

(7) Which properties would be affected when the catalyst is used in the reaction?

(a) rate constant and activation energy.

(b) equilibrium constant and rate constant.

(c) Gibbs energy and activation energy.

(d) enthalpy and Gibbs energy.

(8) Why does the rate of a reaction generally slow with time?

(a) The reaction mixture gets warmer

(b) The number of product molecules decreases

(c) The number of collisions of reactants decreases

(d) The number of product molecules increases

2. The reaction $2NO(g) + Cl_2(g) \rightarrow 2NOCl(g)$ is second order in NO and first order in Cl_2. In a volume of 10 dm^3, 2 mol of nitric oxide and 1 mol of Cl_2 were brought together, and the initial rate was $5.0*10^{-3}$ mol $dm^{-3}s^{-1}$. (a)What is the rate constant? (3 分) (b)What will be the rate when 1 mol of nitric oxide has reacted? (3 分)(c) If by the addition of inert solvent to the reaction mixture(原起始溶液) the total volume were doubled (x2), what is the reaction rate ? (3 分)　　(d) What would be the effect on the rate constant k by the addition of inert solvent? (3 分)

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化學系

科目：物化、分析（滿分 150 分）　　　　（共 5 頁，第 3 頁）

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3.　(a) A Carnot cycle uses 1.00 mol of *monoatomic perfect gas* as the working substances from an initial state of 10 liters(公升) and 650 K. It expands isothermally to a pressure of 20 liters (step 1), and then adiabatically to a temperature of 300 K (step 2). This expansion is followed by an isothermal compression (step 3), and then an adiabatic compression (step 4) back to the initial state. Determine the values of ΔH, ΔS for each stage of the cycle and for the whole cycle. Fill your answer into the table and give your the process of calculation.(計算過程)($C_{v,m} = (3/2)R=12.471$ $JK^{-1}mol^{-1}$, $C_{v,m} = (5/2)R=20.786$ $JK^{-1}mol^{-1}$) (15 分，　每格 1.5 分)(請寫在答案紙上)

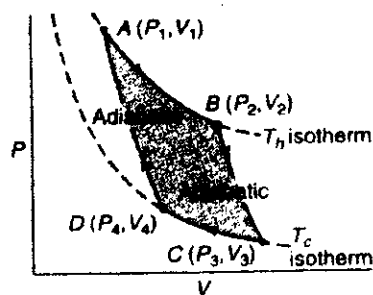| Step	ΔH	ΔS
Step 1(isotherm at T_h)	(a)	(f)
Step 2(adiabatic)	(b)	(g)
Step 3(isotherm at T_c)	(c)	(h)
Step 4(adiabatic)	(d)	(i)
Net(淨值) for cycle	(e)	(j)

FIGURE 3.2
Pressure-volume diagram for the Carnot cycle; *AB* and *CD* are isotherms, and *BC* and *DA* are adiabatics (no heat transfer).

4. Please plot the boundary surfaces of 2S, $2P_x$, $3d_{xy}$ and $3d_{z2}$ orbitals on X, Y and Z coordinates. (8 分)

5. Multiple Choice Questions (choose the best answer from the given choices)

(1) What should you do when you've made an entry error in your laboratory notebook? (5 分)

    A.　Cross out the error with a horizontal line and rewrite the entry.

    B.　Use correction fluid to correct the error so that the notebook will look neat to your teacher.

    C.　Use an eraser to erase the error and rewrite the entry.

    D.　All of the above.

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(2) Dissolution of a solute in water is one of the most important phenomena in chemistry in general, and in qualitative analytical chemistry in particular.　Which of the following is most untrue of this process? (10 分)

   A.　Dissolution of polar molecular compounds in water is due to the breaking of hydrogen bonding network and the formation of charged species in the solution, e.g.: $HCl\ (g) + H_2O\ (l) \rightarrow H_3O^+\ (aq) + Cl^-\ (aq)$.

   B.　Dissolution of ionic compounds in water is due to the larger energy of solvation of the charged species by the water molecules as compared to the lattice energy of the solute and the hydrogen bonding energy.

   C.　An increase in temperature sometimes may result in a decrease in solubility of some solid solutes in water.

   D.　The solubility of a solute in water is independent of the rate of dissolution.

(3) Which of the following is not a true statement? (10 分)

   A.　The invention of PMT (photomultiplier tubes) as a detector is the result of the publication of the photoelectric effect by Albert Einstein.

   B.　A faraday of charge is equivalent to 6.02×10^{23} electrons.

   C.　Polarography, voltammetry, and potentiometry are three common electrochemical analytical techniques that measure the voltage of a system with respect to the analyte concentrations.

   D.　Below the column capacity, band broadening of chromatographic peaks is not related to the analyte concentrations.

(4) GC-ECD (electron capture detector) is normally used for analysis of molecules of certain elements only.　What are these elements? (10 分)

   A.　Low electron-affinity elements.

   B.　D-block elements.

   C.　Alkaline elements.

   D.　High electron-affinity elements.

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Comprehensive Questions (Show all your work and logic to receive the maximum credits)

6. Write each answer with the correct number of significant digits. (10 分)
   A. $28.5 - 7.38 =$
   B. $14.3 \times 6.7 =$

7. Sketch a Gaussian curve with a mean of 1000 and a standard deviation (sd) of 20 and label the X-axis correctly. What is the approximate area covered by ± 2 sd? (10 分)

8. A mixture weighing 27.73 mg containing only $FeCl_2$ (FM 126.75) and KCl (FM 74.55) required 18.49 mL of 0.022 37 M $AgNO_3$ for complete titration of the chloride. Find the mass of $FeCl_2$ and the weight percent of Fe in the mixture. (10分)

9. If a 0.030 M solution of a base is 0.27% hydrolyzed ($\alpha = 0.002\ 7$), find K_b for the base. (10分)