國立中山大學114學年度
碩士班考試入學招生考試試題

科目名稱：物理化學及分析化學【化學系碩士班】

—作答注意事項—

考試時間：100分鐘

- **考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示**，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，請衡酌作答。
- 答案卡請以2B鉛筆劃記，不可使用修正液（帶）塗改，未使用2B鉛筆、劃記太輕或污損致光學閱讀機無法辨識答案者，後果由考生自負。
- 答案卷（卡）應保持清潔完整，不得折疊、破壞或塗改應考證號碼及條碼，亦不得書寫考生姓名、應考證號碼或與答案無關之任何文字或符號。
- 可否使用計算機請依試題資訊內標註為準，如「可以」使用，廠牌、功能不拘，唯不得攜帶書籍、紙張（應考證不得做計算紙書寫）、具有通訊、記憶、傳輸或收發等功能之相關電子產品或其他有礙試場安寧、考試公平之各類器材入場。
- **試題及答案卷（卡）請務必繳回，未繳回者該科成績以零分計算。**
- **試題採雙面列印，考生應注意試題頁數確實作答。**
- **違規者依本校招生考試試場規則及違規處理辦法處理。**

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科目名稱：物理化學及分析化學【化學系碩士班】　　題號：422002

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（混合題）　　

物理化學部分

(一)選擇題，共五十分 (單選題，不可於試題紙上作答)

第 1-12 題，每題 4 分，第 13 題 2 分。答錯一題倒扣 1 分。

1. At a particular temperature, the half-life of a zero-order reaction is 29.0min. How long will it take for the reactant concentration to be depleted by a factor of 8 ($[A]_t/[A]_0 = 1/8$)?
   (A) 87.0min
   (B) 58.0min
   (C) 50.8min
   (D) 232min
   (E) 203min

2. Consider the reaction: $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$, for which $\Delta H° = -200.$ kJ and $\Delta S° = -187$ J/K at 25°C. Assuming that $\Delta H°$ and $\Delta S°$ are independent of temperature, calculate the temperature where $K_p = 1$.
(A) 200 K
(B) 1070 K
(C) 2070 K
(D) 970 K
(E) none of these

3. Which of the following statements is/are true of adiabatic process?
   1. In an adiabatic process, no energy such as heat flows into or out of the system.
   2. An adiabatic process occurs when a system is thermally conducted to the surroundings.
   3. For an adiabatic process, $q = 0$ and $\Delta E = w$.
(A) 1 only
(B) 2 only
(C) 3 only
(D) 1 and 2
(E) 1 and 3

4. Which occupied orbital has the highest energy in the rubidium atom at ground state?
(A) 4p
(B) 4s
(C) 5s
(D) 1s
(E) 4d

5. The rate constant for a reaction increases from 10.0 s^{-1} to 100. s^{-1} when the temperature is increased from 315K to 416K. What is the activation energy for the reaction in kJ/mol? ($R = 8.314$ J/mol • K)
(A) 10.8 kJ/mol
(B) 0.0823 kJ/mol
(C) 1.90 kJ/mol
(D) 19.3 kJ/mol
(E) 24.8 kJ/mol

6. How many of the following electron configurations for the species in their ground state are correct?

Ca $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

Mg $1s^2 2s^2 2p^6 3s^1$

V [Ar] $3s^2 3d^3$

As [Ar] $4s^2 3d^{10} 4p^3$

P $1s^2 2s^2 2p^6 3p^5$

(A) 1
(B) 2
(C) 3
(D) 4
(E) 5

7. The elementary chemical reaction

$$O + ClO \rightarrow Cl + O_2$$

is made pseudo-first order in oxygen atoms by using a large excess of ClO radicals. The rate constant for the reaction is 3.5×10^{-11} cm^3/molecule • s. If the initial concentration of ClO is 1.0×10^{11} molecules/cm^3, how long will it take for the oxygen atoms to decrease to 10.% of their initial concentration?

(A) 3.2×10^{-3} s
(B) 0.66 s
(C) 0.017 s
(D) 23 s
(E) 2.4 s

8. Which following quantum model is most adequate as an approximation to describe an p electron moving in benzene?

(A) A particle in a one-dimensional box.
(B) Harmonic oscillator.
(C) A freely moving particle.
(D) Rotation in two dimensions.
(E) A particle in a two-dimensional box.

9. Consider the second-order reaction aA → products (which has a first half-life of 25 s). If the concentration of A after 15.6 s is 0.36 *M*, determine the initial concentration of A.

(A) 0.58 M
(B) 0.26 M
(C) 0.53 M
(D) 0.14 M
(E) 0.16 M

10. For an electron in a 2.00-nm one-dimensional box, calculate the wavelength of electromagnetic radiation to excite the electron from the ground state to the level with $n = 3$.

(A) 140 pm
(B) 467,000 nm
(C) 32 mm
(D) 1,650 nm
(E) 62 fm

11. For the vaporization of water at 1.00 atm,
$\Delta H = 43.54$ kJ/mol at 298 K and $\Delta H = 40.68$ kJ/mol at 373 K
The constant-pressure heat capacity of liquid water is 75.3 J/mol • K. Calculate the constant-pressure heat capacity for $H_2O(g)$.
(A) 20.8 J/mol•K
(B) 2790 J/mol•K
(C) 75.3 J/mol•K
(D) 37.2 J/mol•K
(E) none of these

12. Which of the following is true for ΔS_{surr} and ΔS_{sys}, changes of entropy for surrounding and system, respectively?
(A) For any process, ΔS_{surr} and ΔS_{sys} have opposite signs.
(B) As long as the disorder of the surroundings is increasing, a process will be spontaneous.
(C) If $\Delta S_{surr} = -\Delta S_{sys}$, the process is at equilibrium.
(D) $\Delta H°$ is zero for a chemical reaction at constant temperature.
(E) none of these

13. The density of the solid phase of a substance is 0.9 g/ cm^3 and the density of the liquid phase is 1.0 g/ cm^3. A large increase in pressure will
(A) Lower the freezing point.
(B) Raise the freezing point.
(C) Lower the boiling point.
(D) Raise the triple point.
(E) Lower the triple point.

分析化學部分

(二)選擇題：(單選題，不可於試題紙上作答)

第 14-21 題，每題 5 分、共 40 分

14. Light emitted from a redox reaction at an electrode is called:
(A) photoluminescence (B) bioluminescence (C) chemiluminescence (D) electrochemiluminescence

15. The term laser is an acronym for light amplification by stimulated emission of radiation. What is the basis of laser behavior that causes emission totally coherent with the incoming radiation?
(A) pumping (B) spontaneous emission (C) stimulated emission (D) absorption

16. What kind of optical filter can be utilized to reject a specific wavelength?
(A) edge filter (B) interference filter (C) notch filter (D) cut-off filter

17. The ability of a monochromator to separate different wavelengths depends on its dispersion. The angular dispersion is given by $dr/d\lambda$, where dr is the change in the angle of reflection or refraction with a shift in wavelength $d\lambda$. In contrast, the linear dispersion D refers to the variation in wavelength as a function of y, the distance along the focal plane. If the distance between rulings decreases the linear dispersion would be:
(A) increased (B) decreased (C) unrelated (D) both take place by chance

18. Which monochromator listed below provides better resolution with similar light-gathering power?
(A) prism (B) Echelle grating (C) Echellette grating (D) holographic gratings

19. To determine which photon transducer offers the best sensitivity in the 1000–1500 nm range, which of the following transducers give the best sensitivity?
(A) photomultiplier tube (B) GaAs photovoltaic cell (C) PbS photoconductivity (D) CdS photoconductivity

20. For a compound with Raman activity of a given vibrational mode, scattering occurs owing to change of :
(A) dipole moment (B) electronegativity (C) electron affinity (D) polarizability

21. A unique feature of capillary electrophoresis is electroosmotic flow (EOF). When a high-voltage is applied across a fused-silica capillary tube containing a buffer solution, electroosmotic flow usually occurs, in which the bulk liquid migrates toward the cathode. What is the polarity of EOF in the presence of chemical modification (cetyltrimethylammonium bromide, CTAB) on the capillary wall?
(A) positive (B) negative (C) neural (D) bipolarity

(三)計算題，每題10分，共10分 (不可於試題紙上作答)

1. The efficiency of chromatographic columns can be approximated by van Deemter equation:
$H = \mathrm{A} + \frac{B}{u} + C_S u + C_M u$
Explain why the C_S (or C_M) affect the plate height?