國立成功大學 109 學年度碩士班招生考試試題

系　　所：化學系

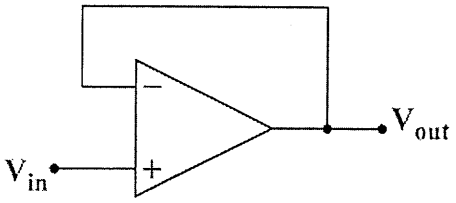
考試科目：分析化學

考試日期：0211，節次：4

※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

Part I. Single or Multiple choice questions. Each question has one or more answers. (75%, 5 points for each question.)

1. Considering 0.5 M aqueous solution of each of the following, which has the lowest pH value?
   (A) KNO_3　(B) Na_2S　(C) NaCl　(D) Na_2PO_4　(E) CH_3COONa
2. Citric acid, $CH_2(COOH)C(OH)(COOH)CH_2(COOH)$, is a weak triprotic acid with dissociation constants as follow: $pK_{a1} = 3.13$, $pK_{a2} = 4.76$, $pK_{a3} = 6.40$. The pH of an aqueous solution of is disodium citrate, $CH_2(COONa)C(OH)(COOH)CH_2(COONa)$, closest to which value?
   (A) 3.13　(B) 3.95　(C) 4.76　(D) 5.58　(E) 6.40
3. Which of the following procedures tend(s) to minimize the influence of random errors on measured results?
   (A) Signal modulation followed by analog filtering and demodulation
   (B) Use of internal standards
   (C) Averaging the results from multiple samples
   (D) Application of a lock-in amplifier
   (E) Decrease the frequency of recorded signal
4. Which of the following statements about the following circuit is/are correct?



   (A) This is an op-amp circuit called "current follower".
   (B) In this circuit, $V_{out} = -V_{in}$.
   (C) The voltage gain of this circuit is 1.
   (D) This circuit is used to boost the current, as well as the power, available from the input signal without increasing the input voltage.
   (E) This circuit acts as an electric buffer to isolate stages while building multistage circuits.
5. For EDTA titrations, the analyte solution and the titrant solution are both buffered at the same pH for which of the following reasons?
   I. Th conditional formation constant is affected by pH.
   II. The fraction of EDTA in the fully deprotonated Y^{4-} form varies with pH.
   III. When EDTA reacts to from a metal complex. H^+ is a product in most cases.
   (A) I only　(B) I and II only　(C) I and III only　(D) II and III only　(E) I, II and III
6. A buffer is made from equal concentrations of a weak acid and its conjugate base. Doubling the volume of the buffer solution by adding water has what effect on this buffer?
   (A) It significantly increases the pH of the buffer.
   (B) It has negligible effect on the pH of the buffer.

(C) It decreases the buffer capacity.
(D) It has negligible effect on the buffer capacity
(E) It shifts the pH toward the pK_a of the acid.

7. Calculate the molar solubility of Ag_2CO_3 ($K_{sp} = 8.1 \times 10^{-12}$) in a solution buffered to a pH of 7.50.
(A) 1.14×10^{-3} M (B) 2.27×10^{-3} M (C) 3.16×10^{-8} M (D) 1.14×10^{-8} M (E) 3.16×10^{-3} M

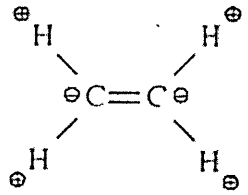
8. For the following redox reaction (not balanced), which statement(s) is/are true?

$$VO^{2+} + V^{2+} \rightleftharpoons V^{3+} \qquad E^{\circ}_{VO^{2+}} = 0.359\,V,\ E^{\circ}_{V^{3+}} = -0.256\,V$$

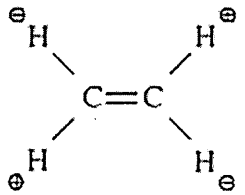
(A) When the above equation is balanced, the VO^{2+} : V^{2+} ratio is 1:2
(B) The equilibrium constant $K_{eq} = 2.4 \times 10^{10}$
(C) For a titration experiment based on the above equation at pH 1.0, the equivalence point potential E_{eq} is -0.154 V
(D) For a titration experiment based on the above equation, using VO^{2+} as the titrant to titrate 0.10 M V^{2+}, $[VO^{2+}] = [V^{2+}] = 0$ at equivalence point.
(E) For a titration experiment based on the above equation, using 0.1 M VO^{2+} as the titrant to titrate 0.1 M V^{2+}, $[V^{3+}] = 0.1$ M at equivalence point.

9. Which of the following stamen (s) is/are correct?
(A) Phosphorescence is obtained when a molecule relaxes from the first electronic singlet state (S_1) to ground state (S_0).
(B) π–π^* transition is the most convenient and useful transition in both fluorescence and phosphorescence.
(C) Fluorescence and phosphorescence are observed when molecules are excited by a powerful source of radiation.
(D) Chemiluminescence does not require a source of radiation
(E) For a specific fluorophore, its emission spectrum more closely resembles its absorption spectrum compared to the excitation spectrum.
(F) The emission spectrum is obtained at higher wavelengths compared to the excitation spectrum.

10. Expect which of the following vibrations is/are active in the IR spectrum.
(A) Symmetric stretching of CO_2
(B) C-C stretching of CH_3CCl_3
(C) Symmetric stretching of SO_2
(D) CH_2 wag:



(E) CH_2 twist:



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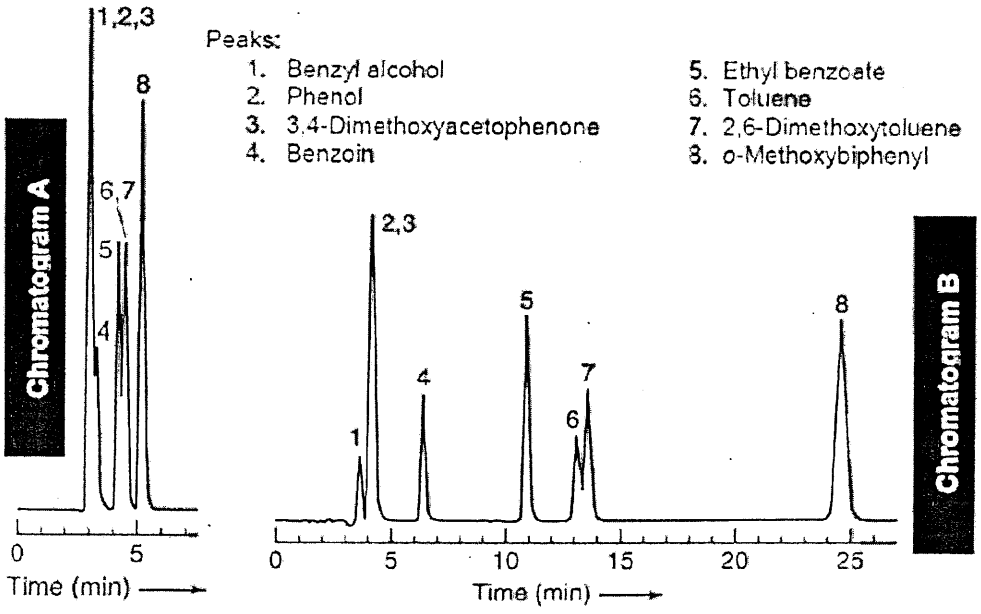
11. What are the following reasons could lead to band broadening in gas-liquid chromatography
    (A) Column is packed by large particles
    (B) Thick layers of stationery phase
    (C) Very high or very low flow rates
    (D) High temperature
    (E) Fast injection rates

12. Calculate "y" including the absolute standard deviation and round the result to include only significant figures. $y = 326(\pm 1) \times \frac{740(\pm 2)}{1.964(\pm 0.006)}$
    (A) 122830.957(±626.000)
    (B) 122831(±626)
    (C) $1.228(\pm 0.006) \times 10^5$
    (D) $1.23(\pm 0.01) \times 10^5$
    (E) $1.2\ (\pm 0.0) \times 10^5$

13. The two chromatograms shown below were recorded using reverse phase HPLC. Chromatogram B was recorded on the same column and with the same sample as chromatogram A, but the separation is very different. Which of the following statement(s) is/are reasonable to explain this result?



    (A) Chromatogram B was recorded using a mobile phase with higher eluent strength than chromatogram A
    (B) Chromatogram B was recorded using a mobile phase with less polarity than chromatogram A
    (C) Chromatogram B was recorded using a mobile phase with lower eluent strength than chromatogram A
    (D) Chromatogram B was recorded using mobile phase with lower temperature
    (E) Chromatogram B was recorded using a mobile phase with higher polarity than chromatogram A

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14. Which accelerating voltage is required to direct a molecule with singly charged water through the magnet has a field strength of 0.240 T (tesla) and the radius of curvature of the ion through the magnetic field is 12.7 cm?

(A) 1.56×10^{22} V　(B) 8.26×10^{-21} V　(C) 4.13×10^{-21} V　(D) 4.98×10^{3} V　(E) 2.49×10^{3} V

15. Which of the following technique does not belong to surface analysis techniques?

(A) Infrared Spectrometry

(B) Secondary-ion mass spectrometry

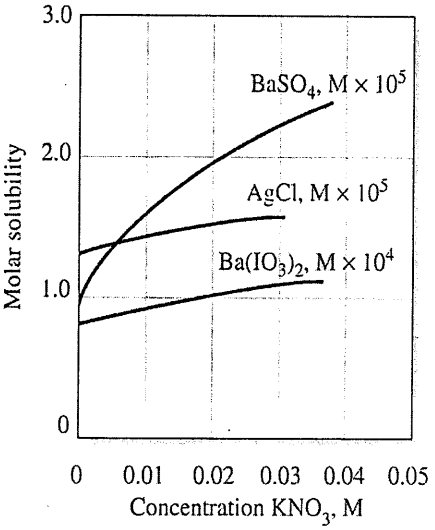
(C) Ellipsometry

(D) Atomic force microscopy

(E) Nuclear Magnetic Resonance Spectrometry

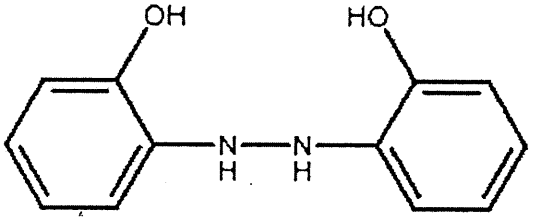
Part II. Problem-solving and short answer questions. Please show all work, steps, units and explanation if applicable. (25%)

1. The figure shown right describes how the electrolyte affects the molar solubility of several salts. Please explain why the electrolyte concentrations influence the molar solubility as illustrated. (5%)

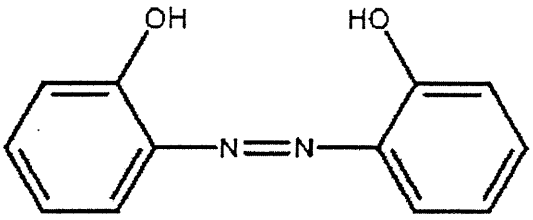


2. For an ion-selective electrode (ISE) designed to selectively detect M^{z+} ions. (a) Draw the structure of a typical ISE and indicate its important components. (5%) (b) Explain the working principle of this ISE for detecting M^{z+} ions. (5%)

3. (a) Please define the term "quantum yield" in fluorescence spectrometry. (5%) (b) For the following pair of chemicals, which is expected to have a greater fluorescence quantum yield, ***explain*** your answer. (5%)



Compand A



Compand B