

國立成功大學

111學年度碩士班招生考試試題

編 號： 47

系 所： 化學系

科 目： 分析化學

日 期： 0220

節 次： 第 4 節

備 註： 不可使用計算機

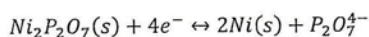
※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

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

1. Calculate "y" including the absolute standard deviation and round the result to include only significant figures. $y = \log[2.00(\pm 0.03) \times 10^{-4}]$ ($\log 2 = 0.301$)

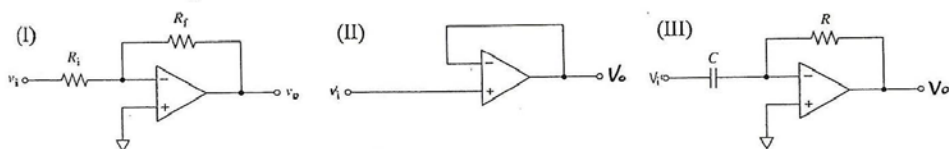
- (A) -3.69897 (± 0.00811)
 (B) -3.699 (± 0.004)
 (C) -3.699 (± 0.008)
 (D) -3.70 (± 0.00)
 (E) -3.70 (± 0.01)

2. The solubility product of $Ni_2P_2O_7$ is 1.7×10^{-13} . Calculate E^0 for the following reaction.



- (A) 0.19 V (B) 0.06 V (C) 0.44 V (D) 0.32 V (E) 0.25 V

3. What of the following statements about the function of the operational amplifier circuits is/are correct?



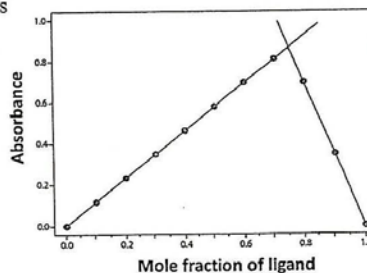
I: When the ratio of $R_f/R_i > 1$, this operational amplifier circuit works as a divider.

II: This circuit is called a voltage follower that displays a unit voltage gain but a very large power gain.

III: This circuit works as a differentiator which provides an output signal v_o as differentiation of v_i .

- (A) Only I (B) Only II (C) Only III (D) I and II (E) II and III

4. The figure shown right is obtained via the method of continuous variation utilized for complex-ion studies. According to the recorded data, what formula is correct for the complex under study? (M: metal ion, L: ligand)

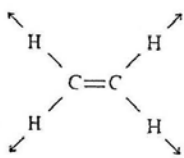


- (A) ML
 (B) ML_2
 (C) M_2L
 (D) ML_3
 (E) M_3L

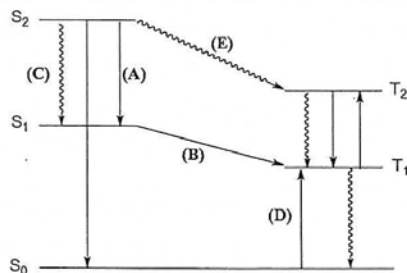
5. Which of the following solution(s) display(s) the best buffer capacity at pH 4.15?

- (A) 0.5 M, 100 mL $C_5H_7O_4COOH$ + 1.0, 50 mL $C_5H_7O_4COO Na$ (pK_a of $C_5H_7O_4COOH = 4.10$)
 (B) 1.0 M, 100 mL $HCOOH$ + 1.0 M, 100 mL $HCOONa$ (pK_a of $HCOOH = 3.75$)
 (C) 2.0 M, 50 mL CH_3COOH + 4.0, 25 mL CH_3COONa (pK_a of $CH_3COOH = 4.75$)

- (D) 0.2 M, 10 mL HCOOH + 2.0 M, 25 mL HCOONa HCOOH (pKa of HCOOH = 3.75)
 (E) 2.0 M, 50 mL C₆H₅COOH + 4.0 M, 25 mL C₆H₅COONa (pKa of C₆H₅COOH = 4.20)
6. The elution order for the following solutes in a liquid chromatography system consisting of a toluene mobile phase and a silica stationary phase would be:
 (A) benzene, tetrahydrofuran (C₄H₈O), methanol
 (B) methanol, benzene, tetrahydrofuran (C₄H₈O)
 (C) tetrahydrofuran (C₄H₈O), methanol, benzene
 (D) methanol, tetrahydrofuran (C₄H₈O), benzene
 (E) benzene, methanol, tetrahydrofuran (C₄H₈O)
7. Which of the following statements about the redox titration $I_2 + S_2O_3^{2-} \rightarrow S_4O_6^{2-} + I^-$ (unbalanced) is/are correct?
 (A) The color transition range of a redox indicator is associated with a potential change of 2.303RT/F.
 (B) The titration curve is affected when the concentrations of I_2 and $S_2O_3^{2-}$ are diluted by a factor of 5.
 (C) For redox titration, pre-reduction or per-oxidation of reagents is required to ensure the quantitative accuracy of the titration experiment.
 (D) The equivalence-point potential for this redox titration equals $(E_{I_2/I^-}^0 + E_{S_4O_6^{2-}/S_2O_3^{2-}}^0)/2$
 (E) An appropriate redox indicator must possess a standard potential close to the equivalence point potential of the redox titration.
8. Which of the following statements about the figure of merit for analytical methods is/are correct?
 (A) Bias provides a measure of the random error of an analytical method.
 (B) Calibration sensitivity refers to the slope of a calibration curve while it does not indicate what concentration difference can be detected.
 (C) Limit of linearity refers to the concentration at which the calibration curve departs from linearity by a deviation of ~5%.
 (D) The limit of quantitation can be quantified as three times the standard deviation of the blank measurement.
 (E) Selectivity defines the degree to which an analytical method is free from interference by interferents contained in the sample matrix.
9. Which of the following statements is/are true for an acid-base titration using NaOH to titrate a triprotic acid H₃A? (The dissociation constants of H₃A are K_{a1}, K_{a2}, and K_{a3} for the first, second, and third step dissociation, respectively.)
 (A) At the first equivalence point, the pH value of the solution is determined by K_{a1}
 (B) At the second half-equivalence point, the pH value of the solution equals pK_{a2}
 (C) At the second equivalence point, the major species in the solution are H₂A⁻ and H₂O.
 (D) At the third equivalence point, the pH value of the solution is determined by the dissociation of A³⁻, whose dissociation constant K_b equals K_w/K_{a1}.

- (E) At the second equivalence point, the pH value of the solution equals $(pK_{a2} + pK_{a3})/2$
10. Which of the following statements about instrumental noise is/are true?
- (A) Jonson noise is caused by thermal agitation of charge carries in components of an instrument and is present even in the absence of current in the instrument.
- (B) The influence of flicker noise is especially obvious for high-frequency signals.
- (C) Shot noise takes place whenever electrons or other charged particles flow across a junction such as an anode/ cathode interface.
- (D) Thermal noise can be reduced by narrowing the frequency bandwidth of the signal and cooling the system.
- (E) Both flicker noise and Jonson noise are white noise.
11. Which of the following reasons would result in deviations from the linearity of Beer's Law?
- (A) High analyte concentration (>0.01 M).
- (B) Analytes prepared in a concentrated electrolyte.
- (C) Stray light, especially when the analyte concentration is low.
- (D) Fluorescence or phosphorescence of the sample.
- (E) Usage of monochromatic radiation
12. Which of the following vibrations is/are correct in the activity for both the IR and Raman measurement?
- | Molecule | Motion | Infrared | Raman |
|-------------------|---|----------|----------|
| (A) SO_2 | Symmetric stretching | active | inactive |
| (B) CO_2 | Symmetric stretching | inactive | active |
| (C) CH_3-CCl_3 | C-C stretching | active | active |
| (D) $CH_2=C=CH_2$ | Asymmetric stretching
C-C stretching | active | inactive |
| (E) $CH_2=CH_2$ |  | inactive | inactive |
13. Which of the following characteristics is/are the advantages offered by Fourier transform infrared spectrometer compared to a dispersive infrared instrument?
- (A) Enhanced signal-to-noise ratio.
- (B) Faster data collection speed.
- (C) Reduced interference from stray light.
- (D) Improved accuracy of wavenumber.
- (E) Higher spectral resolution.
14. Which of the following labels for the processes in the Jablonski diagram for a photoluminescent molecule is/are "not" correct?

- (A) Fluorescence
 (B) Phosphorescence
 (C) Internal conversion
 (D) Allowed absorption
 (E) Vibrational relaxation



15. Which of the following statements about the width of atomic spectral lines is/are true?
- (A) The natural width of an atomic spectral line is determined by the lifetime of the excited state.
 (B) The collisional broadening is highly dependent on the gaseous medium.
 (C) The pressure broadening is temperature independent.
 (D) Doppler broadening results from the rapid motion of atoms as they emit or absorb radiation.
 (E) Doppler broadening becomes more pronounced as the flame temperature decreases.

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

1. A fluorescent object and a phosphorescent object are both lit with an appropriate UV lamp. How could you distinguish between the objects? Explain why your method works. (10 points)
2. Define and explain the fundamental reasons to cause the (A) alkaline error and (B) acid error in pH measurements. (10 points)
3. Draw the configuration of significant components for fluorescence measurement, including the (1) excitation source, (2) wavelength selector, (3) sample cell, (4) detector, and (5) signal processor and readout. (5 points)