

類組：化學類 科目：分析化學(1005)共 4 頁 第 1 頁

※選擇題請在答案卡內作答，非選擇題請在答案卷內作答

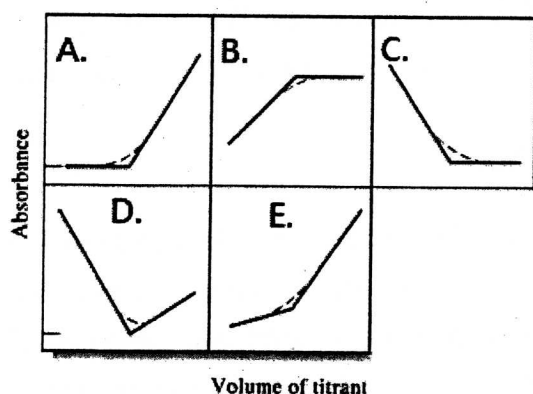
## 一、單選題（每題 4 分，答錯不倒扣，選擇題答案請填於答案卡）

1. Which of the following variables can increase column efficiency for a capillary column in gas chromatography? (1) thicker film, (2) thinner film, (3) shorter column, (4) smaller inner diameter, (5) larger inner diameter, (6) increase carrier gas flow rate.  
A.(2, 3, 4) B. (2, 4) C. (1, 4, 6) D. (3, 5, 6) E. (6)
2. Overall, electrothermal (graphite furnace) atomization in atomic absorption spectrometry (AAS) has better sensitivity than flame-AAS due to which of the following reasons: (1) better atomization efficiency than nebulizer used in flame AAS, (2) average residence-time of the atoms in the optical path is much shorter than in the flame AAS, (3) more sample can be introduced per analysis, (4) much higher equilibrium concentration of the analyte, (5) better detector.  
A.(2, 3) B. (1, 2, 4) C. (1, 3, 4) D. (4, 5) E. (1, 3, 5)
3. PM<sub>2.5</sub> is collected by specialized filter papers which ambient air is pumped through. If one needs to analyze the composition of heavy metals in the filter samples but still needs the filter samples for subsequent analysis of other various chemical/physical properties. Which of the following analytical technique can serve the purpose and still keep the filter samples intact for other analytical studies?  
A.ICP-MS B. XRF C. AAS D. GC/MS E. NMR
4. In FT-IR, interferometer is used to serve what purposes? (1) to perform Fourier transformation. (2) to detect IR signal and to reveal multiplex advantage, (3) to reduce IR frequencies from the light source in a proportional way, (4) In theory, if the data acquisition electronics is rapid enough, the interferometer can be omitted, (5) The moving mirror in the interferometer is designed to allow diffraction to occur like a prism.  
A.(4, 5) B. (3, 4, 5) C. (1, 2, 4) D. (3, 4) E. (1, 2, 3, 5)
5. If an analyte is determined to be exactly at the detection limit of the method, which of the following statements are better fit to describe this condition? (1) The analyte is found with 99% confidence, (2) There is still 50% chance that the analyte cannot be distinguishable from the blank, (3) The analyst is 95% sure that he/she has found the analyte. (4) Only 1% chance the blank is determined to be the analyte.  
A.(1) B. (2) C. (3) D. (2, 4) E. (1, 4)

注意：背面有試題

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6. When possible, internal standardization (I.S.) is chosen over external standardization for concentration calibration in an analysis. Which of the following interfering factors can be greatly reduced by adopting the technique of internal standardization. (1) random error, (2) matrix problem, (3) sample loss before adding I.S., (4) human error, (5) instrumental instability or drift.  
A. (1, 3, 5) B. (3, 4) C. (1, 2, 4) D. (2, 3, 5) E. (2, 5)
7. The advent of LC/MS came much later than GC/MS. What major breakthrough was made to the advance of LC/MS by successfully coupling HPLC with mass spectrometry?  
A. improvement in HPLC column preparation technique B. the availability of better detection  
C. the method involving rapidly evaporating solvent D. the introduction of MALDI. E. the introduction of time-of-flight mass spectrometry.
8. In a typical photometric titration using UV-Vis, which one of the following curves corresponds to the condition of:  $\epsilon_T > \epsilon_P > 0$   $\epsilon_A = 0$   $\epsilon$ , A, P, T stand for absorption coefficient, analyte, product and titrant, respectively.



9. Which of the following statements are true? (1) Systematic error affects accuracy, (2) Random error comes from undetermined sources and can be effectively minimized or removed. (3) Random error affects accuracy and are also called indeterminate errors. (4) Accuracy can be improved by good calibration. (5) Random error can be improved by good training and sufficient practice.  
A. (1, 4) B. (1, 2, 3) C. (3, 5) D. (1, 3, 5) E. (2, 3, 5)
10. What could be the consequence if the distance of the moving mirror in the interferometer of FT-IR is shorter than necessary?  
A. Loss of sensitivity B. loss of stability C. decrease in reproducibility  
D. loss of spectral details E. increase in sensitivity.

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11. The Lambert Beer's law is frequently used in quantitative spectral analysis based on a simple linear relationship between concentration and instrumental response. Name the following quantitative techniques that are not based on the Lambert Beer's law. (1) AAS, (2) ICP-OES, (3) UV-Vis absorption, (4) GC/MS, (5) FT-IR, (6) Cyclic voltammetry.  
A.(2, 3, 4) B. (1, 3, 6) C. (2, 4, 6) D. (3, 5) E. (4, 6)
12. Which of the following practices have little to do with improving accuracy? (1) Analyze standard reference materials, (2) Increase the number of repeated analyses, (3) Run blanks, (4) Increase recovery, (5) Increase sample volume.  
A.(1, 3) B. (2, 3) C. (1, 3, 4) D. (2, 5) E. (2, 3, 5)
13. Which of the spectral line broadening effects with the emission or absorption peaks in atomic spectrometry cannot be altered for the degree of broadening: (1) Uncertainty effect, (2) Doppler effect, (3) Pressure effect, (4) Collision effect, (5) Temperature effect.  
A.(1, 2, 3) B. (2, 3, 4) C. (1) D. (4, 5) E. (4, 5)

二. 簡答題 (中英文作答皆可。請按題號依序作答。計算題應詳列計算過程，無計算過程者不予計分。簡單的加減乘除，請以手計算即可，不用計算機。)

- (一) (4 pts) 1. How is it possible to differentiate X-ray photoelectron and Auger electron in surface analysis? 2. What technique can be used to study the interface between two immiscible liquids?
- (二) (4 pts) Define 1. diffuse layer 2. diffusion layer in electrochemistry.
- (三) (8 pts) Show the typical electrochemical cell in the shorthand schematics used to measure the activity of  $H^+$  in aqueous analyte, such as  
anode||analyte|glass|electrolyte|cathode  
Specify the anode, cathode and electrolytes in your configuration.
- (四) (8 pts) In a redox titration experiment, where an analyte containing  $M^{2+}$  is titrated against  $Ce^{4+}$  in 1 M  $H_2SO_4$  at room temperature. Answer the following questions on this titration. ( $Ce^{4+} + e^- \rightarrow Ce^{3+}$ ,  $E^{0'} = 1.44$  V vs. standard hydrogen electrode)
1. If  $M^{2+}$  is oxidized to  $M^{4+}$ , and the potential observed at the equivalent point is 0.78 V. Find the formal potential of the reaction  $M^{4+} + 2e^- \rightarrow M^{2+}$ .
  2. Calculate the concentration ratio between  $M^{2+}$  and  $M^{4+}$  (in the log format) at the equivalent point in this titration experiment.  $\log ([M^{2+}]/[M^{4+}]) = ?$

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- (五) (8 pts) 1. Draw the concentration profile (concentration versus distance to the electrode surface) of a reactant "O" in a general redox reaction  $O + 1e^- \rightarrow R$  at a potential 120 mV more negative than its formal potential in a typical cyclic voltammetry condition, where the electrode area is much smaller than the volume of a stationary solution. The bulk concentration of O is denoted by  $C^*$ .
2. What is the relationship between this concentration vs. distance profile and the current density measured at a stationary working electrode?
- (六) (8 pts) 1. Name two advantages of Raman spectroscopy over infrared spectroscopy.
2. Draw the typical transmittance and wavelength characteristics of a Notch filter used in Raman spectroscopy.
- (七) (8 pts) For the following operational amplifier, derive the relationship between the output voltage  $V_o$  and input voltages  $V_2$  and  $V_1$ .

