

類組：化學類 科目：分析化學(1005)

※請在答案卡內作答

單選題：每題 4 分 (請將答案寫在電腦答案卡上) (其中計算題皆為加減乘除運算，無需用到計算機!!)

1. Which of the following definitions are **correct**?

- (1) Precision: how well replicate measurements agree with each other.
- (2) Accuracy: a measure of how close a measured value is to the "true" value.
- (3) t-test: use to decide whether the results of two experiments are within experimental uncertainty of each other.
- (4) Confidence interval: range of values within which there is a specified probability that the value of standard deviation lies.
- (5) Outlier: a datum that lies far from the other data in a set of measurement.

Your answer: **A.** (1), (2) and (5); **B.** (1), (2), (3) and (5); **C.** (2), (3) and (4);  
**D.** (1), (3) and (4); **E.** (1), (3) and (5).

2. Which of the following definitions are **correct**?

- (1) Method blank: a sample contains all components, and it is taken through all steps of the analytical procedure.
- (2) Field blank: a sample is similar to a method blank, but it has been exposed to the site of sampling.
- (3) False positive: a conclusion that the concentration of analyte is below a certain limit when, in fact, the concentration is above the limit.
- (4) Robustness: ability of an analytical method to be unaffected by small, deliberate changes in operating parameters.
- (5) Matrix effect: a change in analytical signal caused by anything in the sample other than analyte.

Your answer: **A.** (1), (2) and (5); **B.** (2), (3) and (5); **C.** (1), (2) and (3);  
**D.** (2), (4) and (5); **E.** (1), (2), (3) and (5).

3. For ionic strength and activity coefficients, which of the following statements are **true**?

- (1) The ionic strength of 0.020 M KBr plus 0.010 M  $\text{Na}_2\text{SO}_4$  is 0.050 M.
- (2) At very low ionic strength, activity coefficients approach unity.
- (3) Activity coefficients are assumed to be zero for neutral molecules.
- (4) Activity coefficients increase with increasing ionic strength.
- (5) The greater the ionic strength of the solution, the higher the charge in the ionic atmosphere.

Your answer: **A.** (1), (3) and (5) **B.** (1) and (5); **C.** (1), (2) and (5); **D.** (1), (4) and (5);  
**E.** (1) and (2).

4. The analysis of constituents of  $\text{Na}_2\text{CO}_3$ ,  $\text{NaHCO}_3$  and  $\text{NaOH}$  in mixture requires two titrations with a strong acid: one using an alkaline-range indicator (i.e., phenolphthalein), and the other with an acid-range indicator (i.e., bromocresol green). The composition of the solution can then be deduced from the relative volumes of acid needed to titrate equal volumes of the sample. To determine the constituent(s) in sample, which of the following statement is **not correct**? (Here,  $V_{\text{phth}}$ : volume of acid needed for a phenolphthalein end point; and  $V_{\text{beg}}$ : volume of acid needed for a bromocresol green end point)

- A.** If  $V_{\text{phth}} = V_{\text{beg}}$ , only  $\text{NaOH}$  is in the sample.
- B.** If  $V_{\text{phth}} = \frac{1}{2}V_{\text{beg}}$ , only  $\text{Na}_2\text{CO}_3$  is in the sample.
- C.** If  $V_{\text{phth}} > 0$  and  $V_{\text{beg}} = 0$ , only  $\text{NaHCO}_3$  is in the sample.
- D.** If  $V_{\text{phth}} > \frac{1}{2}V_{\text{beg}}$ , both  $\text{NaOH}$  and  $\text{Na}_2\text{CO}_3$  are in the sample.
- E.** If  $V_{\text{phth}} < \frac{1}{2}V_{\text{beg}}$ , both  $\text{NaHCO}_3$  and  $\text{Na}_2\text{CO}_3$  are in the sample.

注意：背面有試題

類組：化學類 科目：分析化學(1005)

※請在答案卡內作答

5. The amino acid Arginine ( $\text{H}_3\text{Arg}^{2+}$ ) has  $pK_1 = 1.82$ ,  $pK_2 = 8.99$  and  $pK_3 = 12.1$ . Which is the **second prominent species** at  $pH 3$ .

Your answer: A.  $\text{H}_3\text{Arg}^{2+}$ ; B.  $\text{H}_2\text{Arg}^+$ ; C.  $\text{HArg}$ ; D.  $\text{Arg}^-$ .

6. For Kjeldahl Nitrogen Analysis. A typical protein contains 16.0 wt% nitrogen. A 0.5-mL aliquot of protein solution was digested, and the liberated  $\text{NH}_3$  was distilled into 10.0 mL of 0.020 M HCl. The unreacted HCl required 3.0 mL of 0.020 M NaOH for complete titration. Calculate the concentration of protein (as **mg-protein/mL**) in the original sample.

Your answer: A. 0.14; B. 24.5; C. 1.96; D. 12.25.

7. The van Deemter equation tells us how the column and flow rate affect plate height. Which of the following statements are **correct**?

- (1) Longitudinal diffusion term to plate height is proportional to the linear velocity of the eluent.
- (2) Longitudinal diffusion is of significance in liquid chromatography where diffusion rates are much larger.
- (3) Mass transfer term (or finite equilibration time) to plate height is proportional to the linear velocity of the eluent.
- (4) Mass transfer plate height is decreased by increasing temperature.
- (5) Eddy diffusion to plate height is independent to the linear velocity of the eluent.

Your answer: A. (1), (3) and (4); B. (1), (4) and (5); C. (3), (4) and (5);

D. (2), (3), and (5); E. The statements are all correct.

8. For open tubular GC columns, which of the following statement is **not correct**?

- A. Narrow columns provide higher resolution than wider columns.
- B. The number of theoretical plates on a column is inversely proportional to column length.
- C. At the constant linear velocity, increasing the thickness of the stationary phase increases retention time and increases resolution of early-eluting peaks.
- D. Thicker films are used with highly volatile analytes because such films retain solutes for a longer time.
- E. Compared with packed column, open tubular GC columns offer short analysis time.

9. For the physics properties of supercritical fluid (SF), which of the following statements are **correct**?

- (1) The density of SF is close to that of a liquid, where as its viscosity is like gas.
- (2) The diffusion coefficient of SF is like liquid.
- (3) Compared with gas, SF has good solvating power, which is like liquid.
- (4) The diffusivity of SF is better than liquid, and SF has high viscosity, and high surface tension.
- (5)  $\text{CO}_2$  is commonly used for SF since it reacts with other compounds easily.

Your answer: A. (1) and (3); B. (1), (2) and (4); C. (1), (3) and (4);

D. (3) and (4); E. (1), (3) and (5).

10. For ion-exchange and ion chromatography, which of the following statements are **correct**?

- (1) strongly acidic cation exchangers containing sulfonate groups;
- (2) weakly basic anion exchangers containing quaternary ammonium groups;
- (3) the relative selectivity coefficients of cations,  $\text{Li}^+$  is smaller than  $\text{K}^+$ , since  $\text{Li}^+$  has smaller hydrated radius;
- (4) in suppressed-ion cation chromatography, anion-exchange membrane is used to suppress the anions;
- (5) in suppressed-ion cation chromatography, HCl is commonly used as the eluent.

Your answer: A. (1), (3) and (4); B. (1), (4) and (5); C. (1), (3) and (5);

D. (2) and (5); E. (3), (4) and (5).

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類組：化學類 科目：分析化學(1005)

※請在答案卡內作答

11. For capillary zone electrophoresis (CZE), the charges of the analytes including:  $A^{2-}$ ,  $A^{1-}$ ,  $C^{1+}$ ,  $C^{2+}$ , and N (as a neutral compound), predict their migration order from the first be detected to the last?

Your answer: **A.**  $A^{2-}$ ,  $A^{1-}$ , N,  $C^{1+}$ ,  $C^{2+}$ ; **B.**  $C^{2+}$ ,  $C^{1+}$ , N,  $A^{1-}$ ,  $A^{2-}$ ;  
**C.** N,  $C^{2+}$ ,  $C^{1+}$ ,  $A^{2-}$ ,  $A^{1-}$ ; **D.**  $A^{1-}$ ,  $A^{2-}$ , N,  $C^{1+}$ ,  $C^{2+}$ .

12. For a triple quadrupole mass spectrometer (QqQ), which following is not its main mode in MS/MS operation:

Your answer: **A.** Product ion scan; **B.** Selected reaction monitoring; **C.** Neutral loss scan;  
**D.** Selected ion monitoring; **E.** Precursor ion scan.

13. An organic pollutant contents two bromines (Br) and one chlorine (Cl) in its structure. Estimate the possible ratio of the isotopic patterns on the molecular ion.

Your answer: **A.** 9:6:3:1; **B.** 1:3:3:1; **C.** 3:7:5:1; **D.** 9:15:7:1.

以下為單、複選題；每題 4 分（可能有一個以上的正確答案，全對才給分，答錯不倒扣）（請將答案寫在電腦答案卡上）

14. What are the major advantages of Raman spectroscopy as compared with infrared spectroscopy?

- (A) Raman instrumentation is usually cheaper.
- (B) Raman spec can be used to analyze aqueous samples.
- (C) Raman experiments usually have higher signal intensity.
- (D) Raman spectra usually have fewer peaks for the same molecule.
- (E) Raman experiments require less sample preparation.

15. Which of the followings determine the effective penetration depth of the evanescent wave in the attenuated total reflectance spectroscopy?

- (A) power of the incident light (B) wavelength (C) refractive indexes of the crystal and the sample (D) incident angle of light (E) color of sample

16. Which of the followings are detectors applicable to mid-infrared spectrometer?

- (A) thermal couple (B) thermistors (C) pyroelectric detector (D) HgCdTe detector
- (E) charge-coupled device

17. What of the followings are the strength of Fourier transform infrared spectroscopy?

- (A) Multiplex advantage (B) Jacquinot advantage (C) Coulomb advantage (D) Faraday advantage (E) Fellgett advantage

18. Which of the followings are correct in Raman spectroscopy?

- (A) Laser with shorter wavelength is preferred, because it can prevent fluorescence.
- (B) A notch filter is needed to isolate a single laser line.
- (C) A bandpass filter is used to minimize the Rayleigh scattered radiation.
- (D) A charge-coupled device is used to detect simultaneously an entire Raman spectrum.
- (E) Remote sensing is made possible via a fiber-optic probe, which allows transmission of light for 100 m or more.

19. Which of the followings can enhance concentration polarization in typical electrochemical systems?

- (A) reducing electrode area (B) increasing analyte concentration (C) raising cell temperature (D) increasing electrolyte concentration (E) mechanical agitation

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※請在答案卡內作答

20. Which of the followings are correct concerning the X-ray tube?
- (A) A tungsten cathode and a metal anode are housed in a vacuum tube.
  - (B) Mg is the most commonly used window material.
  - (C) A heater circuit used to control the energy of the emitted X-rays.
  - (D) Production of X-rays is a very inefficient process. Less than 1% of the electric power is converted to radiant power.
  - (E) X-ray radiation can be detected by semiconductor transducers.
21. Which of the following are correct in pH electrode (potentiometry)?
- (A) Two reference electrodes are needed.
  - (B) Junction potential is one of the major sources of error.
  - (C) Concentration, not activity, is measured.
  - (D) The glass membrane used in pH measurement is non-conductive.
  - (E) A voltage follower is needed as the first stage of the electronic circuit used to measure the cell potential of the electrochemical cell.
22. Which of the followings are capable of determining the chemical compositions at the surface of a solid sample placed in a vacuum environment?
- (A) Scanning tunneling microscopy
  - (B) X-ray photoelectron spectroscopy
  - (C) Auger electron spectroscopy
  - (D) Ion scattering spectroscopy
  - (E) Surface plasmon resonance
23. What are the characteristics of a reversible redox couple in cyclic voltammetry experiments using a stationary electrode?
- (A) Peak currents of the anodic and cathodic peaks equal.
  - (B) The anodic and cathodic peaks should be separated by less than 30 mV.
  - (C) Peak current is directly proportional to the scan rate of potential under diffusion control.
  - (D) Non-faradaic (or Charging current) is also directly proportional to the potential scan rate.
  - (E) Current of the reduction peak starts to decrease when the potential is made more negative than the formal potential of the redox couple.
24. Which of the followings are correct in a typical voltammetric experiment using a three-electrode configuration?
- (A) The reference electrode does not pass current.
  - (B) The current passing the working electrode is measured via a current-to-voltage operational amplifier.
  - (C) A potentiostat is used to control the potential difference between the working and counter electrodes.
  - (D) The reference electrode should be placed close to the working electrode.
  - (E) Current at the working electrode reflects the rate of redox reactions occurring there.

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25. Which of the following operational amplifiers circuit is able to perform mathematical operation of integration, where  $v_o$  is an integration of  $v_i$ .

