

一、單選題：每題 4 分，答錯不倒扣

1. For types of error, which of the following statements are TRUE?

- (1) Systematic error is a consistent error that can be detected and corrected.
- (2) Random error can be eliminated by improved technique.
- (3) A key feature of systematic error is that it is reproducible.
- (4) Systematic error can be detected by using the same method to measure the same quantity.
- (5) Analyze a known sample to see if you obtain known result can detect systematic error.

Your answer: A. (2), (4) and (5); B. (1), (2) and (3); C. (1), (3) and (5); D. (2) and (5);
E. The statements are all true.

2. The end point for the Fajans titration is indicated by the

- A. reduction of a colored indicator at the end point.
- B. adsorption of a colored indicator on the precipitate at the end point.
- C. deprotonation of a colored acid-base indicator at the end point.
- D. formation of a soluble, colored complex at the end point.
- E. protonation of a soluble, colored complex at the end point.

3. Which of the following statements about the activity coefficient is NOT TRUE?

- A. The activity coefficient decreases as ionic strength increases.
- B. The activity corrections are more significant for ions with higher charge.
- C. Activity coefficients approach zero when the ionic strength approaches zero.
- D. The smaller the ionic size, the larger the deviation from the concentration becomes.
- E. The activity of a neutral molecule is assumed to equal its concentration.

4. Which of the following statements are NOT TRUE regarding the properties of a buffer solution?

- (1) A buffer is a mixture of a weak acid and its conjugate base.
- (2) A buffer resists pH changes when acids or bases are added.
- (3) The maximum capacity of the buffer is at $\text{pH} = \text{p}K_a$.
- (4) The pH of a buffer is independent on the solution ionic strength and temperature.
- (5) A buffer made from a diprotic acid should not be treated in the same way as a buffer made from a monoprotic acid.

Your answer: A. (2), (4) and (5); B. (1), (2) and (3); C. (1), (3) and (4); D. (4) and (5);
E. The statements are all true.

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5. Which statements are **TRUE** about the titration of a weak base (B) with a strong acid?

- (1) At the equivalence point, the pH is calculated using the acid dissociation reaction of the conjugate acid, BH^+ .
- (2) Past the equivalence point, the excess strong acid determines the pH.
- (3) Before strong acid is added, the solution contains just the conjugate acid, BH^+ .
- (4) Between the initial point and the equivalence point, the solution contains a mixture of B and BH^+ .
- (5) The pH at the equivalence point is more than 7.0.

Your answer: A. (2), (4) and (5); B. (1), (2) and (3); C. (1), (3) and (4);
D. (1), (4) and (5); E. The statements are all true.

6. EDTA titrations of metal ions are pH sensitive. Which statements are **TRUE**?

- (1) At low pH, the amount of EDTA in the form Y^{4-} decreases.
- (2) As the pH is lowered, the end point becomes less distinct.
- (3). Metals with higher formation constants cannot be titrated at lower pH.
- (4) All metal ions require alkaline titration conditions.
- (5) At higher pH values, the metal hydroxide might precipitate.

Your answer: A. (1), (2) and (5); B. (2) and (4); C. (2), (3) and (4); D. (1), (2) and (4);
E. The statements are all true.

7. Two compounds were separated using gas chromatography. The retention times were 628 and 642 s, and the widths at half-height were 8.3 and 9.4 s, correspondingly. Find the resolution for these two compounds, and are the two peaks well resolved?

$$\text{Resolution} = \frac{\Delta t_R}{w_{av}} = \frac{\Delta V_R}{w_{av}} = \frac{0.589 \Delta t_R}{w_{1/2av}}$$

A. 1.6, yes; B. 0.93, no; C. 0.93, yes; D. 7.5, yes; E. 3.8, yes

8. In **reversed-phase chromatography**, which of the following statements are **TRUE**?

- (1) a polar stationary phase and a less polar mobile phase are used.
- (2) a nonpolar or weakly polar stationary phase and a more polar mobile phase are used.
- (3) a less polar mobile phase is a stronger mobile phase.
- (4) increasing the polarity of the mobile phase increasing the elution time of the less polar analyte
- (5) the least polar component is eluted first because it is the most soluble in the mobile phase

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

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9. Which statements regarding mass analyzers are **NOT TRUE**?

- (1) In the time-of-flight mass analyzer, lighter ions travel more quickly than heavier ions.
- (2) The Orbitrap analyzer is a high-resolution mass analyzer that require a magnetic field.
- (3) In the quadrupole mass analyzer, an electric field deflects ions in complex trajectories as they migrate toward the detector.
- (4) The high-resolution FT-ICR analyzer does not require a magnetic field.
- (5) In the linear quadrupole ion trap, manipulating voltages allows ions of a specific m/z to be expelled from the ion trap.

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

10. The electrospray mass spectrum of an unknown protein consists of a series of clusters of peaks arising from intact molecular ions with different charge. One cluster has peaks at m/z 961.63, 961.83, 962.02 (tallest peak), 962.22, 962.41 Da. These peaks correspond to isotopic ions differing by 1 Da. From the observed peak separation, find the **charge** of the ions in this cluster, and from m/z of the tallest peak, estimate the **molecular weight (MW)** of the protein.

- A. +1; 962.5 Da; B. +2; 1924.0 Da; C. +3; 2886.1 Da; D. +4; 3848.1 Da;
E. +5; 4810.1 Da.

11. Which statements are **TRUE** regarding tandem mass spectrometry (MS/MS)?

- (1) A tandem mass spectrometer consists of two m/z separators that are connected in series and separated by a collision cell.
- (2) Tandem mass spectrometry is especially useful with hard ionization techniques that produce a lot of fragmentation.
- (3) In precursor ion scan mode, we can identify which product ions come from a particular precursor ion.
- (4) Tandem mass spectrometers are capable of providing quantitative and qualitative information.
- (5) Selected reaction monitoring greatly improves the chromatographic signal-to-noise ratio because it is highly specific for the analyte of interest.

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

12. What is the **predicted intensity** of the m/z 228 peak relative to the MH^+ peak (m/z 227) for pentobarbital from chemical ionization, $C_{11}H_{19}N_2O_3$? The **isotopic abundances** are $^{13}C = 1.08\%$, $^2H = 0.012\%$, $^{15}N = 0.37\%$, and $^{17}O = 0.038\%$.

- A. 11.5%; B. 10.7%; C. 6.55%; D. 15.2%; E. 13.0%.

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13. Which statements regarding the sample preparation procedure QuEChERS are **TRUE**?

- (1) QuEChERS stands for *Quick, Easy, Cheap, Effective, Rugged, and Safe*.
- (2) It uses a large amount of organic solvent.
- (3) It consists of two steps: extraction of analytes followed by sample cleanup to remove matrix components.
- (4) The procedures include vigorously shaking and centrifuge.
- (5) Commonly, low salt concentration is applied to create aqueous and organic phases, and drives organic analytes into the organic phase.

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

14. Noise caused by random fluctuation of electrons in an electronic device is

- A. white noise.
- B. Johnson noise.
- C. Gaussian noise.
- D. drift noise.
- E. line noise.

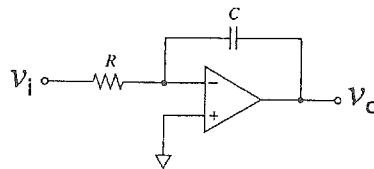
15. Which statement regarding an interferometer is FALSE?

- A. Radiation from the source is split; some is reflected to a stationary mirror and some is transmitted to a movable mirror.
- B. Constructive interference occurs whenever δ is an integer multiple of the wavelength.
- C. A minimum occurs when δ is a half-integer multiple of the wavelength.
- D. Radiation reaching the detector goes through a series of maxima and minima as the mirror moves from the beamsplitter at a constant speed.
- E. All of the statements are true.

16. Which statement is NOT true about surface plasmon resonance?

- A. The angle at which reflectivity is at a minimum is independent of the refractive index of the dielectric.
- B. A surface plasmon is an electromagnetic wave that propagates along the boundary between a metal and a dielectric.
- C. The surface plasmon absorbs some of the incident light when it is in resonance with the incident light.
- D. A chemical-sensing layer can be added to the metal surface to create a specific response to the change in refractive index.
- E. Changes in the surface plasmon resonance angle can be measured with a precision of $\sim 10^{-4}$ to 10^{-5} degrees.

17. The laser medium is irradiated with electromagnetic radiation. What is the function of this incident radiation?
- create a population inversion
 - heat the lasing medium
 - stimulate emission of a photon
 - stimulate nonradiative relaxation
 - amplify the emitted light
18. Which of the following statements about an emission spectrum is FALSE?
- It is collected at a different wavelength compared to the absorption spectrum.
 - It is a mirror image of the absorption spectrum.
 - It is collected by varying the excitation wavelengths and measuring a fixed emission wavelength.
 - It has a higher energy than the excitation spectrum.
 - It is collected by fixing the excitation wavelength and is measured by varying the emission wavelengths.
19. A low-frequency sine wave voltage is the input to the following operational amplifier circuits. What is the relationship between V_i and V_o ?



- $v_o = -R_i C \frac{dv_i}{dt}$
 - $v_o = -\frac{1}{R_i C} \int_0^t v_i dt$
 - $v_o = v_i$
 - $v_o = (R - C) v_i$
 - $v_o = (R/C) v_i$
20. Which detector can be used for infrared spectroscopy?
- photomultiplier tube
 - photodiode
 - charge coupled device
 - photoconductive detector
 - photodiode array

二、複選題：每題 4 分，全對才給分，答錯不倒扣。

21. Which statements about the junction potential in electrochemistry are FALSE?
- A. It depends on the relative mobilities of the electrolyte ions.
 - B. It can be reduced but not completely eliminated.
 - C. It affects the outcome of the potentiometric measurements.
 - D. It is inversely proportional to the difference between the half-cell potentials.
 - E. It cannot be measured.
22. Fe^{2+} is titrated with Ce^{4+} to form Fe^{3+} and Ce^{3+} . Which statements are TRUE of the potential at the equivalence point of this titration?
- A. The potential is equal to the sum of the standard reduction potentials of the two half-reactions minus the potential of the reference electrode.
 - B. The potential is equal to the sum of the standard reduction potentials of the two half-reactions.
 - C. The potential is equal to the average of the standard reduction potentials of the two half-reactions minus the potential of the reference electrode.
 - D. The potential is equal to the average of the standard reduction potentials of the two half-reactions.
 - E. It lies at the mid-point of the redox titration curve.
23. Which statements regarding cyclic voltammetry of a reversible reaction ($\text{O} + n\text{e}^- \rightarrow \text{R}$) are FALSE ?
- A. The peak anodic and peak cathodic currents are similar in magnitude.
 - B. The half-wave potential lies midway between the potentials, at which the peak anodic and peak cathodic currents occur.
 - C. The reaction proceeds fast enough to deplete the concentrations of the reactant and product at the surface of the electrode.
 - D. The peak cathodic current of the first forward sweep is proportional to the log (analyte concentration).
 - E. The potentials at which the peak anodic and peak cathodic currents occur are separated by $57.0/n$ mV at 25°C .
24. Which statements regarding polarography are FALSE?
- A. The dropping-mercury electrode yields a more reproducible current-potential behavior than other electrodes.
 - B. The reduction of a metal into a mercury amalgam is more favorable than reduction to the solid state.

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- C. The current we seek to measure is the charging current, and the current that interferes with every measurement is the faradaic current.
- D. In sampled current polarography, the current is measured only in the initial milliseconds of the life of each Hg drop.
- E. For quantitative analysis, the limiting current should be controlled by the rate at which analyte can diffuse to the electrode, so an unstirred solution is used to minimize convection.
25. Which statements regarding ion-selective electrodes are FALSE?
- A. Ion-selective electrodes involve redox processes.
- B. A difference of $59.16n$ mV, where n is the charge on the analyte, builds up across the membrane for every factor-of-10 change in analyte activity in the outer solution.
- C. The ion-selective electrode responds to the activity of the ion in all forms in the solution, including both the free analyte and that which is complexed by anions in solution.
- D. The smaller the selectivity coefficient for an interfering species, the less interference by that species.
- E. Ion-selective electrodes contain a membrane that selectively binds the ion of interest.