類組：化學類　科目：分析化學(1005)　　共 7 頁 第 1 頁

**單選題 (答案請填於答案卡，答錯不倒扣，每題 2.5 分，共 100 分)**

1. Calculate the mass of $NaCH_3CO_2$ contained in 500.0 mL of a 0.1500 M $NaCH_3CO_2$ solution. ($NaCH_3CO_2$ = 82.0343 g/mol)
   (A) 914.3 μg (B) 283.4 g (C) 24.61 μg (D) 6.153 g (E) 24.61 g

2. Calculate the molarity of a 30.0 wt % hydrogen peroxide ($H_2O_2$, FM 34.0147) solution. The density of 30 wt% hydrogen peroxide is 1.135 g/cm$^3$.
   (A) 7.77 M (B) 0.0100 M (C) 0.100 M (D) 10.0 M (E) 8.82 M

3. Calculate the molarity of a 2.0-ppm $Mg^{2+}$ solution (Mg atomic mass = 24.30).
   (A) $8.2 \times 10^{-5}$ M (B) $8.2 \times 10^{-2}$ M (C) $1.2 \times 10^{-2}$ M (D) $1.2 \times 10^{-5}$ M (E) $4.9 \times 10^{-2}$ M

4. Which scenario has the lowest relative uncertainty?
   (A) delivering 35.50 mL of titrant with a 50 ± 0.05 mL class A buret
   (B) delivering 15.40 mL of titrant with a 50 ± 0.05 mL class A buret
   (C) delivering 18.50 mL of titrant with a 25 ± 0.03 mL class A buret
   (D) delivering 5.40 mL of titrant with a 25 ± 0.03 mL class A buret
   (E) delivering 97.30 mL of titrant with a 100 ± 0.10 mL class A buret

5. Calculate the mass of a heterogeneous mixture containing 139.32 g sand, 34.99 g gravel, and 9.372 g salt. Report the mass with the correct number of significant figures.
   (A) 184 g (B) 183.7 g (C) 183.68 g (D) 184.0 g (E) 183.682 g

6. _____ cannot be eliminated, but it may be reduced by better technique.
   (A) Gross error (B) Internal error (C) Systematic error
   (D) Random error (E) Determinate error

7. A lab technician was asked to determine the weight percent of Fe in an ore sample. The following results were obtained for the six analyses the technician did. What are the degrees of freedom of this data set?
   8.25%, 8.28%, 8.03%, 8.19%, 8.33%, 8.24%
   (A) 1 (B) 5 (C) 6 (D) 7 (E) 4

8. Calculate the overall standard deviation if the analytical standard deviation is 6% and the sampling standard deviation is 4%.
   (A) 6.3 % (B) 8.2 % (C) 7.2 % (D) 5.3 % (E) 4.5 %

注意:背面有試題

9. An ore sample was analyzed for its Fe content. Student A analyzed the sample a total of six times and her results had a standard deviation of 1.33. The same sample was analyzed five times by Student B and his results had a standard deviation of 3.42. To determine if their standard deviations are similar, they perform an F test. The calculated *F* value is _____.
(A) 6.61 (B) 0.38 (C) 2.57 (D) 0.151 (E) 9.92

10. Student's *t* is a statistical tool used most frequently to
I. express confidence intervals.
II. compare results from different experiments.
III. evaluate the probability of an experimental value agreeing with a "known" value.
IV. determine if a questionable data point should be discarded.
(A) I (B) II (C) I and II (D) I, II, and III (E) I, II, III, and IV

11. Which of the following is/are NOT a way to demonstrate the accuracy of a method?
I. Determine the limit of detection for the method
II. Analyze a certified reference material in a matrix similar to the sample
III. Compare the results of two or more different analytical methods
IV. Analyze a blank sample spiked with a known amount of analyte in the same matrix as the sample
(A) IV (B) II and III (C) I and III (D) III (E) I

12. Which acid is the strongest?
(A) acetic acid, pKa = 4.756
(B) benzoic acid, pKa = 4.202
(C) cyanoacetic acid, pKa = 2.472
(D) phenol, pKa = 9.997
(E) formic acid, pKa = 3.744

13. Which statement regarding galvanic cells is FALSE?
(A) Galvanic cells are spontaneous.
(B) Oxidation occurs at the anode, and reduction occurs at the cathode.
(C) Electrons move toward the more negative electrical potential.
(D) Galvanic cells are composed of two half-cells connected by a salt bridge.
(E) The salt bridge maintains electroneutrality throughout the cell.

14. Which statement(s) is/are NOT correct when the silver and vanadium half-cells are connected via a salt bridge and a potentiometer to form a galvanic cell?

$Ag^+(aq) + e^- \rightarrow Ag(s)$ $\quad E^\circ = 0.7993$ V

$V^{2+}(aq) + 2e^- \rightarrow V(s)$ $\quad E^\circ = -1.125$ V

I. $Ag^+$ is reduced.
II. V is oxidized.
III. $E^o_{cell} = 1.924$ V
IV. $V^{2+}$ is reduced.
V. Ag is oxidized.

(A) I and II (B) III, IV, and V (C) I, II, and III (D) III only (E) IV and V

15. An electrode with a fixed potential is the

(A) cathode (B) counter electrode (C) indicator electrode
(D) reference electrode (E) working electrode

16. A 100.00-mL solution of copper(II) chloride is reacted with excess silver nitrate to precipitate 8.926 0 g of silver chloride. Which calculation is NOT required to determine the molarity of the copper(II) solution?

(A) calculate the molar mass of silver chloride
(B) calculate the molar mass of copper(II) chloride
(C) calculate the moles of silver chloride from the precipitate mass
(D) calculate the moles of copper(II) chloride from the moles of silver chloride and the reaction stoichiometry
(E) divide the moles of copper(II) chloride by the volume of the copper(II) chloride solution expressed in liters

17. Which of the following are techniques to promote particle growth?

I. Use a large volume of solution so that the concentrations of analyte and precipitant are low.
II. Rapidly add the precipitant to precipitate all analyte from solution. Then raise the temperature of the solution to promote crystal growth.
III. Slowly add precipitant with vigorous mixing to prevent a highly supersaturated condition in solution.
IV. Raise the temperature of the solution to increase solubility of the precipitate and decrease supersaturation.

(A) III and IV (B) II, III, and IV (C) II and IV (D) I, II, and III (E) I, III, and IV

18. _____ is the energy per unit time per unit area in the light beam.

(A) Irradiance (B) Absorbance (C) Transmittance
(D) Molar absorptivity (E) Frequency

注意：背面有試題

19. If 99% of the light is absorbed by a solution, then according to the equation

$$A = \log\left(\frac{P_0}{P}\right) = -logT$$

(A) A = 1　(B) A = 2　(C) A = 0.1　(D) A = 0.01　(E) A = 0.099

20. Which statement about the excited and ground states of molecules is FALSE?
(A) When a molecule absorbs light of sufficient energy, it is much more likely to undergo the transition S0 → T1 than the transition S0 → S1.
(B) Electron spins are parallel in the triplet, T1, excited state and opposed in the singlet, S1, excited state.
(C) Internal conversion is a nonradiative transition from the S1 state to the S0 state.
(D) When a molecule absorbs light of sufficient energy, an electron transitions from the S0 to the S1 state.
(E) Intersystem crossing is a nonradiative transition from the T1 state to the S0 state.

21. Which figures of merit describe dynamic range of an analytical method?
(A) standard deviation
(B) systematic error
(C) bias
(D) limit of quantification and limit of linearity
(E) coefficient of selectivity

22. Which electronic element can be used to connect a high internal resistance transducer (*e.g.* a pH electrode) to a voltage meter in order to minimize measurement error?
(A) operational amplifier
(B) lock-in amplifier
(C) resistor
(D) diode
(E) transformer

23. Which concept in measurement science refers to the minimum frequency of data points while recording electric potential changes as a function of time?
(A) Ohm's Law
(B) Kirchoff's Laws
(C) power Law
(D) Nyquist sampling theorem
(E) Pythagorean theorem

注意:背面有試題

24. In photomultiplier tube, used in atomic emission spectrometers, which particles are emitted from dynode surface to enable amplification of the acquired signal?
(A) photons (B) cations (C) radical cations (D) electrons (E) clusters

25. Which item does not belong to FTIR spectrometer incorporating Michelson interferometer?
(A) prism (B) radiation beam (C) sample cell
(D) fixed mirror (E) movable mirror

26. Which radiation source is suitable for IR spectrometry in the wavelength range of 1,000-10,000 nm?
(A) hollow cathode lamp (B) Nernst glower (C) Ar lamp (D) $H_2$ lamp (E) $D_2$ lamp

27. In molecular absorption spectroscopy, which instrument-related factor causing deviation from Beer's law should be considered?
(A) instability of the power supply of hollow cathode lamp
(B) association of analyte with solvent
(C) reaction of analyte with solvent
(D) solute interactions at high concentrations
(E) presence of stray radiation

28. What is the input transducer in atomic emission spectrometer?
(A) attenuated light beam
(B) photomultiplier tube
(C) glass electrode
(D) digitizer
(E) ion source

29. Glow-discharge optical emission spectroscopy is useful in:
(A) analysis of volatile organic compounds in gaseous samples
(B) molecular fluorescence measurements
(C) profiling elemental composition of solid samples
(D) inductively coupled plasma mass spectrometry
(E) detection of compounds eluted from liquid chromatography column

30. Which element is not analyzed by hydride generation and atomization system used with atomic absorption spectroscopy?
(A) arsenic (B) lithium (C) tin (D) selenium (E) bismuth

31. Which element is typically analyzed by cold-vapor atomization atomic absorption spectroscopy?
(A) lithium (B) arsenic (C) bismuth (D) lead (E) mercury

32. To provide a mass spectrum, quadrupole mass analyzer uses:
(A) magnetic field only
(B) electric field produced only by DC voltage
(C) combination of magnetic field and electric field produced by DC voltage
(D) combination of magnetic field and electric field produced by RF voltage
(E) electric field produced by both RF and DC voltages

33. Which species can cause spectral interference in the determination of nickel-58 isotope by inductively coupled plasma quadrupole mass spectrometry?
(A) $^{40}CaO$ (B) $^{42}CaO$ (C) $^{44}CaO$ (D) $^{40}CaOH$ (E) $^{42}CaOH$

34. Triple quadrupole mass analyzer typically contains three multipoles (Q1, Q2, and Q3) located between the ion source and the electron multiplier. What is the role of Q2 in MS/MS analysis?
(A) to select one fragment ion
(B) to select one precursor ion
(C) to fragment ions
(D) to detect fragment ions
(E) to deflect fragment ions

35. Which ionization technique would likely be used to obtain mass spectrum of a macromolecule featuring singly charged ion?
(A) electron ionization
(B) chemical ionization
(C) atmospheric pressure chemical ionization
(D) electrospray ionization
(E) matrix-assisted laser desorption/ionization

36. Which bonded stationary phase used in gas chromatography has the lowest polarity?
(A) 100% biscyanopropyl polysiloxane
(B) 100% dimethyl polysiloxane
(C) 14% cyanopropylphenyl 86% dimethyl polysiloxane
(D) 35% diphenyl 65% dimethyl polysiloxane
(E) 90% biscyanopropyl 10% phenylcyanopropyl polysiloxane

37. Which detector is used with gas chromatography to selectively detect halogen-containing organic compounds?
(A) electron capture detector
(B) thermal conductivity detector
(C) differential refractive-index detector
(D) flame ionization detector
(E) ultraviolet absorption detector

38. Which stationary phase will provide the longest retention of toluene in reversed-phase high-performance liquid chromatography?
(A) methyl groups immobilized on silica particles
(B) octyl groups immobilized on silica particles
(C) octadecyl groups immobilized on silica particles
(D) all the stationary phases (a-c) will always provide the same retention times
(E) none of the stationary phases (a-c) can retain toluene

39. What is the purpose of micromembrane suppressor used in some high-performance liquid chromatography systems?
(A) to suppress ionization in liquid chromatography hyphenated with mass spectrometry
(B) to enhance ionization in liquid chromatography hyphenated with mass spectrometry
(C) to remove conductive mobile phase components from eluent prior to conductometric detection
(D) to introduce conductive mobile phase components to eluent prior to conductometric detection
(E) to suppress band broadening in the chromatographic column

40. Ultra-high performance liquid chromatography (UHPLC) is a more advanced version of high-performance liquid chromatography (HPLC) providing superior separation efficiency. What is the key feature of UHPLC?
(A) use of particularly large particles of packing material
(B) use of particularly low flow rates of mobile phase
(C) use of high-viscosity mobile phase
(D) improved mass transfer
(E) improved coupling with mass spectrometry