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Entrance examination – Analytical Chemistry (分析化學)

一、單選題，每題5分，答錯不倒扣。

1. Which of the following properties is not used as a basis for physical separation of analyte species in analytical chemistry?
   (A) Mass
   (B) Polarity
   (C) Molar absorptivity
   (D) Surface charges
   (E) Size

2. Which of the following statements is correct?
   (A) Capillary column GC generally has higher efficiencies than HPLC because of a lower plate height in GC
   (B) HPLC has higher efficiencies than capillary column GC because the column length is longer
   (C) Gradient elution is an important approach in capillary GC to deal with the general elution problem
   (D) Capillary column GC generally has higher efficiencies than HPLC because of a much greater column length in GC
   (E) Mobile phase composition is an important experimental variable in both GC and LC

3. According to the Van Deemter plot for liquid chromatography, theoretical plate height:
   (A) is always proportional to linear velocity of mobile phase
   (B) is always inversely proportional to linear velocity of mobile phase
   (C) directly depends on the polarities of the separated molecules
   (D) is influenced by *longitudinal diffusion* of the separated molecules as well as other processes
   (E) is never influenced by *eddy diffusion*

4. Which of the following analytical techniques relies on detection of ions in the gas phase?
   (A) Mass spectrometry
   (B) Transmission electron microscopy
   (C) Cyclic voltammetry
   (D) Raman spectroscopy
   (E) Fluorimetry

5. Which of the following is not a component of the time of flight analyzer spectrometer?
   (A) Ion source
   (B) Photo tube
   (C) Electron multiplication region
   (D) Field-free separation region
   (E) Vacuum pump

6. A good reason to increase flow rate in chromatography is
   (A) to minimize band broadening due to mobile phase mass transport.
   (B) to minimize band broadening due to mass transport in the stationary phase.
   (C) to minimize eddy diffusion.
   (D) to minimize column bleed.
   (E) to minimize band broadening due to longitudinal diffusion.

注意:背面有試題

7. A weak organic acid has a K_a value of 6.2×10^{-5} M^{-1}. The distribution constant, K_D, for this acid between an organic solvent and water is 5.2. An increase in the pH of the aqueous phase would be expected to:
   (A) decrease the fraction of the acid in the aqueous phase.
   (B) have no effect on K_D.
   (C) decrease the analytical concentration in the aqueous phase but have no effect on the actual concentration.
   (D) increase the fraction of the acid in the aqueous phase.
   (E) have no effect on the acid concentration in either phase.

8. Which of the following is not true about the guard column used in liquid chromatography?
   (A) It filters particles that clog the separation column
   (B) It extends the lifetime of separation column
   (C) It allows particles that cause precipitation upon contact with stationary or mobile phase
   (D) The size of packing varies with the type of protection needed
   (E) It is placed before the separation column

二、多選題，ABCDE 每一選項單獨計分，每題 5 分，答錯不倒扣。

9. The most important thing in HPLC is to obtain the optimum resolution in the minimum time. A resolution value _____ between two peaks shall indicate that the sample components are well (baseline) separated to a degree at which the area or height of each peak may be accurately measured.
   (A) = 1
   (B) = 0
   (C) = 0.5
   (D) = 1.5
   (E) > 1.5

10. Which of the following factors may influence electrophoretic mobility?
   (A) Size of molecule
   (B) Shape of molecule
   (C) Buffer pH
   (D) Viscosity of the media
   (E) Charges on the molecule

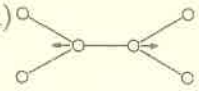
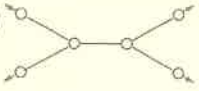
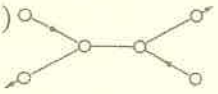
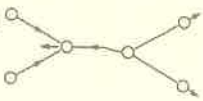
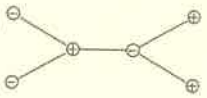
11. Which of the followings are correct about the fluorescence or phosphorescence in Jablonski energy diagram.
   (A) The energy from fluorescence is usually higher than that from excitation (absorption).
   (B) Fluorescence occurs as the electrons jump from the lowest singlet excited state to the ground states
   (C) Phosphorescence might happen for the molecules with heavy atoms and has shorter lifetime than fluorescence
   (D) Non-radiative relaxation can also occur during the process of fluorescence
   (E) In normal cases, vibrational relaxation has a shorter lifetime than fluorescence.

12. Which of the followings are correct concerning the spectroscopy?
   (A) NMR spectroscopy has much lower selectivity but higher sensitivity as compared to UV spectroscopy.
   (B) In a gas sample at room temperature, there are greatest number of molecules occupying in the higher rotational energy states other than the lowest rotational energy state.
   (C) Vibrational energy type has evenly spaced energy levels.
   (D) UV absorbance can be used to quantitatively determine the concentration of molecules.
   (E) The peaking spacing in rotational spectrum can be used to calculate the bond length of the molecule.

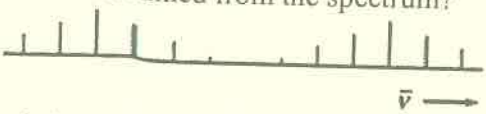
13. Which of the following molecules will exhibit a rotational absorption (not rotational Raman) spectrum?
(A) HCl (B) Cl_2 (C) CH_4 (D) CO_2 (E) PF_3

14. Which of the following mechanisms are the reasons of peak broadening in fluorescence spectra?
(A) unstable intensities of excitation source
(B) a Franck-Condon transition
(C) variation of vibrational states
(D) Heisenberg uncertainty principle
(E) the position of the nuclei is fixed during transition

15. The vibrational Raman transition v=1 to v=2 in HCl gives rise to a line that is much *less* intense than the line from the v=0 to v=1 transition at room temperature. Which of the followings are NOT true:
(A) v=1 to v=2 transition is forbidden
(B) v=1 state has a smaller dipole moment
(C) v=1 state has more rotational states than the v=0 state
(D) v=1 to v=2 transition requires more energy
(E) v=0 state is more populated than v=1 state

16. Which of the following normal modes of ethylene are inactive in the infrared spectroscopy but active in vibrational Raman spectroscopy?
(A)  (B)  (C)  (D)  (E) 

17. A high-resolution infrared absorption spectrum of a heteronuclear diatomic molecule is shown below. Which of the following information about kinds of energy levels can be obtained from the spectrum?



(A) Electronic (B) Vibrational (C) Rotational (D) Translational (E) None of them

18. Which of the followings are true about vibrational Raman scattering?
(A) Raman scattering requires a change in dipole moment during vibrations.
(B) Raman frequency shifts are independent of the frequency of excitation.
(C) Raman scattering results in equal shifts in frequency above and below the incident frequency.
(D) Some Raman-active transitions are not infrared active.
(E) Raman scattering requires a change in polarizability due to vibrations.

19. Which of the following statements about complexes that form between metals, M^{n+}, and EDTA in aqueous solutions are NOT true?
(A) Metal-EDTA complexes have an equilibrium concentration that is independent of pH
(B) Metal-EDTA complexes are usually highly colored
(C) Metal-EDTA complexes are often 2:1 in stoichiometry
(D) Metal-EDTA complexes are usually less stable than the corresponding metal-amine complexes
(E) The presence of other complexing ligands affects the equilibrium concentrations of metal-EDTA complexes

20. The thickness of the electric double layer of AgCl could be affected by which of the following?
(A) The size of container (B) Salt (C) Glucose (D) Cholesterol (E) Temperature