Fundamentals of UV-Visible Spectrophotometry

20 Advanced Multiple-Choice Questions

Calculation-based and conceptual questions

Instructions
Circle the single best answer for each question. Read every option carefully before selecting your answer.

Based on: Instrumental Analysis - Fundamentals of Spectrophotometry

Questions

Circle the correct answer.

1. A UV radiation beam has a wavelength of 285 nm. What is its wavenumber in cm^-1?

(A) 3.51 x 10^2 cm^-1
(B) 3.51 x 10^4 cm^-1
(C) 2.85 x 10^4 cm^-1
(D) 3.51 x 10^6 cm^-1

2. A monochromatic beam used in a spectrophotometric experiment has a wavelength of 486 nm. What is its frequency? Use c = 3.00 x 10^8 m/s.

(A) 6.17 x 10^12 s^-1
(B) 6.17 x 10^14 s^-1
(C) 1.62 x 10^14 s^-1
(D) 1.46 x 10^15 s^-1

3. A photon has a frequency of 7.15 x 10^14 s^-1. What is the energy carried by this photon? Use h = 6.626 x 10^-34 J.s.

(A) 4.74 x 10^-21 J
(B) 4.74 x 10^-20 J
(C) 4.74 x 10^-19 J
(D) 1.08 x 10^-18 J

4. What is the energy of a photon having a wavelength of 242 nm? Use h = 6.626 x 10^-34 J.s and c = 3.00 x 10^8 m/s.

(A) 2.74 x 10^-19 J
(B) 6.41 x 10^-19 J
(C) 8.21 x 10^-19 J
(D) 1.22 x 10^-18 J

5. During a UV-Visible absorption process, the changes in electronic, vibrational, and rotational energies are 315.0, 12.4, and 0.065 kJ/mol, respectively. What is the total absorbed energy?

(A) 302.535 kJ/mol
(B) 315.065 kJ/mol
(C) 327.400 kJ/mol
(D) 327.465 kJ/mol

6. The radiant power entering a sample is 2.40 mW, while the radiant power reaching the detector is 0.780 mW. What is the transmittance?

(A) 0.225
(B) 0.325
(C) 0.675
(D) 3.08

7. A beam containing 8.00 x 10^5 photons passes through a sample. Only 1.36 x 10^5 photons reach the detector. What is the percent transmittance?

(A) 5.88%
(B) 17.0%
(C) 58.8%
(D) 83.0%

8. The incident radiant power is 4.80 mW, while the transmitted radiant power is 0.096 mW. What is the absorbance?

(A) 0.0200
(B) 0.699
(C) 1.699
(D) 2.500

9. A compound has a molar absorptivity of 2.25 x 10^4 L mol^-1 cm^-1 at a particular wavelength. A 3.20 x 10^-5 mol/L solution is measured using a 0.750 cm cuvette. What absorbance should theoretically be obtained?

(A) 0.054
(B) 0.240
(C) 0.540
(D) 1.080

10. A sample produces an absorbance of 1.350. What percentage of the incident light is transmitted?

(A) 2.24%
(B) 4.47%
(C) 22.4%
(D) 44.7%

11. A calibration curve of absorbance versus concentration has a slope of 1.92 x 10^4 L mol^-1 when measurements are made using a 1.20 cm cuvette. What is the molar absorptivity?

(A) 1.33 x 10^4 L mol^-1 cm^-1
(B) 1.60 x 10^4 L mol^-1 cm^-1
(C) 1.92 x 10^4 L mol^-1 cm^-1
(D) 2.30 x 10^4 L mol^-1 cm^-1

12. Which explanation best accounts for the broad absorption bands commonly observed in UV-Visible molecular spectra?

(A) Every molecule absorbs only one wavelength, but instrumental noise broadens the resulting line.
(B) An electronic transition is accompanied by numerous closely spaced vibrational and rotational transitions whose individual wavelengths cannot usually be resolved.
(C) UV-Visible radiation produces rotational transitions exclusively, and these transitions overlap with one another.
(D) Broad bands arise because molecular absorption is not quantized and can therefore occur at every possible energy.

13. Which sequence correctly matches each electromagnetic region with its principal molecular effect?

(A) Microwave - electronic excitation; infrared - rotation; UV-Visible - bond ionization
(B) Microwave - rotation; infrared - bond vibration; UV-Visible - electronic excitation
(C) Microwave - bond breaking; infrared - electronic excitation; UV-Visible - nuclear rearrangement
(D) Microwave - vibration; infrared - rotation; UV-Visible - proton-spin change

14. A chemically stable analyte obeys Beer's law at low concentrations but shows nonlinearity when its concentration exceeds 0.01 M. Which explanation is most consistent with the lecture?

(A) The deviation must be caused exclusively by polychromatic radiation.
(B) High analyte concentration may produce solute-solute and solute-solvent interactions, hydrogen bonding, or molecular screening.
(C) The deviation occurs because absorbance becomes independent of concentration above 0.01 M.
(D) The deviation results from a transition from electronic excitation to nuclear excitation.

15. A dilute, chemically stable analyte shows a downward deviation from Beer's law at high absorbance. The cuvettes are correctly matched, but reducing internal reflections and scattered light improves the linearity. What is the most likely cause?

(A) Association or dissociation of the analyte
(B) Hydrogen bonding caused by excessive analyte concentration
(C) Stray radiation reaching the detector outside the selected wavelength band
(D) A change from vibrational excitation to rotational excitation

16. Which statement most accurately connects the dual nature of electromagnetic radiation with spectrophotometric phenomena?

(A) The wave model explains absorption and emission, whereas the particle model explains reflection and diffraction.
(B) The particle model explains refraction, whereas the wave model explains quantized electronic transitions.
(C) The wave model explains reflection, refraction, and diffraction, whereas the photon model explains absorption and emission.
(D) Both models predict that radiation energy is independent of wavelength.

17. Why does a molecular UV-Visible absorption spectrum usually appear as a broad band rather than a single sharp line?

(A) Electronic energy levels are continuous rather than quantized.
(B) Each electronic transition is accompanied by many closely spaced vibrational and rotational transitions.
(C) UV-Visible radiation causes only rotational transitions, which cannot be separated experimentally.
(D) Molecules absorb all wavelengths equally once the photon energy exceeds a minimum value.

18. Phenol red exhibits different absorption characteristics in acidic and basic media. How should this deviation from Beer-Lambert law be classified?

(A) A real deviation caused by molecular screening at high concentration
(B) An instrumental deviation caused by stray radiation
(C) A chemical deviation caused by a pH-dependent change in molecular structure and electron distribution
(D) An instrumental deviation caused by unequal cuvette path lengths

19. In a double-beam UV-Visible spectrophotometer, what is the principal purpose of comparing radiation passing through the sample with radiation passing through the blank?

(A) To generate monochromatic radiation without using a monochromator
(B) To compensate for absorption caused by the solvent, cuvette, and other background components
(C) To increase the analyte concentration before detection
(D) To convert absorbance into fluorescence intensity

20. Two cuvettes contain the blank and analyte solutions, but the cuvettes have unequal optical path lengths. What is the most likely analytical consequence?

(A) A chemical deviation because the analyte changes molecular form
(B) A real deviation because solute molecules interact at high concentration
(C) An instrumental deviation because the measured difference includes unequal light travel distances
(D) No deviation, because absorbance is independent of path length

Model Answer Key

Check your responses only after completing all questions.

1 B	2 B	3 C	4 C	5 D
6 B	7 B	8 C	9 C	10 B
11 B	12 B	13 B	14 B	15 C
16 C	17 B	18 C	19 B	20 C

End of Quiz