EXPERIMENT 3

Ultraviolet-Visible Spectroscopy - Qualitative Analysis

15 Very Hard Multiple-Choice Questions

Instructions: Circle the correct answer. Choose one answer only for each question.

1. If the frequency of electromagnetic radiation increases by a factor of four while its velocity remains constant, its wavelength will:

A. Increase by a factor of four.
B. Increase by a factor of two.
C. Decrease to one-fourth of its original value.
D. Remain unchanged.

2. Two electronic transitions absorb radiation at 300 nm and 600 nm, respectively. Which statement is correct?

A. The 600 nm transition requires twice the energy of the 300 nm transition.
B. The 300 nm transition involves the larger energy difference between orbitals.
C. Both transitions require the same energy because they occur in the UV-Vis region.
D. Transition energy increases as wavelength increases.

3. Based only on the structural requirements described for UV-Vis absorption, which compound would be least likely to contain a chromophore?

A. A compound containing a carbon-carbon double bond.
B. A compound containing a carbonyl group.
C. A compound containing an oxygen atom with lone-pair electrons.
D. A saturated hydrocarbon containing only carbon-carbon and carbon-hydrogen single bonds.

4. Which statement correctly distinguishes the spectrometer from the photometer in a spectrophotometer?

A. The spectrometer produces light of a selected wavelength, whereas the photometer measures light intensity.
B. The spectrometer measures absorbance, whereas the photometer prepares the blank.
C. The spectrometer splits the beam, whereas the photometer selects the wavelength.
D. The spectrometer detects transmitted light, whereas the photometer produces ultraviolet radiation.

5. The principal reason a double-beam spectrophotometer provides greater accuracy than a single-beam instrument is that:

A. It eliminates the need for a blank solution.

B. It passes both beams through the same cuvette.

C. Variations in lamp intensity affect the sample and reference beams approximately equally.

D. It uses only one detector to measure both beams simultaneously.

6. A researcher wishes to record spectra at both 250 nm and 600 nm without changing either the lamp or the cuvette. Which combination is most appropriate?

A. Tungsten/halogen lamp and plastic cuvette.

B. Deuterium lamp and glass cuvette.

C. Tungsten/halogen lamp and glass cuvette.

D. Xenon lamp and quartz cuvette.

7. A sample is diluted while its chemical identity and solvent remain unchanged. Under ideal conditions, which change is expected in its UV-Vis spectrum?

A. Both absorbance and λmax increase.

B. Absorbance decreases, but λmax remains approximately unchanged.

C. Absorbance remains constant, but λmax shifts to a shorter wavelength.

D. Both absorbance and λmax remain completely unchanged.

8. An organic compound produces two well-defined maximum absorption peaks in its UV-Vis spectrum. The most appropriate interpretation is that:

A. The instrument accidentally measured the blank twice.

B. The compound must contain two different solvents.

C. More than one electronic transition with different energy requirements is allowed.

D. The compound concentration changed during the scan.

9. A potassium permanganate stock solution has a concentration of 1.00 mg/mL. A 10.0 mL portion is diluted to 100.0 mL to prepare Solution 1. Then, 10.0 mL of Solution 1 is diluted to 25.0 mL to prepare Solution 2. What is the concentration of Solution 2?

A. 0.040 mg/mL

B. 0.100 mg/mL

C. 0.250 mg/mL

D. 0.400 mg/mL

10. What is the overall dilution factor between the original potassium permanganate stock solution and Solution 2?

A. 2.5
B. 4
C. 10
D. 25

11. Which sequence correctly represents the optical pathway in the double-beam spectrophotometer used in the experiment?

A. Light source -> beam splitter -> monochromator -> detector -> cuvettes
B. Light source -> monochromator -> beam splitter -> sample/reference cuvettes -> detectors
C. Light source -> sample cuvette -> monochromator -> reference cuvette -> detector
D. Monochromator -> light source -> cuvettes -> beam splitter -> detectors

12. Distilled water is placed in the blank cuvette primarily to:

A. Correct for absorption or transmission effects caused by the solvent, cuvette and instrumental background.
B. Increase the absorbance of potassium permanganate.
C. Determine the exact concentration of the stock solution.
D. Prevent the monochromator from selecting ultraviolet wavelengths.

13. Why is a plastic cuvette acceptable for the practical scan performed from 400 to 700 nm?

A. Plastic absorbs all visible wavelengths and prevents detector saturation.
B. Plastic is more transparent than quartz in the ultraviolet region.
C. The selected scan range lies within the visible region, where plastic cuvettes may be used.
D. Potassium permanganate cannot be placed in a quartz cuvette.

14. After completing the full wavelength scan, selecting the peak pick option is expected to:

A. Automatically prepare Solution 2.
B. Replace the sample spectrum with the blank spectrum.
C. Convert wavelength values directly into concentration values.
D. Display a table identifying spectral peaks and valleys.

15. A student mistakenly scans Solution 1 instead of Solution 2. Compared with the correct sample, which result is most likely under ideal conditions?

A. The measured absorbance will be lower, and λmax will disappear.
B. The concentration will be 2.5 times higher, producing greater absorbance while λmax remains approximately unchanged.
C. The concentration will be 10 times higher, but the absorbance will remain unchanged.
D. The concentration will be 25 times lower, causing λmax to shift into the ultraviolet region.

MODEL ANSWER KEY

Question 1	**C**	**Question 6**	**D**	**Question 11**	**B**
Question 2	**B**	**Question 7**	**B**	**Question 12**	**A**
Question 3	**D**	**Question 8**	**C**	**Question 13**	**C**
Question 4	**A**	**Question 9**	**A**	**Question 14**	**D**
Question 5	**C**	**Question 10**	**D**	**Question 15**	**B**

Review tip: Focus on wavelength-energy relationships, electronic transitions, instrument components, cuvette selection, blank correction, dilution calculations, and interpretation of λmax.