

CASE STUDY BASED PUZZLE

BP701T: INSTRUMENTAL METHODS OF ANALYSIS

TOPIC: UV VISIBLE SPECTROPHOTOMETER

Puzzle 1: Quality Control in Tablet Formulation

In a pharmaceutical manufacturing unit, a quality control analyst is testing aspirin tablets for potency using UV-Vis spectroscopy at 280 nm. The standard curve shows linearity up to 20 $\mu\text{g/mL}$, but the sample extract gives an absorbance of 1.2 at a concentration of 25 $\mu\text{g/mL}$, leading to non-linear results.



1. Explain the likely deviation from Beer's-Lambert law and suggest a correction method.
2. How would you verify if the issue is due to chemical interactions or instrumental limitations?

Puzzle 2: Herbal Extract Analysis

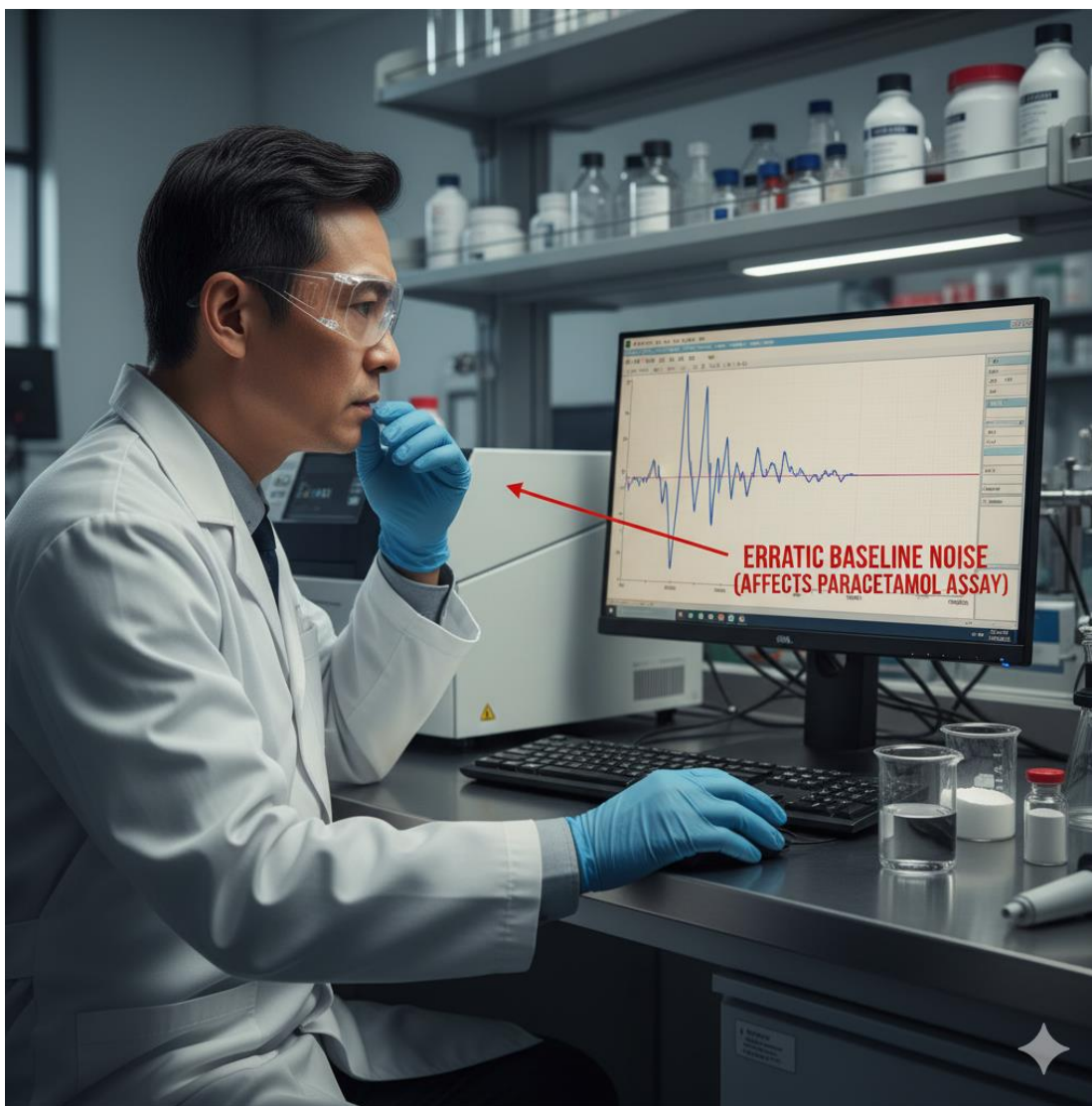
A researcher analyzing a quercetin-rich herbal extract observes absorption maxima at 370 nm in ethanol but a bathochromic shift to 375 nm when switching to methanol. The extract is used for antioxidant quantification.



1. Identify the type of spectral shift and its cause related to solvent polarity.
2. Recommend an optimal solvent based on solubility and minimal interference for accurate quantification.

Puzzle 3: Instrumentation Troubleshooting

During routine calibration of a double-beam UV-Vis spectrophotometer in a hospital pharmacy, the analyst notices erratic baseline noise when scanning from 200-800 nm, especially below 250 nm, affecting paracetamol assay results.



1. Pinpoint the probable faulty component (e.g., source or detector) and explain why it impacts the UV region.
2. Outline steps for performance qualification to resolve this.

Puzzle 4: Chromophore Identification in Dye Impurity

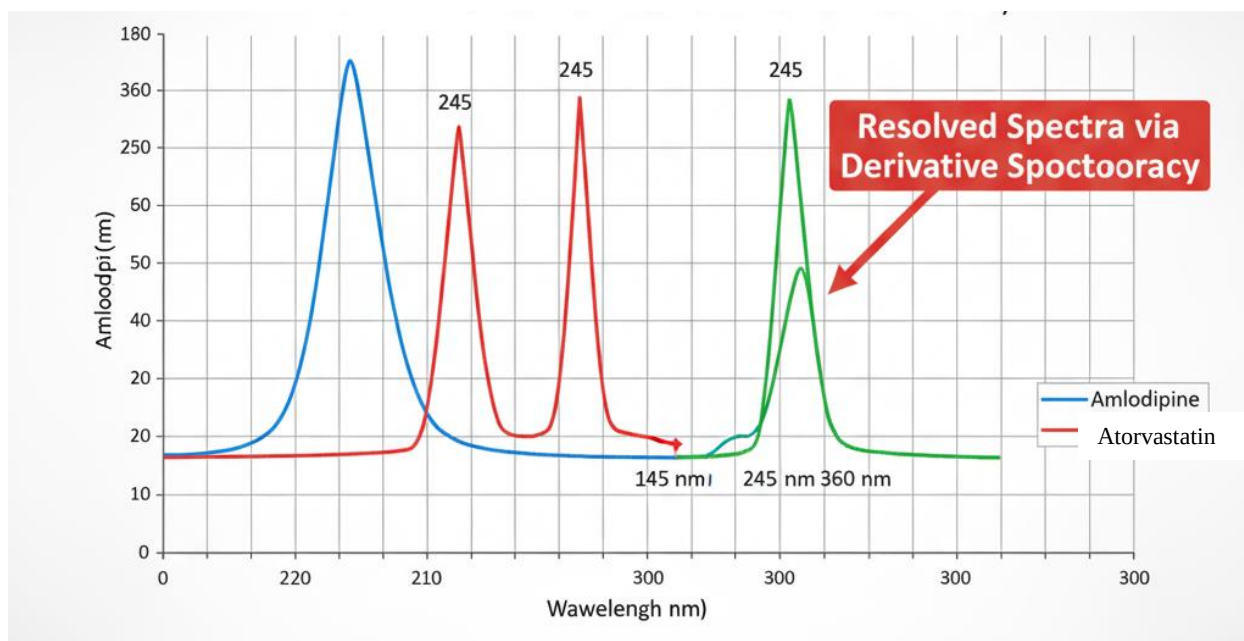
A batch of colored gelatin capsules shows unexpected absorbance at 450 nm due to a dye impurity. The dye contains a benzene ring conjugated with a nitro group, suspected to cause toxicity issues.



1. Classify the electronic transition responsible and identify the chromophore/auxochrome involved.
2. Propose a UV-Vis method to quantify the impurity level against pharmacopoeial limits.

Puzzle 5: Multicomponent Formulation Challenge

In developing a fixed-dose combination tablet of amlodipine and atorvastatin, overlapping spectra at 360 nm and 245 nm complicate simultaneous estimation. The lab uses derivative spectroscopy to resolve this.



1. Describe how first-derivative UV-Vis helps in multicomponent analysis here.
2. Calculate the expected resolution if amlodipine's λ_{max} is 360 nm and atorvastatin's is 245 nm (assume zero-crossing points).

Puzzle 6: Stability Study Deviation

During accelerated stability testing of a salicylic acid suspension, absorbance at 296 nm increases unexpectedly after 3 months, despite no microbial growth, raising concerns about degradation products.



1. Hypothesize the cause of hyperchromic shift and link it to molecular changes (e.g., auxochrome effects).
2. Design a spectrophotometric titration to confirm if it's due to ionization or solvent interaction.