

Sugar Identification Using Polarimetry

15 Very Difficult Multiple-Choice Questions

Instructions: Circle the single best answer for each question. All questions are based only on the supplied experiment material.

1

Two compounds have identical molecular compositions and are mirror images of each other, but no spatial rotation allows one structure to be superimposed on the other. Under identical experimental conditions, one rotates plane-polarized light by $+24.6^\circ$. Which conclusion is most accurate?

- ☐ A) They are achiral diastereomers, and the second compound must rotate light by $+24.6^\circ$.
- ☐ B) They are identical molecules because they have the same molecular composition.
- ☐ C) They are enantiomers, and the second compound must rotate light by -24.6° .
- ☐ D) They are racemic mixtures with equal clockwise rotations.

2

An unknown sugar sample weighing 1.025 g is dissolved and diluted to exactly 50.0 mL. Its observed rotation in a 2.00 dm polarimeter tube is $+2.829^\circ$. What is the most probable identity of the sugar?

- ☐ A) D-Fructose, $[\alpha] = -86^\circ$
- ☐ B) D-Glucose, $[\alpha] = +69^\circ$
- ☐ C) D-Galactose, $[\alpha] = +82^\circ$
- ☐ D) Sucrose, $[\alpha] = +64.5^\circ$

3

A solution containing sucrose has an observed rotation of $+3.225^\circ$ when measured using a 1.00 dm sample tube. If the specific rotation of sucrose is $+64.5^\circ$, what is the concentration of the solution?

- ☐ A) 0.0250 g/mL
- ☐ B) 0.0323 g/mL
- ☐ C) 0.0500 g/mL
- ☐ D) 0.0645 g/mL

4

The pure S-enantiomer of a compound has a specific rotation of $+16.7^\circ$. A mixture of its R- and S-enantiomers has an observed specific rotation of $+5.01^\circ$. Which composition is correct?

- ☐ A) 70% R and 30% S
- ☐ B) 85% R and 15% S
- ☐ C) 50% R and 50% S
- ☐ D) 35% R and 65% S

5

A pure R-enantiomer has a specific rotation of -16.70° . What rotation should be expected from a mixture containing 70% R and 30% S, assuming identical measurement conditions?

- ☐ A) -6.68°
- ☐ B) $+6.68^\circ$
- ☐ C) -11.69°
- ☐ D) $+3.34^\circ$

6

A polarimeter gives a reading of exactly 0.00° for a solution containing equal concentrations of two enantiomers. Which explanation is most scientifically appropriate?

- ☐ A) Both enantiomers are individually achiral.
- ☐ B) The equal and opposite rotations of the enantiomers cancel each other.
- ☐ C) The solution contains only one optically inactive stereoisomer.
- ☐ D) The specific rotations of both enantiomers become zero after mixing.

7

According to the experiment, all of the following can influence the magnitude of optical rotation except:

- ☐ A) The wavelength of the incident light
- ☐ B) The temperature of the solution
- ☐ C) The internal diameter of the polarimeter tube
- ☐ D) The nature of the solvent

8

Which sequence correctly represents the path of light through a conventional polarimeter?

- ☐ A) Sodium vapor lamp $\rightarrow$ polarizer $\rightarrow$ sample tube $\rightarrow$ analyzer $\rightarrow$ rotation measurement
- ☐ B) Sodium vapor lamp $\rightarrow$ analyzer $\rightarrow$ sample tube $\rightarrow$ polarizer $\rightarrow$ rotation measurement
- ☐ C) Sample tube $\rightarrow$ sodium vapor lamp $\rightarrow$ analyzer $\rightarrow$ polarizer $\rightarrow$ rotation measurement
- ☐ D) Polarizer $\rightarrow$ sodium vapor lamp $\rightarrow$ analyzer $\rightarrow$ sample tube $\rightarrow$ rotation measurement

9

Which statement most accurately describes plane-polarized light according to the theory presented in the experiment?

- ☐ A) It vibrates equally in every plane perpendicular to the direction of propagation.
- ☐ B) It consists only of right-circularly polarized light.
- ☐ C) It consists only of left-circularly polarized light.
- ☐ D) It can be represented as the vector sum of right- and left-circularly polarized components of fixed magnitude rotating in opposite directions.

10 For a solution of a pure optically active compound, the concentration is doubled while the length of the polarimeter tube is reduced to one-half of its original value. All other conditions remain constant. What happens?

- ☐ A) The observed rotation doubles, but the specific rotation remains constant.
- ☐ B) Both the observed rotation and specific rotation remain constant.
- ☐ C) The observed rotation is halved, but the specific rotation doubles.
- ☐ D) Both the observed rotation and specific rotation are halved.

11 A compound at a concentration of 0.5% w/v produces an observed rotation of 1.3° in a tube that is 25 cm long. The correct specific rotation is 104° . A student instead calculates 10.4° . Which error most likely caused this result?

- ☐ A) The student converted the concentration from percent to g/mL twice.
- ☐ B) The student used the rotation angle in radians instead of degrees.
- ☐ C) The student used 25 directly as the tube length instead of converting 25 cm to 2.5 dm.
- ☐ D) The student changed the sign of the observed rotation.

12 Which procedure most accurately describes the preparation of the known-concentration sugar solution?

- ☐ A) Dissolve approximately 1 g of sugar in about 15 mL of deionized water, quantitatively transfer it to a 50 mL volumetric flask, rinse the beaker, and adjust the bottom of the meniscus exactly to the calibration line.
- ☐ B) Place approximately 1 g of sugar directly into the polarimeter tube and add water until the tube is full.
- ☐ C) Dissolve exactly 1 g of sugar in exactly 50 mL of water in a beaker without using a volumetric flask.
- ☐ D) Dissolve the sugar in approximately 50 mL of water and transfer only 15 mL of the solution to the volumetric flask.

13 The degree of optical rotation may be used for all of the following purposes:

- 1. Determining the identity of an optically active substance**
- 2. Evaluating the enantiomeric purity of a substance**
- 3. Determining the concentration of a known substance in solution**
- 4. Determining the boiling point directly from the polarimeter reading**

Which combination is correct?

- ☐ A) 1 and 2 only
- ☐ B) 2 and 4 only
- ☐ C) 1, 3 and 4 only
- ☐ D) 1, 2 and 3 only

14

A 0.750 g sugar sample is diluted to 50.0 mL. Its observed rotation is $+1.77^\circ$ in a 1.00 dm tube. Based on the reference values supplied in the experiment, what is the identity of the sample?

- ☐ A) D-Galactose
- ☐ B) Maltose
- ☐ C) Sucrose
- ☐ D) D-Allose

15

Which statement correctly distinguishes the functions of the polarizer and analyzer in a polarimeter?

- ☐ A) The analyzer produces unpolarized light, while the polarizer measures the rotation angle.
- ☐ B) The fixed polarizer produces plane-polarized light, while the rotatable analyzer determines the orientation of the light after it passes through the sample.
- ☐ C) Both components are fixed and have identical functions.
- ☐ D) The polarizer contains the sample, while the analyzer controls the concentration of the solution.

Model Answer Key

Use this section only after completing all questions.

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

Source: Experiment 5 - Sugar Identification Using Polarimetry (supplied course material).