Finding Why a Layered Panel Bends

Base your answers on the information provided and your knowledge of chemistry. Use the 2025 Chemistry Reference Tables as needed.

A museum models a panel made from two thin sheets bonded across their entire surfaces. The free sheets are both 100 mm long. In humid air, free sheet M grows to 102 mm and free sheet N grows to 100.5 mm. When bonded, the sheets stay attached but the whole panel can bend. The layer on the outside of a bend follows the longer path.

Stack	Top sheet	Bottom sheet	Layer on outside of bend in humid air
P	M	N	Top
Q	N	M	Bottom
R	M	M	No measurable bend

1 Which observation best supports the claim that the bending direction follows the layer order?

(1) P and Q bend with opposite sides of the stack on the outside.

(2) Only R uses two sheets.

(3) The free sheets start at the same length.

(4) M expands by 2 mm when free.

2 Use the free-sheet lengths and the path around a bend to explain why sheet M is on the outside in both stacks. [1]

Answer and work

A candidate replacement for N, sheet S, grows from 100 mm to 101.8 mm under the same conditions. Its bending stiffness is the same as N in this model.

3 Explain why substituting S for N could reduce the bend while keeping two different layer materials. [1]

Answer and work

4 Describe a fair test comparing P with the replacement stack. State which observation would support the predicted improvement. [1]

Answer and work