Humidity Control for Paper Archives

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

A town archive displays a historic paper map in a sealed case. When the case is closed on a humid day, water molecules in the air can attach to the internal surfaces of porous silica beads. The beads are stored in a removable tray. The bead material itself stays in the tray during the tests. The archive needs a tray that can take up at least 5.0 g of water at the test humidity and has a dry bead mass of at most 30.0 g.

Tray	**Dry bead mass (g)**	**Bead mass after test (g)**
A	24.0	28.2
B	28.0	33.6
C	34.0	41.0

1 Which tray meets both of the archive’s requirements?

(1) A only

(2) B only

(3) C only

(4) B and C

2 The bead surface has exposed O–H groups. Explain how one of these groups can attract a water molecule in the case. [1]

Answer and work

3 Calculate the mass of water taken up per gram of dry beads in tray A. Show your setup. [1]

Answer and work

Preparing the tray for another display

The archivist moves tray B to a dry cabinet to release water from the beads. The beads began this step with the mass recorded after the humidity test. Only water leaves the tray during drying. For the next display the archivist wants at most 1.0 g of water left on the beads before reinstalling the tray.

Time in dry cabinet (min)	Mass of beads and attached water (g)
0	33.6
15	30.0
30	28.8
45	28.4

4 Which is the earliest measured time that meets the requirement for reinstallation?

(1) 0 min

(2) 15 min

(3) 30 min

(4) 45 min

5 A student says the fall in mass from 0 to 30 minutes shows that some silica was lost. Use the model and the measurements to evaluate that claim. [1]

Answer and work

6 Propose a comparison to test whether drying restores the beads’ ability to take up water. Identify what to measure and one condition to keep the same. [1]

Answer and work