Updating a Water Model After Proton Transfer

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

A class updates a display about hydrogen chloride entering water. In its model, an HCl molecule transfers a hydrogen ion to a water molecule. The two electrons in the original H–Cl bond stay with chlorine. The water molecule uses one of its oxygen lone pairs to form a bond to the added hydrogen.

$HCl(g) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$

1 Before the transfer, water has two O–H bonds and two lone pairs on oxygen. Describe how both counts change when it becomes H_3O^+. [1]

Answer and work

2 Which statement fits the chlorine model after transfer?

(1) Chlorine keeps the original H–Cl bond pair and becomes Cl^-.

(2) Chlorine loses the original H–Cl bond pair and becomes Cl^+.

(3) Chlorine keeps the hydrogen nucleus and stays as HCl.

(4) Chlorine gains one proton and changes element.

In the display, an oxygen center with three bonded hydrogen atoms and one lone pair gives a trigonal pyramidal model. A center with two bonded hydrogen atoms and two lone pairs gives a bent model.

3 How should the student revise a bent water drawing to represent the oxygen center in the product? Name the new shape and identify what changed. [1]

Answer and work

4 The student draws H_3O^+ but leaves the separate chlorine atom neutral. Use charge balance to explain why that drawing is inconsistent with the equation. [1]

Answer and work