Reading a Bond Model After Isotope Replacement

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

A display models a molecule with a hydrogen atom bonded to chlorine. It can replace the hydrogen with a heavier isotope of hydrogen. In this model the connection and the strength of its restoring pull stay the same. A heavier atom at one end makes the bond vibrate fewer times per second.

Model	Hydrogen isotope	Mass number of hydrogen	Vibration rate (model units)
P	Hydrogen-1	1	12
Q	Hydrogen-2	2	9

1 Which model has the slower vibration?

(1) P only

(2) Q only

(3) They vibrate equally fast.

(4) The rate is not given.

2 Explain how Q can have a different vibration rate while its two bonded elements stay the same. [1]

Answer and work

3 A student sees only the slower rate and concludes that the chlorine bond was replaced with a weaker bond. Evaluate the claim using the supplied model. [1]

Answer and work

A mixed display contains some P molecules and some Q molecules. A detector can resolve both model vibration rates separately.

4 Predict which rates it should show. Explain why an average reading of 10.5 would not be a third molecular model. [1]

Answer and work