**When Opposite Bond Pulls Do Not Cancel**

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

A display adds the bond arrows in three models of a molecule. The arrow for each bond points toward the atom that attracts the shared electrons more strongly. The display reports each arrow’s horizontal and vertical components. Negative horizontal values point left. Positive vertical values point up.

| Model | First arrow: horizontal | First arrow: vertical | Second arrow: horizontal | Second arrow: vertical |
|---|---|---|---|---|
| J | −4 | 0 | 4 | 0 |
| K | −4 | 3 | 4 | 8 |
| L | −4 | 3 | 6 | 0 |

**1** Which model gives a combined reading of zero horizontally and a positive reading vertically?

(1) J only

(2) K only

(3) L only

(4) J and L only

**2** A student reads only the horizontal value for J and K. Calculate the two vertical totals and explain why the horizontal reading misses a difference. [1]

Answer and work

The class checks a new display that may have a fixed vertical offset. It rotates model K by 180° in the plane of the display. Each bond arrow reverses direction relative to the display axes.

**3** What vertical total should the display show for rotated K if the display is working correctly? Show how the bond arrows give the result. [1]

Answer and work

**4** The new display shows +11 before and after the rotation. Explain why those readings fail the rotation check. [1]

Answer and work