Cohesive Chemistry Newsletter

#82 - A follow-up (on energy levels, sublevels and orbitals)

(3 min read)

An exchange with a subscriber (thanks, Rafael!) pointed out an inherent issue with the diagram I shared last week and the inevitable contradiction that arises from explaining electron configurations.

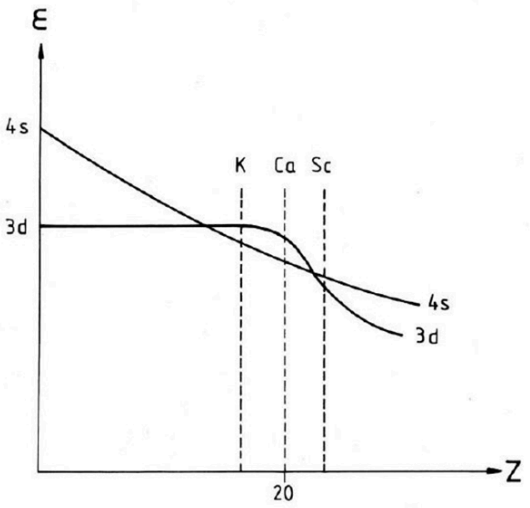
We add electrons to the 4s sublevel before the 3d, but then remove electrons (for an ion) from the 4s sublevel first. Typically, a handful of students will question this, and my response is usually something to the effect of 'once filled, the 4s sublevel becomes higher in energy' or 'the 4th energy level is still the valence one, so it empties first.' This is sufficient for answering exam questions (up to krypton), but it deviates from the truth.

When we reach the 4s/3d sublevels, the correct approach is actually much more complex and better explained as '*differing electron-electron and electron-nucleus interactions mean that there is not a one-size-fits-all rule for electron configurations in the d-block*'. In fact, there are 20 anomalous electron configurations when applying the typical classroom approach to d-block elements!

Here are a couple of excellent articles addressing the issues:

- The trouble with the Aufbau principle
- The order of filling 3d and 4s orbitals

Rafael shared this image with me as a way of touching upon the complexity of the situation, but without getting too deep into the details:



It reminded me that we need to be aware of the trade-off between simplicity and reality. Ideally, we can maintain pace, manage cognitive load and help students perform in assessments…but without sacrificing the truth. This is not always an easy task!

Food for thought.

Cheers

Ollie

Updates on resources

- Link to previous newsletters

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