

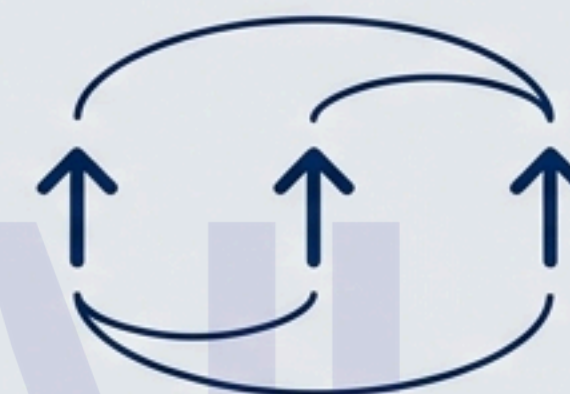
Ionisation Enthalpies of Transition Elements



The Hidden Variables of Stability

Exchange Energy

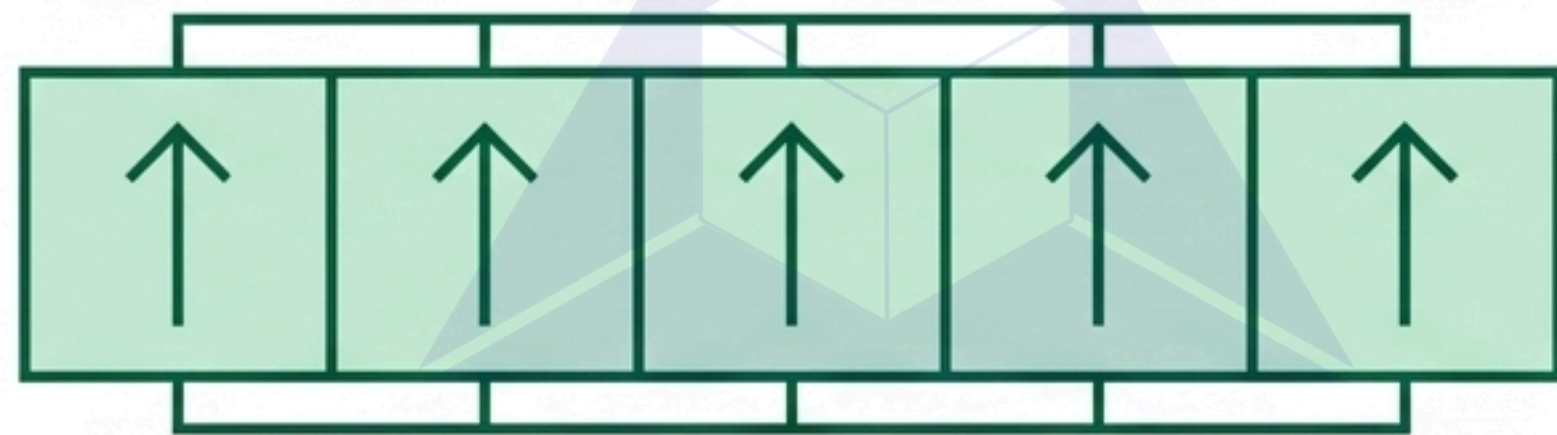
The stabilizing energy proportional to the total number of possible pairs of parallel spins in degenerate orbitals. The loss of exchange energy makes ionisation difficult.



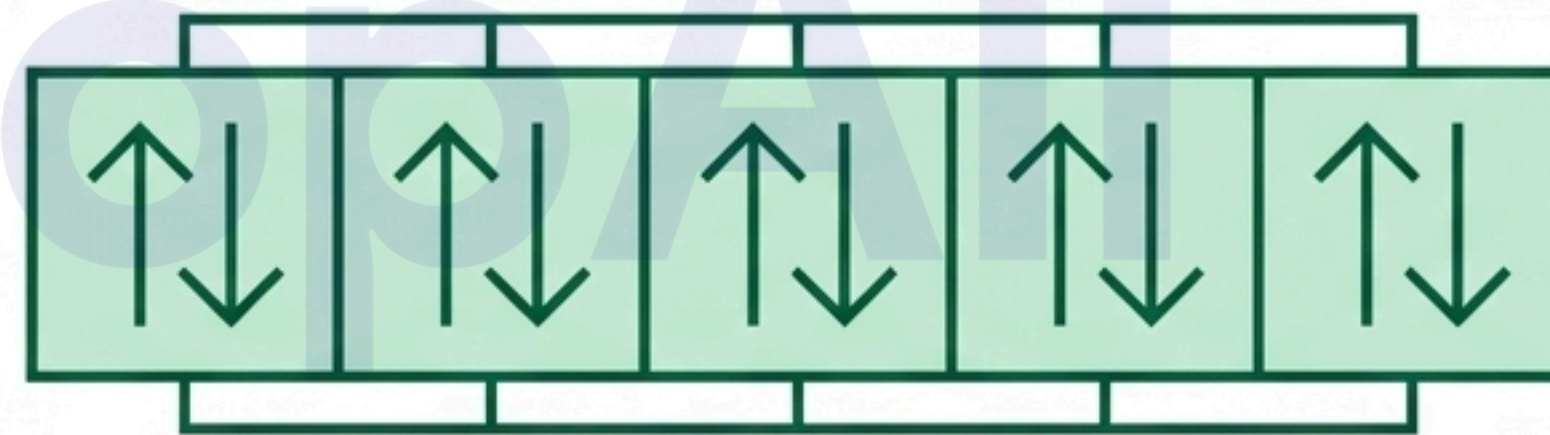
Hund's Rule

The lowest energy state corresponds to the maximum possible extent of single occupation of orbitals and parallel spins.

d^5 and d^{10} configurations carry extra stability.



Half-filled
(Maximum parallel spins)



Completely filled

Because there is maximum exchange energy at these configurations, removing an electron requires breaking this perfect stability.



You've Learned the Theory. Let's Test Them Now.

$$E=mc^2$$



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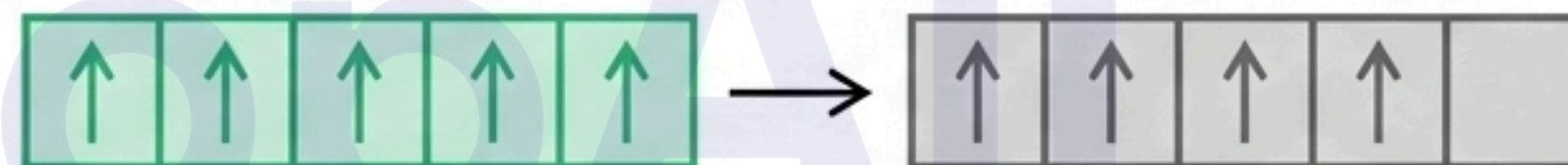


Why does Mn^+ ionise easier than Cr^+ ?



NO loss of exchange energy.

Reaches perfect d^5 state.



Loss of exchange energy.

Breaks perfect d^5 state.



Why is the 3rd Ionisation Enthalpy of Fe lower than Mn?



No loss of exchange energy.

Gains d^5 stability.



Severe loss of exchange energy.

Breaks d^5 stability.



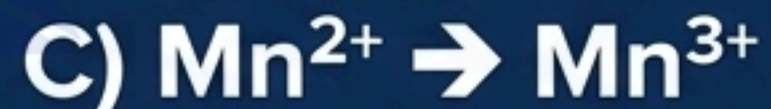
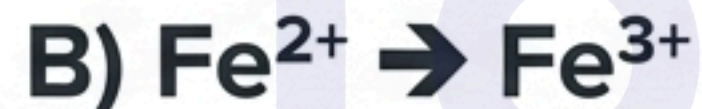
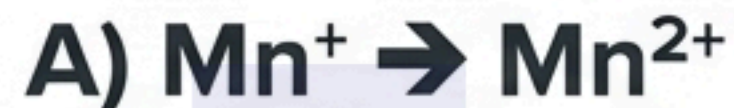
Watch for this: The Z-Increase Trap

~~**Assumption:** Atomic Number (Z) increases →
Ionisation Energy steadily climbs.~~

Diagnostic Check: Always write out the d^n configuration **BEFORE** and **AFTER** ionisation.

In non-transition elements, successive enthalpies climb steadily. In transition elements, the trend breaks abruptly whenever an ionisation involves disrupting a half-filled (d^5) or completely filled (d^{10}) configuration.

Which of the following processes requires the highest amount of energy (highest ionisation enthalpy)?



Hint: Run your Before/After diagnostic. Which one of these breaks a stable $3d^5$ core?

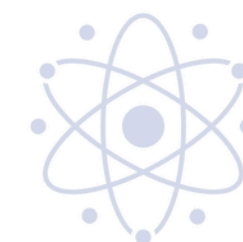
Key Takeaways

- **Exchange Energy rules the d-block.** The highest stability is found in d^5 (half-filled) and d^{10} (completely filled) configurations due to maximized pairs of parallel spins.
- **The Before/After Diagnostic.** Never assume a steady climb in ionisation energy across a period. Always write the exact d^n configuration for the reactant and the product. If the reaction breaks a d^5 or d^{10} state, the energy required will abruptly spike.



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