One element, six oxidation states



Why do transition metals show variable oxidation states?

The d- and f-Block Elements · NCERT 4.3.4

The reason



ns and (n−1)d are very close in energy, so **both** can lose or share electrons.

First the 4s electrons go, then the 3d ones, one at a time.

Manganese: +2 to +7

Mn = $3d^5\ 4s^2$: 7 electrons it can use.

Lose the two 4s → +2 (Mn^{2+})

Lose all seven → +7 ($KMnO_4$)

Up to Mn, highest state = number of 4s + 3d electrons: Sc +3, Ti +4, V +5, Cr +6, Mn +7.

Manganese in compounds



Mn^{2+} +2 MnO_2 +4 $KMnO_4$ +7

The same metal in three oxidation states, with three different looks.

How many states?



Most in the middle (Mn). Sc shows only +3, Zn only +2.

Steps of one

Transition-metal states differ **by one**: Fe^{2+} / Fe^{3+}, Cu^{+} / Cu^{2+}, V +2, +3, +4, +5.

p-block states usually differ **by two**: Sn^{2+} / Sn^{4+}, Pb^{2+} / Pb^{4+}.

Remember: ns + (n–1)d electrons in bonding → many oxidation states.

Quick check



?

$3d^5\ 4s^1$

What is the highest oxidation state of chromium?

Hint: count the 4s + 3d electrons.