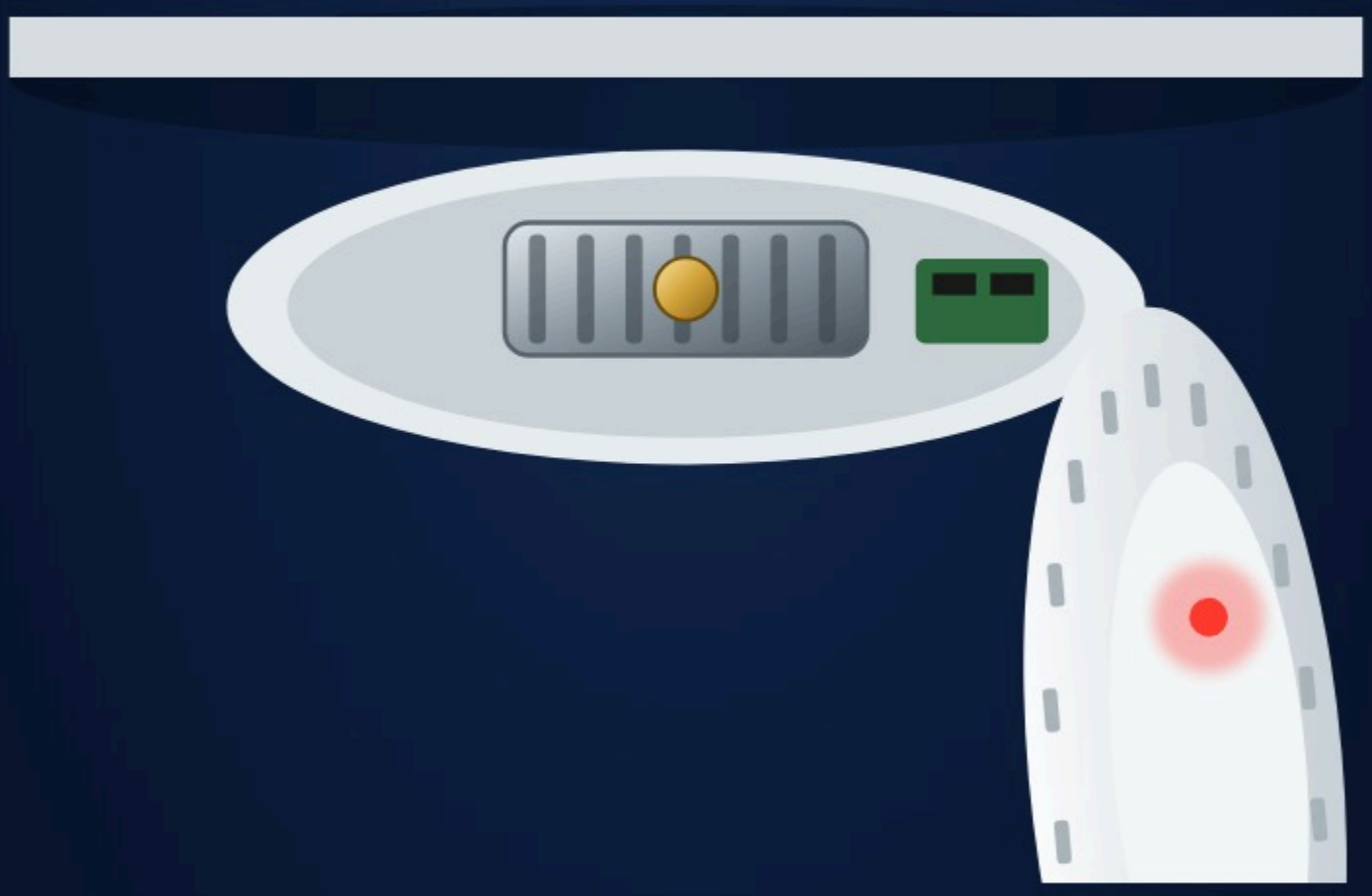
The element on your ceiling



Ionisation smoke detectors hold ≈ 1 µCi of **americium-241**, a man-made actinoid.

Its alpha particles ionise air; smoke cuts the current → **alarm**.

The actinoids

Th Pa U Np Pu Am Cm

$$[Rn]\ 5f^{1-14}\ 6d^{0-1}\ 7s^{2}$$

14 elements, Th (90) → Lr (103); the new electron enters 5f.

Configuration: [Rn] $5f^{1-14}$ $6d^{0-1}$ $7s^{2}$.

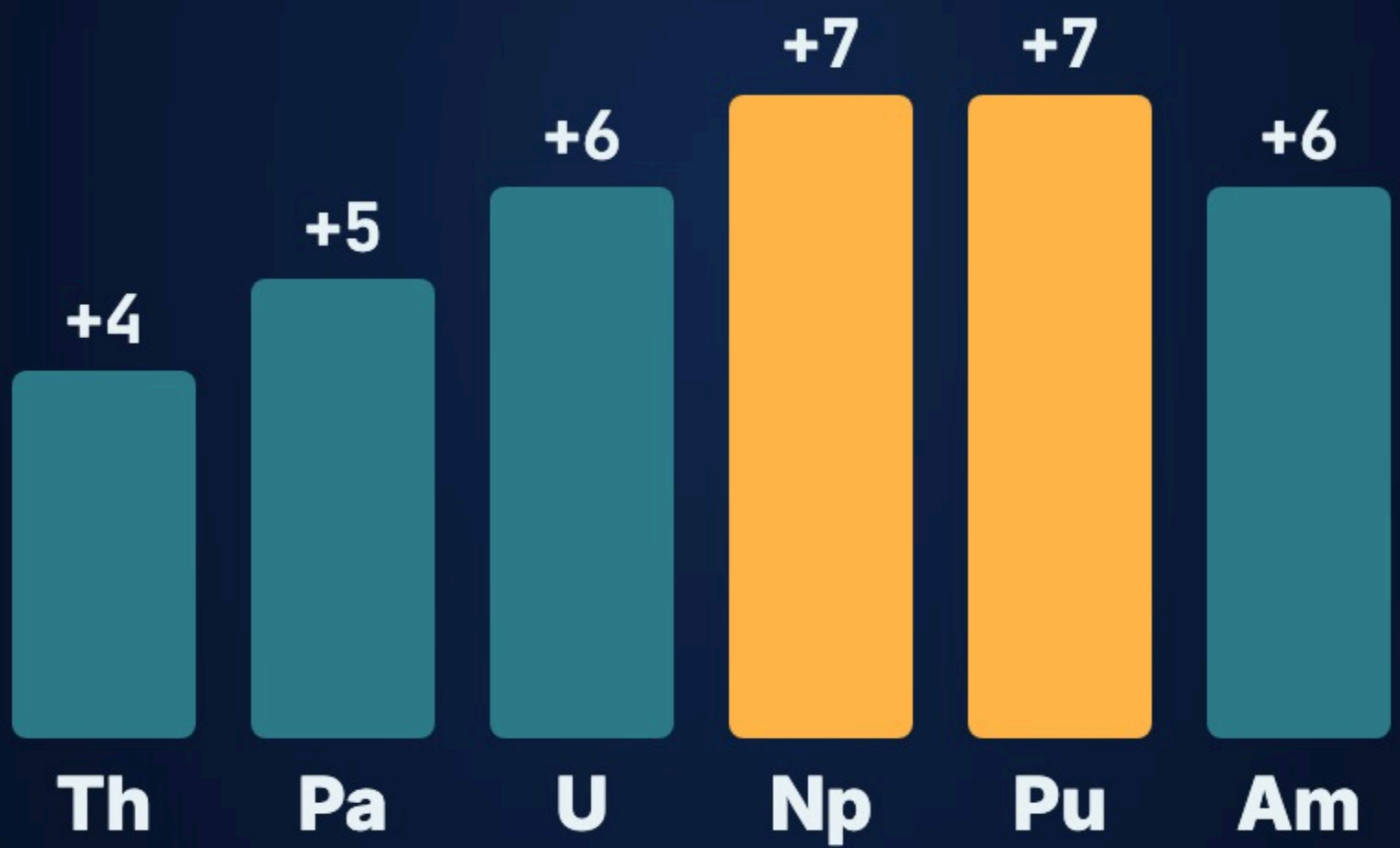
Why so many oxidation states



Lanthanoids: 4f buried deep. Actinoids: **5f ≈ 6d ≈ 7s** in energy.

So more electrons can be used: **a wider range of oxidation states**.

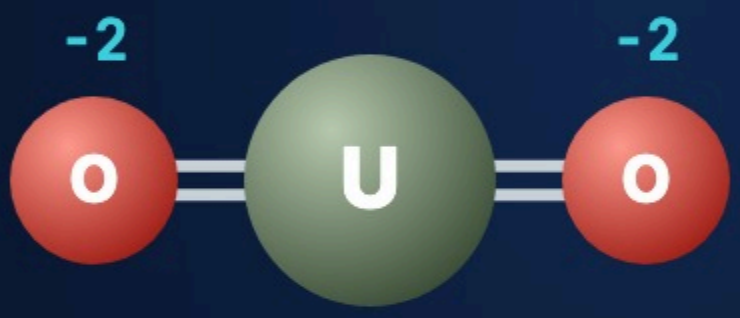
Up to +7



+3 is common to all; the first half climbs: Th +4, Pa +5, U +6, **Np, Pu +7**.

Later actinoids fall back towards +3.

Uranyl: U is +6





UO_2^{2+}: $x + 2(-2) = +2$, so **$x = +6$**.

Uranyl makes uranium glass **glow green under UV**.

Bigger contraction · reactive



5f shields poorly → actinoid contraction > lanthanoid contraction.

Boiling water → oxide + hydride; HCl attacks; HNO_3 → protective oxide layer; alkalies: no action.

All radioactive



Th-232 U-238

Th-232: ≈ 14 billion years; U-238: ≈ 4.5 billion years.

Only Th and U are natural; beyond U they are man-made (Np, 1940), the last ones lasting minutes to hours.

Your turn

$$PuO_2^{2+}$$

Pu = ?

What is the **oxidation state of plutonium** in PuO_2^{2+}?

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