▶ Video explanation (YouTube Short)

Lanthanoids in Everyday Technology

Strike a lighter and the sparks look like chips of stone. They are not: the "flint" is a metal alloy rich in cerium, and every spark is a tiny shaving of that metal burning in air. The lanthanoids are reactive metals, and that reactivity, together with their f electrons, puts them in steel, petrol, screens and phones (NCERT 4.5.4, Fig. 4.9).

1. The lighter flint: mischmetall

Mischmetall: about 95 % lanthanoid metal (mostly cerium) and about 5 % iron, with traces of S, C, Ca and Al.

- In a magnesium-based alloy it is used for **bullets, shells and lighter flint**.
- The striker wheel scrapes off tiny shavings; cerium ignites at only about 150–180 °C, so the shavings burn in air. The sparks are burning metal, not stone.

2. General properties

- Silvery-white, **soft** metals that **tarnish rapidly** in air.
- Hardness increases with atomic number; **samarium is steel-hard**.
- Typical metallic structure; good conductors of heat and electricity.
- Reactivity: the early members are quite reactive, like **calcium**; with increasing atomic number they behave more like **aluminium**.
- E° for $Ln^{3+}(aq) + 3e^- \rightarrow Ln(s)$ is about −2.2 to −2.4 V (Eu −2.0 V): strong reducing metals.

3. Reactions (NCERT Fig. 4.9)

With	Condition	Balanced equation / product
O_2	burns	$4Ln + 3O_2 \rightarrow 2Ln_2O_3$ (cerium: $Ce + O_2 \rightarrow CeO_2$)
Halogen X_2	burns	$2Ln + 3X_2 \rightarrow 2LnX_3$
Water	slow cold, faster hot	$2Ln + 6H_2O \rightarrow 2Ln(OH)_3 + 3H_2$
Dilute acid	—	$2Ln + 6H^+ \rightarrow 2Ln^{3+} + 3H_2$
N_2	heated	$2Ln + N_2 \rightarrow 2LnN$
S	Δ	$2Ln + 3S \rightarrow Ln_2S_3$
C	2773 K	$Ln + 2C \rightarrow LnC_2$ (carbides Ln_3C, Ln_2C_3 and LnC_2 are known)
H_2	gently heated	$Ln + H_2 \rightarrow LnH_2$ (hydride)

The oxides Ln_2O_3 and hydroxides $Ln(OH)_3$ are **basic**, like the alkaline-earth oxides and hydroxides. The hydroxides are definite compounds, not just hydrated oxides.

4. Colour and magnetism

- Many Ln^{3+} ions are coloured in the solid and in solution because of their **f electrons**: Pr^{3+} green, Nd^{3+} lilac (violet), Er^{3+} pink. The colours are pale and the absorption bands are narrow.
- **La^{3+} ($4f^0$) and Lu^{3+} ($4f^{14}$) are colourless**.
- Ions other than the f^0 (La^{3+}, Ce^{4+}) and f^{14} (Yb^{2+}, Lu^{3+}) types are paramagnetic.

5. Uses

1. **Alloy steels** for plates and pipes: the best single use.
2. **Mischmetall** in Mg-based alloys: bullets, shells, lighter flint.
3. **Mixed oxides as catalysts in petroleum cracking** (La and Ce in the zeolite cracking catalyst).
4. **Oxides as phosphors** in television screens and fluorescing surfaces; europium-based red phosphors made bright red possible in colour TV.
5. Beyond NCERT: **neodymium magnets ($Nd_2Fe_{14}B$)** in phone speakers and vibration motors.

6. Rare earths are not rare

Element	Crust abundance
Ce	~60 ppm (≈ copper, ~60 ppm)
Tm	~0.5 ppm
Ag	~0.075 ppm

The name is historical ("earths" were oxides found in unusual minerals). What is hard is finding rich deposits and separating the lanthanoids from each other.

7. Exam extras

- First ionisation enthalpy ≈ 600 kJ mol^{-1}, second ≈ 1200 kJ mol^{-1} (comparable with calcium).
- Density and other properties change smoothly except for Eu and Yb (occasionally Sm and Tm).
- Melting points lie roughly between 1000 and 1200 K. NCERT states that samarium melts at 1623 K; the RSC and Britannica list about 1345 K (1072 °C). Use the NCERT value in CBSE answers.

8. Common mistakes

- ✗ "Lighter flint is a stone." ✓ It is mischmetall, a metal alloy; the sparks are burning metal.
- ✗ "All lanthanoids burn to Ln_2O_3." ✓ Cerium gives CeO_2.
- ✗ "$Ln(OH)_3$ is acidic or amphoteric." ✓ It is basic.
- ✗ "Rare earths are rare." ✓ Cerium is about as common as copper.

9. Key takeaways

- Soft, silvery, very reactive metals (Ca-like → Al-like).
- They react with O_2, X_2, water, acids, N_2, S, C and H_2; oxides and hydroxides are basic.
- f electrons give most Ln^{3+} ions pale colours (La^{3+}, Lu^{3+} colourless).

- Uses: alloy steels, mischmetall (flints, bullets, shells), cracking catalysts, phosphors, magnets.

Practice questions

1. (MCQ) Mischmetall contains about: (a) 50 % Ln, 50 % Cu (b) 95 % Ln, 5 % Fe (c) 95 % Fe, 5 % Ln (d) pure Ce
2. (MCQ) Which lanthanoid is steel-hard? (a) La (b) Ce (c) Sm (d) Eu
3. (MCQ) The product of Ln with water is: (a) $Ln_2O_3 + O_2$ (b) $Ln(OH)_3 + H_2$ (c) LnH_3 (d) no reaction
4. (MCQ) Which ion is colourless? (a) Pr^{3+} (b) Nd^{3+} (c) Er^{3+} (d) Lu^{3+}
5. (MCQ) With carbon at 2773 K lanthanoids form: (a) LnC_2 (b) $LnCO_3$ (c) $Ln(CN)_3$ (d) no reaction
6. (Very short) Name the best single use of the lanthanoids.
7. (Very short) Write the formula of the oxide formed when cerium burns in oxygen.
8. (Short) Write balanced equations for Ln with water and with dilute acid.
9. (Short) Why are La^{3+} and Lu^{3+} colourless while Pr^{3+} is green?
10. (HOTS) Explain why a lighter can make sparks from a metal rod.

Answer key

1. (b).
2. (c) Sm.
3. (b).
4. (d) Lu^{3+}.
5. (a) LnC_2.
6. Alloy steels for plates and pipes.
7. CeO_2.
8. $2Ln + 6H_2O \rightarrow 2Ln(OH)_3 + 3H_2$; $2Ln + 6H^+ \rightarrow 2Ln^{3+} + 3H_2$.
9. Colour comes from excitation within the 4f level; La^{3+} ($4f^0$) has no f electrons and Lu^{3+} ($4f^{14}$) has a full 4f level, so no f–f excitation is possible; Pr^{3+} ($4f^2$) can absorb.
10. The "flint" is mischmetall, a cerium-rich alloy; the wheel scrapes off tiny shavings that ignite in air at a low temperature (~150–180 °C for cerium); the burning shavings are the sparks.

▶ Watch the video explanation