

Scandium group

| Element | Symbol | Electronic structure | Oxidation states |
|-----------|------------------|--|------------------|
| Scandium | Sc ₂₁ | [Ar] 3d ¹ , 4s ² | III |
| Yttrium | Y ₃₉ | [Kr] 4d ¹ , 5s ² | III |
| Lanthanum | La ₅₇ | [Xe] 5d ¹ , 6s ² | III |

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The only oxidation state is +3

It forms NO ions with a partly filled 3d sub-shell

Chemical Properties

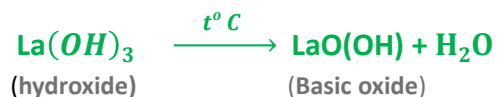
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1. Reaction with water

* Scandium and Yttrium when heated, they dissolve in water to form a solution consisting of ions Sc (III) or Y(III) and hydrogen gas.



* Lanthanum is quite electropositive and reacts slowly with cold water but fairly quickly if it reacts with hot water to form hydrogen gas and hydroxide Lanthana.



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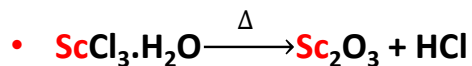
2. Reaction with Halogens

Scandium is very reactive towards the halogens, F₂, Cl₂, Br₂ and I₂, and burns to form the tri-halides:



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By heating of halogens, oxides are obtained



All Y salts $\{\text{Y}(\text{OH})_3, \text{Y}_2(\text{CO}_3)_3, \text{Y}_2(\text{SO}_4)_3, \text{Y}(\text{NO}_3)_3\}$
decomposed to oxides by heating



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Oxides can be obtained also the reaction of metals with O_2

Scandium metal tarnishes in air and burns readily to form a white oxide, Sc_2O_3 .

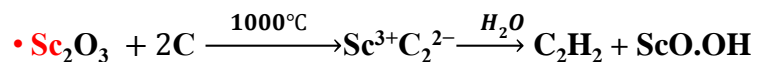
Yttrium metal is passivated by an oxide layer and is quite stable in air.



(at normal Temperature)

(M= Sc, Y, La)

Reaction with Carbon, C



- Sc should be divalent but magnetic and conductivity measurements have shown that it contains Sc^{3+} ions, C_2^{2-} ions and free electrons

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Metal oxide acid-base character

Sc_2O_3 dissolves in acids to form colorless solutions of the respective salt e.g.



- It also dissolved in NaOH



- This behavior suggested that scandium possess some acidic character in strong basic and there for amphoteric.
- Y_2O_3 is weak basic

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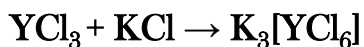
Complex formation

These metal ions are rarely forming complexes, because of their fairly large size.

Scandium is the smallest ion and form complexes more readily

$[\text{ScF}_6]^{3-}$, $[\text{Sc}(\text{bpy})_3]^{3+}$, $\text{mer-}[\text{ScCl}_3(\text{THF})_3]$ and $[\text{Sc}(\text{acac})_3]$.

- YCl_3 forms a hexahydrate which is correctly formulated as $[\text{YCl}_2(\text{OH}_2)_6]\text{Cl}$.



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The color of scandium compounds

- *Most scandium compounds and complex ions are white or colorless???*
- (Sc only exhibits a +3 oxidation state with electronic configuration $[\text{Ar}]3d^0$, giving a completely empty 3d sub-shell.

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Extraction

- **Difficult to separate the elements Sc, Y, La and Ac from their compounds due to**

- 1- High melting points**
- 2- Their reactivities with water**
- 3- Their stable oxides**

Extraction

- The oxides are converted to fluorides during reactions with hydrofluoric acid. The resulting fluorides are reduced with alkaline earth metals or alloys of the metals; metallic calcium is used most frequently.

For example:



- Y usually is produced by electrolysis of the chloride salt:



Applications

• Uses of Scandium

- Scandium oxide, Sc_2O_3 , is used in electronic components.
- Scandium iodide, ScI_3 , is used in high intensity light-bulbs.
- Al-Sc alloy is used for sports equipment (bikes) and aerospace industry that have a high quality.

- These applications are not yet well developed, however, because of the high cost of the metal.

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Applications

Uses of Yttrium

- Yttrium is used in the red *phosphor* in television picture tubes and flat plasma screens.
- Yttrium iron *garnet* has applications in optics and radar.
- Y_2O_3 is used in ceramics, optical glasses and refractory materials.
- Alluminium Yttrium Garnet $\text{Y}_3\text{Al}_5\text{O}_{12}$ is used for laser, stimulant and diamond.

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