# Student's Card 1 Let's make recycling Blue

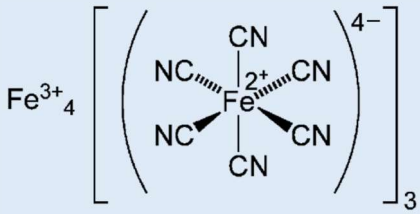
### A versatile system for a sustainable recovery of Critical Raw Materials from water

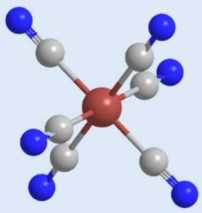
## Module 1

### Objective: Synthesis of Prussian Blue

## Introduction

The Prussian Blue (iron hexacyanoferrate: $Fe_4[Fe(CN)_6]_3$) is a metal complex.



Prussian blue was first synthesized around 1704 by the reaction of salts of iron in the +2 oxidation state (ferrous salts) with potassium ferrocyanide; modern commercial methods are similar:

$4FeCl_3 \cdot 6H_2O + 3K_4[Fe(CN)_6] \cdot 3H_2O \rightarrow Fe_4[Fe(CN)_6]_3 + 12KCl$

**Coordination compounds** are molecules that possess one or multiple metal centres that are bound to ligands (atoms, ions, or molecules that donate electrons to the metal). These complexes can be neutral or charged. When the complex is charged, it is stabilized by neighbouring counter-ions. A complex ion has a metal ion at its centre with a number of other molecules or ions surrounding it. These can be considered to be attached to the central ion by coordination bonds and in some cases, the bonding is actually more complicated than that. The molecules or ions surrounding the central metal ion are called ligands.

## Necessities

| Reagents | Formula | | Quantity (g) or Concentration (M) |
|---|---|---|---|
| **Hexacyanoferrate trihydrate** | $K_4[Fe(CN)_6]\cdot 3H_2O$ | | 1.0 g in 10 ml of distilled water |
| **Ferric chloride hexahydrate** | $FeCl_3 \cdot 6H_2O$ | | 2.6 g in 10 ml of distilled water |

**List of materials/tools**

- 4 beakers
- Glass-rod stirrer
- Magnetic stirrer with heating plate

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- Stirring bar
- Plastic spatula
- Graduated pipette
- Graduated cylinder
- Buchner funnel

## Lab Procedure

The best synthesis is the one with a stoichiometric ratio between the reagents of 2:1 ($FeCl_3$ and $K_4[Fe(CN)_6]$).

- 2.6 g of $FeCl_3$ were dissolved in 10 ml of distilled water.
- 1.0 g of $K_4[Fe(CN)_6]$ was dissolved in 10 ml of distilled water.
- The two solutions were mixed and a blue precipitate was obtained (Prussian Blue).
- Prepare the paper filter to be inserted in the buchner funnel.
- Filter the precipitate obtained with a buchner funnel.
- Blue precipitate was obtained (Prussian Blue).
- Allow to dry before proceeding with Module 2.

## Additional Safety Notes

$K_4[Fe(CN)_6]$ has a long-lasting harmful effect on aquatic life, and it must not be dispersed in the environment.

$FeCl_3$ is corrosive, therefore it can cause skin and eye burns. Use protective gloves and goggles.

## Calculations (optional: it is a way to brush up on old concepts)

Mass of Prussian Blue got: ..... g (actual mass)

mol $FeCl_3 \cdot 6H_2O$ =

mol $K_4[Fe(CN)_6]\cdot 3H_2O$ =

mol $Fe_4[Fe(CN)_6]_3$ =

g $Fe_4[Fe(CN)_6]_3$ = (Theoretical mass)

Theoretical mass of Prussian Blue (which you should have obtained theoretically by making calculations with the reaction ratio): ..... g

Reaction percentage yield = Actual mass / Theoretical mass * 100

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## Questions/Quiz

1. What kind of compound do you get from the synthesis?
2. From a chemical point of view, what are its characteristics?
3. Why is it appropriate to pay attention during the practical activity carried out?
4. Why did we synthesize Prussian Blue?