Midas' Magic

Abstract

Two clear colorless solutions are mixed together resulting in the formation of a thick yellow precipitate.

Materials

Lead Nitrate $Pb(NO_3)_2$
Potassium Iodide KI
1000 mL beaker
2- 500 mL containers
glass stir rod

Safety

Lead nitrate and potassium iodide should both be considered hazardous. Both chemicals can cause skin, eye and respiratory irritation. Prolonged exposure to lead nitrate can result in burns and can be toxic to the central nervous system and the peripheral nervous system. When working with these compounds work in a vented hood and avoid breathing in any dust particles.

Procedure

Preparation of Stock Solutions:

0.1M lead nitrate solution—dissolve 16.6 g $Pb(NO_3)_2$ in distilled water and dilute to 500 mL.

0.1M potassium iodide solution—dissolve 8.3 g KI in distilled water and dilute to 500 mL.

Presentation:

To an empty 1000 mL beaker add about 100 mL of the first colorless solution $Pb(NO_3)_2$, and then about 100 mL of the second colorless solution KI and a dense yellow precipitate forms instantly.

Discussion

This experiment is dramatic in that it shows the creation of a colorful product from two colorless solutions. The reaction is a classic example of a precipitation reaction, which results in the formation of an insoluble product. In this example, when an aqueous solution of lead nitrate $Pb(NO_3)_2$ is added to an aqueous solution of potassium iodide KI, a yellow precipitate of lead iodide PbI_2 is formed as well as some potassium nitrate KNO_3 which stays in solution:

$Pb(NO_3)_2$ (aq) + 2KI (aq) ----------→ PbI_2 (s) + KNO_3 (aq)

The reaction is an example of a metathesis reaction, which involves the exchange of ions between the $Pb(NO_3)_2$ and KI. The Pb^{+2} ends up going after the I^- resulting in the formation of PbI_2, and the K^+ ends up combining with the NO_3^- forming KNO_3.

Ion	General Solubility Rule
NO_3^-	All nitrates are soluble.
$C_2H_3O_2^-$	All acetates are soluble ($AgC_2H_3O_2$ only moderately.)
Cl^-,Br^-, I	All chlorides, bromides, and iodides are soluble except Ag^+, Pb^+, and Hg_2^{2+}. ($PbCl_2$ is slightly soluble in cold water and moderately soluble in hot water.)
SO_4^{2-}	All sulfates are soluble except those of Ba^{2+}, Pb^{2+}, Ca^{2+} and Sr^{2+}.
CO_3^{2-} and PO_4^{3-}	All carbonates and phosphates are insoluble except those of Na^+, K^+, and NH_4^+. (Many acid phosphates are soluble.)
OH^-	All hydroxides are insoluble except those of Na^+ and K^+. Hydroxides of Ba^{2+} and Ca^{2+} are slightly soluble.
S^{2-}	All sulfides are insoluble except those of NA^+, K^+, NH_4^+, and those of the alkaline earths: Mg^{2+}, Ca^{2+}, Sr^{2+}, and Ba^{2+}. (Sulfides of Al^{3+} and Cr^{3+} hydrolyze and precipitate as the corresponding hydroxides.)
Na^+, K^+, and NH_4^+	All salts of sodium ion, potassium ion and ammonium ion are soluble except several uncommon ones.

A quick glance at a solubility table shows that all nitrates are always soluble and all iodides are soluble except those formed with Pb^{+2}, Ag^{+} and Hg_2^{2+}

Disposal

The products of the reaction should be poured out into a properly labeled waste container for proper disposal.

References

Shakhashiri, B. Z. *Chemical Demonstrations: A Handbook for Teachers of Chemistry;* University of Wisconsin: Madison, WI, **1983**; Vol. 1, pp. 286-292

Chemistry Behind the Magic: Chemical Demonstrations for the Classroom

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