

Chemistry BC2001x
Lab lecture 11
QUALITATIVE ANALYSIS III



"TODAY EVERYONE HAS TO KNOW 'WHAT'S IN THE FOOD?', 'WHAT'S IN THE WATER?', 'WHAT'S IN THE AIR?' THIS IS TRULY THE 'GOLDEN' AGE OF ANALYTICAL CHEMISTRY."

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Preparing to test for unknown anion
Two preliminary considerations...

- 1) The salt may be **insoluble** in water, but you need to get the anion into solution to run the tests.
Your unknown may be soluble in water, only slightly soluble in water, or very insoluble in water.
- 2) The metal cation (unknown at this point) may **interfere** with some of the anion tests.
The metal cation might or might not interfere with some of the anion tests -- you simply don't know.

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Preparing to test for unknown anion
Two preliminary considerations...

Since we don't know all the possibilities now or the actual situation with any particular unknown **we will treat all the salts C alike.**

Both the problems above can usually be dealt with by **TRANSPOSITION.**

This process **usually** forces the **anion** of the unknown into solution, and at the same time separates and removes the potentially interfering metal **cation.**

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Transposition

If a salt is insoluble in water and in acid, how can you get the ions into solution to do tests?

Introduce another anion, one that forms an even less soluble salt with the cation.

What anion? **carbonate.**

Carbonate salts are generally insoluble in water, often less soluble than the salts of other anions with a given cation.

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Transposition: example: PbBr_2

Is PbBr_2 soluble in water?

No. Halides of Pb^{2+} are insoluble in water.

Is this salt soluble in acid?

No. HBr is a strong acid: HBr will not form.

Add some $\text{Na}_2\text{CO}_3(\text{s})$.

Is this salt soluble in water?

Yes. Almost all sodium salts are soluble.

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Transposition example: PbBr_2

What reaction can occur?



Transposition

If this reaction goes to products, the lead ion goes into the precipitate, and the bromide anion is left in solution (along with the sodium cation).

Eureka!



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Transposition example: PbBr_2



Will this reaction go significantly?

What is the value of K ?

$$K = \frac{[\text{Br}^-]^2}{[\text{CO}_3^{2-}]} \times \frac{[\text{Pb}^{2+}]}{[\text{Pb}^{2+}]} = \frac{K_{\text{sp}}(\text{PbBr}_2)}{K_{\text{sp}}(\text{PbCO}_3)} = \frac{6.3 \times 10^{-6}}{1.5 \times 10^{-13}}$$

$$= 4.2 \times 10^{+7} \gg 1. \text{ The } \text{PbBr}_2 \text{ dissolves.}$$

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Transposition of PbBr_2

Filter. The Br^- ion has been released into the solution where anion tests can now be done.

Transfer the solid lead carbonate into a separate test tube. Treat it with HNO_3 , releasing Pb^{2+} ion.

The cation and anion are now in separate solutions!

Will this always work? No.

The unknown could be even less soluble than a carbonate (for example, a sulfide), or the unknown could be a carbonate.

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Transposition

When transposition works, what is the result?

- (1) The original cation M^{n+} is in the solid carbonate.
Almost none is in the solution.
- (2) The original anion X^{m-} is in the solution.
- (3) Na^+ or K^+ from the soluble carbonate is also in the solution.
- (4) Lots of CO_3^{2-} ion is in the solution, because excess carbonate was used.