Precipitation Reactions

DR. MIOY T. HUYNH
YALE UNIVERSITY
CHEMISTRY 161
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What is a salt?

A salt is an ionic compound: metal + nonmetal

Some salts are **soluble** in water (*aqueous*, *aq* = dissolves in water).

Some salts are **insoluble** in water (precipitate, solid, *s*).

Q: What happens when we mix salt solutions?

A: Sometimes we can get a new, insoluble salt (or a precipitate) to form.

Sometimes nothing happens though …

It really depends on the ions.

		Exceptions
SOLUBLE	Group 1 cations	
	NH_4^+	
	NO_3^-	
	CH_3COO^-	
	Cl^-, Br^-, I^-	Ag^+, Hg_2^{2+}, Pb^{2+}, Cu^+
	SO_4^{2-}	Hg_2^{2+}, Pb^{2+}, Ba^{2+}, Ca^{2+}, Sr^{2+},
INSOLUBLE	OH^-	Group 1 cations, Ba^{2+}, Ca^{2+}, Sr^{2+}, NH_4^+
	S^{2-}	Group 1 cations, Ba^{2+}, Ca^{2+}, Sr^{2+}, NH_4^+
	CO_3^{2-}, PO_4^{3-}, F^-	Group 1 cations, NH_4^+

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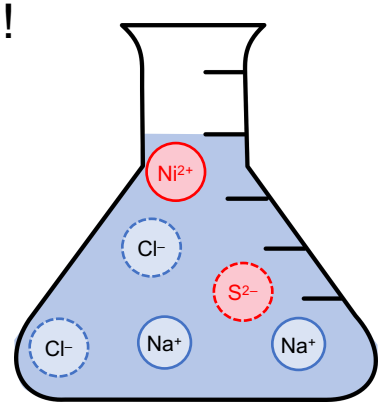

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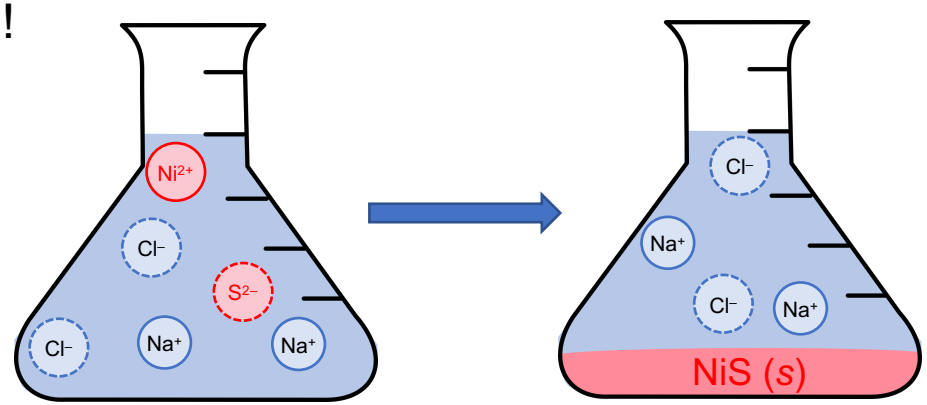
→ NiS precipitate (solid) forms & other ions float in solution



Writing Chemical Equations

This is called a molecular equation because we keep the salt as neutral “molecules”:

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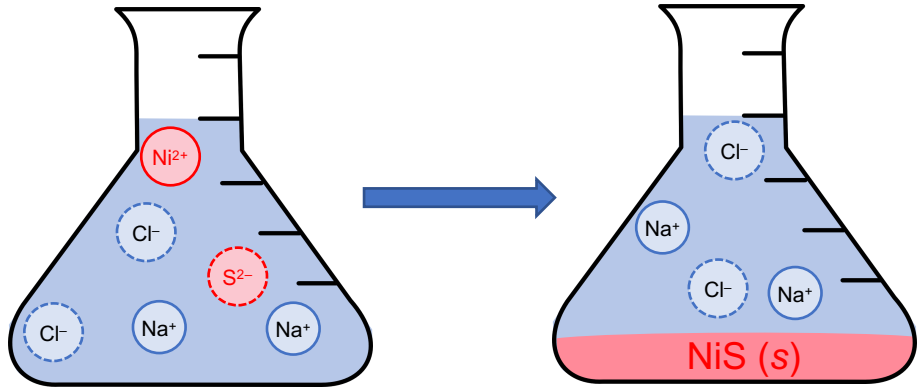

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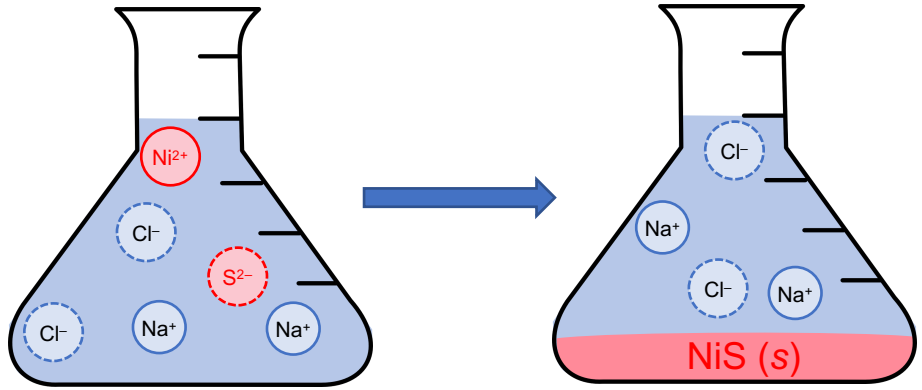

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You may notice that some of these ions (Na^{+} and Cl^{-}) don't actually chemically react.

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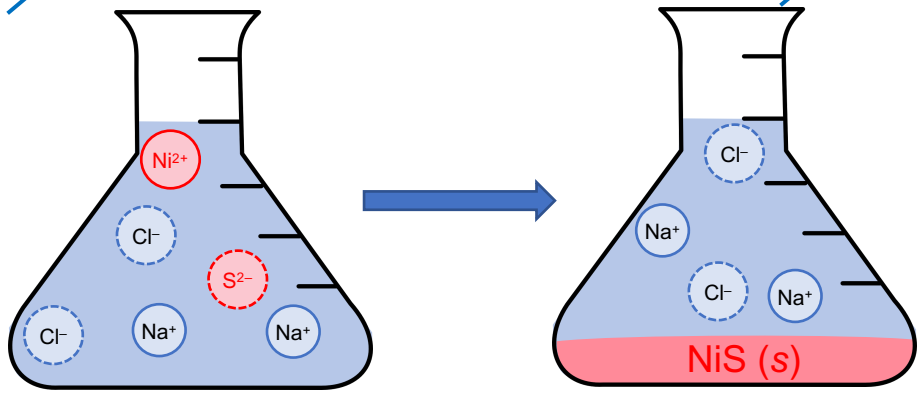

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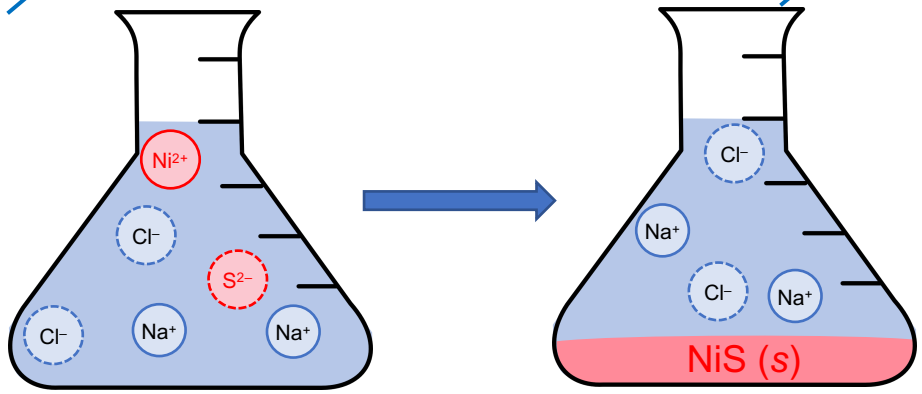

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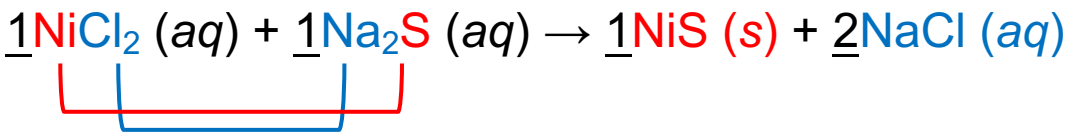
When we mix to aqueous salt solutions together, we can sometimes get a new precipitate to form:



We call these double exchange reactions because we “swap” the two ions (red and blue).

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Once you do enough of these problems, you can take the shortcut of "swapping" the ions like above.

Write the molecular equation for each of the following reactions:

1. A nickel(II) chloride solution is mixed with an ammonium sulfate solution.

2. An aqueous solution of potassium carbonate is added to a barium nitrate solution.

3. $FeSO_4$ (*aq*) + KOH (*aq*) →

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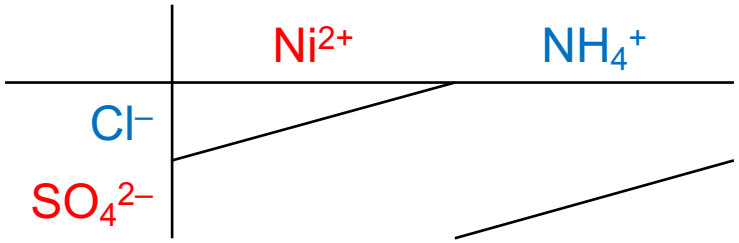

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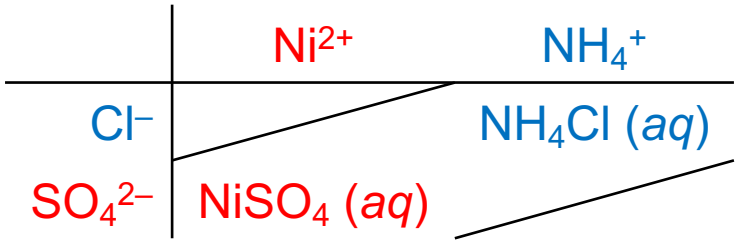

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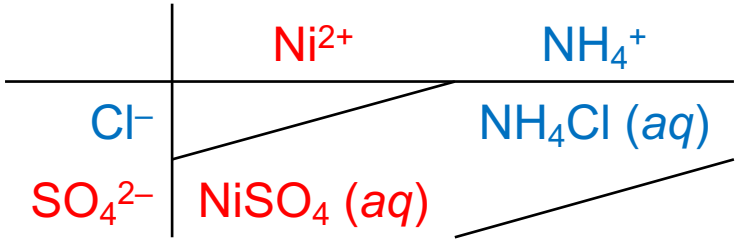

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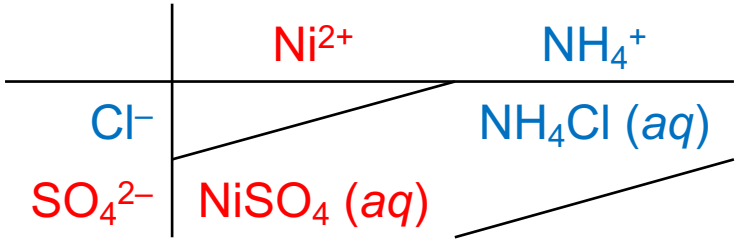

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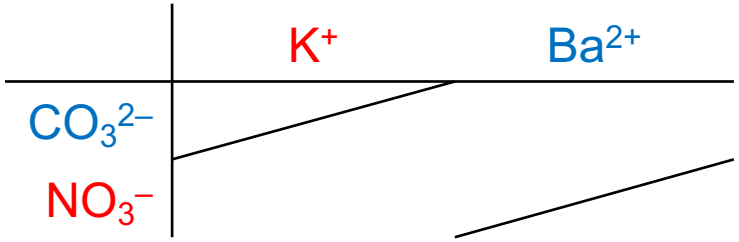

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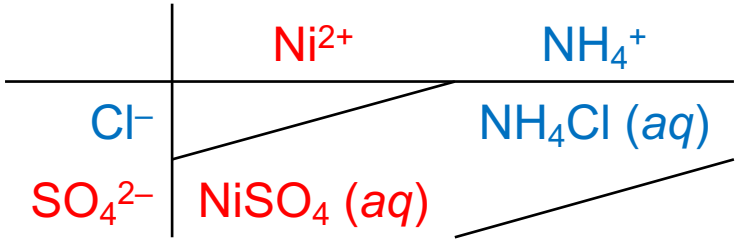

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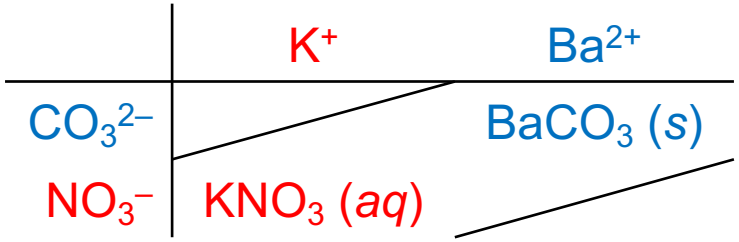

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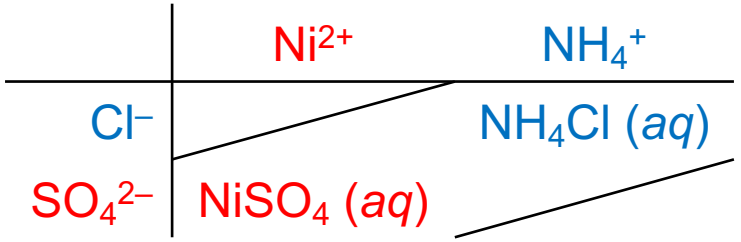

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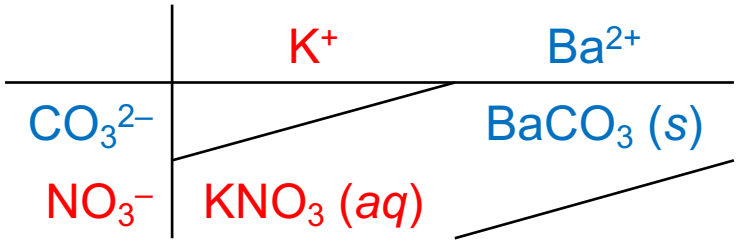

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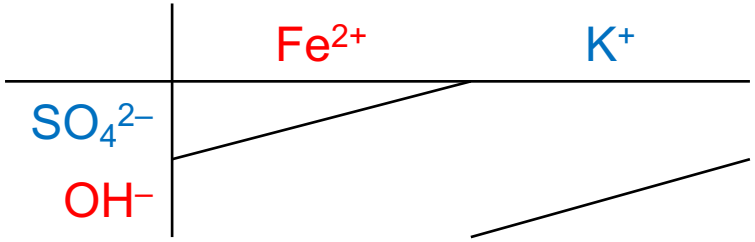

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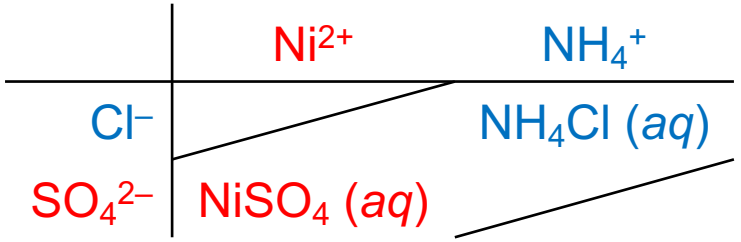

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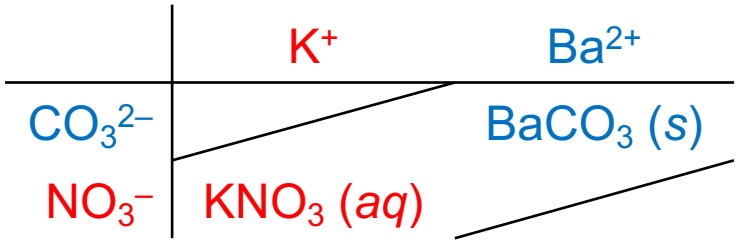
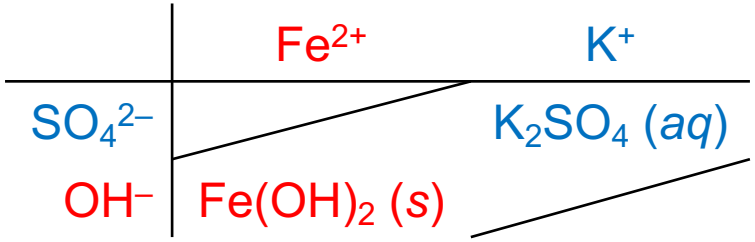
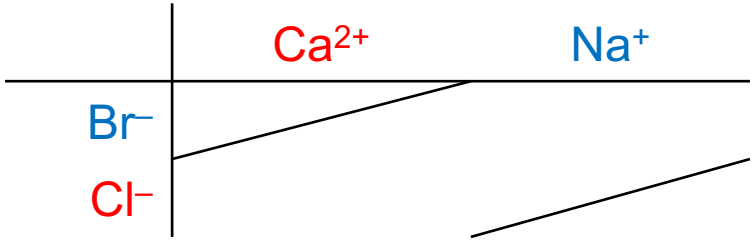


3. $FeSO_4\ (aq) + 2KOH\ (aq) \rightarrow Fe(OH)_2\ (s) + K_2SO_4\ (aq)$



4. $CaBr_2\ (aq) + NaCl\ (aq) \rightarrow$



Write the molecular equation for each of the following reactions:

1. A nickel(II) chloride solution is mixed with an ammonium sulfate solution.

   $NiCl_2\ (aq) + (NH_4)_2SO_4\ (aq) \rightarrow NiSO_4\ (aq) + 2NH_4Cl\ (aq)$

	Ni^{2+}	NH_4^+
Cl^-		$NH_4Cl\ (aq)$
SO_4^{2-}	$NiSO_4\ (aq)$	

2. An aqueous solution of potassium carbonate is added to a barium nitrate solution.

   $K_2CO_3\ (aq) + Ba(NO_3)_2\ (aq) \rightarrow 2KNO_3\ (aq) + BaCO_3\ (s)$

	K^+	Ba^{2+}
CO_3^{2-}		$BaCO_3\ (s)$
NO_3^-	$KNO_3\ (aq)$	

3. $FeSO_4\ (aq) + 2KOH\ (aq) \rightarrow Fe(OH)_2\ (s) + K_2SO_4\ (aq)$

	Fe^{2+}	K^+
SO_4^{2-}		$K_2SO_4\ (aq)$
OH^-	$Fe(OH)_2\ (s)$	

4. $CaBr_2\ (aq) + NaCl\ (aq) \rightarrow$

	Ca^{2+}	Na^+
Br^-		$NaBr\ (aq)$
Cl^-	$CaCl_2\ (aq)$	

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CO_3^{2-}		$BaCO_3\ (s)$
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	Fe^{2+}	K^+
SO_4^{2-}		$K_2SO_4\ (aq)$
OH^-	$Fe(OH)_2\ (s)$	

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SO_4^{2-}		$K_2SO_4\ (aq)$
OH^-	$Fe(OH)_2\ (s)$	

4. $CaBr_2\ (aq) + 2NaCl\ (aq) \rightarrow CaCl_2\ (aq) + 2NaBr\ (aq)$

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Br^-		$NaBr\ (aq)$
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In a complete ionic equation: write the soluble or aqueous (*aq*) "molecules" as dissociated ions

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Remember to balance your equation!

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   $Fe^{2+}\ (aq) + SO_4^{2-}\ (aq) + 2K^+\ (aq) + 2OH^-\ (aq) \rightarrow Fe(OH)_2\ (s) + 2K^+\ (aq) + SO_4^{2-}\ (aq)$

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In a net ionic equation: get rid of the "spectator ions" and only keep what forms the precipitate or insoluble salt (*s*)

Write the net ionic equation for each of the following reactions:

1. A nickel(II) chloride solution is mixed with an ammonium sulfate solution.

   $NiCl_2\ (aq) + (NH_4)_2SO_4\ (aq) \rightarrow NiSO_4\ (aq) + 2NH_4Cl\ (aq)$

   $Ni^{2+}\ (aq) + 2Cl^-\ (aq) + 2NH_4^+\ (aq) + SO_4^{2-}\ (aq) \rightarrow Ni^{2+}\ (aq) + SO_4^{2-}\ (aq) + 2NH_4^+\ (aq) + 2Cl^-\ (aq)$

   → This reaction doesn't form any precipitate, so no net ionic equation!

2. An aqueous solution of potassium carbonate is added to a barium nitrate solution.

   $K_2CO_3\ (aq) + Ba(NO_3)_2\ (aq) \rightarrow 2KNO_3\ (aq) + BaCO_3\ (s)$

   $2K^+\ (aq) + CO_3^{2-}\ (aq) + Ba^{2+}\ (aq) + 2NO_3^-\ (aq) \rightarrow 2K^+\ (aq) + 2NO_3^-\ (aq) + BaCO_3\ (s)$

   $CO_3^{2-}\ (aq) + Ba^{2+}\ (aq) + \rightarrow BaCO_3\ (s)$

3. $FeSO_4\ (aq) + 2KOH\ (aq) \rightarrow Fe(OH)_2\ (s) + K_2SO_4\ (aq)$

   $Fe^{2+}\ (aq) + SO_4^{2-}\ (aq) + 2K^+\ (aq) + 2OH^-\ (aq) \rightarrow Fe(OH)_2\ (s) + 2K^+\ (aq) + SO_4^{2-}\ (aq)$

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   $Fe^{2+}\ (aq) + SO_4^{2-}\ (aq) + 2K^+\ (aq) + 2OH^-\ (aq) \rightarrow Fe(OH)_2\ (s) + 2K^+\ (aq) + SO_4^{2-}\ (aq)$

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Remember to balance your equation!

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