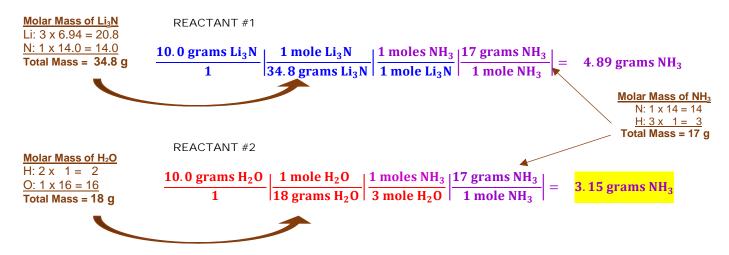# Stoichiometry – Limiting Reactant and Percent Yeild
[Must Show All Work]

Lithium nitride reacts with water or moisture in the air to generate corrosive lithium hydroxide and toxic ammonia gas, according to the following reaction:

$$1 \; Li_3N \; (s) + 3 \; H_2O \; (l) \rightarrow 1 \; NH_3 \; (g) + 3 \; LiOH \; (aq)$$

1. If 10.0 grams of each reactant are used, which one is the limiting reactant?

IF YOU SOLVED FOR NH_3, LOOK BELOW. IF YOU SOLVED FOR LiOH SCROLL DOWN.

Molar Mass of Li_3N
Li: 3 x 6.94 = 20.8
N: 1 x 14.0 = 14.0
Total Mass = 34.8 g

REACTANT #1

$$\dfrac{10.0 \text{ grams } Li_3N}{1} \bigg| \dfrac{1 \text{ mole } Li_3N}{34.8 \text{ grams } Li_3N} \bigg| \dfrac{1 \text{ moles } NH_3}{1 \text{ mole } Li_3N} \bigg| \dfrac{17 \text{ grams } NH_3}{1 \text{ mole } NH_3} \bigg| = 4.89 \text{ grams } NH_3$$

Molar Mass of NH_3
N: 1 x 14 = 14
H: 3 x 1 = 3
Total Mass = 17 g

Molar Mass of H_2O
H: 2 x 1 = 2
O: 1 x 16 = 16
Total Mass = 18 g

REACTANT #2

$$\dfrac{10.0 \text{ grams } H_2O}{1} \bigg| \dfrac{1 \text{ mole } H_2O}{18 \text{ grams } H_2O} \bigg| \dfrac{1 \text{ moles } NH_3}{3 \text{ mole } H_2O} \bigg| \dfrac{17 \text{ grams } NH_3}{1 \text{ mole } NH_3} \bigg| = 3.15 \text{ grams } NH_3$$

2. What is the mass of the theoretical yield of **ammonia**?

$$3.15 \text{ grams } NH_3$$ (IF YOU SOLVED FOR LiOH SCROLL DOWN)

3. How much of the excess reactant is left over after the reaction is complete?

   First use the amount of limiting reactant used to calculate the amount of excess reactant used.

$$\dfrac{10.0 \text{ grams } H_2O \text{ used}}{1} \bigg| \dfrac{1 \text{ mole } H_2O}{18 \text{ grams } H_2O} \bigg| \dfrac{1 \text{ mole } Li_3N}{3 \text{ mole } H_2O} \bigg| \dfrac{34.8 \text{ grams } Li_3N}{1 \text{ mole } Li_3N} \bigg| = 6.44 \text{ grams } Li_3N \text{ used}$$

   Next subtract the amount of excess used from the original amount to calculate amount leftover.

$$10.0 \text{ grams } Li_3N \text{ starting} - 6.44 \text{ grams } Li_3N \text{ used} = \boxed{3.6 \text{ grams } Li_3N \text{ leftover}}$$

4. Suppose a chemist performed this reaction and only produced 2.95 grams of ammonia. Calculate the percent yield based on this result.
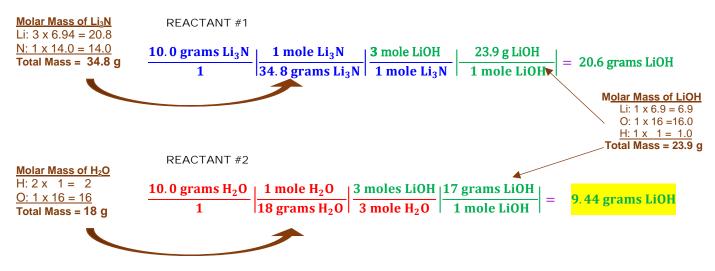
$$\dfrac{2.95 \text{ grams } NH_3}{3.15 \text{ grams } NH_3} \times 100 = \boxed{93.7\% \text{ Yield}}$$

IF YOU SOLVED FOR **LiOH**…

Lithium nitride reacts with water or moisture in the air to generate corrosive lithium hydroxide and toxic ammonia gas, according to the following reaction:

$$1\ Li_3N\ (s) + 3\ H_2O\ (l) \rightarrow 1\ NH_3\ (g) + 3\ LiOH\ (aq)$$

1. If 10.0 grams of each reactant are used, which one is the limiting reactant?

Molar Mass of Li₃N
Li: 3 x 6.94 = 20.8
N: 1 x 14.0 = 14.0
Total Mass = **34.8 g**

REACTANT #1

$$\frac{10.0\ grams\ Li_3N}{1}\left|\frac{1\ mole\ Li_3N}{34.8\ grams\ Li_3N}\right|\frac{3\ mole\ LiOH}{1\ mole\ Li_3N}\left|\frac{23.9\ g\ LiOH}{1\ mole\ LiOH}\right| = 20.6\ grams\ LiOH$$

Molar Mass of LiOH
Li: 1 x 6.9 = 6.9
O: 1 x 16 =16.0
H: 1 x 1 = 1.0
Total Mass = 23.9 g

REACTANT #2

Molar Mass of H₂O
H: 2 x 1 = 2
O: 1 x 16 = 16
Total Mass = **18 g**

$$\frac{10.0\ grams\ H_2O}{1}\left|\frac{1\ mole\ H_2O}{18\ grams\ H_2O}\right|\frac{3\ moles\ LiOH}{3\ mole\ H_2O}\left|\frac{17\ grams\ LiOH}{1\ mole\ LiOH}\right| = 9.44\ grams\ LiOH$$

2. What is the mass of the theoretical yield of **lithium hydroxide**?

$$9.44\ grams\ LiOH$$

3. How much of the excess reactant is left over after the reaction is complete?

First use the amount of limiting reactant used to calculate the amount of excess reactant used.

$$\frac{10.0\ grams\ H_2O\ used}{1}\left|\frac{1\ mole\ H_2O}{18\ grams\ H_2O}\right|\frac{1\ mole\ Li_3N}{3\ mole\ H_2O}\left|\frac{34.8\ grams\ Li_3N}{1\ mole\ Li_3N}\right| = 6.44\ grams\ Li_3N\ used$$

Next subtract the amount of excess used from the original amount to calculate amount leftover.

$$10.0\ grams\ Li_3N\ starting\ -\ 6.44\ grams\ Li_3N\ used = \boxed{3.6\ \ grams\ Li_3N\ leftover}$$

4. Suppose a chemist performed this reaction and only produced 2.95 grams of **lithium hydroxide**. Calculate the percent yield based on this result.

$$\frac{2.95\ grams\ LiOH}{9.44\ grams\ LiOH} \times 100 = \boxed{31.3\%\ Yield}$$