

Percentage Yield Notes

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Questions involving percentage yield are lovely questions to get. There are only two kinds of questions we could be asked. We could be asked to calculate the percentage yield of a reaction or we could be asked to state the reasons why we never get 100 % yield.

Percentage yield: a measure of the efficiency of a reaction to turn the reactants into the desired products. It is calculated by dividing the actual yield of a reaction by the theoretical yield and then multiplying 100.

The actual yield: the actual amount of product that we get from the doing the experiment.

The theoretical yield: the maximum calculated amount of a product that we could get from the experiment.

Note: we could see a question where we asked to calculate the percentage yield when we have been given the balanced equation for the reaction and the actual yield. We need the theoretical yield to do this but we can calculate it using a standard mole calculation.

Equation for Percentage Yield

$$\text{Percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100$$

Why was the yield less than 100% or why was the yield lower than expected?

Here are three reasons why this might occur. Most questions ask for one or two, so three is plenty.

1. Reactants can be lost during the process or some products could also be lost.
2. The reactants may not have fully reacted or the reaction is incomplete. The reaction could also be reversible.
3. There may be competing/ unwanted/ side reactions occurring in the reaction vessel.

Let's have a look at some examples.

Example 1: A sample of calcium carbonate is strongly heated in a crucible until there is no further loss in mass. The mass of calcium oxide remaining in the crucible is 5.450 g.

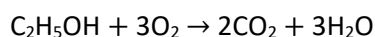
The theoretical yield of calcium oxide in this experiment is 5.600 g.

Calculate the percentage yield of calcium oxide.

$$\text{Percentage yield} = \frac{5.450}{5.600} \times 100$$

$$\text{Percentage yield} = 97.3\%$$

Example 2: A reaction between ethanol (C₂H₅OH) and oxygen (O₂) produces carbon dioxide (CO₂) and water (H₂O).



Theoretical yield of carbon dioxide is 44.0 g, but only 36.0 g of carbon dioxide is collected (actual yield).

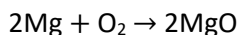
What is the percentage yield?

$$\text{Percentage yield} = \frac{36}{44} \times 100$$

$$\text{Percentage yield} = 81.8 \%$$

Let's have a look at two examples where we are given the actual yield and we need to calculate the theoretical yield in order to calculate the percentage yield.

Example 3: A student reacts 5.00 g of magnesium metal (Mg) with excess oxygen (O₂) to form magnesium oxide (MgO). The balanced equation for the reaction is:



After the reaction, the chemist obtains 6.50 g of MgO. Calculate the percentage yield. Give your answer to 1 decimal place.

Step 1: we need to calculate the theoretical yield via a mole calculation.

$$\text{Moles of Mg} = \text{mass} \div \text{Mr}$$

$$\text{Moles of Mg} = 5 \div 24$$

$$\text{Moles of Mg} = 0.208$$

The ratio of moles is 1 : 1 for Mg and MgO

$$\text{Moles of MgO} = 0.208$$

$$\text{Mass of MgO} = \text{mols} \times \text{Mr}$$

$$\text{Mass of MgO} = 0.208 \times 40$$

$$\text{Mass of MgO} = 8.32 \text{ g}$$

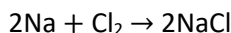
This is the theoretical yield 😊

Step 2: Now we have the theoretical yield we just substitute in the values for actual and theoretical yields into the equation for percentage yield.

$$\text{Percentage yield} = \frac{6.50}{8.32} \times 100$$

$$\text{Percentage yield} = 78.1 \%$$

Example 4: A student reacts 10.0 g of sodium (Na) with excess chlorine gas (Cl₂) to produce sodium chloride (NaCl).



The student forms 18.5 g of NaCl from the reaction. Calculate the percentage yield.

Step 1: we need to calculate the theoretical yield via a mole calculation.

$$\text{Moles of Na} = \text{mass} \div \text{Mr}$$

$$\text{Moles of Na} = 10 \div 23$$

$$\text{Moles of Na} = 0.4347$$

The ratio of moles is 1 : 1 for Na and NaCl

$$\text{Moles of NaCl} = 0.4347$$

$$\text{Mass of NaCl} = \text{mols} \times \text{Mr}$$

$$\text{Mass of NaCl} = 0.4347 \times 58.5$$

$$\text{Mass of NaCl} = 25.4 \text{ g}$$

This is the theoretical yield.

Step 2: Now we have the theoretical yield we just substitute in the values for actual and theoretical yields into the equation for percentage yield.

$$\text{Percentage yield} = \frac{18.5}{25.4} \times 100$$

$$\text{Percentage yield} = 72.8 \%$$