

Percentage yield

4.3.3.1 · Quantitative chemistry · revision notes

The yield is the amount of product you actually obtain. Percentage yield compares it with the maximum (theoretical) amount that could be made. This is in GCSE Chemistry only, not Combined Science.

Key facts

- Yield = amount of product actually obtained
- Actual mass = % yield $\times$ theoretical mass $\div$ 100
- A percentage yield cannot be more than 100% (if it is, the product is probably impure or still wet)
- % yield = actual mass $\div$ theoretical mass $\times$ 100
- Low yield: reversible reaction; product lost when separated; reactants react in unexpected ways

Notes

Yield and percentage yield

- The **yield** is the amount of product obtained.
- The **theoretical yield** is the maximum mass of product that could be made, calculated from the balanced equation.
- percentage yield = (mass of product actually made $\div$ maximum theoretical mass of product) $\times$ 100
- Example: theoretical yield 12.5 g, actual yield 10.0 g: $10.0 \div 12.5 \times 100 = 80.0\%$.

maximum (theoretical) yield = 12.5 g



actual yield = 10.0 g



2.5 g lost

Percentage yield = $10.0 \div 12.5 \times 100 = 80.0\%$. The missing 2.5 g is the product that was not obtained.

Why the yield is less than 100%

- No atoms are gained or lost, but it is not always possible to obtain the calculated amount of product because:
- the reaction may not go to completion because it is **reversible**
- some of the product may be **lost when it is separated** from the reaction mixture (e.g. left on the filter paper or in the apparatus)
- some of the reactants may **react in ways different** to the expected reaction.
- A high percentage yield wastes fewer reactants and less energy, which saves resources and money.

How to answer each type of question

Calculate the percentage yield

2 marks

Grade 5

1. Divide the actual mass by the theoretical (maximum) mass.
2. Multiply by 100 and give the % sign.

Example. The maximum theoretical mass of magnesium sulfate that could be made in a reaction was 6.00 g. A student obtained 4.20 g of dry crystals.
Calculate the percentage yield. [2 marks]

Model answer. $4.20 \div 6.00 \times 100$ (1)
= 70.0% (1)

Give reasons why the yield is less than 100%

2 marks

Grade 5

1. Choose from the three standard reasons.
2. Make each reason specific and link it to the context if one is given.

Example. Give **two** reasons why the percentage yield of a product is less than 100%. [2 marks]

Model answer. Any two from:

the reaction is reversible, so it does not go to completion (1)

some product is lost when it is separated from the reaction mixture (1)

some reactants react in ways different to the expected reaction (1)

Don't lose marks

- ✗ Putting the theoretical mass on top and getting an answer over 100%.
- ✗ Confusing percentage yield with atom economy: yield uses measured masses; atom economy uses M_r values from the equation.
- ✗ Giving vague reasons such as 'human error' or 'mistakes' instead of the three standard reasons.
- ✗ Saying that atoms are lost. Atoms are never lost; product is lost from the apparatus or never forms.

More tips

Memory tricks

- Actual over theoretical: what you got goes on top, so the answer is below 100%.
- Remember the reasons as R, L, S: Reversible, Lost when separating, Side (unexpected) reactions.
- Quick check: a 50% yield is half the theoretical mass.
- A 100% yield would mean every bit of reactant became product and none was lost.

Exam technique

- Learn the three reasons for a low yield word for word; each is often worth a mark.
- Write the division before multiplying by 100 so you can earn the method mark.
- Give the % sign and round only at the end.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 4

State what is meant by yield

The amount of product obtained from a reaction.

Grade 5

Calculate percentage yield

$\% \text{ yield} = \text{mass of product actually made} \div \text{maximum theoretical mass} \times 100.$

Grade 5

Give reasons why yield is below 100%

The reaction is reversible, some product is lost when it is separated, or some reactants react in unexpected ways.

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