

# Percentage Yield Answers

Use a calculator and a periodic table to answer the following questions.

- 19.62 g of zinc reacted with an excess of hydrochloric acid to produce a solution of zinc chloride.



Crystallisation of the solution yielded 35.46 g of zinc chloride.

Calculate the percentage yield.

Give your answer to an appropriate number of significant figures.

$$\text{moles of Zn} = \frac{\text{mass of substance (g)}}{A_r \text{ or } M_r \text{ of substance (g mol}^{-1}\text{)}}$$

$$A_r \text{ of Zn} = 65.4$$

$$\frac{19.62}{65.4} = 0.3000 \text{ moles}$$

$$\text{stoichiometric ratio of Zn : ZnCl}_2 = 1 : 1$$

$$\text{maximum possible moles of ZnCl}_2 = 0.3000 \text{ moles}$$

$$\text{theoretical yield of ZnCl}_2 = \text{number of moles} \times A_r$$

$$M_r \text{ of ZnCl}_2 = (65.4 \times 1) + (35.5 \times 2) = 136.4$$

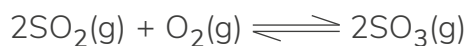
$$0.3000 \times 136.4 = 40.92 \text{ g}$$

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

$$\frac{35.46}{40.92} \times 100 = 86.6568915$$

$$\text{percentage yield} = \mathbf{86.66\% (4 \text{ s.f.})}$$

2. At room temperature and pressure, 120 cm<sup>3</sup> of sulfur dioxide reacts with 100 cm<sup>3</sup> of oxygen to produce 109 cm<sup>3</sup> of sulfur trioxide.



- a. Calculate the percentage yield of this reaction.

Give your answer to an appropriate number of significant figures.

**at room temperature and pressure the volume of one mole of gas = 24.0 dm<sup>3</sup>**

**stoichiometric ratio of SO<sub>2</sub> : O<sub>2</sub> = 2 : 1**

**O<sub>2</sub> is in excess (only 60 cm<sup>3</sup> of O<sub>2</sub> needed to react completely with 120 cm<sup>3</sup> of SO<sub>2</sub>)**

**stoichiometric ratio of SO<sub>2</sub> : SO<sub>3</sub> = 2 : 2 = 1 : 1**

**theoretical yield of SO<sub>3</sub> = 120 cm<sup>3</sup>**

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

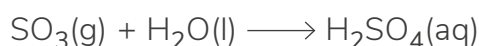
$$\frac{109}{120} \times 100 = 90.83333333$$

$$\text{percentage yield} = \mathbf{90.8\% \text{ (3 s.f.)}}$$

- b. Explain why the percentage yield of this reaction is not 100%.

**The reaction is reversible. Therefore, some of the sulfur trioxide will always decompose to form sulfur dioxide and oxygen.**

- c. The above reaction occurs during one of the steps in the Contact process. In the next step of the Contact process, sulfur trioxide reacts with water to make sulfuric acid.



The percentage yield of this step is 93.3%.

Calculate the overall percentage yield of the steps shown above.

$$\frac{90.8}{100} \times \frac{93.3}{100} \times 100 = \mathbf{84.7164}$$

$$\text{overall percentage yield} = \mathbf{84.7\% \text{ (3 s.f.)}}$$

3. On heating, 62.1 g of calcium carbonate produced 16.5 g of carbon dioxide.



Calculate the percentage of the calcium carbonate that decomposed.

Give your answer to an appropriate number of significant figures.

$$\text{initial moles of CaCO}_3 = \frac{\text{mass of substance (g)}}{A_r \text{ or } M_r \text{ of substance (g mol}^{-1}\text{)}}$$

$$M_r \text{ of CaCO}_3 = (40.1 \times 1) + (12.0 \times 1) + (16.0 \times 3) = 100.1$$

$$\frac{62.1}{100.1} = 0.6203796204 \text{ moles}$$

$$\text{stoichiometric ratio of CaCO}_3 : \text{CO}_2 = 1 : 1$$

$$\text{number of moles of CaCO}_3 \text{ decomposed} = \text{number of moles of CO}_2 \text{ produced}$$

$$\text{moles of CO}_2 = \frac{\text{mass of substance (g)}}{A_r \text{ or } M_r \text{ of substance (g mol}^{-1}\text{)}}$$

$$M_r \text{ of CO}_2 = (12.0 \times 1) + (16.0 \times 2) = 44.0$$

$$\frac{16.5}{44.0} = 0.375 \text{ moles}$$

$$\text{percentage decomposition} = \frac{\text{actual number of moles decomposed}}{\text{theoretical number of moles decomposed}} \times 100$$

$$\frac{0.375}{0.6203796204} \times 100 = 60.4468599$$

$$\text{percentage decomposition} = \mathbf{60.4\% (3 \text{ s.f.})}$$

4. 4.745 g of bromomethane ( $\text{CH}_3\text{Br}$ ) reacted with an excess of sodium hydroxide. The percentage yield of the reaction is 93.1%.



What is the mass of methanol ( $\text{CH}_3\text{OH}$ ) produced?

A. 1.09 g ☐

B. 1.49 g ☒

C. 1.93 g ☐

D. 2.04 g ☐

**Working:**

$$\text{moles of CH}_3\text{Br} = \frac{4.745}{94.9} = 0.05$$

$$\text{theoretical yield of CH}_3\text{OH} = 0.05 \times 32.0 = 1.60 \text{ g}$$

$$\text{actual yield} = \frac{93.1}{100} \times 1.60 = 1.4896 \text{ g} = \mathbf{1.49 \text{ g (3 s.f.)}}$$