

Reacting masses and gas volumes

Learning objectives

- 1 Define molar volume and explain how to use this when finding reacting volumes in a gas phase reaction.
- 2 Explain how to find the theoretical and percentage yield of a product in a reaction.
- 3 Combine writing with calculations to give a full explanation of chemical concepts.

Introduction

Atoms, molecules and formula units have different relative masses, so 10 grams of one substance can contain a very different number of these compared to 10 grams of a different substance. Therefore, in chemistry we use 'amount of substance', measured in moles, to discuss how much of a particular substance we are using, in a reaction, for example. By using moles, we can calculate the yield of a product that we expect to make, if starting with a given mass of reactant. Or, if we know how much of our product we need to make, we can work out how much reactant we should start with.

This works well for many substances, but gases are harder to weigh. We usually measure how much gas we have by finding its volume. Therefore, we need to be able to relate the volume of a gas to the number of moles that it contains.

Instructions

1. Stick the structure strip in the margin of your exercise book/paper.
2. Reflect on what you already know about reacting mass and gas volume calculations, and where you have seen the key terms before. Follow the prompts and use your knowledge to write a summary of reacting masses and gases. If you'd like more support, what other sources could you use to find the information, e.g. a textbook, online?
3. Answer the exam-style question to apply your knowledge of reacting mass and volume calculations to a new context.

Key words

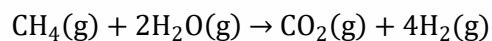
Use these key words and phrases in your responses:

- measuring cylinder • gas syringe • delivery tube • conical flask • mole
- molar volume • theoretical yield • actual yield • percentage yield

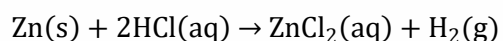
Structure strip Reacting masses and gas volumes	Structure strip Reacting masses and gas volumes	Structure strip Reacting masses and gas volumes	Structure strip Reacting masses and gas volumes	Structure strip Reacting masses and gas volumes
Describe at least one method of measuring the volume of gas produced during a chemical reaction.	Describe at least one method of measuring the volume of gas produced during a chemical reaction.	Describe at least one method of measuring the volume of gas produced during a chemical reaction.	Describe at least one method of measuring the volume of gas produced during a chemical reaction.	Describe at least one method of measuring the volume of gas produced during a chemical reaction.
Explain how to convert a volume of 150 cm ³ into dm ³ .	Explain how to convert a volume of 150 cm ³ into dm ³ .	Explain how to convert a volume of 150 cm ³ into dm ³ .	Explain how to convert a volume of 150 cm ³ into dm ³ .	Explain how to convert a volume of 150 cm ³ into dm ³ .
I have one mole each of methane and carbon dioxide. Explain what volume each will occupy at room temperature and pressure.	I have one mole each of methane and carbon dioxide. Explain what volume each will occupy at room temperature and pressure.	I have one mole each of methane and carbon dioxide. Explain what volume each will occupy at room temperature and pressure.	I have one mole each of methane and carbon dioxide. Explain what volume each will occupy at room temperature and pressure.	I have one mole each of methane and carbon dioxide. Explain what volume each will occupy at room temperature and pressure.
100 cm ³ of propane undergoes complete combustion: $\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$ Explain how you determine the volume of carbon dioxide that will be produced.	100 cm ³ of propane undergoes complete combustion: $\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$ Explain how you determine the volume of carbon dioxide that will be produced.	100 cm ³ of propane undergoes complete combustion: $\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$ Explain how you determine the volume of carbon dioxide that will be produced.	100 cm ³ of propane undergoes complete combustion: $\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$ Explain how you determine the volume of carbon dioxide that will be produced.	100 cm ³ of propane undergoes complete combustion: $\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$ Explain how you determine the volume of carbon dioxide that will be produced.
A chemist reacts 2.4 dm ³ of oxygen with magnesium. $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$ Show how you determine the theoretical yield, in grams, of magnesium oxide.	A chemist reacts 2.4 dm ³ of oxygen with magnesium. $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$ Show how you determine the theoretical yield, in grams, of magnesium oxide.	A chemist reacts 2.4 dm ³ of oxygen with magnesium. $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$ Show how you determine the theoretical yield, in grams, of magnesium oxide.	A chemist reacts 2.4 dm ³ of oxygen with magnesium. $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$ Show how you determine the theoretical yield, in grams, of magnesium oxide.	A chemist reacts 2.4 dm ³ of oxygen with magnesium. $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$ Show how you determine the theoretical yield, in grams, of magnesium oxide.
The actual yield of magnesium oxide from the reaction is 6.4 g. Determine the percentage yield.	The actual yield of magnesium oxide from the reaction is 6.4 g. Determine the percentage yield.	The actual yield of magnesium oxide from the reaction is 6.4 g. Determine the percentage yield.	The actual yield of magnesium oxide from the reaction is 6.4 g. Determine the percentage yield.	The actual yield of magnesium oxide from the reaction is 6.4 g. Determine the percentage yield.

Extended answer question

The hydrogen gas needed in the Haber process is often produced by reacting methane with steam in a gas phase reaction:



Hydrogen is also a product of the reaction between a metal and an acid, for example:



Describe how you would determine the mass of zinc and the volume of methane needed to produce 240 cm³ of hydrogen by each reaction. Explain the differences in your processes.