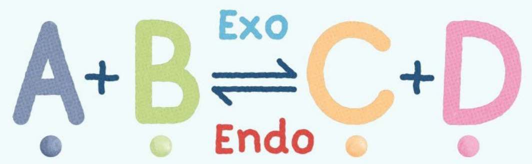
14–16 years

Reaching dynamic equilibrium: storyboard



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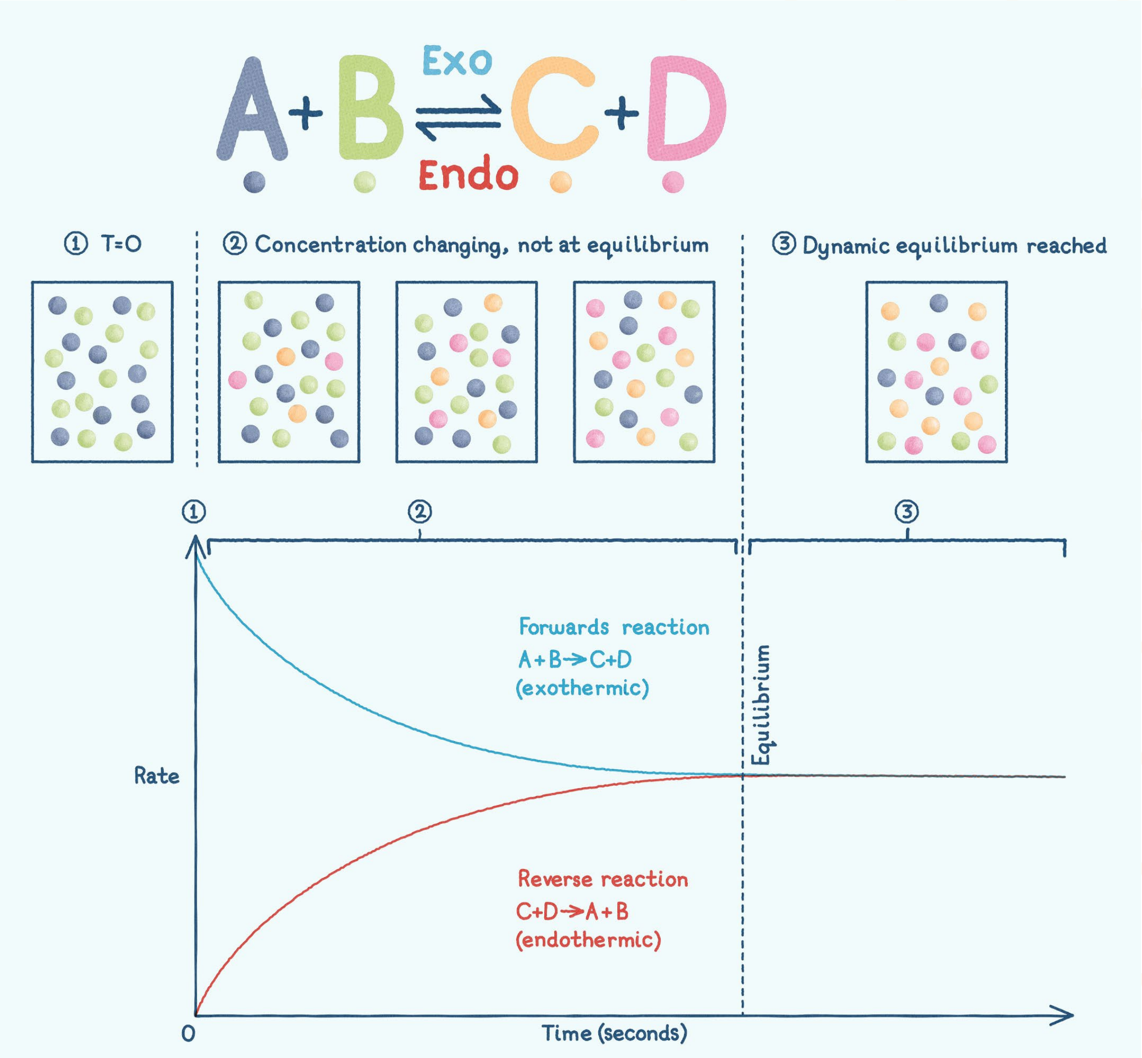
Dynamic equilibrium

Most chemical reactions you have studied so far are **irreversible**, where the reaction only takes place in one direction.

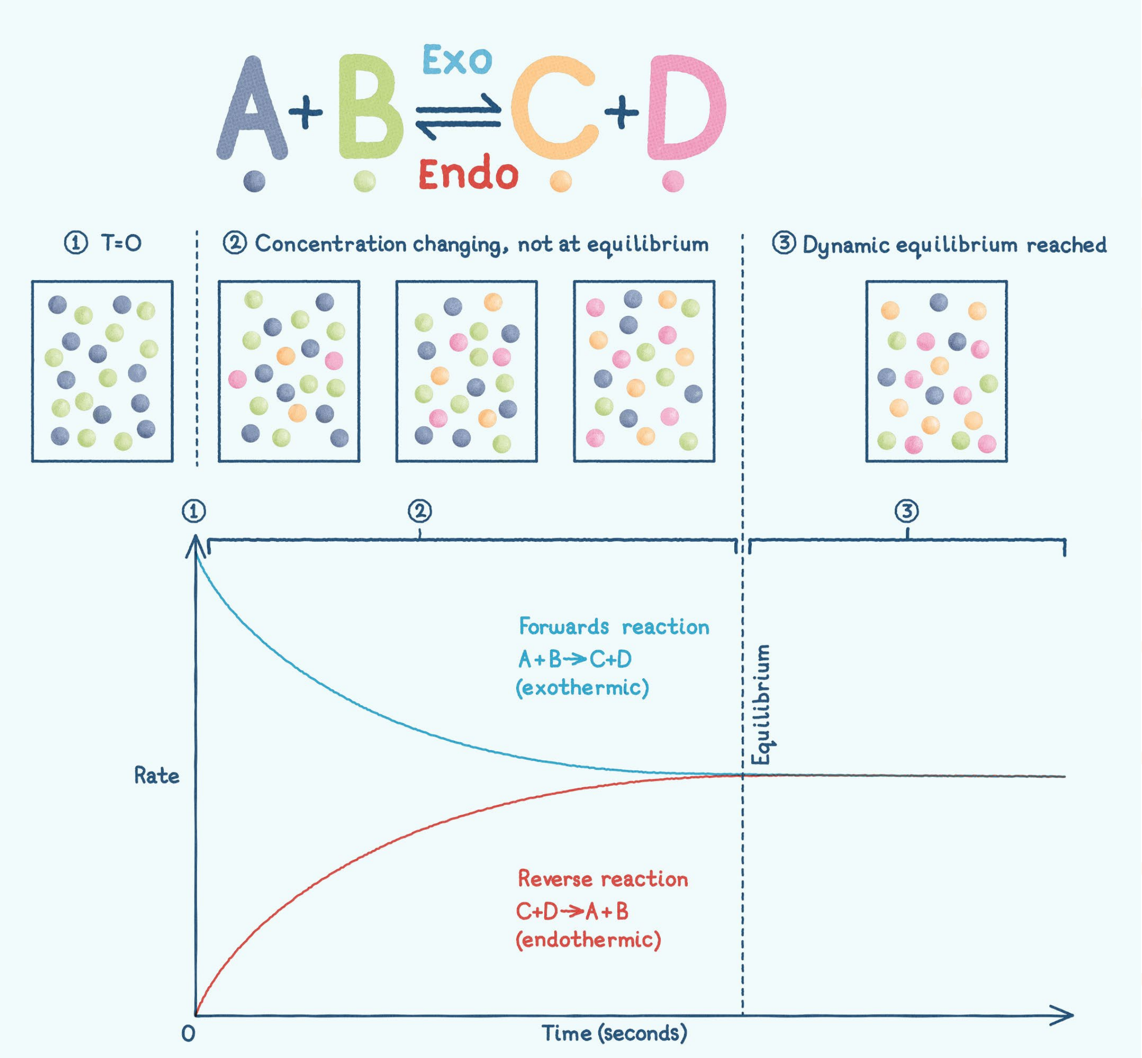
However, many chemical reactions are **reversible**: the products can react together to reform the original reactants. The **forwards reaction** and the **reverse reaction** are both occurring.



Why is equilibrium important?

In **dynamic equilibrium**, the forwards reaction and reverse reaction occur at **the same rate** in a **closed system**. The **concentrations** of substances at equilibrium are **constant**, they are not changing.

Equilibrium is an important process in industry. To make reversible reactions as **efficient and sustainable** as possible, manufacturers need to understand equilibrium. Because the **equilibrium position** – the concentrations of substances present at equilibrium – affects the **yield** of the product.



What are we going to do today?

1. State what a reversible reaction is.

2. Describe how a chemical reaction reaches dynamic equilibrium.

Learning objectives

True or false?

1. Combustion is an example of an irreversible reaction.
2. The symbol for a reversible reaction is →.
3. Products must be allowed to leave the flask in a reversible reaction.
4. A reversible reaction can only reach dynamic equilibrium in a closed system.
5. A reaction at equilibrium has stopped.
6. At equilibrium, the rate of the forwards reaction is equal to the rate of the reverse reaction.
7. If a reaction is at equilibrium, it means that all reactants have been fully converted into products.
8. A system at equilibrium will show measurable changes in the concentrations of reactants and products over time.
9. If the forwards reaction is exothermic, then the reverse reaction will be endothermic.

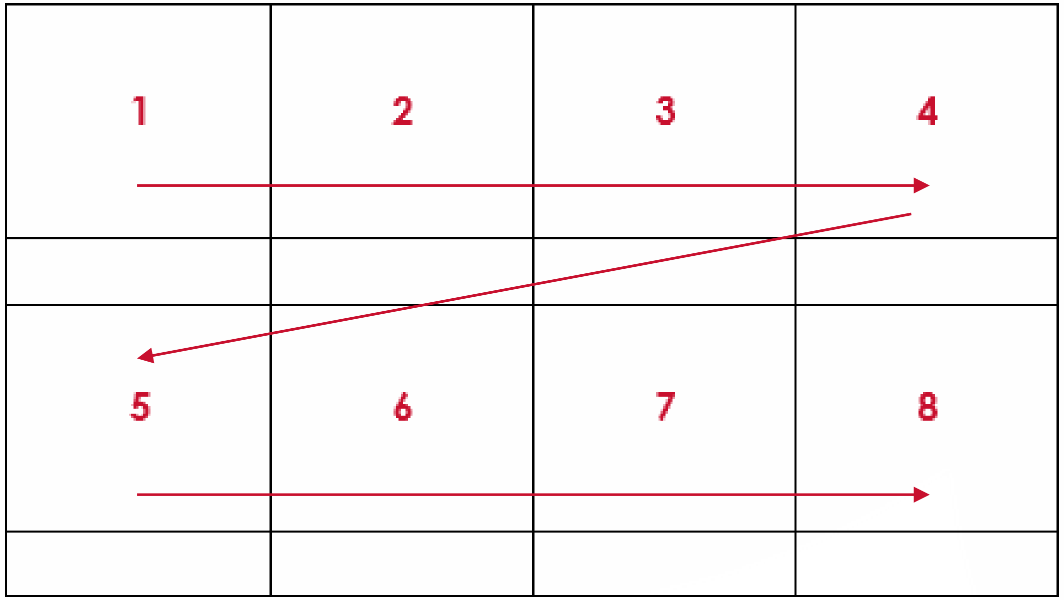
True or false?

1. Combustion is an example of an irreversible reaction. **True**
2. The symbol for a reversible reaction is →. **False**
3. Products must be allowed to leave the flask in a reversible reaction. **False**
4. A reversible reaction can only reach dynamic equilibrium in a closed system. **True**
5. A reaction at equilibrium has stopped. **False**
6. At equilibrium, the rate of the forwards reaction is equal to the rate of the reverse reaction. **True**
7. If a reaction is at equilibrium, it means that all reactants have been fully converted into products. **False**
8. A system at equilibrium will show measurable changes in the concentrations of reactants and products over time. **False**
9. If the forwards reaction is exothermic, then the reverse reaction will be endothermic. **True**

Create a storyboard

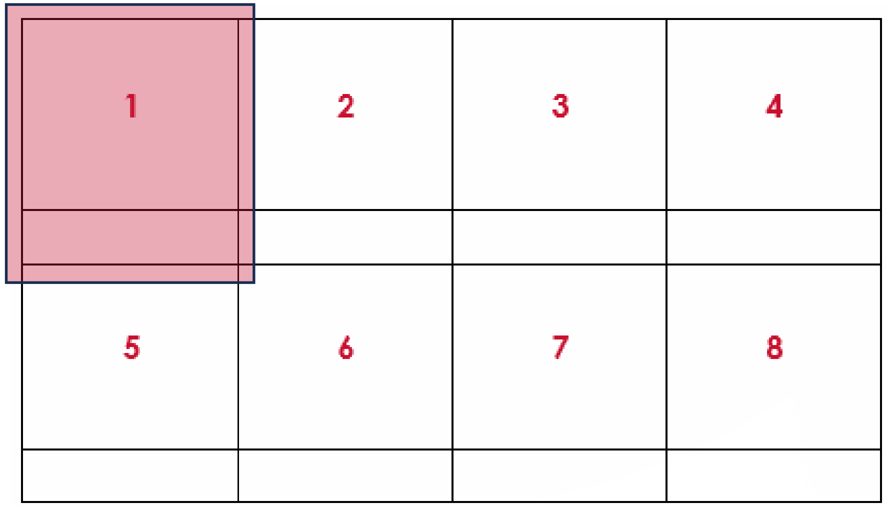
A storyboard contains an illustration with a short section of text underneath to describe what is happening in the picture.

Use the template to create a storyboard to describe how a reversible reaction becomes a dynamic equilibrium.



Instructions

Prompts: box 1



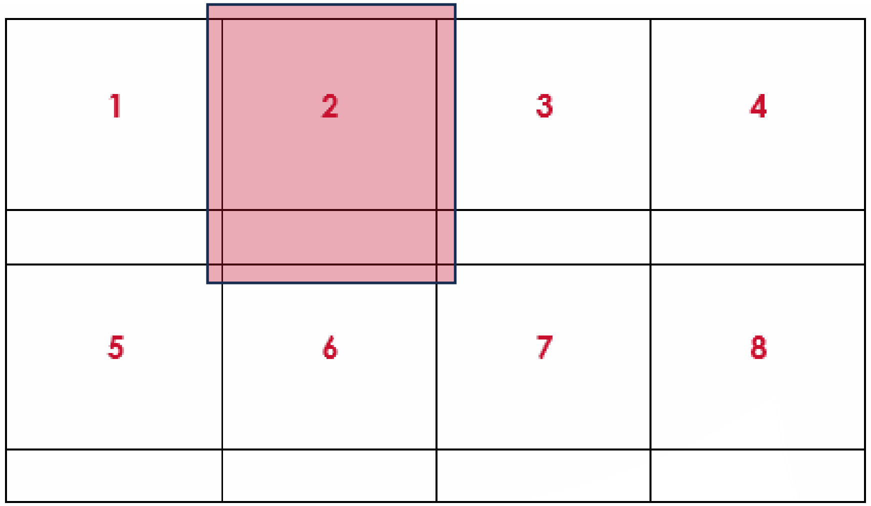
Describe a common example of an irreversible reaction.

Choose from the keywords:

carbon dioxide	irreversible
concentrations	products
equilibrium	rate
closed	escape
decrease	time
forwards	reacting
combustion	oxygen
equal	reverse
increase	reactants
reversible	open
product	

Box 1

Prompts: box 2



Explain what a reversible reaction is and write an example of one.

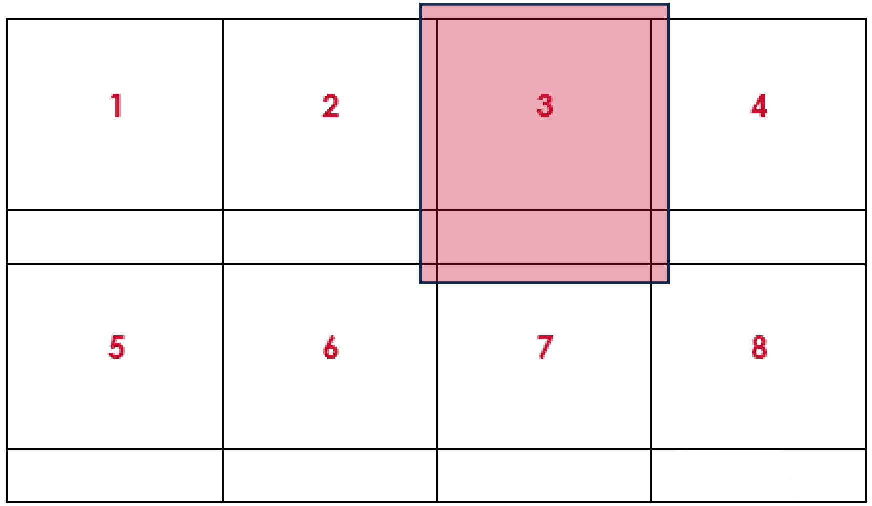
HINT: you may use letters to represent chemicals, eg A, B, C and D.

Choose from the keywords:

carbon dioxide	irreversible
concentrations	products
equilibrium	rate
closed	escape
decrease	time
forwards	reacting
combustion	oxygen
equal	reverse
increase	reactants
reversible	open
product	

Box 2

Prompts: box 3



Describe what is meant by the forwards and reverse reaction.

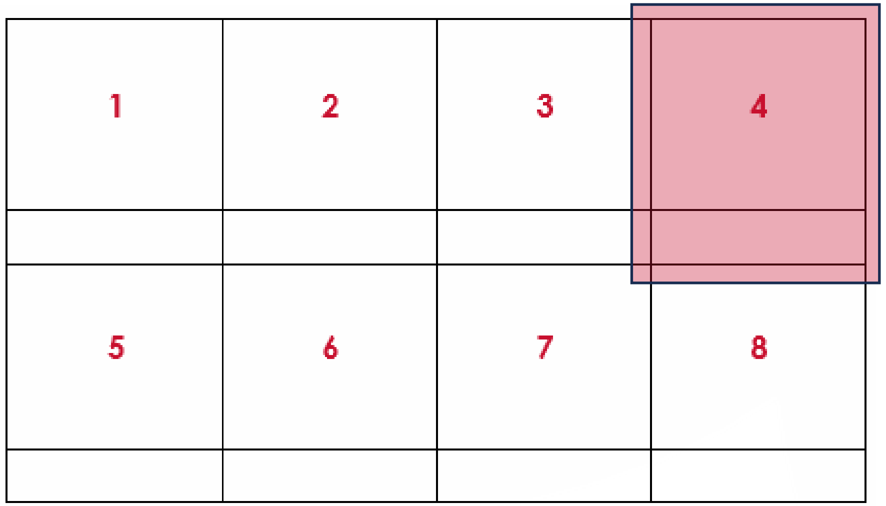
Write equations for these.

Choose from the keywords:

carbon dioxide	irreversible
concentrations	products
equilibrium	rate
closed	escape
decrease	time
forwards	reacting
combustion	oxygen
equal	reverse
increase	reactants
reversible	open
product	

Box 3

Prompts: box 4



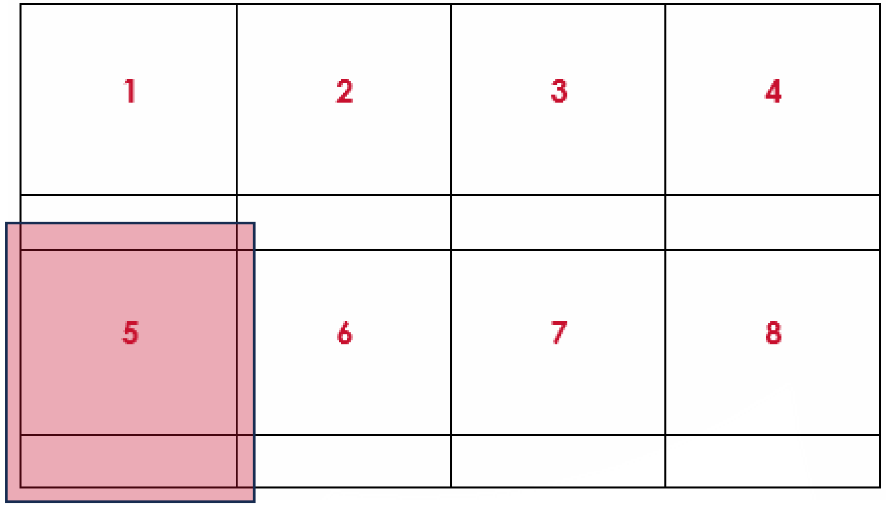
State whether dynamic equilibrium needs an open or closed system.

Choose from the keywords:

carbon dioxide	irreversible
concentrations	products
equilibrium	rate
closed	escape
decrease	time
forwards	reacting
combustion	oxygen
equal	reverse
increase	reactants
reversible	open
product	

Box 4

Prompts: box 5

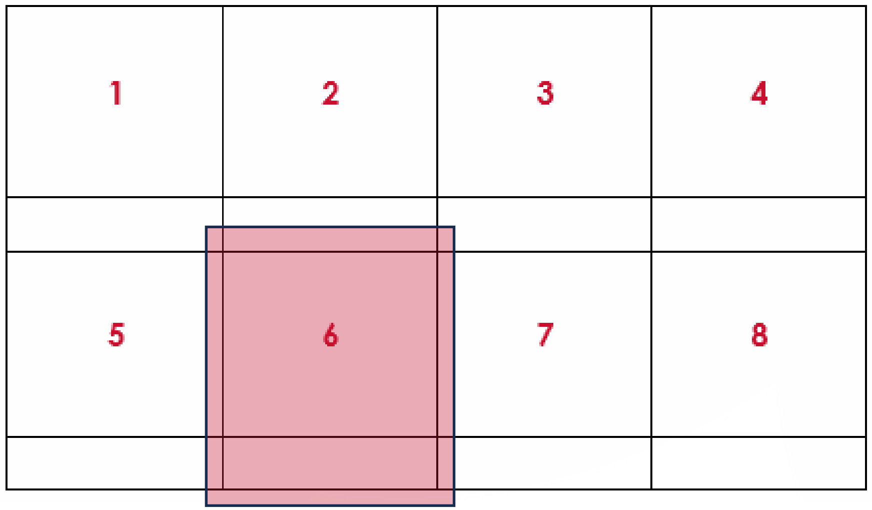


Discuss the concentrations of substances and the rate of the forwards reaction at the beginning.

Choose from the keywords:

- carbon dioxide
- concentrations
- equilibrium
- closed
- decrease
- forwards
- combustion
- equal
- increase
- reversible
- product
- irreversible
- products
- rate
- escape
- time
- reacting
- oxygen
- reverse
- reactants
- open

Prompts: box 6



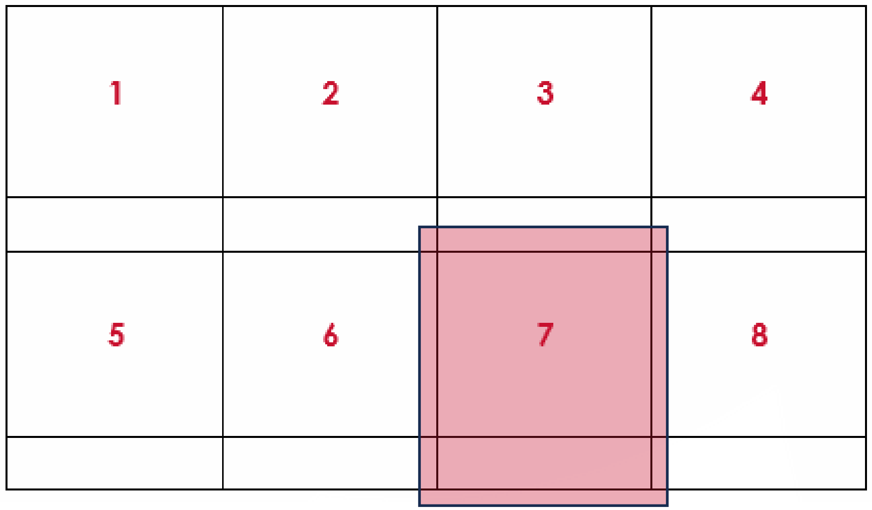
Discuss how the concentrations of substances and the rates of the forwards and reverse reaction change during the reaction.

Choose from the keywords:

carbon dioxide	irreversible
concentrations	products
equilibrium	rate
closed	escape
decrease	time
forwards	reacting
combustion	oxygen
equal	reverse
increase	reactants
reversible	open
product	

Box 6

Prompts: box 7



Describe what happens to the rates of the forwards and backwards reactions as equilibrium is reached.

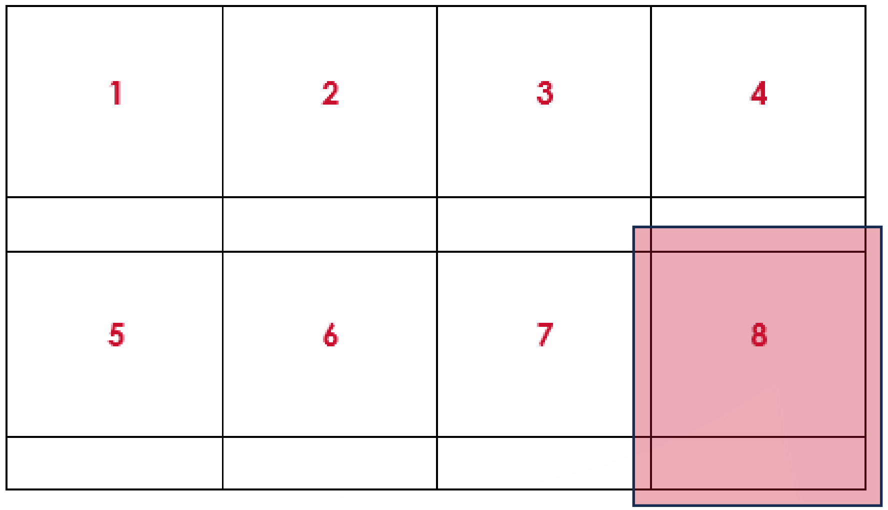
Sketch a graph to show how the rates of the forwards and reverse reaction change with time.

Choose from the keywords:

carbon dioxide
concentrations
equilibrium
closed
decrease
forwards
combustion
equal
increase
reversible
product
irreversible
products
rate
escape
time
reacting
oxygen
reverse
reactants
open

Box 7

Prompts: box 8



Describe what happens to the concentrations of substances as equilibrium is reached.

Sketch a graph to show how concentrations change from the beginning of the reaction to equilibrium being reached.

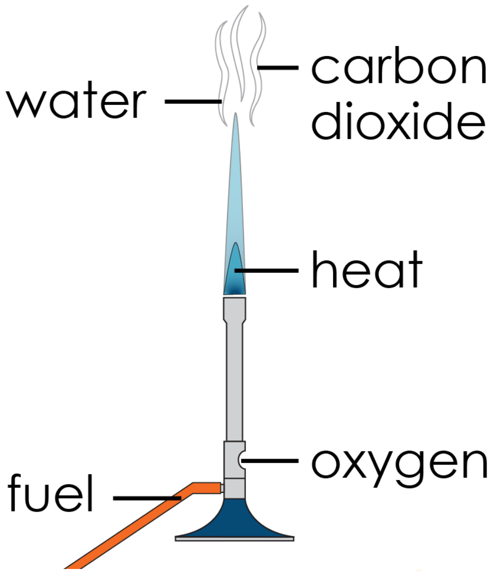
Choose from the keywords:

- carbon dioxide
- concentrations
- equilibrium
- closed
- decrease
- forwards
- combustion
- equal
- increase
- reversible
- product
- irreversible
- products
- rate
- escape
- time
- reacting
- oxygen
- reverse
- reactants
- open

Box 8

Answers: box 1

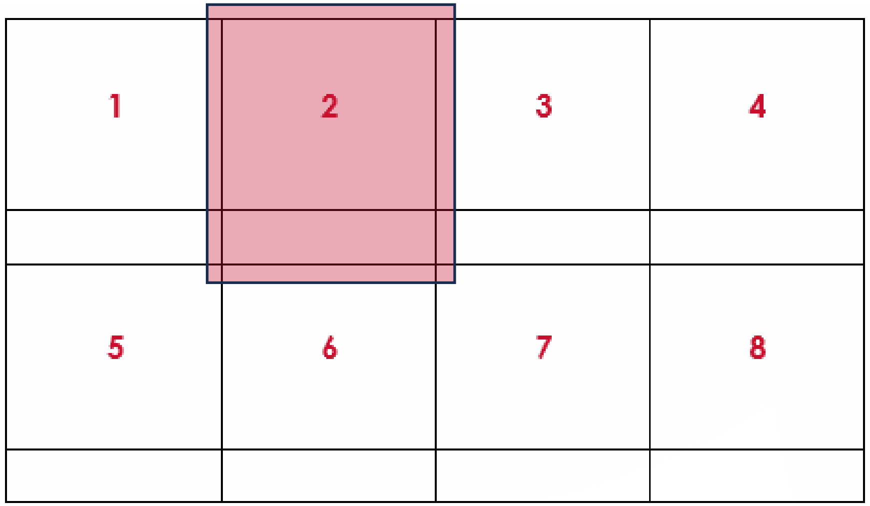
1	2	3	4
5	6	7	8

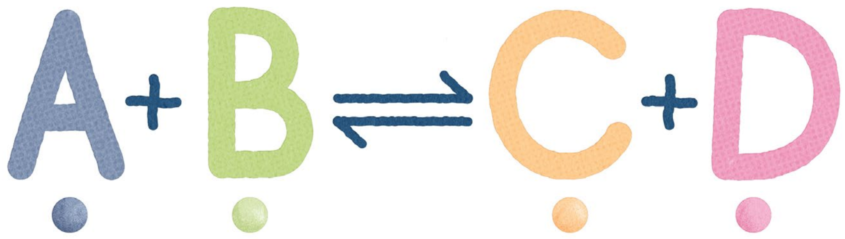


Combustion is an example of an **irreversible** reaction, where a fuel reacts with **oxygen** to form **carbon dioxide** and water.

Box 1 answers

Answers: box 2

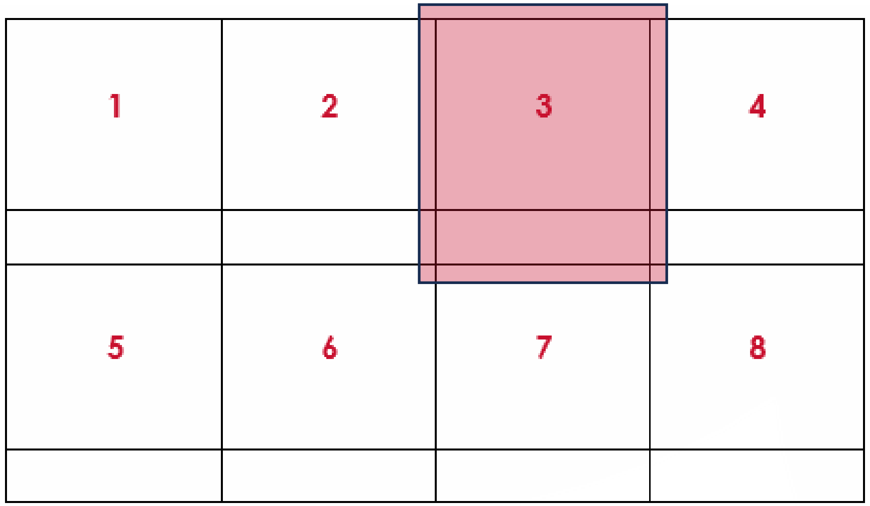




Many chemical reactions are **reversible**, where the **products** can react together to reform the original reactants.

Box 2 answers

Answers: box 3



Forwards reaction:

$A + B \rightarrow C + D$

Reverse reaction:

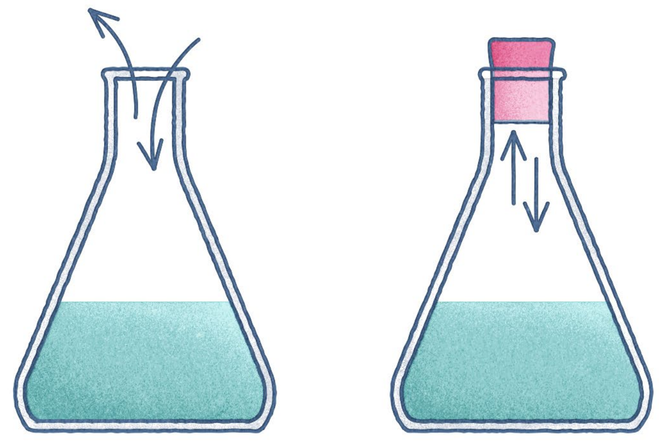
$C + D \rightarrow A + B$

In a reversible reaction, the **forwards** reaction and the reverse reaction are occurring at the same **time**.

Box 3 answers

Answers: box 4

1	2	3	4
5	6	7	8

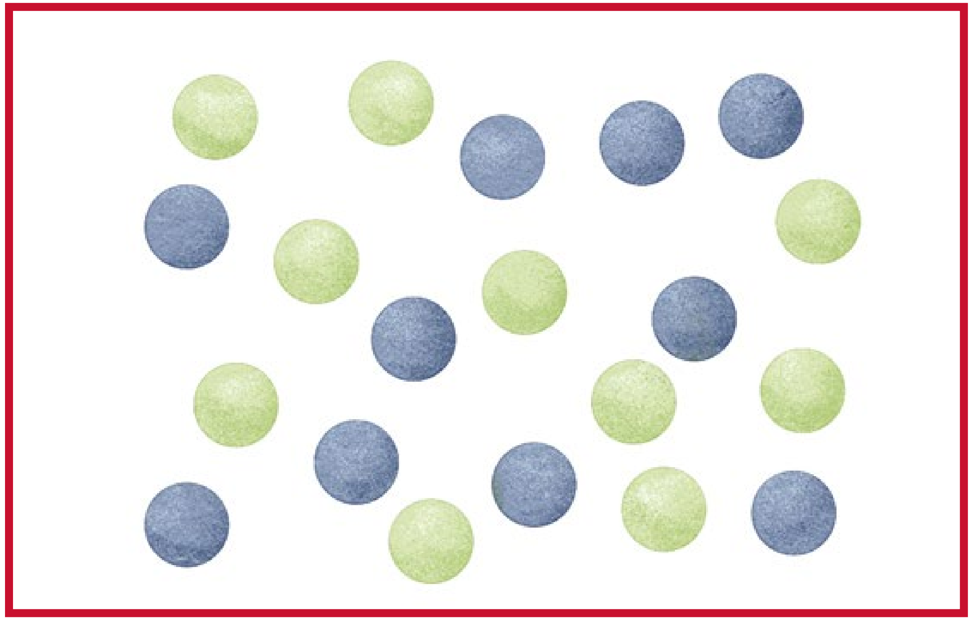


For a reversible reaction to reach equilibrium, nothing must be able to enter or **leave (escape)** the flask. This is called a **closed** system.

Box 4 answers

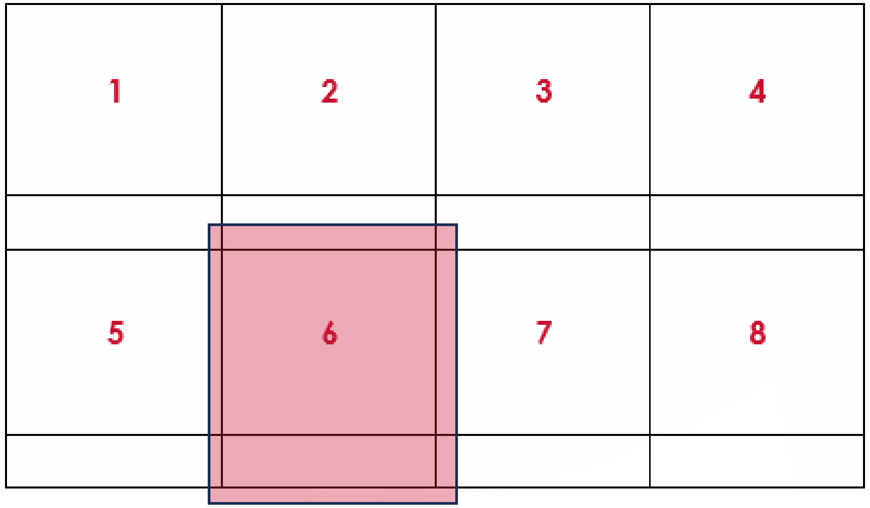
Answers: box 5

1	2	3	4
5	6	7	8



At the beginning of the reaction, the **concentrations** of A and B are at their highest, therefore the **rate** of the forwards reaction is the highest.

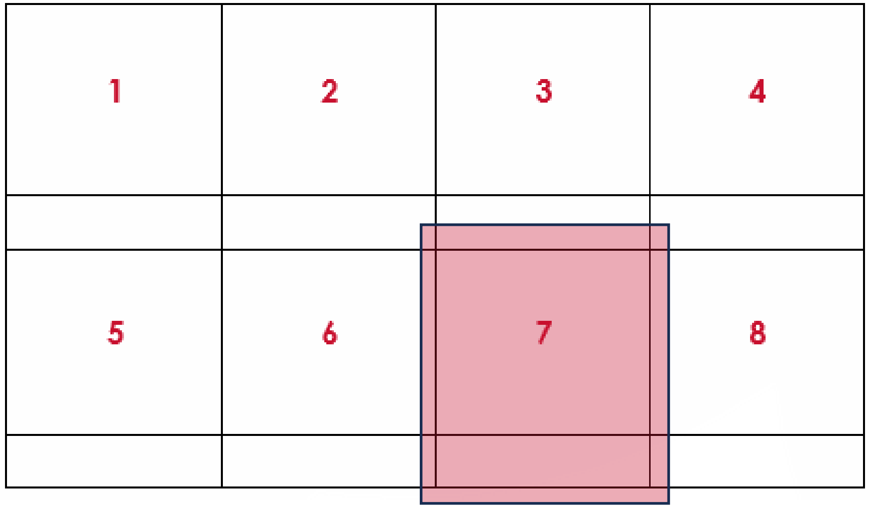
Answers: box 6

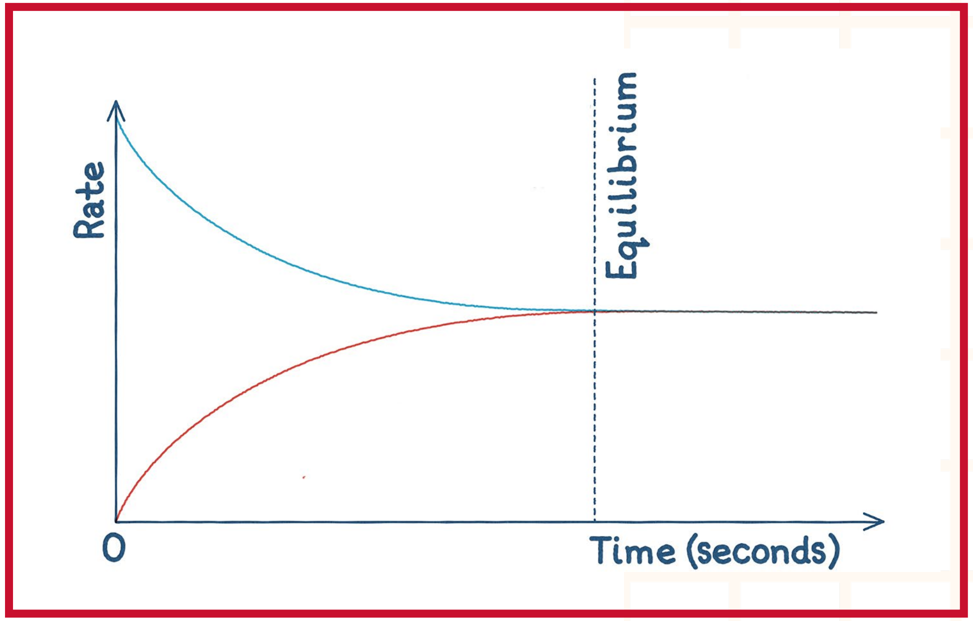


When A and B react, their concentrations **decrease**, decreasing the rate of the forwards reaction. The reaction produces C and D so their concentrations **increase**, increasing the rate of the reverse reaction.

Box 6 answers

Answers: box 7



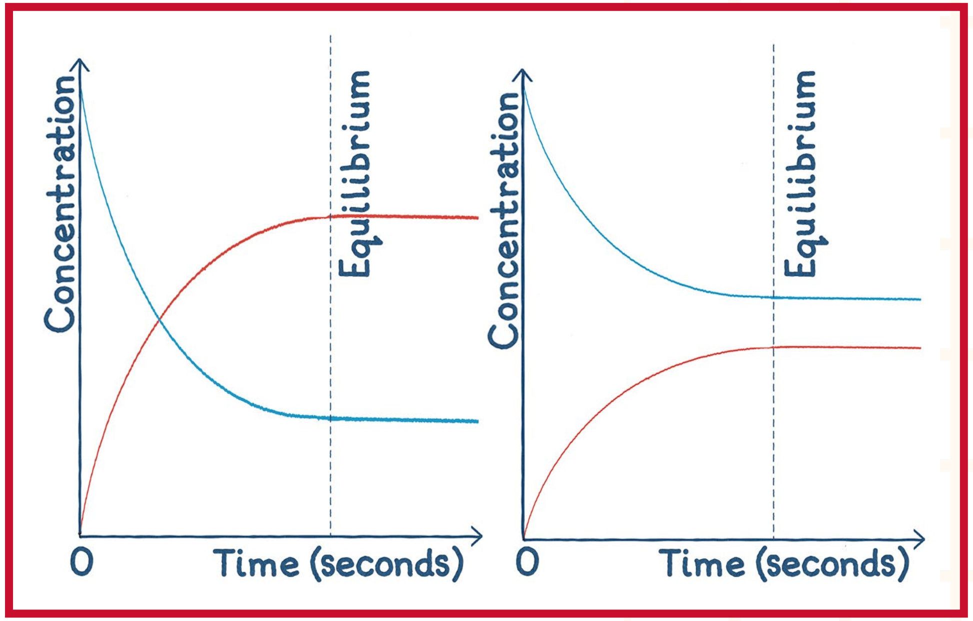


Eventually, the rates of the forwards and reverse reaction become **equal**, and **equilibrium** is reached.

Box 7 answers

Answers: box 8

1	2	3	4
5	6	7	8



Particles are still **reacting**, but as A and B react to produce C and D, another C and D react to produce A and B, maintaining a constant **concentration**.

Box 8 answers