Reaching dynamic equilibrium: storyboard

Learning objectives

1. State what a reversible reaction is.
2. Describe how a reversible chemical reaction reaches dynamic equilibrium.

Introduction

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.

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.

True or false? Checking understanding

|  |  |  |
| --- | --- | --- |
| **Q.** | **Statement** | **True or false?**  |
|  | Combustion is an example of an irreversible reaction. |  |
|  | The symbol for a reversible reaction is 🡪. |  |
|  | Products must be allowed to leave the flask in a reversible reaction. |  |
|  | A reversible reaction can only reach dynamic equilibrium in a closed system. |  |
|  | A reaction at equilibrium has stopped. |  |
|  | At equilibrium, the rate of the forwards reaction is equal to the rate of the reverse reaction. |  |
|  | If a reaction is at equilibrium, it means that all reactants have been fully converted into products. |  |
|  | A system at equilibrium will show measurable changes in the concentrations of reactants and products over time. |  |
|  | If the forwards reaction is exothermic, then the reverse reaction will be endothermic. |  |

Instructions

Create a storyboard to describe how a chemical reaction reaches dynamic equilibrium. A storyboard contains an illustration and a short section of text underneath to describe what is happening in the picture. The storyboard shows a sequence of events.

What does a storyboard look like?

Use the table to show how the stages progress:

|  |  |  |  |
| --- | --- | --- | --- |
| **1** | **2** | **3** | **4** |
|  |  |  |  |
| **5** | **6** | **7** | **8** |
|  |  |  |  |

Complete the cloze activity on the storyboard sheet. Choose from the keywords in the box below:

**Keywords**

[ ]  carbon dioxide [ ]  closed [ ]  combustion

[ ]  concentrations [ ]  decrease [ ]  equal

[ ]  equilibrium [ ]  forwards [ ]  increase

[ ]  irreversible [ ]  leave [ ]  oxygen

[ ]  products [ ]  rate [ ]  reacting

[ ]  reversible [ ]  product [ ]  time

Complete the storyboard. Use the keywords to fill in the gaps below.

|  |  |  |  |
| --- | --- | --- | --- |
| An illustration of a Bunsen burner with a blue flame. The rubber tubing is labelled 'fuel', the hole on the Bunsen is labelled 'oxygen', the base of the flame is labelled 'heat' and above the flame three white wavy lines are labelled 'water' and 'carbon dioxide'. | An illustration of the chemical equation A+B <>C+D featuring the reversible reaction symbol. The letters are coloured with a matching circle beneath each letter. A is blue, B is green, C is orange and D is pink. | Forwards reaction:**A** + **B** $\rightarrow $ **C** + **D**Reverse reaction:**C** + **D** $\rightarrow $ **A** + **B** | An illustration of two partly filled conical flasks. The flask on the left has two curved arrows - one coming into the neck of the flask and one pointing out from the neck of the flask. The flask on the right has a rubber bung. There are also two shorter straight arrows in the neck of the flask - one pointing towards the bung and the other pointing back down from the bung. |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is an example of an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ reaction, where a fuel reacts with \_\_\_\_\_\_\_\_\_\_\_\_\_ to form \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_ and water.  | Many chemical reactions are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, where the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ can react together to reform the original reactants. | In a reversible reaction, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ reaction and the reverse reaction are occurring at the same \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. | For a reversible reaction to reach equilibrium, nothing must enter or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the flask. This is called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ system. |
| An illustration of 10 blue and 10 green circles which are irregularly positioned and evenly mixed. None of the circles are touching. | An illustration of 4 blue, 4 green, 6 orange and 6 pink circles which are irregularly positioned and evenly mixed. None of the circles are touching. | An illustration of a sketch graph. The x axis is labelled 'Time (seconds)' and the y-axis is labelled 'Rate'. The origin is labelled 0. A blue line curves down from a high intercept with the y-axis and flattens out. A pink line curves up from origin and flattens out as it meets the blue line. A vertical dotted line that goes through where the two curves first meet is labelled 'Equilibrium'. | An illustration of two sketch graphs side-by-side. The x axis is labelled 'Time (seconds)' and the y-axis is labelled 'Concentration' on both graphs. The origin is labelled 0. On both graphs a blue line curves down from a high intercept with the y-axis and flattens out. On both graphs a pink line curves up from origin and flattens out. On the left hand side graph the pink line crosses the blue line and flattens out above it. On the right hand side graph the pink line flattens out below the blue line. A vertical dotted line that goes through where the gradient of both lines flattens to zero is labelled 'Equilibrium'. |
| At the beginning of the reaction, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of A and B are at their highest, therefore the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the forwards reaction is the highest. | When A and B react, their concentrations \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ , decreasing the rate of the forwards reaction. The reaction produces C and D, so their concentrations \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, increasing the rate of the reverse reaction. | Eventually, the rates of the forwards and reverse reaction become \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is reached. | Particles are still \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, but as A and B react to produce C and D, another C and D react to produce A and B, maintaining a constant \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. |

Use the keywords to fill in the gaps below. Choose the illustration from the support sheet.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is an example of an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ reaction, where a fuel reacts with \_\_\_\_\_\_\_\_\_\_\_\_\_ to form \_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_ and water.  | Many chemical reactions are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, where the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ can react together to reform the original reactants. | In a reversible reaction, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ reaction and the reverse reaction are occurring at the same \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. | For a reversible reaction to reach equilibrium, nothing must be able to enter or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ the flask. This is called a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ system. |
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Support sheet

Use these images to complete the storyboard. You will need to put them into the correct order in the sequence.





Forwards reaction:

**A** + **B** $\rightarrow $ **C** + **D**

Reverse reaction:

**C** + **D** $\rightarrow $ **A** + **B**

