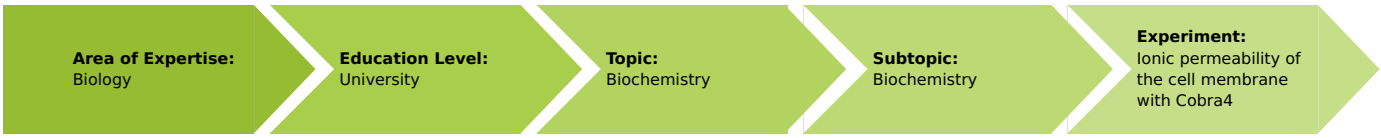
Ionic permeability of the cell membrane with Cobra4

(Item No.: P4120260)

Curricular Relevance



Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	40 Minutes	2 Students

Additional Requirements:

- Android tablet or iPad
- PHYWE measure App

Experiment Variations:

- with Computer with USB port, Windows

Keywords:

Ionic permeability, Artificial cell membrane, Dialysis tube, H^+ ions, OH^- ions, Osmotic processes

Overview

Principle

The cell membrane controls the transport of nutrients and water into the cell as well as the transport of waste products and water out of the cell. This can be passive, i.e. caused by osmotic processes, as well as active. The aim of this experiment is to examine the selective permeability of an artificial membrane (dialysis tube) with regard to H^+ and OH^- ions.

Fig.1: Experimental setup

Equipment

Experiment with Cobra4 Wireless/USB-Link with Android tablet or iPad

Position No.	Material	Order No.	Quantity
2	Cobra4 Wireless/USB-Link incl. USB cable	12601-10	1
3	Cobra4 Sensor-Unit pH, BNC connector	12631-00	1
4	pH-electrode, plastic body, gel, BNC	46265-15	1
5	digital magnetic stirrer with heating, stainless steel, 280 °C, 100-1500 rpm	FHO-RSM10HS	1
6	Magnetic stirring bar 30 mm, cylindrical	46299-02	1
7	Separator for magnetic bars	35680-03	1
8	Retort stand, h = 750 mm	37694-00	1
9	Boss head	02043-00	2
10	Universal clamp	37715-00	2
11	Graduated cylinder 25 ml	36627-00	1
12	Funnel, glass, top dia. 55 mm	34457-00	1
13	Wash bottle, plastic, 500 ml	33931-00	1
14	Beaker, high, BORO 3.3, 250 ml	46027-00	2
15	Beaker, high, BORO 3.3, 50 ml	46025-00	2
16	Dialysis tubing 24A,diam.44mm, 1m	64208-00	1
17	Dialysis clips, 2	64209-00	2
18	Disposable gloves, 100pcs,medium	46359-00	1
19	Buffer solution tablets pH4, 100	30281-10	1
20	Buffer solution tablets pH10, 100	30283-10	1
21	Hydrochloric acid, 1.0 mol/l, 1000 ml	48454-70	1
22	Caustic soda solution, 1.0 m, 1000 ml	48329-70	1
23	Water, distilled 5 l	31246-81	1
24	USB charger for Cobra4 Mobile-Link 2 and Wireless/USB-Link	07932-99	1
Additional material:			
	Android tablet or iPad		
	PHYWE measure App		

Android iPad

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Experiment with Cobra4 Wireless/USB-Link and PC

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Additional material:			
	Computer with USB port, Windows		

Task

- Examine the selective permeability of an artificial membrane (dialysis tube) with regard to H^+ and OH^- ions.

Safety information

Depending on the concentration, sodium hydroxide solutions have a strong corrosive or irritating effect on the skin, eyes, and mucous membranes. Sodium hydroxide fog irritates the respiratory organs. Chemical burns lead to the destruction of tissue and severe pain. Keep away from children.
Depending on the concentration, hydrochloric acid has a strong corrosive or irritating effect. Hydrochloric acid fog irritates the respiratory organs, in particular the mucous membranes and upper respiratory tract. Concentrated acids destroy the skin and textiles.
Do not breathe in any vapours (fog). Avoid contact with the skin. Wear suitable protective clothing, gloves, and goggles when working with these substances.
First aid: Immediately flush the skin with plenty of water. If the eyes are affected, flush them immediately with plenty of water while keeping the eyes open. In the event of eye injuries, seek medical attention immediately. In the event of an accident or if the affected person does not feel well, seek medical attention immediately. Inhalation: Provide fresh air and keep the respiratory tracts clear. If breathing proves difficult, transport the affected person in a semi-sitting position to a doctor.
Disposal: Dilute the solution with water, neutralise it (pH 6-8), and flush it away.

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Ionic permeability of the cell membrane with Cobra4 (Item No.: P4120260)

Overview

Task

- Examine the selective permeability of an artificial membrane (dialysis tube) with regard to H^+ and OH^- ions.

Fig.1: Experimental setup

Equipment

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Android iPad

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Disposal: Dilute the solution with water, neutralise it (pH 6-8), and flush it away.

Set-up and procedure

Set-up

Preparation of an artificial cell (bag made of a dialysis tube):

- Cut two pieces of approximately 15 cm off the dialysis tube and seal them at one end with a dialysis clip. *Tip*: If the dialysis tube is difficult to open, soften it briefly in distilled water.
- Place one bag made of the dialysis tube into a 250 ml beaker and fill in 15 ml of hydrochloric acid (1mol/l) with the aid of the graduated cylinder. Caution: Wear protective gloves! Then, seal the bag with a dialysis clip, clean it on the outside with distilled water, and place it on a clean surface.
- Fill the second bag with a sodium hydroxide solution (1 ml/l) in the same way. Clean the 250 ml beaker beforehand! Ensure that the two bags do not touch each other!

- Set up the equipment as shown in Fig. 1.
- Connect the pH electrode to the corresponding port of the Cobra4 Sensor-Unit pH.
- Connect the Cobra4 Sensor-Unit "pH" with the Wireless/USB-link.
- Switch Cobra4 Wireless/USB-link on ( ). Connect your tablet via WiFi with the Wireless/USB-link (maximum range 50m). Open the PHYWE measure App and select the sensor "pH".

Fig. 2: Select the sensor "pH"

Fig. 3

Procedure

- **Calibrate the pH electrode:**
  To do so, fill the two buffer solutions into two 50 ml beakers and proceed in the app as follows:

  - go to "Configuration" (fig. 4)
  - then go to (scroll down if necessary) "Calibration" (fig. 4)
  - Click on the value (fig. 5)

  If the electrode has already been calibrated recently, a new calibration is not necessary.

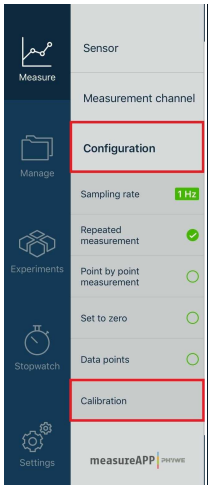

Fig. 4

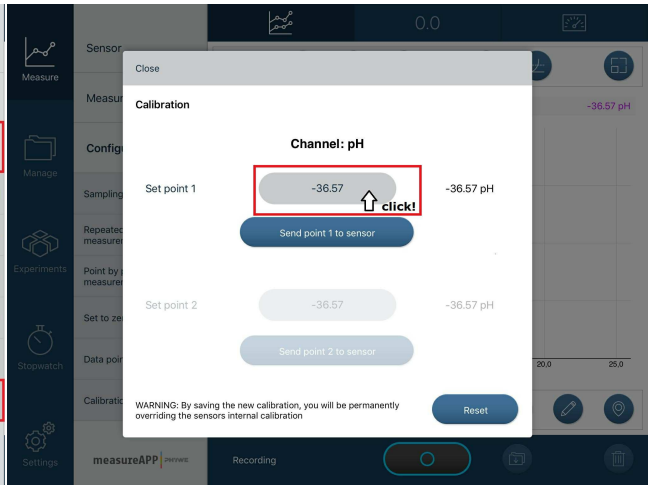

Fig. 5

- Repeat the procedure for the second value (set point 2).

- Fasten the universal clamps with the bosshead to the support rod of the retort stand.
- Place a magnetic stirring bar into a 250 ml beaker, fill in approximately 150 ml of distilled water, and place the beaker on the magnetic stirrer.
- Attach the pH electrode with one of the universal clamps to the setup so that it is completely immersed in the distilled water.
- Set the stirrer to a medium stirring speed (*Caution*: The magnetic stirring bar must never hit the pH electrode!).
- Start the measurement  .
- Approximately 20 seconds after the start of the measurement, lower the dialysis bag filled with hydrochloric acid into the beaker and fasten it with the second universal clamp.
- The time course of the reaction can be observed on screen. (runtime about 60 minutes; Stop: )
- Save the data after the measurement.

Repeat the measurement with the dialysis bag filled with the sodium hydroxide solution (wash the beaker, pH sensor, and the magnetic stirring bar thoroughly with distilled water beforehand).

Theory and evaluation

The figures show the pH-time-curves for hydrochloric acid and sodium hydroxide solution as they are displayed by the program after the end of the measurement.

Due to the release of H^+ ions, the pH in the beaker decreases, whereas it increases following the release of OH^- ions. The speed at which the pH changes can be evaluated with the aid of the measurement function .

If you use distilled water instead of demineralised water – as was carried out for this experiment description – the pH may be higher. You can increase the pH even more by boiling the water. This releases carbon dioxide dissolved in the water.

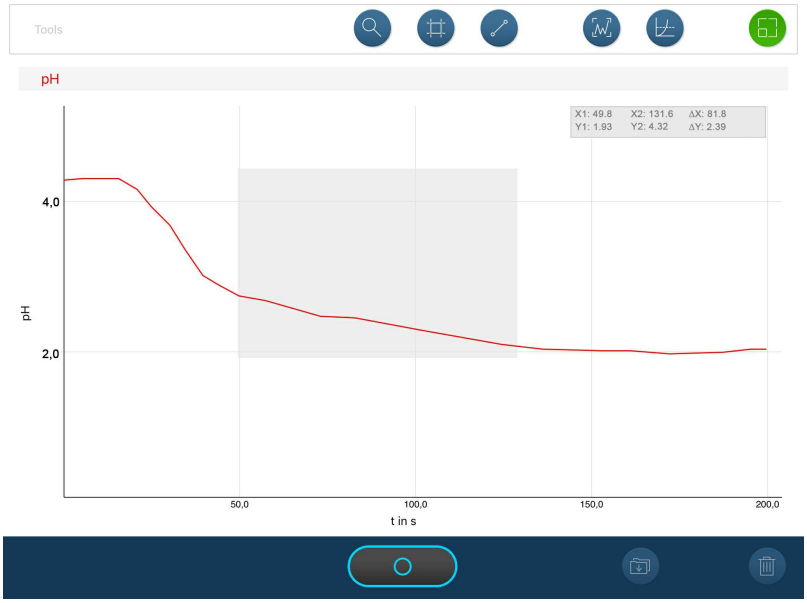

Fig. 6: pH-time-curve showing the release of H+ ions

Fig. 7: pH-time-curve showing the release of OH- ions

Overview

Task

- Examine the selective permeability of an artificial membrane (dialysis tube) with regard to H^+ and OH^- ions.

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- Fill the second bag with a sodium hydroxide solution (1 ml/l) in the same way. Clean the 250 ml beaker beforehand! Ensure that the two bags do not touch each other!

- Set up the equipment as shown in Fig. 1.
- Connect the pH electrode to the corresponding port of the Cobra4 Sensor-Unit pH.
- Connect the Cobra4 Sensor-Unit "pH" with the Cobra4 Wireless/USB-link.
- Switch on the Cobra4 Wireless/USB-Link ( ). Connect your computer via WiFi with the Wireless/USB-link (maximum range 50m) or attach the Cobra4 device to the computer with the USB cable.
- Start the software . The Cobra4 measuring device will be automatically detected.

  Choose the experiment from the start screen by selecting `Load Experiment`. Accordingly, choose “PHYWE experiments”, search for “P4120260”, and select desired folder containing the experiment. All necessary presetting will be loaded.

Procedure

- **Calibrate the pH electrode:**
  To do so, use the buffer tablets for the two pH values to perform two-point calibrations.
  If the electrode has already been calibrated recently, a new calibration is not necessary.

  Go to settings and select pH Sensor. Click on Calibration (Fig. 3) and perform a 2-point calibration by using two buffer solutions, e.g. pH 4.0 and pH 10.0 (Fig. 4).

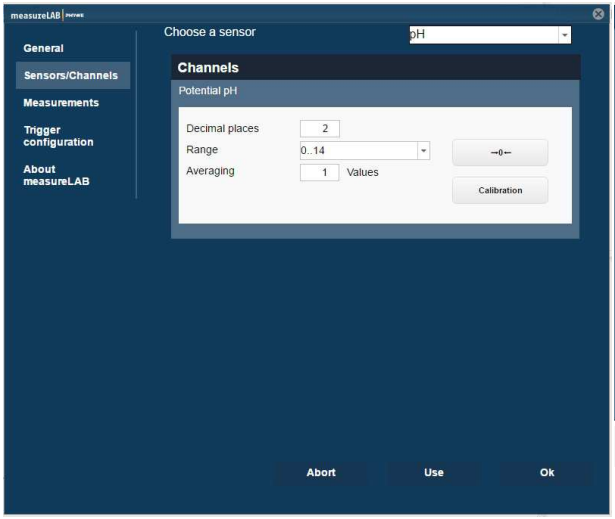

Fig. 3: pH calibration

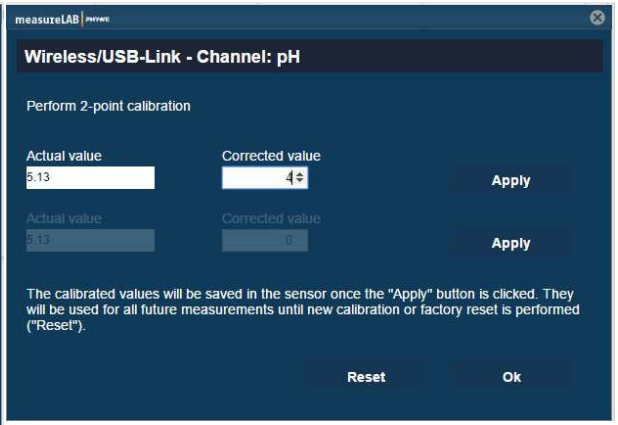

Fig. 4: pH Calibration (Correction of values)

- Fasten the universal clamps with the bosshead to the support rod of the retort stand.
- Place a magnetic stirring bar into a 250 ml beaker, fill in approximately 150 ml of distilled water, and place the beaker on the magnetic stirrer.
- Attach the pH electrode with one of the universal clamps to the setup so that it is completely immersed in the distilled water.
- Set the stirrer to a medium stirring speed (*Caution*: The magnetic stirring bar must never hit the pH electrode!).
- Start the measurement .
- Approximately 20 seconds after the start of the measurement, lower the dialysis bag filled with hydrochloric acid into the beaker and fasten it with the second universal clamp.
- The time course of the reaction can be observed on screen. (runtime about 60 minutes; Stop:)
- Save the data after the measurement.

Repeat the measurement with the dialysis bag filled with the sodium hydroxide solution (wash the beaker, pH sensor, and the magnetic stirring bar thoroughly with distilled water beforehand).

Theory and evaluation

Result and evaluation

The figures show the pH-time-curves for hydrochloric acid and sodium hydroxide solution as they are displayed by the program after the end of the measurement.

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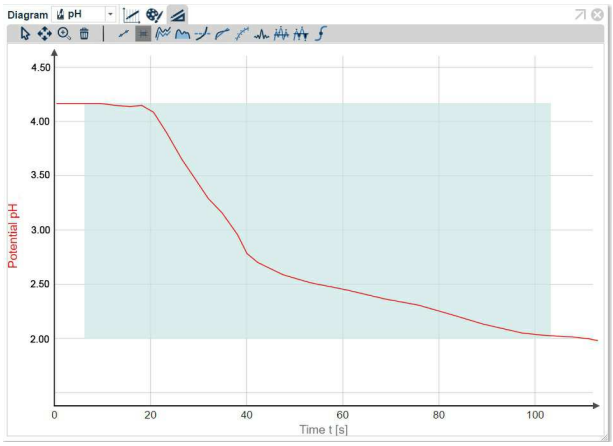

Fig. 2: pH-time-curve showing the release of H+ ions

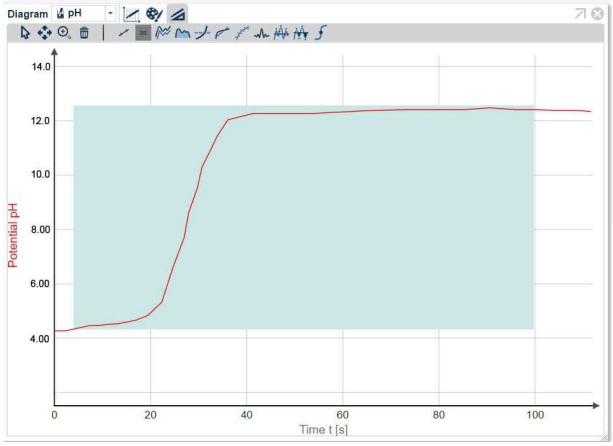

Fig. 3: pH-time-curve showing the release of OH- ions

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