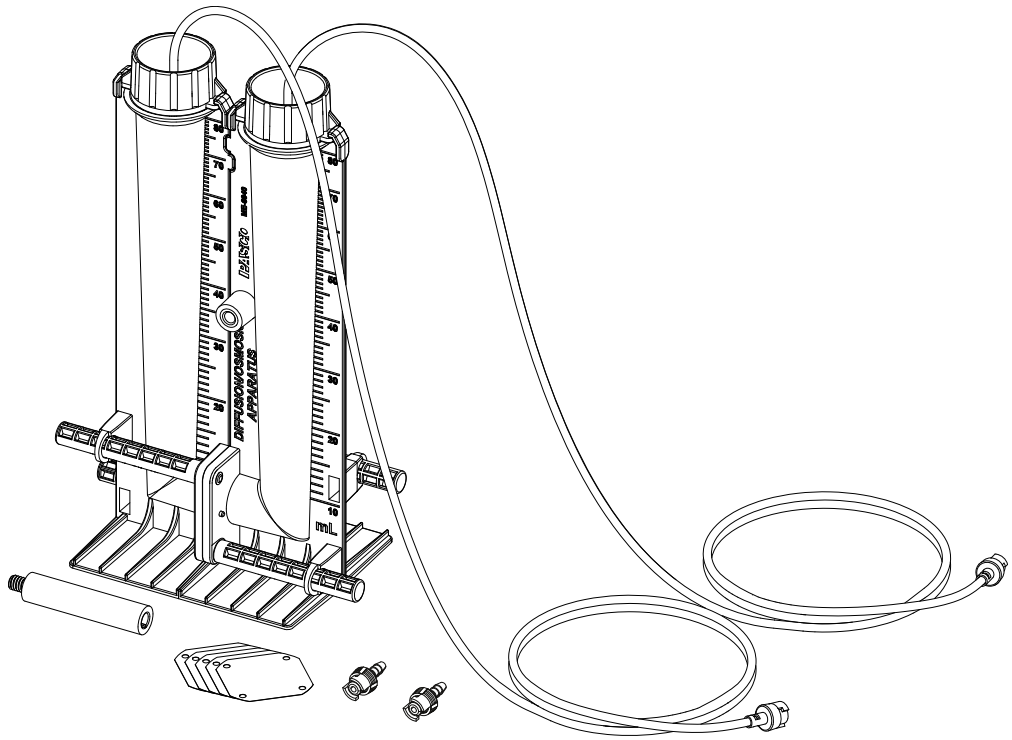
Diffusion-Osmosis Apparatus

ME-6940



What's included

- Diffusion-Osmosis apparatus
- 2× Coupling connectors
- Sensor mounting stud
- 20× Semipermeable membranes

Introduction

Open any biology textbook to the osmosis section and you will find the image of a U-shaped tube composed of two clear columns separated by a semipermeable membrane. This classic figure is the most commonly used model to visualize the osmotic movement of water due to a concentration gradient. PASCO's Diffusion-Osmosis Apparatus is a U-shaped apparatus consisting of two cylinders separated by a semipermeable membrane. The transparent, graduated cylinders allow students to observe and measure volume changes due to osmosis. In conjunction with pressure sensors, the apparatus allows students to measure the changes in pressure and volume caused by the osmotic movement of water across a semipermeable membrane. Using other sensors like conductivity, pH, carbon dioxide gas, or oxygen gas, students can explore the diffusion of molecules across the semipermeable membrane.

About the membrane

- The membrane is a regenerated cellulose membrane preserved in glycerol.
- To conserve moisture, membranes should be stored in an airtight, moisture-proof container in a cool location. If the membranes are not stored correctly, they can dry out, lose flexibility, and develop microscopic holes that alter expected experimental results.
- Tension on the membrane in one direction can reduce pore size slightly. Tension on the membrane in both directions can increase pore size slightly.
- Membranes cannot be reused if they are allowed to dry out. Drying causes unrecoverable collapse of the pore structure.
- Membranes are resistant to water solutions of salts, alcohols, and dilute solutions of vinegar.
- Membranes aren't resistant to >25% hydrochloric, nitric or perchloric acids, 96% sulfuric acid, 1 M potassium hydroxide, and 10% phenol.

Maintenance and care

- Don’t use the apparatus with strong bases (hydroxide solutions), halogenated hydrocarbons, ketones, esters, and solvents containing nitrogen.
- Always disassemble the apparatus after an experiment. Empty all fluid from the cylinders and separate the two cylinders to remove the membrane. Rinse the inside and outside of the cylinders, the O-rings, and the area around the O-rings. Use cool, warm, or hot water. You may also use soap, but it isn’t necessary. Dry the rinsed pieces of the apparatus on a paper towel or drying rack.
- Reassembling the apparatus (without a membrane) for long-term storage will help to ensure that all of the pieces stay together.
- The columns are dishwasher-safe but be sure to remove the O-rings first. Do not put the blue caps and plastic tubing in the dishwasher.

Safety

- Be careful when removing the caps from the columns as pressure may have built up during your experiment.
- Protect your eyes by wearing protective eyewear. Do not lean over the apparatus if pressure has accumulated, or when removing the caps.
- Pressure in the columns can be as great as 20 psi.

Using the Apparatus

Required equipment

- Pressure sensors

  Use either a PASPORT Dual Pressure Sensor or two Wireless Pressure Sensors.
- Testing solutions
- Distilled water

Prepare the membrane and solutions

1. Soak a membrane in distilled water at room temperature for at least 30 minutes to remove the preservative on the membrane. Rinse the membrane thoroughly with distilled water.

   > ✔ NOTE
   >
   > Do not allow the membrane to dry out.

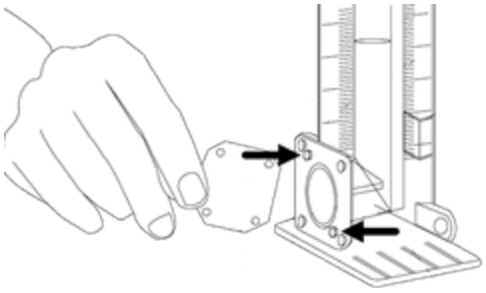
2. Prepare the solutions necessary for your experiment. All solutions must be at room temperature before starting the experiment.

Assemble the apparatus

1. Unscrew the four bolts and separate the two cylinders.

   > ✔ NOTE
   >
   > The apparatus needs to be clean and dry.

2. Line up two of the four corner holes on the soaked membrane with the two raised pegs on one of the cylinders. It does not matter which cylinder you put the membrane on.
3. Carefully place the other cylinder against the membrane so that the two raised pegs on the second cylinder goes into the two membrane holes.

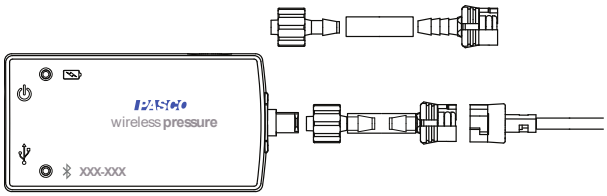
   Check that:

   - the membrane is securely in place between the two O-rings and pulled tightly across the space, with no folds or gaps.
   - all four raised pegs are inserted into the membrane holes.
   - the two alignment tabs near the top of the cylinders are aligned.
4. Screw in the four bolts quickly and carefully. Ensure that they are tight. The two cylinders should be tightly secured to each other, with the membrane separating the space between the two cylinders.

   > TIP
   >
   > Label the two cylinders with a sticker or marker. This will help reduce confusion if the solutions are similar in color.

Assemble the Wireless Pressure Sensor adapters

This procedure is only required if you’re using Wireless Pressure Sensors. The Diffusion-Osmosis Apparatus includes two Coupling Connectors for assembling an adapter that connects the Wireless Pressure Sensors to the apparatus.



1. Attach a male Luer connector to a short piece of plastic tubing. Both of these items are included with the Wireless Pressure Sensor.
2. Attach a Coupling Connector to the other end of the tube.
3. Repeat the process to make another adapter for the other Wireless Pressure Sensor.

The Coupling Connector attaches to the Quick-Release Connector on the thin tubing of the Diffusion-Osmosis Apparatus.

Set up the sensors

1. Connect the sensors to SPARKvue or PASCO Capstone.
2. Select the **Diffusion-Osmosis** Quick Start experiment.
3. Reduce the sampling rate to 1 or 2 samples per minute. Reducing the sampling rate is necessary to prevent data overload.
4. Attach the quick-release connectors at the ends of the two plastic tubes to the pressure sensors.

Fill the cylinders

1. Pour the required amount of solution into the first cylinder. Tilt the apparatus in all directions, being careful not to spill, to allow any bubbles in the bottom of the cylinder to escape.
2. Repeat the previous step with the second cylinder. If you expect the volume within the cylinder to increase during your experiment, do not fill the cylinder with greater than 60 mL of solution. This prevents the solution from overflowing, or entering the plastic tubing and damaging the sensor.
3. Place the blue cap into the first cylinder, press it down, then turn the cap to seal the cylinder.
4. Repeat the previous step with the second cylinder.
5. Allow the system to equilibrate for five minutes before beginning data collection
6. Begin data recording. Allow the processes of diffusion and osmosis to occur within the apparatus undisturbed. Leave the setup in a location where the ambient temperature will remain relatively constant.

Experiment suggestions

- Observe the osmotic movement of water without observing pressure changes by filling the columns with solutions of varying solute concentration. As long as the solute does not cross the membrane, you will observe the volume of change. Examples of substances that are too large to cross the membrane include disaccharides (Sucrose), polysaccharides (Starch), and proteins. Examples of substances that are small enough to cross the membrane include monosaccharides (Glucose), ions (Na^+, Cl^-, protons), and Gases (CO_2, O_2).
- Explore the concept of semi-permeability by observing the movement of solutes across the membrane. Fill one column with distilled water and the other column with pickle juice. Test the initial conductivity, pH, and blue absorbance of the water and pickle juice. After 45-60 minutes, measure the final conductivity, pH, and absorbance of the fluids to determine whether salts, acetic acid, and yellow dye diffused across the membrane.
- Determine the size of solute molecules by comparing their rate of diffusion across the membrane.
- Add a few grams of dry yeast and a few grams of sugar to 50 mL of distilled water to create an activated yeast solution. Allow the yeast 15-20 minutes to become active. Make a 10% glucose solution by dissolving 10 g of glucose in 100 mL of water. Remember, table sugar is sucrose, not glucose! Fill column #1 with 30 mL of yeast solution and column #2 with 30 mL of glucose solution. Place the CO_2 gas sensor into column #1 and the O_2 gas sensor into column #2. Measure the increase in CO_2 and the decrease in O_2 as the glucose diffuses across the membrane and is used in the respiration of the yeast.
- Chemistry and physical science classes can use the apparatus to study the gas laws. Explore the effects of volume on pressure changes within the columns.
- Assign different student groups different 2.0 M disaccharide sugar solutions (sucrose, lactose, maltose). Add 40 mL distilled water to one column and add 40 mL sugar solution to the other column. Collect pressure data over 24 hours. Calculate the osmotic pressure that must be applied to the column with solution to prevent osmosis from occurring. The formula for osmotic pressure is $\pi = iMRT$ where

  π = osmotic pressure in kPa
  i = van 't Hoff factor (# of particles produced per unit solute dissolved)
  M = molarity of solution
  R = ideal gas constant, 8.314 L•kPa/mol•K
  T = 298 K

  Have students compare the observed volume changes, pressure changes, and calculated osmotic pressure for their own assigned solution with another group's data. Does the identity of the solution affect osmotic pressure? What if the solute was ionic such as NaCl? What do the pressure and volume results indicate about the compressibility of gases versus liquids?

AP® Biology Lab 1: Diffusion and Osmosis*

Part 1

1. Make a 15% glucose/1% starch solution using glucose test strips and iodine test for the initial presence of sucrose and starch.
2. Fill column #1 with distilled water and column #2 with the glucose/starch solution. Do not put the caps on the apparatus. Leave it open to the environment.
3. After 45-60 minutes, test again for the presence of starch and glucose on both sides of the membrane. Students should observe the presence of glucose on both sides of the membrane because glucose is small enough to cross the membrane. Starch is too large to cross the membrane, so students should not observe starch on both sides of the membrane.

Part 2

Measure the effects of varying the sucrose concentrations on the pressure in the columns.

1. Create a variety of sucrose solutions (0.2 M, 0.4 M, 0.6 M, 0.8 M and 1.0 M). Assign one solution to each group.
2. Instruct students to place the sucrose solution in one column and distilled water in the other. Students should measure the pressure and volume within the columns for 24 hours.
3. After 24 hours, have the students share their data with all groups and compare the rate of pressure change related to the varying sucrose concentrations.

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Experiment files

Download one of several student-ready activities from the PASCO Experiment Library. Experiments include editable student handouts and teacher notes. Visit **pasco.com/freelabs/ME-6940**.

Software help

The SPARKvue and PASCO Capstone Help provide additional information on how to use this product with the software. You can access the help within the software or online.

SPARKvue

Software	Main Menu > Help
Online	**pasco.com/help/sparkvue**

PASCO Capstone

Software	Help > PASCO Capstone Help
Online	**pasco.com/help/capstone**

Specifications and accessories

Visit the product page at **pasco.com/product/ME-6940** to view the specifications and explore accessories. You can also download experiment files and support documents from the product page.

Technical Support

Need more help? Our knowledgeable and friendly Technical Support staff is ready to answer your questions or walk you through any issues.

Chat	**pasco.com**
Phone	1-800-772-8700 x1004 (USA) +1 916 462 8384 (outside USA)
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Warranty

For a description of the product warranty, see the Warranty and Returns page at **pasco.com/legal**.

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