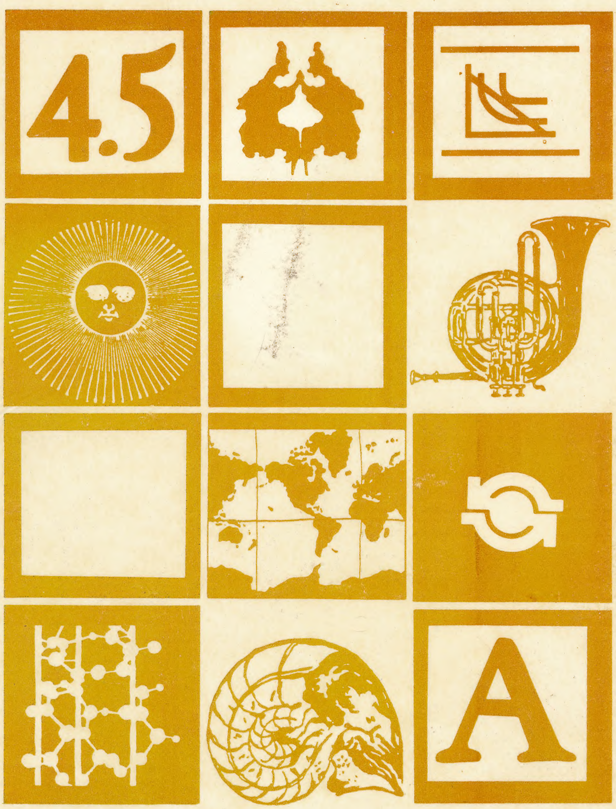
Osmotic Pressure

User's Notes



James D. Spain

CONDUIT/The University of Iowa/Oakdale Campus/Iowa City, IA 52242
(319)353-5789

BIO362A, Osmotic Pressure

for the Apple II family.
Minimum requirements: Applesoft in ROM, 48K, one disk drive.

Package Contents

One copy User's Notes
Software on two diskettes (one original, one backup)
Software Purchase Agreement

Documentation

These notes supplement the User's Notes for Osmotic Pressure.

Warranty

TEST THE DISKETTE IMMEDIATELY. CONDUIT will replace damaged, missing, or unreadable parts of the package within the first 30 days from the date shipped. After 30 days, the customer will be charged $10 for a replacement copy of each diskette and the actual (list) price for replacement manuals. Complete and return the Software Purchase Agreement to ensure your purchase is covered by our warranty.

Getting Started

1) Place the diskette in Drive 1.

2) If your machine is off, turn it on.

3) If your machine is on and it is an Apple IIe: hold down the OPEN-APPLE key while you press both the CONTROL key and the RESET key.

4) If your machine is on and it is an Apple II or Apple II+: hold down the CTRL key while you press the RESET key. When the Applesoft prompt (]) appears, type PR#6 and press the RETURN key.

5) Now follow the directions on the screen.

Note: If you have difficulty starting the diskette, refer to your Apple II manual for DOS (Disk Operating System), consult a local Apple II expert, or call us at CONDUIT.

Your First Run

Simply respond to the program prompts, referring to the User's Notes as needed. Note that you may have to adjust the color controls on your monitor. (As a reference, the fluid in the osmometer should be blue-green.)

Backup

Since you may not copy the diskette for this package, we are including a backup copy.

For Assistance

If you have problems loading or using the programs, call CONDUIT at (319) 353-5789 and we will help you solve the problem.

*Apple Note

Software Purchase Agreement

Purchaser agrees to the following:

Purchaser assures that protected software will not be copied and that unprotected software will be copied no more than once, for back-up purposes only. (For networking software, contact CONDUIT for a special Network Purchase Agreement. For purchasing additional copies of the software, see the current CONDUIT catalog.) Purchaser agrees to forward to CONDUIT any nontrivial changes made to, and errors detected in, the programs or printed materials.

CONDUIT agrees to the following:

One year warranty

CONDUIT assures the programs operate as described in the package and is available for consultation concerning the programs.

Thirty day warranty

If the purchaser is not satisfied with the package, he may return it to the place of purchase for a full refund within thirty days of the date of purchase. The purchaser must provide proof of purchase when returning the package and if the package was purchased directly from CONDUIT, the purchaser must first obtain authorization from CONDUIT. CONDUIT will also replace damaged, missing, or unreadable parts of the package within thirty days of date of purchase, provided purchaser has proof of purchase.

After thirty days, purchaser will be charged for new diskettes or manuals.

If you want to be notified of any changes or updates to the package, you must return the bottom half of this card. You will not receive notice unless you have returned the card.

Micro Package Warranty

Package catalog # ______________________ Date______________________

Package title ______________________

Customer name (please print) ______________________

Customer institution ______________________

Customer address ______________________

Where did you learn about the package?

___Colleague ___Magazine (title/date: ______________________)

___CONDUIT Catalog ___Conference (specify: ______________________)

___Other (specify: ______________________)

Where did you purchase the package?

___CONDUIT ___Store/Distributor (name: ______________________

city, state: ______________________)

What computer software magazines do you regularly read or subscribe to?__________

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What professional publications do you regularly read or subscribe to?__________

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How can CONDUIT better serve you?

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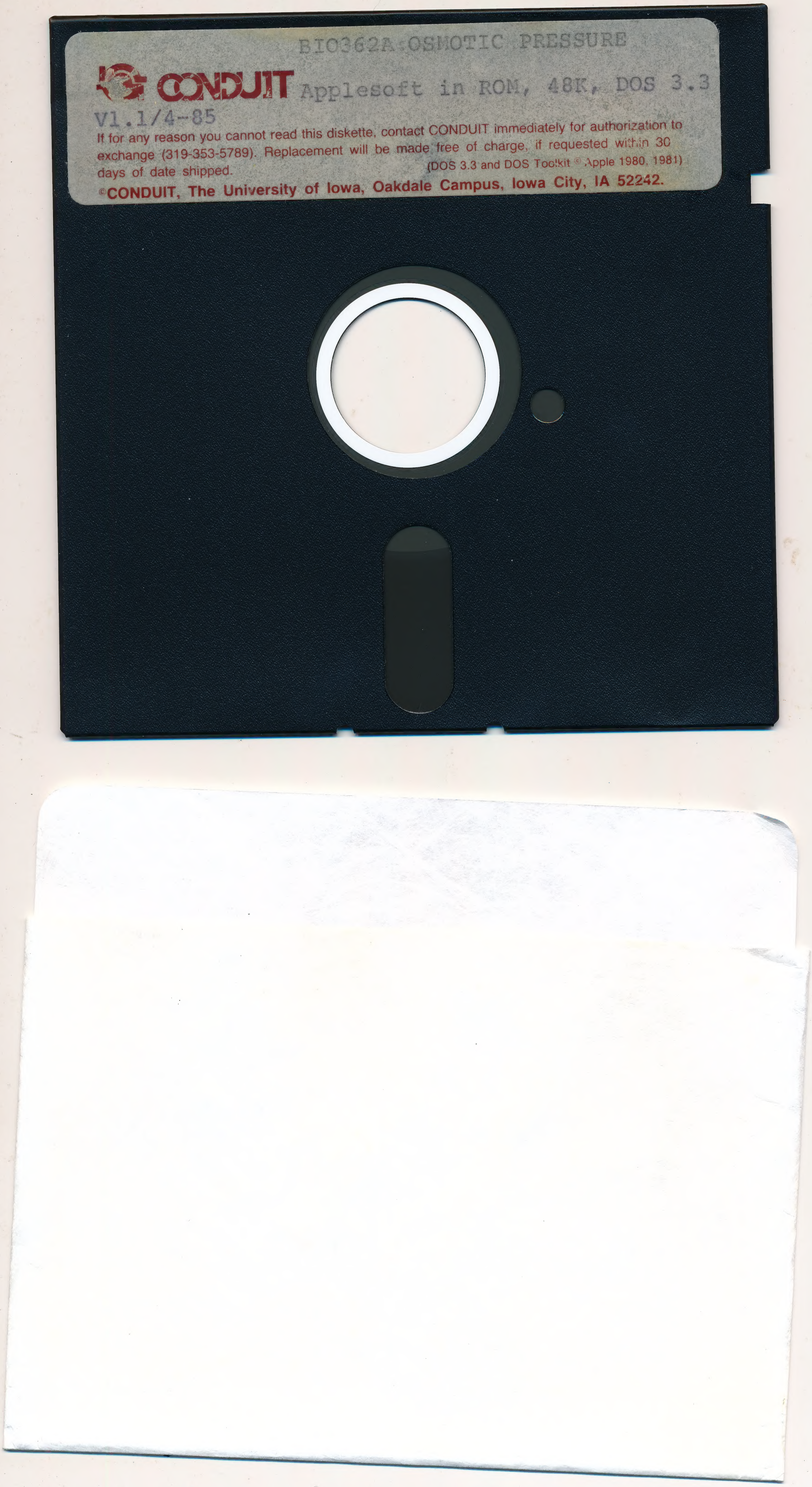
BIO362A OSMOTIC PRESSURE
CONDUIT
Applesoft in ROM, 48K, DOS 3.3
V1.1/4-85
If for any reason you cannot read this diskette, contact CONDUIT immediately for authorization to exchange (319-353-5789). Replacement will be made free of charge, if requested within 30 days of date shipped.
(DOS 3.3 and DOS Toolkit © Apple 1980, 1981)
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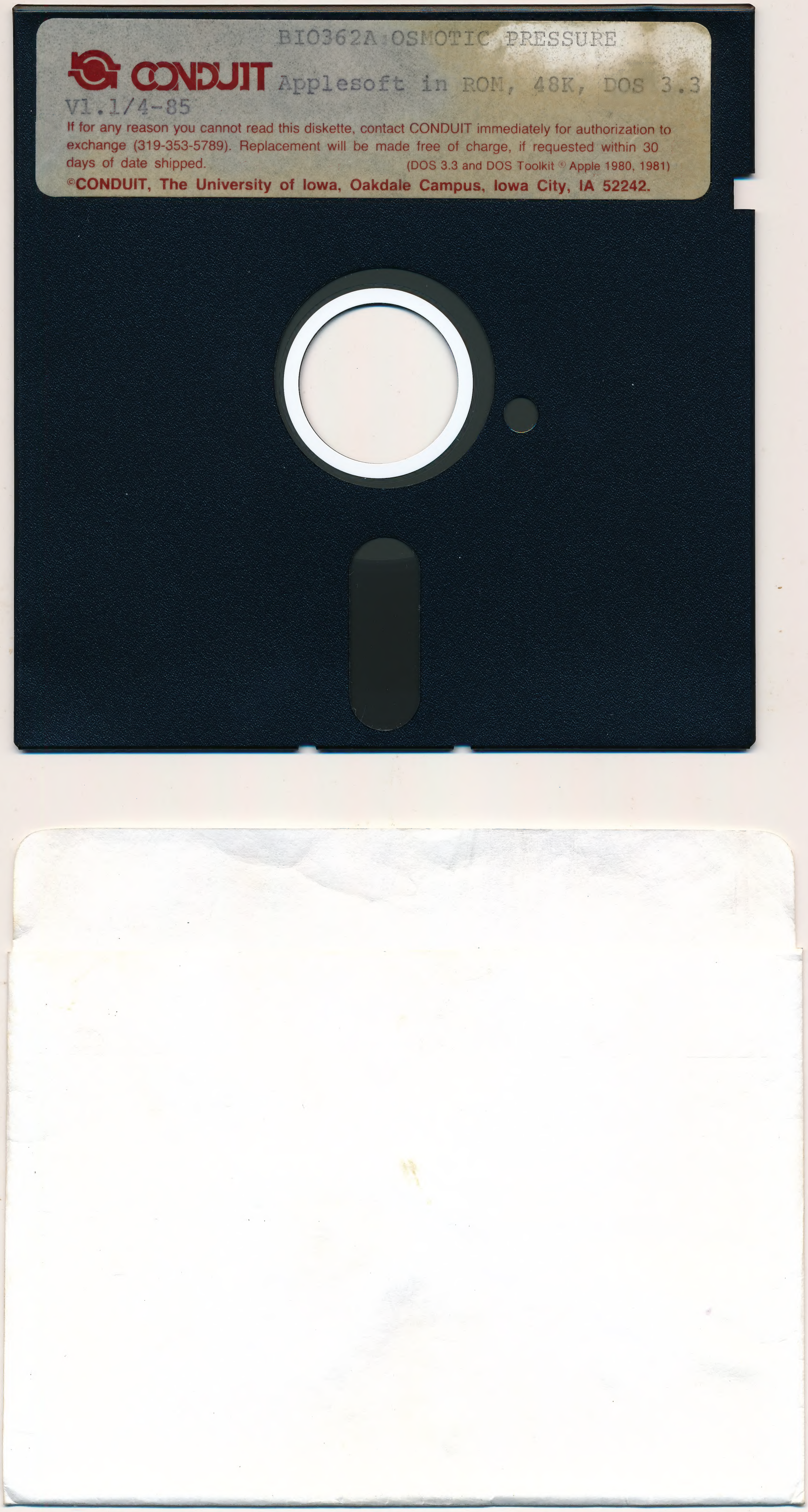
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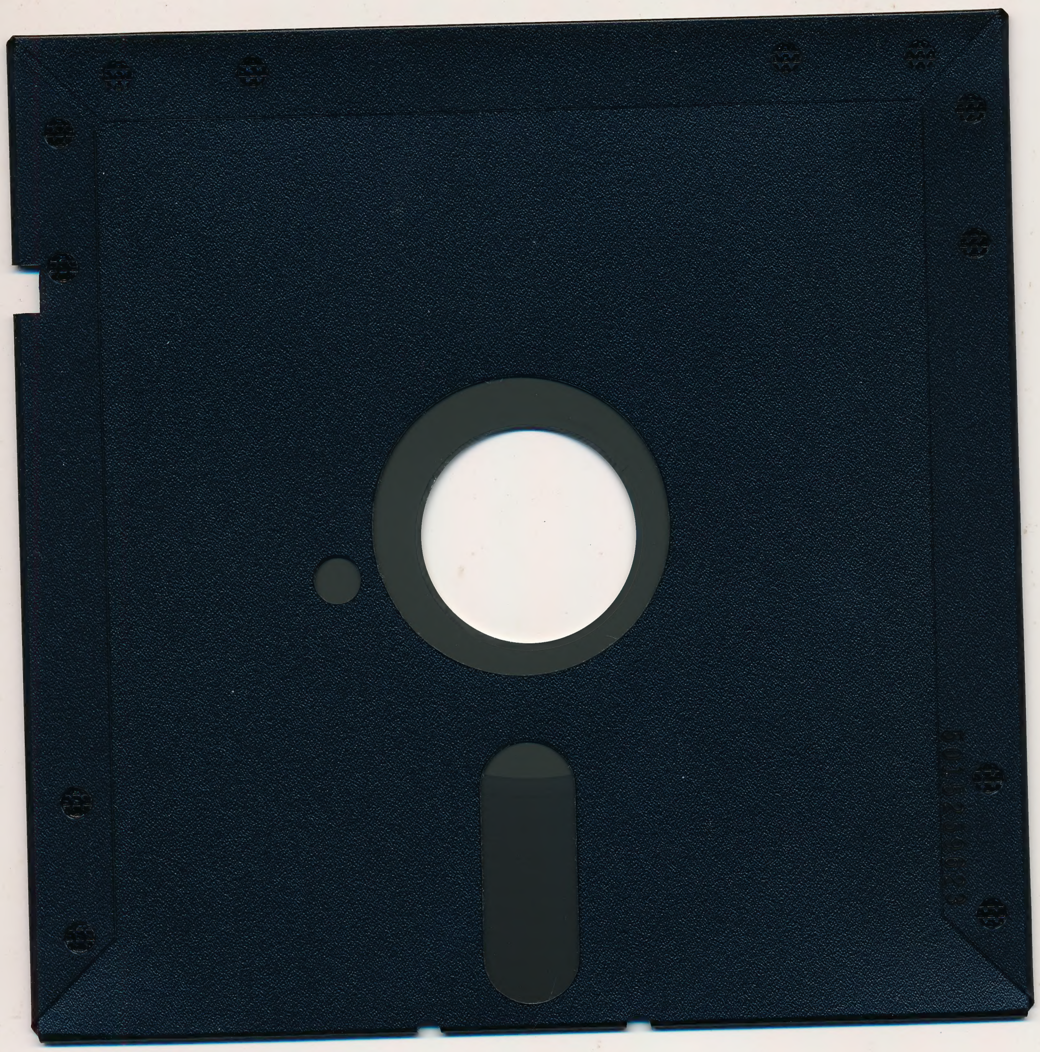
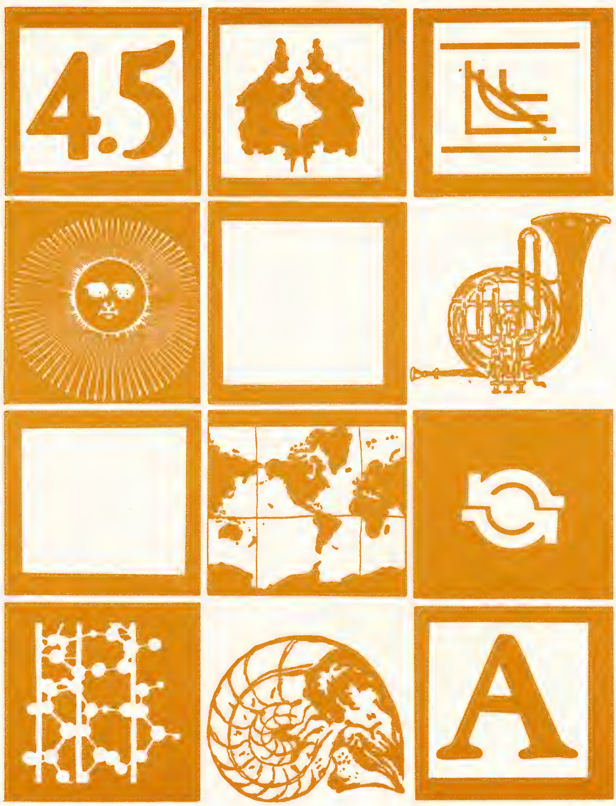


Osmotic Pressure

User's Notes



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Osmotic Pressure

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User's Notes

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Contents

Osmotic Pressure

This package allows the user to perform several simulated experiments involving osmotic pressure. In running the programs, the user should gain a better understanding of the phenomena resulting from osmotic flow and the factors that determine osmotic pressure.

This guide describes the package's two programs and their theoretical basis. Several discussion questions are also included to help the user focus on key aspects of osmosis.

Osmotic Pressure is appropriate for introductory college biology or botany courses. It may also be used in general physiology and in advanced high school biology. The programs may be presented as lecture demonstrations or as student laboratory exercises. Students will, however, need some discussion of the concepts in lecture before using the programs themselves.

Osmotic Pressure Simulations

The Osmotic Pressure Simulations program offers the user several options for measuring osmotic pressure. The first option presents background information on osmotic pressure and the classic thistle tube demonstration. The user can refer to this option as a general introduction to the other simulations included in the program.

The second option allows the user to vary the concentration of solute and observe the effect on the osmotic pressure. The user begins by selecting a solute from a list of four carbohydrates having different molecular weights. The program then displays water moving up a thistle tube osmometer and also plots the hydrostatic pressure and osmotic flow as a function of time. The final equilibrium pressure represents the osmotic pressure for that experiment. (Note: If the user selects a weight of solute that would cause an overflow in the osmometer, he is directed to select a new weight.)

After the user has had an opportunity to examine the four different concentrations, the program displays a summary of the data, followed by a plot of osmotic pressure as a function of concentration. This plot demonstrates that osmotic pressure is a linear function of concentration. The user may then examine another solute or return to the program's menu.

The third option in the program allows the user to study the osmotic pressure of four different solutes at the same concentration (expressed in either grams/liter or moles/liter). Here the program draws the curves of the four solutes on a graph of hydrostatic pressure vs. time. When the concentration is expressed in moles per liter, each solute has the same hydrostatic pressure curve.

The program also displays a table of summary data, which shows that each solute has the same molar osmotic pressure (centimeters of water pressure for a one molar solution). The program then compares the average molar osmotic pressure obtained in the simulation with the value obtained by the gas law equation.

The fourth option demonstrates how osmotic pressure may be used to determine the molecular weight of a non-ionizable solute. The program generates an unknown molecular weight for a hypothetical solute and asks the user to select the number of grams of unknown that are to be dissolved in one liter of water. The simulation then proceeds as in the previous two options. In this case, however, the program plots the hydrostatic pressure and displays its value in centimeters. When the simulation is complete, the program asks the user to calculate the solute's molecular weight from the osmotic pressure and the molar osmotic pressure.

This option includes a calculator subroutine that allows the user to figure the molecular weight without resorting to a separate hand calculator. When prompted, the user simply types in his values along with the appropriate operators: C to clear, * to multiply, / to divide, and = to obtain the answer. The user can then confirm the resulting calculation and it will be automatically entered into the program, or he can enter a new figure and press RETURN.

If the user's answer is within 10% of the correct answer, the program reports it as very good, if within 20%, fairly good. If the estimate is outside this range, the program directs the user to try again, and after his second attempt, it displays the actual value. At this point the user may either try the osmotic pressure measurement a second time with a different sample size or return to the menu.

Molecular Model for Osmosis

The second program in the package, Molecular Model for Osmosis, presents an animation of the molecular motion that occurs during the process of osmosis. The program begins by displaying two compartments with 10 water molecules and 10 solute molecules in the right compartment, and 20 water molecules in the left compartment. The program then animates the molecules moving in a semi-random fashion. Although water molecules can move across the semipermeable membrane that separates the two compartments, solute molecules are confined to the right compartment. Since there are more water molecules on the left side, more molecules tend to move from left to right than vice versa. As the simulation continues, the system tends to approach an equilibrium condition with about 15 water molecules in each compartment. And since there are more total molecules (15 water plus 10 solute) in the right compartment, this compartment has an increased (hydrostatic) pressure.

After the initial description of this process, the program gives the user the option of continuing to look at the animation or returning to the menu. Note: Because of the small number of molecules involved, the oscillations about equilibrium (equal number of water molecules in each compartment) are very evident. Such oscillations are much less noticeable in nature because of the enormous number of molecules involved (on the order of 10^{23}).

Theoretical Basis for the Programs

The theory behind *Osmotic Pressure* assumes that the flow of water during osmosis is simply a diffusional flow going from high concentration of water toward the lower concentration of water (high solute concentration). The solute is assumed not to flow because of the semipermeable nature of the membrane. The rate of water flow may be described by the equation:

Flow in = K1*(WO - WC) (1)

where K1 is a proportionality constant that depends on the properties of water in relation to the membrane, the thickness of the membrane, and the area of the membrane. WO is the water concentration outside the membrane expressed as a mole fraction, in this case 1 (i.e., pure water). WC is the mole fraction of water inside the membrane, that is W/(W + S), where W is the number of moles of water and S is the number of moles of solute per unit volume inside the compartment.

Equation 1 then becomes:

Flow in = K1*(WO - (W/(W + S)))   (2)

The backflow of water across the membrane is the result of a difference in hydrostatic pressure. It is described by the equation:

Flow out = $K'(P_1 - P_0)$ (3)

where K′ is a flow constant relating the flow rate to the hydrostatic pressure difference across the membrane (i.e., $P_1 - P_0$). Since the pressure will be a function of the volume and geometry of the chamber and the manometer, as well as the amount of solution inside the membrane, this equation may be simplified by basing the flow on the amount of water in the chamber relative to the initial amount (which will be assumed to have been adjusted to zero pressure). This gives the following:

Flow out = K2*(W - WI)   (4)

where W is the amount of water in the chamber at any time t, and WI is the initial amount of water when $P = P_0$. K2 is a new proportionality constant that depends on the properties of the membrane and the geometry of the chamber and manometer.

Equations 2 and 4 can now be combined to give an equation for net flow across the membrane as a result of flow in and flow out:

Net flow = flow in (diffusion) - flow out (hydrostatic flow)
= K1*(WO - (W/(W + S)) - K2*(W - WI).

At osmotic equilibrium, flow in = flow out, and

K1*(WO - (W/(W + S)) = K2*(W - WI).

Questions for Discussion

Although the programs in this package are designed to be self-contained and suitable for use either by instructors in lectures or directly by students, most students will benefit from an introduction to osmosis before they use the package. The following questions all relate to topics handled in *Osmotic Pressure*. Some instructors may wish to discuss these questions before actually running the programs. Other instructors may prefer to use the questions as a basis for follow-up discussion.

1. What is the relationship between osmosis and simple diffusion?
2. What are the basic requirements for osmotic flow to occur?
3. Why is there a net movement of water across a semipermeable membrane toward the side containing solute?
4. How is osmotic pressure affected by concentration of solute?
5. What is osmotic pressure and how does it relate to hydrostatic pressure?
6. What is the net osmotic flow when osmotic pressure equals hydrostatic pressure?
7. What physical property of the solute is most directly related to the osmotic pressure produced by a given weight of solute?
8. How can you use osmotic pressure to determine the molecular weight of an unknown solute?

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