Of wetting and osmotic transport

In his article “The First Wetting Layer on a Solid,” Peter Feibelman (PHYSICS TODAY, February 2010, page 34) points out that the first layer of water molecules on a solid surface embodies the boundary condition for water transport, pollution, corrosion, and other molecular transport phenomena. That observation and the revealing high-resolution images presented bring to mind a fundamental problem of osmotic water transport.

In 1827 René Dutrochet pointed out that osmosis actually involves binary transport, in which water moves one way and solute moves the other way. In 1855 Adolf Fick took the idea much further, expanding on the work of other experimentalists. He considered a cylindrical pore in a hydrophilic membrane separating either water or a dilute salt solution on one side and a concentrated one on the other. He reasoned that water will preferentially flow along the walls and salt will tend to migrate along the axis of the pore. As a consequence, he expected concentration gradients in the plane of the pore. Under certain conditions, he suggested, salt migration could be completely inhibited even though the pore might be large enough to allow migration of salt molecules. Subsequent contributions by Jacobus van’t Hoff4 and Walther Nernst5 established that molecular diffusion in aqueous solutions involves the migration of a solute in one direction driven by the gradient of osmotic pressure, and the flow of water in the opposite direction.

Binary transport in aqueous solutions is widely recognized, but the actual mechanisms are not clear. Solute diffusion involves the random migration of free molecules or ions. However, because water is a condensed phase, its migration cannot be visualized in terms of random motion of molecules. It is not clear if such a flow of water can be considered viscous, because viscosity typically involves wall effects and external forces. If it is viscous, what is the nature of that flow?

Work along the lines described in Feibelman’s article may throw more light on the nature of binary transport in osmosis and on molecular diffusion in which random motion of unattached molecules in one direction is accompanied by the migration of a condensed phase in the opposite direction.

References

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so. When circumstances allow, I use a two-pen method of collaborative testing.

The method is simple. First, schedule approximately 50% more time for the exam than you think would be required to complete the test, and provide about twice the space you think the students might need to answer each question on the paper. Hand out pens of a particular color and brand that are not commonly used (for example, a particular shade of blue), and have the students commence to work on their exams individually. After the expected time of completion has elapsed, collect the first set of pens, and hand out pens of a different color. (I use red as the second color, then grade their work in the second. As you can imagine, they find most of their mistakes themselves and correct them, so I generally have much less work trying to figure out what they did wrong and how many points it should be worth. Students have told me that they leave the exam having figured out what they didn’t understand, filled in the gaps, and strengthened their relationships with their peers. An easy win–win for a busy professor.

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Building for NCAR’s future

We at the National Center for Atmospheric Research (NCAR) enjoyed the article “Laboratory Architecture: Building for an Uncertain Future” (PHYSICS TODAY, April 2010, page 40). However, we would like to correct a factual inaccuracy about our organization.

Although NCAR is planning construction of a new supercomputing center in Cheyenne, the project is still in the design and approval process; our operations remain in Boulder, Colorado, at this time. The NCAR-Wyoming Supercomputing Center project is a collaborative partnership that is regionally valuable and offers the scientific community critical computing resources. NCAR weighed several location options and selected the Wyoming site because it combined the greatest increase in scientific benefits for the university community NCAR serves and the best value for taxpayer investment.

The founding vision of collaboration among scientists will remain a reality at the Mesa Lab, even if the supercomputing operations move. The significant changes in the NCAR computing facility will be in the length of the fiber-optic network, the greater efficiency of the new facility, and the 20-fold increase in computing power.

More information is available at http://www.cisl.ucar.edu/nwsc.

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Correction

April 2010, page 18—We should have stated that by 2007, mass-independent fractionation of mercury isotopes had been independently observed by several groups.1

Reference

1. See, for example, T. A. Jackson et al., Appl. Geochem. 23, 547 (2008); L. Laffont et al., Environ. Sci. Technol. 43, 8985 (2009); B. A. Bergquist, J. D. Blum, Elements 5, 353 (2009) and references therein.