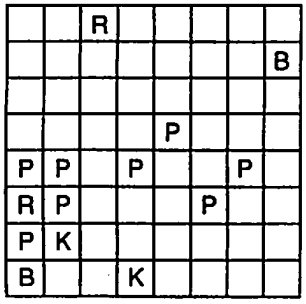
Fiddling with the Roof

Mary Lindenberg reports that her husband Martin, when interviewing high school students applying to MIT, always encourages them to take advantage of sailing the Tech dinghies. Mary usually shows them "Puzzle Corner" and points out an interesting problem. Martin includes comments in his report if they solve the problem.

It has been at least a year since I specified the size of the backlogs for the various kinds of problems that are printed. Let me do so now. When the size of the column was reduced and the number of regular and speed problems per issue halved, the backlog had an instantaneous doubling (measured in months, not letters). I now have nearly 2 years worth of speed problems and even more for regular problems. However, I have very few of the special (chess, bridge, computer, go) problems. So if you have any of these special problems, send them in. If not, I may soon just merge the special with the regular problems and print three from the combined list each issue instead of the current 1 special, 2 regular policy.

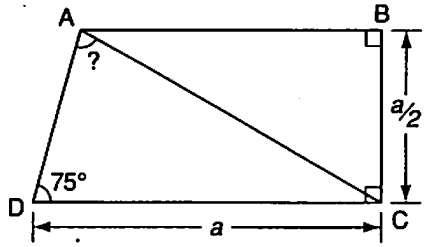
Problems

APR 1. A wild one from Jorgen Harmse. White is to move and mate in 12.



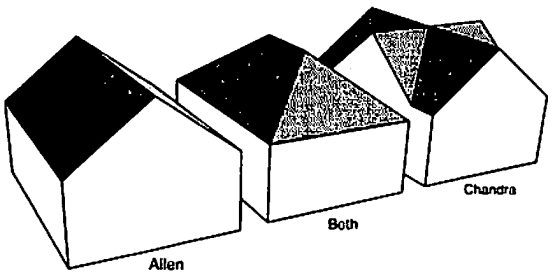
APR 2. Jerry Grossman needs help training his robots. Ten workers in a certain high-tech office have purchased a fleet of voice-activated robots to help them with various tasks, such as getting coffee, delivering mail, and carrying furniture. The robots are expensive, so they bought only seven of them, assuming that no more then seven workers would be needing robots simultaneously. Each robot can serve any number of masters (though only one at a time), but in order to respond to voice commands, a time-consuming and expensive training session is needed between each robot and each master it will serve. To avoid waste, the workers want to conduct as few training sessions as possible. Determine what training sessions should be conducted to achieve these aims.

APR 3. Liet Van Phan wants you to find angle DAC without using either Pythagoras's theorem or trigonometry. Measured in degrees, angles B and C are each 90 and angle D is 75 and CB is half as long as DC.



Speed Department

Geoff Landis notes that Allen, Beth, and Chandra built houses with identical planforms, but decided on different roof designs as shown below. The pitch of the roofs are identical. Which has the greatest roof surface area and which the least?



SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO ALLAN J. GOTTLIEB, '67, THE COURANT INSTITUTE, NEW YORK UNIVERSITY, 251 MERCER ST., NEW YORK, N.Y. 10012, OR TO: GOTTLIEB@NYU.EDU

Solutions

N/D 1. We begin with a bridge problem from Winslow Hartford in which South is in an impossible contract of 6NT. However, West leads the spade 4, which East wins with the ace and returns the spade queen. How can South now make his contract assuming best defense from this point onward?

North
♠ 5
♥ A K 8
♦ A 8 3
♣ A J 10 7 5 4

West	East
♠ 10 8 7 4 3	♠ A Q 9
♥ 7	♥ J 6 5 4 2
♦ Q 10 9	♦ J 6 5 2
♣ Q 8 3 2	♣ 6

South
♠ K J 6 2
♥ Q 10 9 3
♦ K 7 4
♣ K 9

The following solution is from Jonathan Hardis. William Tripp remarks that the problem is an example of a guard squeeze.

After the ace of spades is played and East leads the queen, it's easy to count 9 tricks:

♠-K, J
♥-A, K, Q
♦-A, K
♣-A, K

The problem is to develop three more. South covers the queen of spades with his king, and discards the diamond 8 (not a club, not the 3!) in dummy. South next leads the club 9 from his hand. If West plays low (best defense), South overtakes with the 10, which becomes the first extra trick. If West plays the queen, South overtakes with the ace and dummy's clubs provide all three extra tricks.

South next leads the heart 8 from the board. If East plays the jack, South overtakes with the queen and the 10 of hearts becomes the second extra trick. If East plays low, South plays the 3 and the 8 becomes the second extra trick. At this point, West's hand looks like this:

♠-10 x x
♥
♦-Q x x
♣-Q x x

South cashes the ace and king of hearts, returns to his hand with the king of clubs, and cashes the queen or 10 of hearts. West must find three discards for the hearts. (1) If he discards a club, the club jack becomes the third extra trick. (2) If he discards two spades, South's fourth spade becomes the third extra trick. (3) He discards at least two diamonds. (East protects the diamond jack.)

South plays accordingly: (1) On the fourth heart, discard the diamond 3, cross to dummy with the diamond ace, and cash the ace and jack of clubs,

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ILLUSTRATIONS: DAVID HRUBY

Continued from Page MIT 47

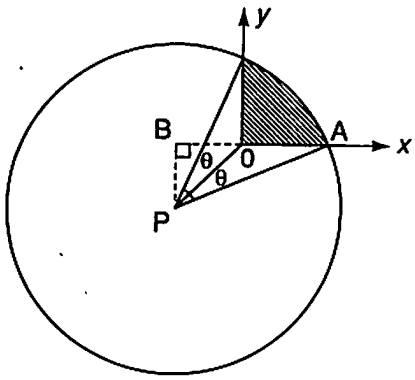
pitching the diamond and spade losers. (2) On the fourth heart, discard a low club, cash the spade jack and 6, discarding two low clubs, cash the diamond king, cross to dummy with the diamond ace, and take the ace of clubs, pitching the diamond loser. (3) On the fourth heart, discard a low club, play the diamond 4 to dummy's diamond ace, pitch the spade 6 on dummy's ace of clubs, then lead back the (well preserved) three of diamonds, finessing East's jack.

N/D 2. Matthew Fountain wants to know how large is the volume that lies within two inches of all the corners of a two-inch cube. All the volume must lie within two inches of all the corners.

John Salmon notes that this problem was solved in his thesis, which I happen to know involves a very sophisticated solution technique for hierarchical N-body problems. Indeed, the required formula is actually a numbered equation (6.8). The solution below is from Eugene Sard:

It is convenient to use a rectangular coordinate system with x-, y-, and z-axes parallel to the cube faces, and whose origin is at the center of the cube. The 8 cube corners are then at the 8 arrangements of (±1, ±1, ±1). The distance of the origin from each corner is $(1^2+1^2+1^2)^{1/2}=3^{1/2}$ and the volume in question is a small symmetrical 8-surface "nut" around the origin. Each of the 8 surfaces subtends a solid angle of $\pi/2$ between x-y, y-z, and x-z planes.

Consider the surface where x, y, and z are all positive. Each point on this surface is 2 inches from the corner at (-1,-1,-1), or $((x+1)^2+(y+1)^2+(z+1)^2)^{1/2}=2$. Recasting for a fixed z gives a boundary equation of a circle in an x-y plane, $(x+1)^2+(y+1)^2=4-(z+1)^2$, with center P(-1, -1) and radius $PA+(4-(z+1)^2)^{1/2}$.



The complete shaded area of interest is also bounded by the lines x=0 and y=0. Other key dimensions are PB=0B=1, $0P=2^{1/2}$, and 0A=AB -0B=$(3-(z+1)^2)^{1/2}-1$. From the law of cosines, angleθ= arccos $((1+(3-(z+1)^2)^{1/2})/(2(4-(z+1)^2))^{1/2})$.Thus 2$\theta$ varies from .33984 to 0 rad. as z varies from 0 to $2^{1/2}-1$. The shaded area is the difference between the full sector area and twice the area of triangle 0AP, or $A=\theta(4-(z+1)^2)-\sin\theta\,(2(4-(z+1)^2))^{1/2}$. Finally the "nut" volume, $V=8\int_0^{2^{1/2}-1} A\,dz$. Numerical integration gives V=.121644 cubic inches to 6 significant figures.

N/D 3. Robert Sackheim notes that all readers know that if a man leaves home, walks a mile south, then walks a mile west, shoots a bear, then walks a mile north and finds himself back home, that the bear is white because the man's home is at the North Pole and the bear is a polar bear. Sackheim wonders if there is any other place on earth where a person can go a mile south, then a mile west, then a mile north and be back at the starting point?

The answer is clearly yes, there are an infinite number of solutions near the South Pole. Several readers pointed out that no bears will be found. The following solution is from Jack Bross:

There are an infinite number of latitudes from which one may go 1 mile south, 1 mile west, 1 mile north, and find oneself back where one started: all of them are slightly more than a mile away from the South Pole (accumulating on the circle 1 mile from the pole). The idea is that if going one mile south brings you near the pole, west will circle around the pole several times. For any n, we can find a distance so that one mile wraps exactly n times around the pole. Then, north will take us back to where we started. The actual values depend on one's assumption about the curvature of the earth near the pole, but of course the earth is fairly flat at a distance of one mile, so they are well approximated by $1+1/2\pi n$ miles.

Other Responders

Responses have also been received from E. Biek, W. DeHart, M. Deskey, S. Feldman, M. Fountain, D. Fraser, N. Gevirtz, C. Keavney, K. Kiesel, M. Lindenberg, A. Ornstein, W. Pulver, A. Reed, K. Rosato, P. Sanchez, R. Schweiker, A. Silva, D. Smith, J. Uretsky, D. Wachsman, C. Whittle, J. Wilson, J. Woolston, H. Zaremba.

Proposer's Solution to Speed Problem

All three are the same.

the Nature Conservancy and the objective is to improve the management of natural resources throughout Central America while promoting sustainable development projects. PACA is working in Belize, Guatemala, Honduras, El Salvador, Nicaragua, and Costa Rica. The project consists of four technical components: wildland management, environmental education, conservation information, and strategic planning. . . . **Gregg F. Martin**, SM '88, has mentioned that the College of Naval Command and Staff is outstanding. There are only 200 students—100 Naval officers, 34 Army, 30 Air Force, 25 Marine, and the remainder Coast Guard and civilians. The orientation is on joint military operations, strategy, and national policy. So far they have analyzed historical military case studies ranging from antiquity to modern times. . . . **Marina Skumanich**, SM '88, has joined Battelle's Environmental Policy and Social Research Center as a research associate. . . . **Simon Stokes**, SM '88, is working for a patent and corporate law firm in London. He expects to qualify as a solicitor in 1992. After Christmas he hopes to take a part-time course in European law at King's College in London. . . . We have heard that **Terry Turnipseed**, SM '88, has married a redheaded nurse.

Jennifer Croissant, SM '89, taught "Women in Science and Engineering" at Rensselaer High School Summer Program. She also completed her qualifying and dissertation exams in the Science and Technology Studies doctoral program at Rensselaer. . . . **Jeff Dieffenbach**, SM '89, is currently a project manager at IBIS Associates, an engineering consulting firm in Wellesley, Mass. He is also working on issues for the Paul Tsongas for President Campaign. . . . **Aaron "Todd" Curtis**, SM '90, is on staff at the Boeing Commercial Airplane Group in Seattle, Wash., as a safety systems engineer. . . . **Mark Roberts**, SM '90, has been in Washington, D.C., for a year now, working at the Congressional Office of Technology Assessment. He has found a great number of TPP alumni/ae at OTA. He is currently working on a study of defense conversion beating missiles into microwave ovens. . . . **James "Jamie" Winebrake**, SM '90, is presently working on a PhD at the University of Pennsylvania's Center for Energy and the Environment. . . . **Paul Chan**, SM '91, has joined the staff of Koeneman Capital Management, Pte, Ltd., which is an international investment firm based in Singapore. The firm was started by two MIT alumni. Paul is currently working on a data visualization project which he finds both interesting and challenging.—Réné Smith for Richard de Neufville, Technology and Policy Program, MIT, Rm. E40-252, Cambridge, MA 02139.

STS PROGRAM IN SCIENCE, TECHNOLOGY & SOCIETY

Professor Jill Conway gave a talk about Australian history entitled "Fatal Shore or Luck Country" last December at the Smithsonian Institution. . . . Professor **Deborah Fitzgerald** is editing a new series, *Revisiting Rural America*, for The Johns Hopkins University Press. . . . Professor **Loren Graham** delivered the keynote address at the joint meeting of the Society for the History of Technology and the History of Science Association in Madison, Wisc., last November. He and Professor **Eugene Skolnikoff**, '49, SM '50 (VI), PhD '65 (XVII), traveled in early December to Moscow to speak to leaders of the Soviet and Russian Academies of Science about the restructuring of Soviet and Russian science. . . . Professor **Lily Kay** presented a paper on the technological roots of early molecular biology at the 1991 4S meeting. She is spending the spring term at the Max Planck Institute for Physical Chemistry in Gottingen. . . . Professor emeritus **Leo Marx** gave a talk in Sharon, N.H., entitled "Henry Thoreau and the Humanistic Perspective on Environmental Degradation.". . . Professor **Leon Trilling** presented a paper on engineering education and international perspectives at the seventh IEEE Careers Conference in Denver last October.

The following are STS graduate student notations. **Bruce Bimber** delivered a paper, "The Politics of Expertise and the Separation of Powers" at the annual American Political Science Association meeting in Washington last September. . . . **Dan Grossman**, '82 (VIII), SM '86 (XVII), and Seth Shulman were the coauthors of "Over There: The U.S. Military's Toxic Reach," in the November 28, 1992, issue of *Rolling Stone*. . . . **David Mindell** went to the Galapagos Islands in November and December as part of the Jason Project, an educational program aimed at getting secondary school students interested in science and technology. Mindell is control system engineer and navigator for this year's project, having developed the undersea robot "Jason Junior" in his work at the Woods Hole Oceanographic Institute.—Phyllis Klein, STS Program, MIT, E51-128, Cambridge, MA 02139.

Deceased

The following deaths have been reported to the Alumni/ae Association since the *Review* last went to press:

L.G. Lee Thomas, '20; November 22, 1991; Naples, Fla.