MATHEMATICS

# An Awesome Look at Japan's Math SAT

Study after study has shown that Japanese high school students are head and shoulders above their U.S. counterparts, especially in math and science. In spite of much public handwringing in the United States, the gap doesn't seem to be closing (see page 53). A case in point is the complexity of the math problems on Japanese university entrance exams.

The Mathematical Association of America (MAA) has just published an English translation of the mathematics portion of the 1990 University Entrance Center Examination (UECE)—Japan's equivalent of the American SAT—and a sample of individual university exams. U.S. mathematicians who have read the translation are awed, even dumbfounded, by the mathematical sophistication expected of students taking the tests. "It's an impressive amount of mathematics," says Don Albers, associate director of MAA, who sought the translation in order to "get some facts on the table." Agrees the translator, Eileen Wu of Menlo College in Atherton, California, "They're asking quite a bit more of their students." Richard Askey, a professor of mathematics at the University of Wisconsin is blunter: College-bound U.S. students given the exams "would bomb out completely," he predicts.

Even if Askey is right, there's a caveat: The significance of any comparison between students is muddied by statistical differences in the test-taking groups. According to 1987 data, the SAT was taken by 31% of the U.S. college-age population; the corresponding figure for the Japanese UECE is 14%. Presumably the better students in Japan are disproportionately represented among the test-takers there. But Askey opines that only the very best U.S. students would match the Japanese students' average scores. "The level at which [Japanese] students perform on these [exams] is just incredible," he says.

Faced with problems this challenging, Japanese students have one thing to be thankful for: The UECE has just a handful of problems, compared with dozens of multiple-choice questions on the SAT. Each UECE problem, though, typically has several parts, and students don't have a multiple-choice menu of answers to fall back on. (The Japanese exam uses a unique response format that allows complex answers to be graded by machine.)

How do *Science* readers stack up against fresh high school graduates in Japan? Readers can test their mettle on the sample problem from the UECE in the box. And if you're feeling even more daring, take a crack at the following problem, from an exam given by Tokyo University:

"Given a regular pyramid, there is a ball with its center on the bottom of the pyramid and tangent to all edges. (A regular pyramid has four isosceles triangles adjoined to a square base.) If each edge of the pyramid base is of length $a$, find the height of the pyramid and the volume of the portion it has in common with the ball." (Answer: Height= $\sqrt{2}/2\ a$; shared volume= $(7\sqrt{6}/54 - 1/4)\pi a^3$.)

Admittedly, Tokyo University is Japan's most elite school. But the pyramid problem isn't given to prospective math and science majors. No, it's for students who want to study humanities. When U.S. math majors might trail even lit students in Japan, there's a lot of catching up to do.

–Barry Cipra

## The Exam Starts Easy

Directions: Each problem contains several blanks. Blanks are represented by bracketed, underlined numbers. Each blank must be filled with a single digit or sign.

**Section 1, Question 1**

Suppose the polynomial $P(x)$ with integer coefficients satisfies the following conditions:

(A) If $P(x)$ is divided by $x^2-4x+3$, the remainder is $65x-68$.

(B) If $P(x)$ is divided by $x^2+6x-7$, the remainder is $-5x+a$.

Then we know that $a$ = {1}.

Let us find the remainder $bx + c$ when $P(x)$ is divided by $x^2 + 4x - 21$.

Condition (A) implies that {2} $b + c$ = {3} {4} {5} and $a$ = {1}.

Condition (B) implies that {6} {7} $b + c$ = {8} {9}. It follows that $b$ = {10} and $c$ = {11} {12} {13}.

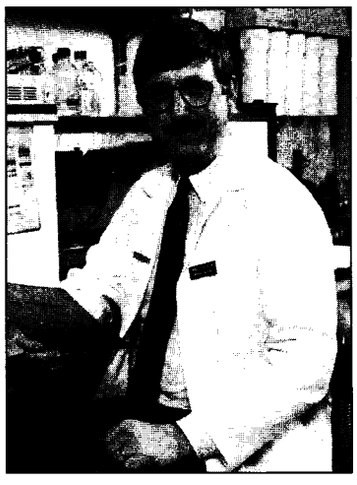
**Answer**

$a$ = {1}
$a = 2$
{2} $b + c$ = {3} {4} {5}
$3b + c = 127$
{6} {7} $b + c$ = {8} {9}
$-7b + c = 37$
$b$ = {10}
$b = 9$
$c$ = {11} {12} {13}
$c = 100$

HUMAN GENOME PROGRAM

# Healy and Collins Strike a Deal

After months of rumor, speculation, and frequent campus sightings, geneticist Francis S. Collins has agreed to take over the directorship of the National Center for Human Genome Research at the National Institutes of Health (NIH). "We have a verbal agreement which is very concrete," NIH Director Bernadine Healy told *Science*. "It's the biggest Christmas present for NIH. This is a scientific coup, and a morale booster for all of the NIH campus." Although final details need to be resolved, the deal Healy has struck with Collins will result in a major expansion of human genome studies on NIH's Bethesda campus.



HOWARD HUGHES MEDICAL INSTITUTE

**Gene meister.** Francis Collins will head a new institute.

Collins confirmed that he has tentatively accepted the job, which was vacated last April by James Watson. He hopes to start part time this month, full time in March, and relocate his laboratory from the University of Michigan Medical School over the next year. But, he cautioned, "I have not yet received a written offer, nor made a formal acceptance." The stumbling block seems to be in Little Rock. While both Healy and Collins have gotten general support for the appointment from the transition team of President-elect Bill Clinton, Collins says, "I need to get a stronger sense of how deep their enthusiasm is for the genome project. The resources we are asking for will only be truly meaningful if they are backed up by the Administration and Congress."

Healy and Collins want a lot of resources because they expect to turn the genome center into NIH's newest institute: the National Institute for Human Genetics. NIH's share of the genome project—$106.2 million this year—now goes mostly to university scientists. The proposed new genetics institute will add an intramural component, rapidly expanding funds, space, and personnel for genetics research on the NIH campus.

To lure Collins from Michigan, Healy threw in everything, including the laboratory sink. She committed most of the NIH director's discretionary budget to set up a new lab for Collins, agreeing to spend between $5 million and $10 million in the first year to begin relocating his Michigan crew. They will be housed in 45,000