More Than Fun Answers

Concretely Puzzling
Match the phrases:
A-4 B-6 C-2 D-1 E-3 F-5

Unscramble the words:

A. CURE	D. CEMENT
B. SYNTHETIC STONE	E. TEMPERATURE
C. CRYSTALS	F. REINFORCING ROD

How'd They Do That
The officers crawled through the pipe at different times.

Sequential Letters
The next three letters are T E T. The letters are the first letters of the numbers one through twelve.

It All Adds Up

25	35	17	=	77
19	46	7	=	72
6	28	34	=	68
50	109	58		

Can You Make a 6?
Add an S in front of IX.

technology today

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Hydrogen: The Ultimate 21st-Century Fuel

For the hydrogen economy to blossom, we need a technological breakthrough that can process hydrogen as it is needed from a substance that is simple and safe to store. The second thing we need is inexpensive fuel cells. Scientists all around the world are hoping to make these needed breakthroughs.

Back in December 2006, I wrote a column that described General Motors' Project Driveway. This project placed 119 fuel cell vehicles on the road. The cars in the study were all hydrogen/electric hybrids that used a fuel cell to generate electricity. The fuel cells in these cars were very expensive and fueling them with hydrogen was definitely a complex operation. These hydrogen/electric hybrids only spewed clean water vapor from their tailpipes. You can read the 2006 column online at www.technologytoday.us/PastColumn PDFs/116_Fuel_Cell_Vehicles.pdf. These cars are still on the road today and they have driven over 3 million miles since the study began. (See Photo 1.)

General Motors

Photo 1—The GM hydrogen/electric hybrids described in my December 2006 column are still on the road and they have now clocked almost 3 million miles.

A fuel cell can supply electricity as long as it receives a steady flow of hydrogen and oxygen. A fuel cell creates electricity by running the electrolysis process in reverse. It combines hydrogen and oxygen to generate electricity and creates water as a bi-product. The electrolysis process and fuel cells both use platinum and other rare metal catalysts. To acquire a good understanding on how fuel cells work, go to http://americanhistory.si.edu/fuelcells/basics.htm.

The goal of building a less-expensive fuel cell and a less-expensive water electrolysis process were both being tackled by Hongjie Dai in his lab at Stanford University. His team's first breakthrough in 2012 was the development of carbon nanotubes and other hybrid materials for fuel cells that could greatly reduce how much it costs to manufacture them in the future.

His team's latest breakthrough was announced this past August. It is a very inexpensive way of decomposing ordinary water into its hydrogen and oxygen components. The process runs at room temperature using the electricity supplied by a single 1.5 V battery. (See Photo 2.) The

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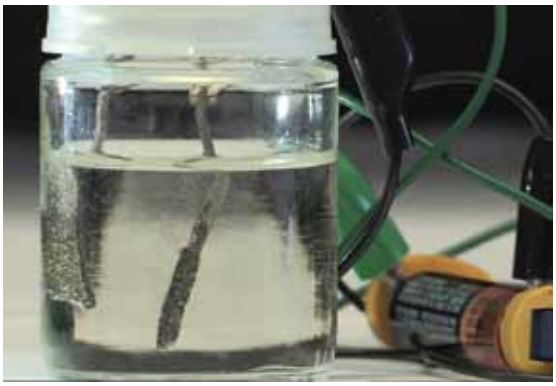
research that led to this discovery included scientists and technologists from Stanford University, Oak Ridge National Laboratory, the University of Tennessee, National Taiwan University of Science and Technology, and Canadian Light Source Inc.

What the researchers did is test all kinds of materials that were created through nanoscale engineering to see if they could use an inexpensive composite material as catalysts in place of platinum and iridium. It seems appropriate here to quote a proverbial statement of Thomas Edison: "Genius is often 1% inspiration and 99% perspiration." The researchers discovered a nickel iron combination that performed well as the electrocatalysts. This discovery, which was made by Ming Gong, a Stanford University graduate student, was so unexpected that Hongjie Dai has actually indicated that all of the esteemed scientists involved don't understand scientifically why their electrolysis apparatus is working so well.



Mark Shwartz/Stanford University

Photo 2—Stanford scientists have developed a low-cost device that uses an ordinary AAA battery to split water into oxygen and hydrogen gas. Gas bubbles are produced by electrodes made of inexpensive nickel and iron.

What they need to do now is find ways to keep their electrodes from breaking down after working perfectly for a few days. They also need to convert what is a tabletop apparatus into a functional industrial process. Perhaps one day, as these scientists and technologists continue to refine their improved electrolysis process, a hydrogen fuel generator for cars will become possible. If the breakthroughs continue, one day we may all be able to fill our gas tanks with water.

Recalling the Facts

1. Why is a hydrogen/electric hybrid better for the environment than a gas/electric hybrid?
2. Even if automobile manufacturers could build them, why would it still be impossible for manufacturers to start selling hydrogen/electric hybrid cars nationwide by 2015?
3. *Student Internet research topic:* Back in 2006, what did GM have to do to build a safe hydrogen/electric hybrid vehicle?
4. Have the construction challenges covered in Question 3 changed much over the last 8 years? Why? TD