SCIENTIST'S NOTEBOOK

The Legend of The Gold Crown

Syracuse, Sicily, (then a Greek seaport, now part of Italy), 287 B.C.–212 B.C.

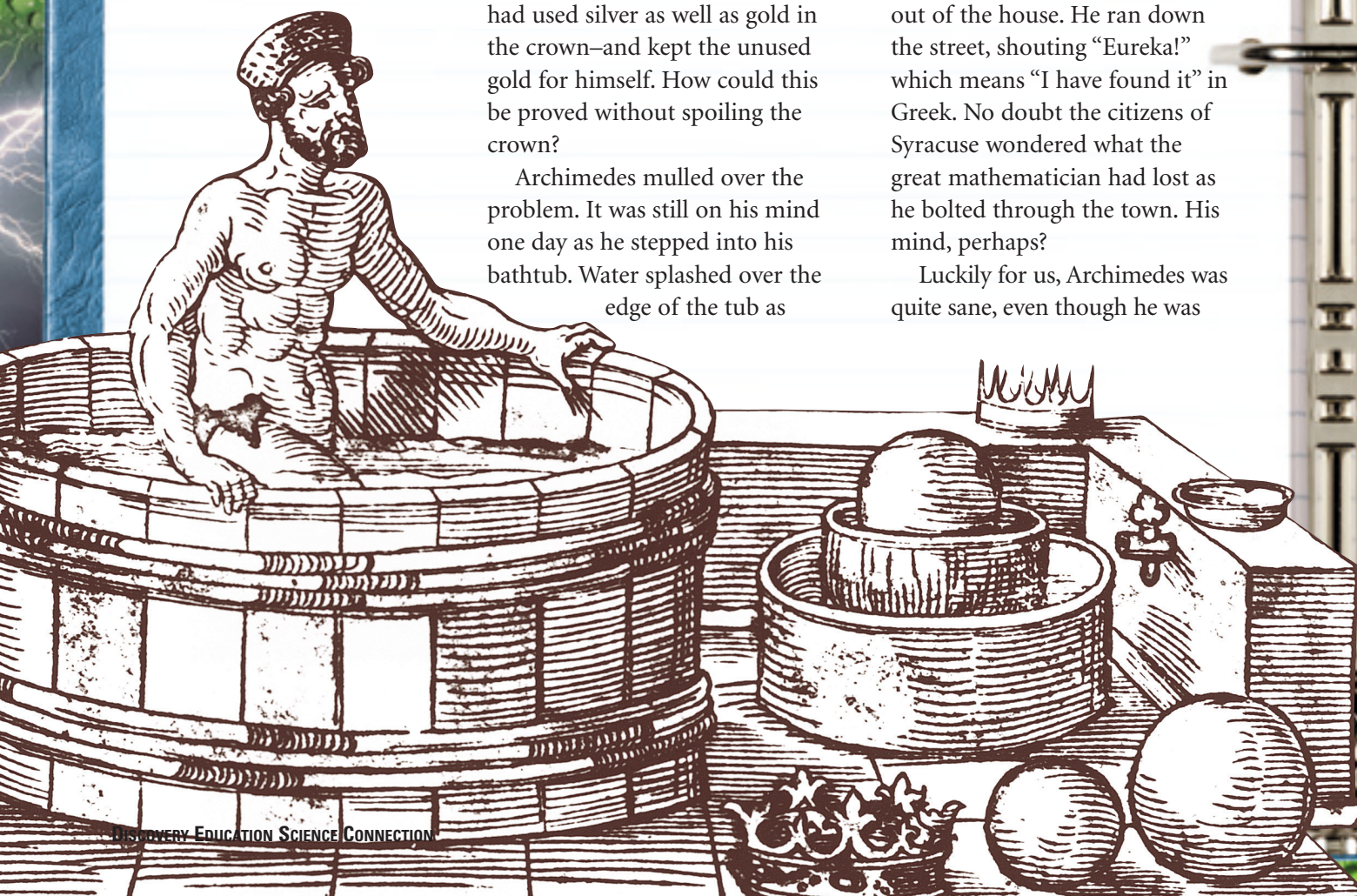
The Wise One. The Master. The Great Geometer. These were a few of the nicknames given to the Greek mathematician Archimedes, a man who forgot to stop for meals when he was hard at work on a mathematical problem. He often gave advice to the ruler of Sicily, King Hiero II, who was his friend.

One day, Hiero II asked Archimedes to help him solve a problem. Hiero II had hired a goldsmith and had given him a block of gold weighing a specified amount to use to make a gold crown. When the crown was finished, Hiero II weighed it. It weighed the same as the gold block the king had given the goldsmith. Yet Hiero II had a sneaking feeling that the goldsmith had cheated him and had used silver as well as gold in the crown–and kept the unused gold for himself. How could this be proved without spoiling the crown?

Archimedes mulled over the problem. It was still on his mind one day as he stepped into his bathtub. Water splashed over the edge of the tub as Archimedes settled into it. As the water dripped, a realization popped into the great mathematician's mind: the water he splashed out of the tub when he got in was equal to the volume taken up by his body.

At that moment, Archimedes knew he had the key to Hiero II's dilemma. More water splashed on the floor as he leaped out of the tub and, without even stopping to grab a towel, dashed out of the house. He ran down the street, shouting "Eureka!" which means "I have found it" in Greek. No doubt the citizens of Syracuse wondered what the great mathematician had lost as he bolted through the town. His mind, perhaps?

Luckily for us, Archimedes was quite sane, even though he was



and the Bathtub

forgetful about ordinary things such as towels and clothes. But what did the water in the bathtub have to do with whether Hiero II's crown was pure gold or a mixture of silver and gold?

Well, Archimedes knew that a piece of gold weighs more than a piece of silver the same size. According to legend, Archimedes weighed the king's crown. Then he got a piece of pure gold that weighed the same amount as the crown. He placed the gold into a bowl of water, measured how much it made the water rise, and took the gold out.

Next, he put the crown into the water and saw that it made the water rise higher than the piece of gold had. Why? Because this crown was larger than one made of pure gold. The goldsmith had to make the crown larger when he substituted silver for some of the gold so that it would weigh the same as a pure gold crown. But the silver-gold crown took up more space in the bowl and made the water rise higher.

Because Archimedes took a bath, the dishonest goldsmith was now in hot water!

2,000 Years Later

Modern historians note that there are some things wrong with the Archimedes story. Nobody knows for sure whether Archimedes ran through Syracuse naked, for one thing. More important, the difference in the amount of water displaced by a pure gold crown and a silver gold crown is so small that it couldn't have been measured using the tools that existed in Archimedes' time. Also, water would cling to objects as they were taken out, which would distort the results. But even if the story is wrong in its details, Archimedes' principle has remained true for the past 2,000 years!

Activity

FLOAT IT! **Scientists today call Archimedes' discovery the Archimedes Principle. It states that an immersed object is "pushed up" or buoyed up by a force equal to the mass of liquid it displaces. What does this mean? Liquids push up against the bottom of objects. This is buoyant force. Objects float when the buoyant force of the liquid is greater than the weight of the object. A big and heavy object floats when the force of the water pushing up against it is greater than its mass. Two objects can have the same mass, yet one might sink while the other one will float. This happens when one has the mass spread out more, taking up more space for the water to push against.**

To test this idea of buoyant force, get a piece of clay or play dough about the size of a golf ball. Work it into different shapes, testing each shape to see if it sinks or floats. What are you holding constant by using the same ball of clay? What are you changing?