Archimedes was an inventor, engineer, mathematician, and all-around smart guy in the ancient Greek city of Syracuse. One day in 265 BC, as he was about to take a bath, his cousin King Hiero sent for him to help solve a problem.

The king wants you! Okay, I guess bathtime will have to wait. Thank goodness you’re here, Archimedes. Listen: I gave a bar of gold exactly like this to a goldsmith to make into a crown.

Well, silver weighs less than gold. If some gold was replaced with an equal weight of silver, the silver would have to have a larger volume than the stolen gold. So the volume of the crown would be greater than the volume of the gold bar you started with.

Here it is—it’s a real beauty, made to look like a laurel wreath. This balance scale shows that its weight is exactly the same as the weight of the gold I gave to the goldsmith, so I figured everything was fine.

But then I heard a rumor that the goldsmith had stolen some of the gold and replaced it with an equal weight of silver, melting them together before making the crown. Can you help me figure out if the goldsmith cheated me?

Gold Crown

Gold and Silver

Mmm–hmm...
Eureka!!! *

"Eureka" is Greek for "I found it."

As Archimedes lowered himself into his bath, he noticed the water level rising...

**WEIGHT AND VOLUME. HMMM. HOW CAN I FIND THE VOLUME OF AN IRREGULARLY SHAPED OBJECT? HMMM, MUTTER, MUTTER...**

**EUREKA!!! ***

I wonder what Archimedes found? Not his clothes, I guess...

* “Eureka” is Greek for “I found it.”

If we melted the crown and shaped its metal into a cube, we could easily compare its volume to that of an equal weight of gold.

But I don’t want to melt it if it’s a genuine, pure gold crown. I really like it!

That’s certainly a complicating factor.

Right. So what are we going to do?

We? Well, what I’m going to do is go take my bath. This problem seems impossible.

That’s certainly a complicating factor.

Right. So what are we going to do?
It's not crazy at all. Watch! We'll start with two containers, each with the same volume of water. We'll put the gold bar in one and the crown in the other.

"Displaces"?

Yes. If we submerge the crown in water, the water level will rise in the container because the crown displaces the water: the crown takes the place of the water, and so the water level has to rise to make up for the added volume of the crown.

It's so crazy it just might work...

It's not crazy at all. Watch! We'll start with two containers, each with the same volume of water. We'll put the gold bar in one and the crown in the other.

If the goldsmith put all the gold into the crown, it should displace exactly the same volume of water as the gold bar. But if he swapped some of the gold for an equal weight of silver, the crown should displace...

...a greater volume of water!
Next? I think I'll finally go finish taking my bath...

Aw, shucks, I just pay attention and think about things, that's all. As I lowered myself into my tub, I realized that a submerged object must **displace** an amount of water equal to its volume.

What's more, an object that is lighter than water will stop sinking and float at the point where the amount of water it **displaces** has a weight equal to the weight of the object. We can call this ability of water to hold up light objects "buoyant force," and we can call the ratio of volume to weight (or, strictly speaking, mass) "density," and furthermore...

Do you get it?!

Yes... yes I get it! And, oh boy, is that no-good goldsmith going to get it!

Well, Archimedes, you really are the smartest guy in Syracuse.

Hold on, hold on... you're making my head spin with all these new concepts! What will you think of next?!

Next? I think I'll finally go finish taking my bath...

The End

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