Archimedes Principle

The Greek Scientist Archimedes made a brilliant discovery around 212 BCE. Hiero II, ruler of Syracuse, suspected that the royal goldsmith had not used pure gold to make his crown. The king asked Archimedes to determine whether the crown was made entirely of gold.

Archimedes knew that all he had to do was determine whether the 1)density of the crown matched the density of gold. The formula for density is “Density = Mass ÷ Volume ” or “*D = m÷V”.*  Therefore, Archimedes could measure the 2)mass of the crown easily with a balance. How could he measure the volume of an object as irregularly shaped as a crown?

Archimedes solved the problem while at the public baths. He stepped into the almost-full bath, and water gushed all over the floor. The solution to the problem came to Archimedes in a flash, a solid object can 3)displace water out of a container. That is, a solid object can move water out of the way.

Archimedes reasoned that the water that was displaced in the tub must have exactly the 4)same 5)volume as the volume of his body. Therefore, to find the volume of the crown, Archimedes would simply submerge the crown in a container full of water. He would then collect and measure the volume of the water that spilled out. When Archimedes carried out this test, he showed that the crown was made of a mixture of gold and silver. He concluded that the goldsmith had tried to cheat the king

Archimedes applied his new ideas to another 6)property of fluids. He believed that the displaced fluid held the key to whether the object placed in the fluid would 7)sink or 8)float. He wondered why he would sink if he stepped into a bathtub, but he would float if he stood in a boat on the water, He concluded that the amount of 9)buoyant 10)force that would push up against the object immersed in the fluid would equal the force of 11)gravity (the weight) of the fluid that the object displaced.

The 12)particle 13)theory can explain why this was a reasonable conclusion. If the water in a container is still, or at rest, then the water particles are neither rising nor sinking. An object immersed in a fluid such as water does not rise or sink *if the amount of force pulling down (gravity) 14)equals the amount of force pushing up (15)buoyancy).* This condition is known as 16)neutral 17)buoyancy, therefore, the water particles in the lower part of the container must be exerting a buoyant force 18)equal to the weight, or force of gravity, of the water displacing it.

If 1 Litre of water is displaced, the object replacing it would have the 19)same 20)volume (1 L) but might have a 21)different 22)weight than the 1 Litre of water. If the object is 23)heavier than the displaced water, then the weight of the object will be a force 24)greater than the buoyant force that had supported the displaced water. Thus, the object will 25)sink. If the object is lighter than the displaced water, the object will 26)rise to the surface and then 27)float.

When Archimedes stepped into the bath, he sank because the amount of water that he displaced weighed 28)less than he did. When he stepped into a boat, however, a 29)larger 30)volume of water was displaced. The weight of the water far exceeded the weight of the boat and Archimedes combined. Therefore, the 31)buoyant 32)force was 33)greater and the boat, with Archimedes in it, floated on the surface.

Why would Archimedes and his boat not continue to rise, with such a large buoyant force pushing it upward? At the surface, of the water, the fluid supporting the object is 34)air. As mentioned earlier, the buoyancy of air is much 35)less than that of water. Therefore, the upward motion 36)stops at the water’s surface.

Archimedes made the following conclusion, now known as 37)Archimede’s 38)Principle: *The buoyant force acting on an object equals the weight (force of gravity) of the fluid displaced by the object*. Archimede’s principle is useful in predicting whether object will sink or float. Note that the buoyant force 39)does 40)not depend on the 41)weight of the submerged object, but rather on the weight of the 42)displaced 43)fluid. A solid cube of aluminum, a solid cube of iron, and a hollow cube of iron, all of the same volume, would experience the 44)same buoyant force.