

Archimedes

(287-212 B. C.)

Archimedes was killed in 212 B. C., at the age of seventy or over. He was not only a first-rate mathematician, but a first-rate scientist. As a mathematician, he broke away from the formal and rather narrow methods of Greek geometry, and invented something very like the integral calculus.

Among the propositions which he proved was that the area of a sphere is the same as that of the curved part of a cylinder which just fits round it. The design of a sphere in a cylinder was engraved on his tomb. He also showed that, the ratio of the circumference of a circle to its diameter, is between $3 \frac{1}{7}$ and $3 \frac{10}{71}$.

But his most important work was the founding of the science of hydrostatics. According to the story usually told, King Hieron of Syracuse had bought a crown which was alleged to be of pure gold. The king suspected that it had a core of mere silver, but did not want to cut it open, so he asked Archimedes how to decide the question.

Archimedes hit on the answer in the public bath, and was so excited that he rushed through the streets to the palace without dressing. If this is true, he was the first absent-minded professor in history, and the crown was worth more than all other crowns put together.

He saw that a pound of silver occupies nearly twice as much space as pound of gold, and that bulk can be measured by putting each in a full vessel, and measuring how much water runs over. So he compared the bulk of the crown with those of an equal weight of silver.

This led at once to the notion that every substance has a characteristic density, or specific gravity. Thus a cubic inch of gold weighs 19.25 times as much as a cubic inch of water, while a cubic inch of silver weighs 10.5 times as much. So a silver crown displaces nearly twice as much water as a golden crown of the same weight, and a mixed one displaces an intermediate amount.

For thousands of years before Archimedes merchants had been weighing and measuring. Weight and bulk are examples of what are called extensive properties of matter. They add up. Two pounds and three pounds make five pounds, and so on.

But density is an intensive property. It does not add up. If you mix a metal with a density of 6 and one with a density of 10, you do not get an alloy with a density of 16, but usually with one somewhere between 6 and 10.

World Famous Scientists

Modern physics and engineering are based on intensive properties which can be measured. Here are few of them. Temperature, electrical conductivity, heat conductivity, hardness, elasticity, refractive index, albedo (fraction of light reflected) melting-point, boiling-point, solubility in water, magnetic susceptibility, coefficient of thermal expansion, viscosity.

Any engineer could mention dozens more. There are other extensive properties besides weight and bulk, such as heat content, entropy, electrostatic capacity, and so on. But physics could not start without the measurement of the intensive properties.

Archimedes went on to found the science of hydrostatics, and did it so well that some of his propositions are taught today, almost without change. And he made a beginning with statics, introducing such fundamental ideas as that of the centre of gravity.

He laid the foundations of physics, but very little was built on them until Stevin continued his work on statics, and Galileo founded dynamics, in the sixteenth century A. D. science died out when the free Greek cities such as Syracuse were conquered by the Romans, and was born again in the United Provinces of the Netherlands, and in the free cities of Italy.

We can see why it died out from the life of Archimedes himself. He invented a number of machines, including a screw for raising water, and others used in defending Syracuse against the Romans. He is said to have set fire to their ships with a concave mirror, but this is no more possible than the heat ray in Wells's *The War of the Worlds*.

He refused to write accounts of any these inventions, except a sphere for demonstrating the motions of the planets. He regarded them as beneath the dignity of a philosopher. This attitude to manual work was inevitable in a society based on slavery. But the gap between thought and manual work was not very wide in the Greek cities, where many citizens were craftsmen, and if they owned a slave or two, worked beside them at the bench.

As the Romans conquered the Mediterranean basin, and made millions of slaves, the gap became so great that science died out. Eighteen centuries later, in Holland and Italy, craftsmen once more became leading citizens, and science started again.

There was another reason why science decayed under the Roman Empire. Unemployment developed among the free population of Rome and other great towns, while the slaves were worked to death. The government paid for the building of temples, baths, circuses, and other buildings to give work.

The historian Suetonius tells us that an inventor approached the emperor Vespasian with a machine for moving heavy stones. He turned it down because it would have displaced labour.

Science only flourishes in special conditions. Italian science has been decaying for a generation or more, and Fermi, the greatest living Italian scientist, is a refugee in America. Sicily still produces mathematics, but little or no science.

If Archimedes's countrymen are allowed to decide their own destinies, the liberation of Sicily may make it possible for Sicilians once more to serve humanity as Archimedes served it.

Questions

A

1. What were the achievements of Archimedes as a mathematician?
2. Retell briefly the story of how Archimedes came to the notion that every substance has a characteristic density or specific gravity.
3. What is the difference between intensive and extensive properties of matter?
4. Of what branches of science did Archimedes lay the foundation?
5. Why did Archimedes refuse to give accounts of his inventions?
6. Why did science decay under the Roman Empire?
7. What style does the author use to describe scientific achievements?
8. Find in the text the sentences where Passive Voice is used?
9. Explain the difference between «find» and «found».

B

1. What intensive and extensive properties of matter besides those mentioned in the text do you know? Describe some of them.
2. Speak on the links between science and practice in ancient and modern times.