ARCHIMEDES AND HIS NUMBERS

BIOGRAPHY BOOKS FOR KIDS 9-12

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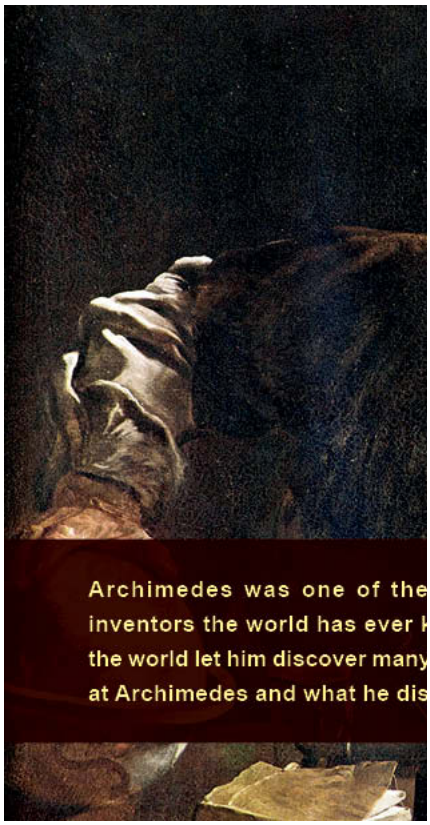
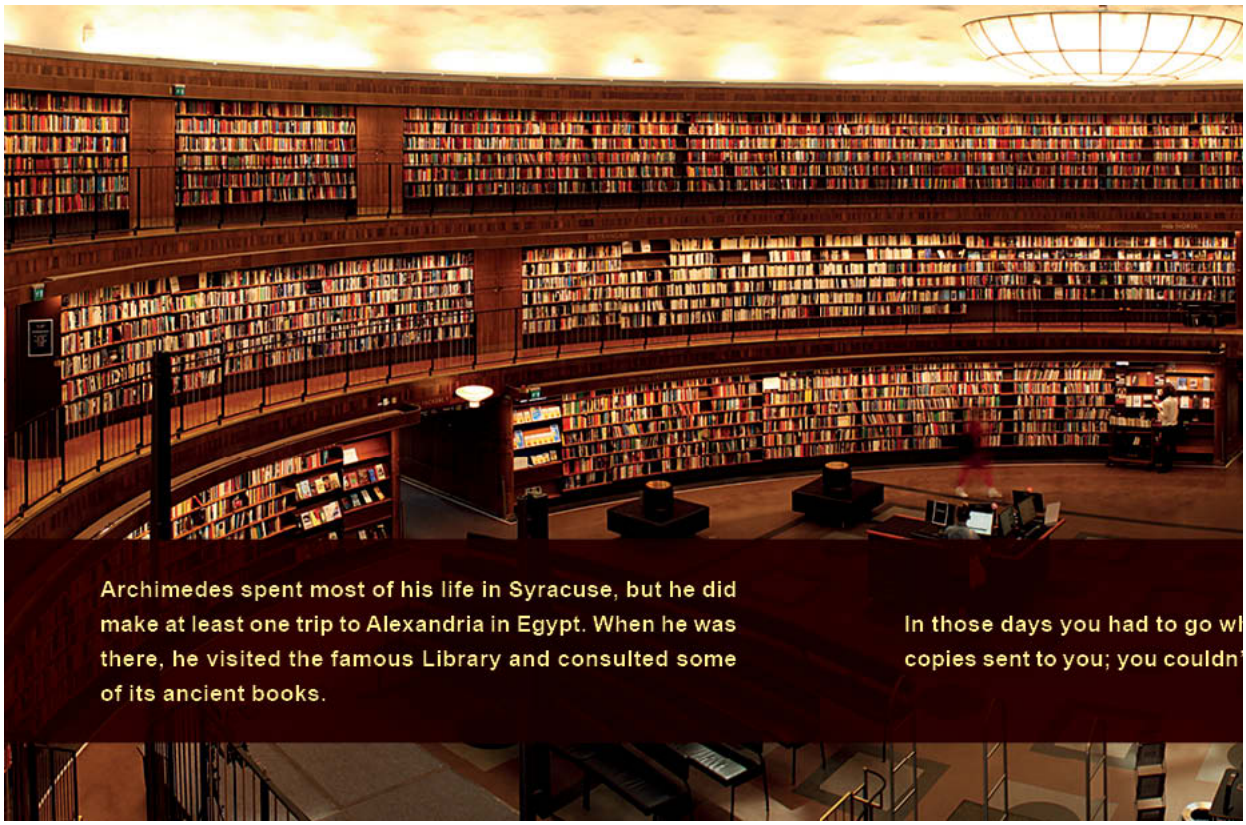
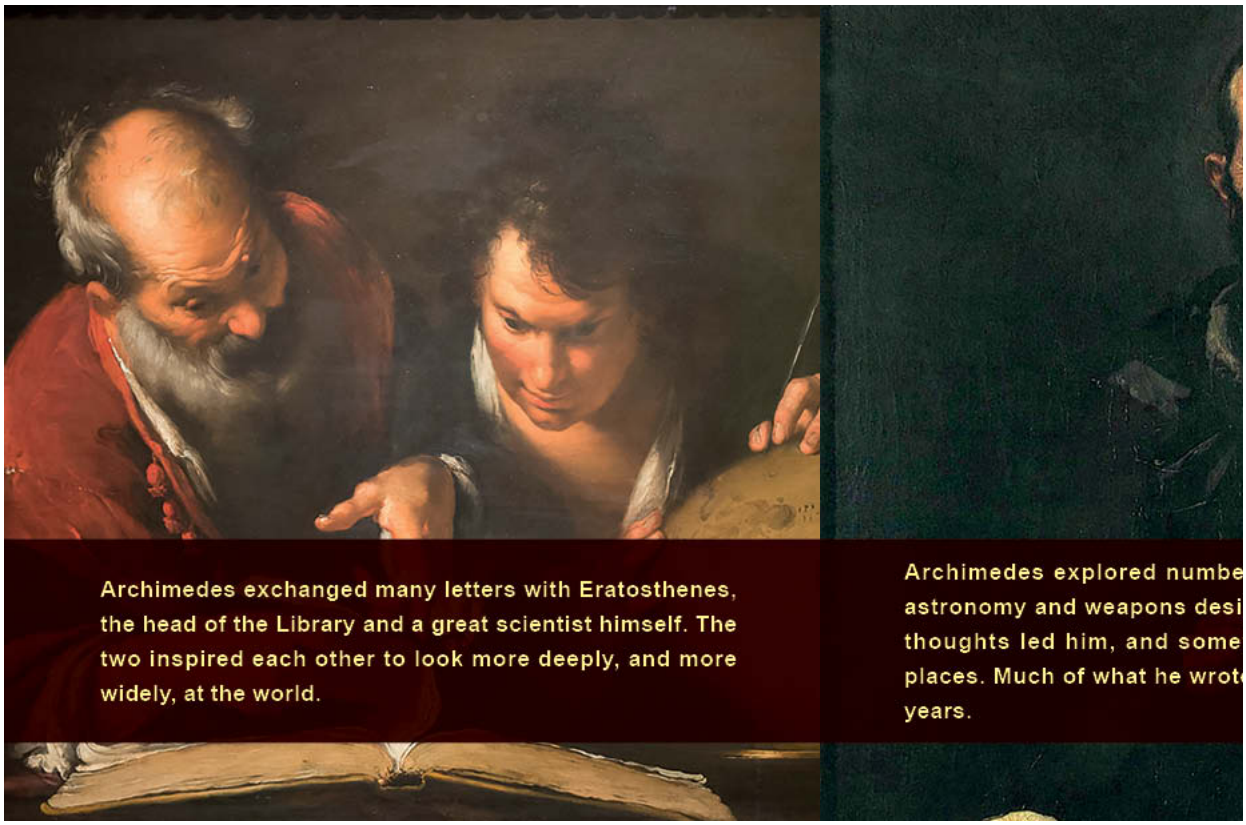


Archimedes was born in the Gre
now part of Italy, about 287 B
an astronomer.



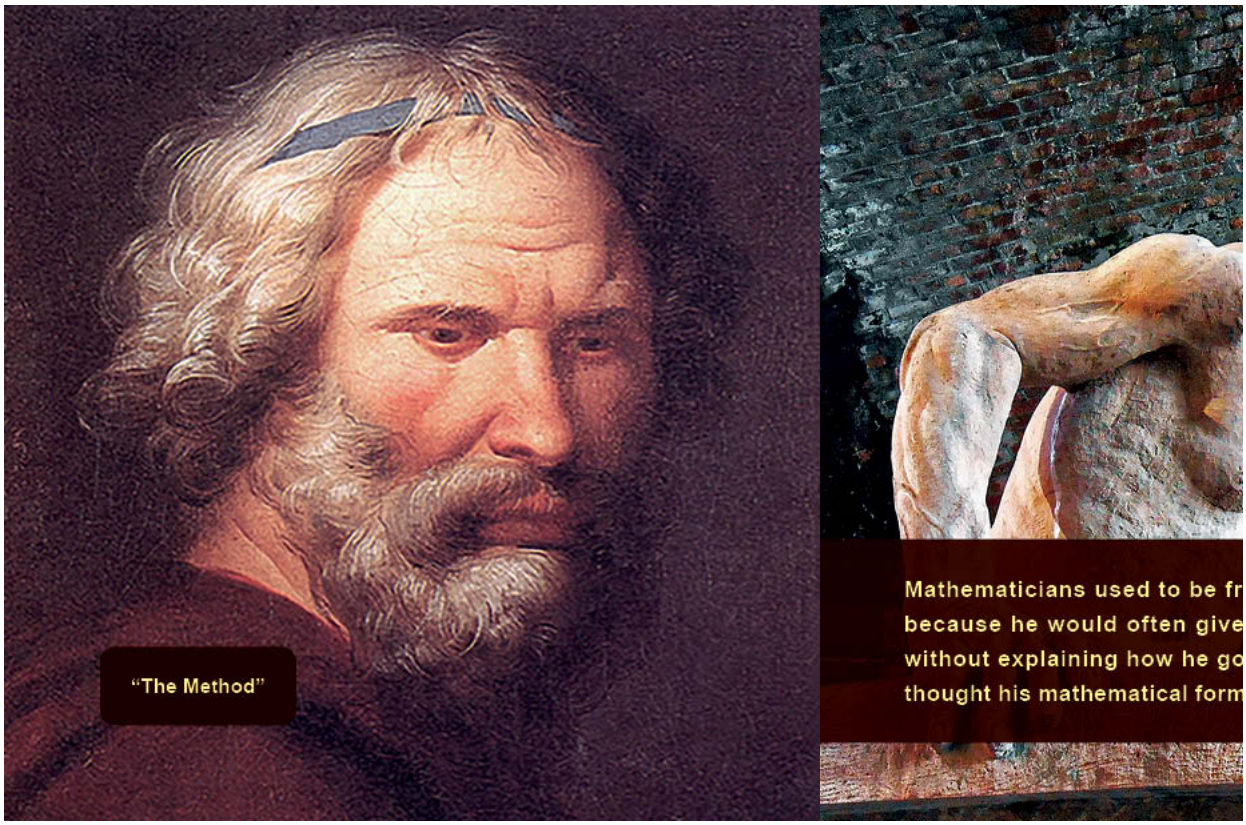
Archimedes spent most of his life in Syracuse, but he did make at least one trip to Alexandria in Egypt. When he was there, he visited the famous Library and consulted some of its ancient books.

In those days you had to go wh
copies sent to you; you couldn'



Archimedes exchanged many letters with Eratosthenes, the head of the Library and a great scientist himself. The two inspired each other to look more deeply, and more widely, at the world.

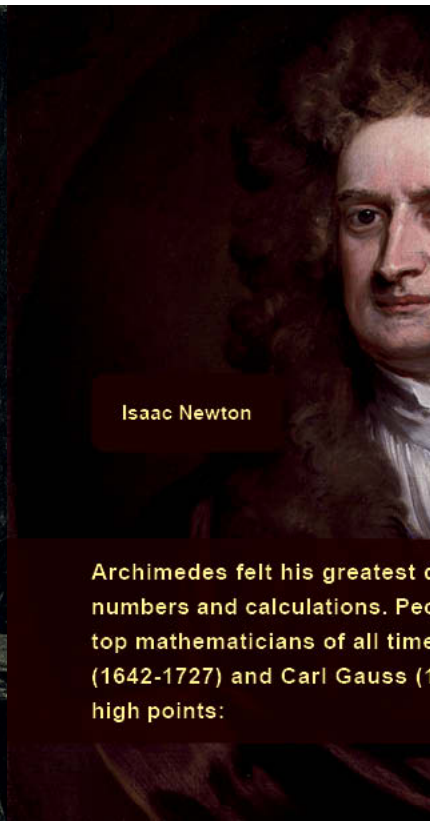
Archimedes explored numbe
astronomy and weapons desi
thoughts led him, and some
places. Much of what he wrot
years.


"The Method"
Mathematicians used to be fr
because he would often give
without explaining how he go
thought his mathematical form


Then, in 1906, Johan Heiberg found an old Christian prayer book in what is now Istanbul, Turkey.
Heiberg noticed that someon
material from the book before

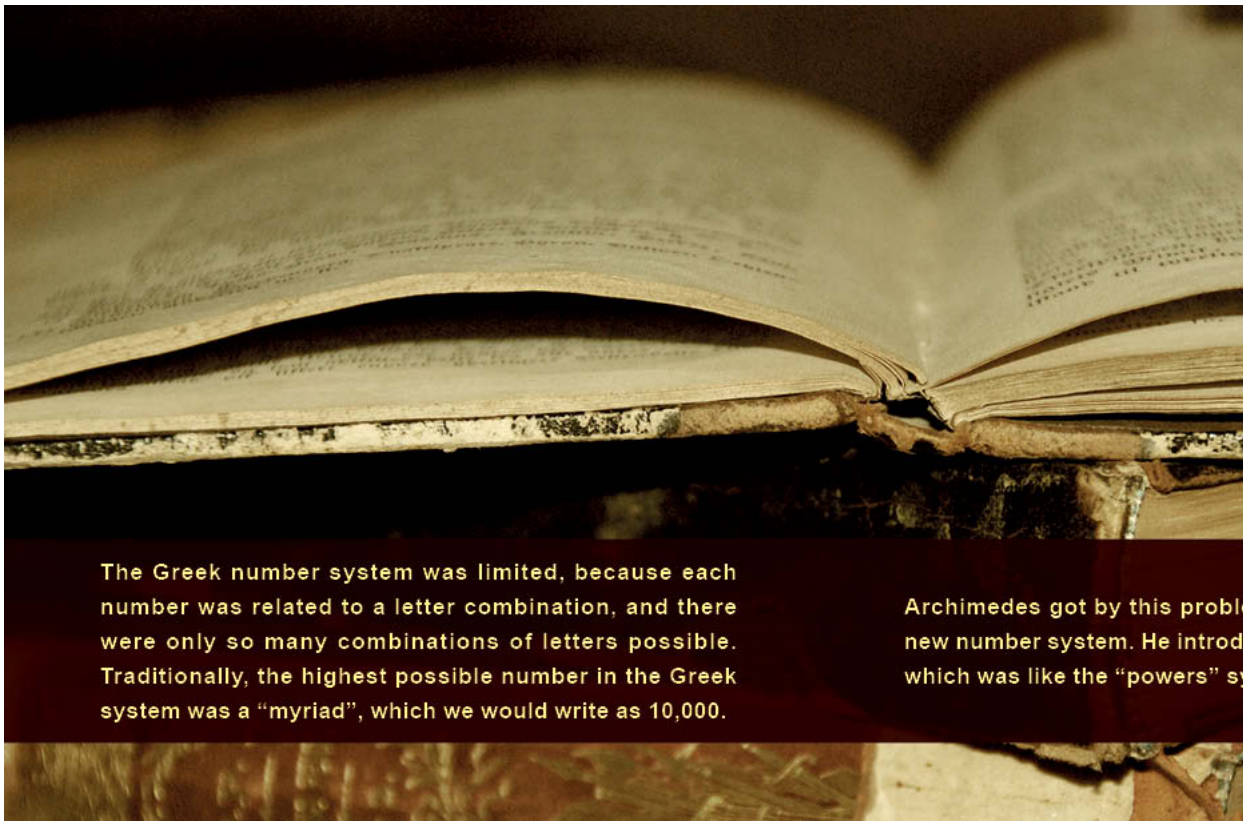
That older material turn
century copy of Archim
which he explained how
had sent the original to l
for safe-keeping, but all c
the prayer book had been
the centuries.

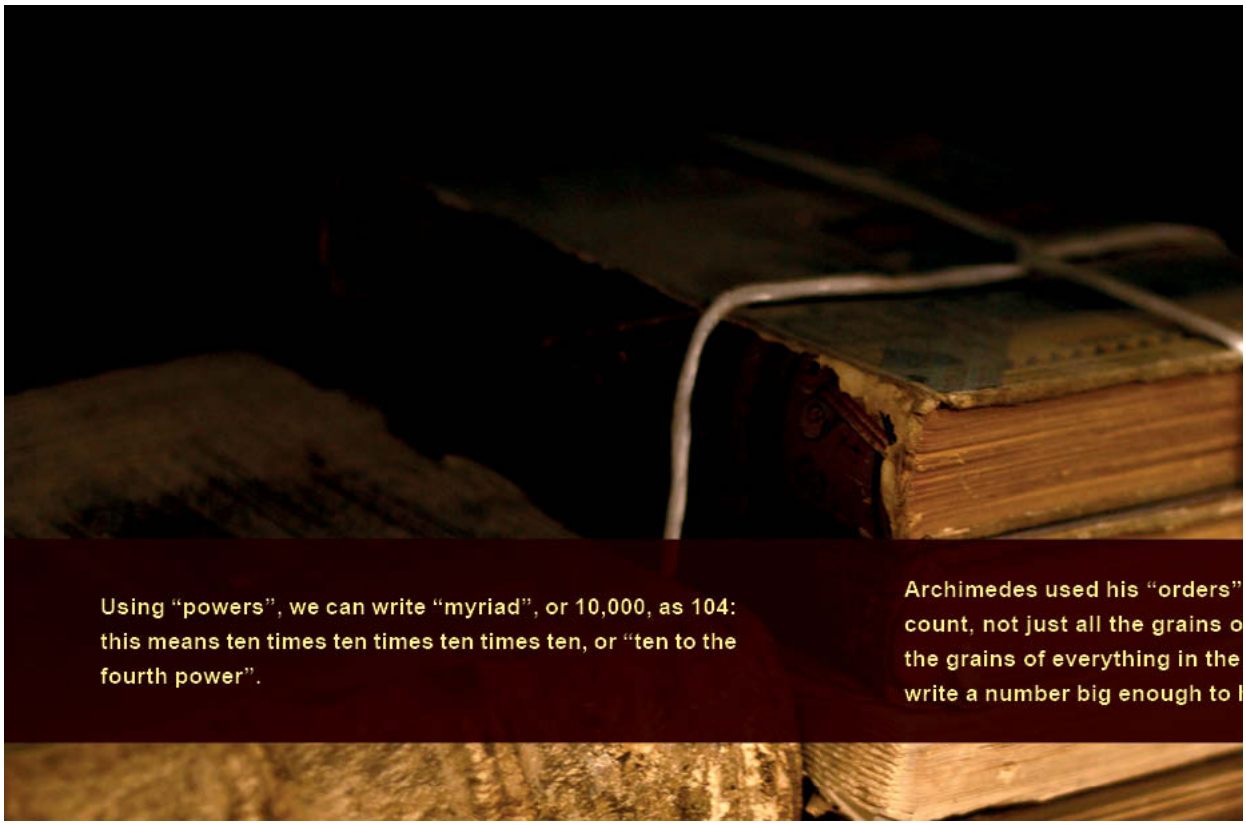

Archimedes


Isaac Newton
Archimedes felt his greatest
numbers and calculations. Pe
top mathematicians of all tim
(1642-1727) and Carl Gauss (
high points:

The Beast Number

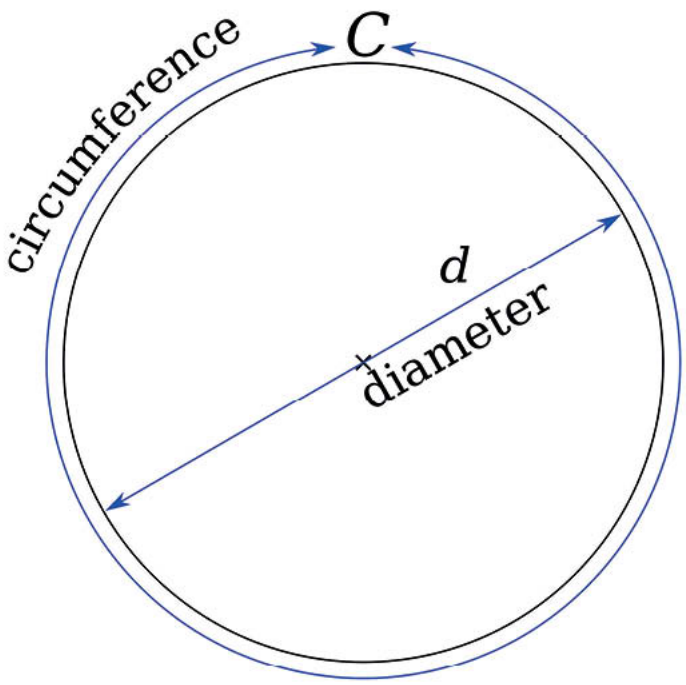
Archimedes became annoyed by people saying it would not be possible to count the number of grains of sand in the sea, or the number of drops of water in the ocean, because numbers could not go that high.

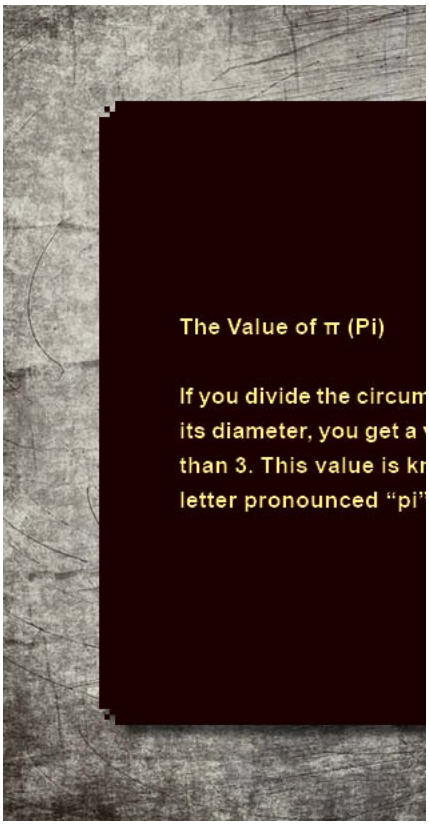

The Greek number system was limited, because each number was related to a letter combination, and there were only so many combinations of letters possible. Traditionally, the highest possible number in the Greek system was a “myriad”, which we would write as 10,000.
Archimedes got by this probl
new number system. He introd
which was like the “powers” s

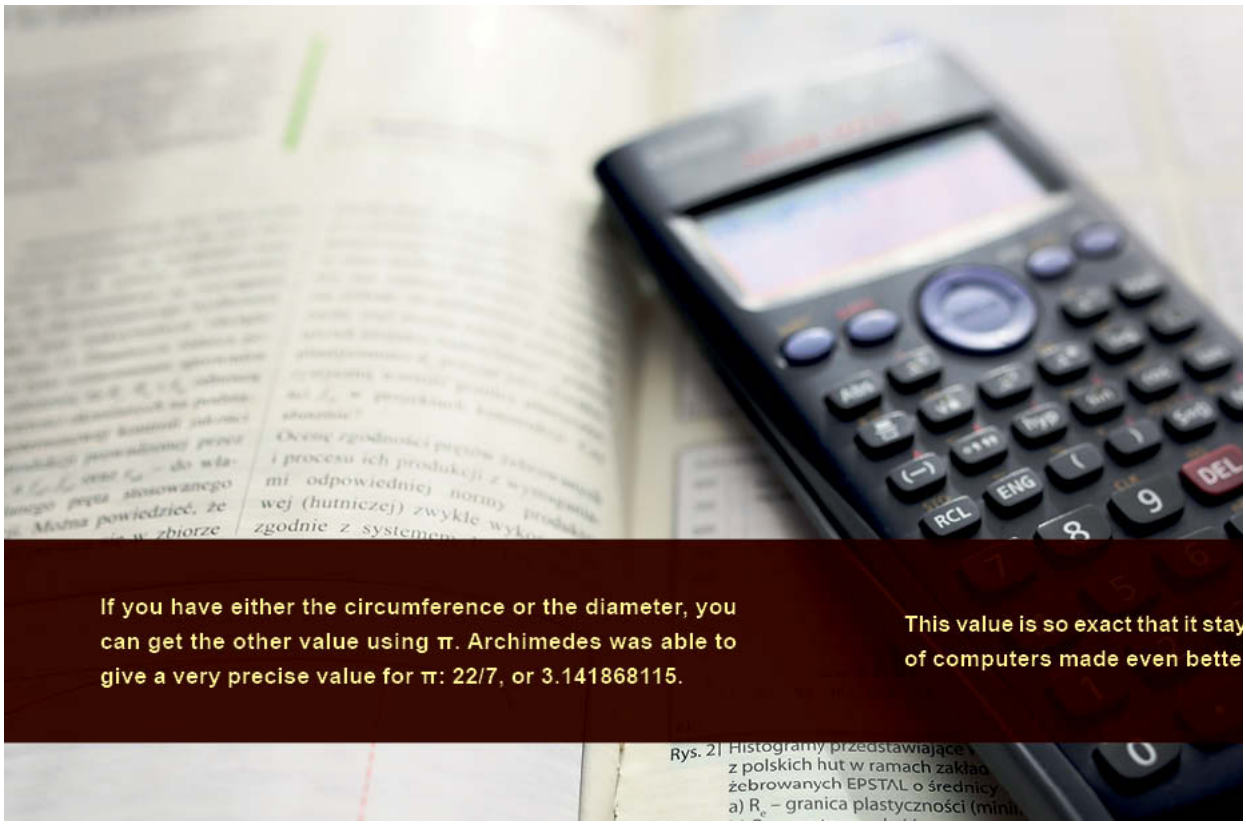


Using “powers”, we can write “myriad”, or 10,000, as 104: this means ten times ten times ten times ten, or “ten to the fourth power”.

Archimedes used his “orders”
count, not just all the grains o
the grains of everything in the
write a number big enough to

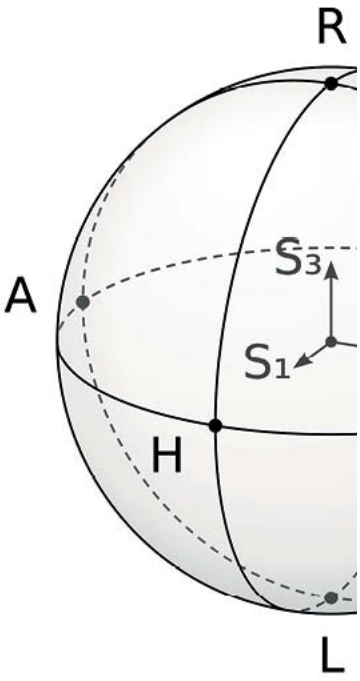

circumference
C
d
diameter

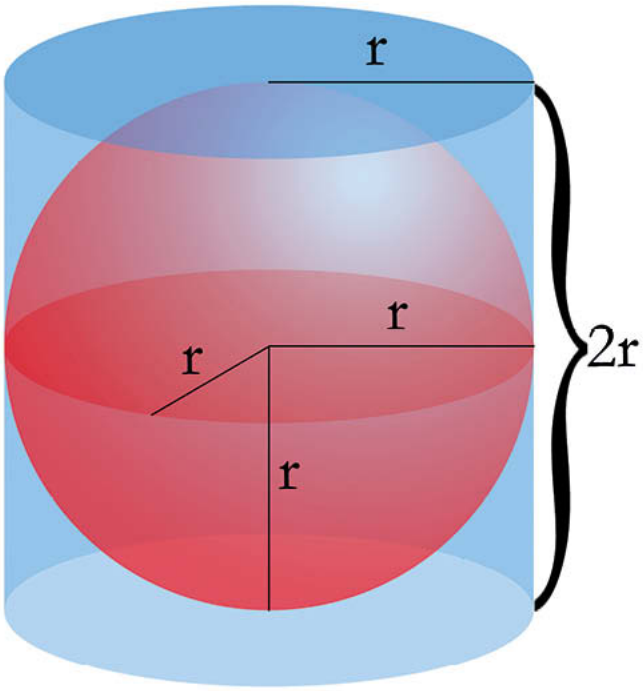

The Value of π (Pi)
If you divide the circum
its diameter, you get a
than 3. This value is kn
letter pronounced “pi”

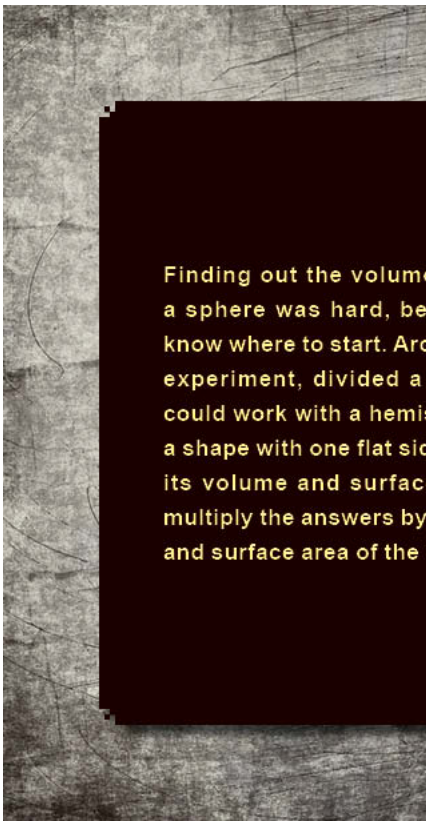

If you have either the circumference or the diameter, you can get the other value using π. Archimedes was able to give a very precise value for π: 22/7, or 3.141868115.
This value is so exact that it stay
of computers made even bette

Measuring a Sphere

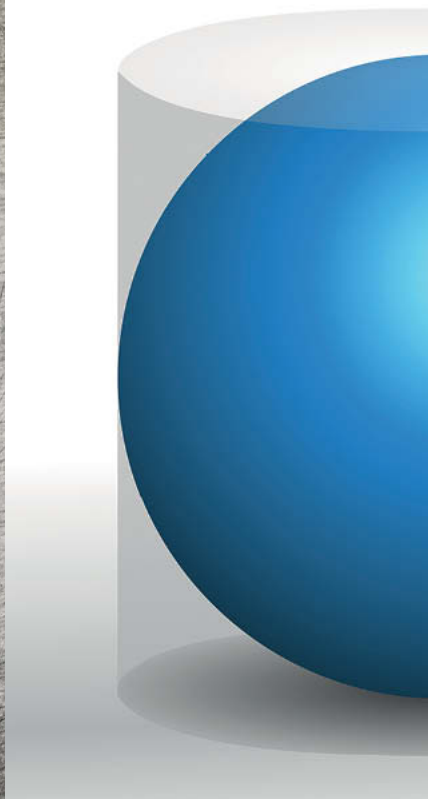
Archimedes considered this his greatest work. He asked that his tomb should have a symbol on it (a sphere inside a cylinder) marking this discovery.

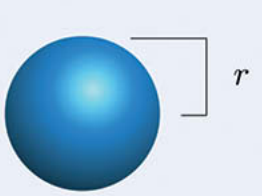


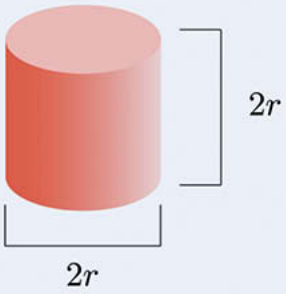

r
r
r
r
2r


Finding out the volum
a sphere was hard, be
know where to start. Arc
experiment, divided a
could work with a hemi
a shape with one flat sic
its volume and surfac
multiply the answers by
and surface area of the

Okay, so now in his imagination Archimedes has a hemisphere inside a cylinder. The width and height of the cylinder are the same as the diameter and radius (the value r, equal to half the diameter) of the sphere. Measuring a cylinder was already known: its volume was πr2h. Since in this example radius (r) and height (h) are the same value, we can simplify the statement to πr3.



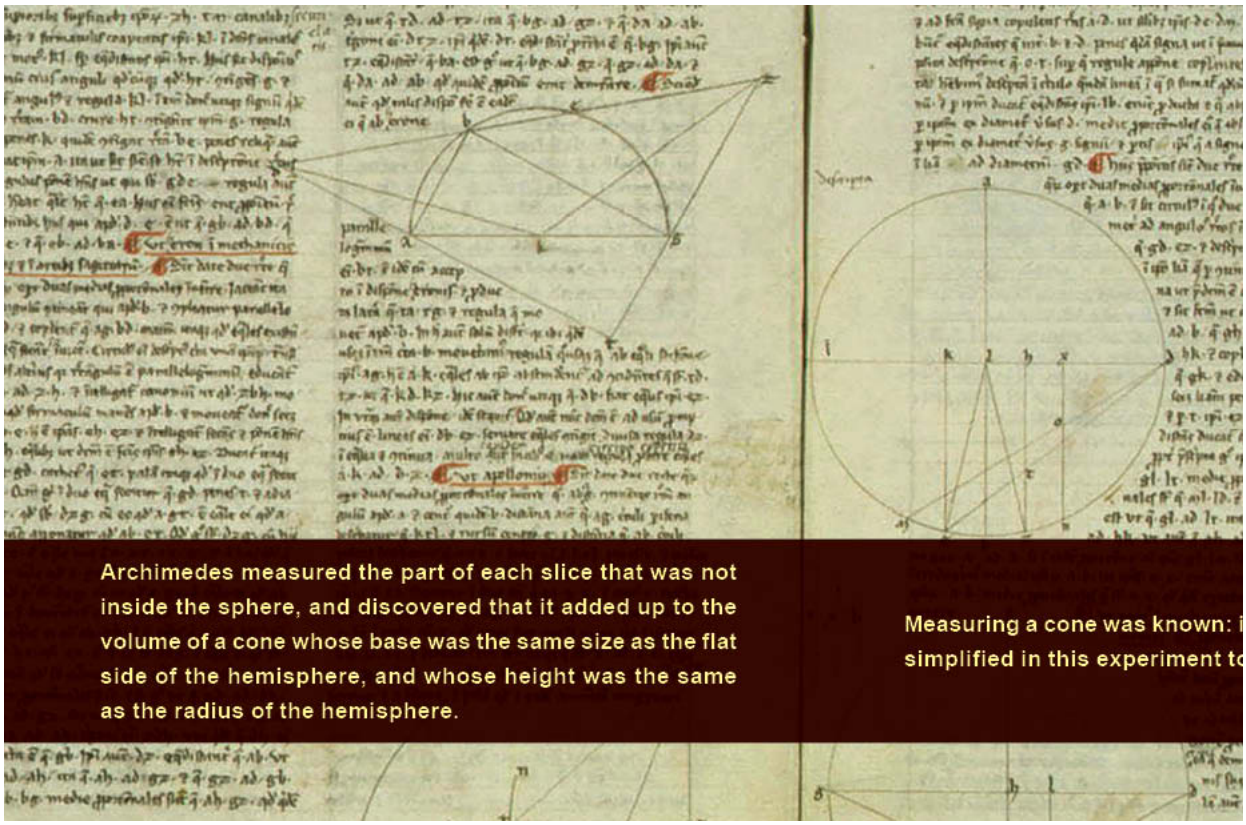




$$\frac{V_{\text{cylinder}}}{V_{\text{sphere}}} = \frac{\pi r^2 \cdot (2r)}{\frac{4}{3}\pi r^3} = \frac{3}{2}$$

$$\frac{A_{\text{cylinder}}}{A_{\text{sphere}}} = \frac{2 \cdot \pi r^2 + 2\pi r \cdot 2r}{4\pi r^2} = \frac{3}{2}$$

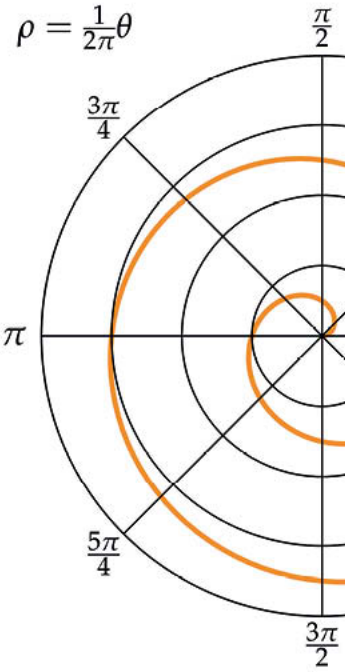
So Archimedes knew
hemisphere would be l
the hemisphere was in
how much less? In his im
started slicing the cylinc
a round loaf of bread. E
the middle for the part
inside the sphere.

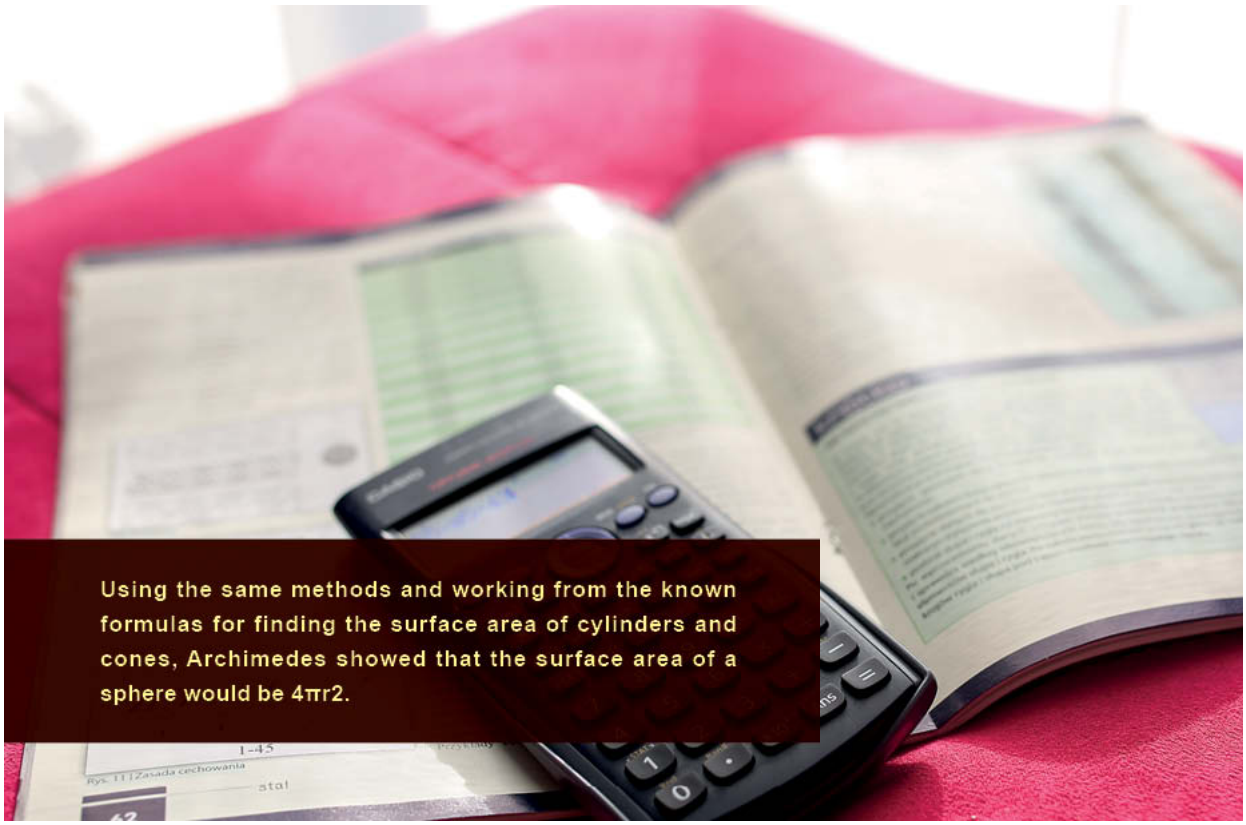


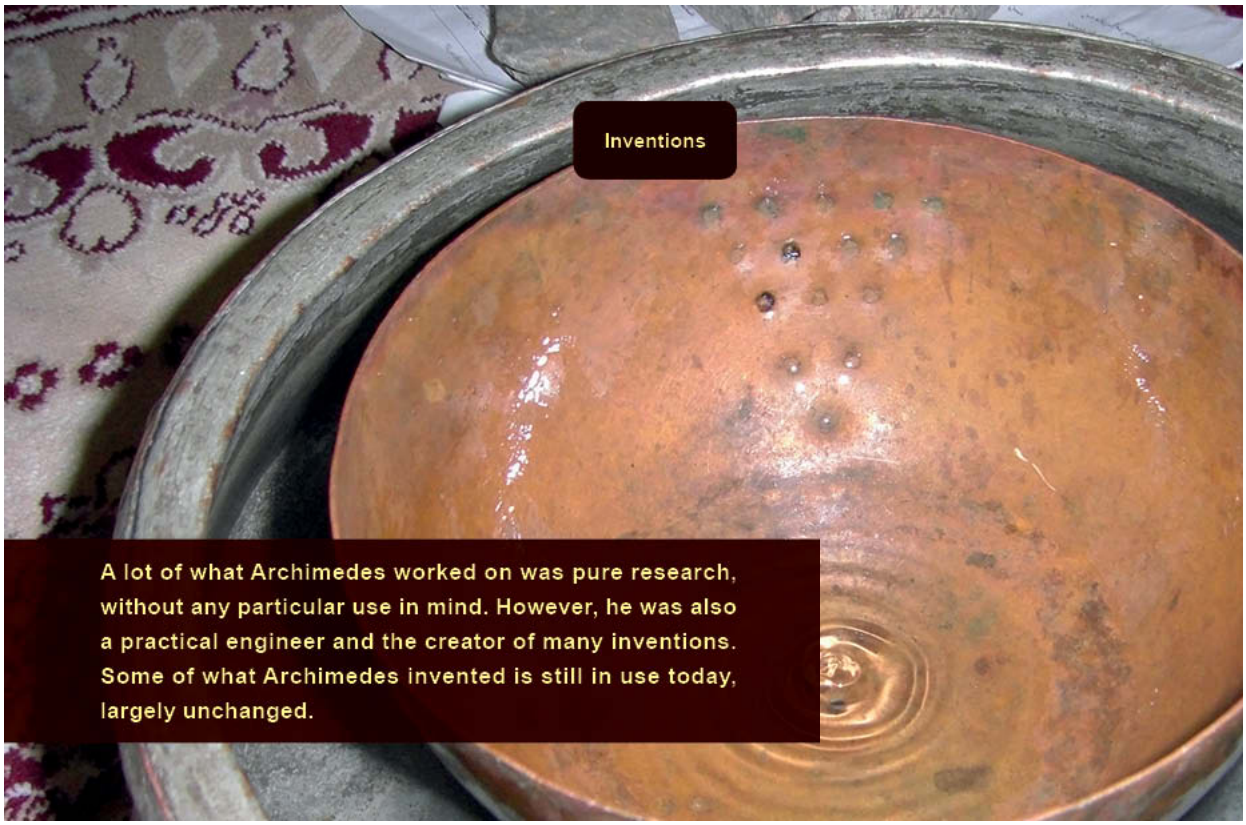
Archimedes measured the part of each slice that was not inside the sphere, and discovered that it added up to the volume of a cone whose base was the same size as the flat side of the hemisphere, and whose height was the same as the radius of the hemisphere.

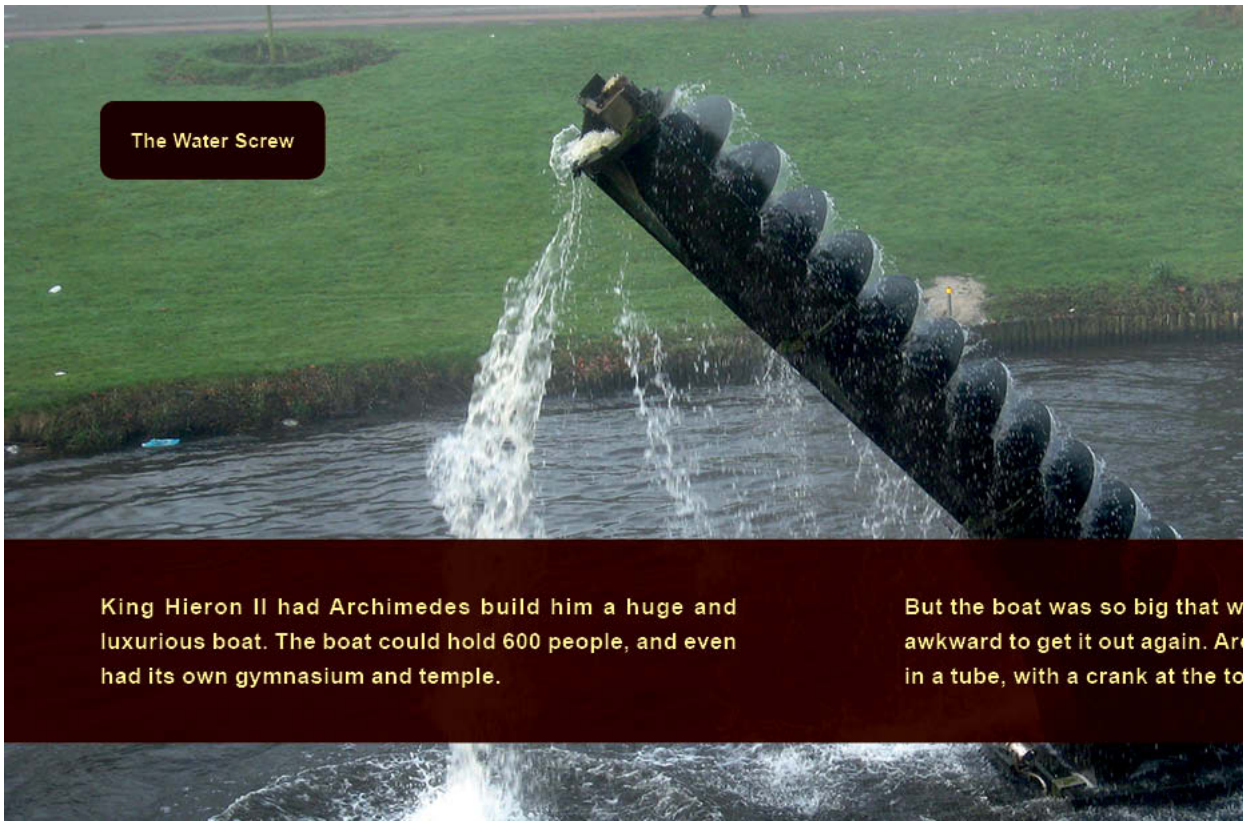
Measuring a cone was known: i
simplified in this experiment to

Having gotten to here, Archimedes knew that the volume of the hemisphere would be the volume of the cylinder minus the volume of the cone: πr3 - ⅓πr3, or ⅔πr3. Now that he had the volume of a hemisphere, he showed that the volume of the whole sphere would be two times that, or 4/3 πr3.



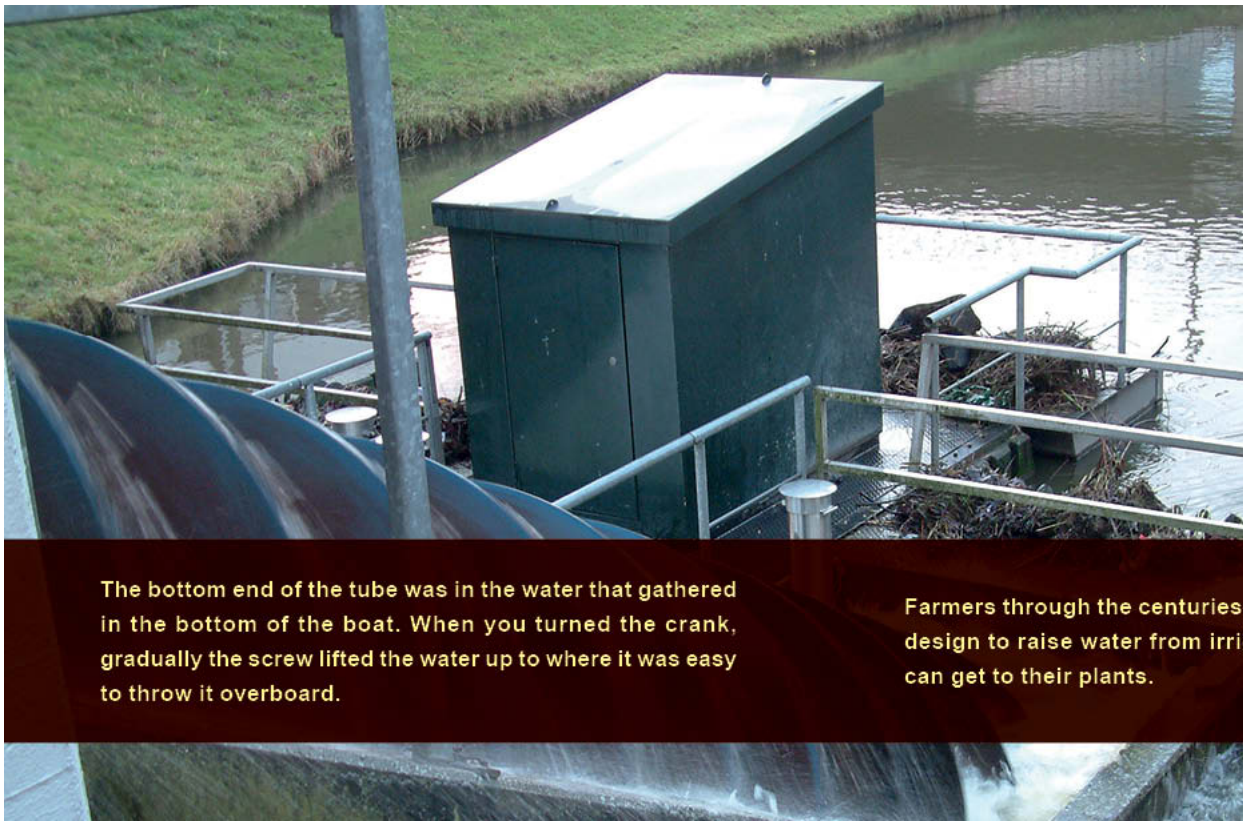

Using the same methods and working from the known formulas for finding the surface area of cylinders and cones, Archimedes showed that the surface area of a sphere would be 4πr2.


Inventions
A lot of what Archimedes worked on was pure research, without any particular use in mind. However, he was also a practical engineer and the creator of many inventions. Some of what Archimedes invented is still in use today, largely unchanged.



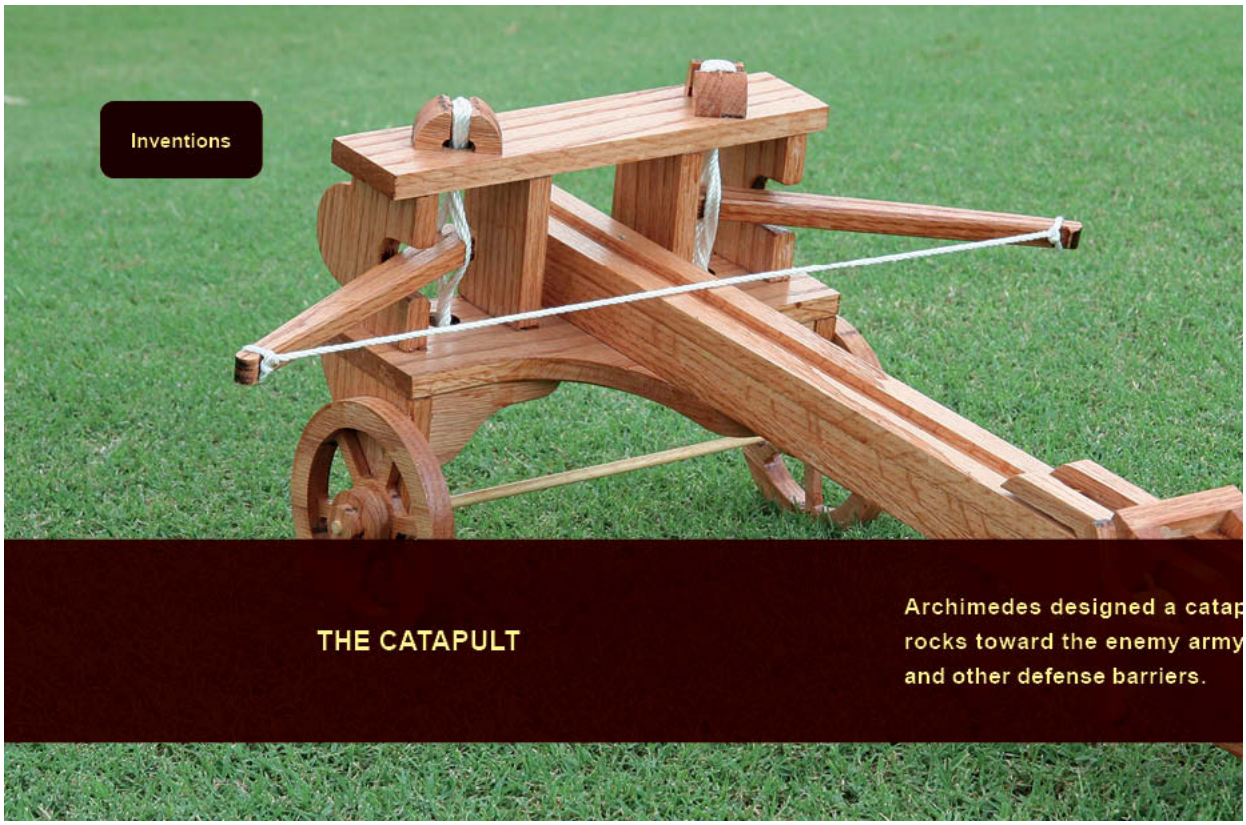
King Hieron II had Archimedes build him a huge and luxurious boat. The boat could hold 600 people, and even had its own gymnasium and temple.

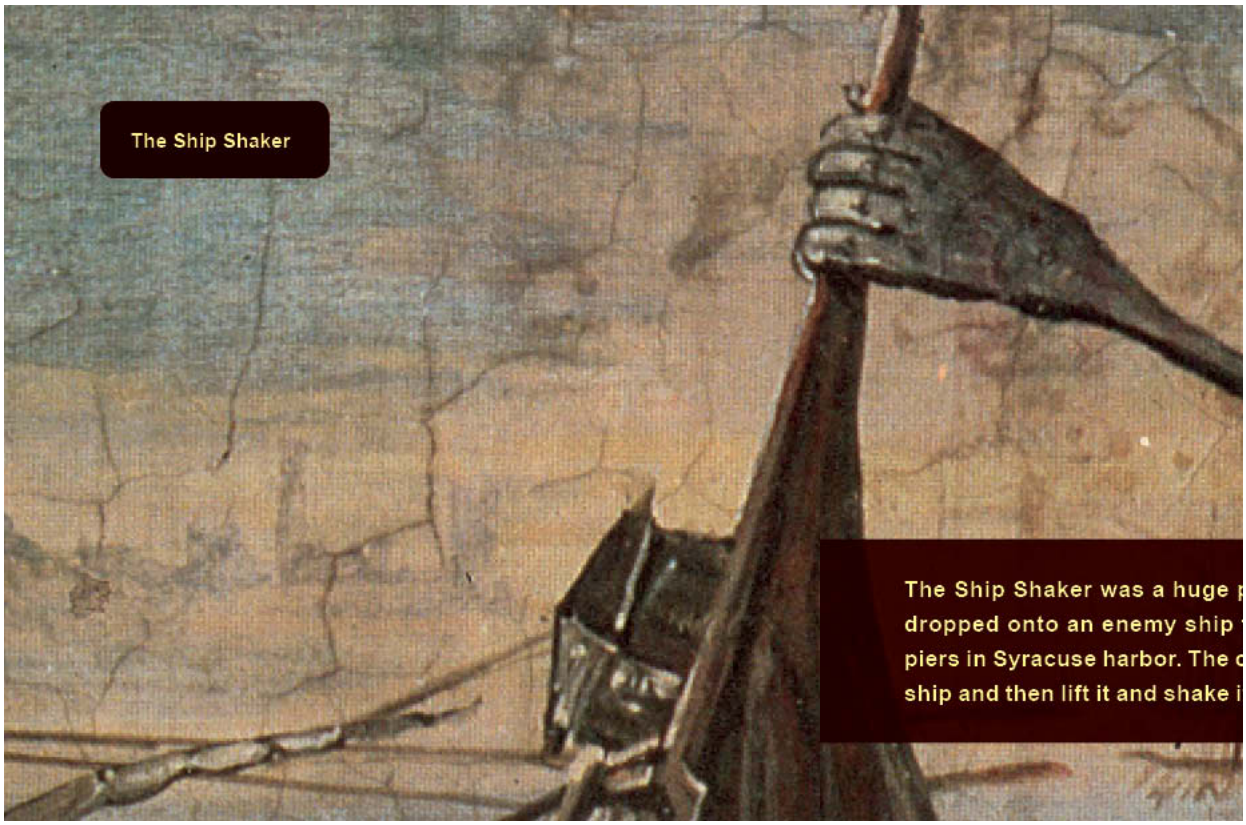
But the boat was so big that w
awkward to get it out again. Ar
in a tube, with a crank at the to



The bottom end of the tube was in the water that gathered in the bottom of the boat. When you turned the crank, gradually the screw lifted the water up to where it was easy to throw it overboard.

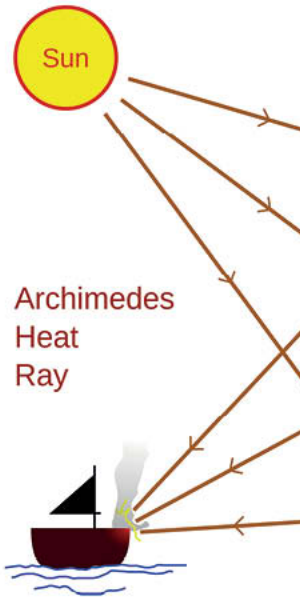
Farmers through the centuries design to raise water from irri can get to their plants.

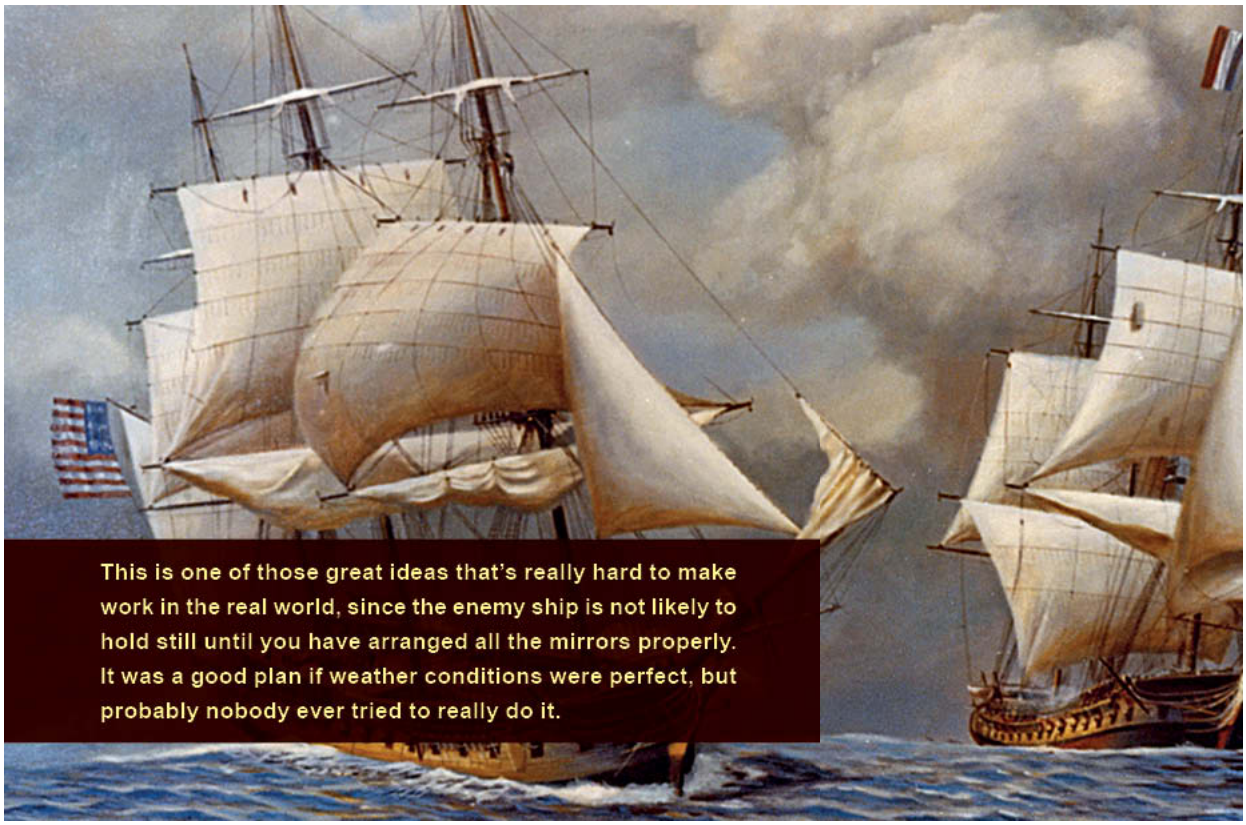

Inventions
THE CATAPULT
Archimedes designed a catap
rocks toward the enemy army
and other defense barriers.


The Ship Shaker
The Ship Shaker was a huge p
dropped onto an enemy ship
piers in Syracuse harbor. The c
ship and then lift it and shake i

The Heat Ray

Archimedes designed a huge array of mirrors. In theory, on a bright, still day, if you adjusted all the mirrors so the light each one reflected fell on the same part of a ship's sail, the concentrated sunlight would make the sail burst into flames.



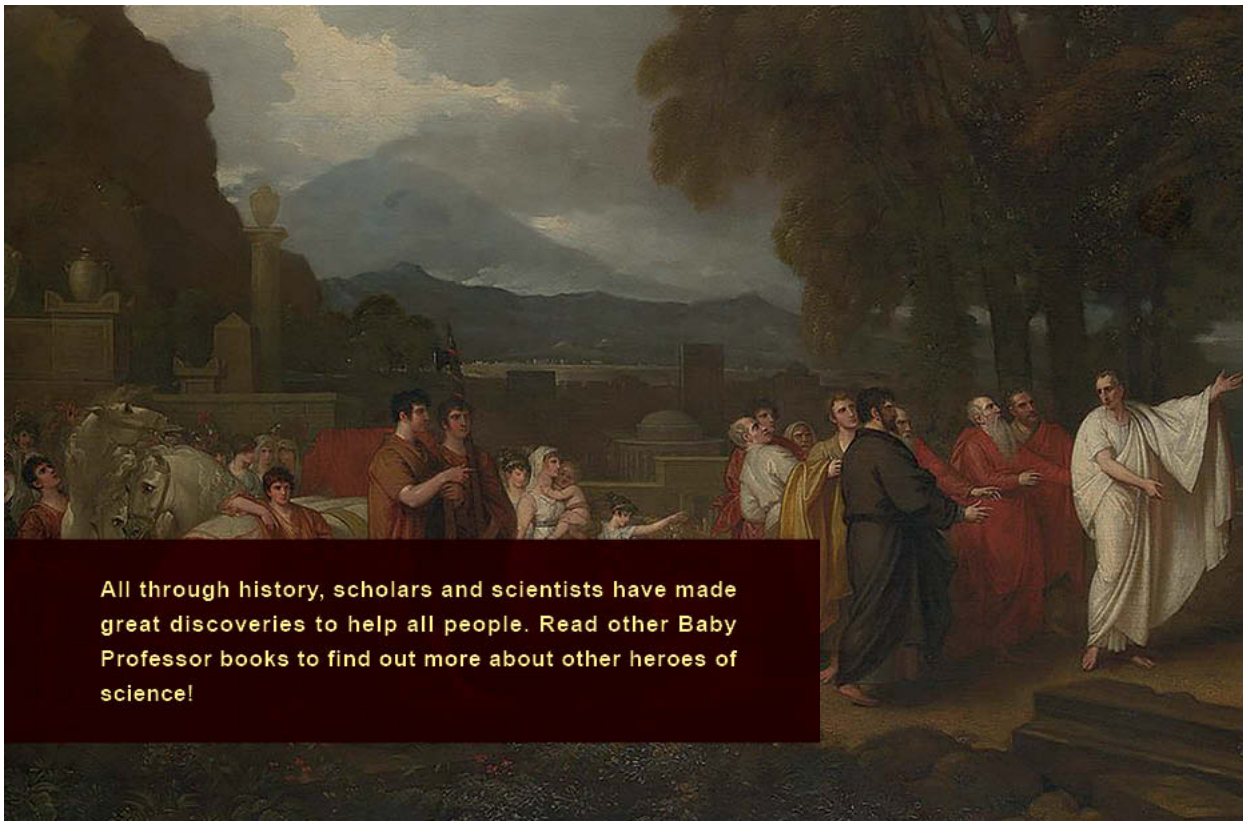

This is one of those great ideas that's really hard to make work in the real world, since the enemy ship is not likely to hold still until you have arranged all the mirrors properly. It was a good plan if weather conditions were perfect, but probably nobody ever tried to really do it.

The Planetarium

Archimedes built two models of the solar system as people knew it in his day, with the sun, earth, moon, and five other planets. The planetarium had gears so when you turned a handle all the planets moved in relation to each other. General Marcellus took the devices back to Rome after he conquered Syracuse.

The Death of Archimede

When Rome attacked an
one of their goals was t
Rome wanted to use his
weapons of war. Archi
hard when the soldiers
Archimedes was deep
possibly did not even r
on. He refused to leave
grew impatient and ki
was 74.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