

For Creative Minds

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Sink or Float: Understanding Buoyancy

If you put a rock in the bathtub, it sinks. If you put a rubber duck in the tub, it floats—even if the rock and the boat weigh the same amount. Why?

Buoyancy is a force in liquids. It pushes objects up. Gravity pulls objects down. When you put a rock or a rubber duck on the surface of the water, it will sink or float depending on which force is stronger. The force of buoyancy changes depends on the weight of the liquid and the weight of the object.

If you fill a cup all the way to the very top and then put a rock in it, some of the water spills over. The water that spills over is **displaced**. It is pushed out of the way by the rock. That water has the same **volume** as the rock. It takes up the same amount of space in the cup. If you weigh the water that spilled and weigh the rock, you will see that the rock weighs more. Although they are the same volume, the rock is more **dense**. (Archimedes' principle)

The force of buoyancy is the same as the weight of the displaced liquid. Because the rock is heavier than the force pushing up against it, the rock sinks through the water. If you put a rubber duck in a very full bowl of water, will the duck weigh more or less than the water that is displaced?



Hands-on Learning

You will need:

- a cup
- warm water
- an egg
- salt
- a spoon



Fill the cup halfway with warm water. Place the egg in the cup.

Does the egg sink or float?

Add a spoonful of salt and stir until it dissolves. Be gentle stirring with the egg in the cup. If the glass is too small, take the egg out and put it back in after the salt dissolves.

Has anything changed? Add another spoonful of salt. Stir until it dissolves.

Continue adding salt one spoonful at a time and dissolving it in the water.

Does anything change as you add more salt?

What is the difference between fresh water and salt water?

How does that difference affect the force of buoyancy acting on the egg?

What do you think will happen if you add more fresh water to fill the rest of the cup?

Try it and see! What happens? Were you right?

Using Scales

How much does an elephant weigh? How much does a car weigh? How much do you weigh? How do you know?

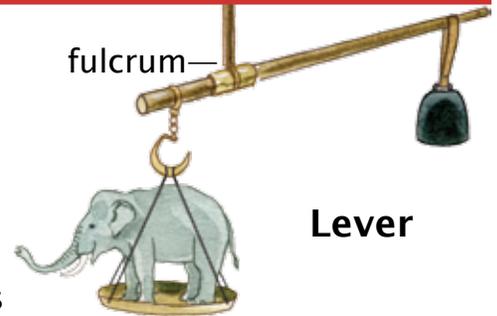
A **scale** is a tool used to weigh things. It measures gravity's pull on an object.

Today, scales are common, high-tech devices. Modern scales provide very accurate measures almost instantly. But this has not always been the case.

A mechanical scale uses a simple machine, a **lever**, to compare two weights. A lever is a rod that pivots (turns) on a fixed point, called the **fulcrum**. One side of the scale holds a known weight, called the reference weight. The other side holds the object being measured.

You can find the weight of the object by changing the reference weight. You can add or remove reference weights until the lever balances out. Or you can move the reference weight along the lever. The farther a weight is from the fulcrum, the more **force** it has. Like an adult and a child on a seesaw, the scale can balance out when the lighter weight is farther from the fulcrum.

Chong used a mechanical scale and the principal of buoyancy to weigh an elephant. He put the elephant on a boat and marked the water level. Then the servants filled the boat with rocks until it sank to the same line as when the elephant was on it. They weighed each rock and Chong added the weights together. These rocks combined weighed the same as the elephant, because they both made the boat sink to the same level in the water.



Today, elephants are weighed on giant, digital scales.

This scale measures weight in pounds. Callee weighs 7825 pounds. This is the same as 3549 kg or 7098 jin.

Does Callee weigh more or less than the elephant in this story?



Callee, the African elephant, being weighed at the Birmingham Zoo. Photograph by George Richey



Cao Chong in History

Cao Chong was born in 196 AD, near the end of the Han Dynasty. By the time Chong was five years old, people said he was as smart as an adult. When an elephant arrived as a gift from the Wu Kingdom, Chong used the principal of buoyancy to weigh the large animal.

Chong's father, Cao Cao, was the chancellor (another word for Prime Minister) of Han. The emperor at this time, Emperor Xian, was a young man. Cao Cao ruled in the young emperor's name, but never tried to take the title of "emperor" for himself.

After Cao Cao died in 220, the Han Empire split into three kingdoms. These were the Wei Kingdom, the Wu Kingdom, and the Shu Kingdom. Seventy years later, a historian named Chen Shou wrote the story of Chong and the elephant in his history book, called the *Records of the Three Kingdoms*.



Three Kingdoms, 220 AD

Cao Chong's name is sometimes written as Chong Cao. His given name is Chong, and his family name is Cao. A given name is the name that refers to one individual person within a family. A family name, also called a surname, is shared by people in the family to show that they are related. In Chinese tradition, the family name comes first and then the given name. In American tradition, the given name (first name) is followed by the family name (last name).

What is your given name? What is your family name?

Things to think about:

1. Is Cao Chong a historical figure or a fictional character?
2. How long ago did Cao Chong live?
3. How do you think Chong's life was different from yours?
4. How do you think Chong's life was similar to yours?
5. Do you and Chong have anything in common?
6. Have you ever come up with a solution for a problem? What was the problem? How did you solve it?



On June 1, 2008, International Children's Day, the Chinese government issued stamps to celebrate Cao Chong, the child who figured out how to weigh an elephant.



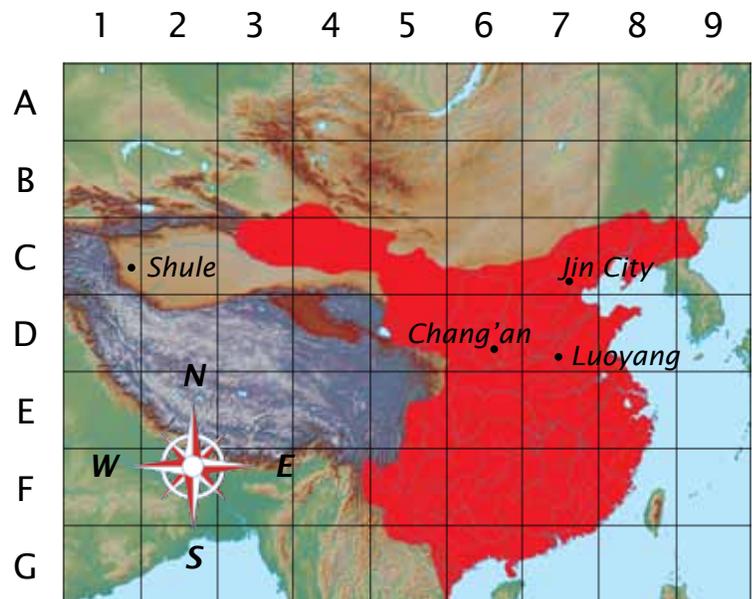
Geography: China Then and Now

These maps show Han (red) in 200 AD and China (white) in 2000 AD.

A coordinate grid is a tool used to locate a specific place on the map. A letter and number together point to a single square on the map. For example, D9 shows the southern part of the Korean peninsula. Today this is the country of South Korea. Use the coordinate grid on the maps below to answer the following questions.

1. Which is larger, Han in 200 AD or China in 2000 AD?
2. Where is Chang'an?
3. Where is Luoyang?
4. On this map, one square is approximately 250 miles on each side. In 190, the young Emperor Xian moved from Luoyang to Chang'an. About how far did he go?
5. Chang'an still exists today, although it has a different name. What is Chang'an called in modern China?
6. Shule was part of a major trade route called the "Silk Road." This trade connected ancient China and ancient Europe. What is the modern name for this city?
7. Was Shule part of Han in 200 AD?
8. Modern China is formally called the People's Republic of China. The capitol is Beijing. Where is Beijing?
9. What was Beijing called in Han?
10. Which city is north of Luoyang?
11. Which of these four cities has the same name that it had in 200 AD?
12. Which city is to the west of Beijing?

Answers: 1) China. 2) D6. 3) D7. 4) 250 miles. 5) Xi'an. 6) Kashgar. 7) no. 8) C7. 9) Jin City. 10) Jin City/Beijing. 11) Luoyang. 12) Kashgar.



Han Empire, 200 AD



People's Republic of China, 2000 AD