HOME SCIENCE TOOLS
THE GATEWAY TO DISCOVERY

Young Science Explorers
Science fun for 4 to 9-year-olds!

February 2010 – Mass & Weight

Why do objects fall to the ground and why don't we float through the air? What is mass? Is it the same as weight? You'll learn about mass, weight, and gravity in this issue!

Science Projects

Make a Balance

Learn how you can use a plastic hanger and some paper cups to make a balance and compare the mass of different objects!

What You Will Need:

Plastic coat hanger
String or yarn
Two paper cups
Wooden skewer
Paperclips

What To Do:

1. Ask an adult to carefully poke two holes in each cup using the wooden skewer. The holes should be a little below the cup's rim and directly across from each other.
2. Cut two pieces of string about two feet long. They need to be the same length.
3. Make a cup handle: Use the skewer to push an end of one piece of string through one of the holes in one cup. Tie the end in a knot so it is securely attached to the rim of the cup. Push the other end through the hole on the opposite side of the cup and tie it.
4. Do the same thing with the other cup and piece of string. The loops of string on each cup need to be exactly the same length so that the cups will hang evenly on your scale. Before you tie the second side, check to make sure they are the same.
5. Find a place to hang your scale. You need a place where it can hang freely without bumping into anything. A shower curtain rod works well. Have an adult tie a piece of string to the hanger's hook and tie the other end around the curtain rod so that the hanger is easy for you to reach.
6. Now hang the loop of each cup on one of the small clothing hooks on each side of the hanger. The hanger should be balanced and the cups should hang down at equal levels on each side.

7. Now you can experiment with your balance! What happens if you add an object to the cup on one side but not the other? Can you find an object to put in the other cup that will make the cups balance again?

What's Happening?

You just made a balance. You can use it to compare the the ***mass*** of different objects. All things are made up of *matter*. Mass is a measure of the amount of matter that an object has, or how much "stuff" it is made up of.

How does the balance work? Since the paper cups are the same size and made from the same material and the strings you used were the same length, the hanger balanced evenly because each side had the same mass. Notice that if you take one cup off, the balance tips so that the side without the cup goes up in the air! That's because the mass from the other cup is pulling down on the hanger. When you put the cup back on, the hanger is balanced again and the cups are level.

If you place a quarter in the cup on the left, the balance tips. The coin adds more mass to the left side, so it tips down and the right side with the empty cup goes up. If you put a dime in the cup on the right, its mass will push the cup down. It has less mass than the quarter, though, so the right side will still be higher. If you add a penny to the cup on the right, the mass will change even more and the balance will move again. This time the cups should balance. Now the mass in each cup is the same (or almost the same) and the cups balance each other again. A quarter has the same mass as one dime plus one penny! You can compare the mass of lots of different objects with this balance.

Do you know the difference between mass and weight? Mass is a measure of how much matter is in an object, but ***weight*** is a measure of how much gravity is pulling on the object. ***Gravity*** is a force that affects us all the time. (You'll learn more about it later. For now, you just need to know that there is less gravity on the moon than there is on Earth.) When you stand on a bathroom scale, it tells you how much you weigh. It doesn't tell you how much mass you have. A scale measures how much force is pushing down on it. When you stand on it, it measures how much gravity is pulling down on you while you are pushing down (in other words, standing) on it. If you could go to the moon and stand on your bathroom scale, you would find that you weigh much less than you do on Earth, because there would be less gravity pulling down on your body as you stand on the scale.

So, what do you think would happen if you could use your hanger balance in space, where there is less gravity pulling on objects? Since your balance only compares the mass of objects, not their weight, you would get the same results on the moon as you do on earth! Even on the moon, a quarter on one side of your balance would still have the same *mass* as a dime and penny on the other side of the balance. The coins would weigh less on the moon, but their mass would not change! Objects still have the same mass--amount of "stuff" in them--no matter how much or how little gravity pulls on them.

Ball vs. Feather

Which object do you think will fall to the ground faster, a ball or a feather? Test it out!

What You Will Need:

a small ball
a feather or a tissue
two sheets of paper

What To Do:

1. Hold the ball in one hand and the feather or tissue in the other.
2. While standing up, hold your arms out in front of you with the backs of your hands facing up.
3. Open both of your hands at the same time and watch the objects fall. Which one reaches the floor first?
4. Now try dropping the ball and a sheet of paper (hold your hand flat under the paper and then pull your hand out to let it drop). Which one makes it to the floor first?
5. Crumple one sheet of paper into a ball. Drop the paper ball and the full sheet of paper at the same time. What happens?
6. Now drop the ball and the paper ball at the same time and notice what happens.

What's Happening:

Even though you dropped both objects from the exact same height, the ball hit the ground much sooner than the feather (or tissue). You probably found that the ball also reached the floor before the sheet of paper. Can you explain why? In step 5, you probably found that the paper ball hit the floor several seconds before the sheet of paper did. Both pieces of paper had the same mass, so why did one get to the floor before the other? You can try it again if you like, to see if you can get the sheet of paper to reach the ground at the same time as the ball of paper, but you will find that the ball always gets there first! The results of step 6 might have surprised you even more. The paper ball reached the floor at the same time as the regular ball! How is that possible?

Even though it seems like heavier objects (or objects with more mass) would fall to the ground fastest, that isn't always true. Mass and weight do not determine how quickly an object will fall to the ground. It's easy to think that the ball will fall first because it has more mass. To understand this, you need to know what makes objects fall. The force of ***gravity*** is what causes objects to fall. If you throw or kick a ball into the air, it will eventually come back down, because gravity is pulling down on it. All objects actually fall at the same speed, because gravity pulls on them equally, no matter how heavy they are! That explains why the paper ball and the regular ball landed on the floor at the same time, but why didn't the sheet of paper, tissue, or feather fall as quickly?

Well, it turns out that objects will only fall at the same speed if no other force is acting on them. So they started out falling at the same speed, but after falling a few centimeters, the air started pushing up against the objects just as gravity was pulling down on them. Since a ball is round and smooth, the air couldn't resist it very much and the force from gravity that was pulling

down on it was still stronger than the force of the air pushing up against it. However, the feather, tissue, and paper were affected by air resistance. Air that was caught underneath the objects pushed up against them and their fall was slowed down.

The shape of an object has a lot to do with how much air resistance will affect it. Think about a parachute falling to the ground. Why do you think it falls to the ground slowly enough to keep a person from getting hurt when he or she lands on the ground? It's because of the air that gets caught under the parachute and pushes back up against the force of gravity that is pulling it down. The air actually slows the parachute down as it is falling!

Fun Facts

The gravitational pull on the moon is only about 1/6th of the gravitational pull on the earth, so if you weigh 100 pounds, you would only weigh around 16.5 pounds on the moon!
Gravity that pulls on objects on the earth is always the same, so a ball that weighs 1 pound in Texas will also weigh 1 pound in France!

Silly Science

Anything that doesn't matter has no mass.
The law of gravity says it's not fair to jump up without coming back down.
What did the doctor tell the mass on the moon?

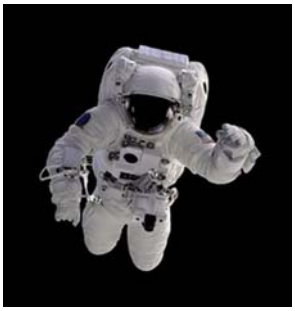
- *You need to gain some weight!*

Way Cool Websites

Watch this video to learn more about the difference between mass and weight.
This animated website explains the difference between mass and weight.

Teacher Tidbits

Gravity



Pick up a book and then drop it on the floor. Why did it fall? It fell because of ***gravity***. Gravity is a very strong force that pulls on objects. All objects experience the force of gravity pulling down on them all the time. On the earth, gravity pulls things down towards the center of the earth. It doesn't push things up, only down. When you throw a ball in the air, it might travel up for a little while because of the force of your arm throwing it, but eventually the force of gravity will pull it back down to the ground. The amount of gravity that pulls on objects on earth always stays the same. However, on the moon, in space, and on other planets, the pull of gravity is different. The amount of gravity that pulls on objects on the moon is much less than the amount of gravity that pulls on objects on the earth. Each planet has its own gravitational field that pulls objects towards its center.

If the book hadn't hit the floor, what do you think would have happened to it? Would it have kept falling? An object will continue to fall and be pulled closer to the center of the earth until it is stopped by something, like the floor or a table. Even once it stops, gravity is still pushing down on it, but there is nowhere else for it to go, so it stays still.

Since the earth is round, have you ever wondered why we don't fall right off of it? What keeps you from floating through the air when you jump up? It's because of gravity, which pulls us constantly towards the earth, keeping us from floating away into space! Gravity keeps our feet on the ground so we can walk instead of floating randomly through the air. It is also what allows rain and snow to fall to earth.

Gravity helps us in a lot of different ways. It is what keeps objects in place when we set them down, which allows us to eat and drink without making much of a mess. Gravity keeps food on our plates and liquids in our cups. Eating and drinking in space where there is less gravity can be quite an interesting experience! You can learn more about food in space here.

Mass and Weight

All things are made up of *matter*. ***Mass*** is a measure of the amount of matter that an object has, or how much "stuff" it is made up of. ***Weight*** is a measure of how much gravity pulls on a mass or object. On the moon, there is less gravity pulling on objects, so they weigh less. For example, a rock that weighs one pound while on Earth will weigh less than that if it is taken to the moon. But does its mass change just because it is on the moon? No, it is still the same size and looks the same, it just has less gravity pulling on it, so it weighs less. That is why objects that seem heavy to us on Earth end up being light enough to float around if they are taken into space.

Something similar happens in very high places, like tall mountain peaks. There is less gravitational pull in high places, so you would weigh a tiny bit less on the top of Mt. Everest (the highest mountain peak in the world), but your mass would still be the same! This is because the peak of a mountain is higher and farther away from the center of the earth, so the pull of gravity in that spot is weaker than at the bottom of the mountain. Remember, even if you weigh less because of a change in gravity's force on your body, your body's mass is still the same.

As your body grows, you will have more mass, which also means you will weigh more. That's because when you're on the earth, the amount of gravity that pulls on you stays the same. So when your mass changes, so does your weight!

Science Words

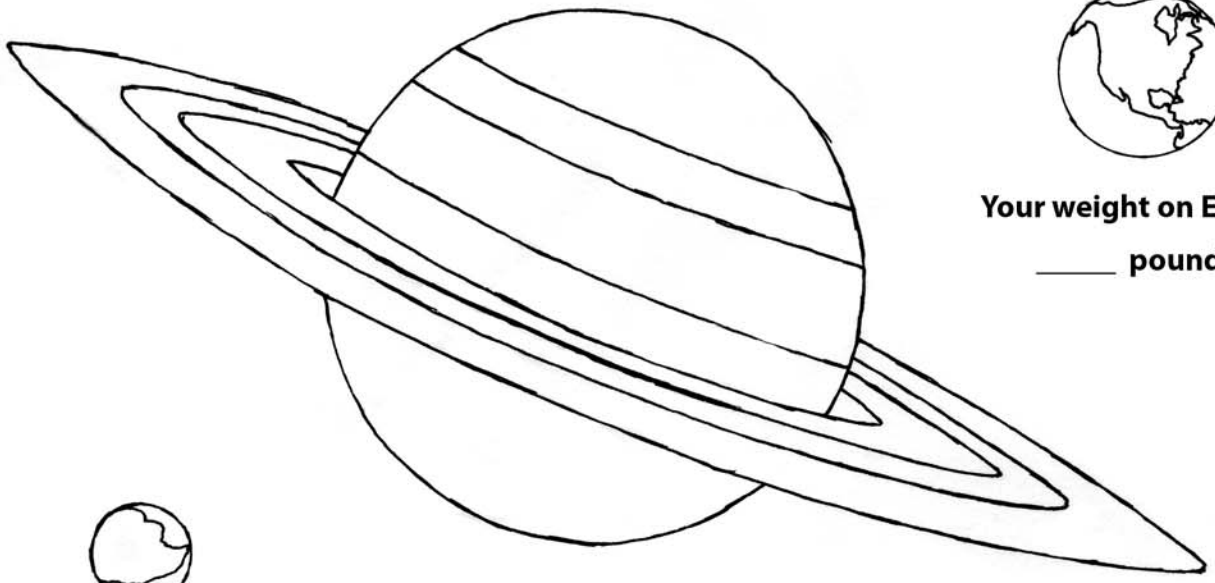
Mass - the amount of matter than an object is made of. Mass does not change with gravity.

Weight - the amount of gravity acting on (pulling down on) an object (or mass).

Gravity - a natural force that pulls objects downward. Earth's gravity pulls us and all objects downwards towards its center.

Printable Worksheet

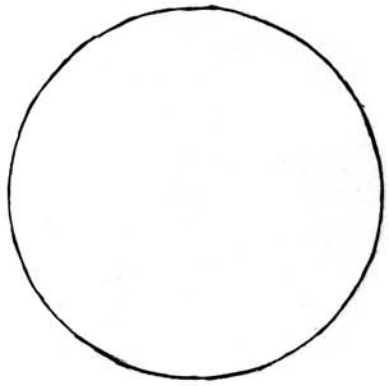
Review the concepts of mass, weight, and gravity. To help kids understand how they could weigh different amounts on different planets, use the worksheet on the next page along with this website to show them how much they would weigh on planets with more or less gravitational pull than Earth. Remind them that even though their weight would change if they could visit other planets, their mass would stay the same!



Your weight on Earth:

_____ pounds

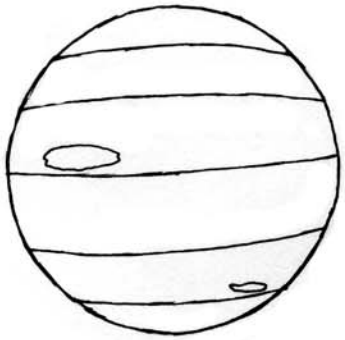
_____ pounds
on the Moon



_____ pounds
on Uranus

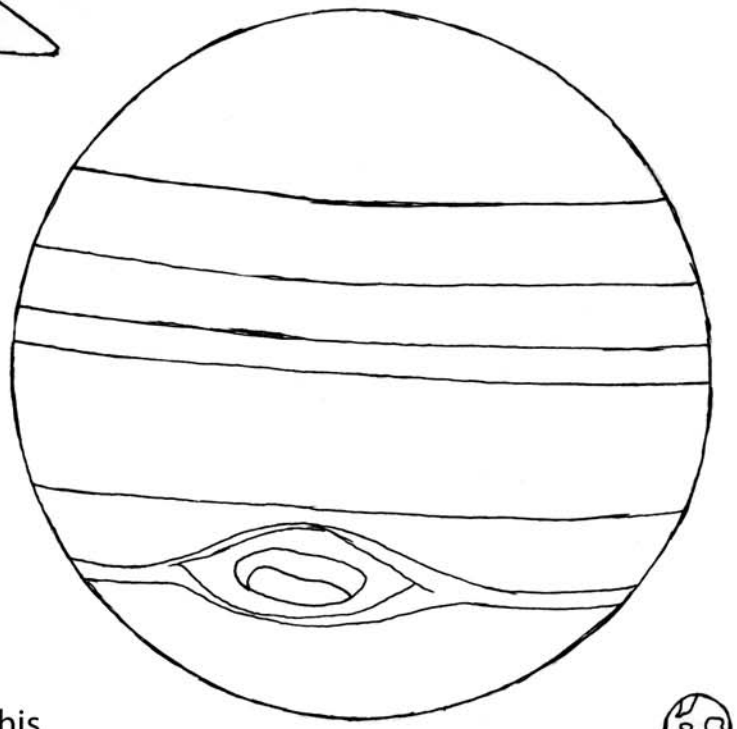
_____ pounds
on Mars

_____ pounds
on Saturn



_____ pounds
on Neptune

_____ pounds
on Venus



_____ pounds
on Jupiter

_____ pounds
on Mercury

1. To find out how much you would weigh on each of the planets, go to this website: http://www.exploratorium.edu/ronh/weight/.
2. Write how much you would weigh on each planet in the space below it.
3. Color the planets.