LET'S DO IT!

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Teacher Edition

Science Is A Verb!

Part 6

Teacher Edition

Contents

Introduction to the lab manual:

This lab manual provides structure for teachers who wish to engage students in hands-on interactive learning but also provides support for teachers who are more comfortable with enquiry based learning. If you are a teacher who is taking his or her first "dive" into hands-on Science, the background material is designed to provide enough structure to help support the organisation of the lab and its materials. Most of the materials are commonly found in local supermarkets and department stores at a nominal cost. A few materials, like scales and hand microscopes can be found on-line. The lab sheets can be given to students so they follow step-by-step or they can be told a general structure to follow.

The critical portion of any lab is to have a thorough discussion of the results and their thinking after the experiment is completed. It is suggested that you take as much time as the experiment to have this discussion with students. The real learning occurs not from the hands-on experiment, but from a deep discussion of the experiment, while making connections to the concept they are learning. For this reason, it is suggested that the students do the experiment FIRST and then have the students learn the concepts. They will have a better understanding of the concept if they first conduct an experiment, gain the experience and then discuss a new concept.

Even without a strong Science background, get into the habit of asking questions. The process of asking questions and being inquisitive will generate more excitement for students and will engage them in a deeper way of learning Science. "I don't know" is as important to learning as having all the answers. Together you can learn Science and discover the major ideas that Scientists' research.

If you are an experienced teacher, the Teacher Guided Questions to Enquiry are designed to provide prompts for students. These questions are not intended to be assessment questions, but ones that will engage students in the general direction of the benchmark. The teacher may select one or two, but not all of them, to have students start on an open enquiry approach to learning. The students will engage in their own experiment, create their own procedures and make conclusions from their data. For this reason, there are no answers to those questions. They are open ended and can be used to formulate interesting experiments for advanced students. The slight variation in some of the questions in each of the labs is designed to provide a sufficient number of prompts at various levels of Bloom's Taxonomy to engage students.

Throughout the year, encourage questioning, student dialogue and the scientific process. There is no one exact scientific method as is often suggested. The process of learning about the world and universe, drawing conclusions from facts and building these facts into strong scientific theories is the work of Science. Science is always growing, stretching and expanding its knowledge base. It is about challenging well-supported ideas to discover weakness. This is exactly what students should be encouraged to do! And in the end, Science is not something to study, it is something to do!

Science is a VERB!

Science is a Verb

Earth Sciences

WHAT IS THE ROLE OF GRAVITY?

Description: Students will create a track for a marble to model how gravity influences the motion of the planets and other objects in the solar system.

Student Materials (per group):
- Marble
- Styrofoam pipe insulation
- Masking tape
- Stopwatch

Additional Teacher Materials:
- Cutting tool

Background and Misconceptions:

Gravity is one of 4 fundamental forces of nature but it is also the weakest force. Gravity is an attractive force that is dependent on the amount of mass an object has. The distance between two or more objects influences the force of gravity the two objects experience. The relationship between mass, distance and gravitational pull is called the Law of Universal Gravitation.

ANYTHING that has mass has gravity. Many students believe that only objects like planets have gravity and that gravity and the existence of an atmosphere are related. While it is true that the force of gravity has an effect on the existence of an atmosphere, the lack of an atmosphere does not mean that gravity does not exist. This misconception often appears when students are asked if the Moon has gravity. They often answer it does not because there is no atmosphere. Because gravity is a tremendously weak force, their only experience with gravity is a result of Earth's gravity and not from other smaller common objects. Students need to understand that gravity results from all objects and is only dependent on the amount of mass and the distance between two or more objects.

The early solar system formed out of the gas and dust of the remains of a previous star that exploded. Small amounts of material were attracted to each other by their gravity. Slowly, as the mass increased the gravity also increased, pulling in more material. The Sun formed

out of helium and hydrogen that slowly condensed. As more mass was added gravity continued to increase and this caused the pressure inside the core to become so high that nuclear fusion caused the hydrogen gas to fuse releasing tremendous amounts of energy in the form of heat and light. It is gravity that caused the Sun to become the star that forms the centre of the solar system.

However, the suns' gravitational attraction did not sweep up all the material in the solar system. Rocky material slowly condensed to form the inner planets, and much of the gas that was farther from the Sun also condensed to form gaseous outer planets. These planets are also composed of primarily hydrogen and helium (with a few other compounds that influence the colour of the outer planet's atmospheres).

Gravity also keeps the planets and other objects in their orbits. Gravity is not the only force operating. Gravity is an attractive force so one may conclude that the planets will dive into the Sun. However, each planet and other body in the solar system has a forward motion that got their initial push as the Sun and the solar system were forming. The suns gravity pulled on the planets, but they didn't dive in directly. They started to move around in a circle. It is each planets own inertia (which is not a force but a property of the planet itself) which keeps it moving with a fairly constant velocity. Inertia however acts to move the object in a straight line. The combined effect of the planet's inertia and the suns gravity causes the planet to move in a circular orbit.

The planets are slowing down though, similarly to what is observed in this experiment. The outer planets are moving slower because they are farther from the Sun. The faster planets are closer to the Sun. Their paths around the Sun cause them to slowly move closer to the Sun. However, the yearly amount is so small that the Sun will go nova long before we dive into the Sun!

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Teacher Guided Questions to Enquiry:

Use these questions to get the students started on their own enquiry!

1. How does gravity influence the motion of the planets?
2. How can the track be used to model how planets move in the solar system?
3. What effect does gravity have on the formation of the solar system?

Additional Hints:

- The piping can be obtained in the plumbing section of many large hardware stores. Cut these in half lengthwise.
- Make the connection between gravity operating on the marble and how the planets also move in various orbits.
- Point out how the speed changes as the marble moves toward the centre and make the connection to the planets.

WHAT IS THE ROLE OF GRAVITY?

TEACHER ANSWER KEY

Description: Gravity is one of 4 fundamental forces that is instrumental in the motion of objects in the solar system. Yet, it also was instrumental in the formation of the solar system, including the Sun itself. In this experiment, you are going to create a model to demonstrate how gravity affects the motion of objects and how it is an important attractive force.

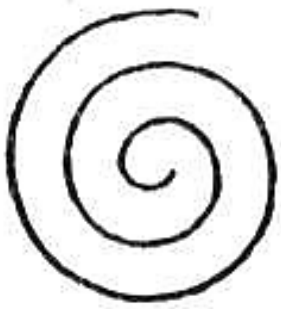
Materials:

- Marble
- Masking tape
- Styrofoam pipe insulation
- Stopwatch

Procedures:

1. Using the pipe insulation ,you will create several models to illustrate the effect that gravity has on stars and planets.
2. Start by designing a path in which a marble that is released into the pipe will follow a path that "orbits" as many times as possible before it either falls out or exits the track. Draw a picture of your design below.

Students may have different setups, but the most successful shape will be one in which the track corkscrews down.



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WHAT IS THE ROLE OF GRAVITY?

3. Build the path and then record the time it takes for the marble to travel from the beginning to the end. Record your times below. Change the path as needed to increase the time of travel.

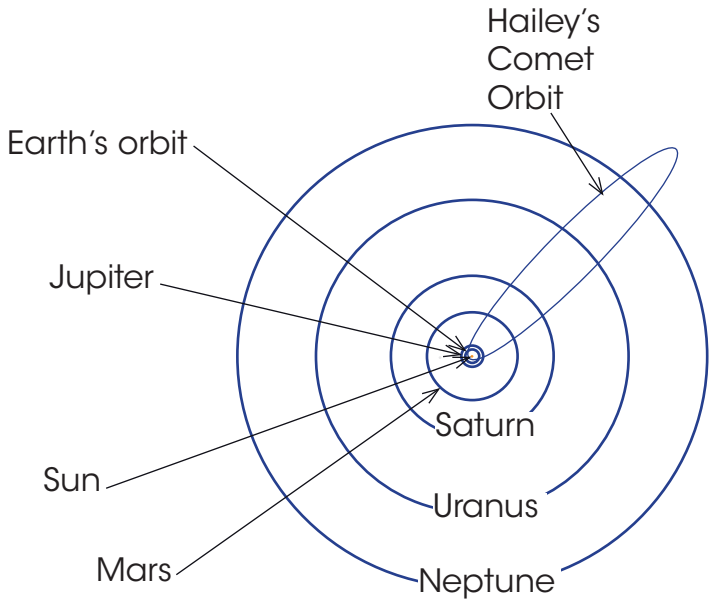
	Trial 1	Trial 2	Trial 3	Trial 4
Time (s)	Sample data: 45	52	63	80
What did you change to increase the time? Did it work?	Sample answer: Changed so that the pathway was much more circular and slopes down gradually.			

4. What is the force that causes the ball to start to move down the path? How is the speed of the ball controlled, even though this force is always acting on the ball?

Gravity – the shape of the track changes how fast it will travel. Even though gravity is always acting, the slope of the track keeps the ball from moving too quickly.

5. Examine the diagram below. Various objects in the solar system follow very different paths. Use your piping to recreate the path of Halley's Comet, a comet that returns to the inner solar system every 76 years, the next time being in 2061.

WHAT IS THE ROLE OF GRAVITY?



6. Describe how you modeled the path of Halley's Comet.

The track is U shaped and very steep so the ball moves very quickly down and then turns at the bottom.

7. How does the speed of the marble change as it moves around the track?

It moves faster at the bottom and slower near the top. The speed of the comet is greater as it moves closer to the Sun, and much slower when it is farther out in the solar system.

Summary:

Gravity is the major force that shapes the planets, and keeps objects moving in the solar system. The Law of Universal Gravitation that was discovered by Isaac Newton states that gravity exists between all objects in the universe. Anything that has mass has gravity! Gravity pulls on all objects, regardless of the size or shape. Things as small as marbles or as large as planets have gravity, but gravity is such a weak force that we don't feel us being pulled by a marble. Only objects like planets have enough gravity to cause a noticeable effect. Yet, given the relatively enormous size of Earth, we can still build spacecrafts that can move fast enough to leave the gravity of Earth.

Gravity is the force that initially caused the dust and gas to collapse and form our Sun. Rocky material in the solar system came together under the force of gravity to form the planets of the inner solar system. And the gravity of the Sun is what keeps the planets, asteroids, and comets orbiting around it.

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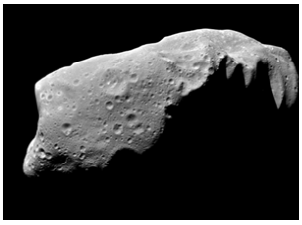
WHAT IS THE ROLE OF GRAVITY?

Questions:

1. Which of the following objects has the highest gravity? Why do you think?



OBJECT 1

OBJECT 2

This object has the higher gravity because it is spherically shaped. This shape is not possible without more mass and therefore more gravity.

2. How did gravity influence the formation of the Sun and solar system?

Gravity is what caused the gas and dust to condense and form the Sun. Gravity also caused the rocky materials to condense to form the inner planets, and the remaining gas and dust to form the outer planets.

3. Thinking about your track that you made, how does gravity affect the motion of the planets in the solar system? Which do you think move faster? Which do you think move slower?

The planets move around the Sun because of the attraction of the Sun to the planets. The forward motion of the planets keep them from swirling into the Sun. The planets that move the fastest are closest to the Sun and those that move slower are farthest.

4. Thinking about how the marble moves in your track, what do you expect will happen to all the planets in the solar system in the far distant future?

They will all slowly swirl into the Sun, speeding up as they go.