KANSAS CITY PUBLIC SCHOOLS

The lab of MR.Q

KCMO PD Workshops - Scott McQuerry

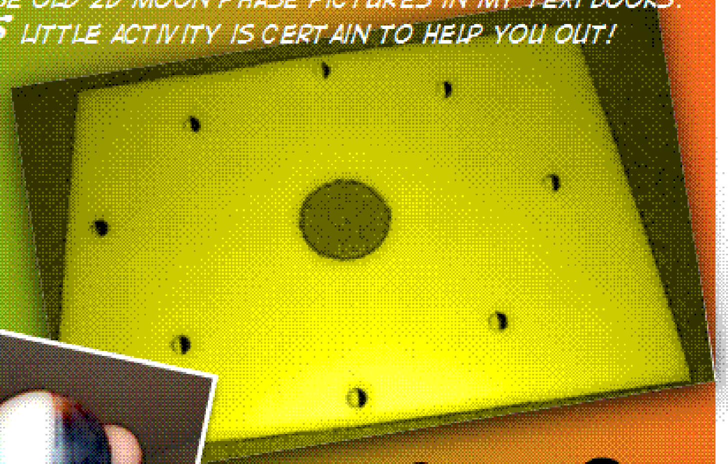
Fall 2013

Don't Just Take Up Space!

SCIENCE PIONEERS

The lab of MR.Q

*I DON'T KNOW ABOUT YOU, BUT I NEVER UNDERSTOOD HOW TO READ THOSE OLD 2D MOON PHASE PICTURES IN MY TEXTBOOKS. BUT **THIS** LITTLE ACTIVITY IS CERTAIN TO HELP YOU OUT!*



It's just a phase...

What you need:

LARGE SHEET OF HEAVY CARDBOARD (ABOUT THREE FEET SQUARE)
KNIFE
EIGHT PING-PONG BALLS OR STYROFOAM BALLS
GLUE
BLACK PERMANENT MARKER

What's going on?

DURING THE MOON'S CYCLE, THE ACTUAL SHAPE OF THE MOON NEVER CHANGES. IT IS ALWAYS A SPHERE. WE ONLY SEE THE MOON BECAUSE SUNLIGHT REFLECTS BACK TO US FROM ITS SURFACE; IT HAS NO LIGHT SOURCE OF ITS OWN. WHAT CHANGES IS THE PORTION OF THE MOON THAT CAN BE SEEN FROM EARTH.

THE SUN ALWAYS ILLUMINATES HALF OF THE MOON. THE HALF OF THE MOON FACING THE SUN IS ALWAYS LIGHTED; BUT THE LIGHTED SIDE DOES NOT ALWAYS FACE EARTH. AS THE MOON CIRCLES EARTH, THE AMOUNT OF ITS DISK FACING US THAT IS LIGHTED BY THE SUN CHANGES, ALTERING HOW MUCH OF THE LUNAR SURFACE APPEARS BRIGHT AND HOW MUCH IS IN DARKNESS.

THE CHANGES ARE KNOWN AS PHASES, AND THEY REPEAT IN A SPECIFIC CYCLE. THESE ARE THE PRIMARY PHASES: NEW MOON, FIRST QUARTER, FULL MOON, LAST QUARTER. (IT TAKES 29.5 DAYS TO GO FROM ONE NEW MOON TO THE NEXT.)

What to do:

TAKE THE LARGE PIECE OF CARDBOARD AND CUT IT INTO A SQUARE AND CUT A CIRCLE IN THE CENTER OF THE CARDBOARD LARGE ENOUGH FOR A CHILD TO PUT HIS/HER HEAD THROUGH.

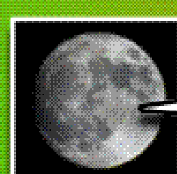
USING A BLACK PERMANENT MARKER, COLOR ONE HALF OF EACH OF THE EIGHT PING PONG BALLS.

GLUE THE BALLS TO THE CARDBOARD SHEET ABOUT 16-24 INCHES AWAY FROM THE HOLE IN ITS CENTER USING THE PICTURE ABOVE AS YOUR GUIDE.

IT IS VERY IMPORTANT TO GLUE EACH OF THE BALLS WITH THE BLACK SIDE FACING THE SAME DIRECTION.

NOW THE FUN PART...

HAVE THE CHILD INSERT THEIR HEAD INTO THE HOLE OF THE CARDBOARD. THEIR HEAD REPRESENTS THE EARTH. NOW, HAVE THE CHILD ROTATE THEIR HEAD WHILE INSIDE THE HOLE TO MODEL THE ROTATION OF THE EARTH. AS THEY FACE EACH PING PONG BALL, THEY WILL NOTICE A DIFFERENT PHASE OF THE MOON!



NEED A REMINDER ABOUT THE MOON PHASES? CLICK ***HERE*** TO BRUSH UP ON YOUR SKILLS!

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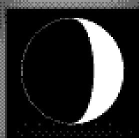
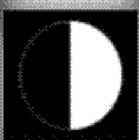
PHASES OF THE MOON

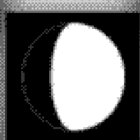
NEW MOON – THE MOON'S UNILLUMINATED SIDE IS FACING THE EARTH. THE MOON IS NOT VISIBLE (EXCEPT DURING A SOLAR ECLIPSE).



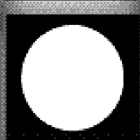
WAXING CRESCENT – THE MOON APPEARS TO BE PARTLY BUT LESS THAN ONE-HALF ILLUMINATED BY DIRECT SUNLIGHT. THE FRACTION OF THE MOON'S DISK THAT IS ILLUMINATED IS INCREASING.



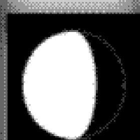
FIRST QUARTER – ONE-HALF OF THE MOON APPEARS TO BE ILLUMINATED BY DIRECT SUNLIGHT. THE FRACTION OF THE MOON'S DISK THAT IS ILLUMINATED IS INCREASING.



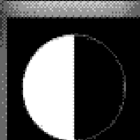
WAXING GIBBOUS – THE MOON APPEARS TO BE MORE THAN ONE-HALF BUT NOT FULLY ILLUMINATED BY DIRECT SUNLIGHT. THE FRACTION OF THE MOON'S DISK THAT IS ILLUMINATED IS INCREASING.



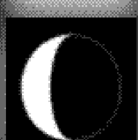
FULL MOON – THE MOON'S ILLUMINATED SIDE IS FACING THE EARTH. THE MOON APPEARS TO BE COMPLETELY ILLUMINATED BY DIRECT SUNLIGHT.



WANING GIBBOUS – THE MOON APPEARS TO BE MORE THAN ONE-HALF BUT NOT FULLY ILLUMINATED BY DIRECT SUNLIGHT. THE FRACTION OF THE MOON'S DISK THAT IS ILLUMINATED IS DECREASING.



LAST QUARTER – ONE-HALF OF THE MOON APPEARS TO BE ILLUMINATED BY DIRECT SUNLIGHT. THE FRACTION OF THE MOON'S DISK THAT IS ILLUMINATED IS DECREASING.



WANING CRESCENT – THE MOON APPEARS TO BE PARTLY BUT LESS THAN ONE-HALF ILLUMINATED BY DIRECT SUNLIGHT. THE FRACTION OF THE MOON'S DISK THAT IS ILLUMINATED IS DECREASING.

The reason for the seasons

Children will discover why the earth has different seasons during the year.

Materials:

One bright flashlight
One piece of paper
Pen/pencil
Several small objects (i.e. BB's, tiny marbles, paper dot cut-outs, etc.)
Dark room

Activity:

1) While inside a darkened room, hold the flashlight over a the paper that has been placed on a table.
2) The parent will hold onto the flashlight while the child draws a circle around the brightest circle on the paper. Be certain to take note of the height of the flashlight over the paper! (If your flashlight does not create a powerful beam, you can create a blinder around the edge of the flashlight out of paper. Or... you can cover the flashlight with a piece of aluminum foil and cut out a circle for the beam to travel through.)
3) Repeat this same procedure one more time. However, keeping the flashlight the same distance from the paper, hold it at an angle. Now have the child draw the oval-shaped light that can be seen on the paper.
4) Turn on the lights and ask the child to predict which object they drew is larger?
5) Now instruct the child to "fill in" the circles with their small objects. Small candies work well, as do paper dots, marbles, etc... Have the child count the number of objects needed to fill both of the drawings. They should notice that the oval shape takes more objects to fill than does the circle.

Explanation:

This is a model of what happens to the earth during our seasons. For those of us in the northern hemisphere, we receive more direct sunlight during the summer months. This is similar to the circle-shaped light that the child completed first. This means that more of the sun's energy is allowed to reach our area and therefore keeps us very warm.

However, since the earth is tilted on an axis, the sun's rays are spread out more during the winter months. This is similar to what happened with the oval-shaped drawing. The light is spread out over a greater area. On earth, this means the heat we receive is spread out too!!! This is why it is colder during the winter months.

Build Your Own Robot Arm

**adapted from the tryengineering.org*

Teacher Resources

Divide your class into teams of three or four students, and provide student handout (attached). Students are then instructed to examine the materials provided (see list below) and to work as a team to design and build a robot arm out of the materials. The robot arm must be at least 18 inches in length and be able to pick up an empty Styrofoam cup. Teams of students must agree on a design for the robot arm and identify what materials will be used. Students should draw a sketch of their agreed upon design prior to construction.

Explain that teamwork, trial, and error are part of the design process. There is no "right" answer to the problem - each team's creativity will likely generate an arm that is unique from the others designed in your class.

Materials

3" wide and approx. 22" long strips of cardboard-- 5 or so
Binder clips (different sizes)-- 8 or more
Brads-- @10
Clothespins-- 6
Craft sticks--10-15
Fishing line-- 3-4 feet
Hangers-- 1 or 2
Paper clips (diff. Sizes)-- 10-15
Pencils-- 3-4
Rubber bands (different sizes)--15
Tape-- clear and masking (partial rolls should be fine)
Twine-- 3-4 feet
Various size scraps of cardboard--10 assorted

Extension Ideas

"Humans and Robots," a NASA educational brief which is attached, describes the robotics features on the International Space Station. The brief's classroom activity is about making and using an ISS grapple fixture known as an end effector. The PDF file is also available at http://spacelink.nasa.gov

Student Resource:

http://virtualastronaut.tietronix.com/teacherportal/pdfs/Humans.and.Robots.pdf

Following the remarkable successes of the Apollo Moon landings and the Skylab space station program, many space experts began reconsidering the role of humans in space exploration. In a healthy debate on exploration strategies, some experts concluded the goals of the future would be best served by robotic spacecraft. Human space travelers require extensive life support systems. With current propulsive technologies, it would just take too long to reach any destination beyond the Moon. Robots could survive long space voyages and accomplish exploration goals just as well as humans. ther space experts disagreed. Humans have an important place in space exploration, they contended.

Robots and humans are not interchangeable. Humans are far more adaptable than robots and can react better to the unexpected. When things go wrong, humans can make repairs. This, they pointed out, was demonstrated conclusively during Skylab, when spacewalkers made repairs that saved the mission. Today, new exploration strategies are at work. The goal is no longer humans or robots. It is humans and robots working together. Each bring important complimentary capabilities to the exploration of space. This has been demonstrated time and again with the Space Shuttle Remote Manipulator System (RMS) robot arm. The arm, also called Canadarm because it was designed and constructed by Canada, has been instrumental to the success of numerous space missions.

The 15-meter-long arm is mounted near the forward end of the port side of the orbiter's payload bay. It has seven degrees of freedom (DOF). In robot terms, this means that the arm can bend and rotate in seven different directions to accomplish its tasks. Like a human arm, it has a shoulder joint that can move in two directions (2 DOF); an elbow joint (1 DOF); a wrist joint that can roll, pitch, and yaw (3 DOF); and a gripping device (1 DOF). The gripping device is called an end effector . That means it is located at the end of the arm and it has an effect (such as grasping) on objects within its reach. The RMS's end effector is a snare device that closes around special posts, called grapple fixtures. The grapple fixtures are attached to the objects the RMS is trying to grasp. On several occasions, the RMS was used to grasp the Hubble Space Telescope and bring the spacecraft into the orbiter's payload bay. After the spacecraft was locked into position, the RMS helped spacewalking astronauts repair the telescope and replace some of its instruments. During operations, the RMS is controlled by an astronaut inside the orbiter. The RMS actually becomes an extension of the operator's own arm. Television cameras spaced along the RMS permit the operator to see what the arm is doing and precisely target its end effector. At times, during the Hubble servicing, one of the spacewalkers hitched a ride on the end effector to gain access to parts of the telescope that were difficult to reach. The arm became a space version of the terrestrial cherry picker.

Robots on the International Space Station The International Space Station (ISS), currently under construction in Earth orbit, will have several robots to help astronauts complete their tasks in space. Five of the ISS international partner nations are developing robotic systems for the station. Japan is developing the JEM Remote Manipulator System. The European Space Agency and the Russian Space Agency are developing the European Robotic Arm. Canada and the United States are developing the Mobile Servicing System (MSS). Detailed information on each of these systems can be obtained at the website listed below.

Mobile Servicing System The most complex robotic system on the ISS is the MSS. It consists of the Space Station Remote Manipulator System (SSRMS), the Mobile Remote Servicer Base System (MBS), the Special Purpose Dexterous Manipulator (SPDM), and the Mobile Transporter (MT). The MSS will be controlled by an astronaut working at one of two Robotics Work Stations inside the ISS. The primary functions of the MSS robotic system on the ISS are to:

- assist in the assembly of the main elements of the station (e.g. aligning newly delivered modules to the structure)
- handle large payloads
- replace orbital replacement units (plug-in equipment designed to be periodically replaced with newer units)
- support astronauts during extravehicular activities
- assist in station maintenance
- provide transportation around the station

The main component of the MSS is the 17-meter- long SSRMS robot arm. It is similar to the Shuttle RMS but will ride from one end of the station to the other on the mobile transporter, which will glide along the giant truss beam. After arriving at a worksite, the arm will grasp payloads, modules, or other structures with its wire snare end effector. If a work location is too distant for the arm to reach while still attached to the transporter, the arm can connect to an intermediate grapple fixture. Electrical power will be rerouted through that fixture. The SSRMS will then release its other end and “inchworm” itself through successive fixtures until it reaches the desired site. The SSRM is also able to pick up and connect to the SPDM. This unit consists of a pair of 3.5-meter, 7-joint arms conected to a single joint base. The SPDM can pick up small tools for repair or servicing activities or effect delicate manipulations of smaller objects than the SSRMS can handle.

Student Worksheet:

Team members: ____

Identify, Research, and Design Stage

You are a member of a team of three or four students, all working together to design and build a robot arm out of the following materials which are provided to you. The robot arm must be at least 18 inches in length and be able to pick up an empty Styrofoam cup. Your team must agree on a design for the robot arm and identify what materials will be used. Your team should draw a sketch of their agreed upon design prior to construction. Meet as a team and discuss the problem you need to solve. Then develop and agree on a process for solving the challenge. You'll need to determine what materials you want to use.

Draw your design below, and be sure to indicate the description and number of parts you plan to use.

Construction Phase

Choose your best product design and your best process design. Build your design. During construction you may decide you need additional materials or that your design needs to change. This is ok – just make a new sketch and revise your materials list.

Testing and Evaluation Phase

Each team will test their design and process. If your design and process were unsuccessful, redesign and test again. Continue until you are happy with your solution. Be sure to watch the tests of the other teams and observe how their different designs worked.

Sketch your Redesigned idea (make sure to label your sketch):

Evaluation Phase

1) Did you use all the materials provided to you? Why, or why not?
2) Which item was most critical to your robot arm design?
3) How did working as a team help in the design process?
4) Were there any drawbacks to designing as a team?
5) What did you learn from the designs developed by other teams?

Playing with Parachutes

**adapted from the tryengineering.org*

For Teachers:

The goal of this lesson is for students to develop a parachute that can carry a metal washer to a 10 cm diameter target on the ground with the slowest rate of descent. Student teams design their parachutes out of everyday materials and then test their designs. Students then evaluate the effectiveness of their parachutes and those of other teams, and present their findings to the class.

Materials:

Student Resource Sheets
Student Worksheets
Meterstick
Small ladder (for teacher use only)

One set of materials for each group of students:

roll of string
plastic trash bag
plastic shopping bag
several sheets of copy paper
coffee filters
newspaper
aluminum foil
scissors
masking tape
metal washer (3cm diameter)
ruler

Procedure

1. Show students the various Student Reference Sheets. These may be read in class, or provided as reading material for the prior night's homework.
2. Divide students into groups of 2-3 students, providing a set of materials per group.
3. Explain that students must develop their own working parachute from everyday items that can carry one metal washer to the ground from a height of 2 M. The parachute has to hit a target 10 cm in diameter with the slowest rate of descent. The parachute that can hit the target with the slowest descent rate is the winner.
4. Students meet and develop a plan for their parachute. They agree on materials they will need, write or draw their plan, and then present their plan to the class.
5. Student teams may trade unlimited materials with other teams to develop their ideal parts list.
6. Student groups next execute their plans. They may need to rethink their plan, request other materials, trade with other teams, or start over.
7. Next....teams will test their parachutes. Drop height should be measured from the bottom edge of the washer. The teacher should serve as the dropper. The target can be made on the ground with tape or string, or a paper plate can be used.
8. Teams then complete an evaluation/reflect on worksheet, and present their findings to the class.

Student Resource:

History of Parachutes

Parachutes are devices used to slow the movement of objects. Parachutes are typically used to slow the movement of falling objects but they can also be used to slow down horizontally moving objects such as racecars. The word parachute is believed to be of French origin combing the words para, (a French word with Greek roots) chute meaning to shield against falling. The modern parachute has evolved over several centuries. It is believed that Chinese acrobats used parachutes in their acts as early as the 1300's. Leonardo DaVinci sketched designs for a pyramid shaped parachute in the mid 15th century. The first time a parachute was actually attempted by a human was in the mid 16th century by Faust Vrancic, a Croatian Inventor. He called his invention Homo Volans or the Flying man. He actually tested out his parachute in 1617 by jumping off a tower in Venice. Andrew Garnerin was the first person on record to use a parachute that did not possess a rigid frame. He used his parachute to jump out of hot air balloons from a height of 8000 feet! He was also the first person to include a vent in the canopy to reduce instability. The parachutes we are more familiar with today didn't begin to take shape until the 18th century.

Parts of a parachute

The upper portion of the parachute is known as the canopy. Historically, canopies were made of silk but now they are usually made out of nylon fabric. Sometimes the canopy has a hole or vent in the center to release pressure. When a parachute is housed in a container such as a backpack, it may consist of main canopy and another smaller canopy known as a pilot chute. The pilot chute comes out of the container first and serves to pull open the main canopy. A set of lines connects the canopy to the backpack. The lines are gathered through metal or canvas links attached to thick straps known as risers. The risers are then connected to a harness if the parachute is going to be used by a person.

Types of Parachutes

There are many different types of parachutes. Here are some of the more common parachute designs. Round parachute The parachute most people are familiar with is the round parachute. The round parachute is characterized by a circular canopy.

Square parachute

The square or cruciform parachute possesses a squarish shaped canopy. Square parachutes are beneficial because they reduce jostling of the user and have a slower rate of descent; reducing injuries.

Ram-air parachute

Most of the parachutes which are intended for use by people that we see today are ram-air parachutes. The design of ram type parachutes gives the person using it a great deal more control. The canopy in a ram type parachute is made up of 2 layers of material which are sewn together to form air filled cells.

Ribbon and ring parachute

Ribbon and ring parachutes are intended to be used at supersonic speeds. The canopy has a hole in the center which is designed to release pressure. Sometimes the ring is cut into ribbons so more pressure can be released and so the canopy doesn't explode. These types of parachutes are used when a great deal of strength is required.

Here are a few key science concepts to keep in mind when you are designing and testing your parachutes.

Law of Falling Bodies
Galileo Galilei (1564-1642) was an Italian astronomer and physicist. Galileo conducted much research on motion and developed what is known as the Law of Falling Bodies. This law states that all objects regardless of their mass fall at the same speed, and that their speed increases uniformly as they fall. Galileo's calculations however, did not take into consideration air resistance. Drag, or the force that opposes the motion of an object plays a significant role in the motion of a falling parachute.

Newton's Laws of Motion
Sir Isaac Newton (1642 – 1727) was a brilliant mathematician, astronomer and physicist who is considered to be one of the most influential figures in human history. Newton studied a wide variety of phenomena during his lifetime, one of which included the motion of objects and systems. Based on his observations he formulated Three Laws of Motion which were presented in his masterwork Philosophiæ Naturalis Principia Mathematica in
1686.

Newton's First Law
– An object at rest will remain at rest and an object in motion will remain in motion at a constant speed unless acted on by an unbalanced force (such as friction or gravity). This is also known as the law of inertia.

Newton's Second Law
– An object's acceleration is directly proportional to the net force acting on it and inversely proportional to its mass. The direction of the acceleration is in the direction of the applied net force. Newton's Second Law can be expressed as: $F = ma$

Newton's Third Law
– For every action there is an equal and opposite reaction.

Gravity
Newton's work on developing the Laws of motion led him to formulate the Law of Universal Gravitation. The law states that two bodies attract each other with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. We can use the following equation to calculate the force of gravity with which an object is attracted to the Earth:

$F = mg$
m = mass of the object
g = the acceleration of gravity 9.8 m / s^2

Student Worksheet:

You are a team of engineers who have been given the challenge to design a parachute out of everyday items. Your challenge is to design a parachute that can carry one metal washer to the ground from a height of 2M and hit a 10 cm target with the slowest possible rate of descent. The parachute that can hit the target with the slowest descent rate is the winner.

Planning Stage

Meet as a team and discuss the problem you need to solve. Then develop and agree on a design for your parachute. You'll need to determine what materials you want to use.

Draw your design in the box below, and be sure to indicate the description and number of parts you plan to use. Present your design to the class.

You may choose to revise your teams' plan after you receive feedback from class.

Design:

Materials Needed:

Construction Phase

Build your parachute. During construction you may decide you need additional materials or that your design needs to change. This is ok – just make a new sketch and revise your materials list.

Testing Phase

Each team will test their parachute. You'll need to time your test to make sure you can support the washer and achieve the slowest rate of descent.

Parachute Testing Data				
	Drop Height (m)	**Drop Time (s)**	**Velocity (m/s)**	**Distance Landed from Target**
Test 1				
Test 2				
Test 3				
Test 4				
Average				

Evaluation Phase

1. Did you succeed in creating a parachute that could hit the target? If so, what was your slowest rate of descent? If not, why did it fail?
2. Did you decide to revise your original design or request additional materials while in the construction phase? Why?
3. Did you negotiate any material trades with other teams? How did that process work for you?
4. If you could have had access to materials that were different than those provided, what would your team have requested? Why?
5. Do you think that engineers have to adapt their original plans during the construction of systems or products? Why might they?
6. If you had to do it all over again, how would your planned design change? Why?
7. What designs or methods did you see other teams try that you thought worked well?
8. Do you think you would have been able to complete this project easier if you were working alone? Explain…
9. What kind of changes do you think you would need to make to your design if you needed to transport a heavier payload? Try it!