INTERACTIVE

FUN²

INNOVATIVE

$$y = \left(\frac{b^2}{6}\right)x^2 + bx + 1.5$$

INSPIRE

FAMILY GUIDE TO MATH

MathAlive!
Presented By Raytheon

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INTRODUCTION

*Welcome to **MathAlive!** The activities in this family guide are designed for parents with children in elementary and middle school. We've also added a few suggestions so that little brother or sister can join in and an Expert Challenge for the real math lovers. Each activity relates to an area of the **MathAlive!** exhibit.*

Math wasn't your best subject in school? Don't worry. These activities are fun, easy and hands-on. You'll only need simple, inexpensive supplies, things that you probably already have around your home.

*We've written and illustrated the activities so that you can hand this guide over to your kids and they can figure things out. They're in charge and you can join in the fun! For more information about the **MathAlive!** exhibit and related events in the community, please visit our website at www.mathalive.com.*

MathAlive!
About the Exhibit

One of the most interactive and inspiring exhibitions exploring the world of mathematics ever to tour.

MathAlive! is designed to inspire, to spark the imagination and to reveal not only math at work, but also the endless possibilities of math. Primarily designed for kids in grades 3-8, the exhibition brings to life the real math behind what kids love most — video games, sports, fashion, music, robotics and more — and creates interactive and immersive experiences that bring to life the math at work in each, whether in design, application or use.

In this 5,000-square-foot exhibition, visitors will ride snowboards in a 3-D experience, design (and play) their own video games, capture their 360-degree images in a unique interactive, jump into a binary dance party, even design a custom skateboard for "pop" — the quick, snapping motion that allows a board to do the best tricks. Through nearly 40 unique, interactive experiences, the exhibit takes math from its native form into the applied worlds of design, engineering, technology and science.

They'll explore and operate simulations of NASA's latest robotics, including the Robonaut 2 and the Curiosity rover. Around a large-scale futuristic bridge they learn how engineers work to make a city hum while taking on different engineering roles to design a more sustainable infrastructure.

This innovative exhibit responds to the national movement toward greater focus on STEM development and STEM career awareness. By engaging kids in fun, math-based activities, the content can inspire students to make math a priority, reaching them in that window of vulnerability when math gets more challenging and kids begin to lose interest.

The exhibition is designed to help answer the age-old question: "Will I ever use all this math they're teaching us?"

Visitors are accompanied by fun and quirky virtual guides. Along the way they'll meet and hear professionals, visionaries and inspiring personalities talk about math in their work across fields kids are most interested in exploring. The exhibit addresses all math strands and subjects for upper elementary and middle school, and neatly aligns with standards for educator planning.

HIGHLIGHTS OF THE EXHIBIT BY SECTION

OUTDOOR ACTION... ADVENTURE SPORTS
- *Boardercross...* Snowboard Experience
- *Get a Grip...* Rock Climbing
- *Measure Up...* Scatter Plot
- *It's a Stretch...* Arm Span
- *Ramp It Up...* Build a Skateboard with POP
- *Pedal to the Peak...* Mountain Bike Challenge
- Featured Personality: Eric "Tuma" Britton, professional skater/instructor

BUILD YOUR WORLD... ENVIRONMENT
- *Bridge to the Future...* The Engineered City
   - o *Power Play...* Energy
   - o *Test the Waters...* Water
   - o *Easy on the Gas...* Transportation
   - o *Going Viral...* Communications
- Featured Personality: Rondi Davies, geologist and champion marathon swimmer

FUTURE STYLE... STYLE AND DESIGN
- *Style Revolution...* 360-degree Photo Shoot
- *Make It Fit...* Tessellations
- *Nature's Numbers...* Nature's Patterns
- *Shadow Play...* Shadows
- Featured Personality: Neri Oxman, architect and designer, MIT Media Lab
- Featured Personality: Daniel Ferguson, IMAX film director and screenwriter
- Featured Personality: Ajay Kapur, musician and computer scientist

KICKIN' IT... ENTERTAINMENT
- *Mix It Up...* Giant Musical Instrument
- *Flicker Fusion...* Make a Movie
- *Step Up...* Dance Motion
- *3-D Mapping...* Game Developer

GAME PLAN... VIDEOGAMES AND OTHER GAMES
- *Game Developer*
- *Crack the (Binary) Code*
- *Flip It...* Probability
- *Game Box Kids*
- Featured Personality: Robin Hunicke, game developer
- Featured Personality: Michael Mateas, game developer

ROBOTICS AND SPACE
- *Space Walk...* NASA Robot
- *Curiosity Rover*
- *Future Robots...* Robot Artifact Display
- *Picture This...* Hubble Telescope
- Featured Personality: Dennis Hong, robotics engineer
- Featured Personality: Robin Murphy, robotics engineer
- Featured Personality: Kathryn Gray, student and supernova searcher
- Featured Personality: Robonaut 2

RESOURCE CENTER
- *Play...* Sum of All Thrills, MathMovesU.com
- *Explore...* Math Programs, Competitions, etc.
- *Connect...* Local Events, Activities Center

MATH IN THE FRONT YARD

Going outside to hang out with your friends? Try this:

You will need: three people — a Jumper, a Timer and a Recorder — stopwatch, pencil, paper, data table.

SECONDS	# OF JUMPS
0	0
10	9
20	17

> 9–0 = 9 JUMPS IN 10 SEC. OR 9/10

> 17–9 = 8 JUMPS IN 10 SEC. OR 8/10

1. Prepare a data table for recording jumping jacks, like the sample shown here. You will have a total time of 2 minutes (120 seconds) in 10-second intervals.

2. Do you think the jumper will get faster, slower, or pretty much stay the same over 120 seconds of continuous jumping? Record your prediction in the table.

3. So, here goes! The Timer says "go" and, once the Jumper begins, starts the stopwatch. The Jumper starts doing jumping jacks. The Recorder counts how many jumping jacks the Jumper does. Every 10 seconds, the Timer says "record," and the Recorder writes down the number of jumping jacks in the table. Continue this process for the full 120 seconds (2 minutes), recording the number of jumps that have occurred at each 10-second mark.

4. How did the jumping jack rate (# of jumping jacks per second) change as time passed? What's the range (you need to define range; many will not have a clue what it is, believe it or not) of numbers? Was your prediction correct?

5. What does this pattern tell you about how a bike-riding speed might change over time?

6. What is the Jumper's average jumping jack rate over 2 minutes?

What's the Math?
Math involves figuring out how things that you can count or measure change over time. By taking a number of samples of data, you can figure out how the number of jumping jacks changes over time.

For the Little Kids: No matter how old they are, they will have fun jumping and can practice counting!

MATH BEHIND THE REFRIGERATOR

Want to know who uses the most electricity in your family? Try this:

You will need: lots of large and small household appliances, paper, pencil, your household electric bill.

1. Take a walk around every corner of your house or apartment looking for things that use electricity. Look carefully at the labels on the backs of the appliances to find out how many watts they use.

2. Make a table listing the name of each appliance, with three columns labeled "intensity," "duration" and "power use." The number of watts goes in the "intensity" column.

3. To fill in the "duration" column, you need to know how much time an appliance is used each day. Some of these you already know — like that your refrigerator is always plugged in — but some you may not.

4. Choose three appliances to study — one large, one medium-sized and one small. Take a few days to observe and record each appliance's pattern of usage. Record "minutes per day" in the "duration" column. Make the best estimate you can, based on your observations.

5. Multiply intensity by duration to get "power use" for each of the three appliances. Is the appliance that needs the most watts always the one that uses the most power? If you want to save energy, where can your family cut back?

6. Take a close look at the electric bill. How is your family's power use measured there? How would you use the data you collected to estimate next month's bill?

7. Create your own advertisements for two different electrical appliances — one that is energy efficient and one that isn't.

What's the Math?
Power use is a function of intensity (wattage) and duration. Both variables matter.
1 kilowatt = 1,000 watts
1 kilowatt hour = one 1,000-watt appliance running for 1 hour

For the Little Kids: Even if they can't read yet, they can join in the scavenger hunt for appliances that use electricity!

MATH AT THE PICNIC TABLE

Can you create a special effect with some extra paper plates? Try this:

You will need: four paper plates, scissors, pencil, tape, a mirror, ruler.

1. Fold the first paper plate in half, unfold it and cut a slit in the outside edge of the plate, about 1/8 inch wide and 1 inch long at each end of the fold. Make another fold in the plate, perpendicular to the first fold. Unfold it and cut two more slits, so you have four equally-spaced slits altogether. This is plate #1.

2. For plate #2, begin just as you did with plate #1, but continue folding and cutting until you have eight evenly-spaced slits.

3. Put plate #1 over a new plate (plate #3), mark the same slits, and cut them. On plate #3, draw an identical person or object in between each pair of slits.

4. Repeat step three using another plate (plate #4) to go with plate #2.

5. On both plates #3 and #4, add a small change to each of the people or objects you have drawn, showing some kind of increasing movement on each picture.

6. Stick the pencil point through the center of each set of plates so that the slits and two holes line up and your pencil can slide in and out.

7. Tape the edges of the each set of plates together back-to-back so that your drawings are on the outside and all the slits are lined up. You just made two zoetropes.

8. One at a time, hold each zoetrope with the figures facing the mirror. Balance the pencil eraser on your chin and spin the plate. Look into the mirror through the slits as they spin by. What happens?

9. What are the sizes of the angles in each zoetrope? How does the size of the angle relate to the length of the space between the slits? To make the very best zoetrope, what angles and distances between the slits do you think will get the best images? Why?

What's the Math?
Your zoetropes demonstrate the functional relationship between the angle size and the number of slits and also the functional relationship between the number of slits and the quality of the image.

For the Little Kids: Making the zoetrope might be too hard, but if you help them, they can spin it and see the images move in the mirror.

Fold 2 plates in 1/4ths
then 2 plates in 1/8ths
Cut slit on folds
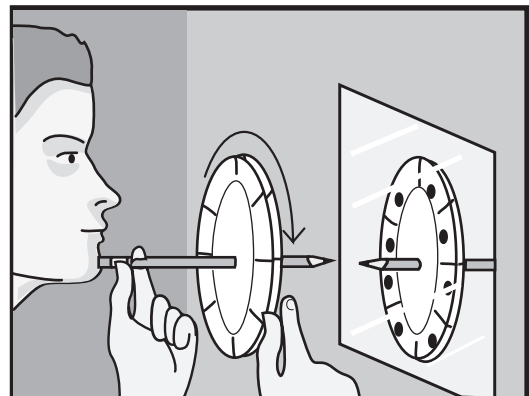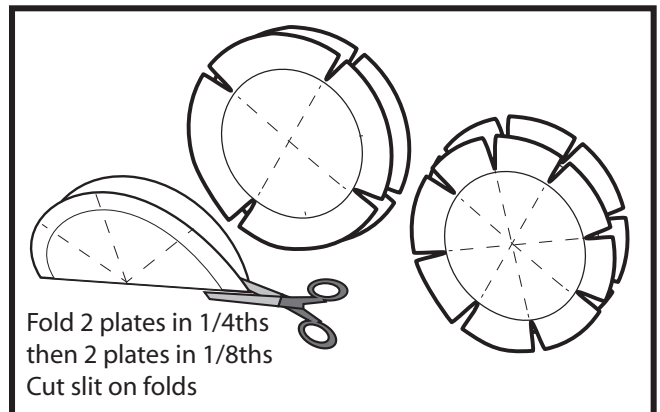
MATH OUT OF THE RECYCLING BIN

What can you do with that empty shoe box, cereal box and tissue box? Try this:

You will need: different sizes and shapes of cardboard boxes without tops, different lengths of rubber bands, black marker, ruler, pencil, paper.

1. Stretch rubber bands across the boxes, like strings across a guitar. Pluck each rubber band to hear the sound it makes.

2. Use the ruler to find the center point of the rubber band and mark that spot. What happens if you hold your finger in the center and, with the other hand, pluck each side?

3. Hold the rubber band down at another spot, while plucking with the other hand. Mark the spot where your finger was. How is the sound different?

4. Repeat step three at other spots along the rubber band. What do you notice? What do you think will happen if you try this with different sizes of boxes? How does the pitch of the sound change with shorter or longer lengths of rubber bands?

5. Make some new rubber band instruments and compare your results. Can you tune your instruments to all play the same sound?
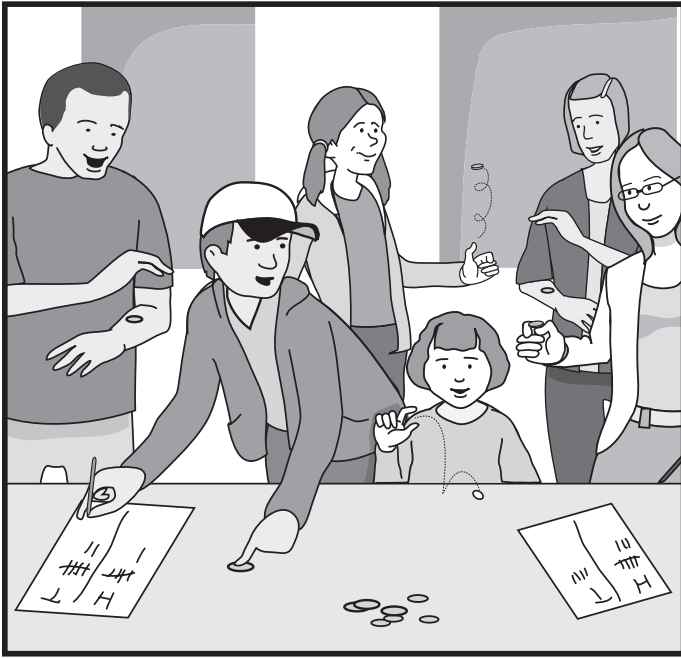
What's the Math?
Your musical instruments demonstrate a relationship between math and music. The shorter the length of rubber band you pluck, the higher the pitch.

For the Little Kids: Everyone in the family can have their own rubber band musical instrument!

MATH IN YOUR WALLET

Do you know what the odds are that your team will win the coin toss? Try this:

You will need: coins, paper, pencil, friends.

1. Make three tables on your paper, each with one column labeled "heads" and one labeled "tails." The first table is for data from 10 flips of the coin, the second table for 50 flips and the third table for 100 flips.

2. Before you begin flipping the coin, predict what you think will happen. Out of 10 coin flips, how many will be heads and how many will be tails?

3. Flip the coin 10 times, recording the results on the first table as tally marks in the appropriate columns. Flip 50 times and record it on the second table and 100 flips on the third table. What pattern do you see? What percentage of the time does it turn up heads in each trial? What percentage does it turn up tails?

4. Ask a lot of your friends to try the same experiment. If you add the results of their data with yours, what do you predict the result will be? Try it and see if you're right!

What's the Math?
Your coin toss experiment shows that the larger your sample size, the more reliable your prediction becomes.

For the Little Kids: Tossing a coin can be as simple as dropping it on the floor. They can definitely help with this one, and the more tosses, the better!

Expert Challenge: Ask your parents if you can help balance their checkbook. While you're at it, find out how to write out a check, pay a bill online or use a debit card. What are the differences and pros and cons between these methods of payment and using a credit card?
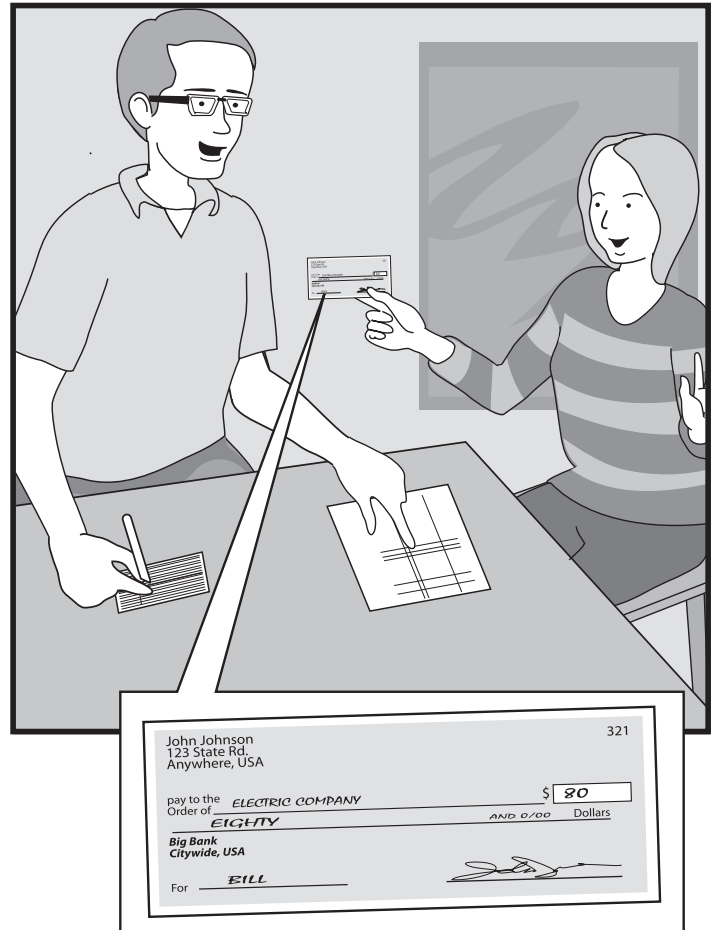
MATH FROM THE GROCERY BAG

What do all those different sizes of canned goods you bought have in common? Try this:

You will need: soda can, string, tape measure, cans and wheels of all different sizes.

1. If you wrap a piece of string around the circumference of the soda can and then take that string length and stretch it out, will it be longer, shorter or the same length as the height of the can? Make your prediction first and then try it.

2. Try the same experiment on different sizes of cans. What do you notice?

3. Now try this: Wrap a strip of paper around the can. Then hold the strip across the diameter of the can and fold it into as many diameter lengths as you can. What happens? If you do it with the other cans, what do you find?

4. The Mars rover's six wheels are each 26 cm in diameter. The rover can travel up to 5 cm per second. Using what you know about circles, what information can you figure out about the circumference of the rover's wheels?

5. How would you design a model to compare the wheels, movement and speed of the rover to your family car?

What's the Math?
No matter how big or small the circle is, the relationship between diameter and circumference is a fixed ratio, which is called Pi: 3.14159…..

For the Little Kids: Send them on a scavenger hunt for cylinders around the house. How many different sizes of cans will they find on the shelves of your kitchen?
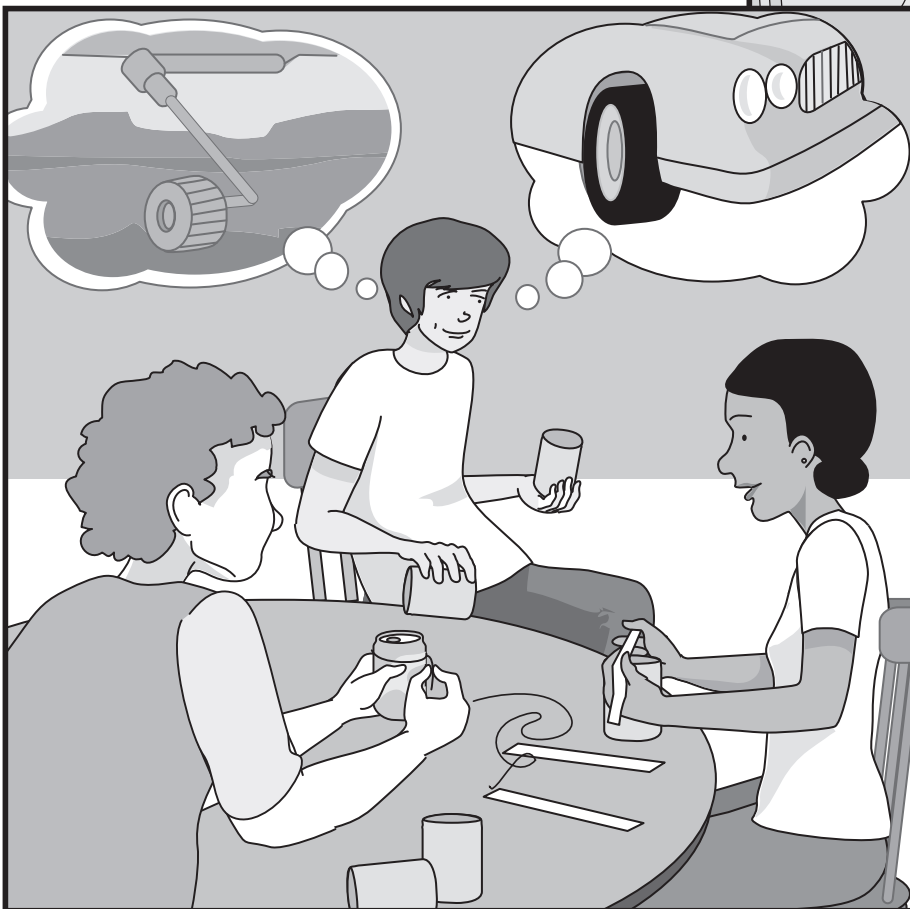
MATH ALL AROUND YOU

Parents, you can show your children the math that's all around them. Here are just a few everyday situations where you can get them involved and help them experience the math in their world.

When you're cooking, they can work with all the different ways of measuring — liquids and solids, ounces and teaspoons, adding and subtracting, etc.

When you're at the grocery store, you can give them a copy of your shopping list and see if they can estimate how much it will cost.

When you fill up the car with gas, they can help you figure out how many miles per gallon your car gets, or estimate how much your gas tank holds.

Together you can explore all the 3-D geometric shapes in your house — like a cylinder full of tennis balls or a box of cereal — measure the dimensions and figure out the volume, read the label to see how much it holds, etc.

Together buy picture frames that are 4x6, 5x7, 8x10, and so on. What does that size mean? Discuss together the meaning and what other items are sold with this type of label.

Landscaping together, figure out how many square feet a 2-cubic-foot bag of mulch will cover. If you know the size of the space you need to cover, how much should you purchase?

Watering the yard for 20 minutes, determine how much water is used. Turn on the hose and fill a 5-gallon pail to determine how long it takes for the hose to run out that much water. Then use that information to figure out how much water comes out for the 20 minutes of watering.

VISIT
http://mixinginmath.terc.edu/materials/athomewithmath.cfm for more great math activities to do at home.
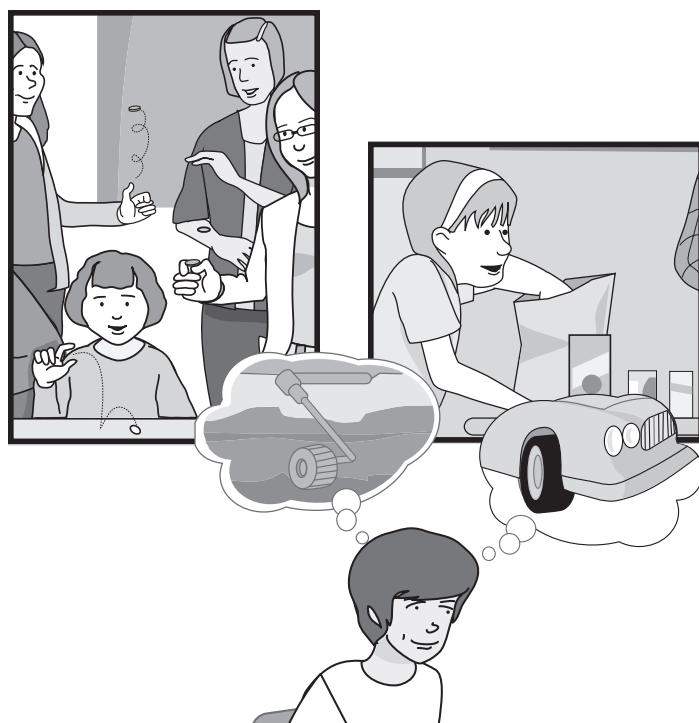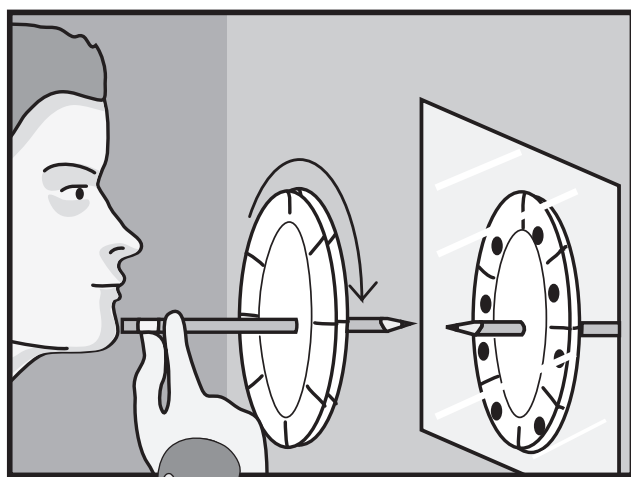
RESOURCES

Here are some great websites where math really comes alive with fun activities and interactives.

mathmovesu.com
mathcounts.org
spacemath.gsfc.nasa.gov
illuminations.nctm.org
mathwire.com
http://mixinginmath.terc.edu/
coolmath.com
funbrain.com
mathplayground.com
http://teacher.scholastic.com/maven/

For more resource listings and websites, visit www.mathalive.com

ACKNOWLEDGMENTS

MathAlive! is one element of Raytheon's many-tiered MathMovesU program, which utilizes a host of engaging learning programs — including MathMovesU's interactive website, scholarships, sponsorships and events — to help students from middle school through college remain interested in math and science and, by extension, ensure the continued strength of the American work force. Some of the innovative initiatives supported by MathMovesU include the following:

MathMovesU.com
Sum of All Thrills™
Math Hero Award
Middle School Scholarship
Bonus STEM Study
FIRST Robotics Scholarship
Raytheon STEM Model
Hall at Patriot Place
MATHCOUNTS
Questacon
'Science of Sports'
Eduventures®
Team America Rocketry Challenge
MathMovesUniversity
FIRST Robotics
Change the Equation
Engineering is Elementary

Learn more at www.mathmovesu.com.