ARIZONA SCIENCE CENTER
MATHEMATICAL ADVENTURE

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Welcome to an Arizona Science Center Mathematical Adventure designed by Arizona State University’s PRIME Center.

You will need:
- Pencil for recording information
- Measuring tape (customary and metric units)
- Quarter coin
- Calculator
- A watch with a second hand
- A partner to help with the measurements

Follow these directions to the various problem sites. Gather the data you need at those sites. You can solve the problems as you go, or you can wait until after the tour to complete the problems. You will find all of the directions inside the rectangles on the following pages. For formulas and measurement units, see the Appendix (not a human one!) at the end of this tour booklet.

Have a great day learning science and doing math.
Ready? Set? Go!

After you walk through the main entry, you will see a ramp.
Walk down the ramp. Stop midway.
You are walking on mathematical carpeting.

1. Mathematical Carpeting

Look at the carpet and find a triangle with the letters $a$, $b$ and $c$.

1a. What is the length of Side $a$? __________

1b. What is the length of Side $b$? __________

1c. Use the lengths of Sides $a$ and $b$ to compute the value of $c$.

   What is the length of side $c$? __________ (Hint: Think Pythagoras!)

   Then measure Side $c$ to check.

1d. Is this a right triangle? __________

Continue down the ramp to the first floor.
2. Eye in the Sky!

What is the circumference of the inner lens of the telescope?

To figure it out, here’s where that quarter (coin) comes in handy. The quarter is conveniently about 1 inch in diameter.

Use the quarter and your measuring tape to follow these steps:

- Hold the quarter up to your eye.
- Move the quarter back and forth until the edge of the quarter eclipses (matches up exactly) with the inner lens of the telescope.
- Have your partner measure the distance from your eye to the quarter AND the floor distance from the tip of your toes to the bottom edge of the telescope. (Estimate where the bottom edge would be if extended down to the floor.)

2a. Distance from quarter to eye: _____ inches

2b. Floor distance – tip of your toes to bottom edge of telescope: _____ inches

2c. Use this proportion to figure out the diameter of the lens in inches.

\[
\frac{\text{Diameter of quarter (1in.)}}{\text{Diameter of the lens}} = \frac{\text{Distance from eye to quarter}}{\text{Floor distance (toes to telescope edge)}}
\]

Diameter of the lens: ____________ inches

2d. Use the diameter to estimate the circumference of the lens.

Circumference is about ____________ inches
3. Velocipede: An Antique Motor Bike

Consider how the different sized wheels are related. Do your best to determine the following measurements through the glass.

3a. Measure the diameter of the large wheel of the bike. Determine the circumference of that wheel.
\[ d = ____ \text{ inches} \quad \text{and} \quad C = ____ \text{ inches} \]

3b. Measure the diameter of the small wheel of the bike. Compute the circumference of that wheel.
\[ d = ____ \text{ inches} \quad \text{and} \quad C = ____ \text{ inches} \]

3c. How many times will the small wheel rotate for one rotation of the large wheel? ____ times

Continue on. Bear left and walk to the W.O.N.D.E.R. Center.


What are the words?

W____________________ D____________________
O____________________ E____________________
N____________________ R____________________
5. Brainy Facts!

5a. The sperm whale has the largest brain. It weighs about 17 pounds. The weight of a human adult brain is about 18% the weight of a sperm whale’s brain. An adult’s brain is about _______ pounds.

5b. A newborn’s brain is about 1/3 the weight of an adult’s brain. About how many pounds is a newborn’s brain? _______ pounds

You can estimate the weight of your brain. Follow these steps:

5c. Record your body weight in pounds. _____ pounds

5d. Your brain is about 2% of your body weight. About how much does your brain weigh? _______ pounds

5e. What percent of your brain is water? _______ percent

5f. About how many pounds of your brain weight is water? _______ pounds
Walk behind the life-size brain to find the Sleep On It Exhibit.

6. Sleep On It!
6a. How many hours do you sleep each night? _____ hours
6b. How many hours do you sleep in one year? _____ hours
6c. What percent of a year do you spend sleeping? _____ percent

Continue on to the All About Me Gallery.
Look for the skeleton.

7. Bones and You
The skeletal system is composed of the bones in your body AND the tendons, ligaments and cartilage that connect the bones.
Together, the number of bones in your two hands and two feet is 106. There is one more bone in one hand than in one foot.
7a. How many bones are in one hand? ______
7b. How many bones are in one foot? ______
7c. You have 2 dozen ribs. The total number of bones in your body is 14 more than 8 times the number of ribs. You have a total of ______ bones in your body.
8. Have a Heart!

Your cardiovascular system includes your heart, arteries and veins.

8a. How big is your heart? Clench your fist. That’s about the size of your heart. Your heart weighs about 10 ounces. What percent of your total body weight is the weight of your heart? _____ percent

8b. Your pulse is your heart rate, or the number of times your heart beats in one minute. Take your pulse. You can get your pulse from the underside of your wrist (wrist pulse) or on your lower neck (neck pulse). Use a watch with a second hand. Count the beats you feel for 15 seconds. Multiply that number by 4 to get your pulse rate for one minute.

My pulse rate is _____ beats per minute.

8c. **Super Challenge:** At that pulse rate, beginning January 1, on what date (month and day) will your heart make its 1,000,000th beat? ___________
9. Speedy Wheels

Note: All measures here use metric units.

9a. What is the diameter of one of the back wheels of the wheelchair?
   \[ d = \underline{\phantom{0}} \text{ centimeters} \]

9b. Use that diameter to compute the circumference of the wheel.
   \[ C = \underline{\phantom{0}} \text{ centimeters} \]

9c. How many times must the wheel rotate to travel 1 kilometer?
   \[ \underline{\phantom{0}} \text{ times} \]

9d. Sit in the wheelchair and turn the wheels as fast as you can and finish the race. The display screen will show you both the distance traveled and the time it took to travel that distance.

   Calculate your rate in meters/second. \[ \underline{\phantom{0}} \text{ meters/second} \]

9e. At that rate, how long would it take you to complete the Boston Marathon, about 42 kilometers long?
   \[ \underline{\phantom{0}} \text{ minutes} \]
10. How big is your skin?

Did you know that your skin is the largest organ in your body?

10a. What is your height in feet and inches? (Use the measuring board to get your height.) ________

10b. What is your weight in pounds? (Estimate.) ________ pounds

10c. Use your height, weight and the chart to figure out how many square feet of skin you have. ________square feet

10d. How many square inches of skin do you have? (One square foot is 12 inches by 12 inches, or 144 square inches). ________square inches
Walk to the exhibit of the Digestive System and the Monster Stomach.

Tour the inside of the model stomach,
then walk behind the model to see a real digestive system.

11. How long are your intestines?

The first step in digesting food begins in your mouth. From there, the food you eat is broken down into nutrients that are absorbed by your body. The digestive tract, also called the alimentary canal, is a long tube of organs that includes the esophagus, the stomach, and the small and large intestines. Let’s take a look at the intestines.

The small intestine is located just below your stomach. In an adult, the small intestine has a circumference of $1\frac{1}{2}$ to 2 inches. If the small intestine is stretched out, it would be about 22 feet long!

The large intestine is almost the last stop before the rectum in the digestive tract. The circumference of the large intestine in an adult is 3 to 4 inches. The large intestine is about 5 feet long.
11a. Using the measurements above, what are the diameters of the:
   Small intestine? _______ inches
   Large intestine? _______ inches

11b. The average height of an adult male in the United States is 5’9”. His height is how many times the length of his:
   Small intestine? _______ times
   Large intestine? _______ times

11c. The average height of an adult female in the United States is 5’4”. Her height is how many times the length of her:
   Small intestine? _______ times
   Large intestine? _______ times

Go to What’s in Your Body?
Look at the wall chart that shows the elements in your body.

12. It’s Elemental!
12a. What percent of your body is carbon (C)? _______ percent
12b. Use your weight to determine the number of pounds of carbon (C) in your body. _______ pounds
12c. Use your weight to determine the number of pounds of potassium (K) in your body. _______ pounds
13. Drinking Fountains and Showers

As you walk up the stairs, you will see two drinking fountains. The tall one is a standard drinking fountain. The shorter fountain is designed to be in compliance with the Americans with Disabilities Act (ADA).

Most ADA Drinking Fountains are 36 inches in height, from the floor to the center of the spout. Standard Drinking Fountains are 42 inches from the floor to the center of the spout.

13a. What is the height of the standard fountain? _____ inches
13b. What is the height of the ADA fountain? _____ inches
13c. Do they measure up to the ADA and Standard Drinking Fountain heights? ________
13d. Most drinking fountains have a flow rate of one quart of water per minute. Most showers have a flow rate of 3 gallons of water per minute. In one minute, about how much more water is used in a shower than in a drinking fountain? _____ quarts
14. Swing It!

The *bob* is the object at the end of the pendulum. The *period* is the length of time it takes for a pendulum to swing away and back to its starting point.

14a. Does the mass of the *bob* affect the *period*? 

14b. Does the length of the rod holding the *bob* affect the *period*?

14c. Can you lengthen the *period*? If so, how?

14d. Can you shorten the *period*? If so, how?
15. Ouch!

Lie down on the Bed of Nails. Use the control switch to pump up the nails. Feel anything sharp? You shouldn’t, because the bed has more than 1500 nails and your body weight is distributed over the nails. Your body will probably cover about 1000 nails.

About how many pounds is that per nail? ________ pounds per nail
16. Stream Table

*Grade* is a way of describing the steepness of an incline. A steep highway grade is 6%. That means that for every 100 feet of horizontal distance, the road decreases (or increases) in height by 6 feet. What is the grade of the stream bed?

(Read the sign above the stream bed.)

16a. How long is the stream bed (highest to lowest point of the bed only)?

______ inches

16b. What is the height (from the floor) of the stream bed on the high end?

______ inches

16c. What is the height (from the floor) of the stream bed on the low end?

______ inches

16d. What is the difference between the high and low heights?

______ inches

16e. Calculate the grade. (Be sure that all measurements have the same units.) ______ percent
On the wall is a picture of the Roosevelt Dam. Check out the models in the cases.

17. The Roosevelt Dam

The Roosevelt Dam on the Salt River, northeast of Phoenix, took 5 years to build.

17a. Construction began in 1906 and concluded in ______, one year before Arizona became a state in ______.

17b. The Dam is 109 meters high. Its length is 42 meters more than 3 times its height, or ______ meters long.

17c. Its width at the base is 49 meters less than its height, or ______ meters wide.

17d. Its width at the crest (top) is 1/10 its base width, or ______ meters wide.

17e. The Dam was renovated beginning in 1989 and concluded 7 years later in ______.
Continue on to the Forces of Nature Immersion Theater.
Step up onto the platform.
Watch the video. Get wet! Get baked! Get blown away!
Then, solve these problems.

18. Ha Ha Haboob!

*Haboobs* are walls of dust and dirt that can have wind speeds of 25 – 50 miles per hour. Haboobs usually last 2 – 3 hours and can be as high as 3000 feet above the ground.

18a. Suppose that you are leaving a store one day and you see a haboob in the distance. You get into a car with your family and try to outrun the haboob, which is 3 miles behind you. If you live 5 miles away, can you get home before the haboob overtakes you? The speed limit is 35 mph, but you must take into account traffic signals and traffic back-ups. ________

18b. Suppose that you are riding a bike at a speed of 5 miles per hour. Can you out-bike the haboob? ________

Explain.__________________________________________
___________________________________________________________________________________
19. Sparks in the Sky

Have you ever seen lightning? There are about 100 lightning strikes on our planet every second! A bolt of lightning can travel at a speed of 140,000 miles per hour, and can reach a temperature of 54,000 degrees Fahrenheit. People who study the science of lightning are called fulminologists.

19a. About how many lightning strikes occur on Earth in:

   One hour? __________
   One day? __________

19b. How many times greater than the boiling point of water (212 degrees Fahrenheit) is the high temperature of lightning? _______ times

With lightning we often hear thunder. You can estimate how far away you are from the lightning by counting the number of seconds between the time you see the lightning and when you hear the thunder. When there is five seconds between seeing lightning and hearing thunder, that means the lightning is about one mile away. Why is that so? Here’s how to figure it out.

   Fact: Speed of sound is 1,115 feet per second.

19c. How many feet will sound travel in 5 seconds? _______ feet

19d. How does that distance compare with the number of feet equal to one mile? ____________________________________________
20. 2011 Shake Ups!

Whenever you hear about an earthquake, you usually hear its Richter scale rating. The Richter scale was developed by Charles Richter in California in 1930 and depends on the wave measurements of the earthquake that are recorded on a seismometer. That rating tells you about the relative strength of an earthquake. For example, a Richter scale rating of 6 means the earthquake is 10 times stronger than an earthquake with a rating of 5, and 100 \((10 \times 10)\) times stronger than an earthquake with a rating of 4.

In March 2011, Japan had a 9.0 magnitude earthquake on its eastern coast near Sendai. The earthquake triggered a deadly tsunami with giant waves that destroyed cities and rural areas, and swept away buildings, trains, boats, and cars.

In August 2011, the United States had an almost 6.0 magnitude earthquake. It occurred 38 miles northwest of Richmond, Virginia.

In October 2011, Turkey had a 7.0 magnitude earthquake. Ercis, an eastern city closest to the Iranian border, was hit the hardest.

About how many times greater was the Japanese earthquake than the earthquake in:

20a. The United States? ________ times
20b. Turkey? ________ times
21. Blown Away

A hurricane is a large tropical storm with very heavy winds (at least 75 mph) and lots of areas of rainfall. When strong enough, hurricanes can generate tornados. Hurricanes have a quiet/peaceful center called the “eye.” You can see it in the picture below. The eyes can be 10 to 30 miles wide and have calm winds and clear skies. The winds around the eye can gust up to 186 mph.

In August 2005, Hurricane Katrina hit the United States near New Orleans. With a maximum speed of 175 mph and high seas, it claimed more than 1800 lives and left 450,000 people homeless. About 80% of New Orleans was left underwater. The sky view photo below shows Hurricane Katrina. The arrow pinpoints the eye of the hurricane. The white cloud-like formation is the hurricane.

Katrina: Legend in miles

![Hurricane Katrina Image]
When Hurricane Katrina reached land, assuming a circular region:

21a. What was its radius?

_________ miles

21b. What was its land area?

\[ A = \text{_________ square miles} \]

21c. The fastest wind ever recorded was in Oklahoma in 1999. The speed was 318 mph. About how many times greater is this fastest wind speed than the greatest speed of Katrina?

_________ times

This concludes your Mathematical Adventure.

Complete the problems.

Check your answers with the answer key.

Come back for another visit!
# Appendix

<table>
<thead>
<tr>
<th>Customary Measures of Length, Capacity and Weight:</th>
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<tbody>
<tr>
<td><strong>Length:</strong></td>
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</tr>
<tr>
<td>1 foot = 12 inches</td>
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<tr>
<td>1 yard = 3 feet or 36 inches</td>
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<tr>
<td>1 mile = 5280 feet</td>
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<tr>
<td>1 square foot = 12 inches x 12 inches, or 144 square inches</td>
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<tr>
<td><strong>Capacity:</strong></td>
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<tr>
<td>1 cup = 8 ounces</td>
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<tr>
<td>1 pint = 2 cups, or 16 ounces</td>
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<tr>
<td>1 quart = 4 cups, or 2 pints, or 32 ounces</td>
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<tr>
<td>1 gallon = 4 quarts, or 8 pints, or 16 cups, or 128 ounces</td>
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<tr>
<td><strong>Weight:</strong></td>
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<tr>
<td>1 pound = 16 ounces</td>
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<tr>
<td>1 ton = 2000 pounds</td>
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<tr>
<th>Formulas for Circles:</th>
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<tbody>
<tr>
<td><strong>Circumference (C):</strong> (The distance around a circle.)</td>
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<tr>
<td>$C = 2\pi r$ or $C = \pi d$, where $r$ is the length of the radius of a circle, and $d$ is the length of the diameter. (Radius is the distance from the center of a circle to its edge. Diameter is the distance from one edge of a circle to the other edge of the circle through its center.)</td>
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<tr>
<td><strong>Area of a circle (A):</strong></td>
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<tr>
<td>$A = \pi r^2$</td>
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<tr>
<th>Metric Measures of Length:</th>
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<tbody>
<tr>
<td>1 meter (m) = 100 centimeters (cm)</td>
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<tr>
<td>1 kilometer (km) = 1000 meters (m)</td>
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<table>
<thead>
<tr>
<th>$\pi$</th>
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<tbody>
<tr>
<td>3.14</td>
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<tr>
<td>$\pi$ is the ratio of the circumference of a circle to its diameter: $C/d$ and has a value approximating 3.14.</td>
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<tr>
<th>Pythagorean Formula: (for a right triangle)</th>
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<tr>
<td>$a^2 + b^2 = c^2$, where $a$ and $b$ are the lengths of the shorter sides, and $c$ is the length of the longest side, or hypotenuse of the right triangle.</td>
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