Kinetic City Leader Guide Information Sheet

**Club Name:** ____________________

**Crew 1 Name:** ____________________

| | Codename | Password |
|---|---|---|
| 1: | | |
| 2: | | |
| 3: | | |
| 4: | | |
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**Crew 2 Name:** ____________________

| | Codename | Password |
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| 1: | | |
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**Crew 3 Name:** ____________________

| | Codename | Password |
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**Crew 4 Name:** ____________________

| | Codename | Password |
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| 1: | | |
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| 3: | | |
| 4: | | |
| 5: | | |
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**Crew 5 Name:** ____________________

| | Codename | Password |
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| 1: | | |
| 2: | | |
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| 4: | | |
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## Dear **Kinetic City** Leader:

It's not every day that you and your after school program get to save a Universe. But that's what you and other Kinetic City clubs around the world will be doing with **Kinetic City: Mission to Vearth**.

Is this an awesome responsibility? Well, sure. But it's also lots of fun.

In each two-week mission, you and your kids will perform five exciting activities focused on a single area of science. Then, using what they've learned, your kids will play an on-line Mission to Vearth game to earn **Kinetic City Power Points** for your Club.

These Kinetic City Power Points help protect Planet Vearth from the nasty Deep Delete virus. They will also appear on your Club Web Site, showing the world what you've accomplished.

Please don't worry if you're not a computer whiz, or a science whiz. The activities in this box should be fun and easy for you and your kids to do. Most of them can be done away from the computer.

In this Leader's Guide, you will find instructions on how to get started with Kinetic City, including how to register your Club and set up your Club Web Site. There are also overviews of the four missions in this box, including copies of the five activities that correspond to each mission. If you need more copies of these activity pages, you can photocopy them or print them out from the website.

If for some reason your Club is unable to go to the Kinetic City website, simply use the paper copies of the activities in this Leader's Guide. Again, most Kinetic City activities do not require a computer.

Thank you so much for participating in **Kinetic City: Mission to Vearth**. We hope you and your children enjoy following the adventures of the Super Crew, and helping them defeat Deep Delete.

Who would've thought that saving a Universe could be so much fun?

Sincerely,

BOB HIRSHON
Executive Producer
**Kinetic City: Mission to Vearth**

# An URGENT Message from the Kinetic City Super Crew

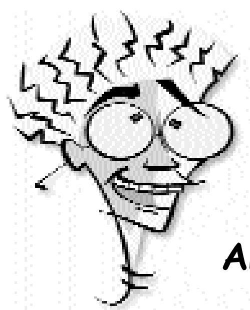
**Wow, are we glad you're here!** We're the Kinetic City Super Crew. We solve mysteries, fight crime and have fun on our incredible train, the **Kinetic City Express**. We also have an amazing computer named **ALEC**.

Maybe you've heard us on the **radio**, or read our **books**.

But now we're in big trouble, and we need your help. We live in a virtual universe inside a computer, on a planet called Vearth. A really awful guy named Gruel has attacked our universe with a computer virus called **Deep Delete**. It chews up science information from our world, and then strange things begin to happen. Gruel is being helped by our old enemy **Count Sonos,** and his unbelievably lazy nephew, **Lumbert**.

Every two weeks, Deep Delete attacks some part of our world. It might mess up gravity. Or make all our machines work backwards. Or it could do strange things to our environment.

Whatever happens, there's only one way to fix it: we need you Earth kids to figure out how the world is **supposed** to be. In other words, discover the **truth** about things. We'll help you with a set of activities called **Reality Reboots**. Once you do them, you'll be an expert on whatever it is Deep Delete is wrecking. Then you can use your smarts to go online, take a **Mission To Vearth**, and zap Deep Delete.



**ALEC**

To find out more, and to see what's happening today, just come to our home site at **www.kineticcity.com**

We hope to be seeing a lot of you. After all, without your help, we're in **big trouble**.

Thanks!

Your friends,
**The Kinetic City Super Crew**

# Getting Started with Kinetic City: Mission to Vearth

The following steps are recommended to help your kids get the most they can out of **Kinetic City: Mission to Vearth.**

As always, we encourage and look forward to your comments and suggestions!

## GETTING STARTED

The very first thing to do is introduce your kids to Kinetic City. Explain to them that they are about to play a new kind of interactive game on the Internet called **Kinetic City: Mission to Vearth.** In this game, there is a virtual world named Vearth that desperately needs their help to survive.

After this brief explanation, give each student a copy of the Urgent Letter from the Super Crew. The letter describes the situation the Super Crew is in, and why they need "Actual" kids to help them. You may also wish to read the letter aloud. Emphasize to the kids that the future of Vearth depends on their heroic efforts!

Next, pass out the letters and consent forms. These let the children's parents know that their kids will participate in a new science program; that the children will work on the Internet; and, most importantly, that they may post work to their own Kinetic City Club website. It is up to the Club to decide if their website will include a team picture or other photographs of the children. While the children are completely anonymous on the site, and while parents rarely object to having their kids' picture in their town newspaper (which is often also posted online), they still may be uncomfortable with this idea. We highly recommend that you not include photos if parents object or do not return the form at all.

The next step is to pass out the Kinetic City backpack tags and ID cards. Once your Club has a name, and the children log on and register, the kids can write their code names on their cards and keep them in their backpack tags. Of course, these tags can be put on anything, from a book bag to a notebook, if they don't wish to have them on backpacks.

Now, pass out the Kinetic City Case Journals and let the kids know they'll be sent on a new mission every two weeks. They should know that they will play an important role in the **Kinetic City: Mission to Vearth** story.

# NAMES AND PASSWORDS

Your first job is to form an official Kinetic City Club, and divide it up into five groups called "Crews." Have the kids spend some time coming up with a fun name for their Club. Pick something that does not identify exactly where you are (in other words, you can call yourselves the New York Brainiacs, but not the New York P.S. 138 Brainiacs). Once your entire Kinetic City Club has a name, have the children break up into five groups of roughly equal members to form the Crews. Have the Crews spend a few minutes coming up with a good name for their group. Let them know that this name will appear on their Crew's home page on the Web, and will be the name by which other players from all over the world will know them.

Finally, the children will have to make up names and passwords for themselves. They should not use their own names or other personally identifiable information. Animal names are fine (tiger, eagle, froggie), or inanimate objects (scooter, puppet, cookie), or famous characters (merlin, ariel, batman, anastasia) or even words they make up (freegle, blotz, morpholog). Their passwords should be hard to guess but easy for them to remember.

The reason they have codenames and passwords is that they will be playing games on the computer, and we need to keep track of their scores. That way, they can log on from any computer in the world and play to improve their score or look at new challenges. We don't know any of the children's identities—just the made-up names and passwords.

# GOING ONLINE

To participate in Kinetic City online, you will need an Internet-connected computer with a browser (preferably **Internet Explorer**) and a free plug-in called **Flash.** (To download Flash, go to www.macromedia.com/downloads and click on "Macromedia Flash Player")

A fast Internet connection will make the wait times shorter. If you have a slower connection (for example, one that dials over a phone line), it would be a good idea to open each Kinetic City page once before the children arrive. After your computer opens a page once, it will save it to its memory, and open faster when the kids go back to it.

Once all of the kids are in Crews and the Club name is set, go online to www.kineticcity.com and have the kids register individually at the Join page. Each child will be asked to choose a code name and password. Whenever they come back to Kinetic City, they can then log in, an dsee how many Kinetic City Power Points they have earned. They can also follow the progress of their club and follow club members.

## GETTING FAMILIAR WITH THE SITE

Once the kids are at the site, they can learn a little more about the Super Crew characters. Have them explore the Home Page and the Control Car especially. Any of the pages on the site can be printed out and copied for the children.

Once your children are familiar with **Kinetic City**, you're ready to get started!

# Evaluation and Assessment

K**inetic City: Mission To Vearth** is, to the best of our knowledge, the only after-school program based entirely on national science learning benchmarks, and developed specifically with each of those benchmarks in mind. We are confident that children performing our activities will gain a new understanding of these benchmarks, and be more motivated, confident learners.

Research by independent evaluators supports this confidence. The full text of this evaluation is available at our www.kcmtv.com website. We will continue to perform these evaluations and post the results on our website.

We also include tools that allow you to assess individual child performance, built into the program. For example, all children record their activity data and results in their *Kinetic City Case Journals*, providing leaders with detailed information on how each child is progressing through the material.

Each Mission in the *Case Journals* begins with topic questions that ask children to think about the topic before they have explored it. This provides a baseline for each mission for each child.

Examining the work sheet for each activity allows leaders to check for participation and assess the conclusions children have drawn from their data. Leaders can look for progress by comparing the children's pre-mission ideas and theories with the conclusions they present after each activity. Leaders can even pose the pre-mission questions again at the conclusion of the mission, and have children discuss what they learned.

In addition, each team is encouraged to report on their activities on their *Kinetic City* Web Page, giving leaders more information on their progress.

Of course, every child plays the *Mission To Vearth* game, which poses ten multiple-choice questions for each mission. By earning *Kinetic City Power Points*, children demonstrate basic understanding of some of the key learning goals in the mission.

By building these assessments into the *Kinetic City* game itself, children record data, draw conclusions, take quizzes, etc., without thinking of any of them as "tests." They are all just part of the fun of participating in *Kinetic City*.

In addition, an independent evaluator will be creating and administering more detailed assessments for a subset of several hundred children, the results of which will help us plan and develop the *Kinetic City* program. In addition to the results of this study, we will also make available on our website the same assessment tools used by the evaluator for Club Leaders who wish to use them.

As an after-school program, *Kinetic City* will never replace a well-designed, rigorous, in-school, teacher-led curriculum. That is not our intent.

However, our assessments have shown that children who participate in **Kinetic City: Mission to Vearth** quickly out-perform other children on knowledge of standards-based content information, conceptual information, and in overall motivation toward science learning.

Overall, we feel that **Kinetic City: Mission To Vearth** has been shown to be effective by independent experts more than any other after school program. This is part of an ambitious and rigorous evaluation that will continue and, we hope, expand as we continue to improve and refine *Kinetic City*.

## HELP!

Site isn't loading? Game piece missing? Fly in your coffee? Whenever disaster strikes, check www.kcmtv.com to see if your problem is addressed there. Or use our email center to contact us. When all else fails, call our toll-free sales and service line, 1-888-438-5272.

# Mission Pack: Sigma

In this set of four missions, children will learn about mathematical inquiry, models, the Universe, and the Copernican insight that displaced the Earth from the center of the Universe.

THE FLOPERATOR ("Mathematical Inquiry") focuses on the use of math to describe and investigate the world. One approach in this unit is to encourage students to manipulate numbers abstractly. In the Mind Game, students will wind their way through a mathematical maze, looking for different routes to their numerical goal, while in the Move Crew, they'll have to maintain a consistent score using tokens with constantly fluctuating numerical values. Another skill that this unit develops is the use of numbers and shapes to describe the world. In the Write Away, they'll have to describe an object using as many numbers as possible, while in the Smart Art, they'll learn to see larger shapes as composites of smaller ones. Finally, in the Fab Lab, they'll play a game in which the object is not to get the right answer, but to ask the right question – a crucial element of mathematical skill that is often underplayed in elementary curricula.

In MUDDLES ("Models"), the children will explore several different kinds of models. The Fab Lab is a traditional experimental model (of ocean currents), but students are asked to think not so much about the ocean but about the relationship of the model to the process it represents. In the Smart Art, they'll work with a popular kind of model – the paper airplane – and explore how adjusting and refining its shape can yield different results. In the Mind Game, they'll tinker with a computer model of a frozen-slush business, while in the Move Crew, they'll develop their own modeling system for original dances. Finally, in the Write Away, the children will write their own myths, which model natural phenomena in the world. Throughout the unit, encourage the children to compare the different types of models, and to think about what the definition of a model really is. Their concept of a model should progress from something limited (probably physical models of planes and trains) to a broader, more sophisticated understanding.

PUNIVERSE ("The Universe") is about the world beyond the Earth, particularly the stars and planets. Several of the activities look at stars and constellations, including the Mind Game, in which students search for constellations in a virtual sky; the Smart Art, in which students look at constellations from a very different vantage point; and the Write Away, in which they think about the role of stars in history and literature. When discussing constellations, it's important to remind the children that they are human inventions, created to help astronomers describe and navigate the night sky. In other words, the stars themselves are real, but whether they belong in Orion or Ursa Major is strictly a human call. This unit also includes a demonstration of the phases of the Moon in the Move Crew. Finally, the Fab Lab is a card game in which planets, moons, and stars are grouped and ordered, and interesting facts are learned along the way.

In SLOPERNICUS ("Displacing the Earth from the Center of the Universe"), students build on their knowledge of the universe in the context of the revolutionary work of Copernicus and Galileo. Some activities focus on the process of discovery itself, including the Mind Game, which takes students on a virtual tour of scientific history, and the Write Away, in which students are forced to defend absurd propositions in order to gain insight into the selectivity that sometimes mars scientific thinking. In the Move Crew, they'll delve into the apparent (and misleading) equivalence in size of the Sun and the Moon, while in the Smart Art, they'll look at the surprising differences in the size and placement of the nine planets. Finally, in the Fab Lab, they'll take an ever-accelerating journey through the Universe, learning what they would see at different points along
the way.

Overall, these four missions encourage children to develop key habits of mind that will serve them well in future science classes, and introduce important new concepts to their worldview. By the end of Mission Pack: Sigma, we hope that all children participating will have at least a basic grasp of these concepts and feel interested and motivated enough to learn more.


# Mission Overview:
# The Floperator

This two-week Mission is about mathematical inquiry. The goal here is not so much to develop proficiency in specific skills like long division, but rather to enhance students' abstract understanding of the nature and purpose of math, and to encourage them to see the world in a mathematical context. To that end, the activities in this unit challenge students to manipulate numbers in different ways, select the appropriate mathematical operations for a given question, and describe everyday objects in terms of numbers and shapes.

These activities include: **Number Cruncher,** a kind of mathematical "maze" in which students must arrive at a target number from a given starting point, using several mathematical operations; **What's Your Problem?,** a math quiz game in which students succeed not by giving the right answer, but by posing the right question; **Get Ten,** in which students try to maintain a fixed score with colored tokens that constantly change in value; **Tri, Tri Again,** a visual activity that shows how a larger shape can be broken down into smaller, constituent shapes; and **By the Numbers,** which challenges students to describe an object in as many numerical ways as possible.

## For other explorations of mathematical inquiry, consult these resources:

**Clever Games for Clever People** is a collection of online math-based puzzles designed by the mathematician John Conway:

**http://www.cs.uidaho.edu/~casey931/conway/games.html**

**Fun Mathematics Lessons** contains 20 math activities for kindergarten through adult ages.

**http://math.rice.edu/~lanius/Lessons/**

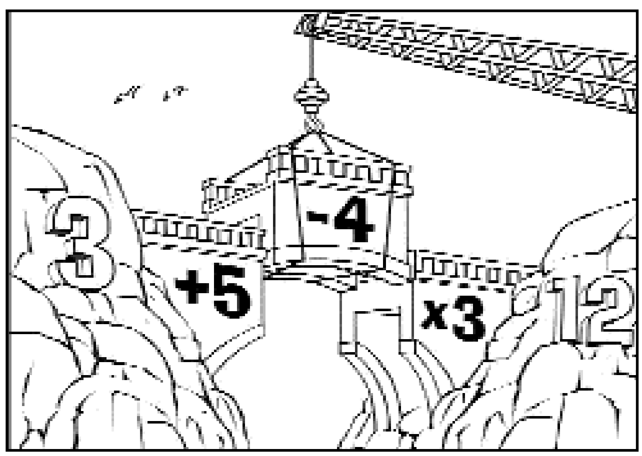
Rob Eastaway and Jeremy Wyndham's *Why Do Buses Come in Threes?* (Wiley & Sons, 1999; ISBN 0471347566) is a fun collection of mathematical problems that have real-life applications and logical solutions.

Margaret Kenda's *Math Wizardry for Kids* (Barrons Juveniles, 1995; ISBN 0812018095) contains over 200 puzzles and games designed to challenge and engage the minds of even math-phobic students.

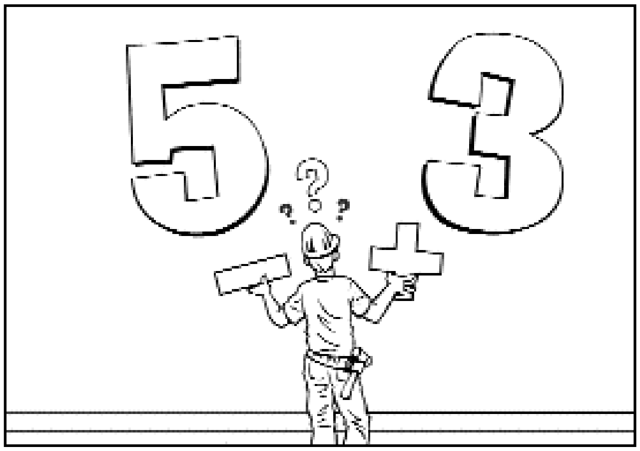
# ACTIVITY NOTES FOR LEADERS:

# The Floperator

## Mind Game: NUMBER CRUNCHER

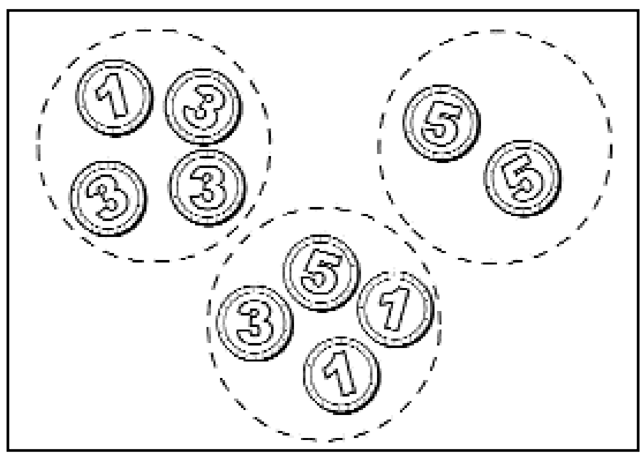



In this online game, students are presented with a 5 x 5 matrix. Above the matrix is a target number that the player must get to. In the center of the matrix is a starting number, which may be greater than or less than the target number. The other squares in the matrix each have a mathematical operation, such as "+ 7" or "x 2." From the starting number, the player moves from one square to the next, trying to get to the target number in the fewest possible moves. Students should know that there are several possible paths to success. The goal of this activity is to get students to manipulate numbers strategically and to think several steps ahead.



## Fab Lab: WHAT'S YOUR PROBLEM?

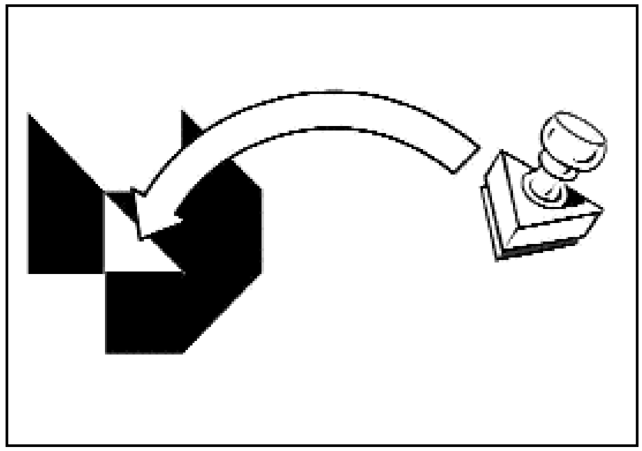
This is a card-based board game, in which students advance for answering questions correctly. The twist is that the answers themselves are questions, in the form of math problems. Students are presented with a complex word problem and must choose the mathematical procedure that will solve the problem correctly. Other players are asked to agree or disagree with their opponents' responses, and are rewarded for accurate judgments. It's important to note that some of the word problems contain irrelevant information, and others don't provide enough information to solve the problem. Being alert to these situations should be portrayed as a crucial element of the game, and of problem-solving in general.



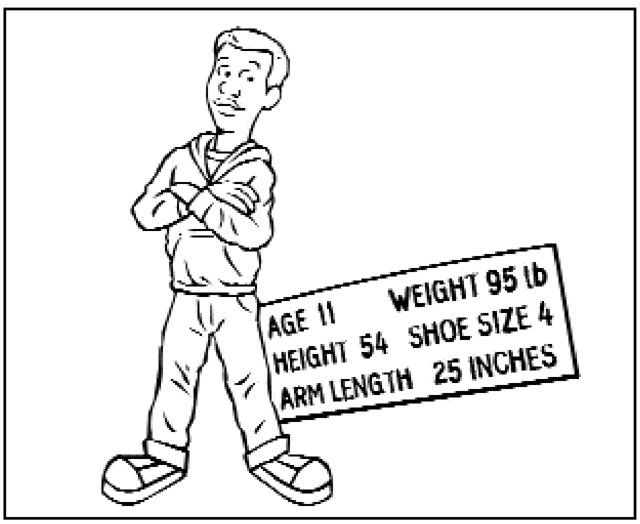
## Move Crew: GET TEN!

The object of this game is to get exactly ten points, using colored tiles worth 1, 3, and 5 points. The challenge is that the values of the tiles keep changing: for example, red tiles might be worth 5 points in one round and only 1 in the next. To succeed in the game, students must quickly recalculate their points every time the values change, and trade in their tiles to get back to 10. If you play this game enough times, some kids may develop strategies that allow them to trade in as few tiles as possible. These strategies should be discussed with the group, since they show how numbers can be manipulated in abstract ways.

## Smart Art:
## TRI, TRI AGAIN



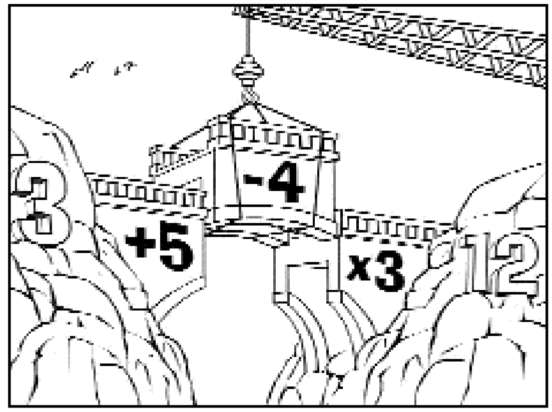
Here, students are given the outline of an abstract shape, and asked to fill it in with small triangles of equal size (using a stamp or sponge). It's important that students try and estimate the number of triangles that will fill the shape beforehand, and then compare what they discover when they use the stamp. Students should try the activity with several different outlines to see if they can improve the accuracy of their estimates. Eventually, they should start to visualize the composition of the larger shapes in terms of the smaller triangles. You might want to talk about what this kind of thinking could be useful for (answers include architecture, visual art, and map-making.)




## Write Away:
## BY THE NUMBERS

How many different ways can you describe something with numbers? That's the simple question posed by this activity. The kids will be provided with a number of measuring instruments to analyze an object with, but they should be encouraged to come up with other numerical descriptions, including the numbers of parts or constituent shapes (see Tri, Tri Again). As a companion activity, students might be asked to think about how many numbers might describe a person, although this could tread on potentially touchy subjects such as weight, test scores, or numbers of friends. Perhaps a famous person, or a pet, might be a safer choice.

# Number Cruncher




## Briefing

How do you get from 5 to 8? The easiest way is to add 3. But you could also add 4 and subtract 1, or multiply by 2 and subtract 2. In this Mind Game, you'll find your way through a math maze to get from start to finish!

## Activity

On the screen you'll see a grid full of numbers.

The number in the center is your starting point.

The number above the grid is your target (the number you're trying to get to.)

Starting from the center square, move around the grid by clicking on the other squares one at a time. You can move only between squares that are next to each other. You can move horizontally or vertically, but not diagonally.

The number in the center will change every time you click on a new square. For example, if the center number is 5 and you click on "+2", the center number will change to 7. If you then click on "x 3" the center number will change to 21.

Keep playing until the number in the center matches the number above, or until you get stuck.

You can't click on a square more than once – so don't get trapped!

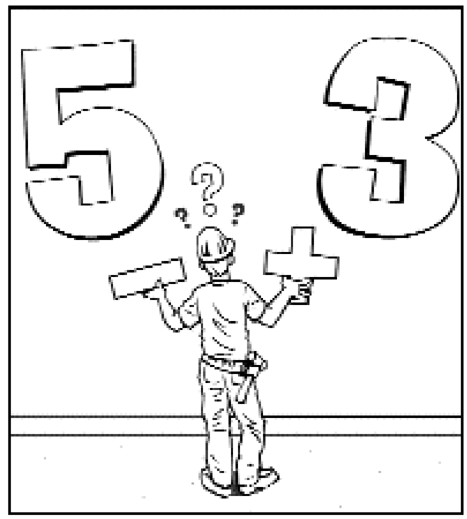
See if you can reach your target number in as few moves as possible.

## Debriefing

What was the best strategy for this game? Did you go one step at a time or did you think several steps ahead? Was it always helpful to get as close to your target as possible on every single move?

If you've got your Case Journals, answer the questions in it now. Then you can go back and try the other ways to play the game!

# What's Your Problem?



## Briefing

When you do math in school, a lot of times you're given the problem you have to solve. (For example, 16 x 42 or 553 – 109). But when you do math in real life, half the challenge is figuring out what the problem really is! So in this Fab Lab, all your answers will be problems, not solutions!

## Activity

### WHAT YOU'LL NEED:

What's Your Problem? Game Board and pieces NEED ART/PRODUCT

What's Your Problem? Cards NEED ART/PRODUCT

### WHAT TO DO:

This game can be played with 2 to 5 players, plus a GameMaster (referee).

Roll a die or flip coins to see who goes first.

On each turn, the GameMaster picks a card and reads the question out loud.

After each question, there are four possible math problems that might be used to answer the question. Only one is correct.

The player whose turn it is tries to guess the correct answer. (The GameMaster should NOT say if the answer is right or wrong just yet.)

Next, all the OTHER players must decide if they “agree” or “disagree” with that answer. Start with the next player on the left and go around the circle, one at a time.

After everyone has responded, the GameMaster reads the correct answer.

If the player got the right answer, he or she moves forward THREE spaces, and everyone who agreed moves forward ONE space.

If the player’s answer was wrong, everyone who disagreed moves forward TWO spaces.

The turn then passes to the next player on the left.

- Other rules (???):

- If you land on MOVE FORWARD or MOVE BACK, do it right away.

- If you land on DOUBLE JUMP, jump ahead the same number of spaces you just moved. (For example, if you just moved two spaces to get there, move ahead another two.)

- If you land on LOSE NEXT TURN, guess what? You lose your next turn (whether it’s a chance to answer the question or a chance to agree or disagree.)

The first player to reach the FINISH line is the winner.

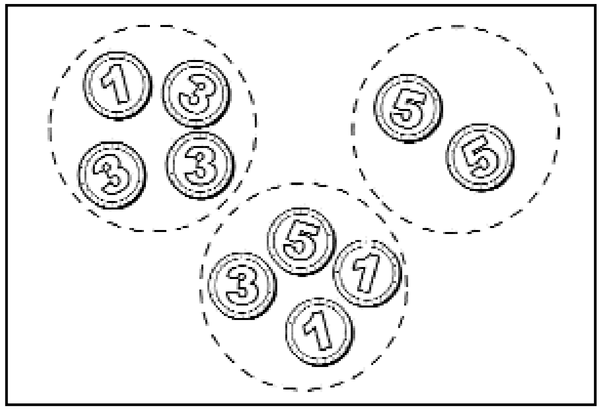
## Debriefing

Did these questions remind you of anything in your own life? When was the last time you had to figure out what kind of a math problem to do? Did it work? Why or why not?

If you’ve got your Case Journals, answer the questions in it now!


Floperator

# Get Ten!




## Briefing

Suppose a dime was worth 25 cents on Mondays, 10 cents on Tuesdays, and a dollar on Wednesdays. You'd have to be pretty careful counting out your lunch money! How would you keep track of how much money you had? You'll face a challenge like that in this Move Crew!

## Activity

WHAT YOU'LL NEED:

- Colored tiles or poker chips (blue, red, yellow), 5 of each color
- "Get Ten!" Playing Cards
- 5 Chairs
- 5 Plastic plates
- Notepad and pencil

Recommended: 6 players, including referee. For a 5-player game, use only 4 tiles of each color, and so on.

GETTING READY:

- Choose one player to be the Referee.
- Spread the chairs out in a circle, as far apart as possible.
- Have each player pick a chair as a "home base." Put one plastic plate on each chair.
- Put the colored tiles on a table in the center.

The Referee should write the names of all players on the notepad. This will be used to keep track of each player's Strikes.

## HOW TO PLAY:

The object of the game is to be the last player standing. To stay in the game, you need to collect EXACTLY ten points in every round, as fast as possible.
**Here are the rules:**

- At the start of a round, the Referee draws a card from the deck. The card tells you how much each color is worth in this round. For example: Red=5 points; Yellow=3 points; Blue=1 point.
- The Referee reads this out loud, lays the card down on the table where everyone can see it, and then says “Go!”
- Each player tries to get EXACTLY ten points on his or her home plate. You do this by carrying the red, yellow, and blue tiles back and forth from the table.

**You have to follow these rules:**

- You can make as many trips as you want, but you can carry only ONE tile at a time.
- You can’t hide tiles or put them aside – they either have to end up on your plate, or back in the center pile.
- No throwing – tiles must be carried in your hand.
- As soon as you get EXACTLY 10 points on your plate, raise your hand.
- The round ends when everyone except one player has a hand up. That final player gets one Strike.

The Referee also gives one Strike to anyone who doesn’t really have 10 points, and to any player who broke a rule.

Now you’re ready for the next round. LEAVE ALL THE TILES WHERE THEY ARE, and stand by your chair.

The Referee takes the old card away, draws a new one, reads it out loud, and lays it down on the table. These are the NEW point values for each of the colors. Look at your plate—if you had 10 points before, you probably don’t have it now!

When the Referee says “Go,” try and get back to exactly 10 points. Follow the rules above. This time, you may have to carry some tiles back to the center pile. (Remember, you can carry only one tile at a time – but it’s okay not to carry anything.)

Keep going until all but one person has 10 points again, and give out Strikes.

After three Strikes, you're eliminated! Put your tiles back in the center pile and and step out of the game.

The last player standing is the winner.

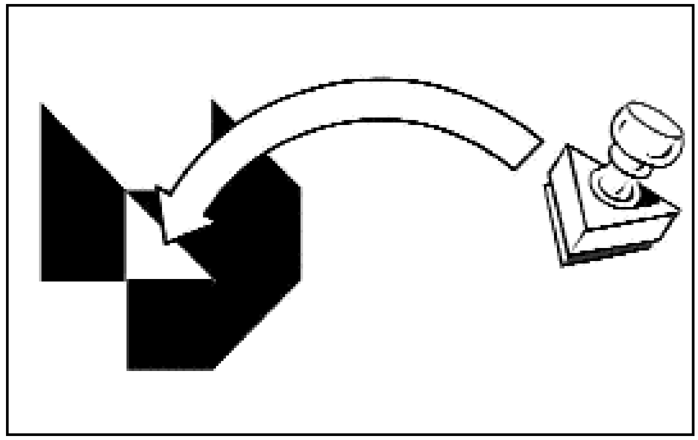
## Debriefing

Did the game move faster or slower as time went on? Why do you think that happened?

Did you (or anyone else) develop a strategy for this game? What was it?

If you've got your Case Journals, go ahead and answer the questions in it now!

# Tri, Tri, Again



## Briefing

Quick: what shape is pizza? It depends, right? A whole pie is usually round, but then you slice it up into shapes like triangles.

Just like a pizza, any shape can be broken down into a bunch of smaller shapes. Try drawing a square on a piece of scrap paper. Can you divide it into two triangles? Four? Six? Eight?

Once you get the hang of that, you're ready for this Smart Art challenge!

## Activity

WHAT YOU'LL NEED:

- Outlines of large shapes (you'll want 3 or 4 copies of each)
- A triangle rubber stamp and ink pad

WHAT TO DO:

- Each sheet of paper contains the outline of a big shape.
- Your job is to fill in the shape completely using your triangle stamp.
- Before you start, write down how many triangles you think it will take to fill in the whole shape.
- Next, start filling in the shape with your stamp. The edges of the triangles should be just touching – not overlapping.
- If you mess up, that's okay – just get another copy of the shape and start over.
- When you finish, count the number of triangles you needed. Was it more or less than what you guessed?
- Move on to a new shape and see if you can guess better. See if you can get it exactly right at least once!

## Debriefing

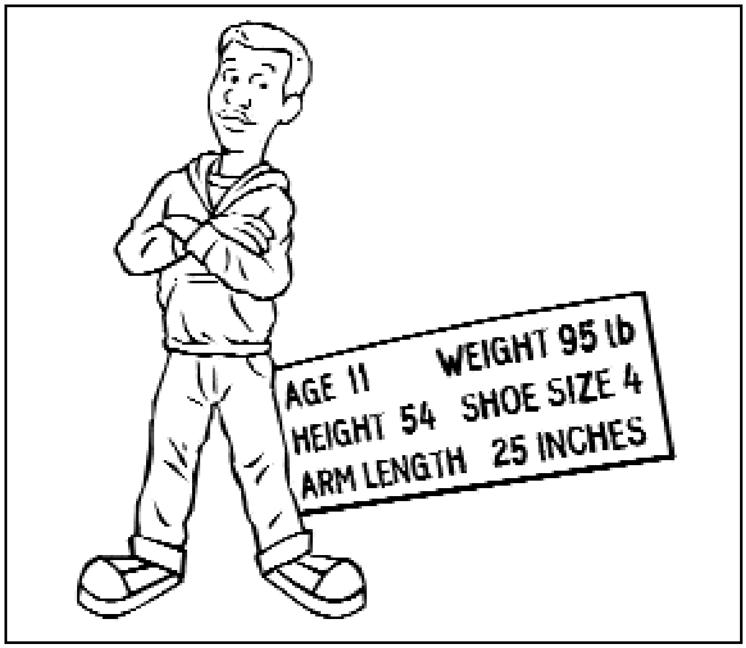
When you guessed how many triangles it would take to fill the space, were you right? Did you think it would take more triangles than it did? Fewer? Why do you think that is?

If you've got your Case Journals, answer the questions in it now!

## Extra Page

If you don't have the rubber stamp and ink pad, you can still do the activity. Using some cardboard or construction paper, cut out a triangle that is exactly **X** inches on each side.  Instead of using a rubber stamp, you can trace around this triangle with a pencil, and then color in the outline.

# By the Numbers




## Briefing

We all know how to describe things with words -- words like “big,” or “green,” or “square,” or “metal.” But did you know you can also describe things with numbers? You’ll do that in this Write Away.

## Activity

WHAT YOU’LL NEED:

- A tape measure

WHAT TO DO:

Find a partner to play with.

1. Have your partner leave the room, or cover his or her eyes with a blindfold.

2. Pick an object in the room: a computer, a chair, a shoe, a ballpoint pen, or anything else you can find. Don’t tell your partner what it is.

3. Using only numbers and shapes, try to describe your object in as many ways as you can. For example, if you picked a desk, you might say:
    - My object is 21 inches tall.
    - My object is 42 inches wide.
    - My object is twice as wide as it is tall.
    - My object has a handle 18 centimeters long.
    - My object is a rectangle.
    - My object has 4 rectangles inside it. (the drawers)
    - My object is 12 inches away from the wall.
    - My object contains 3 different colors.

HINTS:

Use the tape measure in as many ways as you can think of!

Be specific! Don't use general descriptions like:

- My object is big.
- My object is tiny.
- My object is colorful.

4. When you've written down everything you can think of, bring your partner back to the room or undo the blindfold.

5. Start reading your descriptions to your partner, one at a time. Don't give it away by naming the object, what color it is, or what kind of parts it has (like "drawers" or "buttons.") Stick to numbers and shapes.

    After each line you wrote, your partner guesses what the object is. See how many lines it takes for your partner to get it right.

6. When you're done, switch around and let your partner pick the object.

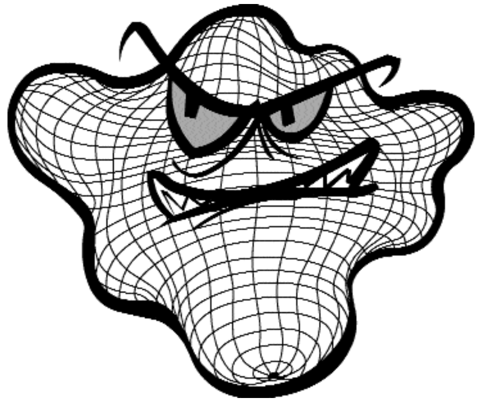
## Debriefing

Did your partner take as many guesses as you expected? Why do you think that is?

If you had other tools besides a tape measure, how else could you describe your object with numbers?

How many numbers can you come up with that describe YOU?

If you've got your Case Journal, answer the questions in it now!



# Mission Overview:

# Muddles

This two-week Mission is about the nature and use of models. Students explore a number of different types of models, including computer models, physical models, conceptual models, and notation systems. A key question within each activity is how the model is like and unlike the real-world object or process that it imitates. Throughout the unit, students should be asked to think about why people use models, and to look for connections and similarities between the models in these activities.

These activities include: **Slush Rush,** a computer simulation of owning and running a frozen treat stand; **Current Events,** a practical model of ocean currents; **Dance Diagram,** in which the students develop their own modeling system for physical movements; **Plane Brain,** in which students make paper airplanes and test the effects of various adjustments; and **Hey Myth-ster!,** in which students write their own myths to explain some aspect of nature.

## To further develop students' understanding of models,consult these resources:

**About.com** has this page of links to online simulation games:

**http://compsimgames.about.com/cs/online/**

**Neuroscience for Kids** has a page full of brain-related models that kids can make:

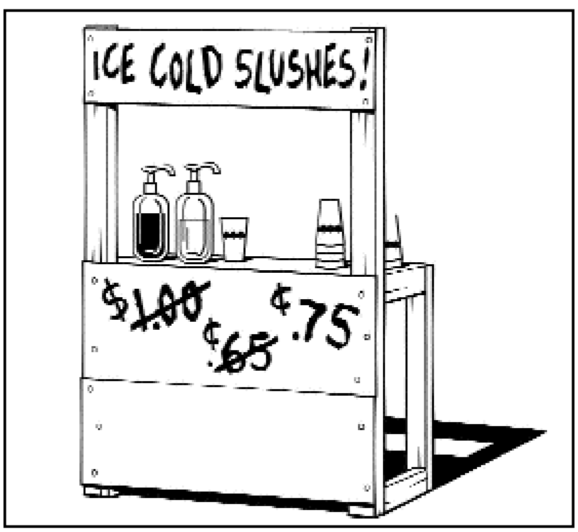
**http://faculty.washington.edu/chudler/chmodel.html**

**"The Greatest Paper Airplanes,"** a program by Kitty Hawk Software, uses full interactive 3D animation to show you how to fold extraordinary paper airplanes. Information on the software and free demo versions are available at Kitty Hawk's web site:

**http://www.khs.com/aboutgpa.htm**

Christopher Baker's *Virtual Reality: Experiencing Illusion* (Millbrook Press, 2000; ISBN 0761313508) explains virtual reality technology, its value, and its applications in science.

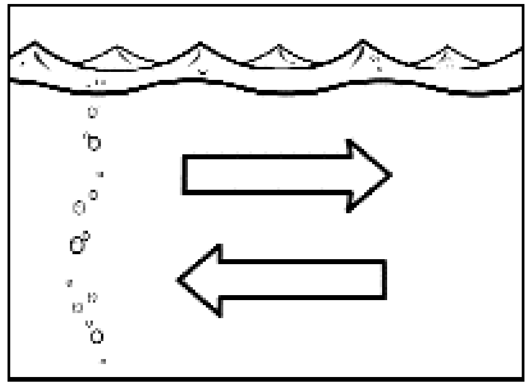
# ACTIVITY NOTES FOR LEADERS: Muddles




## Mind Game: SLUSH RUSH

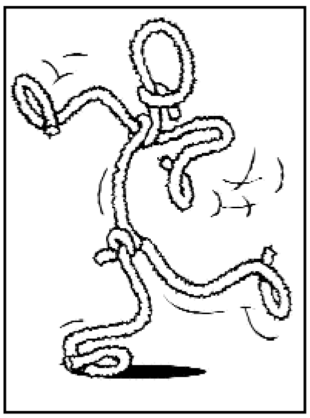
This is a high-tech adaptation of the classic lemonade-stand business. Here, the students are selling fruity, frozen slushes, and need to decide how much syrup and ice to use, how much to charge, and how many cups to buy, depending on the weather and past experience. Students should discover that no one formula works equally well in all conditions; constant adjustments and educated guesses are needed. When they've completed the activity, ask the students how much the computer model is like real life. What else could affect their sales that isn't dealt with in the model?

## Fab Lab: CURRENT EVENTS



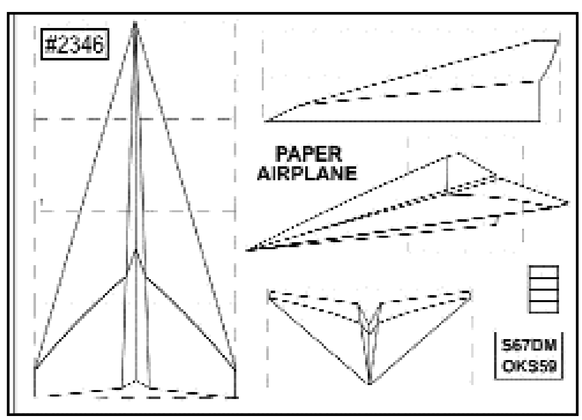
This activity is often used in earth science classes to model the movement of ocean currents. Here, the focus is not so much on learning about the ocean currents but on the model itself: What is it showing? What can they learn from this model that would be hard to observe in the ocean? How do the students think scientists study ocean currents? What are the model's limitations? Asking questions like these will take the activity out of the specific arena of oceanography and into the cognitive sphere that this unit is concerned with.

## Move Crew: DANCE DIAGRAM



Models are often used to communicate, and in this case, they're used to communicate a dance routine. One kid invents the dance, a second models it using pipe cleaners, and a third tries to replicate it despite never having seen the original dance. The kids should be encouraged to make their dance moves simple and distinctive – they shouldn't blur into each other too much. Kids making the models have free rein to do whatever they want, but remind them that they will only have the models to refer to themselves, so they shouldn't rely too much on memory. It's advisable for the model-makers to assemble a bunch of different pipe cleaner stick-figures before the activity begins. Choosing exactly how to make the stick figures is part of the challenge of the exercise.

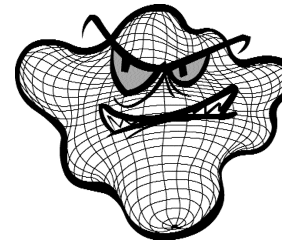
## Smart Art: PLANE BRAIN




The kids have their choice of several different paper airplanes, which can be folded according to the instructions. The key here is to challenge the kids to set specific goals for their airplane – to fly the farthest, to stay in the air the longest, or to do tricks. Then they should carefully measure their progress toward the goal, by flying the planes several times, keeping records, and then making changes to the plane and testing them again. Explain that the planes are not designed to fly as well as they possibly can at first – the adjustments they make can improve them greatly. The students should try to alter their planes with an eye to their chosen goal. Also, emphasize that they will need to test the planes out at least five times before and after each change to see if the adjustments really work.

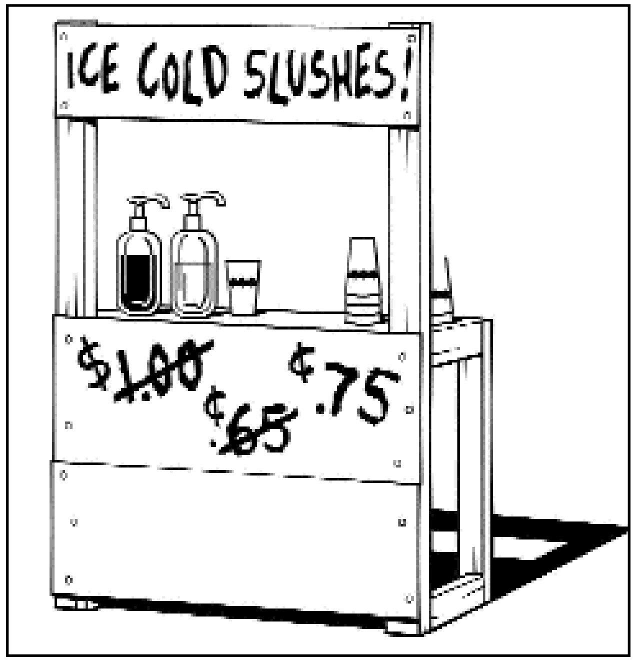
## Write Away: HEY MYTH-STER

Using the example of "Demeter and Persephone," a Greek myth that explains the changing seasons, students are asked to think of myths as early models of natural processes. They are asked to choose another natural phenomenon, and to write a myth that explains it. If they have trouble, ask them to think about the questions they asked when they were small: Why is the sky blue? Where does the wind come from? Why does it get dark at night? These are the same questions that human beings have asked for thousands of years. Then suggest that they imagine a make-believe time when the sky *wasn't* blue, or *before* there was wind (or night, or whatever their chosen natural phenomenon is). Who caused the change? Why? Refer back to Demeter and Persephone as a model.



Muddles

# Slush Rush




## Briefing

There are all kinds of models: diagrams, drawings, miniature versions of objects, and more. One popular kind of model is a computer model. In this Mind Game, you'll use a computer model to run your own virtual slush business!

## Activity

In this game, you're selling slushes on the street on a summer day. (If you never had a slush, it's a cold treat made with crushed ice and flavored syrups.)

You'll be asked to make some important business decisions: how many supplies to buy, how much to charge, and how big and sweet to make your slushes.

Pay close attention to the weather forecast when making your decisions. They'll affect how many slushes you can expect to sell. Also, your ice will melt faster when it's hot and sunny!

When you make all your decisions, click START SELLING and you'll watch the day go by. At the end of the day, we'll tell you how you did. You can use that information to make new choices in the next round.

Play the game at least five times, and see if you can get better at it!

## Debriefing

What kinds of strategies did you use in this game? How did the computer change the way your customers acted depending on the weather, and the choices you made? Did you change your choices on other days because of what you saw?

Do you think this model is a lot like real life, or not really? Do you think businesses in real life use models like these? Give reasons for your answer.

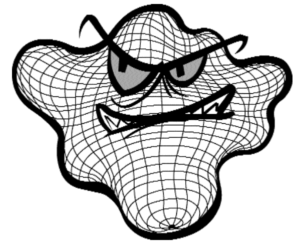
If you've got your Case Journals, answer the questions in it now!

## More Info Page

This game is an example of a computer model. It's imitating the kinds of events we might see in real life. For example, the computer is programmed for more people to buy slushes when it's hot and sunny than if it's cool and cloudy.

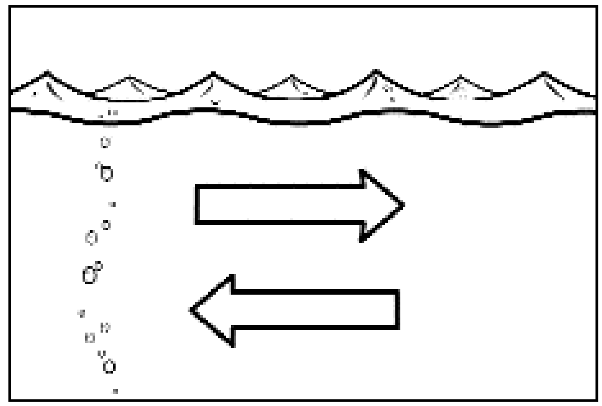
The computer also has some information about people's likes and dislikes (for example, they like lots of syrup and big slushes) and how much they might be willing to pay. It can calculate how much money you've made, and how much you've spent on supplies. It can even keep track of how fast your ice melts, depending on the weather.

How much do you think this model is like real life? In what ways is it different? What are some things that might affect how well you sell slushes that AREN'T covered in this game?



Muddles

# Current Events



## Briefing

The city of London, England is a lot farther north than Chicago or Minneapolis. But it's not nearly as cold there in the winter. That's because warm ocean water from the tropics flows up towards England and helps warm the air. In this Fab Lab, you'll make a model that shows how that happens.

## Activity

WHAT YOU'LL NEED:

- A source of hot and cold water
- Red and blue food coloring
- A bucket (about 1 gallon — clear, white, or some other pale color)
- Two small (30 ml) measuring cups (like the kind you use to take medicine)
- Plastic wrap
- Two large marbles
- Rubber bands
- A sharpened pencil or fork

## WHAT TO DO:

For this activity, wear a smock – you might get spattered with food dye!

PART ONE

- Put a marble in one of the small cups, and then fill it up with hot water. This is like the warm water in the tropics.
- Add 5-10 drops of red food coloring.
- Cover the cup with plastic wrap, seal it with a rubber band, and poke a few small holes in the top with the pencil or fork.
- Fill the bucket with cold water. This is like the cold ocean up near England.
- Put the small container of hot (red) water inside the bucket.
- Write down what happens to the hot (red) water.
- Slowly turn the large container around and around. This is like the Earth rotating on its axis. What happens then?

PART TWO

- Take out the small cup and empty it.
- Empty and rinse out the bucket.
- Re-fill the bucket with cold water.
- Add the marble, fresh hot water, and red food coloring to the small measuring cup again.
- Put the other marble in the other small cup. Fill it up with COLD water and BLUE food coloring.
- Seal both small cups with plastic wrap and poke holes in the tops. Make sure the holes are about the same size on each of the cups.
- Write down what you think will happen when you put both cups in the cold water.
- Put both cups in the water at the same time.
- Watch what happens right away. Did you guess right?
- Keep watching for a few minutes. Does anything change?

## Debriefing

Warm water naturally flows into areas of colder water. Did this model help you see that?

How did the model help show how warm water moves around the world?

What happened when you used cold (blue) water instead of hot water? Why?

Why do you think a scientist would need to use a model to study the currents in the ocean?

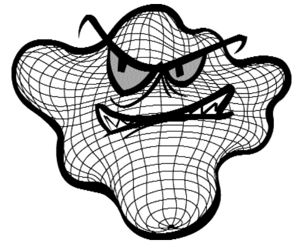
If you've got your Case Journals, answer the questions in it now!

## More Info Page

Water (or air, or anything else) doesn't like to be mixed-up when it comes to temperature. So if you add hot water to cold water, the hot water will move into the colder areas, until everything evens out.

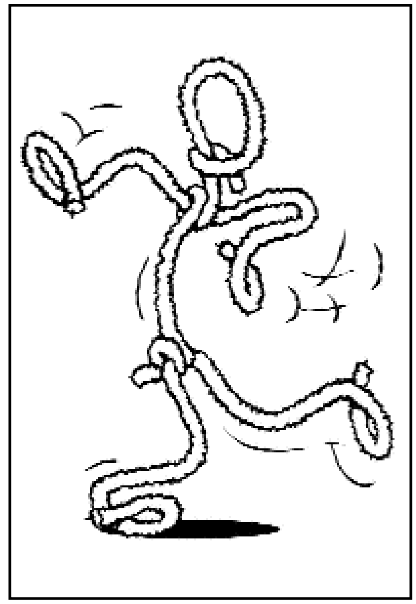
That's why ocean currents happen: water flows from the warm parts of the ocean to the colder parts. But because the ocean is gigantic, and because the Sun heats up the ocean a little bit differently every day, the temperature never evens out and the currents keep flowing.

The same thing happens with air. At some particular time of day, the air in one town might be warmed by the Sun, but in the next town over, the Sun might be blocked by clouds. So the air will rush from the warmer area to the colder area. And if you're in the way, you'll feel the air moving. The moving air is called wind!



Muddles

# Dance Diagram



## Briefing

There's an old saying: "A picture is worth a thousand words." That's why models often use pictures or images. In this Move Crew, you'll make a model that shows your teammates how to bust a move!

## Activity

WHAT YOU'LL NEED:

- Pipe Cleaners
- A stopwatch
- Pen and paper

- The object of the game is to teach a new dance to your fellow players, without doing it in front of them.
- Choose one player to be the Dance Captain, one to be the Model Maker, and one to be the Performer.
- Have the Performer leave the room.

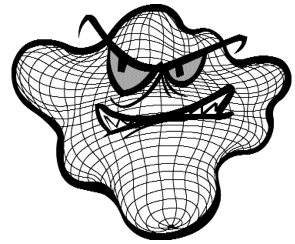
- Using the pipe cleaners, the Model Maker makes eight human stick figures. You will use these stick figures to represent dance moves, so make sure they have arms, legs, and heads.
- The Dance Captain makes up a dance with eight different moves. The moves can be really simple, like putting a hand up in the air. Or they can be more complicated. It's really up to you.
- Once the Dance Captain figures out a routine, he or she shows it to the Model Maker, one step at a time.
- Using the pipe cleaners, the Model Maker makes a model of the whole dance routine. Use one stick figure for each move.
- When the Model Maker is finished, invite the Performer back in and start the clock on the stopwatch. From this point on, NO TALKING IS ALLOWED.
- Using the model, the Model Maker shows the dance to the Performer. You can't talk, or do the dance yourself, but you can move the models around (like puppets) as much as you want.
- Once the Performer understands the dance, he or she should perform it. When the Performer gets it right, everyone claps. If the dance isn't exactly right, the Performer should keep working with the Model Maker until it is. See if you can do it in less than three minutes!

## Debriefing

What techniques made the models easy to understand? What made them confusing?

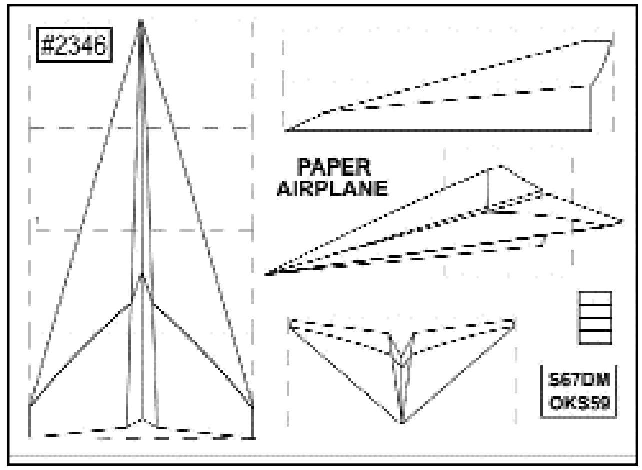
How was the model NOT like a real dancer? Were you able to do anything that made up for these differences?

If you've got your Case Journal, answer the questions in it now!



Muddles

# Plane Brain




Suppose you were designing an airplane. Can you name three things that would change the way it flew?

In this Smart Art, you'll build and perfect your own planes!

## Activity

WHAT YOU'LL NEED:

- Plenty of regular photocopy paper (not loose-leaf or hole-punched)
- A stopwatch or clock with a second hand
- A tape measure or yardstick
- Paper clips (optional)

## WHAT TO DO:

STEP ONE

Make a paper airplane from one of these diagrams:

- The Fly
- The Dragonfly
- The Butterfly
- The Hornet

STEP TWO

Once you've made your plane, practice throwing it several times. If your plane isn't folded well and it's not flying right, make a new one.

STEP THREE

After you've practiced, get somebody to help you test the plane's abilities. Throw the plane, and measure how far it goes and how long it stays in the air. Take notes on the way the plane flies – does it glide straight, does it loop or curve, or does it crash straight into the ground? Make your notes on the worksheet.

Take notes on five different throws. Try to throw the plane in about the same way every time. When you're finished, go on to Step Four.

STEP FOUR

Make a change to your airplane. Here are some suggestions:
(INSERT DIAGRAMS FROM BYT HERE)

- Bend the sides of the wings up or down.
- Bend the bottom of the plane to the left or right.
- Tear little tabs on the backs of the wings, and point them up or down.
- Add a weight to some part of the plane, like a paper clip.

Now practice throwing the plane again. After you've practiced, throw it five times and write down the distance, time in the air, and the way it flies. (Use the same worksheet.) How did the change in the plane's shape change these things?

If you have time, make more changes and take more notes!

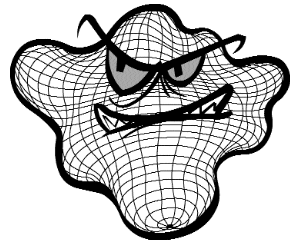
## Debriefing

A paper airplane is a lot simpler than a real airplane, but they work in similar ways. Knowing what you found out about your paper airplane, what can you guess about the way real airplanes are built?

If you've got your Case Journals, go answer the questions in it now!

## More Info Page

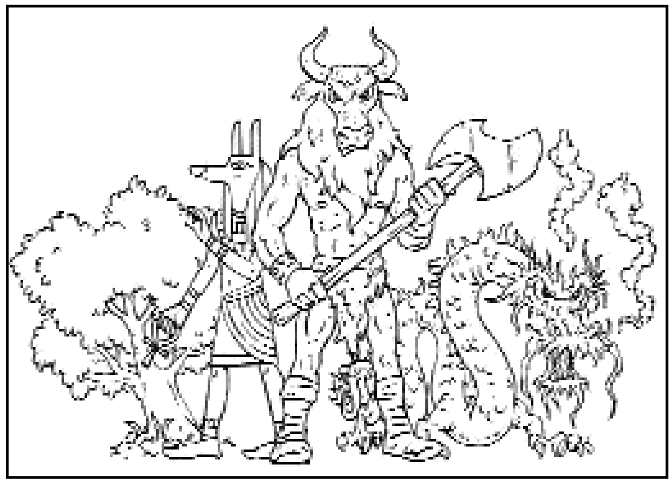
INSERT DIAGRAM : AIR FORCES ONE, TWO, THREE, AND FOUR from BYT


Muddles

# Hey Myth-ster!

## Briefing

Humans have always been curious. We want to know how the world works. Before science started giving us some answers, humans relied on **myths** (stories). In this Write Away, you'll come up with some myths of your own!



## Activity

A **myth** is a kind of story that explains how the world works. Myths were an important part of almost all ancient human cultures. They answered big questions and made the world seem less scary and mysterious.

Myths are not true or scientific, and most of them sound pretty crazy today. But they're great stories, and they make sense in their own way. Many myths survived for thousands of years by word of mouth alone.

Here's an example of a myth from ancient Greece:

- A long, long time ago, there was no such thing as winter. **Demeter** (pronounced *dee-MEE-ter*), the Goddess of the Earth, kept the weather warm and the flowers in bloom year-round.

- Demeter had a beautiful daughter named **Persephone** (*per-SEF-oh-nee*). One day **Hades** (*HAY-dees*), the God of the Dead, kidnapped Persephone and took her to the Underworld to be his Queen.

- This made Demeter so sad that she took her power away from the Earth. Leaves fell. Flowers died. The land became cold and barren.

- Soon there was a famine and the people were starving. To make things right again, **Zeus** (*rhymes with "juice"),* King of the Gods, ordered that Persephone had to come back from the Underworld. But Hades wouldn't let her go completely, so every year she spends part of the year on Earth and part of the year in the Underworld.

- This myth explains why we have seasons. Winter comes because Demeter is sad that Persephone has gone to the Underworld. When she returns, Demeter is happy, and Spring comes back to the Earth.

Now write your own myth! Your myth can answer any ONE of the following questions:

- Why does a giraffe have a long neck?
- Why do old people have wrinkles?
- Why does the Moon look different on different nights?
- Why do things fall down when you drop them?
- Why do birds fly south in the winter?
- Why do leaves change color in the fall?
- What causes thunder and lightning?
- Why don't humans have tails?
- Why are days shorter in the winter and longer in the summer?
- Why are there waves in the ocean?

Here's a hint: Your myth should start in an imaginary time BEFORE that thing was true. For instance, if you choose question #1 above, your myth should start in a time when giraffes had short necks. If you choose question #2, it should start off in a time before anyone got wrinkles.

Your first sentence might begin: "A long, long time ago…"

If you want, you can make up your own question instead!

You can put anything you want in your story: heroes, gods and goddesses, monsters, magical creatures, and so on. You can have talking trees or walking mountains. The only rule is that your story has to answer the question!

## Debriefing

When you're finished, read a friend's myth (or re-read your own). Do you actually know the real scientific answer to the question? Is any part of the myth like something that really happens? How?

If you've got your Case Journal, answer the questions in it now!

# Mission Overview:
# Puniverse

This two-week Mission is about the Universe. To narrow that down slightly, it's about the world that exists beyond the Earth, and specifically about the relationships between the Sun, Moon, planets, and stars. Although some of the activities discuss constellations, and others convey facts about the stars and planets, memorization is not the primary goal. Rather, it is the understanding that stars are grouped into constellations by humans, as an organizational tool, not because of any natural relationship between the stars; that the planets beyond Earth have unique characteristics that are based on what they're made of and their distance from the Sun; and that how things appear from here on Earth is *not* necessarily the way they look from space.

The activities for this unit include: **Star Search,** an online constellation-finding challenge; **Spaced Out,** a card game based on grouping stars, planets, and moons; **By the Light of the Moon,** a demonstration of what creates the Moon's phases; **Constellation Chamber,** in which students see the constellations from a different vantage point; and **Stars of the Story,** which encourages students to think about the role that stars have played in history and literature.

## To further develop a students' understanding of the Universe, consult these resources:

**Astronomy Café** contains a wealth of resources about astronomy for students and teachers:

**http://itss.raytheon.com/cafe/cafe.html**

**PlanetScapes** is an award-winning site about the planets, asteroids, comets, and more, hosted by the Hawaiian Astronomical Society:

**http://planetscapes.com/**

This online star map allows students to zoom through the night sky and look at the constellations:

**http://www.pdesign.net/astronomy/javamap.htm**

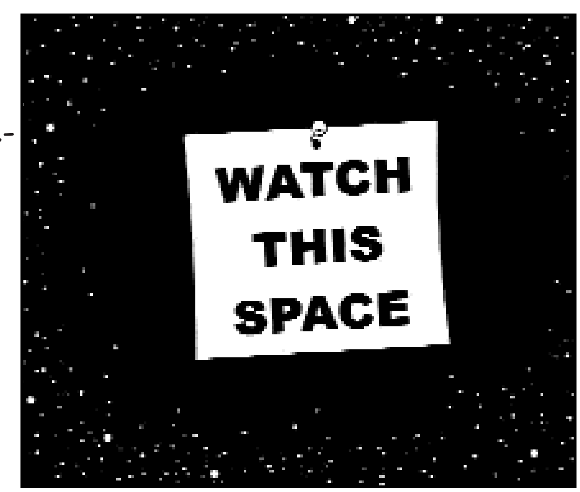
Ron Miller's *Worlds Beyond* book series (Twenty-first Century Books, 2002) features full-color depictions of the landscapes of nearby planets.

Robin Kerrod's *Stars and Galaxies* (Raintree/Steck Vaughan, 2002; ISBN 0739828169) raises exciting questions about the nature and origins of the Universe for young readers.

# ACTIVITY NOTES FOR LEADERS:

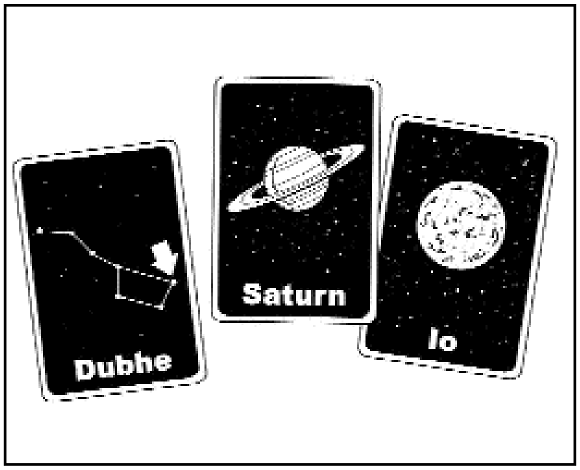
# Puniverse

## Mind Game: STAR SEARCH



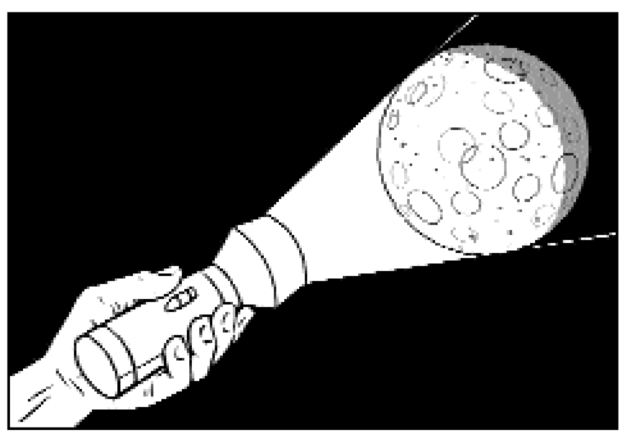

This game combines elements of connect-the-dots and the popular book series "Where's Waldo?" Students look at an online star map and attempt to identify major constellations by clicking and dragging their "outlines" onto the stars themselves. If students comment that constellations are hard to spot, or that they see other shapes within the star map, that can prompt a discussion about the essentially arbitrary nature of constellations and the challenges of learning to navigate the night sky.

## Fab Lab: SPACED OUT

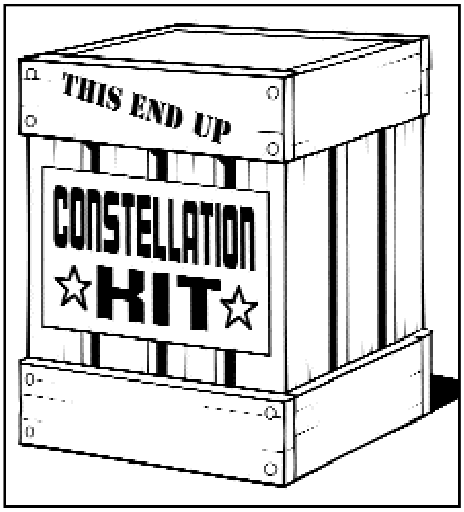



This is a card game, somewhat like Gin Rummy, except it uses stars, planets, and moons instead of traditional playing cards. Players try to collect sets, either of stars in the same constellation or of planets and their orbiting moons. Just finding out that other planets have not one but several moons may be a revelation to many kids. The cards also have facts on them that can encourage kids to compare stars, planets, and moons to each other. If possible, ask the children general questions about the facts on the cards after they play the game: How many moons did some planets have? Are stars in the same constellation all the same distance from Earth? Were most of the stars brighter or dimmer than the Sun? If they're brighter, why do they look so tiny?

## Move Crew: BY THE LIGHT OF THE MOON



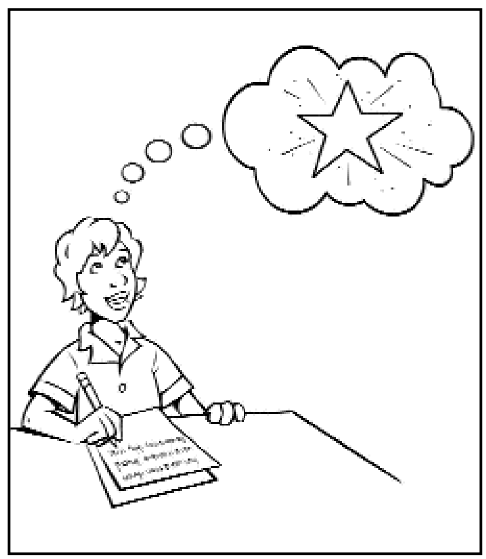
In this activity, the students model the phases of the moon using a flashlight and a small foam ball on a stick. The activity works best when the person holding the Moon holds it just a few inches higher than her own head. (That way, her body won't block the sunlight during what should be a "full" moon.) While only two kids perform the activity, it's useful for several other kids to observe the positions of the "Sun" (the kid with the flashlight), "Earth" (the kid holding the Moon), and "Moon" (the ball) while it's happening. Kids should switch roles in order to observe the demonstration from all possible angles.




## Smart Art:
## CONSTELLATION CHAMBER

Here, the students model one of several constellations using clay balls at the end of long sticks. The key idea is that while the constellation may look like its picture when it's viewed straight-on, it looks very different from the side, because the stars are at very different distances from the Earth. The children should understand that in real life as well, what we see in the night sky would look very different if we were to travel into deep space. The children should also come to understand that a star's visibility from Earth depends on both distance and brightness, and that a bright, distant star may look similar to a faint, nearby star from our perspective.

## Write Away:
## STARS OF THE STORY

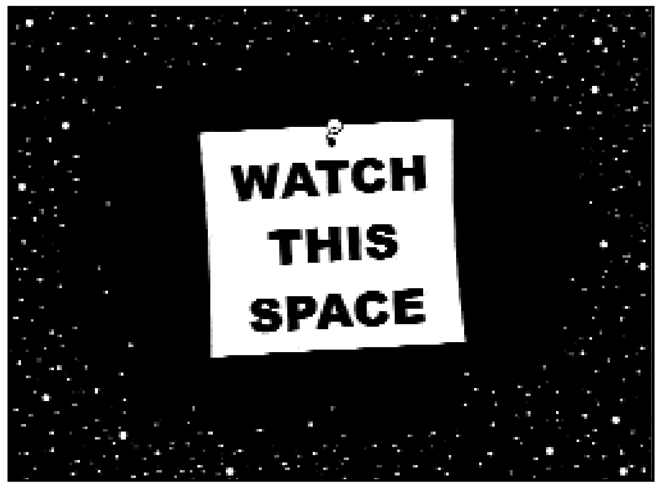


Although the stars have often been a centerpiece of superstition and pseudo-science (astrology being a main example), humans throughout history have used stars in three useful ways: for navigation, as a calendar, and for determining the time of night. Students are asked to recall any stories (true or fictional) in which stars are used in one or more of these ways, and to write one of their own. This activity underscores the notion that stargazing can be useful as well as fun.

# Star Search

## Briefing

To help them map the night sky, ancient astronomers grouped stars into **constellations.** The constellations were named after what they thought the star patterns looked like. In this Mind Game, you'll scan the skies for those patterns without leaving your computer!




## Activity

On the screen, you'll see a window to the night sky. To zoom around the sky, use the scroll bars on the window.

Underneath you'll see outlines of major constellations. When you think you spot that constellation in the night sky, click and drag the outline onto the star window.

If you're right, it will snap into place. If you're wrong, you'll get the chance to try again!

See how many constellations you can find!

## Debriefing

Did you think the constellations looked like what they're named after? Did you see other patterns in the stars that would make good constellations? What would you name them?

If you've got your Case Journals, answer the questions in it now!

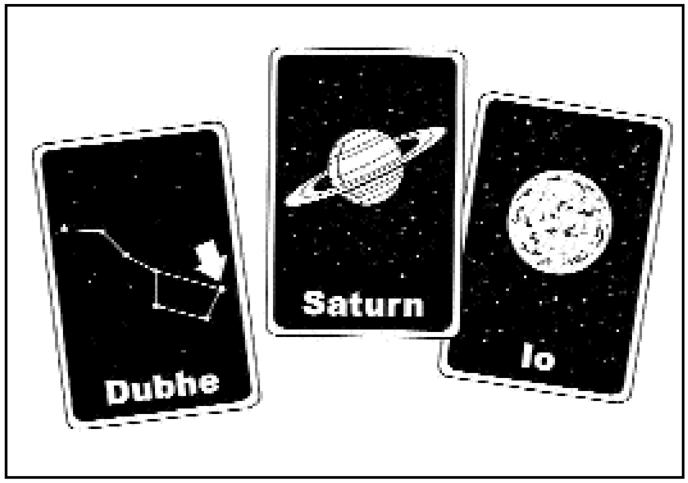
## More Info Page

Constellations aren't "real" – they don't have anything to do with where the stars are made of, or any scientific connections between the stars. Constellations are just a way of grouping the stars so humans can keep better track of them.

The stars in a constellation aren't always close to each other, either. For example, two stars may look like they're side-by-side from the Earth, but in reality one of them might be much, much farther away from us. If the more distant star is larger and a lot brighter, it can appear that the stars are next-door neighbors.

If different astronomers had named the constellations, it's very likely that they might have been grouped slightly differently, or given different names. The next time you look up at the night sky, ask yourself how *you* would group the stars you see.

# Spaced Out




## Briefing

In case you haven't noticed, there's an awful lot of stuff in the sky. To keep track of it all, astronomers have a bunch of different ways of grouping and classifying objects in space. You'll sort out the sky for yourself in this Fab Lab!

## Activity

WHAT YOU'LL NEED:

- Spaced Out playing cards

HOW TO PLAY:

Each card has a picture of either a planet, a moon, or a star.

The object of the game is to collect two sets, either a set of three cards and a set of four, or a set of five and a set of two. Here's what belongs in a set:

Planets IN ORDER, like they are in the solar system. Each Planet card has a number on it, starting with 1 for closest to the Sun (Mercury) and 9 for farthest away (Pluto). You don't have to start with 1 (for example, you might have 5, 6, and 7) but you can't skip around (for example, 2, 4, and 9 is not a set)

Planets and their moons. Some planets (like Earth) have only one moon. Some have none. Some have so many that we can't include them all here (Jupiter has 17!) If you have a planet and at least one of its moons, that's a set. Both the Planet and the Moon cards tell you what you need to know.

Stars in the SAME CONSTELLATION. Every Star card tells you what constellation it belongs in.

Start by dealing seven cards to each player. Put the other cards face down in the center. Turn one card over face up next to the deck.

The player to the left of the dealer goes first.

On each turn, a player can draw ONE card from either the face-down deck or the face-up pile.

Then the player discards one card into the face-up pile.

The turn then passes to the next player on the left.

If the deck runs out, shuffle the discard pile and turn it face-down.

If you get two sets, say so and show everyone your cards.

The first person to collect two sets is the winner.

NOTE: If you have more than four players, you can play a six-card version instead. The winner needs either two sets of three, or a set of two and a set of four.

## Debriefing

In this game, you learned different ways of grouping some of the objects in the sky. The groups have different reasons behind them. The order of the planets has to do with how far they are from the Sun. Planets and moons go together because the moons orbit around the planets.

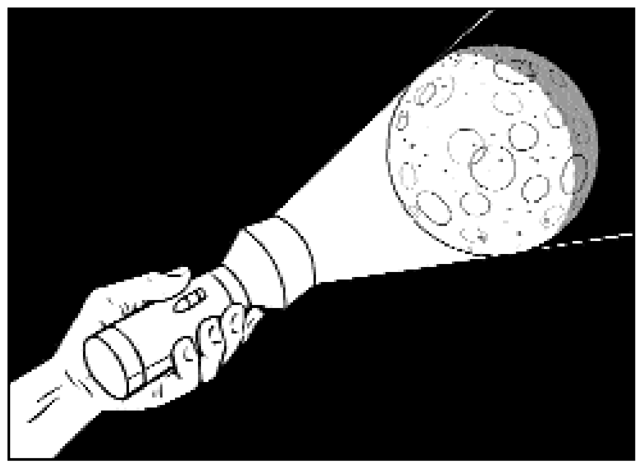
Constellations, on the other hand, are just groups that scientists made up because of the way the stars look in the sky. Why do you think these groups are helpful?

If you've got your Case Journals, answer the questions in it now!

# By the Light of the Moon

## Briefing

If the Moon is just a big hunk of rock, where does moonlight come from? The answer is the Sun! Sunlight reflects off the surface of the Moon, so we can see it from the Earth. In this Move Crew, you'll see why the moon goes from full to dark and back again.



## Activity

WHAT YOU'LL NEED:

- A flashlight
- A foam or rubber ball
- A pencil or pointy stick

## WHAT TO DO:

Find a partner to work with.

Choose one person to be the Sun, and the other to be the Earth.

Stick the pencil or pointed stick into the ball, like a lollipop. The ball represents the Moon.

Give the flashlight to the Sun. Give the ball on a stick representing the Moon to the Earth.

Stand about five to ten feet apart. Face each other.

If you're the Earth, hold the Moon out in front of you at arm's length, just above your head.

If you're the Sun, hold the flashlight above your head and shine it EXACTLY on the Moon.

Turn out the lights. Pull down the window shades if you have to.

If you're the Earth, describe what the Moon looks like now.

Now start slowly turning in place, away from the Sun, with the Moon still held out in front of you. (You should be spinning like a top, except very slowly)

If you're the Sun, stand still and keep the flashlight focused EXACTLY on the Moon at all times.

If you're the Earth, keep describing what you see as you turn. Pause every couple of seconds and look at the Moon. What kind of a Moon is it now?

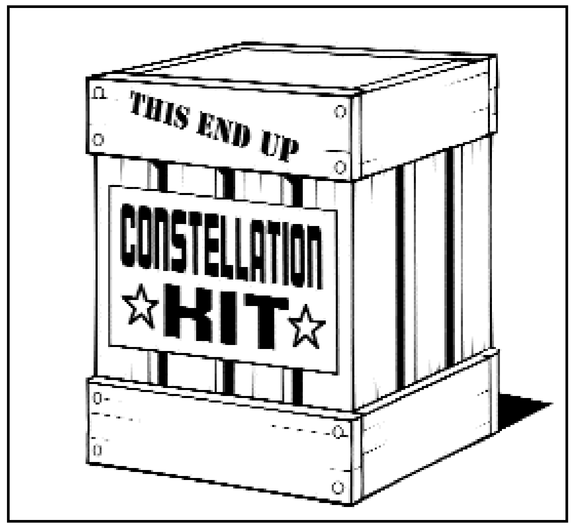
Keep doing this until you've turned all the way back to where you started. Switch roles and do the activity again.

## Debriefing

Now can you explain in words why the Moon looks different at different times? What would happen if the Moon didn't revolve around the Earth?

If you've got your Case Journals, answer the questions in it now!

# Constellation Chamber




## Briefing

Ancient astronomers named constellations (groups of stars in the sky) based on what they looked like from Earth. Do you think they'd look the same from some other part of outer space? You'll find out in this Smart Art!

## Activity

WHAT YOU'LL NEED:

- A shoe box
- A Constellation Chamber grid
- Thin black skewers
- Yellow or white clay
- Glue or tape
- A ruler
- Scissors

## WHAT TO DO:

Cut out your Constellation Chamber grid and glue or tape it to the bottom of your shoe box.

Cut out two sides of the shoebox (one short side and one long side). Your constellation chamber is now ready!

To make a constellation, look at this chart (LINK TO CHART) It will tell you how to set up each star in your constellation. For each star, you'll need a stick of a certain length and some clay.

Using your ruler, find a stick that's just the right length for the star you need. The stick represents how far away that star is from the Earth.

Now look at the number assigned to that star. Find that number on the grid in the shoebox. Poke the stick into the shoebox right on the numbered dot. Put a little wad of clay underneath the shoebox where your stick pokes through, to hold it in place.

To make your star, roll up a little piece of clay into a ball and put it on the other end of the stick (the part sticking up out of the shoebox).

Keep doing this for all the stars in the constellation.

Once you've made your constellation, look straight down into the box from about one foot away. Does your constellation look like the picture? Draw what you see.

Now look at the constellation from the side (one of the open sides of the box). Does the pattern of the stars look the same or different? Draw what you see from this point of view. Then have a look from the other side. What do you see now?

When you're finished, you can use your box to make some of the other constellations.

GOING FURTHER

If you have time, try inventing your own constellation. Make a picture with different sized sticks – a letter of the alphabet, a number, a simple shape. Make sure it looks right only from above. Then have a friend look at your constellation from the side, and see if he or she can guess what it is!

## Debriefing

When you looked at your constellation from above, that was like looking at it from the Earth. Even though some of the stars in any constellation are much farther from the Earth than others, they look like they're right next to each other. That's because they're all very far away from Earth – so far that we don't really notice the differences – and because we're looking at them all from the same angle.

As you found out, if you looked at a constellation from somewhere else in outer space, it would look pretty different!

If you've got your Case Journals, answer the questions in it now!

## More Info Page

Need charts for four or five constellations (star name, distance from Earth, stick length and coordinate position).

# The Stars of the Story

## Briefing

Think of a story that you know that includes the stars (or just one star). What was the role of the stars in that story? How were they used by the people in the story?

In this Write Away, you'll come up with a star-studded story of your own!

## Activity

For thousands of years, people have noticed several important things about the stars in the night sky:

The patterns of stars in the sky seem to rotate from the beginning through the end of the night. (Actually, it's the Earth that's rotating!)

Even though they rotate, the stars stay in the same patterns and don't wander around on their own. (For instance, the stars in the Big Dipper constellation don't get all scrambled up, so they always look like a big dipper, and not a Big Fork or a Big Salad Bowl.)

The patterns of stars in the sky change gradually throughout the year.
The sky looks different from different parts of the world.

As a result, humans have been able to do three useful things with the stars:

- They can figure out what time of night it is.
- They can figure out what time of year it is.
- They can use the stars as a compass to find their way.

Your job is to write a story in which the stars are used in at least one of these three ways. To get you started, here are some possible first sentences:

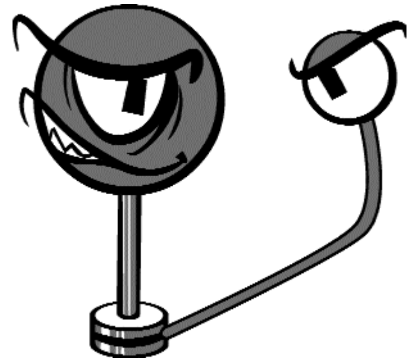
- Tyrone was lost in the forest and it was getting dark.
- Maria was on a sailboat boat in the middle of the ocean, trying to get to Spain.
- Hector was a farmer who lived thousands of years ago. The summer had gone on long that year. He needed to know when winter was coming so he could harvest his crops in time.
- Cathy was sick of being picked last in gym class. (This one's a challenge—use your imagination!)

If you like, you can make up the first line (and the rest of the story!) instead.

## Debriefing

Now that you've written your own story, think back to the story that you remembered at the beginning of this exercise. Do the people in the story use the stars in one of the ways we talked about? Do you think the story is realistic? Why why not?

If you've got your Case Journals, go answer the questions in it now!



# Mission Overview:
# The Slopernicus

This two-week Mission is built around the historic discovery that the Earth is not the center of the Universe, as advanced by Copernicus and Galileo. We approach this concept from a number of different angles, including looking at other crucial insights in the history of science, exploring the Solar System as it really is, and provoking thought about how erroneous ideas can become widely accepted.

The activities for this unit include: **Mind-Bending Moments,** an online trip through the annals of science history; **Far Out,** a board game trip through the Universe; **Size It Up!,** an activity that shows why the Sun and Moon appear to be the same size; **Solar System on a Stick,** a modeling project in which students compare the relative sizes of, and distances between, the nine planets, and **A Tiger Is a Fish,** a thought experiment in which kids are asked to justify ludicrous claims.

## To further develop students' understanding of the concepts in this unit, consult these resources:

Rice University's **Galileo Project** is an online source of information about the life and work of Galileo:

**http://es.rice.edu/ES/humsoc/Galileo/index.html**

**Stargazers**, by DiscoverySchool.com, features biographies of famous and not-so-famous astronomers, from Copernicus through the 20th century:

**http://school.discovery.com/schooladventures/universe/stargazers/index.html**

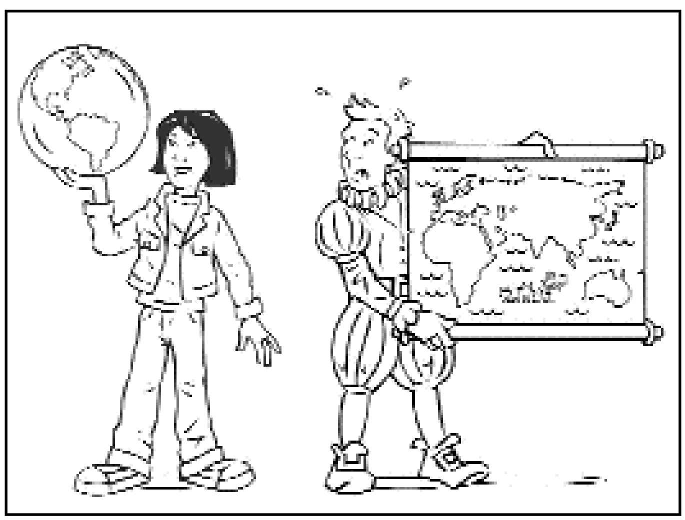
Michael White's *Galileo Galilei: Inventor, Astronomer, Rebel* (Blackbirch, 1999; ISBN 1567113257) is an engaging biography of Galileo aimed at middle-schoolers.

Philip Morrison et al's *Powers of Ten* (W.H. Freeman, revised 1994; ISBN 0716760088) offers an awe-inspiring, visually striking journey from a scene on Lake Michigan inward (to the smallest sub-atomic particles) and outward (to the limits of the known universe).

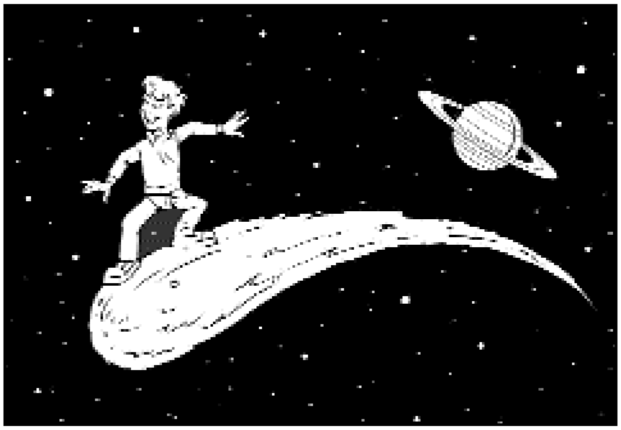
# ACTIVITY NOTES FOR LEADERS:

# The Slopernicus

## Mind Game: MIND-BENDING MOMENTS



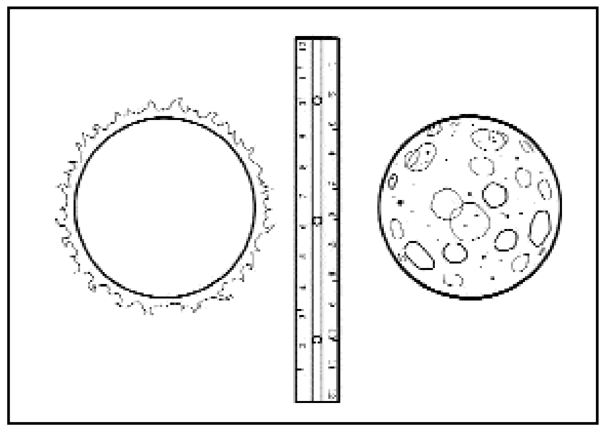
In this computer game, students are given key discoveries in the history of science, and are asked to spot the fake. It is assumed that the children will not necessarily be familiar with the discoveries mentioned in the game; the challenge is to make educated guesses based on what they know about the world, and to learn from their incorrect guesses. After they play the game, it may be useful to ask the kids to discuss what they learned, and what surprised them the most.



## Fab Lab: FAR OUT!

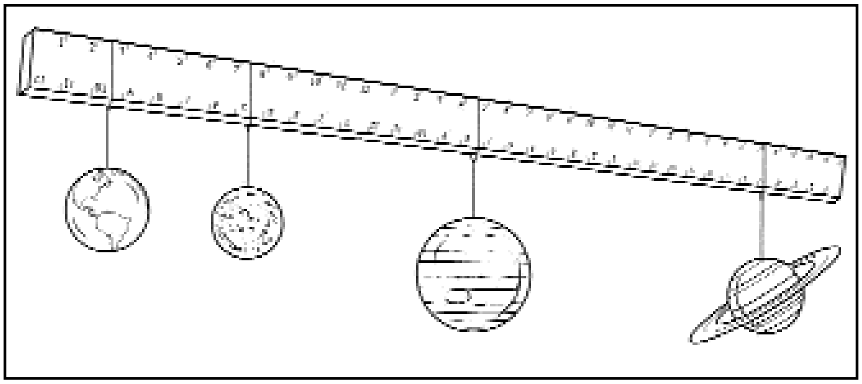
In this board game, students race from their grandmother's house to the farthest reaches of the Universe. They key conceit in the game is that they keep going ten times faster, and ten times faster again, in order to reach various milestones along the way. The game should help introduce the concept of scale and the vastness of outer space, as well as the comparative distances between the heavenly bodies.

## Move Crew: SIZE IT UP!



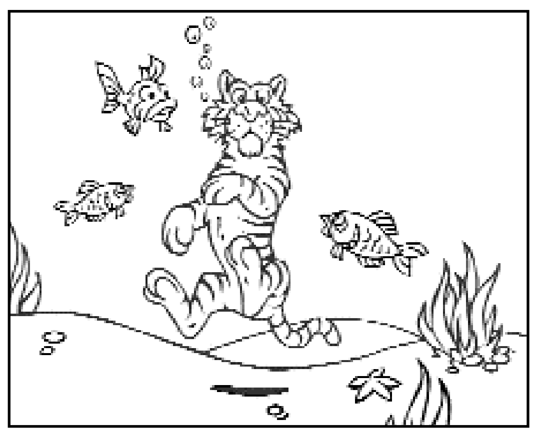
Kids may (or may not) know in principle that the Sun is bigger than the Moon, but this runs counter to their intuition and experience of seeing these objects in the sky. In this activity, students are given two disks (a large Sun and a small Moon), and are asked to move around the room until they appear to be the same size from another kid's vantage point. By using a ruler to compare the objects' "apparent" sizes, they can better understand that appearances can be deceiving. The children may point out that the difference in size between the disks is always obvious to them, even when they're using the ruler. That's because they know how big everything else in the room is, and can unconsciously estimate the size of the disks by comparison. The sky, on the other hand, is much farther away and doesn't have any reference points that we've ever seen up close. So it's a lot harder to judge the true size of the Sun, Moon, and stars.

## Smart Art: SOLAR SYSTEM ON A STICK

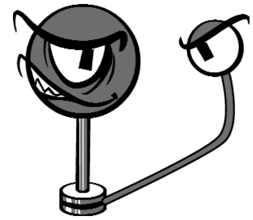


Here, the students make two scale comparisons of the Solar System. The first is based only on distance from the Sun. Most students will probably assume that the planets are spaced roughly equally from the Sun. By following the instructions and hanging the planets from points on a yardstick, they will see that the spacing actually gets much wider the farther out that you go. Next, the students will compare the relative size of the planets. The difference between gas giants like Jupiter and Saturn and smaller planets like Mercury and Pluto will be very striking. When you compare the yardstick model to the size comparisons, it should be obvious why we couldn't suggest a complete scale model that combines both size and distance: either the planets would have to be teensy, or the distances would have to be enormous.

## Write Away: A TIGER IS A FISH

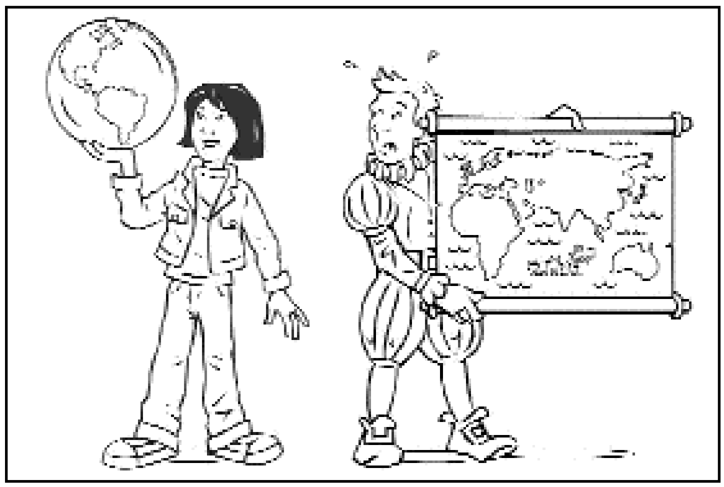


Some ancient ideas (for example, that the Earth is flat) may seem silly to kids who have been raised in an era of modern knowledge. Discuss with the children why people might have believed things that we now know to be untrue. In this writing activity, they'll have to defend a ridiculous proposition (like "a tiger is a fish") by backing it up with hard facts (such as "fish eat, and so do tigers"). Doing this activity may help kids understand why many people today can defend ideas or superstitions that seem silly or ridiculous to others, and how selective use of facts can reinforce one's own biases. It may even spark a discussion about prejudices and stereotypes, and the logic that is used to defend them.



The Slopernicus

# Mind-Bending Moments



## Briefing

The idea that the Earth revolved around the Sun may not sound like a big deal, but in the history of science, it was huge! People had thought the opposite – that the Sun revolved around the Earth – for thousands of years. That change in thinking paved the way for everything we know about the Earth and space today.

In this Mind Game, you'll look at some other mind-bending moments in history!

## Activity

HOW TO PLAY:

In this game, you'll try and sort out some of the biggest ideas in science history.

At the bottom of your screen, you'll see some kind of scientist at work.

Above the scientist, you'll see three thought bubbles. Inside each thought bubble is a Mind-Bending Moment: a really important idea that came along at some time in history.

Actually, only two of these Mind-Bending Moments are real. One is a fake. Maybe the whole idea is wrong, or maybe it's described in the wrong place and time.

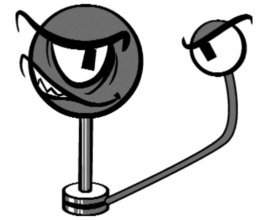
Can you spot the fake? Click on it and hit Go to find out.

We'll tell you if you're right, and then give you a new challenge!

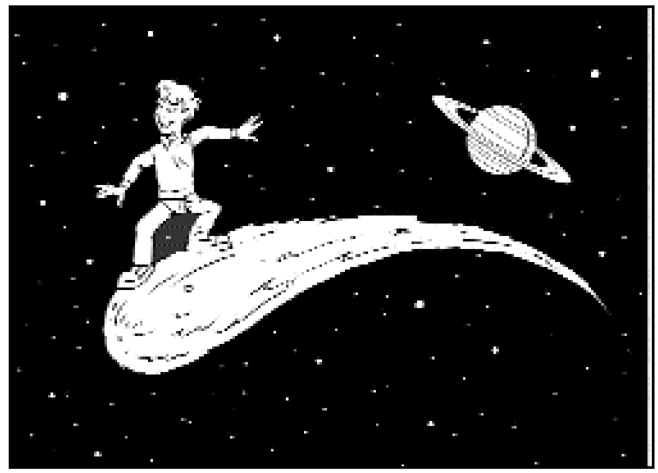
## Debriefing

What Mind-Bending Moments surprised you the most? Why? Can you think of any other Mind-Bending moments that weren't mentioned in this activity?

If you've got your Case Journals, answer the questions in it now!



# Far Out!



## Briefing

When human beings first went to the Moon, the trip was about ten times farther than a trip around the world. But if we ever send people to Mars, the trip will be a hundred times longer!

In this Fab Lab, you'll race all the way to the edge of the Universe. To get there, you'll have to accelerate from 55 miles per hour (the speed of a car) to 8 trillion times the speed of light.

## Activity

WHAT YOU'LL NEED:

- Far Out game board
- Game pieces
- Booster chips
- A six-sided die

OBJECT:

The object of the game is to reach the edge of the Universe.

To get there, you'll have to keep boosting your speed by ten, a hundred, a thousand, or even ten thousand times. That's because each of your destinations will be up to ten thousand times farther away than the last.

Each space on the board represents the distance you would cover in about half an hour at your current speed.

## HOW TO PLAY:

### 1) REACHING YOUR DESTINATION

Everyone begins on Start. Your first destination is your friend's house. You're going 55 miles per hour.

Pile the Booster chips together in a "bank."

Roll to see who goes first.

When it's your turn, roll the die and move that number of spaces ahead.

Some spaces will give or take away Booster chips. If you land on one of them, follow the direction.

If you land on a purple space, follow the directions.

When you reach the orange arrow marked STOP, you've reached your first destination! You MUST STOP THERE and wait for your next turn, no matter what you just rolled.

### 2) CROSSING THE WARP ZONES

Just past the STOP arrow is a wavy area called a Warp Zone. When you go through the Warp Zone, you'll boost your speed for the next part of your trip.

To make it through the Warp Zone, you'll need to roll above a certain number.

What number? Depends on how much faster you need to go – it's written on the game board. For example, to go ten times faster, you'll need to roll a 3 or higher.

So when your turn comes around again, roll the die to see if you make it through.

If you don't roll high enough, stay where you are and try again next time.

If you roll high enough, congratulations! You made it through the Warp Zone. No matter what you just rolled, move your piece to the Go triangle on the other side.

On your NEXT turn, you can start moving normally to your next destination.

## 3) USING YOUR BOOSTERS

Want to increase your chances of crossing the Warp zone? Use your booster chips!

Just turn in as many boosters as you like BEFORE you roll the die. Then add that number to your next roll. For example, if you turn in 2 booster chips and then roll a 3, you would count the roll as a 5.

Remember, you have to use your boosters BEFORE you roll, not after. In other words, you can't wait to see how you roll before you decide. Once you use your boosters, they're gone – even if you wouldn't have needed them anyway.

Some of the purple spaces let you trade in boosters for other opportunities. Just follow the directions.

## 4) ENDING THE GAME

The first player to reach the FINISH wins the game.

## Debriefing

What did you learn about the distances in space? Did that surprise you? Have pictures that you've seen of outer space make these changes in distance clear? Why do you think that is?

## More Info Page

Here are the actual distances from Earth to each of the destinations in the game.

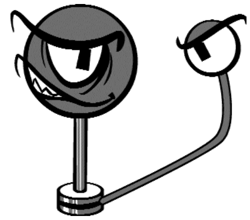
A **light-year** is not a measure of time, but of distance. It's the distance light can travel in one year – about 5.8 trillion miles.

Notice how much bigger the distances get the farther out you go.

What's beyond the Universe? Nobody knows!

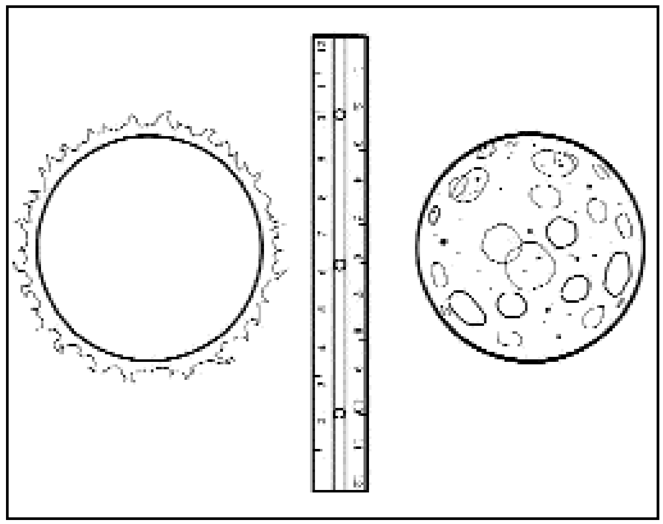
**DESTINATION DISTANCE:**

1. Friend's house (okay, we made up the friend) 180 miles (about the distance from Chicago, Illinois to Indianapolis, Indiana)
2. Coast-to-coast across the US 3,000 miles
3. Zoom around the world! 24,000 miles
4. The Moon 239,000 miles
5. Mars 49 million miles
6. Pluto 3.7 billion miles
7. Proxima Centauri, the nearest star (besides the Sun) 25 trillion miles
8. Crab Nebula 6,000 light-years
9. Andromeda 2.9 million light-years
10. The edge of the known Universe 14 billion light-years



The Slopernicus

# Size It Up!



## Briefing

In the sky, the Sun and Moon look like they're about the same size. But the Sun is really over 400 times bigger! How can that be? You'll see for yourself in this Move Crew.

## Activity

WHAT YOU'LL NEED:

- At least 2 flat discs of 2 different sizes. (For example, you might use a paper plate and a large pizza pan. You can also make your own discs from construction paper or posterboard)
- A ruler
- A tape measure
- Masking tape
- A marker

WHAT TO DO:

Using the tape measure, measure how big each disc is across the middle. Write down your measurements.

Using the marker and masking tape, label the discs A (the larger one) and B (the smaller one).

Give disc A to one kid, and disc B to another. Have them stand side by side and hold the discs out in front of them. The discs should be exactly next to each other.

Using the tape measure, find a spot ten in front of the two discs. Mark the spot on the floor with masking tape.

Stand on the spot, hold the ruler at an arm's length in front of you, and close one eye. Write down how "tall" each one of the discs seems to be. Let other kids see for themselves. Trade spots with the kids holding the discs so they can see too.

Now, have kid A walk backwards until disc A looks as small as disc B against the ruler.

Measure the distance between discs A and B with a tape measure. How far back did disc A have to go? Mark the spot with masking tape.

Try swapping out disc A for other round things: a wall clock, a penny, or make your own discs from cardboard. Try and guess where A will have to stand to look the same size as B. See if you can guess within three inches!

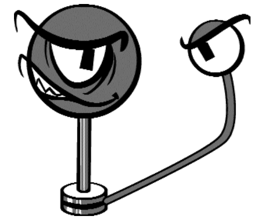
## Debriefing

Did you come up with any kind of system to figure out how far back the disc had to move? What was it?

If the Sun is 400 times bigger than the Moon, what does that say about where it is?

If you weren't closing one eye and looking right past the ruler, you could probably tell which disc was bigger no matter what. Why do you think that is? How was this situation different from looking at the Sun and the Moon in the sky?

If you've got your Case Journals, go ahead and answer the questions in it now!



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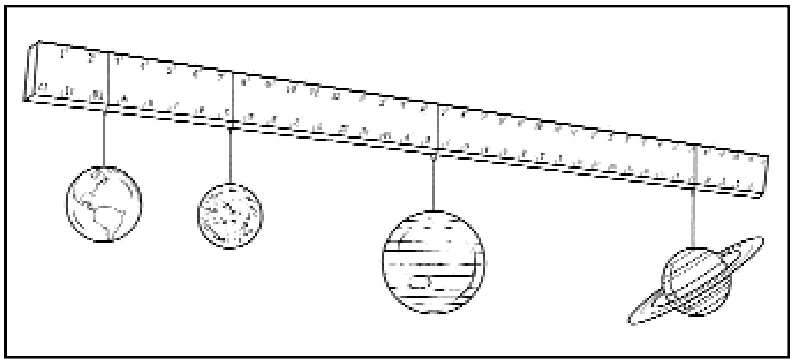
# Solar System on a Stick

## Briefing



On a pad and paper, draw a quick sketch of the Solar System. Show where you think the nine different planets are.

Were they spaced out evenly? Were they all the same size? You'll see how the planets shake out in this Smart Art.

## Activity

WHAT YOU'LL NEED:

- Construction paper
- Posterboard, newspaper, or rolled brown paper
- Scissors
- Tape
- A yardstick

## WHAT TO DO:

### PART ONE

First, we'll compare how far the planets are from the Sun. Make nine planets out of construction paper. The planets are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto. Don't worry about making the sizes accurate, but they should all be pretty small – maybe a couple of inches across.

Next, cut nine pieces of string of different lengths. Tape each piece to the center of one of the planets.

Next, tie the strings for each planet to the yardstick at the following spots:

- Mercury: 1/3 inch
- Venus: ? inch
- Earth: 1 inch
- Mars: 1 ? inches
- Jupiter: 4 ? inches
- Saturn: 8 ? inches
- Uranus:18 inches
- Neptune: 27 inches
- Pluto: 36 inches

Now hold the yardstick straight out, so the planets hang down from their strings. In this model, the Sun is at 0 inches (where your hand is). Give your model to another kid so you can see it.

What do you notice about the way the planets are spaced out?

### PART TWO

Now, we'll compare how big the planets are. You'll need some big posterboard, newspaper, or rolled paper for some of these. Make new models of the planets. Each planet should be the following distance across the center (for some planets, you'll have to tape pieces together):

- Mercury: 2 inches
- Venus: 5 1/3 inches
- Earth: 5 ? inches
- Mars: 3 inches
- Jupiter: 63 inches
- Saturn: 53 inches
- Uranus: 22 ? inches
- Neptune: 21 ? inches
- Pluto: 1 inch

Label the planets as you make them. What do you notice?

Compare them to the planets hanging from your yardstick. Why do you think you made these models separately?

## Debriefing

Why do you think you made two separate models? What do you think the differences between them were? How can they both be correct in their own ways? (Hint: Think about the difference between a city map and a map of the whole country.)

If you've got your Case Journals, answer the questions in it now!

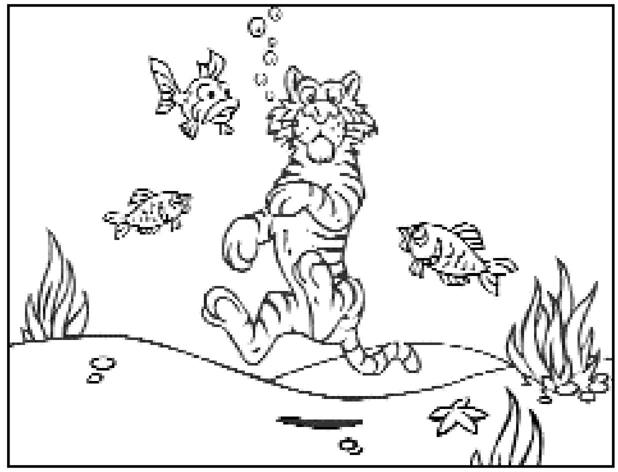
## **More Info Page**

Weighing in on Scale

The nine planets are very different in size, and very different in their distance from the Sun. You just made two different models to show the differences. Each model was accurate in its own way, but they used different **scales.** The model of the sizes of the planets was on a much larger scale than the model of the distances. It's like the difference between a map of the whole country and a map of your city: if the maps were the same size, an inch on the map of the country would represent many more miles than an inch on your city map.

Because the planets are much, much further apart than they are large, it would be hard to make a model of the Solar System that put the sizes of the planets and the distances between them on the same scale. Either the planets would have to be teensy, or the distances would have to be huge—bigger than your classroom or maybe even your neighborhood!

# A Tiger is a Fish



## Briefing

For thousands of years, people thought the Sun revolved around the Earth. People also used to think the Earth was flat. We know both of these aren't true, but you can understand why people thought that. In this Write Away, you'll try on some much crazier ideas for size!

## Activity

When people thought the Earth was flat, they weren't just stupid. As far as they could tell, it WAS flat. After all, the Earth looks flat from our point of view. And back then, they couldn't take pictures from space or travel around the globe.

So it's easy to believe something that's not true if you don't have all the facts.

Now think about this sentence: "A tiger is a fish." Sounds crazy, right?

But suppose all you knew were these facts:

- Fish are living things. So are tigers.

- Fish have eyes and mouths. So do tigers.
- Fish live in the water. People have seen tigers in the water.

These things are all true, right?

So if you didn't know ANYTHING else about tigers or fish, you could argue that a tiger was a kind of fish.

Now see if you can come up with three arguments that support one of these untrue statements. They might sound crazy, but that's part of the challenge!

Remember, use true facts for your arguments – just assume you don't know anything else.

Here are your choices. You can roll a six-sided die to pick one, or just choose one yourself.

- A shoebox is a kind of building.
- Chicken pox is caused by math class.
- Clouds are made of cotton candy.
- Somebody paints all the trees red and gold in the fall.
- When people leave the room, they vanish into thin air.
- Computers have brains like people do.

When you're done, write down at least three arguments AGAINST your statement. Don't just say "It's stupid" or "I know it's wrong" – use facts!

## Debriefing

Now that you've done this, can you understand how people would believe something that seemed to be true, like "the Earth is flat?" Can you think of other things people might have believed before science gave them more facts?

If you've got your Case Journal, answer the questions in it now!