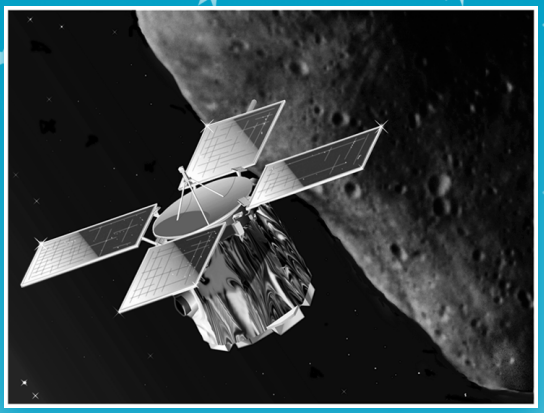


EXPLORATION IS NEAR!

Dear Parents and Teachers,

This activity book is designed to provide you with a number of fun activities to teach children about asteroids and some of the science concepts involved in the NEAR mission.

The Near Earth Asteroid Rendezvous (NEAR) mission was designed, built, and managed by The Johns Hopkins University Applied Physics Laboratory for the National Aeronautics and Space Administration (NASA). NEAR is the first spacecraft launched in NASA's Discovery Program, which is striving for "Faster, Better, Cheaper" missions. A global team of scientists and engineers are working together to explore the mysteries of the universe.

As the first spacecraft to orbit an asteroid, NEAR promises to answer fundamental questions about the nature and origin of asteroids and comets. This is important because these objects are the primary source of collision with the Earth, greatly influencing the life, surface, and atmosphere of our planet. It is likely that an asteroid collision with the Earth caused the extinction of dinosaurs. Asteroids and comets are thought to contain preserved clues to the nature of the early solar system since the surface and interior of asteroids and comets are exposed to little erosion and geologic activity to alter these clues.

Table of Contents

What science concepts and activities can I find in this book?

HI, I'M DR. NEARSIGHTED. LOOK FOR MY NOTES TO FIND FUN THINGS TO DO! I LEFT NOTES ALL OVER THAT LOOK LIKE THIS. WHEN YOU FIND ONE, THINK ABOUT THE QUESTIONS AND TRY THE ACTIVITY. NOW, LET ME SEE...WHERE DID I LEAVE THOSE NOTES???

Do you ever wonder about things in space, like what things are made of, what things look like, or how big or little things are? Scientists wonder about these same things. For example, scientists wonder about asteroids. Asteroids are chunks of rock and metal that travel around the sun. Most asteroids travel between Mars and Jupiter in an area called the asteroid belt, but some travel closer to Earth and are called near-Earth asteroids. Scientists want to know more about asteroids because they can help us understand our solar system and Earth better. This is why scientists sent a spacecraft called NEAR to study a near-Earth asteroid called Eros. NEAR will send back pictures of the asteroid and information that will tell us what the asteroid is made of, how big it is, what the surface is like and much more!

To learn more about the NEAR mission and asteroids, explore the games and Dr. NEARsighted's activities in this book!

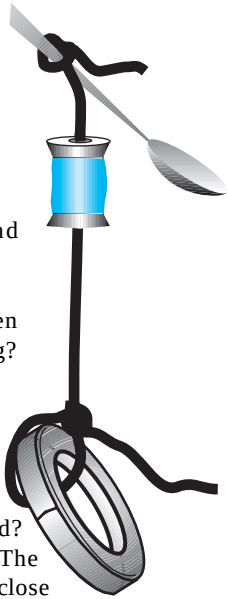
ACTIVITY 1

TRY THIS!

Do you wonder how the NEAR spacecraft is going to study the asteroid Eros? What keeps the spacecraft moving in a path around the asteroid?

MATERIALS: 1 yard of string, 1 metal spoon, 1 spool of thread, 1 masking tape roll

This activity should be done outside or in a room with lots of open space.



1. Put the string through the spool.
2. Tie one end of the string to the spoon handle.
3. Tie the other end of the string to the masking tape roll.
4. Hold the masking tape roll in one hand and the spool in the other hand.
5. Swing the hand holding the spool in a circular motion above your head. The spoon will begin to swing.
6. Once the spoon is swinging let go of the masking tape roll and continue moving the spool in a circular motion.

★ What keeps the spoon from flying away? What would happen if the masking tape was not tied to the other end of the string? The weight of the tape is a force. A force is something that pushes or pulls. The tape force pulls on the string and keeps the spoon from flying away. Now, think of the tape as the asteroid and the spoon as the spacecraft.

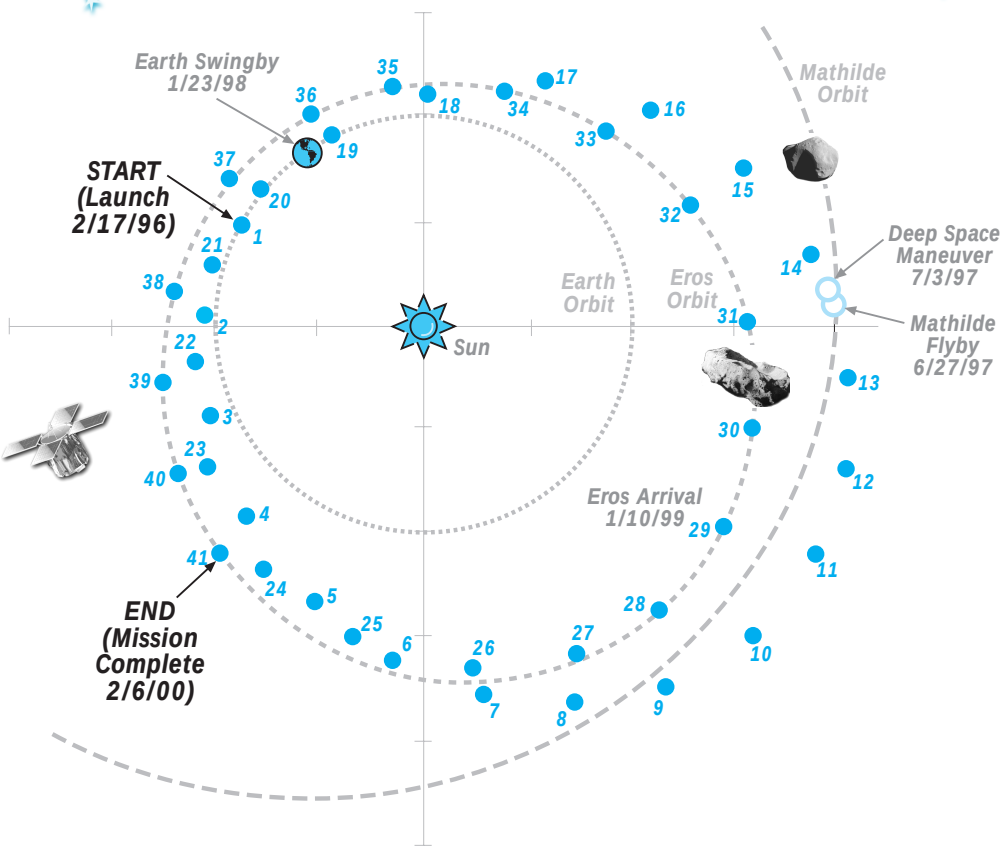
★ What is the force that pulls the spacecraft close to the asteroid? Stand up and jump! You came right back down, didn't you? The same force that pulls you close to Earth, pulls the spacecraft close to the asteroid. This force is called gravity.

★ If gravity pulls you onto Earth, why doesn't gravity pull the spacecraft onto the asteroid?

★ Did the spoon get pulled down by the tape? Why or why not?
When the spacecraft arrives at the asteroid, the engines will move it into a path around the asteroid, just like your arm moved the spoon in a circular motion. The spacecraft (and the spoon's) forward speed keep it from being pulled onto the asteroid (the tape).

ACTIVITY 2

The NEAR spacecraft has been launched! Draw the path that NEAR took from Earth to the asteroid Eros by connecting the dots.



Fun Facts!

Congratulations! You have helped scientists bring NEAR to the asteroid Eros! What do you notice about the path? Did NEAR travel directly to Eros? NEAR traveled around the sun and back by Earth before traveling to Eros. NEAR could not travel directly to Eros because it needed a force (or a push) from Earth to help it travel in the right direction towards the asteroid. Look at the launch date and the arrival date…How much time does the trip take?

ACTIVITY 3

TRY THIS!

Did you ever wonder how we get all those cool pictures of things in space? Try this to create a picture the same way NEAR scientists create pictures of things in space.

MATERIALS: 3 crayons: 1 black, 1 white, 1 gray

Pictures of things in space are called images. An image is different from a regular photograph taken by a camera. An image is made of square sections that create a picture when they are put together. To create an image, color each square.

	1	2	3	4	5	6	7	8	9	10	11
A	2	2	2	2	2	0	2	2	2	2	2
B	2	2	2	2	0	0	0	2	2	2	2
C	2	2	2	0	0	0	0	0	2	2	2
D	2	2	0	0	0	0	0	0	0	2	2
E	2	2	0	0	2	2	2	0	0	2	2
F	2	1	0	0	0	1	0	0	0	1	2
G	2	1	0	0	0	1	0	0	0	1	2
H	2	1	0	0	0	1	0	0	0	1	2
I	2	1	0	0	0	1	0	0	0	1	2
J	2	1	0	0	0	1	0	0	0	1	2
K	2	1	0	0	0	1	0	0	0	1	2
L	2	1	0	0	0	1	0	0	0	1	2
M	2	1	0	0	0	1	0	0	0	1	2
N	2	1	0	0	0	1	0	0	0	1	2
O	2	1	0	0	0	1	0	0	0	1	2
P	2	1	0	0	0	1	0	0	0	1	2
Q	2	1	0	0	0	1	0	0	0	1	2
R	2	1	0	0	0	1	0	0	0	1	2
S	2	2	0	0	0	0	0	0	0	2	2
T	2	0	0	2	2	0	2	2	0	0	2
U	0	0	2	2	0	0	0	2	2	0	0
V	0	0	2	2	0	0	0	2	2	0	0
W	0	0	2	2	0	0	0	2	2	0	0

1. Look at the first number on the computer screen.
2. Pick the crayon color that matches the number (If the number is 0–pick black, 1–pick gray, or 2–pick white).
3. Color the first square with that crayon.
4. Follow the same steps for each of the squares in the first row, moving to the next square on the image and the next number on the screen each time.
5. When every square in a row is colored, move to the next row on the image and the next row on the computer screen until you have colored every square.

	1	2	3	4	5	6	7	8	9	10	11
A											
B											
C											
D											
E											
F											
G											
H											
I											
J											
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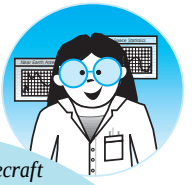


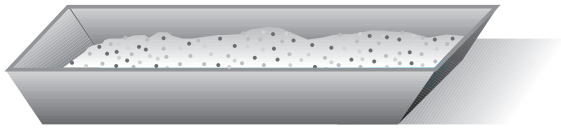
An instrument on the spacecraft sends numbers to the computer that scientists read from left to right, just like a book. The first number tells the color of the first square, the second number tells the color of the square next to it and so on. Each new row on the computer is a new row on the image. Use the information on the computer screen to create your own image.

ACTIVITY 4

TRY THIS!

Did you ever wonder what craters are? Do you want to see what a crater looks like? Try this activity to make your own!

MATERIALS: brownie pan, all purpose flour, glitter (or any powder mixture that will contrast with the flour), small ball shaped object such as a marble or golf ball, newspaper



1. Cover the work area with newspapers.
2. Fill the brownie pan about half full with flour.
3. Sprinkle a layer of glitter on top of the flour…You have just made your surface!
4. Before dropping the ball-shaped object to make your crater, think about how the crater might look. (How deep? How wide? What shape? What will happen to the layer of glitter?)

Now it's time to make some craters!

5. Hold the ball above the pan and let it drop!
6. Carefully remove the ball and study your crater.

- ★ What happened to the glitter layer on top?
- ★ What shape is your crater?
- ★ How wide and deep is your crater?
- ★ Does it look like you guessed it would?
- ★ What do you think would happen if you dropped the same object farther from the surface, How about closer?
- ★ What about dropping smaller or bigger balls, how would those craters look?

As you make your craters, study the differences between them (in shape, how wide, how deep, and what happens to the glitter) and try to figure out what causes those differences.

ACTIVITY 5

MATCHING ASTEROIDS

Can you find and circle
two asteroids that are exact matches?

I've got to get these glasses fixed.... I'm seeing double!

Fun Facts!

Asteroids look a lot alike, but they do not look exactly the same. Asteroids are shaped like peanuts or potatoes and most are smaller than a mountain. Asteroids are different shapes and sizes, but one thing they all have are craters. Craters are like holes and are made in the surface when something hits it. You can find craters on most planets and the moon.

ACTIVITY 6

TRY THIS!

Is seeing believing? If you can see the size of an object, is that enough to tell how heavy it is? On page 4 (Activity 3), you learned that scientists will create images of the asteroid. From the images scientists can tell how big the asteroid is. If they know how big the asteroid is, can they tell how heavy it is?

MATERIALS: 2 cups or jars of the same size: 1 filled with water and 1 filled with sand, and a friend

1. Find two cups of the same size.
2. Fill one cup full of sand and one cup full of water.
3. (Make sure your friend doesn't watch what you put inside!)
4. To make sure that your friend cannot see what is inside the cups, cover the sides with paper or use colored cups and don't forget to cover the top!
5. Place the two cups side by side on a table.
6. Ask your friend, Do the cups look like they are the same size?
7. Ask your friend, Do you think the cups will feel the same heaviness if you pick them up?
8. If your friend answers yes, have him / her pick each cup up. If your friend answers no, have him / her guess which one he / she thinks is heavier, and then have your friend pick each cup up. Did your friend guess which one was heavier?

Sometimes seeing is not believing. When we see two things that are the same size, we usually think that they will feel the same weight (both heavy or both light). The two cups are the same size and take up the same amount of space, but the cup filled with the sand is heavier than the cup filled with water. It is not enough to know what size an object is to know how heavy it is, it depends on what the object is made of (what is inside).

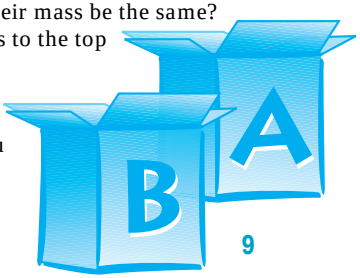
The size of an object or the amount of space it takes up is called volume. The two cups have the same volume because they take up the same amount of space. The heaviness an object has when you pick it up or how much it weighs is called mass. The more mass an object has the heavier it feels.

★ Which cup had more mass, the cup filled with sand or the cup filled with water?

★ If you filled two trash cans of the same size, one with water and the other with sand, would their volume be the same? Would their mass be the same?

★ What if someone asked you to carry one of these boxes to the top of a hill, which one would you carry?

What if I told you that box A was filled with bricks and B box was filled with feathers, now which box would you carry?



ACTIVITY 7

TRY THIS!

Did you ever wonder why one object might feel heavier (have more mass) than another object if they are the same size (volume)? On page 7 you felt that sand had more mass than water. If there was the same amount of each (volume), why does sand feel heavier? Try this to find out.

MATERIALS: many cups of equal size, flour, sugar, bathroom scale, pencil, paper

1. Fill one cup with sugar and place it on the scale.
2. Write down how much it weighs (mass) and take it off the scale.
3. Fill one cup with flour and place it on the scale.
4. How much does it weigh? Even though there is the same volume of each, they have a different mass.
5. Leave the cup of flour on the scale and place another cup of flour on it.
6. Keep placing full cups of flour onto the scale until the mass (weight) of all the cups is close to the mass you wrote down for one cup of sugar.

★ How many cups of flour did it take to be close to the same mass as one cup of sugar?

★ Why does it take more cups of flour to equal the same mass as one cup of sugar?

★ Why does the same amount of sand and water have a different mass? (From: "Try This!," Activity 6 on page 7).

Tiny pieces that are too small to see can fit together to make each object like a grain of sugar or flour. Some objects are made of pieces that are very close together and other objects are made of pieces that are farther apart. How close the pieces fit together is called density. An object is more dense when the pieces are close together and less dense when the pieces are farther apart.

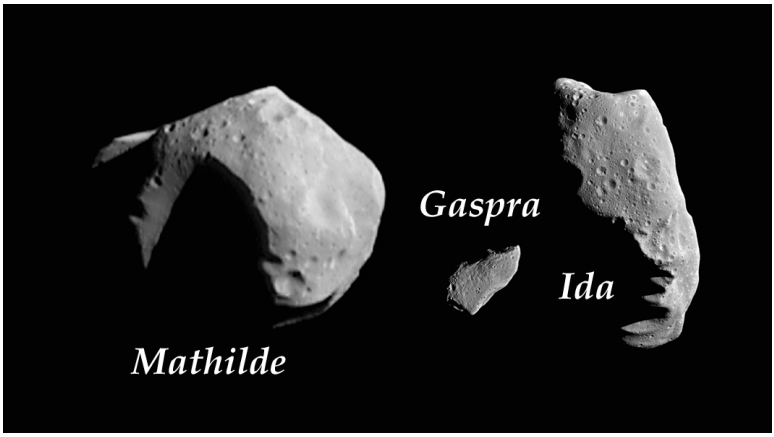
It takes more flour to equal the same mass as one cup of sugar because sugar is made up of pieces that fit together more closely than the pieces that make up flour. Since the pieces that that make up sugar are closer together, more sugar pieces can fit into one cup, which is why it has more mass (more weight). When you hold the same volume of sand and water the sand feels heavier (has more mass), because sand is more dense. The pieces that make sand are closer together, so more sand pieces can fit into the cup than water pieces.

Just like when you pack a suitcase, if you squish as much as you can into it, the suitcase will be heavier than if you threw a few things in.

ACTIVITY 8

MASS, VOLUME, & DENSITY OF AN ASTEROID

Step 1 Scientists will get information from the NEAR spacecraft to make images of the asteroid Eros like this image of the asteroids Mathilde, Gaspra, and Ida. From the images scientists will be able to tell how much space the asteroid takes up or what the volume of the asteroid is. Scientists also want to know the mass and the density of the asteroid.



Step 2 Trying the activity on page 2 you learned that the Earth and the asteroid have a force that keep things near them. The force is called gravity. The Earth is much bigger and has more mass than the asteroid. So, the pull from gravity is stronger than on the asteroid. When the spacecraft gets to the asteroid, scientists will be able to figure out how strong the pull of gravity from the asteroid is by how much it pulls on the spacecraft, changing its direction. Once scientists know how strong the pull of gravity is from the asteroid, they will have an idea of the mass, because more pull from gravity means more mass and less pull from gravity means less mass.

Step 3 Once scientists have figured out the volume from the images and the mass from the pull of gravity, they will know the density because density is a measure of how much mass can fit into a certain volume.

ACTIVITY 9

TRY THIS!

Did you ever wonder what magnets are? What things are pulled by magnets? Why?

MATERIALS: magnet, many objects made of different material (Suggestions: button, screw, paper clip, foil, marble, tack, soap, nail)

1. Put the magnet on one item at a time.
2. Make two piles of objects, one for objects that are pulled by the magnet and one for objects that are not pulled by the magnet.
3. When you have tested as many objects as you can, study the two piles.

★ What do you notice about the objects that were pulled by the magnet? Do the objects have anything in common?

★ What do you notice about the objects not pulled by the magnet? Do the objects have anything in common?

Magnets have an invisible force that pulls objects to them or pushes objects away. Magnets will only pull objects to them that are made out of certain types of metal. The most common type of metal found that is pulled by magnets is iron. So, the objects pulled by the magnet in your experiment are all made out of metal and probably made out of iron.

Fun Facts!

Asteroids can be made of rock, metal, or both rock and metal. NEAR scientists want to know what the asteroid Eros is made of. The NEAR spacecraft has an instrument that will use the same invisible force found in magnets to help figure out what the asteroid is made of. Since the invisible force in magnets is attracted to or pulls metal, scientists will be able to figure out if the asteroid is made of rock, metal, or both, just like you were able to figure out what things were made of metal and what things were not made of metal using a magnet.

MORE FUN WITH MAGNETS

1. Fill a bowl with water.
2. Cut a fish shape out of paper.
3. Slide one paper clip onto each fish and put them into the water.
4. Tie one end of a string to a stick and one end to a magnet (fishing rod).
5. Go Fishing!!!

★ Can your magnet fishing rod pull the fish out of the water? Why or Why not?

★ Does the magnet work through water if the fish are under water?

★ Does the magnet have to touch the paper clip in order for you to catch a fish?

Being close to the asteroid, scientists can figure out if the asteroid is made out of metal. The invisible force in magnets works without having to touch metal.

ACTIVITY 10

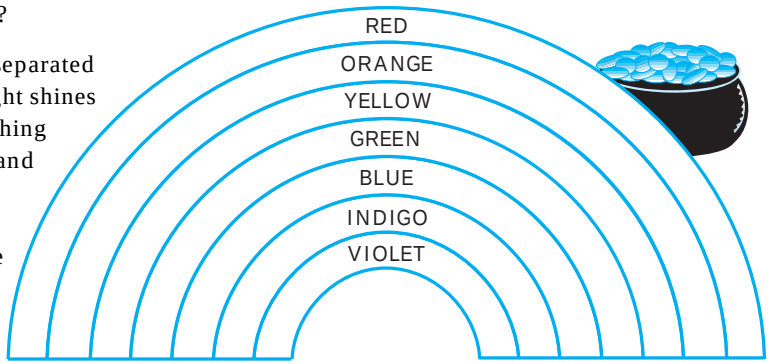
TRY THIS!

Did you ever wonder where color comes from? Try this to find out!

MATERIALS: 1 plastic square container, water, 1 piece of white paper, sunshine or flashlight, mirror

1. Go to a sunny window.
2. Fill the container with water.
3. Lean the mirror against the back of the container so that the light from the sun is shining through the water onto it.
4. Hold the paper in front of the container.
5. Look at the paper to see what happens to the light.

★ What do you see when the sunlight shines through the water onto the paper?
★ What colors do you see?
★ Look at the order that the colors are in…..Have you seen that order before? If so, where?



You have just separated light! When light shines through something clear, it bends and spreads out, separating, letting you see the colors in it! What is clear that bends the light in this experiment? The mirror's job in this experiment is to put the separated light onto the paper so that you can see it.

Here's a trick to help you remember the colors of light in order…take the first letter of each color, put the letters together and you make the name ROY G. BIV. Color the rainbow to see for yourself!

I don't see a pot of gold anywhere ... do you?

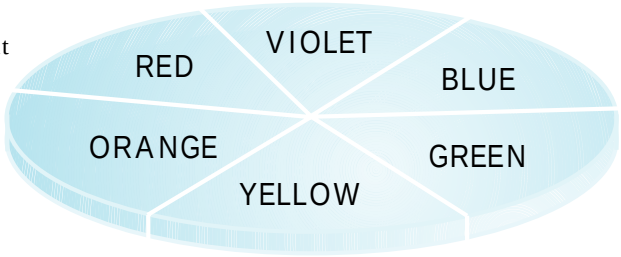
TRY THIS!

If light contains colors, why don't we see them all the time? Try this to find out why we see light as white or yellow, and why we do not see the colors in light all the time!

MATERIALS: 1 piece of cardboard, 6 crayons: red, orange, yellow, green, blue, violet, 1 sharpened pencil

1. Draw a circle about 4 inches across on the cardboard.
2. Cut out the circular disk.
3. Separate the disk into six equal pie-shaped sections.
4. Color the sections as shown in the picture.
5. Carefully put the sharpened pencil through the middle of the disk (you may want to ask an adult for help).
6. Twist the pencil like a top on a smooth surface and watch your disk spin! The faster you can spin the disk the better!

★ What do you notice about the colors?
★ Do you still see each color?
★ What color do you see?



Your spinner is just like light. All around us there is light made up of the same colors on your spinner, red, orange, yellow, green, blue, and violet. Why couldn't you see the colors when the spinner was spinning? Just like your spinner, light moves too fast for our eyes to see these colors, so instead we see white or yellow light.

MORE FUN WITH COLOR!

1. Cut out 3 more disks (follow steps 1 and 2 above).
2. Separate each disk into 2 parts by drawing a line down the middle.
3. Color 1 disk blue and red, 1 disk yellow and red, and 1 disk yellow and blue.
4. Carefully put a pencil through the middle of each disk.
5. Spin each disk one at a time on a smooth surface.

★ How does each disk look when it is spun?

★ When you spin a disk, what color do you see?

★ What would happen if you tried other color combinations on a disk?

ACTIVITY 11

TRY THIS!

Have you ever wondered how rainbows are made? Where do all those colors come from? Try this to learn more about rainbows and how to make your own!

MATERIALS: hose with running water, sunshine

1. Stand outside with the sun shining on your back.
2. Spray water from the hose in front of you (you can make the water spray using a hose nozzle or by putting your finger over part of the opening where the water comes out).
3. Look where the water is being sprayed….can you see your rainbow?

Congratulations you have just made a rainbow! When you see a rainbow, the same thing is happening in the sky that happens when you make your rainbow. But instead of a hose, the water comes from rain. In Try This!! #1 you discovered that clear objects can separate light so that we can see the colors in it. Each drop of water, when it is raining or when the hose is spraying, separates light letting us see the colors and creating a rainbow. The next time it is raining and the sun is shining bright behind you look around for a rainbow in the sky!

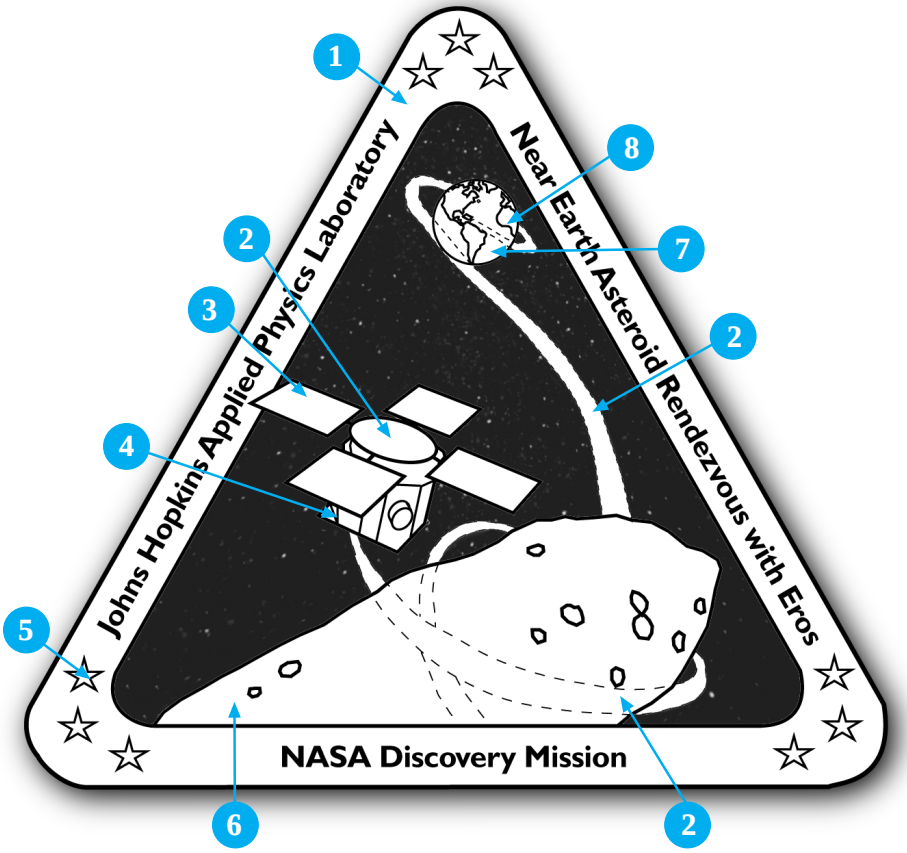
Fun Facts!

The NEAR mission will use the colors in light to help figure out what kind of rocks and minerals make up the asteroid Eros. Different types of rocks and minerals take in different colors from light. When light from the sun shines on the asteroid, an instrument on the spacecraft can tell what colors are taken in and what colors are not. Using this information and information from other spacecraft instruments scientists can figure out what the asteroid is made of.

ACTIVITY 12

Put the finishing touches on the NEAR mission patch! Look at the list below to see which colors go with which number and finish the patch!

1 **Red**	4 **Yellow**	7 **Light Blue**
2 **Light Gray**	5 **White**	8 **Brown**
3 **Blue**	6 **Dark Gray**	



Fun Fact!

Every space mission creates its own mission patch. The patch shows information about the mission. Look at the NEAR mission patch above. From this patch you can see the groups of people involved in the mission, the name of the mission, what the spacecraft looks like, and what it is going to do.

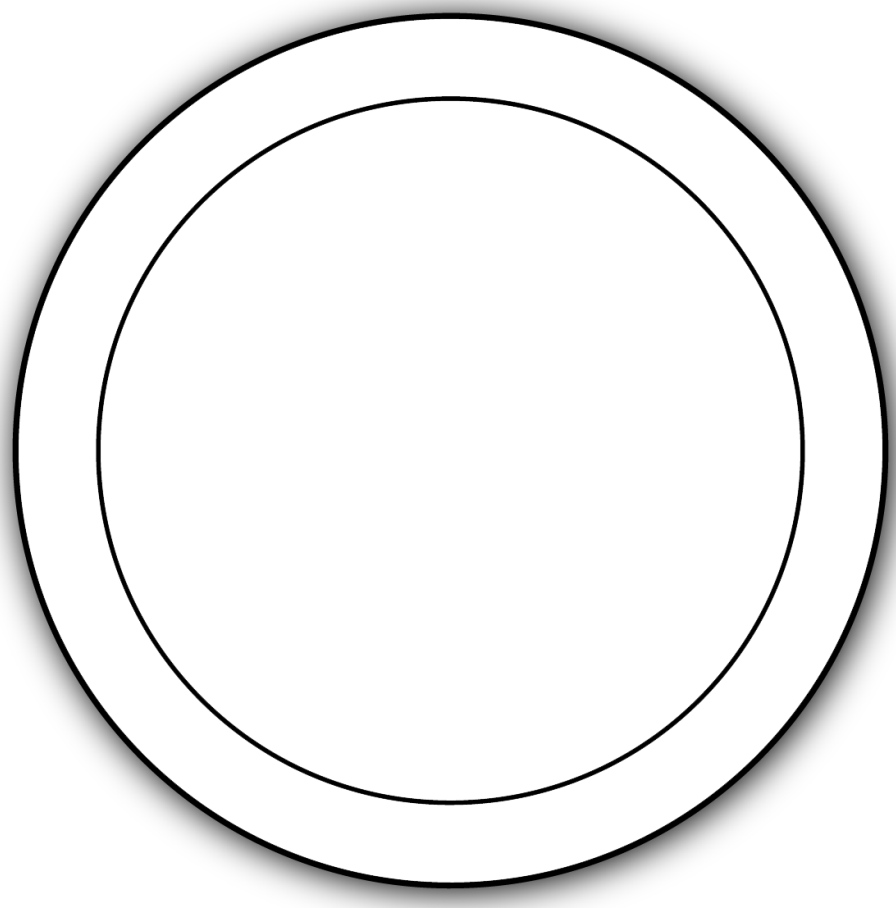
TRY THIS!

Have you ever wanted to have your own space mission? Here is your chance to tell others about your mission by creating your own mission patch!

MATERIALS: crayons, markers, or colored pencils

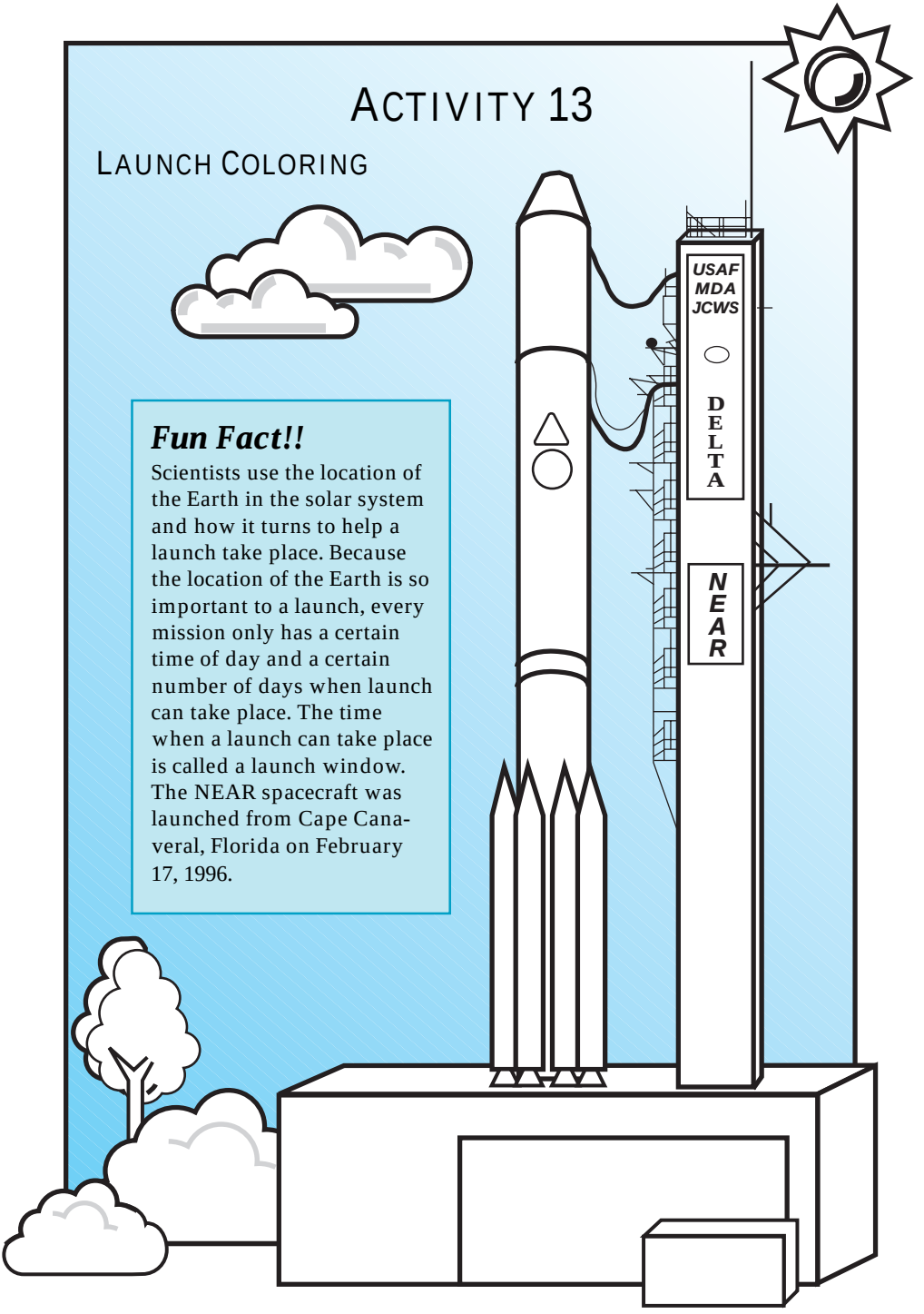
If you could study anything in space, what would it be? What do you want to know about it? How will you study it? What tools will you use to study it? Take the answers to these questions and design a patch that will tell others about your mission. You can use the empty patch below or draw your own patch shape. Be creative! Make every part of your patch tell about your mission…color, symbols, name, pictures all of this should tell about your mission. Go to the library or search the Web to learn about what you want to study and use that information and pictures to give you ideas for your patch. To see patches done by other NASA missions visit this site:

http://www.hq.nasa.gov/office/pao/History mission_patches.html



ACTIVITY 13

LAUNCH COLORING



Fun Fact!!

Scientists use the location of the Earth in the solar system and how it turns to help a launch take place. Because the location of the Earth is so important to a launch, every mission only has a certain time of day and a certain number of days when launch can take place. The time when a launch can take place is called a launch window. The NEAR spacecraft was launched from Cape Canaveral, Florida on February 17, 1996.

Activity 14

Word Search

Find the words on the list below. Words can be hiding up, down, across, backwards, or diagonal.

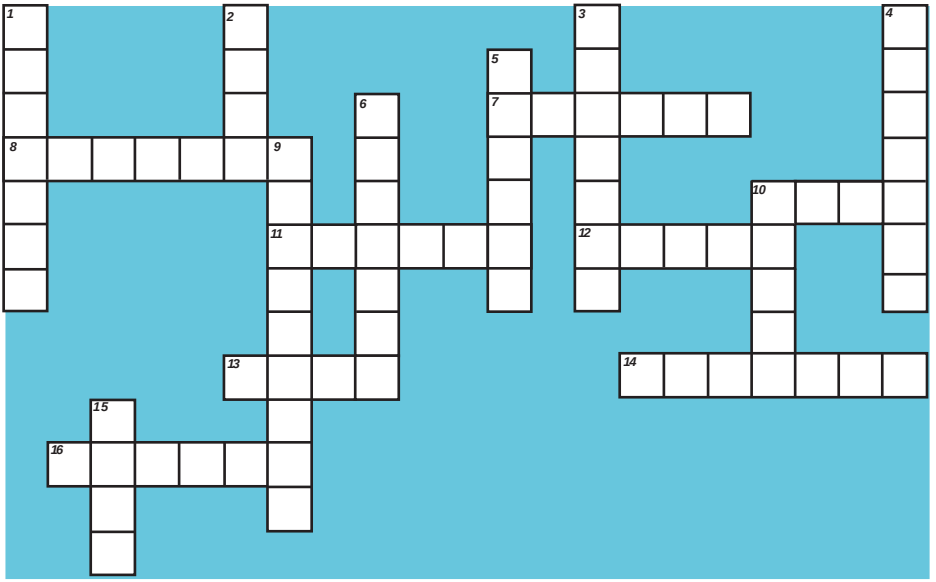
SUN	*ASTEROID*	*METAL*	*VOLUME*
ROCK	*CRATER*	*GRAVITY*	*MISSION*
EROS	*RAINBOW*	*INSTRUMENT*	*IMAGE*
LIGHT	*MASS*	*NEAR*	*MAGNET*
SPACE	*DENSITY*	*COMET*	*MINERALS*

W Y U K P T E N G A M A X T
S U N E C A P S T E M O C N
Q A S T E R O I D A C Q C E
B R R A E N S F D K A K G M
I O A O M N O S E S O R E U
E M N I C A P T N H A V C R
M I A H N K X C S V T N M T
U Y U G P B R S I G Z A L S
L Q N S E A O T T H G I L N
O W S U T L Y W Y A C Q W I
V A C E N O I S S I M K D V
M O R K M N O S L A T E M Q
T N M I N E R A L S I V C W

Crossword Puzzle Answers: *Across:* 7. images, 8. numbers, 10. more, 11. potato, 12. three, 13. mass, 14. smaller, 16. volume. *Down:* 1. rainbow, 2. near, 3. gravity, 4. magnets, 5. window, 6. craters, 9. separated, 10. metal, 15. hole.

CROSSWORD PUZZLE

You can find the answers to the crossword clues by doing the activities in this book and reading the Fun Facts!



ACROSS

7. *Pictures of things in space are called _____.*
8. *Scientists know what color to put in an image from_____ on their computer screen.*
10. *When the pieces that make up an object fit closely together, the object is _____ dense.*
11. *Asteroids are shaped like a _____ or a peanut.*
12. *The trip to the asteroid Eros will take _____ years.*
13. *If an one object is heavier than another it has more _____.*
14. *Most asteroids are _____ than a mountain.*
16. *_____ is the amount of space that an object takes up.*

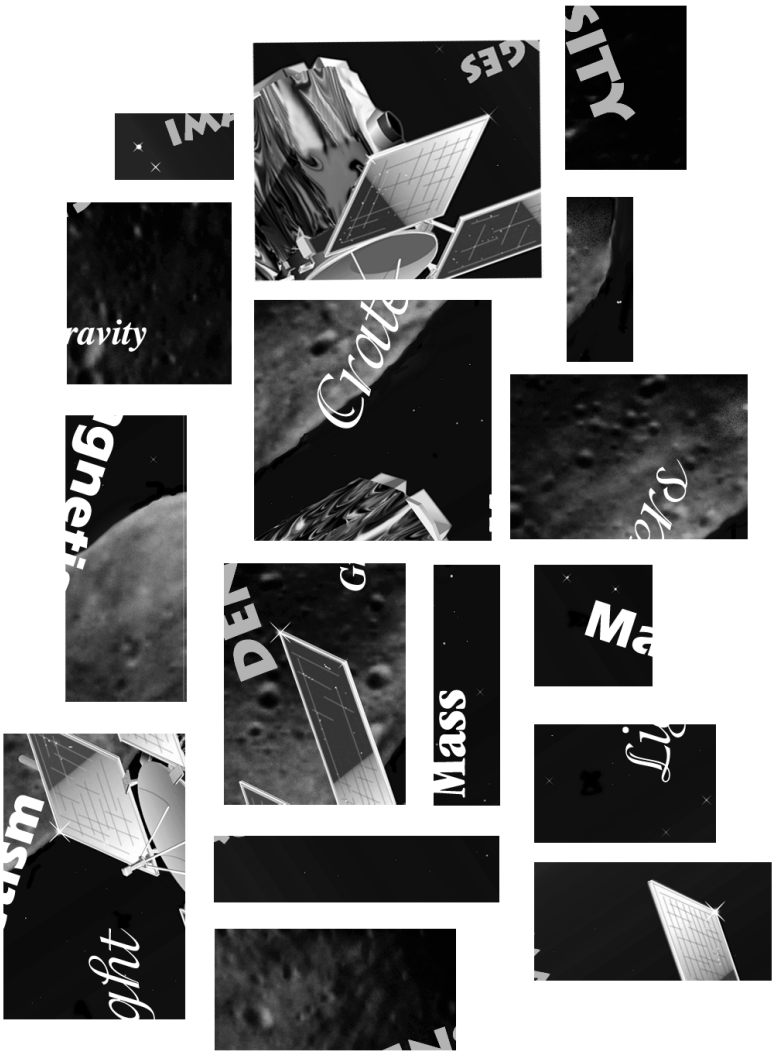
DOWN

1. *A _____ is made when rain separates the sunlight.*
2. *The abbreviation for Near Earth Asteroid Rendezvous is _____.*
3. *The force that pulls the spacecraft close to the asteroid is called _____.*
4. *_____ have an invisible force that can pull objects to them or push objects away.*
5. *The time when a launch can take place is called a Launch _____.*
6. *_____ are holes in the surface of an asteroid, planet or ????*
9. *When light is _____ we can see the colors in it.*
10. *Asteroids are made of rock and/or _____.*
15. *A crater is a _____ in the surface of an asteroid, planet, or the moon.*

The answers to this crossword puzzle are hidden on another page.

ACTIVITY 15

Did you ever put a puzzle together…..You have all these pieces and you know they fit together to make a picture, but you aren't sure how? Putting a puzzle together is a lot like science! There are many pieces of information that are learned from experiments that somehow fit together to understand something or figure something out. By doing the activities in this book you experimented with and learned about many of the pieces that NEAR scientists have to put together to understand the asteroid. NEAR scientists can use what they learn in this mission to help figure out bigger puzzles about space and Earth.



CREDITS AND ACKNOWLEDGMENTS

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★ ***What other resources are available from the NEAR mission?***

1. **NEAR Spacecraft Model**
2. **Asteroids/Comets Cube**
3. **Informational Poster**
4. **Lesson Plans**
5. **Lithographs**
6. **Slides**
7. **Video**

★ ***Resources are available through:***

The NEAR mission Web site
http://near.jhuapl.edu/Education/

JHU/APL Office of Public Affairs Office
240-228-6050 Washington or
443-778-6050 Baltimore

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