Numbers and Shapes

Leader Guide
For Brownie Girl Scouts

Set I

BRIDGING THE GAP

A collaboration
Between
Discovery Place, Inc.
and Hornets' Nest Girl Scout Council.

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The activities described in this Leader Guide are intended to be used under the direct supervision of adults. Discovery Place, Inc. and Hornets' Nest Girl Scout Council can be responsible for any accidents or injuries that may result from conducting the activities without proper supervision, from failing to follow the supplied directions, or from ignoring the cautions contained in the text.

Numbers and Shapes

Table of Contents

These activities are designed to simplify the activities found on pages 231-233 in "Brownie Girl Scout" handbook. They are designed to be fun, easy, and inexpensive. The layout of each activity contains simple instructions for preparation, as well as for sampling the activity before presenting with the Girl Scouts. All GSUSA guidelines should be followed when doing these activities.

Introduction

As Girl Scout leaders and professionals, it is our goal to provide quality programs designed to enable girls to meet the many challenges of the future. Bridging the Gap (BTG) does that by providing easy, fun, and inexpensive activities that build confidence, both in the girls who do them, and in the leaders who guide them. All BTG activities are designed to be hands-on explorations of science, engineering, and mathematics (SEM), where the only limits are the boundaries of the imagination. Here, there is rarely a right or wrong answer. Instead, there is a sense of accomplishment in discovering something new in every effort.

As leaders, BTG gives **you** the opportunity to provide a more successful SEM program for your girls. By providing simple activities in an easy-to-follow format, BTG will enable you to guide your troops with confidence in both the execution and the success of your SEM programming.

With the increasing importance of science and mathematics in our everyday lives, from balancing a checkbook, to surfing the Internet, as well as in the professional world of the future, building confidence and excitement in exploring SEM activities is essential to the success of our girls in the world of tomorrow. But beyond the immediate challenge of these specific activities, there is even a greater importance attached to motivating our girls to explore science, engineering, and mathematics.

Gender Equity and SEM

Girl Scout Councils across the country have done extensive research in the area of gender bias and how girls are affected by it, with a particular view toward science, engineering, and mathematics. In developing materials to be used by troop leaders, special attention has been given to the teaching methods and attitudes that our girls have been exposed to in the conventional classroom.

We know that in formal classroom settings, girls are not always encouraged to develop an interest in advanced science and mathematics studies. Research shows that both male and female teachers tend to expect more from boys, especially in the areas of science, engineering, and math, and, as a result, often unconsciously promote a learning bias. Sometimes this bias is a result of lower expectations for girls, and often reflects the teacher's personal lack of confidence in their own command of the material.

As Girl Scout adults, we need to encourage girls to explore their interests in science, not only for those who seek to become scientists, but also for those who want to become good parents, homemakers, businesswomen, and/or political leaders. Science and math are part of everyday life, from managing the household budget (accounting), to rearranging the furniture (geometry), and even while cooking dinner (chemistry).

The only way that we, as Girl Scout leaders and professionals, can implement a successful SEM program with our girls, is to motivate their natural excitement and curiosity, while reexamining our own perceptions as to what science is, and the role it plays in our lives.

We need to project an enthusiasm for the subject matter, a confidence in using the materials and in teaching the activity. We, the role models, must be *excited* at the opportunity to expand our knowledge through hands-on experiences in science, engineering and math, so that our girls will feed off that enthusiasm, and actively seek to gain the experiences that all of the data suggests they have been missing.

Bridging the Gap lets ***you and your girls*** explore, ask questions, take risks, and stretch your interests as far as your enthusiasm will allow. After all....

Learning is directly proportional to the amount of fun you have!!!

Why SEM is essential for your Girl Scouts

According to data from the Departments of Education and Labor:

- While girls score higher than boys in reading from the 4th grade on, they fall behind boys in science and math test scores as they move further through high school.
- Over the past few years women were awarded fewer than 25% of the degrees in chemistry, less than 20% of the degrees in physics and math, and less than 1 of every 10 degrees awarded in engineering.

This happens despite research that indicates:

- Engineering will be among the highest paying and fastest growing occupations over the next decade.
- Women with good math skills earn more than women without good math skills.
- The fastest growing occupations - computer technology, engineering, and statistical analysis - all require strong backgrounds in science, technology, math, and/or engineering.

Tips for Leaders Beginning SEM Activities

- Examine your own attitude about science and math before attempting the following activities.
- Practice the activities yourself.
- Take risks, get messy, explore, and observe.
- Have fun doing the activities.
- Develop a sense of confidence knowing that it works. It's easy, it's fun, and you can do it.
- Hold high expectations for the girls.
- Encourage the girls to take risks, get messy, explore, and observe.
- Invite the girls to have fun doing the activities.
- Don't readily give the girls answers. Instead, encourage them to discover on their own.
- Help the girls achieve a sense of accomplishment and confidence knowing they can do it.
- Whenever possible invite real role models, female engineers and scientists, to talk with your troop about their careers, and how the girls can start planning a career of their own.

How To Use This Guide

The activities in this guide are intended to be as user-friendly as possible. They were developed to be easy to do, easy to set up and virtually always successful. Each refers to a corresponding section from an official Girl Scout Leader handbook, and that is noted on the 'Contents' page as well as in each activity. For your convenience, we have included an overview, the estimated amount of time you'll need in doing the activity with the troops, the materials needed, safety and clean-up suggestions, and planning suggestions in order to better prepare to do the activity with your girls.

The step-by-step instructions include tips, cautions, questions to challenge your girls, and explanations. Since trying the activities before the troop meeting is strongly encouraged, we have included instructions with most of the activities on how to do it by yourself first. Please read all sections of the activity before trying with your girls. With many of the activities we have included references and resources at the end of the section, or in the back of the Leader Guide, to direct you to areas where your girls may explore further, or where specialty items might be purchased.

You will also find various icons throughout the guide which are placed to draw special attention for the following reasons:

When you see this **pay close attention** to the instructions.

These are questions you may wish to use to challenge your girls.

Look here for an explanation of what is happening and why.

This icon indicates a more in-depth explanation of what is happening.

Here you will find hints on making an activity easier.

Math Shapes

Corresponding Activity

Number and Shapes Try-It,
p. 231, Brownie Girl Scout Handbook

Overview

Tangrams are ancient Chinese puzzles that consist of geometric shapes which fit together to make a square. These shapes can be rearranged to make hundreds of different shapes and patterns. During this activity, the girls will arrange the tangram pieces to resemble a rabbit, a turtle, and a square, and may attempt to rearrange the pieces to make patterns of their own.

Big Idea

Puzzles, such as tangrams, are a form of mathematics that help girls develop spatial reasoning and problem solving skills, and lay the groundwork necessary for higher levels of math such as algebra and geometry. Girls will also learn the names of the different shapes in the tangram puzzle -- square, triangle, and parallelogram -- and discover how these shapes are alike, how they are different, and how they relate to each other.

Estimated Activity Time

30-45 minutes

Materials Needed

Your VSC provides:
For each girl:

- ☐ 1 set of tangram pieces (individually bagged)

Items you provide:
For each girl:

- ☐ Copy of rabbit shape
- ☐ Copy of turtle shape
- ☐ Copy of square shape

The following are optional items to be used for the more advanced girls:

- ☐ Copy of rabbit outline
- ☐ Copy of turtle outline
- ☐ Copy of square outline

Safety

No special precautions are necessary.

Clean-Up

Put tangrams back in bags and store away.

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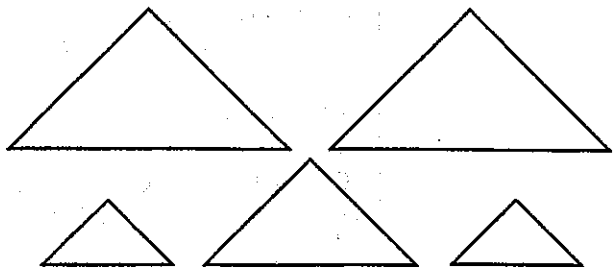
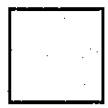
How to Do It

1. Look at the seven-tangram pieces. There are five triangles -- 2 large, 1 medium triangle, and 2 small triangles.



There is one square.



There is one parallelogram.

Both the square and parallelogram have four sides and can also be called quadrilaterals.

2. Try solving the tangram puzzles yourself. Start with the rabbit shape, which is the easiest. Once you have mastered that, continue with the turtle and finish with the square (the most challenging to solve).

Before the Meeting

1. If you have a large troop, make sure you have extra people to assist the girls, such as assistant leaders, parent helpers or older Girl Scout aides.

2. Make sure you have enough copies of the shape designs (turtle, rabbit, and square) for each girl, but, depending on the level of skill of your girls, you may not need copies of the outlines for everyone. It is important not to move to too high a level too quickly. That might frustrate, rather than challenge your girls.

3. You can also make your tangram puzzles for the girls to take home by copying the puzzle on to card stock. Cut out the puzzle and put the pieces into a plastic sandwich bag for each girl.

The tangram pieces need to be cut out accurately to work. Younger girls might have difficulty doing this, so you may wish to cut the pieces yourself.

Doing the Activity with the Girls

1. Hand out the bags of tangram pieces, one bag to each girl.
2. Let the girls explore their pieces.

Ask the girls: **Do you have any triangles?** Yes. **How many?** 5 **What sizes?** 2 large, 1 medium, 2 small. **What other shapes do you have?** Squares. **What about the pieces that are left? What shapes are they? Are they like any other shapes you know?** Yes, squares. **Why?** Each has 4 sides, but the corners are different and the sides have different lengths. The name of the last piece is a ***parallelogram.***

3. Explain that these are pieces to a Chinese puzzle called a ***tangram*** that can be put together to make many different shapes. Today we will make three of them; a rabbit, a turtle and a square.
4. Give each girl a picture of the *rabbit shape* and have them try to move their pieces to make a rabbit. Most Brownies will need to put their pieces directly on the picture itself to make the pattern.

Watch carefully at this point to see which girls are having trouble, and which girls find this too easy. Depending on the number of girls you are working with, you might pair-up someone who finds this easy with someone who is struggling, just through the completion of the rabbit shape.

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If some girls are having trouble, encourage them to keep trying. You may need to show them how to turn over a piece so it fits, but don't solve the puzzle for them. Encourage them to work with a partner or ask questions.

You can create two levels of difficulty for your girls depending on the clues you give them in this activity.

Easy Level: Recommended for young Brownies

To make the puzzles as easy as possible for the girls, use the picture of the shape (rabbit, turtle or square) which shows how the tangram pieces are arranged to make the shape. Placing the tangram pieces directly on the shape sheet, on top of the matching shape, is the simplest way to solve the puzzle. This is also a great way to help someone who started on the challenging level, but was having difficulties. Letting them see one solution may help them with the second puzzle.

Young girls will be challenged just by turning over and rotating the tangram pieces until they match the picture. Next, have them try building the puzzle by looking at the shape, but not building on the sheet.

Challenging Level: Recommended for older girls

This is a good level for young girls who are already good at doing puzzles. Have them look at the shape sheet for a few seconds as a clue, and then put the sheets away (or turn them upside down) and use the outline sheets as a guide to arrange the seven tangram pieces. All seven pieces will fit together inside the outline of the shape.

As an added challenge, have them use the outline sheet as their only clue to solving the puzzle. All seven puzzle pieces will fit into the outline.

5. Repeat the process with the turtle shape and the square shape and have the girls make both patterns with their tangrams. If you have girls who are picking it up very easily, you might consider moving them to the challenging level.

Tell the girls that a special thing about tangrams is that all seven pieces can be put together to make a square.

More to Explore

Challenge the girls to create other shapes with the tangrams, and share their new shapes with the rest of the group.

An excellent car game is *Tangoes*, available in many toy and educational stores, which contains a tangram set and over 50 cards with shapes to create. There are many similar 'shape-building' games also on the market, such as *Brick-by-Brick*, which follows the same basic principle.

Two books which can provide a further exploration of tangrams are *Grandfather Tang's Story*, by Ann Tompert, and *Tangram: The Ancient Chinese Shapes Game*, by Joost Elffers.

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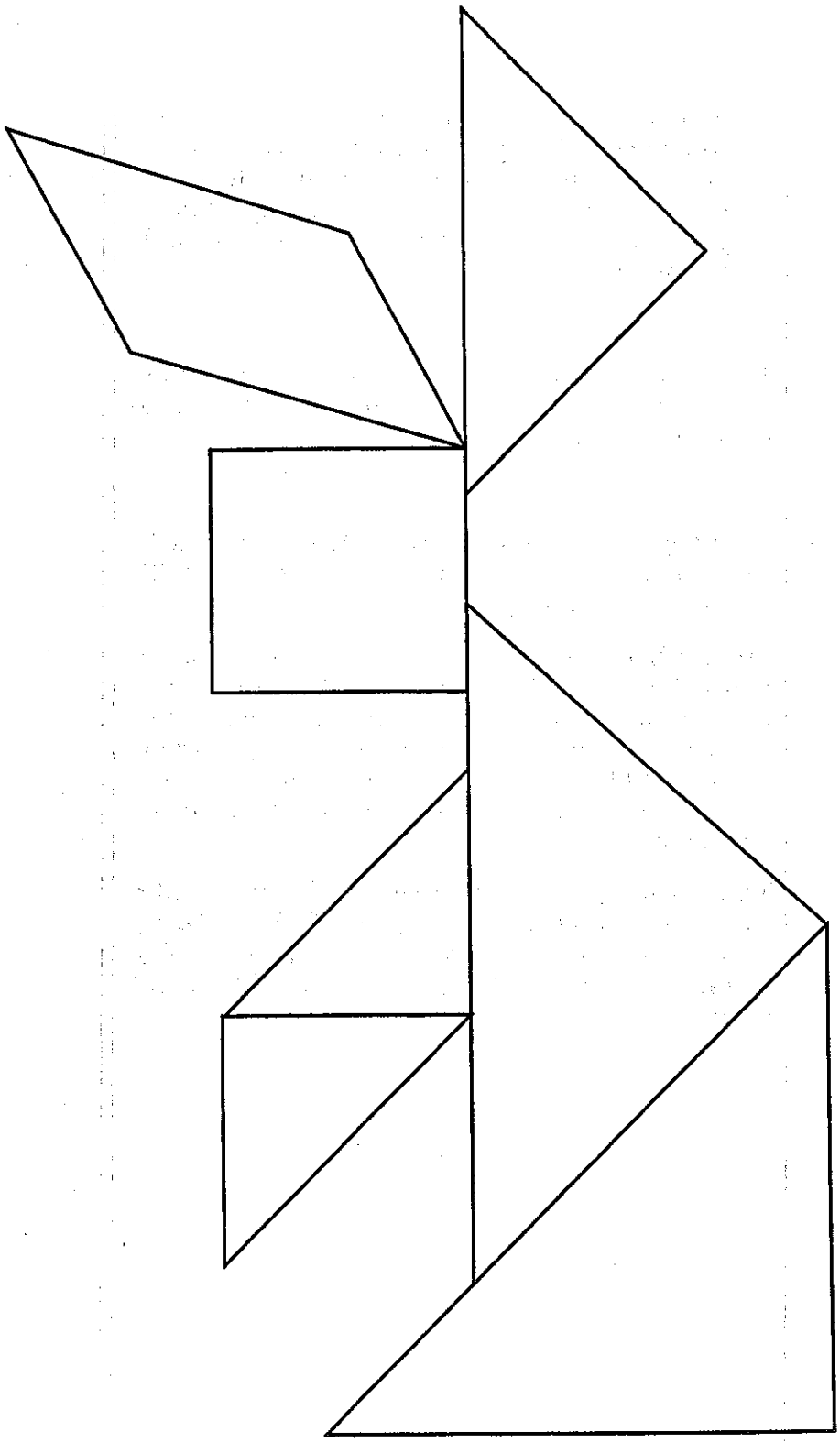
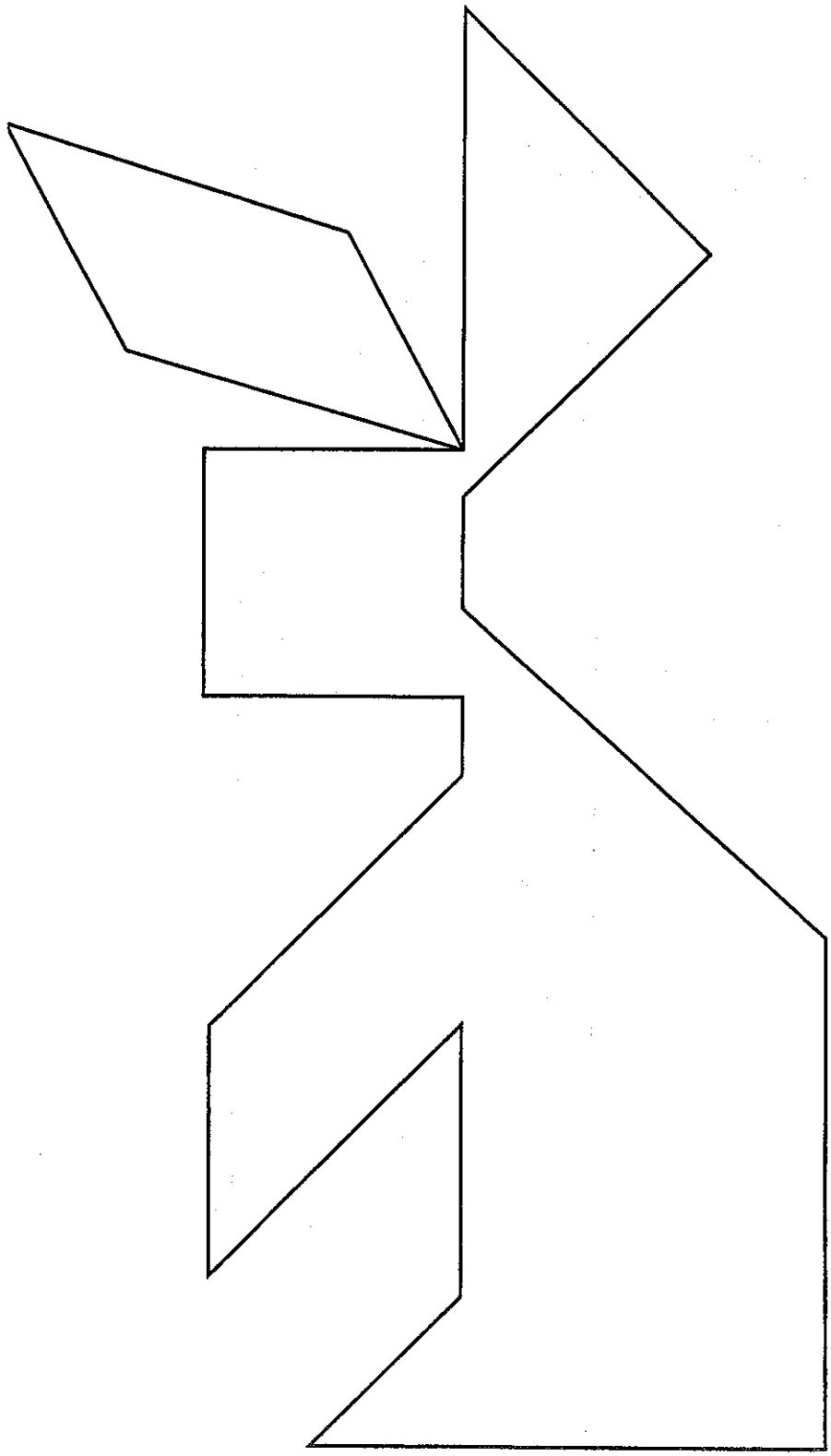
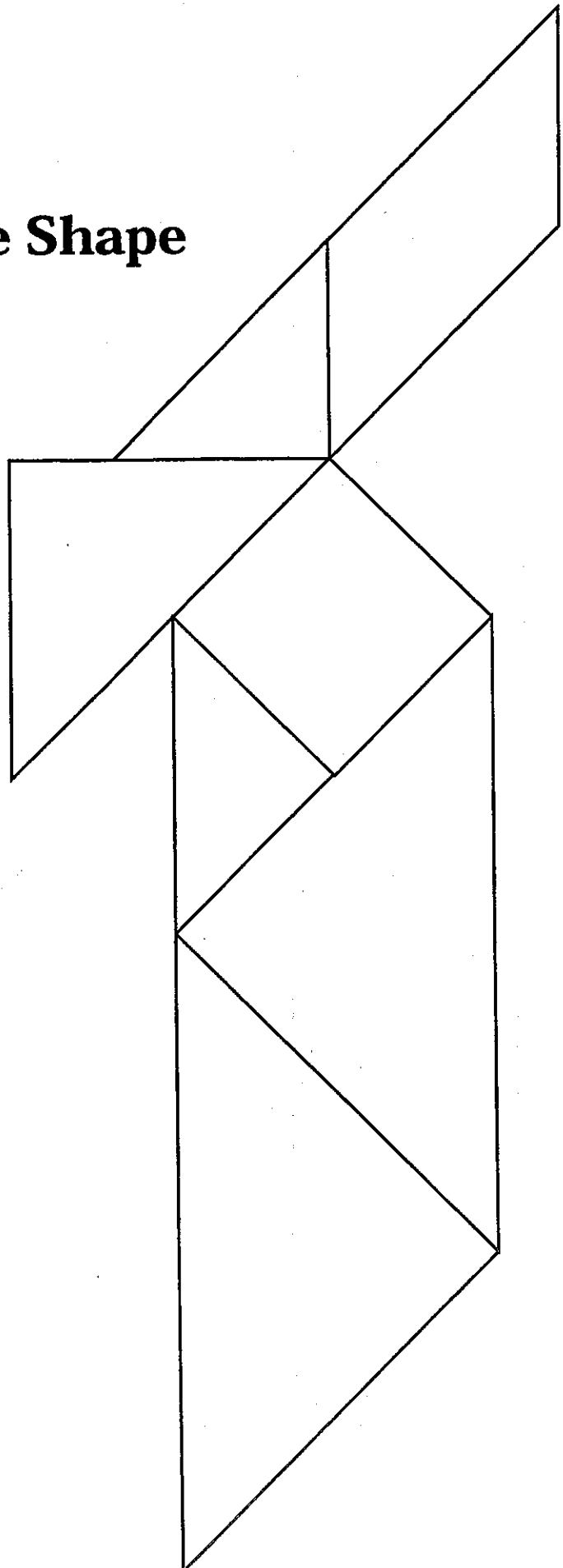


Rabbit Shape

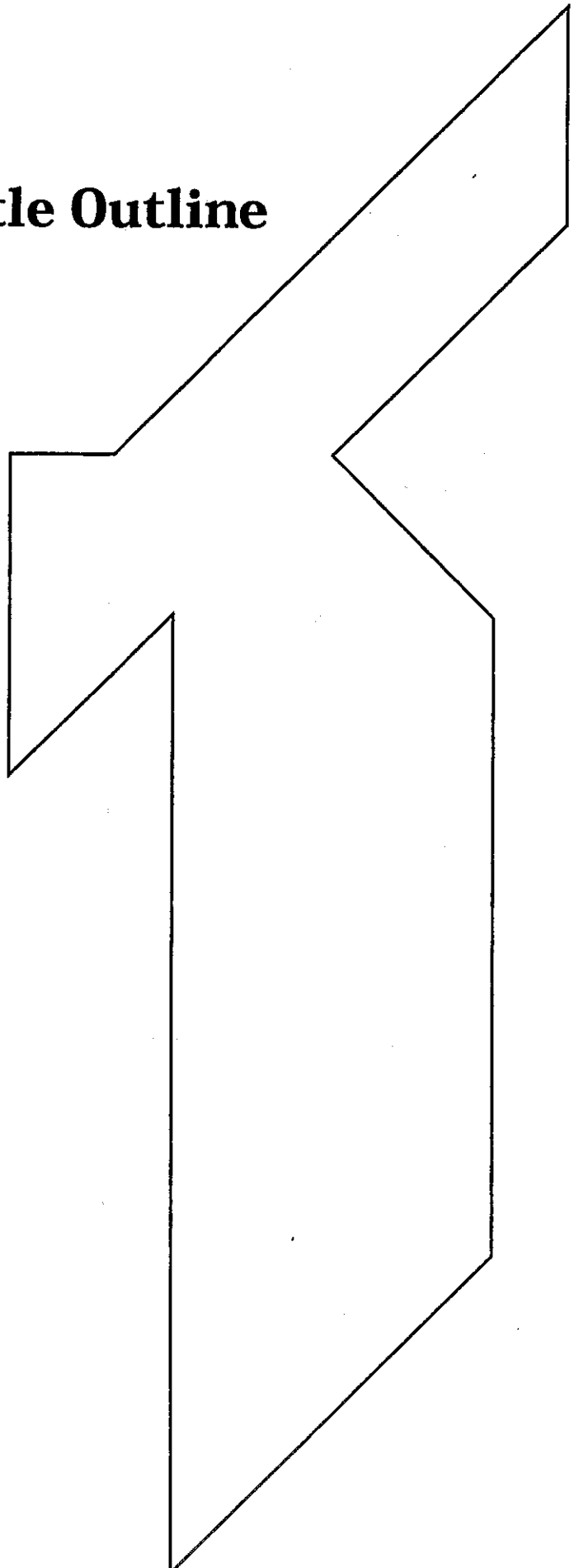


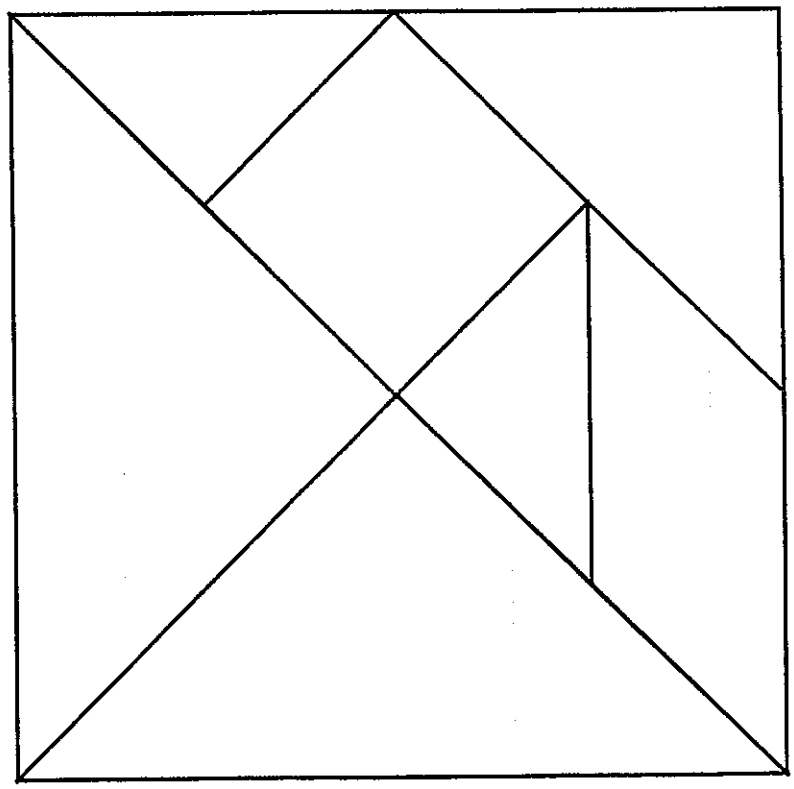
Rabbit Outline

Turtle Shape

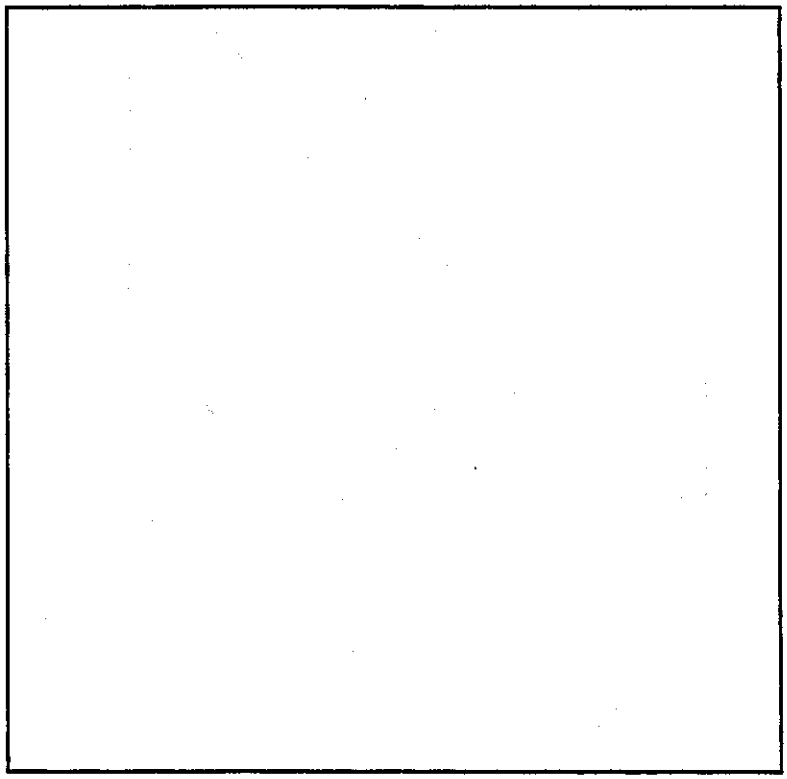


Turtle Outline



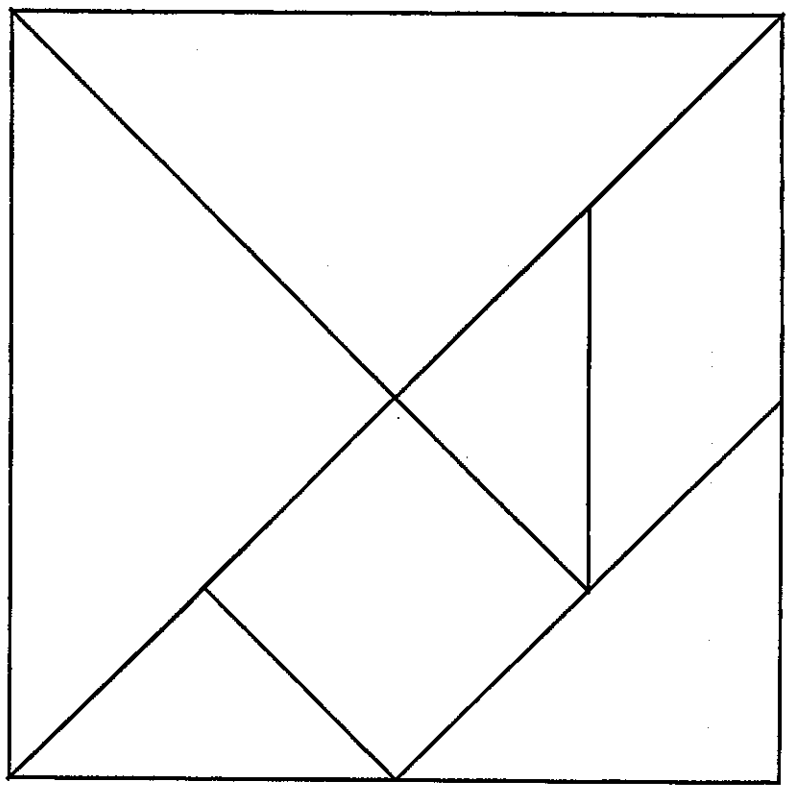


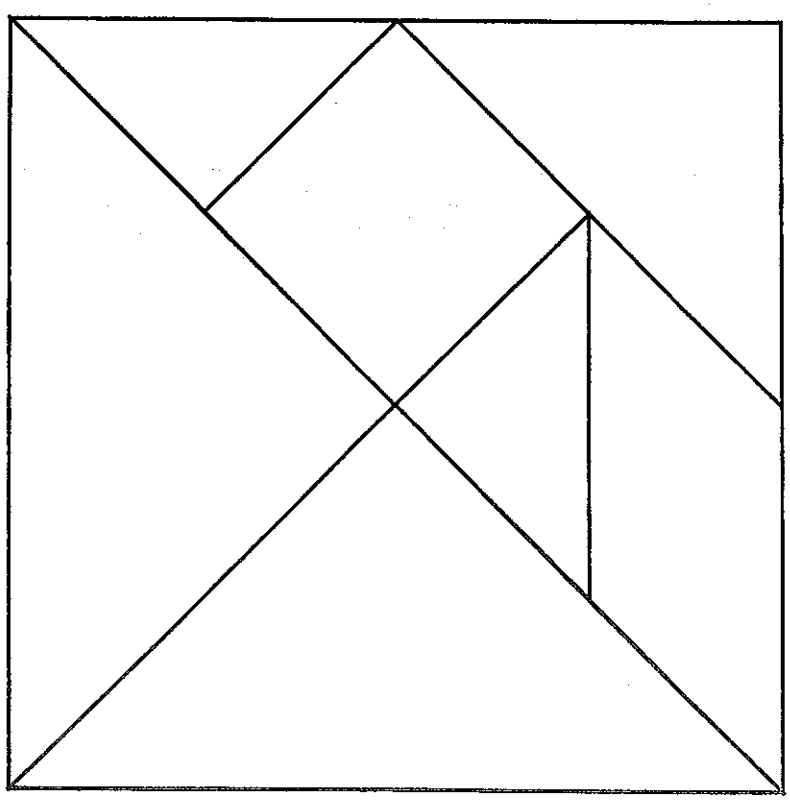
Square Shape



Square Outline

Tangram Master





Origami

Corresponding Activity

Numbers and Shapes Try-It,
p. 231-232, Brownie Girl Scout Handbook.

Overview

The girls will learn how to fold two different origami figures, a cat and a cup.

Big Idea

This activity will help girls develop their spatial visualization skills while reviewing shapes such as squares and triangles, and the way they fit together to make other shapes.

Estimated Activity Time

30 – 45 minutes

Materials Needed

Your VSC provides:

- ☐ Large (8-1/2"x11") copies of the pictures for each step of the origami project

Items you provide:

For each girl:

- ☐ Origami paper (one sheet for each figure) or regular wrapping paper cut in a square shape, 6"x6" or larger
- ☐ Pen or marker (to draw with if desired)

Genuine origami paper is easiest to use and is very pretty. It can be purchased at toy, craft, or school supply stores. If you can't use origami paper use wrapping paper or plain paper cut into a square. Plain paper can be decorated on one side with colored pencils or crayons that won't bleed through so it will be easy to tell one side from another.

Safety

No special precautions are necessary.

Clean-Up

Dispose of paper in the trash.

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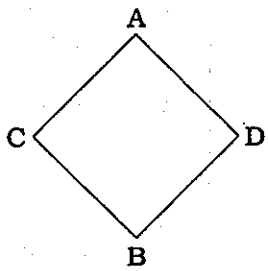
How To Do It

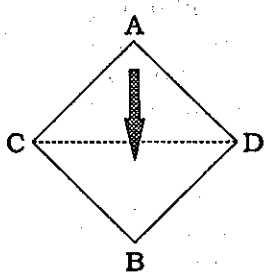
The following instructions are written for using paper that is colored on only one side.

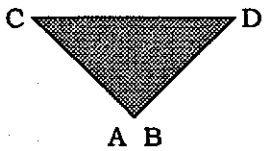
Activity #1 -Origami Cat

1. Put one piece of the paper on a flat surface (colored side down) with corners at the top, bottom and sides so it looks like a diamond.

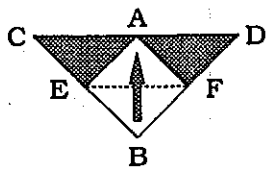


2. Fold the paper in half to make a triangle, by taking the top corner A, and bringing it even with the bottom corner B. The colored side of the paper should be showing now.





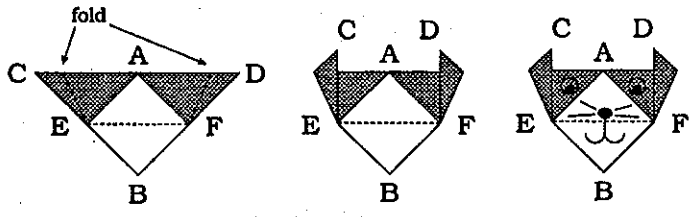
3. Fold corner A up to meet the middle of the top side of the triangle. A white diamond shape should be seen on the side facing you. Locate two new reference points on the side corners of the white diamond, points E and F.



4. Now make the cat's ears. Fold corner C up at point E, so that the edge makes a straight line up from point E.

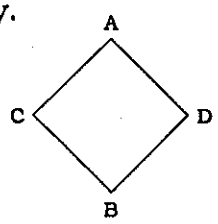
Next fold corner D up at point F, so that the edge makes a straight line up from point F.

Draw eyes, nose, whiskers, and a mouth to complete your cat.

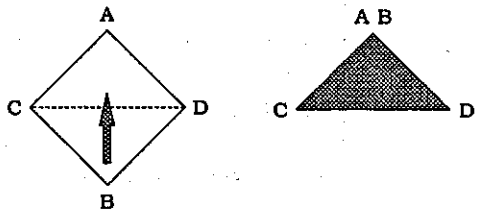


Activity #2 - Origami Cup

1. Put the paper down on a flat surface (colored side down) with corners at the top, bottom, and sides so that it looks like a diamond, as in the previous activity.



2. Fold the paper in half to make a triangle, by taking the bottom corner B, and bringing it even with top corner A. The colored side of the paper should be showing now.



3. Grab corner C, and pull it across to the opposite side of the large triangle. Move it along until corner C is on the edge, midway between points B and D. Crease the paper to complete the fold. Locate a new reference point called E at the top of this crease.

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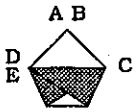
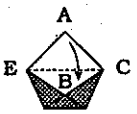
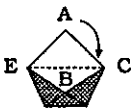
4. Grab corner D, and pull it across to point E on the opposite side. Crease the paper to complete the fold.



5. Fold corner B down (only corner B – the front piece), and crease along the line from E to C. The white paper should now make a diamond shape.



6. Pick up the paper, and fold corner A back along the line from E to C, and crease it.



7. Push, your now completed cup, open at the top.

Before the Meeting

It is important that you learn how to fold origami figures yourself before the meeting. After you have done it once, it should be easy to do it again when you demonstrate for the girls.

Buy origami paper or cut wrapping paper into squares. Real origami paper will be easier to work with for you and the girls. Regular plain white or other paper can also be used, just make sure to cut enough paper into squares before the meeting. If you are using plain paper, mark one side lightly with colored pencils or crayons that won't bleed through.

If you have a large troop, have assistant leaders or other adult helpers present to check how the girls are doing and offer guidance.

Doing the Activity with the Girls

1. Have the girls sit at a table, or on the floor, where they can see and hear you. Each girl will need to be able to watch what you are doing and follow along, step by step.

Use the large size pictures, included both at the end of this guide and in your activity tub, to show the girls how the paper should be folded.

The girls, especially younger Brownies, may have some trouble remembering left from right. Be aware of this when telling the girls how to fold the origami figures. You may also have a few older Brownies who may be experienced at origami. Let them be your helpers, or, let them share their talent with the rest of the troop.

2. Encourage the girls to work with a partner, and help one another with each step. Working together to solve a problem, and the feeling of accomplishment at having done it themselves, are important goals to achieve for this activity. The quality of the final product is less important than the means used to get there.

Make sure everyone in the group has completed each step before you show the girls how to do the following step. This keeps the group all working at the same pace. The girls who catch on faster can help those who are having trouble with a particular step.

3. Proceed with the steps in the order and fashion as listed in the 'How To Do It' section of this activity.

4. As you fold the figures, ask the girls if they can see any triangles or squares (or other shapes) in their origami figures. You can also use the terms *square* and *triangle* when you tell the girls how to fold the figures. For example, both the cat and the cup start with a square, and you fold the paper to make a triangle.

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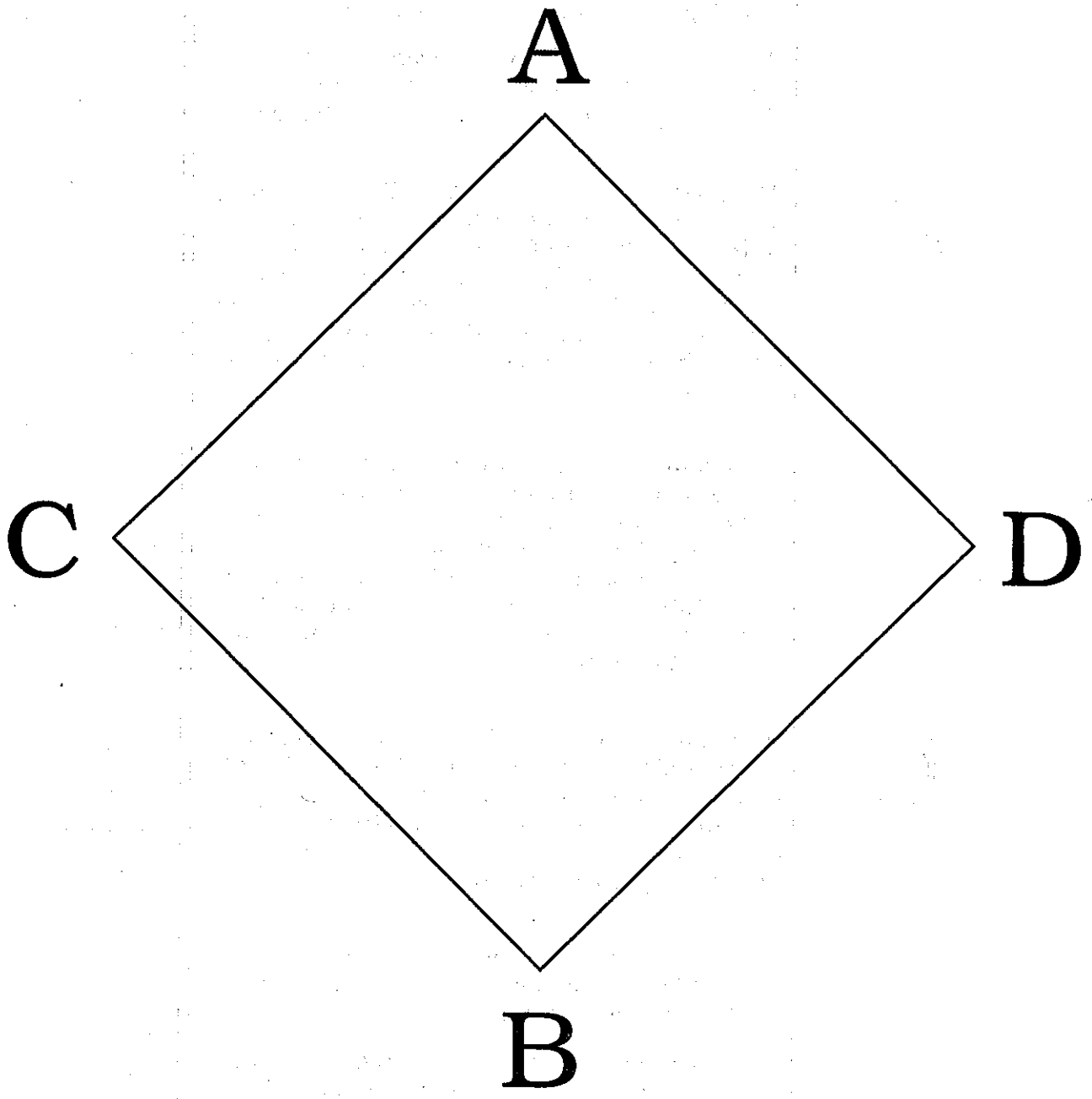
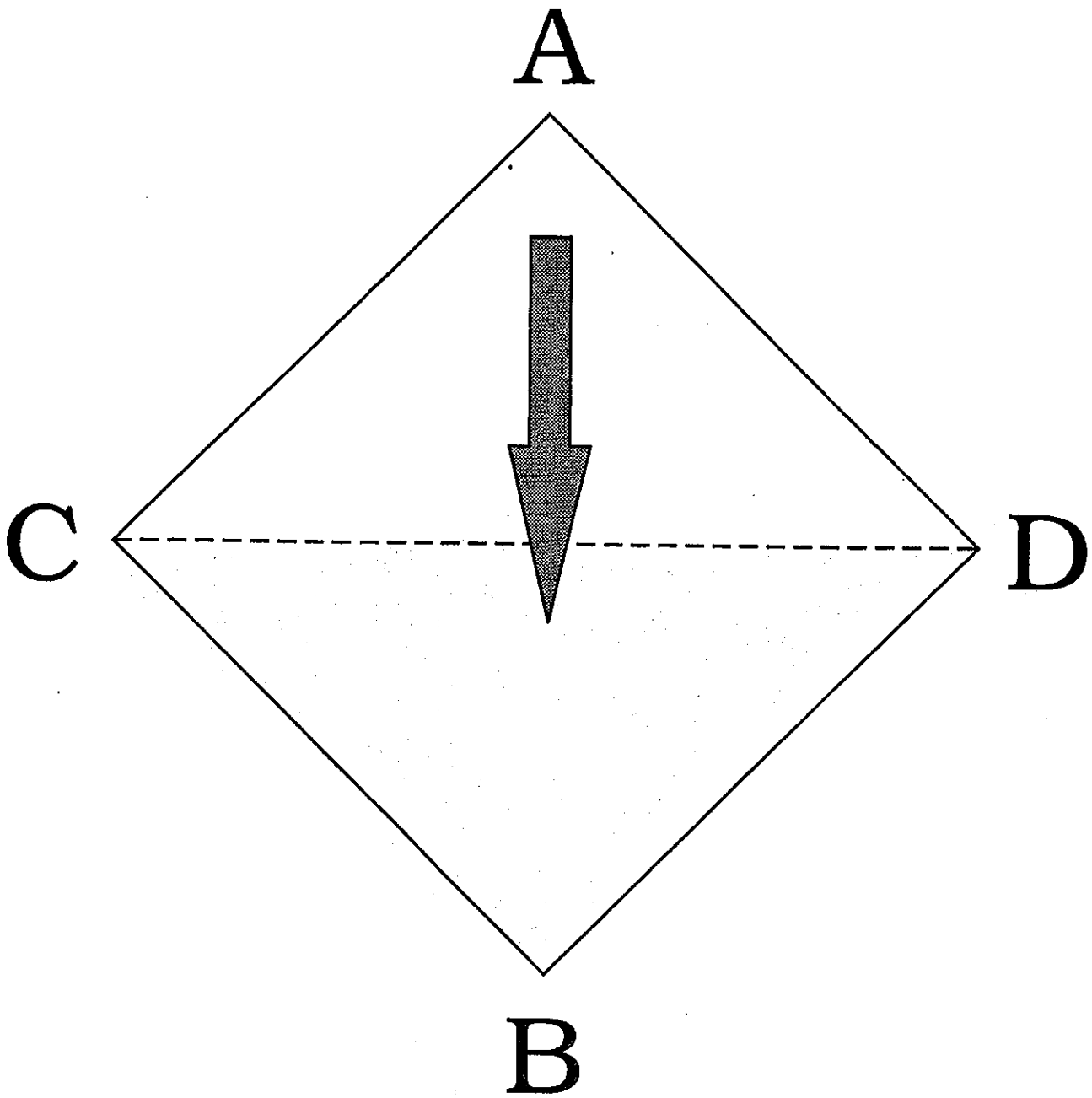
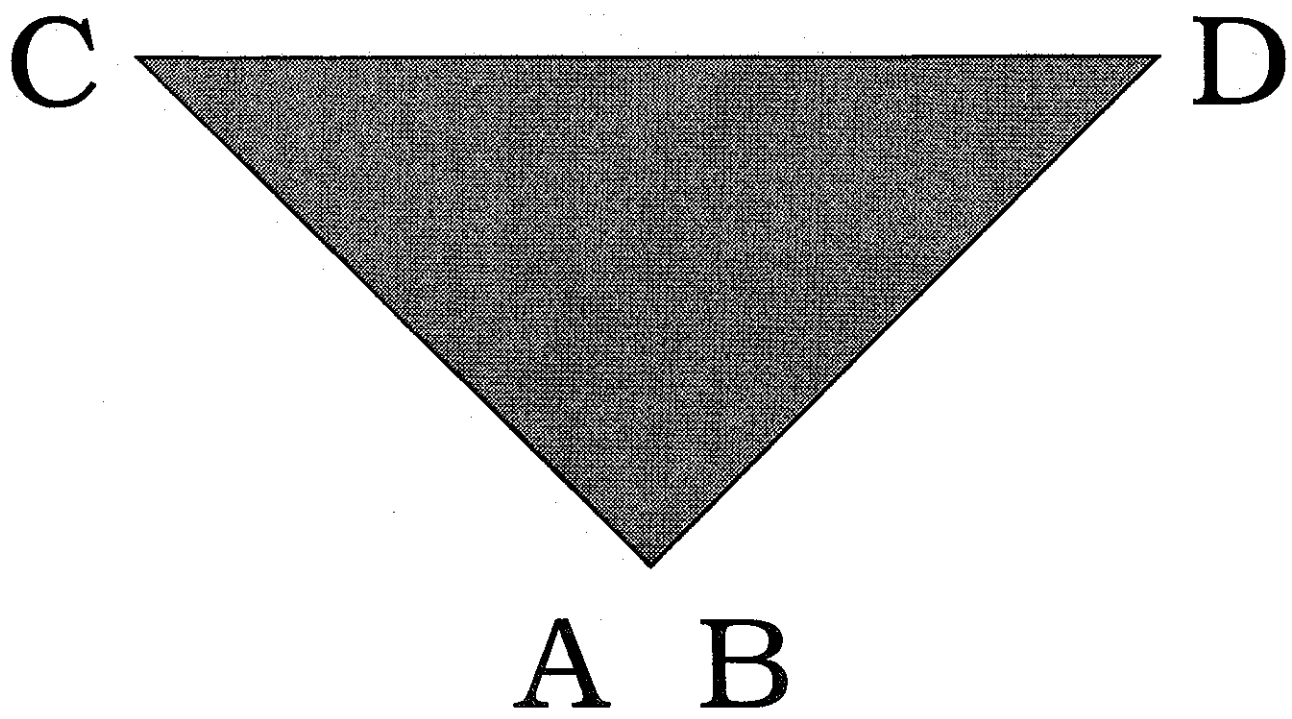
Origami Cat - Picture 1 of 7



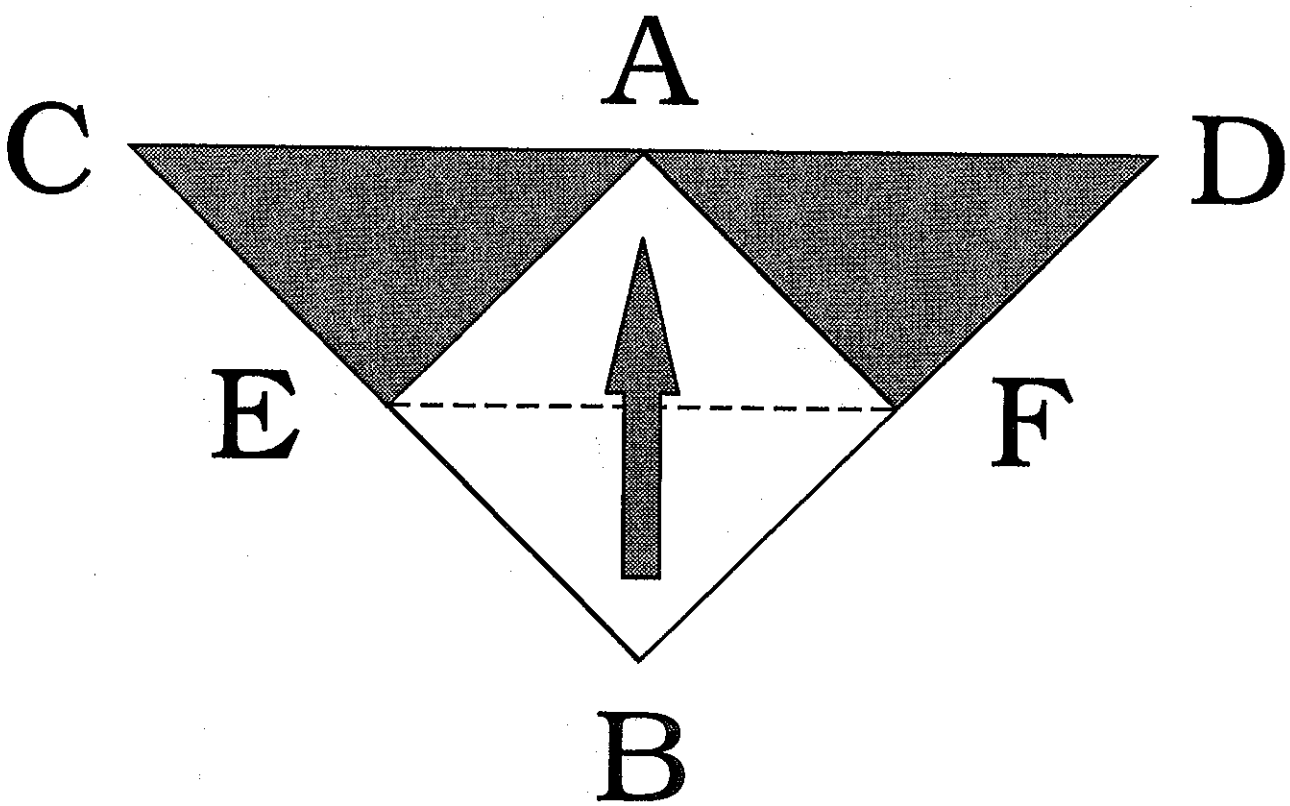
Origami Cat - Picture 2 of 7



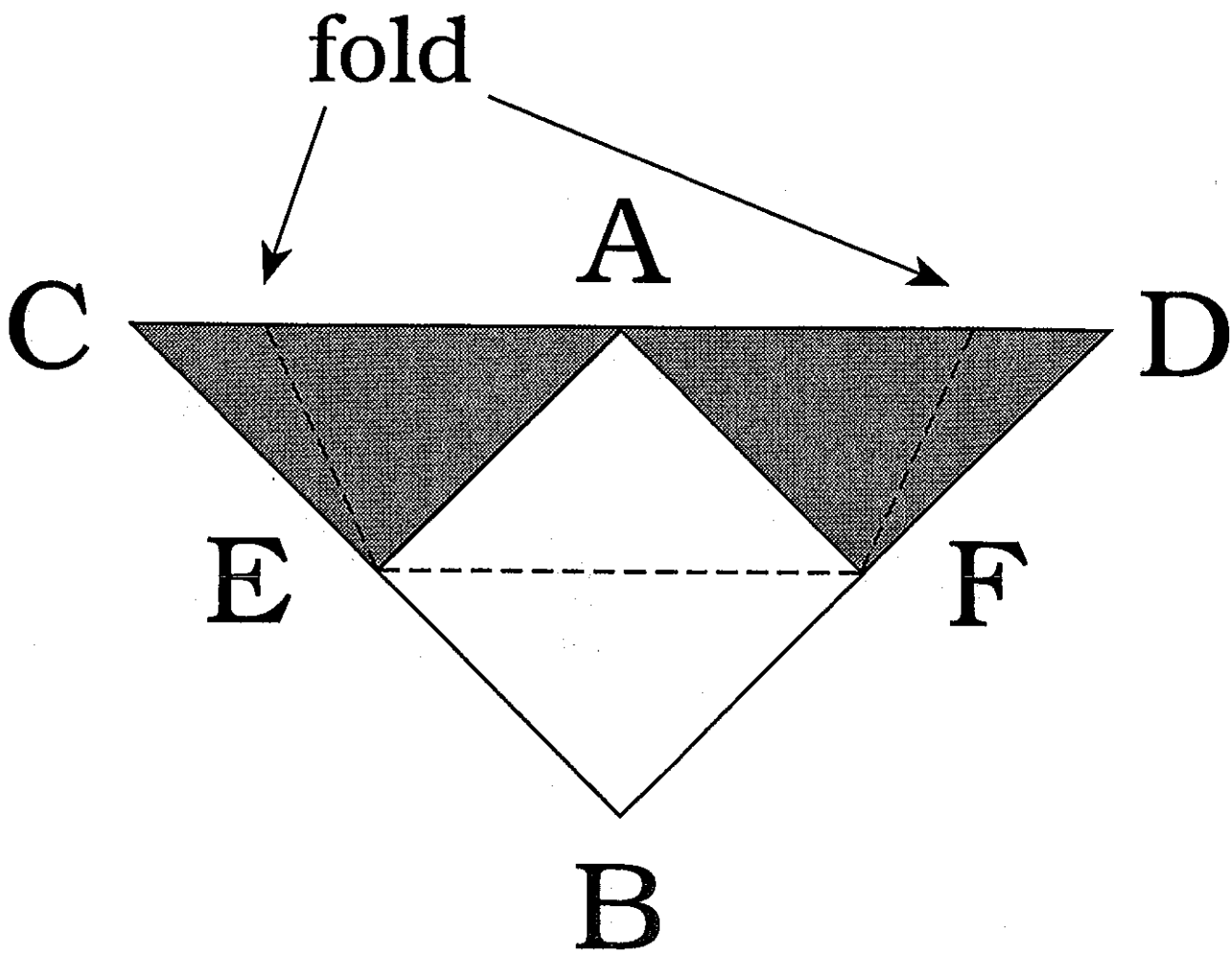
Origami Cat - Picture 3 of 7



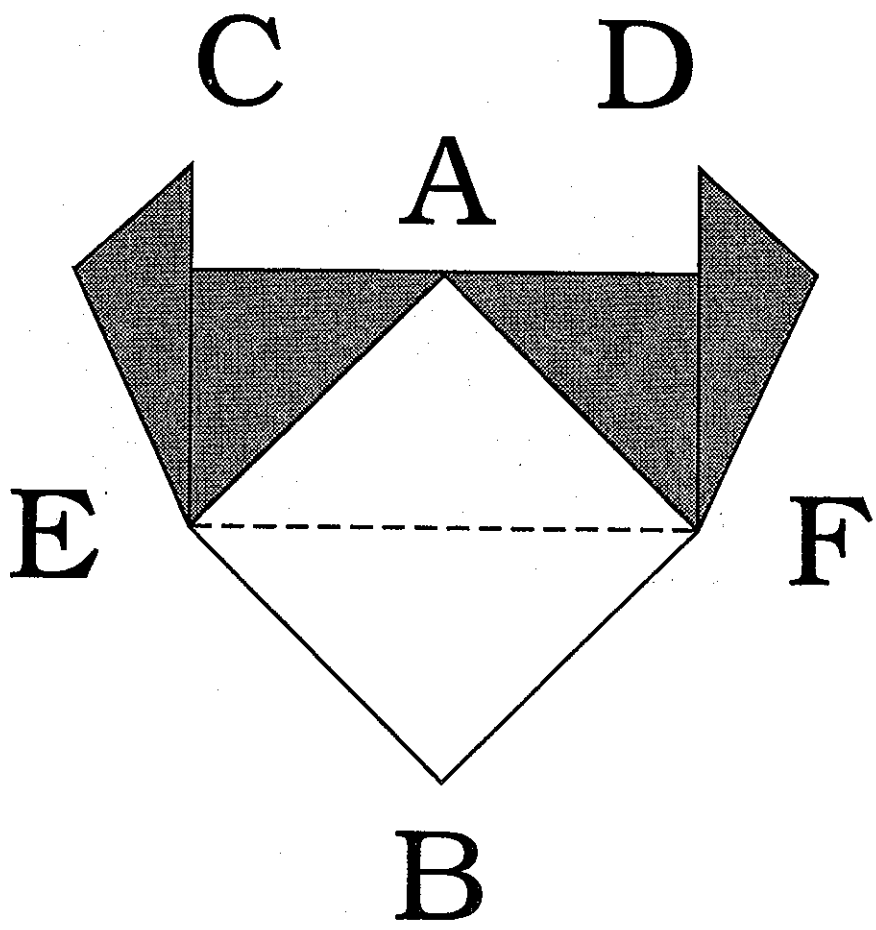
Origami Cat - Picture 4 of 7



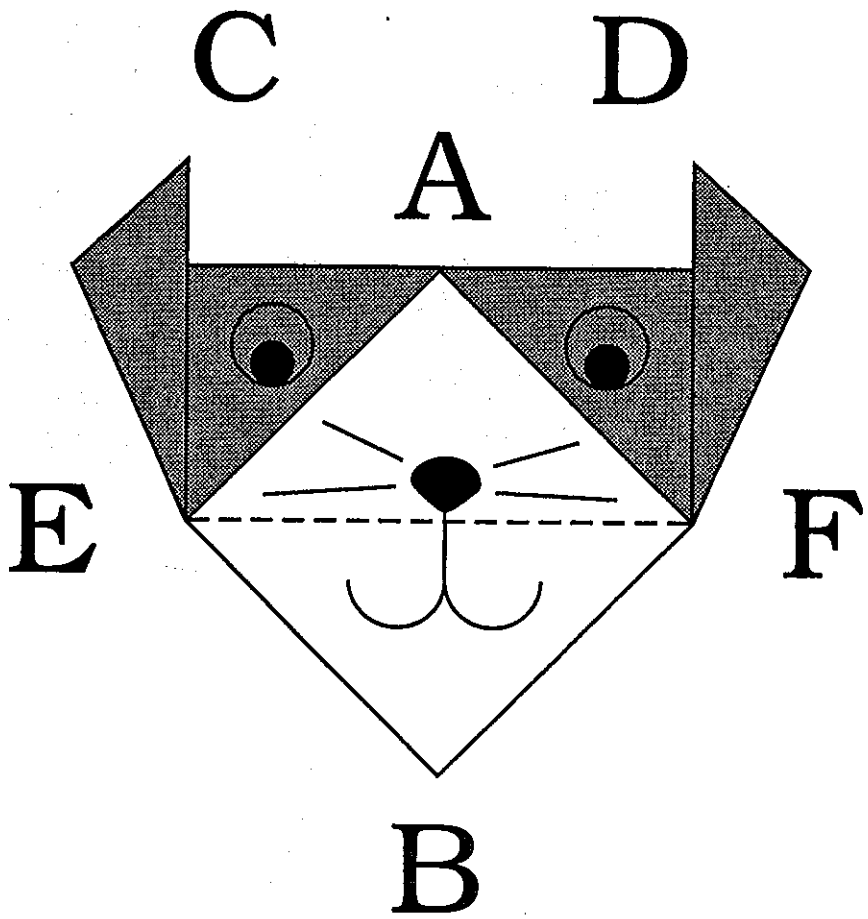
Origami Cat - Picture 5 of 7



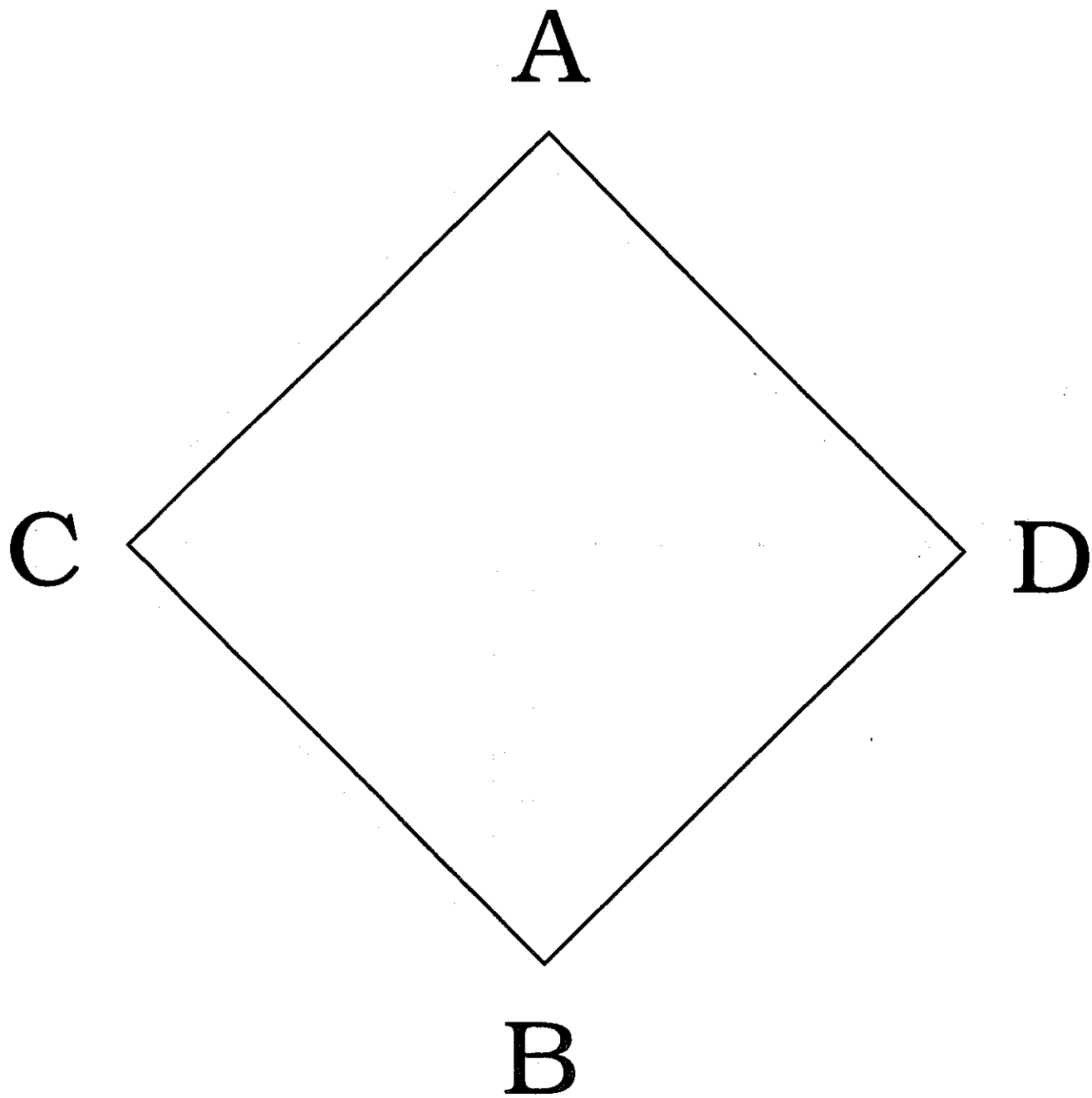
Origami Cat - Picture 6 of 7



Origami Cat - Picture 7 of 7



Origami Cup - Picture 1 of 10



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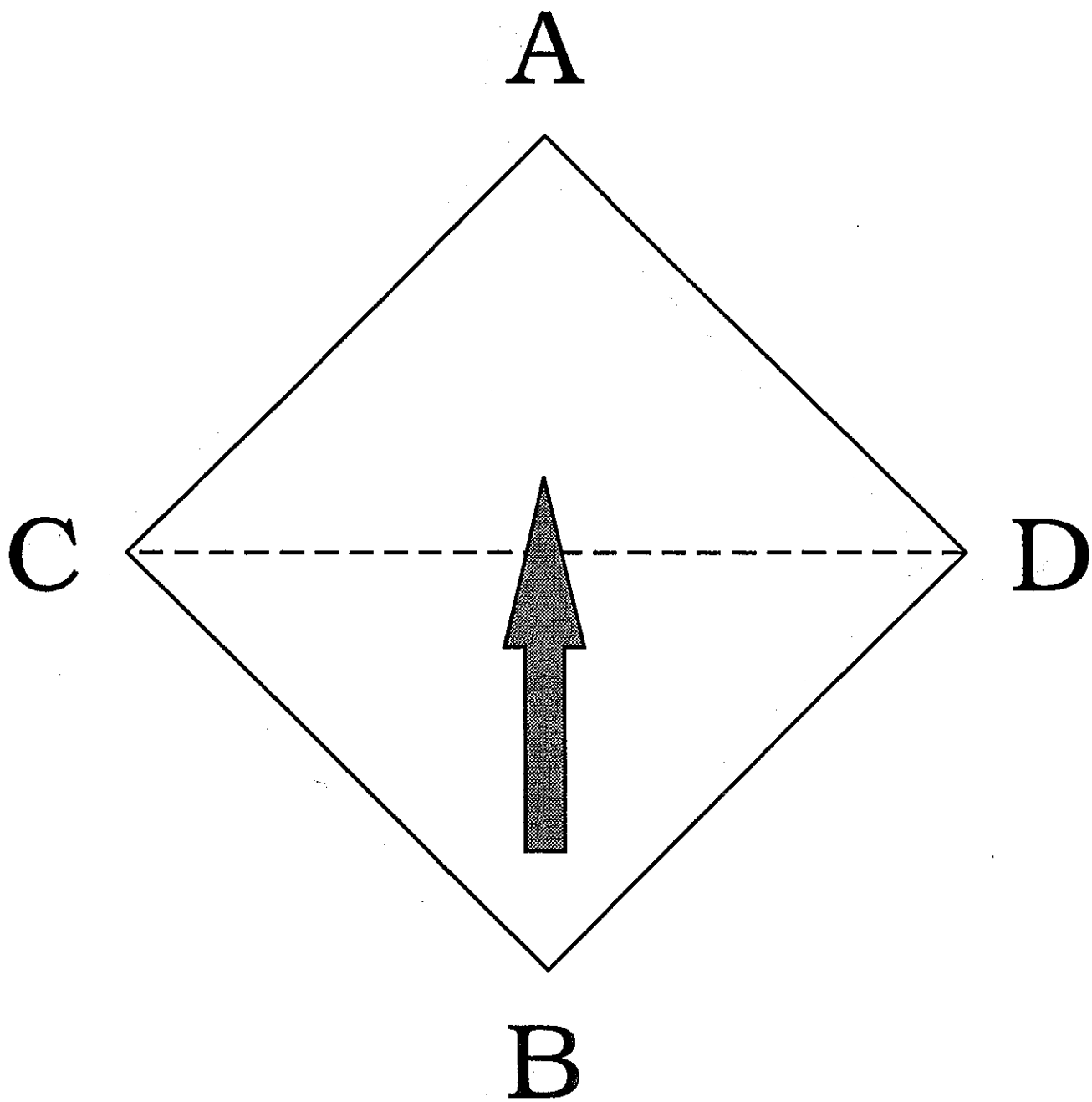

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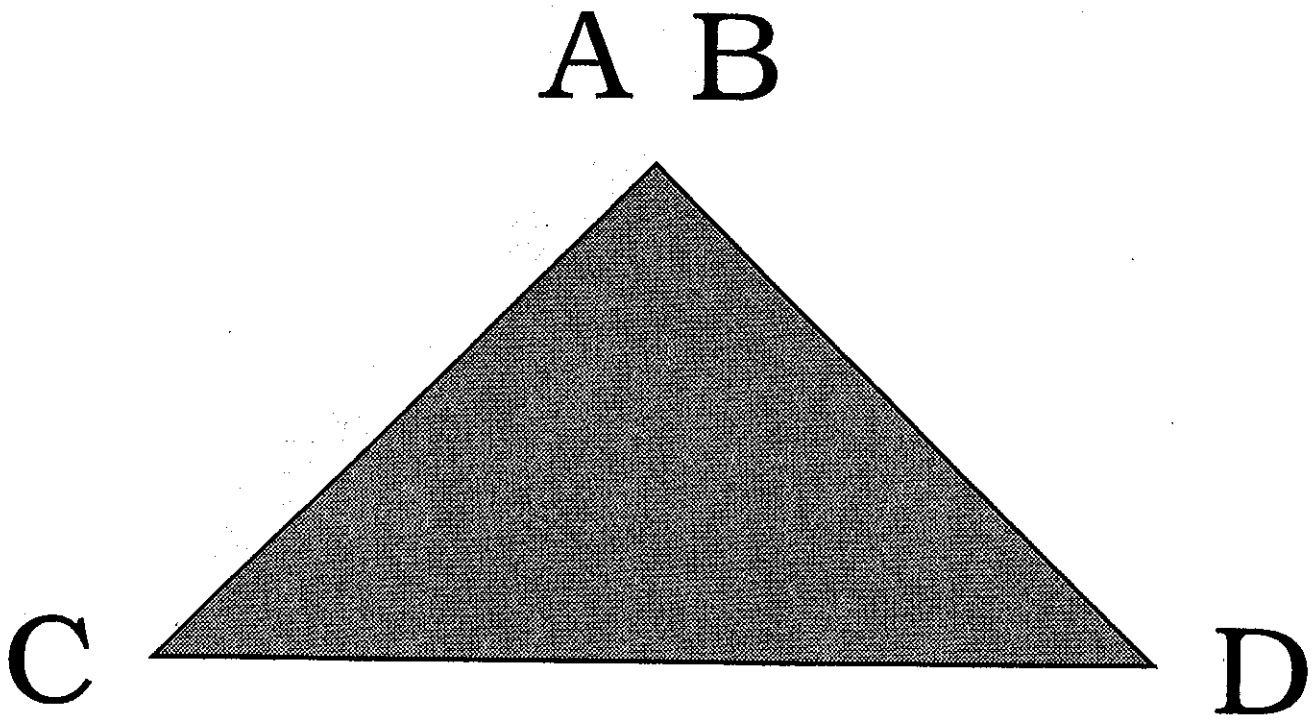

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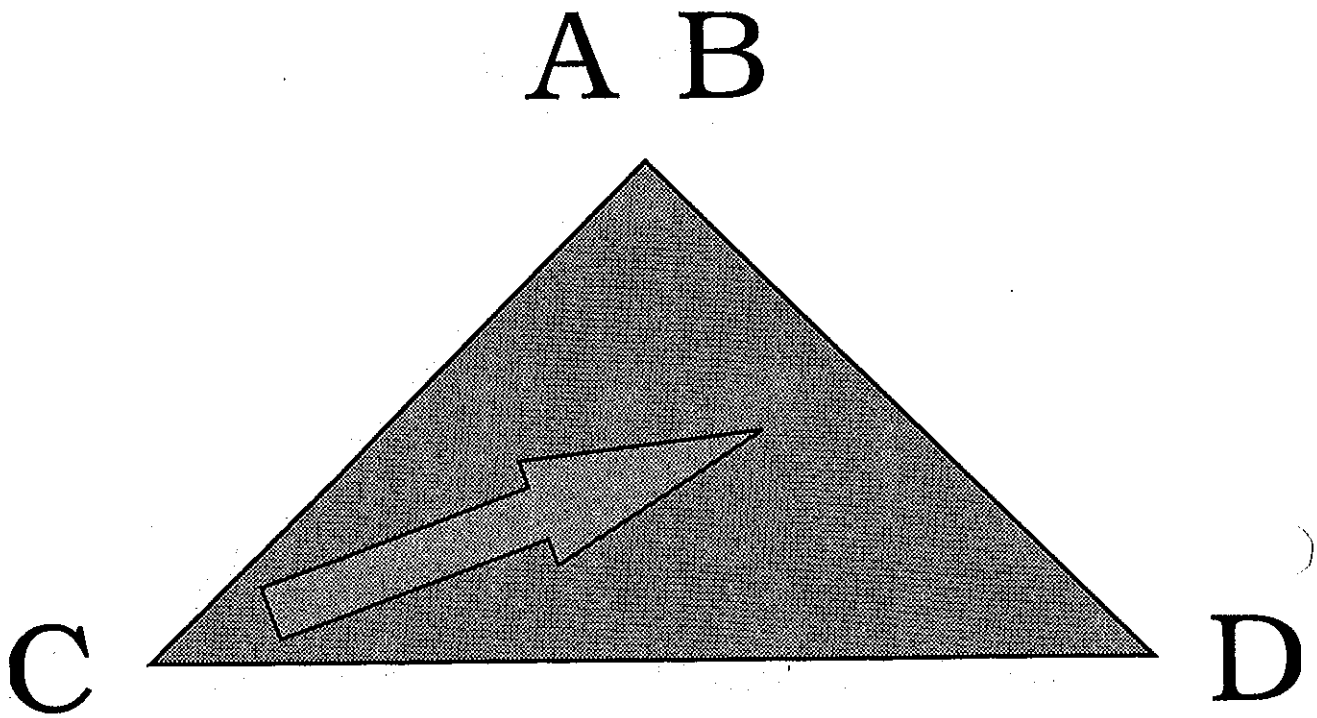

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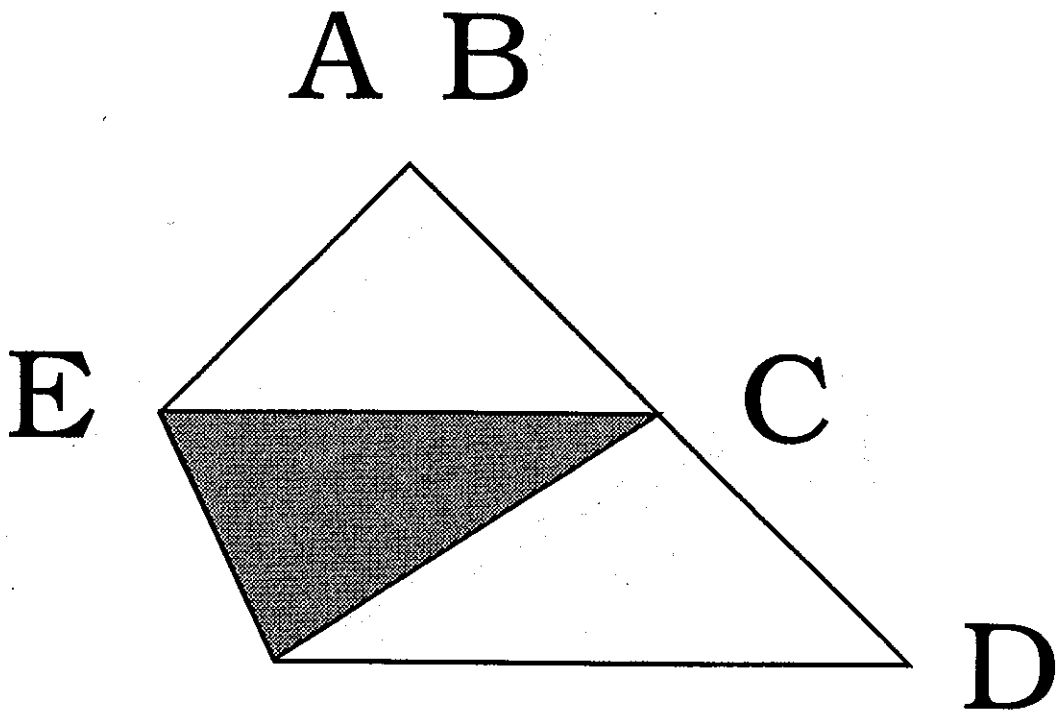

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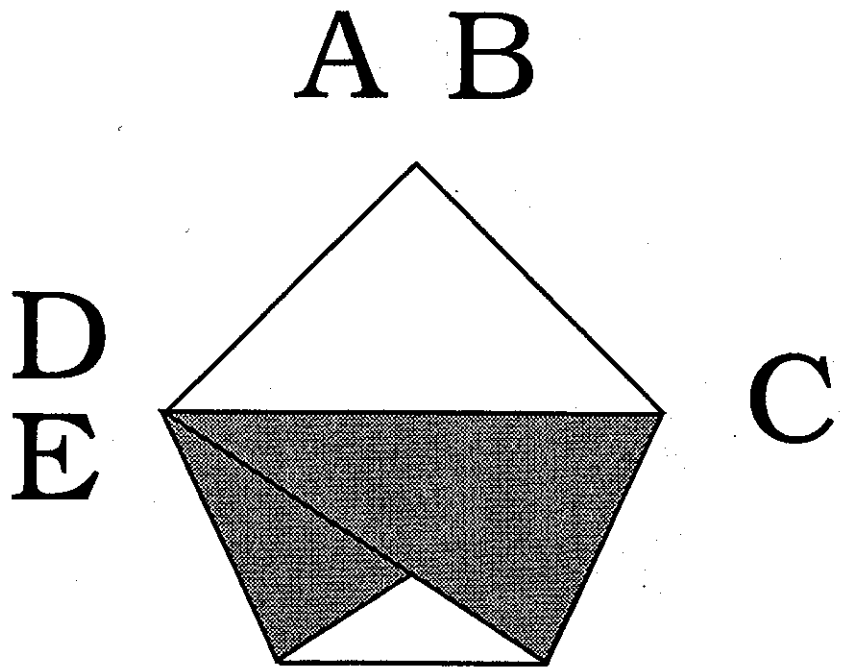

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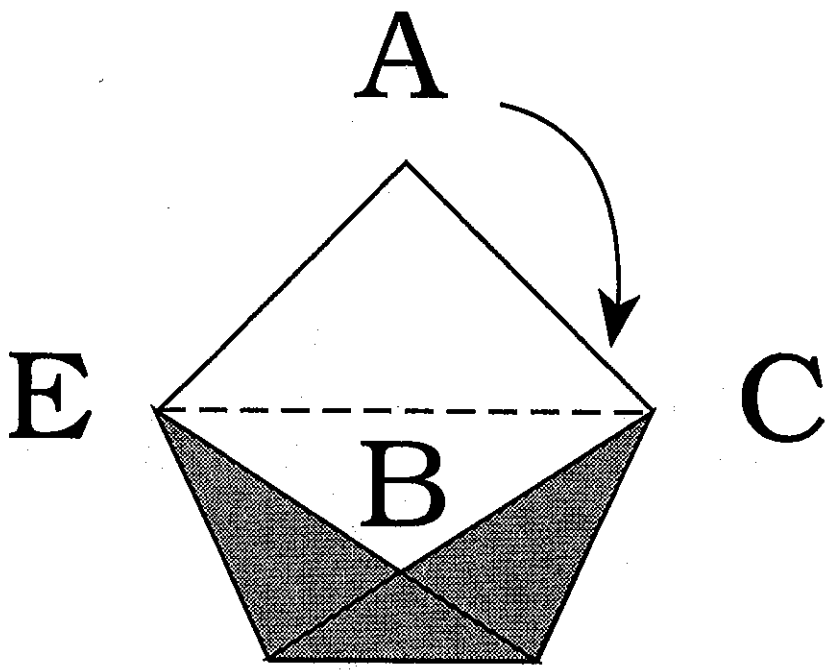

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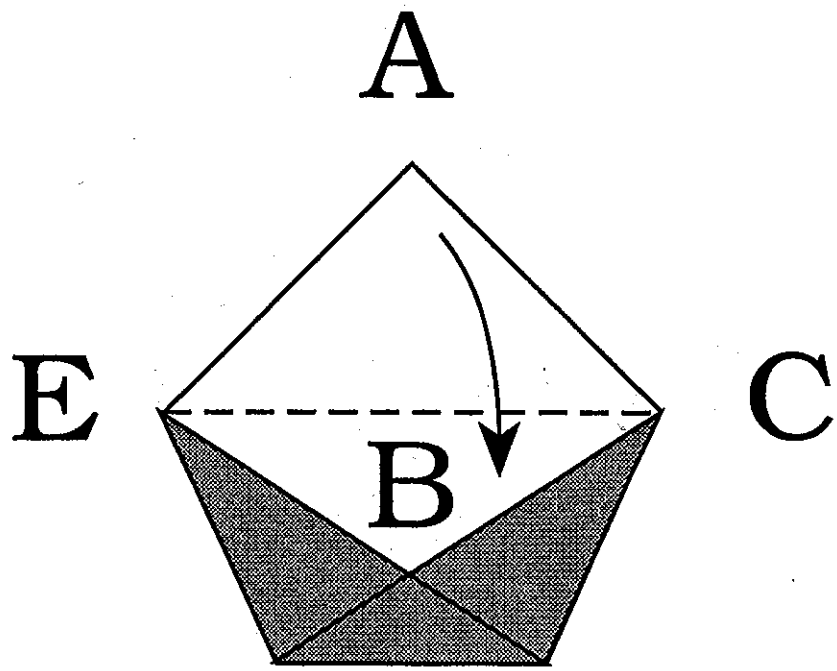

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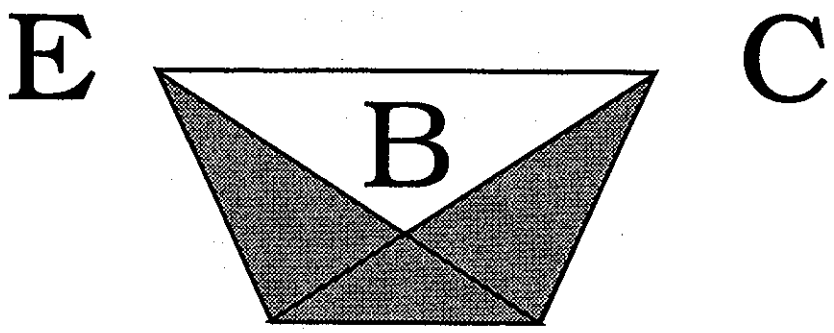

Origami Cup - Picture 10 of 10

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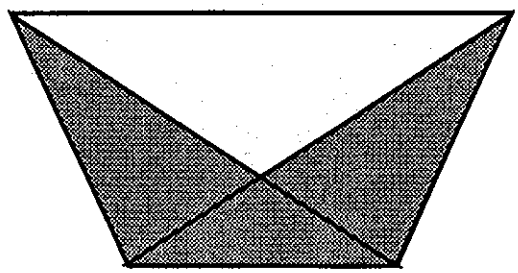

Mobius Strips

Corresponding Activity

Numbers and Shapes Try-It,
p. 232, Brownie Girl Scout Handbook.

Overview

The girls will be making loops and Mobius (mo-bee-us) strips with paper strips. A Mobius strip is a loop with a half twist. It has the unusual property of having only one side and one edge.

In this activity, the girls will learn about three kinds of loops:

- a regular loop with no twists which has two sides and two edges
- a Mobius strip which is a loop with a half twist having one side and one edge
- a loop with a full twist which has two sides and two edges

Big Idea

Making Mobius strips incorporates a different kind of math called ***topology***, and helps the girls understand that there are math activities that have nothing to do with adding and subtracting, and many that can be fun.

Estimated Activity Time

30 – 45 minutes

Materials Needed

Your VSC provides:

- ☐Rolls of cash register or adding machine tape
- ☐Completed models of a plain loop, full twist, and a mobius strip

Items you provide:

For each girl:

- ☐Scissors
- ☐Clear tape/dispenser (at least one for every 2 girls)
- ☐Crayons, or colored pencils

Optional supplies for leader use:

- ☐Yardstick or rulers
- ☐Rolls of wrapping paper

Safety

Use normal cautions when using scissors.

Clean-Up

Dispose of paper in trash.

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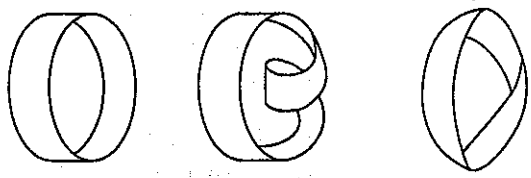
How to Do It

Experimenting with the three types of loops; plain, full-twist, and Mobius strip, before doing the activity with the girls, will help you develop an understanding of Mobius strips.



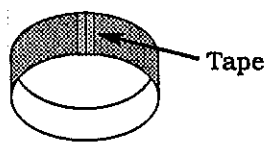
Plain Loop Full Twist Mobius Strip

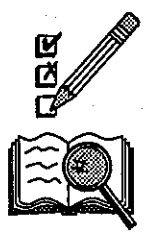
Activity #1 - Experiment with a Plain Loop

1. Cut a strip of adding machine tape, 24 to 36 inches long, and color one side of it...OR...Cut a strip of wrapping paper, 2 inches wide by 24 to 36 inches long.

2. Tear off 2 pieces of tape, at least 2" in length (the width of the paper), and put them to the side.

3. Pick up both ends of the strip of paper, and overlap them with no twists, so that you are matching the colored sides. Tape the sides together to make a loop.

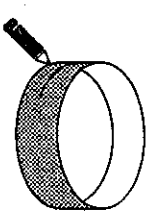




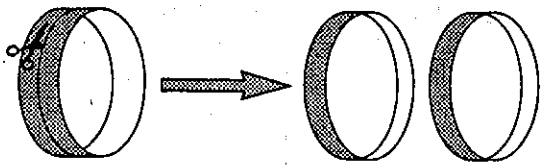
Check to see if it looks like the model.

A plain loop has 2 sides, an inside and an outside. It also has two edges.

4. Draw a line down the middle of the outside of this plain loop. Only draw on the outside of the loop.



5. Cut your loop in half along the line you just drew. You get 2 separate plain loops.



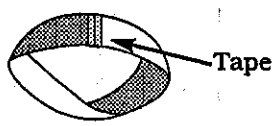
This is a fundamental property of a plain loop: whenever you cut it in half, you get two separate plain loops.

Activity #2 - Experiment with a Mobius Strip (half-twist)

1. Cut a strip of adding machine tape, 24 to 36 inches long. Lightly mark or color one side of it...OR...Cut a strip of wrapping paper, 2 inches wide by 24 to 36 inches long.

2. Tear off 2 pieces of tape, at least 2" in length (the width of the paper), and put them to the side.

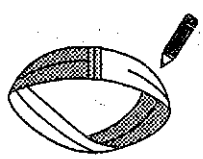
3. Pick up both ends of the paper, and overlap them with a half-twist, so that you have matched the colored side to the white side. Tape the edges securely where the strip over laps. You have now made a Mobius strip, which is a loop with very different properties than what you have seen in the previous loop.



4. Start drawing a line down the middle of the "outside" of this loop just as you did with the plain loop before. Continue drawing until you come back to the point you started. What happened?

Did you draw a line that seemed to cover both the "inside" and the "outside?"

Did you cross over an edge, or did you just draw on the side?



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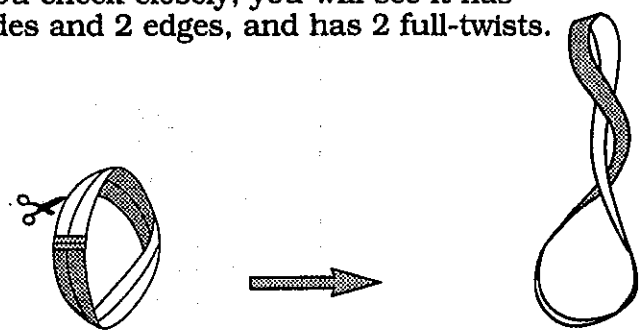
A Mobius strip doesn't have an inside and an outside like the other two loops you made earlier. It only has one side. Because it only has one side, you can draw a line down the middle of the entire surface and come back to the starting point without ever crossing over the edge.

Having just one side is a fundamental property of a Mobius strip. Augustus Ferdinand Mobius first discovered the "strip without a second side" in the 19th century.

A Mobius strip has another fundamental property - it has just one edge. You can prove this to yourself by tracing around the edge of your Mobius strip with a marker or a crayon.

6. Cut your Mobius strip in half, lengthwise, down the middle. What do you think will happen? You will get only one loop of paper. Observe the properties of this new loop. If you check closely, you will see it has 2 sides and 2 edges, and has 2 full-twists.



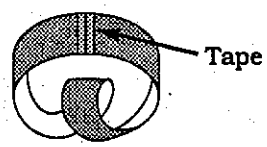
Activity #3 - Experiment with a Loop with a Full-Twist

1. Cut a strip of adding machine tape, 30 to 36 inches long. Lightly color one side of it...OR...cut a strip of wrapping paper, 2 inches wide by 30 to 36 inches long.

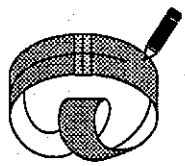
2. Tear off 2 pieces of tape, at least 2" in length (the width of the paper), and put them to the side.

3. Pick up both ends of the strip of paper and overlap them exactly as before, matching colored side to colored side. DON'T TAPE IT YET!

4. Now put a full-twist in your loop. Hold one end steady, and turn the other end over, so the white part is showing. Continue turning the end in the same direction until the col ored side matches the colored side again. Tape both sides together to make a loop. You now have a loop with a full-twist in it.

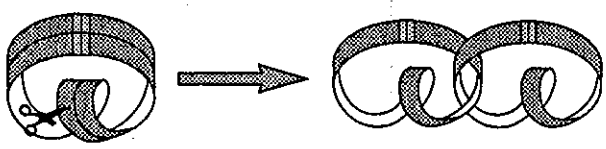


5. How many sides does this strip have? Draw a line down the middle of one side of this loop, and continue drawing until you reach the point where you started. Your strip has 2 sides. It also has 2 edges. You can trace around one edge of the strip with a marker or crayon to prove this.



6. Cut this full-twist loop in half lengthwise, along the centered line you drew. What do you think will happen?
You get 2 joined loops. Each of these loops also has a full twist.

A loop with a full-twist has some properties that are like a plain loop. It has 2 sides and 2 edges, however it behaves differently when it is cut in half lengthwise.



Before the Meeting

The girls, especially young Brownies, may need to practice two essential skills before they do this activity. These skills are 1) cutting with scissors and 2) tearing off pieces of Scotch tape. If the girls have trouble cutting paper or using tape, they will need assistance. Make sure to have enough helpers available when you do this activity with your troop.

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Remember, the idea behind this activity is to show the girls that mathematics can be fun, and that math is more than just doing arithmetic. Keep it light and interesting. Young Brownie Girl Scouts are just going to explore the idea that when they cut different types of paper loops, surprising things can happen. Older Brownie Girl Scouts may be able to trace edges and sides of the loops. Most girls will have fun trying to put different numbers of twists and half-twists into loops and seeing what happens when they or you (as a demonstration) cut them in half. The girls love to wear the cut paper loops as necklaces and bracelets.

Pre-cut paper strips for the girls. A rough measure of an arm's length per paper strip will work just fine. It doesn't need to be exact.

If you have younger girls, you may want to draw a line down the middle of the strips of paper before the meeting, as a guideline for cutting. Young girls have trouble drawing a line down the middle of their loops. If you have older girls, they may be able to draw their lines. Make sure to have them use pencils or crayons to draw with that won't bleed through the paper.

Doing the Activity with the Girls

1. Have the girls sit where they can see you. Make sure they have tape, scissors and drawing materials. Have the paper strips handy to be passed out, or where the girls can easily get them.

It is important that you demonstrate everything that you expect the girls to do. Show them how to tape a loop or cut one in half. For each step in the process: You do the step first, and then they do the same.

The girls will need you or a helper to check their progress, particularly at the beginning, to make sure they have enough tape to secure both ends of the paper strip, or that they have it twisted the correct number of times.

2. Start by telling the girls they are going to experiment with different loops, and that this is a kind of math called ***topology***. We are going to do our first experiment with a plain ordinary paper loop.

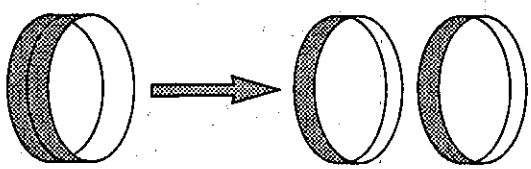
3. Hand out the strips of paper, and have the girls prepare 2 pieces of tape (2" in length each, or about the width of their paper strip), and put the tape to the side for the moment.

If age appropriate, and if you have not done it for them before the meeting, have them draw a line down the middle. Show them where the sides and the edges of the strip are, using yours as an example.

4. Have them pick up both ends of the strip of paper, and overlap them with no twists in the paper, and tell them to tape the sides together to make a loop.

Ask them: How many sides does your loop have? 2. How many edges does it have? 2. Have them show you the sides and edges of their loop. Teach them how to follow the sides and edges around their loop by tracing the lengthwise line drawn down the middle.

5. Have them cut their loop in half down the cen ter (lengthwise) line.



Ask them: **What do you think you will have when you are finished cutting?** Show them what happened to yours. Does the same thing happen to theirs? Whenever you cut a plain loop in half, you get two separate plain loops.

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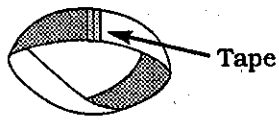
Activity #2 - Experiment with a Mobius Strip (half-twist)

1. Tell them that next, they are going to make a special loop called a Mobius strip. Give each girl another strip of paper, and have them prepare 2 more pieces of tape, the same length as before, and put the tape to the side.

You may need to draw a line down the center of the strip (lengthwise, as before) to make this easier for younger girls.

2. Have them pick up both ends of the paper, and overlap them with a half-twist.



Have them closely watch you doing this, while you describe it. Then watch them do it, and make sure they all have done it correctly, before moving on to the taping step.

3. Tape the edges securely where the strip over laps. Tell them they have made a Mobius strip, which is a loop with very different properties than a plain loop.

Brownie Girl Scouts like to do things and not spend much time on explanations, so keep them moving.

4. If you have not already done this for them before the meeting, have them draw a line down the middle of the 'outside' of this loop, or trace the pre-drawn line around the Mobius strip, the same as they did with the plain loop.

Ask them: **Did you draw (or trace) a line that seemed to cover both the inside and the outside? Did you cross over an edge, or did you just draw on the side?**

Explain to them that a Mobius strip doesn't have an inside and an outside like the other two loops you made earlier. It only has one side. Because it only has one side, you can draw a line down the middle of the entire surface and come back to the starting point without ever crossing over the edge.

The girls can prove this to themselves by tracing around the edge of their Mobius strip with a marker or a crayon. This idea is a bit harder to understand and requires concentration to trace.

5. Next, have them cut the Mobius strip in half, down the center, and have them guess what they will end up with. They will be surprised when they only get one loop.

What properties does this new loop have? If you check, you should see it has 2 sides and 2 edges and has 2 full-twists.

A Mobius strip is a very special kind of paper loop with a half-twist that has only one side and one edge and that is why it does so many unusual things.

Activity #3 - Experiment with a Loop with a Full-Twist

1. Next they are going to make a loop with a full-twist. Give each girl another strip of paper, and have them prepare 2 more pieces of tape, the same length as before, and put the tape to the side.
2. Have them pick up both ends of the strip of paper, and overlap them exactly as when they made a plain loop. But remind them - DON'T TAPE IT YET!
3. Now put a full-twist in your loop. Hold one end steady, and turn the other end over, so the ends match. Continue turning the end in the same direction until the ends match up again.

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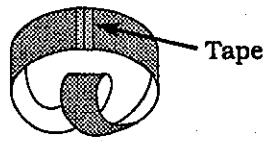
Check that the girls have made a loop with a full-twist before moving to the next step.

4. Tape both sides together to make a loop. You now have a loop with a full-twist in it.



5. Again, have them draw a line down the mid dle of one side of this loop, or trace the pre-drawn line, the same as they had done with the previous loops. Drawing will be harder on this loop.

Ask them: **How many sides does this loop have?** Their loop has 2 sides. It also has 2 edges. They can trace around one edge of the strip with a marker or crayon, to prove this.

6. Tell them to cut this full-twist loop in half, lengthwise, along the centered line. Encourage them to think about what will happen.

Ask them: **What will you get when you have finished cutting?** They will get 2 joined loops. Each of these loops also has a full-twist. A loop with a full-twist has some properties that are like a plain loop. It still has 2 sides and 2 edges, however it behaves differently when it is cut in half lengthwise.

7. Encourage the girls to do their experiments. Let them twist the strips as many times as they want, cut them, and see what happens. At this point, you will probably be cutting paper strips as fast as you can and the girls will be wearing their experiments like neck-laces. This is a good time to reinforce that math can be fun.

More to Explore

Going Further with Mobius Strips

Studying about Mobius strips is part of a branch of mathematics called ***topology***. Topology explores the fundamental properties of different shapes that remain the same, even when that shape is distorted.

Mathematicians have been experimenting with Mobius strips for over 100 years and you can learn more about them if you are interested. Because they have one side and one edge they can be used to solve mathematical problems that are impossible to solve any other way.

Mobius strips can also solve practical problems. An engineer used a Mobius strip to make a conveyer belt that lasted longer because it wore out evenly on its one side.

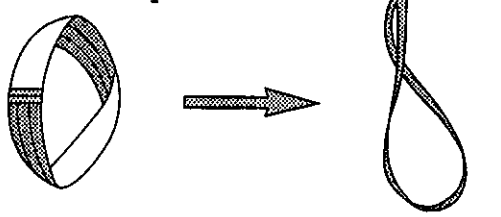
If you want to do another trick with a Mobius strip, try this activity.

1. Cut a strip of paper to make a Mobius strip. Draw 2 lines lengthwise to divide it into thirds.

2. Take this paper, overlap the ends with a half-twist, and tape it to make the Mobius strip.

3. Cut along one of the lines you drew, cutting the strip 1/3 of the way from the edge. Keep cutting until you come back to the starting point. What happens?

With this cut, you get two joined loops. One is a Mobius strip, and the other is a loop with a full-twist.



4. Keep experimenting with different numbers of twists, and types of cuts, observing what happens.

NOTES

This chart is a summary of different loop experiments.

Name	No. of Twists	No. of Sides & Edges	Kind of Cut	Result of Cut
Plain Loop	0	2 sides, 2 edges	center	2 plain loops
Plain loop	0	2 sides, 2 edges	one-third	2 plain loops of different widths
Mobius strip	one-half	1 side, 1 edge	center	1 loop with 2 full-twists
Mobius strip	one-half	1 side, 1 edge	one-third	1 Mobius strip joined to 1 loop with a full-twist
Loop with full-twist	1	2 sides, 2 edges	center	2 joined loops with full-twists
Loop with full-twist	1	2 sides, 2 edges	one-third	2 joined loops with full-twists which have different widths

Jigsaw Puzzles

Corresponding Activity

Numbers and Shapes Try-It,
p. 233, Brownie Girl Scout Handbook

Overview

The girls will learn how to design jigsaw puzzles. They will also learn how to make their puzzles easy or hard to solve.

Big Ideas

This activity will help girls develop problem solving skills as well as spatial visualization skills.

Estimated Activity Time

30-45 minutes

Materials Needed

Your VSC provides:
No items for this activity.

Items you provide:
For each girl:

- ☐ Card stock or paper printed with blank four-square and nine-square puzzles
- ☐ Crayons
- ☐ Scissors
- ☐ Resealable plastic sandwich bags, or envelopes, to keep puzzles pieces

Safety

Follow normal precautions when using scissors.

Clean-Up

Dispose of scrap paper in the trash.

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How to Do It

1. Start by coloring the picture on the four-square puzzle and the nine-square puzzle. Color both puzzles the same way.
2. Cut out the four-square puzzle into its 4 separate pieces. Rearrange the 4 pieces to make a complete picture again. Note how easy it was to do.
3. Cut out the nine-square puzzle into its 9 separate pieces. Rearrange the 9 pieces to make a complete picture again. This puzzle is more complicated because it has more pieces, and all of those pieces are the same shape, making it harder to do.
4. Think of ways you could make the puzzles easier to solve. Using color clues, adding detail, putting objects in the corners, and having an object drawn in 2 or more squares are all ways to make a puzzle easier to solve. Puzzles are also easier to solve when you have a complete picture to look at, as a reference, when you try to solve them.

With these things in mind, color another nine-square puzzle page, giving yourself some clues to make it easier to solve. Cut it out and solve it.

Before the Meeting

Make enough copies of the four-square puzzle for each girl to have one copy, and enough copies of the nine-square puzzle pages for each girl to have at least 2 copies. Bring along plenty of extras as well.

Doing the Activity with the Girls

1. First, have the girls color the four-square puzzle and the nine-square puzzle so that they are identical. The girls may really become involved in the coloring. Tell them at the beginning that these pictures are going to be cut into pieces to make puzzles. Perfect coloring isn't important.
2. Have them cut out the four-square puzzle, into its 4 separate pieces, and try to solve it.

Ask them: **Was this hard or easy to solve? Why?**

2. Now have the girls cut out the nine-square version of their puzzle, into its 9 separate pieces. Have them try to solve it.

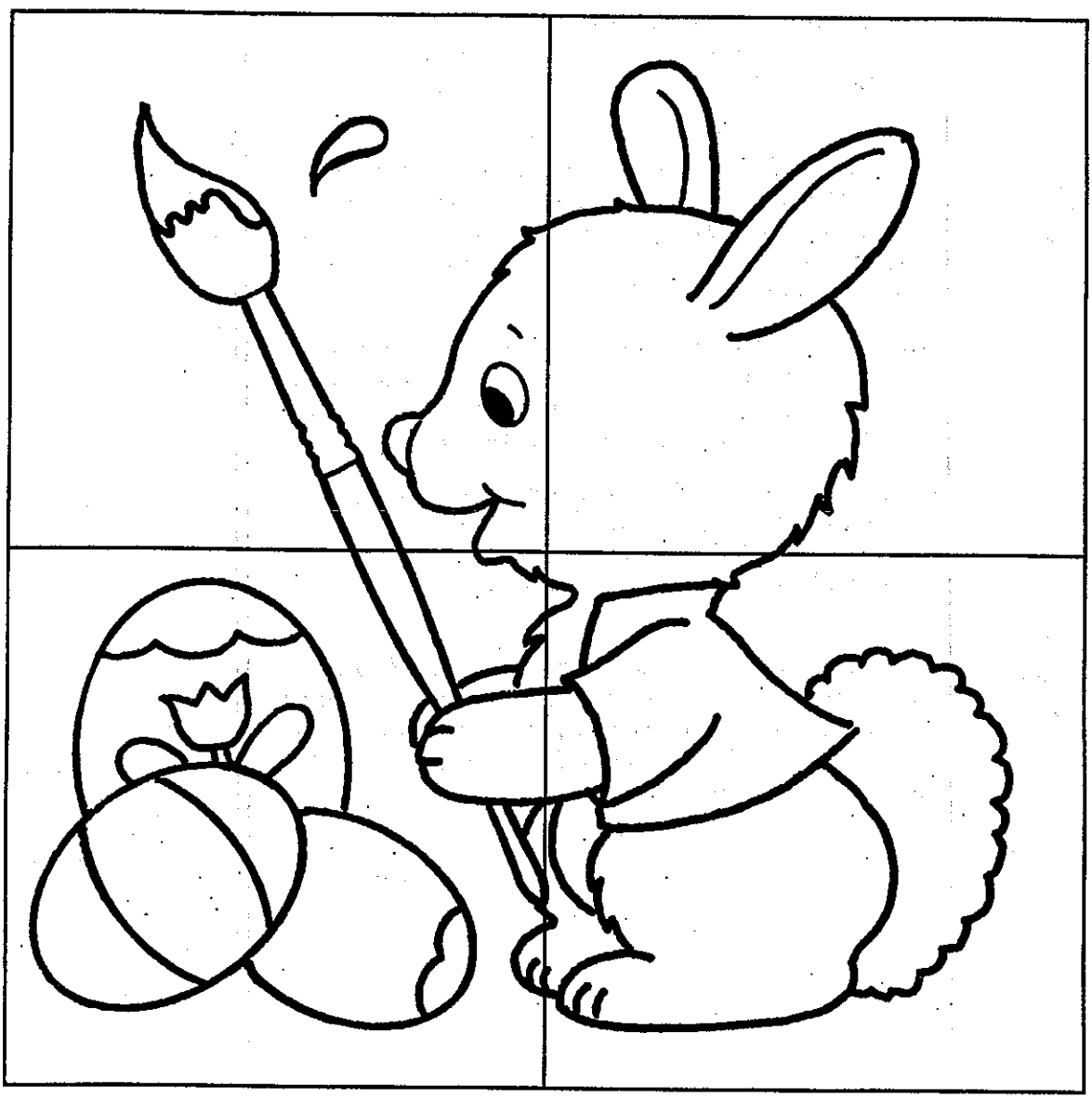
Ask them: **Is puzzle easier or harder to solve than the four-square puzzle? What made it easier or harder to solve?** Challenge them to think of ways they can make it easier for someone to solve a puzzle they design.

3. Ask the girls to decide if they want to color a puzzle so it is easy to solve, or hard to solve. Give them another nine-square puzzle page and have them design their puzzle.

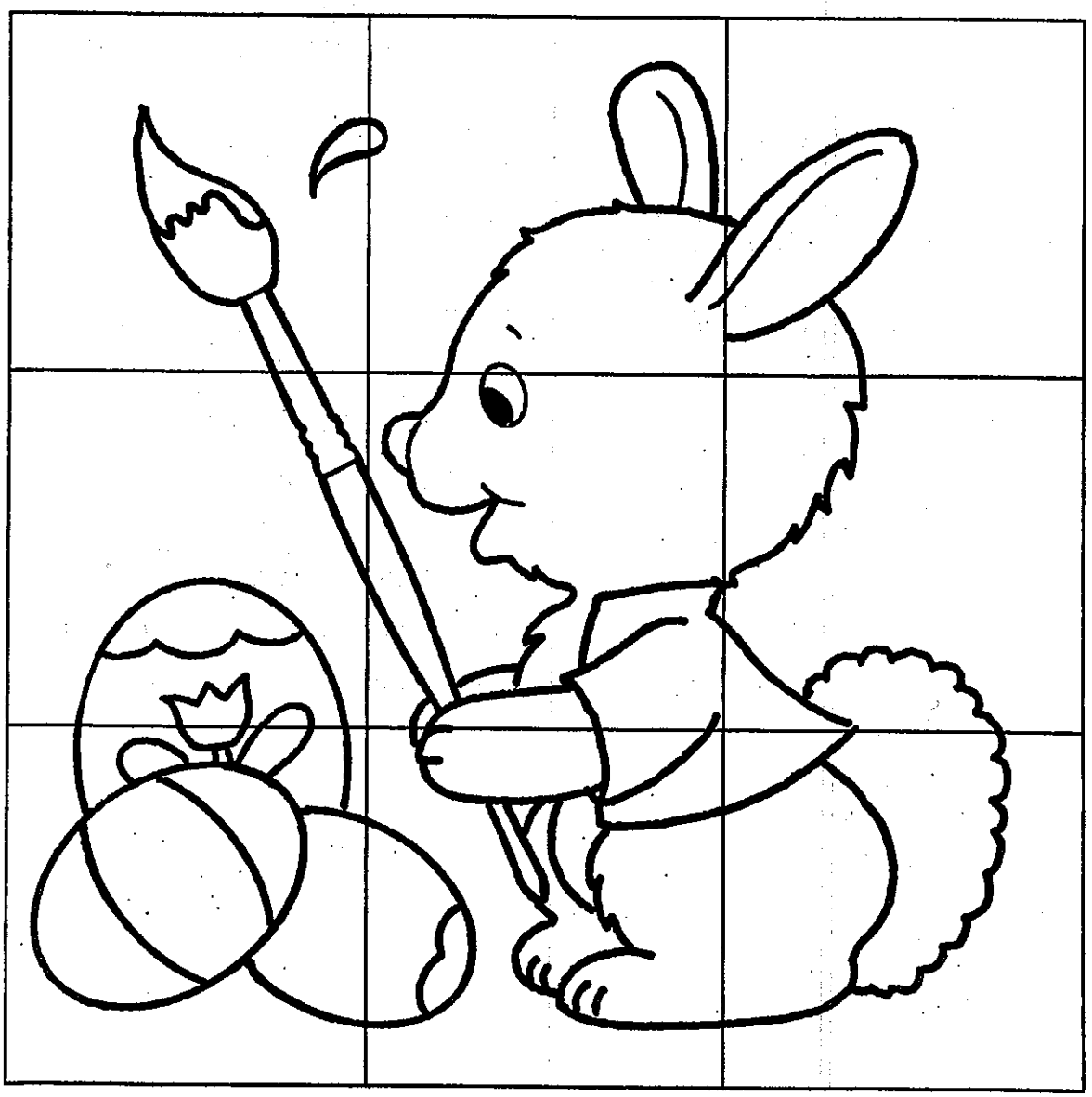
5. Have them cut out and solve their puzzle. Did their design work the way they expect ed? Have the girls store their puzzle in a resealable plastic bag or envelope.

You may want to have the girls trade them, and try to solve each other's puzzles. You may also want to put the easy puzzles in one area, and the harder puzzles in another, and let everyone try solving them.

NOTES



Four - Square Puzzle



Nine - Square Puzzle

NOTES

Time and Money

Corresponding Activity

Numbers and Shapes Try-It, Time and Money, p. 233, Brownie Girl Scout Handbook

Overview

This is a game called *Money Match*, which helps children count change. It first appeared in a booklet published by the U.S. Department of Education, titled *Helping Your Child Learn Math*.

Big Idea

Girls will reinforce their counting skills and coin recognition skills.

Estimated Activity Time

15-20 minutes

Materials Needed

Your VSC provides:

- ☐Dice (One die for every 2-4 girls)
- ☐Plastic dimes
- ☐Plastic quarters
- ☐Plastic half-dollars

Items you provide:

- ☐1-2 rolls of each should suffice
- ☐Pennies (10 per girl)
- ☐Nickels (4-5 per girl)

Safety

No special precautions are necessary.

Clean-Up

Collect coins and dice at the end of the game.

How to Do It

1. Review the game rules as listed in "Doing the Activity with the Girls" and try playing a few rounds.

Before the Meeting

1. Each group of 2-4 girls will need one die to roll and some coins, appropriate to the level they are playing.

You can use play money or real money for pennies and nickels. Obtain rolls of coins at a bank, and play money from toy and educational supply stores.

2. Choose a set amount for the winner to reach. Ten or twenty cents is good for younger children. Twenty-five or fifty cents is good for older children. As the girls improve, and their confidence level increases, have higher amounts set for them to play towards, such as $1.

Doing the Activity with the Girls

1. Review the names of coins with the girls, and how many pennies are equal to each different coin. Modify the level according to the age of the girls.

2. After explaining the rules of the game, let them play. You can start with pennies and nickels, and then add dimes and quarters to make it more challenging. You also have the option of using half-dollars to make it even more challenging for older Brownies.

Money Match Game Rules

This game helps children count change. Continuous repetition will make it even more effective.

For younger players, 5 and 6-year olds, use only 2 coins. Pennies and nickels work best. Older children can use all coins.

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1. The object of the game is to be the first player to earn a set amount.

10 to 20 cents is a good amount for the younger girls; 25 to 50 cents is a good amount for the older ones. As they increase their confidence levels, increase the amounts.

2. The first player rolls the die, getting an amount of pennies equal to the number on the die.
3. Players take turns rolling the die to collect additional coins.
4. As each player accumulates 5 pennies or more, the 5 pennies are traded for a nickel. (2 nickels for a dime, 2 dimes and a nickel for a quarter, and so forth)
5. The first player to reach the set amount wins.

Add the quarter to the game when the children are ready. Counting money, which involves counting by 1's, 5's, 10's, and 25's, is a challenging skill and usually does not come easily to children until about the third grade.

Shapes in Our World

Corresponding Activity

Numbers and Shapes Try-It, Nature Shapes, p. 233, Brownie Girl Scout Handbook

Overview

The girls will be involved in a scavenger hunt around your meeting place to find different geometric shapes. This can be made simple or more complex depending on the age of the children.

Big Idea

The girls will review the names of geometric shapes they know, and learn the names of new ones. Both two dimensional and three dimensional shapes will be explored.

Estimated Activity Time

30 – 45 minutes

Materials Needed

Your VSC provides:

- ☐2-D shape cards to include: circle, square, rectangle, triangle, parallelogram, hexagon, and trapezoid
- ☐3-D shape models to include: cube, sphere, cylinder, cone, prism, and pyramid

Items you provide:

For each girl:

- ☐Scavenger hunt sheets
- ☐Pencils

Safety

Be careful of the sharp points on some of the 3-D models, especially the cone and the pyramid.

Clean-Up

Put away models.

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How to Do It

This is a very simple activity to do with the girls. It does not require any special practice on your part before the meeting, however be sure to read through the "Before the Meeting" and "Doing the Activity With the Girls" sections prior to attempting this activity with your troop.

Before the Meeting

1. Review the names of the different shapes on the "*Shapes in Our World: Scavenger Hunt*" sheet found at the end of this activity, and be sure to make copies of the sheet for each girl.
2. At the troop meeting place, find some examples of the shapes. You can use these as examples, or hints for the girls, when they begin their scavenger hunt.
3. Prepare a number of categories to recognize accomplishment from the hunt such as:
   a) Who found the most rectangles?
   b) Who found the most spheres?
   c) Who found the most different kinds of shapes?
   d) Who found the most different kinds of 2-D shapes?
   e) Who found the most different kinds of 3-D shapes

Doing the Activity With the Girls

1. Brownies will need an explanation of what 2-D and 3-D means.

Ask the girls: **What is the difference between a 2-D and a 3-D shape?** A 2-D shape is always flat. A 3-D shape is not flat. Use the models to show the difference. A circle is flat but a ball or sphere is not.

Some common objects can be a combination of different shapes. A scoop of ice cream on top of a sugar cone is a combination of a cone and a sphere. A potato chip can is a cylinder, but the lid is also a circle. The tip of a sharpened pencil is a cone, and the eraser on the other end is

2. Go over the 2-D shapes using the picture cards. Start with the more common shapes such as circle, square, triangle, and rectangle, before introducing the parallelogram, hexagon, and trapezoid.

Ask the girls: **How are the square and the parallelogram alike? How are they different?** They both have 4 sides, but the angles at the corners are different. **How many sides does the hexagon have?** The answer is six. **Which of these shapes have four sides?** The square, the parallelogram, the trapezoid, and the rectangle all have four sides.

3. Next introduce the 3-D shapes to the girls. The older girls will probably be familiar with some of them, but this might be new material to younger Brownies.

Pass around the 3-D models, if possible, so the girls can feel and explore the shapes.

4. Go over the scavenger hunt sheet with the girls. Review the names of the shapes to search for, and match them to the shapes before the girls start on the scavenger hunt.

Give the girls some clues to get started. Show them a few shapes that you located in the area before the meeting. You may even want to put a few objects, such as a potato chip can, in the area for the girls to find.

5. Tailor your scavenger hunt rules to your site and time of year.

   * Will it be inside, outside, or both?
   * How much time do you want to allow?
   * Have the girls work with a buddy.
   * Have them find lots of different shapes, both 2-D and 3-D, or
   * Have them look for 2-D first, then share their results, and look for 3-D

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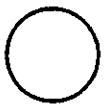
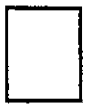
The girls can use their scavenger hunt sheets (the ones containing all of the shapes) to keep a running tally of how many of each shape they found.

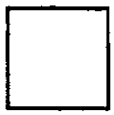
6. When the girls report back, have the girls share the results of their hunt. If you wish you can use the categories you prepared earlier, and recognize the "winners" for find ing so many, but insure that you have enough categories for everyone to be recognized.

Shapes in Our World: Scavenger Hunt

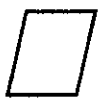
2-D Shapes:


Circle

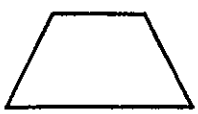

Rectangle


Square

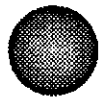

Triangle

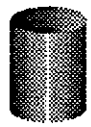

Parallelogram

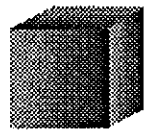

Hexagon


Trapezoid

3-D Shapes:

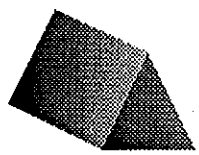

Sphere


Cylinder

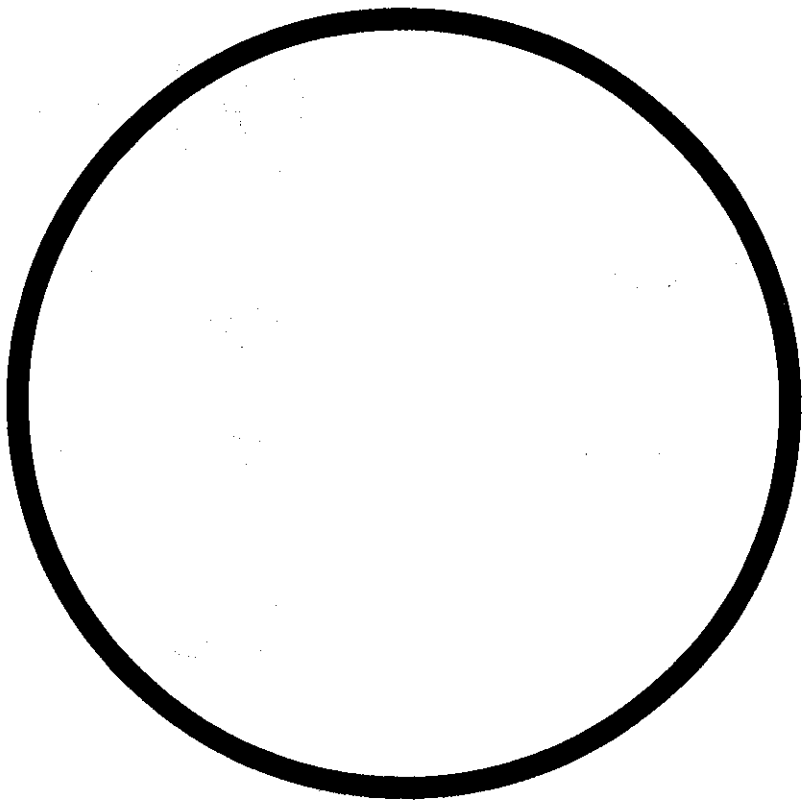

Cube


Pyramid

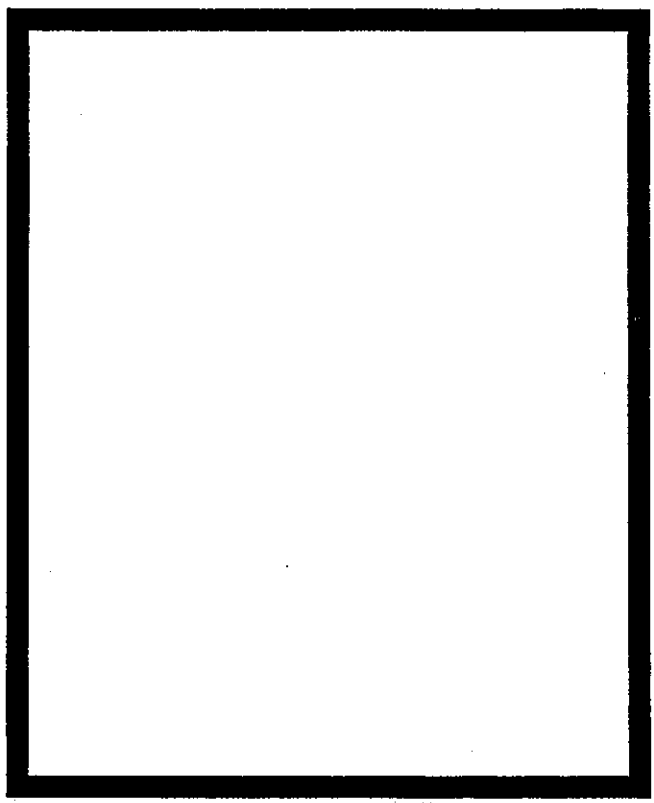

Cone


Prism

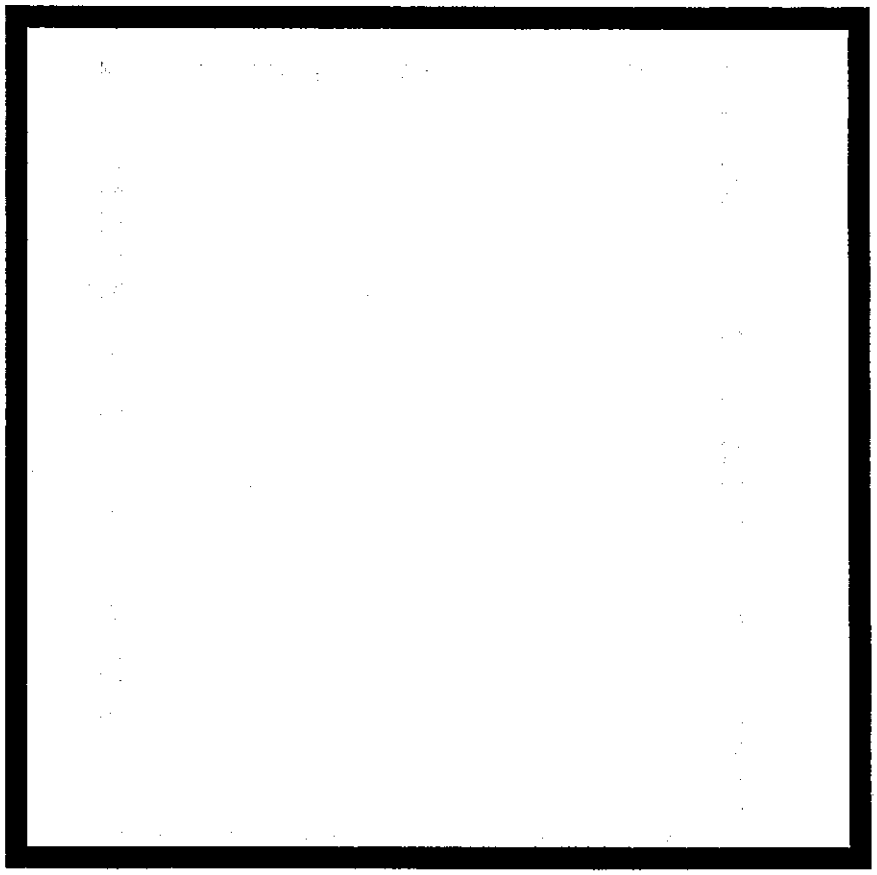
Circle



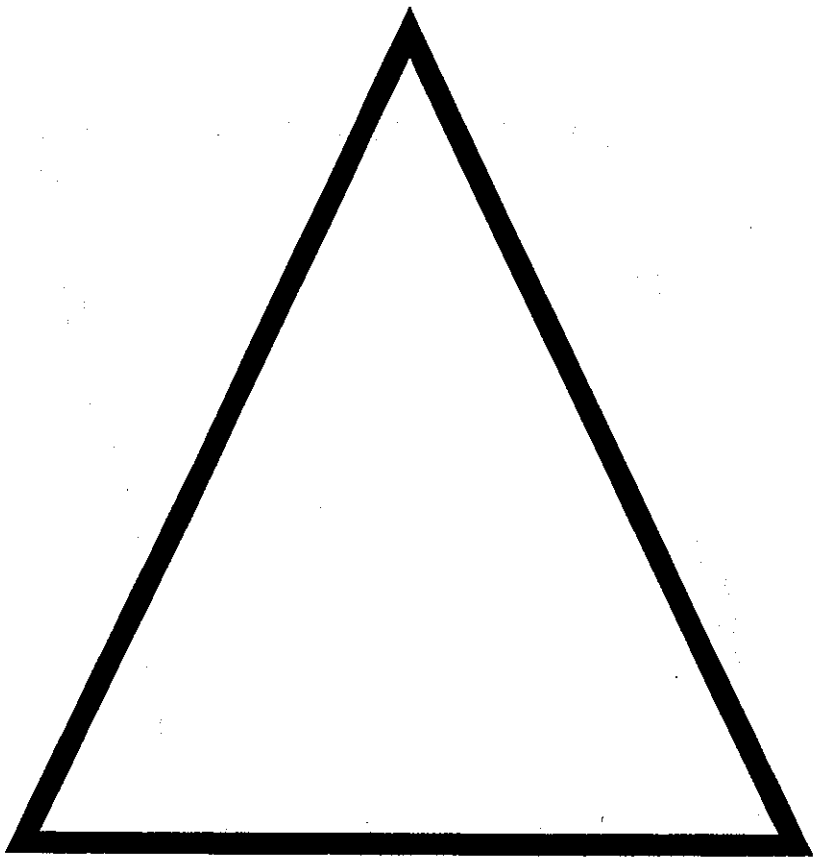
Rectangle



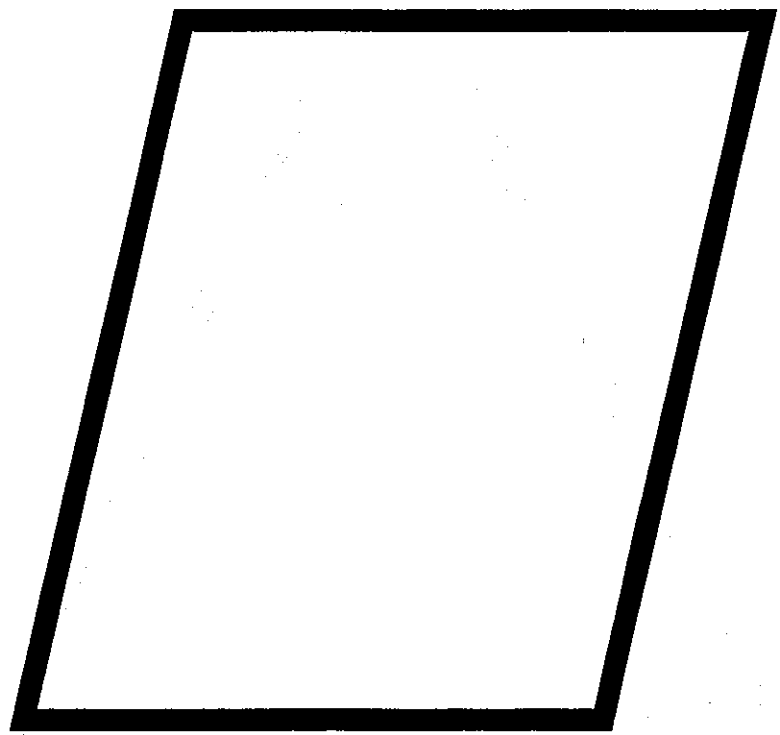
Square



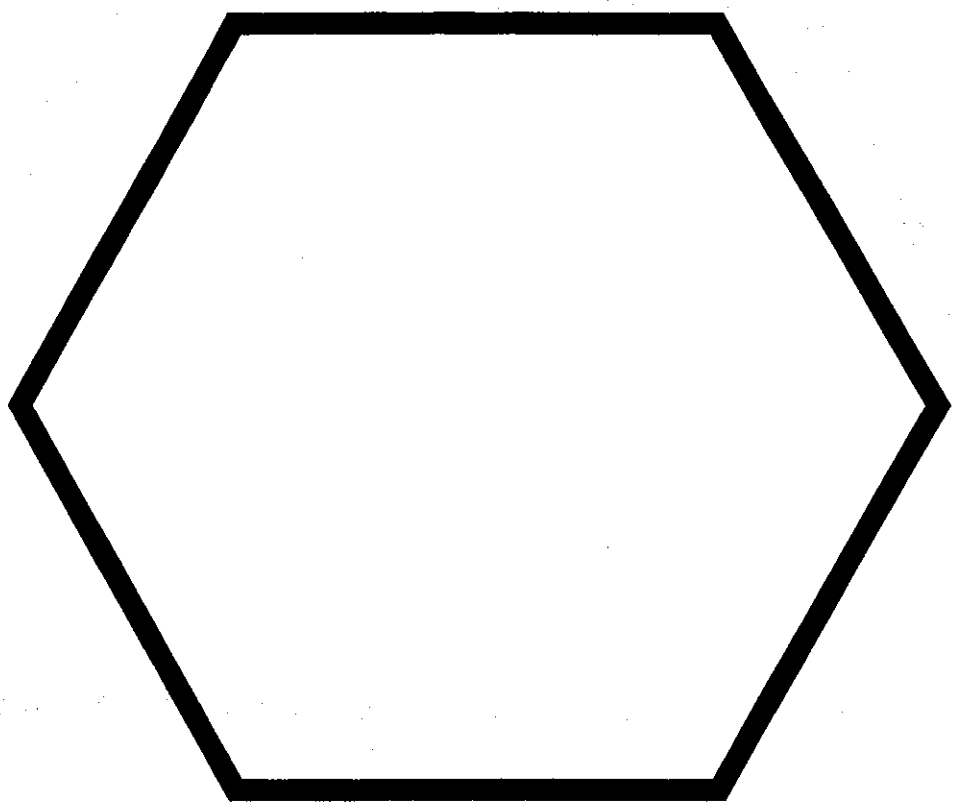
Triangle



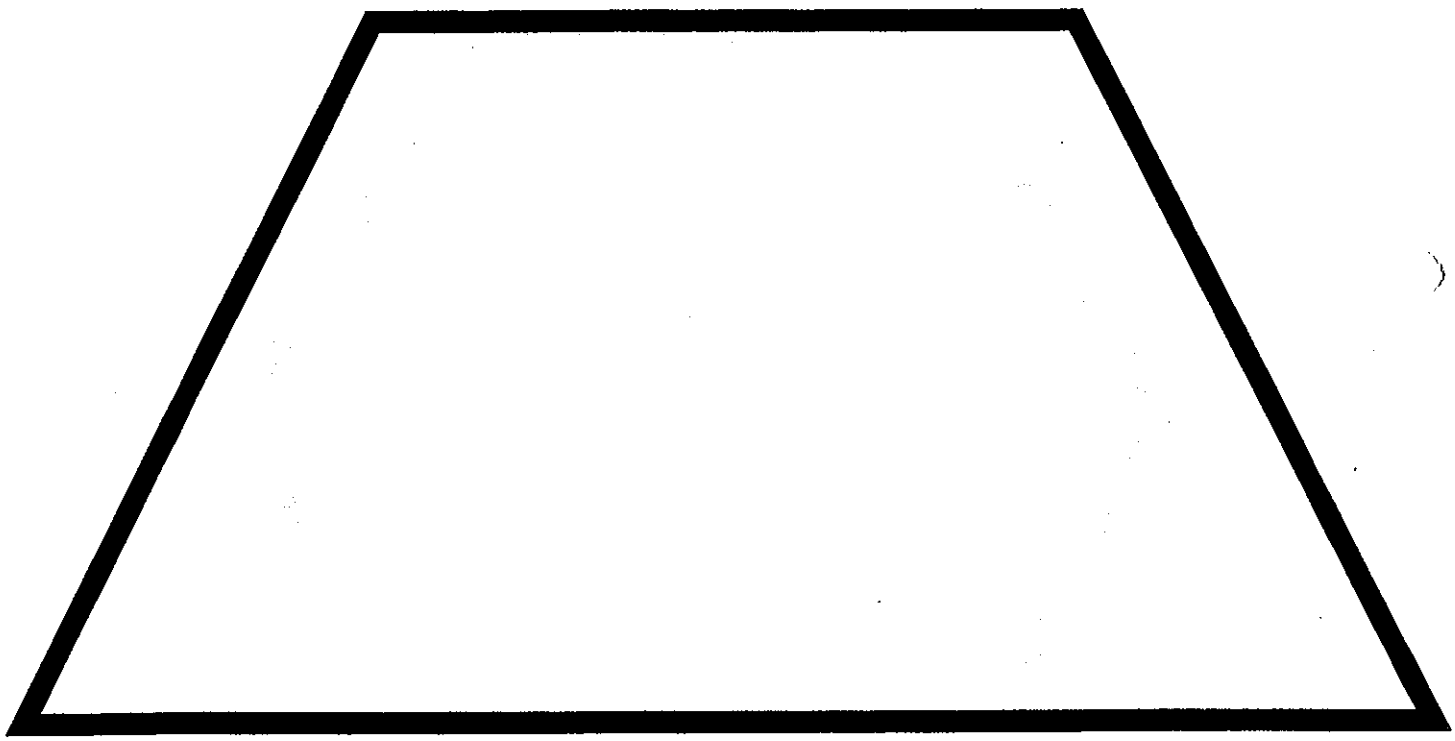
Parallelogram



Hexagon



Trapezoid



Program Links for *Numbers and Shapes*

Brownie Try-Its
Colors and Shapes

Resources:

Hornets' Nest Girl Scout Council
Bridging the Gap
The Science Resource Center
7007 Idlewild Road
Charlotte, NC 28212

Discovery Place, Inc
301 North Tryon Street
Charlotte, NC 28202

NOTES

Material List for *Numbers and Shapes* activities

Math Shapes

Tub contents:

- ☐30 sets of tangrams

You provide:

For each girl:

- ☐Copy of rabbit shape
- ☐Copy of turtle shape
- ☐Copy of square shape

Optional copies depending on the ability level of the girls:

- ☐Copy of rabbit outline
- ☐Copy of turtle outline
- ☐Copy of square outline

Origami

Tub contents:

- ☐1 copy of laminated diagram steps in manila envelope for both cat and cup

You provide:

For each girl:

- ☐Origami paper (one sheet for each figure) or regular wrapping paper cut in a square shape, 6" x 6" or larger
- ☐Pen or marker (to draw with if desired)

Mobius Strips

Tub contents:

- ☐5 rolls of adding machine tape
- ☐3 models (mobius strip, regular loop, loop with full twist) in gallon bag

You provide:

For each girl:

- ☐Scissors
- ☐Clear tape/dispenser (at least one for every 2 girls)
- ☐Crayons, or colored pencils

Optional supplies for leaders (only if substituting wrapping paper for adding machine tape):

- ☐Yardstick or rulers (at least one for every 2 girls)
- ☐Rolls of wrapping paper

Jigsaw Puzzles

Tub contents:

None

You provide:

For each girl:

- ☐Card stock or paper printed with blank four-square (min. 1 per girl) and nine-square (min. 2 per girl) puzzles
- ☐Crayons
- ☐Scissors
- ☐Resealable plastic sandwich bags, or envelopes, to keep puzzles pieces

Time and Money

Tub contents:

- ☐8 dice in a sandwich bag
- ☐Plastic dimes
- ☐Plastic quarters
- ☐Plastic half-dollars

You provide:

- ☐Pennies (10 per girl)
- ☐Nickels (4-5 per girl)

Shapes in Our World

Tub contents:

- ☐Manila envelope containing a set of laminated 2-D shape cards
- ☐Six 3-D shape models in a quart bag

You provide:

For each girl:

- ☐Copy of scavenger hunt sheets
- ☐Pencils

Bridging the Gap
Numbers and Shapes
Troop Leader Survey

Today's Date: _____ Number of Girls Participating: _____

1. Approximately how long did you spend on each of the following activities?

Math Shapes	**____ minutes**	**Jigsaw Puzzles**	**____ minutes**
Origami	**____ minutes**	**Time and Money**	**____ minutes**
Mobius Strips	**____ minutes**	**Shapes in Our World**	**____ minutes**

2. What activity did you or your girls enjoy the most, and why?

3. What activity did you or your girls like the least, and why?

4. Were your girls interested in exploring any of the activities further? ☐Yes ☐No

5. Which one(s)?

6. What did you do to fulfill that interest?

7. What can be done to make this more successful for your girls?

Thank you for your help and for your opinions!!!

Please return all forms to: _____

_____

_____

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Project Coordinator	Idella Hill-Edwards, Hornets' Nest Girl Scout Council
Co-Principal Investigator	Jerry Reynolds, Discovery Place, Inc.
Co-Principal Investigator	Patricia H. Baldwin, Hornets' Nest Girl Scout Council

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GIRL SCOUTS ®

Patricia H. Baldwin
Executive Director
Hornets' Nest Girl Scout Council

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Attn: Bridging the Gap
301 North Tryon Street
Charlotte, NC 28202

Hornets' Nest Girl Scout Council
Attn: Bridging the Gap
7007 Idlewild Road
Charlotte, NC 28212

We encourage you to visit our website at www.bridginggap.org. *Let us hear from you!*