

# SMILE WORKCARDS

## Properties of Shapes Pack Three

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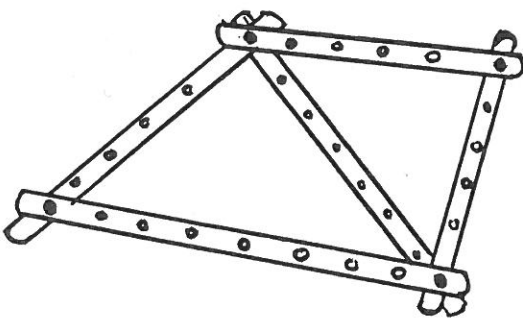
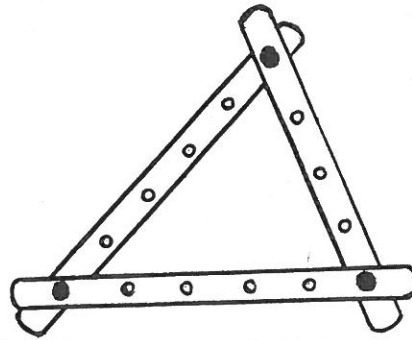
You will need: geo-strips, split pins

Is it Rigid?

- (1) Use 3 geo-strips to make a triangle.

Is it rigid (firm)?

Make some different triangles and see if they are rigid.



- (2) Make some different quadrilaterals using 4 geo-strips each time.

Add a diagonal to each one to make them rigid.

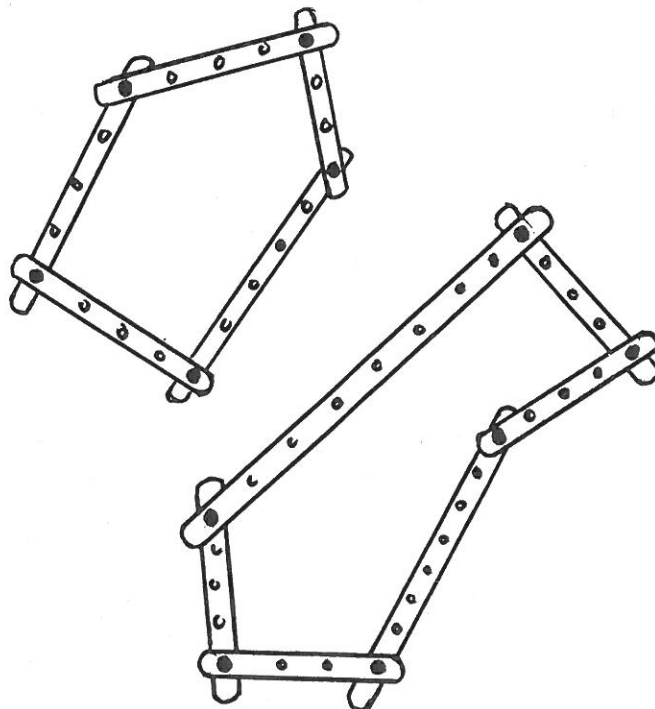
Can you see why the diagonal makes them rigid?

- (3) Make a pentagon, a hexagon, and polygons with more than 6 sides

Add the right number of diagonals each time to make them rigid.

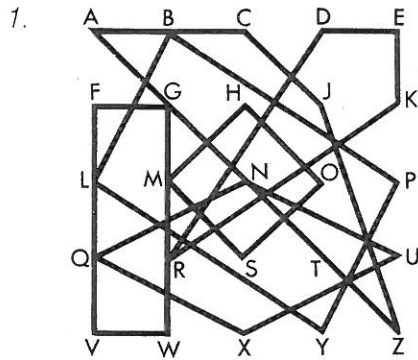
How many diagonals do you need each time?

Find a rule - if you can.



# Tangled quadrilaterals

Smile 1764



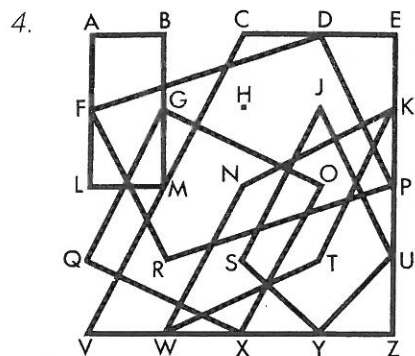
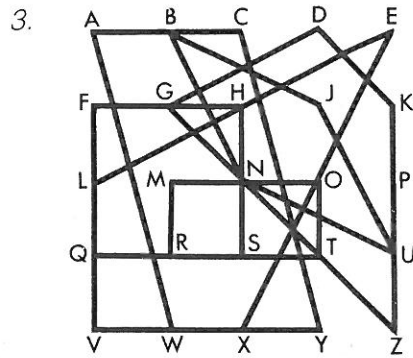
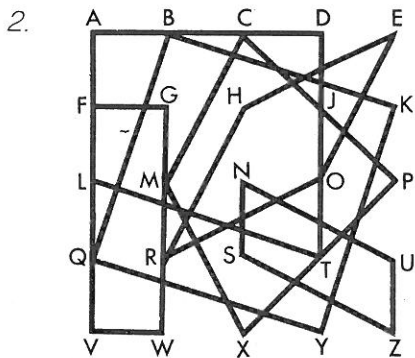
Find:

- a square
- a trapezium
- a rhombus
- a rectangle
- a kite
- a parallelogram

e.g. HOSM is a square

No letter is used more than once.  
Which letter is not used?

Now do the same with these:



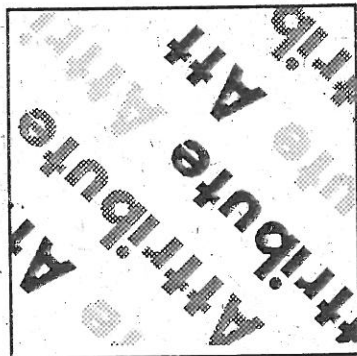
5. Design one of your own to try out on a friend.

Use a pinboard to help you.

A game for 2 - 4 players.

# Shape Up

This envelope contains:  
A set of 24 Attribute Cards  
and a set of 14 Shape Cards.



The rules are on the back of the envelope.

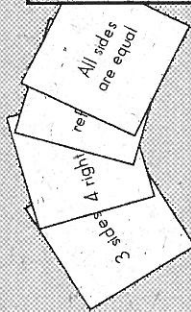


- Play the game several times.  
Which Attribute Cards would you most like to have dealt to you?  
Which Attribute Cards would you least like to have dealt to you?
- Pick one of the shapes.  
Draw the shape and write its name.  
Describe the shape using all the Attribute Cards which apply.

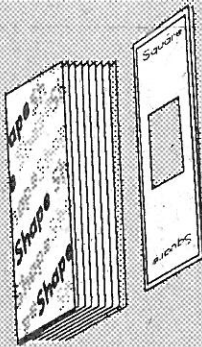
# Shape Up Ruler

A game for 2 - 4 players.

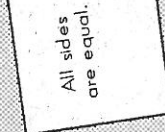
1) Deal out all the Attribute Cards. Each player, may look at their cards.



2) Put the Shape Cards face down on the table.  
Turn over the top Shape Card.



3) Put down in front of you as many of the Attribute Cards that apply to the shape.



4) Each player scores 1 point for each Attribute Card. Other players may challenge wrongly placed cards.

5) Take back your Attribute Cards.

6) Continue until all the Shape Cards have been used.

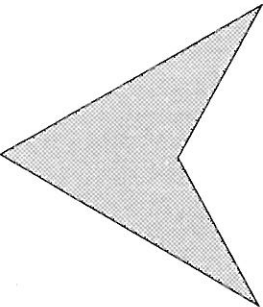
The winner is the player with the most points.

*When you have finished questions on the front of the envelope.*

# Shape Up




Arrowhead



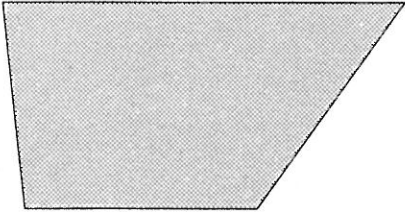
Arrowhead

Right-angled triangle



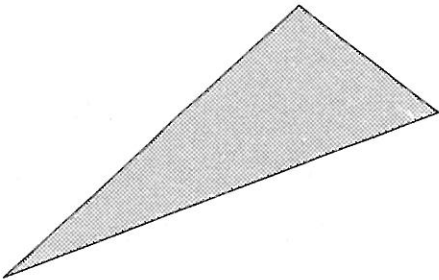
Right-angled triangle

Trapezium



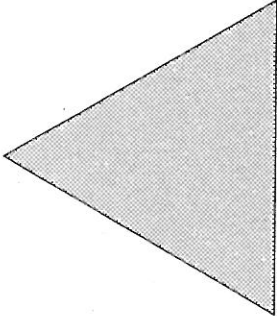
Trapezium

Scalene triangle



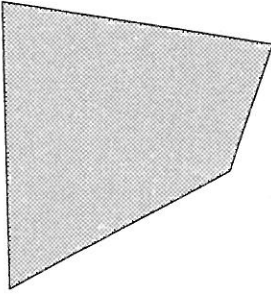
Scalene triangle

Equilateral triangle



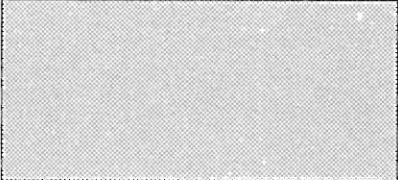
Equilateral triangle

Irregular quadrilateral



Irregular quadrilateral

Rectangle



Rectangle

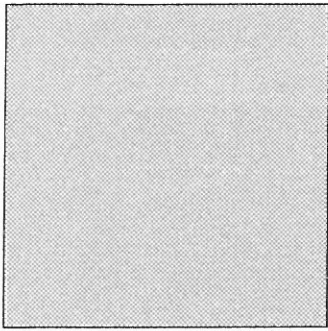
These cards and those from Smile 2170b and 2170c should be cut out and kept in the envelope Smile 2170.

# Shape Up

Smile 2170b

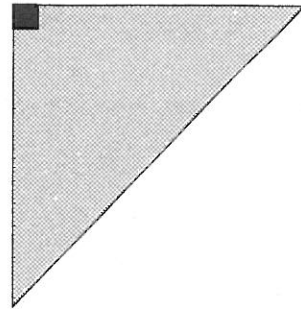


Square



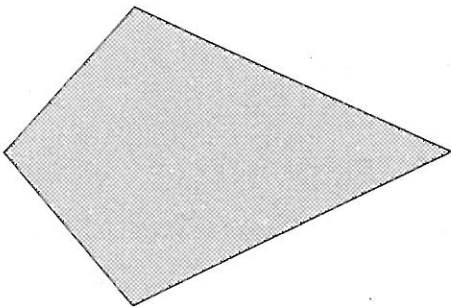
Square

Right-angled  
isosceles  
triangle



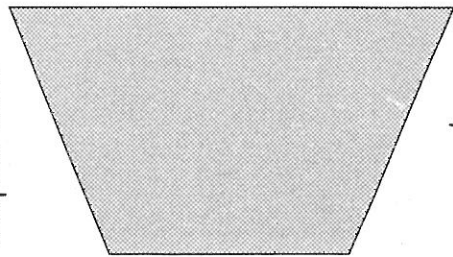
Right-angled  
isosceles  
triangle

Kite



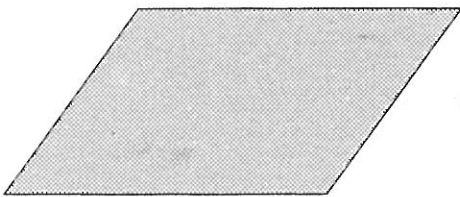
Kite

Isosceles  
trapezium



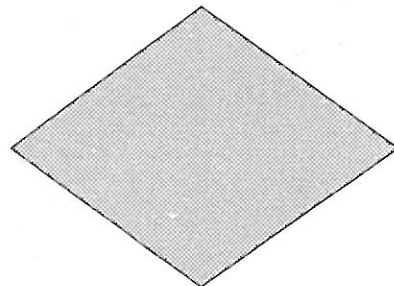
Isosceles  
trapezium

Parallelogram



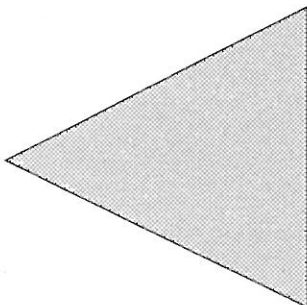
Parallelogram

Rhombus



Rhombus

Isosceles triangle



Isosceles triangle

These cards and those from  
Smile 2170a and 2170c should  
be cut out and kept in the  
envelope Smile 2170.



## Shape Up

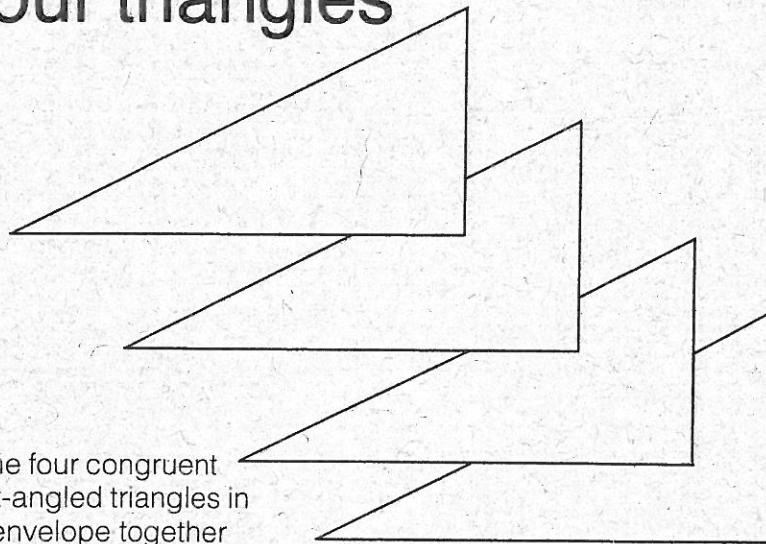
These cards and those from Smile 2170a and 2170b should be cut out and kept in the envelope Smile 2170.



Only two sides are equal.	All sides are different.	All angles are equal.	One right-angle.
4 right angles.	Only two angles are equal.	One pair of sides are parallel.	All angles are different.
The diagonals cross at right-angles.	Opposite angles are equal.	3 sides.	All sides are equal.
One pair of opposite angles are equal.	One line of symmetry.	Opposite sides are equal.	4 sides.
3 lines of symmetry.	2 lines of symmetry.	No diagonals.	At least one obtuse angle.
One reflex angle.	Adjacent sides are equal.	No lines of symmetry.	4 lines of symmetry.

# Four triangles

Smile 1772



Fit the four congruent right-angled triangles in the envelope together to make:

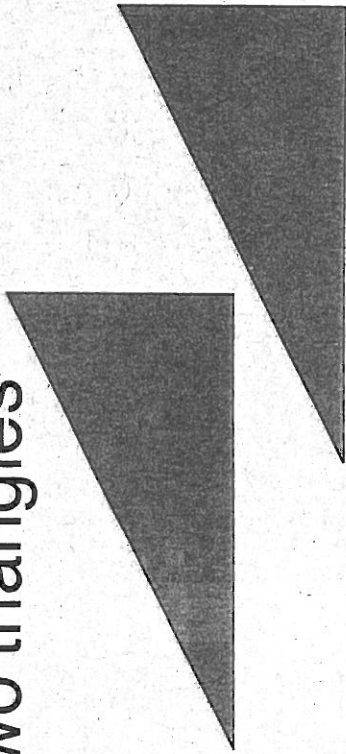
- (a) a square
- (b) a rectangle
- (c) a rhombus
- (d) a parallelogram
- (e) a trapezium
- (f) a kite
- (g) a quadrilateral that is not one of the above

Draw your answers.  
You may find squared dotty paper will help.



# Two triangles

Smile 1773



Fit the two congruent right-angled triangles in the envelope together to make:

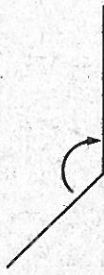
- (a) a rectangle
- (b) an acute-angled isosceles triangle
- (c) an obtuse-angled isosceles triangle
- (d) a parallelogram
- (e) a kite
- (f) a quadrilateral that is neither a kite nor a parallelogram
- (g) a pentagon
- (h) a hexagon

Draw your answers. You may find squared doty paper will help.

Types of angles:



**acute**



**obtuse**



**reflex**

Types of triangles:



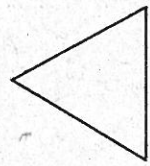
**scalene**

(all sides are different)



**isosceles**

(2 sides are equal)



**equilateral**

(3 sides are equal)

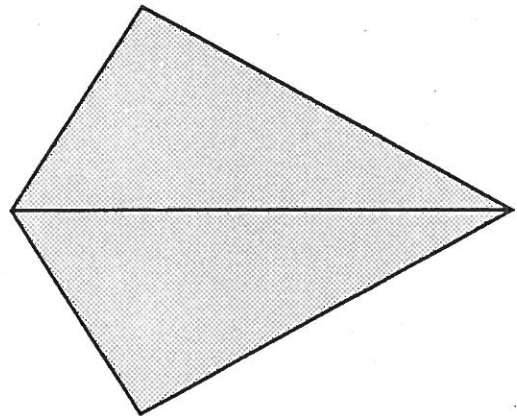
# Using a Triangle

Use the right-angled triangles to make

- a rhombus
- a parallelogram
- a rectangle
- 2 different isosceles triangles

List the properties of these shapes.

Use the right angled triangles from Smile 1772 to make this kite.



List the properties of the kite.

Think about . . .

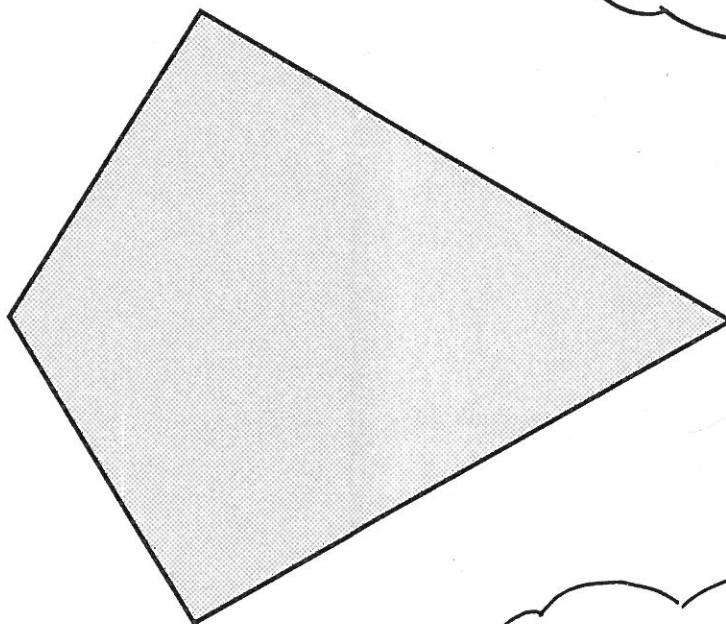
angles

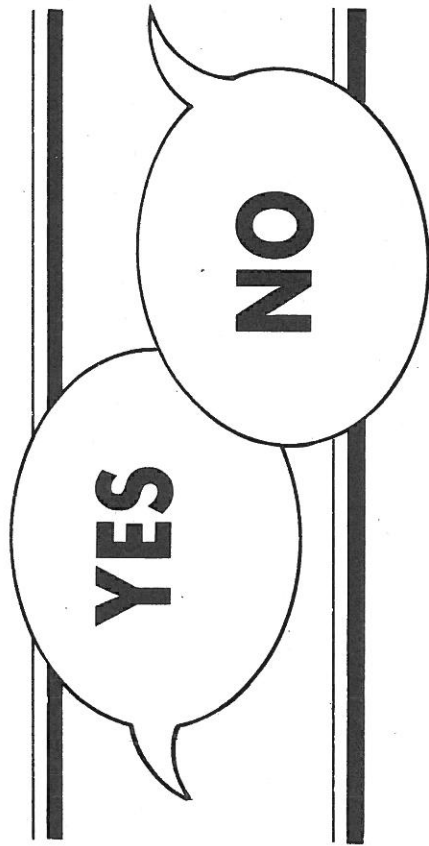
lengths of sides

diagonals

parallel lines

symmetry  
(line and rotational)





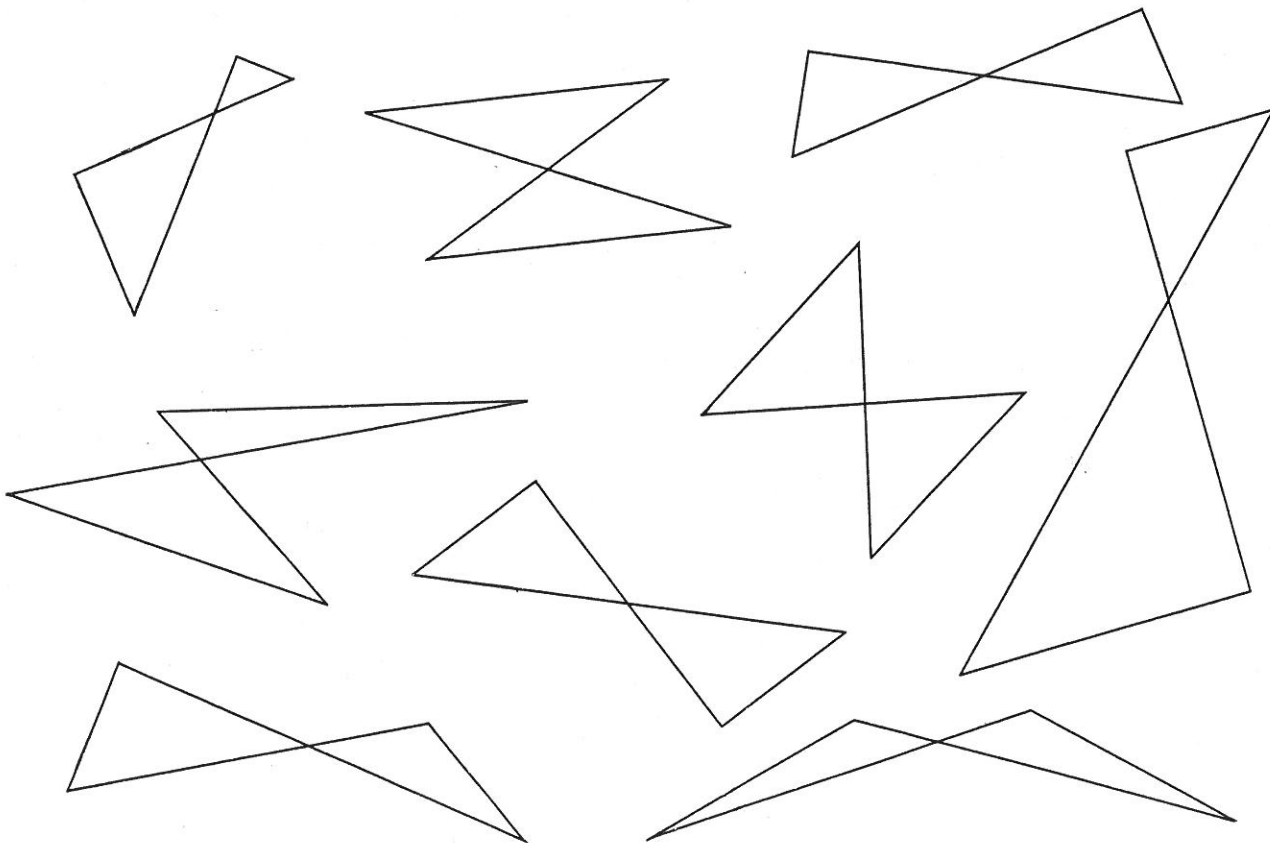
A ● GAME ● FOR ● 2 ● OR ● MORE ● PLAYERS

**T**his card contains three separate boards. Decide which board to use.

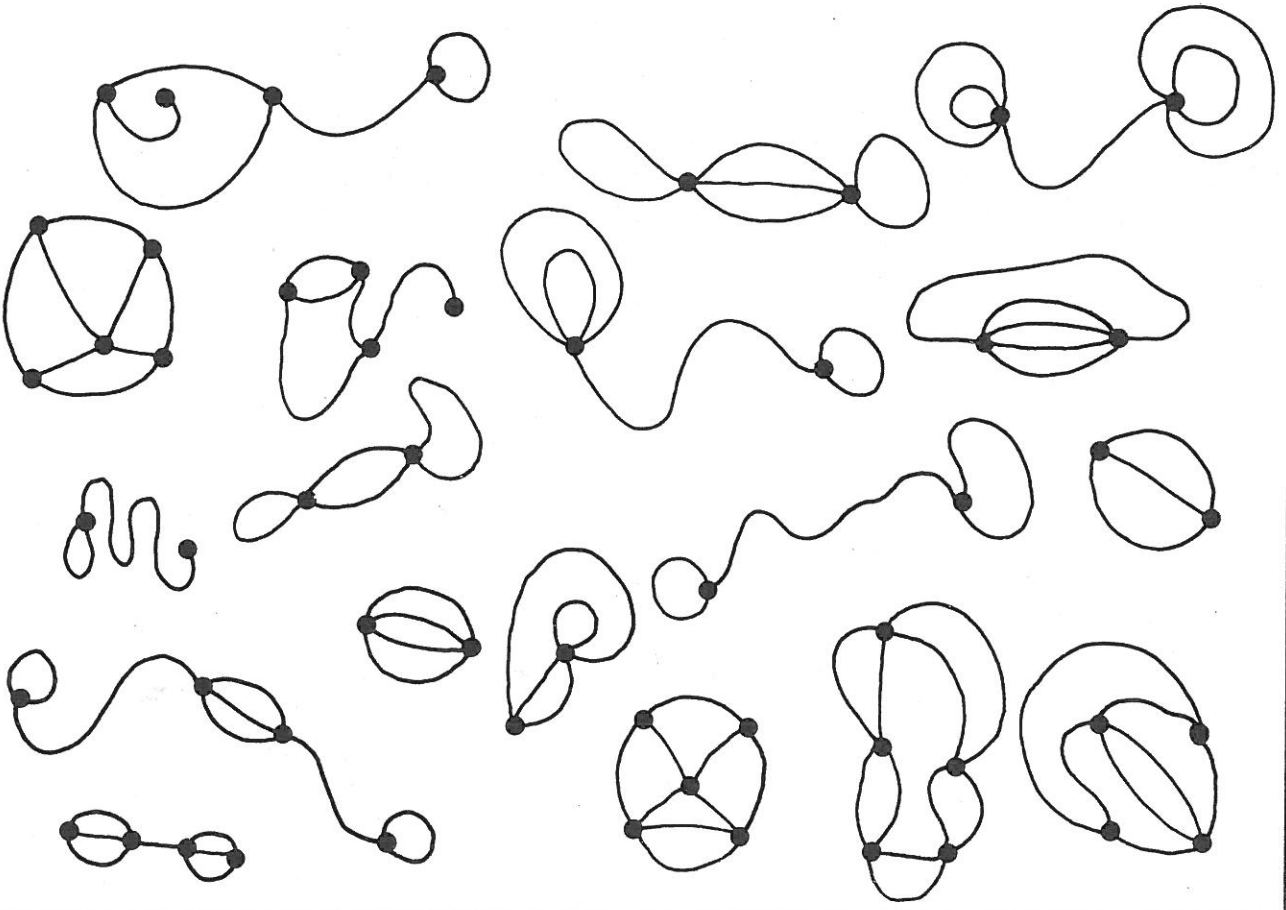
**O**ne player secretly chooses one of the diagrams on that board. The other players must then try to work out which diagram was chosen by asking questions.

**P**layers may only ask questions which can be answered YES or NO. Questions like "Is this the right one?" are *not* allowed. Try to ask as few questions as possible.

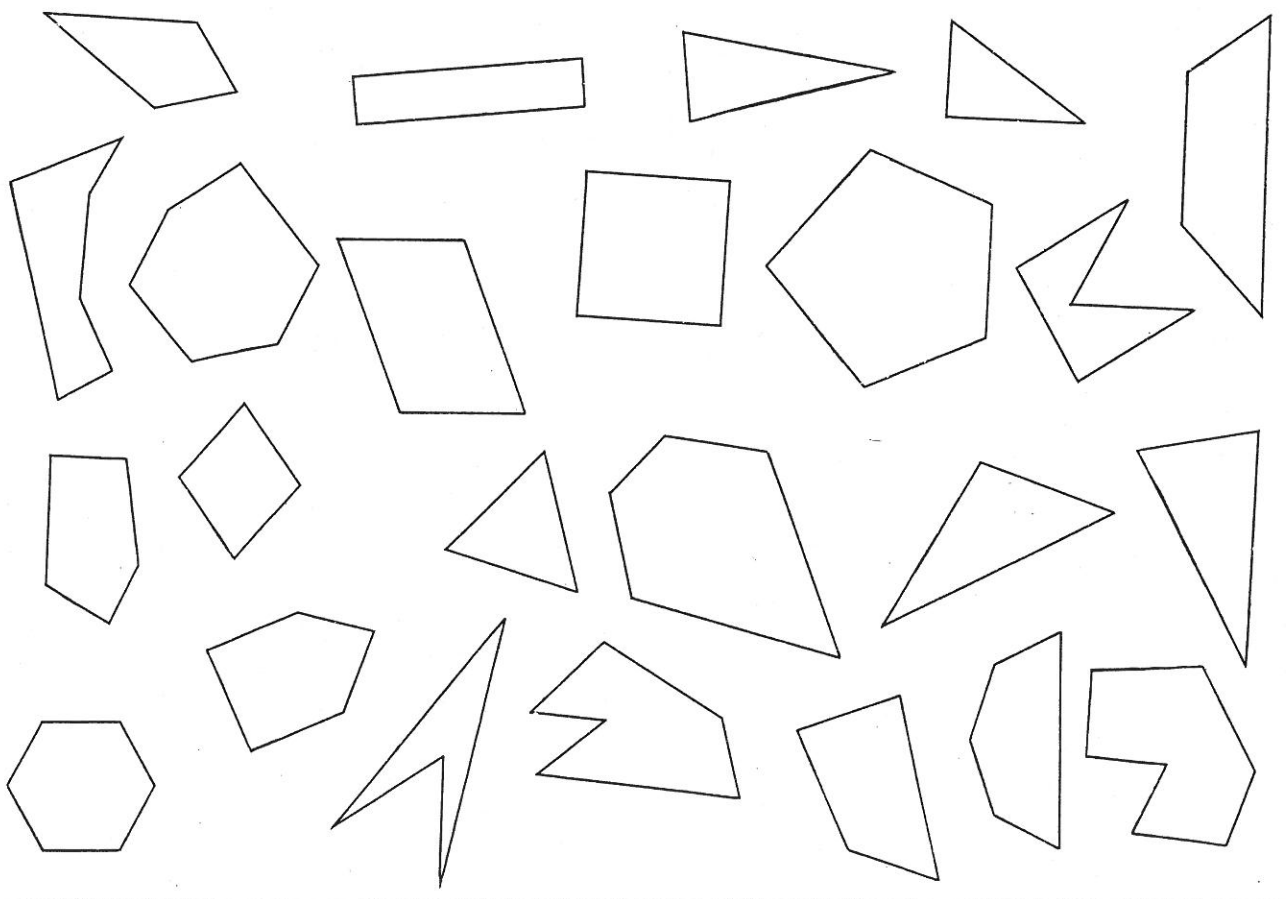
Game 3



Game 2



Game 1





Smile 1382

## Paper Folding

This pack is for a group of 4.

You should:

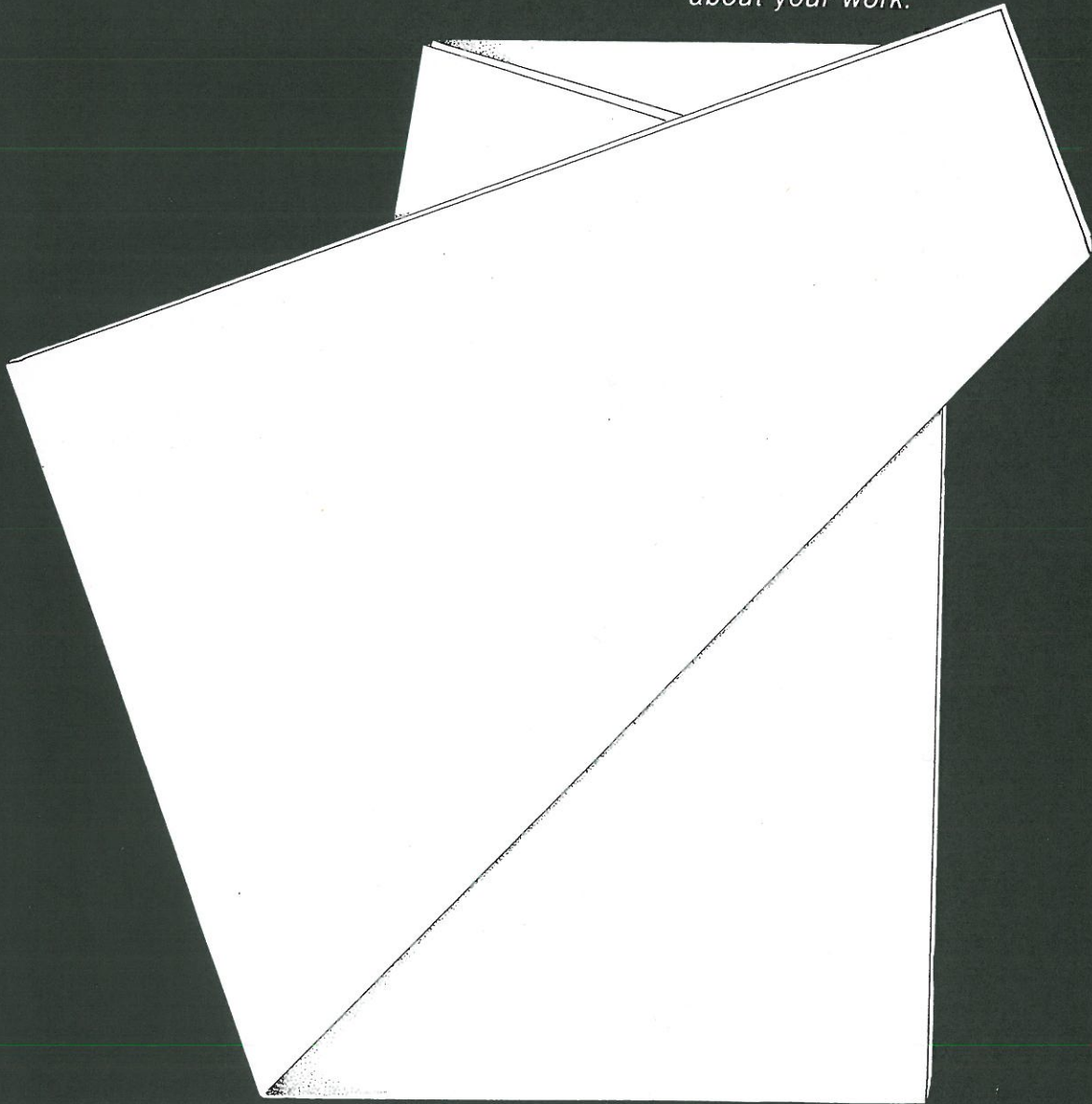
*all start with card A*

*share out cards B, C, D and E*

*all finish with card F*

*make a display of your work  
as you go along*

*add notes to your display,  
explaining how you made  
your shapes. You might also  
like to talk to the class  
about your work.*



### Contents

1382A What shape do you get?

1382B One fold

1382C Right-angle fold

1382D Two folds

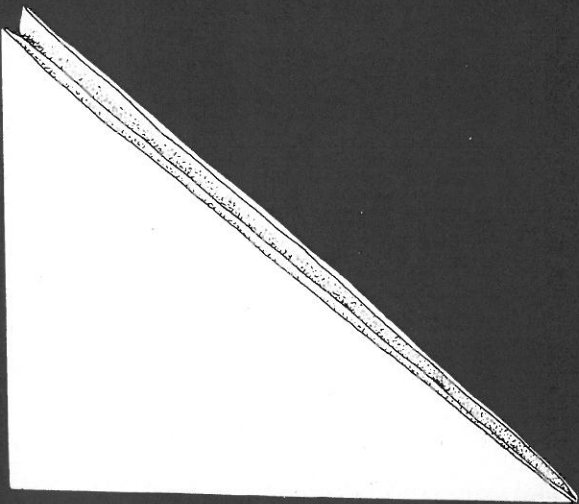
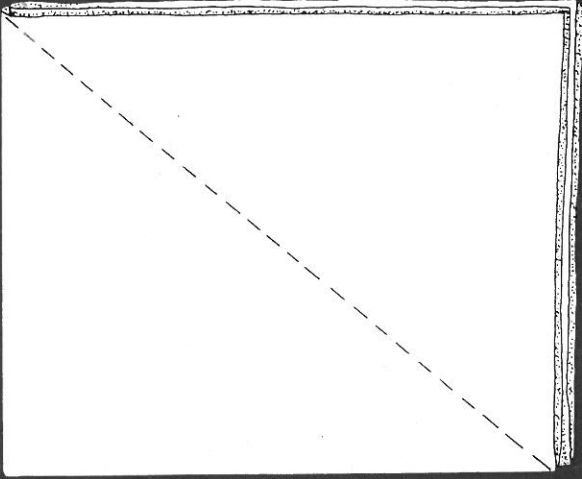
1382E Straight cut

1382F Three folds



# What shape do you get?

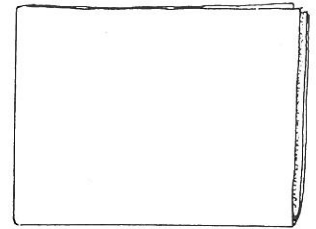
If you fold a piece of paper twice, and cut off a triangle at the corner.....



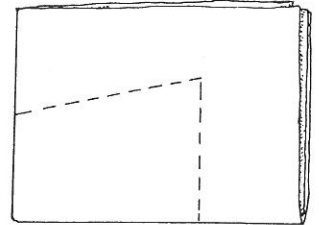
and open it out.....

What shape will you get? *First guess, then try it and see.*

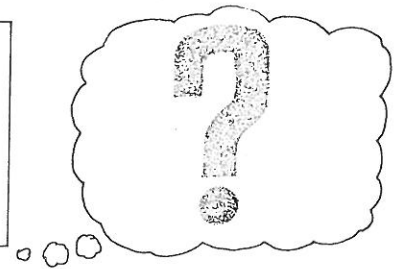
Fold the paper twice



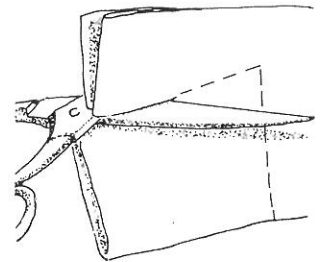
Draw lines



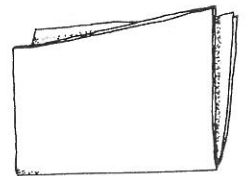
Predict the shapes



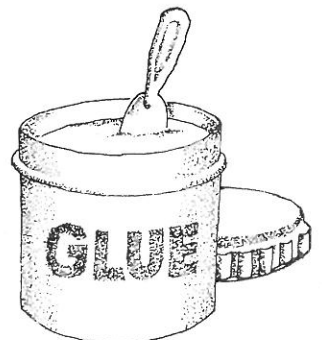
Cut it out



Unfold the shape to see if you were right

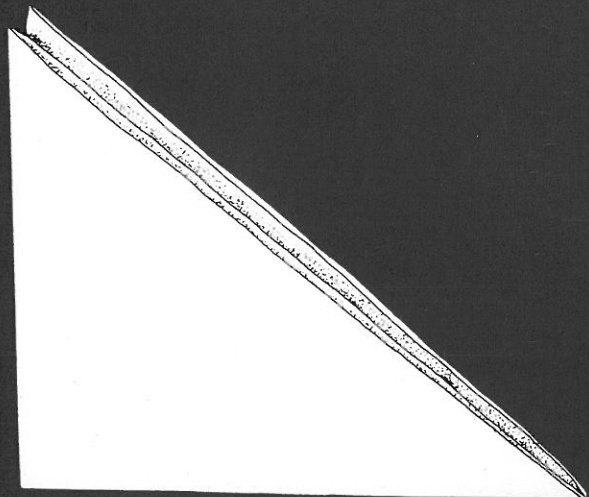
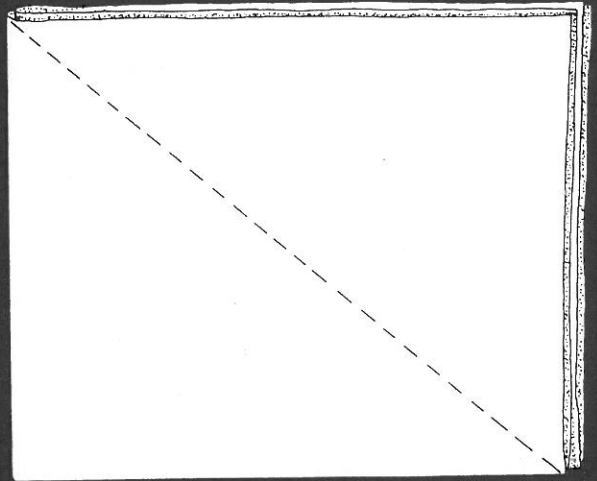


Stick the shape in your book or start a wall display



# What shape do you get?

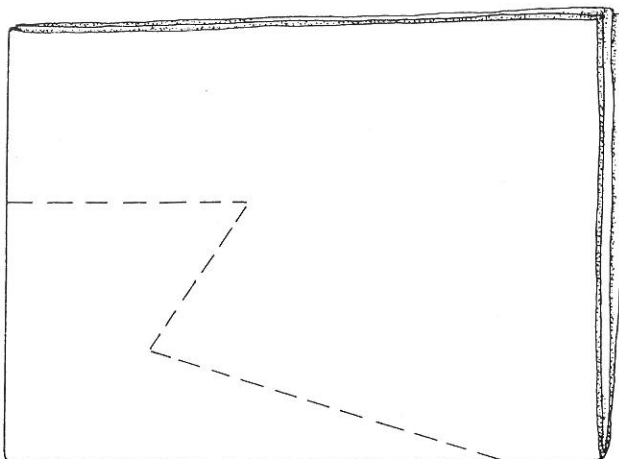
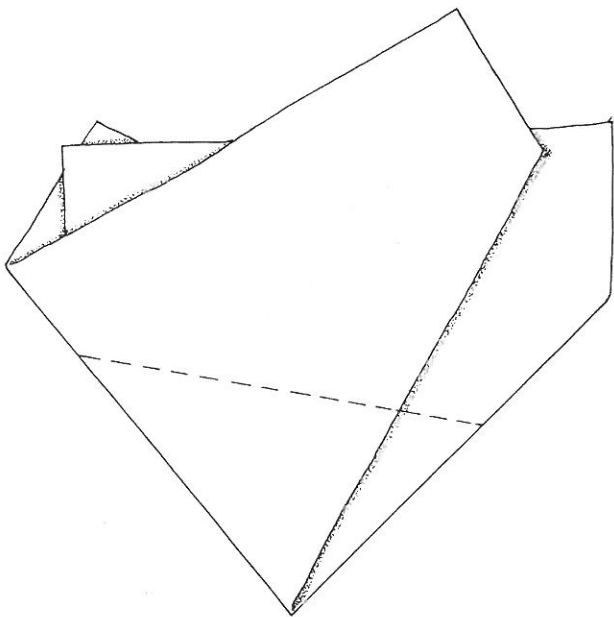
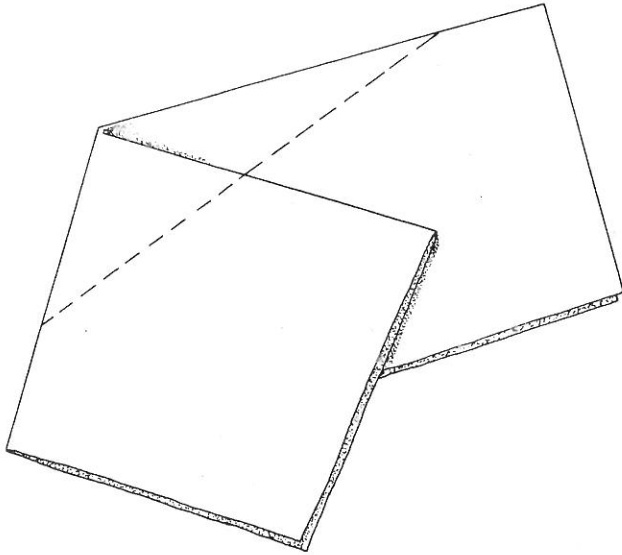
If you fold a piece of paper twice, and cut off a triangle at the corner.....



and open it out.....

What shape will you get? *First guess, then try it and see.*

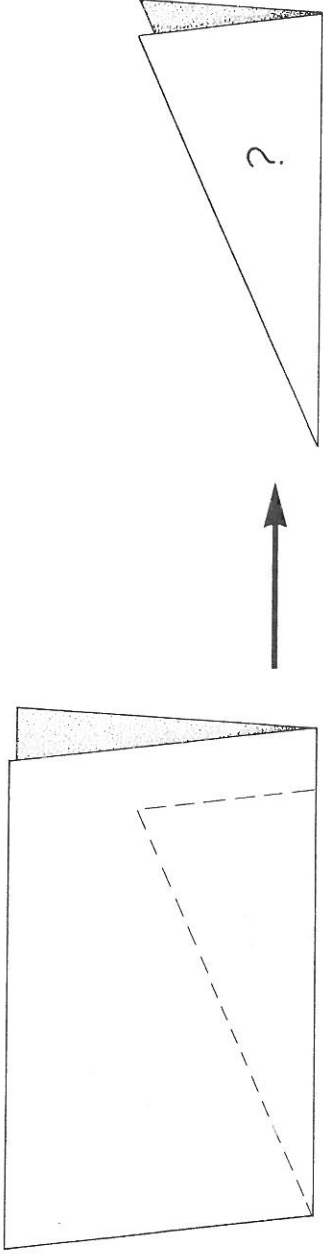
Try lots of different folds and cuts.



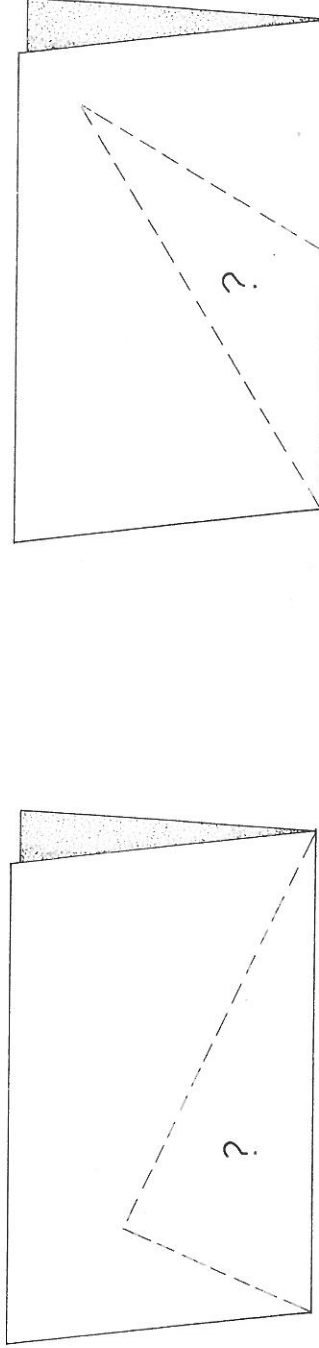
Turn over

# One fold

Experiment with one fold. Cut a triangle from the folded edge.  
*What shape do you get?*



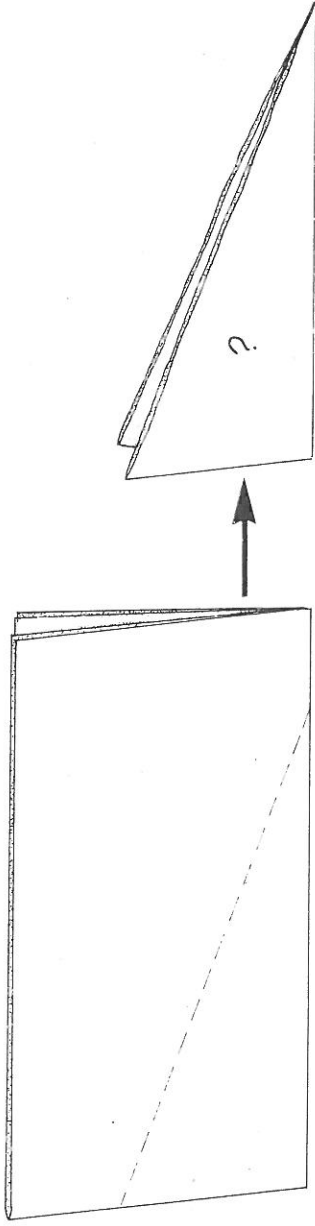
Change the shape of the triangle.



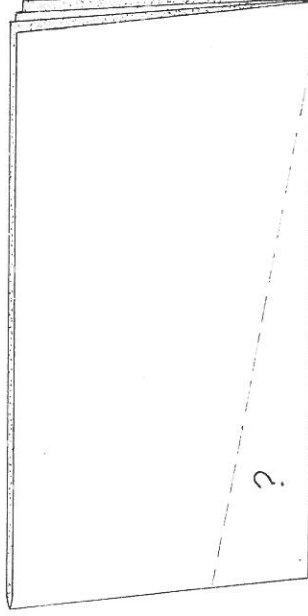
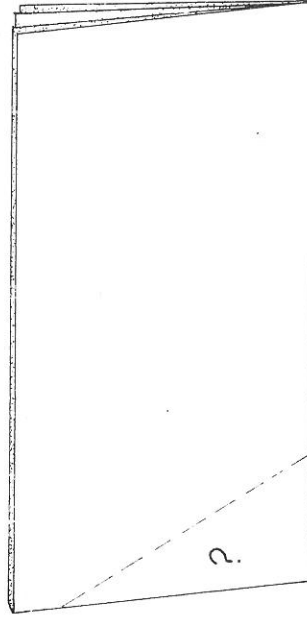
Can you make an *isosceles triangle*? .... a *rhombus*?

## Right-angle fold

Experiment with two folds at right angles and one straight cut across the folded corner.  
*What shapes do you get?*



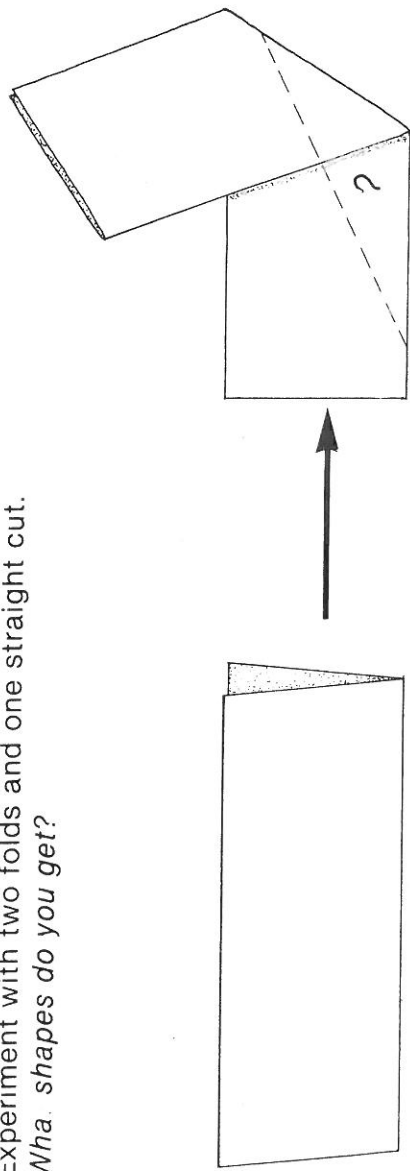
Change the shape of the triangle.



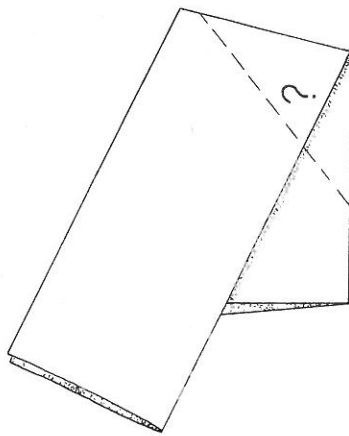
Can you make a square?

## Two folds

Experiment with two folds and one straight cut.  
*Wha. shapes do you get?*



Change the angle between the folds.

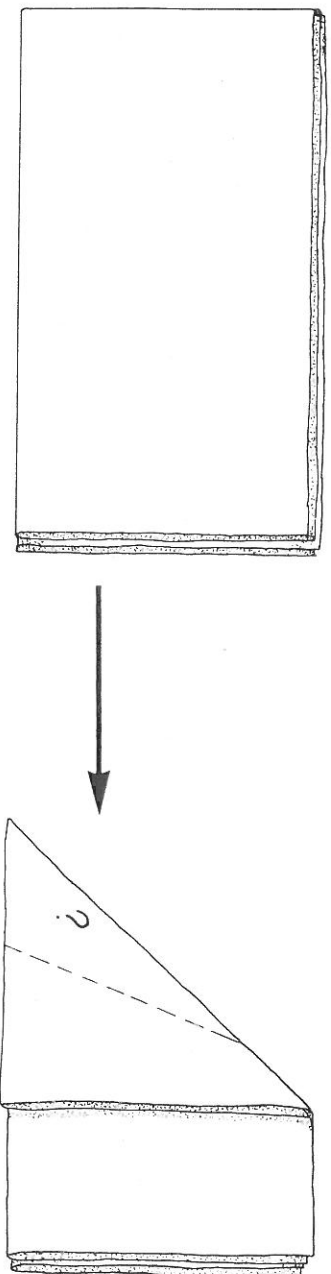


Can you make a kite? .... an arrowhead kite? .... an isosceles triangle?

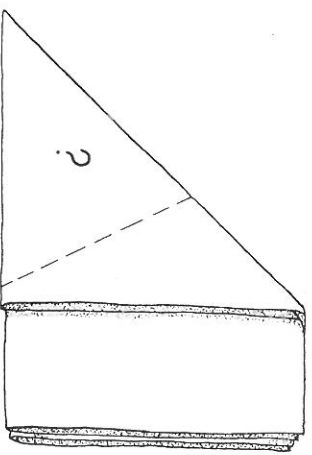


## Straight cut

Experiment with three folds as shown below, and one straight cut across the corner.  
*What shapes do you get?*



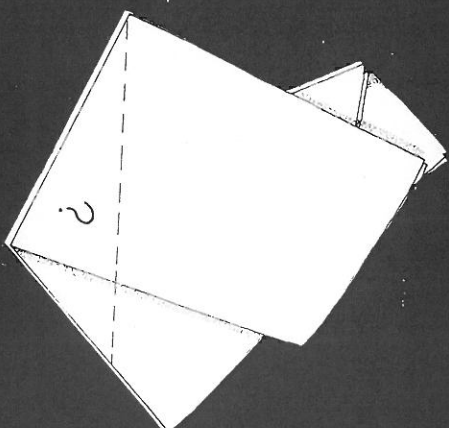
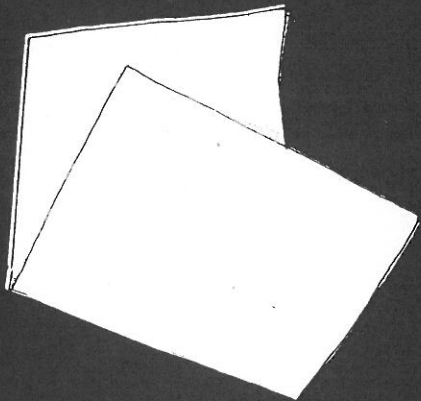
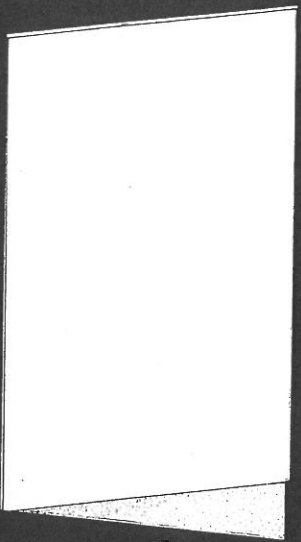
Change the angle of the cut.



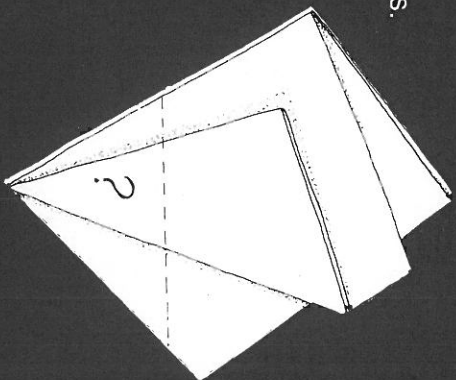
Can you make an octagon? .... a four pointed star? .... a square?

## Three folds

Experiment with 3 folds like these and one straight cut.  
*What shapes do you get?*



Change the angles between the folds.



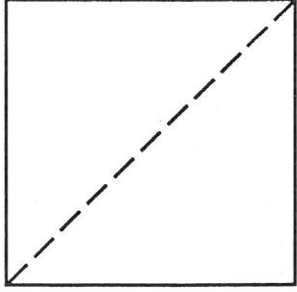
*How many different shapes can you find? What happens if the 3 folds do not all meet at one point?*

# Ask me another . . .

■ Complete the following by drawing the lines, answering the question, or writing the question yourself.

**Example**

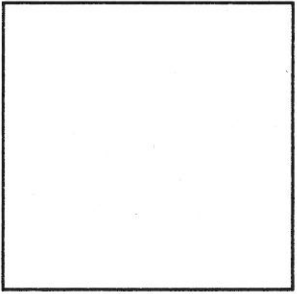
What would you get . . .  
 . . . if you drew a line from the top left vertex of this square to the bottom right vertex?



You would get . . .  
 . . . two right-angled isosceles triangles.

**1**

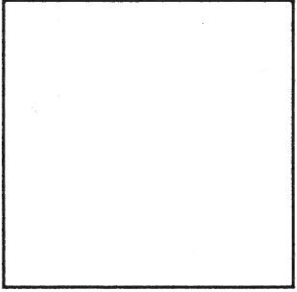
What would you get . . .  
 . . . if you drew a line from the middle of the left side to the middle of the right side?



You would get . . .  
 . . . two rectangles.

**2**

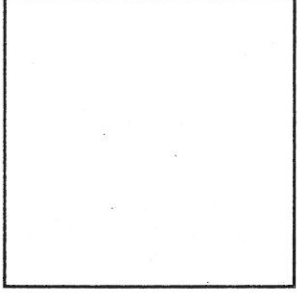
What would you get . . .  
 . . . if you drew a line from the top right vertex to the bottom left vertex, and from the top left vertex to the bottom right vertex?



You would get . . .  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**3**

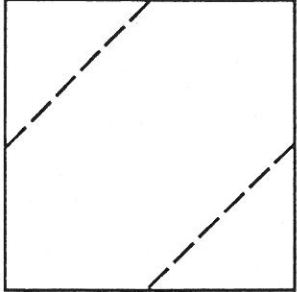
What would you get . . .  
 . . . if you drew a line from the middle of the top side to the middle of the left side?



You would get . . .  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**4**

What would you get . . .  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_



You would get . . .  
 . . . two right-angled isosceles triangles and an irregular hexagon.

**Useful words**

vertical horizontal perpendicular bisect acute obtuse

If you do not know the meaning of any of these words look them up in **2163 Geometry Facts** or a maths dictionary.

**Now try these!**

*You might like to use shading to show the shapes more clearly.*

**5**

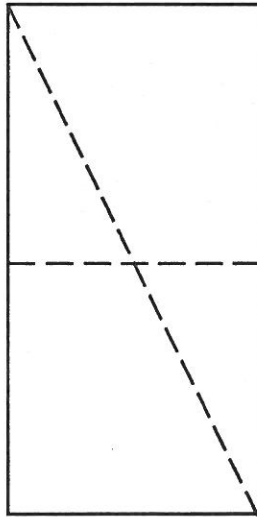
What would you get ...

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You would get ...

---

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**6**

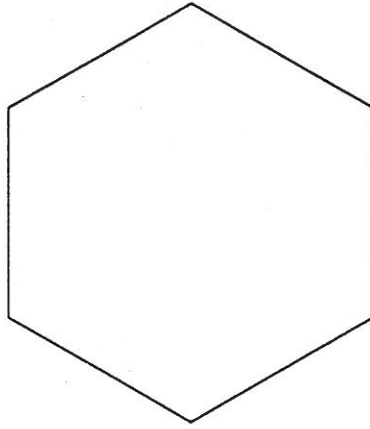
What would you get ...

---

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You would get ...

an isosceles triangle  
a right-angled triangle  
and a trapezium

---

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---

---

**7**

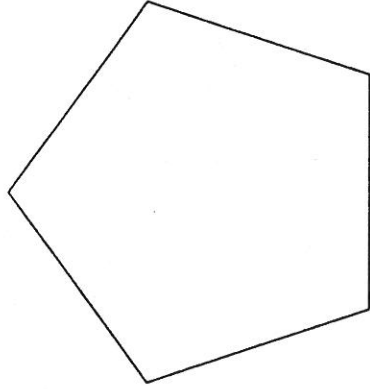
What would you get ...

---

---

---

---



You would get ...

a kite and  
two obtuse-angled scalene triangles

---

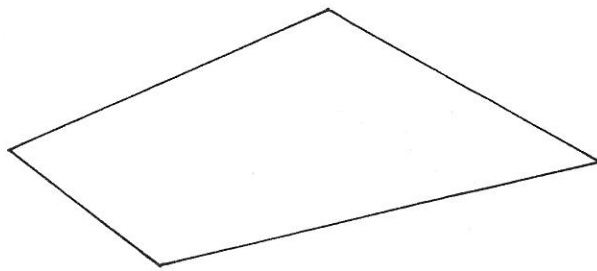
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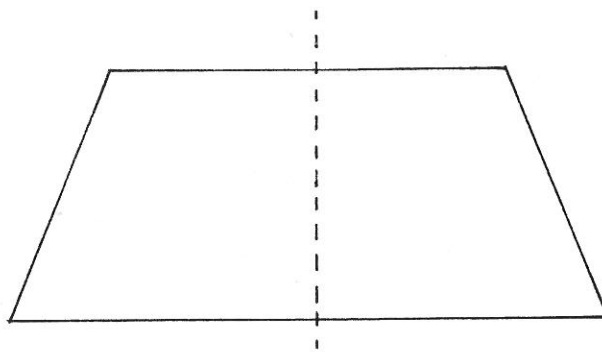
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# Polygon Symmetries

You can draw a quadrilateral with  
... no lines of symmetry



... or 1 line of symmetry.



Can you draw a quadrilateral  
with 2 lines of symmetry?

... 3 lines ... ?

... 4 lines ... ?

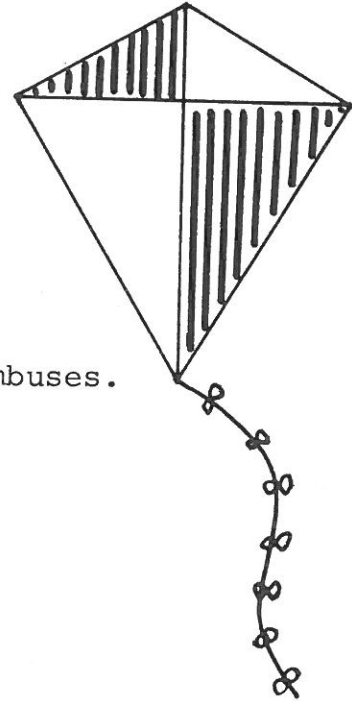
What happens with other polygons ?



You will need: worksheet 0738A

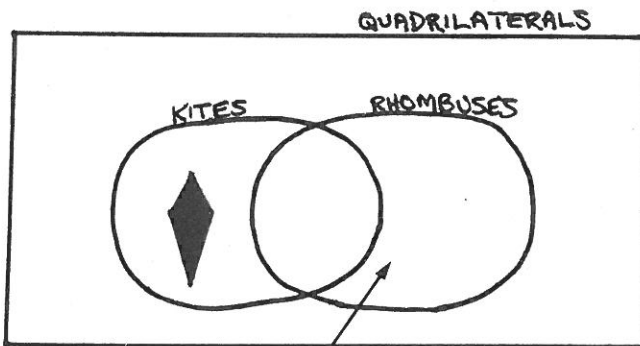
## The Family of Quadrilaterals

- (1) What do you know about the sides of a kite?
- (2) What do you know about the sides of a rhombus?



The diagram shows the sets of kites and rhombuses.

- (3) What shapes go in the intersection?

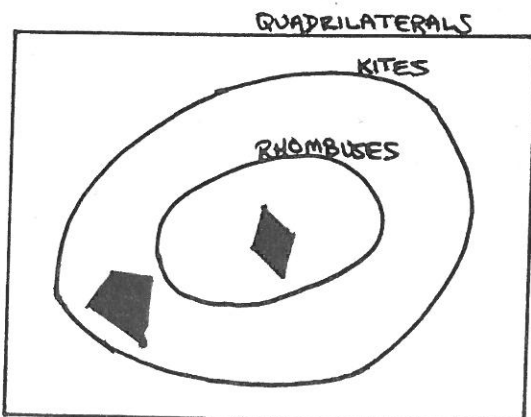


- (4) Why does this space remain empty?

### THE ARGUMENT

A kite has 2 pairs of adjacent sides equal.  
 A rhombus has 4 sides equal.  
 So, a rhombus is a special sort of kite.

So the RHOMBUSES loop fits entirely inside the KITES loop.



$$\{\text{RHOMBUSES}\} \subset \{\text{KITES}\}$$

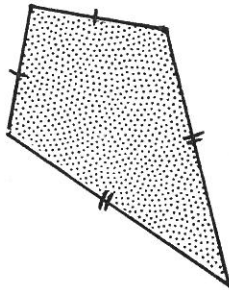
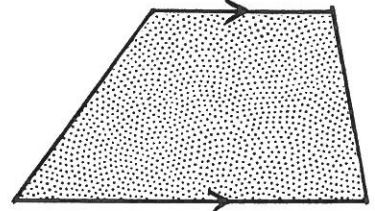
The set of rhombuses is a SUBSET of the set of kites.

- (5) It is possible to find several more SUBSET relationships within the set of QUADRILATERALS.

Compare the following pairs of QUADRILATERALS using arguments similar to the ones we used for comparing RHOMBUSES and KITES.

Write down any "is a special case of" relationships you find.

- i) {RHOMBUSES} and {SQUARES}
- ii) {SQUARES} and {RECTANGLES}
- iii) {RHOMBUSES} and {PARALLELOGRAMS}
- iv) {RECTANGLES} and {PARALLELOGRAMS}
- v) {KITES} and {PARALLELOGRAMS}



- vi) {TRAPEZIUMS} and {PARALLELOGRAMS}
- vii) {TRAPEZIUMS} and {KITES}
- viii) {RHOMBUSES} and {RECTANGLES}
- ix) {KITES} and {QUADRILATERALS}
- x) {TRAPEZIUMS} and {QUADRILATERALS}

- (6) Now fill in the arrows on the "is a special case of" diagram (0738A)

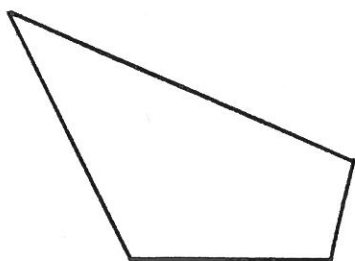
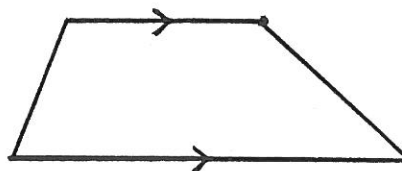
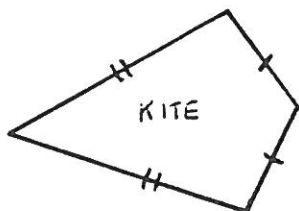
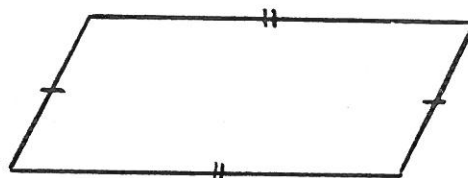
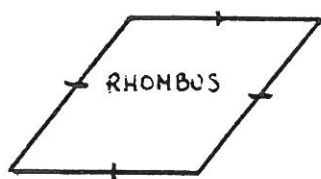
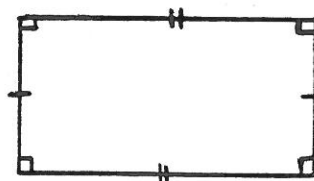
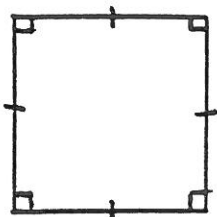
You should have eight arrows altogether.

- (7) You may have drawn up to ten two-loop VENN DIAGRAMS in your work in question 5. It is possible to combine these on one large diagram. Try to draw one.

- (8) Difficult? An outline for your diagram is drawn on the back of sheet 0738A. Now try again using this outline.

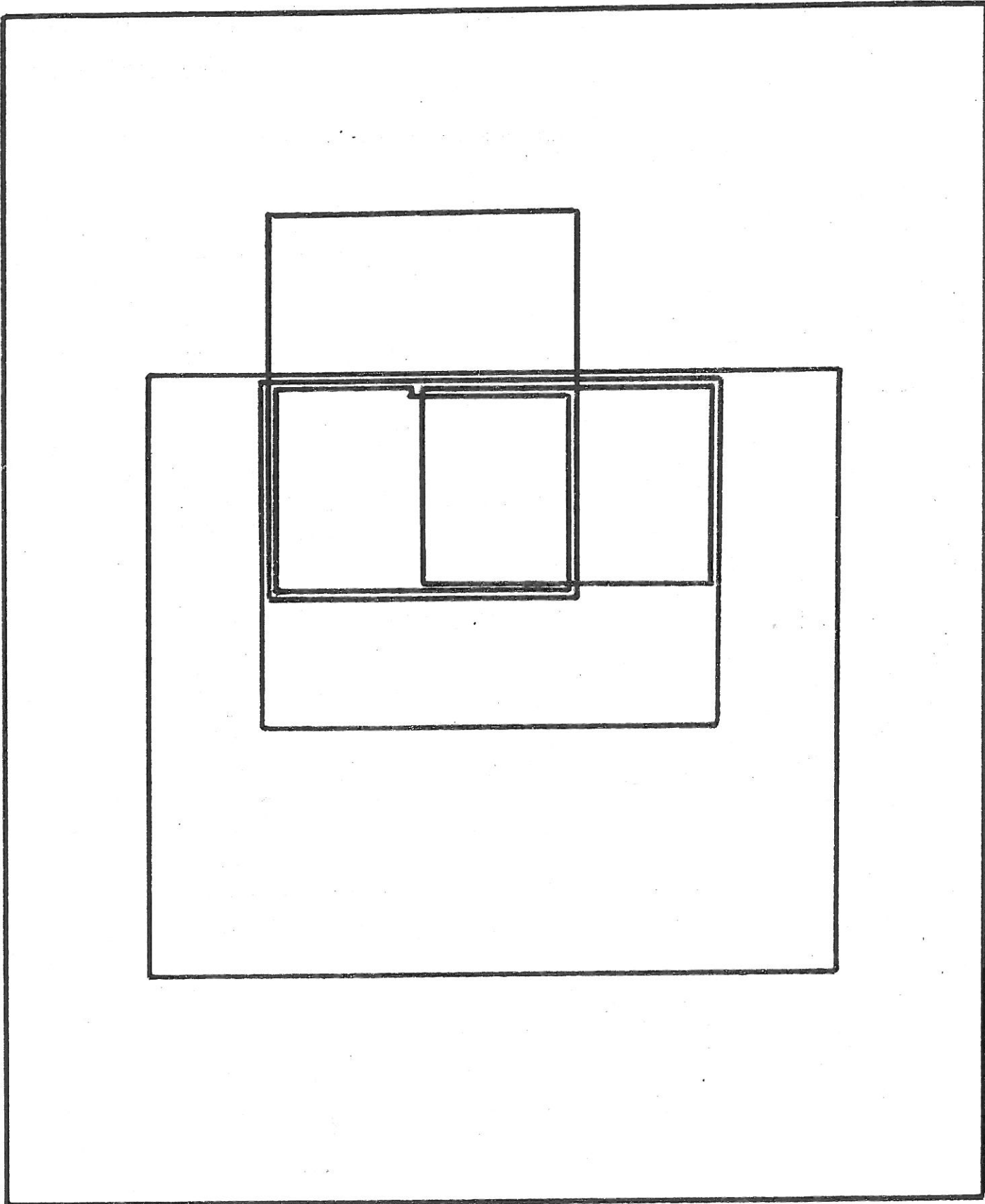


# Quadrilaterals Worksheet



A  $\longrightarrow$  B means "A is a special case of B"

NOW USE SHEET 2

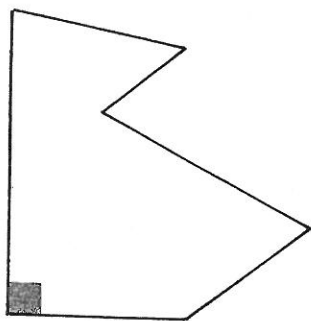


# Polygons and Right Angles

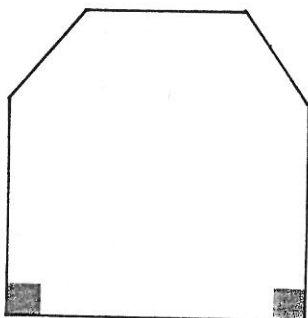
Investigate  
**how many**  
right-angles

A hexagon has 6 sides.

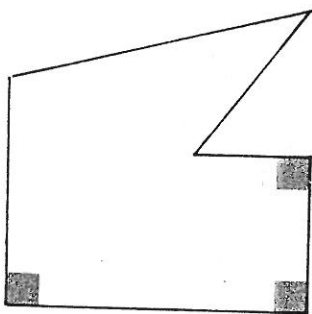
It can have ...



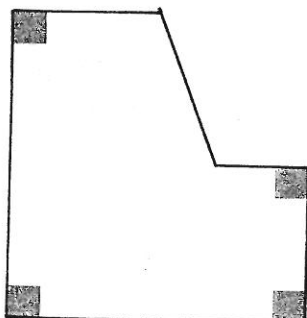
1 right angle ...



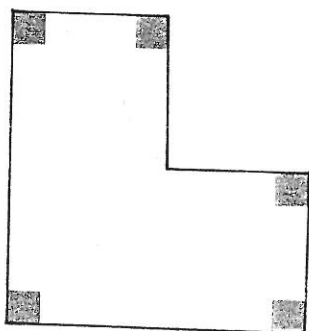
or 2 right angles ...



or 3 right angles ...



or 4 right angles ...



or 5 right angles ...

A hexagon  
cannot have  
6 right angles  
Why?

**other**  
polygons  
can have.

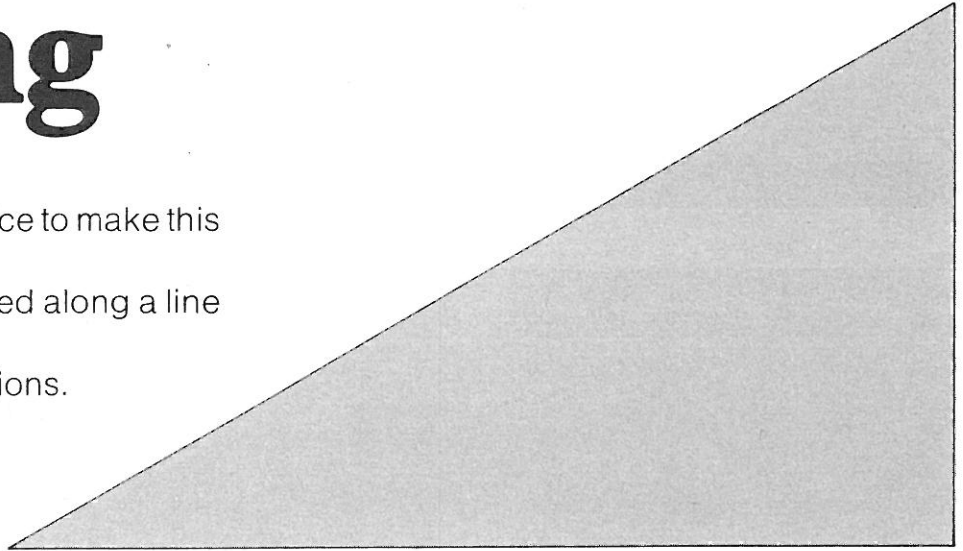


# Folding

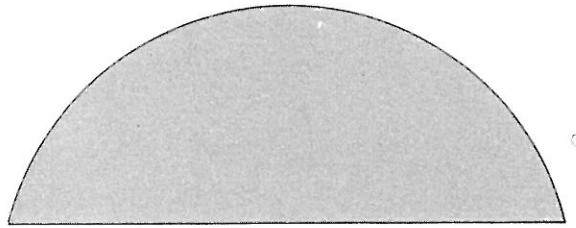
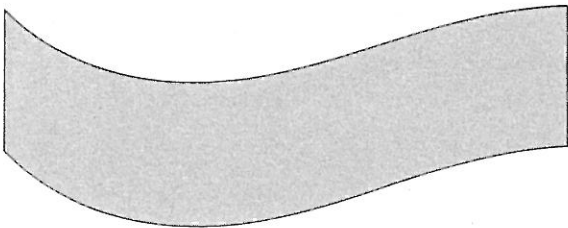
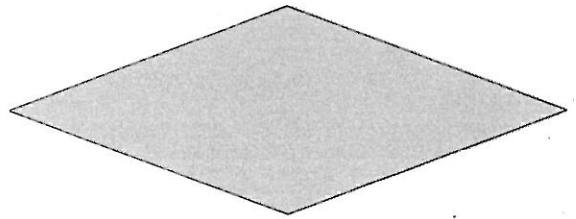
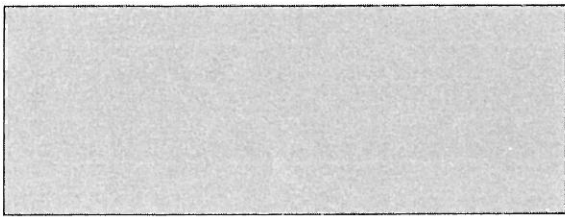
Which shape was folded twice to make this triangle?

The original shape was folded along a line of symmetry each time.

Try to find all possible solutions.



Do the same for the shapes below:





# Identical halves

Show how each one can be cut into two identical pieces.

