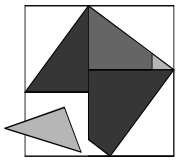


Investigating

Space and Shape

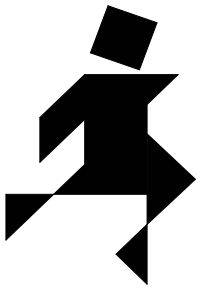
with the

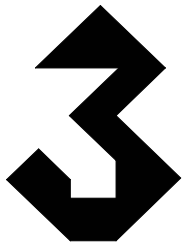
Tangram Puzzle

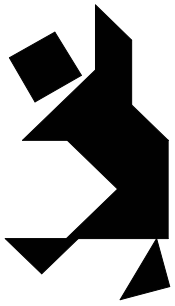
The Hands-on Approach

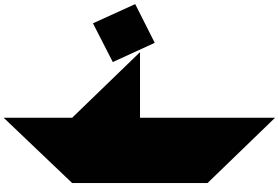
Student Booklet

Volume 1









Copyright © 2008 By Alan Bowen. All Rights Reserved. No part of this booklet may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photo-copying, recording or by any information storage or retrieval system, without the permission in writing from the author.

Recognition and Visualisation Exercises

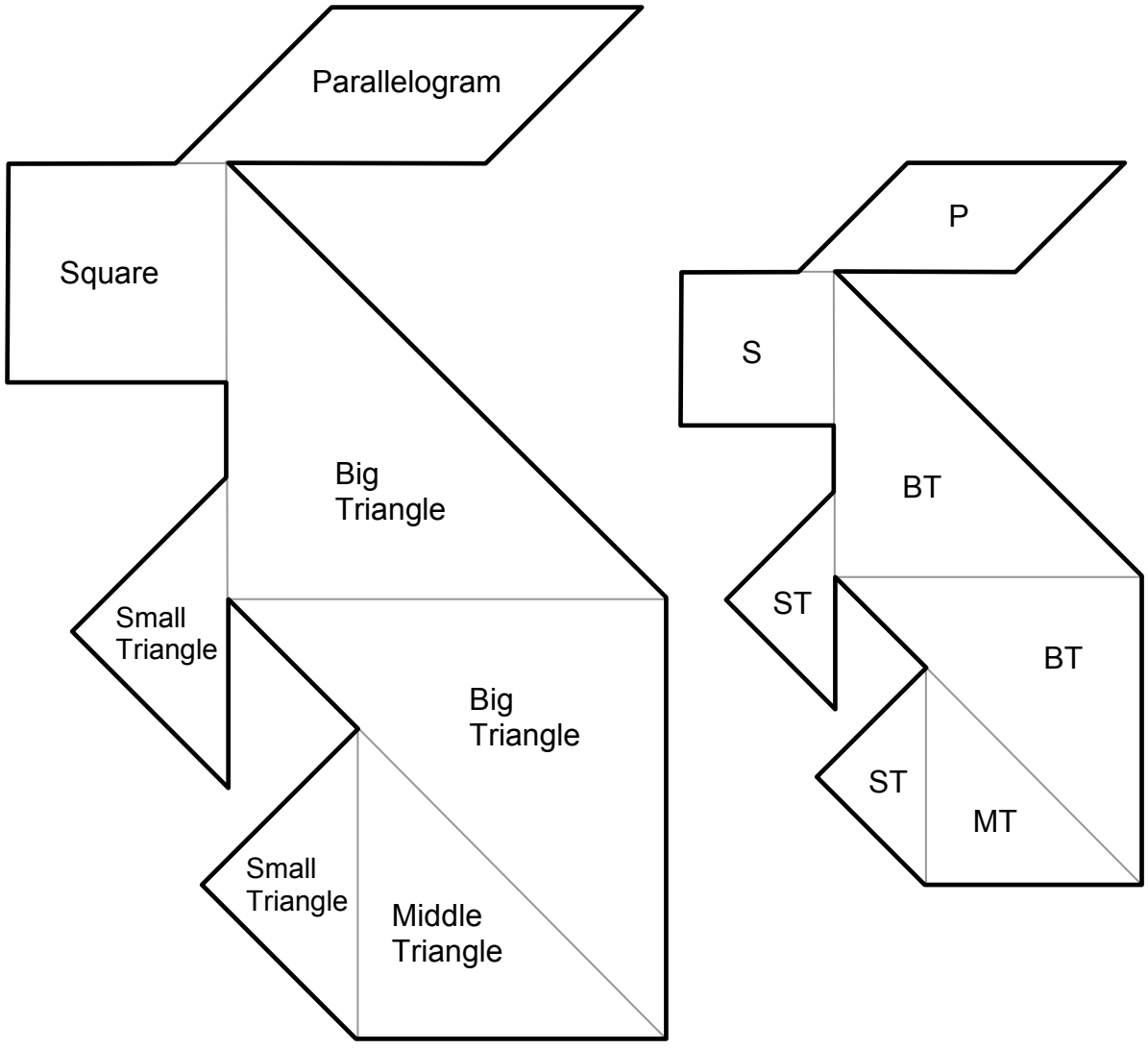
First form the shape shown below using the 7 Tangram pieces.
Then, using a ruler and a pencil, draw in the missing lines to show each piece. Next write the name of the figure inside its shape.

Instead of writing the name in full, you may want to abbreviate the words:

For square write S. For parallelogram write P. Small triangle can be written as ST. The middle triangle could be written as MT and finally the large triangle as LT.

Note: You may place the pieces on the shape below and then remove them before drawing in the lines.

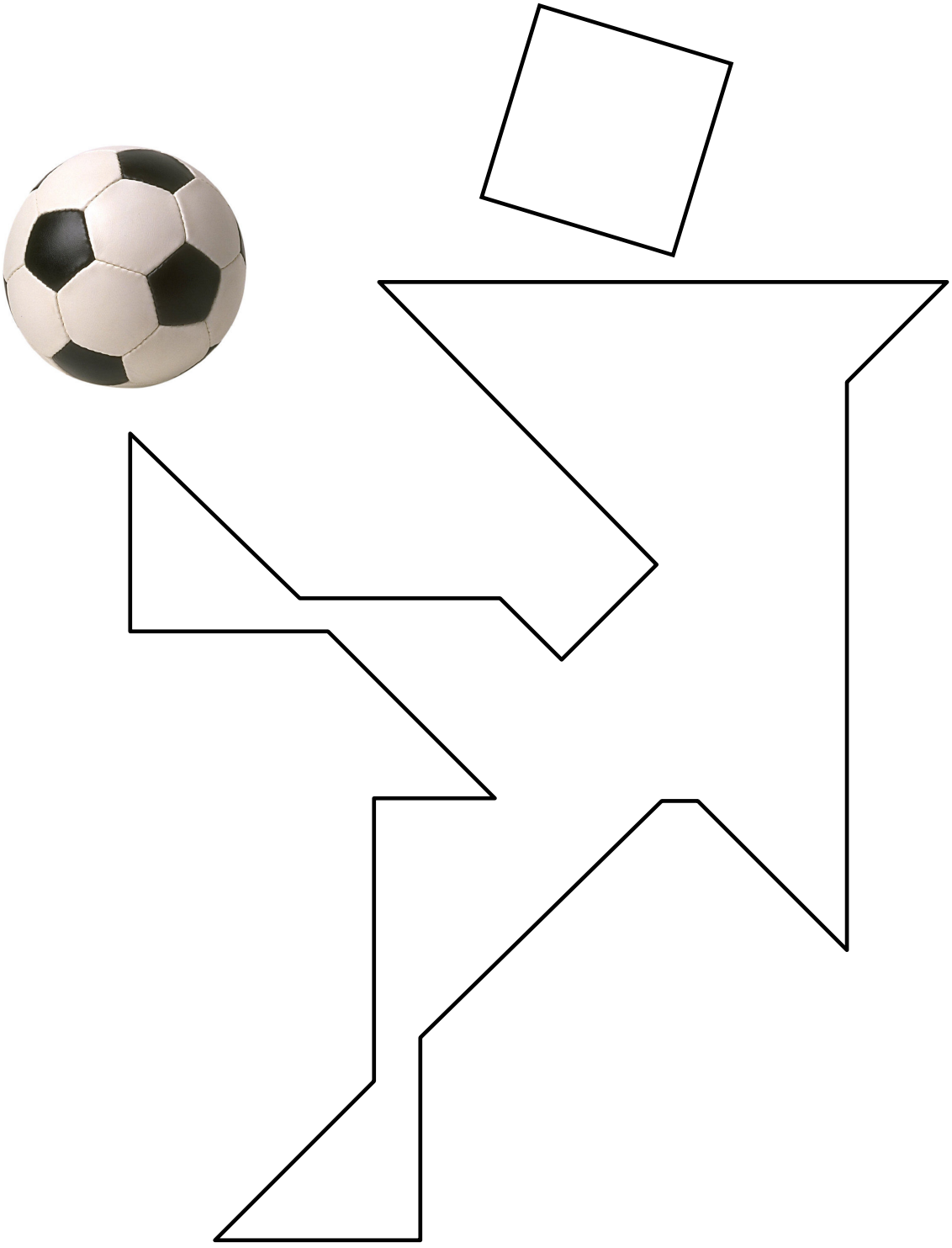
Below is an example.



Exercise 1

First form the shape shown below using the 7 Tangram pieces.
Then, using a ruler and a pencil, draw in the missing lines to show each piece. Next write the name of the figure inside its shape.

Note: You may place the pieces on the shape below and then remove them before drawing in the lines.

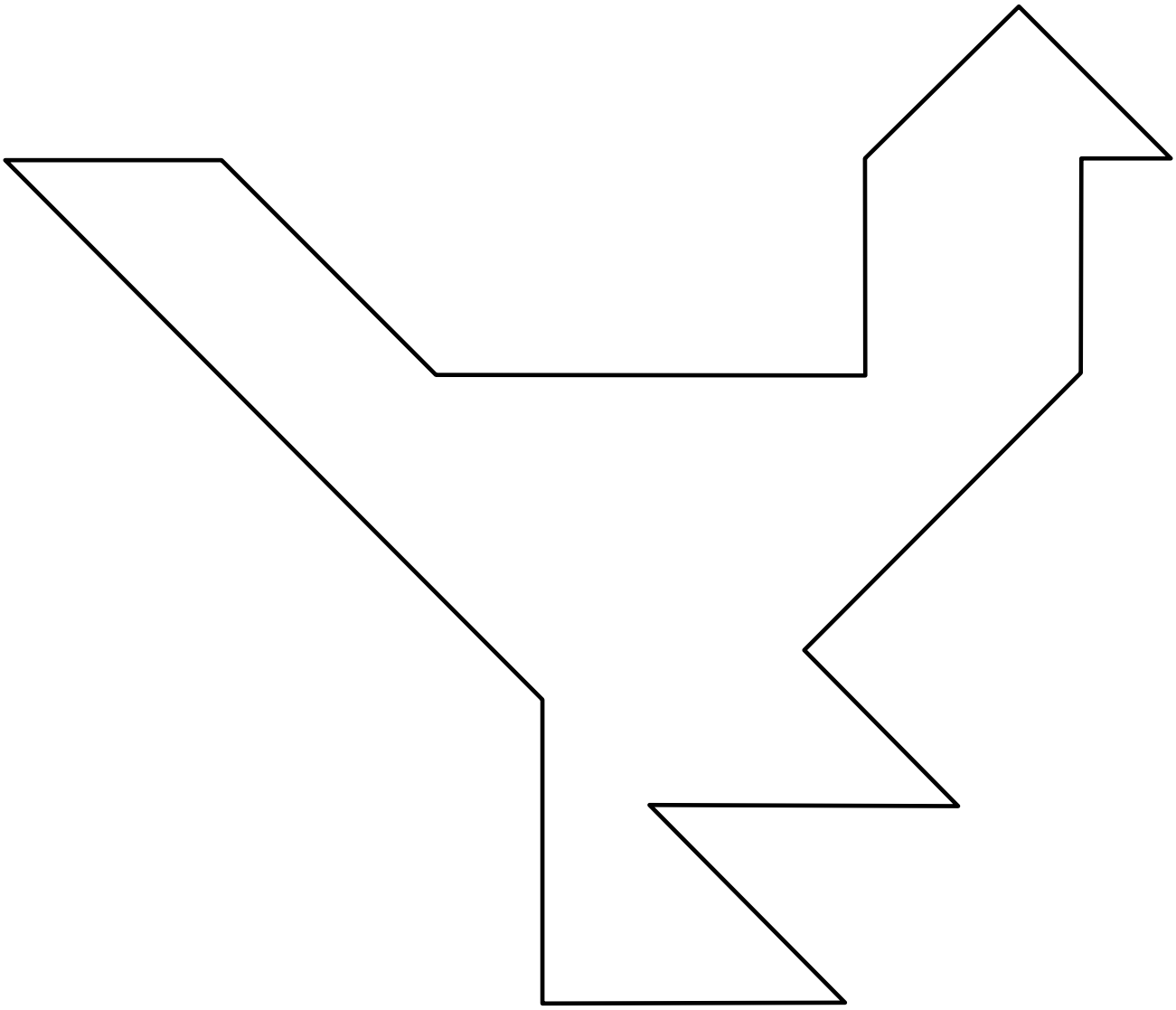


Soccer Player

Exercise 2

First form the shape shown below using the 7 Tangram pieces.
Then, using a ruler and a pencil, draw in the missing lines to show each piece. Next write the name of the figure inside its shape.

Note: You may place the pieces on the shape below and then remove them before drawing in the lines.

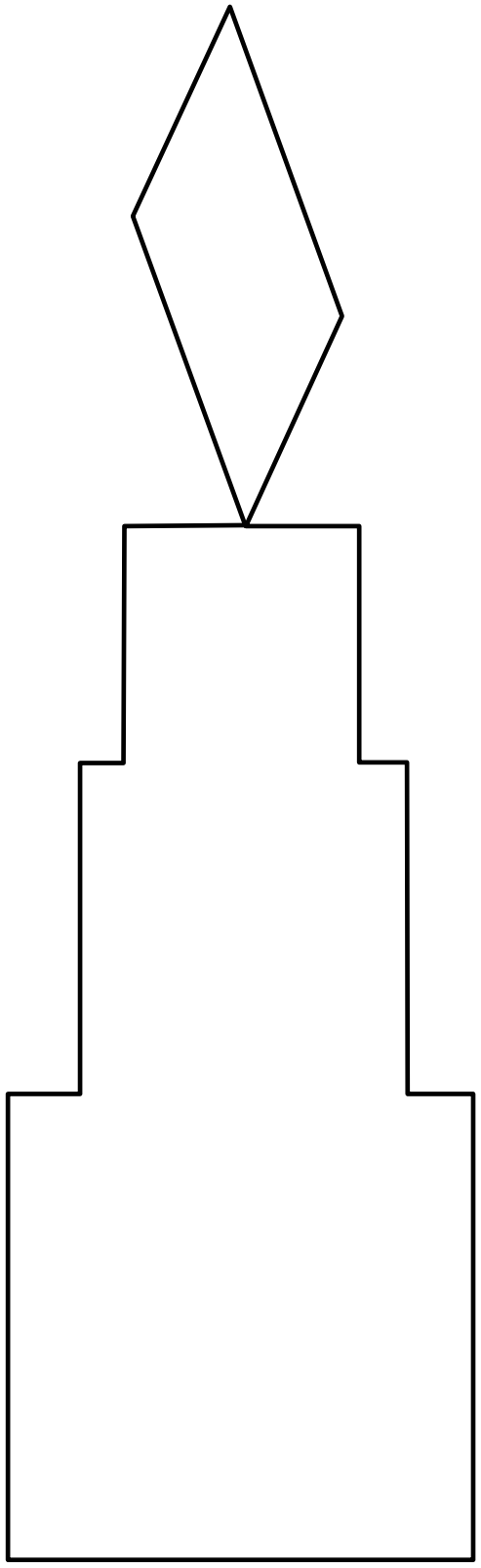


Chicken

Exercise 3

First form the shape shown below using the 7 Tangram pieces. Then, using a ruler and a pencil, draw in the missing lines to show each piece. Next write the name of the figure inside its shape.

Note: You may place the pieces on the shape below and then remove them before drawing in the lines.

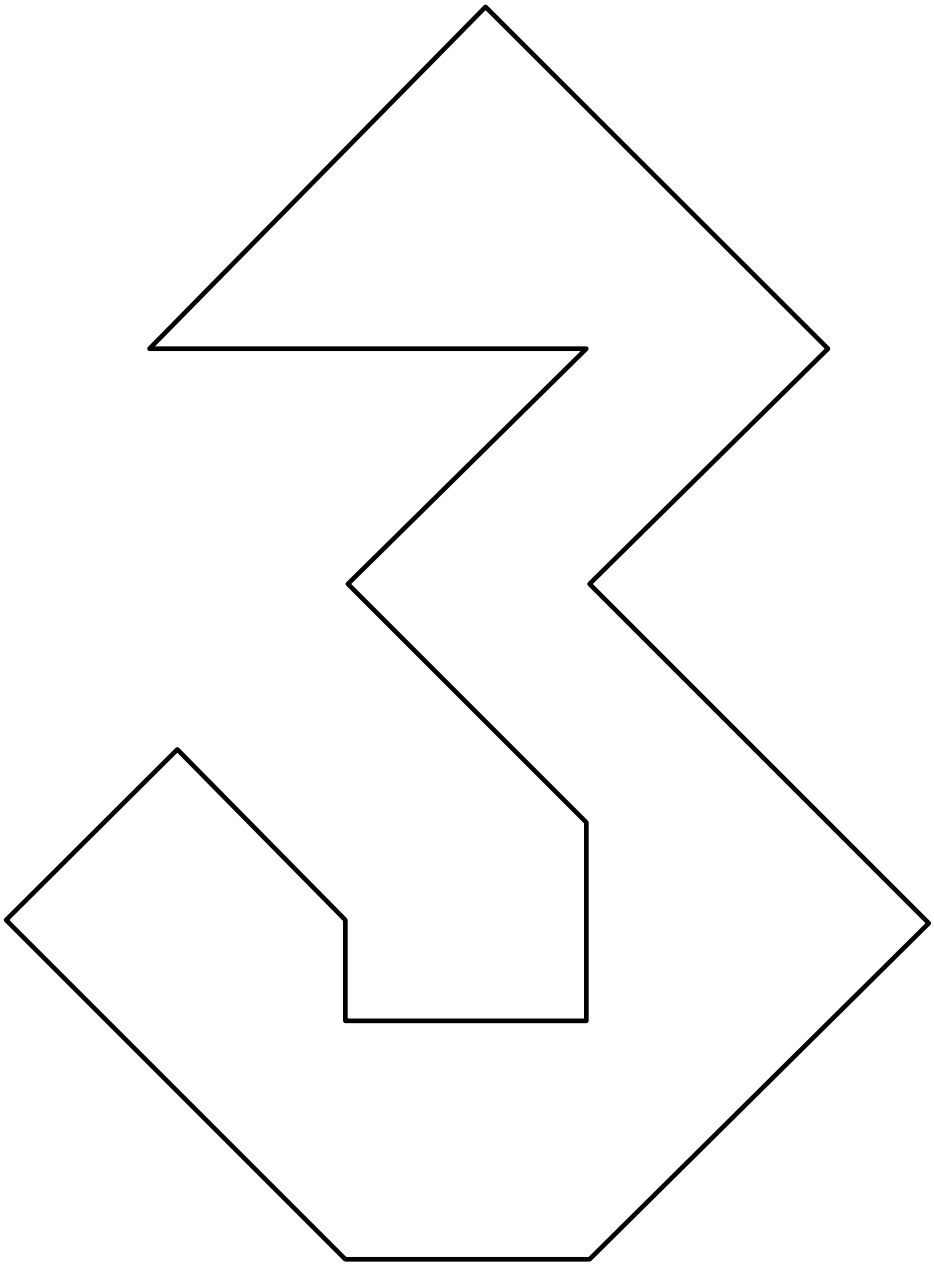


Candle and Flame

Exercise 4

First form the shape shown below using the 7 Tangram pieces.
Then, using a ruler and a pencil, draw in the missing lines to show each piece. Next write the name of the figure inside its shape.

Note: You may place the pieces on the shape below and then remove them before drawing in the lines.

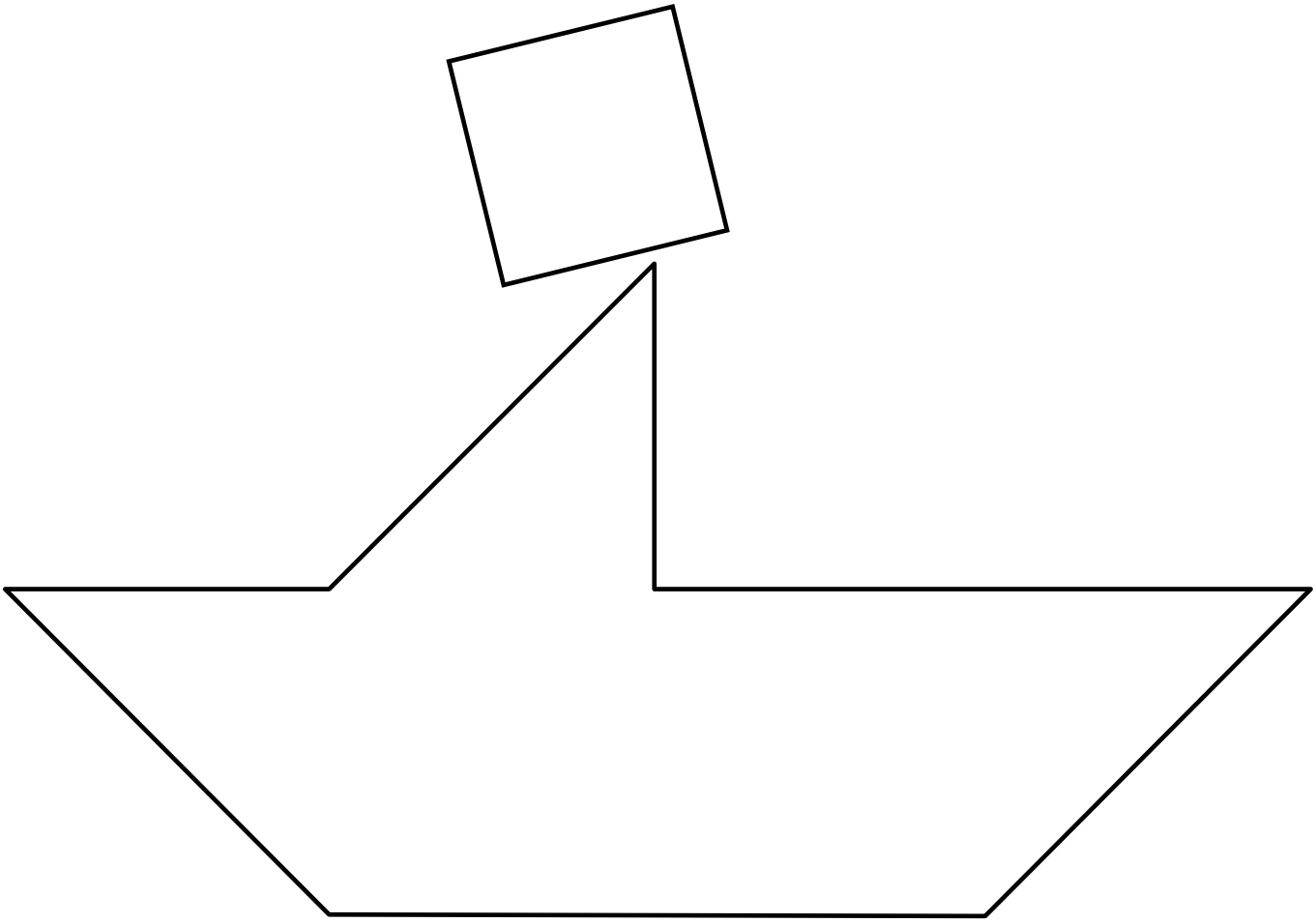


Number 3

Exercise 5

First form the shape shown below using the 7 Tangram pieces.
Then, using a ruler and a pencil, draw in the missing lines to show each piece. Next write the name of the figure inside its shape.

Note: You may place the pieces on the shape below and then remove them before drawing in the lines.

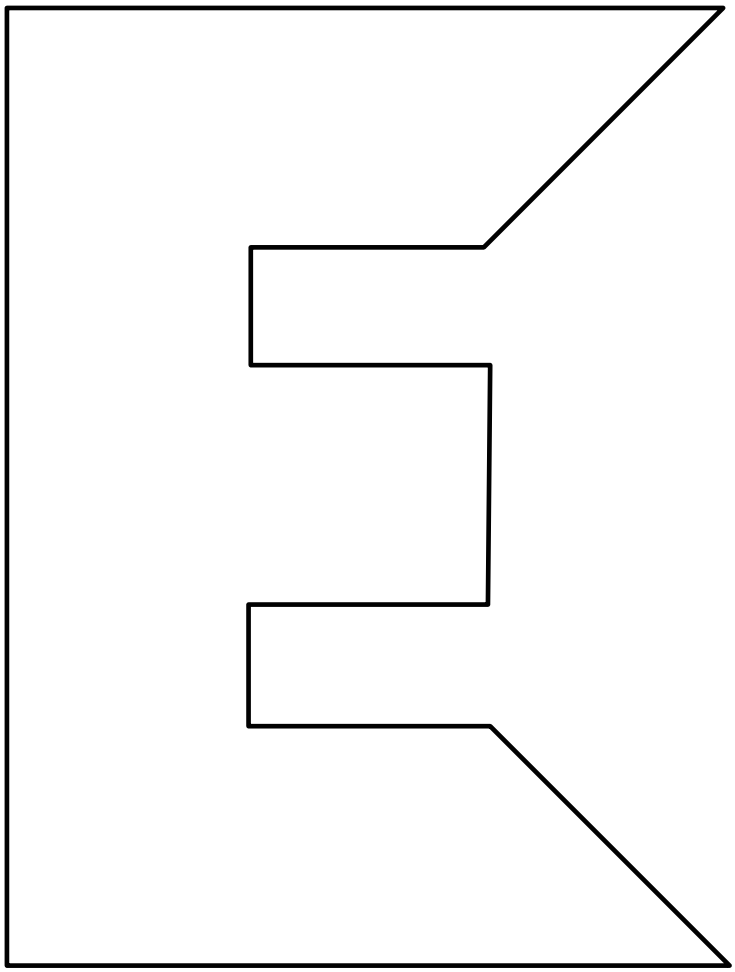


Person in Boat

Exercise 6

First form the shape shown below using the 7 Tangram pieces.
Then, using a ruler and a pencil, draw in the missing lines to show each piece. Next write the name of the figure inside its shape.

Note: You may place the pieces on the shape below and then remove them before drawing in the lines.

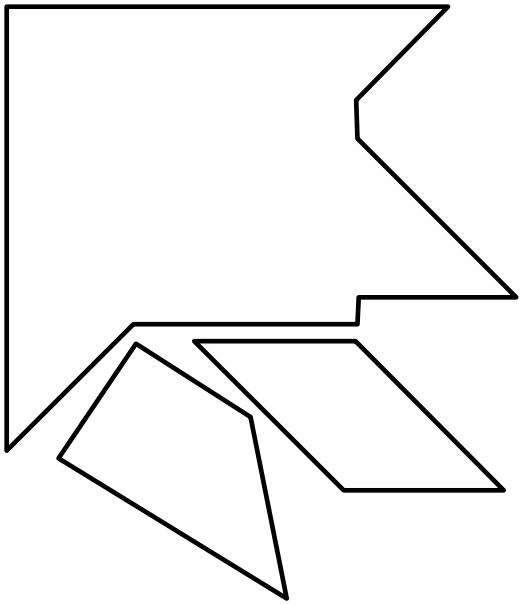


Letter E

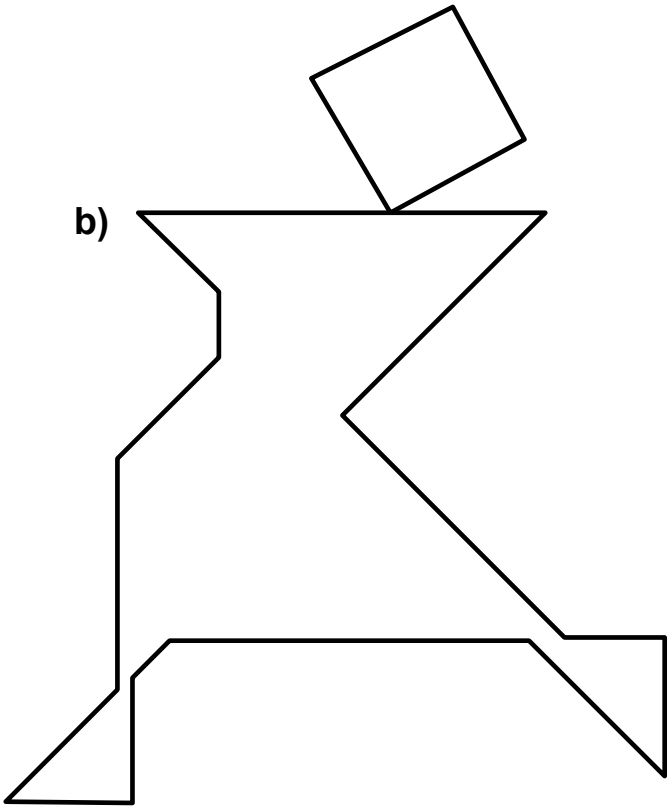
Exercise 7

Draw in the missing lines without the help of the Tangram pieces.

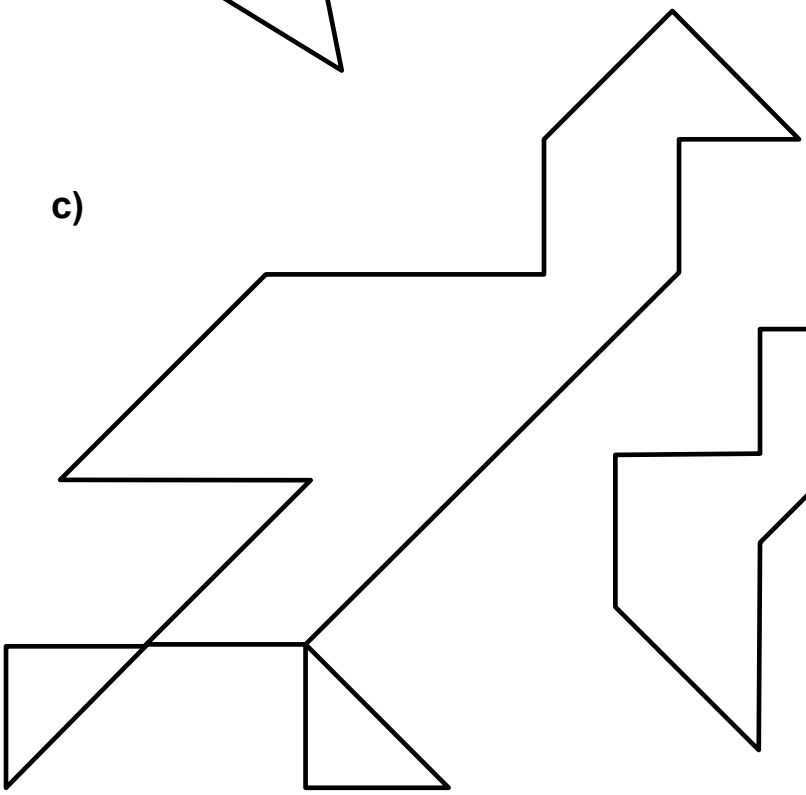
a)



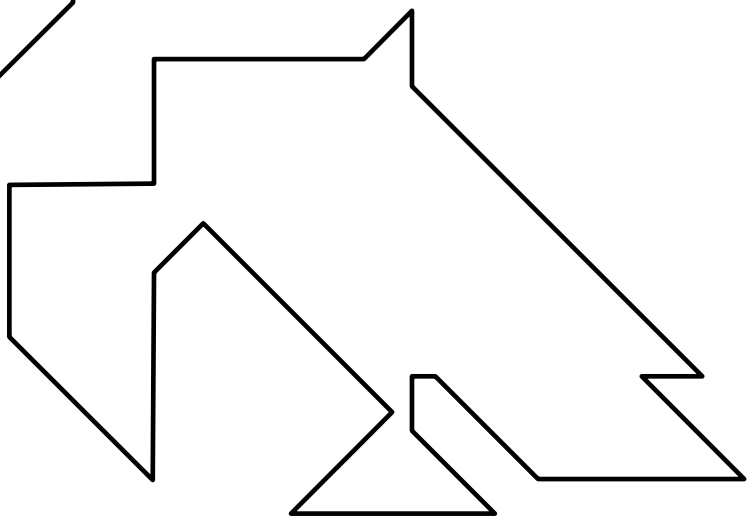
b)



c)



d)



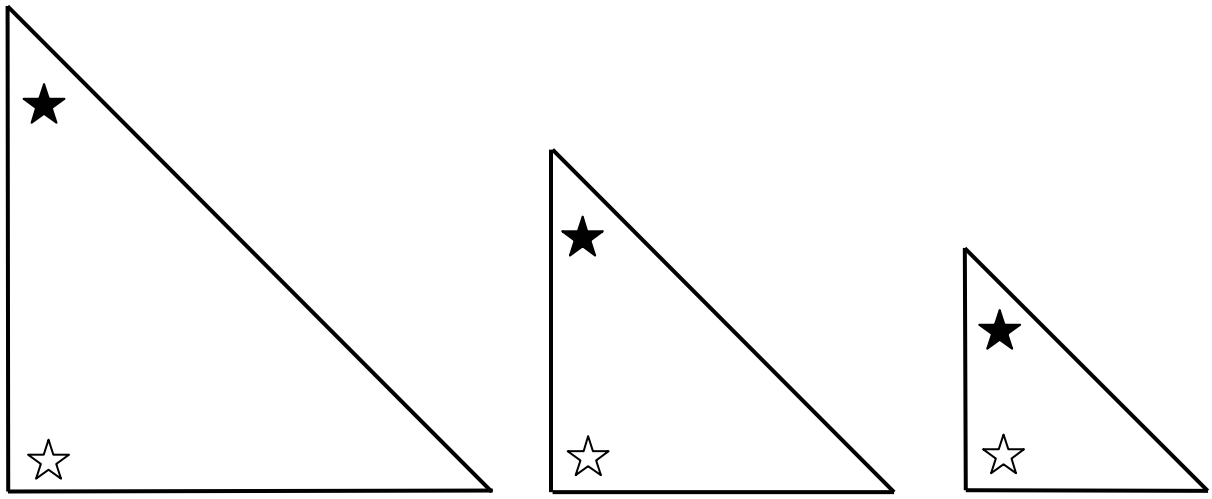
Hints: Figures: a, b and c can be done with 4 lines; figure d can be done with 6 lines.

Exercise 8 Lines and Angles of Triangles

When two lines meet each other an angle is formed. The point where the lines meet is called the vertex. (The plural of vertex is vertices).

How many sides does a triangle have? ____ How many angles? _____

Place three triangles over the outlines and then answer the questions that follow.



1. What is the size of ☆? _____

2. How can we show that they are all the same size?

_____

3. What is the size of ★? _____

4. How can we show that they are all the same size?

_____

5. What are the sizes of the unmarked angles? _____

6. What is the common feature of all three triangles shown above?

_____

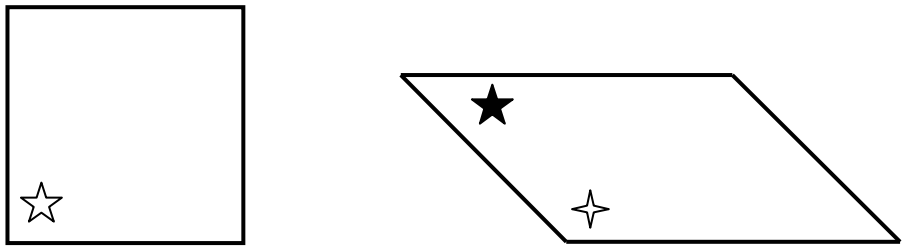
7. What do you notice about the two shorter sides of each triangle?

_____

8. We call these triangles, _____ triangles.

Exercise 9 Lines and Angles of the Square and Parallelogram

Place the square and parallelogram over the outlines.



1. What is the size of ☆? _____

2. What are the other three angles of the square equal to? _____

3. What is the size of ★? _____

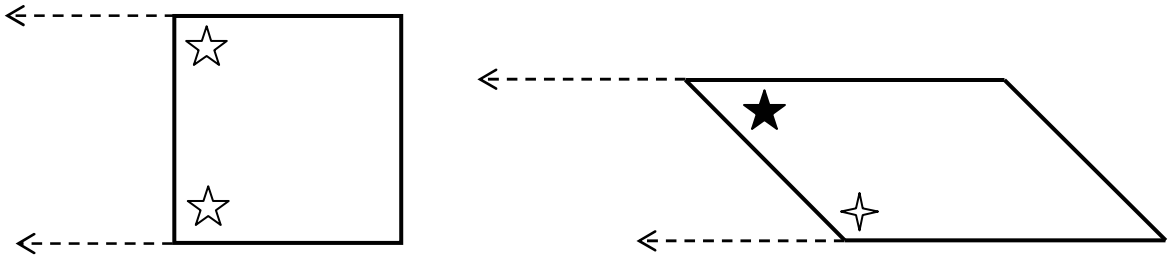
4. What is the size of ✧ ? _____

5. What are the other two angles equal to? _____

6. How can we show this using the Tangram piece and the outline?

_____

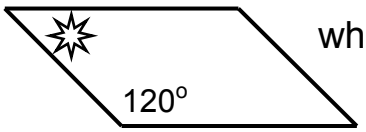
7. If we extend the opposite sides or lines of the square and parallelogram as shown below, would they meet? _____



8. These pairs of lines are called _____

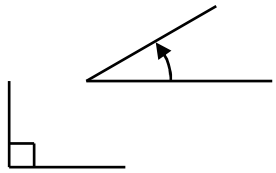
9. What is the answer if we add ☆ and ☆? _____

10. What is the answer if we add ★ and ✧ ? _____

11. If we had 

what would the size of ✸ be? _____

The Names of Angles

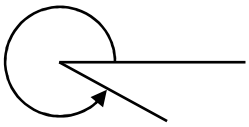


Any angle between 0^o to 90^o is called an **acute angle**.

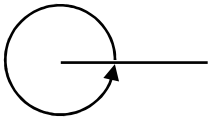
An angle of 90^o is called a **right angle**.

Any angle between 90^o to 180^o is called an **obtuse angle**.

An angle of 180^o is called a **straight angle**. (Why?)



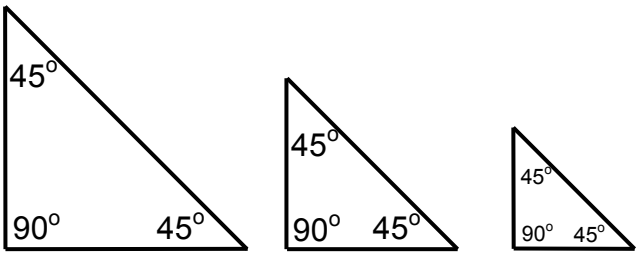
Any angle between 180^o to 360^o is called a **reflex angle**.



An angle of 360^o is called a **revolution**.

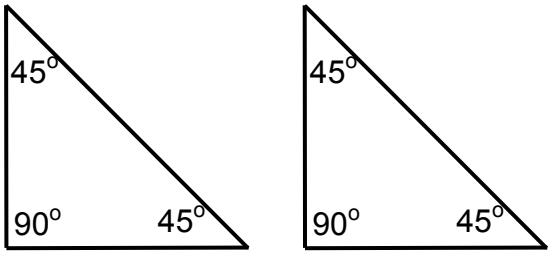
Summary

The Tangram triangles are called right-angled isosceles triangles.

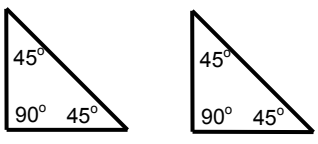


They are called **similar** triangles because each triangle has 90^o, 45^o and 45^o for its angles. (Their shapes are the same but their sizes differ).

However in the case of the two big triangles or the two small triangles, the angles **and** the sides are the same. These pairs are identical or **congruent** to each other.



An identical or **congruen**t pair



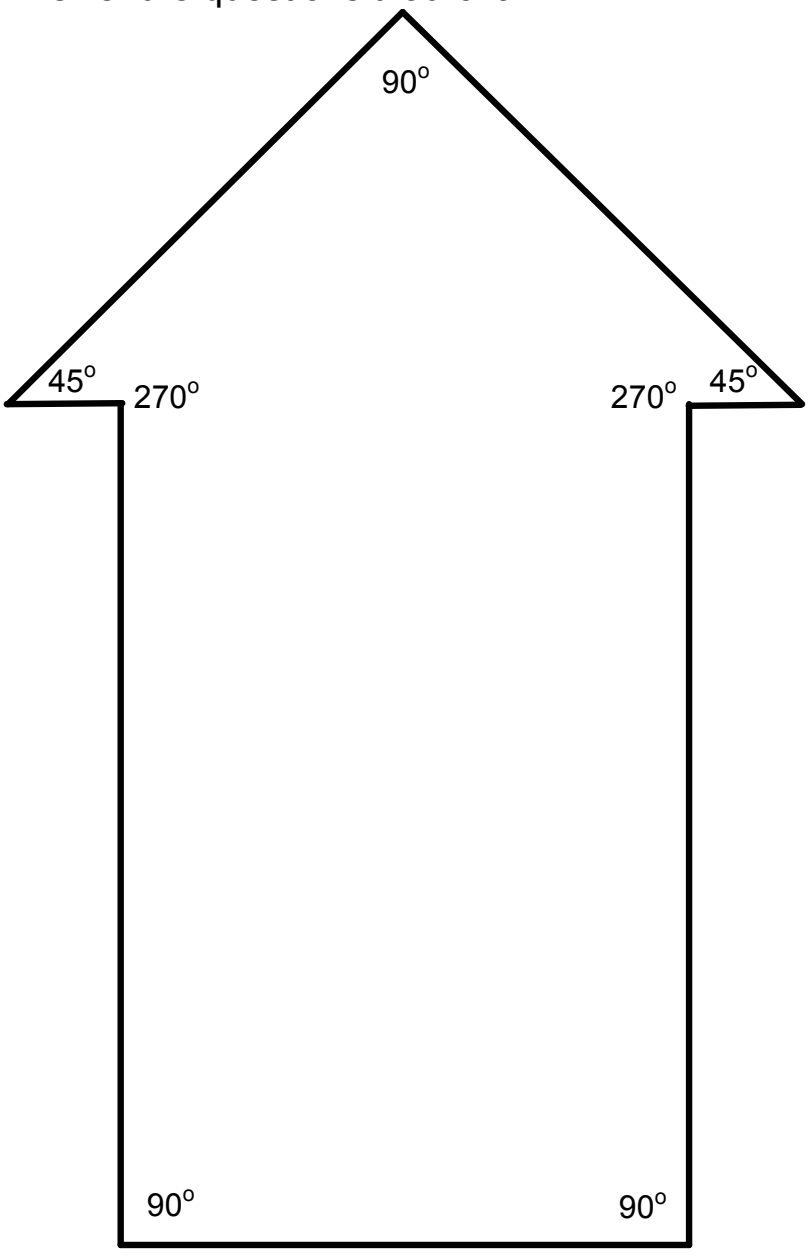
An identical or **congruen**t pair

Example

First form the shape shown below using the 7 Tangram pieces.
Then, show what the internal angles are at each vertex. (A vertex is found where two lines meet each other).

Note: You may place the pieces on the shape below and then remove them before writing in the angles.

Exercise 10 Answer the questions that follow.



1. How many right angles are there in this figure?____

2. How many reflex angles are there?____

3. How many acute angles are there?____

4. What is the sum of all the angles in the figure? _____

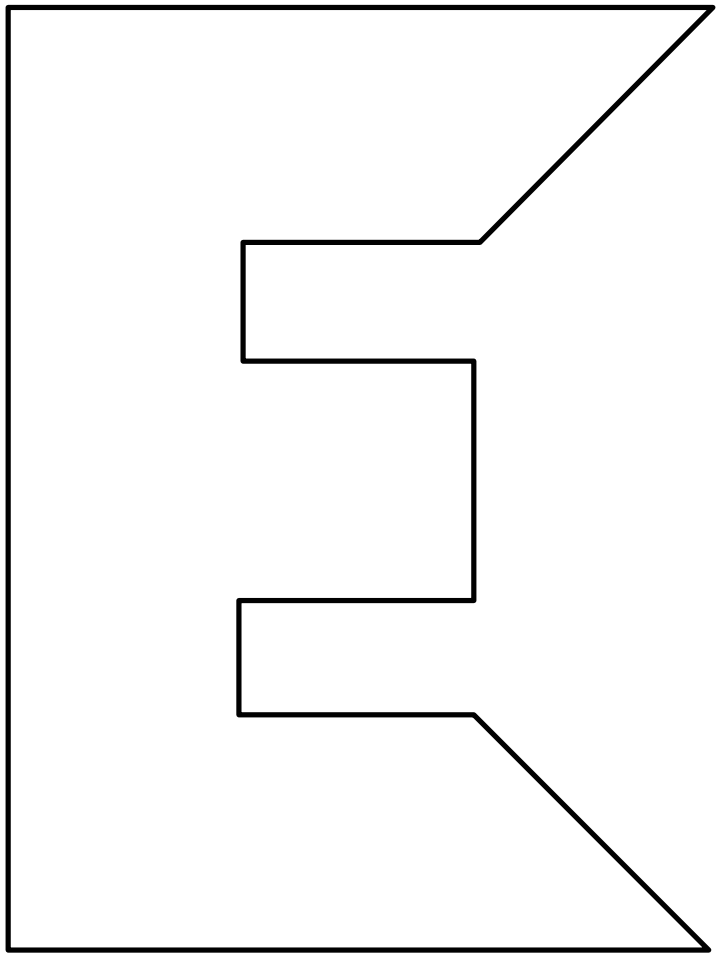
Exercise 11

First form the shape shown below using the 7 Tangram pieces.

Then, show what the internal angles are at each vertex. (A vertex is found where two lines meet each other).

Note: You may place the pieces on the shape below and then remove them before writing in the angles.

Answer the questions that follow (Consider only the interior angles).



1. How many right angles are there in this figure?____

2. How many obtuse angles are there?____

3. How many acute angles are there?____

4. How many reflex angles are there?____

5. The number of horizontal parallel lines is _____

6. The number of vertical parallel lines is _____

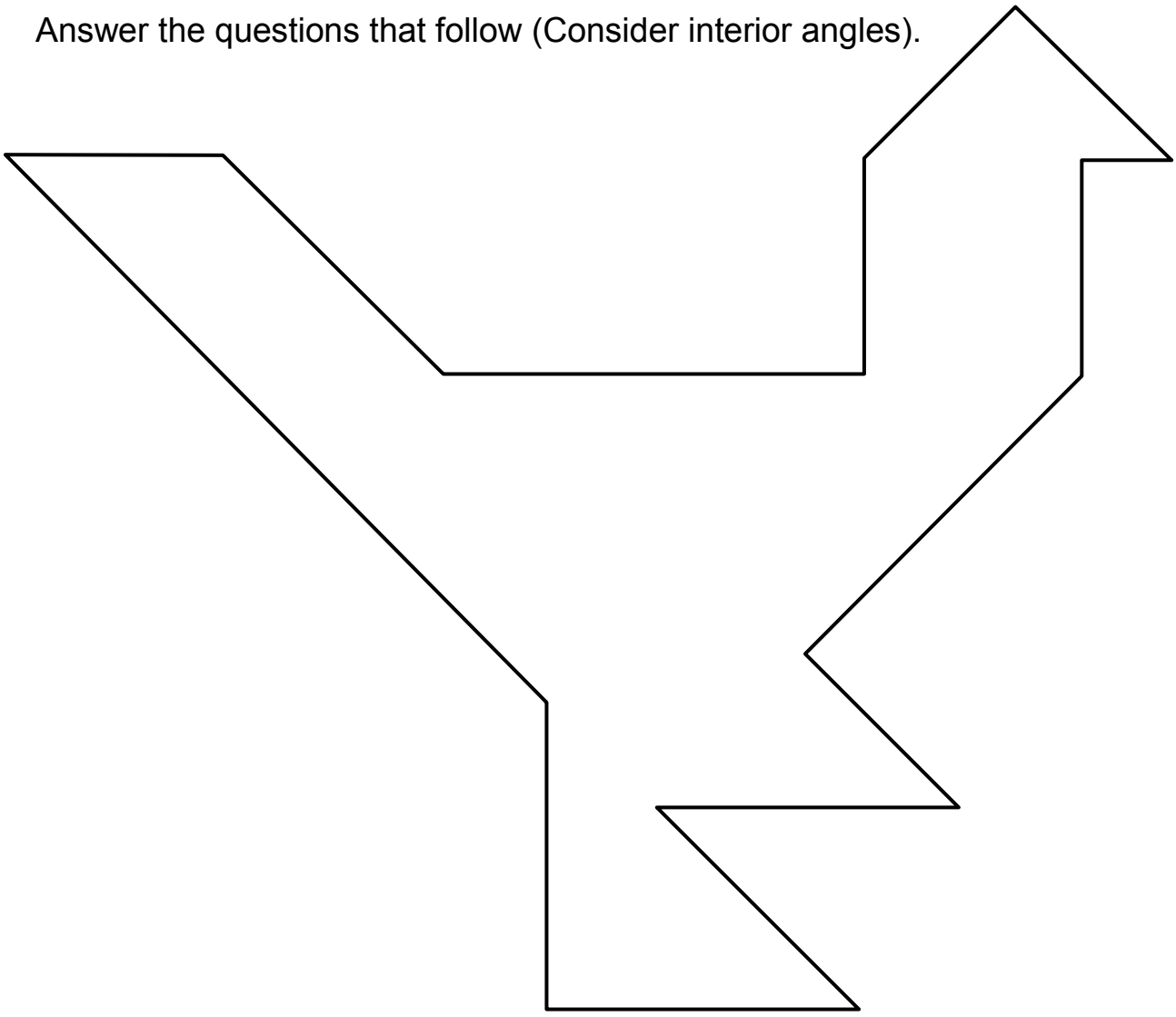
Exercise 12

First form the shape shown below using the 7 Tangram pieces.

Then, show what the internal angles are at each vertex. (A vertex is found where two lines meet each other).

Note: You may place the pieces on the shape below and then remove them before writing in the angles.

Answer the questions that follow (Consider interior angles).



1. How many right angles are there in this figure?____

2. How many obtuse angles are there?____

3. How many acute angles are there?____

4. How many reflex angles are there?____

5. The number of horizontal parallel lines is _____

6. The number of vertical parallel lines is _____

Tesselations (Using a grid)

A **tessellation** is an arrangement of (one or more) shapes which fit together to fill a space.

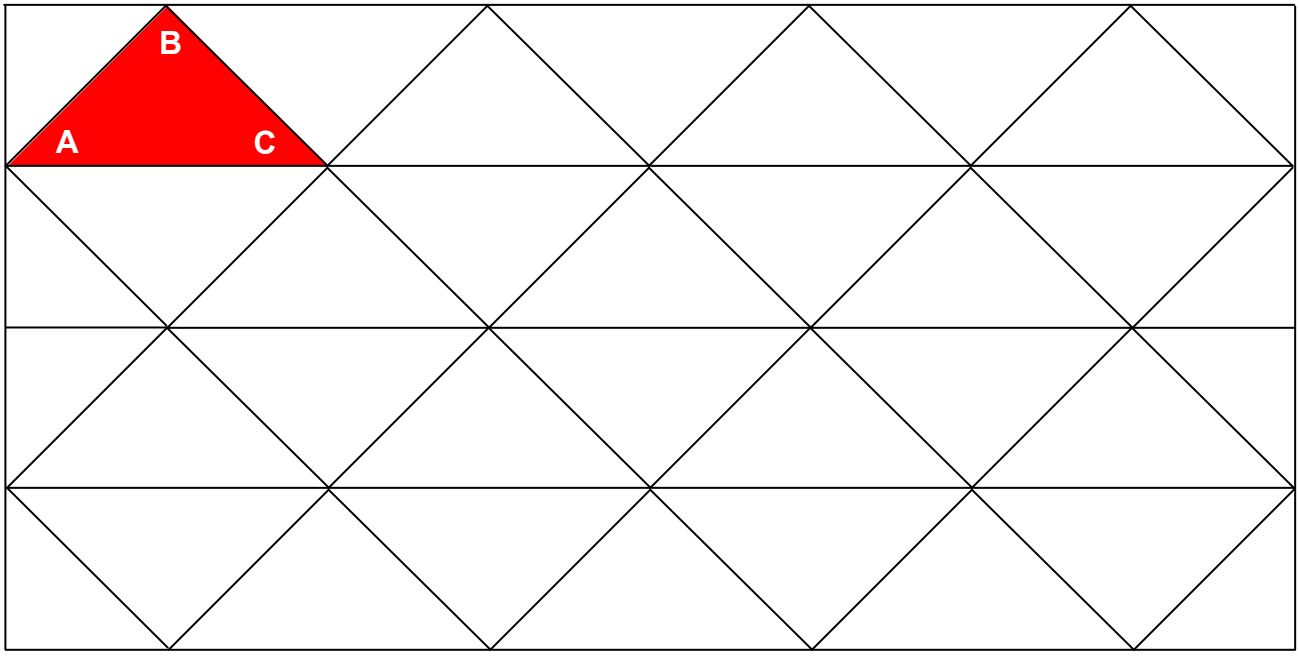
A **tiling** is a tesselation in 2-dimensional space which uses only a single repeated shape.

In the exercise that follows we shall investigate some of the properties of the Tangram shapes.

Exercise 13

Place one small red triangle over the triangle marked ABC as shown below.

1. How many red triangles would you need to cover the grid? (You may leave out the four corners because they are smaller triangles). _____



2. How many horizontal lines are there? _____

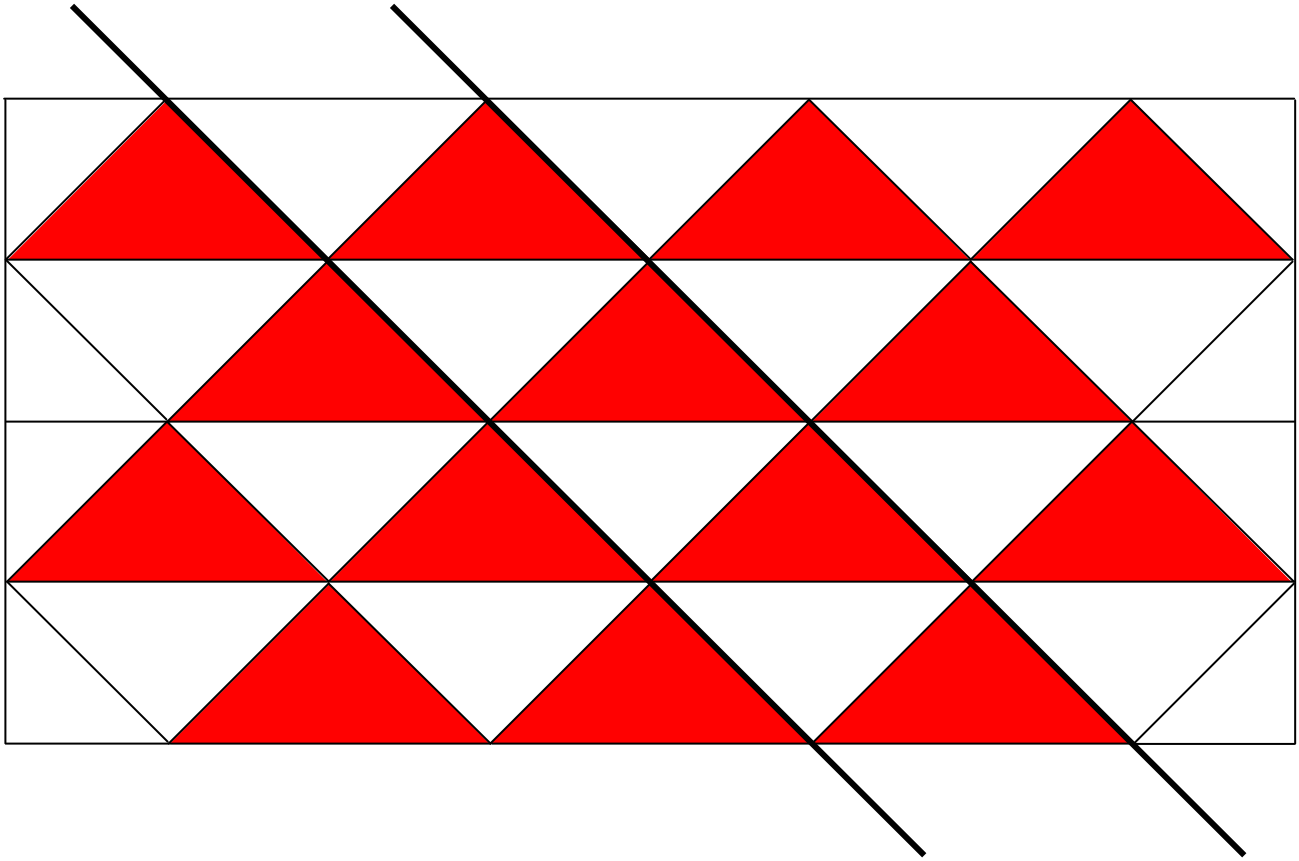
3. How many lines, sloping up from left to right ↗ are there? _____

4. How many lines, sloping up from left to right ↘ are there? _____

5. What is the special word used to describe lines like these: ↗↗↗

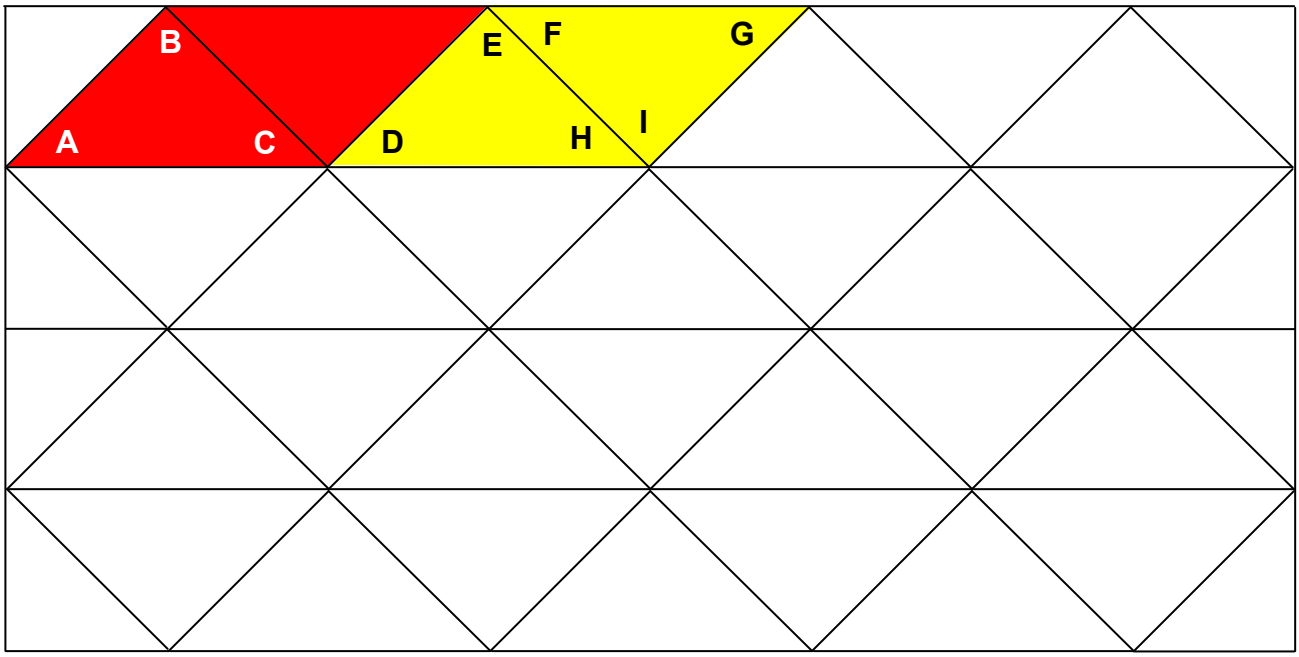
(i.e. lines which never meet) _____

Notice that if we place triangles as shown below, the sides begin to form parallel lines. Two parallel lines are shown but in fact there are many more.



Exercise 14

Next place two red triangles and the parallelogram as shown below.



1. What can we say about the area of the parallelogram compared with two red squares? _____

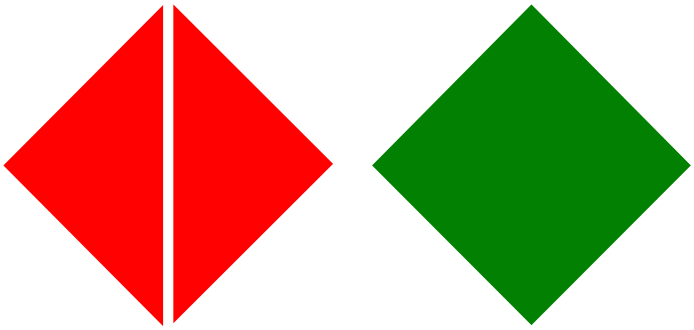
2. How would you describe the area of the parallelogram compared to one red triangle? _____

Let us investigate the angles now.

3. What are the sizes of the angles of the isosceles triangle?

   $\hat{A}$ = _____ $\hat{B}$ = _____ $\hat{C}$ = _____

   One method to check your answers is to take the square and two red triangles and place them as follows: (The four acute angles must all be equal)



4. Having worked out the sizes, what will the sum of $\hat{E}$ and $\hat{F}$ be? _____

5. To check the angles of the paralleogram, we can **spin** or **rotate** the shape through a half turn (180^{o}). What are the sizes of $\hat{D}$ and $\hat{G}$? ____

6. What are the sizes of $\hat{E}$ and $\hat{F}$ as well as $\hat{H}$ and $\hat{I}$? _____

7. What conclusion can you make about the opposite angles of the parallelogram? _____

8. Finally, write down an important property about the opposite sides of a parallelogram. _____

   _____

(Half spin the parallelogram to double check your answer)