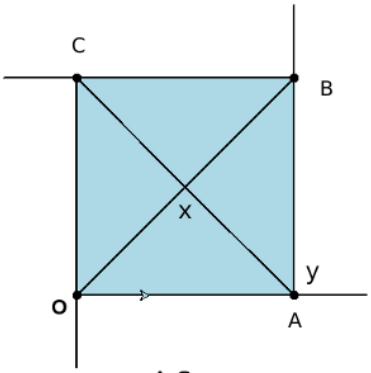
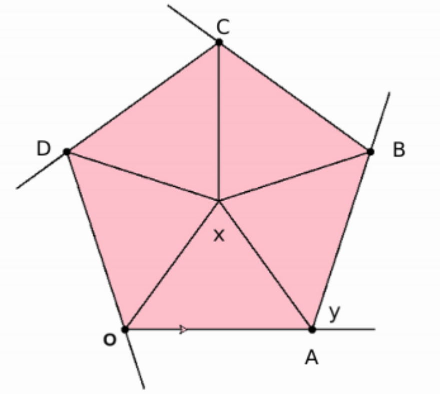
UCL/CAS Training for Teachers
Algorithms and Programming Module 1



A Square



A regular pentagon

WORKBOOK 10
ACTION GEOMETRY
SQUARE AND PENTAGON

- Action Geometry Unplugged: starting with the square, we explore the properties of simple regular polygons, circles, stars with a view to designing our own unique coloured patterns. We use an unplugged approach with the sprites and turtles of Scratch, Logo, Python and Coffeescript to investigate the static and dynamic geometry of shapes. We employ learning and teaching strategies which call on experimentation, deduction from symmetry, pattern recognition, induction, decomposition and generalisation.

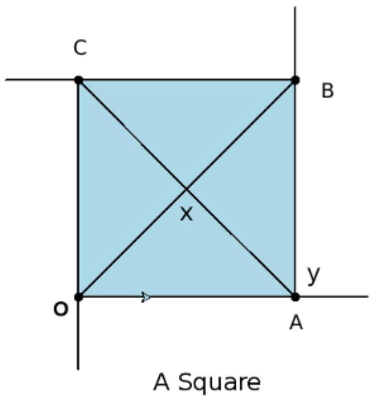
Activities are graded: easy to hard – 0 to 5*.

CONTENTS

MISSION 1: 'UNPLUGGED': BACKGROUND KNOWLEDGE OF GEOMETRIC SHAPES

- This section mimics the tracing action of the sprite/turtle of Scratch and Python; and its awareness only of its:
    1. present position
    2. turning angle/direction.
- The emphasis in this workbook is on learning by doing, experimentation, deduction from symmetry, induction and ***decomposing, generalising, abstraction***
- You will be asked to devise your own questions to support and challenge your class in Activities 3 and 4 --- enquiry-based learning exercises. Activity 3 and the start of Activity 4 contain some example illustrations.

"ACTION GEOMETRY": MIMIC THE SPRITE/TURTLE



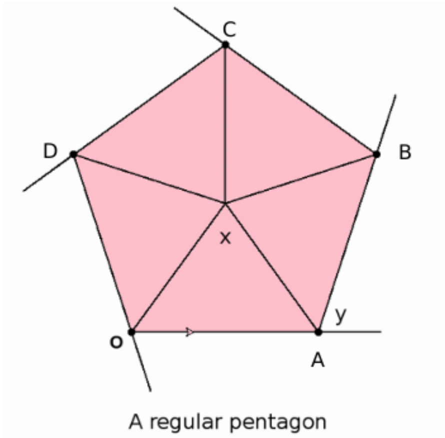


Figure 3. *action geometry:* symmetry, draw the square and the pentagon like a pet/sprite/turtle

ANGLES AND SPIN (360)

- Patterns are not all symmetric. Some people are able to recognise crossword solutions by patterns of letters. Can you find words to fit the following crossword patterns?

  _ A _ T _ _ N and _ _ _ M _ T _ Y
- This next exercise lends itself to introduce computational thinking in different ways and at different levels. For example, it could be undertaken as a formal lesson in geometry. Here we suggest that the teacher uses an enquiry-based approach to encourage and support computational thinking by appealing to symmetry, pattern recognition and induction through 'action geometry' in the first instance, and to principles of ***decomposition and generalising*** to complete the task.

- Devise a set of questions to form an enquiry-based exercise to help your class to formulate how to calculate angles x and y in the square in Figure 3 (y is the turning angle for the sprite/turtle when tracing out the figure). We are more interested in this formulation than the actual values of the angles because that may provide clues for what is to follow.

- Afterwards use exactly the same questions but substitute the words 'regular pentagon' wherever you see the word 'square' in your questions. The questions should lead the class to calculate the values of the angles x and y when applied to the pentagon. Here are a couple of example questions to start:

First the Square: (a 4-sided simple, regular, symmetric polygon)

Decomposition:

Some starter questions:

(a) What are the properties of a square? What makes a four-sided figure a square?
(b) Why is "The lengths of the 4 sides must be equal" not enough to define a shape as a square. (only a *necessary* condition to be a square)
(c) Why is "The 4 angles must be equal" not enough to define a 4-sided figure as a square
(d) What conditions do you have to insist on to make sure that in your four-sided figure you have a square? (*sufficient* to be a square)

……..

"Action Geometry" some starter questions:

(e) Hint: If you turn round completely once and face the same way as you started, how many degrees have you turned through? We will call this a SPIN.
(f) What can you say about are the other angles at the centre of the square in relation to angle x?
(g) Hint: In the diagram of the square, start at O follow the arrow to A, turn through angle y go on to B and continue round the square until you come back to O and face in the original direction. What angle did you turn through at B?
(h) How many turns did you make in total, in order to face the same way as you started?

Generalising from the known to the unknown questions:

In the last example with the square, we may have known from our experience what the values of x and y are. In other polygons, we may not be so familiar with angle sizes, hence the importance of *how we work the values of x and y out* with the square. We then have a possible basis for *generalising* to the pentagon.

MORE ANGLES AND SPIN(360)

- Now the pentagon: (a 5-sided simple, regular, symmetric polygon). Use exactly the same questions you devised for the square but substitute the words 'regular pentagon' wherever you used the word 'square' (***generalisation***)

- What are the properties of a regular pentagon? What makes a five-sided figure a regular pentagon?
- Note: A sufficient condition for a polygon to be a simple regular polygon:

the sides are all equal and the internal angles at the vertices are all equal. (includes the square and the equilateral triangle in this definition)

- How would you ***generalise*** the previous activity, to work out the answer for angles x, y in
  i. **a 6-sided regular polygon (hexagon)
  ii. **a 7-sided regular polygon (heptagon)
  iii. *** an n-sided regular polygon

ANGLES AND MULTI-SPIN(360)

- ***** How would you work out the turning angle y in a 5-sided star (pentagram)?
  Hint: you need to observe the number of complete SPINS on itself the sprite/turtle goes through in drawing the pentagram. Figure 1(b). (Or see unplugged_power.py).