COMMAND THE ROBOT

What commands would you give to make the turtle go around the rectangle and come back to its starting position?

This activity will help you to start writing programs to command the robot even if you have never done anything like this before and you know nothing about coding. The LOGO language is simple to learn. You can start coding and get some pleasing results with a few commands.

The following LOGO commands are sufficient to make the robot-turtle run around a rectangular path. Changing the numbers changes the lengths and angles.

forward 100 (or fd 100) moves the turtle forward drawing a line 100 units in length.

back 100 (or bk 100) moves the turtle backward drawing a line 100 units in length.

right 90 (0r rt 90) turns the turtle through 90 degrees to the right (clockwise).

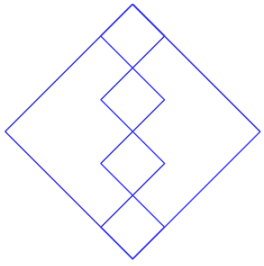
left 90 (or lt 90) turns the turtle through 90 degrees to the left (anti-clockwise).

What would you expect the following two programs to do?

PROGRAM 1	**PROGRAM 2**
forward 70 right 90 forward 130 right 90 forward 70 right 90 forward 130 right 90	repeat 2 [forward 70 right 90 forward 130 right 90]

Did you guess that both programs do exactly the same thing, that they make the turtle move around a rectangle as above, but only once? This shows you how the repeat command works.

Here are 5 more commands:
clearscreen (cs) , hideturtle (ht) , showturtle (st) , penup (pu) , pendown (pd).



With these commands together with the commands:
forward, back, right, left, repeat can you write a program to draw this 5-square pattern?

You can download free Logo software, either FMSLogo for Microsoft Windows from http://fmslogo.sourceforge.net/or ACSLogo for Mac OS X from http://www.alancsmith.co.uk/logo/

Both come with a Tutorial to help you to get started.

HELP

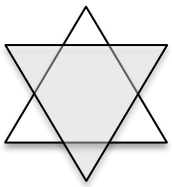
Experiment and draw some patterns of your own before you try the 5-square challenge.

There are small toy robots with a pad of keys on their backs so that children can press keys for 0, 1, ...9 and keys for forward, back, right and left.

Very young children learn to send the robot wherever they want it to go and avoid obstacles on the way.

NEXT

Write a program to draw an equilateral triangle. You can use the commands right 60 and left 60. The right and left commands can be used to turn through any angle.

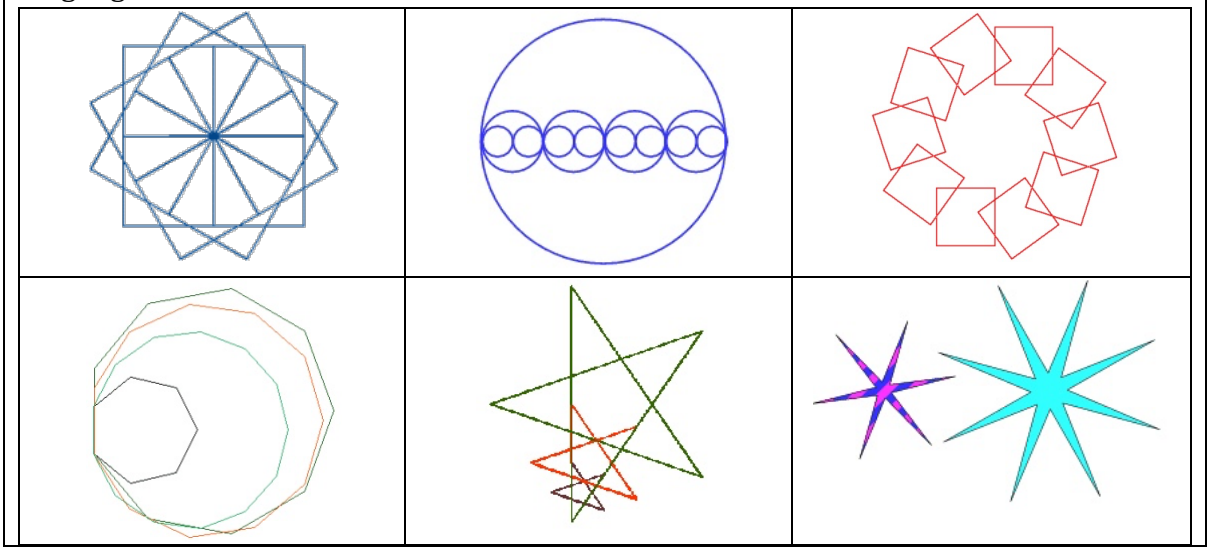


Write a program to draw this star pattern.

Draw your own pattern and write commands for the turtle to draw it.

See **First Forward into Logo** on the NRICH website https://nrich.maths.org/8045 for a series of guided challenges to help you to learn to code in the Logo language, learning a few more commands with each new pattern you draw like the images below. Each challenge helps learners to reinforce and develop understanding of geometry.

This **First Forward into Logo Series** culminates in an introduction to Lisp programming in Logo to sum simple series and carry out algebraic processes. Logo gives you a sound foundation on which to go forward to learn coding in the latest languages.



NOTES FOR TEACHERS

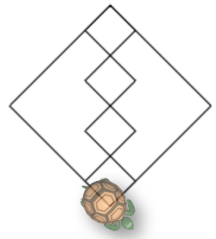
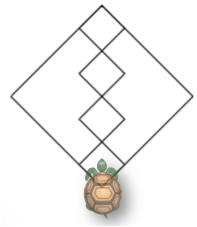
SOLUTION

Lower case or capitals? ***Some versions of the Logo Language use capitals, other versions use lower case, and other work equally well in both. In this document we use lower case in some sections and capitals in other sections. You must adapt to the version of Logo you are using.***

You will know that your program is correct if it draws the required shapes but you could write different programs and still get the same result.

Start by planning how you would draw this pattern. You can choose the lengths so let's make the small squares have edge length 30 and then the big square will have edge length 120.

This program will draw the 5-square pattern

clearscreen rt 45 fd 30 lt 90 fd 60 rt 90 fd 60 lt 90 fd 60		The clearscreen command clears the screen and puts the turtle in the start position. These commands make the turtle move up the zig-zag path as in the picture.
rt 90 fd 30 rt 90 fd 30 rt 90 fd 60 lt 90 fd 60 rt 90 fd 60 lt 90 fd 30		These commands make the turtle move down the zig-zag path to draw the small squares.
repeat 4 [lt 90 fd 120]		These commands make the turtle draw the outer square.
lt 135		This command turns the turtle to the same position as at the start. You should try to put the robot-turtle back to the start position at the end of the program.

Why do this activity?

The 'people maths' part of this activity can be done with children of all ages even in Foundation years. This activity enables older primary, as well as secondary, learners to write their own simple programs and to gain a deeper understanding of simple geometry. It begins to help them to understand how programs might be written to control robots and other machinery.

Learning objectives

In doing this activity students will have an opportunity to:

- begin to learn the principles of simple coding;
- meet some of the basic ideas of how a computer program can control the movements of a machine;
- develop mathematical thinking about the order of the steps to code the commands to draw a simple diagram, and about the angles and lengths to use.

Generic competences

In doing this activity students will have an opportunity to learn to write simple code for a computer and to develop awareness of some of the ways computers control machines.

Suggestions for teaching

You could start with the AIMING HIGH activity Command the Robot 1 if the class has not done it.

https://aiminghigh.aimssec.ac.za/years-4-9-command-the-robot-1/

Ideally have the learners in a space outdoors, in a wide corridor or in a room such as the school hall. Ask them what they know about robots. Let them talk a bit about drones and driver-less cars, about robots that move around warehouses to pick up and carry loads from place to place, about robots that mow lawns and clean floors, about robots that control complicated machinery in manufacturing processes etc.

Then say that in this lesson they are going to command robots but to start with they have **to pretend to be robots themselves** and they must follow your commands.

Then tell them that, when you give the command RIGHT 90, they must turn through 90^{o} to their right (clockwise) and when you give the command LEFT 90, they must turn through 90^{o} to their left (anti-clockwise). Then practise this a few times so that they have to turn right or left as you give the commands. Then tell them that you can change the angle so give commands like RIGHT 45, LEFT 180, RIGHT 10 etc.

Then introduce the commands FORWARD 7 and BACK 2 (7 for 7 steps and 2 for 2 steps) and ask the learners what they think these commands mean. Then practise giving these commands and all the class should do exactly the same moves.

Then give these commands slowly, one command at a time, and the learners must obey.
FORWARD 3, RIGHT 90, FORWARD 7, RIGHT 90,
FORWARD 3, RIGHT 90, FORWARD 7, RIGHT 90

Did everyone walk around a rectangle and end up at the same point they started at and facing the same direction?

Practise sets of commands making the learners walk around other rectangles and an equilateral triangle and a square. You could put one of the learners in charge of the robots and the learner could give the commands.

Then return to the classroom and either give the learners a worksheet copied from page 1 above, or write the problem on the board. The learners could work individually or in pairs.

If you have a computer in the classroom and can demonstrate the Logo program in action then you could do so but it is not at all necessary. In any case it would be better to do this at the end of the lesson or in a subsequent lesson.

If time you can ask the learners to tell the class how they would write the commands to make the robot turtle draw the 5-square pattern. Alternatively this could be a homework challenge and you could say that you want the learners to do their best but you do not expect them to get a complete answer and you will discuss it next lesson. Then there should be no stress over the task but you can be enthusiastic in your praise if anyone does succeed.

Key questions

- How would you draw that shape with a pencil on a piece of paper?
- Imagine yourself walking around that shape, what would you do?
- Imagine yourself walking around that shape, what angle would you turn through at that corner?
- Would you turn right or left at that corner?

Follow up

See **First Forward into Logo** on the NRICH website https://nrich.maths.org/8045

Note: The Grades or School Years specified on the AIMING HIGH Website correspond to Grades 4 to 12 in South Africa and the USA, to Years 4 to 12 in the UK and school years up to Secondary 5 in East Africa.
New material will be added for Secondary 6.
For resources for teaching A level mathematics (Years 12 and 13) see https://nrich.maths.org/12339
Mathematics taught in Year 13 (UK) & Secondary 6 (East Africa) is beyond the SA CAPS curriculum for Grade 12

	Lower Primary Approx. Age 5 to 8	Upper Primary Age 8 to 11	Lower Secondary Age 11 to 15	Upper Secondary Age 15+
South Africa	Grades R and 1 to 3	Grades 4 to 6	Grades 7 to 9	Grades 10 to 12
East Africa	Nursery and Primary 1 to 3	Primary 4 to 6	Secondary 1 to 3	Secondary 4 to 6
USA	Kindergarten and G1 to 3	Grades 4 to 6	Grades 7 to 9	Grades 10 to 12
UK	Reception and Years 1 to 3	Years 4 to 6	Years 7 to 9	Years 10 to 13