Module 1: Tiling Patterns

Investigation 1	Investigation 2	Investigation 3	Investigation 4
Moving, Turning and Stamping	Repeating and Alternating Patterns	Creating Circular Rose Patterns	Defining Your Own Pattern Blocks

Introduction to Module 1

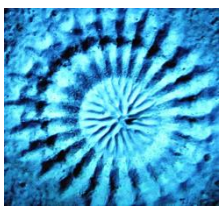
The theme of Module 1 is **repeating patterns**. You may like to introduce this module by linking it to another area of the curriculum such as art or science where similar patterns can be found. Some examples are below.

Art: Islamic or Gothic Art

Geometric patterns have been used extensively in Islamic art for many centuries and can also be found in gothic architectural features, such as stained glass windows.


Science: Patterns in Nature

Geometric patterns are seen in nature for example in snowflakes or in the sand sculptures created by puffer fish on the ocean floor.

Key Vocabulary and Concepts Covered by Module 1

Scratch	Computing	Mathematics
Sprite	Command	Symmetry
Stage	Program, programming	Translation
Block	Debugging	Angles (right, obtuse, reflex and acute)
Stamp block	Sequence	Patterns
Hat block	Repetition	Rotation
Turn block	Logical reasoning	Transformation
Snapping blocks	Algorithm	Sequences
Script	Definition	Positive and negative numbers
Move block		Coordinates
Repeat block		
Costume		
Define block		

Map Of Module 1

	Activity 1	Activity 2	Activity 3	Activity 4
Investigation 1 Moving, Turning and Stamping 	**Drag and Stamp** Starter project: 10-Tile Stamp	**Drag, Turn and Stamp** Starter project: 11-Tile Turn	**Move, Turn and Stamp** Starter project: 12-Tile move	**Unplugged: Simple Scripts**
Investigation 2 Repeating and Alternating Patterns 	**Repeating Flowers** Starter project: 13-Tile Repeat	**Unplugged: Calculating Angles**	**Alternating Flowers** Continue with: 13-Tile Repeat	**Repeating and Alternating** Continue with: 13-Tile Repeat
Investigation 3 Creating Circular Rose Patterns 	**Moving Forwards and Backwards** Starter project: 14-Rose Patterns Video: 1-Pattern Algorithms	**Unplugged: Predicting Patterns**	**Combining Different Costumes** Continue with: 14-Rose Patterns	
Investigation 4 Defining Your Own Pattern Blocks 	**Defining your own Block** Continue with: 14-Rose Patterns	**Unplugged Assessment: Reading Scripts**	**Building a Row of Roses** Continue with: 14-Rose Patterns	**Roses of Roses** Continue with: 14-Rose Patterns

The **red** dashed line indicates the **core** activities which are important to complete before moving on to the next module.

For activities which require pupils to continue with a project from a previous lesson you can alternatively use the suggested 'INT' (intermediate) project for those pupils who do not have a project to continue with or if you wish all pupils to begin from the same point.

Contents Of Module 1

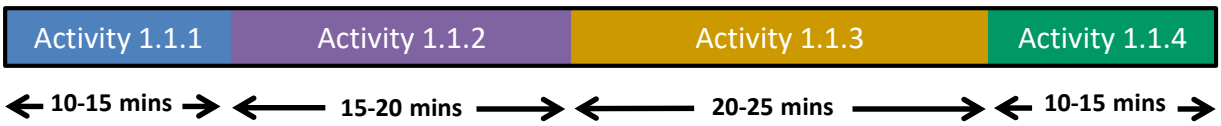
Text

MODULE 1: INVESTIGATION 1
Moving, Turning and Stamping

OVERALL LEARNING OBJECTIVE: Drag, turn, move and stamp a sprite, and build a simple script to create a pattern without using unnecessary blocks.

This investigation introduces three important Scratch commands (**move**, **turn** and **stamp**) and gradually builds to using these in a program (script) to create a simple pattern. The investigation comprises of four activities.

- **Activity 1.1.1** – Drag and Stamp
- **Activity 1.1.2** – Drag, Turn and Stamp
- **Activity 1.1.3** – Move, Turn and Stamp
- **Activity 1.1.4** – Unplugged: Simple Scripts



We recommend allowing **60 to 90 minutes** for this investigation.

Scratch starter projects

10-Tile Stamp
11-Tile Turn
12-Tile Move

LINKS TO PRIMARY NATIONAL CURRICULUM

CURRICULUM OBJECTIVES	LINK WITH SCRATCHMATHS
Computing	
Design, write and debug simple programs that accomplish specific goals.	▶ Pupils are required to create a script that produces a pattern.
Mathematics	
Identify lines of symmetry in 2D shapes presented in different orientations.	▶ Pupils are required to create patterns with one or more lines of symmetry.
Identify, describe and represent the position of a shape following a translation.	▶ Pupils are required to move and stamp their sprite to create patterns.
Recognise angles as a description of a turn, know angles are measured in degrees, identify different types of angles and use angle sum facts.	▶ Pupils are required to use their knowledge of angles to rotate their sprite and create different patterns.

Module 1 • Investigation 1 • Activity 1.1.1

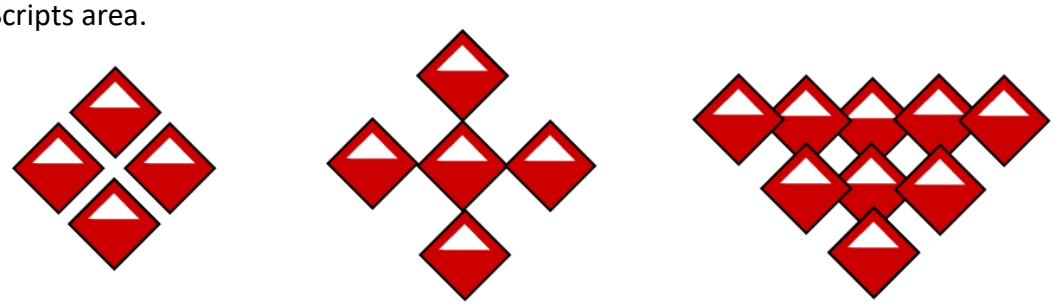
Drag and Stamp

Learning Objectives

Explore how to drag and stamp a sprite to create symmetrical patterns.
Explain what is happening when the green flag is clicked.

Activity Instructions

1. Pupils open project **10-Tile Stamp**, save as a copy and add their name(s) to the title.
2. Pupils create a symmetrical pattern by dragging the Tile sprite and clicking on the **stamp** block in the Scripts area.



3. Pupils can save their pattern by right-clicking (or Shift + click) on the stage and selecting **save picture of stage**.
4. Pupils click on the green flag to run the **setup script** – this resets the stage and the sprite.

Things to Note

- **The setup script should not be modified.**
- Stamped patterns are not saved in your project – you can only save a picture of the whole stage.
- You need to click on the **stamp** block carefully to make sure it runs (look to see if the green flag flashes).

Vocabulary

A **sprite** is an object.

The **stage** is where you can see the sprites.

A **block** represents a *command* which tells the sprite what to do and you can run by clicking on it.

The **stamp** block tells the sprite to print an image of itself on the stage.

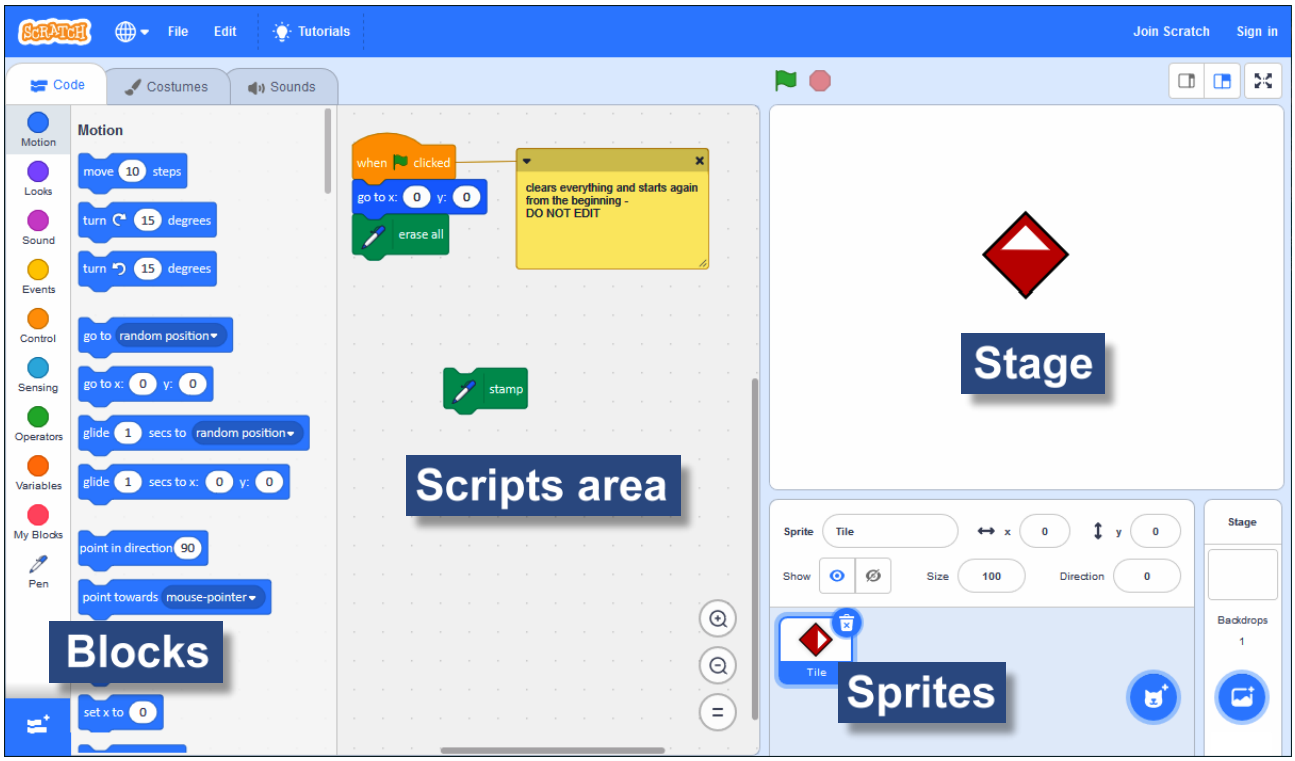
The **when green flag clicked** block is called a **hat block**, it is always placed at the top of a script.

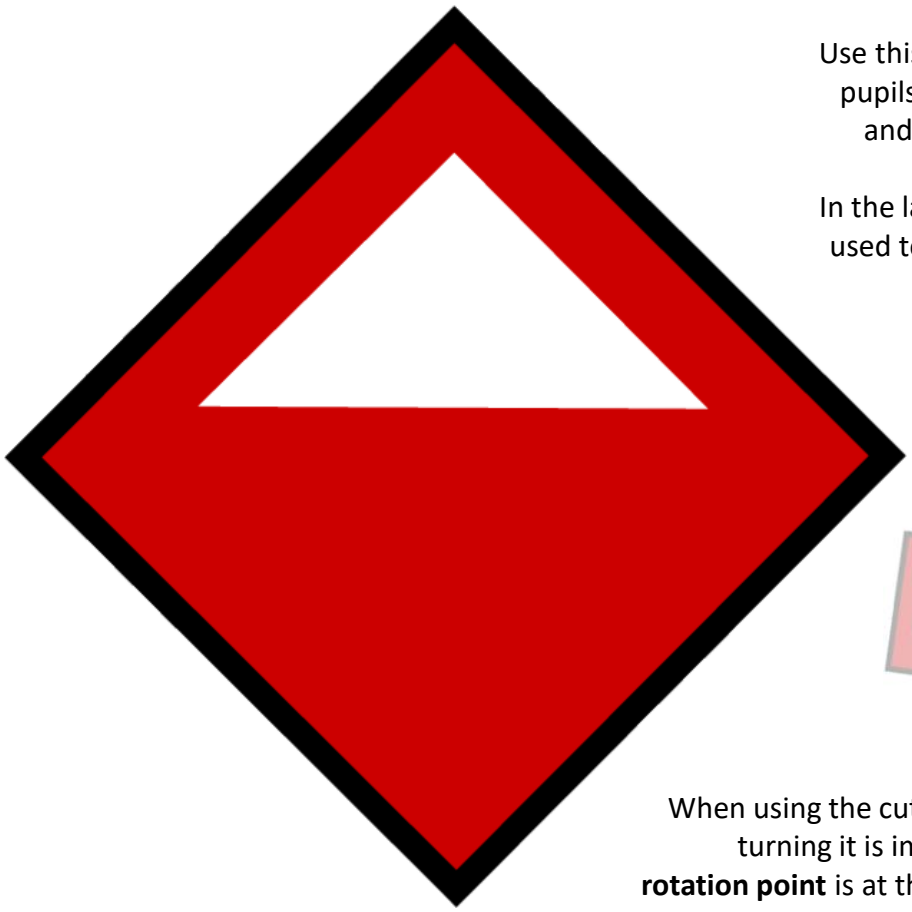
Discussion Points

- How many stamps have you used?
- What colour is the **stamp** block? Which group of blocks does it belong to? Where can we find it?
- Did you have any problems with stamping?
- Have you clicked on the green flag to start again? What happens? Why do you think it does this?
- What does **go to x: 0 y: 0** mean? (go to centre of stage)
- When the sprite is moved what happens to the x,y coordinates?
- What makes your pattern symmetrical?
- How many lines of symmetry does your pattern have?

ADDITIONAL SUPPORT

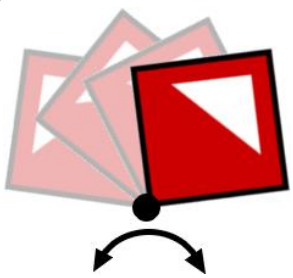
This screenshot shows the names given to the different areas of the Scratch interface.





Use this cut-out to show your pupils what the Tile sprite is and that is pointing north.

In the later activities it can be used to demonstrate turning and moving.



When using the cut-out to demonstrate turning it is important to show the **rotation point** is at the bottom of the tile.

Module 1 • Investigation 1 • Activity 1.1.2

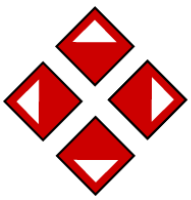
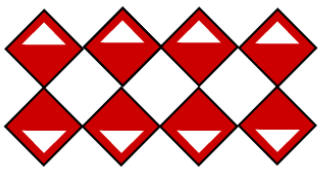
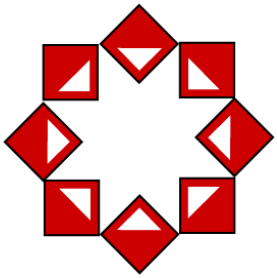
Drag, Turn and Stamp

Learning Objectives

Explore how to rotate a sprite both clockwise and anti-clockwise as well as change the direction it is pointing to create a symmetrical pattern.
Explain what the setup script does and how to set the direction of a sprite.

Activity Instructions

1. Pupils open project **11-Tile Turn**, save as a copy and add their name(s) to the title.
2. Pupils try clicking the different **turn** blocks (use Tile cutout from 1.1.1 additional support to explain turning different amounts e.g. 90 degrees).
3. Look at the **setup script** and identify what is different from Activity 1.1.1. Discuss what this extra block does and why it is required (see additional support for explanation).
4. Ask pupils to stand up and turn their bodies to face each of the four possible directions from the **point in direction** block e.g. (0) up, (90) right, (180) down, (-90) left
5. Pupils drag the Tile sprite, click the **turn** blocks and the **stamp** block to create a symmetrical pattern.
6. Pupils drag additional **turn right 15 degrees** and **turn left 15 degree** blocks into the scripts area, change them to **turn right 90 degrees** and **turn left 90 degrees**, and then use all of the 6 turn blocks (but they should not snap them together yet, see additional support).

7. Pupils can save their patterns by right-clicking (or Shift + click) on the stage and selecting **save picture of stage**.

Vocabulary

Turning a sprite means changing the direction it is pointing.

Snapping blocks means connecting them together (do not snap blocks until Activity 1.1.3).

A **script** is a sequence of blocks, snapped together, which represents a *program*. To run a script click on any block in the script.

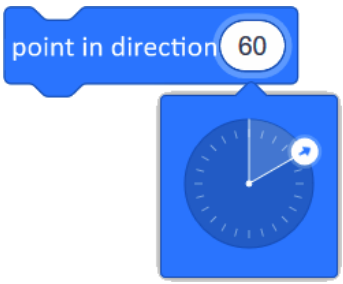
Discussion Points

- Have you used both turning left and right?
- What colour are the **turn left** and **turn right** blocks? Which group of blocks do they belong to? Where can we find them?
- What does each block in the **setup script** do? Why are they needed?
- Which types of angle have you used?
- If I click **turn right 15 degrees** three times how many degrees has my sprite turned? What could I click on instead to do the same thing?

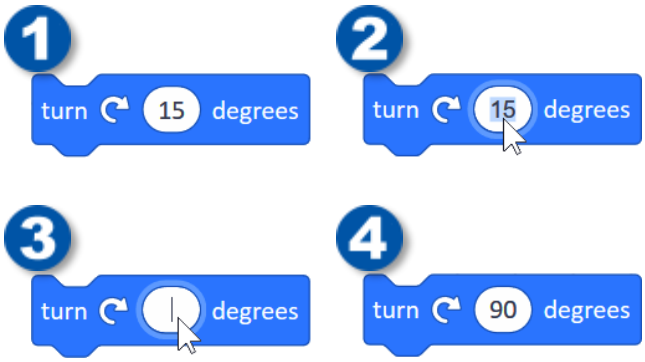
ADDITIONAL SUPPORT

There is a new block in the **setup script** **point in direction 0** which sets the Tile sprite to **point upwards** (north). This allows the pattern to be stamped from the initial starting position with initial direction after the **setup script** has been run.

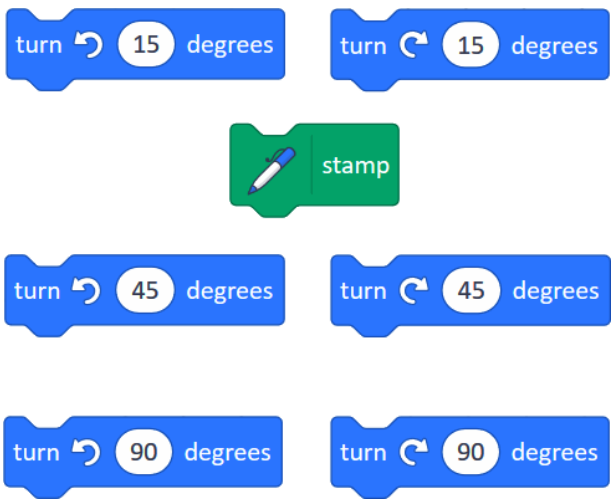
Encourage pupils to explore the block and use their bodies or toys to understand the different directions the sprite will point in:



Inputs in the blocks ("holes") can be edited:



The pupils will end up with these blocks in the script area by the end of this activity.



MODULE 1 • INVESTIGATION 1 • ACTIVITY 1.1.3

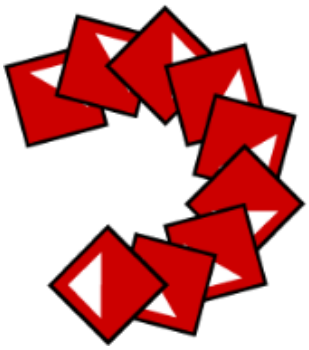
Move, Turn and Stamp

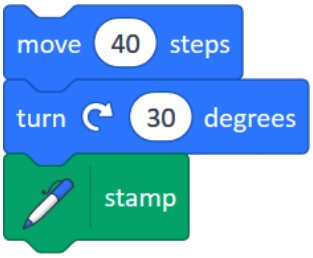
LEARNING OBJECTIVES

Explore how to move the sprite without dragging it and snap blocks together to create a script.
Explain what is meant by debugging a script.

ACTIVITY INSTRUCTIONS

1. Pupils open project **12-Tile Move**, save as a copy and add their name(s) to the title.
2. Pupils move the Tile along the stage by clicking on the **move 80 steps** or **move 40 steps** blocks in the scripts area – the Tile should now be moved only using the blocks, **no dragging allowed**.
3. Pupils snap together one of the **move** blocks, one of the **turn** blocks and the **stamp** block and then click to run them as a whole script.





4. Pupils try the same with the other blocks in the Scripts area.
5. Pupils can save their pattern by right-clicking (or Shift + click) on the stage and selecting **save picture of stage**.
6. Pupils try using a different number of steps by changing the number in the **move** block.
7. Pupils try turning the Tile sprite a different angle by changing the number in the **turn** block.

THINGS TO NOTE

- It is possible that the pupils will choose values that cause the Tile to go off the stage. If this happens simply click the **setup script** to return the Tile to starting position.

VOCABULARY

Moving a sprite means changing its position on the stage.

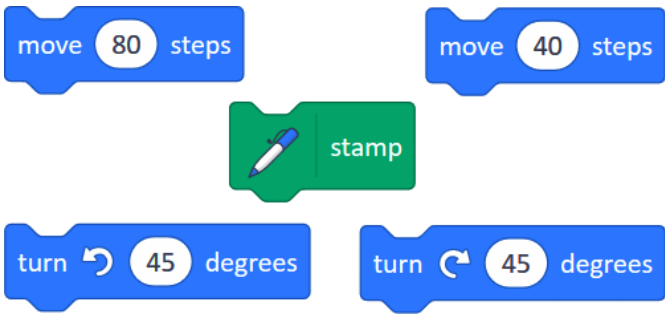
Debugging is the process of identifying and removing 'bugs' or 'mistakes' within your program (i.e. script).

DISCUSSION POINTS

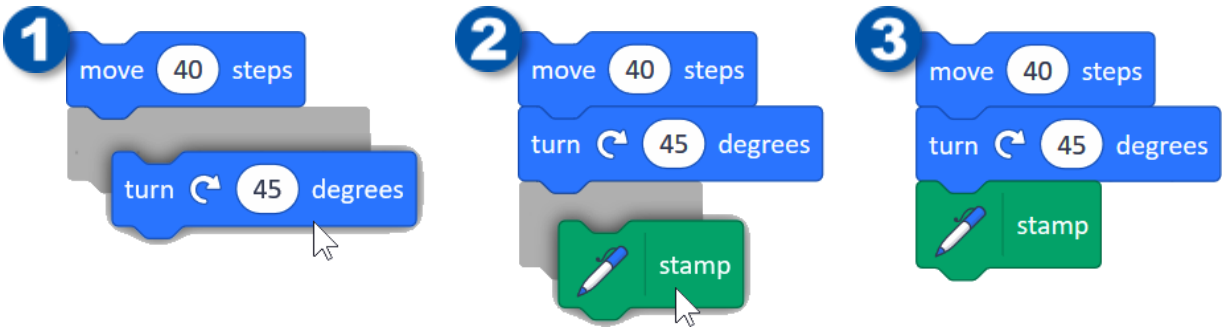
- What happened if you clicked on your script multiple times? Did you manage to get the Tile sprite back to where it started? How many times did you have to click?
- Did you have any problems with your script? How did you solve these? What is this process called?
- What happened to the pattern when you used the **move 40** or **move 20** block instead of **move 80**?
- What types of transformation have you used? (rotation, translation)

ADDITIONAL SUPPORT

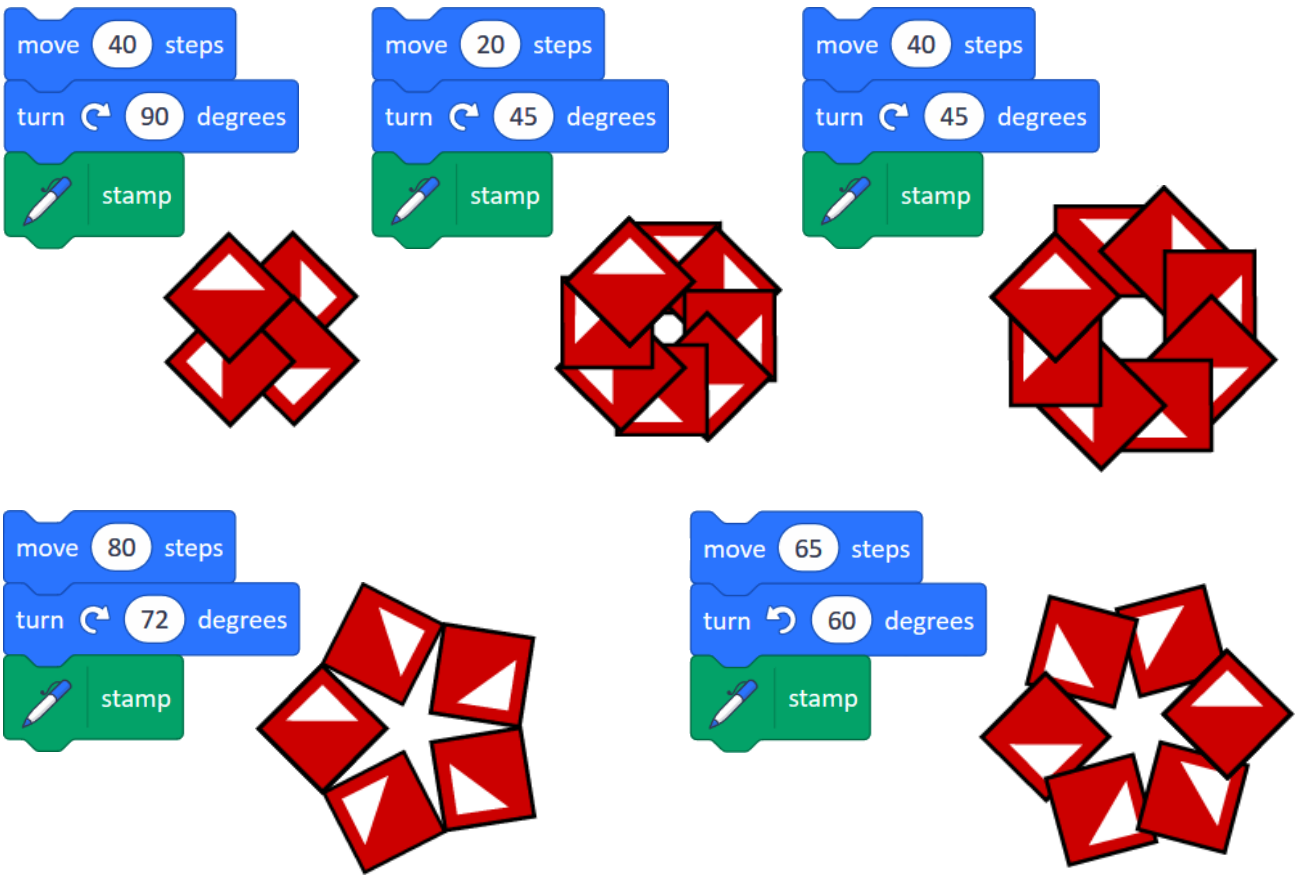
These are the initial blocks in the Scripts area of the **12-Tile Move** project:



Snap blocks together:



Encourage pupils to explore different values of inputs and clicking the **move** – **turn** – **stamp** script several times. Note that some scripts below have different **move** and the same **turn**:



MODULE 1 • INVESTIGATION 1 • ACTIVITY 1.1.4

Unplugged: Simple Scripts

LEARNING OBJECTIVES

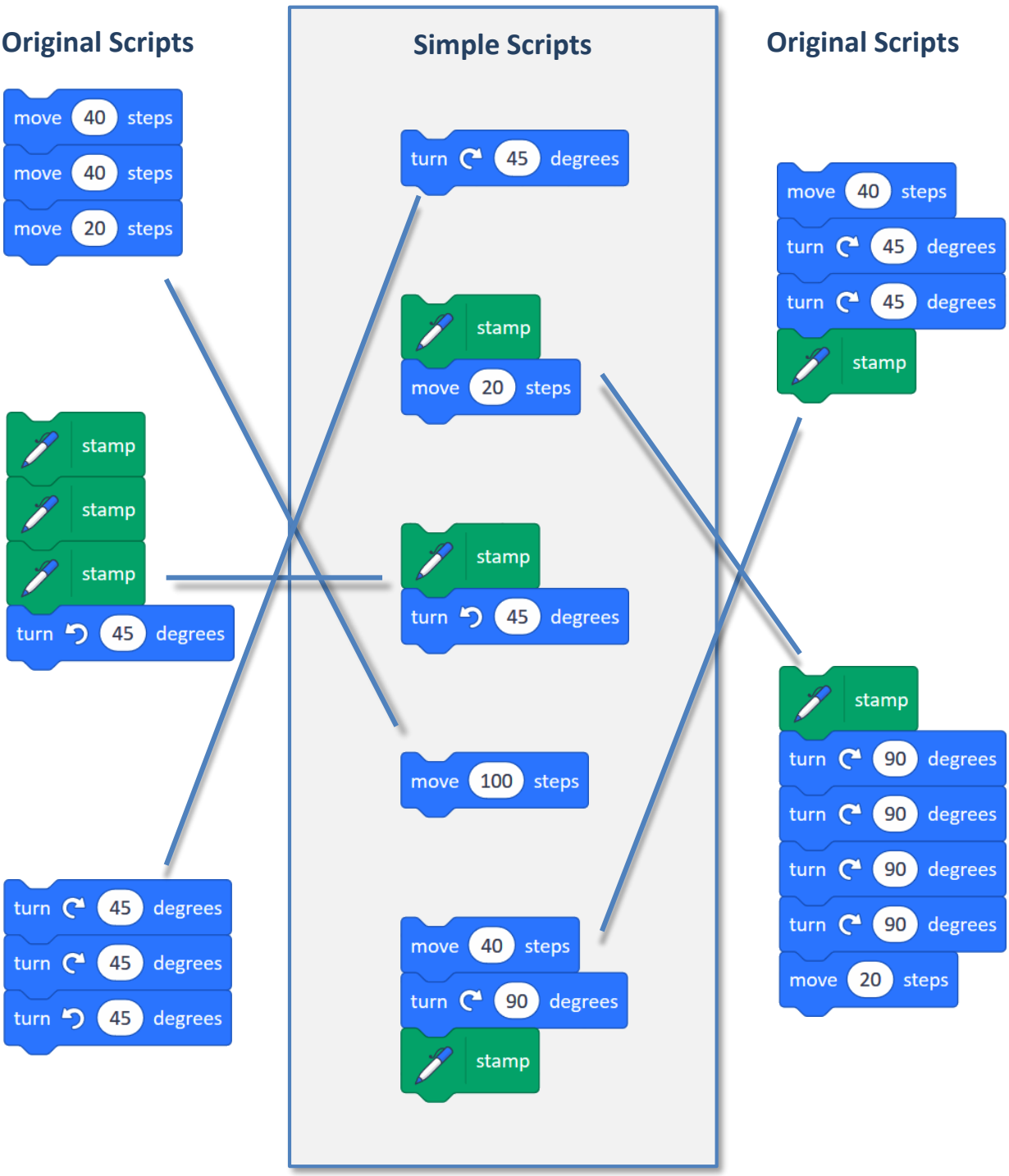
bridgE to knowledge about addition of two digit numbers and mathematical fluency (using as few steps as possible).
Envisage the outcomes of different scripts to match scripts with the same result.
Explain why the two scripts have the same outcome and why it is important to make scripts as simple as possible.

ACTIVITY INSTRUCTIONS

1. Print and distribute the unplugged pupil worksheet 1.1.4.
2. For each of the original scripts (1) find a simple script (2) that has the same outcome. Draw a line between the two matching scripts.
3. Ask pupils to explain their answers. Why is it important to make scripts simple?
4. Differentiation ideas:
   - *Pupils who struggle* can be provided with one of the Tile sprite paper cutouts (see page 27) to support them in visualizing the outcome of each script.
   - *Higher attainers* can alternatively be given the **extension worksheet (page 14)** which requires them to simplify the scripts themselves instead of simply matching.

   Note that script (f) on page 14 cannot be simplified. Pupils should explain why this is so.

UNPLUGGED WORKSHEET SOLUTIONS



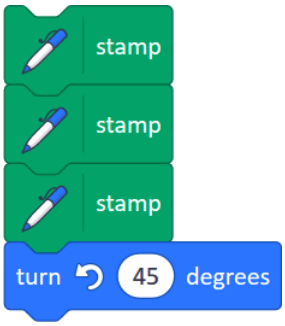
NAME

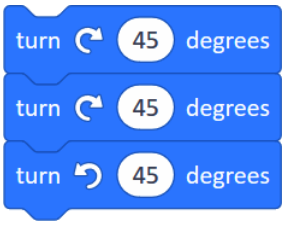
WHAT TO DO

For each of the **original scripts (1)** find a **simple script (2)** that would have the same outcome when you click on it. Draw a line between these two scripts.

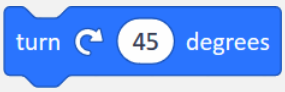
SCRIPTS

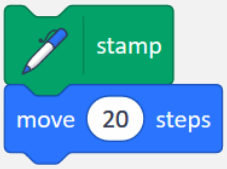
Original Scripts

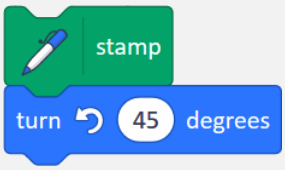


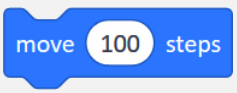


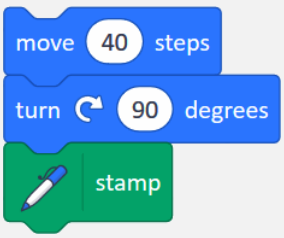
Simple Scripts



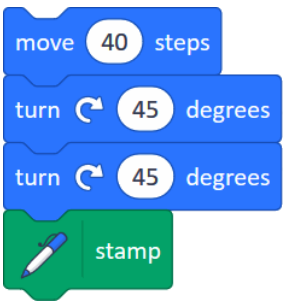


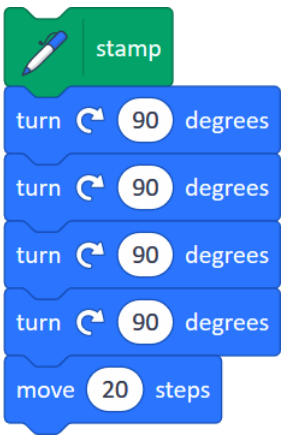






Original Scripts





NAME

WHAT TO DO

Rewrite each of the **original scripts (1)** into a simpler script (less blocks) that would have the same outcome when you click on it.

Write your new simple script in the box next to the matching original script.

SCRIPTS

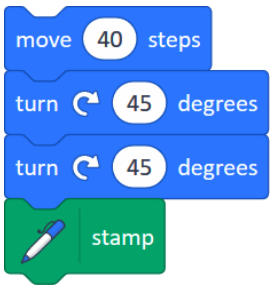
Original Script a

Simpler Script

Original Script b

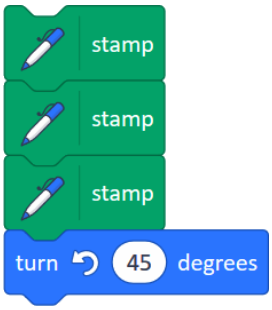
Simpler Script

Original Script c



Simpler Script

Original Script d

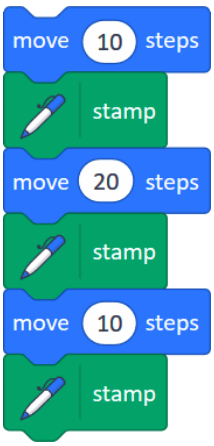


Simpler Script

Original Script e

Simpler Script

Original Script f



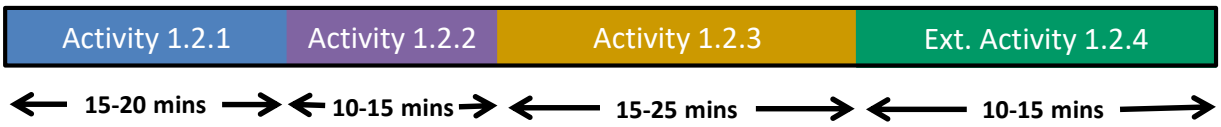
Simpler Script

MODULE 1: INVESTIGATION 2
Repeating and Alternating Patterns

OVERALL LEARNING OBJECTIVE: Use the **repeat** and **next costume** blocks to create more complex patterns.

This investigation introduces the key concept of repetition as an alternative to clicking a script multiple times and also demonstrates how to switch between different appearances of the sprite using the **next costume** command. The investigation comprises of three core activities plus one extension activity.

- **Activity 1.2.1** – Repeating Flowers
- **Activity 1.2.2** – Unplugged: Calculating Angles
- **Activity 1.2.3** – Alternating Flowers
- **Extension Activity 1.2.4** – Repeating and Alternating



We recommend allowing **60 to 90 minutes** for this investigation (if you are short on time you can skip over Extension Activity 1.2.4).

Scratch starter project **13-Tile Repeat**

LINKS TO PRIMARY NATIONAL CURRICULUM

CURRICULUM OBJECTIVES	LINK WITH SCRATCHMATHS
Computing Use sequence, selection, and repetition.	▶ Pupils are required to sequence blocks to create alternating patterns. ▶ Pupils are required to select different costumes for their sprite. ▶ Pupils are required to use the repeat block to create patterns.
Mathematics Identify angles at a point and one whole turn (total 360 degrees). Use angle sum facts and other properties to make deductions about about missing angles and relate these to missing number problems. Order and arrange combinations of mathematical objects in patterns and sequences.	▶ Pupils are required to calculate the size of the angle and number of rotations to complete a circular symmetrical pattern. ▶ Pupils are required to calculate the missing values for the angle size and number of rotations within existing pattern scripts. ▶ Pupils are required to create a pattern of alternating shapes.

Module 1 • Investigation 2 • Activity 1.2.1

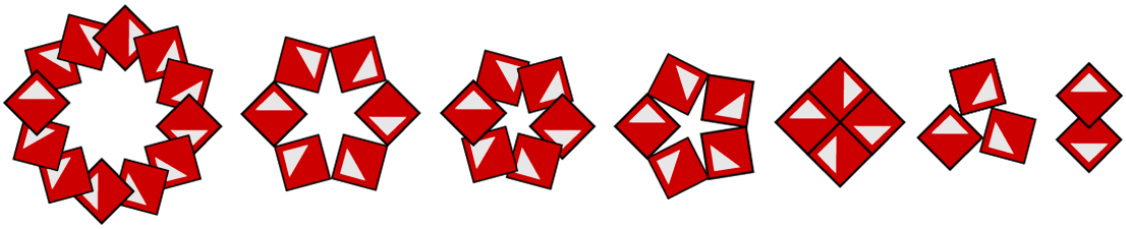
Repeating Flowers

Learning Objectives

Explain the minimum number of times a script needs to be clicked to create a complete circular pattern.
Explore using the repeat block as an alternative to repeatedly clicking a script to create a circular pattern and how this links with the minimum number of clicks.

Activity Instructions

1. Pupils open project **13-Tile Repeat**, save as a copy and add their name(s) to the title.
2. Pupils click on the **move-turn-stamp** script (see **1** in additional support) repeatedly until they create a complete circular pattern i.e. **one whole turn**.
3. Discuss the *minimum number of clicks* we needed to complete the pattern.
4. Pupils click the green flag to clear the stage.
5. Pupils find the **repeat** block in the **Control** group and put it around the script (see **2** and **3**).
6. In the **repeat** block pupils type the *minimum number of clicks* that they previously calculated to create the same pattern as before (see **4**) and run the script.
7. Pupils duplicate their script by right-clicking (or Shift + click) on it and selecting **duplicate**.
8. Pupils place this script in the scripts area and change the numbers in the **repeat** and **turn** blocks to create different flower patterns (see additional support).



9. Pupils may add the **wait** block to their script to see how the pattern is created (see additional support).

Things to Note

- If the **when green flag clicked** block is added to the top of the script and the green flag is used to run the script it will also run the **setup script** in parallel, so it would not be possible to keep multiple patterns on the stage.
- Use the lowest number possible in the **repeat** block to complete your pattern and ensure it is a **whole number**.

Vocabulary

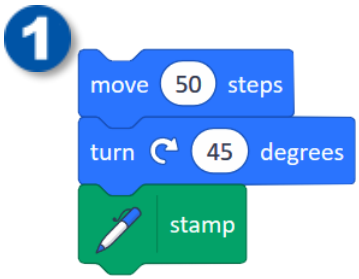
The **repeat** block runs the script the number of times that its value is set to.

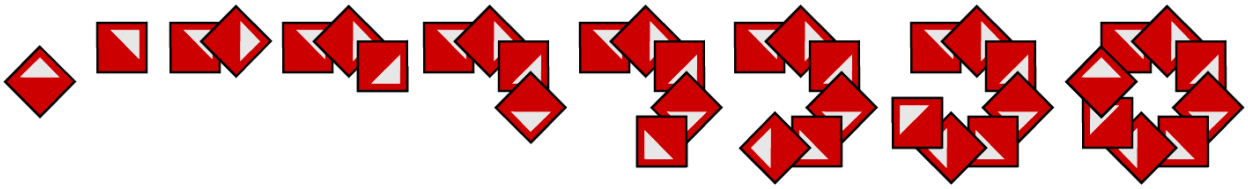
Discussion Points

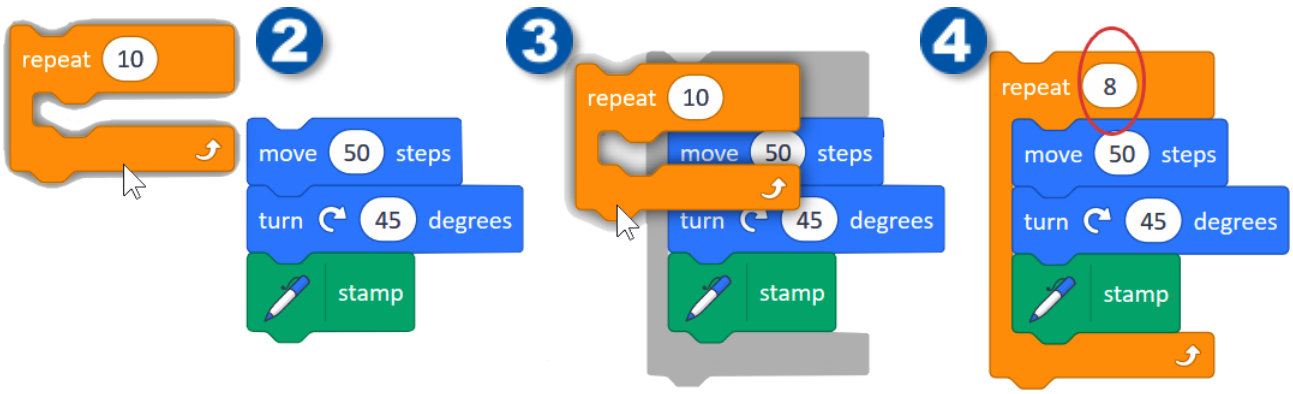
- Did you manage to create a complete flower? How did you do this?
- What number did you put in your **repeat** block? If this was lower or higher would it change the pattern?
- How many degrees did your Tile sprite turn for each **stamp**?
- How did you decide what values to use in the **repeat** and **turn** blocks?
- How many degrees did your Tile sprite turn **in total** to create the whole flower? Was this always the same?

ADDITIONAL SUPPORT

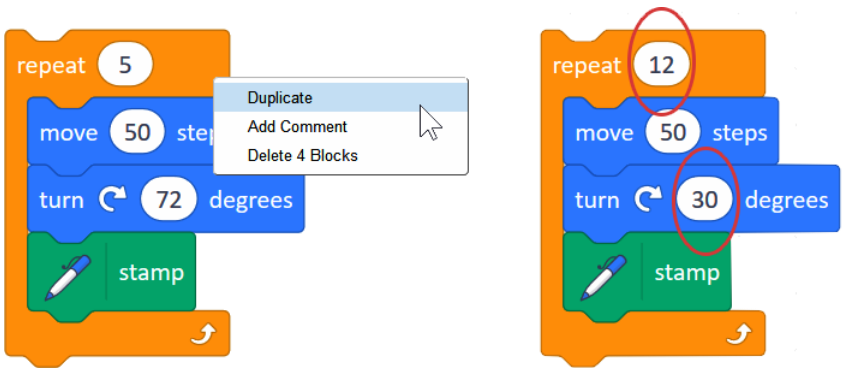
This screenshot shows the actions described in the Activity 1.2.1 instructions.





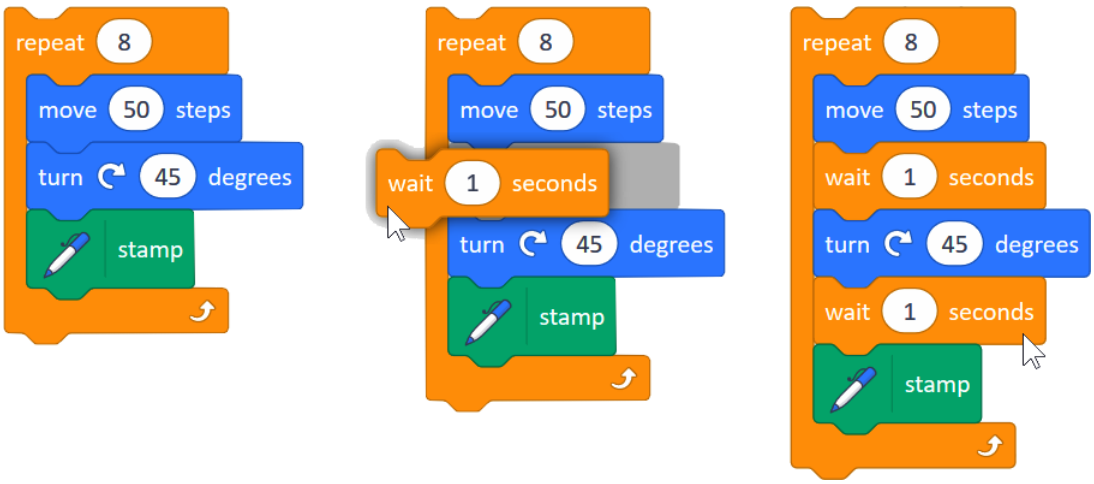


Instead of modifying the values in a single script if you duplicate your script and change the values in the duplicated script you can recreate your previous patterns even if you clear the stage. To duplicate right click (or Shift + click) on your script and select **duplicate**. Click anywhere in the **Scripts area** to place your duplicated script.



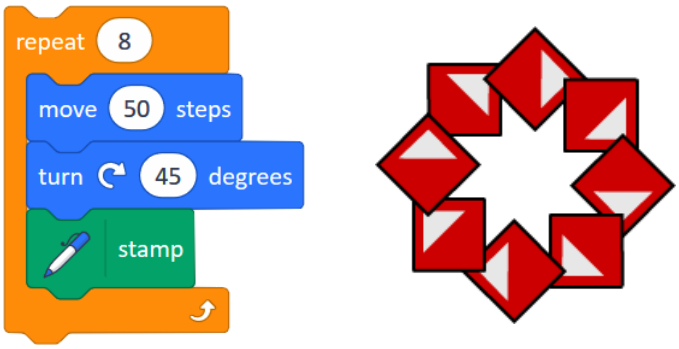
ADDITIONAL SUPPORT CONT.

Add in one or more **wait** blocks to slow down your script so you can see how the pattern is being created.



Relationship between repeat, turn and total turn

In order to create a complete circular pattern the Tile sprite needs to turn 360 degrees in total – this ensures that the Tile is pointing in the same the same direction as it was at the start, i.e. it has returned to its starting point.



If you select an angle that you want your Tile sprite to **turn**, for instance 45 degrees, to calculate how many times your script needs to **repeat** divide 360 by the angle (i.e. 45), which in the example above would equal 8 repeats. This ensures that you Tile stamps a complete circular pattern with no additional unnecessary stamps (most efficient). Similarly you can divide 360 by the **repeat** value to calculate the angle of the **turn**.

If you want to work out the script for a given pattern (with no script provided), firstly count the number of stamps in the pattern – this is the value to put in the **repeat** block. Secondly divide 360 by this repeat number – this is the value to put in the **turn** block.

MODULE 1 • INVESTIGATION 2 • ACTIVITY 1.2.2

Unplugged: Calculating Angles

LEARNING OBJECTIVES

bridgE to knowledge about total number of degrees in a whole turn (showing mathematical fluency) and mathematical reasoning (doing & undoing/what's changing or staying the same).
Envisage the missing repeat/turn values by using knowledge of shape and angle.
Explain the relationship between the repeat and turn blocks**.**

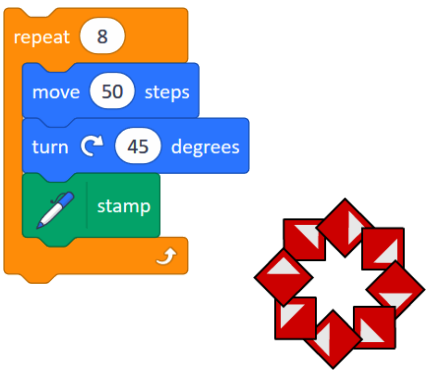
ACTIVITY INSTRUCTIONS

1. Print and distribute the unplugged pupil worksheet 1.2.2 (for high attainers see page 21).
2. This can either be completed individually or worked through as a class, and you may discuss:
   - What is the relationship between the **repeat**, **turn** and total turn?
   - How did you work out the number in the **repeat** and **turn** blocks?
   - Why does the total number of degrees turned need to equal 360?

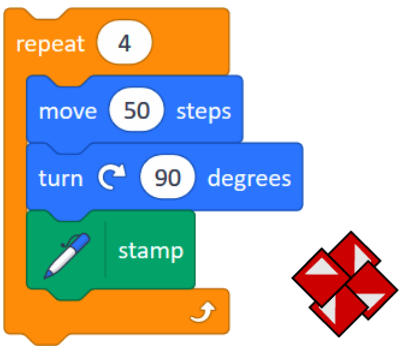
UNPLUGGED WORKSHEET SOLUTIONS

Three text items are: **Number in repeat block**, **Number of degrees in turn block**, and **Total number of degrees Tile sprite turned**.

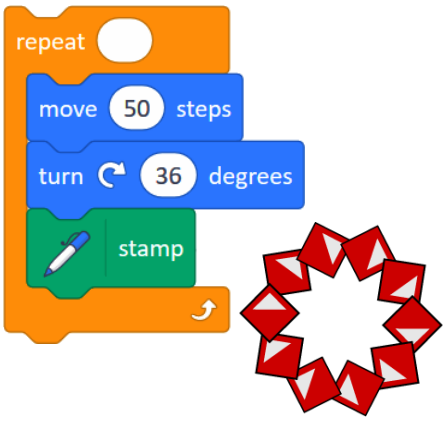
8, 45 degrees, 360 degrees



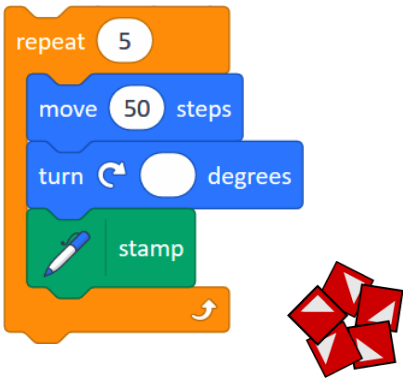
4, 90 degrees, 360 degrees



10, 36 degrees, 360 degrees



5, 72 degrees, 360 degrees

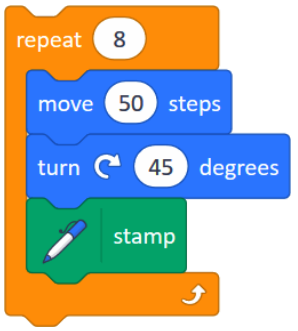


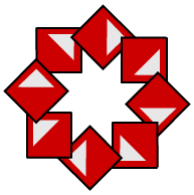
NAME

WHAT TO DO

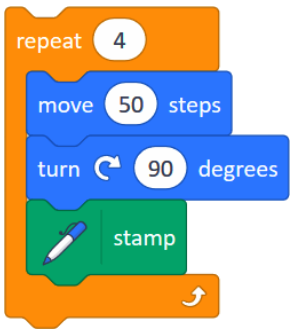
For each of the flower scripts below, fill in the missing values in the table – the **number** in the **repeat** block, the **number of degrees** in **turn** block or the **total number of degrees** your Tile sprite turned to create the pattern.

FLOWERS PATTERNS

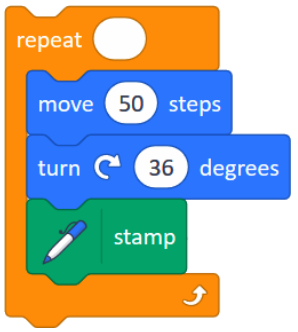




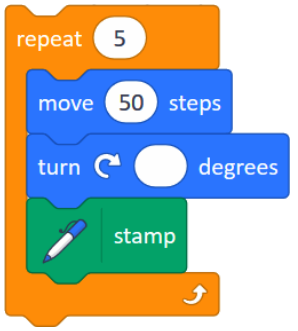
Number in repeat block	Number of degrees in turn block	Total number of degrees Tile sprite turned
8	45 degrees	____ degrees



Number in repeat block	Number of degrees in turn block	Total number of degrees Tile sprite turned
____	____ degrees	360 degrees



Number in repeat block	Number of degrees in turn block	Total number of degrees Tile sprite turned
____	36 degrees	____ degrees



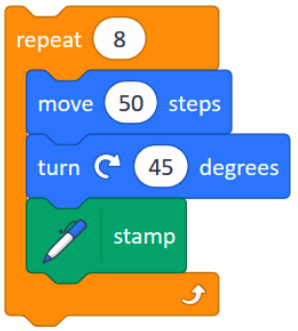
Number in repeat block	Number of degrees in turn block	Total number of degrees Tile sprite turned
5	____ degrees	____ degrees

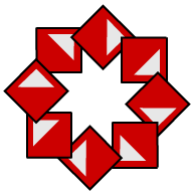
NAME

WHAT TO DO

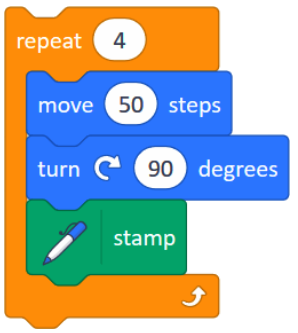
For each of the flower scripts below, fill in the missing values in the table – the **number** in the **repeat** block, the **number of degrees** in **turn** block or the **total number of degrees** your Tile sprite turned to create the pattern.

FLOWERS PATTERNS

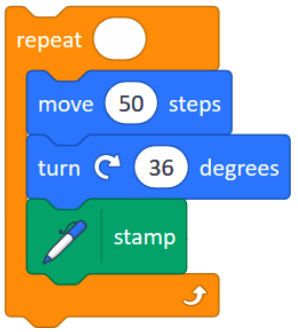




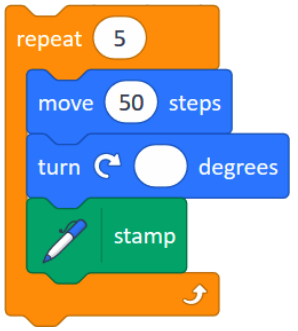
Number in repeat block	Number of degrees in turn block	Total number of degrees Tile sprite turned
____	____ degrees	____ degrees



Number in repeat block	Number of degrees in turn block	Total number of degrees Tile sprite turned
____	____ degrees	____ degrees



Number in repeat block	Number of degrees in turn block	Total number of degrees Tile sprite turned
____	____ degrees	____ degrees



Number in repeat block	Number of degrees in turn block	Total number of degrees Tile sprite turned
____	____ degrees	____ degrees

Module 1 • Investigation 2 • Activity 1.2.3

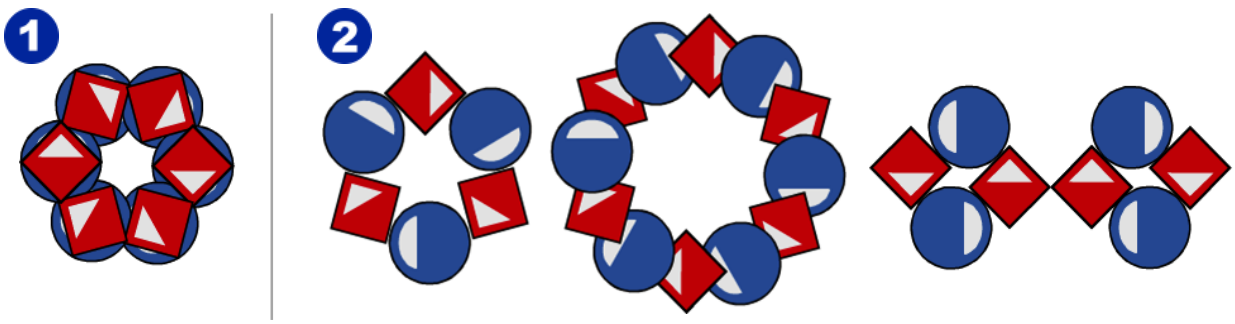
Alternating Flowers

Learning Objective

Explore how to use multiple costumes within a single pattern.

Activity Instructions

1. Pupils continue in their copy of the **13-Tile Repeat** project.
2. Pupils clear the stage and choose one of their previous flower scripts to use.
3. Pupils click on the **Costumes** tab between the stage and the scripting area. They will find the Tile sprite has two different shapes or 'costumes'.
4. Pupils click on the second costume – the circle. They go back to the **Scripts** tab and run their script.
5. Then they go to the **Costumes** tab again and select the first costume – the square. They run their script again.
6. Pupils drag the **next costume** block from the **Looks** blocks to the Scripts area. Encourage them to explore what happens when they click it as isolated block – again and again.
7. Pupils try to create example pattern **1** below, then experiment with other patterns (e.g. **2**).



8. As before to save their pattern pupils can right-click on the stage (or Shift + click) and select **save picture of stage**.

Things to Note

- It is important not to edit the costume(s) of the sprite when in the **Costumes** tab as this may cause problems in later activities.
- In this activity we are still working with just **one sprite**, which has two different costumes – a square and a circle.
- The sprite should not be duplicated as this may cause confusion in later activities.

Vocabulary

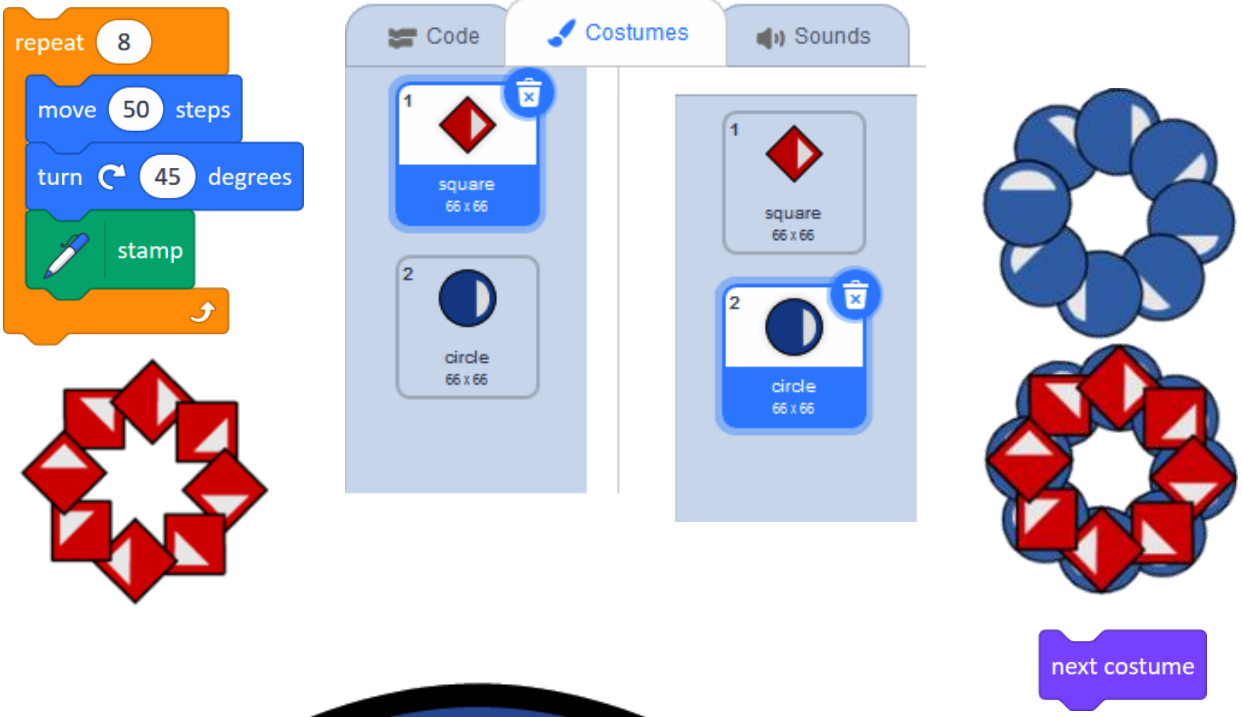
Costumes are alternative ways that a sprite can look on the stage.

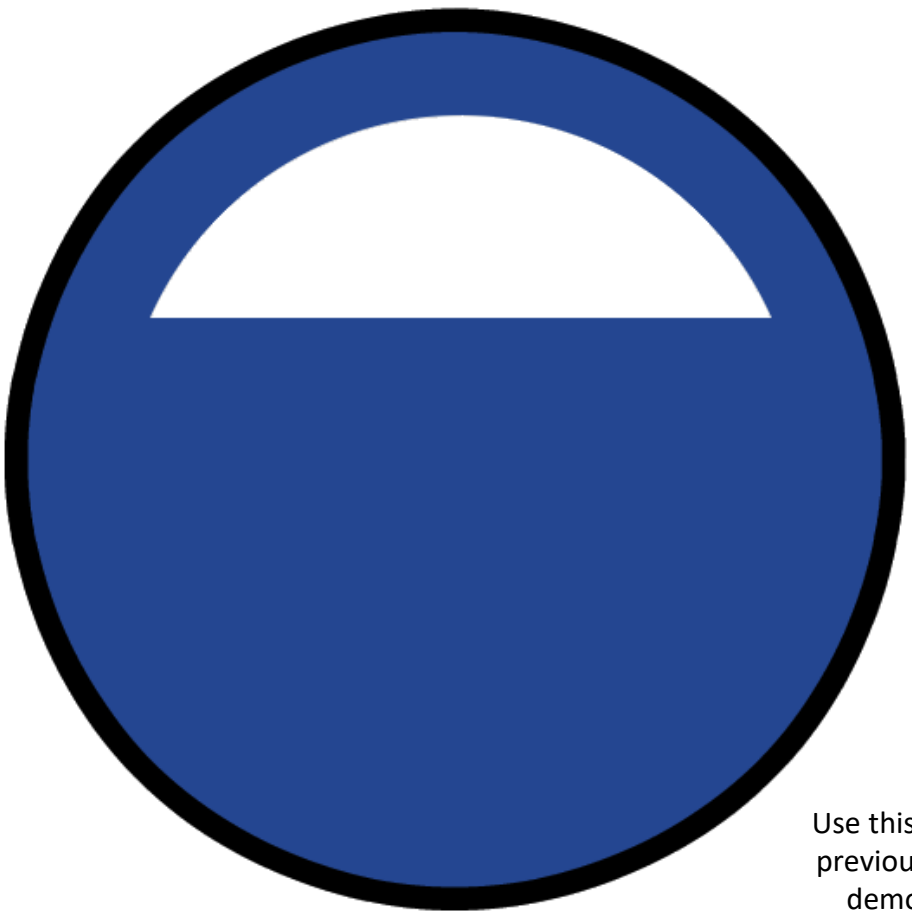
Discussion Points

- Where did you place the **next costume** block in your script? If you moved it how might this change your pattern?
- How many squares and circles were in your patterns?

ADDITIONAL SUPPORT

The screenshot below shows how to create patterns using multiple costumes.

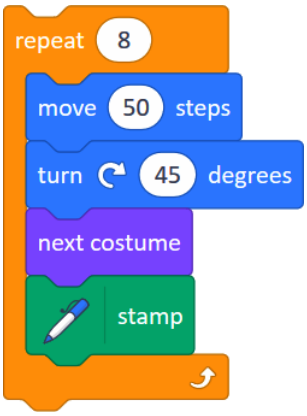


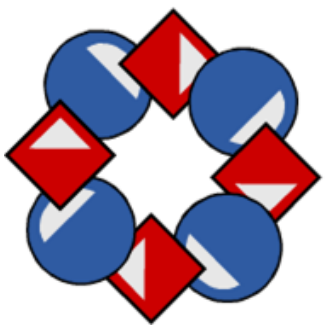


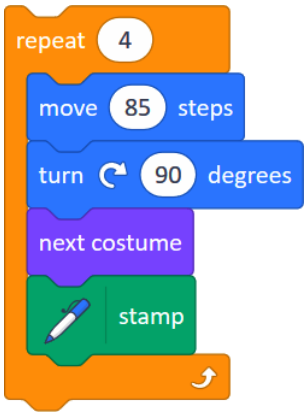
Use this cut-out along with the previous square Tile cut-out to demonstrate how the pupils could alternate the shapes in their patterns

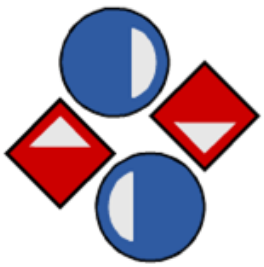
ADDITIONAL SUPPORT CONT.

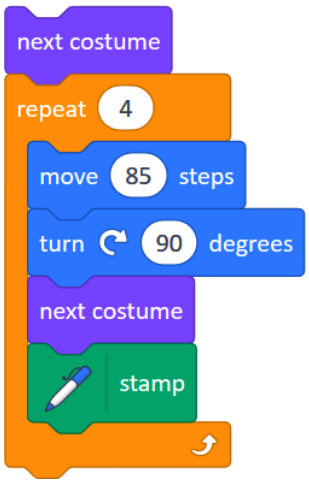
Below are the scripts for some of the alternating costume patterns.











Module 1 • Investigation 2 • Activity 1.2.4

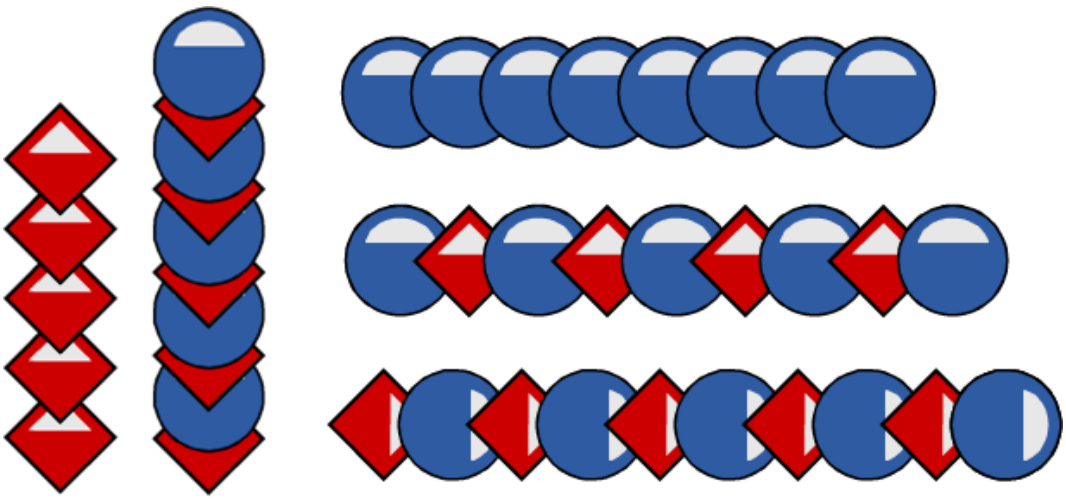
[Extension] Repeating and Alternating

Learning Objectives

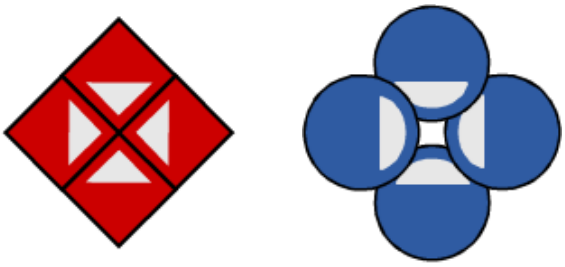
Explore how to create a repeating and alternating pattern.

Activity Instructions

1. Pupils continue in their copy of the **13-Tile Repeat** project.
2. Pupils rearrange the blocks inside the **repeat** block of their flower scripts so that they create patterns similar to those bellow. *Hint: They might need to remove some of the blocks or use them more than once.*



Advanced Patterns

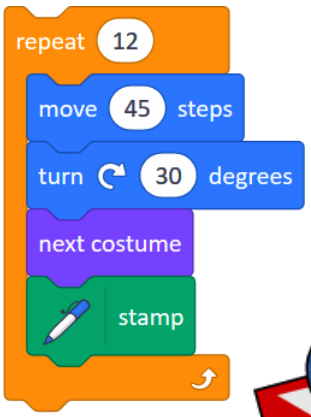


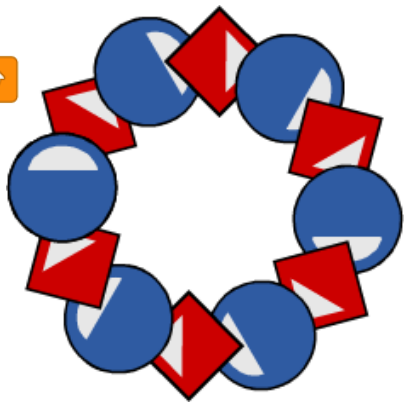
Discussion Points

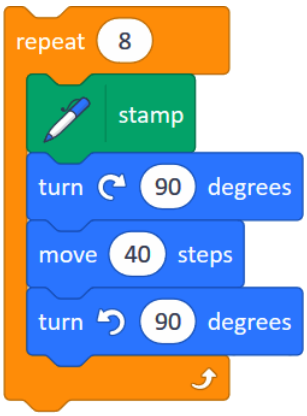
- Which patterns did you manage to create?
- Can you describe a strategy that you used to create one of your patterns?
- Did you use different sequences of costumes in your patterns?

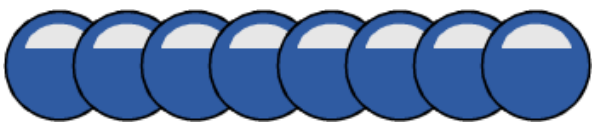
ADDITIONAL SUPPORT

Below are the scripts for some of the patterns.

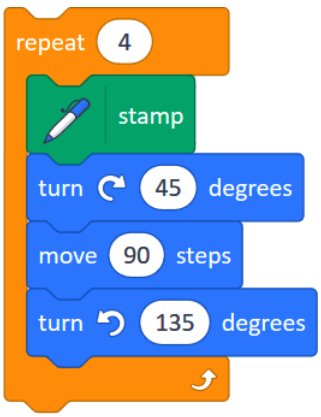






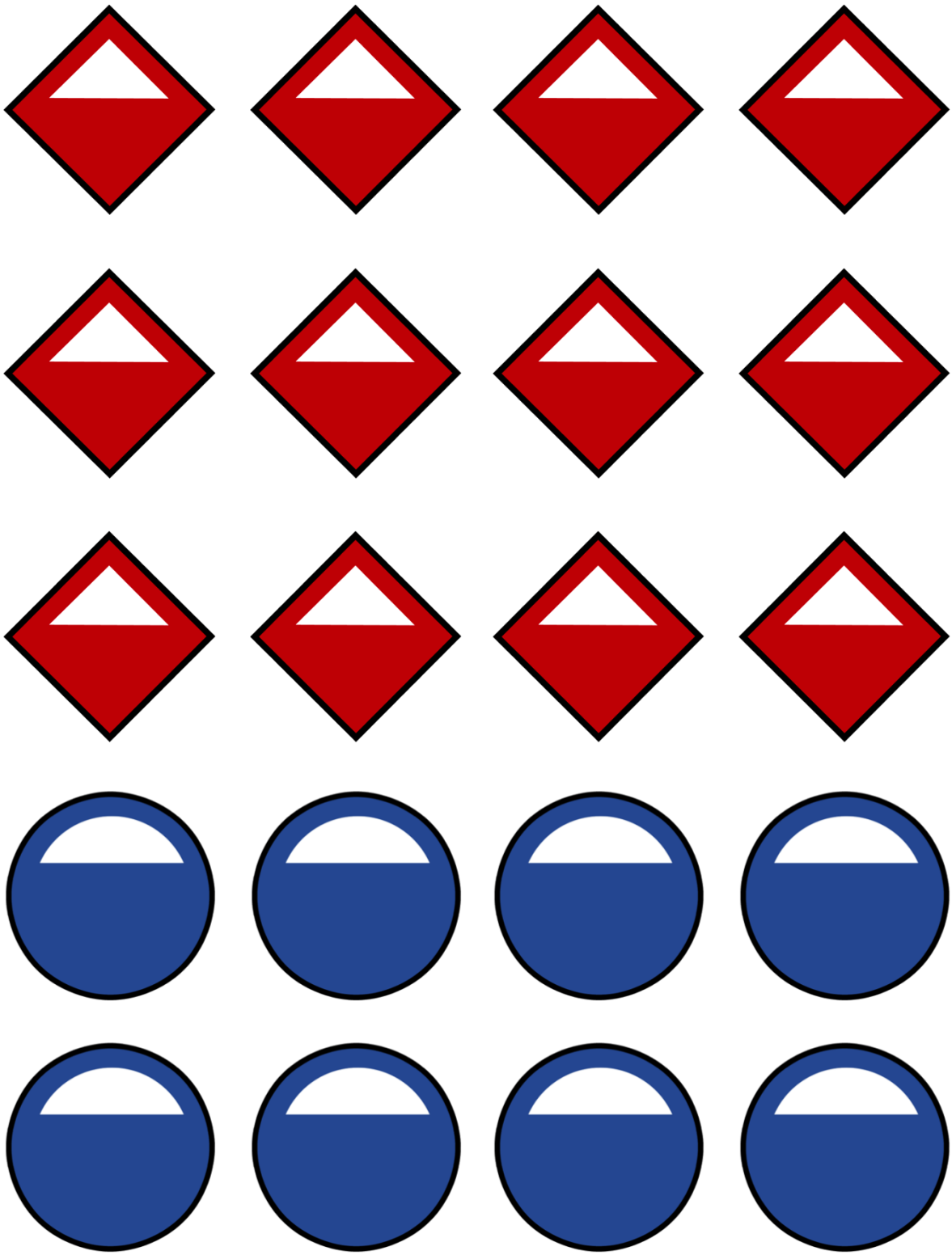


Advanced Pattern



ADDITIONAL SUPPORT

[Optional] You can give these Tile cut-outs to pupils to help them plan a strategy for creating the example patterns in this activity.



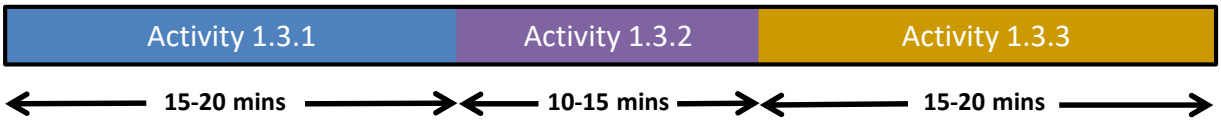
MODULE 1: INVESTIGATION 3

Creating Circular Rose Patterns

OVERALL LEARNING OBJECTIVE: Move the sprite both forwards and backwards to build more complex patterns as well as attempt to predict different features of a pattern before it is created based on knowledge of the script.

This investigation introduces the use of negative numbers to move the sprite backwards and provides an alternative strategy for building more complex patterns by rotating around a central point. It also prompts pupils to read and interpret scripts in order to make predictions about the outcome. The investigation comprises of three activities.

- **Activity 1.3.1** – Moving Forwards and Backwards
- **Activity 1.3.2** – Unplugged: Predicting Patterns
- **Activity 1.3.3** – Combining Different Costumes



We recommend allowing **50 to 70 minutes** for this investigation.

Scratch starter project	**14-Rose Patterns**
Video	**1-Pattern Algorithms**

LINKS TO PRIMARY NATIONAL CURRICULUM

CURRICULUM OBJECTIVES	LINK WITH SCRATCHMATHS
Computing Use logical reasoning to explain how some simple algorithms work.	▶ Pupils are required to use logical reasoning to predict the type of patterns a script will create.
Mathematics Recognise and use the inverse relationship between addition and subtraction and use this to solve missing number problems.	▶ Pupils are required to use their knowledge of the inverse relationship between addition and subtraction to calculate the values of move blocks within a script.
Interpret negative numbers in context, count forwards and backwards with positive and negative whole numbers.	▶ Pupils are required to understand how to use negative numbers to return to a central point from which to build their pattern.
Identify lines of symmetry in 2D shapes presented in different orientations.	▶ Pupils are required to create more complex patterns with multiple lines of symmetry.

MODULE 1 • INVESTIGATION 3 • ACTIVITY 1.3.1

Moving Forwards and Backwards

LEARNING OBJECTIVES

Explore how to use a different algorithm to create a circular pattern from a centre point.
Explain how to move the sprite backwards.

ACTIVITY INSTRUCTIONS

In the previous investigation pupils used the algorithm **move-turn-stamp** to create their patterns.

1. Show the video **1-Pattern Algorithms**.

We are now going to use a different algorithm to create a rose pattern – **move-stamp-move back-turn**.

2. Discuss what the difference between the two algorithms is. How do they think they could program their sprite to move backwards? Physically step through the algorithms with pupils.
3. Pupils open the **14-Rose Patterns** project, save as a copy and add their name(s) to the title.
4. Pupils build a script to create the circular rose pattern below using the **repeat** block (see additional support). Include **wait** block to slowly demonstrate how the pattern is created.

5. Pupils experiment with changing the number of steps in the **move** block, the number of degrees in the **turn** block and the number in the **repeat** block.
6. Pupils try changing the numbers in their scripts to create some of the patterns below.

THINGS TO NOTE

- If you want to drag the Tile sprite to create several patterns on your stage, you must drag it by the red outline – it cannot be dragged by the transparent centre.

VOCABULARY

- An **algorithm** is a precise set of instructions for solving a problem.

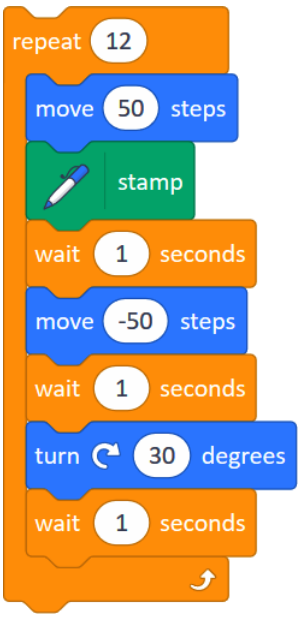
DISCUSSION POINTS

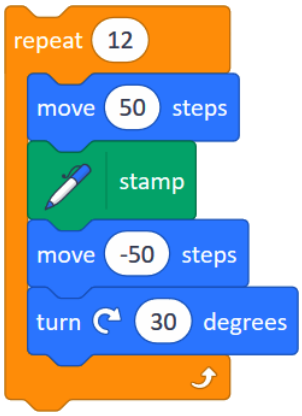
- If you **move 50 steps** from your current location, how do you get back to the same location? Think about different strategies.
- What is the relationship between the values needed to **move** forward and **move** backwards in this new algorithm?

ADDITIONAL SUPPORT

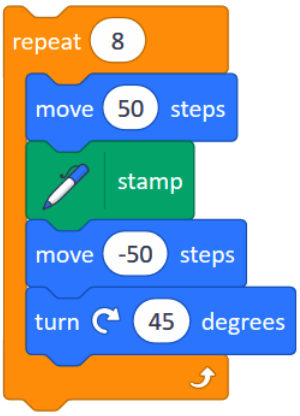
You could have a pupil **physically demonstrate** how the rose pattern is stamped in front of the class – e.g. take 1 step forward, stamp your foot, take 1 step backward, rotate slightly to the right and repeat…

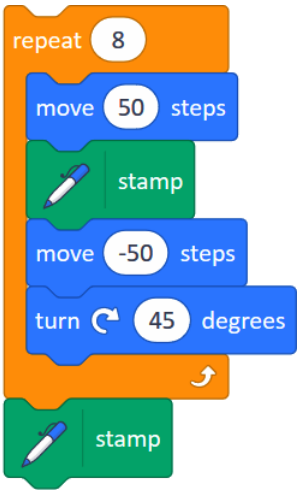
You can use the script below to create the rose pattern on the right. Use the script that includes the **wait** blocks to slowly demonstrate how the pattern is stamped.

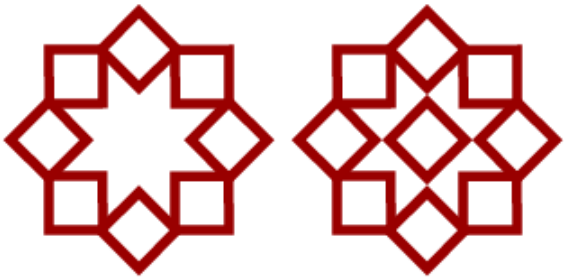




The scripts below create rose patterns without and with a **stamp** in the centre.



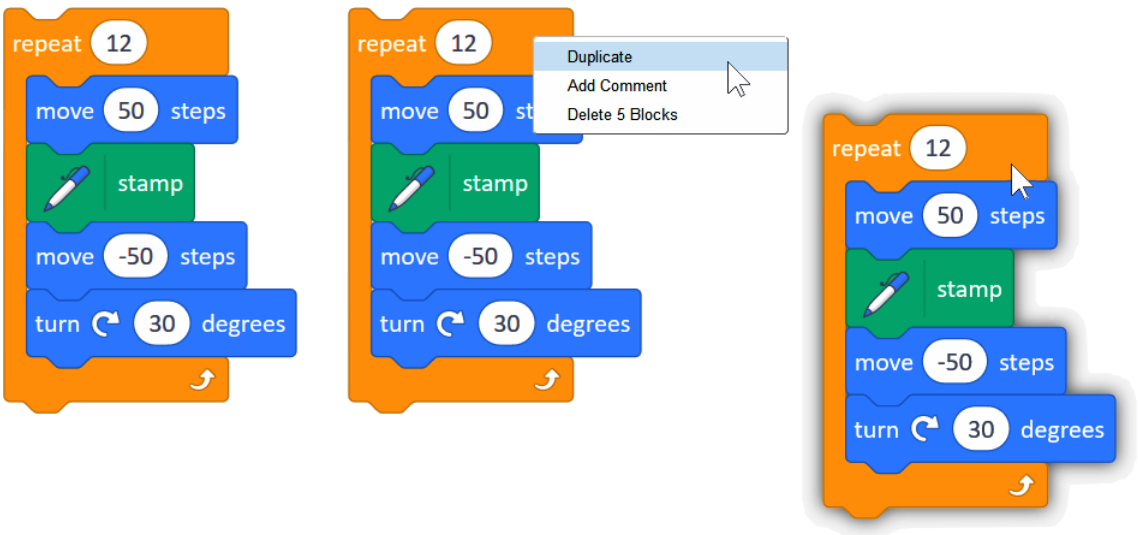




ADDITIONAL SUPPORT CONT.

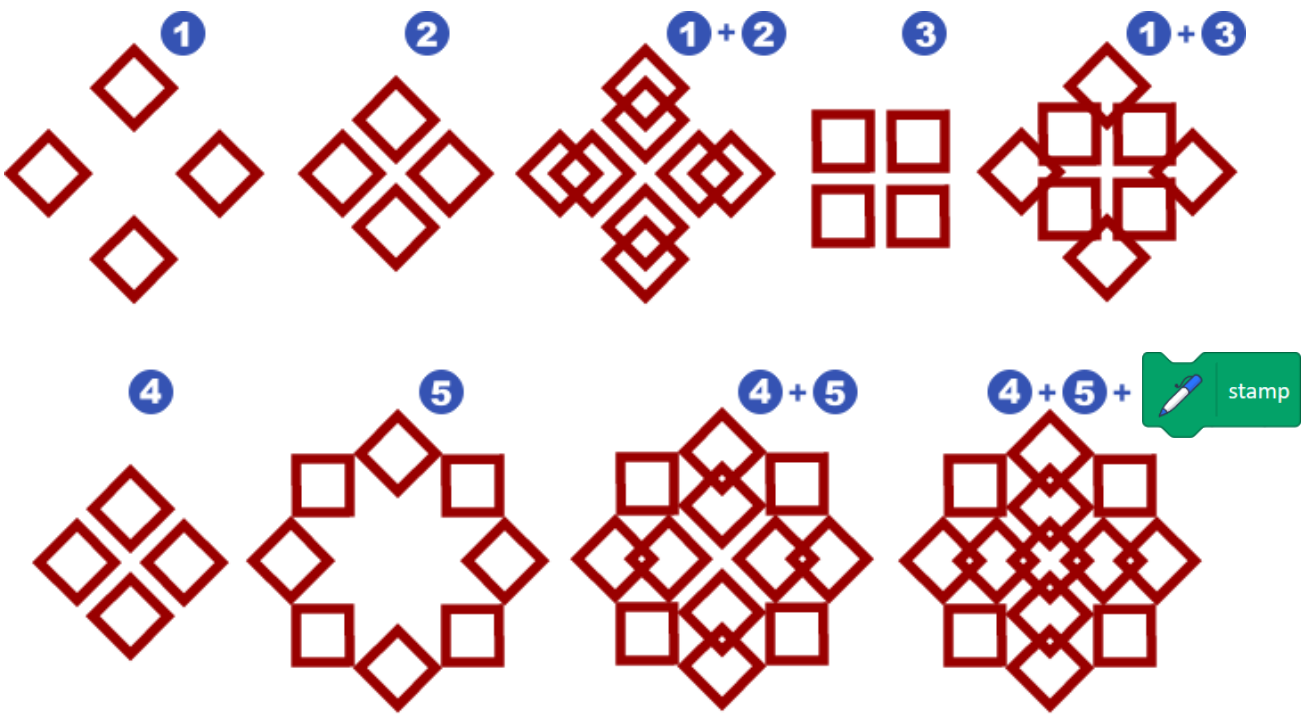
Encourage pupils to **duplicate a script** before they start modifying the numbers in it, so that they can reproduce and share their previous work at any time. In the extension of this activity (see below) pupils may snap two similar scripts together (the second one with modified numbers of the first one).

To duplicate a script, right click (or Shift click) its first block and choose **duplicate**.



EXTENSION TO ACTIVITY 1.3.1

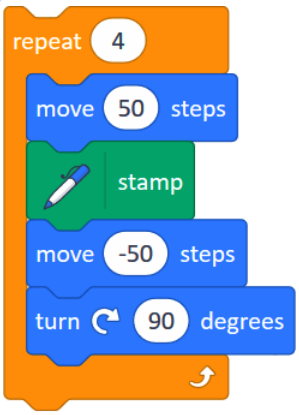
6 Pupils can try combining two different rose patterns together. They may look at the examples below and try to create their own.



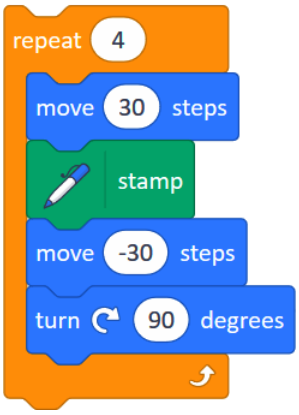
ADDITIONAL SUPPORT

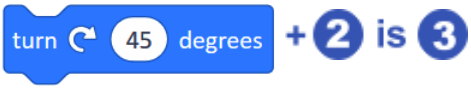
Below are the scripts for some of the patterns above.

1

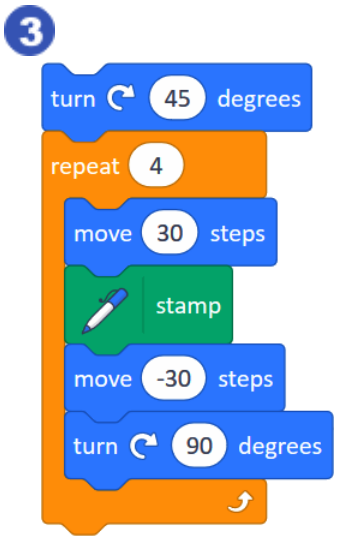


2

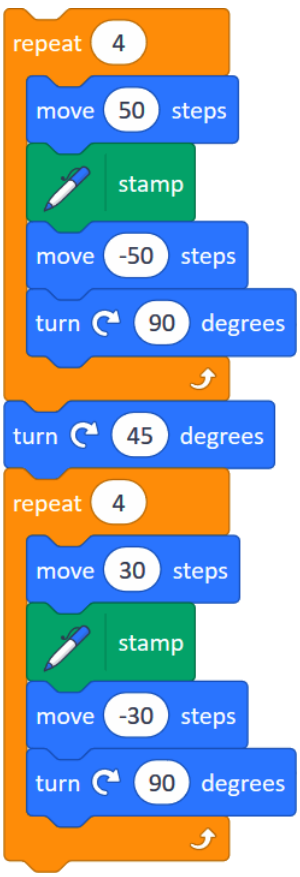




3



1 + 3



Module 1 • Investigation 3 • Activity 1.3.2

Unplugged: Predicting Patterns

Learning Objectives

bridgE to knowledge about total degrees in one whole turn and positive/negative numbers (showing mathematical fluency) and problem solving (visualising/conjecturing).
Envisage the script required to create a specific pattern using logical reasoning.
Explain why a script would or would not create a specific pattern.

Activity Instructions

1. Print and distribute the unplugged pupil worksheet 1.3.2.
2. Discuss as a class which script would stamp the pattern on the left when clicked.
3. Below are some discussion points about each of the scripts:

A. This script is incorrect because the Tile sprite does not move far enough back when it returns to the centre and therefore will not create this circular pattern.
B. This is the correct answer.
C. This script is incorrect because the Tile sprite does not turn enough for each stamp and would therefore not turn the full 360 degrees needed to complete the pattern.
D. This script is incorrect because it does not repeat enough times.
E. This script is also technically correct as it would produce the same pattern as B but repeats more times than is necessary.
F. This script is incorrect because it moves too far each time. However, because it is difficult to visualise exactly how far each stamp is from the centre of the pattern as well as know the size of the stamp this would also be a reasonable prediction.

Unplugged Worksheet Solution

Answer = B (or E, F?)

Vocabulary

- **Logical reasoning** means to apply rules in a systematic way to complete a task (e.g. apply knowledge about what each block does to predict the outcome of a script).

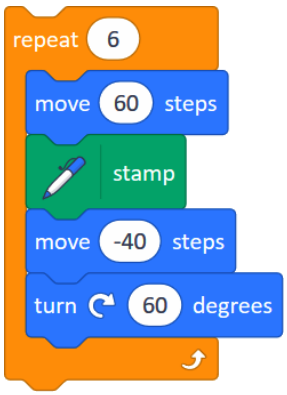
NAME

WHAT TO DO

Find the script that will correctly create the rose pattern on the right. Use the space below to explain if each script would or would not create this pattern and why.

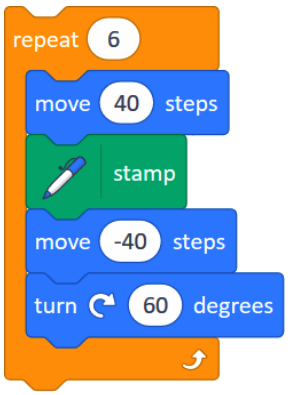
ROSE PATTERN SCRIPTS

A



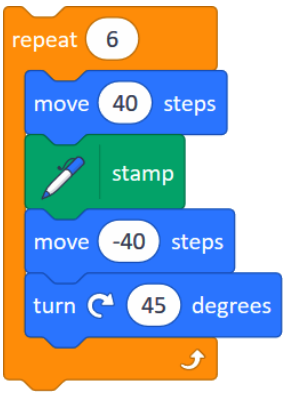
Explain why **Script A** would or would not create the pattern above.

B



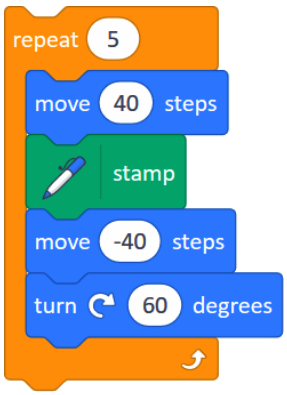
Explain why **Script B** would or would not create the pattern above.

C



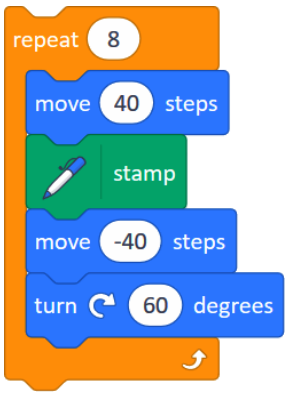
Explain why **Script C** would or would not create the pattern above.

D



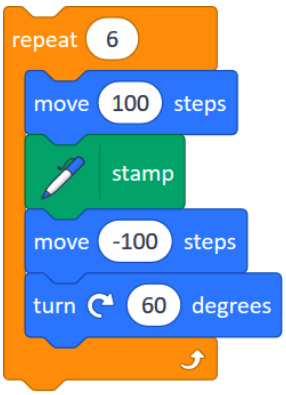
Explain why **Script D** would or would not create the pattern above.

E



Explain why **Script E** would or would not create the pattern above.

F



Explain why **Script F** would or would not create the pattern above.

Module 1 • Investigation 3 • Activity 1.3.3

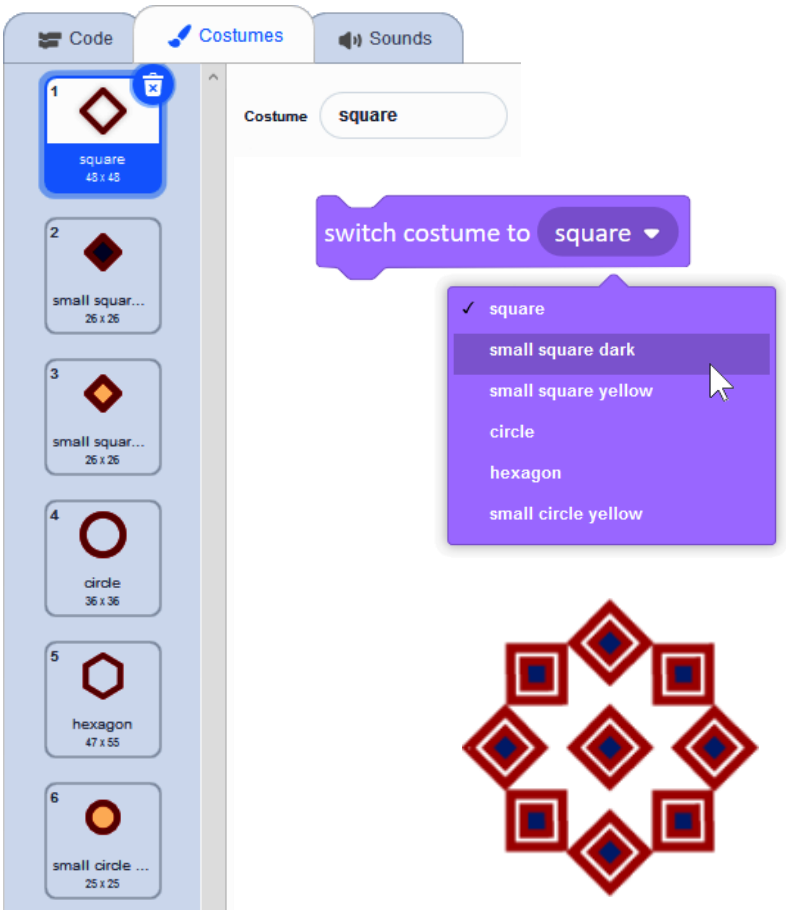
Combining Different Costumes

Learning Objectives

Explore how to create rose patterns which include switching to specific costumes.
Explain the difference between the two different blocks for changing the costume of a sprite and when you might use each block.

Activity Instructions

1. Pupils continue in their copy of the **14-Rose Patterns** project.
2. Pupils go to the **Costumes** tab and explore how many costumes the Tile sprite has. They look at each of the different costumes and notice each costume has its own name.
3. Pupils find the **switch costume to …** block and click on its drop down menu: this has the same list of costume names.
4. Pupils use this block in their scripts to create their own rose patterns (see additional support for example scripts).



Things to Note

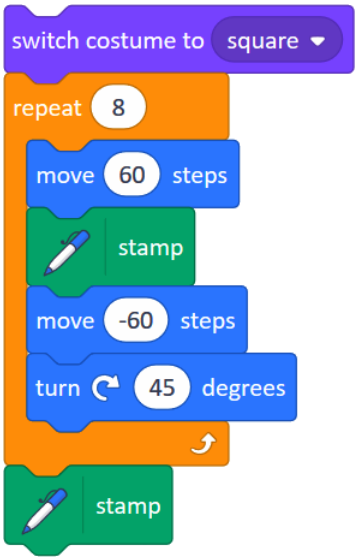
- Keep your previous rose pattern script, duplicate it and add the **switch costume to …** block.
- Then add the **switch costume to …** into the first script as well.
- It is sometimes interesting to change the inputs in the *move* and *move backwards* blocks in the second script, see patterns in the third line in the picture above.

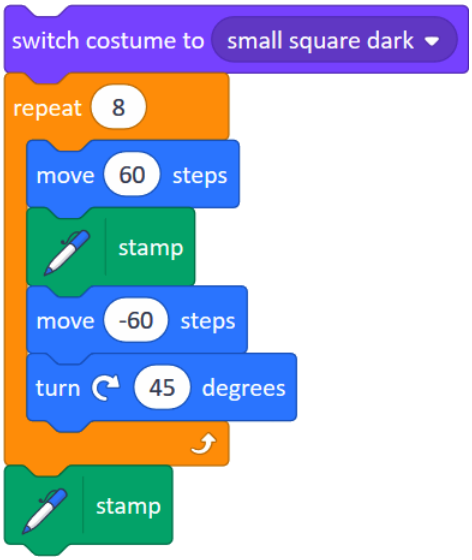
Discussion Points

- How many different costumes did you use in each of your patterns?
- Why might you use the **switch costume to …** block instead of **next costume**?
- Where in your script did you place the **switch costume to …** block? Did you move it – if so what happened?
- How many lines of symmetry can you identify in your patterns?

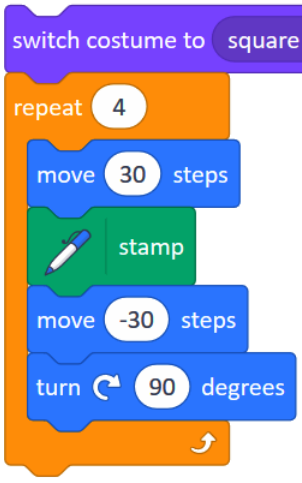
ADDITIONAL SUPPORT

You can use the script below to create the first rose pattern on the left.



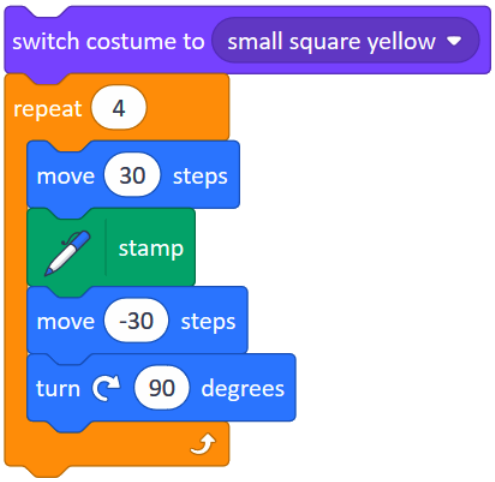


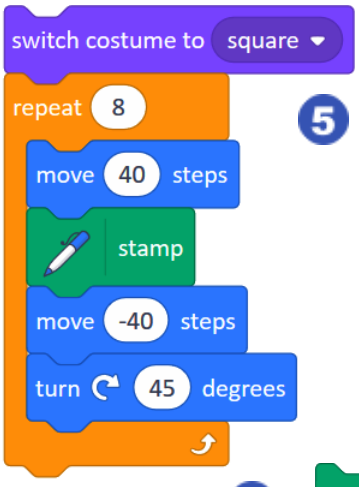
Before changing the inputs and the costume to use, duplicate the script. Finally snap both scripts together so that the whole pattern is created by single click. Here are some more scripts for creating the example patterns in Activity 1.3.3.



1

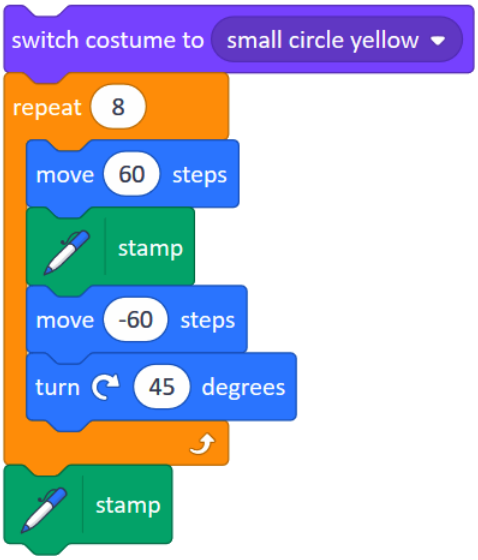
2





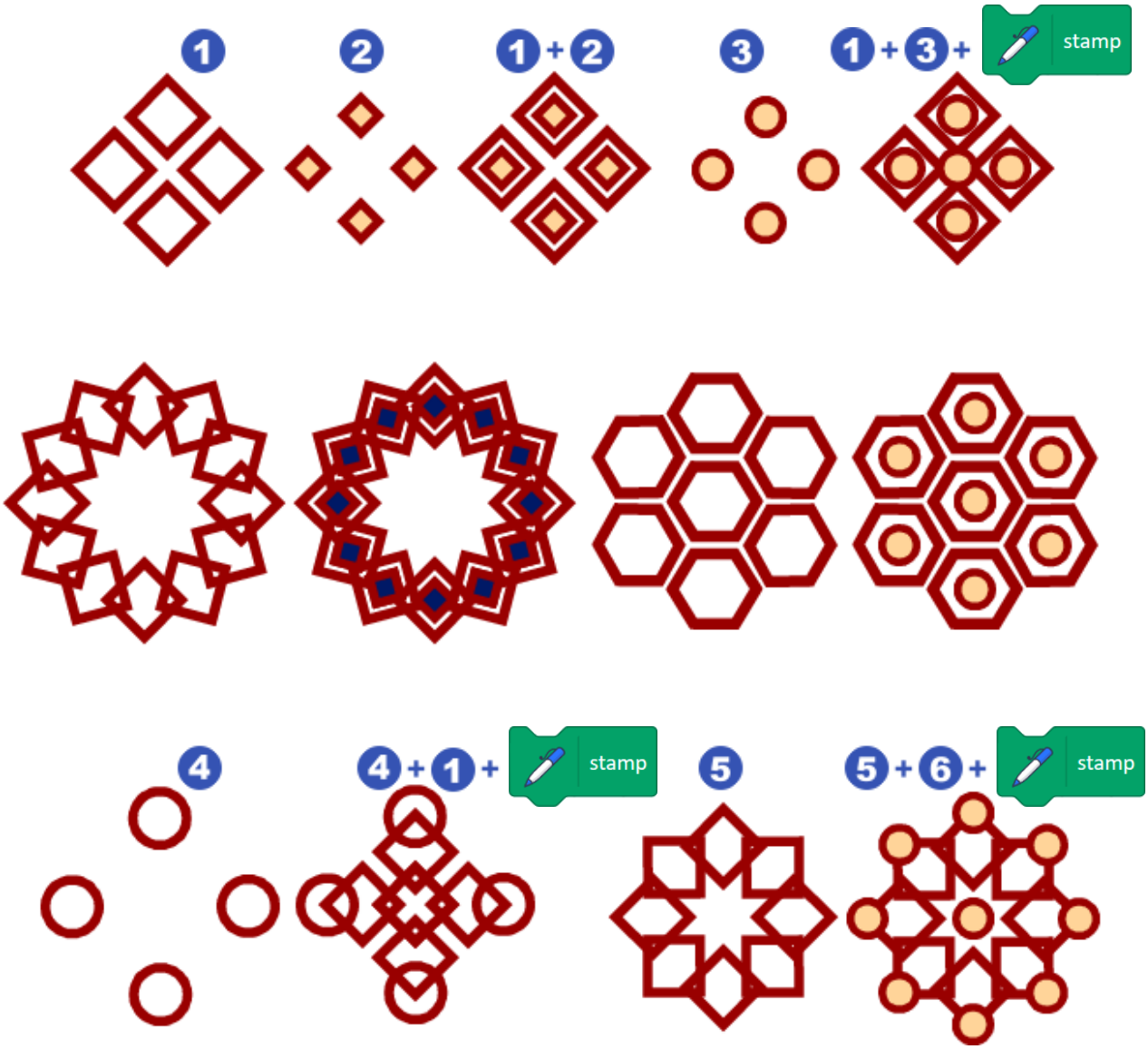
5

6 +



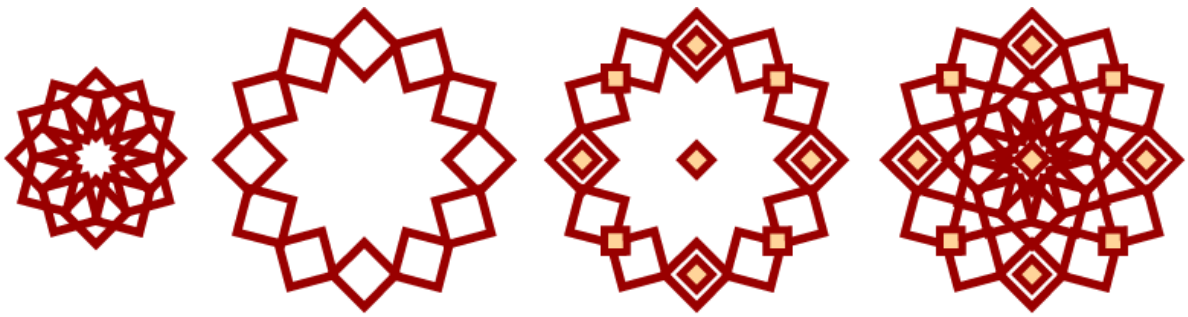
ADDITIONAL SUPPORT

More ideas for combining different costumes in one rose:



EXTENSION TO ACTIVITY 1.3.3

5 Pupils can try combining two or more distinct rose patterns together. Pupils may look at the examples below and try to create their own.



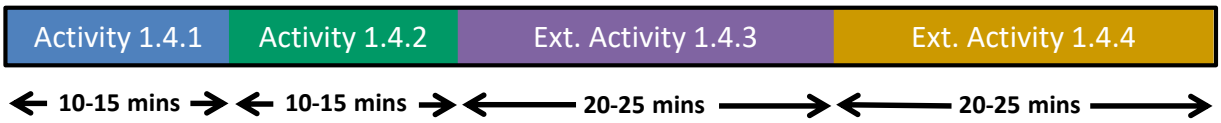
MODULE 1: INVESTIGATION 4

Defining Your Own Pattern Blocks

OVERALL LEARNING OBJECTIVE: Create a definition of your own pattern block and use this block within a script to create complex patterns.

This investigation introduces the concept of **definition**, which allows a pattern to be represented as a single block within other scripts. It also includes an unplugged assessment activity requiring pupils to apply what they have learned throughout this module to reason about the outcomes of a range of scripts. The investigation comprises of two core activities and two extension activities.

- **Activity 1.4.1** – Defining your own Block
- **Activity 1.4.2** – Unplugged Assessment: Reading Scripts 1
- **Extension Activity 1.4.3** – Building a Row of Roses
- **Extension Activity 1.4.4** – Roses of Roses



We recommend allowing **40 to 90 minutes** for this investigation (depending on how many of the extension activities your pupils attempt).

Scratch starter project **14-Rose Patterns** (continued from Investigation 3)

LINKS TO PRIMARY NATIONAL CURRICULUM

CURRICULUM OBJECTIVES	LINK WITH SCRATCHMATHS
Computing Design, write and debug program that accomplish specific goals. Use logical reasoning to explain how some simple algorithms work.	▶ Pupils are required to build the definition for a new block and to use this block in their scripts to create more complex patterns. ▶ Pupils are required to use logical reasoning to predict the outcomes of scripts that include concepts learned across the whole module.
Mathematics Describe positions on a 2-D grid as coordinates.	▶ Pupils who attempt the extension activities are required to specify the layout of their patterns on the stage using coordinates.

Module 1 • Investigation 4 • Activity 1.4.1

Defining your Own Pattern Blocks

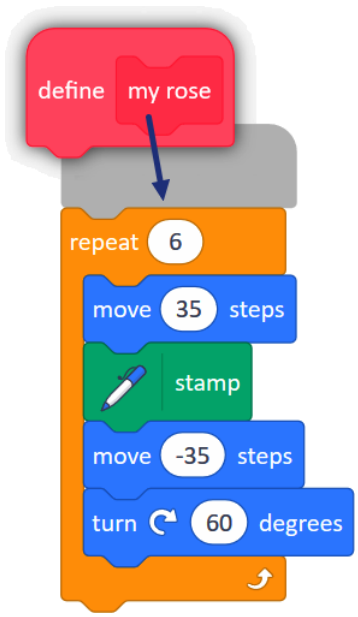
Learning Objectives

Explore how to define a new block, use this new block in a script and edit the definition.
Explain what a block definition is and why you might want to define a new block.

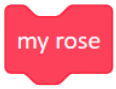
Activity Instructions

1. Pupils continue in their copy of the **14-Rose Patterns** project.
2. Pupils build a script of their favourite rose pattern using the algorithm **move-stamp-move back-turn**. (e.g. see 1 in additional support).
3. In the **My Blocks** group pupils click on the **Make a Block** button (see 2).
4. In the **New Block** window pupils give their new block a name, e.g. **my rose**, and click OK (see 3). A new hat block called **define my rose** will appear in the scripting area (see 4). Also, a new block 

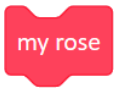
in the **My Blocks** group is created (see 5).
5. Pupils put this hat block on top of their selected rose pattern script. This completes the definition of a new block (see 6). This definition can be modified whenever needed.

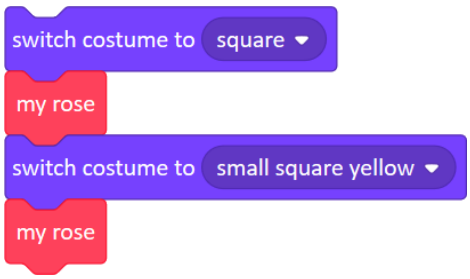


Our new block can be used – as isolated block or in a script – to stamp the whole rose.

6. Pupils drag their new 

block into the scripts area and click it. They drag their sprite somewhere else on the stage then click their new block again.
7. Pupils build scripts using their new block more than once.





8. **[Extension]** Pupils try changing definitions of their new block or creating several new blocks with different names and using them in one script.

Vocabulary

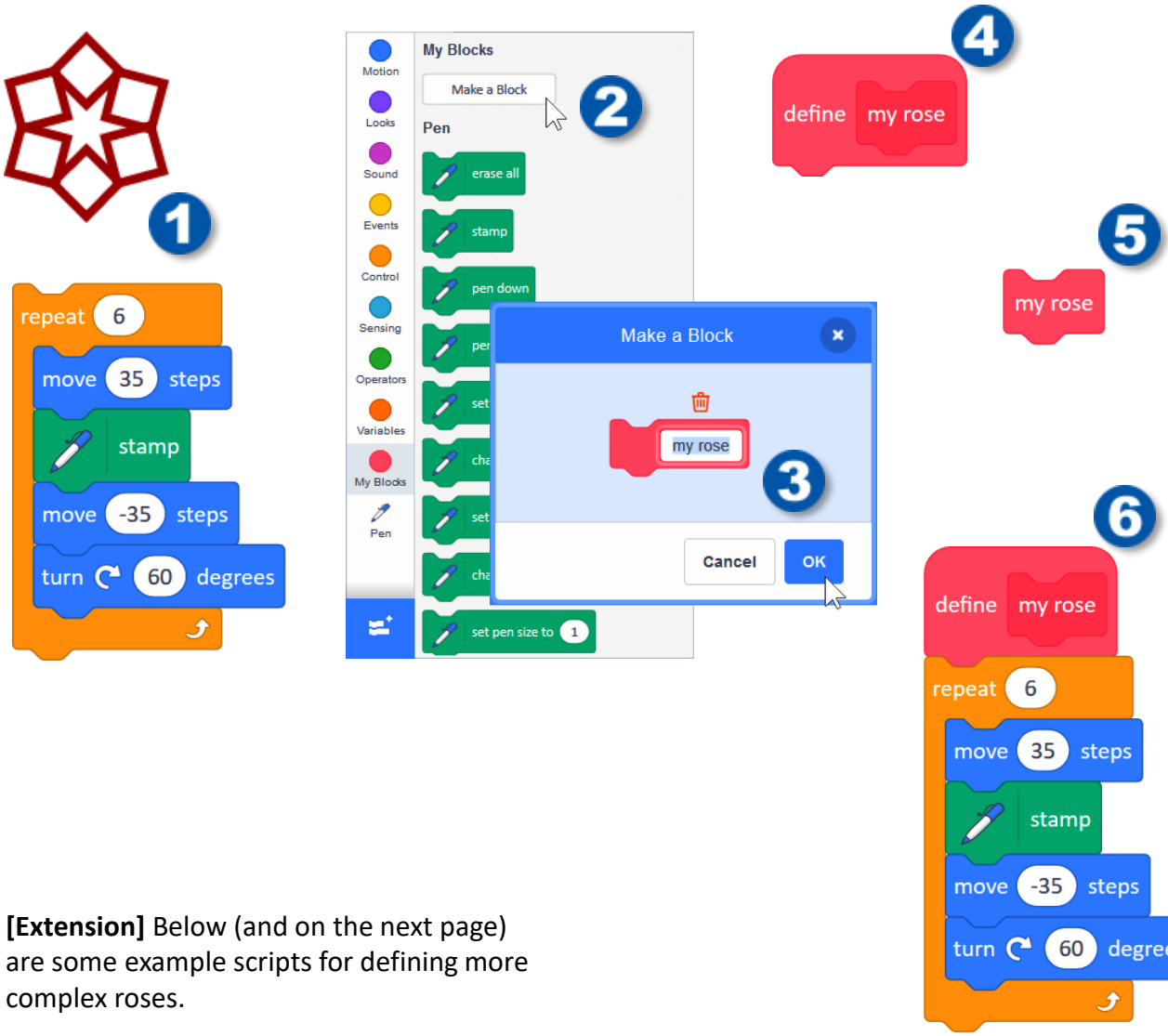
- The **definition** of a new block means the script that is connected to its define hat block. This tells you what your new block will do when clicked.

Discussion Points

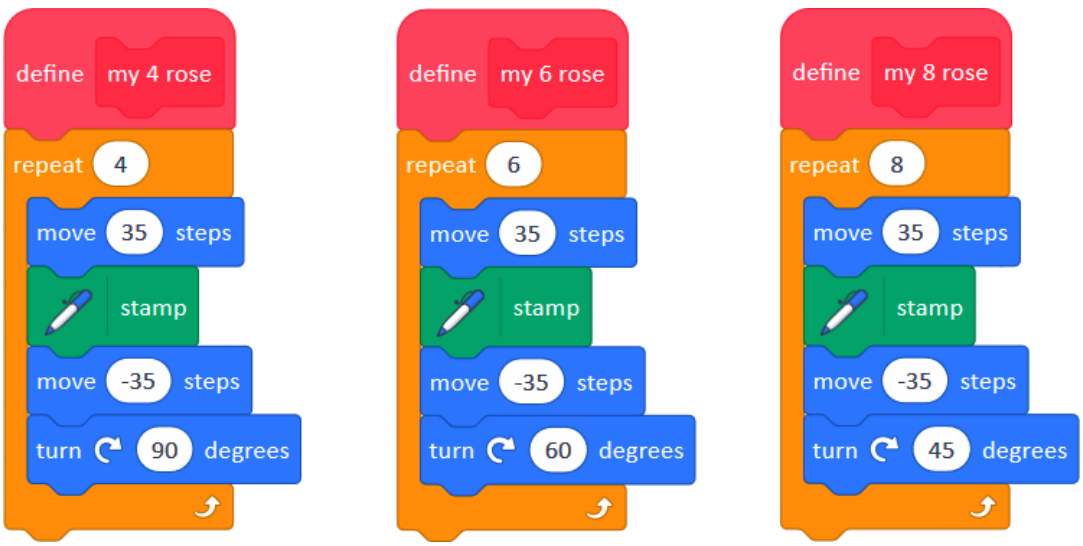
- Why do you think it is useful to define your own blocks?
- Why might it be important to give your new block a meaningful name?

ADDITIONAL SUPPORT

Below is the process of how to create a new block.

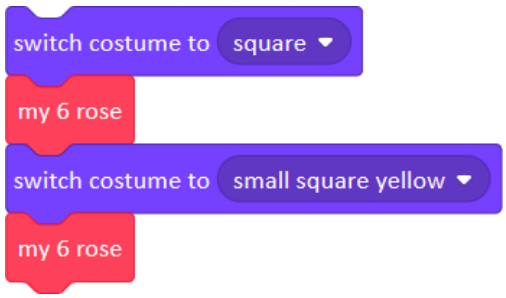


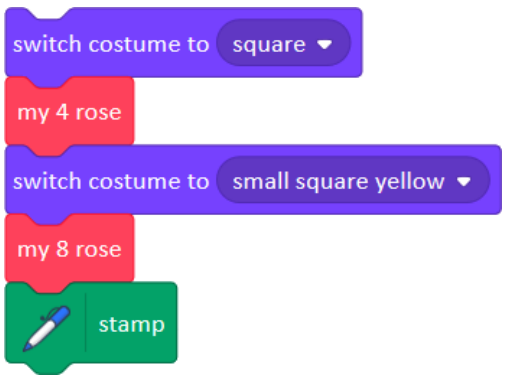
[Extension] Below (and on the next page) are some example scripts for defining more complex roses.

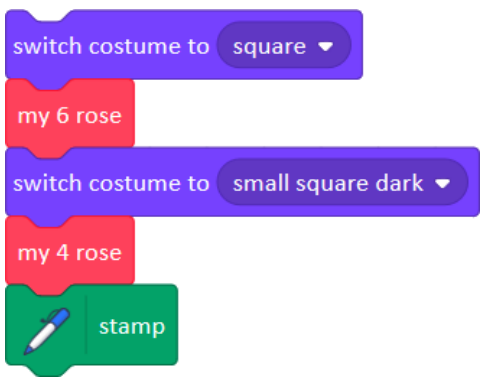


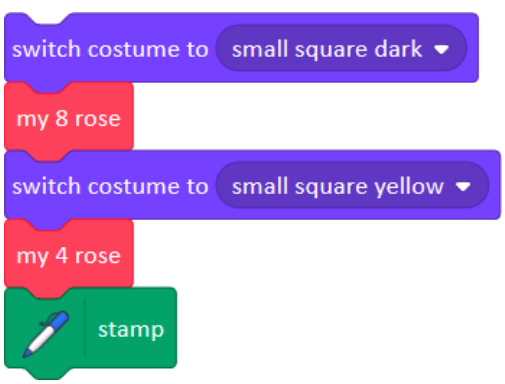
ADDITIONAL SUPPORT CONT.

Below is the process of how to create a new block.









MODULE 1 • INVESTIGATION 4 • ACTIVITY 1.4.2

Unplugged Assessment: Reading Scripts

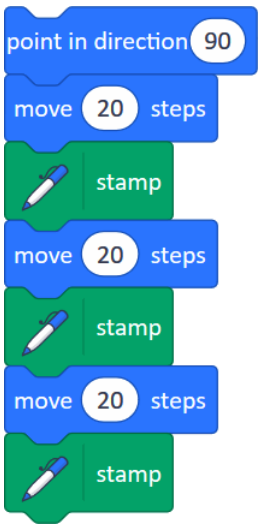
LEARNING OBJECTIVES

bridgE to knowledge of rotation, angles, multiplication and translation.
Envisage the outcome of different scripts.
Explain why a script would have a particular outcome and how to complete a script to generate a specified outcome.

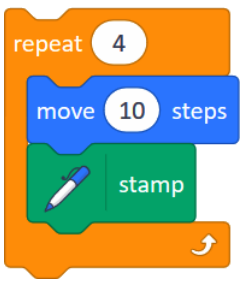
ACTIVITY INSTRUCTIONS

1. Print and distribute the unplugged pupil worksheet 1.4.4.
2. Ask pupils to work individually to check what they have learned during Module 1.
3. The answers to the worksheet are below:

1. 80 steps (4 x 20)
2. Replace both **move 10 steps** blocks with one **move 20 steps**
3. 180 degrees (60 + 60 + 60)
4. →



5. 120 degrees (4 x 30)
6. 6 (360 / 60)
7. 45 degrees (360 / 8)
8. →



9. 16 times (8 x 2 stamps)

[Extension]

10. The patterns should look the same (the second script would stamp an extra two tiles over the first two but this would not show in the final pattern). Starting point is in the centre of the pattern.

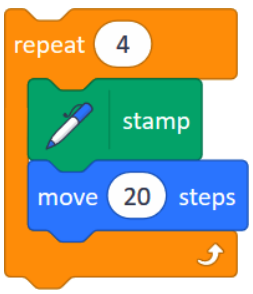
NAME

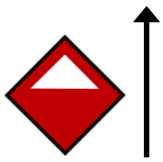
WHAT TO DO

Read each script, think about what would happen on the stage when it is clicked and then write your answer to the question in the box on the right hand side.

ASSESSMENT TASKS

1 How **many steps** will my Tile sprite move in total when I click on the script on the right?

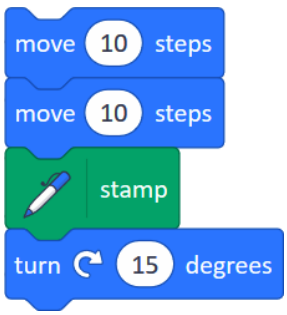




Total number of steps moved =

---

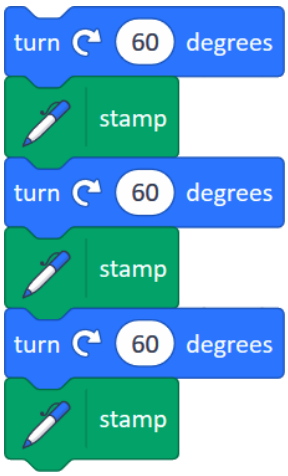
2 How could I make this script **simpler** and still have the same outcome?

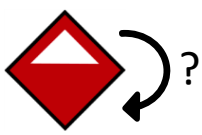


Write simple version of script below:

---

3 How **many degrees** will my Tile sprite turn in total when I click on the script on the right?





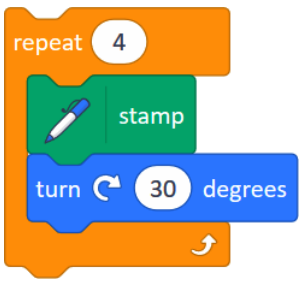
Total number of degrees turned =

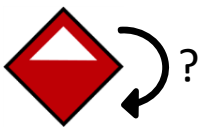
ASSESSMENT TASKS CONTINUED

4 **Write a script** that has the same outcome as the script on the right but without using the **repeat** block.

Write a script with same outcome without **repeat** below:

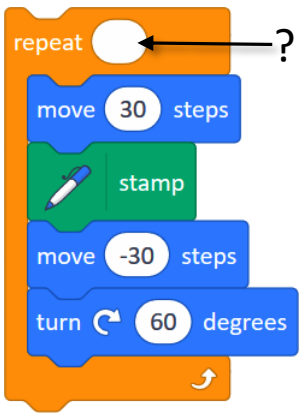
5 How **many degrees** will the Tile sprite turn in total when I click on the script on the right?





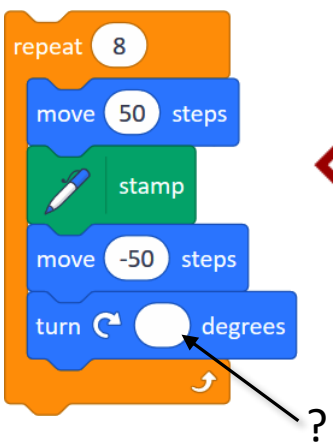
Total number of degrees turned =

6 What is the **lowest number** that could go into the **repeat** block to create the pattern on the right?



Repeat number =

7 Which **number** do I need to put into the **turn** block to create the pattern on the right?

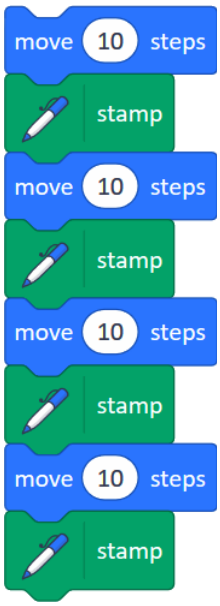


Number of degrees =

ASSESSMENT TASKS CONTINUED

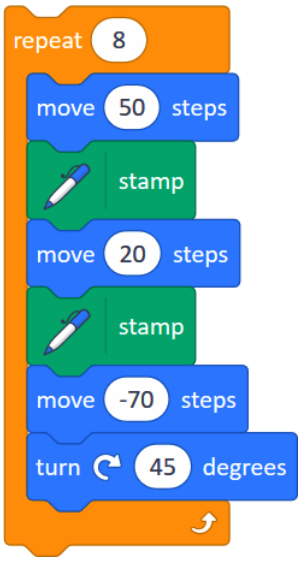
8 Make the script on the right **shorter** by using the **repeat** block.

Write the shorter script using the **repeat** block below:



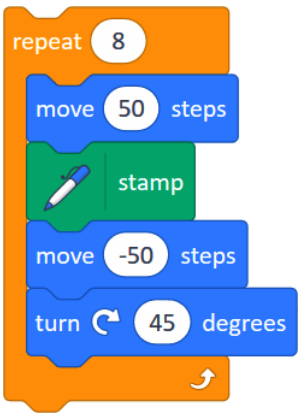
9 How **many times** will the Tile sprite stamp if I click on the script on the right?

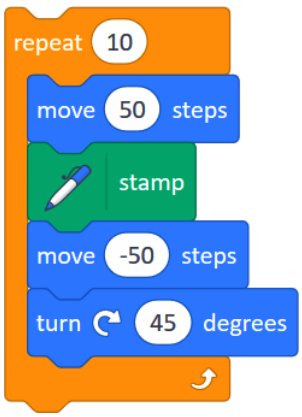
Number of tiles stamped =



[Extension]

10 In the boxes on the right **draw the pattern** that will be stamped by the Tile sprite when each of the scripts on the right are clicked on.





Start

Start

Module 1 • Investigation 4 • Activity 1.4.3

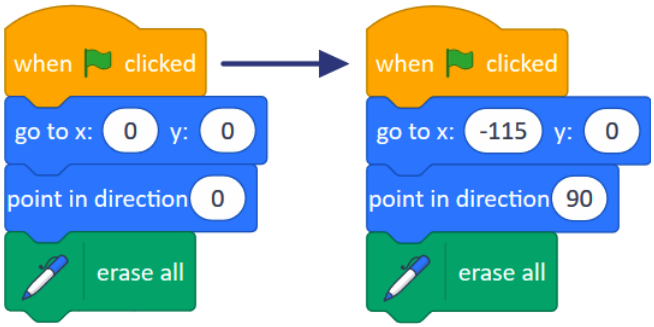
[Extension] Building a Row of Roses

Learning Objective

Explore how to use all of the techniques learned during Module 1 to plan and build a repeated pattern made from multiple rose patterns.

Activity Instructions

1. Pupils continue in their copy of the **14-Rose Patterns** project.
2. Pupils edit the *setup script* so that the Tile sprite is initially positioned closer to the left edge of the stage, pointing to the right. (E.g. by **go to x: -140 y: 0** and **point in direction 90**, exact x position will depend on the size of their roses).



3. Pupils decide which rose pattern script they will use repeatedly. They create a new block to stamp that pattern, e.g. **my best rose**.

4. Pupils build a small script of only two blocks: **my best rose** and **move 115 steps** (see 1 in additional support).
5. Pupils click this script multiple times to stamp multiple rose patterns in a row. Then they clear the screen and add the **repeat** block to create the same pattern in one go (see 2).

Things to Note

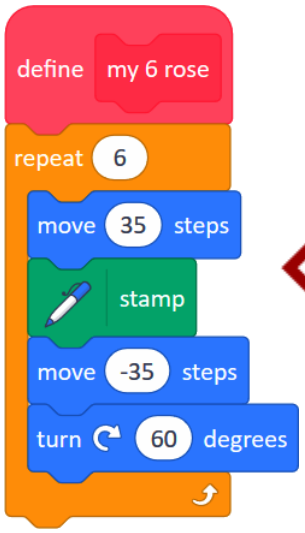
- If the individual rose patterns are too big it will not be possible to fit multiple patterns on the stage.
- Dragging or manual costume switching is not allowed.
- If the sprite bounces off the edge of the stage it may impact the angles and regularity of the pattern.

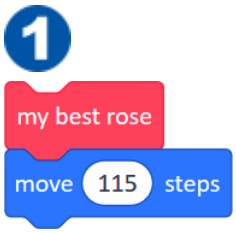
Discussion Points

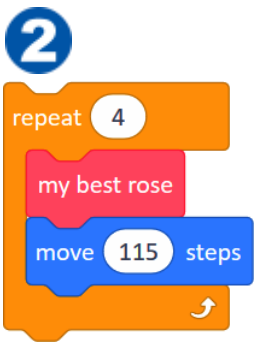
- Could you plan a strategy for a pattern with four repeated roses? How about six roses in two rows of three?
- How can you find out the exact coordinates (i.e. x position and y position) for the starting point of each of your rose patterns?

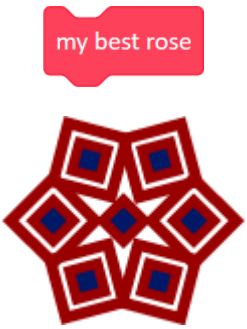
ADDITIONAL SUPPORT

Below are the blocks that you can use to create a row of rose patterns (note that in the setup script the initial direction of the Tile is set to 90).





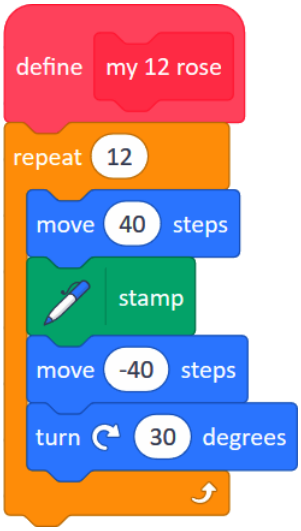


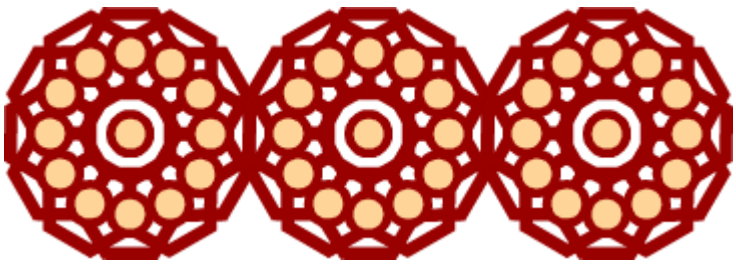


More ideas for a row of roses (see also next page):

ADDITIONAL SUPPORT CONT.

More ideas for a row of roses:





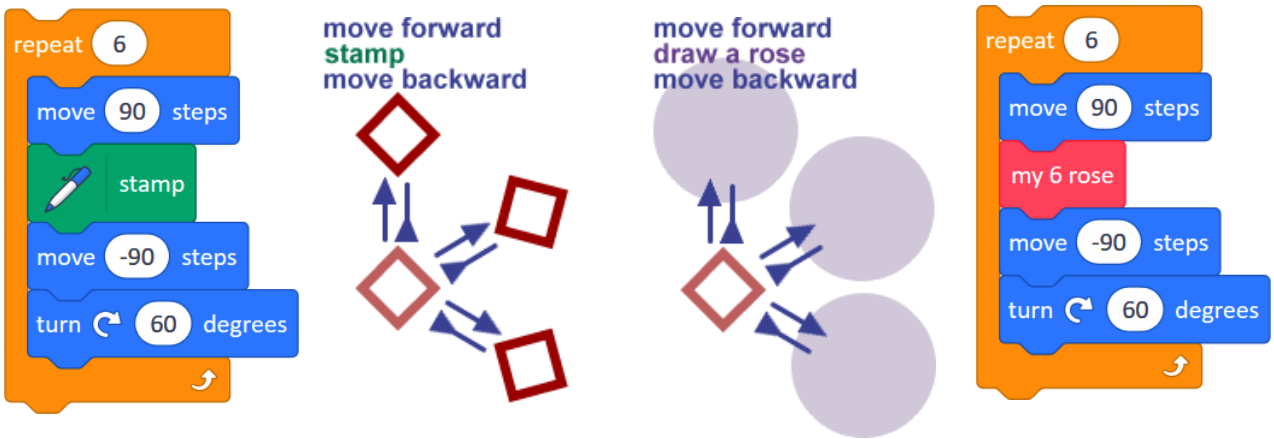
MODULE 1 • INVESTIGATION 4 • ACTIVITY 1.4.4
[Extension] Rose of Roses

LEARNING OBJECTIVE

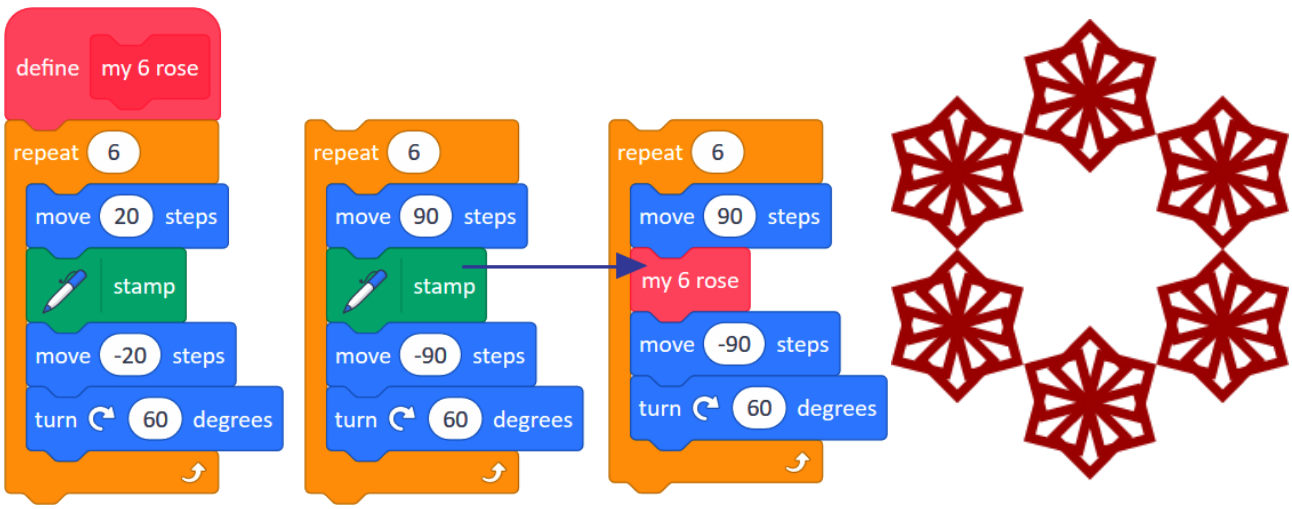
Explore how to use all of the techniques learned during Module 1 to plan and build a *rose pattern made from multiple smaller rose patterns*.

LEARNING OBJECTIVE

1. Pupils continue in their copy of the **14-Rose Patterns** project.
2. Analyze and discuss with the pupils in detail a simple rose pattern script with large moves, for example **move 90** and **move -90**. Discuss the role of the **stamp** block and the possibility to replace it by more complex action, e.g. stamping a whole rose pattern, then moving back…



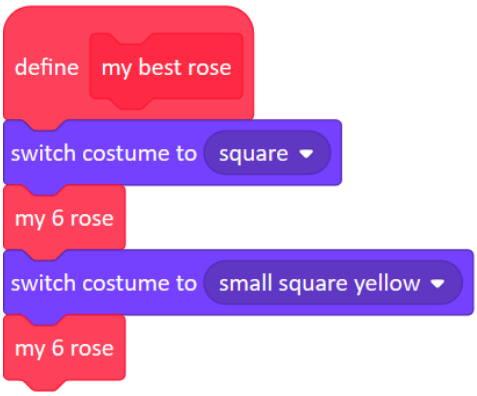
3. Pupils build their own **my rose** script, trying to keep that rose simple and small at the beginning. Then build the script to stamp a circular pattern of roses – *a rose of roses*.

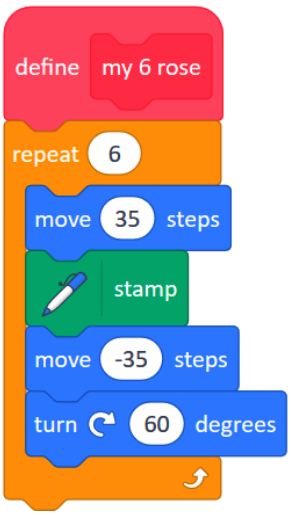


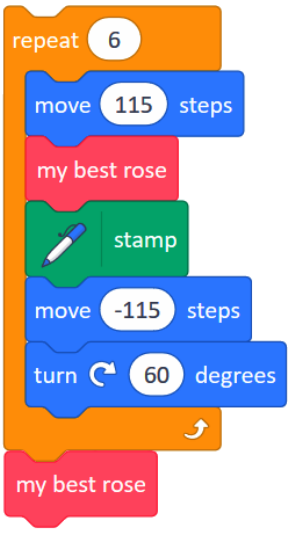
4. Pupils use the algorithm **move**-**my rose**-**move back**-**turn** with different **my rose** blocks, number of steps, number of **repeat** and angle. They may add the same **my rose** in the centre.

ADDITIONAL SUPPORT

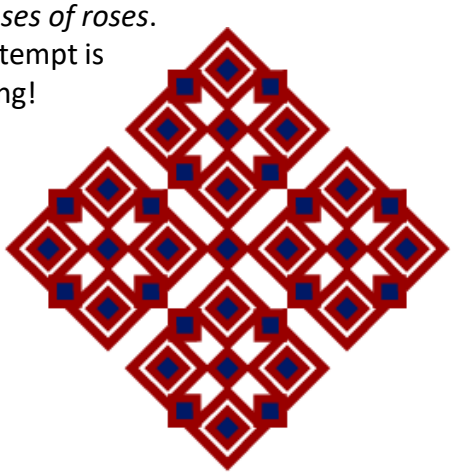
The scripts below will create the following rose of roses patterns

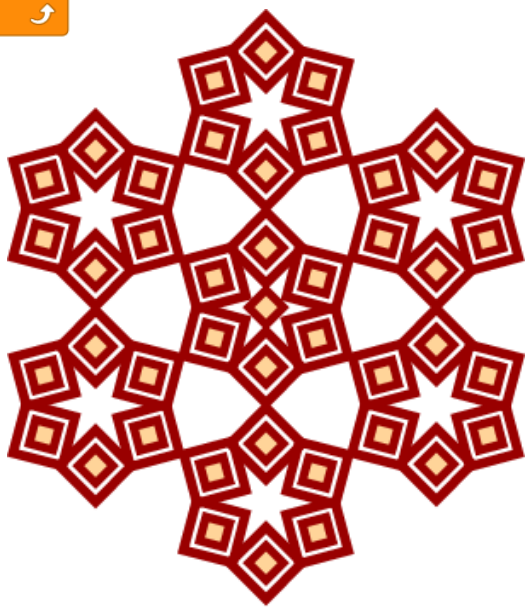


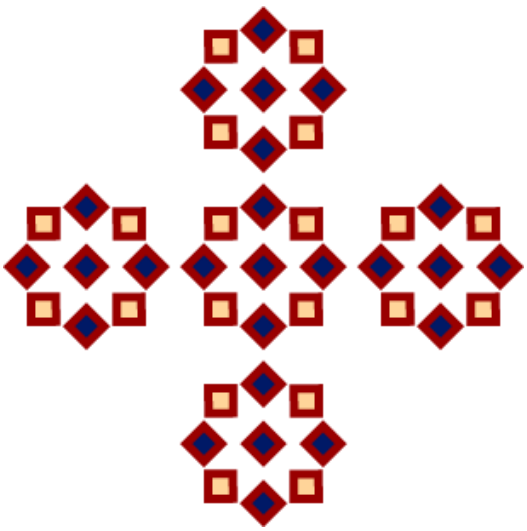


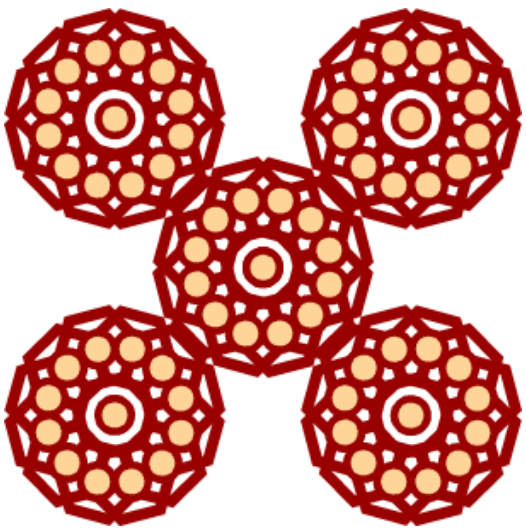


Experiment with other roses and other *roses of roses*. Every attempt is rewarding!









Module 1 Success Criteria

By the end of Module 1 pupils should be able to:

Blocks

- Identify and use several individual blocks such as **stamp**, **turn**, **move**, **next costume**, **switch costume to…**
- Change the input or inputs of a block
- Snap blocks together to create a script
- Duplicate a block, delete a block
- Define own block and use it in a script

Repeat Structure

- Understand the concept of repetition
- Find and use the minimum value required within the **repeat** block in order to create a complete circular pattern
- Recognize a repeating pattern in a simple sequence of blocks and replace it by a **repeat** structure

Sprite

- Set its position by dragging and by running a block or a script
- Set its direction
- Change its costumes
- Turn it
- Move it
- Stamp it

Problem Solving

- Identify multiple algorithms that will produce the same pattern
- Simplify a script by collapsing multiple **move** or **turn** blocks into a single block
- Use logical reasoning to work out missing values in given circular pattern script

Scripts

- Build a script, insert a block in a script, reorder blocks in it, remove a block from it
- Run a script
- Read and make predictions about a simple script
- Modify a script by changing its inputs
- Duplicate a script, delete a script
- Debug a script
- Understand when neighbouring identical blocks can be collapsed to simplify the script

Mathematical Understanding

- Use mathematical understanding of angles to calculate number of degrees to turn and number of times to repeat in order to create a circular pattern
- Understand how to move backward using a negative number of steps
- Understand a whole turn as turning and coming back to the starting position
- Analyse and create several different repeating patterns and be able to recreate them
- **[Extension]** Position their sprite using x and y coordinates