

Lesson 4.4 - Passwords and Patterns

Overview

This lesson requires 2 periods (approximately 90 minutes). In the first session, students will gain understanding of the importance of secure passwords and best practice in keeping their digital information safe. They will also develop fluency with AND logic gates. In the second session, students will learn about chaining AND gates and be introduced to the NOR logic gate. Students will integrate and exhibit learning by creating systems which are activated after pressing a series of keys or dots (as on a smartphone).

Key Information

Level 4: (Ages 11-12) US Grades 5 or 6

Time: 90 minutes

Warm-Up	5 minutes
Mini-lesson	15 minutes
Worked Example	25 minutes
Challenge 1	20 minutes
Challenge 1 - Debug	10 minutes
Challenge 2	10 minutes
Tidy Up / Exit Ticket	5 minutes

Lesson Topics

- **Computing**
 - Logic gates and chaining, conditional statements and encryption
 - Personal security and passwords
- **Math**
 - Combinations and permutations
- **History**
 - Puzzle boxes
- **Scientific Thinking**
 - Asking relevant questions and using different types of scientific enquiries to answer them
- **Design and Technology**
 - Generate, develop, model and communicate ideas through talking, drawing and mock-ups
- **English Language Arts**
 - Use information gained from illustrations and text to demonstrate understanding
 - Write informative/explanatory texts to examine a topic and convey ideas and information clearly

Learning Objectives

- **As a result of this lesson, students will be able to**
 - Explain the concept of secure passwords
 - Explain how a secure password can be made
 - Explain how AND and NOR gates work in computing systems
 - Design a SAM system to replicate the working of an unlock pattern on a smartphone

Materials

- SAM Labs Kit
- SAM Labs Student Workbook

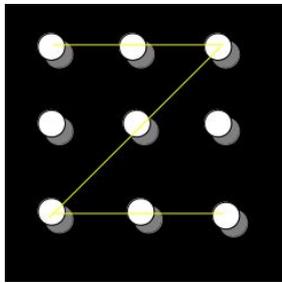
Warm Up – Scientific Inquiry

5 minutes

How do we use passwords?

Objective: Conduct scientific inquiry about secure passwords

Procedures: Students look at the different types of passwords and identify which of them they commonly use. The teacher asks, *What is a password? Which type/s of passwords do you use? Why are they important?* The teacher identifies a few ‘real world’ / current event examples of the relevance of passwords to personal information and confidentiality.



Link forward: The teacher identifies requirements for a secure password

Mini-lesson

15 minutes

How do you create a secure password?

Objective: Students learn how to create a secure password

Procedures: The teacher reiterates two requirements for a secure password, eg: That they are designed to be secure and are kept in a safe place. *What does secure mean? Do you already know any rules?*

Here are some example rules:

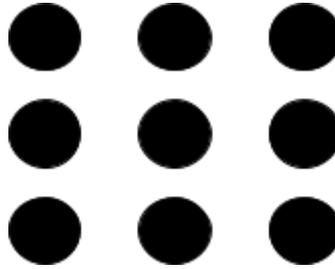
- Use special characters, eg: >, #
- Use long passwords: about 8 characters is a good minimum
- Use different passwords for different things
- Keep a copy in a very safe place
- Change them up regularly
- Never tell anyone your password

Explain that the security of a password is directly related to its length. The more combinations possible, the longer it will take someone to guess the password, so length is proportional to security. *The teacher asks, “How many ways can you combine the numbers ‘1’ and ‘2’? And ‘1’, ‘2’ and ‘3’?”* Explain how to rapidly calculate possible combinations, for example:

- 1, 2, and 3 can be combined: $1 \times 2 \times 3$ ways = 6 different ways
- Any two letters can be combined 26×26 times = 676 times

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How many combinations can be made of the nine dots in a smartphone locking patterns?



Due to their relative security, many premises use number or letter-based passwords as a supplementary locking system.

At the end of the mini-lesson, students can match or define keywords in their workbooks. (2 minutes)

Keywords

- Sequence
- Secure
- Safe
- Mnemonic
- Pattern
- Special characters



Let's Discuss: Why is the security of a password proportional to its length? In your workbooks or with a partner, record, discuss, or share an example of a safe password.

Link forward: Students will build a lock using a combination of Key Presses to unlock the system.

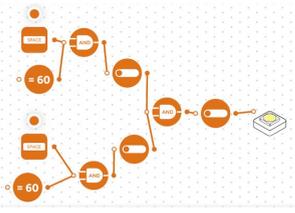
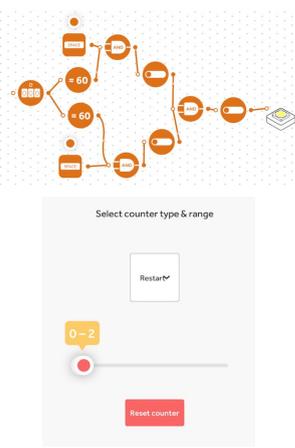
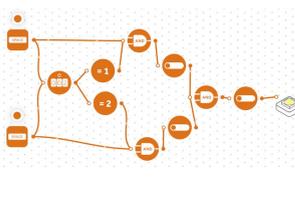
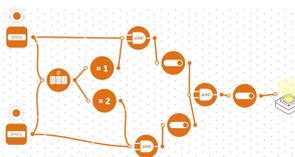
Worked Example

25 minutes

Design a SAM system that will illuminate a light on inputting a code

Instructions	Workspace	Notes for Teachers
<p>Step 1. Turn on and pair:</p> <ul style="list-style-type: none"> • RGB LED <p>Drag the 'AND' block and Toggle onto the Workspace. Connect them.</p>		<p>The teacher says, "The 'AND' block will connect to the Toggle block and the Toggle block connect to the Light block. When we activate our 'AND' block the Light will turn on".</p>
<p>Step 2. Add and connect 2 more Toggle blocks to the 'AND' block.</p>		<p>An 'AND' block has two inputs and both must be true before it will signal the Toggle to switch on the RGB LED.</p> <p>Each Toggle is going to respond to two inputs:</p> <ul style="list-style-type: none"> • When the Key Press is pressed • The number of presses

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<p>Step 3. Connect two more 'AND' blocks to the Toggle blocks. Then, connect a Key Press and Compare block to each 'AND' block.</p>		<ul style="list-style-type: none"> • The top Key Press is referred to as the 'A' key • The bottom Key Press is referred to as the 'B' key <p>(Please note, we are referring to the Key Press blocks here as A and B for convenience)</p>				
<p>Step 4. Connect a Counter block to the 2 Compare blocks. Open the Settings of the Counter block and set it to 'Restart' and '2'. Now, set the Compare blocks to '=1' and '=2'.</p>		<p>The Key Press will provide one input to the 'AND' blocks</p> <p>The number on the Counter will check the order of the keys pressed because the Compare blocks are set to:</p> <ul style="list-style-type: none"> • =1 (for the 'A' Key) • =2 (for the 'B' Key) 				
<p>Step 5. Now, connect both Key Press blocks to the Counter block.</p>		<p>The teacher says, "To make sure the Compare blocks check the order of the keys pressed, we need to connect both keys to the Counter so that:</p> <ul style="list-style-type: none"> • when we press the first 'A' Key the Counter counts to '1' • when we press the second 'B' Key the Counter counts to '2'". 				
<p>Step 6. Test it! Press both of the Key Presses to turn the RGB LED on.</p>		<p>The teacher says, "Each Key Press</p> <ul style="list-style-type: none"> • activates the counter and increases by 1 • sends True to the corresponding 'AND' gate" <p>Each 'AND' gate receives input from the Counter via the Compare block if the Keys are pressed, thus:</p> <table border="1" data-bbox="901 1456 1077 1556"> <tbody> <tr> <td>A</td> <td>1st</td> </tr> <tr> <td>B</td> <td>2nd</td> </tr> </tbody> </table> <p>Therefore, each 'AND' gate receives:</p> <ul style="list-style-type: none"> • 'Key A has been pressed (from the Key) and it is the first Key (from the Counter)' • 'Key B has been pressed (from the Key) and it is the second Key (from the Counter)' <p>When each 'AND' gate receives True from:</p> <ul style="list-style-type: none"> • The Counter • The Key <p>... it activates a Toggle!</p>	A	1st	B	2nd
A	1st					
B	2nd					

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		When both Toggles move to True, the 'AND' gate before the Toggle, which activates the light, receives True from both Toggle inputs and sends True to the Light, which then illuminates!
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Challenge 1

20 minutes

Design a SAM system that illuminates a light on inputting a secret code

Instructions	Workspace	Notes for Teachers
<p>Step 1. Following on from the Worked Example, add 7 more Key Press blocks to the left of your system. Arrange them in a square. (We will join these with your system shortly.)</p>		<p>Teachers says, "Now that have covered the basics we are going to make it more like real life. We are going to replicate the unlock pattern found on a cellphone".</p>
<p>Step 2. Create a secret pattern!</p>		<p>The teacher says, "Your pattern can use up to 7 keys. Don't use a common pattern."</p> <p>Most common patterns: https://youtu.be/35tGhMV07AM</p> <p>We have used a "Z" for clarity, but this is not recommended as a secure pattern.</p>
<p>Step 3. Now, add the necessary number of:</p> <ul style="list-style-type: none"> Compare blocks AND gates Toggles <p>... for your pattern</p> <p>Set each Compare block to a different number from 1 to 7 the number of Keys your pattern uses</p>		<p>The teacher says, "In your pattern, in what order are the Keys pressed? This tells you which Key to connect to each AND gate. Eg., if a Key Press is 3rd in the pattern then it connects to the AND gate after the '=3' Compare block".</p> <p>"Here, we have a pattern of 7 keys , so we need 7 Compare blocks set from '=1', to '=7'"</p>
<p>Step 4. Connect each Key Press to:</p> <ul style="list-style-type: none"> The Counter block An AND gate (depending on if it is the 1st, 2nd 3rd etc) Key to be pressed in the pattern) <p>Connect the Counter block to the Compare blocks and the</p>		<p>Teacher says, "Here is the setting for two Key Presses, Repeat this for each of them" 'Set the Counter to reset after '7'</p> <p>Here we have rearranged the system slightly to show the connections clearly</p>

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<p>Compare blocks to the corresponding AND gate</p>		
<p>Step 5. Connect any unused Keys Presses to a Toggle.</p>		<p><i>This will be important in the next step...</i></p>
<p>Step 6. Here is the completed system!</p>		
<p>We suggest finishing Session One here and picking up again in Session Two at Step 7</p>		
<p>Step 7. Cover the rest of the screen. Leave only the buttons showing. Challenge your classmates to guess your pattern!</p>		<p><i>Teacher says, "People trying to guess your pattern will not know which keys to press. As we have connected all the blocks, they will not know which keys are used."</i></p>

Checks for understanding: What do the AND gates immediately after the Keys do? Why do we connect unused keys to something else?

Challenge 1 - Debug it

10 minutes

Why does the light comes on only after two Keys are pressed?

Instructions	Workspace	Notes for Teachers
<p>Step 1. After each pair of Toggles, add another AND gate.</p>		<p>The teacher says, "AND gates can only handle two inputs. "We have an odd number of Toggles, so we will have 3 AND gates and one input left over</p> <p>Continue like this, dividing by 2, until there are only 2 inputs to the final AND gate</p>
<p>Step 2. After each pair of AND gates, add another AND gate, until there are only 2 inputs to the last Toggle, just before the RGB LED.</p>		<p>The teacher says, "Now our final AND gate only has two inputs and the system will work".</p>

Challenge 2

10 minutes

Let's improve the original system

Instructions	Workspace	Notes for Teachers
<p>Step 1. First let's add another Key Press so that we need 3 keys to switch on the RGB LED</p>		<p>The teacher says, "At the moment, to reset the system we have to do a few things:</p> <ul style="list-style-type: none"> ● Press either Key to reset the Counter. ● Press both keys in the correct order to reset the Toggles ● Press either Key to reset the Counter ● Activate the Key sequence again to switch the light off ● Press either Key to reset the Counter." <p>"Don't forget to set the Counter to reset after '3'. You will need another Compare block set to '=3'".</p>

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<p>Step 2. Resetting the Counter is simple. We add a Key Press and a Text box that sends 'reset' to the Counter</p> <ul style="list-style-type: none"> • add a Key Press block • add a text block • make the content of the Text block 'reset'. <p>Connect the Key Press, Text Block and Counter.</p>		<p>Teacher says, "We have seen this 'reset loop' before".</p>
<p>Step 3. Now that we have three Key Presses, we need to reduce the number of inputs to the final Toggle to two</p>		<p>Teacher says... "The Logic gates only handle 2 inputs so we chain AND blocks to reduce the number of inputs to the final AND gate to 2"</p>
<p>Step 4. Add a 'NOR' block to the Workspace and connect it between the Toggle and the first two Key Presses. Then, connect it to the output from the third Key Press. Finally, connect it to the Toggle before the RGB LED.</p>		<p>Teacher says, "The NOR block is special. When all inputs are False it sends True. When all the Toggles to the left are off, the NOR block activates the Toggle before the Light and switches it off".</p>
<p>Step 5. Now, try your system.</p> <p>We have a system where:</p> <ul style="list-style-type: none"> • the light goes on when we press 'A,B,C' • we reset it • the light goes off when we press 'A,B,C' • etc. 		<p>Teacher says, "Now it is simpler.</p> <ul style="list-style-type: none"> • Switch on the light using 'A', 'B', 'C'. • Reset the Counter using the 'reset Loop'. • Switch off the light using 'A', 'B', 'C' again. • Now the system is ready for use again
<p>Extension Ideas:</p> <ul style="list-style-type: none"> • Computing <ul style="list-style-type: none"> ○ Use the new way of resetting the system and switching off the light for the system in Challenge 2 • Math <ul style="list-style-type: none"> ○ Calculate the number of possible patterns there are using 7, 8, and 9 dots • English Language Arts <ul style="list-style-type: none"> ○ Write an explanatory text about passwords, how to make them secure and how more complex passwords are created. Write using this scaffold: <ul style="list-style-type: none"> ■ Introduce the topic or text clearly ■ Provide reasons supported by facts and details. ■ Link opinion and reasons using words and phrases (e.g., for instance, in order to, in addition). ■ Provide a concluding statement 		

Checks for understanding: The AND gate sends a signal when...? The NOR gate sends a signal when...?

Tidy Up / Exit Ticket

5 minutes



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Reinforcing the learning objectives of the lesson, students can reflect on key takeaways by completing and submitting an exit ticket.