Lesson 4.1 - Exploring Circuits

Overview

During this lesson, students will gain understanding of how electricity is used to run common appliances, the parts that make up a simple circuit and the difference between open and closed circuits. Students will integrate and exhibit learning by creating an electrical circuit.

Key Information

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

Time: 45/90 minutes

Warm-Up	5 minutes
Mini-lesson	10 minutes
Worked Example	7 minutes
Challenge 1	7 minutes
Challenge 1 - Debug	5 minutes
Challenge 2	7 minutes
Tidy Up / Exit Ticket	4 minutes

Lesson Topics

- **Science**
    - Energy can be moved from place to place by moving objects or through sound, light, or electric currents
- **Engineering**
    - Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships
    - Apply scientific ideas to design, test, and refine a device that converts energy from one form to another
- **Art and Design**
    - Explore and use devices and materials for imaginative activity that leads to original and creative outcomes
- **Design and Technology**
    - Generate, develop, model and communicate ideas through talking, drawing and mock-ups
- **Computing**
    - Inputs, outputs, abstraction, debugging

Learning Objectives

- ***As a result of this lesson, students will be able to***
    - Identify common uses and the importance of electricity
    - Identify the components needed to construct a simple circuit
    - Use SAM blocks to create a basic circuit using a button, switch and light
    - Identify if a light will be on or off based on the switch position
    - Identify symbols used to create a diagram of a circuit

Materials

- Cardboard Paper Roll
- Large piece of card or piece of string
- Blu-tack

Materials continue on Page 2

- Marker pens
- SAM Labs Kit
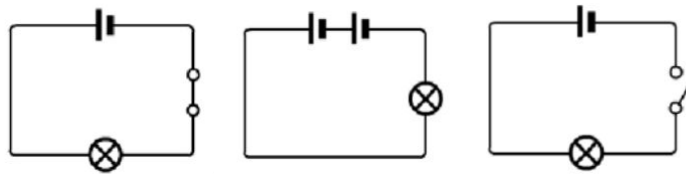- SAM Labs Student Workbook

Warm Up – 'Spot the difference'   5 minutes
Are these circuits on or off?

Objective: Identify whether or not a lamp will turn on (light) in a simple series circuit, based on whether or not the lamp is part of a complete loop.

Procedures: Batteries are used to generate electricity, and this is used within many smaller circuits you use everyday like torches, remote control cars, toys, mobile phones have a type of battery too. Teacher asks the students to look at the two images and spot the difference; drawing out that although the circuits are the same and the battery is generating the electricity, without the switch being turned on to act as a gate to the loop, the electricity cannot reach the light to switch it on.

Sample photo ideas: Electrical circuits

Link forward: Students will learn the difference between open and closed circuits and how to represent these differences when drawing circuits.

Mini-lesson   10 minutes
Can circuits be drawn without images?

Objective: Students learn the main symbols used in a circuit to identify whether a light is on or off. Students learn the importance of using symbols instead of images and the difference between an open and closed switch with impact on the circuit. (8 minutes)

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

Keywords
- Circuit
- Electricity

- Battery
- Switch

Let's Discuss: *Why do we use symbols instead of images for circuits? In your workbook or with a partner, record, discuss, or share an example of an open and closed circuit.*

Link forward: Students will create a circuit to using a switch and a light.

Worked Example   7 minutes
Design a SAM circuit to show a light that flashes red, green and blue

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: ● 1 RGB LED block	RGB LED	This block is called the RGB LED block, it can be set to a vast array of colours.
Step 2. Add the following software blocks to the Workspace ● Key Press block ● Toggle block ● Interval block ● Cycle Colours block	SPACE · RGB	Remember, when you drag a new block to the Workspace you will see them in different colours, they only become one colour when you connect them together in a system.
Step 3. Connect the Key Press to the RGB LED. Connect the Toggle block, Interval block and Cycle Colors block between them.	SPACE · RGB	*The teacher says, "There is only one clear input here, the Key Press and one clear output, the RGB LED. The other 3 are part of a system connected by inputs and outputs. The position of these 3 is important to allow the flow of information to be correct to the light... It's a specific algorithm."*
Step 4. Set the Interval block to 20 milliseconds.	Select time for interval to trigger Hours 0 Minutes 0 Seconds 0 Milliseconds 20	The Settings of the Interval block can be changed to speed up or slow down the flashing light.
Step 5. Test it!	SPACE · RGB	Press the Key Press and see the light cycle through the three colors red, green and blue.

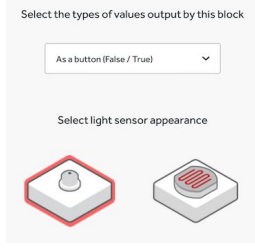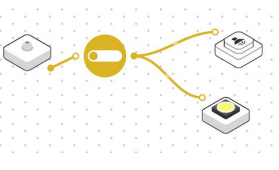## Challenge 1   7 minutes
Create a SAM system to show a circuit using light and sound

Instructions	Workspace	Notes for Teachers
Step 1. Using cardboard, draw a square to represent the wire.		A good link to the mini lesson - how a circuit is visibly laid out.
Step 2. Use a cylinder shape (like a paper roll) to create a battery. Label it.	Battery	Although we do not need a battery when using SAM blocks, it is important for students to understand that a battery is needed in a circuit.

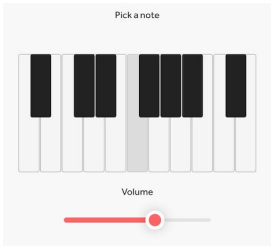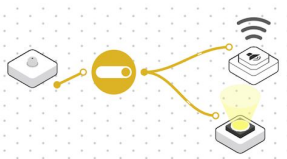|		
Step 3. Fix the string or draw a line in the shape of a rectangle.		The string isn't essential - drawing the line is sufficient. However, using the string allows the students to construct the circuit and see it take shape as a 'physical' circuit and not a drawing.
Step 4. Fix the RGB LED, Light Sensor and, if it's available to you, the Buzzer block onto the string circuit.		You can secure the blocks and string in a number of ways, here we've used blue tac.
Step 5. Turn on and pair the Light Sensor and RGB LED. Add the following blocks to the Workspace: ● Light Sensor ● RGB LED ● Toggle ● Buzzer (/Sound Player)		If you don't have the Buzzer block, use the Sound Player block.
Step 6. Change the Light Sensor to be a Button.		If you have the Button block, it can be used in lieu of the Light Sensor. Alternatively, students can use the Key Press block. Encourage students to explore different inputs to activate their system. *The teacher says, ""Students, you may notice that the word 'false' now appears above the Light Sensor . This means the button is off. When you cover/touch it will change to 'true' which means it's on."*
Step 7. Connect the Light Sensor to the RGB LED and Buzzer (or Sound Player). Add a Toggle in between.		Remind students here that blocks will appear the same color when they are successfully connected in a system. The Light Sensor block (as a Button) and the Toggle block are acting as a switch in our electrical circuit. This allows 'electricity' to flow to different outputs.
Step 8. Test it!		When you cover/touch the Light Sensor block the Switch will be turned on. The light will illume and the Buzzer (/Sound Player) will sound. Here the importance of a battery in the circuit should be reinforced. Because SAM blocks are linked to software, we do not need one. When constructing a circuit the battery is essential to power the electricity flowing through the circuit.

Checks for understanding: *What is the function of the Toggle in this system? What is a correct algorithmic description of the system?*

Challenge 1 - Debug it   5 minutes
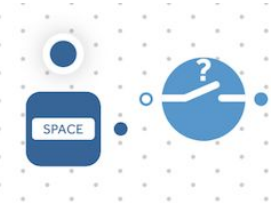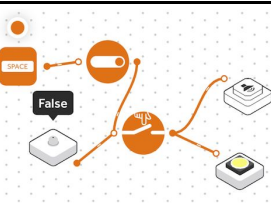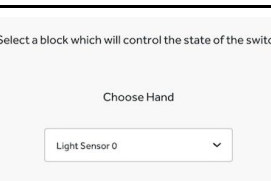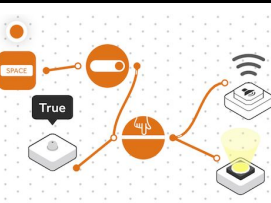*Why is the Buzzer quiet and the pitch low?*

Instructions	Workspace	Notes for Teachers
Step 1. Open the Settings icon to edit the pitch of the Buzzer (Sound Player).	Pick a note / Volume	You can edit the settings of the Buzzer block (/Sound Player) and change the sound of the note and the volume.
Step 2. Let's test it!		Teacher says, "Test the system again. Can you hear the difference this makes... Can you hear the Buzzer better now? Edit the settings to find the right pitch and volume to suit the needs of the circuit."

Challenge 2   7 minutes
Create a system that uses a switch to activate the RGB LED and Buzzer (/Sound Player)

Instructions	Workspace	Notes for Teachers
Step 1. Add to the Workspace ● Key Press block ● Switch block	SPACE	It's helpful at this juncture to invite students to select the appropriate input for the Switch block. This can be changed via Settings. In this instance, we're using Key Press as the input.
Step 2. Connect the Key Press to the Toggle. Place the Switch in the middle of the system.	False	The teacher says, *"Which block connects the system between inputs and outputs?"* (Hint: Switch)
Step 3. Select an input to control the switch.	Select a block which will control the state of the switch / Choose Hand / Light Sensor 0	The teacher says, *"More than one input can control our Switch… look at the options available. We are going to set the input to Light Sensor".*
Step 4. Test it!	True	The teacher says, "When the system is turned on by the Key Press block will turn the Toggle on too. The Light Sensor, when activated, will then turn the Switch on. The Switch will close virtually in the Workspace as the RGB LED and Buzzer (/Sound Player) are activated. The Switch will then open as they go off".

Extension Ideas:
- Can students get the light to flash using an interval block and/or flash red, green and blue?
- **Music**:
  - What are the sequence of notes on the keyboard in the buzzer? (Eg. Do, Re, Mi...)
- **Science**:
  - Why is water and electricity dangerous when combined?
- **ICT/English/Art**

- ○ Create a poster or informational text on circuit design, include photographs of open and closed circuits.
- **History**
  - ○ Who invented the lightbulb? How significant was the discovery? How has electricity evolved?
- **ICT/Science**
  - ○ Is electricity safe? How do we stay safe?

Checks for understanding: *What does the Switch do in our system? Why is a battery required in a circuit?*

Tidy Up / Exit Ticket   4 minutes

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