Exploring Circuits

Overview

During this lesson, students will gain understanding of how electricity is used to run common appliances, 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 10-12) US Grades 5 and 6 Time: 45/90 minutes

Lesson consists of...	
Warm-Up	5 mins
Mini-lesson	10 mins
Worked Example	7 mins
Challenge 1	7 mins
Challenge 1 - Debug	5 mins
Challenge 2	7 mins
Tidy Up / Exit Ticket	4 mins

Learning Objectives

As a result of this lesson, students will be able to

- ➔ Identify the components needed to construct a simple circuit and how to tell if it is open or closed
- ➔ Identify the symbols needed to draw a simple circuit
- ➔ Create a SAM system to show a circuit using light and sound
- ➔ Create a system that uses a switch to activate the RGB LED and Buzzer (or Sound Player)

Lesson Topics

Physical 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

Computing
- ➔ Energy can be moved from place to place by moving objects or through sound, light, or electric currents

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

Materials required

- ➔ SAM Labs Kit
- ➔ Student Workbook
- ➔ Cardboard Paper Roll
- ➔ Blu-tack
- ➔ Marker pens
- ➔ Large piece of card or piece of string

Warm Up – 'Spot the difference' — 5 minutes

Are these circuits on or off?

Objective: Identify the difference between a circuit that is on or off (open or closed)

Procedures: "*Today we are going to learn about electrical circuits, the parts needed to create a simple circuit and how to tell the difference between open and closed circuits*"

- Discuss how batteries are used to generate electricity.
- Circuits occur in batteries to power everyday items such as torches, remote control cars, toys, and mobile phones.
- Look at the images and spot the differences.
- Draw 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: Identifying the difference between open and closed circuits and how to represent these differences when drawing circuits.

Mini-lesson — 10 minutes

Identify the symbols needed to draw a simple circuit, recognize the difference if it is open or closed

Objective: Demonstrate the use of symbols to indicate if a circuit is open or closed

Procedures:

- Look at the main symbols used in a circuit to identify the battery, switch and light
- Identify how these are used to represent whether a light is on or off
- Draw examples of circuits that are on and off
- Discuss the importance of using symbols instead of images and the difference between an open and closed switch when looking at a circuit diagram. (8 minutes)

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

Keywords

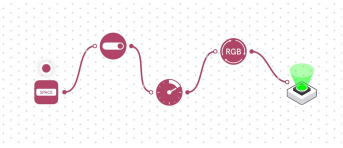
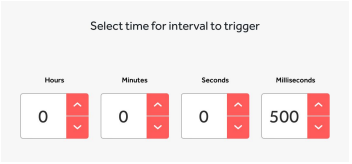
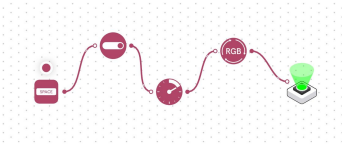
- Circuit
- Electricity
- Battery
- Switch

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

Link forward: Link to creating their own circuit using a switch and light.

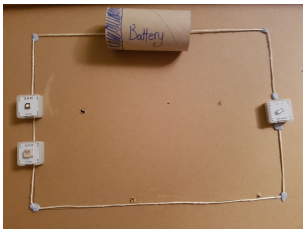
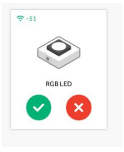
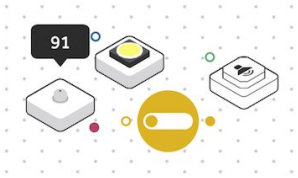
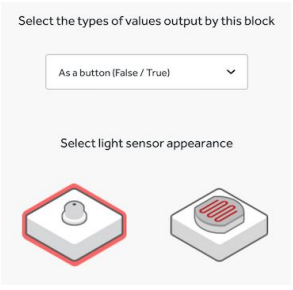
Worked Example — 7 minutes

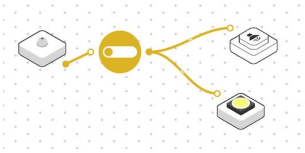
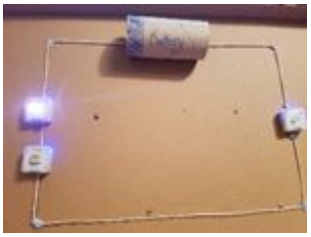
Design a SAM circuit to show a light that flashes red, green and blue

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 1 RGB LED block		*The RGB LED is the output in this system and can be set to different colors.*
Step 2. Drag on and add the following blocks to the workspace: • Key Press block • Toggle block • Interval block • Cycle Colours block		*If you have a Button, this can be used in lieu of a Key Press. 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 blocks in the following order; Key Press block, Toggle block, Interval block, Cycle Colors block and RGB LED		*There is only one input, the Key Press block and one output, the RGB LED. The position of the other 3 blocks is important to allow the flow of information to be correct to the light... It is a specific algorithm.*
Step 4. Set the Interval block to 500 milliseconds.		*The Settings of the Interval block can be changed to speed up or slow down the flashing light.*
Step 5. Test your system.		*Press the Key Press block 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

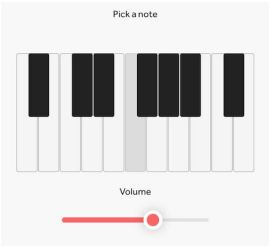
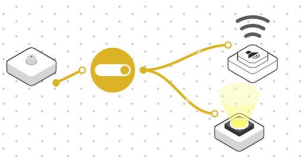
Instructions	Workspace	Notes for Teachers
Step 1. Using cardboard, draw a square to represent the wire.		*This will reinforce how a circuit is laid out visually.*
Step 2. Use a cylinder shape (like a paper roll) to create a battery. Label it.		*Although we do not need a battery when using SAM blocks, 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.		*Ensure the red light changes to show it is connected to the system and remember you can check the color changes on the workspace when the block is connected*
Step 6. Add the following blocks to the workspace: ● Light Sensor block ● RGB LED ● Toggle block ● Buzzer block (/Sound Player block)		*If you don't have the Buzzer block, you can use a virtual Buzzer or the Sound Player block.*
Step 7. Change the Light Sensor to be a Button within the settings.		*If you do not have a Light Sensor block, a Button can be used in lieu. Alternatively, students can use the Key Press block. Encourage students to explore different inputs to activate their system.* *You may notice that the word 'false' now appears above the Light Sensor, this means the button is off. When you cover/touch the Light Sensor block it will change to 'true' which means it's on.*

Step 8. Connect the blocks in this order: • Light Sensor block to the Toggle block • Toggle block to the RGB LED and Buzzer (or Sound Player).		*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 9. Test your system		*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 store their charge, we do not need a conventional battery. 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 (or Sound Player).		*You can edit the settings of the Buzzer block (/Sound Player) and change the sound of the note and the volume.*
Step 2. Test your system.		*Test the system again. 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

Instructions	Workspace	Notes for Teachers
Step 1. Drag onto the workspace: • Key Press block • Switch block		*Invite students to open the settings of the Switch block and note the options. We'll do this again after the system is connected.*
Step 2. Connect the blocks in the following order: • Key Press block to Switch block • Light Sensor to Toggle block to Switch block • Switch block to RGB LED and Buzzer block (or Sound Player)		*We now have two inputs to the system the Key Press block and the Light Sensor block. Ensure the Light Sensor block is set to act as a Button. Again, if you have a Button, it can be used in place of the Light Sensor.*
Step 3. In the settings of the Switch block select the Toggle block to control it		*More than one input can control the Switch and can be seen in the drop down menu. We are going to set the input to Toggle block.*
Step 4. Test your system.		*When the system is turned on by the Key Press block, this will activate the Switch. However, as we have selected the Switch to be activated by the Toggle, the Light Sensor (or Button block if using) has to be activated, to turn the Toggle on. When the Toggle is on and the Key Press is activated, the Switch will open and the RGB LED will light and the Buzzer (/Sound Player) will sound. The Switch will then open as they go off.*

Extension Ideas:
- **Computing:**
  - 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.

Earth and Orbit

Overview

During this lesson, students will gain understanding of what an orbit is and how it varies for different planets. Students will develop a mnemonic to remember the order of planets. Students will integrate and exhibit learning by creating a SAM system to demonstrate planets orbiting the sun.

Key Information

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Lesson consists of...	
Warm-Up	5 mins
Mini-lesson	10 mins
Worked Example	7 mins
Challenge 1	7 mins
Challenge 1 - Debug	5 mins
Challenge 2	7 mins
Tidy Up / Exit Ticket	4 mins

Learning Objectives

As a result of this lesson, students will be able to

- ➔ Identify the planets and the order they are from the sun and create a mnemonic to recall them.
- ➔ Describe what an orbit is and what a low level orbit is and how to get there.
- ➔ Create a system to simulate an orbit around the sun.
- ➔ Modify the system to show Mercury, Venus and the Earth's Moon.

Lesson Topics

Earth Science

➔ Students will learn about the orbits of Earth around the Sun, and of the Moon around Earth.

English Language Arts

- ➔ Participate in collaborative conversations.
- ➔ Use information gained from illustrations and text to demonstrate understanding.

Math

- ➔ Solve problems involving the calculation and conversion of units of measure, using decimal notation up to three decimal places where appropriate

Materials required

- ➔ SAM Labs Kit
- ➔ Student Workbook
- ➔ Blu-tack
- ➔ Floral wire
- ➔ Styrofoam balls
- ➔ Pom poms
- ➔ Felt tip pens

Earth and Orbit

Warm Up — 5 minutes

In what order do planets orbit the sun?

Objective: Identify the planets and the order in which they orbit the sun, creating a mnemonic to remember them.

Procedure: "*Today we are going to learn what an orbit is and the order in which planets orbit the sun.*"

- Look at the images of the planets and name them in the correct order from the sun.
- Discuss the meaning of the word 'mnemonic'.
- Students create their own mnemonic to remember the order of the planets.

Sample photo ideas: Solar system graphic

Link forward: Link to looking at the definition of an orbit and how to get into orbit

Mini-lesson — 10 minutes

What is an orbit?

Objective: Recognize how orbiting works and that different planets are following different orbits.

Procedure:

- Define what an orbit is.
- Explain that the Earth and all planets are within their own, individual orbits of the sun.
- Consider how each planet is a different distance away from the sun, this means some orbits are shorter or longer than others.
- Identify how long it takes to orbit the sun for different planets
- Option to describe low level orbit and how we have achieved it through advancements in technology. You may wish to reference the space race, satellites and or rocket technology. (8 minutes)

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

Keywords

- Orbit
- Elliptical
- Earth
- Space
- Low level orbit
- Planets

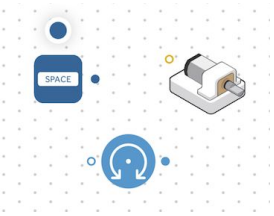
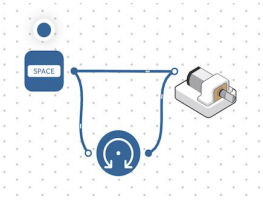
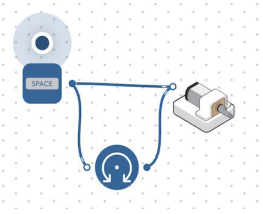
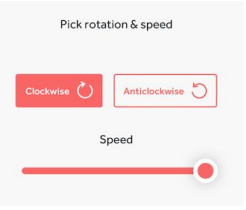
Let's Discuss: *What is an orbit? In your workbook or with a partner, record, discuss, or share your definition of a low level orbit.*

Link forward: Link to creating a SAM system to simulate the earth's orbit of the sun.

Worked Example

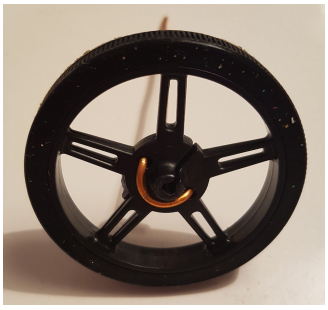
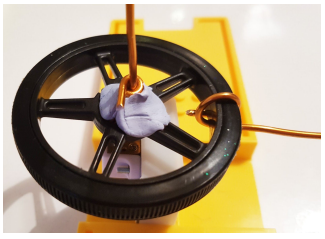
7 minutes

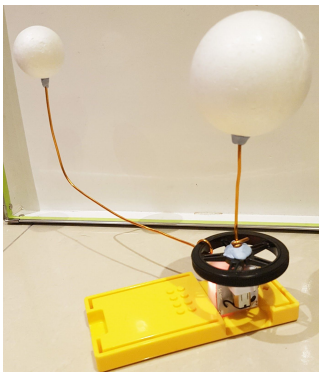
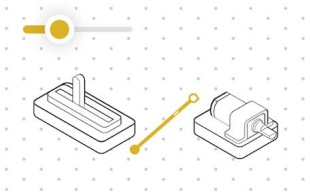
Alternating the direction of orbit

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • DC Motor block		*Press and hold the power button on the DC Motor block and pair it with the workspace*
Step 2. Drag on the following blocks to the Workspace: • DC Motor block • Switch Direction block • Key Press block		*If you have a Button block, this can be used in place of the Key Press.* *The Switch Direction block allows the direction to be changed every time we press the Key Press block.*
Step 3. Connect the Key Press block to the Switch Direction block and the DC Motor. Connect the Switch Direction block to the DC Motor.		*The Switch Direction block cannot just go inline between the Key Press block and the DC Motor as the command will not make it to the DC Motor.* *The Key Press block must be connected to both the motor and the Switch Direction block to enable the command to work.*
Step 4. Use the Key Press block to test your system.		*When you press and hold the Key Press block the motor will go in one direction; always clockwise first as this is the default setting, when you press and hold the Key Press block again the motor will run in the opposite direction*
Step 5. Open the settings of the DC Motor to change the speed.		*If you access the settings of the DC Motor block you will see the speed is adjustable change the speed setting and observe the effect.*

Challenge 1 — 7 minutes

Create a system to simulate an orbit around the sun.

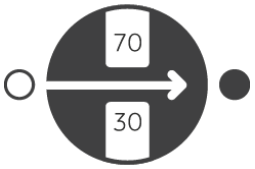
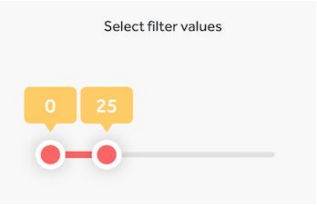
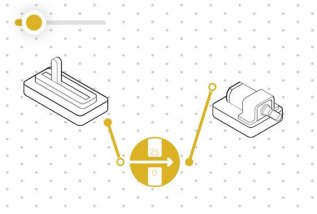
Instructions	Workspace	Notes for Teachers
Step 1. Collect materials: • Wire - floral • Blu Tack • 2 x different sized styrofoam balls	 	*We have used Floral Wire here as it is easier to bend and is secure but you could also use gardening wire, or thin metal wire.*
Step 2. Cut a piece of wire and attach to the DC Motor Wheel.		*The wire has been fed through the two holes on either side of the middle section of the wheel.*
Step 3. Wind the two ends together to have one piece of wire going up and secure down with blue tack.		The wire needs to be combined together to help stability and the blue tack helps secure the wire in one position pointing up.
Step 4. Cut a second piece of wire and secure to wheel edge.		It is important that the second wire leaves the wheel at a right angle to the existing wire going up.
Step 5. Secure the Wheel to DC Motor and the Car Chassis.		The DC Motor needs to be pointing up and the Car Chassis ensures the DC Motor stays still when the system is activated.

Step 6. Attach the Styrofoam balls to the top of the wires.		It is important the wire for the Earth is bent and is level with the sun. The wire pierces into the styrofoam balls and is held in place by blue tack. Although the orbit of the Sun is an Elliptical shape the DC Motor only offers a circular orbit but simulates the movement around the Sun.
Step 7. Turn on and pair: ● 1 Slider/Virtual Slider ● 1 DC Motor block		*The input will be the Slider block and the output will be the DC Motor block.*
Step 8. Connect the Slider block to the DC Motor block.		*If you do not have the Slider block it can still be used on the workspace virtually.*
Step 8. Test your system.		*Increase the Slider block and see the speed of the DC Motor increase. It is easier to slow the motor down than start slow and a good speed to reduce to is about 15.*

Checks for understanding: *What is the purpose of the Slider? How long is one orbit of the sun?*

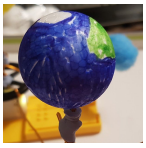
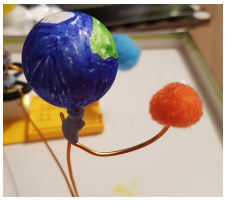
Challenge 1 - Debug it — 5 minutes

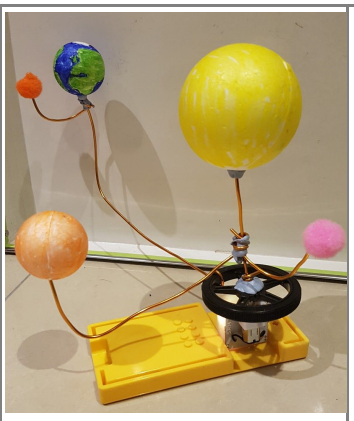
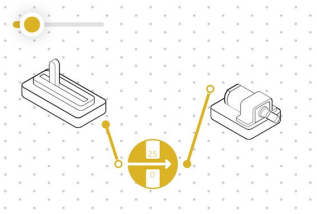
The speed of the motor is too fast, how can we slow it down?

Instructions	Workspace	Notes for Teachers
Step 1. Drag a Filter block to the Workspace.		*A filter block allows a certain range to travel through to the output*
Step 2. Edit the range of the block to '0-25'.		*By editing the range to 0-25 (or similar) we are able to stop the excessive speeds from being achieved as it will cut off after the speed reaches 25.*
Step 3. Connect the Filter block in between the Slider block and the DC Motor block and test		*Test the system by slowly increasing the speed to check it stops when it reaches 25. You will also find it easier to reduce the speed to a slower one than increase it slowly*

Challenge 2 — 7 minutes

Modify the system to show Mercury, Venus and the Earth's Moon

Instructions	Workspace	Notes for Teachers
Step 1. Decorate the Sun and Earth.		*The decoration of the styrofoam balls will aid the recognition of the planets in the system.*
Step 2. Cut a piece of wire smaller than the others to show the closest planet to the Sun, Mercury.		*The planet needs to be smaller and here we have used a small pom pom, it also needs to be closer to the sun. The wire is wound around the wire for the sun and blue tack used to hold in place.*
Step 3. Cut a small piece of wire and attach a small pom pom and attach to the Earth wire as the Moon.		*It is important than the Moon is smaller than the Earth and positioned close to the Earth.*

Step 4. Decorate a third styrofoam ball as Venus and cut and attach a piece of wire to the Sun wire so the distance is between the Earth and Mercury.		*The color of Venus is a brown/orange color. The use of blue tack on the wires is to help keep in place.*
Step 5. Pair the blocks, test the system and edit the Filter block range if required.		*The range set within the Filter block may need adjusting as the added weight may affect the speed of the DC Motor.* *Although the planets in space orbit the Sun at different speeds this SAM system is only using one motor, which controls the speed of the whole model. This model uses the different positions and distances to create a model of planetary orbit.*

Extension Ideas:

- **Science**:
  - How does a rocket get into space?
  - How are rockets and satellites built? What materials are suitable?
  - What is the atmosphere and the effects it has on materials as it passess through?
  - Look at how the Sun rotates at different speeds at different locations on the Sun and not as one like the Earth.
- **Geography:**
  - Where in the world are the launch sites and what environmental factors make it a good launch site
- **History**:
  - What is the timeline of key space launches and technological advancements
- **ICT/Computing:**
  - How does a satellite work? Choose a type and research the uses and how we rely on them daily
- **Maths:**
  - Calculate the relative speed of the all planets and the the time their orbits/days are.

Checks for understanding: *What is the purpose of the Filter block? What shape does the Earth orbit the Sun in?*

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.

Lesson 4.3

Night and Day

Overview

During this lesson, students will gain understanding of how the Earth spins on its axis around the sun, creating day, night and different seasons across the world. Students will demonstrate and exhibit learning by modelling Earth on its axis and programming a sunrise.

Key Information

Level 4: (Ages 10-12) US Grades 5 or 6 Time: 45/90 minutes

Lesson consists of...	
Warm-Up	5 mins
Mini-lesson	10 mins
Worked Example	7 mins
Challenge 1	7 mins
Challenge 1 - Debug	5 mins
Challenge 2	7 mins
Tidy Up / Exit Ticket	4 mins

Learning Objectives

As a result of this lesson, students will be able to

- ➔ Identify that the Earth spins on an axis
- ➔ Describe the relationship between the position of the sun to the time of day, night and season.
- ➔ Design a system that simulates the Earth's spinning
- ➔ Program the system to create a sunrise, observing the effect on the model of Earth.

Lesson Topics

Earth Science
- ➔ The movement of the Earth creates observable patterns such as night, day and seasons

Scientific Thinking
- ➔ Planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary

Design and Technology
- ➔ Generate, develop, model and communicate ideas through computer-aided design

Computing
- ➔ Variable inputs, outputs, debugging

English Language Arts
- ➔ Participate in collaborative conversations.
- ➔ Use information gained from illustrations and text to demonstrate understanding.

Materials required

- ➔ SAM Labs Kit
- ➔ Student Workbook
- ➔ Styrofoam or ping-pong ball
- ➔ Protractor
- ➔ Blu tack
- ➔ Thin dowel or similar
- ➔ Yellow cardstock
- ➔ Markers

Night and Day

Warm Up - True or False — 5 minutes

What do you already know about how the Earth spins?

Objective: Recognize that the Earth spins on an axis

Procedures: "*Today we are going to learn how the Earth spins on an axis. The rotation of the Earth means we have a 24-hour day, with some hours light (day-time) and some hours dark (night-time)*"

- Based on prior knowledge alone, ask students to decide which of the statements in their workbook are true or false
- Discuss that the earth is tilted, relative to its orbital plane, and spins on an axis.
- The tilt in the axis of the Earth is called its obliquity and the Earth's axis is tilted 23.4° from vertical.
- Let's try something together. Stand up and all look at the teacher and turn around slowly trying to keep your eyes on the teacher whilst you turn. At a certain point you have to move your head and you can not see the teacher for a time. This is a bit like how the earth spins on an axis. When it spins, that certain parts of the earth can not see the sun - this is nighttime.

Link forward: Link to how the sun rises and sets for us by turning in space

Mini-lesson — 10 minutes

What's the relationship between the Earth's axis and the time of day or season it is?

Objective: Describe the relationship between the position of the sun to the time of day.

Procedures:

- Consider the sun's apparent movement across the sky throughout the day. The sun rises in the East and sets in the West.
- The position of the sun denotes the time of day. A sundial shows this by using a shadow generated by the suns position.
- We get different seasons because the Earth's axis is tilted.
- This tracker (http://www.liverpoolmuseums.org.uk/kids/games-quizzes/sun/suntracker.html) allows students to change the date and location to see the motion of the sun.
- Based on the input from the warm-up and mini-lesson, ask students to review their responses to the True/False questions in their workbooks. Do they want to change any of the answers? Review final answers as a class. (8 minutes)

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

Key Words

- Axis
- Tilted
- Sun
- Day
- Night
- Earth

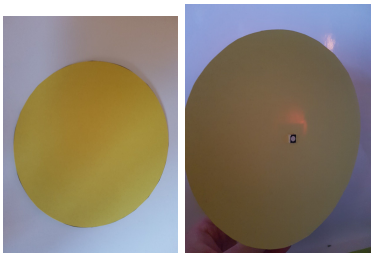
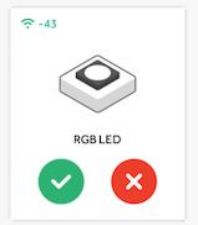
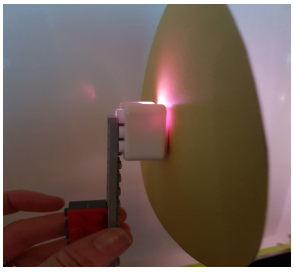
Let's Discuss: *How does the Earth move? In your workbooks or with a partner, record, discuss, or share how the position of the sun can tell us the time.*

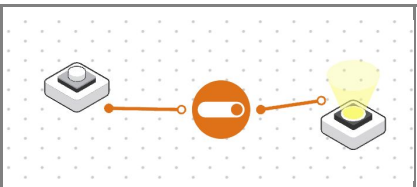
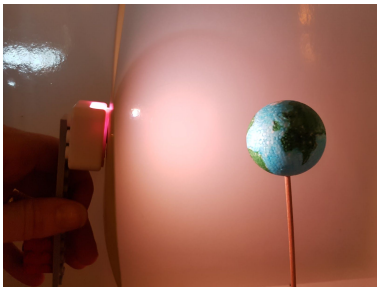
Link forward: Link to creating systems to show day and night and make a 'sunrise'

Worked Example

7 minutes

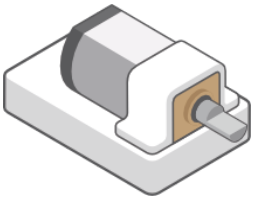
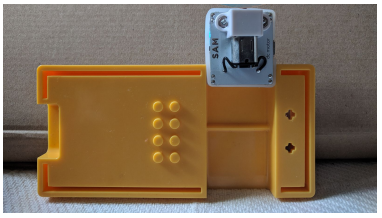
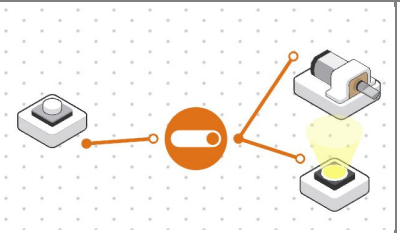
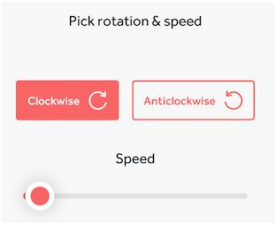
Design a system to simulate the Earth's motion

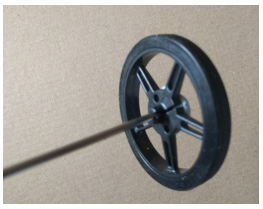
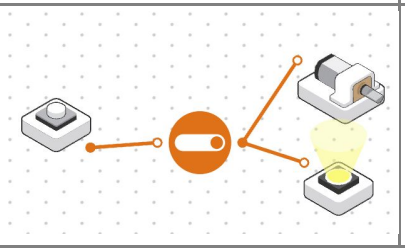
Instructions	Workspace	Notes for Teachers
Step 1. Color a small styrofoam ball to represent the Earth.		*Choose a globe pattern to draw on a styrofoam ball and try to be realistic to aid understanding.*
Step 2. Using a wooden stick or pencil - place the ball on top so that the Earth is on a stick.		*It is important to have the ball on a stick to allow it to be held and no shadows from your hand be seen*
Step 3. Cut out a circle on yellow card and pierce the middle so the RGB LED can be placed through the hole.		*The yellow circle is a 2D representation of the Sun and the accurate ratio can be calculated to make everything to scale.* *Note: Ratio is approx 109:1* *Earth = 6370km* *Sun = 695,000km*
Step 4. Turn on and pair: ● RGB LED block ● Button/Virtual Button block Add both blocks and a Toggle to the workspace.		*The RGB LED needs to be set at its brightest and be Yellow and should be this as default but can be checked in the settings.*
Step 5. Mount the RGB LED onto a stand to make the 'sun' free standing.		*The stand here has been made out of Lego but could also be secured with blue tac to a secure wall.*

Step 6. Connect the Button to the Toggle. Connect the Toggle to the RGB LED.		*The Toggle block will act as a switch to keep the RGB LED on generating the sun as a constant light.*
Step 7. Hold the 'Sun' a hands-length away from the sphere. Test the system.		*This needs a dark room with a white background in order to see the shadow effect on the Earth showing day and night.*

Challenge 1 — 7 minutes

Design a system to simulate the Earth's motion

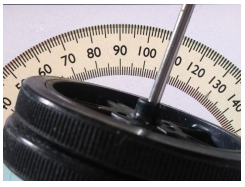
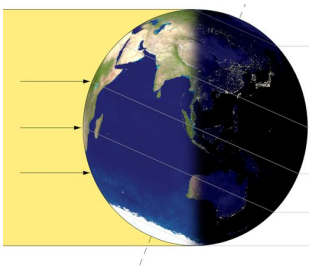
Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • DC motor		*The DC motor is our output and will enable our Earth to spin.*
Step 2. Secure the DC Motor block sideways on the Car Chassis.		*The Motor axel will be the 'axis' of our Earth*
Step 3. Connect the DC Motor to the Toggle block.		*The Toggle block allows us to turn the system on and off using the Button.*
Step 4. Open the DC Motor blocks settings. Reduce the speed of the motor to slow as possible without it stopping.		*The speed of the DC Motor will need to be as slow as possible to see the effect clearly.*

Step 5. Mount a small stick onto the wheel. Remount the Earth onto the opposite side of the stick with blu tack.		*The stick should fit in the hole in the centre of the wheel.*
Step 6. Add a 2nd wheel to the motor. Place the two motors together.		*The added weight of the two wheels should help slow down the entire system. Blu tack is the easiest way to connect the two wheels*
Step 7. Test your system.		*Activate the system and make sure the Earth model is in position near the sun and see the Earth spin.*

Checks for understanding: *What is the purpose of having two wheels on the DC Motor? What is the purpose of the Toggle block?*

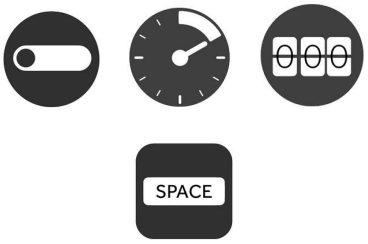
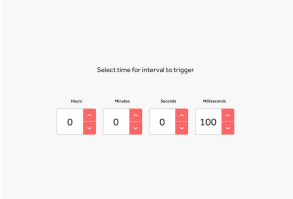
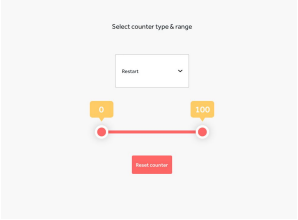
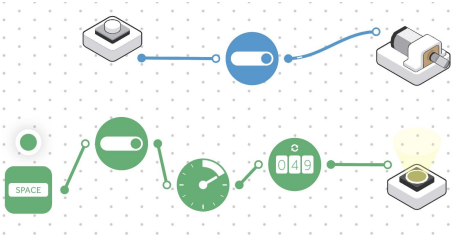
Challenge 1 - Debug it — 5 minutes

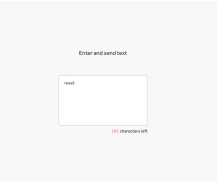
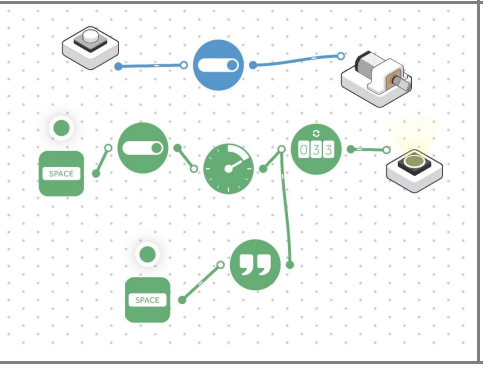
The Earth is not realistic, how can we tilt it?

Instructions	Workspace	Notes for Teachers
Step 1. Adjust the tilt of the DC Motor block - Incline it to about 23°.		*The DC Motor will need to be tilted and can be done within the Car Chassis as it will hold it securely*
Step 2. Test your system.		*As the system is activated you will see the light shine and that the South pole never gets dark as it is always tilted towards the sun.* *Option to discuss that seasons change as a result of the amount of sunlight reaching the Earth.*

Challenge 2 — 7 minutes

Modify the system to create a sunrise and observe the effect on the Earth model

Instructions	Workspace	Notes for Teachers
Step 1. Disconnect the RGB LED from the Toggle. Drag the following blocks onto the workspace: • Key Press • Toggle block • Interval block • Counter block		*The Key Press block will be the input for the system and the RGB LED will be the output.*
Step 2. Connect the blocks in the following order; Key Press block, Toggle block, Interval block, Counter block, RGB LED		*The system flow is from left to right and the input will travel down the system to generate the output.*
Step 3. Access the settings of the Interval block and set to 100 milliseconds		*This will allow the Counter block to increase quickly and the light increase through the RGB LED.*
Step 4. Access the settings of the Counter Block.		*The default is 0-100 range and set to restart at the end - leave this as set*
Step 5. Test your system.		*Press the Key Press block and see the light increase slowly to full brightness when the Counter block reaches 100.*
Step 6. Drag a Key Press and a Text block onto the workspace. Connect them to the input of the Counter block.		*If you are using the app on a desktop then the Key Press block will need to be changed to another input key in the settings, we have used 'A'*

Step 7. Edit the settings of the Text block to 'reset' (in lowercase).		*In the settings of the Text block add the word 'reset' in lowercase*
Step 8. Test your system.		*The system can be reset at any point by pressing the Key Press block connected to the Text block.* *Observe the sunrise effect on the Earth and the shadows generated.* *Discuss whether this model has a sunset.*

Extension Ideas:

- **Computing:**
  - Can you make the sunrise and sunset automatically using a sensor?
- **History**
  - Look at the history of how people believed day and night occurred
- **Geography**
  - Does the sun affect the weather in different countries?
  - Where in the world does it stay light the longest? Darkest the longest?
- **Science**
  - How do seasons occur?
  - How do the seasons affect the sunrise/sunset?
  - Exploring arctic and antarctic summer and winter
- **ELA**
  - Did you know that global warming is changing the Earth's axis? Students can read this article and watch the video to develop an informative or persuasive essay on the topic: https://www.smh.com.au/technology/global-warming-is-changing-the-earths-tilt-20160413-go5tgb.html

Checks for understanding: *What is the purpose of the Text block? What is the purpose of the Counter block?*

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.

Lesson 4.4

Morse Code Alert

Overview

During this lesson, students will extend their knowledge of Morse Code, its use during wartime and how it supported communication. Students will demonstrate and exhibit learning by creating an a Morse alert system utilizing light and sound. This lesson builds on 3.2 Morse Code.

Key Information

Level 4: (Ages 10-12) US Grades 5 or 6 Time: 45/90 minutes

Lesson consists of...	
Warm-Up	5 mins
Mini-lesson	10 mins
Worked Example	7 mins
Challenge 1	7 mins
Challenge 1 - Debug	5 mins
Challenge 2	7 mins
Tidy Up / Exit Ticket	4 mins

Learning Objectives

As a result of this lesson, students will be able to

- ➜ Decipher a hidden message in Morse Code
- ➜ Describe how the use of Morse Code during the American Civil war helped and hindered the sending of messages
- ➜ Design a system to send an alert 'SOS' message when the system is activated AND button pressed.
- ➜ Modify the system to have a continuous green light until the alert is activated

Lesson Topics

Computing
- ➜ Inputs, outputs, abstraction, debugging

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

History
- ➜ Technical innovation in communication

English Language Arts
- ➜ Participate in collaborative conversations
- ➜ Use information gained from illustrations and text to demonstrate understanding
- ➜ Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5-6 topic or subject area

Materials required

- ➜ SAM Labs Kit
- ➜ Student Workbook

Morse Code Alert

Warm Up – 'Decode it' — 5 minutes

Can you decipher the code to find the hidden message?

Objective: Decipher a hidden message in Morse Code

Procedures: *"Today we are going to look at the use of Morse Code and how it can be used to alert others to distress. We are also going to look at how Morse Code has been utilized during wartime."*

- Students look at the Morse Code dots and dashes and how they are used to send letters
- Look at the hidden message in Morse Code and decipher the hidden words
- How are words split up? Discuss how it is sent with the dots being short taps and dashes being longer

Student Workbook: Decipher the hidden message in Morse Code

Link forward: Link to how Morse Code was used in the war to send and receive hidden messages.

Mini-lesson — 10 minutes

How was Morse Code used to send and receive messages?

Objective: Describe how Morse Code helped and hindered the sending of messages during the American Civil war.

Procedures:

- Discuss how the use of Morse Code was important to send messages over large distances.
- Morse Code was the first form of encrypted messages.
- In 1860, 5 million Morse Code messages were being sent annually.
- A telegraph was used to transmit messages. This allowed the dots and dashes to be translated into words and sentences.
- Consider how President Lincoln utilized Morse Code and, as this was the first form of encrypted messages, the Civil War was won by using Morse Code. This influenced the history of the world. (8 minutes)

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

Keywords

- American Civil War
- Morse Code
- Decipher
- Telegraph
- Messages
- Encrypted

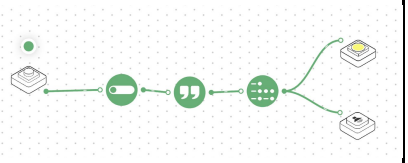
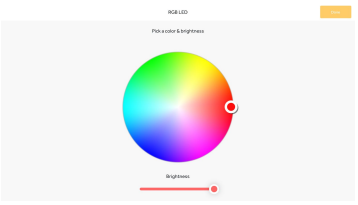
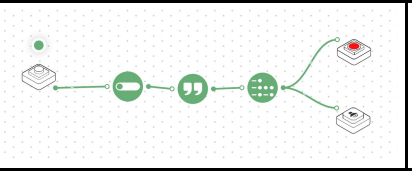
Let's Discuss: *How were messages sent? In your workbook or with a partner, record, discuss, or share how Morse Code helped Lincoln win the American Civil War.*

Link forward: Link to creating a Morse Code alert system to send an emergency message

Morse Code Alert

Worked Example — 7 minutes

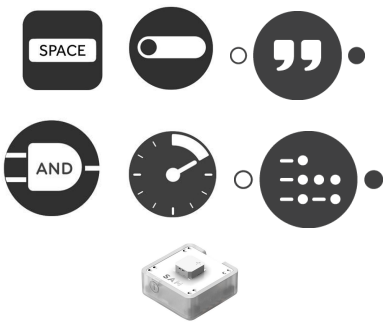
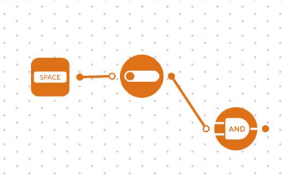
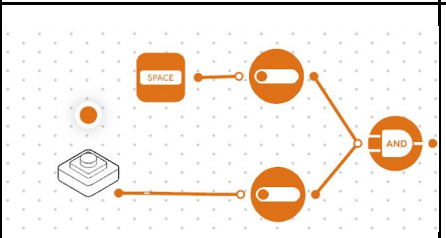
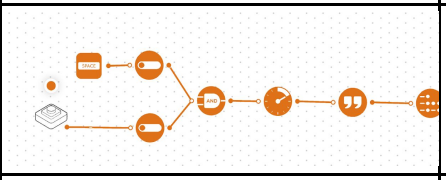
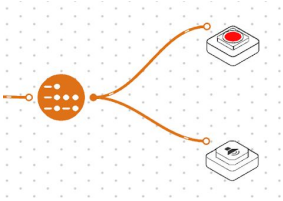
Sending a message using the Morse Code Block in light and sound

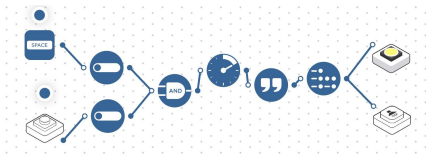
Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • Buzzer block • RGB LED block • Button/Virtual Button block		*The RGB LED will allow the message transmitted to be seen and the Buzzer block allows it to be heard, showing how the message could be relayed to others.*
Step 2. Connect the blocks in this order: • Button block, Toggle block, Text block, Morse Code block • Morse Code block to both the RGB LED and the BUzzer block		*This will ensure the Morse Code message is transmitted to the RGB LED and the Buzzer blocks* *If you do not have the physical blocks you can either use the virtual blocks for the same blocks or substitute the Button with a Key Press block and the Buzzer with a Sound Player block*
Step 3. Edit the settings of the Text block to 'SOS'.		*The SOS message is linked to the type of message that is sent as an alert and is globally recognised as a distress signal*
Step 4. Edit the color of the RGB LED block to red.		*The color of the RGB LED is to also convey the urgency to the message and will need to be changed to red*
Step 5. Test your system.		*Press the Button and see the system play the SOS message in Morse code in light and sound*

Morse Code Alert

Challenge 1 — 7 minutes

Create a program to send an 'SOS' message that uses the AND logic block

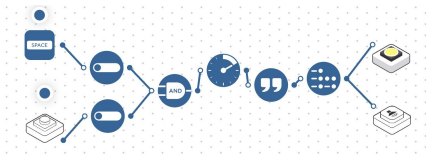
Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • Buzzer/Virtual Buzzer block Drag onto the workspace: • 2 Toggle blocks • Key Press block • AND gate block • Interval block • Text block • Morse Code block • Buzzer block		*If you do not have the physical blocks you can either use the virtual blocks for instance, a Sound Player block instead of a Buzzer.* *Logic blocks are also known as logic gates.*
Step 2. Connect the Key Press block to a Toggle block. Connect the Toggle to the AND gate block.		*The Key Press block will form one of the inputs*
Step 3. Connect the Button Block to the other Toggle block and into the AND gate block		*There are now two inputs to the system; the Key Press block and the Button block.* *The AND gate block now ensures that both of these inputs have to be active in order for the system to continue the flow throughout the system*
Step 4. Connect the output of the AND gate block to the other blocks in this order; Interval block, Text block, Morse Code block		*The Interval block will ensure the message is repeated after each lapse of time*
Step 5. Connect the output of the Morse Code block to the RGB LED block and the Buzzer block		*This system now has two outputs in light and sound*
Step 6. Pair the Button block, RGB LED block and the Buzzer block with the system		*You can check the blocks are paired on the workspace by the shading on the virtual blocks changing to show a 3d aspect and the color on the physical blocks changing from red*

Step 7. Test your system.		*Activate the system by pressing the Key Press block and the send the alert message press the button to see the system work with both inputs activated.*

Checks for understanding: *Which inputs need to be ON with the AND gate block for the system to work? Which blocks are the inputs for this system?*

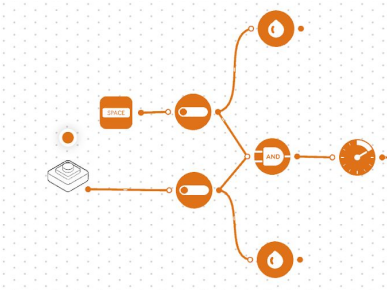
Challenge 1 - Debug it — 5 minutes

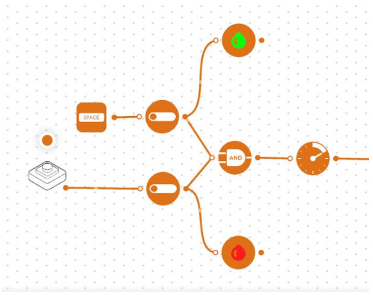
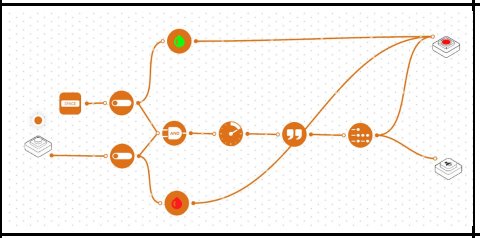
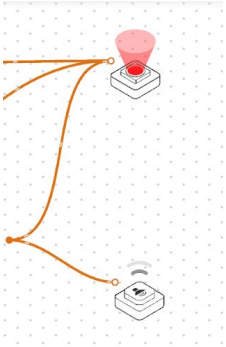
Why is the message cut short?

Instructions	Workspace	Notes for Teachers
Step 1. Open the Settings icon of the Interval block		*The default setting for the Interval block is 1 second, to ensure the full message is played before repeating it, change this to 3 seconds.*
Step 2. Test your system		*The system should now play the message in full when activated by both inputs and repeat until switched off by the Key Press block.*

Challenge 2 — 7 minutes

Modify the system to have a continuous green light until the alert is activated

Instructions	Workspace	Notes for Teachers
Step 1. Drag on 2 Color blocks		*If we are asking the system to alternate between colors we can no longer have the color set on the RGB LED and will need to use this block to define the color*
Step 2. Connect the Color block to the Toggle block - so each Toggle block has one attached to it		*There should be a Color block from each of the Toggle blocks as we want to define the color depending on the input activated*

Step 3. Select the settings of the Color blocks and set to Green and Red.		*Set the top Color block to GREEN and the bottom Color block to RED as the Button block needs to have the RED color attached* *Once a color is set you will see it set on the workspace.*
Step 4. Connect both outputs of the Color blocks to the RGB LED.		*Both the outputs of the Color blocks need to be attached to the RGB LED for the system to send the correct message through to the RGB LED*
Step 5. Test your system.		*When you switch on the system using the Key Press block the light on the RGB LED will be continuous green.* *When the Button block is pressed to set the alert off the Morse Code message will be sent and the light will change to red.*
Extension Ideas: ● **History:** ○ How did Morse Code evolve after the first version was introduced? ● **Science/Art**: ○ Can you build your own Morse code alert box to house the physical blocks and showcase the system built		

Checks for understanding: *What is the purpose of the Color block? What would happen if the Key Press was OFF and the Button block was pressed?*

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.

Lesson 4.5

Patterns and Passwords

Overview

During this lesson, students will learn what a strong, secure password is and how to create a password. Students will integrate and exhibit learning by programming two systems; one that requires a range of passwords and one that requires just one.

Key Information

Level 4: (Ages 10-12) US Grades 5 or 6 Time: 45/90 minutes

Lesson consists of...	
Warm-Up	5 mins
Mini-lesson	10 mins
Worked Example	7 mins
Challenge 1	7 mins
Challenge 1 - Debug	5 mins
Challenge 2	7 mins
Tidy Up / Exit Ticket	4 mins

Learning Objectives

As a result of this lesson, students will be able to

- ➜ Identify characteristics of strong and weak passwords
- ➜ Discuss the requirements to make a strong, secure password
- ➜ Create a system that requires a password to activate the system
- ➜ Create a system that will only accept one password to unlock it

Lesson Topics

Computing
- ➜ Inputs, outputs, abstraction, debugging

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

Math
- ➜ Combinations and permutations

English Language Arts
- ➜ Participate in collaborative conversations
- ➜ Use information gained from illustrations and text to demonstrate understanding
- ➜ Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 4-5 topic or subject area

Materials required

- ➜ SAM Labs Kit
- ➜ Student Workbook

Patterns and Passwords

Warm Up – 'Strong or Not' — 5 minutes

Which is the strongest?

Objective: Identify characteristics of strong and weak passwords

Procedures: *"Today we are going to learn about passwords, what makes a strong, secure password and how to create a password to open a system"*

- Look at the different types of passwords and identify what makes them
- Look at what makes a strong and secure password and in particular the rules to follow to help create passwords and reasons why. 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
  - Change them regularly
  - Never tell anyone your password
- Link to a relevant security breach of data due to passwords being hacked and e-safety - click here for top data breaches of the 21st century

Link forward: Link to looking at why it is important to stay safe online and the threats we face

Mini-lesson — 10 minutes

Why should we be safe online?

Objective: Discuss how staying safe online is essential. Become aware of common threats when we use online spaces.

Procedures: Look at e-safety and how the use of personal information can lead to grooming, hacking, cyberbullying, trolling, sexting, identity theft and much more.

- Discuss how people on the internet can pretend to be someone they are not and use this to gain your trust to access further information, meet, gain inappropriate images that leave you vulnerable.
- Ensure understanding of how once something is on the internet it is there forever. It can be discovered by anyone; universities and employers are now using the internet to research candidates.
- Consider trolling and cyberbullying and the effects it has on individuals. In some cases, suicide can be the consequence.
- You may wish to show this video from the NSPCC (UK) on keeping children safe online https://www.nspcc.org.uk/preventing-abuse/keeping-children-safe/share-aware/ (8 minutes)

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

Keywords

- Cyberbullying
- E-safety
- Hack
- Grooming

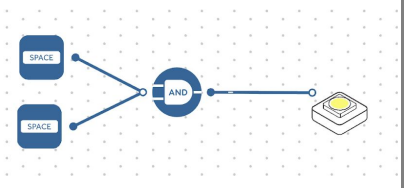
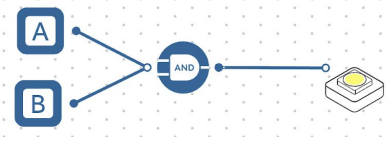
Let's Discuss: *What information online is used by universities and employers to check a candidate? In your workbook or with a partner, record, discuss, or share what you can do to make sure you stay safe online and not fall victim to cyberbullying.*

Link forward: Link to creating a system that requires a password to activate

Patterns and Passwords

Worked Example — 7 minutes

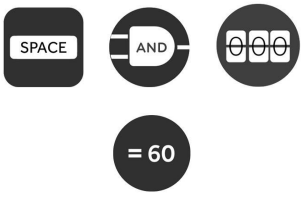
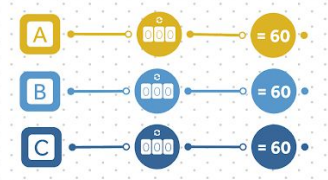
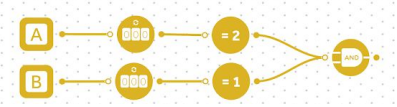
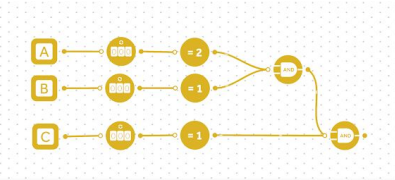
Utilize the AND gate and 3 inputs to activate a system

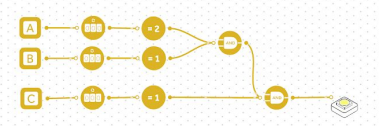
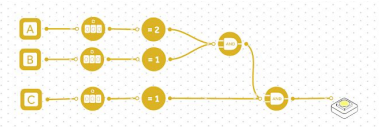
Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 1 RGB LED block		*The RGB LED will be the output for the system and RGB stands for Red, Green and Blue.*
Step 2. Drag on to the workspace • 2 x Key Press blocks • 1 x AND gate block		*The 2 x Key Press blocks will be the inputs for the system.* *The AND logic gate requires both the inputs to be ON for the system to continue; also known as a binary operator.*
Step 3. Connect both the Key Press blocks to the input of the AND gate block. Connect the AND gate output to the RGB LED block.		*The 2 x Key Press blocks connected to an AND gate block means both inputs must be ON for the AND gate to send the signal through to the output.*
Step 4. Access the settings of the Key Press blocks and set them to A and B.		*The inputs all need to be different so the AND gate block can recognize the different inputs to activate the output.*
Step 5. Test your system.		*Press the inputs and see how both Key Press blocks must be pressed for the RGB LED to turn on.*

Patterns and Passwords

Challenge 1 — 7 minutes

Create a system that requires a password to activate the system

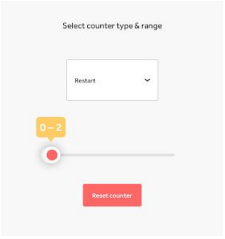
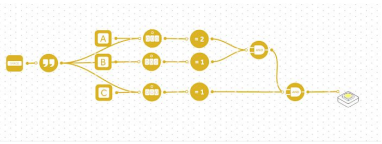
Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 1 RGB LED block		*The RGB LED will be the output for the system and RGB stands for Red, Green and Blue*
Step 2. Drag on to the workspace • 3 x Key Press blocks • 3 x Counter blocks • 3 x Compare blocks • 2 x AND gate block		*The 3 x Key Press blocks will be the inputs for the system*
Step 3. Label the Key Press blocks A, B and C		*The inputs all need to be different so they can be recognized as different inputs to activate the output.*
Step 4. Connect each Key Press block to its own Counter block and then into a Compare block		*Each Key Press block has its own Counter to determine how many times it has been pressed and the Compare block will be used to see if the right input has been reached to continue within the system.*
Step 5. Each Compare block needs to be edited within the settings to: • A = 2 • B = 1 • C = 1		*This now means that when the Counter block reaches 2 on the A input it will activate the system and the same for B and C inputs that are looking for a 1 on the Counter blocks*
Step 6. Connect the output of A and B Compare blocks to an AND gate block		*This will mean that both A and B inputs need to be ON for the system to continue. Notice how the color of the system is all one color now as they have been connected together.*
Step 7. Connect the output of C Compare block to an AND gate block		*Notice how the color of this one is different to step 6 as it has not been connected yet as one system.*
Step 8. Connect the output of the first AND gate block to the input of the second AND gate block.		*The system now is looking at A and B being ON (TRUE to the Compare blocks) AND C being ON (TRUE to the Compare block) to continue with the system*

Step 9. Connect the output of the AND gate to the RGB LED.		*The RGB LED will only activate if ALL inputs have been activated correctly = A x 2, B x 1 and C x 1*
Step 10. Test your system.		*Test the system and see how many different combinations of A x 2, B x 1 and C x 1 can be used to activate the light, what patterns can you find*

Checks for understanding: *What is the purpose of the AND gate block? What does '=2' mean on the Compare block?*

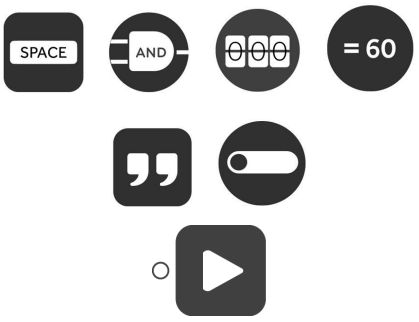
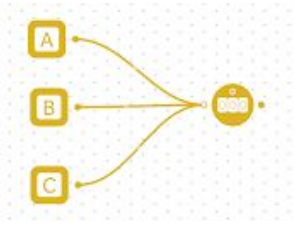
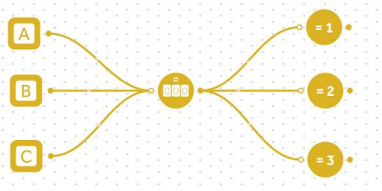
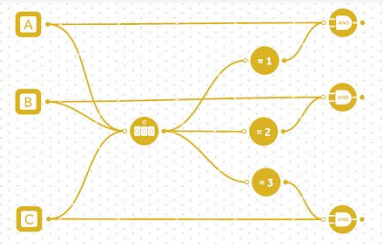
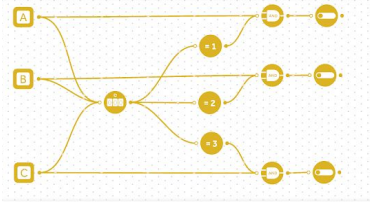
Challenge 1 - Debug it — 5 minutes

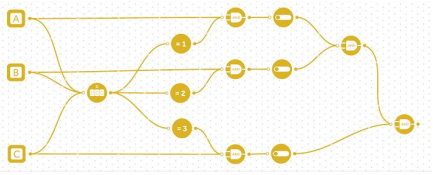
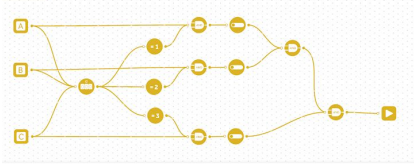
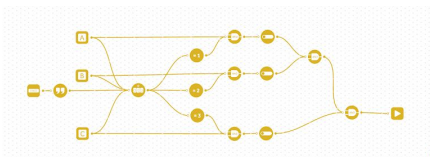
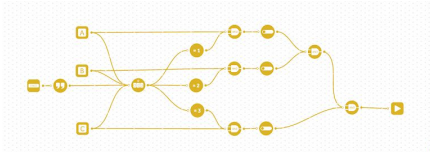
How do I reset the Counter blocks?

Instructions	Workspace	Notes for Teachers
Step 1. Set the range of each Counter block.		*Access the settings of each Compare block and make sure the range maximum is equal to the number required on the Compare blocks. E.g. A = 2 so the Counter block range is 0-2*
Step 2. Drag onto the workspace: • Key Press block • Text block		*Even with the range on the Counter blocks set we still need to be able to reset the Counter to 0 on all when the numbers are reached*
Step 3. Connect the Key Press block to the Text block and the output of the Text block to all Counter block inputs.		*Now when the passwords have been tried the system can be reset to 0 to try again*
Step 4. Type lowercase 'reset' into the field of the Text block.		*The word 'reset' needs to be added to the Text block as the command to action*

Challenge 2 — 7 minutes

Create a system that will only accept one password to unlock it

Instructions	Workspace	Notes for Teachers
Step 1. Drag on to the workspace • 5 x AND gate block • 4 x Key Press blocks • 3 x Compare blocks • 3 x Toggle blocks • 1 x Counter blocks • 1 x Text block • 1 x Sound Player block		*The 3 x Key Press blocks will be the inputs for the system*
Step 2. Label the Key Press blocks to A, B and C.		*The inputs all need to be different so they can be recognized as different inputs to activate the output*
Step 3. Connect the output of the Key Press blocks A, B and C into the Counter block.		*The Counter block will determine how many times an input has been pressed.*
Step 4. Connect the output of the Counter block to the 3 x Compare blocks and set them to; '=1', '=2', '=3'		*The Compare blocks will look at the Counter block and see if the number on there matches the one they are looking for.*
Step 5. Connect: • The output of A and the output of '=1' Compare block to an AND gate block • The output of B and the output of '=2' Compare block to an AND gate block • The output of CA and the output of '=3' Compare block to an AND gate block		*It is important that each Key Press here has the output connected to the Counter block and the AND gate block.*
Step 6. Connect each AND gate block to a Toggle block.		*The Toggle blocks will act as switches to show if the output of the AND gate block is ON*

Step 7. • Connect the top two Toggle blocks to an AND gate block • Connect the third Toggle block to an AND gate. Connect the output of the AND gate above to the input of this last AND gate.		*It is important that the top two Toggle blocks are connected to an AND gate and then that AND gate block into another AND gate block connected with the third Toggle block*
Step 8. Connect the output of the AND gate block to a Sound Player block. Set the sound within the settings.		*There are numerous options for the sound to be used when the password is successful, we used Sound FX 1 and Success Sting.*
Step 9. Add the reset option using the 4th Key Press block and Text block and connect them to the counter.		*This is the same as the Debug earlier; add and connect the Key Press block to the Text block and edit the settings of the Text block to 'reset'*
Step 10. Test your system.		*The system will only unlock with the password ABC. To reset the Counter block you use the Key Press block. To reset the Toggle blocks the same password will need to be entered to return them to the OFF position.* *Try another password and the system will not unlock and you will need to reset it to the starting position.*

Extension Ideas:

- **Computing**:
  - Can you change the password required to set the Sound Player off?
  - How could the system be improved to reset the Toggle blocks easily?
- **History/Maths/Computing**:
  - Look at encryption and how systems have been developed over the years to hide what others can see
  - Look at the Enigma machine and how Alan Turing built a machine to crack the code, resulting at the Allies knowing and using the information gathered but not inform the Germans that the code had been cracked.
- **Science/Computing**:
  - What others methods of securing devices are there?
  - Are passwords and security important? Look at what could happen if hacking was not tackled and why cyber security is an important role.

Checks for understanding: *How many inputs are there in this system? How many passwords are there to open this system?*

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.

Lesson 4.6

Every Action...

Overview

During this lesson, students will gain understanding of Newton's Third Law of Motion; every action has an equal and opposite reaction. Students will integrate and exhibit learning by building a SAM car and programming a system to study the third law in action.

Key Information

Level 4: (Ages 10-12) US Grades 5 and 6 Time: 45/90 minutes

Lesson consists of...	
Warm-Up	5 mins
Mini-lesson	10 mins
Worked Example	7 mins
Challenge 1	7 mins
Challenge 1 - Debug	5 mins
Challenge 2	7 mins
Tidy Up / Exit Ticket	4 mins

Learning Objectives

As a result of this lesson, students will be able to

- ➔ Discuss how a balloon moves forward when air is released
- ➔ Describe Newton's Third Law of Motion
- ➔ Design a system to demonstrate Newton's Third Law of Motion using the SAM car
- ➔ Design a SAM system to show Newton's Third Law of Motion using water

Lesson Topics

Physical Science
- ➔ Forces and interactions

Computing
- ➔ Inputs, outputs, abstraction, debugging

Design and Technology
- ➔ Generate, develop, model and communicate ideas through talking, drawing and mock-ups

Scientific Thinking
- ➔ Asking relevant questions and using different types of scientific enquiries to answer them

Math
- ➔ Measure and estimate lengths in standard units

English Language Arts
- ➔ Participate in collaborative conversations

Materials required

- ➔ SAM Labs Kit
- ➔ Student Workbook
- ➔ Container of water
- ➔ Pencils
- ➔ Plastic propeller
- ➔ Small plastic container (for boat)
- ➔ Balloon
- ➔ Lego

Warm Up – 'Let it go' — 5 minutes

How does a balloon move forward?

Objective: Recognize how a balloon moves forward when air is released

Procedures: *"Today we are going to learn about Newton's Third Law of Motion."*
- All students to be given a balloon and asked to blow it up a little and hold it.
- Discuss what will happen when they let go of the balloon.
- As the balloon propels forward the air within the balloon is released and pushes against the air around it
- Use the correct words to describe what happens when the balloon is released from your hand

Link forward: Link to looking at applications of Newton's Third Law of Motion

Mini-lesson — 10 minutes

What is Newton's Third Law of Motion?

Objective: Describe Newton's Third Law of Motion

Procedures: "*Newton's Third Law of Motion says that every action has an equal and opposite reaction".*
- This clip (https://www.youtube.com/watch?v=dCF--YOjiOw) from space shows how the Third Law is easy to see in space as two objects collide.
- If one object is heavier than the other, the force can not be seen as easily.
- When wheels move on the road it exerts a force on the road to move the car forward and it is only because the road is stronger you do not see the opposite force as easily as the balloon. (8 minutes)

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

Keywords
- Newton's Third Law
- Motion
- Action
- Reaction
- Opposite
- Equal

Let's Discuss: *What is applied to every action? In your workbook or with a partner, record, discuss, or share an example of how Newton's Third Law of Motion can be seen.*

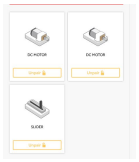
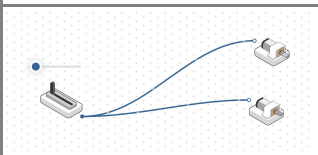
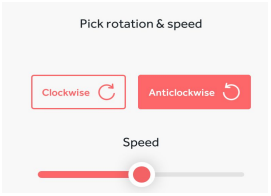
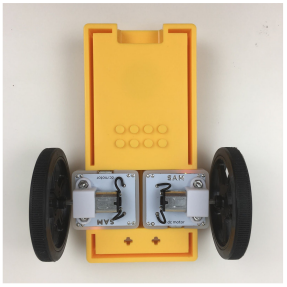
Link forward: Link to designing a system to show Newton's Third Law of Motion.

Every Action...

Worked Example

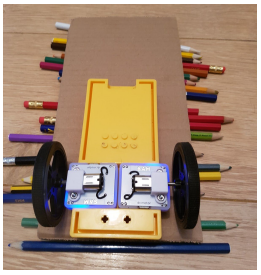
7 minutes

Build a car to show Newton's Third Law of Motion through driving forward

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • 2 DC Motor blocks • 1 Slider/Virtual Slider block		*If you do not have the Slider block you can use it on the workspace virtually*
Step 2. Connect the Slider block to both DC Motor blocks.		*The Slider block is the input and will activate both outputs when the Slider is moved to the right.*
Step 3. Access the settings icon of one of the DC Motors and set to 'anticlockwise'.		*It is important to change the rotation of one of the motors to 'anticlockwise'. Otherwise the car will simply go round in circles.*
Step 4. Connect the 2 wheels to the DC Motors and insert into the Yellow Car Chassis. Insert the roller underneath the car.		*Ensure the lights in the blocks are all the same colour and not red, which means that all are connected to the system*
Step 5. Test your system.		*Test the car and see how the movement of the wheels propel the car forward by pushing on the surface below, but because the surface is solid you can not see the opposite force.* *If the car goes backwards you will need to swap the DC Motor you set as 'Anti-clockwise'*

Challenge 1 — 7 minutes

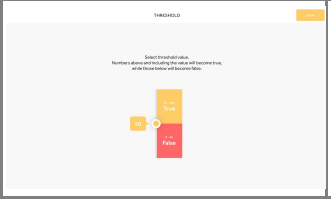
Design a system to show Newton's Third Law of Motion clearly using the SAM car

Instructions	Workspace	Notes for Teachers
Step 1. Place pencils on a flat surface.		*The pencils need to be laid out together and will form part of the road.*
Step 2. Place a piece of cardboard on top of the pencils.		*The cardboard needs to be placed on top of the pencils and in the centre*
Step 3. Place the car on top of the cardboard.		*The cardboard needs to be wide enough for the wheels to be on and the car needs to placed at the start of the cardboard.*
Step 5. Test your system.		*As the car moves forward the cardboard is pushed back over the pencils and clearly shows Newton's Third Law of Motion of how if an object wants to go forward it has push against something to do so.*
Step 6. Experiment with the speed of the car.		*Reset the cardboard and car and using the Slider block experiment with the speed and the effect it has, to see the action used to move forward has an equal opposite reaction.*

Checks for understanding: *What happens to the cardboard as the car moves forward? What is the output in this system?*

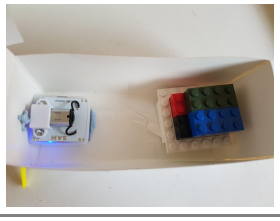
Challenge 1 - Debug it — 5 minutes

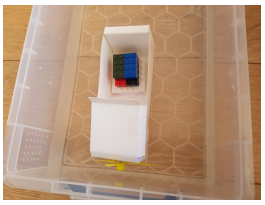
How can I move at a greater speed instead of starting slow?

Instructions	Workspace	Notes for Teachers
Step 1. Drag on and add a Threshold block between the Slider and DC Motor blocks.		*The Threshold block allows numbers over the set threshold to be True and below False*
Step 2. Set the Threshold to '50'.		*This will take the input value from the Slider block and if it is over 50 it will start the car moving at that speed.*

Challenge 2 — 7 minutes

Design a SAM system to show Newton's Third Law of Motion using water

Instructions	Workspace	Notes for Teachers
Step 1. Use a small plastic box and pierce a hole through the end.		*You may wish to teach Challenge 2 as a whole class activity given the materials required.* *The hole needs to be in line to where the DC Motor block would stick through and secure the DC Motor block to the bottom of the box with blue tac*
Step 2. Push the end of the DC Motor through and attach a plastic propeller.		*The plastic propeller needs to have a hole pierced on the one side big enough for the end of the DC Motor to fit in*
Step 3. Balance the weight.		*The weight of the block on the one side needs to be balanced out and here we have used lego blocks*
Step 4. Fill a container with water.		*The container needs to big enough to allow the boat to move easily and the water needs to be enough for the propeller to move freely.*

Step 5. Place the boat in the water at the one side.		*Placing the boat at one side will allow the movement to clearly be seen*
Step 6. Start the DC Motors.		*Move the Slider block and watch the propeller start when over 50 and see the force push forward and the water move backwards; Newton's Third Law of Motion*

Extension Ideas:

- **Computing**:
  - Can you create a system that allows the boat to switch the direction of the motor and visualize the effect on the water?
- **D&T/Science:**
  - Look at boat design and discuss whether that has an effect on the force generated
- **Science**:
  - How are rockets launched into space using Newton's Third Law of Motion?
  - Create water rockets and paper aeroplanes to further demonstrate Newton's Third Law of Motion
  - Look at sport and how Newton's Third Law of Motion applies to outfit and device design to aid movement

Checks for understanding: *When the boat moves forward what is pushed back in this experiment? What is the purpose of the Threshold block?*

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.

Exploring Heredity

Overview

During this lesson, students will work collaboratively to investigate heredity and how our parents genes combine to create our own unique genetic signature. Students will integrate and exhibit learning by designing a system that demonstrates how allele combinations produce different eye colors.

Key Information

Level 4: (Ages 10-12) US Grades 4 or 5 Time: 45/90 minutes

Lesson consists of...	
Warm-Up	5 mins
Mini-lesson	10 mins
Worked Example	7 mins
Challenge 1	7 mins
Challenge 1 - Debug	5 mins
Challenge 2	7 mins
Tidy Up / Exit Ticket	4 mins

Learning Objectives

As a result of this lesson, students will be able to

- ➜ Explain that every living object is made up of DNA which contains the genetic information which explains what we look like.
- ➜ Explore cause and effect.
- ➜ Explain why different organisms vary in how they look and function because they have different inherited information.
- ➜ Develop and use a model to describe phenomena.

Lesson Topics

Life Science
- ➜ Develop and use a model to describe why sexual reproduction results in offspring with genetic variation

Computing
- ➜ Develop and use a model to solve a problem

Scientific Thinking
- ➜ Asking relevant questions and using different types of scientific enquiries to answer them
- ➜ Use evidence to support an explanation

Design and Technology
- ➜ Generate, develop, model and communicate ideas through talking, drawing and mock-ups

Math
- ➜ Probability- what is the probability of inheritance based on given factors

English Language Arts
- ➜ Participate in collaborative conversations

Materials required

- ➜ SAM Labs Kit
- ➜ Student Workbook
- ➜ White Cardstock

Warm Up — 5 minutes

What do we inherit from our parents?

Objective: Explain that living objects are made up of DNA which contains the genetic information that prescribe what we look like.

Procedures: "*Inheritance is the process by which genetic information (DNA) is passed on from parent to child. This is why members of the same family tend to have similar characteristics.*"

- Students to watch a trailer for the film/ documentary "Twinsters" https://www.imdb.com/title/tt2980626/
- What do you notice is the same and different about these two girls?
- Sketch yourself. Identify your physical features and label who you think you have inherited them from.

Link forward: We inherit our physical features from our parents, but how does it work?

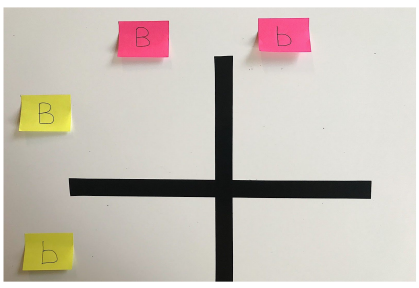
Mini-lesson — 10 minutes

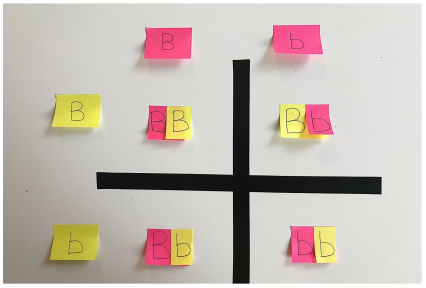
What makes up our genes?

Objective:.Understand how a combination of alleles determine the eye color of our offspring.

Procedures: *Traits are passed down from organisms to offspring via genetics.*

- Can you think of any traits you have inherited from your parents?
- Different forms of the same gene are called alleles.
- Display four different glasses. Each glass contains Coke (or different waters). Students taste each drink and determine the flavor (Cherry, Vanilla, Diet, Zero). There are four different flavors, but all of the drinks are Coke.
- In this example, the Coke is the gene and the flavors are the alleles. An Allele is a variation of the same gene.
- The gene we inherit to determine our eye color has an allele for blue eyes and an allele for brown eyes.
- Alleles can be dominant or recessive. We show this using capital (dominant) and lowercase (recessive) letters. A dominant gene will hide the traits of a recessive gene.
- We use a Punnett square to trace dominant and recessive traits. We are going to use the square to predict the eye color of offspring from two parents with brown eyes. The allele of the brown eyes is Bb.
- Use masking tape to create a Punnett square on the floor. Class to sit in circle around the square. How can we use this to help us predict the eye color of future offspring? Have a set of post its with capital and lowercase b's on them. Discuss where to place the alleles to represent that both parents have brown eyes (Bb). Can students use post it notes to complete the rest of the square?





- What is the ratio of brown eyed to blue eyed offspring? How do you know?

- Would the ratio change if one of the parents had blue eyes (bb)? Can students use post-it notes to represent this using the Punnett square?

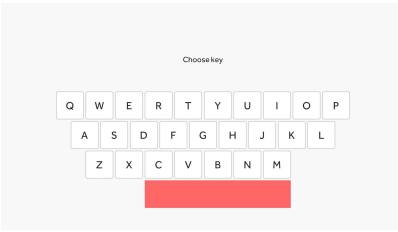
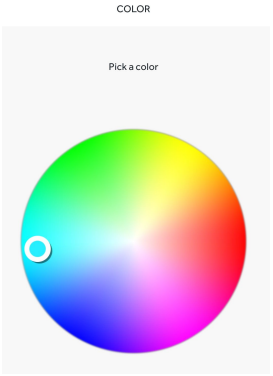
Keywords
- Dominant
- Allele
- DNA
- Recessive
- Gene

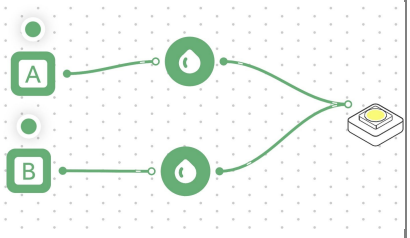
Let's Discuss: Why it is important we understand our genes? Discuss how having a secure understanding of our DNA can help us in the future.

Link forward:
We are going to design a system which will represent the gene selection described in our eye color Punnett square.

Worked Example — 7 minutes

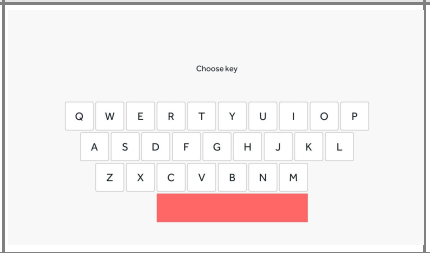
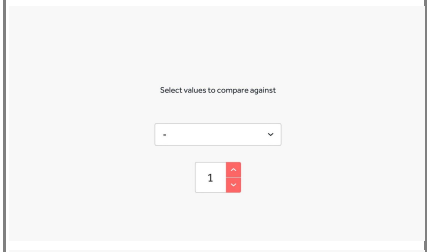
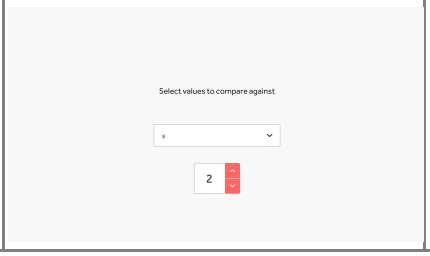
Design a program that selects eye color based on two inputs

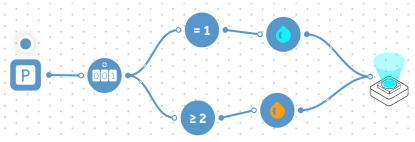
Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • RGB LED Add the RGB LED to the workspace.		*The color of the RGB LED will represent the eye color of the offspring.*
Step 2. Add to the workspace: • 2 x Key Press • 2 x Color blocks		*The Color block will allow us to change the color of the RGB LED. The Key Press will act as our input.*
Step 3. Access the settings of each Key Press to change its label. Select A for the first Key Press and B for the second Key Press.		*Key Press A and Key Press B will turn the RGB different colors.* *It is important students recognise that this example is just being used to test the system. The Key Press buttons do not, at this stage, represent parents.*
Step 4. Access the settings of the Color blocks and change one to blue and one to brown.		*Students will need to use dark orange to represent the brown eye color as brown is not an available color.*

Step 5. Connect each Key Press to a Color block. Connect both Color blocks to the RGB LED.		*Pressing A will now turn the RGB LED blue. Pressing B will turn the RGB LED brown.* *Which color represents the dominant allele? How do they know?*
Step 6. Test your system.		

Challenge 1 — 7 minutes

Design a system to represent the eye color Punnett square.

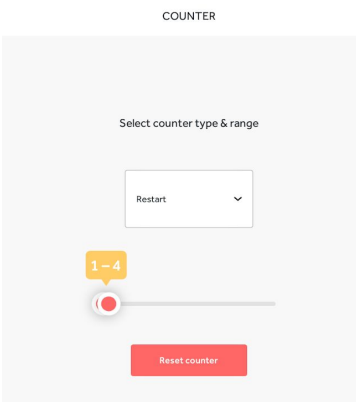
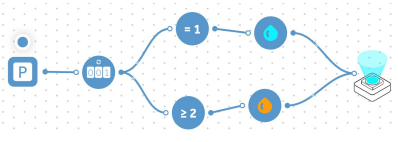
Instructions	Workspace	Notes for Teachers
Step 1. Delete one Key Press block from the workspace. Access the settings of the remaining Key Press and change the label to P.		*The one Key Press will now represent the genes of both parents.*
Step 2. Delete the connection between the remaining Key Press and Color block.		*Select the connection and press the X to delete.*
Step 3. Drag a Counter block and 2 x Compare blocks to the workspace.		*The Compare block =1 will represent the recessive allele (blue) and the Compare block ≥2 will represent the dominant allele (brown).*
Step 4. Access the settings of the first compare block and set it to =1. Access the settings of the second Compare block and set it to ≥ 2.	 	

Step 5. Connect the Counter block to the Key Press. Connect the Counter block to both Compare blocks, then connect each Compare block to its corresponding Color block.		*The Compare block =1 must be connected to the blue Color block.* *The Compare block which is 'equal to or greater than 2' must be connected to the brown Color block.*
Step 6. Connect the output of each Color block to the RGB LED.Test your system.		*Pressing the button once will turn the RGB LED blue. Pressing the button again will turn the RGB LED brown. In this system, the light will not turn blue again.* *Is this system a good representation of the eye color Punnett square? Can students think of a way to improve the system?*

Checks for understanding: *How do we end up with our eye color? Why do some children have a different eye color to their parents?*

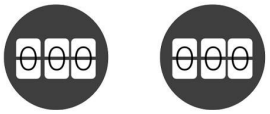
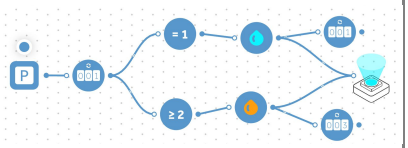
Challenge 1 - Debug it — 5 minutes

How can we reset our system?

Instructions	Workspace	Notes for Teachers
Step 1. Access the settings of the Counter block and set range to 1-4.		*The Counter block will now reset when it reaches 4. The number 4 now represents the 4 potential allele combinations from two parents with brown eyes (Bb).*
Step 2. Test your system.		*The RGB LED will now flash blue once then brown four times. The system now represents the probability of offspring having blue or brown eyes.*

Challenge 2 — 7 minutes

Create a system which displays the ratio of brown to blue eyed offspring.

Instructions	Workspace	Notes for Teachers
Step 1. Drag 2 x Counter blocks onto the workspace.		*We will use these to record the amount of times each color will flash.*
Step 2. Connect each Counter block to the Color block output.		*The Counter blocks attached to the Color blocks act as a display to show how many times the blue or brown has been showed. This allows you to observe the ratio of blue to brown in eye color.*
Step 3. Test the system.		*Test your system by pressing the Button blocks and see the effect on the color generated. When the number is equal to or greater than 2 it will simulate the dominant alleles, showing brown eye color and if the number is equal to 1 it will simulate the recessive alleles, showing blue eye color.* *How are the numbers changing? What is the ratio of blue to brown eyes after 4 children? What about after 8, 12 etc.*

Extension Ideas:

- **Computing**:
  - Is there a way of writing this program using SAM Blockly?
- **Geography/Science**:
  - What are the dominant/ recessive genes which have been discovered?
  - Are there different genetic patterns across the world- for example you could investigate eye color in China compared to eye color in the UK?
- **Science**:
  - Can you make a model of a DNA structure and label some of the allele's?
- **Maths:**
  - Investigate the ratio of brown to blue eyes within your classroom. Is it the same ratio as the system you have built shows? If it is different, why do you think this is?

Checks for understanding: *What did the system model in terms of recessive and dominant genes? What is the probability of you inheriting your parents eye color?*

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.

Lesson 4.8

Grey or Ginger Kittens

Overview

During this lesson, students will investigate how genetic variation of traits increase chance of survival. They will build a system using SAM Blockly to show the randomization of gene selection and investigate which traits are advantageous to an animal's survival.

Key Information

Level 4: (Ages 10-12) US Grades 5 and 6 Time: 45/90 minutes

Lesson consists of...		Learning Objectives
Warm-Up	5 mins	**As a result of this lesson, students will be able to**
Mini-lesson	10 mins	➜ Describe how living things have adapted to their habitat
Worked Example	7 mins	➜ Understand that some individuals are more successful at surviving than others because of variant traits
Challenge 1	7 mins	➜ Describe how genetic variation occurs within a species
Challenge 1 - Debug	5 mins	➜ Build a system using SAM Blockly to show randomization of gene selection
Challenge 2	7 mins	
Tidy Up / Exit Ticket	4 mins	

Lesson Topics

Science
- ➜ Genetic variation and natural selection
- ➜ Adaption

Math
- ➜ Ratio and probability

Computing
- ➜ Inputs, outputs, abstraction, debugging

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
- ➜ Participate in collaborative conversations

Materials required

- ➜ SAM Labs Kit
- ➜ Student Workbook
- ➜ Colored bibs/sashes
- ➜ 4 different Coca-Cola flavors or 4 different flavours of water
- ➜ Laptop
- ➜ Sweets

Grey or Ginger Kittens

Warm Up – 'Genetic Variation' — 5 minutes

How do specific genetic variations of traits increase our chance of survival?

Objective: Explain that specific traits are more advantageous to our survival than others.

Procedures:

- Play 'Genetic Variation' game. This game will need to be played in a large space such as a gymnasium or playground.
  - Students split into 2 teams.
  - Team 1 wear blue bibs/sashes, Team 2 wear red bibs/sashes.
  - Team 1 can only walk throughout the game. Team 2 can jog.
  - Teacher to place a number of small sweets over the floor. The winning team is the one who collects the most sweets.
  - Repeat game. This time Team 2 can run, Team 1 walk.
  - Repeat game. Team 2 can now sprint, Team 1 walk.
- *Which team collected the most sweets? Was being able to move quickly more or less advantageous to Team 2? In the last round of the game, was Team 1 able to collect any sweets?*
- Use game to explain that Team 2 had the advantage of being able to move quickly. This meant they were able to collect more food. Team 1 were left with little to no food because they could not move fast enough.
- How does moving quickly increase some animals chances of survival?
- Can students think of any other traits animals have which increases their chance of survival?

Link forward: Living organisms have adapted to their habitat. They have developed special features that help them survive.

Mini-lesson - 'We are the Survivors' — 10 minutes

How have organisms adapted in order to survive?

Objective: Recognise how animals develop particular traits in order to adapt to their habitat.

Procedures:

- *NB - It would be useful for students to have some understanding of genetics and alleles which is covered in 4.7. If this lesson has not been covered, use the coke/water example from the mini lesson to provide a visual example of alleles.*
- Watch 'We are the Survivors' https://www.youtube.com/watch?v=wtLQoTAVY_Y
- Can students identify the specific traits of each animal which have enabled it to survive in a particular habitat?
- Look at example of a grey cat and a ginger cat. Describe the specific traits of each cat. How have these aided its survival? E.g sharp claws to help it climb, thick fur to keep it warm, large ears to hear well, large eyes to see in the dark.
- Which color fur do students think would be more advantageous for a cat to have? Why?
- *If a ginger cat and a grey cat produced offspring, what color would their fur be?*
- Remind students that, in this example, the gene is fur and the allele determines its color.
- For this lesson, the ginger cat carries the dominant alleles (FF) and the grey cat carries the recessive alleles (ff).
- What are the potential variations of fur color for the cats offspring?
- Can students predict how many will be grey and how many will be ginger in a litter of 10? (8 minutes)

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

Keywords:

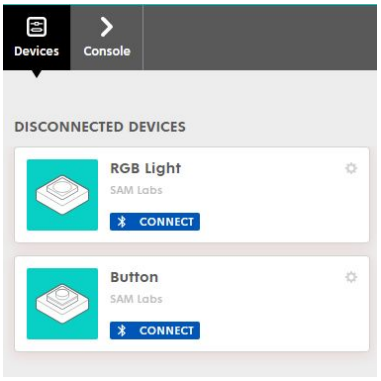
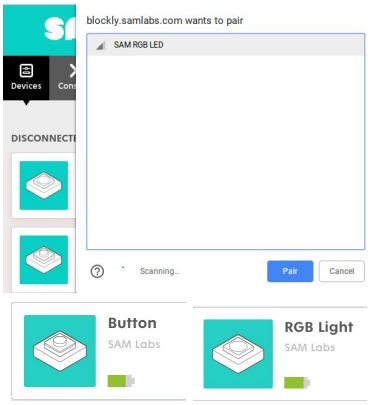
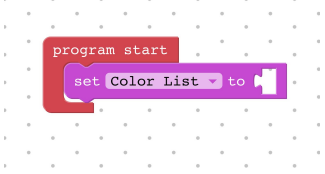
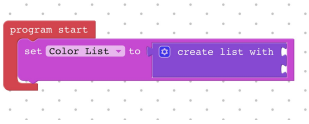
- Evolution
- Genetic variation
- Gene
- allele
- DNA

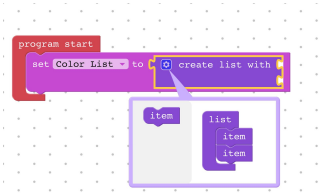
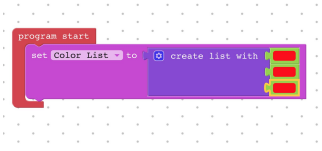
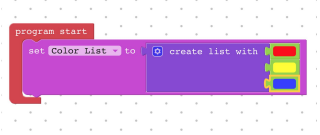
Let's Discuss: In your workbook or with a partner, record, discuss or share how a giraffe has adapted specific traits in order to aid its survival.

Link forward: Build a system using SAM Blockly to show the randomization of gene selection. Students will be working with the concept of a ginger cat and grey cat and using the system to predict the fur colour of their offspring.

Worked Example — 7 minutes

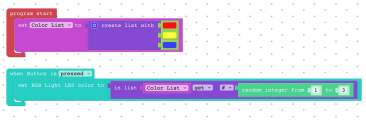
Use Blockly to match a Light color to each gene variation.

Instructions	Workspace	Notes for Teachers
Step 1. Turn on the RGB Light and Button blocks. From 'Devices', click 'Add Device' and select from the list. • 1 RGB LED • 1 Button		*This is a slightly different process than what is used in SAM Space.*
Step 2. Connect the RGB Light and Button by pressing 'Connect' and 'Pair'.		*The battery symbol will tell you how much life your blocks have before you need to recharge them.* *The blocks will turn blue once they are connected.*
Step 3. Drag on the 'Program Start' button from the 'General' tab.		*We will use this to tell our system to begin.*
Step 4. Drag on 'Set Color List' from the 'Variables' tab. Snap it into place.		*This will allow us to input a list of different colors.*
Step 5. Drag on 'Create List' from the 'List' tab. Connect it to the variable.		*This will allow us to select which light settings we want the Light to be able to change to.*

Step 6. Access the settings of the 'Create List' block and drag in one more color option.		*We need three different options as we need three different colors.*
Step 7. Add in three Colors from the Color settings.		*The default color setting is red. We will need to change two of these as we need three different colors.*
Step 8. Click on each Color block and select a different color.		*Students need to decide which color represents which gene variation. It may be worth recording and displaying to aid their recall:* *Red = FF* *Yellow = Ff* *Blue = ff*

Challenge 1 — 7 minutes

Demonstrate the randomization of gene selection.

Instructions	Workspace	Notes for Teachers
Step 1. Drag 'When Button is Pressed' from the 'Button' tab onto the workspace.		*The Button will control when the Light turns on.*
Step 2. Drag on 'Set RGB Light Color' from the 'RGB Light', 'Actions' tab. Snap into 'When Button is Pressed'.		*This will tell the RGB Light to turn red when we press the button.*
Step 3. Drag on 'In List Get #' from the 'List' tab. Snap this into the color section of the 'Set RGB Light Color' block.		*This will allow us to link in our Color List later on.*
Step 4. Drag on the 'Random Integer' block from the 'Math' tab and snap into 'In List Get #'.		*This will randomize the color selection.* *Change the integer settings from 1 to 3. We only have three color options for the system to choose from.*
Step 5. Test the system.		*Does the light flash randomly through the three colors?* *(Expect the system not to work)*

Grey or Ginger Kittens

Checks for understanding: Do you expect the dominant trait or recessive to be expressed more frequently? Why do students think the system is not working?

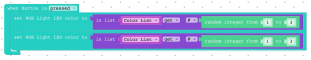
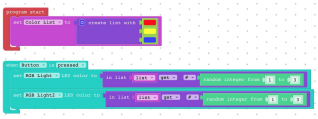
Challenge 1 - Debug it — 5 minutes

Work through the system to find and correct the mistake.

Instructions	Workspace	Notes for Teachers
Step 1. Select the 'List' settings on the 'In List Get #' block. Change it to 'Color List'.		*The system is not working because we have not linked both parts of the code together.*
Step 2. Test the system. Does the light now flash when the button is pressed?		*How many more times is the dominant trait expressed than the recessive if you press the button 10 times?* *What about 20?*

Challenge 2 — 7 minutes

Add a second RGB LED to represent the genes of the second cat.

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • Second RGB LED		*The second light will be used to represent the genetic variation of the second cat.*
Step 2. Highlight and duplicate the code instruction of the first light.		*Highlighting and duplicating saves time as we do not need to search for the identical buttons.*
Step 3. Select the dropdown menu for the 2nd 'RGB Light' and change it to 'RGB Light2'.		*The second light will now flash randomly through each of the three colour selections.*
Step 4. Your system now represents the randomization of gene selection from two cats. Test it.		*Students will need to look at both lights in order to determine the color fur of the kitten.* *E.g. Red + Red = FF (ginger)* *Blue + Blue = ff (grey)* *Yellow + Blue = Ff (ginger)* *How many combinations can they record? Are there more ginger or grey kittens?*

Extension Ideas:

- **PSHE:**
  - Celebrate and embrace difference. Create flowers using our unique fingerprint patterns to show that working together can create something beautiful.
- **Science:**
  - Genetic engineering - design and create a new dinosaur. Think about the purpose of a specific dinosaur and the traits it will need to posses in order to fulfill its role. Show Jurassic World clip: https://www.youtube.com/watch?v=k7LSPL3Gplc as an example of a dinosaur which has been genetically engineered.
- **Math:**
  - Problems surrounding ratio and probability.

Checks for understanding: *How many possible color combinations are there? Which is the only color combination which will produce a grey kitten?*

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.

Lesson 4.9

Solar Energy

Overview

During this lesson, students will learn about energy from renewable and nonrenewable sources. Students will integrate and exhibit learning by creating a solar powered fan and vehicle which enable renewable energy.

Key Information

Level 4: (Ages 10-12) US Grades 5 and 6 Time: 45/90 minutes

Lesson consists of...	
Warm-Up	5 mins
Mini-lesson	10 mins
Worked Example	7 mins
Challenge 1	7 mins
Challenge 1 - Debug	5 mins
Challenge 2	7 mins
Tidy Up / Exit Ticket	4 mins

Learning Objectives

As a result of this lesson, students will be able to

- ➜ Identify positive and negative ways that humans can impact on the environment.
- ➜ Describe the types of renewable energy and how they work
- ➜ Design and create a model to simulate a Solar Powered light and fan
- ➜ Modify the system to simulate a Solar Powered Car

Lesson Topics

Earth Science

- ➜ Explain how increase in human population and the increased consumption of natural resources affects Earth's systems
- ➜ Describe how renewable forms of energy can be used as a sustainable form of energy to support the protection of Earth's resources & environment

Computing
Inputs, outputs, abstraction, debugging.

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.

Math
Investigate relationships between values

English Language Arts
Participate in collaborative conversations.
Use information gained from illustrations and text to demonstrate understanding

Materials required

- ➜ SAM Labs Kit
- ➜ Student Workbook
- ➜ Tissue Paper
- ➜ Blu Tack

Solar Energy

Warm Up – 'Positive or Negative' 5 minutes

Which human actions impact positively or negatively on the environment?

Objective: Identify positive and negative ways that humans can impact on the environment.

Procedures: *"Today we are going to learn about how humans can have both a positive and a negative environmental impact and develop a feasible solution to one of these; the use of solar power as a form of renewable energy"*

- Explain that many of the activities that humans do in the world can greatly affect the environment.
- Create a mind map from some suggestions the students have.
- Students look at the pictures of the different environmental impacts on slide 1 and join each picture to either the statement 'Positive' or 'Negative'.

Link forward: Link to looking at renewable energy forms

Mini-lesson 10 minutes

What is renewable energy and how does it work?

Objective: Describe the types of renewable energy and how they work.

Procedures: *"We are using the earth's resources too fast and need a sustainable form of energy, what does this mean and how might it work?"*

- Students identify the main 3 types of renewable energy - solar, wind and water (hydropower)
- Investigate different terminology; renewable and non-renewable and their relative impact on the environment.
    - Fossil fuels causing pollution and depleting the Earth's resources resulting in the need to utilize a sustainable form of energy.
- Discuss ways students could use renewable energy in their day to day lives to compensate for the shortage of fossil fuels. (8 minutes)

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

Keywords

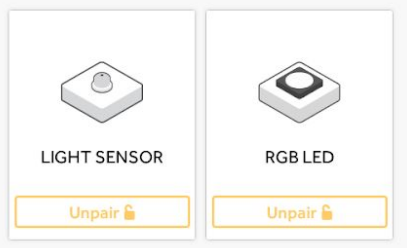
- Fossil Fuels
- Renewable
- Non-renewable
- Solar
- Wind
- Water

Let's Discuss: *What form of renewable energy are most seen in residential homes? In your workbook or with a partner, record, discuss, or share an example of how renewable energy could be used.*

Link forward: Link to creating a solar powered machine

Worked Example — 7 minutes

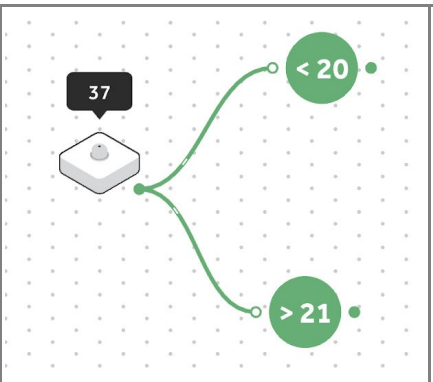
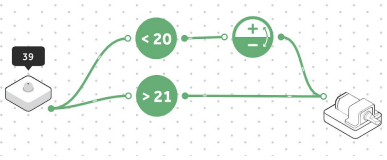
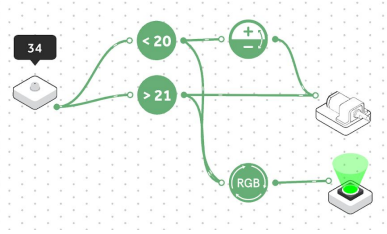
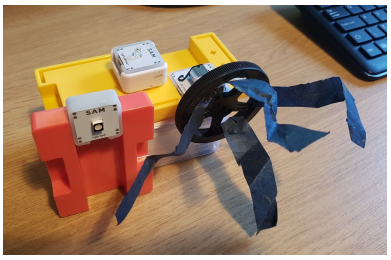
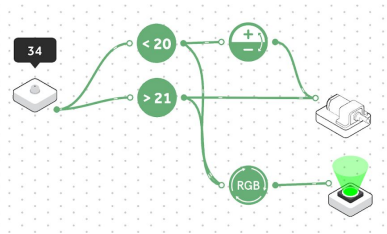
Using the Light Sensor to simulate solar power to control Light

Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • Light Sensor block • RGB LED block • Cycle Colors block		*The Light Sensor block will be the input and the RGB LED will be the output*
Step 2. Connect the Light Sensor block to Cycle Colors block to RGB LED block.		*You will notice the RGB LED block light up straight away as the Light Sensor detects the light in the room.* *Above the Light Sensor block on the workspace is a number and this will change as the light within the environment changes.*
Step 3. Place your hand over the Light Sensor block.		*This can be done with your hand or object and move across the Light Sensor to see the colors change.*
Step 4. Test your system.		*Experiment with the light changes to see if the change can be fast or slow in the environment you are in.*

Challenge 1 — 7 minutes

Design and create a model to simulate a solar powered light and fan

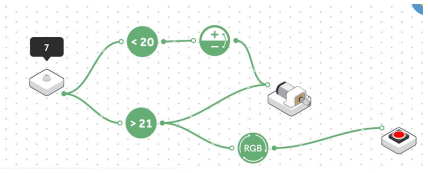
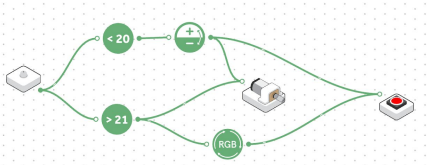
Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • Light Sensor block • RGB LED block • DC Motor block		*The Light Sensor will be the input and the RGB LED and the DC Motor blocks will be the outputs.*
Step 2. Secure 4 x pieces of tissue paper to the Wheel.		*We have used blu tack here to secure the tissue paper to the wheel but other forms could be used to hold in place.*
Step 3. Connect the Wheel to the DC Motor block.		*The purpose of the tissue paper is for you to see the movement and the wind generated; allowing discussion of wind power.*
Step 4. Drag the following blocks onto the workspace: • Cycle Colors block • Compare block x2 • Inverse block		*RGB stands for Red, Green and Blue and this will allow the RGB LED to show when the Light Sensor detects a new level of light and how Light does not stay consistent in a room.*

Step 5. Connect the Compare blocks to the Light Sensor Block. Open the settings of each Compare block and set them to: • < 20 (topmost) • > 21 (bottommost)		*The setting of the Compare blocks may need to be adjusted to react in the environment you are in. Identify the range of light detected by the number above the LIght Sensor block and use this to determine your settings.* *The less than number needs to be lower than the first Compare block as this will also stop the fan until there's enough light to generate the energy.*
Step 6. Connect: • < 20 Compare block to the Inverse block and the Inverse block to the DC Motor block. • > 21 Compare block to the DC Motor block.		*The Inverse block will turn the input into the opposite; the DC Motor will be stopped if there is not enough light.*
Step 7. Connect: • The output of both Compare blocks to the Cycle Colors block • The Cycle Colors block to the RGB LED block		*As the Light Sensor detects a change in the surrounding light the RGB LED block will change through the three colors allowing the students to see how solar power can change.*
Step 8. Secure the Car Controller to the Car Chassis with blu tack and place the blocks in the slots.		*The Light Sensor will need to be within the lego holder to secure to the top of the Car Chassis. The Car Chassis will need to rest on top of a box to allow the DC Motor to freely spin and the Car Controller to stand up.*
Step 9. Test your system.		*Move around the room and see the difference in the light as well as using your hand to move and obscure the light to the Light Sensor block.*

Checks for understanding: *What is the purpose of the Inverse block? Why have we used the Cycle Colors block?*

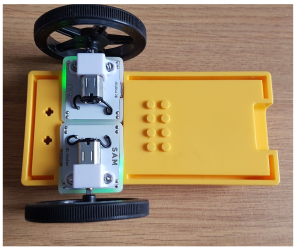
Challenge 1 - Debug it — 5 minutes

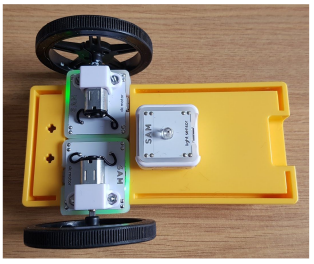
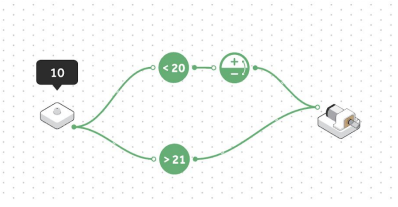
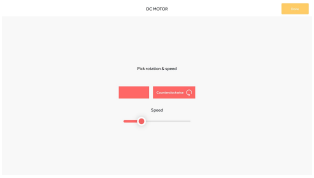
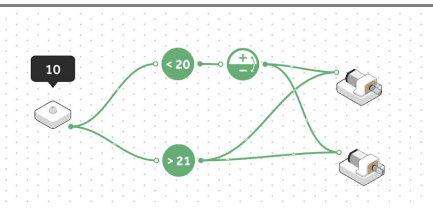
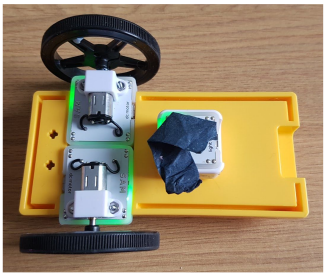
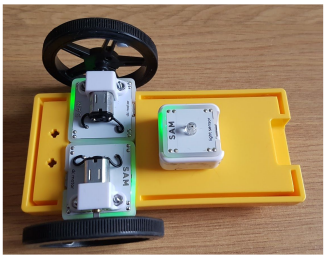
The RGB LED is still changing color when it should turn off

Instructions	Workspace	Notes for Teachers
Step 1. Disconnect the Cycle Colors block from the < 20 Compare block.		*The Light Sensor still detects the light changes below 20 and this is still activating the change in the RGB LED colors.*
Step 2. Connect the output of the Inverse block to the RGB LED block.		*The system will now turn off the RGB LED and DC Motor blocks when the Light Sensor is less than 20.*
Step 3. Test your system.		*Test your system by covering the Light Sensor block to see if the DC Motor and the RGB LED blocks turn off.*

Challenge 2 — 7 minutes

Modify the system to simulate a Solar Powered Car

Instructions	Workspace	Notes for Teachers
Step 1. Secure both DC Motor blocks to the Car chassis.		*The DC Motor blocks fit into the Car Chassis in one place only.*
Step 2. Secure the Roller ball to the bottom of the Car Chassis.		*The Roller ball acts as stability for the car and aids the direction when moving.*

Step 3. Secure the Light Sensor block to the top of the Car Chassis.		*The Light Sensor block will need to be secured to the Car Chassis within the Lego holder.*
Step 4. Remove the Cycle Colors and RGB LED blocks from the system.		*The system now will activate the one DC Motor when the Light Sensor block reaches 21 and above.*
Step 4. Turn on and pair a second: ● DC Motor block		*The DC Motor block will be the other wheel to our car and a third output.*
Step 5. Set the direction and speed of the DC Motor blocks within the settings to: ● 1 x Clockwise ● 1 x Counter Clockwise ● Speed reduced on both but need to be the same		*The speed needs to be roughly the same to keep the direction straight but if not the car will turn in circles. The speed is reduced to ensure the car doesn't speed off when the light is detected.*
Step 6. Connect the 2nd DC Motor block to the Inverse block and the > 20 Compare block.		*Both of the DC Motors will now turn when the Light Sensor reaches 21 and above.*
Step 7. Test your system.	 	*We have used a small piece of black paper to cover the Light Sensor block till in a position to test. Remove the black paper and see the car move as the Light is detected.*

Extension Ideas:

- **Computing**:
  - Can the car's direction be controlled by the Light Sensor? Test it.
  - What advancements in technology have been developed to help support renewable energy?
  - How can a car move at night without the use of solar power?
- **Geography/Science**:
  - Where in the world are forms of renewable = energy utilized most?
  - Why are fossil fuels being depleted?
- **Science**:
  - What effects does the use of fossil fuels have on the environment?
  - How can we help in everyday lives to reduce the use of fossil fuels?
- **English:**
  - Persuasive essay on how to support people to adopt more renewable energy sources

Checks for understanding: *What is the purpose of the Compare block and Inverse block together? What will happen if the light detected is 21?*

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.

Lesson 4.10

Random Numbers

Overview

During this lesson, students will analyze the results of rolling a die a number of times. They will explore number distribution and measures of center (mean, median, mode and midrange). Students will integrate and exhibit learning by programming a system that allows them to enter random numbers, generated by 2 dice, into SAM Blockly. Then, students will use SAM Blockly to generate random numbers.

Key Information

Level 4: (Ages 10-12) US Grades 5 and 6 Time: 45/90 minutes

Lesson consists of...		Learning Objectives
Warm-Up	5 mins	**As a result of this lesson, students will be able to**
Mini-lesson	10 mins	➜ Identify the possible results from rolling 2 dice.
Worked Example	7 mins	➜ To display a list in a graphical format to make the data easier to read and analyze.
Challenge 1	7 mins	➜ Create a SAM Blockly list that can input multiple entries and output sorted results.
Challenge 1 - Debug	5 mins	➜ Program a SAM Blockly system that will generate random rolls of two 6-sided dice and order them from least to most.
Challenge 2	7 mins	
Tidy Up / Exit Ticket	4 mins	

Lesson Topics

Computing
Inputs, outputs, abstraction, debugging, automation.

Math
Organize data into an ordered list.
Analyze data in a list and in a graph.

Materials required

➜ SAM Labs Kit ➜ Student Workbook ➜ Class set of 6-sided dice

Lesson 4.10

Random Numbers

Warm Up — 5 minutes

What are the possible combinations you can get?

Objective: Identify the possible results from rolling 2 dice.

Procedures: *"Today we are going to explore possible combinations from rolling 2 dice, numbered 1 - 6. We are going to record our results ordered least to greatest and consider what the common totals are."*

- Students will list the possible totals that can be made with the 1st die and the 2nd die, this means that 4, 3 is different than 3, 4.
- Students can work systematically: all the numbers when 1 is the 1st roll; when 2 is the 1st roll; … when 6 is the first roll.
- Alternatively, students can work more randomly by rolling the dice recording the value for die 1 and 2 and the total.
- Have a discussion around which method is more efficient / accurate.
- Make a list of the numbers, including repeats, from the least to the greatest totals.

Link forward: Displaying the information in a clearer format

Mini-lesson — 10 minutes

Display the information.

Objective: Display a list in a graph to make the data easier to read and analyze.

Procedures: "*We have a list of numbers from 2 to 12. Let's arrange them into a dot plot to show the occurrence of each total."*

- Students use a dot plot (video clip for information) to organise the data from the list previously generated.
  https://www.youtube.com/watch?v=IFKy2Yi1y-Q
- Students identify the mean, median and mode by consulting the graph.
- Students check the results from the data set. Encourage a problem solving approach to the calculations: rather than adding up all of the values, add the total that are on opposite sides of the center for the mean. For example:
  - 2 + 12 = 14 and divide by 2
  - 3 + 11 = 14 (x2) and divide by 4
  - 4 + 10 = 14 (x3) and divide by 6
  - ...
- There are 36 possible results, the median is between the 18th and 19th value.
- The number 7 occurs 6 times, this is the mode. (8 minutes)

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

Keywords
- Mean
- Median
- Mode
- Dot Plot

Let's Discuss: *How can a graph help to analyze data? In your workbook or with a partner, record, discuss, or share an example of another time when a graph might be easier to analyze than a list of data.*

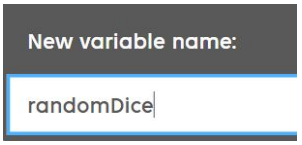
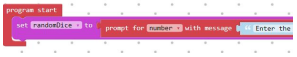
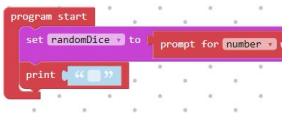
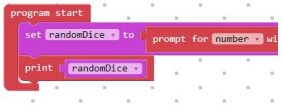
Link forward: Recording the information electronically.

Random Numbers

Worked Example

7 minutes

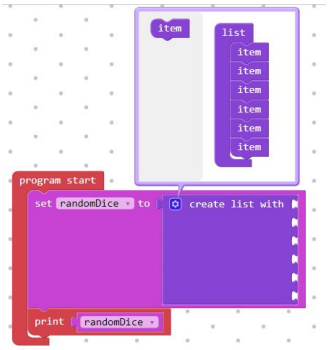
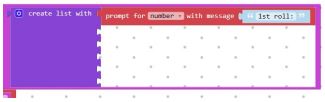
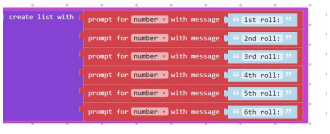
Design a SAM Blockly system that will take an input from a student and print the result later.

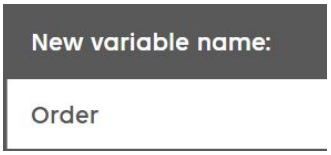
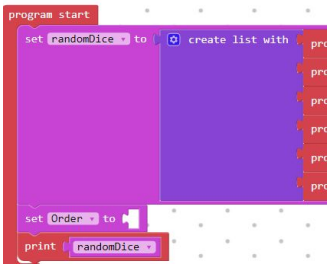
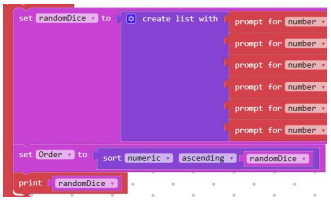
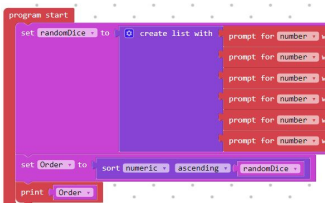
Instructions	Workspace	Notes for Teachers
Step 1. From the 'General' tab, drag a 'Program Start' block onto the workspace.		*This is the start of the SAM Blockly system. All commands will be contained within this block.*
Step 2. Click the 'Variables' tab and 'Create Variable'. Name it 'randomDice'.		*This names a variable to be used later in the SAM Blockly system.*
Step 3. • From the 'Variable' tab, drag the 'Set Variable' block to the workspace. • Connect the 'Set Variable' block to the 'Program Start' block. • Set the variable to 'randomDice'.		*This prepares a variable to, in this case, take an input from the user.*
Step 4. • From the 'General' tab, drag a 'Prompt for Text' block onto the workspace. • Change the drop down menu from 'text' to 'number'.		*This block is to tell the user to do something.*
Step 5. • Change the text in the field 'abc' to, "Enter the number you rolled." • Connect the 'Prompt for Number' block to the 'Set Variable' block.		*There will now be a message displayed for a user once the Run button is pressed.*
Step 6. • From the 'General' tab, drag a 'Print' block onto the workspace. • Connect the 'Print' block below the 'Set Variable' block.		*This will be the output for what the user enters.*
Step 7. • From the 'Variable' tab, drag the 'randomDice' Variable block onto the workspace.		*This will print the result that was previously entered by the user.*

• Connect the randomDice Variable block to the Print block.		
Step 8. Test the system.		*Students will type in the number that they rolled with the dice. This will show the printed result on the SAM blockly console.*

Challenge 1 — 7 minutes

Create a Blockly list that can input multiple entries, from two rolled dice, and output sorted results.

Instructions	Workspace	Notes for Teachers
Step 1. Remove the 'Prompt for Number' block from the 'Set Variable' block. Keep it on the workspace.		*This takes away only one entry for the Blockly system.*
Step 2. • From the 'List' tab, drag a 'Create List With' block onto the workspace. • Connect it to the 'Set Variable' block.		*A list allows for more than one entry, each time the system is run.*
Step 3. • Click the gear icon on the 'Create List' block. • Drag 4 additional 'Item' blocks within the 'List' block. There will 6 'Item' blocks altogether.		*This extends the number of entries to 6. This could be expanded to as many as you want.*
Step 4. • Connect the 'Prompt For Number' block to the first slot for the Create list block. • Change the text to "1st roll:"		*This is the initial one entry from the Worked example, with a slight change in the display text.*
Step 5. • Duplicate the 'Prompt For Number' block and fill the other slots. • Change the text to "2nd roll:" up to, "6th roll:"		*These are the 6 entries that will be taken from the user.* *Students can use Ctrl+C and Ctrl+V to do this quickly, amending the number.*

Step 6. From the 'Variable' tab, select 'Create Variable' and name it 'Order'.		*This new variable will be used for ordering.*
Step 7. • From the 'Variables' tab, drag a 'Set Variable to' block onto the workspace. • Choose 'Order' as the variable. • Attach it between the 'Print' block and the 1st 'Set Variable' block.		*This will carry out a command after all of the entries have been received.*
Step 8. • From the 'List' tab, drag a 'Sort Numeric Ascending' block to the workspace. • From the 'Variables' tab, drag a 'Variable' block to the workspace. • Ensure the 'Variable' block to 'randomDice'. • Connect the Sort block to the 2nd Set variable block.		*This will order the 6 entries from least to most. The 'Variable block might be 'Order' or might be 'randomDice'.*
Step 9. Change the 'Print' block 'Variable' to 'Order'.		*This will print the contents of the variable Order.*
Step 10. Click "RUN" to input the 6 values, one after each roll of the dice.		*This is the display after pressing Run. This example list is in ascending order, the dice rolls would return numbers in an unpredictable order.*

Checks for understanding: *Why is it useful to order the entries from most to least when working with data? Why do some people gather information about events?*

Challenge 1 - Debug it — 5 minutes

Why is my print display not what I expected?

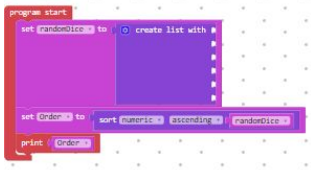
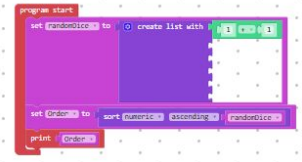
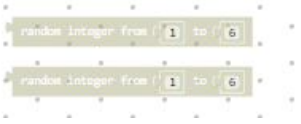
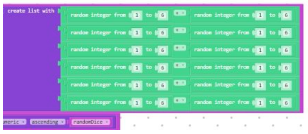
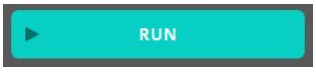
Instructions	Workspace	Notes for Teachers
Step 1. Check that the variable names are correct.		*If students select print randomDice, this will list the dice numbers in the order they were rolled. Students must select the Order variable to list in ascending order.*

Random Numbers

Challenge 2

7 minutes

Design a SAM Blockly system that will generate random rolls of 2 6-sided dice and order them from least to most.

Instructions	Workspace	Notes for Teachers
Step 1. Remove all 'Prompt for Number' blocks from the system.		*This will remove the user input from the system.*
Step 2. • From the 'Math' tab, drag an 'Operation' block onto the workspace. • Connect it to the first slot for the 'Create List with' block.		*This is the beginning of the automated creation of the numbers.*
Step 3. • From the 'Math' tab, drag 2 'Random Integer from' blocks onto the workspace. • Set the values for both to 1 to 6.		*This will make the numbers, for each die, random.*
Step 4. Connect both 'Random integer' blocks to the 'Operation' block.		*This will combine the value for each 'die' and keep the total between 2 and 12.*
Step 5. Duplicate the 'Operation' block to fill all of the empty slots from the 'Create List with' block.		*This will simulate 6 rolls.* *Students can use Ctrl+C and Ctrl+V to do this quickly.*
Step 6. Click "RUN" to test the system.		*This will display the 6 rolls, ordered, on the console.*
Extension Ideas: • **Computing**: ○ Can you extend the system beyond 6 rolls? ○ Can you think of a way to create this system more quickly, for example 100 rolls? • **Math**: ○ Graph the results of your experiment with a dot plot. How do the results compare with the initial chart? ○ Carry out the experiment multiple times, does the graph look more like the original?		

Checks for understanding: *Why is it worthwhile having different variable names? Describe the biggest difference between the results of the user- and machine-input systems?*

Random Numbers

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.

Lesson Number 4.11

Kinetic Energy and Mass

Overview

During this lesson, students will learn about kinetic energy and how molecular structures, related to the mass of the object, can directly affect the amount kinetic energy. It is advised that students have a basic understanding of simple and complex molecular structures prior to this lesson. Students will integrate and exhibit learning by demonstrating that mass affects the kinetic energy. Students will capture and interrogate data through their experiment.

Key Information

Level 4: (Ages 10-12) US Grades 5 and 6 Time: 45/90 minutes

Lesson consists of...		Learning Objectives
Warm-Up	5 mins	**As a result of this lesson, students will be able to:**
Mini-lesson	10 mins	➜ Make a molecule structure from the image and description given
Worked Example	7 mins	➜ To demonstrate how kinetic energy can be measured as a result of calculating the speed and mass.
Challenge 1	7 mins	➜ Create a SAM timer to support data gathering of distance travelled
Challenge 1 - Debug	5 mins	➜ Investigate the effect of mass on the kinetic energy through data gathering
Challenge 2	7 mins	
Tidy Up / Exit Ticket	4 mins	

Lesson Topics

Physical Science
Investigate how mass affects kinetic energy and how energy can be transferred

Computing
Inputs, outputs, abstraction, debugging.

English Language Arts
Participate in collaborative conversations.

Math
Measure and estimate lengths in standard units.

Materials required

- ➜ SAM Labs Kit
- ➜ Student Workbook
- ➜ Jelly beans
- ➜ Tape Measure
- ➜ Plastic bowl
- ➜ Cocktail sticks
- ➜ Wood or books to make border
- ➜ Round objects with different mass

Lesson Number 4.11

Kinetic Energy and Mass

Warm Up — 5 minutes

Can you build the molecule from the picture?

Objective: Make a Molecule structure from the image and description given

Procedures: *"Today we are going to learn about molecules and kinetic energy, focusing on how the mass of the object determines the amount of potential and kinetic energy that object possesses."*

- Recap the difference between simple and complex molecular structures
- Students look at the image given of the molecule and are asked to build it using the materials given; e.g. jelly beans/marshmallows and cocktail sticks

Link forward: Link to looking at the mass of an object as more molecules join together

Mini-lesson — 10 minutes

What is kinetic energy?

Objective: To demonstrate how kinetic energy can be measured as a result of calculating the speed and mass.

Procedures: *"Can kinetic energy be calculated?"*

- Discuss how all objects are made of materials and all materials made up of the molecules. The material the object is made of will affect the mass of the object.
- Investigate what kinetic and potential energy in this short clip (up to 3.02): https://www.youtube.com/watch?v=IqV5L66EP2E&t=105s
- Highlight the difference between kinetic energy and potential energy.
    - Kinetic energy is movement and potential energy is the energy stored for use in the future.
    - Demonstrate with a balloon; blown up and tied shows potential energy vs blown up and let go shows kinetic energy
- Discuss how all objects in motion have kinetic energy. The amount of kinetic energy can be calculated.
- Investigate the formula used to calculate the kinetic energy: Kinetic energy = 0.5 x Mass x speed^2 (speed can be referred to as velocity)
- Kinetic energy is measured in Joules. Mass is measured in kilograms and speed is measured in metres per second.
- Explore this example: A car is travelling at 20m/s and has a mass of 900kg can you calculate the kinetic energy.
    - Kinetic energy = 0.5 x 900 x (20)^2
    - Kinetic energy = 180,000 Joules

Keywords

- Kinetic energy
- Potential energy
- Mass
- Speed
- Joules
- Velocity

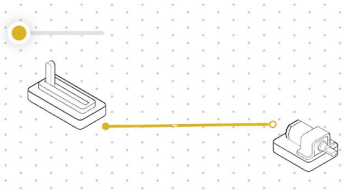
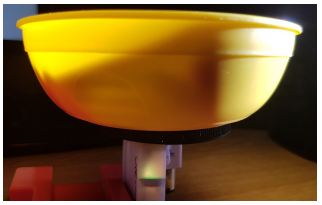
Let's Discuss: *What would the kinetic energy be of a bike with a mass of 200kg and travelling at a speed of 15m/s? In your workbook or with a partner, record, discuss, or share a range of objects that possess kinetic energy.*

Link forward: Link to testing if mass can affect the speed of a DC Motor.

Kinetic Energy and Mass

Worked Example — 7 minutes

Demonstrate the effect of Mass and Speed on Kinetic Energy

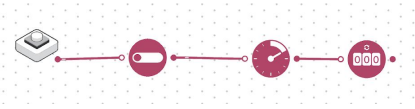
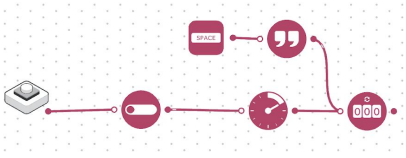
Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • Slider/Virtual block • DC Motor block		*If you do not have the physical Slider block, the virtual one on the workspace can be utilized in the same way.*
Step 2. Drag the Slider and DC Motor blocks onto the workspace and connect them.		*The Slider block will be the input and the DC Motor block will be the output.* *The Slider will regulate our speed, As we increase the speed, the relationship between mass and kinetic energy can be observed. Objects with small mass will require less speed to stimulate motion. Objects with more mass will require greater speed to stimulate motion. Why do you think this is?*
Step 3. Attach the wheel to the DC Motor block.		*The wheel will add the stability needed to place a bowl on top allowing it to be held in place.*
Step 4. Secure the DC Motor vertically in the red Car Controller accessory.		*It is advised to use blu tack under the Car Controller and secure it to the ground. This way, that it doesn't move with added weight.*
Step 5. Using blu tack, secure a plastic bowl to the top of the wheel.		*A plate can be used but as the speed increases the contents may fall off. A bowl will allow it to be contained for the experiment.*

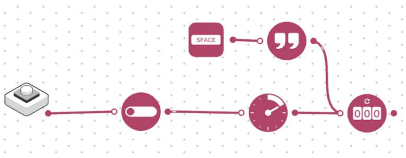
Kinetic Energy and Mass

Step 6. Add jellybeans to the bowl. Increase the Slider speed to see the effect of mass on the speed of the motor.		*Mass and speed have an impact on the amount of kinetic energy generated. The more mass of an object and the higher the speed, the more energy the object possesses.*
Step 7. Experiment with mass.		*Try using different objects or different amounts of jelly beans to see how the mass affects the speed and kinetic energy needed on the Slider block to make it move.*

Challenge 1 — 7 minutes

Create a SAM timer to support data gathering of distance travelled

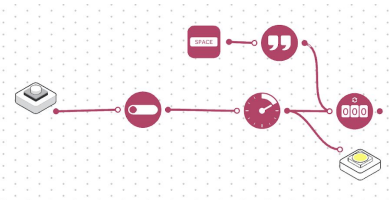
Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • Button/Virtual Button block.		*If you do not have the Button block you can use a virtual button block or can be substituted with a Key Press block.*
Step 2. Drag onto the workspace: • Button block • Toggle block • Interval block • Key Press block • Text block • Counter block		*The Button block will be the input and the output will be the display on the Counter block.*
Step 3. Connect the blocks in the following order: • Button block to Toggle block • Toggle block to Interval block • Interval block to Counter block		*The Interval block default setting is 1 second which is needed in this system to count in seconds.*
Step 4. Connect the following blocks to the system to add a reset function. • The Key Press block to the Text block • The Text block to the Counter block		*We need to be able to reset the timer by adding a reset option.*

Step 5. Access the settings of the Text block and add the text 'reset' all in lowercase.		*When the Key Press block is pressed the message 'reset' will be sent to the Counter block to reset the timer back to '0'.*
Step 6. Test your system.		*Test your system to make sure of the following: it starts and stops when the button is pressed; the Counter block changes with each second and when you press the Key Press block the Counter resets.*

Checks for understanding: *What is the purpose of the Counter block? What does the combination of the Key Press and Text block have in the system?*

Challenge 1 - Debug it — 5 minutes

How can I see the timer easily without looking at the Counter block?

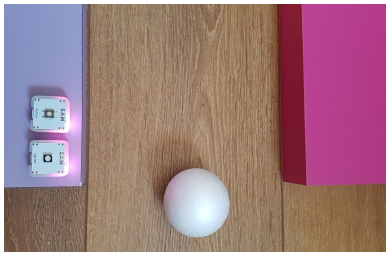
Instructions	Workspace	Notes for Teachers
Step 1. Turn on and pair: • RGB LED block.		*The RGB LED block will be a second output for the system and make the counting visible.*
Step 2. Drag the RGB LED block onto the workspace. Connect Interval block to RGB LED block.		*Connecting the Interval block to the RGB LED block will mean that the 1 second setting on the Interval block will turn the counter and flash the light every second.*
Step 3. Test your system.		*The color of the RGB LED block could be edited in the settings to make it a more visible color if required.*

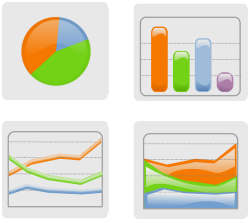
Kinetic Energy and Mass

Challenge 2

7 minutes

Investigate the effects of mass on kinetic energy through data gathering

Instructions	Workspace	Notes for Teachers
Step 1. Create a straight run.		*Two pieces of wood have been used here, but books or other objects can be used to ensure the object goes in a straight line.*
Step 2. Add a starting point.		*Here a ruler has been used to make sure the object starts at the same point, alternatively, a pen mark could be made on the floor.*
Step 3. Set up the blocks and the ball.		*It is recommend that one person controls the airflow of the hairdryer and the second person controls the timer (pressing the Button). A third person could mark where the object travels to after the set time.* *Remind students that every object is made up of molecules. The mass of an object is dependent on its material. For example, a metal ball and a cotton ball of the same size have different mass.*
Step 4. Using a hair dryer turn on at the same time as the button is pressed to start the movement and the timer at the same time.		*The hair dryer has been laid flat on the floor behind the ball so that the air is always coming from the same location.* *Discuss student's predictions of how far the object will travel in the set time.*
Step 5. Capture the data from one object.		*It is important that one person marks where the ball has reached after a set duration e.g. 1 second.* *Here the ball has been placed back in the location to show where it went to after 1 second;, in the experiment it will have continued moving. The distance the Styrofoam ball went was 10 ½ inches.*

Step 6. Use a heavier object and repeat the experiment.		*Discuss the difference that an object with a different mass has, on the distance travelled in the same amount of time.* *It is important to document the setting of the hair dryer if it has more than one setting e.g. High versus Low. This will help to ensure the ensure the data is clear and that it is a fair test.*
Step 7. Place the lighter object in front of the heavier object and repeat the experiment to see the distance the lighter ball travels when hit by the heavier ball.		*We know it will take greater force to move the larger object because it has more mass. We also know energy transfer between the larger and small objects is kinetic energy. Can you predict whether kinetic energy transferred between these objects generates more or less motion than the previous experiment?* *The potential energy of an object is determined by its position. Potential energy is either zero or a positive value. In this example, the potential energy is zero for both objects because they are 0 degree include/flat surface. Opportunity to discuss if the objects were on a small ramp with a incline of 30 degrees--would the potential energy of these objects still be zero? (No due to gravitational potential energy.)*
Step 8. Use the data to create a graph.		*Discuss with students an appropriate choice of graph for this data.*

Extension Ideas:

- **Science/Maths:**
  - Would a hairdryer move a heavier object with a greater mass like metal?
  - Use the data to generate a comparison between heat settings
  - Predict what will happen with different objects and different number of objects
- **Computing:**
  - Use data in another format to generate a different graph. This could be in Excel if not already used

Checks for understanding: *What is kinetic energy? What happens when the air flow behind the ball is increased?*

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.