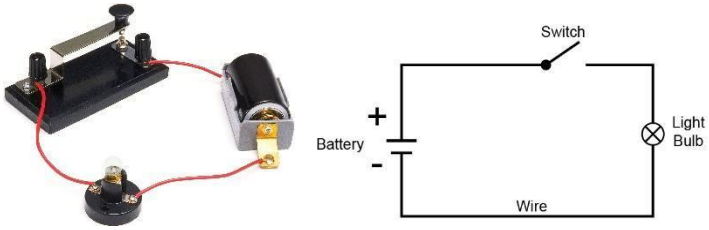
Invent Your Own Electric Gadgets (Level 3)

Description	Learners will explore electric circuits and the effects of electric currents. They will use these concepts to create their own electric appliances.
Leading question	What does it take to create an electric appliance?
Subjects covered	Science, English, Math, Art and Design
Total time required	40-60 min a day for 5 days
Resources required	Batteries/ pencil cells, wires *(alternative: aluminium foil*), small bulb or LED light, paper plate/ thick paper, electric/ masking tape, steel wool, iron nail, thin copper wire, paper clips, paper, pencils, glue
Learning outcomes:	By the end of this project, learners will be able to: Knowledge-Based Outcomes: 1. Identify the components required to complete an electric circuit. 2. Build an electric circuit. 3. Draw a circuit diagram. 4. Describe the heating and magnetic effects of electric current. 21st Century Skill Outcomes: 1. Communicate effectively while presenting their appliances to friends and family. 2. Work creatively with given materials to design a device that solves a problem they face. 3. Think critically while planning their appliances and designing circuits for them.
Previous Learning	What is energy?
Supervision required	Medium

Day 1 -

Today, you will find out what electricity is and make an electric circuit.

Time	Activity and Description
10 minutes	**Introduction to Electricity:** Let us think about the different appliances that we use in our daily lives! - How do you think appliances such as lights and fans work? - What other appliances can you think of that work on electricity? Electricity makes appliances such as lights and fans work. Various appliances that we use in our daily lives, such as refrigerators, water heaters, and ovens, work on electricity. Based on this, how would you define electricity?

	Electricity is a form of energy that can give things the ability to move and work. - We cannot see the energy but we can use it to power things around us. - It is created when tiny particles called electrons move through materials. - When they move they create an electric current. - This electric current gives appliances energy, making lights, fans, and other home appliances work.
10 minutes	**Electrical Circuits** For electricity to flow and power any appliance or object, it needs a circuit - a circular path for the electricity to flow. It is made up of different parts, let us understand what these are. ***Note:*** *Show the learners an image of a real-life circuit, such as the ones shown below.* This is what a real-life circuit looks like. This example shows one of the simplest circuits that you can get. It can also be represented as a drawing (**Appendix 1**).  Let us think about the different components in this circuit. - What different things is it made up of? *(battery, wire, switch, light bulb)* - What symbol is used for each of them? Draw the symbol in your notebook. - What do you think is the purpose of each component in this circuit? Each component in an electric circuit has a specific purpose. - The battery is the source of electricity. It generates the electricity that flows through the circuit. - The wire is like a pipe that allows the electricity to flow. Without the wire, electricity will remain in the cells. - The switch allows us to stop or start the flow of electricity by creating and closing the gap in the circuit. It can be turned off and on. - The light bulb represents the load in the circuit. A load is anything that uses electricity to work. It represents any appliance, in this case, a light bulb.
20 minutes	**Creating Your Own Circuit** - In this project, we will be designing our own device/ appliance and we will have to explain how it works. - At the end of the project, we will have a showcase, where we will present our creations to our friends and parents! - Before we do that, let us create our own circuits, as it is the most basic thing needed to design any appliance.

Note: *Share the given table with learners and ask them to draw it. Describe the materials needed and the method. Once done, get learners to fill in the two sections, create their circuit, and write in their observations and inferences.*

Materials required	*Cell (AA or AAA)* *Two pieces of wire/ strips of aluminium foil (each about 12 cm long)* *Small bulb or LED light* *Electric/ masking tape* *Paper plate/ thick card paper*
Method	*Reference:* ***Appendix 2*** *(https://www.youtube.com/watch?v=qtU4WXlwSUA&ab_channel=SmartycatTV)* 1. *Tape the cell to the top of the paper plate. Ensure the ends or terminals of the cell are not covered.* 2. *Tape the bulb at the bottom leaving the ends with wires exposed.* 3. *Tape the wires in such a way that their ends touch the wires of the bulb.* 4. *Hold the wires against the terminals of the cell to establish a connection.*
Observations:	***Sample observation****:* *The light bulb turns on when both ends of the wires touch the cell.*
Inferences:	***Sample inference:*** *Once the circuit is complete, the electric current passes through the circuit and lights up the bulb. The power comes from the cell.*

- Does the bulb go off when any end of the wire is free? Why?
  (the circuit is broken and electric current can no longer flow through it)

At-home activities

Make a list of 5 items that use electricity in your home and what each item is used for. You can use this table:

Items that Use Electricity	Use
e.g. Fridge	*To keep food and drinks cold, storage of food*

	Discuss with family members and come up with a few ideas for a device/appliance that you would like to create.
Optional Literacy/Numeracy Activity	Ask learners to write a step-by-step explanation of how an electric circuit works, using appropriate scientific vocabulary. Encourage them to describe the flow of electrons, the role of the power source, the function of the load, and the significance of the conducting path in their written explanations.

Day 2

Today, you will brainstorm to come up with ideas for your own appliances and perform an experiment to observe the heating effect of electric current.

Time	**Activity and Description**
20 minutes	**Heating Effect of Electric Current:** In the previous class, we learned about electricity and electric circuits. Today, we will be building on that knowledge to prepare us for further creating our own appliances. - Let us use our circuits from the previous class. - Touch the bulb before switching the circuit on. - How does it feel? Is it warm? - Now let us leave the circuit on for some time. How does the bulb feel now? *(becomes warm)* - This is because electricity has the capacity to create heat. When electricity passes through something it gets warm. This is called the heating effect of electric current. - Have you seen any appliance that uses electricity to heat something? *(heaters, water heaters, irons, electric kettles, and hairdryers)* - Have you felt something, other than a bulb, get hot when electricity is passed through it? *(the side of a refrigerator gets hot, phones get hot while charging, etc)* Let us perform an experiment to observe the heating effects of electric current. ***Note***: - *Get learners to draw the table shown below,* - *Explain the procedure to them based on the method described in the table,* - *Ask them to fill in their hypothesis,* - *Demonstrate the experiment,* - *Get learners to write their observations and share their conclusions.* - *Once done, share with the learners that the steel wool burnt because it heated up as a result of the passage of electric current. This tells us that electric current shows heating effects.*

Hypothesis:	An electric current produces heat.
Materials Needed:	Your circuit from the day before Steel wool (used to wash dishes)

	Method	1. Connect the steel wool to one end of your circuit instead of the bulb. 2. Observe what happens to the steel wool in some time. *(if needed, add one or more cells to increase the current flow in the circuit)*
	Observation	***Sample Observation*** *The steel wool melts as electric current flows through it.*
	Interpretation	***Sample Inference:*** *Electricity causes heating.*
	Appliances, such as electric heaters and electric cookers, work on the principle of the heating effect of electric current. They all have metallic wires coiled up in them that heat up when electricity is passed through them. These coiled wires are called heating elements.	
20 minutes	**Ideas for Appliances** Decide an electric appliance you would like to create, also considering the discussion you had with your family members or friends about it. - You can also think about a challenge or inconvenience that you face in your daily life. Consider how you can develop an appliance that would effectively solve that problem. - Try and use the heating effect of electric current in your device. Once done, list out some details for your appliance, such as: - Use/ need - Components required - Source of power	
At-home activities	Share your appliance ideas with your family members and get their feedback.	
Optional Literacy/ Numeracy Activity	Ask learners to imagine they are inventors who have created a new appliance powered by renewable energy. Ask them to write a short story or a descriptive paragraph explaining the features and benefits of their invention.	

Day 3 –

Today, you will perform an experiment to observe the magnetic effect of electric current and begin designing your appliance!

Time	Activity and Description
5 minutes	**Recap** Based on what you learned in the previous class, can you explain how an electric iron works? 

EAA welcomes feedback on its projects in order to improve. For feedback please use this link https://forms.gle/pVXs3vQEufuzSShs7

<table>
<tr><td></td><td>Just like heaters, irons also use the heating effect of electric current. Irons have a plate or coil in the base that heats up when electricity is passed through it!

Now, let us experiment and discover another effect of electricity.</td></tr>
<tr><td>15 minutes</td><td>Magnetic Effects of Electric Current
Let us do an experiment to see what other effects electricity can produce.

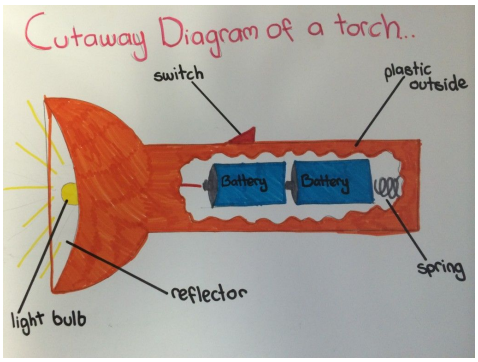
Note:
- Get learners to draw the table shown below,
- Explain the procedure to them based on the method described in the table,
- Ask them to fill in their hypothesis,
- Demonstrate the experiment,
- Get learners to write their observations and share their conclusions.

<table>
<tr><td>Hypothesis:</td><td>Electric current has a magnetic effect.</td></tr>
<tr><td>Materials Needed:</td><td>AA/A cell, copper wire, iron nail, paper clips/any small magnetic material</td></tr>
<tr><td>Method:</td><td>Reference:
Appendix 3
(https://www.youtube.com/watch?v=na_FpTXLFa8&ab_channel=GoodStuffExperiments)

1. Take the copper wire and coil it around the iron nail. Leave the 2 ends of the wire long enough to reach the ends of the cell.
2. Place the two ends of the wire at the terminals of the cell and hold them in place.
3. After a few seconds bring the nail close to the paper clips and observe what happens.</td></tr>
<tr><td>Observations:</td><td>Sample observations:
The iron nail attracts the paper clips like a magnet.</td></tr>
<tr><td>Inferences:</td><td>Sample inferences:
Electric current flowing through the nail creates a magnetic effect.</td></tr>
</table>

During our experiment, the iron nails we used turned into magnets. Such materials that develop magnetic properties when an electric current is passed through them are called electromagnets.

Electromagnets are used in many appliances, such as:
- Generators, motors, transformers
- Electric buzzers and bells
- Headphones and loudspeakers</td></tr>
</table>

	- Data storage devices like VCRs, tape recorders, hard discs, etc. - Induction cookers - Magnetic locks - MRI machines
20 minutes	**Creating the Appliance** - Now, take a few minutes to think about how you can include any electromagnets in your appliance. - Along with your idea, think about the feedback you received from your friends and family, and improve your design. - Once done, draw a plan of how the appliance will look. - Draw an image of the circuit it will use. - Be as detailed as possible.  After the design is drawn out, make a list of all the things you will need to make your device.
At-home activities	- Choose any one appliance at your home that uses the heating effect and one that uses the magnetic effect of electric current. Include this appliance in their presentations and explain how it works. - Get feedback from a family member on the design of your device, and improve the design accordingly. - If possible, speak to an electrician in your community to understand the circuits inside the appliance so you know how it works.
Optional Literacy/ Numeracy Extension	**Numeracy Extension: Calculating Electricity Bills** Learners can calculate the cost of using electrical appliances in a month. Provide learners with the cost per kilowatt-hour (e.g. $0.5) and ask them to multiply the energy usage by the cost to determine the total cost of using different electrical appliances. Learners can think about the different appliances/uses of electricity in their homes per month and calculate how much their bill may come up to. Here are some appliances and their requirements: Fridge - 700 kWh/month Light bulb - 1.5 kWh/month Ceiling Fan - 23 kwH/month Table/standing Fan - 30 kWh Tubelight - 20 kWh *A kilowatt (kW) is a unit of power, which measures the rate at which energy is consumed or produced. Learners can determine how much time would be used on the appliance and multiply this by the kilowatt-hour (you can provide this number).*

Day 4 –

Today, you will create your appliances and prepare for the showcase.

Time	Activity and Description
25 minutes	**Creating Appliances:** Create the models of your electric devices. While creating the models, if you need to make changes to your initial designs, go back and make those changes too.
15 minutes	**Preparing for the Showcase:** Think about the pointers to share for the appliance you have created. Include these pointers: - Its purpose - its design - how it works - what inspired you to create it Additionally, think about the pointers to explain the working of the household appliances (one each working on the heating and the magnetic effects of electric current). Include these points: - its purpose - its structure - how it uses the magnetic or heating effect.
At-home activities	Practise your presentation in front of a mirror and with your friends and family.

Day 5 -

Learners will share their creations with parents and peers.

Time	Activity and Description
10 minutes	**Setting Up** Display your appliances, designs, and any other material on the table so people can see them clearly. Revise your presentation, if needed.
20 minutes	**Presentation** ***Note:*** *Allow learners to present their creations to visitors. Encourage visitors to ask questions about the gadget, its purpose, and its design.*

10 minutes	**Discussion and Reflection** - Did your appliance solve the problem you wanted it to solve? - If you can get more resources to refine your appliance, what changes would you make to it and why? - What went well for you in the project? - What do you think you will do better the next time?

Additional enrichment activities:	Learners can explore the concept of voltage and more components of electrical circuits. They can also dive deeper into different sources of energy and explain concepts of renewable energy and non-renewable energy.
Modifications for simplification	If making a real electric appliance may be challenging, learners can draw a design and create a model using paper, wires, and other items easily available to them.

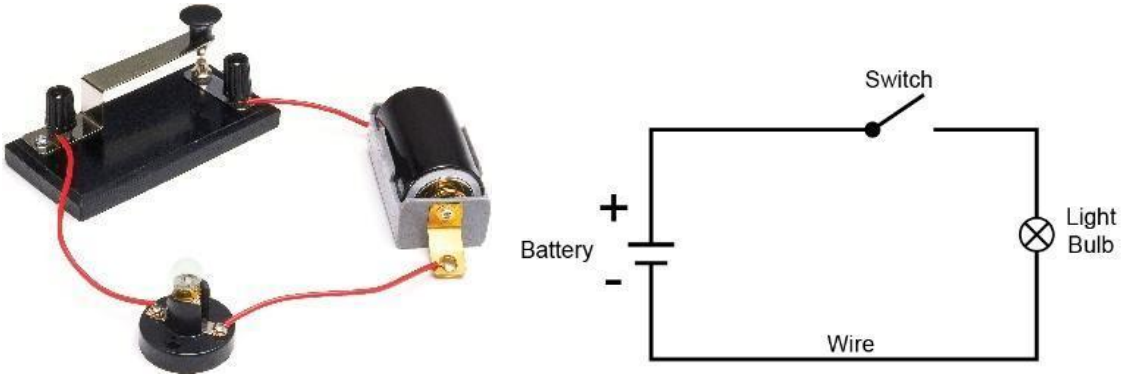
ASSESSMENT CRITERIA

A majority of my students were able to:

☐ Create a working circuit and describe its components.
☐ Explain and identify how appliances use the heating effect of electric current.
☐ Explain and identify how appliances use the magnetic effect of electric current.
☐ Create a useful electrical appliance/device that uses the properties of electric currents and circuits.

APPENDIX 1

A Circuit Diagram



APPENDIX 2

Creating Your Own Circuit Demo

https://www.youtube.com/watch?v=qtU4WXlwSUA&ab_channel=SmartycatTV

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https://forms.gle/pVXs3vQEufuzSShs7

APPENDIX 3

Magnetic Effect of Electric Current Demo
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