Lesson Plan Title: **Bright Ideas: Exploring Series Circuits for Wildlife Control**	Instructor: **Sherrie Hart**

Integration Model:
This lesson plan utilizes all disciplines of STEM by leveraging the natural connections between science, technology, engineering design and math. The "integration sprouts" naturally as the problem-solving reveals to students that these disciplines must be used to solve the problem (Fogarty, 1991.)

Overview: For the **introduction & hook,** students will read and discuss a short story, " Keeping the Lions Away," (ReadWorks, 2025) about a young African boy who solved a wildlife problem for his community because of his knowledge gained by exploring electricity. Through exploration, 8th grade student groups will distinguish the essential parts of a series circuit & construct a series circuit through their challenge to make a bulb a bulb light up **(Science standard SPS10 b.**,) Students will also use an online simulation to design their circuit (**Technology standard ISTE 1.4.b.**) In this process, students will choose ammeters or voltmeters to discover the effects, measurements and calculations of voltage, current & resistance (**Technology standards ISTE 1.1.b., ISTE 1.4.c. Science standard SPS10 a**. and **Math standard 8.PAR.3.6**.)

Our school community is a very wooded area and experiences much undesired wildlife. Students are tasked to use the knowledge gained from the story and their circuitry experience to advance their series circuit to model a design of perimeter series circuit lighting for the yard area where they live to deter unwanted wildlife **(real-world application and problem-solving context** and **Engineering standard MS-ETS1-1.)** Students will use the Ohm's law equation, a real multimeter (**Technology ISTE 1.1.c.**) and related calculations to get feedback to help them repeatedly revise their designs (**Technology ISTE 1.1.c.** and **Engineering MS-ETS1-2.)** This iterative feedback will help students make wise choices for battery voltage, bulb resistance and current as they strive for high levels of bulb brightness and choose appropriate supplies to stay within a specified budget (**MS-ETS1-3 and MS-ETS1-4**.)

Georgia Standards

Science
Georgia Science Standards of Excellence

SPS10 a. Use mathematical and computational thinking to support a claim regarding relationships among voltage, current, and resistance.
SPS10 b. Develop and use models to illustrate and explain the conventional flow (direct and alternating) of current and the flow of electrons in simple series and parallel circuits.

Math
Math Standards K-12

8.PAR.3.6 Use algebraic reasoning to fluently manipulate linear and literal equations expressed in various forms to solve relevant mathematical problems.

<u>Technology</u>
Link to Technology Standards

ISTE 1.4.b. Select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.

ISTE 1.1.c. Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.

<u>Engineering</u>
Next Generation Science Standards Engineering Design Standards:
Middle School

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, considering relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Lesson Plan Context

Introduction & Hook
20 minutes

<u>Day 1</u>

- Students will independently read the article, " <u>Keeping the Lions Away</u>" sharing a story of a young boy solving a problem by creating an electrical circuit that provided very bright light (ReadWorks, 2025).
- Students will be asked to chat within their group and each share something about the story that stood out to them.
- The teacher will ask for a few volunteers to share their responses with the class.
- The teacher will ask the following questions of the class and have students write down their response.
    - What was Richard's problem?
    - Why was solving this problem important to Richard?
    - Explain his solution.
    - Did his first few solutions work?
    - How can it feel when you try hard and fail?

- What do you think made Richard try so many times?
- How would you imagine Richard felt once he succeeded?
- Why did Paula say Richard was a “great innovator”?
- How did Richard learn to make a circuit?

- The teacher asks individuals to share their responses.
- The teacher tells students now they will have a chance to “tinker” like Richard to figure out what it takes to make bulbs light up.

Lesson Body

Part 2: Science Integration (40 minutes)
SPS10 b. Develop and use models to illustrate and explain the conventional flow (direct and alternating) of current and the flow of electrons in simple series and parallel circuits.

- Students will collaborate in groups of four and be asked to use the materials to light the bulb.
- **Materials**: students will have a container the basic parts that could create a series circuit (**alligator clips, copper wire, lightbulbs of varying wattages, bulb holders, D- cell, 9-volt & 12-volt batteries, paper clips, rubber bands) and some distractor items that are not useful (strips of yarn, thin rubber tubing, watch batteries.)**
- Students will be asked to take notes as a group describing & illustrating their setups & observations with each trial.
- Students will also provide their best explanations for what they observed.
- Student groups will compile their answers and a person from each group will share what they found it took to light the bulbs.
- Teachers will ask the following if not addressed with sharing/ class discussion.
    - Did the bulb light when you connected the bulb to the batteries with yarn? Red tubing? Why not?
    - Why do you the larger bulb lit up with wire and some batteries, but not with other batteries?
    - Did all bulbs have the same brightness when they were lit? What ideas do you have about that?
    - Let’s watch this NGS Series Circuit Clip to summarize today’s learning (*Setting up a Simple Circuit*, n.d.)
- Students will then be given guided notes on the components of a circuit (energy source, load, wire,) conductors & insulators, and complete them independently from the group’s **discussion, notes and drawings**.

Day 2

SPS10 a. Use mathematical and computational thinking to support a claim regarding relationships among voltage, current, and resistance.

8.PAR.3.6 Use algebraic reasoning to fluently manipulate linear and literal equations expressed in various forms to solve relevant mathematical problems.

(15 minutes)
Warm Up Phenomena: Rushing River video clip (*Mountain River Flowing in Albania Theth. Relaxing River, White Noise, Nature Sounds for Sleeping.*, n.d.)

- Teacher: Think about what you learned yesterday about how electrons move. How is this river like electricity? (Both called current, both move along a specific path, etc.)
- The teacher makes connections that may have been missed after questioning (how moving water & how many electrons are called current, moving water & moving electrons both push (voltage) and river water can be slowed by rocks & debris, electrons can also be slowed by things in its path -insulators or objects (resistance) in ohms.
- The teacher points out: We measure the current (number of electrons passing by) in amperes, voltage (strength of push) in volts, and resistance (amount of push back) in ohm's.

Part 4: Technology

ISTE 1.1.c. Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.

- Teacher says: Now that you have "tinkered" like Richard Turere and determined the requirements to put together a circuit that will light the bulb, they will learn the measurement units, symbols and math equations necessary to effectively and safely light the bulb (ReadWorks, 2025).
- Students will use the Circuit Construction Kit: DC PhET Simulation instructional technology " (Ellis et al, 2020) and page 1 of the formative worksheet titled Measuring Voltage, Current & Resistance .to identify where & how to measure voltage and current by using an ammeter and voltmeter and identifying the measured resistance in the simulation (PHET, n.d.).

Part 5: Math: Calculating Voltage, Current & Resistance
8.PAR.3.6 Use algebraic reasoning to fluently manipulate linear and literal equations expressed in various forms to solve relevant mathematical problems.
SPS10 a. Use mathematical and computational thinking to support a claim regarding relationships among voltage, current, and resistance.

- Now students will learn the relationship between the three variables using the Ohm's law equation V=I x R. This equation will help them predict the third variable required once they measure the other two.
- Students will then apply their knowledge by practicing Ohm's law math calculations on pg 2 of the formative assignment with problem solving prompts like the following.

"Richard decides to run a trial using 9A bulbs to light his livestock boma circuit. If the in the circuit was 2Ω, how much current is needed to effectively light each bulb?"

- Teachers will circulate and use questioning to keep students on track.
- **Formative Assignment: Measuring Voltage, Current & Resistance**

Day 3

Part 6: Engineering – Designing a Circuit for a Backyard Enclosure

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, considering relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

(10 minutes)

Warm Up Question: Your parents send you into the backyard at 10:00 pm to get a forgotten pan after grilling burgers. What animal have you seen in your neighborhood that you are hoping will not surprise you in your yard that night?

- (Our community is a very wooded area so students will give answers like coyotes, deer, raccoons, possum, bats. Let them share the excitement and a couple stories of run-ins with unwanted wildlife.)
- Teacher: Guess what makes those animals NOT want to come into your backyard? BRIGHT LIGHTS! The brighter your lights are, the more likely you will not see those animals in your yard.

Setting the Context for Design

(50 minutes)

- Teacher: Today your goal is to design lighting for the perimeter of a yard in your community to keep away the animals you do not want to see at night.
- Students will work with their collaboration team to start brainstorming how they will set up a circuit to power the lighting for their own backyards. Students will be encouraged to begin by re-reading , " Keeping the Lions Away", that described the needs for the livestock enclosure's lights.
- Students are told they have a $300 budget. Budgets are a real-world engineering constraint & it's important that students begin to consider real- world challenges that impose careful choices (Guzey et al., 2016).
- Groups will come to browse the Supply Store (a table with miniature fence parts, insulated electrical wire, various sizes and watts of bulbs, bulb holders, various battery sizes, switches, including some more decorative supplies at a higher cost.)
- All parts except the fence pieces have price tags.
- Students are given the following **design challenges to consider**.

- ☐ Light the enclosure as brightly as you can afford.
- ☐ Be mindful of people and animal electrical safety.
- ☐ Choose the best possible brightness level for the lights to keep unwanted animals away.
- ☐ Calculate voltage using Ohm's law to help your design blow out as few bulbs as possible.
- ☐ Stay within budget.
- Students go back to their groups & each student sketches a design plan, creates a budgeted list of supplies, then presents it to the group.
- Each group chooses a plan or merges ideas into one plan, makes a list of materials needed with itemized cost analysis.
- Groups are encouraged to keep a record of design adjustments including the reasons. Students are reminded that this process is "highly iterative," there is no one best answer to the problem so they should keep an open mind as revision ideas are offered by groupmates (Karahan et al., 2014.)
- The iterative process of design trial and error begins. After burning out some bulbs, exchanging supplies & results feedback, student their design until they eventually have operational enclosure lighting.

<u>Day 4</u>

10 minutes

Warm Up: Write about a challenge your group is working through right now. What have you tried so far?

- Teacher: We are going to help each other to troubleshoot our designs before we finish troubleshooting. Who would like to share their group's challenge first?
- Teacher: After students share their challenge, ask the class to give ideas for revision that could help.

(20 minutes)

Part 7: Technology & Math– Troubleshooting & Revising Lighting Design

ISTE 1.4.b. Select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.

ISTE 1.1.c. Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.

8.PAR.3.6 Use algebraic reasoning to fluently manipulate linear and literal equations expressed in various forms to solve relevant mathematical problems.

SPS10 a. Use mathematical and computational thinking to support a claim regarding relationships among voltage, current, and resistance.

- Knowing they needed the brightest lights for the enclosure to keep the undesired animals away from the yard, some groups chose the biggest bulbs for their enclosure.
- However the bigger bulbs are more expensive, so some will go for a high quantity of smaller bulbs to stay within budget – but may blow out bulbs trying to increase brightness.
- Periodically, the teacher must ask some questions to get some collaborative critical thinking going on amongst students to help them come up with different solutions.

- Other groups may think the lower quantity of bigger bulbs were not bright enough to keep lions away.
- Student groups will use a multimeter, to measure voltage, current and resistance in their circuit for calculations of Ohm's law to determine inefficiencies and use the evidence to suggest improvements for their lighting designs-"tools and practices used by practitioners of science, mathematics, and engineering" (Ellis et al., 2020).

(30 minutes) Summative Assessment

Assessments

- **Formative Assessment**
- **Summative Assessment**

References

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