Lesson Title	Fun with simple circuits part 2 (advanced)
Length of Lesson	45min-1.5hr
Created By	Henry Stauffenberg IV
Subject	Physics
Grade Level	9-12 (Physics)
State Standards	Physics: 1 a, b, c, d, e, f, g; 5 b
DOK Level	Physics: 3
DOK Application	Design, formulate, investigate, apply, organize, connect, interpret, draw conclusion
National Standards	9 – 12 A: Inquiry; B: Physical Science; E: Science and Technology
Graduate Research Element	Everything uses simple circuits. Electrodes and geophysical methods use simple circuits and electric fields. Design and testing with hands on application into circuit building. Taking simple circuits and making them into advanced circuits for greater application.

Student Learning Goal:
The purpose of this lesson is to introduce students to more advanced applications of simple circuits, includes series and parallel, and have them make connections of what they learned in class to the real world by creating the circuits themselves; first with a fun interactive program http://www.dcaclab.com/en/lab/ (conceptual setting) and then take working conceptual design and replicate it into the real world. If link not work go through forum http://www.physicsforums.com/showthread.php?t=405326. Replicating design into the real world poses it own challenge taking concept into practice. In the end students will know how to build a working simple circuit and be able to differentiate between series and parallel and how these circuits are applied in the real world. Also they will learn how to make more advanced circuits using diodes, resistors, and possible AC motors (if going into AC vs. DC current).
Important: the goal of the worksheet is to get the students mind starting with inquiry. In end of activity they should be able to use the website and materials that they have to explore more advanced circuits and concepts on their own; or in the least, reinforce class lectures. The worksheet is designed to have additions from the teacher as fit.

Mississippi State Standards
Physics: 1: (a) Use current technologies to explore current research related to a specific topic; (b) Clarify research questions and design laboratory investigations; (c) Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations; (d) Organize data to construct graphs; (e) Evaluate procedures, data, and conclusions to critique the scientific validity of research; (f) Formulate and revise scientific explanations and models using logic and evidence (data analysis); (g) Collect, analyze, and draw conclusions from data to create a formal presentation using

available technology. 5: (b) Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential.

National Science Education Standards of Content 9 – 12

A: Inquiry: identify questions and concepts that guide scientific investigations

- Students should formulate a testable hypothesis and demonstrate the logical connections between the scientific concepts guiding the hypothesis and the design of an experiment. They should demonstrate appropriate procedures, a knowledge base, and a conceptual understanding of scientific investigations.

B: Physical Science: Conservation of energy and electricity

- In some materials, such as metals, electrons flow easily, whereas in insulating materials such as glass they can hardly flow at all. Semiconducting materials have intermediate behavior. At low temperatures some materials become super conductors and offer no resistance to the flow of electrons.

E: Science and Technology: Understanding about science and technology

- Scientists in different disciplines ask different questions, use different methods of investigation, and accept different types of evidence to support their explanations. Many scientific investigations require the contributions of individuals from different disciplines, including engineering. New disciplines of science, such as geophysics and biochemistry often emerge at the interface of two older disciplines.

Materials Needed (supplies, hand-outs, resources):

Attached handout circuits worksheet, 6 volt batteries, copper wire, light bulbs plates, small 6W light bulbs, one way switches, diodes and resistors of various types, AC motor if possible but optional, other batteries are optional as well. website access http://www.dcaclab.com/en/lab/. If link not work go through forum http://www.physicsforums.com/showthread.php?t=405326.

Lesson Performance Task/Assessment:

- Completion of worksheet
- Ability to complete a simple and advanced circuit
- Ability to create a series and parallel circuit both in website and in real world practice
- Ability to explain how simple circuits are applied to real world, ex: circuits in the household, computers, air-conditioning, cars, ect..
- Ability to apply what they learned in classroom into what they created in lab; flow of electrons, voltage, current, ohm's law, and so forth
- Ability to explain what are diodes, resistors, and AC motors are how they make more advanced circuits

Lesson Relevance to Performance Task and Students:

- To take concept into practice building simple/advanced circuits
- To make advanced circuits out of simple circuits and new material
- Understanding other components that make a more advanced circuit such as diodes and resisters
- To understand how series and parallel circuits operate and used in real world
- To practice design, test, and validation of hypothesis's
- Learning circuits is like learning how to change a tire, it is something that everyone can use, and it has a practical application.

Anticipatory Set/Capture Interest:
Show students fun interactive program *http://www.dcaclab.com/en/lab/*. Burn out some light bulbs, fans, and other devices when playing around with some circuit designing. While doing this briefly explain how the program functions (very simple and easy to grasp). Let students play around and get use to it for 5 min. Then handout the circuits worksheet (in materials) and tell students to attack the worksheet by first testing the problems in the conceptual program and then building the simple circuit with the materials mentioned in handout.

Guided Practice:
Already stated in anticipatory set/capture interest section above. The circuits worksheet is step by step with visuals and easy to follow instructions. Teacher only needs to walk around and guide students with additional questions. Each problem in worksheet will have questions that follow after each circuit that students are asked to model using (*http://www.dcaclab.com/en/lab/*.) and then create using available real world materials. The worksheet and website can be expanded to include more complicated circuits with the addition of resistors, diodes, and much more. After activity follow up with a discussion.

Independent Practice:
Students will work in groups but can work on the given concept website by themselves. With the website let them explore various circuits and inquire. They will likely blow out many bulbs and other devices in program but that is ok, better in the program than in real life. The program is specifically designed for teaching and is very interactive, fun, and encouraging for new learners. Let the students be curious and ask questions later.

Remediation and/or Enrichment:
Remediation: individual IEP, partner with helpful student, shorten assignment(s), make lesson more walk through intensive. Focus on walking through handout and depending more on class discussion using website: *http://www.dcaclab.com/en/lab/*.

Enrichment: Have students work with more complicated circuits. Introduce resistors, diodes, AC motors, and other circuit devices. Ask to take more measurements on voltage and amps throughout the circuits and have them interpret their data.

Check(s) for Understanding:
In addition to completion of performance tasks and discussion

- What is the difference between a series and parallel circuit?
- How would I make an advanced circuit using a diode and or resistor?
- Why is proper circuit design important?
- If I ask you to build this circuit would you be comfortable doing that?
- How does voltage, current, and resistance apply to a advanced circuit? Is it any different from a simple circuit?
- What uses advanced circuits?
- Show me an advanced circuit that can get this job done? ex: making lights flash is sequence, ect...

Closure:
End with a discussion about circuits in the working world, graduate application. Have students ask questions about the website and even play around with it some more. Give them a challenge to design a concept circuit built out of many simple circuits; something they can explore in website and then share with class or ask questions about.

Possible Alternate Subject Integrations:

Computer/Technology class: creating a useful simple/advanced circuit that can be used for home use. The website can prove concept before the build.

Teacher notes:
The website is really fun so be careful to keep the students on track. Also, let them play some because it is apart of the learning process. Don't just focus on completing the handout, half of the learning is from exploring and inquiry on their own.