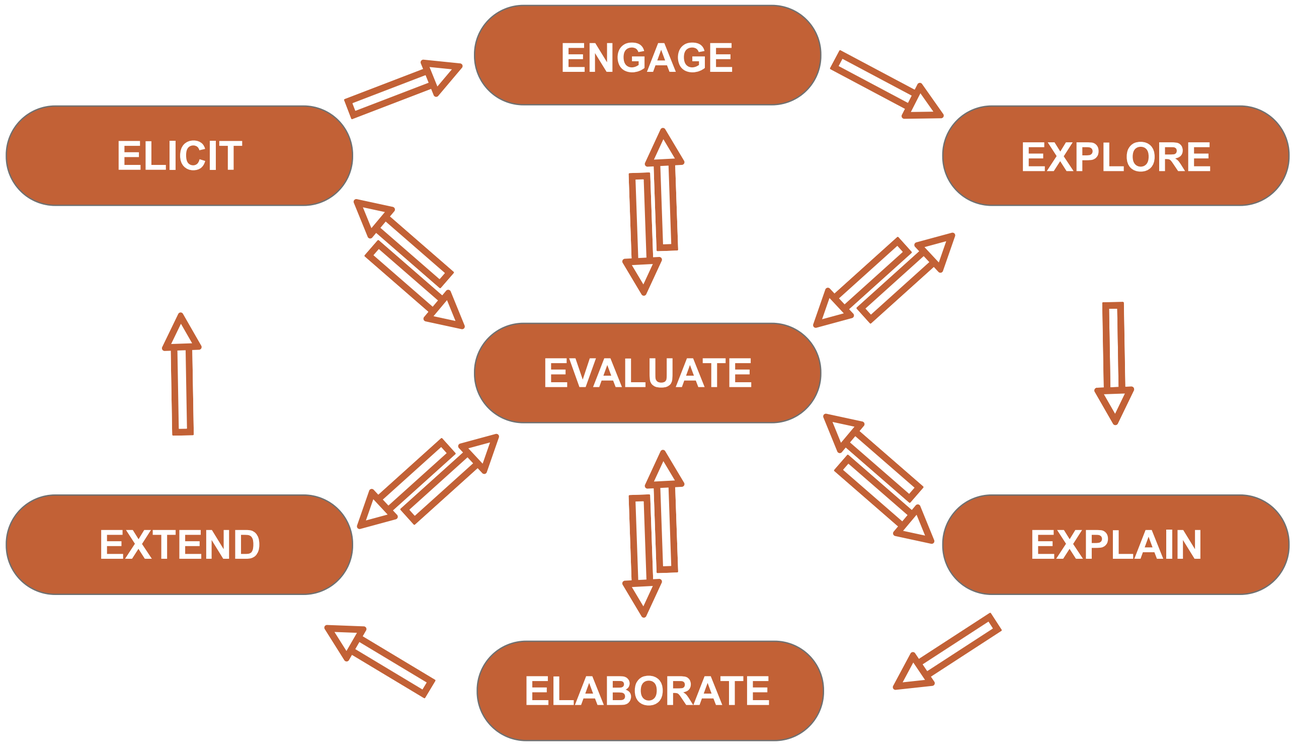
DC Circuits Via the 7E Learning Model

This learning material is designed according to the 7E learning model with the integration of computer simulations in the different learning activities of students. The simulations used are from the PhET Interactive Simulations of the University of Colorado Boulder which can be freely used and/or redistributed by third parties for non-commercial or commercial purposes. The set of activities are designed for STEM students of the senior high school curriculum regardless of the type and classification of these schools. The target competencies are stated in the lesson exemplar that can be accessed through the teachers' resource corner.

Students' Resource Corner

Direction for students: Please click the pages below in chronological order which will direct you to the different activities you need to accomplish.

- ☐ Elicit
- ☐ Engage
- ☐ Explore (1)
- ☐ Explain (1)
- ☐ Explore (2)
- ☐ Explain (2)
- ☐ Explore (3)
- ☐ Explain (3)
- ☐ Explore (4)
- ☐ Explain (4)
- ☐ Elaborate
- ☐ Evaluate
- ☐ Extend



PROPOSED 7E LEARNING MODEL SEQUENCE

Teachers' Resource Corner

- ☐ Lesson Exemplar
- ☐ Notes and Tips
- ☐ Plugins
  - ○ Java Runtime (32)
  - ○ Java Runtime (64)
  - ○ Flash Player (32)
  - ○ Flash Player (64)

Simulations

- ☐ Battery-Resistor Circuit
- ☐ Circuit Construction Kit-DC

Lesson Exemplar

COMPUTER-BASED LEARNING MATERIAL WITH COMPUTER SIMULATIONS
VIA THE 7E LEARNING MODEL
Lesson Exemplar

(Teacher's Guide)

Grade Level: Grade 12
Subject: General Physics 2

Content	Direct Current Circuits
Content Standards:	1. Resistors 2. Kirchhoff's rules 3. Experiments with batteries-and-resistor circuits
Performance Standard	Use theoretical and experimental approaches to solve multi-concept and rich-context problems involving electricity and magnetism.
Learning Competencies	1. Draw circuit diagrams with power sources (cell or battery), switches, lamps, resistors (fixed and variable) fuses, ammeters and voltmeters. 2. Evaluate the equivalent resistance, current, and voltage in a given network of resistors connected in series and/or parallel. 3. Calculate the current and voltage through and across circuit elements using Kirchhoff's loop and junction rules. 4. Solve problems involving the calculation of currents and potential differences in circuits consisting of batteries and resistors. 5. Plan and perform experiment involving batteries and resistors in one or more electric circuits and analyze the data.
Pre-requisite Knowledge	Ohm's Law
Time Allotment	5 hours (May vary)
Materials	• Desktop Computer/Laptop with minimum specifications as required and pre-installed with java runtime, flash player and browser • PhET Circuit Construction Kit-DC
References	• Giancoli, D. C. (2005). Physics: principles with applications Sixth Edition • https://www.electronics-tutorials.ws/dccircuits/dcp_4.html • https://phet.colorado.edu PhET Interactive Simulations University of Colorado Boulder
Teaching-Learning Activities	
Pre-discussion	Teacher will discuss the different procedures in doing the different activities and make sure that each student possesses basic computer skills (internet and email, computers, word processing, graphics and multimedia, and spreadsheets). Students are to be grouped depending on their number and the availability of computer units. Students are asked to access the activities in their computer (offline or online) through the students' resource page. Printed data and observation sheets should have been distributed to the students prior to the start of the first phase (elicit).
Elicit	Students are required to perform a short activity for them to recall their knowledge about Ohm's law. However, at the end of the activity, they are required to answer the following questions related to the learning competencies of the present subject matter: a. What makes a parallel connection different from a series connection? b. What do you think will happen to the individual and total voltage, current, and resistance if the circuit elements are to be connected in series or in parallel? c. How are you going to determine or solve the individual and equivalent voltage, current, and resistance if the circuit elements are connected in combination of series and parallel? Students will write their short responses on their daily logs then share with their groupmates.
Engage	Students are introduced to the DC circuit kit computer simulation. They will be required to undergo a simple activity on how to use the simulation. The main aim of the activity is for students to be able to construct a circuit using the computer simulation.
Explore	Students are required to perform series of exploratory activities focused on making circuit diagrams; evaluating equivalent resistance; current and voltage in a given network of resistors connected in series and or parallel; and deducing Kirchhoff's loop and junction rules in solving for current and voltage through and across circuit elements.
Explain	Students are required to answer the questions in the activities after doing the different exploratory activities. The questions are geared towards answering the different learning competencies.
Elaborate	Students are asked to design a functional DC circuit diagram given a limited number of circuit elements. This circuit will then be given to one of their classmates as part of the evaluation phase.
Evaluate	Using the computer simulation to validate their answers, students are asked to determine the equivalent and individual voltage, resistance and current in the circuit designed by their assigned pair.
Extend	Students are grouped by three's or four's depending on their number and are challenged explore how complex circuits are resolved using matrix. The objective of the activity is for students to use matrix in solving for the unknow current in each branch of a complex circuits. The activity can be given as an assignment if needed.

DONE

Notes and Tips

The set of activities are generally designed for senior high school students of the STEM strand regardless of the type of school management (private, public, regular and science). However, you are free to modify the activities which you think that are appropriate for your students.

The activities can be given as desired whether as a laboratory activity, take-home learning module, teacher-assisted module, etc. for as long as the 7 phases or stages are accomplished according to the sequence of the activities provided.

Make sure that the computer units are pre-installed with the required software to run the simulation. Test the computers and simulations before letting the students perform the set of activities.

A lesson exemplar is provided as your reference or guide. The content standards and competencies are all taken from the teaching guide for general physics 2 for senior high schools.

Make sure that each of your student possesses the basic computer skills (internet and email, computers, word processing, graphics and multimedia, and spreadsheets). If not, it is necessary for you to teach them these basic skills as part of the pre-discussion.

You may print the data and observation sheets for distribution to your students. However, another option is for your students to download the sheets in MS word format in which they can directly encode their answers then send these to your email. Just make sure to instruct the students on the method of submitting the activity sheets prior to the start of the first phase.

For concerns and clarifications, please feel free to contact the author:
Email: jovalson@gmail.com

DONE

Elicit

Activity 1. Ohm's Law and DC Circuits

At the end of this phase, you should be able to recall Ohm's law and determine how are the circuit elements connected.
Procedure:
1. Click the battery-resistor circuit simulation to download. If a pop-up message appears that the file may harm your computer, just click on the "keep" button. Click the executable jar file to open the simulation in a separate window. Observe how are the battery, resistor, ammeter and battery connected.
2. Take note of the movement of electrons within the circuit.
3. Vary the amount of voltage by moving the glider located at the control panel (right side). Observe what happens to the electrons, the amount of current and the polarity of the battery. Write down your observations in your log.
4. Keep the voltage constant at your own desired amount. Predict what will happen to the current as you increase and decrease the resistance of the resistor. Write down your observations after verifying your prediction.
5. Tick/click the box for "show voltage calculation". This will show you how a voltmeter is used to measure the voltage across the different circuit elements. Write down your observation.
6. Close the simulation then briefly discuss your observations with your assigned group.
7. Discuss also with your group the possible answers to the following questions:
a. What makes a parallel connection different from a series connection?
b. What do you think will happen to the individual and total voltage, current, and resistance if the circuit elements are to be connected in series or in parallel?
c. How are you going to determine or solve the individual and equivalent voltage, current, and resistance if the circuit elements are connected in combination of
series and parallel?
8. Proceed only to the engage phase once you are done with the discussion.

DONE

Engage

Activity 2. Introduction to DC Circuit Simulation Kit

At the end of this phase, you are expected to be accustomed in using the DC circuit simulation kit.
Procedure:

1. Click the Circuit Construction Kit-DC to open in a separate window. Choose the “lab” icon to load the simulation.
2. Acquaint yourself with the different circuit elements found at the left control panel. On the opposite side, the right control panel includes the option for current direction, flow of electrons, values, labels, voltmeter, ammeter, battery resistance, wire resistivity and type of view (lifelike or schematic).
3. Discover how to use the different circuit elements, change the different quantities (voltage and resistance) and use the voltmeter and ammeter.
4. Click refresh (lower right button) then proceed to the explore phase for the next activity.

Circuit Construction Kit-DC

DONE

Explore (1)

Activity 3.1 Making Circuit Diagrams

At the end of this activity, you are expected to be able to determine the different circuit elements and illustrate circuit diagrams with power sources (cell or battery), switches, light bulbs, resistors (fixed) fuses, ammeters and voltmeters.

Procedure:

1. Make a simple circuit consisting of a 12V battery, a switch, a light bulb of zero resistance and wires. The circuit should form a rectangular loop. Close the switch (switch on) then observe the flow of electrons around the circuit (rectangular loop) and the direction of conventional current.

2. Change the bulb's resistance to 6 ohms then observe what happens. You may further change instantaneously the resistance of the bulb and voltage of the battery for more observations.

3. Set the voltage of the battery to 12V and the bulb resistance to 6 ohms. Disconnect the circuit by clicking one of the nodes (scissor symbol) before the light bulb.

4. In the disconnected node/junction, connect two (2) resistors of different resistance (8 ohms and 10 ohms) end-to-end to form a single path for the electrons to flow. Observe what will happen to the light bulbs and the flow of electrons as you close (switch on) the switch.

5. Click on the battery schematic button found at the lowest right side. This will show you the different symbols used for the different circuit elements. Familiarize yourself with these symbols including those symbols of elements that are not used.

6. Proceed to the next phase then accomplish the data and observation sheet (Activity 3.).

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DONE

Explain Phase (1)

Activity 3.1 Making Circuit Diagrams
Data and Observation Sheet

Name: _____ Group No: _____

I. Draw the different symbols used for the following circuit elements:

Battery (indicate the + and negative terminal)	Resistor	Fuse
Bulb	Wire	Switch

II. Draw the schematic diagram of the final circuit you have created. Use the correct symbols and labels in diagram.

III. Explain. Answer the following questions:

1. What is the direction of the electron flow with respect to the terminals of the battery when the switch is on?

2. What is the direction of conventional current with respect to the terminals of the battery when the switch is on?

3. What happens to the electrons when the resistance of the light bulb is set to zero ohm?

4. What happens to the brightness of the bulb as you slowly increase its resistance?

5. What happens to the brightness of the bulb as you slowly increase its resistance?

DONE