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Electric Circuit TSPCK Tool

The purpose of this research is to find the difficulties teachers experience and the strategies teachers use when teaching Electric circuits at the Grade 10 level. The assessment instrument consists of two parts; (i) Electric circuit content tool and (ii) Electric circuit Topic Specific Pedagogical Content Knowledge tool

The information will be used for research purposes only: your responses will be treated confidentially. Codes will be used to protect your identity.

Demographic Information

		CODE:	
NAME:			
GENDER	Male	Female	
SUBJECTS YOU ARE CURRENTLY TEACHING			
NUMBER OF YEARS TEACHING SCIENCE			

QUALIFICATIONS

Degree / Diploma	Where Obtained	Main Subjects	Year

Have you taught electric circuits?	**YES**		**NO**	

If yes, please indicate the grade and the number of years for each Grade.

Grade	Number of years	Years (e.g. 2008, 2009)

There are 5 categories of questions in this tool

CATEGORY A:

- **Category A contains typical student responses. Please indicate how you would respond to learners in each case i.e. what feedback you would give learners. Provide as much detail as possible.**

CATEGORY B:

- **Category B relates to planning and sequencing of topics. Your responses will assist in developing a consensus on the main ideas. Main ideas are statements describing key understanding that must be learnt in a topic.**

CATEGORY C:

- **Category C asks you to reflect on which ideas about electric circuits are difficult to teach and get across to learners. This will help us generate a list of difficult ideas that we can use for future research.**

CATEGORY D:

- **Category D provides 2 groups of representation and analogies. Think about which ones you find more useful and then fill in the table relating to the effectiveness of these analogies in the classroom setting**

CATEGORY E

- **Category E gives you a student's exercise and asks you to think about how you would assist this learner develop her conceptual understanding of electric circuits.**

Instructions

- Please type or write responses directly into the response boxes.
- Please be as detailed as possible as to how you respond in your teaching setting

Thank you for your valued input and assistance

Electric Circuit TSPCK Instrument

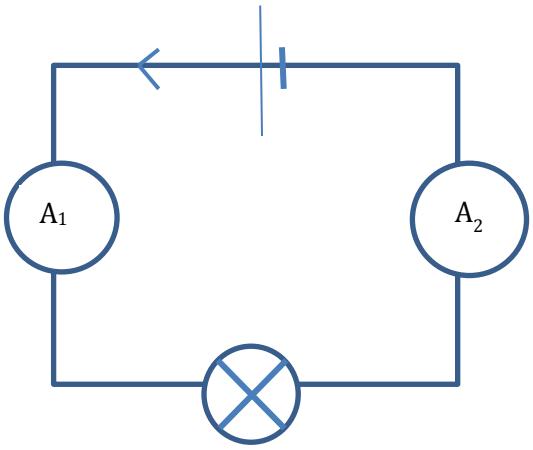
Category A – Typical Student Responses

The two questions below are typical multiple choice items that students have answered incorrectly. A selection of possible teacher responses are provided, none of which are incorrect. Select the response you would most likely use in your practice and explain the reason for your response

A1. How would you comment in writing to the student who **selects B** as the answer to the question below, where A_1 and A_2 are ammeters

Which one of the following options is correct for the circuit shown below?

A. $A_2 > A_1$
B. $A_1 > A_2$
C. $A_1 = A_2$



Response A: Keep in mind that this is a series circuit so current is not divided; therefore the correct answer is C. The current is the same throughout the circuit

Response B: Current is the rate of flow of charge. In this case the charge flowing is electrons. Electrons are particles that have mass and cannot disappear as they flow around the circuit. None of the electrons disappear through the circuit so the correct answer is C

Response C: Charged particles move under the influence of the electric field created by the battery, all the charged particles are in the same field, with the easiest path being in the single, undivided conductor. The flow of the charged particles is same throughout, so the correct answer is C

Response D: None of the above

Choose your response, and expand on the reason for your selection in the space provided

My choice is _____
My reason is …….

A2. How would you respond verbally to a student who answers B to the following question?

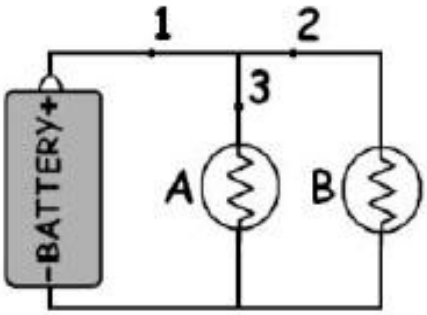


Figure 6

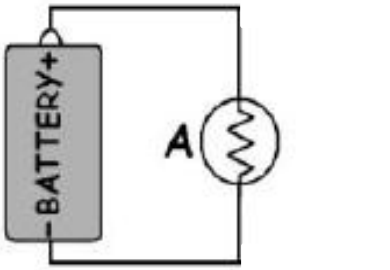


Figure 7

Compare the brightness of Bulb A in Figures 6 and 7.

A. Brighter in Figure 6
B. Brighter in Figure 7
C. The same in the both figures

Response A: Just because there are two light bulbs in figure 6, doesn't mean that A will burn brighter. The brightness is dependent on the amount of current moving through the bulb. In Figure 6 the current has been divided at the parallel connection. The presence of the parallel connection means resistance is halved so current is doubled so the amount of current through the parallel branches, in this case, is the same as through the single bulb so there is no difference in brightness.

Response B: All the bulbs are identical; their brightness is dependent on how efficiently they can transform energy, which is defined by the term power. In electric circuits power can be calculated by P = VI. In the parallel connection if we calculate the equivalent resistance of the parallel connection. If we assume a resistance of 2Ω then $\frac{1}{R_T} = \frac{1}{2} + \frac{1}{2}$ which is equal to 1Ω exactly half the overall resistance in Figure 7. Seeing that as voltage stays the same current would be doubled and then halved again at the parallel connection, so the same amount of current is available to be transformed.

Response C: You seem to have missed that the bulbs in figure 6 are connected in parallel. At the parallel connection the current divides. The bulbs have identical resistance so the current will divide equally through both branches. Two bulbs in parallel halves the resistance, which doubles the current, which is then halved again at the parallel connection, so the net effect is zero and bulbs will burn equally bright.

Response D: None of the above

Choose your response, and expand on the reason for your selection in the space provided

My choice is _____
My reason is _____

Category B – Planning and Sequencing

A selection of content and concepts relating to electric circuits is provided. The question below refers to how knowledge and concepts are ranked and how a teacher makes connections between content and concepts.

B1. Review the list of concepts relating to electric circuits below.

Select and rank three foundational concepts, that you regard, as both basic and central concepts in electric circuits.

1. To obtain an electric current there needs to be a continuous loop from one battery terminal to the other terminal
2. An electric current is the net flow of charge.
3. Parallel connection in a circuit are current dividers
4. The materials that make up the circuit provide the charged particles when there is an electric current
5. A battery provides the energy for an electric current
6. Voltage can be defined as $J.C^{-1}$
7. Ohm's law can be expressed as $V = \frac{R}{I}$
8. When there is a current, energy flows from the battery to the external circuit.
9. Resistance is the opposition to current flow
10. A battery creates an electric field within the materials that make up the circuit. The electric field is the cause of current flow.
11. The resistance of a parallel connection can be calculated by $\frac{1}{R_T} = \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} \ldots$
12. An electric circuit is a system in which changes in one part can affect other parts
13. Power is the rate at which energy is dissipated by the circuit component.
14. Current measured with an ammeter and voltage by a voltmeter

Write the number of the concepts you have selected, in order of importance.

Concepts
Concept 1.
Concept 2.
Concept 3.

B2. Using the three selected concepts from B1, give the sequence you would teach them in and your reasons for doing so

Concept	Reason for sequence

B3. Using the above three concepts as your main ideas, **draw a concept map** of how they inter-relate. In your concept map include other subordinate ideas, from the concepts provided in B1 and from your own practice that you would bring into your teaching of electric circuits.

Draw your concept map here

B3: Why do you think it is important for students to learn about electric circuits?

Write your response here:

Category C - What is difficult to teach?

C1. What **three** electric circuit concepts, in your experience, are the most difficult to present effectively to students and what do you think the reason for this is? Some **examples** are provided, which you may use as a basis for your response or **give your own ideas**. (**Only give reasons for 3 concepts, either using the ones given or your own)**

Fill in your response in the table below

Concept 1 – Energy in circuits	**Reason…….**
Concept 2 – Ohm Law, the relationship between voltage and current	**Reason…….**
Concept 3 – Electric circuits as a system	**Reason…….**
Concept 4 – Resistors in a parallel connection reduced the total resistance	**Reason…….**

Concept 5 – What is meant by voltage	
Concept 6 –	
Concept 7 –	
Concept 8 –	

C2. Physics terminology is quite precise and presents difficulties for students. Which two terms in circuits pose the most difficulty for students and please give a reason for your selection

Term 1	Reason:
Term 2	Reason:

Category D – Representations

D1. Below are three possible representations for teaching the concept of current in a parallel connection are provided. Complete the table below by describing what you like and dislike about each representation and why one representation is better than another.

Representation 1

The total current in a parallel circuit

The current that comes from the battery is the total current. This total current splits up, and part of the current goes through each branch. You can make string-loop models of parallel circuits, as you see in Figure 54 and Figure 55.

Figure 54 *A model of a parallel circuit with two branches.*

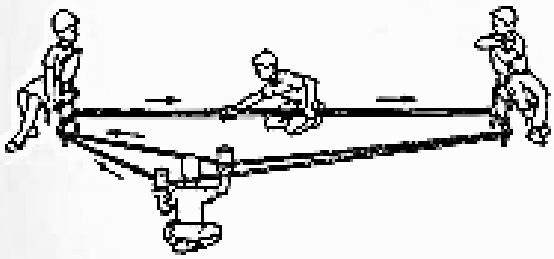
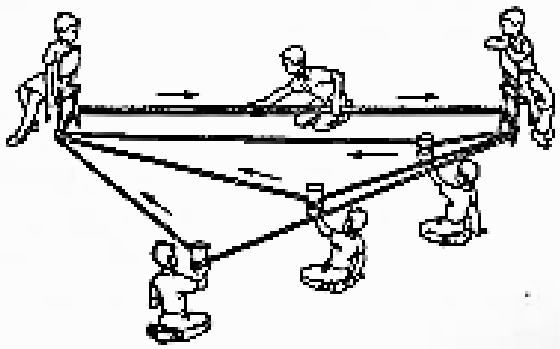


Figure 55 *A model of a parallel circuit with three branches.*

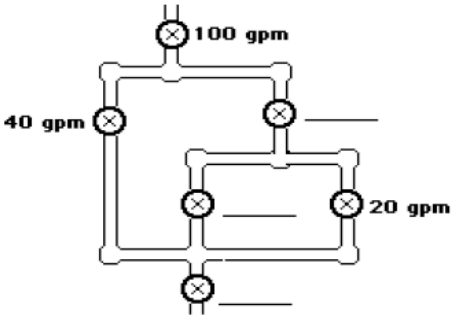


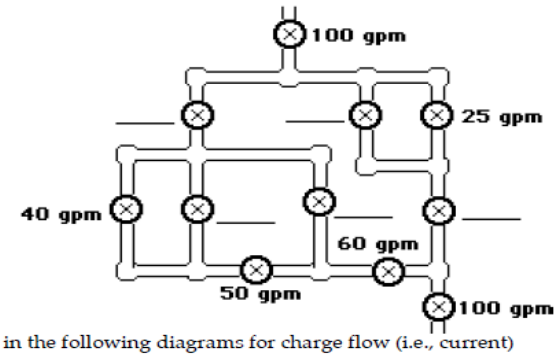
Science for All Grade 9 Learner's Book (Pg 35)

Representation 2

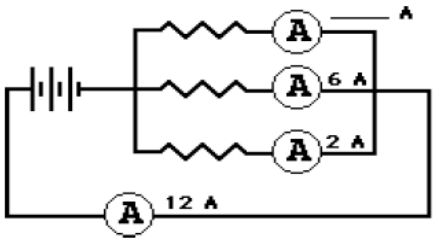
Water Analogy:

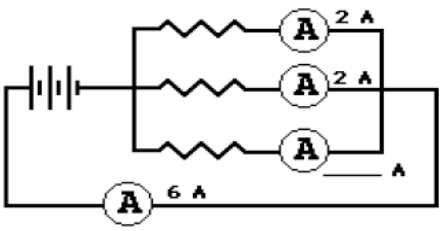
4. When the water flow (or charge flow) is divided into two or more separate pathways (as in a parallel circuit) the sum of the current in each individual pathway equals the total current. Utilize this principle to fill in the blanks in the following two diagrams. The meters in the diagram are measuring water flow rates in gallons per minute ("gpm").





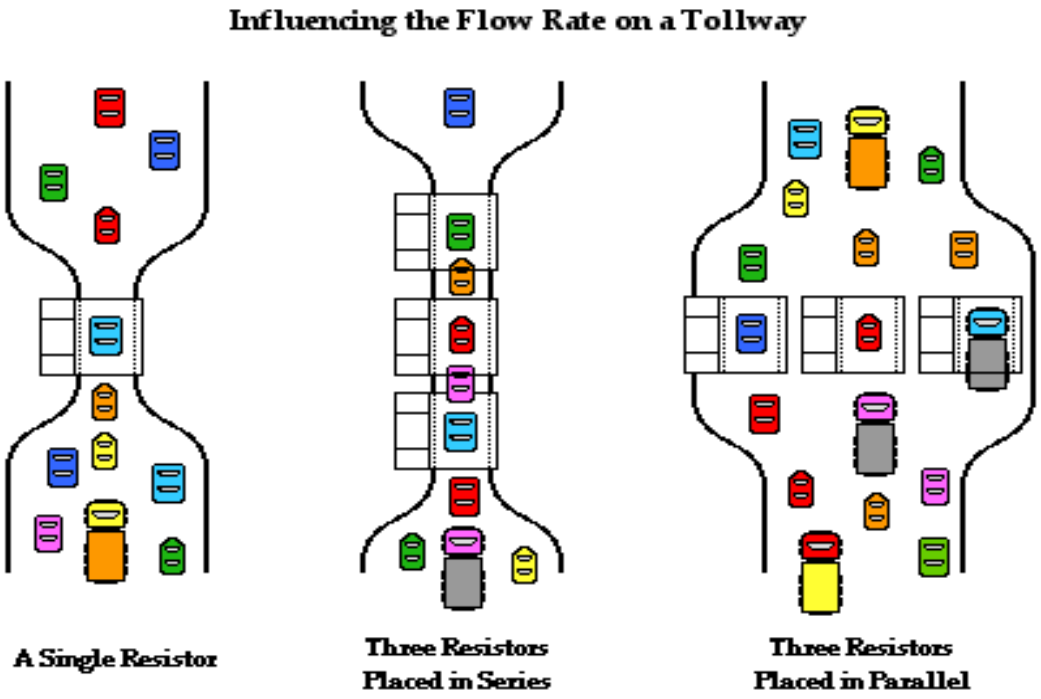
5. Apply the same principle to fill in the blanks in the following diagrams for charge flow (i.e., current) through a parallel circuit.





http://www.windows2universe.org/physical_science/physics/electricity/images/circuit_analogy_water_pipes_sm.jpg

Representation 3



	What I like and why	What I dislike and why
Representation 1		
Representation 2		
Representation 3		

D2. Which one of above three representations did you like the most and how would you use it in a lesson

Representation I liked the most	How would you use the representation selected in a lesson?

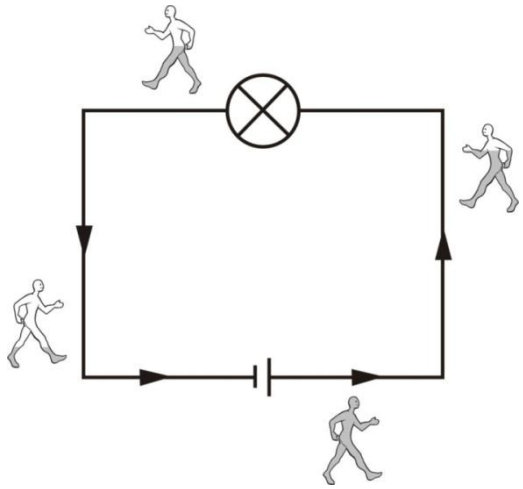
Category E - Conceptual Teaching strategies

E1. Study the student's answers to a classroom activity below. Read through her answers and describe what strategies you would employ to assist the student. The student has given a mix of incorrect and correct responses.

The student responses are given in *bold italic*

Activity

The following diagram represents Sparky who departs the cell full of energy. Answer the following questions with reference to the diagram.



(a) What is represented by Sparky?

Electricity

(b) What is represented by the shaded areas in his body?

Current

(c) Where does Sparky get the energy from?

Battery

(d) What happens while Sparky moves from the positive terminal to the negative terminal of the cell?

Sparky's charge gets used up

(e) Is it correct to say that the electric current is used up? Explain your answer.

Yes because as the current moves around the circuit, it gets used for things like heat and light and by the time it gets back to the battery all the current is finished.

a. What conceptual ideas does this student have in place?

Write your response here

b. What are the key conceptual gaps, in your opinion, that this student demonstrates?

Write your response here

c. What specific strategies would you employ to bridge these gaps?

Write your response here