Achievements of Gymnasium Students in Montenegro on Electric Circuit Test

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Conceptual understanding of electric circuit was investigate by the Electric Circuit test-EC test

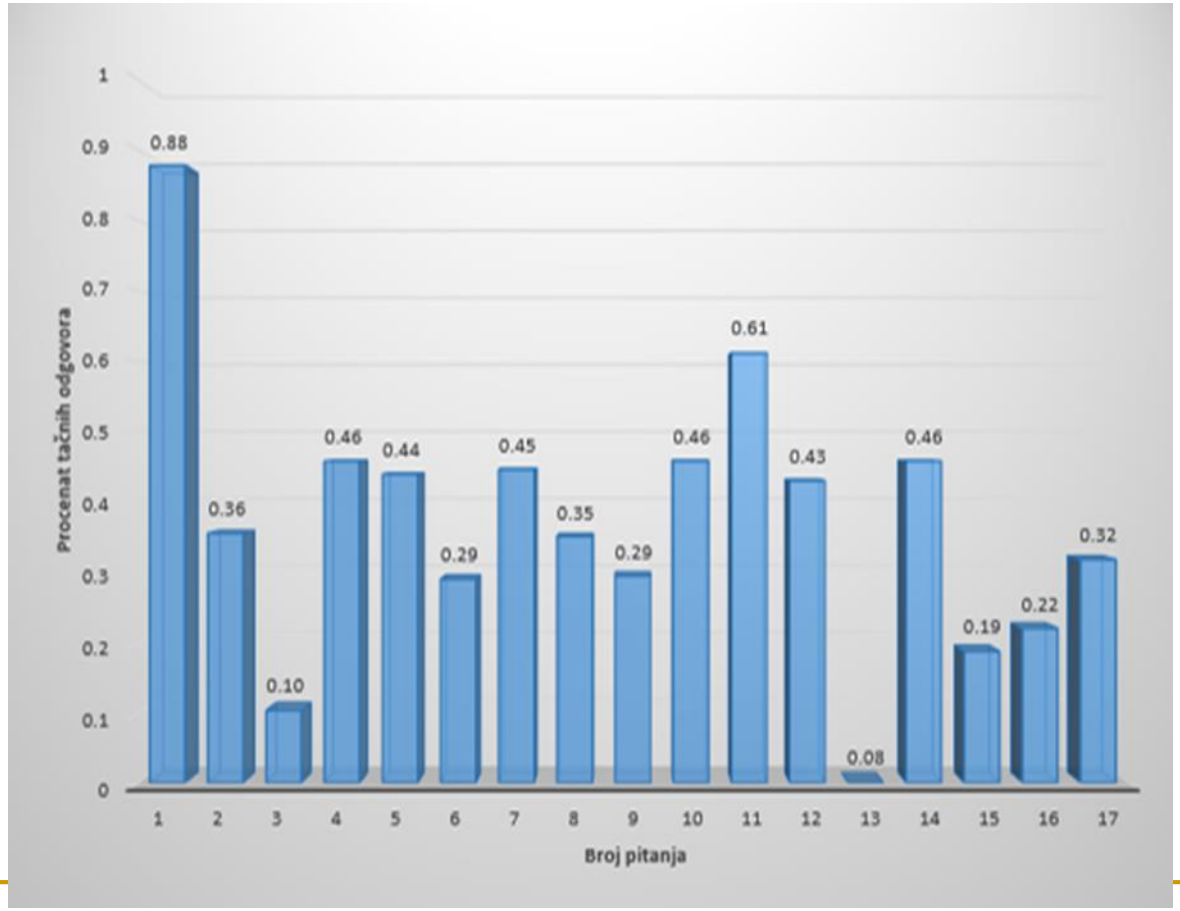
EC test was design to investigate students understanding in four domain concerning electric circuit:

- 1. Misconception (mental model) about a current
- 2. How do students understand a flowing of electrons in circuits
- 3. Influence of the resistance on current
- 4. Concept of potential difference.

EC test consists mainly from two-tiers question.
Students got a peon on the test
if they correctly answered on both part of the question
There were 17 questions.

Overall results

117 student at III grade took a part at this investigation. Max point obtained in our sample was 19.5 (25). Average number of points is 9.4 (37 %).

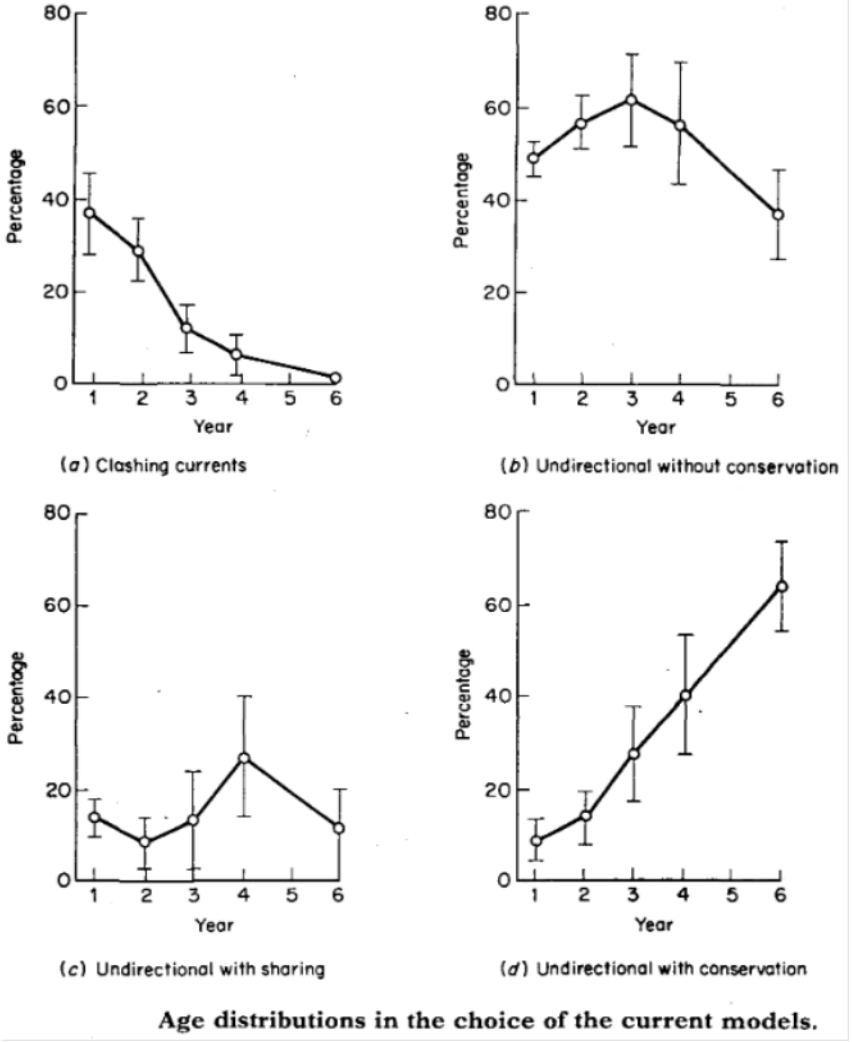


1. Misconception (mental model) about a current

-unipolar model

-clashing current-

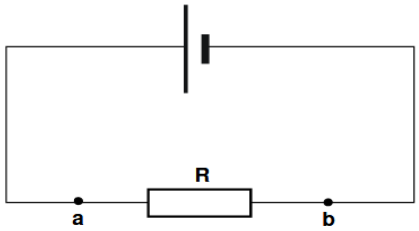
-attenuation and sharing model



Age distributions in the choice of the current models.

Item 1 ID1-0.88, easiest on the test. Scientific model is dominate in MN sample

In this circuit, a battery is connected to a resistor, R.



(a) What can you say about the electric current at points a and b?

Choose one answer.

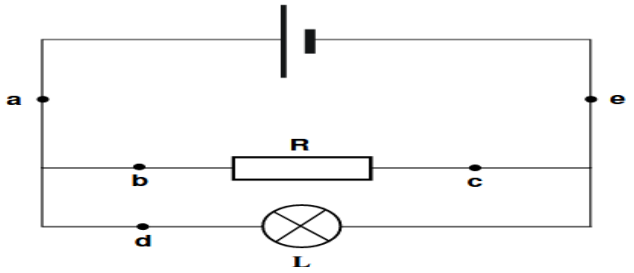
i	The electric current at **a** is bigger than at **b**.
ii	The electric current at **b** is bigger than at **a**.
iii	The electric current is the same size at **a** and **b**.

(b) How would you explain this?

Choose one answer.

i	The current is the same all round the circuit.
ii	**Some** of the current is used up by the resistor.
iii	**All** of the current is used up by the resistor.

In this circuit a battery is connected to a resistor R and a bulb L, as shown.



(a) What can you say about the electric current at points **b** and **c**?

Choose one answer.

i	The electric current at **b** is bigger than at **c**.
ii	The electric current at **c** is bigger than at **b**.
iii	The electric current is the same size at **b** and **c**.

How would you explain this?

(b) Is b equal to d? Yes / No

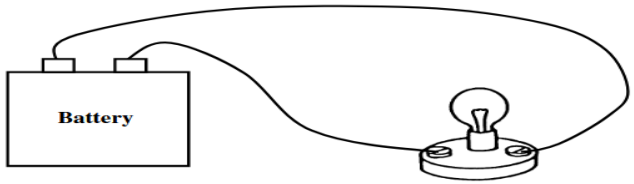
How would you explain this?

ID7- 0.45

ID7.1- 0.81

2.How do students understand a flowing of electrons in circuits was tested by item.2.

In this circuit, the bulb is lit.

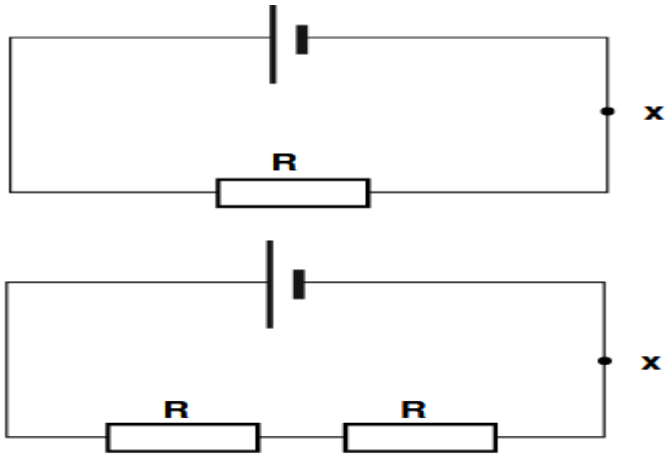


Decide whether each statement is 'True' or 'False' and mark your answer on the answer sheet.

	Statement	True	False	
(a)	Before the battery is connected, there are no electric charges in the wire. When the battery is connected, electric charges flow out of it into the wire.			20.7%
(b)	When the circuit is connected, the free electrons gain kinetic energy. As they move round, the free electrons give this energy to the components they pass through.			37.7%
(c)	The battery, the wire and the bulb filament are all full of charges, all the time. When there is a closed circuit, the battery makes all these charges move round together.			50%
(d)	Before the circuit is connected up, there are free charges in the battery only. There are no free charges in the wires or the bulb filament.			43.3%
(e)	When the circuit is connected, the free electrons which are moving are absorbed by the bulb, to produce light.			28.3%
(f)	Before the circuit is connected up, there are free charges in the battery, the wires and the bulb filament.			41.3%

-3.Influence of the resistance on current

Among the most difficult items is number 3 ID-0.1



3.a III40%

3.b IV 50%??

(a) What happens to the current in the circuit at point x?

Choose one answer. Use the answer sheet.

i	It gets bigger.
ii	It stays the same.
iii	It gets smaller, but not zero.
iv	It drops to zero.

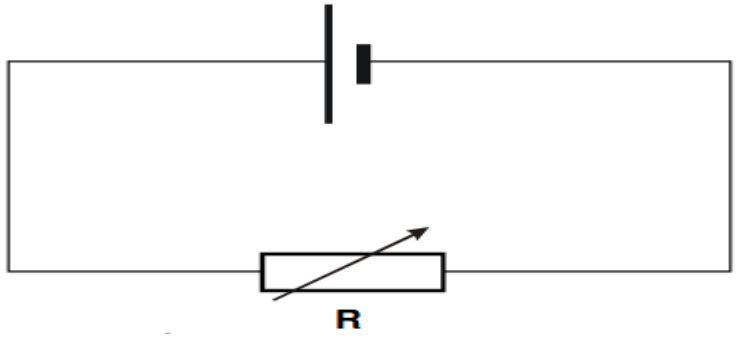
(b) How would you explain this?

Choose one answer. Use the answer sheet.

i	The battery is not strong enough to push any current through two resistors.
ii	The battery cannot push as big a current through two resistors.
iii	It is the same battery, so it supplies the same current.
iv	Two resistors need more current than one on its own.
v	The current is shared between the two resistors, so each gets half.

Item 6 tested same problem as item 3.

ID6-0.3



He then **increases** the resistance of R.

(a) What happens to the current in the circuit?

Choose one answer.

i	It gets bigger.
ii	It stays the same.
iii	It gets smaller, but not zero.
iv	It drops to zero.

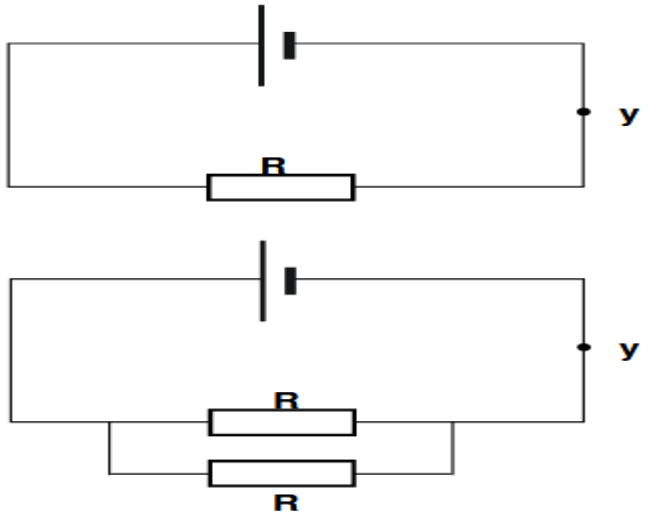
(b) How would you explain this?

Choose one answer.

i	The battery is not strong enough to push any current through a larger resistor.
ii	The battery cannot push as big a current through a larger resistor.
iii	A larger resistance needs more current than a smaller resistance.
iv	It is the same battery, so it supplies the same current.

Results on items treated a parallel connection of the resistors are better

ID4-0.46
4.1 I 55%
4.2 II 67%



(a) What happens to the current at y?

Choose one answer.

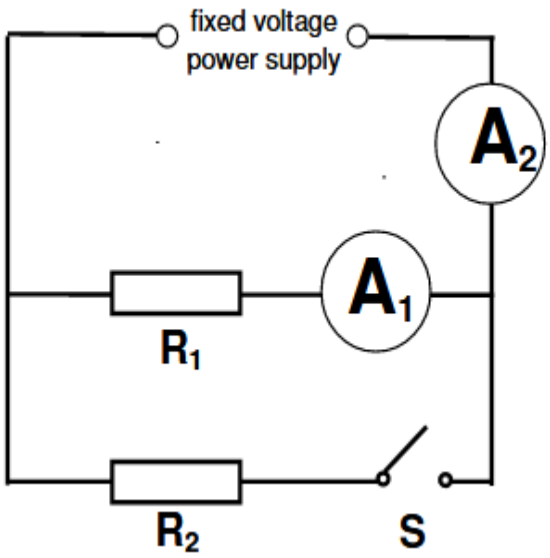
i	It gets bigger.
ii	It stays the same.
iii	It gets smaller.

(b) How would you explain this?

Choose one answer.

i	The battery cannot push as big a current round the circuit.
ii	The second resistor provides an extra path for current to flow.
iii	It is the same battery, so it always supplies the same current.

Items 4 and 16 tested the same problem but ID16 dropped to 0.22



What happens to the reading on ammeter A_2 when S is closed?

Choose one answer.

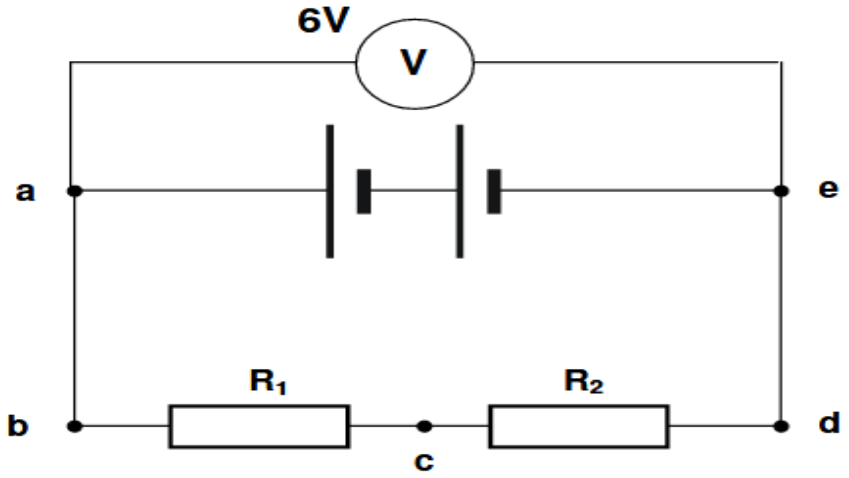
i	It gets bigger.	32%
ii	It stays the same.	42%
iii	It gets smaller.	24.5

How would you explain this?

Choose one answer.

i	Some of the current now goes through R_2, bypassing R_1.	23.7%
ii	Two resistors need a bigger current from the power supply.	32%
iii	The voltage across each parallel branch stays the same.	22%
iv	The total resistance is now bigger, so the current gets less.	23%

Concept of potential difference was tested by items 8,9.,10



ID8-0.35

		More than 6V	6V	Less than 6V	Zero	
(a)	What is the potential difference (p.d.) between points b and d?					34%
(b)	What is the p.d. between points a and b?					65%
(c)	What is the p.d. between points d and e?					40%

The most difficult item . ID13-0.08

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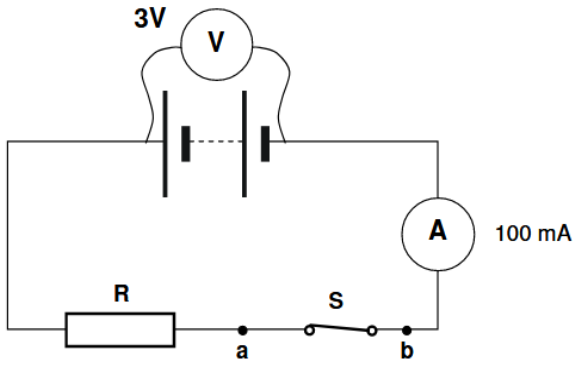
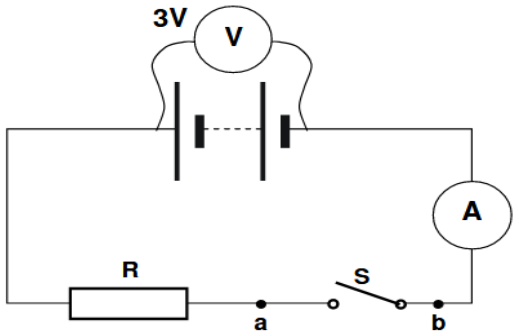
This circuit consists of a 3V battery, connected to a resistor R and a switch S. The switch is **closed**. The ammeter reads 100 mA.



What is the potential difference (p.d.) between **a** and **b**?

The switch S is then **opened**. The voltmeter across the battery still reads 3V.



(i) What is the reading on the ammeter now?

(ii) What is the potential difference (p.d.) between a and b, now?

Discussion and Instruction

-Concept of potential difference is the most difficult

-Wrong interpretation of Ohms Low.

-More time should be spent to the problem such as open switch(potential difference exist although current not)

-More time should be spent in connecting a electrostatics and electric circuits

-roll of the buttery and process that going on should be explain carefully

--more time should be devoted to the qualitative analyze, than skip to the quantitative

-problem occurred in investigation (investigation was done in circumstances of corona crises) .

Thank you