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INTERNATIONL MATHENATICS AND SCIENCE OLYMPIAD FOR PRIMARY SCHOOLS (IMSO) 2004

Science Contest in Taiwan

Experiment III: Black Box Electric Circuit

Name:_____ School:_____ Grade:_____ ID number:_____

A black box containing an electric circuit is provided. Inside the box, there is a 2-position switch to select an appropriate circuit. If the switch is in the position S1, the effective circuit is as shown is figure 1. While if it is in the position S2, the circuit will be as shown is figure 2. A voltmeter Vm is used to measure the voltage difference along the resistor Rm. The voltage measured are: 0V, 2.5V, 3V, 3.75V, …, 15V.

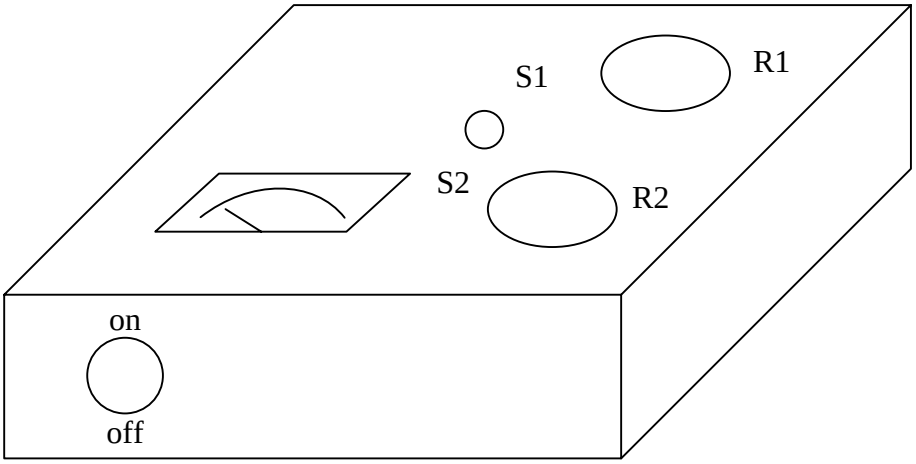


Diagram of the black box

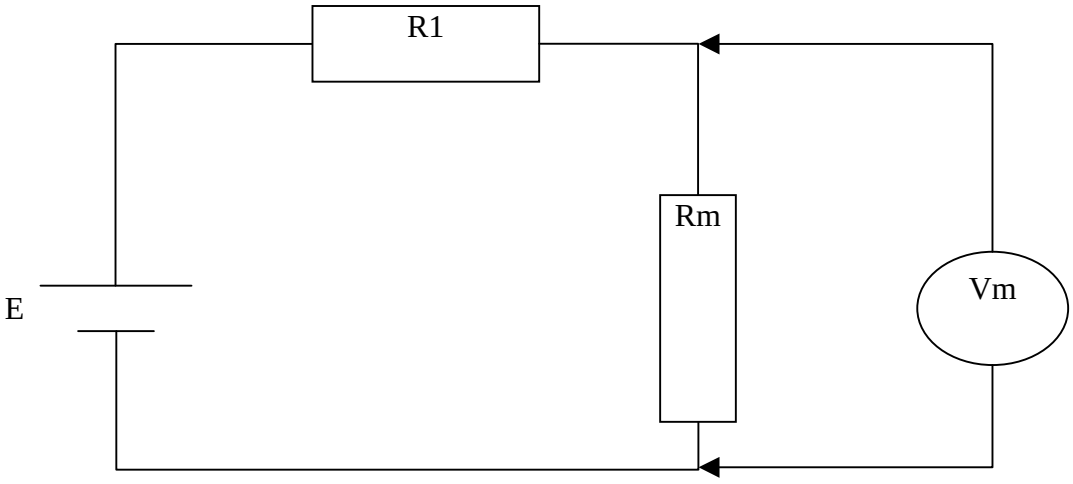


Figure. 1 Electric circuit within the black box with switch at position S1

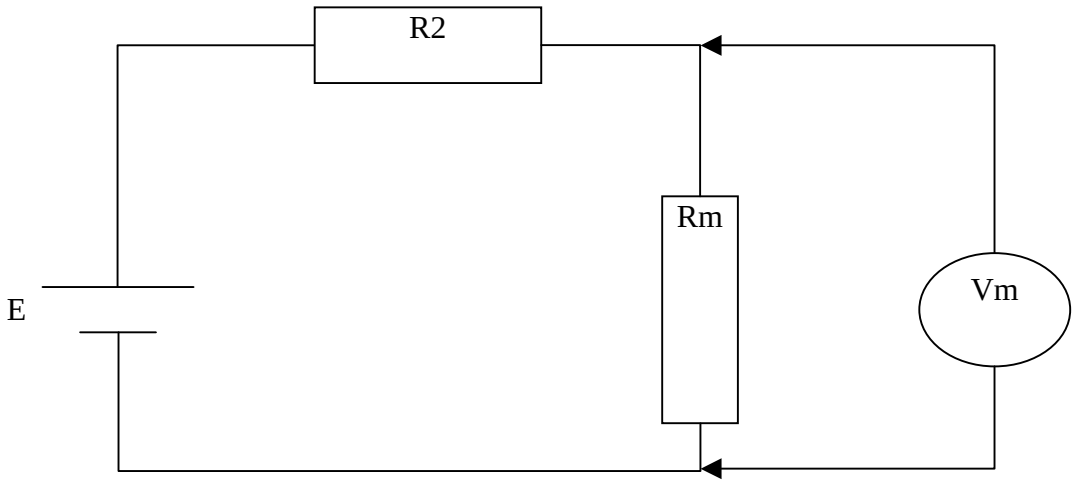


Figure. 2 Electric circuit within the black box with switch at position S2

A. Set the switch at position S1

Resistor is varied as shown in.

1. As the changes of R1, the readout of Vm are shown in column 3 from table 1

2. Choose the following right answer. Theoretically, the current across R1 is
   a. Less than the current across Rm
   b. Equal to the current across Rm
   c. More than the current across Rm
   d. Less than or equal to the current across Rm.
   e. more than or equal to the current across Rm
   (score: 13)

3. Choose the right answer. As the resistance Rm and the battery voltage are kept constant, when the value of R1 is increased, then:
   a. The voltage across R1 (= V_{R1}) will increase.
   b. The voltage across R1 (= V_{R1}) will decrease
   c. The voltage across Rm (= Vm) will increase
   d. The voltage across Rm (= Vm) will decrease
   e. The voltage across R1 (= V_{R1}) will remain constant.
   f. The voltage across Rm (= V_{Rm}) will remain constant
   (score: 6)

4. Fill in table 1 by calculating the current flows through resistor R1. (score: 3)

Table 1

Rotary switch R1	R1 (Ohm)	Vm (Volt)	$V_{R1} = E - Vm$ (Volt)	$I_{R1} = V_{R1} / R1$ (mA)
1	500	2.50		
2	400	3.00		
3	300	3.75		
4	200	5.00		
5	100	7.50		
6	0	15.00		

5. Draw a graph of the Voltage Vm versus the current across R1. (score: 6)

6. The curve has a slope (the ratio between voltage difference and its current). The slope is equal to …….. (score: 5)

7. The slope of the curve represents the value of (choose the right answer):
   a. R1
   b. R2
   c. Rm
   d. The current across R1
   e. The current across R2
   f. The battery voltage E
   (Score: 5)

8. Calculate the current R1 when the resistance R1 equals zero.
   (score: 6)

B. Set the switch at position S2

Resistor R2 (unknown) is varied according to the position of rotary switch R2.

1. As the rotary switch changes of R2, the readout of Vm are shown in column 2 from table 2

2. Calculate the voltage across R2 and fill in the result into the 3rd column of table 2. (score: 6)

C. Data Analysis

Analyze your data to calculate the estimate value of R2. Write your result into table 2. (score: 24)

Table 2

Rotary switch R2	**Vm (Volt)**	**V_{R2} = E – Vm (Volt)**	**R2 (Ohm)**
1	12.50		
2	10.00		
3	7.50		
4	6.00		
5	5.00		
6	3.00		

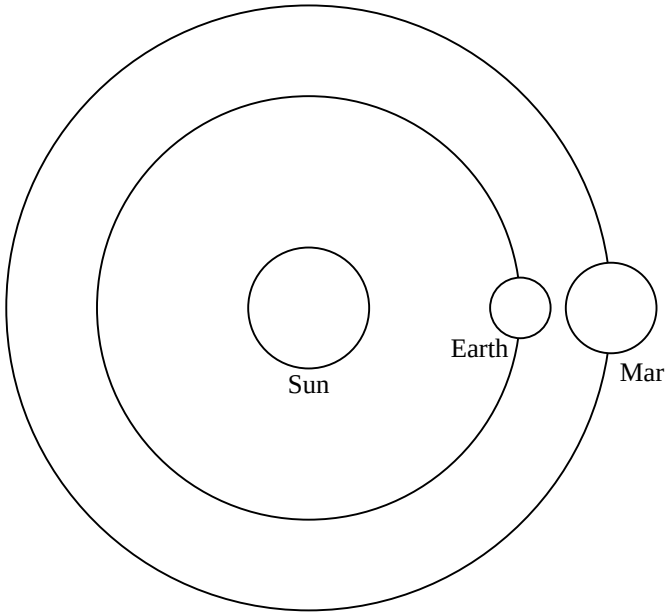
INTERNATIONL MATHENATICS AND SCIENCE OLYMPIAD FOR PRIMARY SCHOOLS (IMSO) 2004

Science Contest in Taiwan

Experiment IV: Our neightbour MARS

Name:_____ School:_____ Grade:_____ ID number:_____

On August 27th, 2003, Mars was in the opposition (the closest position to the Earth). This event is shown at the Following figure:



The next opposition can be estimated using the formula: $\frac{1}{P_{opp}} = \frac{1}{E} - \frac{1}{M}$

P_{opp} = period of the opposition of Mars
E = period of Earth's revolution = 365 days
M = period of Mars's revolution = 687 days

1. Find the period of the opposition of Mars. (Score: 5)

2. a. How many times should Mars revolve around the Sun to reach the next opposition? (Score: 3)
   b. How many times should the Earth revolve around the Sun to reach the next opposition with Mars? (Score: 4)

3. Could you predict (approximately), when the next opposition will occur? (date, month, year) (Score: 8)

4. Draw the diagram or figure of the next opposition. (Score: 6)