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step by step

DIY

Do It Yourself

Electronic Series, KIT-1

Experiment:

Kirchhoff's Voltage Law

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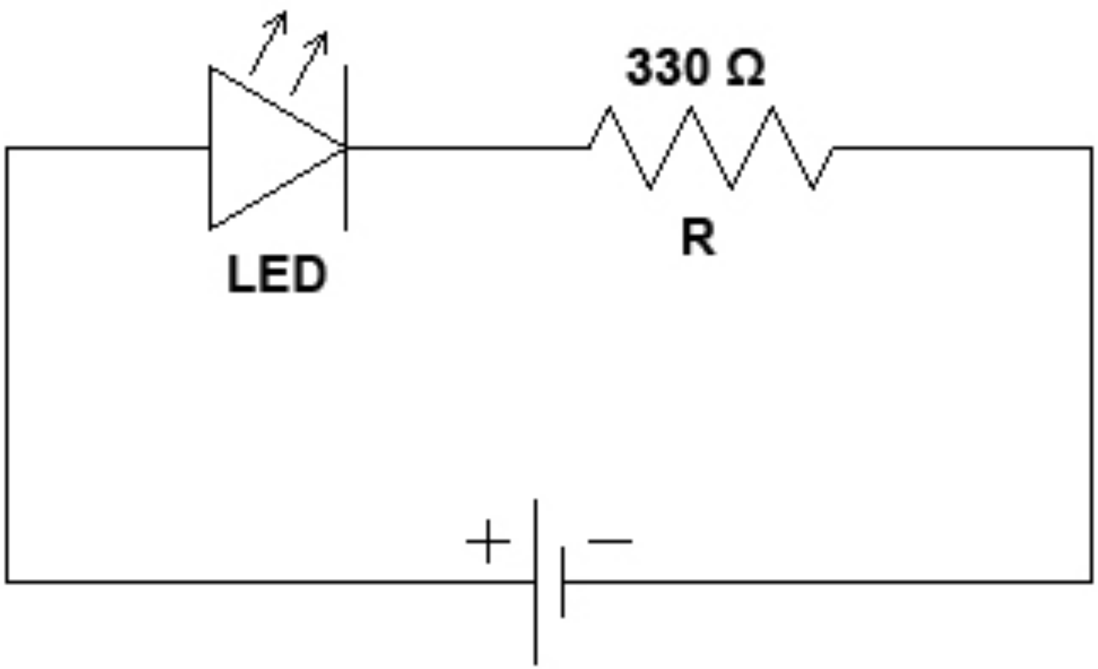
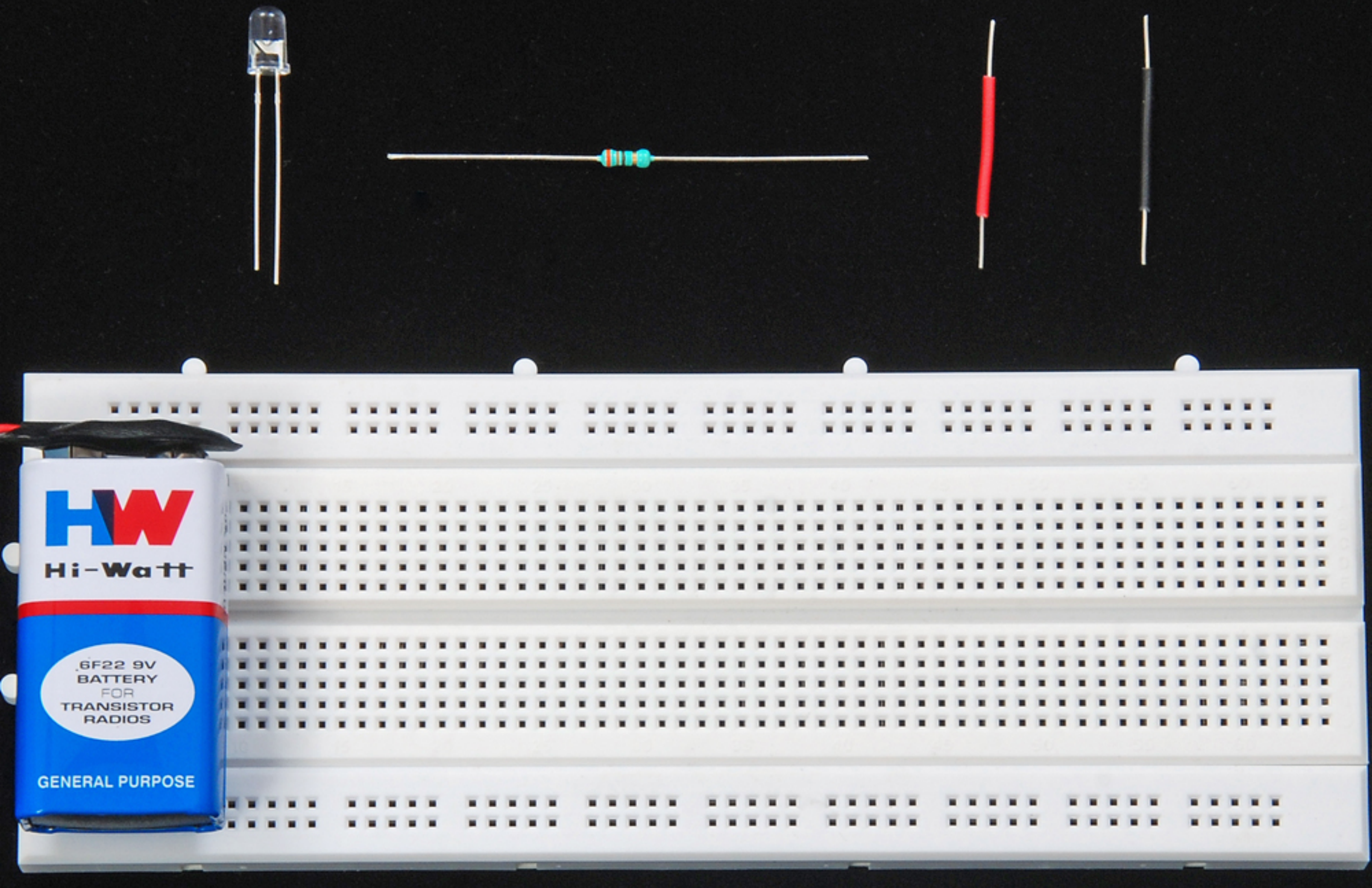
Circuit Diagram



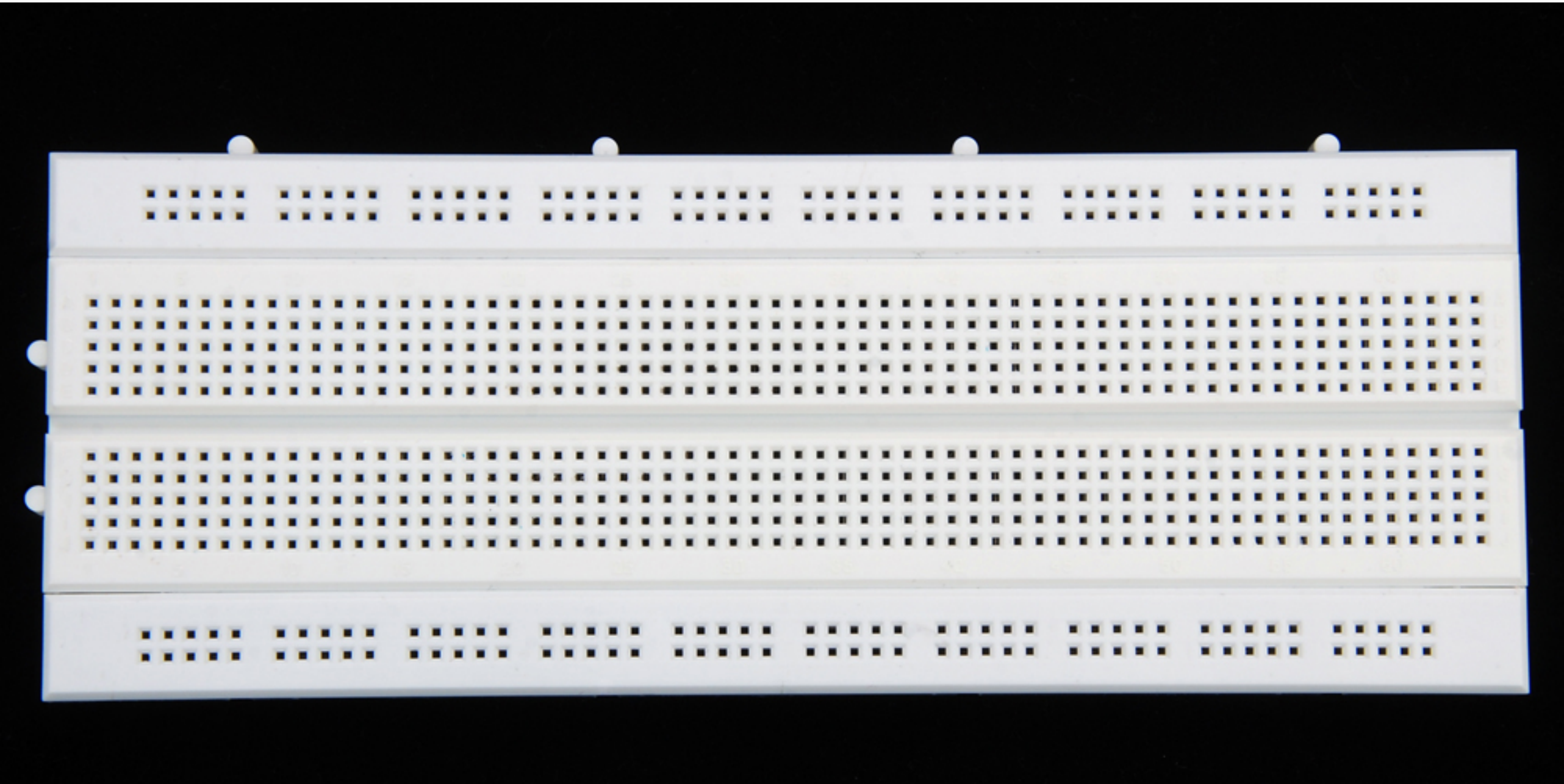
Materials Required

i. Breadboard - 1
ii. LED - 1
iii. Resistor: 330 Ω - 1
Colour Code: 330 Ω - Orange Orange Brown Gold
iv. 9 V Battery - 1
v. Connecting Wire Pieces


HW
Hi-Watt
6F22 9V
BATTERY
FOR
TRANSISTOR
RADIOS
GENERAL PURPOSE

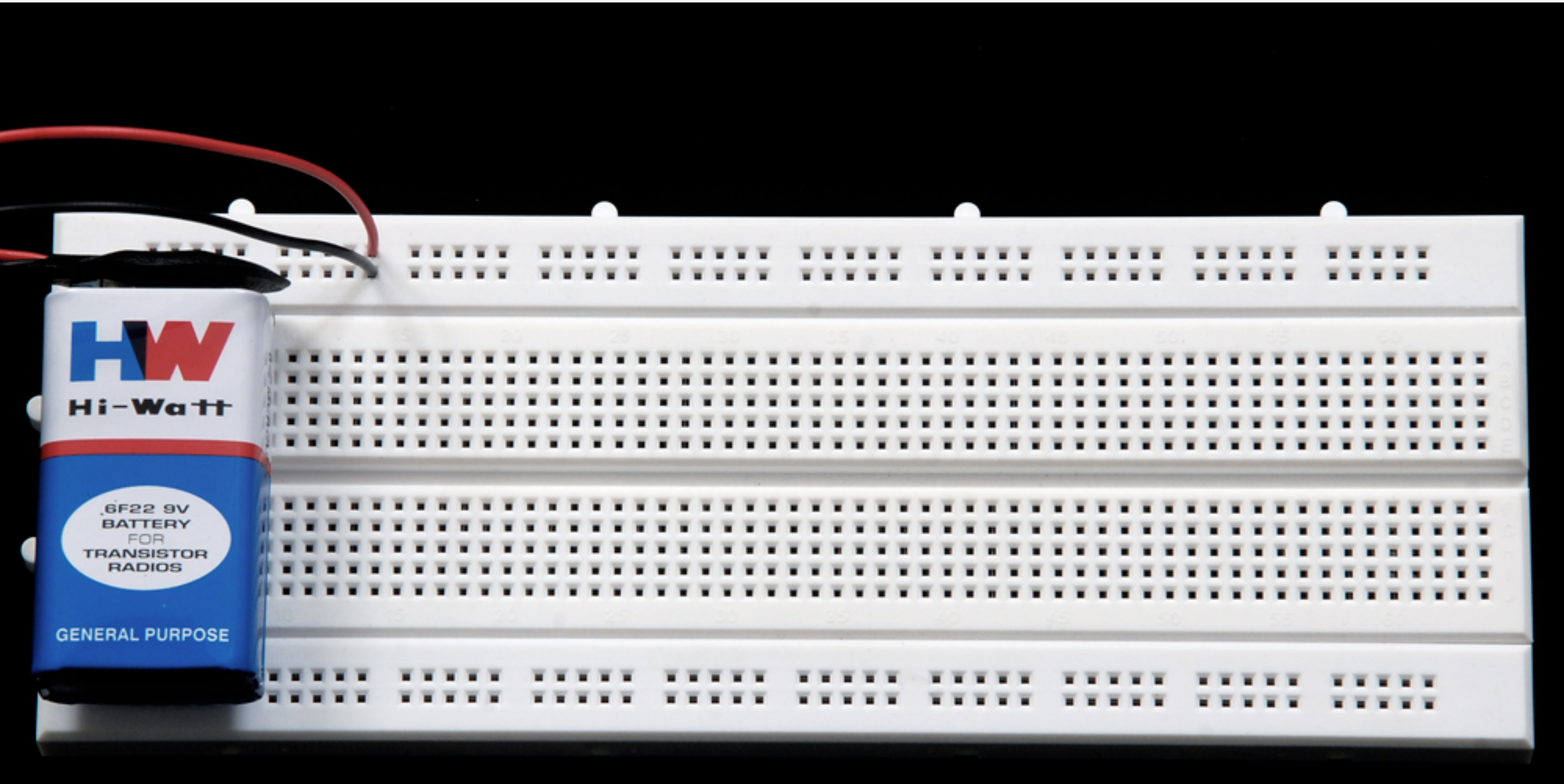
Step No. 1

Take a breadboard.



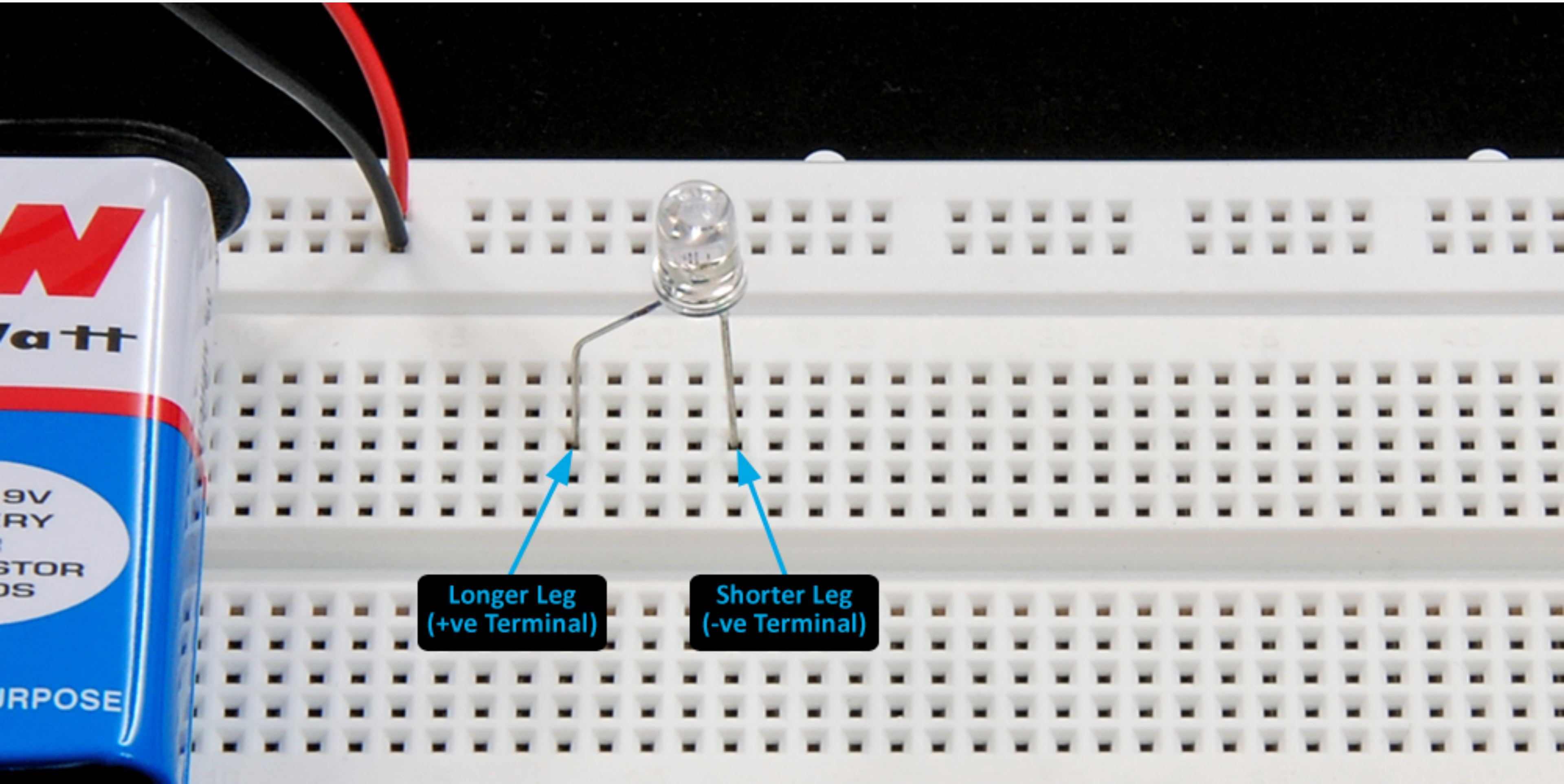
Step No. 2

Connect a 9 V battery on the breadboard.



Step No. 3

Connect an LED on the breadboard.



Step No. 4

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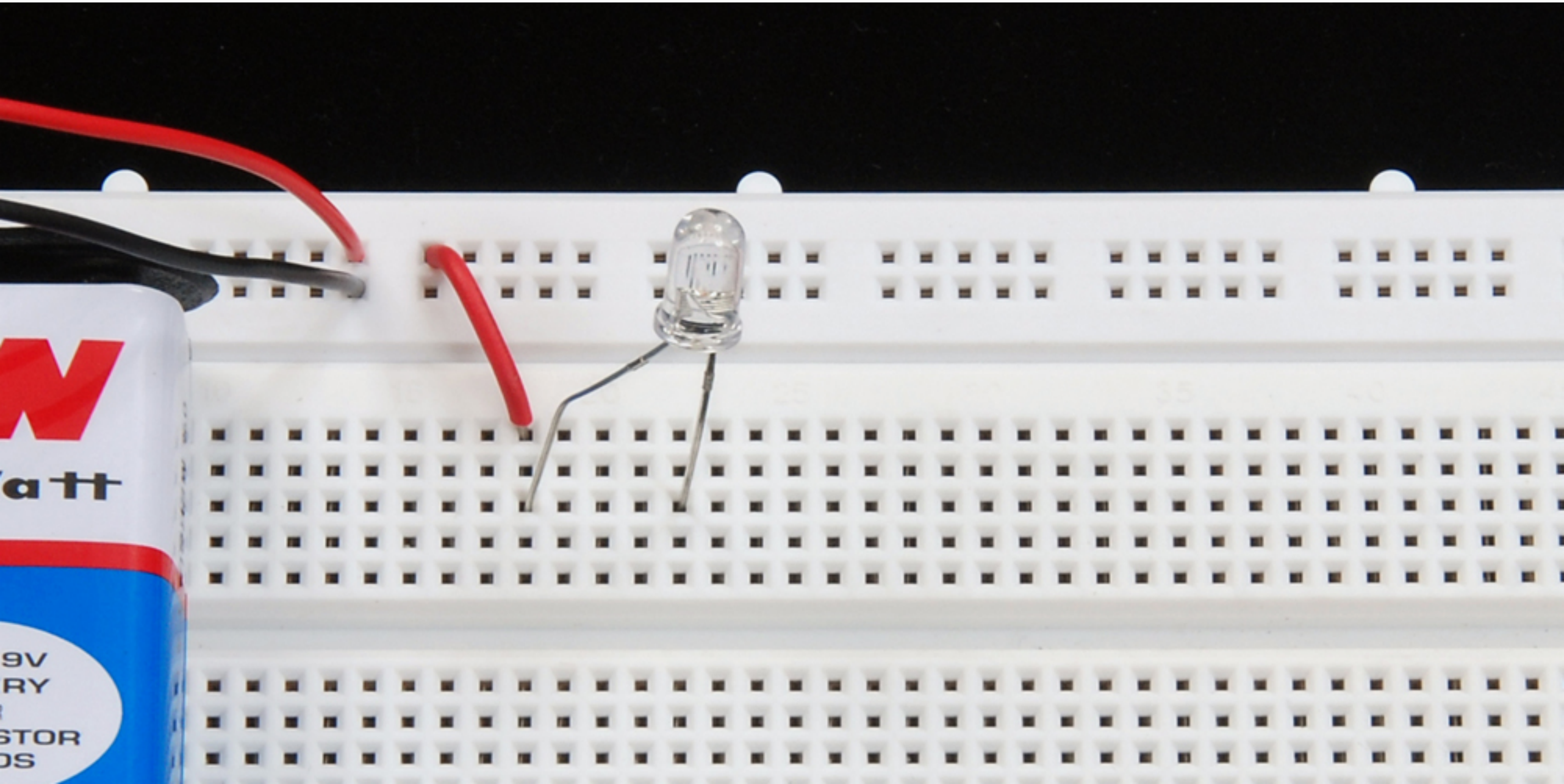
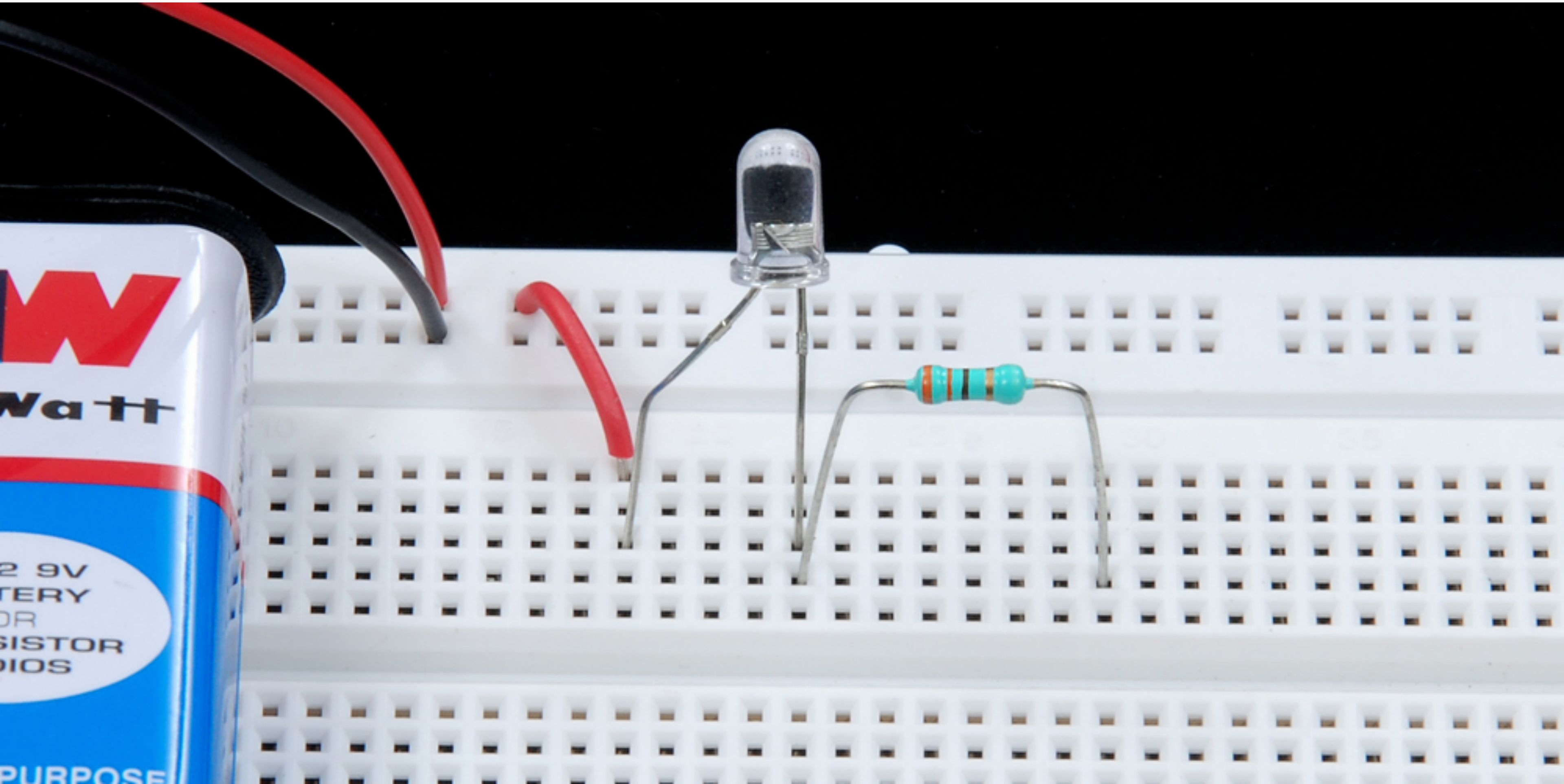
Connect the positive terminal of the LED to Vcc (positive terminal of the battery) with a connecting wire (red).



Step No. 5

Connect one leg of a 330 Ω resistor to the negative terminal of the LED. Connect the other leg of the resistor to any different column of the breadboard.



Step No. 6

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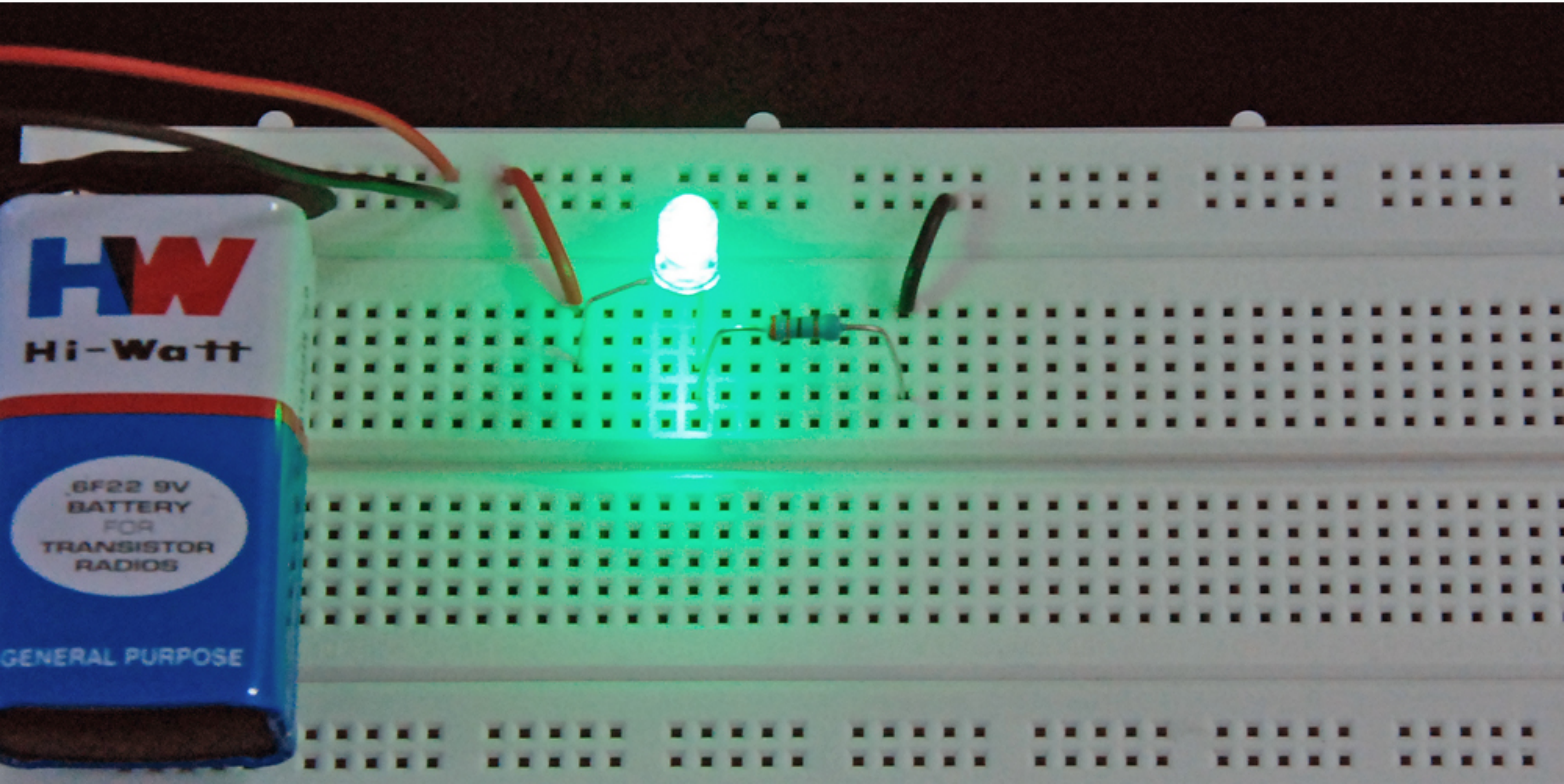
Connect the other leg of the resistor to ground (negative terminal of the battery).



Complete Circuit

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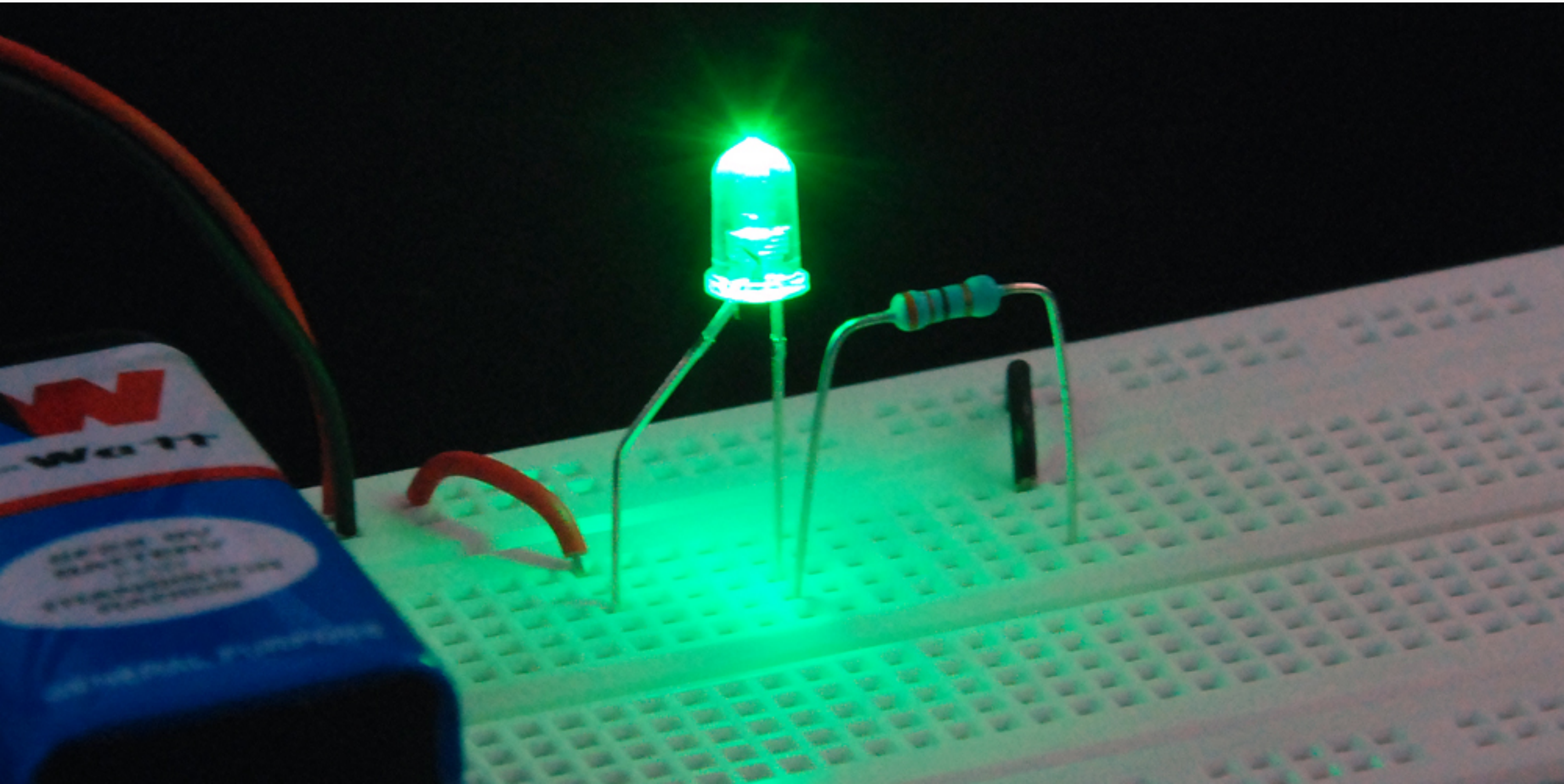
The LED glows. Hence, the circuit is complete. Now we will measure the voltages across the LED and the resistor.



Step No. 7

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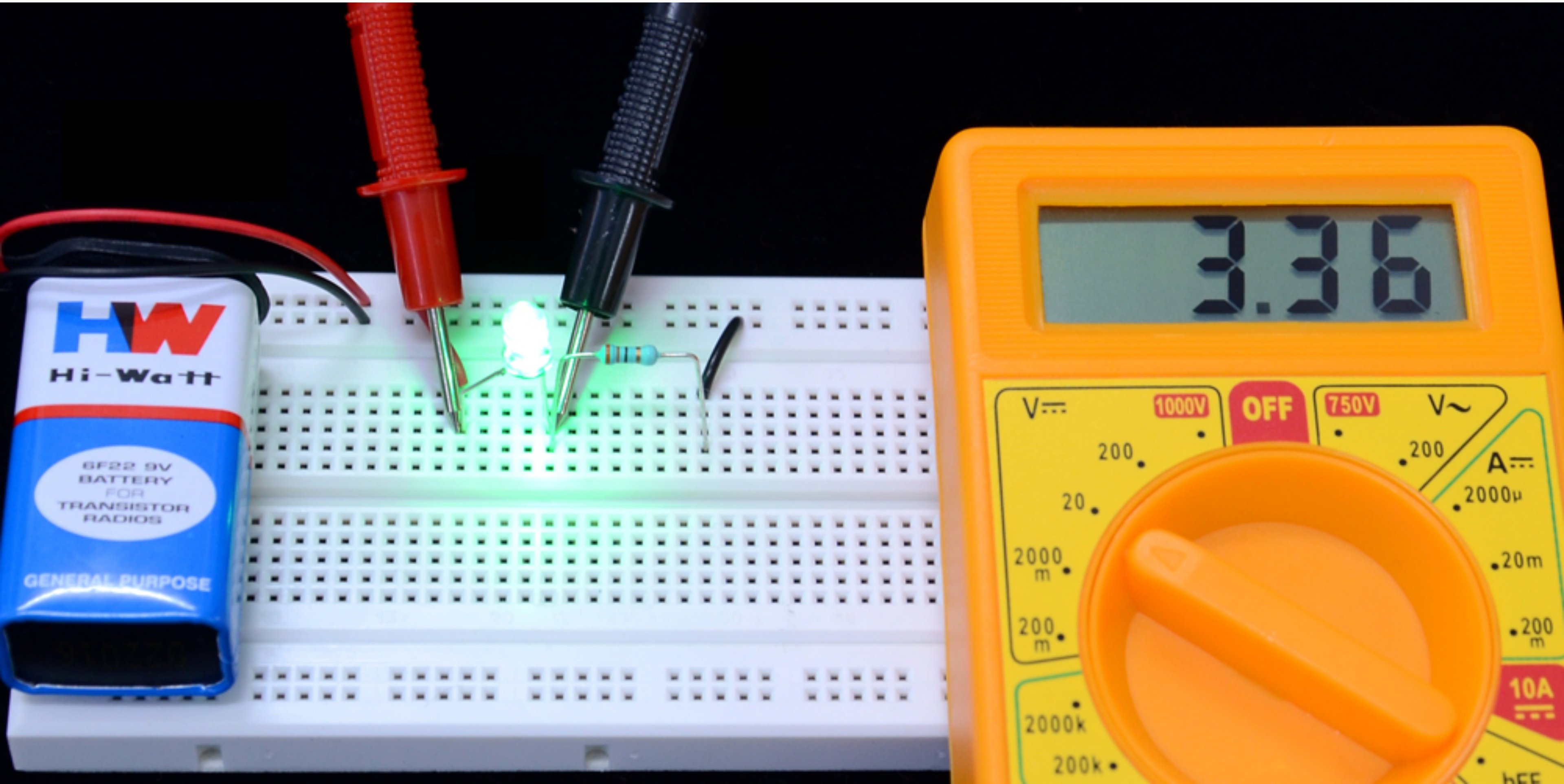
Now take out the multimeter and rotate its dial to 20 V DC.

Step No. 8

To measure voltage across the LED, connect the red and black probes to the positive and negative terminals of the LED, respectively. Let us call this voltage V_1. So, **V_1 = 3.36 V**.



Step No. 9

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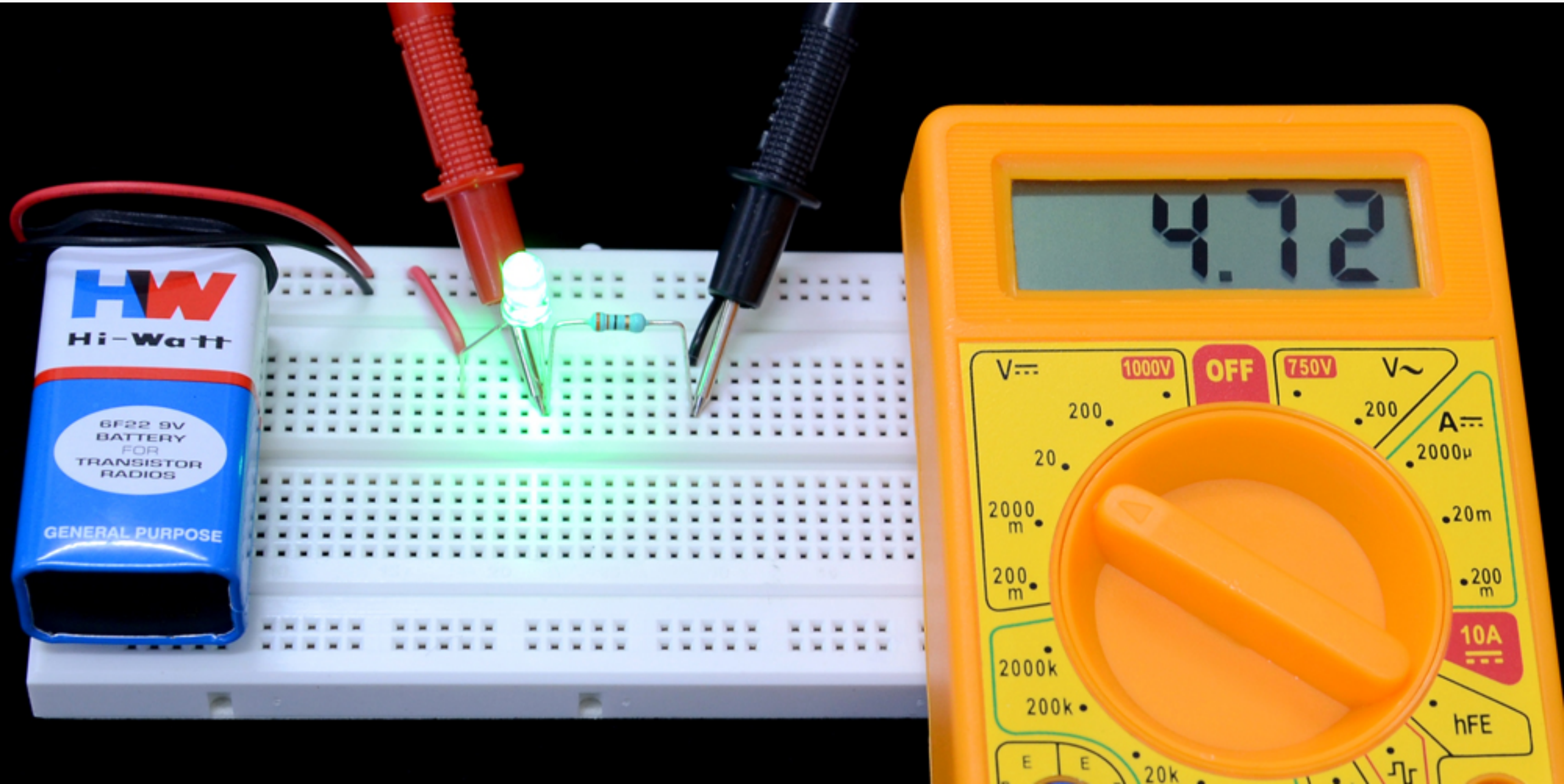
Similarly, measure the voltage across the resistor. Connect the red & black probes to the left and right legs of the resistor, respectively. Let us call this voltage V_2. So, $\mathbf{V_2 = 4.72\ V}$.



Observation

Voltage drop across the LED, $V_1 = 3.36$ V

Voltage drop across the resistor, $V_2 = 4.72$ V

Note: Your readings may differ.

Sum of voltage drops = $V_1 + V_2 = 3.36 + 4.72$

$= 9.6$ V

$\cong$ Battery Voltage (9 V)

$\cong$ Vcc

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Result

On adding the individual voltages across all components, we will find that the total voltage supplied by the battery (source) is divided among the LED and the resistor connected in series, i.e.,

$Vcc = V_1 + V_2$

This establishes Kirchhoff's Voltage Law (KVL) which states that the total voltage drop (sum of voltage drops) in a loop is zero.

i.e., $Vcc - V_1 - V_2 = 0$

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Troubleshooting Tips

- Ensure that the battery voltage is more than 6 volt.
- Ensure that the wires of the battery connector are properly inserted into the breadboard. The red wire should be inserted into the first row, and the black wire into the second row of the breadboard.
- Ensure that the LED is in working state using a multimeter.
- Ensure that the positive terminal (longer leg) of the LED is connected to Vcc, not the other way around.
- Ensure that the stripped ends of the connecting wires should be long enough to fit inside the holes of the breadboard completely.
- Ensure that there are no loose connections.

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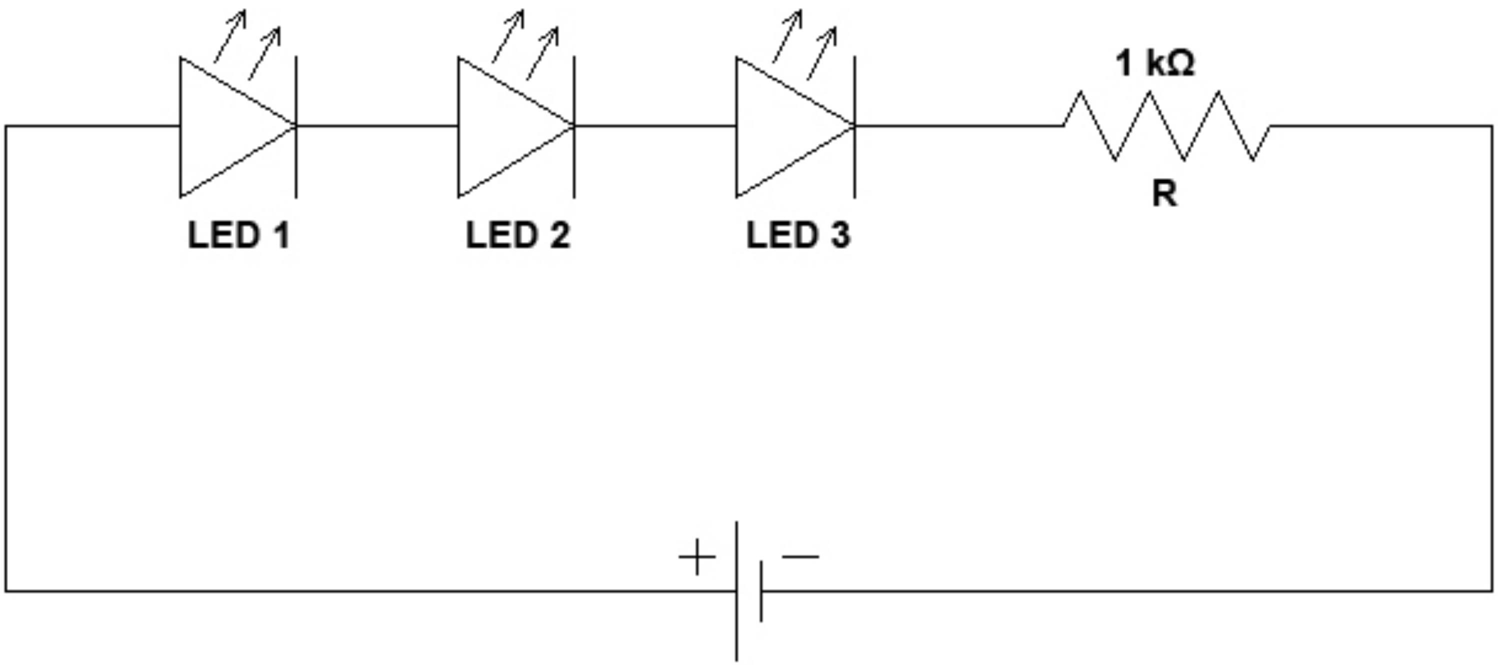
Activity

We can also extend the law for multiple components connected in series. To verify this, we will connect multiple LEDs in series in the next experiment, Series combination of LEDs.

Note: Disconnect (remove) all the components from the breadboard to build series combination of LEDs.

Circuit Diagram



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Materials Required

i. Breadboard - 1

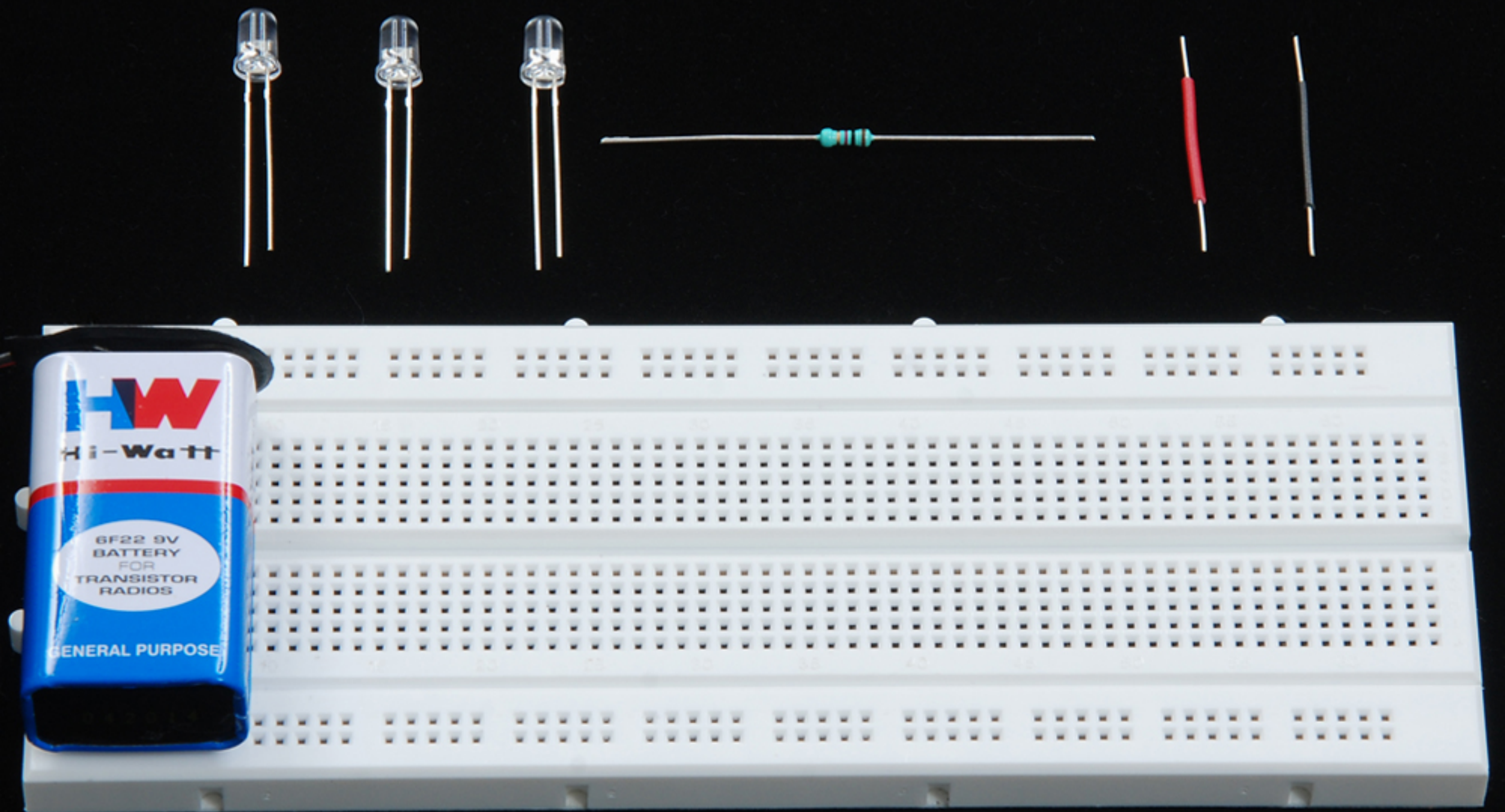
ii. LED - 3

iii. Resistor: 1 kΩ - 1

Colour Code: 1 kΩ - Brown Black Red Gold

iv. 9 V Battery - 1

v. Connecting Wire Pieces


HW
Hi-Watt
6F22 9V
BATTERY
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RADIOS
GENERAL PURPOSE

Step No. 10

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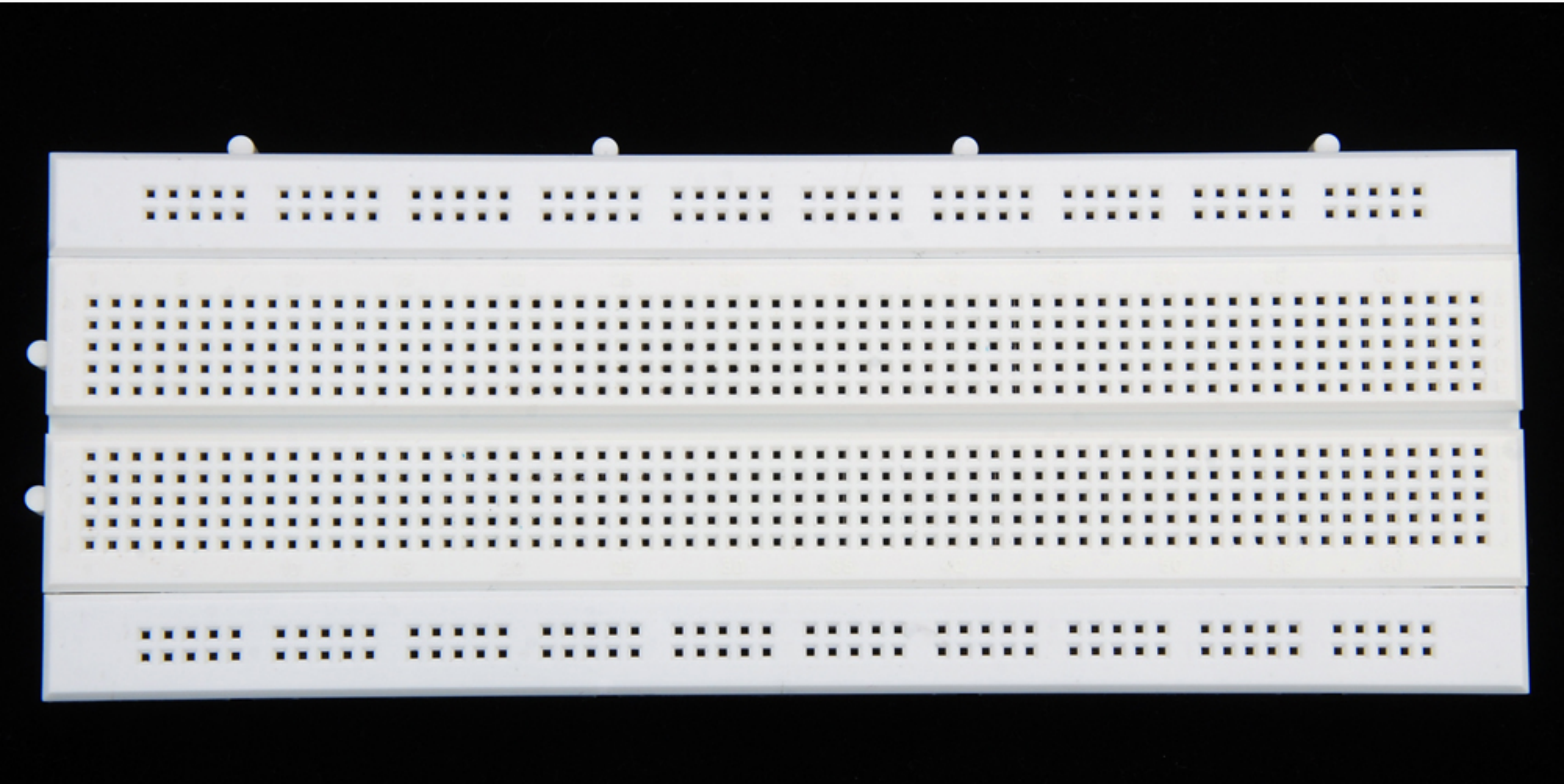
Take a breadboard.



Step No. 11

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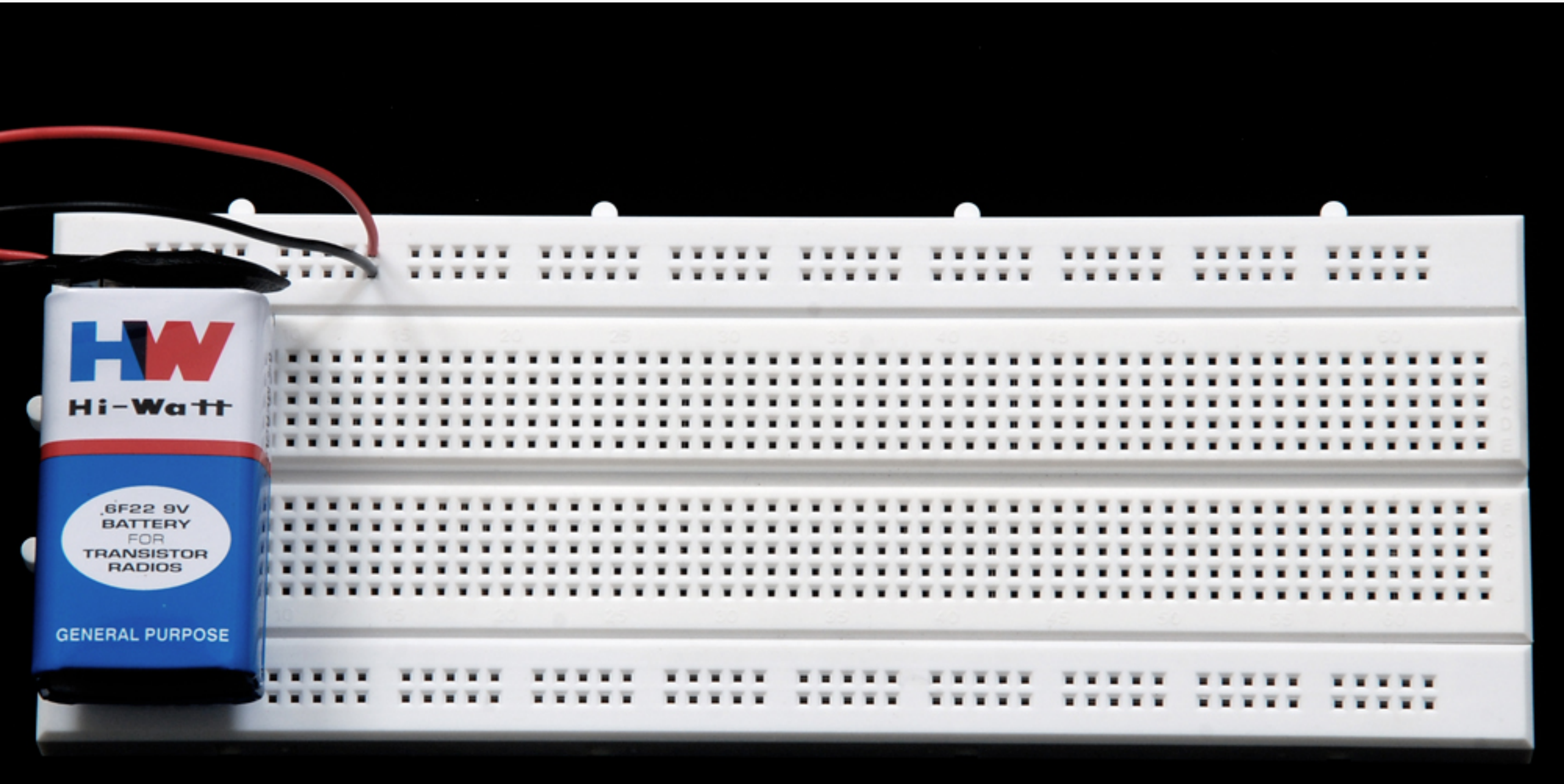
Connect a 9 V battery on the breadboard.



Step No. 12

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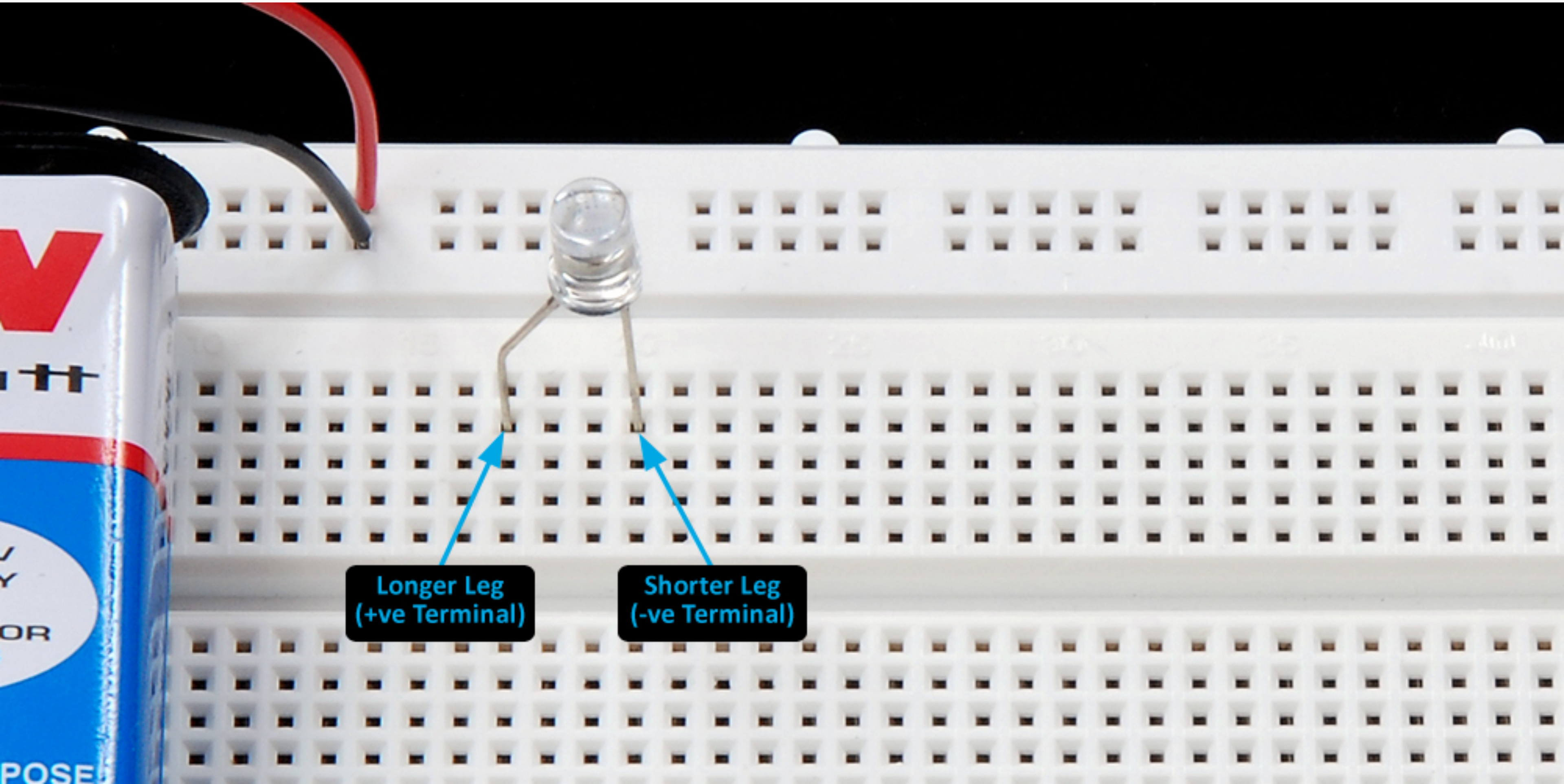
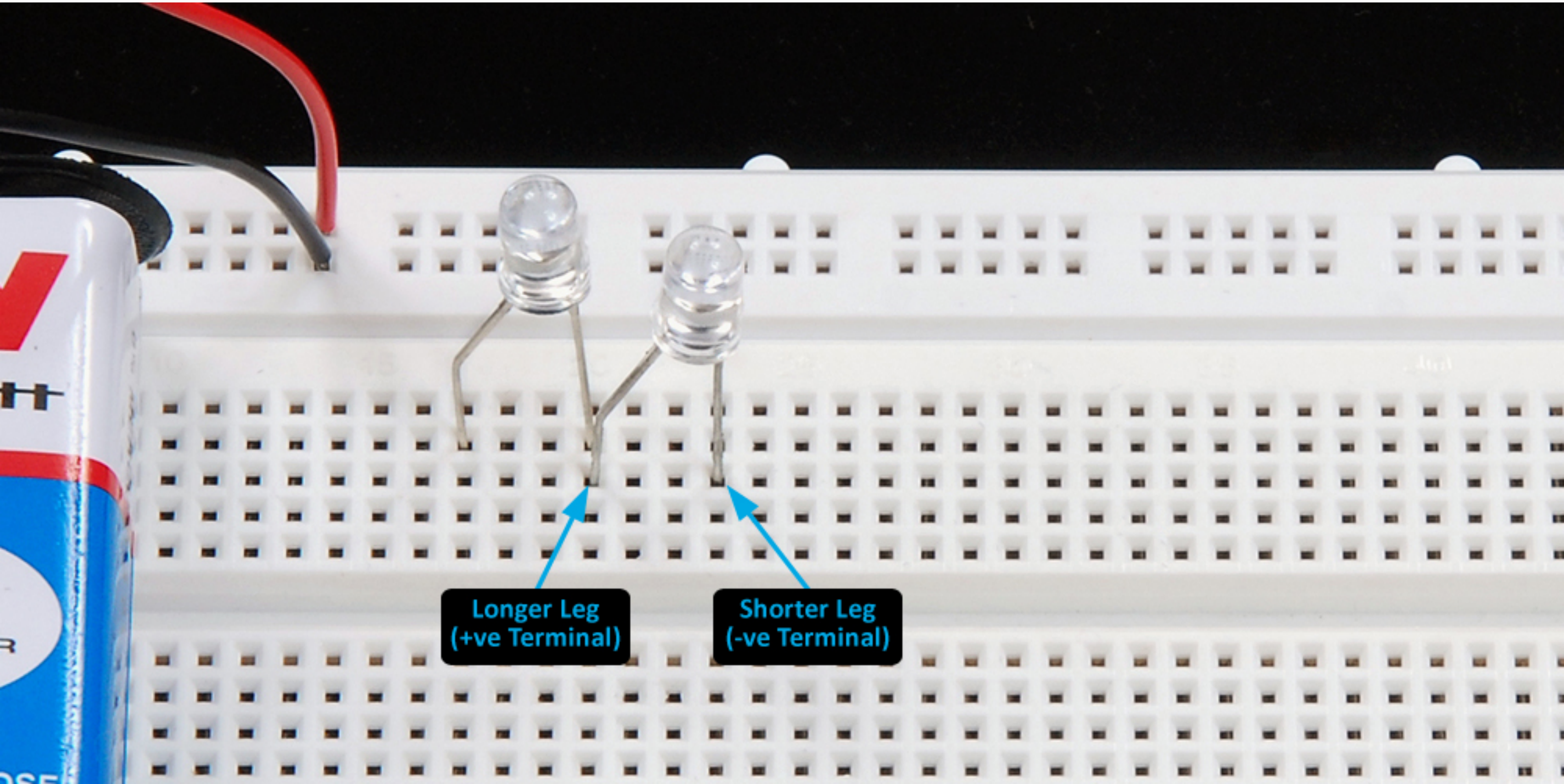
Connect an LED on the breadboard. Let us assume that this is LED_1.



Step No. 13

To combine two LEDs in series, connect the positive terminal of LED_2 to the negative terminal of LED_1. Connect the negative terminal of LED_2 to any different column of the breadboard.



Step No. 14

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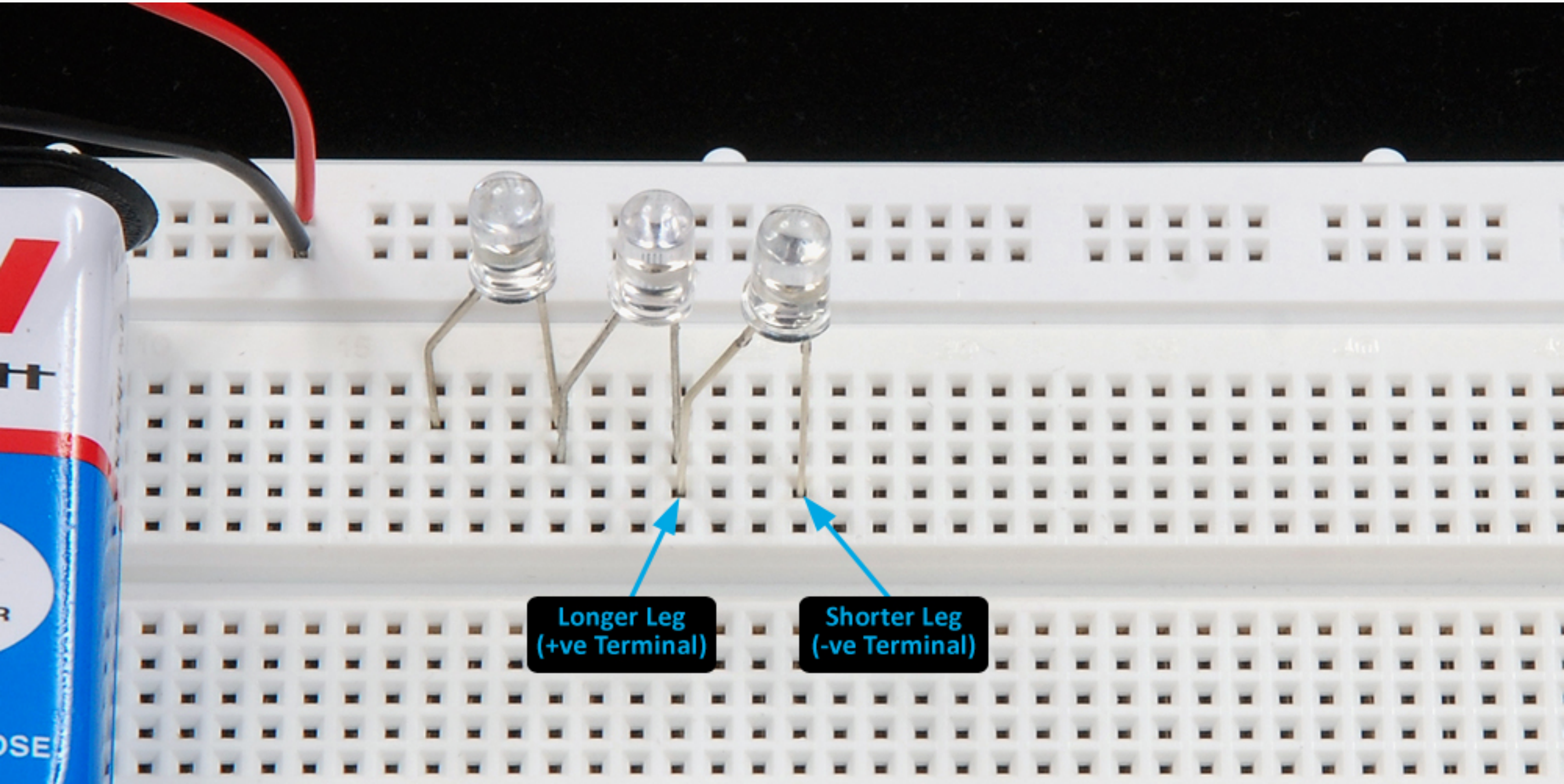
Similarly, connect the positive terminal of LED_3 to the negative terminal of LED_2. Connect the negative terminal of LED_3 to any different column of the breadboard.



Step No. 15

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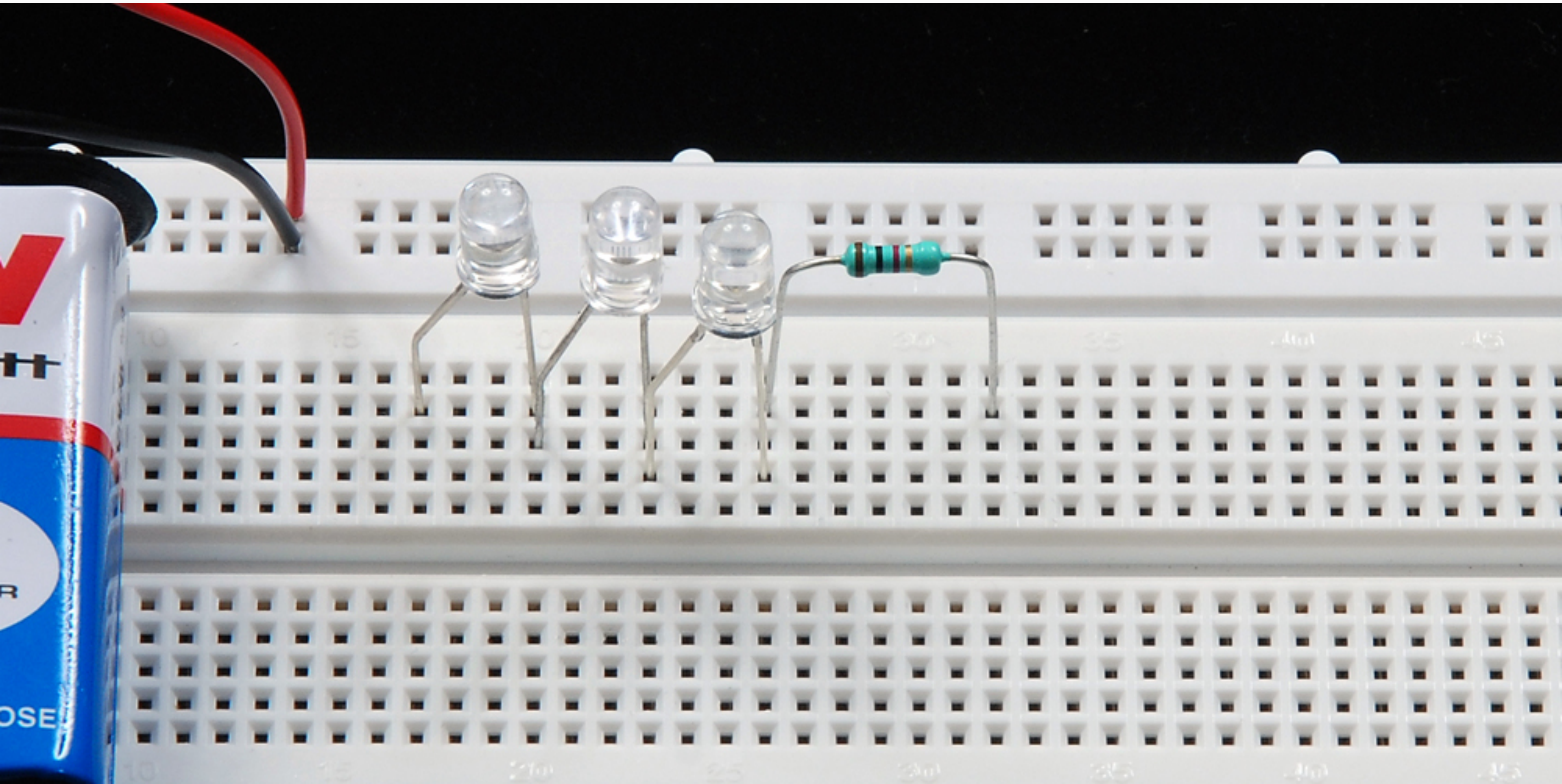
Connect one leg of a 1 kΩ resistor to the negative terminal of LED_3 and its other leg to any different column of the breadboard.



Step No. 16

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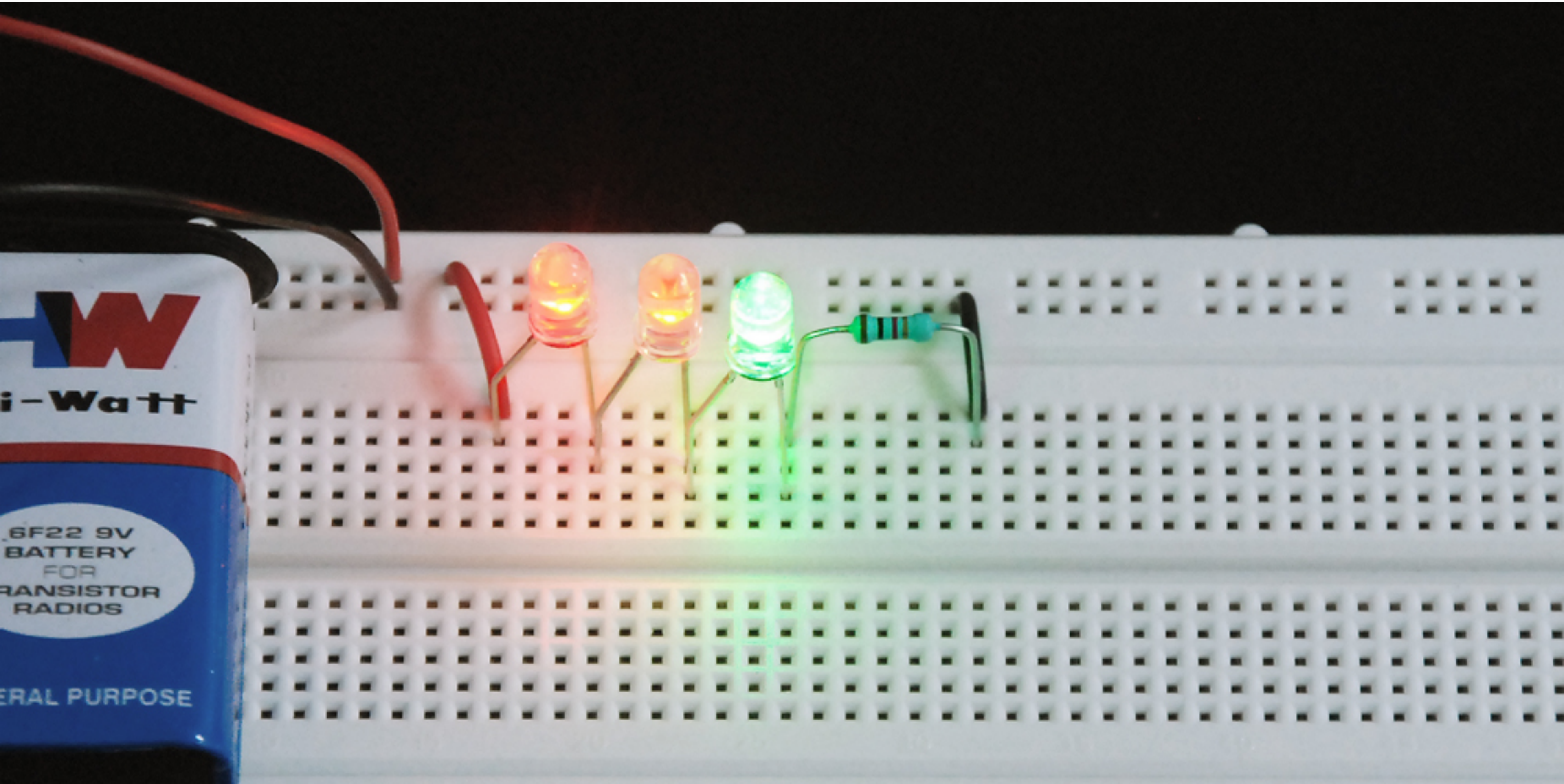
Connect the positive terminal of LED_1 to Vcc and the other leg of the resistor to ground. All the LEDs glow after the circuit is complete.



Activity

Measure the voltage across each LED and the 1 kΩ resistor using a multimeter. Add up all the individual voltages and check whether the sum equals the battery voltage.

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Step No. 17

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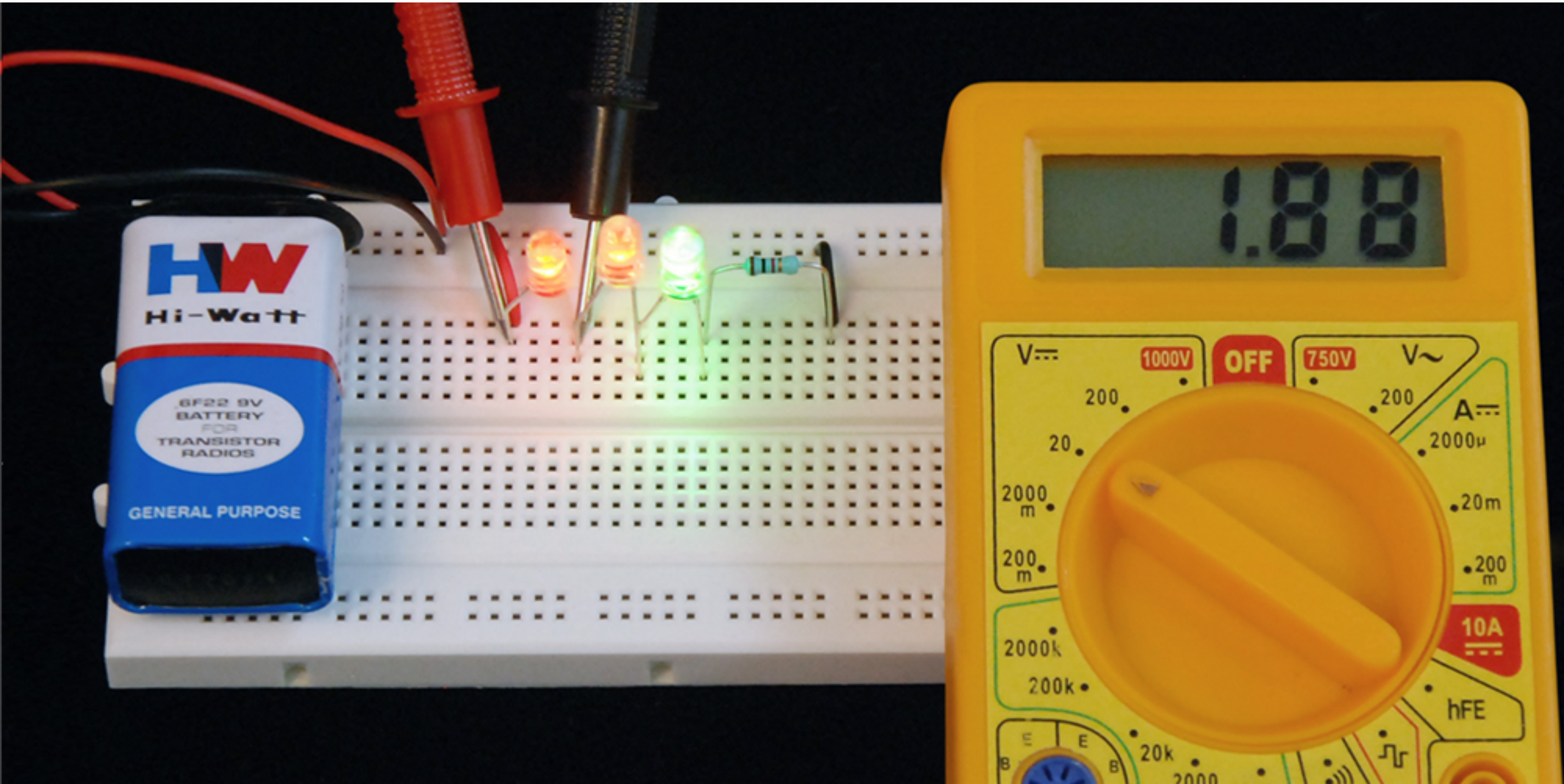
To measure voltage across LED_1, rotate the multimeter dial to 20 V DC. Connect the red probe of the multimeter to the positive terminal of LED_1 and the black probe to the negative terminal of the LED. The multimeter shows the reading; let us call it V_1. **So, V_1 = 1.88 V.**



Step No. 18

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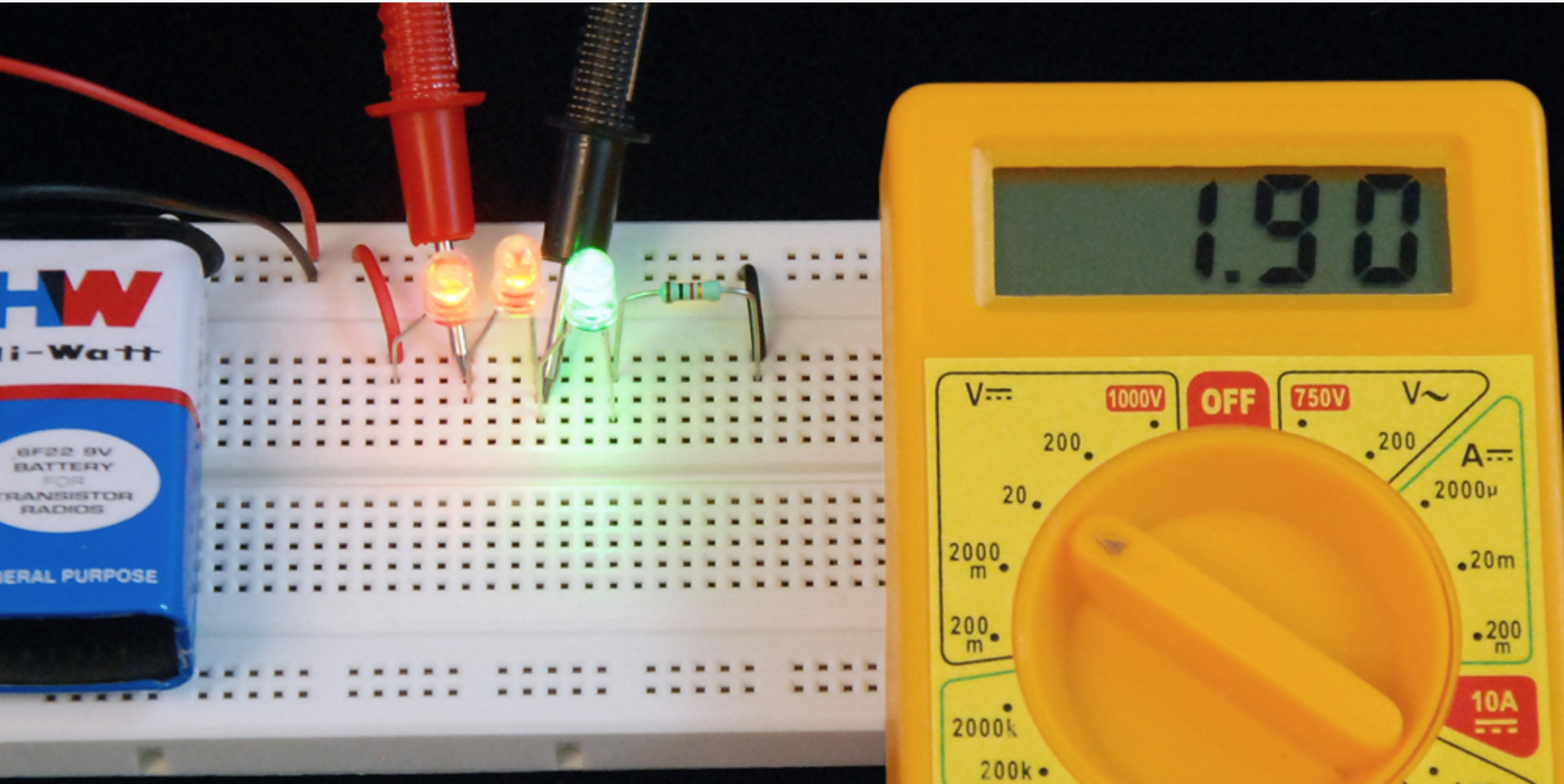
To measure voltage across LED_2, connect the red probe of the multimeter to positive terminal of LED_2 and the black probe to the negative terminal of the LED. The multimeter shows the reading; let us call it V_2. So, $\mathbf{V_2 = 1.9\ V}$.



Step No. 19

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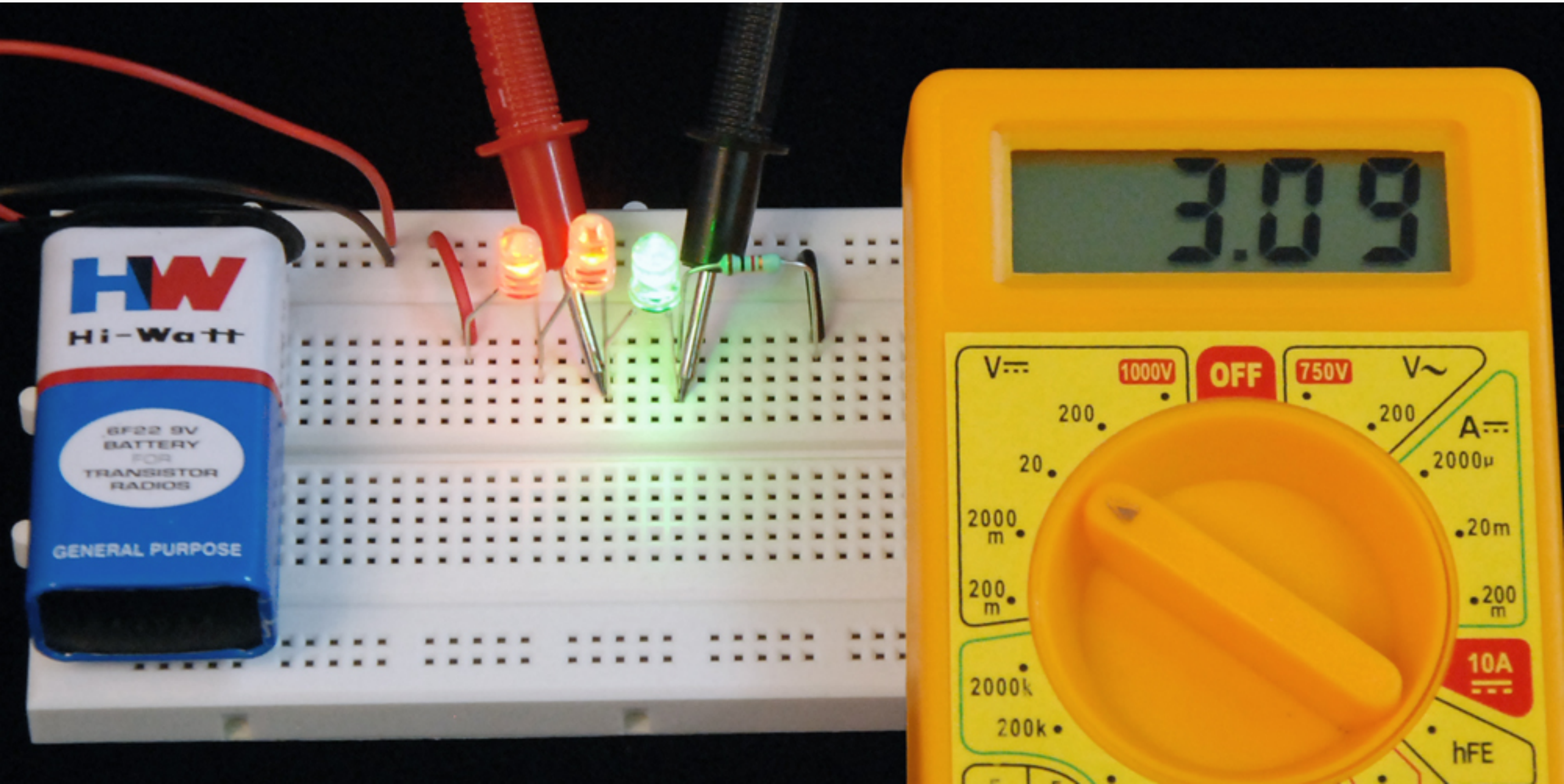
To measure voltage across LED_3, connect the red probe of the multimeter to positive terminal of LED_3 and the black probe to the negative terminal of the LED. The multimeter shows the reading; let us call it V_3. So, $\mathbf{V_3 = 3.09\ V}$.



Step No. 20

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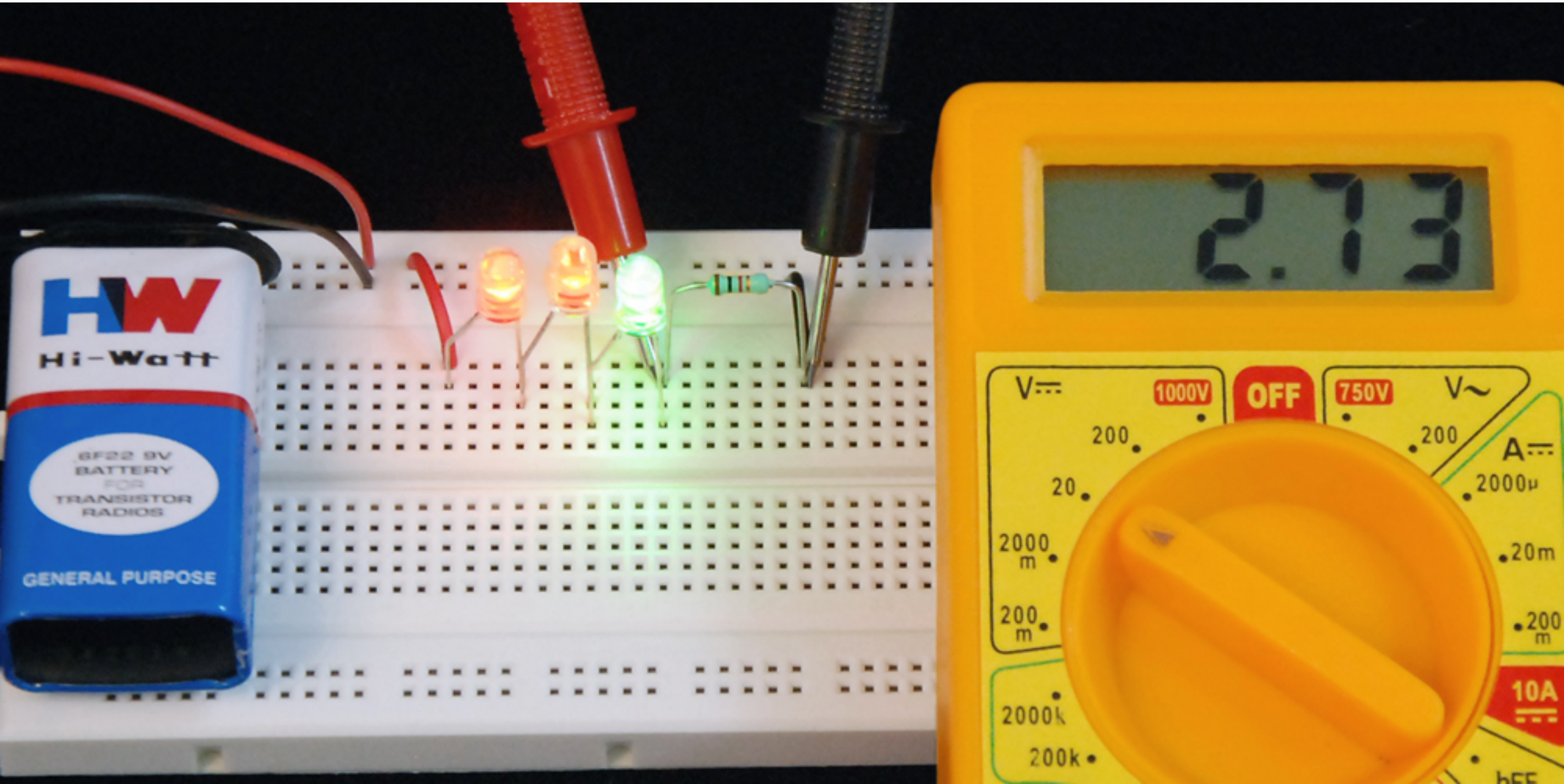
To measure voltage across the resistor, connect the two probes of the multimeter across the legs of the resistor. The multimeter shows the reading; let us call it V_4. So, $\mathbf{V_4 = 2.73\ V}$.



Observation

On completing the circuit, all the three LEDs in series glow.

Readings

Voltage across LED_1, V_1 = 1.88 V

Voltage across LED_2, V_2 = 1.9 V

Voltage across LED_3, V_3 = 3.09 V

Voltage across resistor, V_4 = 2.73 V

$$\begin{aligned} \text{Sum} = V_1 + V_2 + V_3 + V_4 &= 1.88 + 1.9 + 3.09 + 2.73 \\ &= 9.6\ \text{V} \\ &\cong \text{Battery Voltage} \\ &\cong \text{Vcc} \end{aligned}$$

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Result

On adding the individual voltages across all components, we will find that the total voltage supplied by the battery(source) is divided among all the components in series, i.e.,

$Vcc = V_1 + V_2 + V_3 + V_4$

This establishes Kirchhoff's Voltage Law (KVL) which states that the total voltage drop (sum of voltage drops) in a loop is zero.

i.e., $Vcc - V_1 - V_2 - V_3 - V_4 = 0$

Troubleshooting Tips

- Ensure that the battery voltage is more than 6 volt.
- Ensure that the wires of the battery connector are properly inserted into the breadboard. The red wire should be inserted into the first row, and the black wire into the second row of the breadboard.
- Ensure that all the LEDs are in working state using a multimeter.
- Ensure that the positive terminal of LED_1 is connected to Vcc.
- Ensure that the positive terminal of LED_2 is connected to the negative terminal of LED_1.

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Troubleshooting Tips

- Ensure that the positive terminal of LED_3 is connected to the negative terminal of LED_2.
- Restrict the circuit to the first half of the breadboard. To provide Vcc and ground with connecting wires, use only first 25 holes of the first and second row of the breadboard.
- Ensure that the stripped ends of the connecting wires should be long enough to fit inside the holes of the breadboard completely.
- Ensure that there are no loose connections.

Project Report

To write project report, refer the following experiments from the manual:

a) Glowing an LED
b) Series Combination of LEDs

In the report, do include the following:
a) Circuit diagram, Circuit Explanation
b) Final circuit picture
c) Pictures of 'Multimeter readings': Step No. 17, Step No. 18, Step No. 19 and Step No. 20
d) Observation
e) Reasoning (if any)
f) Result (if any)
g) General Theory: About components used (LED, resistor, multimeter, DC battery), about series combination.

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Result

Precaution

Notes

Circuit

Measure

Activity

Advantages

Modification

Do you know?

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