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Electronic Series, KIT-1

Experiment 57:
Joule Thief

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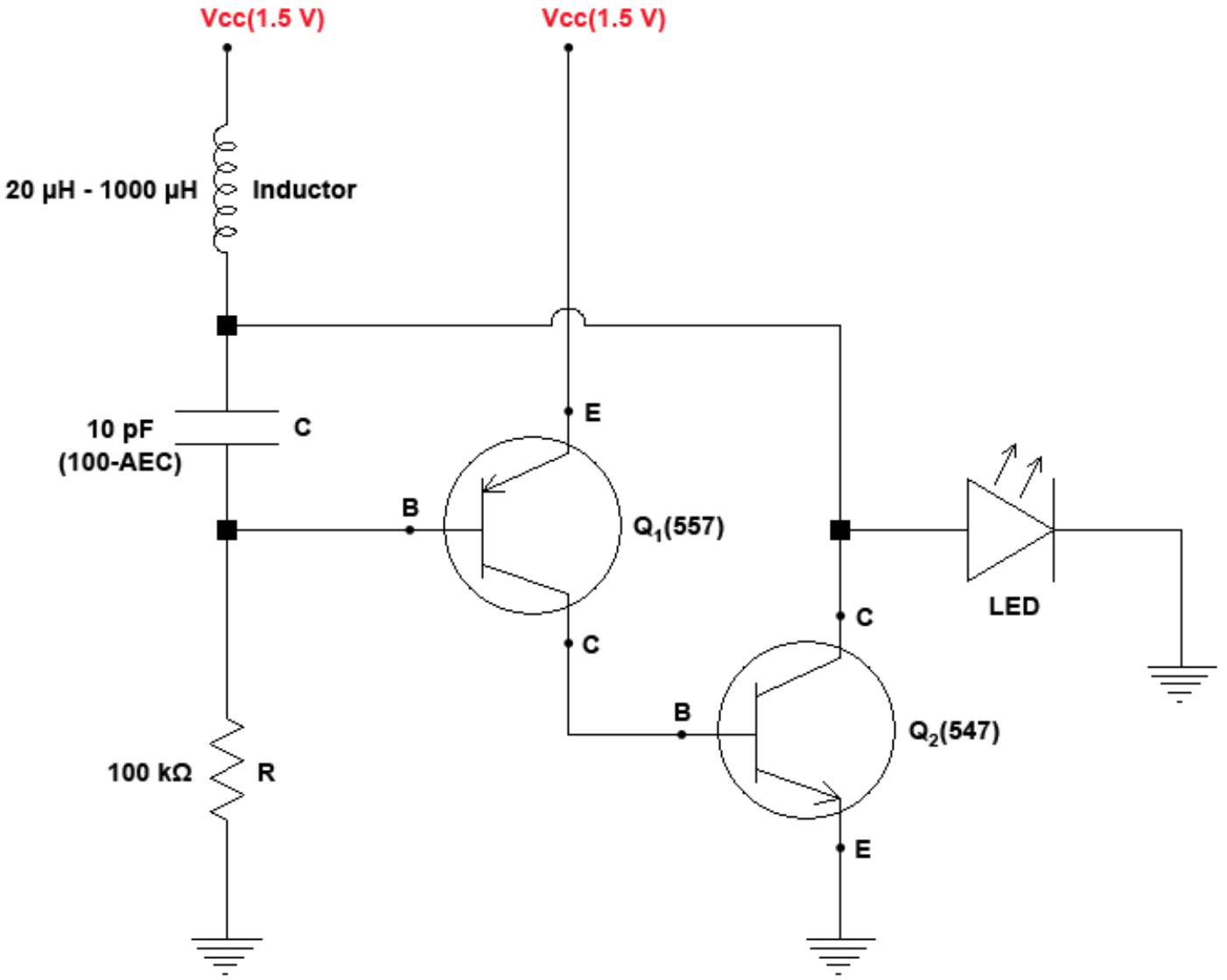
Circuit Diagram



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Materials Required

i. Breadboard - 1

ii. 1.2 V AA Cell - 1

iii. Transistor: BC557 - 1, 547 B - 1

iv. Capacitor: 10 pF - 1 (100-AEC)

v. LED - 1

vi. Resistor: 100 kΩ - 1
Colour Code: 100 kΩ - Brown Black Yellow Gold

vii. Inductor - 1

viii. Connecting Wire Pieces

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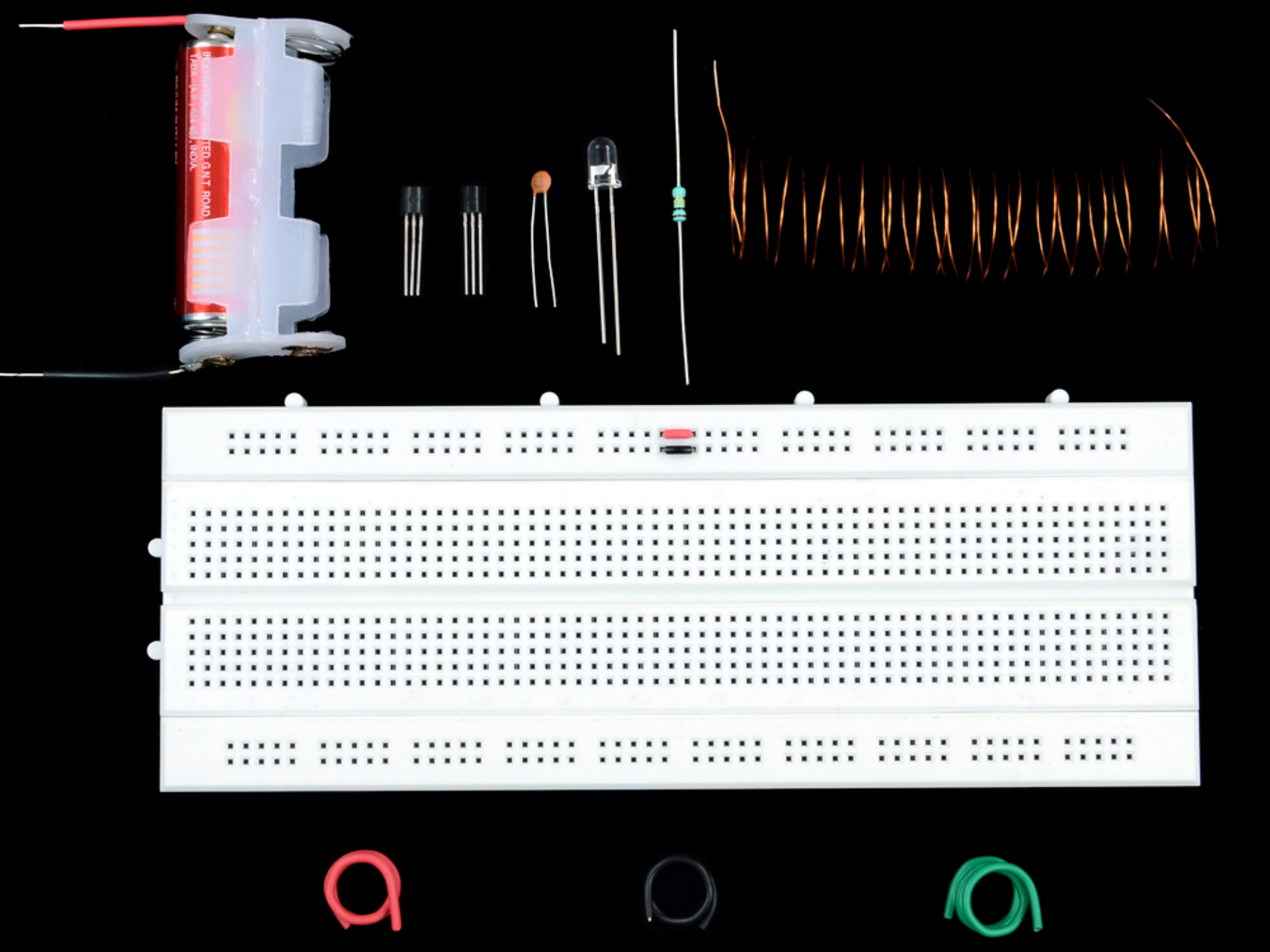
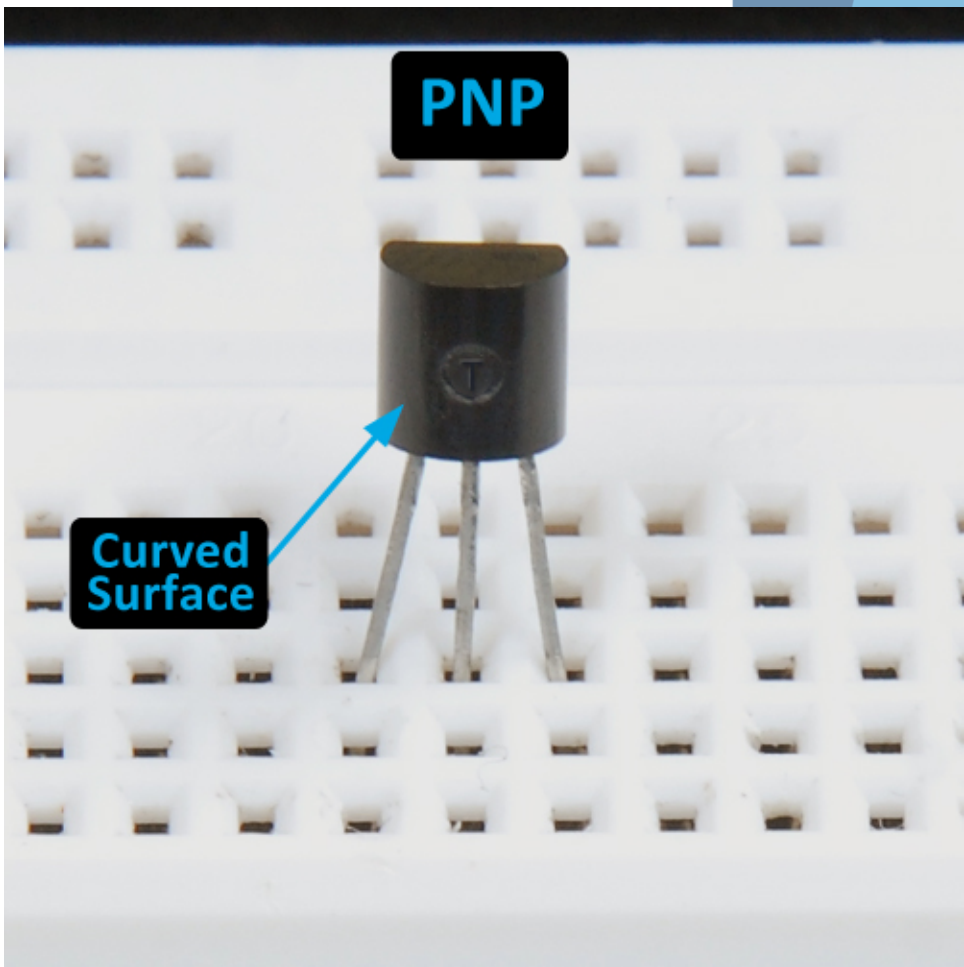


Points to Remember

A PNP transistor has three legs, namely, Emitter (E), Base(B) and Collector (C). BC-557 is a PNP transistor.

‘To identify the legs, we will keep the transistor such that the curved surface faces us. Starting from the left side, the first leg is the emitter, the second is the base and the third is the collector.’



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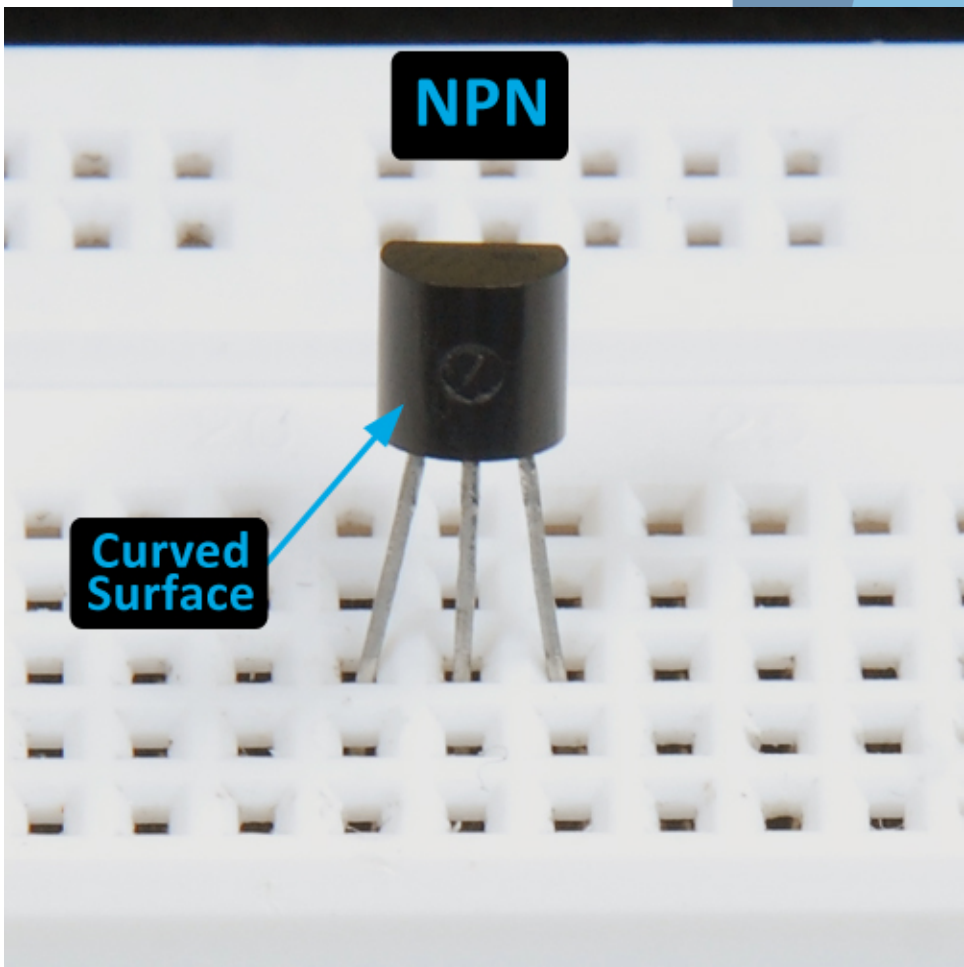
Points to Remember

An NPN transistor has three legs, namely, Emitter (E), Base(B) and Collector (C). 547-B is an NPN transistor.

'To identify the legs, we will keep the transistor such that the curved surface faces us. Starting from the left side, the first leg is the emitter, the second is the base and the third is the collector.'



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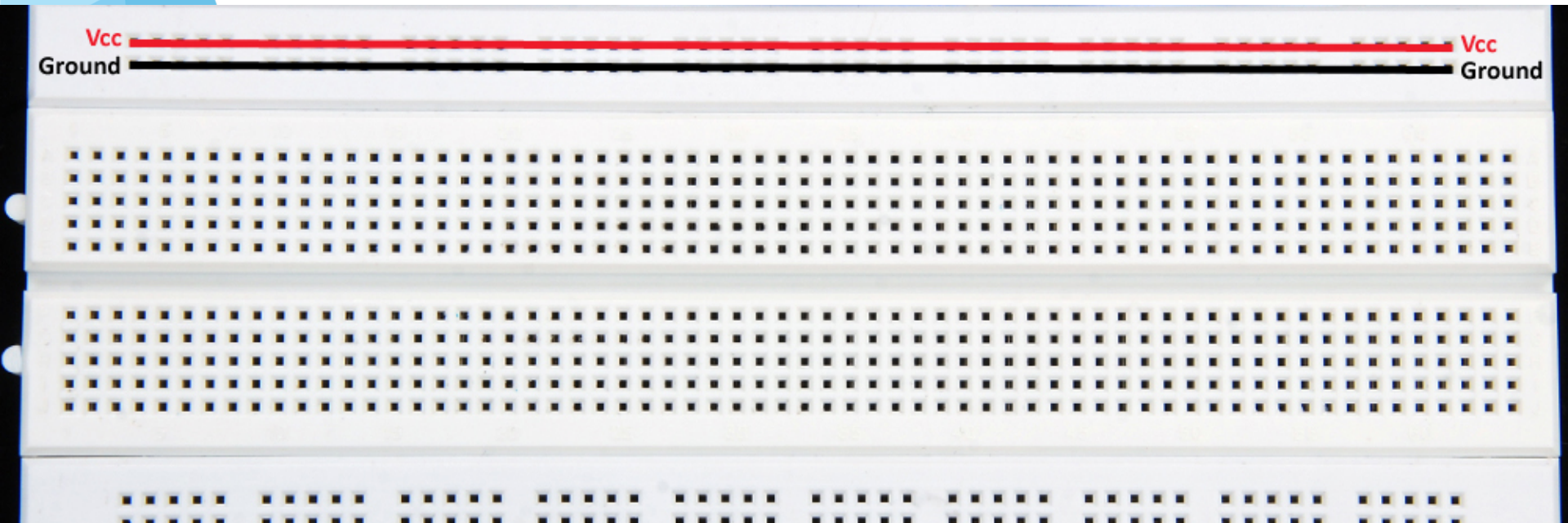
Points to Remember

• In this experiment, first we will build the circuit, and then provide the supply through a cell.

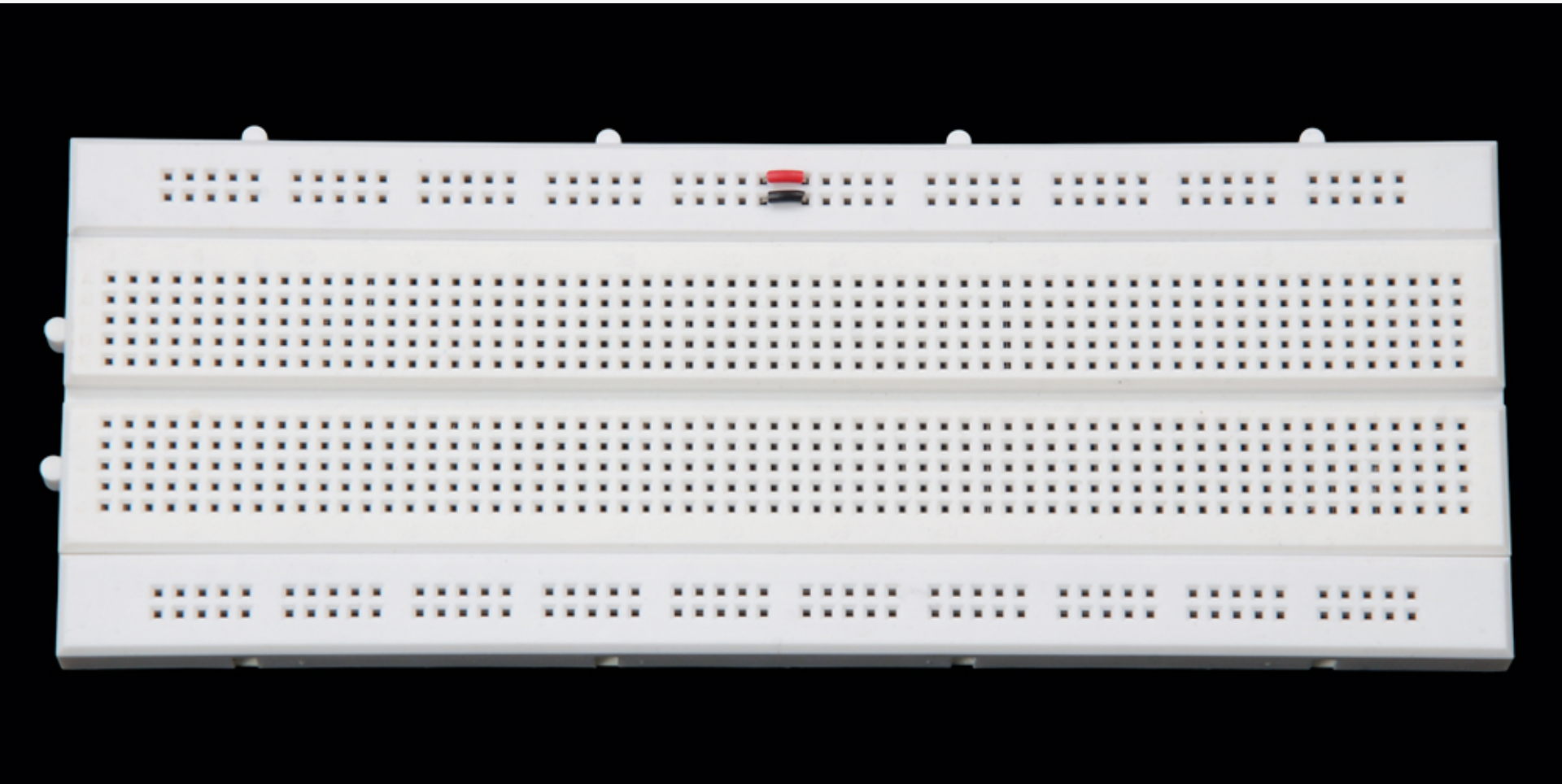
• Assume that the first and second rows of the upper half of the breadboard consists of Vcc and ground,respectively.

• After completing the circuit, we will connect the red wire of the cell holder to the first row and the black wire to the second row of the breadboard.



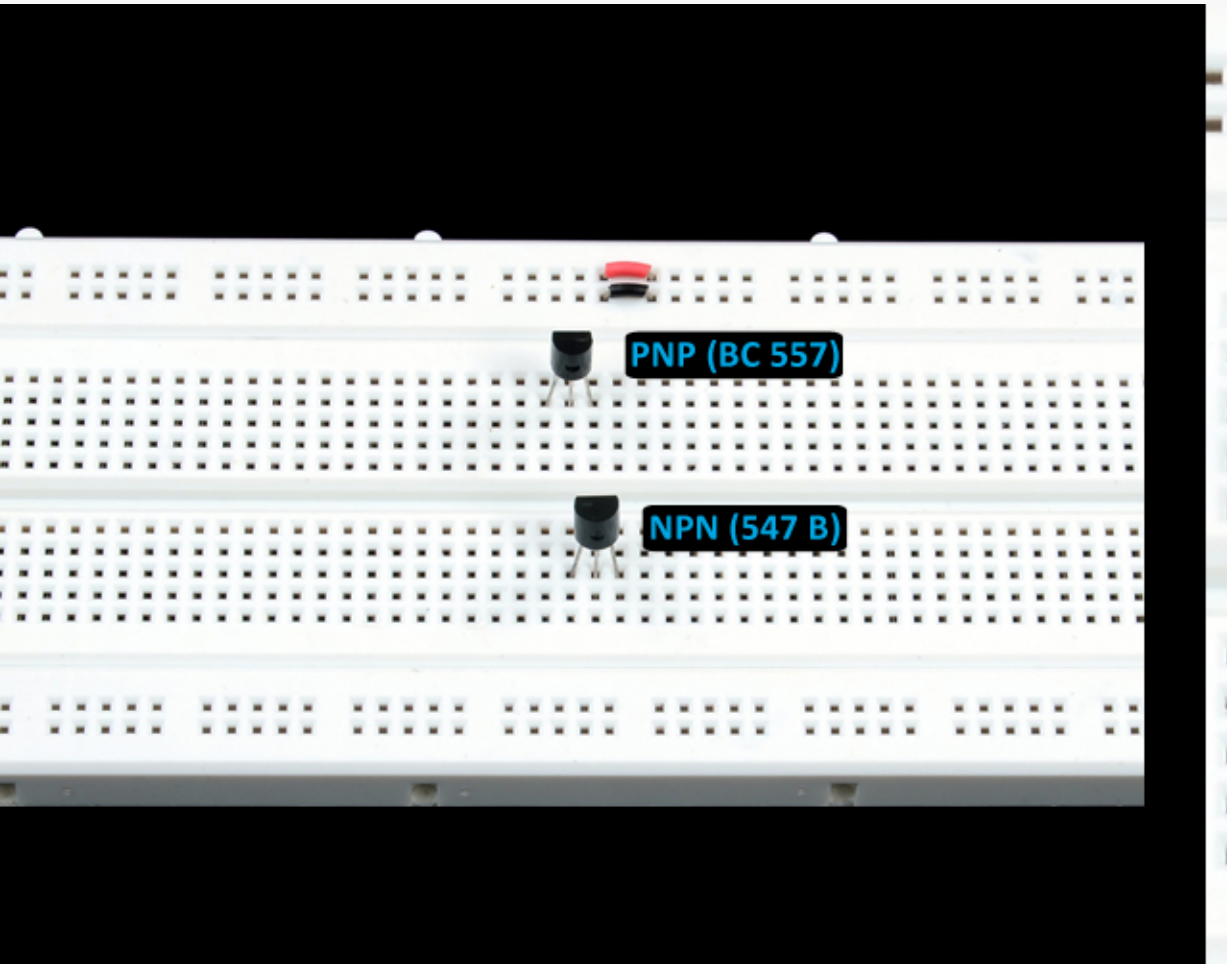
Step No. 1

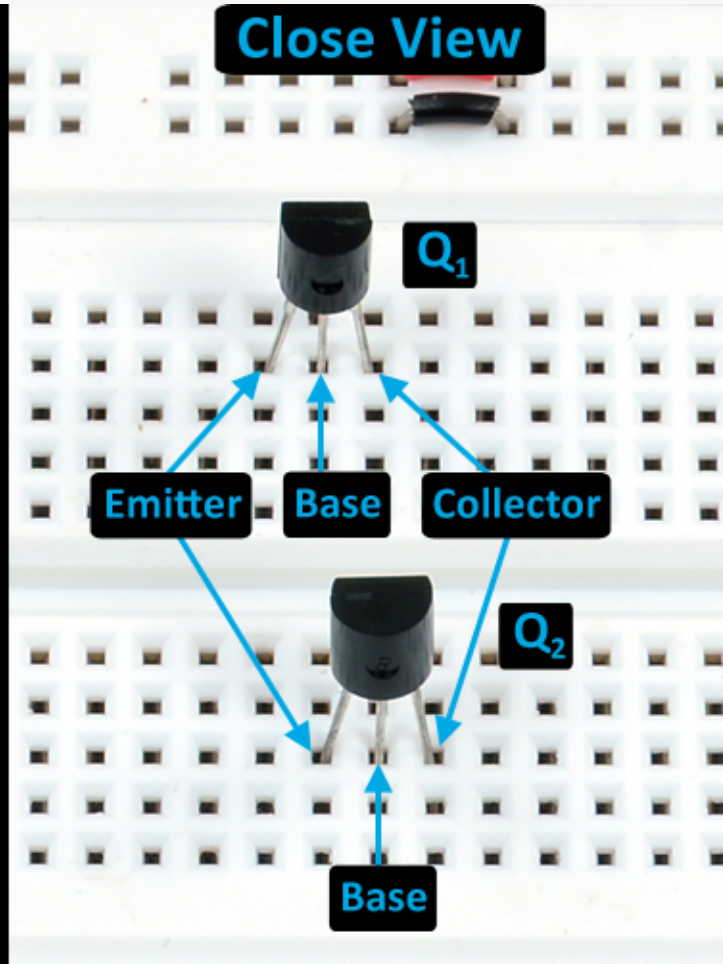
Take a breadboard and connect its two halves as shown in figure below.



Step No. 2

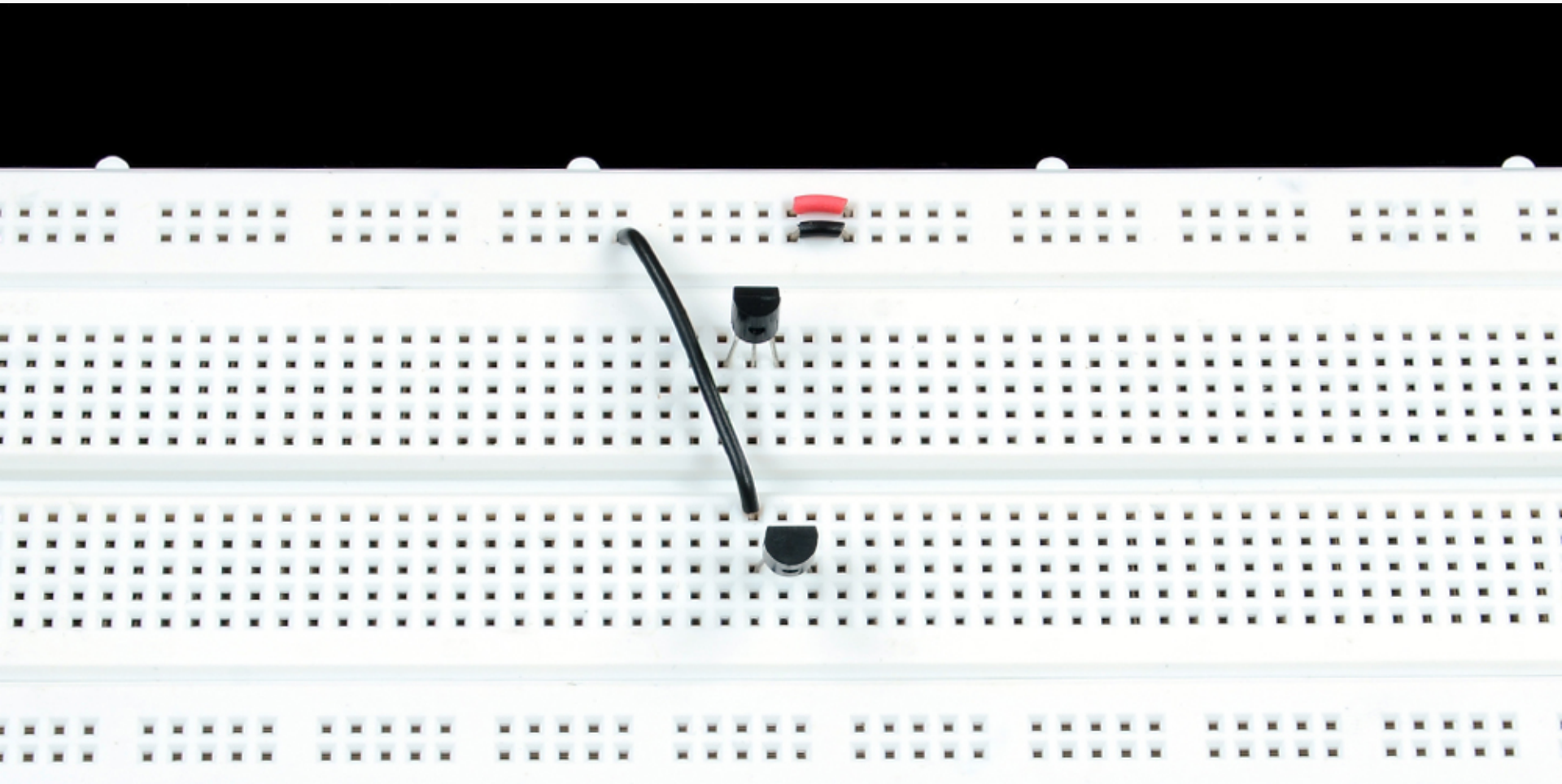
Connect a PNP (Q_1) and an NPN (Q_2) transistor on the upper and the lower halves the breadboard, respectively. Connect the two transistors such that their legs are inserted in different columns, and their curved surfaces should face you.





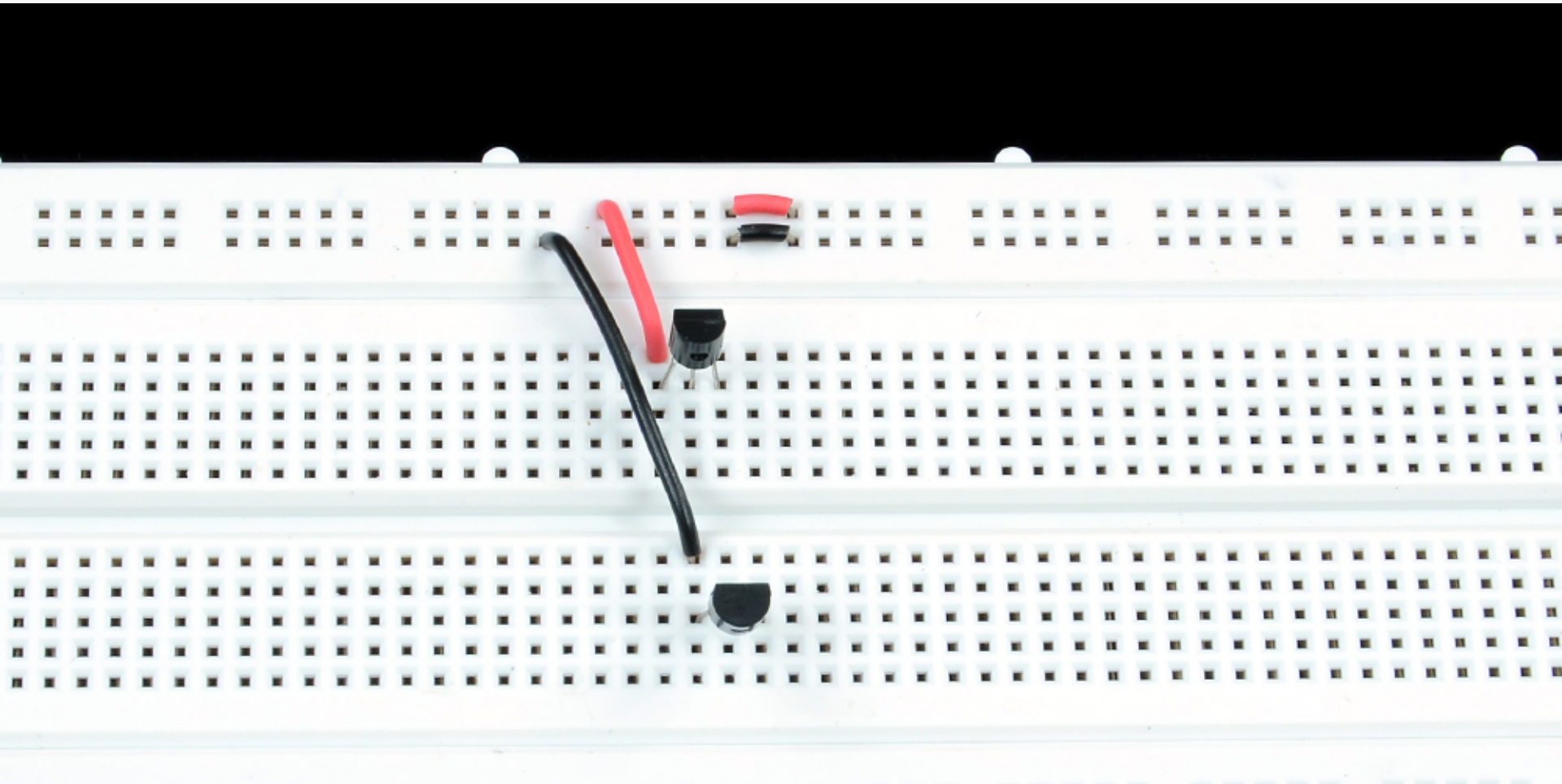
Step No. 3

Connect the emitter of Q_2 to ground.



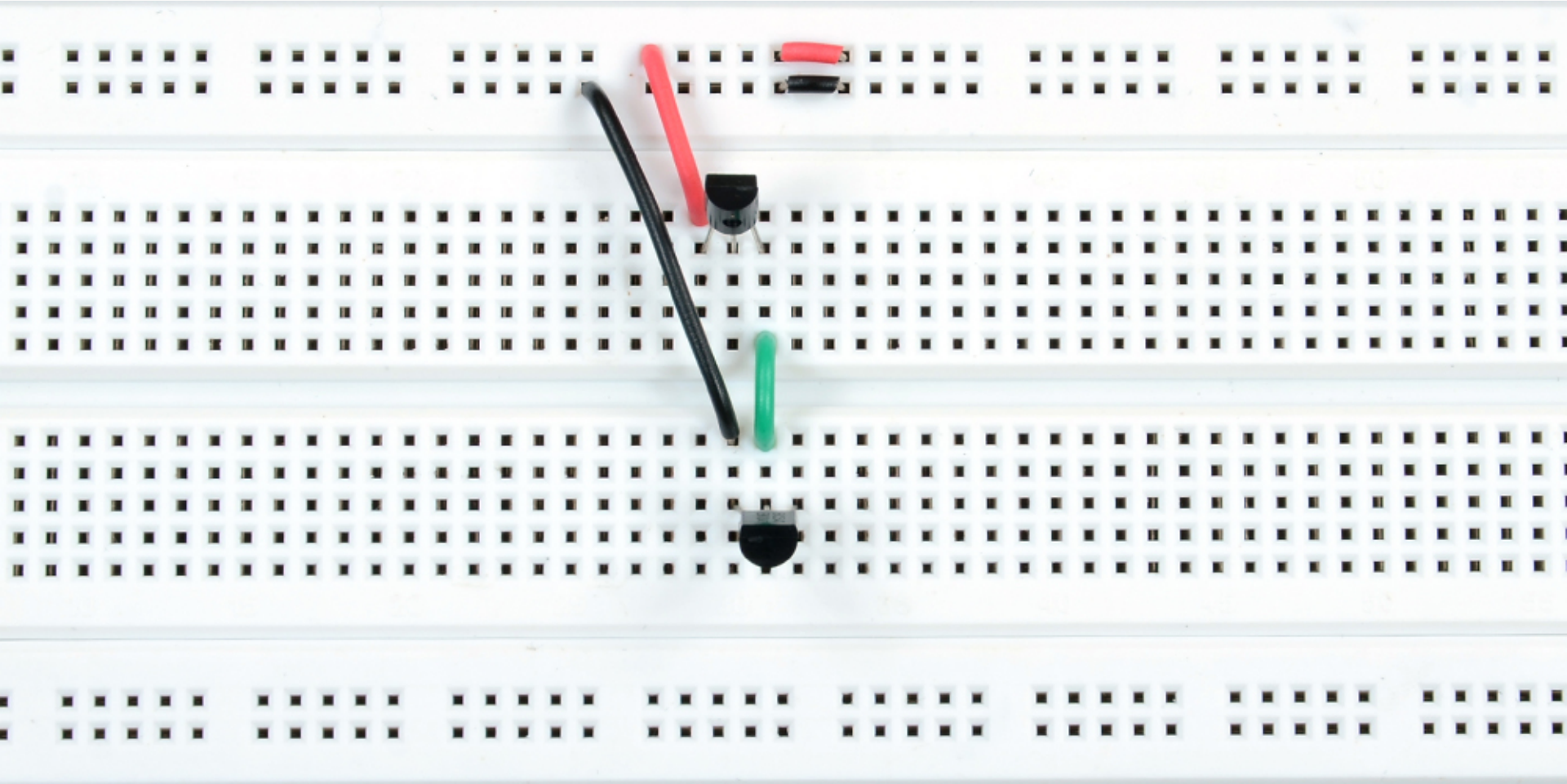
Step No. 4

Connect the emitter of Q_1 to Vcc.



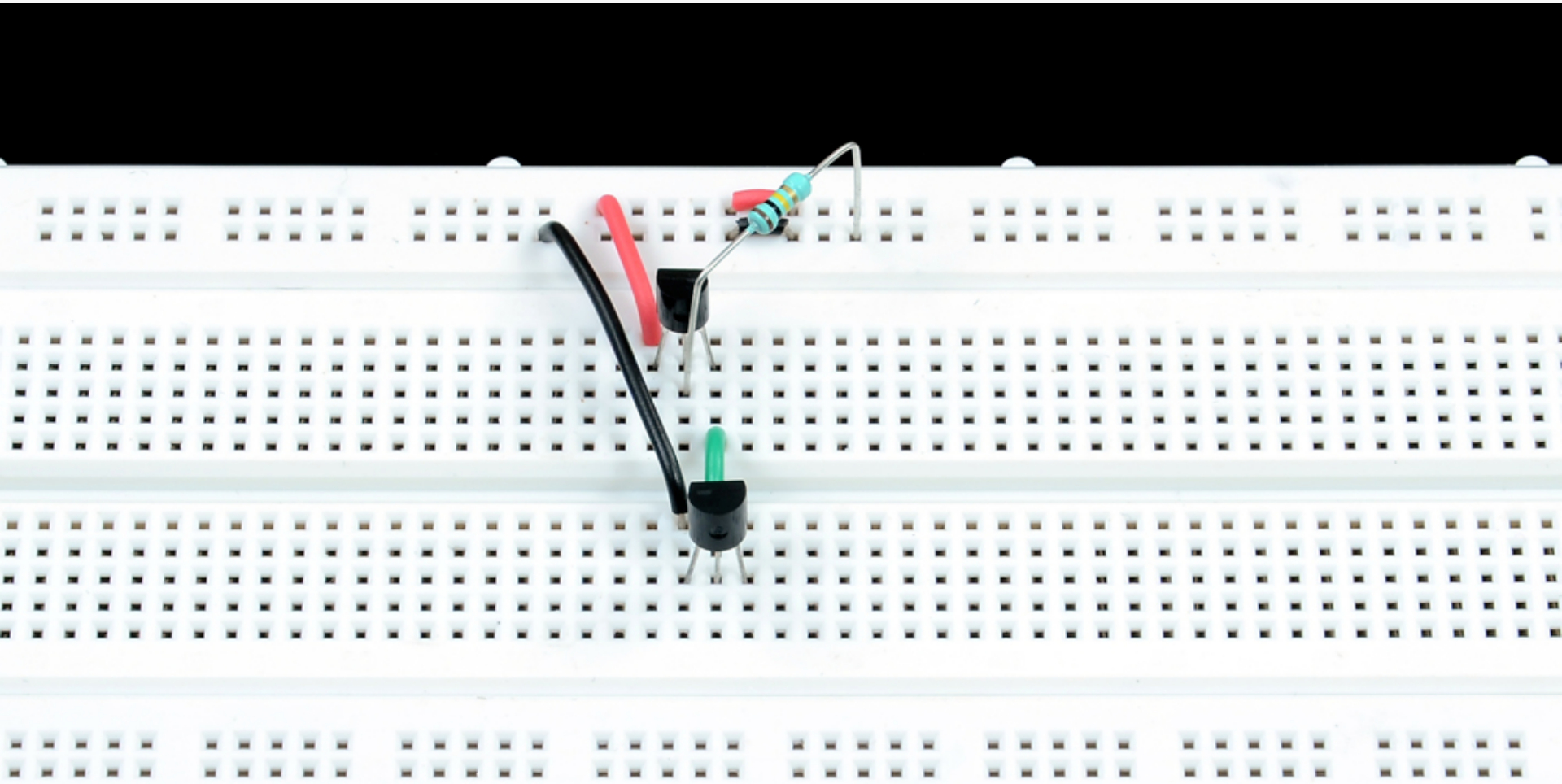
Step No. 5

Connect the collector of Q_1 to the base of Q_2 (shown by green wire in figure below).



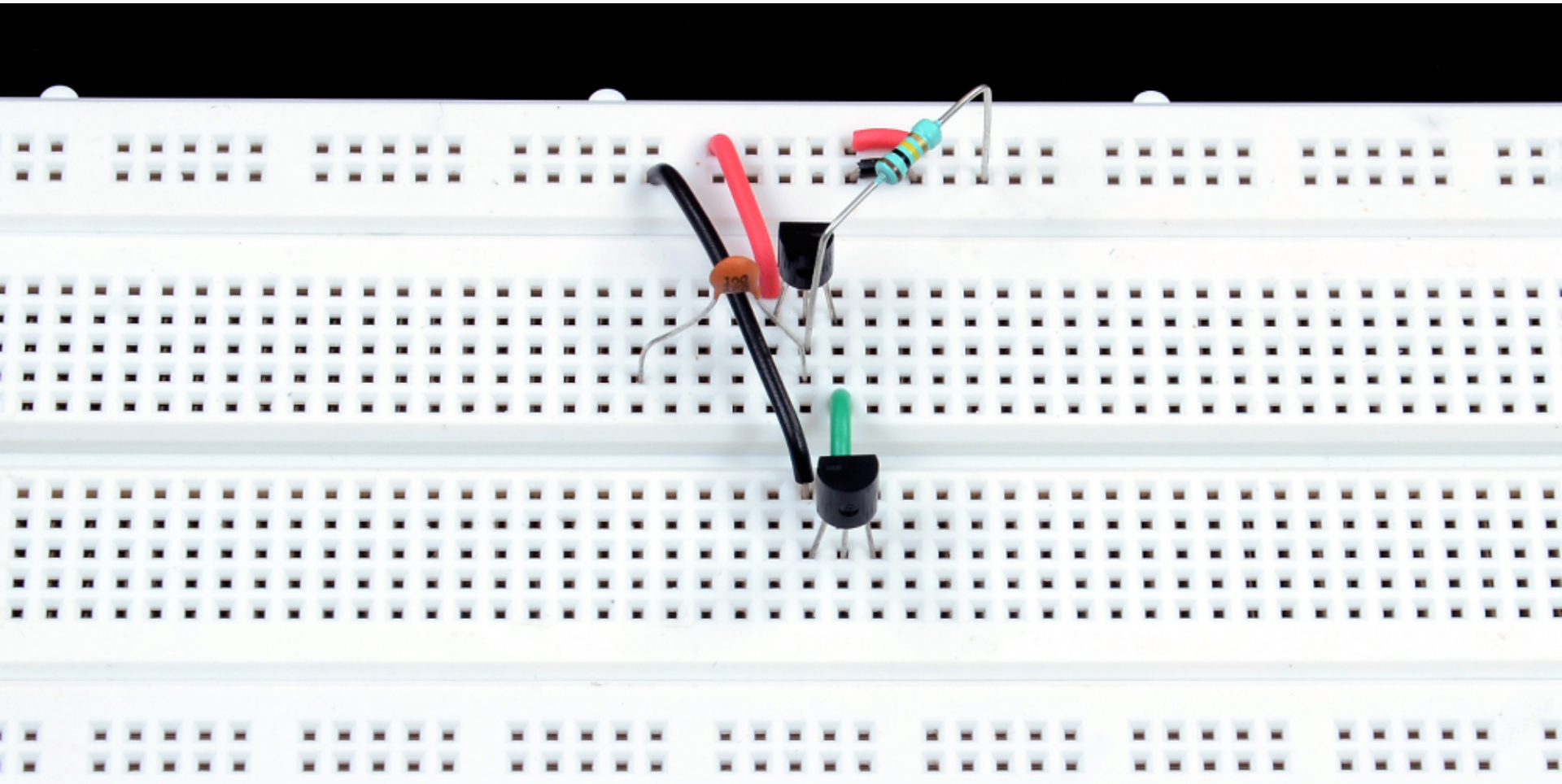
Step No. 6

Take a 100 kΩ resistor and connect its one leg to the base of Q_1.
Then connect its other leg to ground.



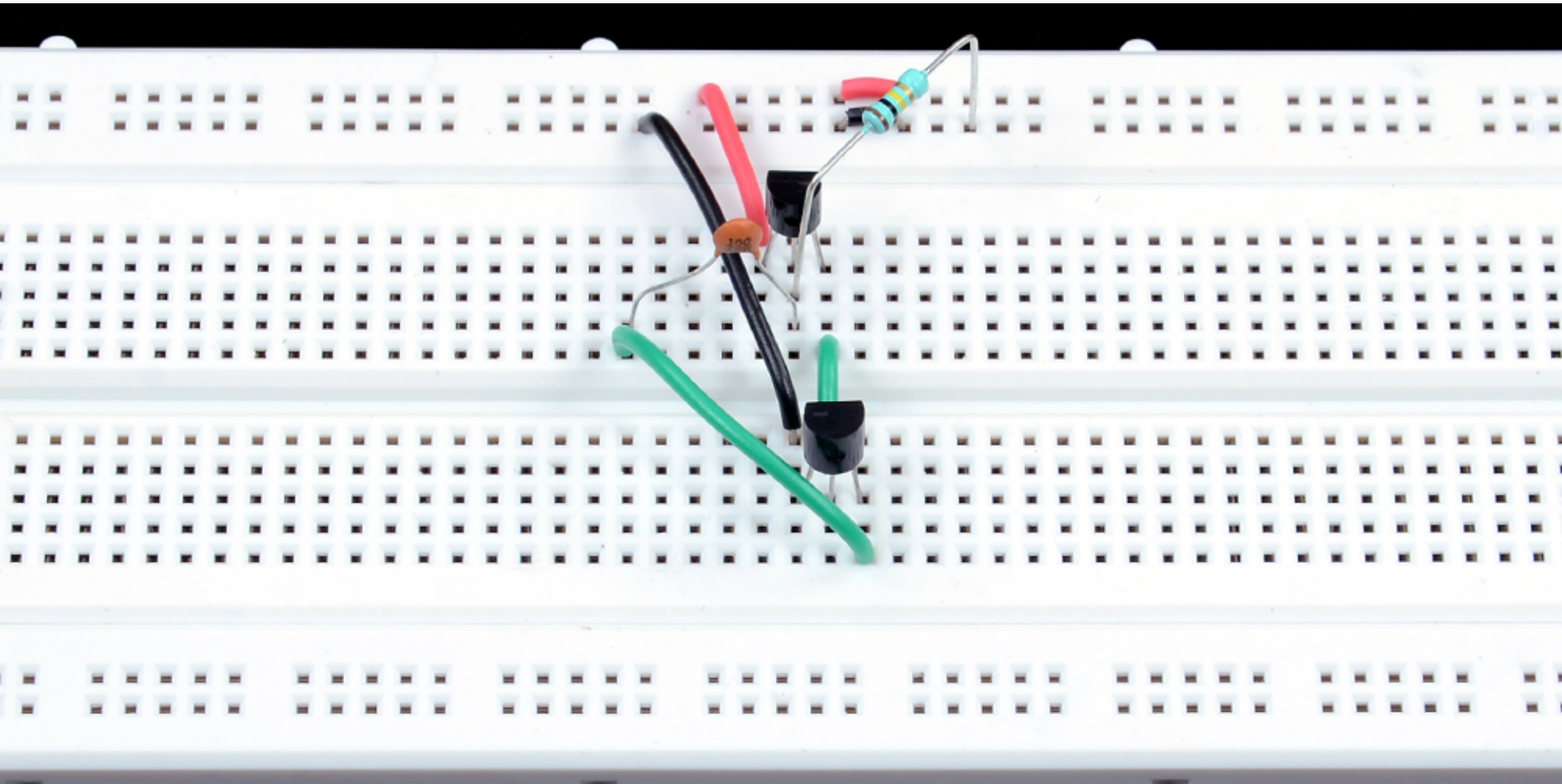
Step No. 7

Take a 10 pf (100 AEC) capacitor and connect its one leg to the base of Q_1. Connect its other leg to any different column of the breadboard.



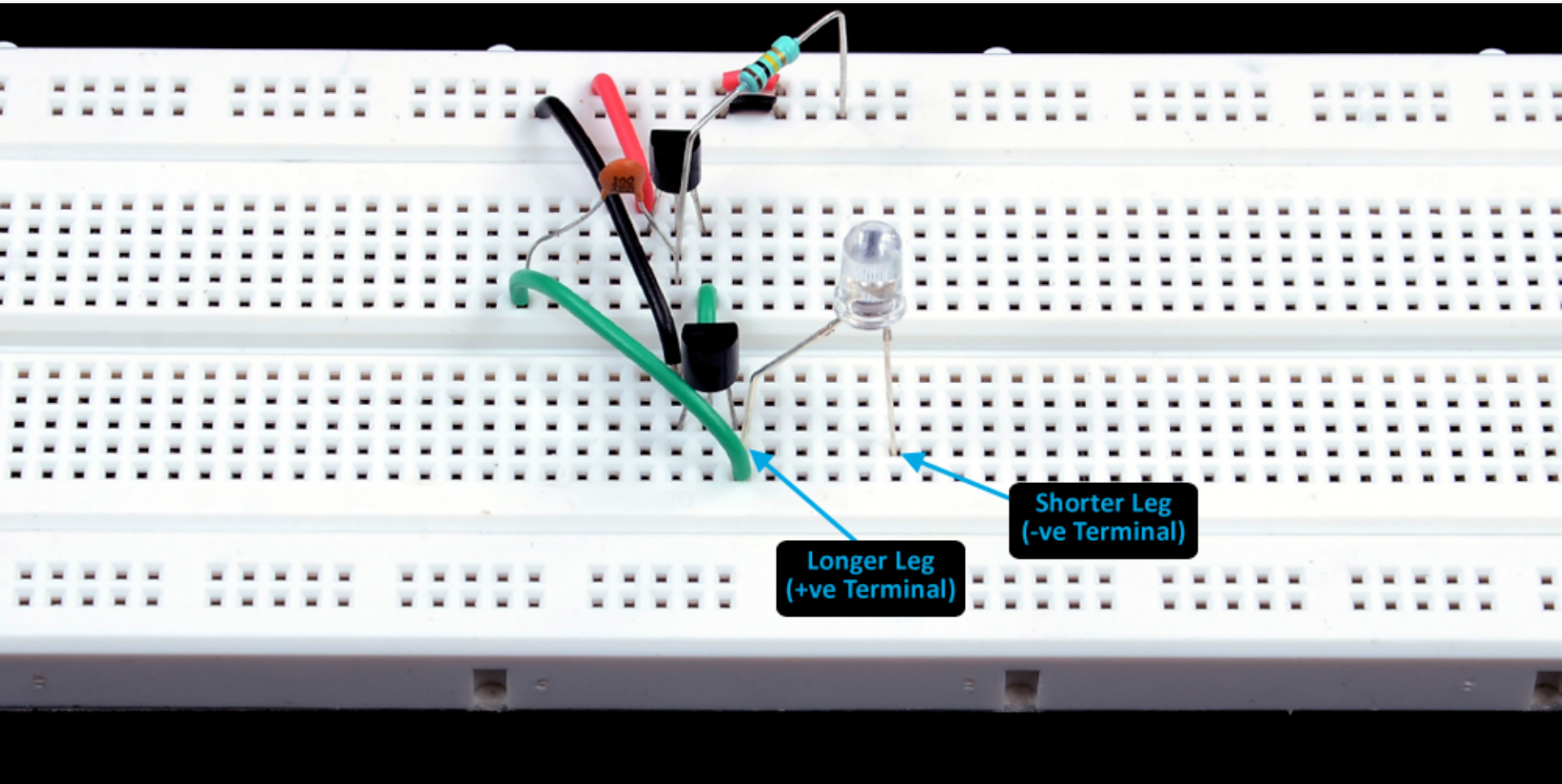
Step No. 8

Connect the other leg of the capacitor to the collector of Q_2.



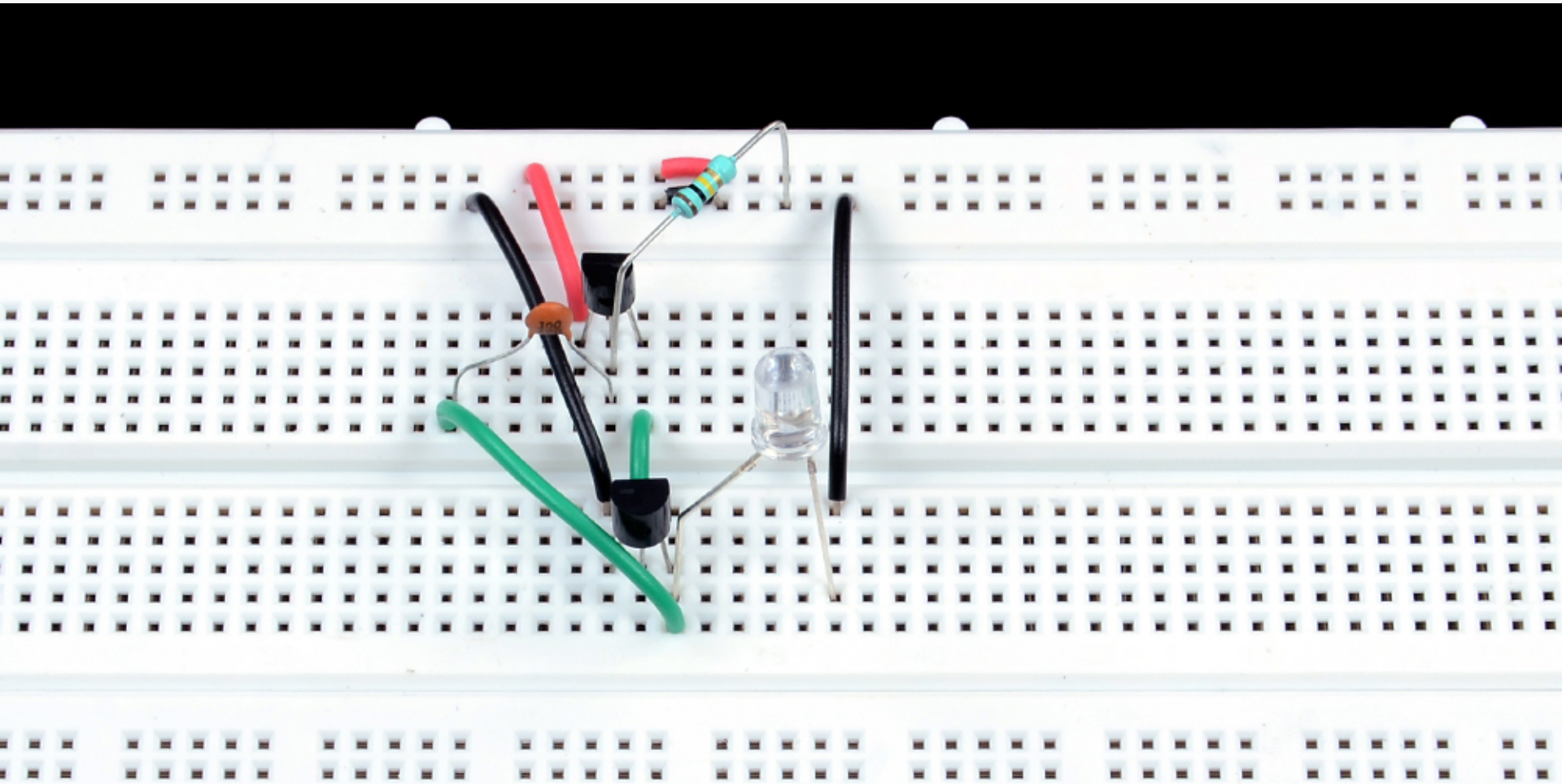
Step No. 9

Take an LED and connect its positive terminal to the collector of Q_2.



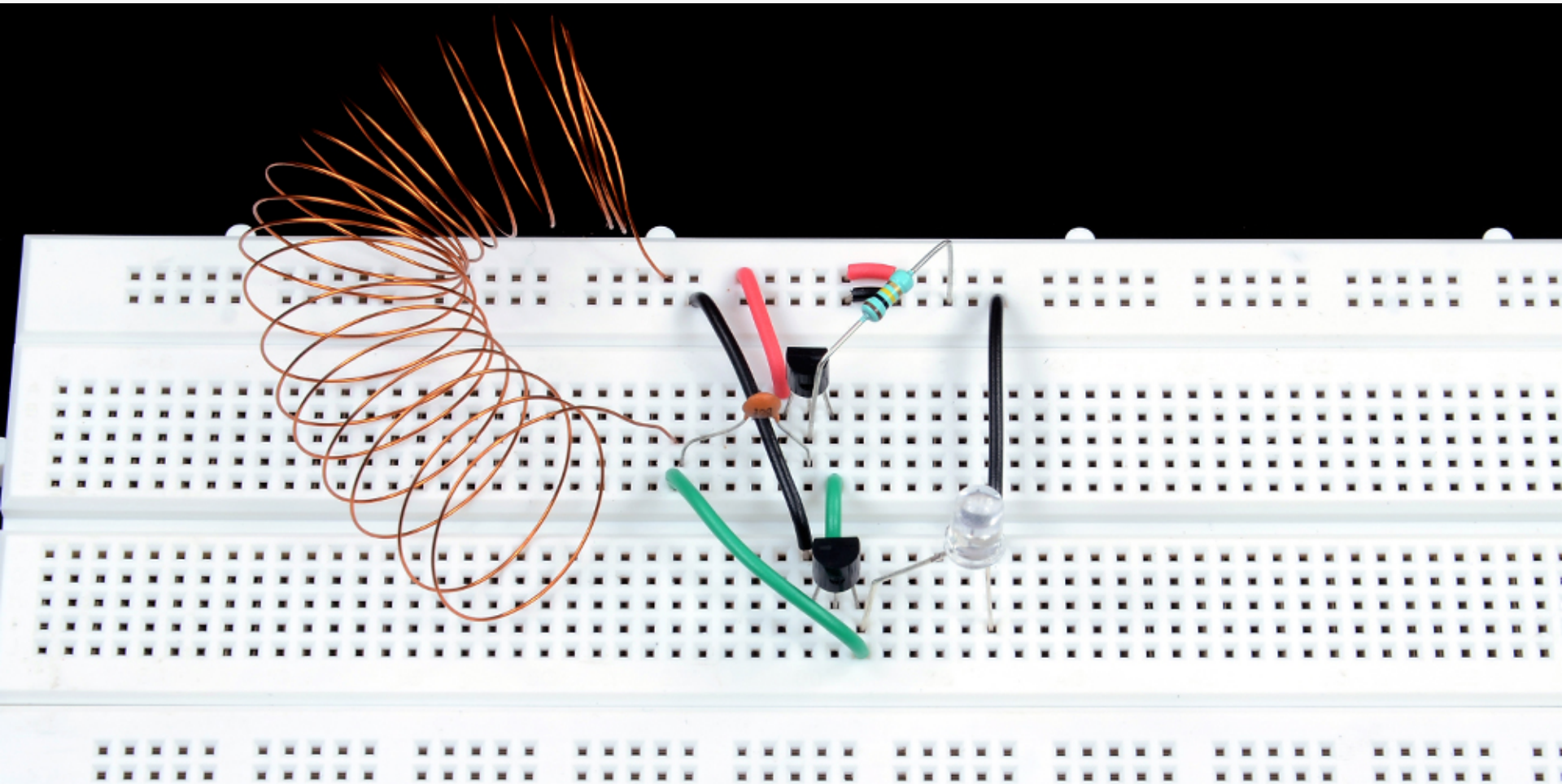
Step No. 10

Connect the negative terminal of the LED to ground.



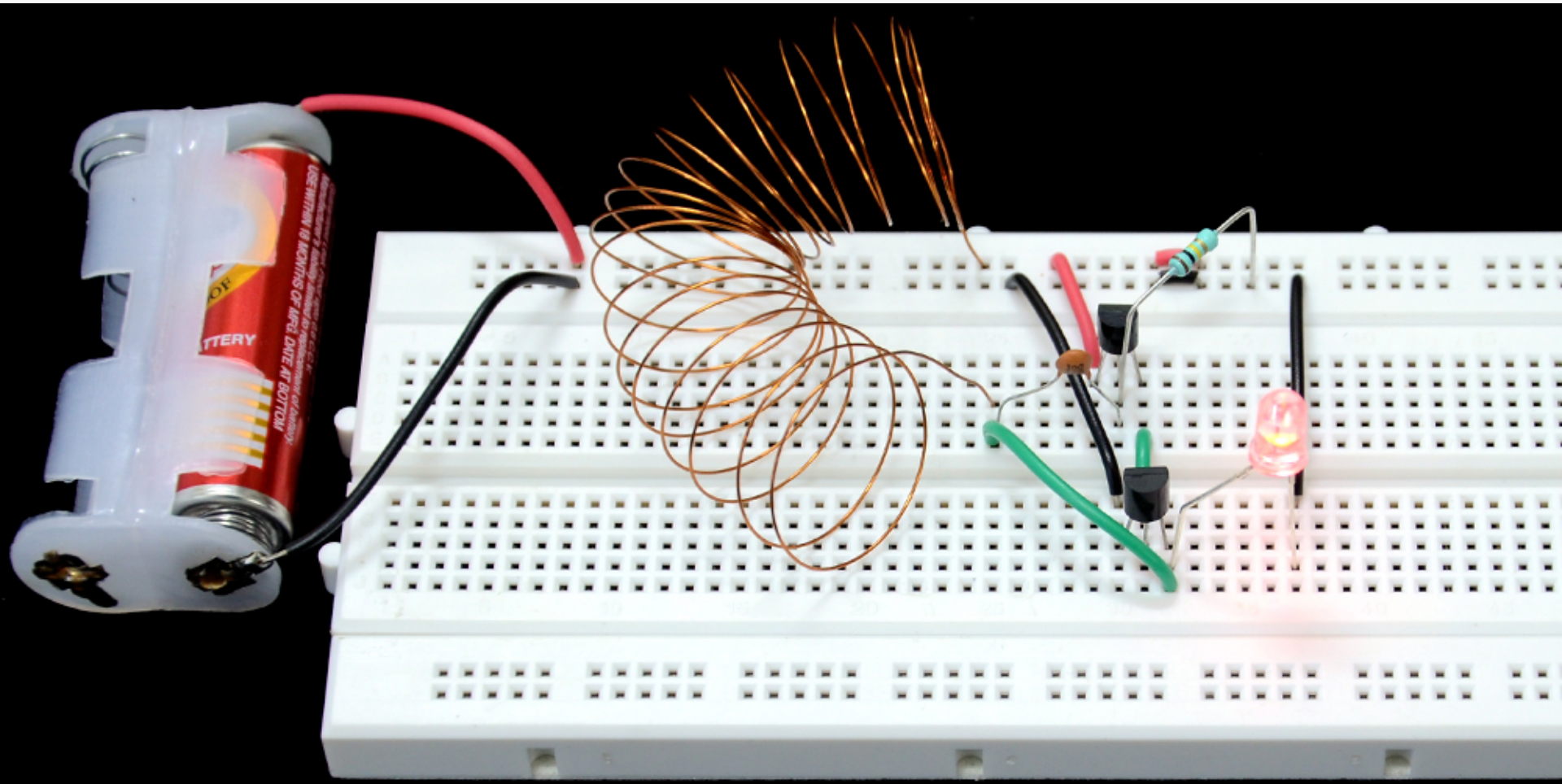
Step No. 11

Take the inductor coil and connect its one end to left leg of the capacitor which is connected to the collector of Q_2. Connect the other end of the coil to Vcc.



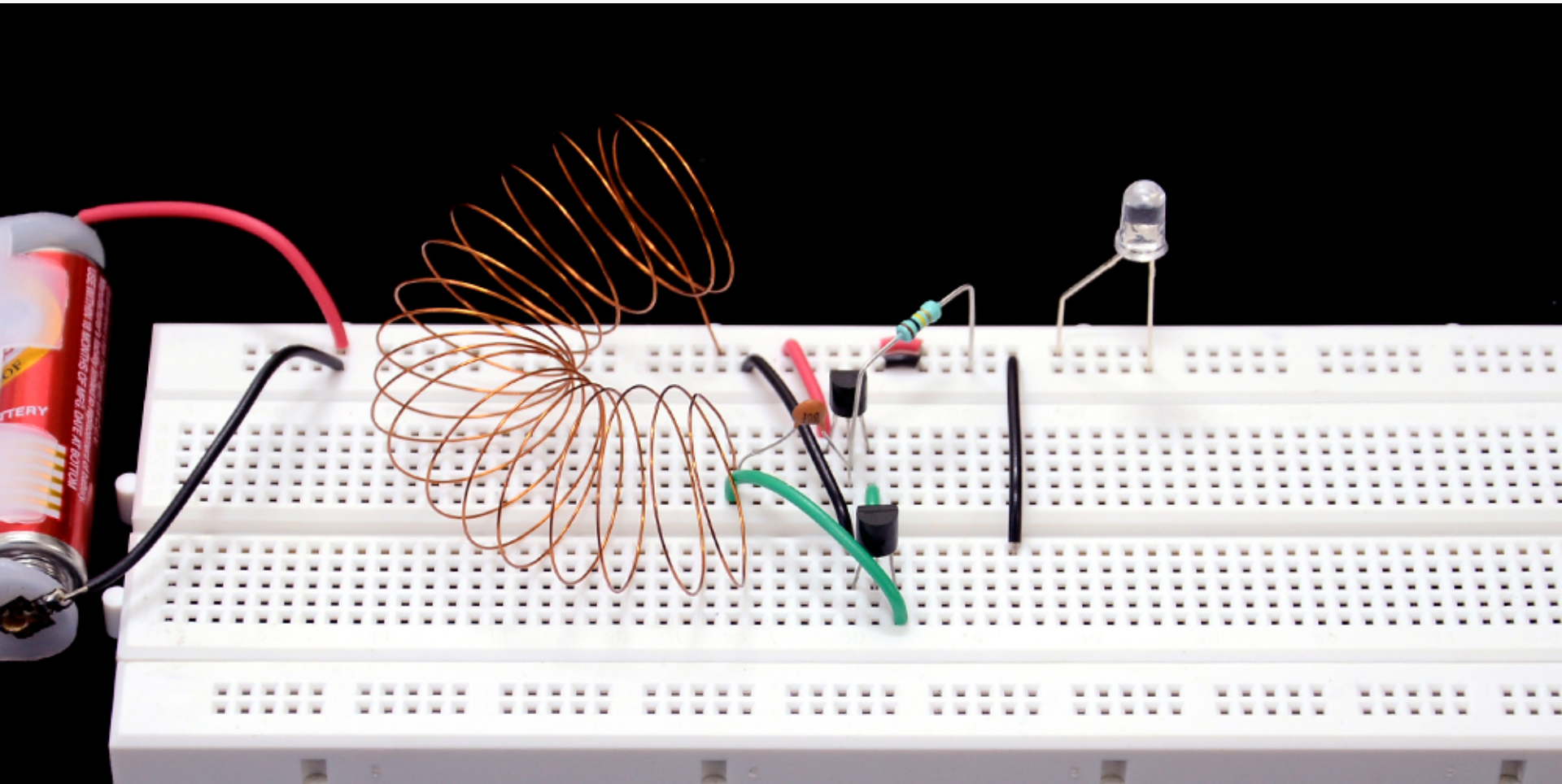
Step No. 12

Place the cell in the cell holder. Connect the red and black wires of the holder to the first and second rows of upper half of the breadboard, respectively. We will notice that the LED glows.



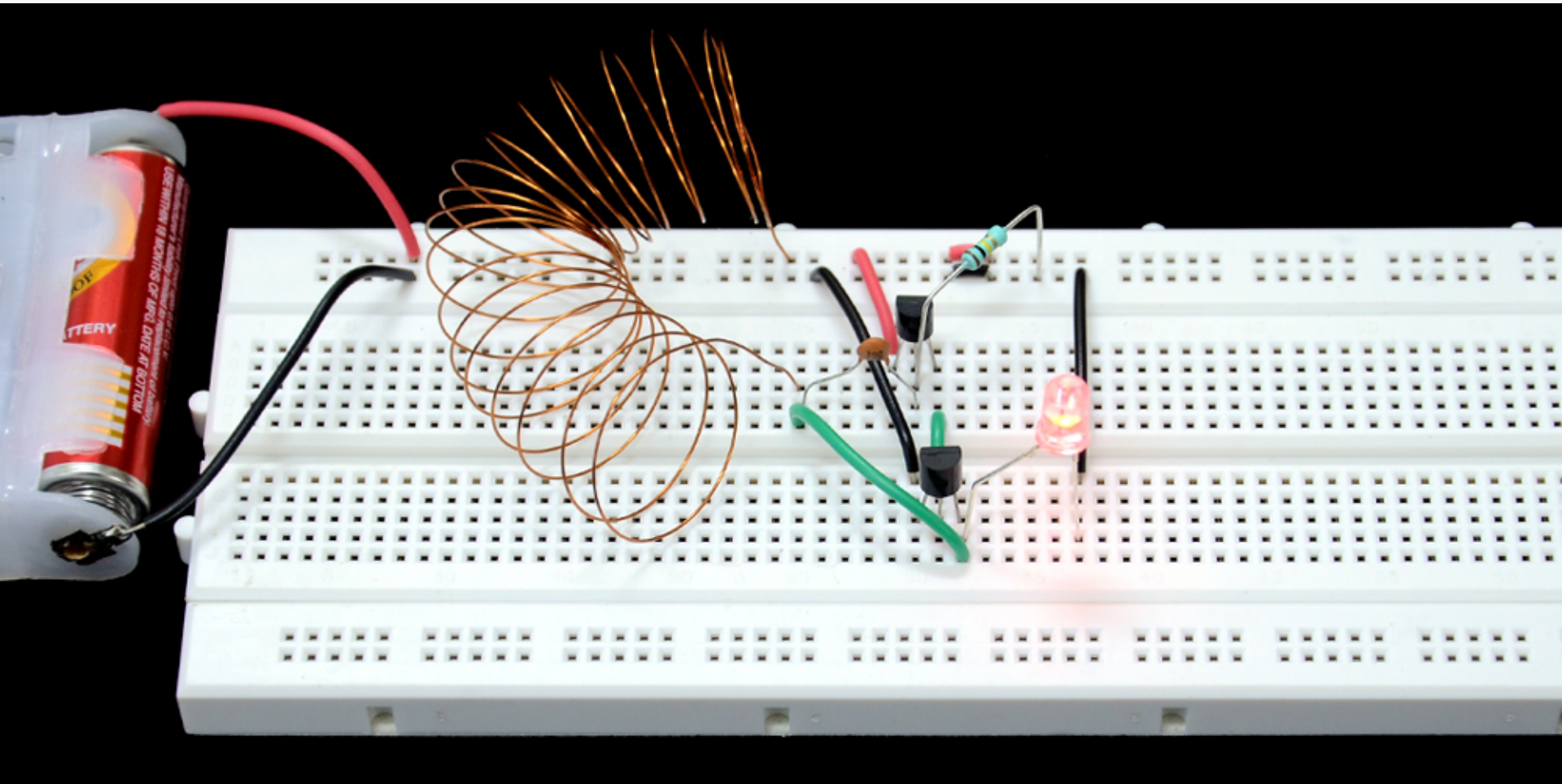
Step No. 13

Now remove the LED and connect it directly to the supply (or cell). To do this, connect the positive and negative terminals of the LED to Vcc and ground, respectively. We will notice that the LED does not glow when it is connected directly to the cell.



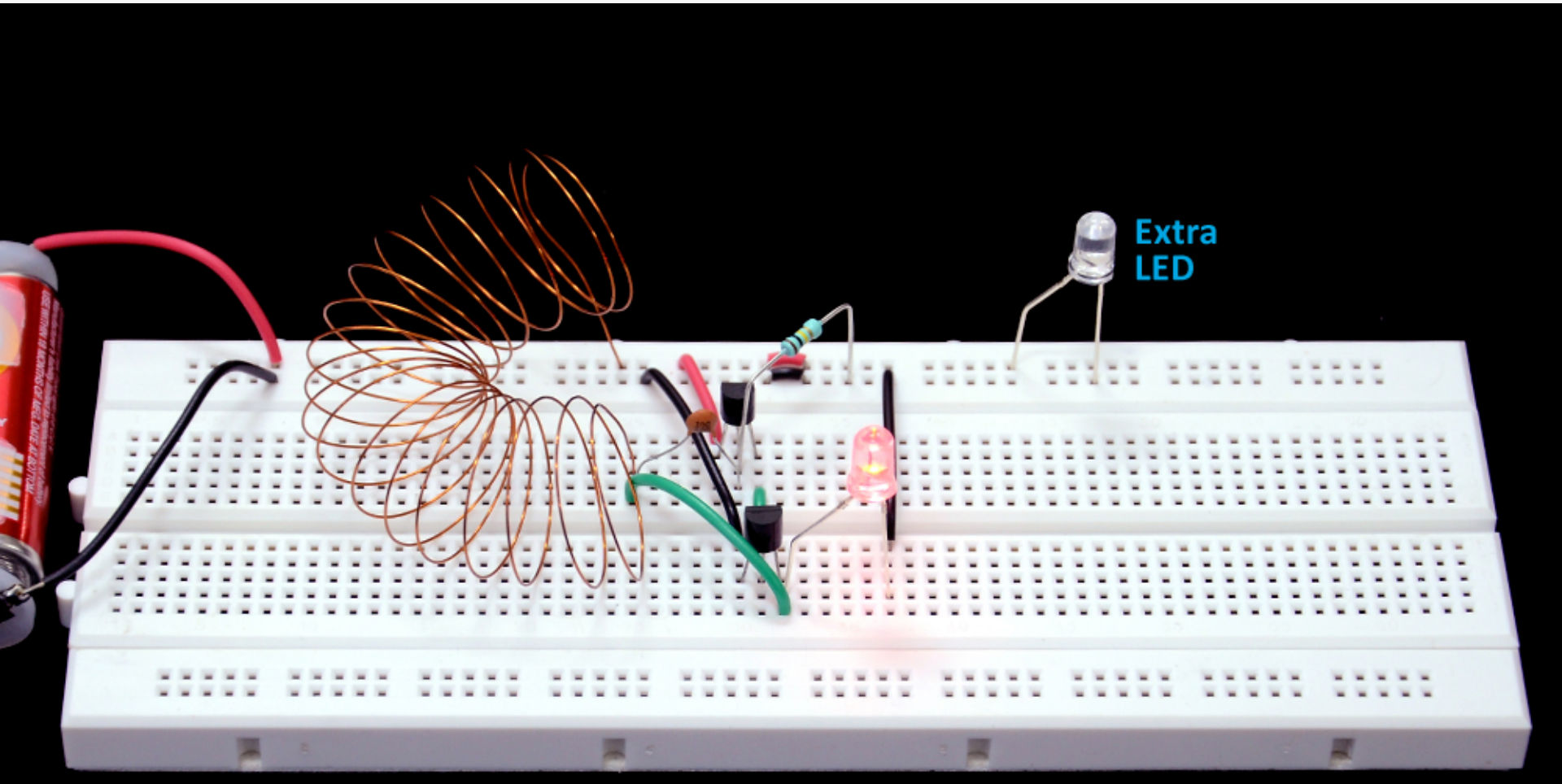
Step No. 14

Connect the LED back to the circuit.



Step No. 15

Alternately, we can also connect an extra LED directly to the cell to demonstrate that the LED connected to the Joule Thief circuit glows with a 1.2 V supply. However, another LED connected directly to the same 1.2 V supply does not glow.



Observation

When the LED is directly powered with a 1.2 V cell, it does not glow. However, when the same LED is connected to the joule thief circuit which is powered using a 1.2 V cell, it starts glowing.

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Reasoning

Please note that the LED does not glow during the discharging of the capacitor. The discharging of the capacitor takes place through the collector-emitter junction of NPN transistor Q_2.

A red LED needs a minimum forward bias voltage of 1.8-2.1 V to glow.

For detailed reasoning, refer the experiment 'joule thief' in the manual.

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Reasoning

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For:

- Activity
- Modification
- Reasoning
- Inference

Refer the Joule Thief Manual (PDF)

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Inference

An inductor behaves like a power source when it faces a decreasing current.

In this case, during the charging of the capacitor, the current through the inductor decreases. When the current is decreased through the inductor, it creates a voltage drop in order to aid the direction of current flow. Thus, the inductor starts acting as a power source. In this condition, the inductor is said to be discharging as it releases its magnetic energy to the circuit. Due to this, the net voltage at the positive terminal of the LED gets boosted up and the LED starts glowing.

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Troubleshooting Tips

- Ensure that the red and black wires are inserted into the first and second rows of the breadboard, respectively.
- Ensure that a 1.2 V AA cell is chosen for the experiment.
- Ensure that a BC 557 transistor and a 547-B transistor are chosen for the experiment.
- Ensure that the transistors are connected on the breadboard such that their curved surfaces should face you.
- Ensure that the transistors are connected properly on the breadboard without twisting their legs.
- Ensure that the positive terminal of the LED is connected to the collector of NPN transistor (Q_2).

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Troubleshooting Tips

- 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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