Aim ↬ To illuminate an LED and explore methods for controlling its brightness.

Equipment Required ↬

Power supply, LED, Resistor, Breadboard, Connecting wires.

Theory ↬

An LED (Light Emitting Diode) is a semiconductor device that emits light when forward-biased, consisting of a p-n junction where the p-side is rich in holes and the n-side in electrons. When a forward voltage is applied, electrons move from the n-side to the p-side, and holes move in the opposite direction, allowing current flow through the junction.

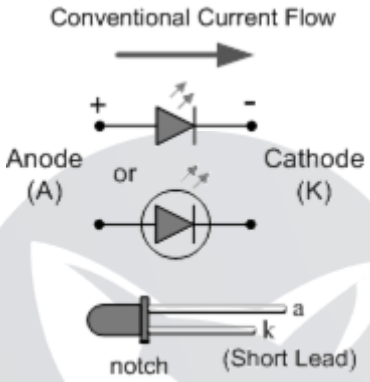

Fig. i) LED representations

Light is emitted when electrons recombine with holes on the p-side, releasing energy as photons through a process called electroluminescence. This light emission depends on the material used and the efficiency of the charge carrier recombination, which also affects the forward voltage drop across the LED, typically between 1.8V to 3.5V.

The color of the LED is determined by the energy bandgap of the semiconductor material, which dictates the wavelength of the emitted light. Different materials like Gallium Phosphide (GaP) for red/green LEDs and Gallium Nitride (GaN) for blue LEDs have specific bandgaps, allowing LEDs to emit a wide range of colors by adjusting material composition and doping.

LEDs efficiently convert electrical energy into light without generating much heat, unlike traditional bulbs. In forward bias, the LED conducts after reaching the threshold voltage, increasing current and light output. In reverse bias, it blocks current, but excessive reverse voltage can damage the LED, highlighting the importance of controlled operation.

Procedure ↬

1. Place the breadboard on a flat surface.
2. Connect the power supply's positive terminal to one rail and the negative terminal to the opposite rail.
3. Insert the LED (long leg to positive, short leg to a free row) and the potentiometer (one terminal to positive, other to negative, wiper to the LED's cathode).
4. Use jumper wires to connect the LED's cathode to the potentiometer's wiper.
5. Turn on the power supply and adjust the potentiometer to change the LED's brightness.

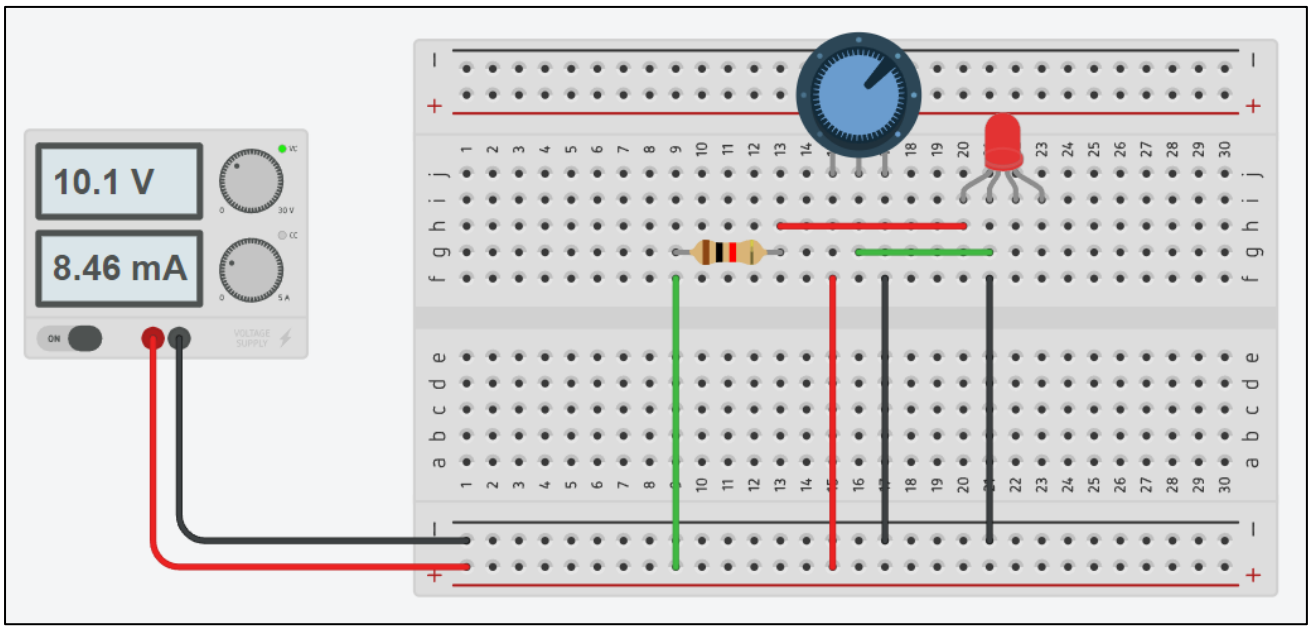

Fig. ii) Circuit in Tinkercad

The impact of the supply voltage is significant; increasing the supply voltage generally increases the current flowing through the LED, leading to a brighter light output until the LED reaches its maximum rated forward current. Conversely, lowering the voltage reduces brightness.

Result ↬

The experiment successfully illuminated the LED and demonstrated that adjusting the potentiometer allowed for varying brightness levels, effectively controlling the current flowing through the LED.

Conclusion ↬

The experiment validated the relationship between voltage, current, and brightness in LEDs, showcasing how brightness can be effectively controlled using a potentiometer.

Precautions ↬

- Ensure correct LED polarity before powering the circuit.
- Do not exceed the recommended current rating to prevent damage.
- Use a suitable resistor to limit current and protect the LED.