Wheatstone Bridge

Scientists use many skills to investigate the world around them. They make observations and gather information from their senses. Some observations are as simple as figuring out the texture and colour of an object. However, if scientists want to know more about a substance they may need to take measurements. Measurement is one of the important aspects of science. It is difficult to conduct experiments and form theories without the ability to measure.

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What is Wheatstone Bridge?

Wheatstone bridge, also known as the resistance bridge, is used to calculate the unknown resistance by balancing two legs of the bridge circuit, of which one leg includes the component of unknown resistance. It was invented by Samuel Hunter Christie in the year 1833, which was later popularized by Sir Charles Wheatstone in 1843.

The circuit is composed of two known resistors, one unknown resistor and one variable resistor connected in the form of a bridge. This bridge is very reliable as it gives accurate measurements.

Construction of Wheatstone Bridge

A Wheatstone bridge circuit consists of four arms of which two arms consists of known resistances while the other two arms consist of an unknown resistance and a variable resistance. The circuit also consists of a galvanometer and an electromotive force (https://byjus.com/physics/electromotive-force/) source. The emf source is attached between points *a* and *b* while the galvanometer is connected between the points *c* and *d*. The current that flows through the galvanometer depends on the potential difference across it.

Wheatstone Bridge Formula

Following is the formula used for Wheatstone bridge:

$$R = \frac{PS}{Q}$$

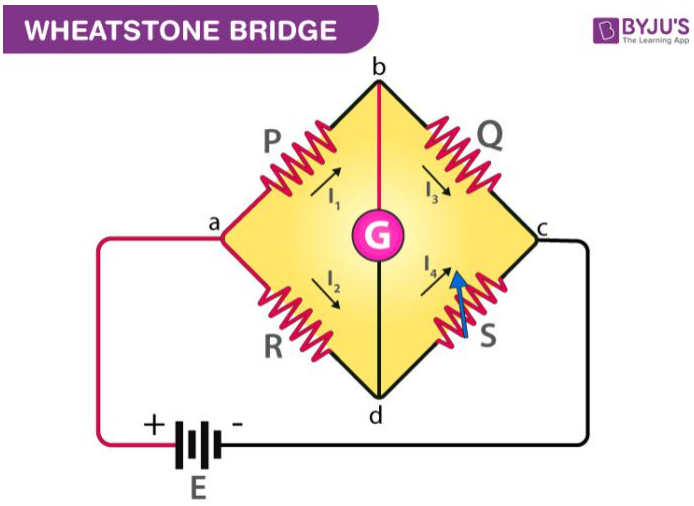
Where,

- R is the unknown resistance

- S is the standard arm of the bridge
- P and Q is the ratio of arm of bridge

What is the Wheatstone Bridge Principle?

The Wheatstone bridge works on the principle of null deflection, i.e. the ratio of their resistances are equal and no current flows through the circuit. Under normal conditions, the bridge is in the unbalanced condition where current flows through the galvanometer (https://byjus.com/physics/moving-coil-galvanometer/). The bridge is said to be in a balanced condition when no current flows through the galvanometer. This condition can be achieved by adjusting the known resistance and variable resistance.



Wheatstone Bridge Derivation

The current enters the galvanometer and divides into two equal magnitude currents as I_1 and I_2. The following condition exists when the current through a galvanometer is zero,

$$I_1P = I_2R \text{ (1)}$$

The currents in the bridge, in a balanced condition, is expressed as follows:

$$I_1 = I_3 = \frac{E}{P+Q} \; I_2 = I_4 = \frac{E}{R+S}$$

Here, *E* is the emf of the battery.

By substituting the value of I_1 and I_2 in equation (1), we get

$$\frac{PE}{P+Q} = \frac{RE}{R+S} \; \frac{P}{P+Q} = \frac{R}{R+S} \; P(R+S) = R(P+Q) \; PR + PS = RP + RQ$$

$$PS = RQ \text{ (2)}$$

$$R = \frac{P}{Q} \times S \text{ (3)}$$

Equation (2) shows the balanced condition of the bridge while (3) determines the value of the unknown resistance.

In the figure, R is the unknown resistance, and the S is the standard arm of the bridge and the P and Q are the ratio arm of the bridge.

Related Articles:

- Electrical Resistance (https://byjus.com/physics/electrical-resistance/)
- Electric Circuit (https://byjus.com/physics/electric-circuit/)
- Kirchhoff's First Law (https://byjus.com/physics/kirchhoffs-first-law/)

Wheatstone Bridge Application

- The Wheatstone bridge is used for the precise measurement of low resistance.
- Wheatstone bridge along with operational amplifier is used to measure physical parameters such as temperature, light, and strain.
- Quantities such as impedance, inductance, and capacitance can be measured using variations on the Wheatstone bridge.

Wheatstone Bridge Limitations

- For low resistance measurement, the resistance of the leads and contacts becomes significant and introduces an error.
- For high resistance measurement, the measurement presented by the bridge is so large that the galvanometer is insensitive to imbalance.
- The other drawback is the change in the resistance due to the heating effect of the current through the resistance. Excessive current may even cause a permanent change in the value of resistance.

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3 Comments

Rohan AUGUST 28, 2019 AT 2:46 PM (HTTPS://BYJUS.COM/PHYSICS/WHEATSTONE-BRIDGE/#COMMENT-21488)

Thanks a lot . Very useful . I now understand what the Wheatstone bridge is all about .

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Navreet singh SEPTEMBER 9, 2019 AT 5:51 PM (HTTPS://BYJUS.COM/PHYSICS/WHEATSTONE-BRIDGE/#COMMENT-23646)

Thanks for this . it is very helpfull to me.

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Preethiraja SEPTEMBER 9, 2019 AT 8:37 PM (HTTPS://BYJUS.COM/PHYSICS/WHEATSTONE-BRIDGE/#COMMENT-23674)

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