SUBJECT : SCIENCE (PHY)

CHAPTER-12:
ELECTRICITY

TOPIC-3:

OHM’S LAW

OBJECTIVES:

Upon completion of the topic, you will be able to

1. DEFINE OHM'S LAW
2. DEFINE RESISTANCE
3. WRITE THE UNITS OF RESISTANCE
4. RELATE BETWEEN POTENTIAL DIFFERENCE, CURRENT AND RESISTANCE
5. DRAW ELECTRIC CIRCUIT TO VERIFY OHM'S LAW
6. DRAW I-V GRAPH AND INTERPRETE IT
7. 1 OHM RESISTANCE
8. SOLVE NUMERICALS BASED ON OHM'S LAW
9. ANALYSE SIMPLE ELECTRIC CIRCUIT

Georg Ohm

- **Georg Simon Ohm** (16 March 1789 – 6 July 1854) was a German physicist and mathematician. As a school teacher, Ohm began his research with the new electrochemical cell, invented by Italian scientist Alessandro Volta. Using equipment of his own creation, Ohm found that there is a direct proportionality between the potential difference (voltage) applied across a conductor and the resultant electric current. This relationship is known as Ohm's law.

VARIATION OF ELECTRIC CURRENT WITH POTENTIAL DIFFERENCE

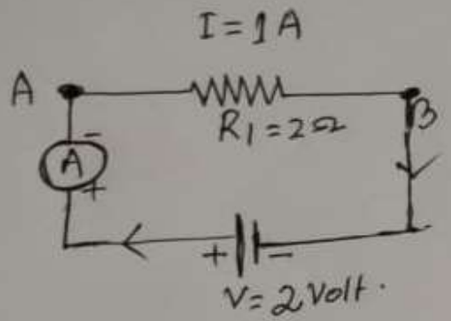


Fig-1

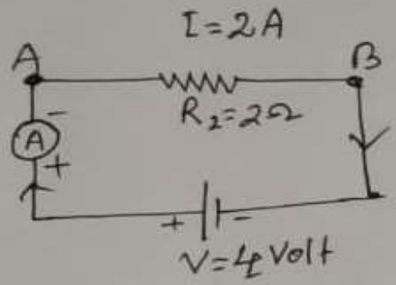


Fig-2

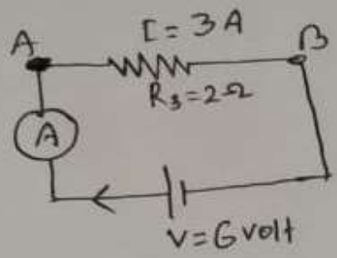


Fig-3.

Potential difference = V

Electric current = I

(Potential difference) $\propto$ (Electric current)

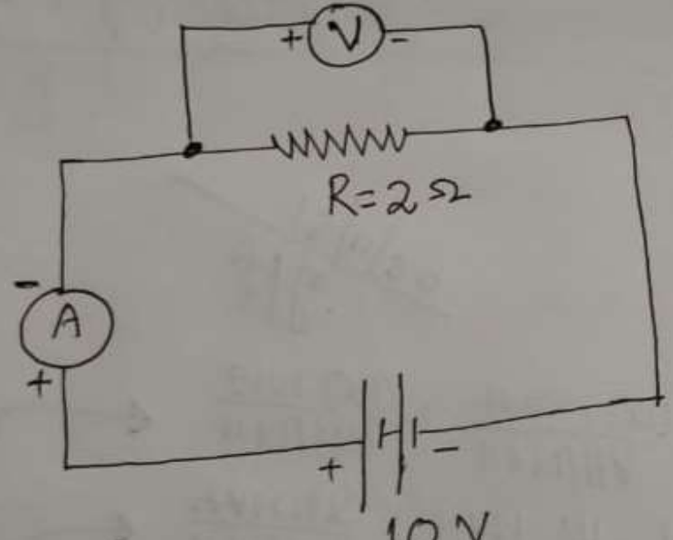
$\Rightarrow V \propto I$

$\Rightarrow V = RI$,

R = Constant
= Resistance of conductor.

$$\boxed{V = RI}$$

or, $$\boxed{I = \frac{V}{R}}$$



What is the reading of Ammeter = ?

What is the reading of voltmeter?

Ohm's Law

- Ohm's Law explains the relationship between voltage (V or E), current (I) and resistance (R)
- Used by electricians, automotive technicians, etc
- According to Ohm's law : At constant temperature, the current flowing through a conductor is directly proportional to the potential difference across its end.

• **OHM'S LAW**: At constant temperature, the potential difference(V), across the ends of a conductor in an electric circuit is directly proportional to the current flowing through it.

- According to Ohm's law:

$$V \propto I$$

or, $V = R \times I$.

where R is constant "resistance" of the conductor.

This can also be written as –

or, $I = \frac{V}{R}$.

So, Current, $I = \frac{V}{R}$.

Therefore,

i. The current is directly proportional to potential difference.

ii. The current is inversely proportional to resistance.

Note: R = V/I , 1 Ohm = 1 volt/ 1 Ampere

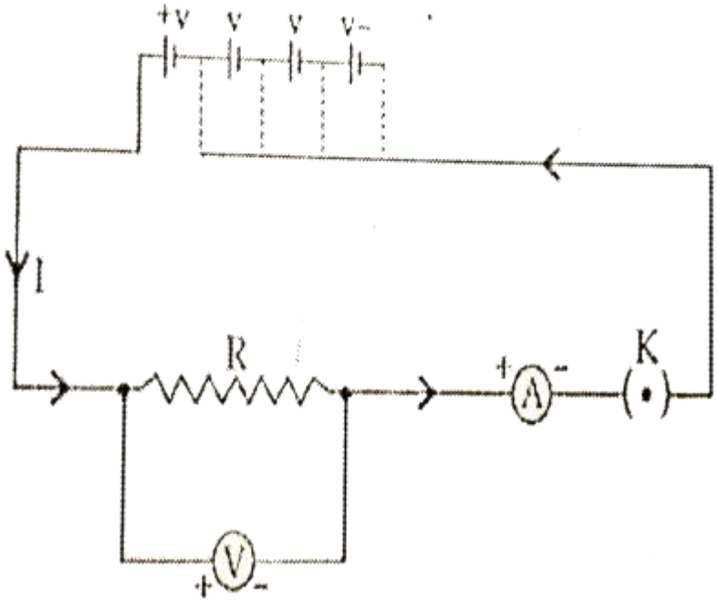
Definition of 1 ohm : If the potential difference across the two ends of a conductor is 1 volt and current through it is 1A, then the resistance of the conductor is called 1 ohm.

Resistance

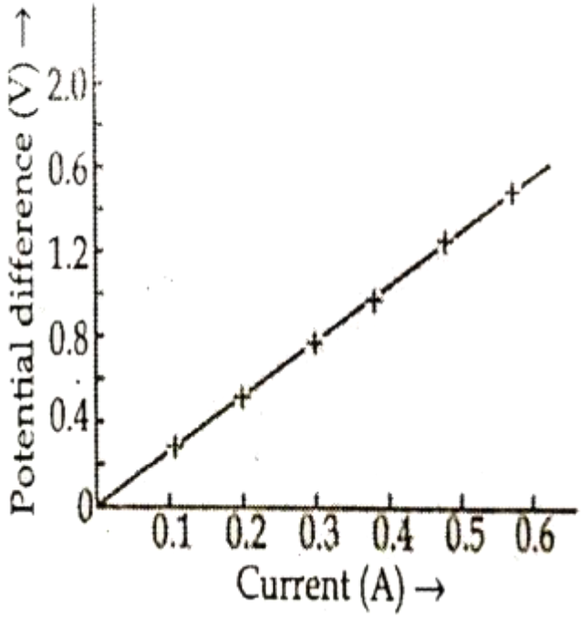
- An electron traveling through the wires and loads of the external circuit encounters resistance. **Resistance** is the hindrance to the flow of charge. For an electron, the journey from terminal to terminal is not a direct route. Rather, it is a zigzag path that results from countless collisions with fixed atoms within the conducting material. The electrons encounter resistance - a hindrance to their movement.
- The S.I. unit of resistance is ohm's (Ω).

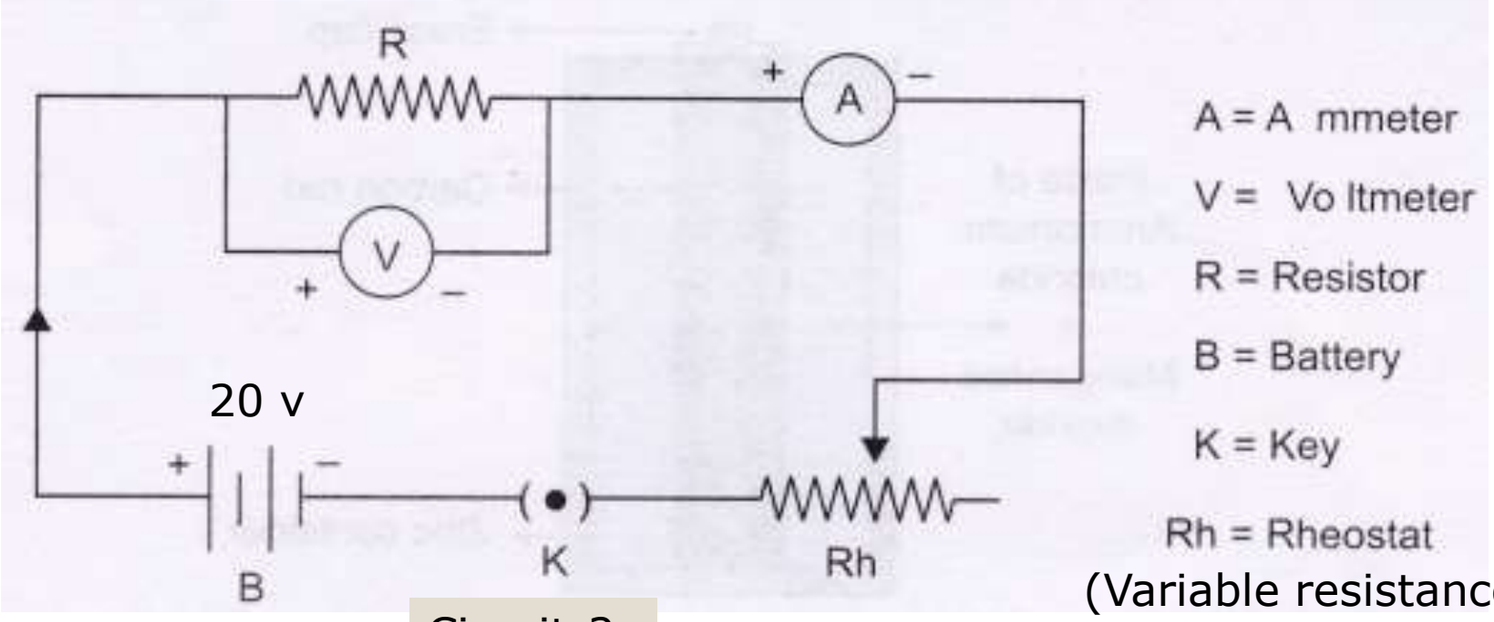
Resistor: A conductor having some appreciable resistance is called a resistor.
Resistance: The property of conductor to resist the flow of electric charges through it is called resistance.
Units of resistance: Ohm, kilo ohm, mega ohm etc

STUDY OF OHM'S LAW (VERIFICATION OF OHM'S LAW)



Circuit-1





(Variable resistance)

Circuit-2

1. To study/verify ohm's law we need to use an electric circuit (either circuit-1 or circuit-2).
2. We study potential difference(V) and current(I) across a conductor of resistance say R. Then V-I graph is drawn. If the graph be straight line as shown in Fig-3, it shows that Ohm's law is verified i.e Potential difference is directly proportional to electric current through it

1. A device has a 150 Ohm resistance and a 2A electric current passes. Find the potential difference.

SOLUTION:

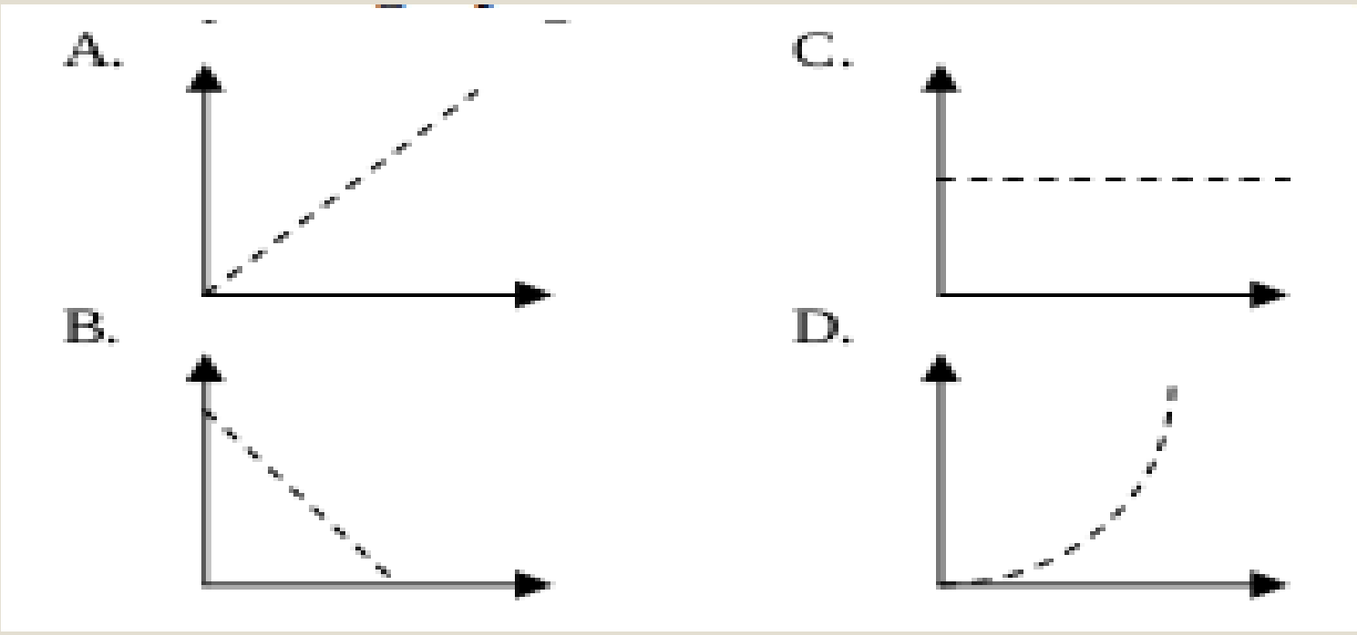
Given,
Resistance (R) = 150 Ohm
The electric current (I) = 2 Ampere
We have to find Voltage (V)
V = I R
V = electric voltage, I = electric current, R = electric resistance
Voltage :
V = I R = (2 Ampere)(150 Ohm) = 300 Volt

2. The electric current in a resistor wire is 4 A. When both ends are given a potential of 12 Volts. What is the electrical resistance?

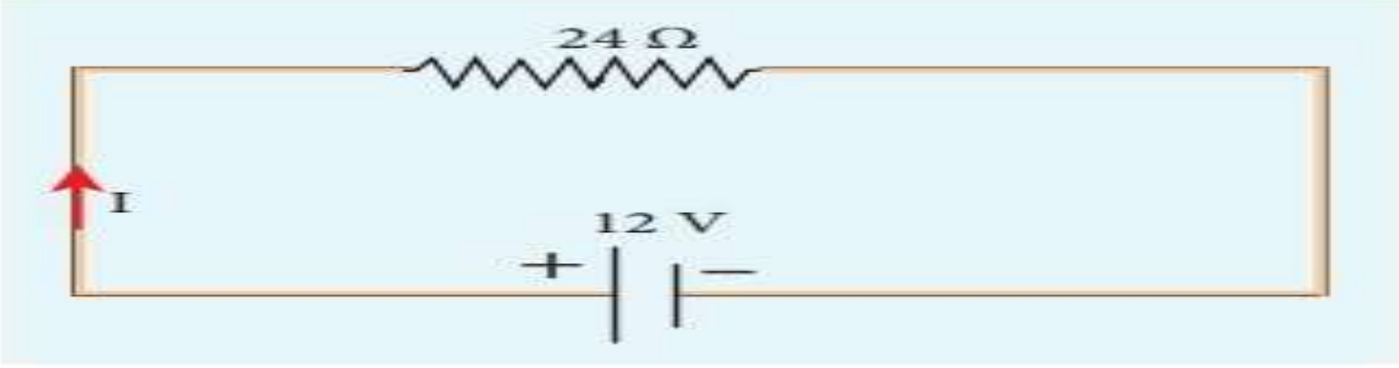
SOLUTION:
Given :
Electric current (I) = 4 Ampere
Voltage (V) = 12 Volt
We have to find Electric resistance (R)

Resistance :
R = V / I = 12 Volt / 4 Ampere = 3 Ohm

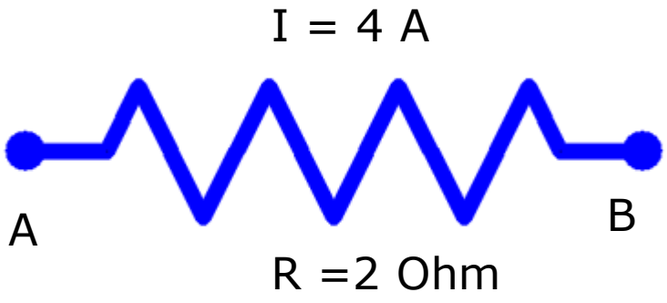
Ques-3:Which graph indicates the relationship between the potential difference with the electric current?

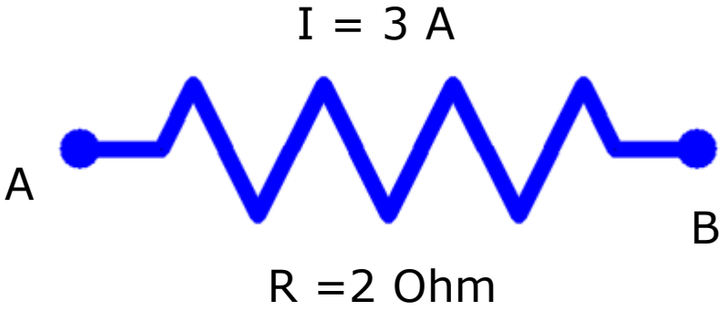


Ques-4:Find the current passing in the following circuit



Q-5. Find potential difference between A & B in the following cases





Q-6: Write any three units of resistance and write the relation between them.
Q-7: Does resistance of a conductor depend on potential difference applied across it?
ANS: No.
Q-8: State Ohm's law in current electricity. Draw a circuit diagram to verify Ohm's Law. How will you verify it?
Q-9: What do you mean by Ohmic and non-Ohmic materials?
ANS: Materials that obey Ohm's law are called Ohmic materials (e.g metals) and the materials that do not obey ohm's law are called Non-Ohmic materials(e.g semiconductors)

Q-10:What happens to the resistance of a conductor when temperature is increased? [CBSE 2010]

Ans :

The resistance of a conductor increases with rise in temperature.

Q-11: How much current will an electric bulb of resistance 1100 W draw from a 220 V source? If a heater of resistance 100 ohm is connected to the same source instead of the bulb, calculate the current drawn by the heater.

Question 11:

When a 12 V battery is connected across an unknown resistor, there is a current of 2.5 mA in the circuit. Find the value of the resistance of the resistor.

Answer 8:

According to Ohm's law, V = IR

$$\Rightarrow R = \frac{V}{I}$$

Here, V = 12 V and I = 2.5 mA = 0.0025 A
Therefore,

$$R = \frac{12}{0.0025} = 4800\ \Omega = 4.8\ \text{k}\Omega$$

Note : unsolved questions are left as Home-Work.