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Ohm's law, electrical resistance, conductance V-I characteristics (linear and non-linear)

CLASS-XII

SUBJECT : PHYSICS
CHAPTER NUMBER: 03
CHAPTER NAME : CURRENT ELECTRICITY

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LEARNING OUTCOME

After this lesson, students will be able:

- To state Ohm's law.
- To state the mathematical definition of resistance.
- To do graphical analysis of Ohm's law.
- To define conductance and resistance
- To derive Ohm's law in vector form.

Slide 2

1	@Format for content and slide heading is missing? Just like you have mentioned in DOC., We need to specify, for each slide's heading and text content, what will be the font style +amanrouniyar@odmegroup.org _Assigned to you_ -Swoyan Satyendu , 6/17/2020

REVIEW

1. Define mobility of a charger carrier.
2. What is the expression of mobility in terms of relaxation time. Give its SI unit.
3. Define current density.
4. State relationship between mobility and conductivity.
5. State relationship between mobility and relaxation time.

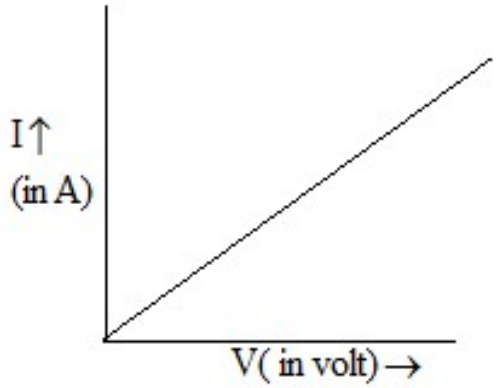
OHM'S LAW

$I \propto V$

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

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

So the graph between current and voltage is a straight line



The slope of the graph $= \frac{\Delta V}{\Delta I} = G = \frac{1}{R}$

Where G = conductance of the conductor

R = resistance of the conductor

RESISTANCE:

The resistance of conductor is the opposition offered by the conductor to the flow of electric current through it.

$$R = V / I$$

Resistance in terms of physical features of the conductor:

$$R = \rho \frac{l}{A}$$

OHM'S LAW IN VECTOR FORM

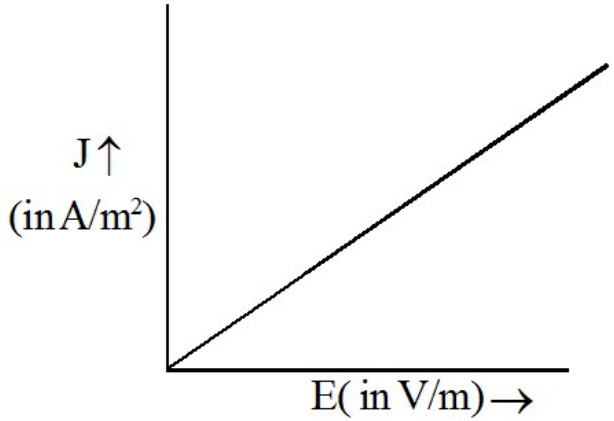
As $\vec{J}$ is directed along the direction of flow of current i.e. the direction of the field $\vec{E}$.

So equation (i) can be written vector ally as

$$\vec{J} = \sigma\vec{E} = \frac{\vec{E}}{\rho}.$$

This is a vector form of Ohm's law.

The graph between J and E must be a straight line passing through the origin. Its slope = $\frac{\Delta J}{\Delta E} = \sigma$



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OHM'S LAW

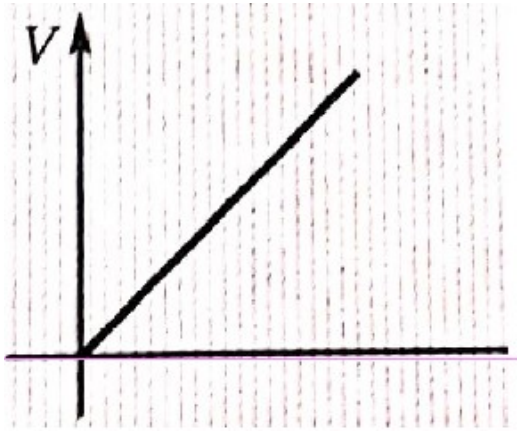
Question: Using the drift speed concept establish Ohm's law.

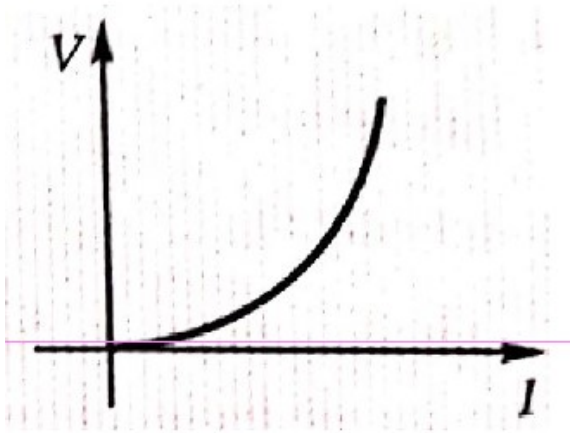
OR

Using the drift speed concept establish the relation $\vec{J} = \sigma \vec{E}$

Drawbacks of Ohm's law

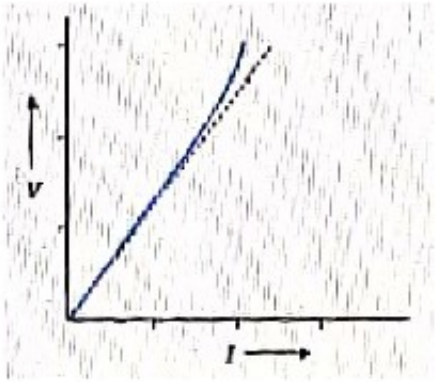
(i) All conductors don't obey Ohm's law strictly. The conductors which obey Ohm's law strictly are called as Ohmic conductors and those don't obey Ohm's law are called as non-ohmic conductors



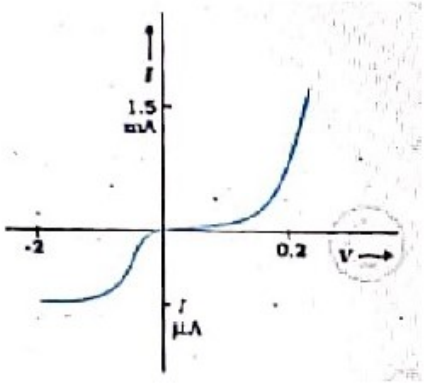


Drawbacks of Ohm's law

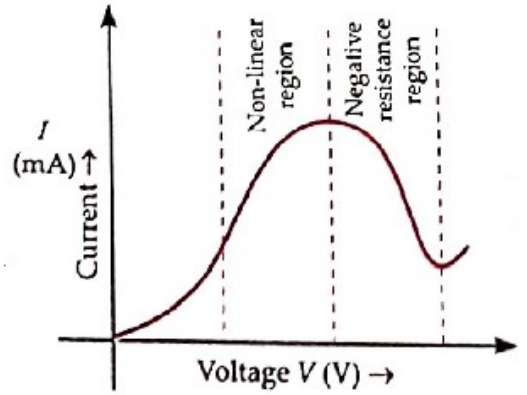
(ii) At higher temperature graph between the current and voltage of a good conductor also deviates from a straight line.



(iii) The semiconductor devices like pn junction diode, junction transistors, vacuum tube devices don't obey Ohm's law .The I ~ V curve of a PN junction is



(iv) The I ~ V curve of GaAs represents that (a) for a single value of current there exist two values of voltage (b) non - linear region and (c) negative resistance region. Hence this doesn't obey Ohm's law.



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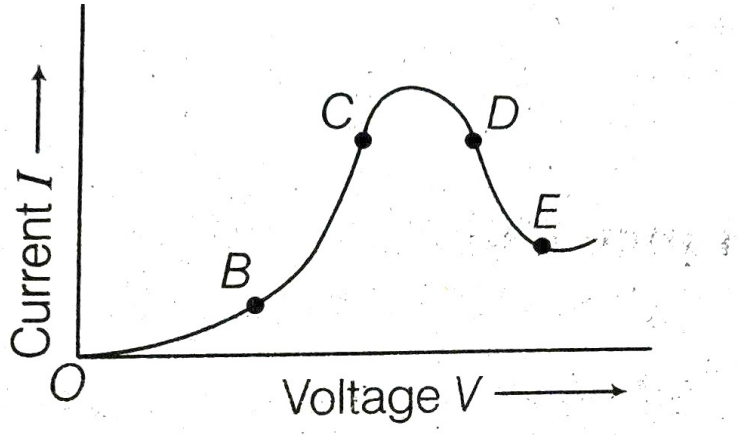
HOME ASSIGNMENT

1. A conductor of length l is connected to a DC source of potential V. If the length of the conductor is tripled by gradually stretching it, keeping V constant, how will
   a) Drift speed of electrons and
   b) Resistance of the conductor be affected? Justify your answer.
2. Define relaxation time of free electrons drifting in a conductor. How it is related to the drift velocity of electrons? Use this relation to deduce the expression for the electrical resistivity of the material.
3. Graph showing the variation of current versus voltage for a material GaAs is shown in the fig. identify the region

a) Of negative resistance

b) Where Ohm's law is obeyed.



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THANKING YOU

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