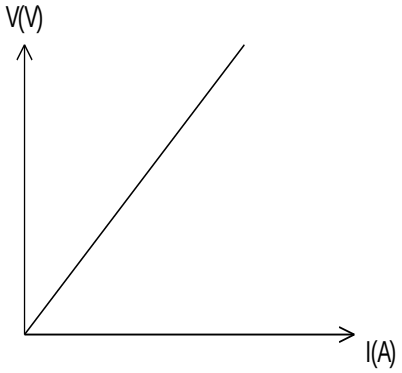
E.5 Ohm's Law

Video: Ohm's Law

In any Circuit, if a circuit element gives a straight line graph of V vs I, as shown



It is said that the element obeys Ohm's Law

$$V \propto I$$

$$V = I R$$

R is called the resistance and is measured in Ohms (Ω)

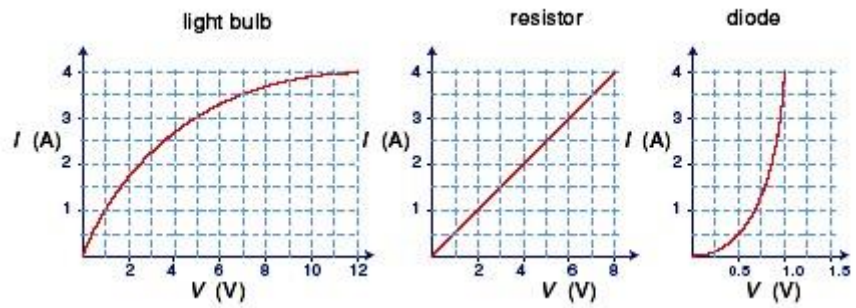
Example

A resistor of 5 Ω is supplied with a potential which can vary from 1 V to 100 V.
a What will be the range of current that will flow in it?
b How much energy will be dissipated in the resistor each second when V = 100V?

Solution
a 5 V are required to make 1 A flow in this resistor. Therefore, at 1 V the current will be A or 0.2 A. More formally:
At 1 V, $I = V/R$= =0.2 A
At 100 V, I= =20 A (or simply 100 times the previous answer).

b At 1 V, 0.2 C flow through the resistor each second. The energy is given by:
$\Delta U = qV$
= 0.2 × 1
= 0.2 J
At 100 V, ΔU = 20 × 100 = 2000 J

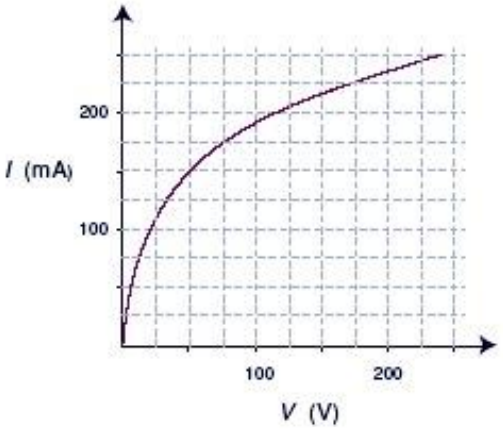
Devices which do not have straight lines for their graphs of V vs I are called non-ohmic devices. Examples of these are light globes and diodes.



When working with non-ohmic devices we use the graph to find our information.

Example

The graph represents the *I* –*V* characteristic of a 240 V, 60 W light bulb.



What is the resistance at:
a 24 V?
b 120 V?
c 240 V?

Solution
Resistance is given by $R = V/I$ at any point on the graph. Note that the current is given in mA (100 mA = 0.1 A).
a At 24 V
$R = 24/0.10$
$= 240\ \Omega$
b At 120 V
$R = 120/0.20$
$= 600\ \Omega$
c At 240 V
$R = 240/0.25$
$= 960\ \Omega$

E.6 Resistances

A resistor or a resistance is a circuit element that resists the flow of electricity (electrons). The higher the number the higher the resistance. The units of resistance are Ohms (Ω). Experiments show that the resistance of a metal will depend on its length, area and material.

$\therefore R = \frac{\rho l}{A}$ where ρ is a constant for the material called the resistivity (Ωm).

Problem Set #4: Text Section 3.4 Page 119-120 Questions 1 – 8