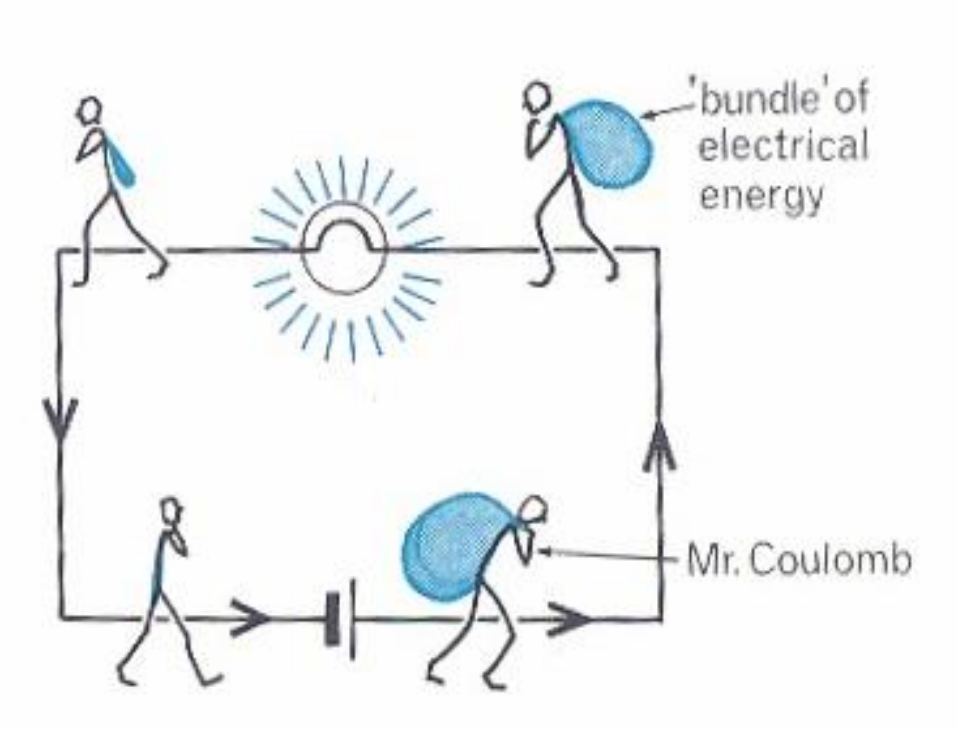
What Is Electricity?

It is a general term used for all phenomena caused by electric charge whether static or in motion.



Ohm's Law:

Ohm's law describes the relationship between voltage, V , which is trying to force charge to flow, resistance, R , which is resisting that flow, and the actual resulting current I .

Power: Power is the Electric energy produced per unit time.

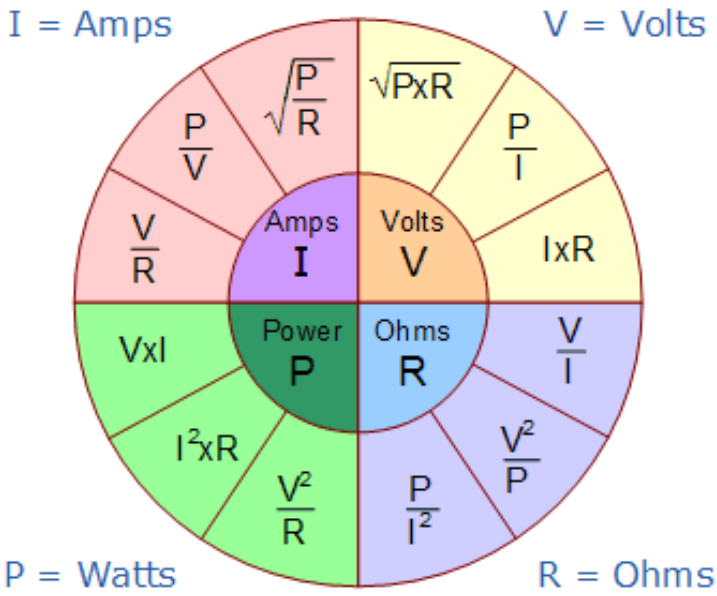
Kirchhoff's Current Rule:

Apply to DC circuits and networks and states that the total current flowing into any DC circuit node, also called a branch point, is always the same as the total current flowing out of the node.

Kirchhoff's Voltage Rule:

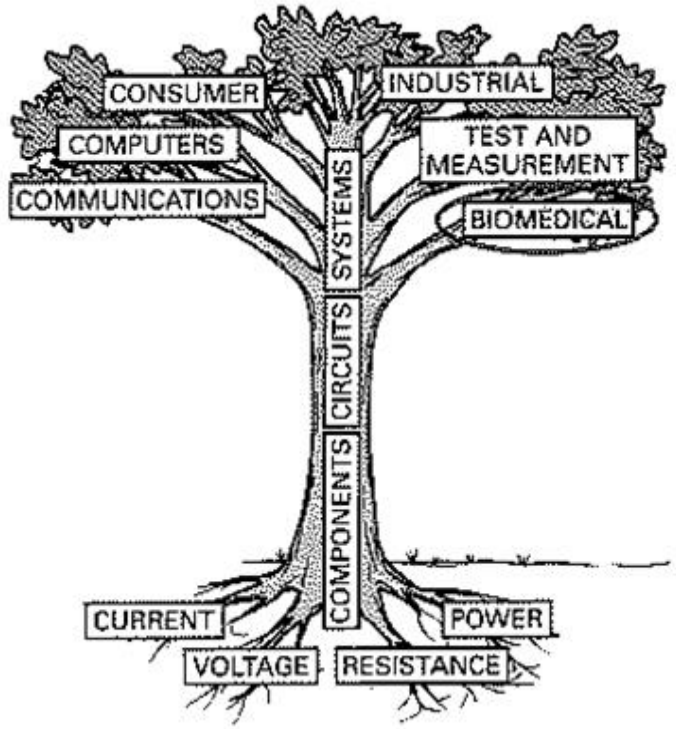
Apply to DC circuits and networks and states that the total voltage across the set of passive components is always equal and opposite to the source voltage. Therefore, the sum of the voltage differences across all the circuit elements (including the source) is always zero.

THE FORMULA CIRCLE



The formula circle shows how the four basic properties – voltage (V), current (I), resistance (R), and power (P) are related.

THE ROOTS OF ELECTRONICS



- We all use Electronic gadgets like computers, radios, mobile phones …. etc (up on the tree branches and leaves).

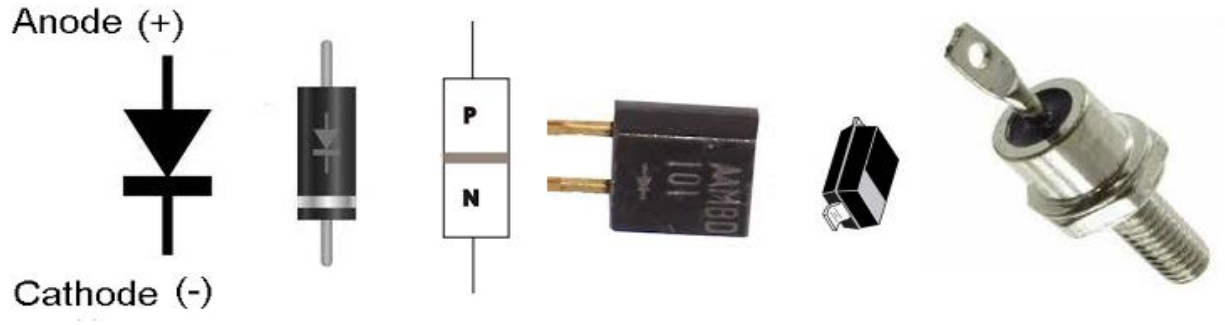
- Moving up the tree little do we know that all the gadgets are made of components, circuits and systems (which make up tree stem).

- But the foundation of electronics rests on the four basic roots or phenomena known as voltage, current, resistance and power (which is the roots of the tree)

Electronics is the science of controlling electrical energy electrically, in which the electrons have a fundamental role. ... Commonly, electronic devices contain circuitry consisting primarily or exclusively of active semiconductors supplemented with passive elements; such a circuit is described as an electronic circuit.

A Diode

Most diodes are made from semiconductors such as silicon; however, germanium is also used sometimes. The first diode was accidentally created by Thomas Edison in 1883 when he was experimenting with his light bulbs. The word diode is derived from the fact that the device has two (di) electrodes (ode). The two electrodes or terminals of the diode are called the anode (+) and cathode (–). Symbols and designs of diodes are shown below:



The two-terminals of a diode (two active electrodes), allows the transfer of current in one direction only. Diodes are known for their unidirectional current property, wherein, the electric current is allowed to flow in one direction. As far as its operation is concerned, the diode operates like a switch. If you give the diode what it wants, that is make the anode positive with respect to the cathode terminal, the device is equivalent to a closed switch, (or the diode is said to be ON) or **Forward Biased**. The vice versa is equivalent to a opened switch, (or the diode is said to be OFF) or **Reverse Biased**.

Question:

1. Determine whether the diodes below are ON or OFF?

i. 

ii. 

iii. 

iv. 

Solution

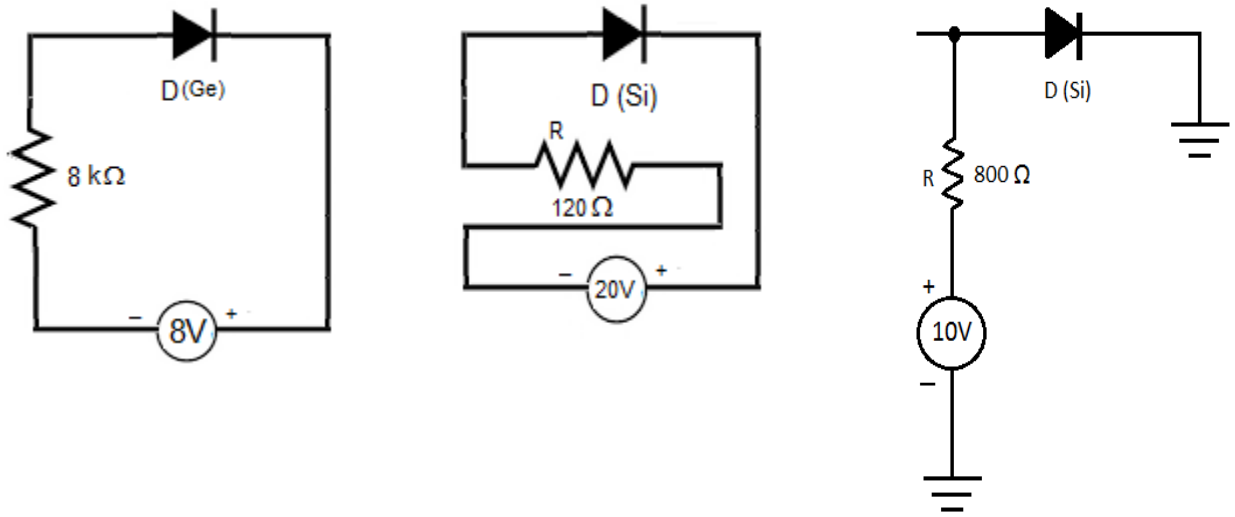
1.

i. Diode is ON since anode is positive relative to the cathode
ii. Diode is OFF since anode is negative relative to the cathode
iii. Diode is OFF since anode is less positive than the cathode
iv. Diode is ON since anode is more positive than the cathode

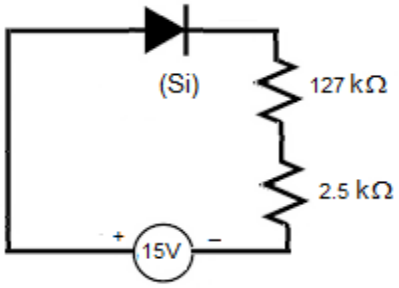
Question:

1. Calculate the voltage drop across the diodes and the resistors in the following:

i. ii. iii.



2. Calculate I_F for the circuit below.



Solution

1.

i. The germanium diode is in the reverse biased mode (+V → n region, –V or ground → p region) and is therefore equivalent to an open switch. Since all of the applied voltage will always appear across an open in a series circuit; Then,

$V_{diode} = V_s = 8\ V$

Therefore $V_R = 0\ V$

ii. This circuit is also a series circuit and similar to (i) therefore,

$V_{diode} = V_s = 20\ V$

Therefore $V_R = 0\ V$

iii. The silicon diode is in forward biased mode (+V → p region, –V or ground → n region) and is therefore equivalent to a closed switch. The voltage drop across a forward biased silicon is approximately equal to the barrier potential voltage of the diode, which is 0.6V.

But $V_s = V_R + V_{diode}$

Therefore $V_R = V_s - V_{diode}$

$= 10\ V - 0.6\ V$

$= 9.4\ V$

2. $R_L = R_1 + R_2 = 2.5 + 127 = 129.5\ \Omega$

$V_{diode} = 0.6\ V$

$V_S = 15\ V$

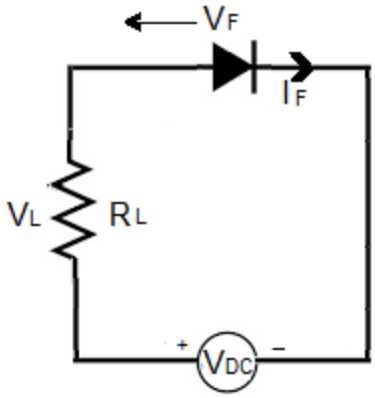
$V_L = R_L I_F$

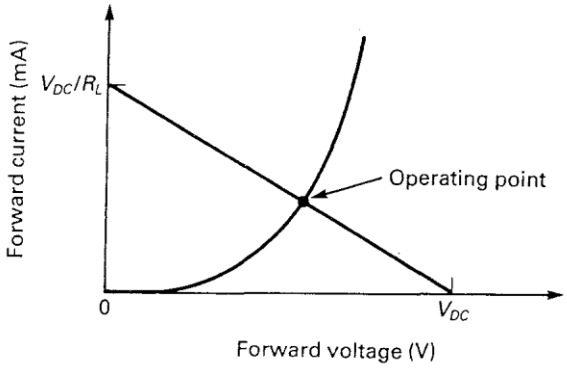
Applying Kirchhoff's voltage rule: $V_S = V_{diode} + V_L = V_{diode} + R_L I_F$

$$\Rightarrow \quad I_F = \frac{V_S - V_{diode}}{R_L} = \frac{15\ V - 0.6\ V}{129.5\ \Omega} = \frac{14.4\ V}{129.5\ \Omega}$$

$= 0.1112\ A = 111.2\ mA$

Diode Load Lines





The current flowing through a diode in series with a resistance, and the voltage dropped across it, can be determined with the aid of a load line drawn on the diode's current-voltage characteristic. Referring to Figure on the right above, the voltage across the diode is equal to the applied voltage minus the voltage dropped across the load resistor. Thus,

$V_F = V_{DC} - V_L = V_{DC} - I_F R_L \quad \rightarrow *$

$I_F = V_{DC}/R_L - V_F/R_L$

This is the equation of a straight line and so only two points are required on the diode characteristic.

Point A: When $I_F = 0$, $V_F = V_{DC}$.

Point B: When $V_F = 0$, $V_{DC} = I_F R_L$, or $I_F = V_{DC} / R_L$.

Both equation * and the points plotted on a diode characteristic must be simultaneously satisfied and this is possible only at the point of intersection of the d.c. load line and the current-voltage curve. The point of intersection gives the quiescent, steady, values of the current and voltage in, and across, the diode and it is known as the ***operating point***.