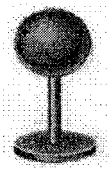
UNIVERSITY COLLEGE – YANBU

Preparatory Physical Science (PHSC 001)

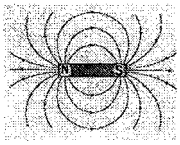
Module 2- Electricity and Magnetism
(Solved Problems)

Prepared by
Engr. Hamdy Abou El-Ela
and
Dr. Naseer Ahmed

Reference Textbook
Conceptual Physical Science by P. Hewitt, J. Suchocki and L. Hewitt,
3rd Edition, Pearson Addison-Wesley (2004)
ISBN: 0-321-10663-6



Solved Problems
Electricity and Magnetism



Question 1: Assume that the attractive force between the two point charges separated by a distance *d*, is *F*:

a) are the charges similar or opposite?
b) what will be the force between them when the separation between them is doubled?

Solution: a) Since *F* is attractive, therefore the charges are opposite.

b) According to the Coulomb's law ($F = k\frac{Q_1 Q_2}{d^2}$) the force *F* is inversely proportional to the square of the separation between the two charges. Therefore, if the separation is doubled the attraction force will become (*F/4*) i.e., one fourth of the original force *F*.

Question 2: How many electrons make one Coulomb?

Solution: The electron charge = -1.6×10^{-19} C
Therefore the number of electrons in one Coulomb is

$$n = \frac{1\,C}{1.6\times10^{-19}\,C} = \frac{10}{1.6}\times10^{18} = 625\times10^{16}$$

Therefore, 625×10^{16} electrons make one coulomb

Question 3: How many electrons per second must pass a given wire in order to have a current of 1 Ampere?

Solution: Since $I = \frac{Q}{t}$

In unit form we can write $1A = \frac{1C}{1s}$

Substituting the value of 1C as calculated in Question 2 above.

$$1A = \frac{625\times10^{16}\ electrons}{1s} = 625\times10^{16} \text{ electron per second}$$

Question 4: A device of *120 V* has a current of *20 A*. What is the resistance of the device?

Solution: According to Ohm's law $V = IR$

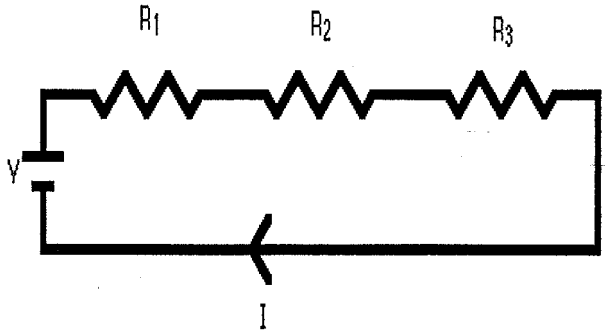
$$R = \frac{V}{I} = \frac{120V}{20A} = 6\Omega$$

Question 5: If the voltage is doubled in a circuit having a resistance *R*, what is the effect on the current flowing in the circuit?

Solution: Since $V = IR$, therefore if *V* is doubled, then *I* will also double.

Question 6: A series circuit is shown in the figure below. Assume that voltage applied to this circuit is *10V* and the values of the three resistors are $R_1 = 8\Omega$, $R_2 = 8\Omega$, and $R_3 = 4\Omega$. Find:

a) the total resistance
b) the total current flowing though this circuit



Solution:

a) The total resistance of this circuit is

$$R_{total} = R_1 + R_2 + R_3 = 8\Omega + 8\Omega + 4\Omega = 20\Omega$$

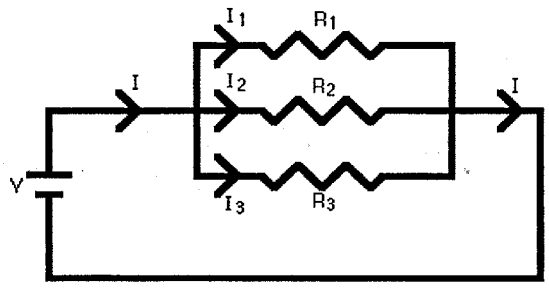
b) The total current in the circuit is:

$$I = \frac{V}{R_{total}} = \frac{10V}{20\Omega} = 0.5A$$

The current through each resistor would be *0.5 A*

Question 7: A parallel circuit is shown in the figure below. Assume that voltage applied to this circuit is $10V$ and the values of the three resistors are $R_1 = 4\Omega$, $R_2 = 4\Omega$, and $R_3 = 2\Omega$. Find:

a) the total resistance
b) the total current flowing though this circuit
c) the current flowing in each individual resistor



Solution: a) The total resistance of this circuit is

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_2} = \frac{1}{4\Omega} + \frac{1}{4\Omega} + \frac{1}{2\Omega} = \frac{1+1+2}{4\Omega} = \frac{1}{\Omega}$$

$$R_{total} = 1\Omega$$

b) The total current in the circuit is:

$$I_{total} = \frac{V}{R_{total}} = \frac{10V}{1\Omega} = 10A$$

c) The current through R_1 *is* $I_1 = \frac{V}{R_1} = \frac{10V}{4\Omega} = 2.5A$

The current through R_1 *is* $I_2 = \frac{V}{R_2} = \frac{10V}{4\Omega} = 2.5A$

The current through R_1 *is* $I_3 = \frac{V}{R_3} = \frac{10V}{2\Omega} = 5A$

The total current passing through the circuit is the sum of the currents passing through individual resistors, i.e.,

$$I_{total} = I_1 + I_2 + I_3 = 2.5A + 2.5A + 5A = 10A$$

Question 8: Which field surrounds:

a) a stationary electric charge?

b) a moving electric charge?

Solution: a) an electric field

b) a magnetic field

Question 9: "*An electron always experiences a force in the existence of an external electric field, but not always in the existence of an external magnetic field*" defend this statement.

Solution: An electron being a negative charge, it experiences a force in an external electric field, the force is opposite to the external electric field. However, in a magnetic field the electron must be moving at a non-zero angle with the direction of the external magnetic field to experience a force.

Question 10: What is the basic difference between an electric motor and generator?

Solution Motor converts electric energy into mechanical energy whereas the generator converts mechanical energy into electric energy.

Question 11: When voltage is induced in a coil?

Solution: When a varying magnetic field passes through the coil.