UNIT 1: CONTUCTORS, INSULATORS AND SEMICPNDUCTORS

If we connect a battery across a body, there is a movement of free electrons towards the positive end. This movement of electrons is an electric current. All materials can be classified into three groups according to how readily they permit an electric current to flow. These are: conductors, insulators, and semiconductors.

In the first category are substances which provide an easy path for an electric current. All metals are conductors; however, some metals do not conduct well. Manganic, for example, is a poor conductor. Copper is a good conductor; therefore, it is widely used for cables. A non-metal which conducts well is carbon. Salt water is an example of a liquid conductor.

A material which does not easily release electrons is called an insulator. Rubber, nylon, porcelain and air are all insulators. There are no perfect insulators. All insulators will allow some flows of electrons; however, this can usually be ignored because the flow they permit is so small.

Semiconductors are mid-way between conductors and insulators. Under certain conditions they allow a current to flow easily but under others they behave as insulators. Germanium and silicon are semiconductors. Mixtures of certain metallic oxides also act as semiconductors. These are known as thermistors. The resistance of thermistors falls rapidly as their temperature rises. They are therefore used in temperature sensing devices.

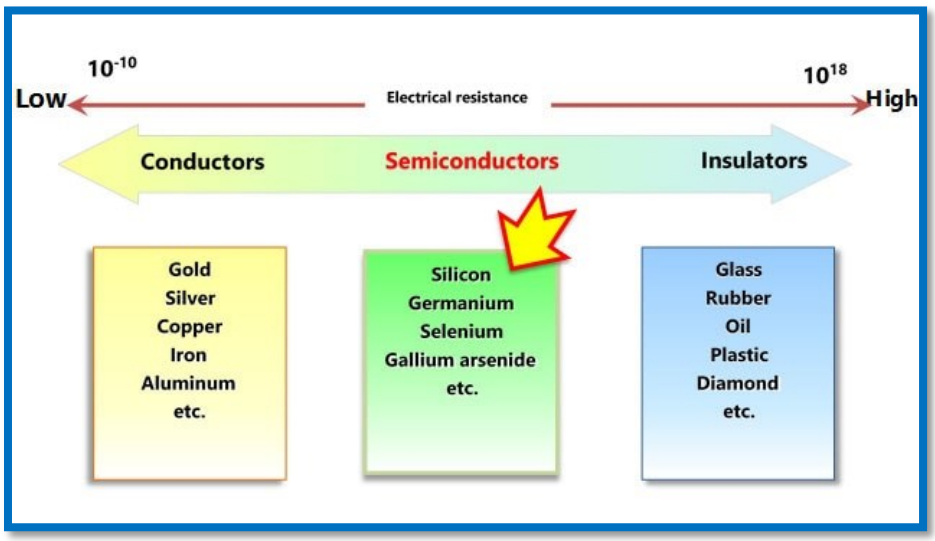

Figure 1-1 Categories of materials according to their electrical resistivity

I. VOCABULARIES

- ***Substance:*** material with physical characteristics.
- ***Conductor :*** a substance that allows heat or electricity to go through it.
- ***Insulator*** : a substance that does not conduct electricity.
- ***Semiconductor*** : a substance, such as silicon, that allows some electricity to flow through it, used in making electronic devices.
- ***Battery*** : a device that produces electricity to provide power for radios, cars, etc.
- ***Cable :*** a set of wires, covered by plastic, that carries electricity, phone signals, etc.
- ***Liquid*** : a substance, such as water that is not solid or a gas and that can be poured easily
- ***Current*** : a movement of water, air, or electricity in a particular direction.
- ***Thermistor*** : a type of resistor in which resistance varies with Temperature
- ***Intermediate :*** being between two other related things,levels, or points
- ***Substation*** : a place that allows electricity to go from one part of the electricity production system to another
- ***Distribution :*** the process of giving things out to several people, or spreading or supplying something
- ***Illumination*** : light
- ***Precision*** : the quality of being exact.
- ***Assemble:*** to make something by joining separate parts.
- ***Resistance*** : the degree to which a substance prevents the flow of an electric current through it.
- ***Armored :***(armoured) covered with a special material that protects against weapons.
- ***Electromagnet:*** a device made from a piece of iron that becomes magnetic when a changing current is passed through the wire that goes around it.
- ***Capacitance:*** the ability of an object or material to store electricity.
- ***Glow:*** to produce a continuous light and sometimes heat.

II. READING AND COMPREHENSION

Exercise 1: *Rephrasing*

Rewrite the following sentences, replacing the words in *italics* with expressions from the passage which has similar meanings:

1. The *flow* of free electrons is called an electric current.
2. Materials in the first *group* are called conductors.
3. *Materials* which provide a path for an electric current are conductors.
4. All insulators *permit* some flow of electrons.
5. Germanium sometimes *acts as* an insulator and sometimes as a conductor.

Exercise 2: *Contextual reference*

Which do the pronouns in italics in these sentences refer to?

I. All materials can be classified into three groups according to how readily *they* permit an electric current to flow.
   a) Three groups
   b) All materials
   c) Free electrons

II. Under certain conditions, *they* allow a current to flow easily but under others *they* behave as insulators.
   a) Conductors.
   b) Semiconductors
   c) Insulators

III. These are known as thermistors.
   a) Metallic oxides.
   b) Semiconductors.
   c) Mixtures of certain metallic oxides.

IV. *They* are therefore used in temperature-sensing devices.
   a) Thermistors.
   b) Semiconductors.
   c) Metallic oxides.

Exercise 3: ***Checking facts and ideas.***

Describe if these statements are *true* or *false*. Quote from the passage to support your decision.

1. Electrons flow from positive to negative.
2. Copper provides an easy path for an electric current.
3. All metals are good conductors.
4. All good conductors are metals.
5. Air is not a perfect insulator.
6. Rubber readily releases electrons.
7. The resistance of a thermistor is higher at low temperatures than at high temperatures.

III. USE OF ENGLISH

Exercice 4: ***Reason and result connectives***

Study these sentences:

1. Copper is used for cables.

2. Copper is a good conductor.

Sentence 1 tells us what copper is used for.

Sentence 2 tells us why it is used, sentence 2 provides a reason for sentence 1.

we can link a statement and a reason using because.

1+2. Copper is used for cables **BECAUSE** it is a good conductor.

Now study

When the reason is a noun a noun phrase, we can use **because of** . Note that a comma is used before therefore.

Now study this pair /

3. The flow of electrons through an insulator is very small.

4. the flow can be ignored.

Sentence 4 is the result of sentence 3. We can link a statement and a result using **THEREFORE**.

Note that a comma is used before **THEREFORE.**

Now link these ideas using because and therefore to make shorten two sentences.

1. Soft iron is used in electromagnets.

   Soft iron can be magnetized easily

2. The voltage is 250 V and the current 5 A.

The resistance is 50 ohms.

3. PVC is used to cover cables.

   PVC is a good insulator.

4. Transistors can be damaged by the heat.

   Care must be taken when soldering transistors.

5. Capacitance is usually measured in micro-farads or pico-farads.

   The farad is too large a unit.

6. Output transistors are mounted on a heat sink.

   Output transistors generate heat.

7. It is easy to control the speed of DC motors.

   DC motors are used when variable speeds are required.

8. A cathode ray tube screen glows when an electron beam strikes it.

   The screen is coated with phosphor.

IV. FURTHER READING

Stage 01: Comprehension

CONDUCTORS, INSULATORS, AND ELECTRON FLOW

The electrons of different types of atoms have different degrees of freedom to move around. With some types of materials, such as metals, the outermost electrons in the atoms are so loosely bound that they chaotically move in the space between the atoms of that material by nothing more than the influence of room-temperature heat energy. Because these virtually unbound electrons are free to leave their respective atoms and float around in the space between adjacent atoms, they are often called *free electrons*. In other types of materials such as glass, the atoms' electrons have very little freedom to move around. While external forces such as physical rubbing can force some of these electrons to leave their respective atoms and transfer to the atoms of another material, they do not move between atoms within that material very easily. This relative mobility of electrons within a material is known as electric *conductivity*. Conductivity is determined by the types of atoms in a material (the number of protons in each atom's nucleus, determining its chemical identity) and how

the atoms are linked together with one another. Materials with high electron mobility (many free electrons) are called *conductors*, while materials with low electron mobility (few or no free electrons) are called *insulators*.

Study the passage above carefully and answer the following questions:

1. What is the influence of room-temperature heat energy on the outermost electrons of metals?
2. What term is used to describe the electrons in metals that are so loosely bound they can move freely in the space between atoms?
3. How do electrons behave in materials like glass, and what limits their movement?
4. What is the term used to describe the relative mobility of electrons within a material?
5. What determines the conductivity of a material?
6. What are materials with high electron mobility and many free electrons called?
7. What are materials with low electron mobility and few or no free electrons called?

Stage 2 summarizing

Complete this summary of the passage using your answers to stage 01

- In metals, the outermost electrons are loosely bound and move chaotically in the space between atoms due to ……...
- These electrons, known as ……., can leave their respective atoms and float around.
- On the other hand, in materials like glass, electrons have ……., and external forces, such as rubbing, may cause some electrons to transfer between atoms, but they do not move easily within the material.
- The relative mobility of electrons is termed ……..., determined by the ……..in a material and how they are linked.
- Materials with high electron mobility are called ……., while those with low electron mobility are called ……... Conductors have ……. free electrons, while insulators have ……..or …….

V. Translation

Translate to French this passage:

"Semiconductors are mid-way between conductors and insulators. Under certain conditions they allow a current to flow easily but under others they behave as insulators. Germanium and silicon are semiconductors. Mixtures of certain metallic oxides also act as semiconductors. These are known as thermistors. The resistance of thermistors falls rapidly as their temperature rises. They are therefore used in temperature sensing devices."