

1.3 Insulators, conductors, semi-conductors, and superconductors

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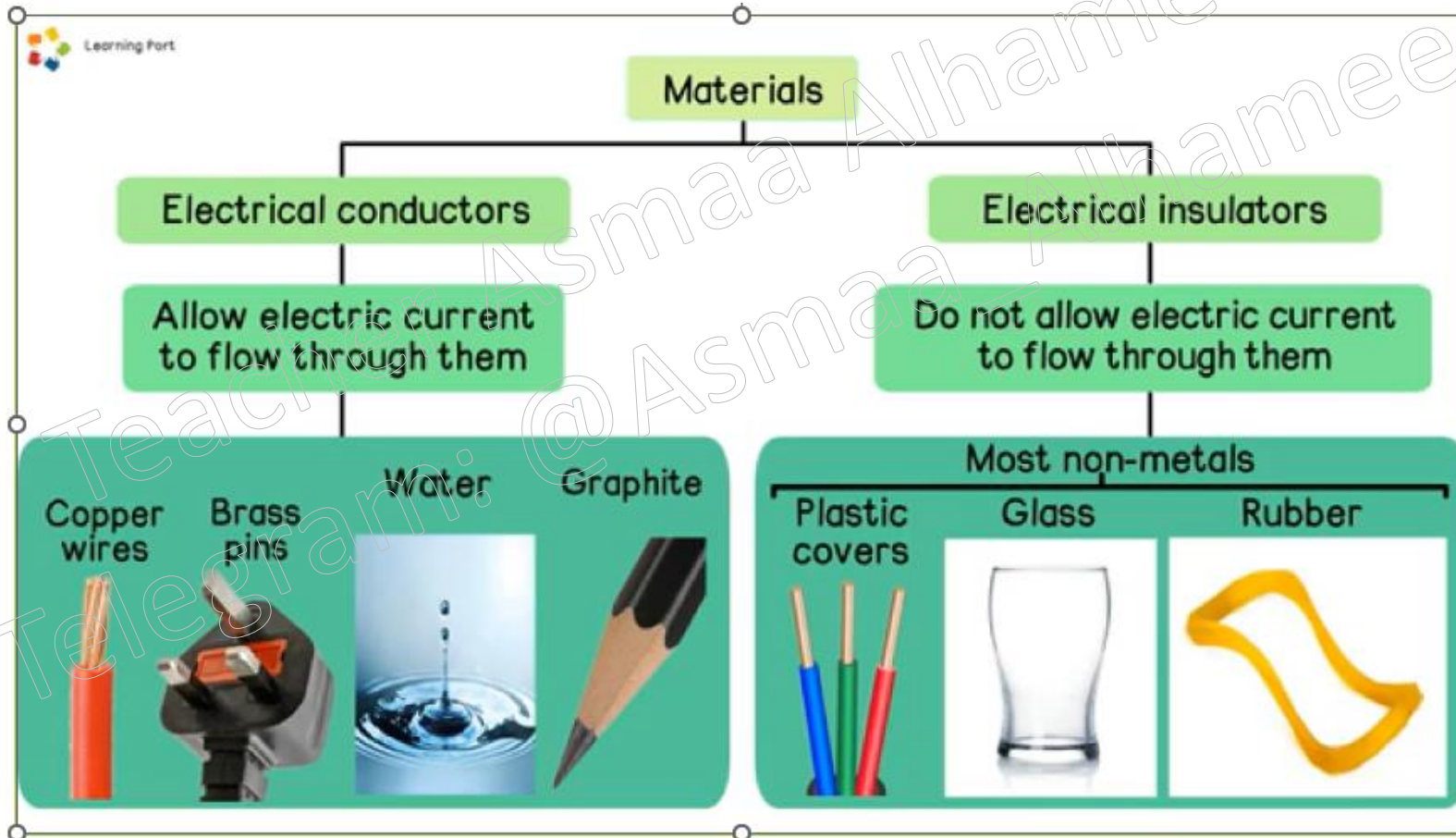
Conductors:

Solid → negative charges
liquid → positive charge
negative charge

- Materials that are conductors have an electronic structure that allows the free movement of some electrons.
- The positive charges of the atom of a conduction material do not move, because they are in the heavy nuclei.
- Examples of conductors: metals like copper.
- Copper is a very good conductor and is therefore used in electrical wiring.
- Fluids and organic tissue (poor conductor) can also be used as conductors.
- Pure distilled water is not a very good conductor. Sea water (water with ions dissolved in it like NaCl) is a very good conductor, because the positively charged sodium ions (Na⁺) and the negatively charged chlorine ions (Cl⁻) can move within the water to conduct electricity.
- Unlike in solids, in liquids, positive as well as negative charge conduct electricity.

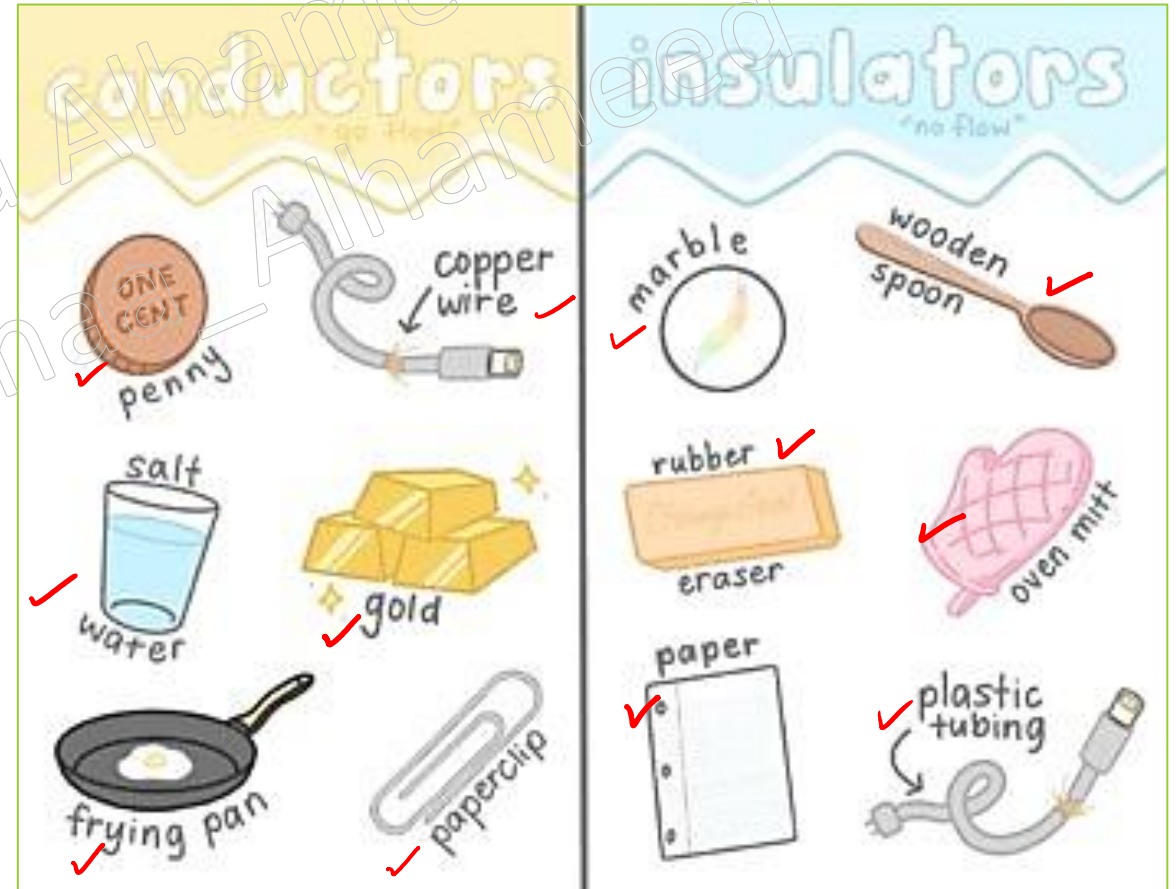


Classifications of materials:



Materials: Electrical property

- Materials that conduct electricity well are called **conductors**. موصلان ✓
- Materials that do not conduct electricity are called **insulators**. عوازل ✓
- There are good and poor conductors and good and poor insulators.



Activity 1: Question

Select the best answers.

Sami performed a small experiment and found that copper conducts a maximum current when connected in a closed circuit. What can you say about copper wire?

Select 2 choice(s)

A

Copper has zero resistivity.

D

Copper has low conductivity. ✗

B

Copper has low resistivity.

E

Copper has high conductivity. ✓

C

Copper has zero conductivity. ✗

F

Copper has high resistivity. ✗

Activity 2: Question

Select the correct answer.

What happens to the conductivity of distilled water when you dissolve table salt in the water?

poor conductor

NaCl

Na⁺ Cl⁻

↑ increase conductivity



A

The conductivity of the water increases. ✓

B

The conductivity of the water decreases. ✗

C

The conductivity of the water stays the same. ✗

D

The conductivity of the water increases to infinity. ✗

Insulators:

- For insulators, no free movement of electrons occurs because the material has no loosely bound electrons that can escape from its atoms and thereby move freely throughout the material.
- Examples of insulators: glass, plastic, cloth.

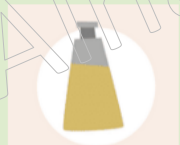
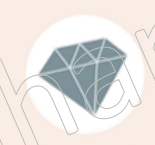


Activity 3: Sort conductors and insulators.



Conductors	Insulators

Activity 3: Sort conductors and insulators.

Conductors				Insulators			
							
sea water	gold	steel	copper	oil	diamond	dry wood	rubber
							
silver				glass			

Semiconductors:



Semiconductors:

Extra understanding:

https://www.youtube.com/watch?v=IQ_VSzdJrnY

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Semiconductors:

- A class of materials that can change from being an insulator to being a conductor and back to insulator again is called **semiconductors**. *
- It is used mostly in computers and electronic industries. Such as transistors, computer chips.
- Semiconductors are two types: intrinsic and extrinsic. Examples of intrinsic semiconductors (are chemically pure crystals) of gallium arsenide, germanium, and silicon. 100%.
- Extrinsic semiconductors are created by doping which is the ^{98%} ^{2%} addition of minute amounts of other materials that can act as electron donors called n-type (n stands for “negative charge”).
- If the doping substance acts as an electron receptor, the hole left behind by an electron that attaches to a receptor can also travel through the semiconductor and acts as an effective positive charge carrier. These semiconductors are consequently called p-type (p stand for “positive charge”).

Superconductors:



Superconductors:

- **Superconductors** are materials that have zero resistance to the conduction of electricity.
- Materials are superconductors only at very low temperature.
- **Examples** of superconductors: **niobium-titanium alloy** ^{example} that must be kept near the temperature of liquid helium (4.2 K) to keep its superconducting properties.
- New materials **high- T_c superconductors** were developed. (T_c) stands for critical temperature, which is the maximum temperature that allows super conductivity. They conduct at temperature at which liquid nitrogen exist (at 77.3 K)

Activity 4: Question

$$R = 0 \, \Omega$$

Sami performed an experiment to find the conductivity of some materials. His aim was to find the superconductive material. Which piece of data below tells Sami a material is superconductive?

A

$$R = 10^7 \, \Omega$$

C

$$R = 0 \, \Omega$$

B

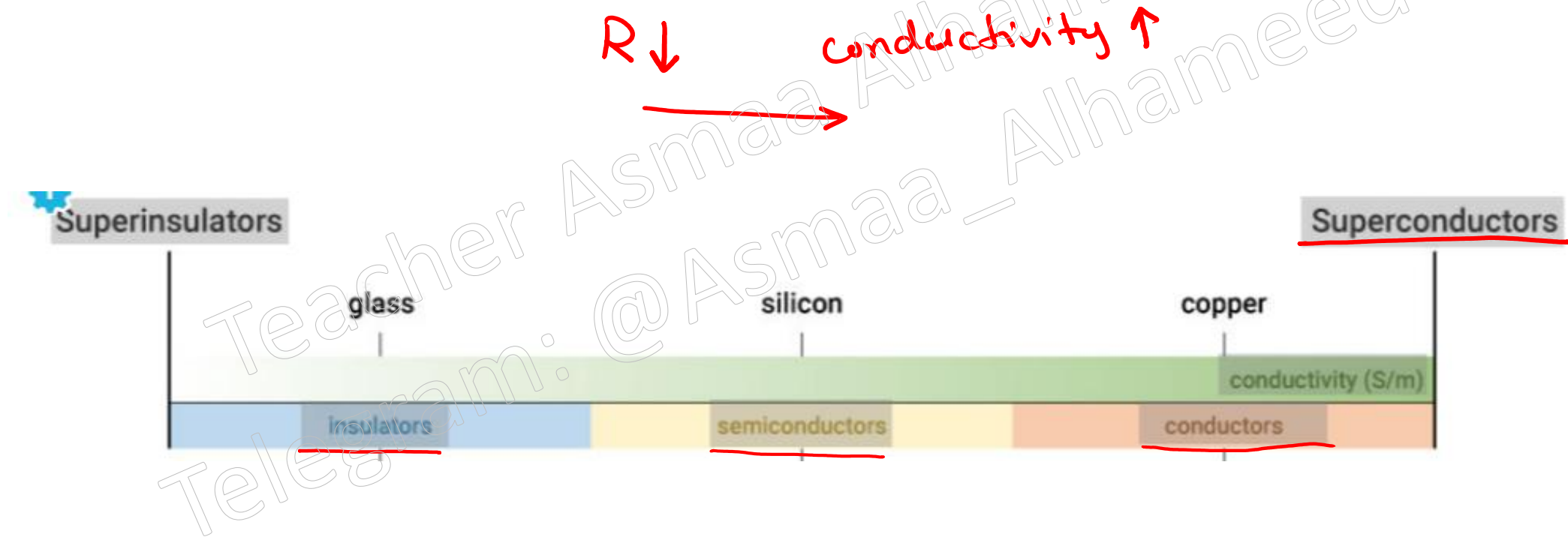
$$R = 1000 \, \Omega$$

D

$$R = \infty \, \Omega$$

superinsulator

Classifications of materials:



Thank you

Link for slides in the description

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