Charges and Electricity

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1st Oct, 2022

Learning Outcome

I highly recommend you to finish this checklist to determine whether you've achieved the learning objectives.

- ☐ understand that atoms has negative electron surrouding
- ☐ explain the phenomenon of charge by friction
- ☐ use electroscope to test whether an object is charged or not
- ☐ understand that charge is quantised
- ☐ memorize the elementary charge
- ☐ understand the term charge and recognise its unit, the coulomb

Leadin

One of the most important application from physics must be the electricity. You've been in great debt to star physicists for bringing currents to daily life, such as Coulomb Faraday, Tesla, Guass, Ampere, Volta, etc. Without their theories and patents orginates from them, The modern life with convenience will never exsit.

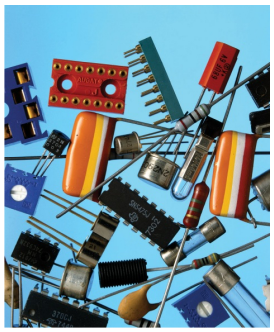


Figure 1: resistors, fuses, capacitors, microchips(logic gates)

Discovery of charges

Before we investigate on the currents, let's look at how charges are discovered and defined.

Charge by friction

Around 600 BC, Thales of Miletus rubbed *amber*[1] with a cloth which caused attraction of lightweight particles, it is the basis for discovery of electric charges. and electricity comes from the greek word-"$\eta\lambda\varepsilon\kappa\tau\rho o\nu$", elektron in English, but stands for amber.

[1] exp:

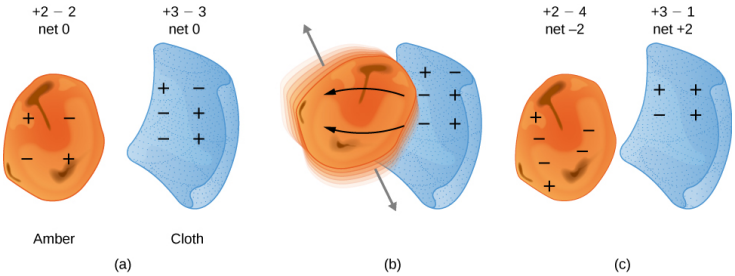


Figure 2: after rubbing amber with cloth, the amber will be charged.

Task

Will the cloth be charged as well?

Electroscope

By putting an object close to/ or touches the metal plate of the electroscope, if the alumimum foil repels and expands, that shows the object is charged.

Task

Instead of amber, we now use two types of rubbing pair, silk and glass rod; fur and plastic rod. Try to illustrate the two types of charging. And use electroscope to show that the materials carry charges.

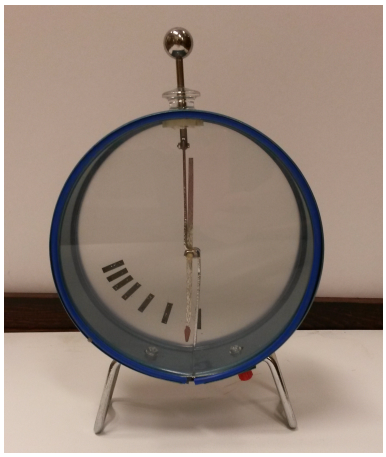


Figure 3: a cylindrical Beetz-type electroscope, inveted in 1873

Franklin's Contribution

Benjamin Franklin is not only the founding father of USA, but also a great and adventurous physicist for his famous kite experiment. And his observations and letters between him and Peter Collison was recorded in "Experiments and Observations on Electricity"

Figure 4: Franklin, A man catching the lightning in 1752

By conducting the kite experiment Franklin proved that lighting was an electrical discharge and realized that it can be charged over a conductor into the ground providing a safe alternative path and eliminating the risk of deadly fires. And that "Philadelphia experiment" has led to the invention of lightning rod, as well as the understanding of **postive** and **negative** charges.

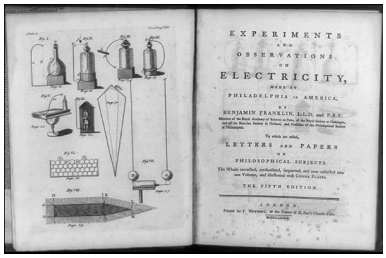


Figure 5: Coverpage of the Experiments and Observation on Electricity

Thomson's Contribution

Sir Joseph John Thomson, who also attended Trinity College from Cambridge University, won the 1906 Nobel Prize for his discovery of "*Cathode Ray*"

which has brought people to the way of dividing atoms into sub-atomic level. He was also famous for his "*plum pudding model*"[2]. Hence, the hero in explaining why objects are neutral, or why sometimes they can be charged, or why there are postive charges and negative charges is finally revealing its veils- the *electron*.

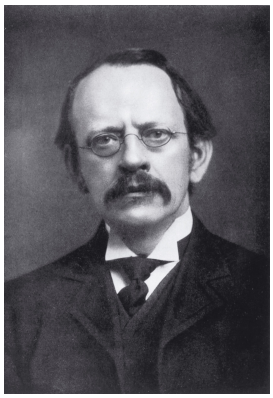


Figure 6: J.J. Thomson
1856-1920

[2] the model is not correct, but still meaningful

Microscopic Explaination

Now,the explaination has finally comes:

- Everything is consist of various
- any atom has _____, and most importantly, in the outside, atom has lots electrons.
- electron is (postively/negatively) charged. while _____ is postively charged.
- Both electron and proton has same amount of charge, but one is negative the other is positve.
- Task: Explain why most objects are neutral

- Electrons are easier to move away from the attraction of nucleus, provided enough energy is transferred to the atom, such energy can be obtained by rubbing the object

- Task: Explain why rubbing can cause charging.

Charge Carriers

In a wire made of metal, the _____ are free to move, thus the charge carriers are the electrons.

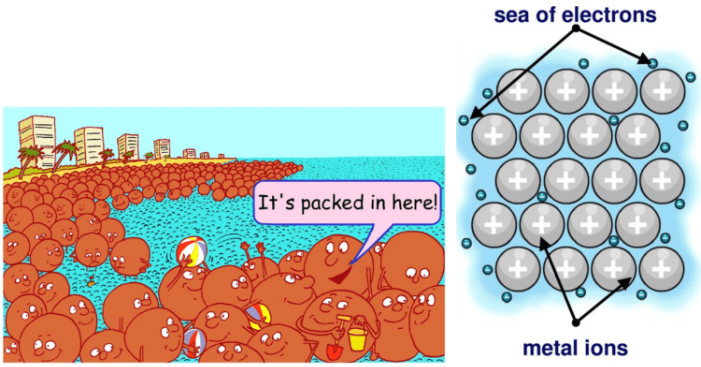


Figure 7: Sea of electrons exist in metal

In a solution, it is not electron but the *Cations* and *Anions*[3] can move if electric field[4] is applied. In this case, the ions are the charge carriers.

[3] def:

[4] it is another topic

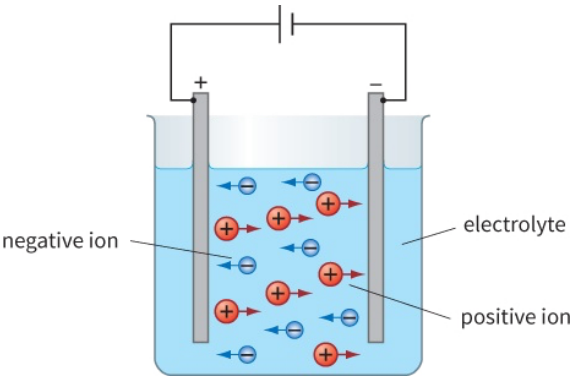


Figure 8: ions are charge carriers in a solution

Task

Using the concept of ions, explain why they can carry charges, and how to determine the amount of charges they carry accroding to the symbol? e.g. Mg^{2+},Cl^{-},CrO_4^{2-} etc.

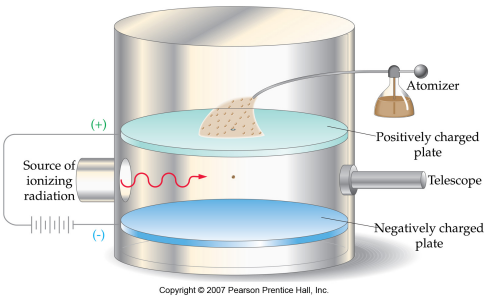
Elementary Charge

Millikan has devised a delicate experiment[5] to deterimine the charge of

[5] oil drop experiment, the result of which is not accurate at first, but has been greatly improved by other young scientists.

electrons. And the amount of charge that an electron carries is _____.
The unit is _____

Such charge is called "*elemenatary charge*" or "*fundamental charge*" and is denoted as $-e$ and a proton has equal amount of charge but is positive, and therefore can be denoted as $+e$ or e.



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