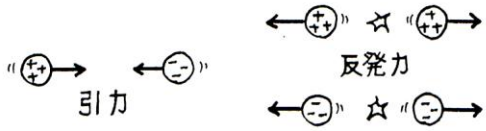
３１　静電気

1　静電気　物体に帯電したまま静止している電気で，物体をこすり合わせたときに生じる。一方が正(＋)に帯電すれば，他方は負(－)に帯電する。

電気の正・負　歴史的な取り決めで定めた。

電気力(静電気力)　静電気どうしの間にはたらく力で，同種の電気は互いに反発し，異種の電気は互いに引き合う。



帯電　物体が電気をもつこと。帯電している物体のことを帯電体という。

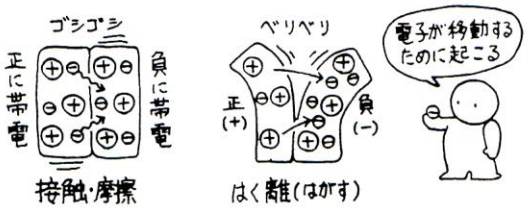
2　電荷と電気量

電荷　物体(帯電体)がもつ電気のこと。

電気量　電荷の量のこと。　単位：〔C(クーロン)〕

1C は 1 A の電流が流れる導体のある断面を 1 s 間に通過する電気量。1C＝1A×1s

電子　すべての物質内にある，負の電気をもった軽い粒子。電気現象は電子の移動による。



3　導体・絶縁体・半導体

導体　電気をよく通すもの。主に金属で，金属原子はいくつかの電子(自由電子)を出し合って金属結合をしている。

絶縁体　電気をほとんど通さないもの。木や石，ゴム。原子中のすべての電子は原子から離れることができない。

半導体　電気の通しやすさが導体と絶縁体の中間程度のもの。Si や Ge など。周期表では金属元素と非金属元素の境界付近にある元素。温度・光などの条件によって電気の流れやすさが変わるため，電子工学部品として利用されている。

31. Static Electricity

Static electricity is the electricity that stays still in an object and is produced when an object is rubbed with another object. If one object is charged positive (+), the other is charged negative (-).

The electric charge on a glass rod rubbed with silk cloth was defined as positive, and the electric charge on an ebonite rod rubbed with fur was defined as negative, and so on.

Electric force is the force between electric charges. Each electric charge repels the same charge and attracts the opposite.

To possess electricity is called “electrification” or “to be charged”.

The electricity or its quantity on the charged objects is called electric charge or quantity of electricity.

The unit of quantity of electricity is Coulomb (C). One coulomb is equal to the charge passing per second by an electric current of one ampere.　1C=1A･1s

Electrons in all materials are light particles with negative charge. The electric phenomena are caused by the movement of electrons.

Conductors allow electricity to pass through them well. Metals are generally good conductors. The metal atoms give some electrons (free electrons) and are joined in metallic bonding.

Insulators such as woods, stones, and rubber inhibit electricity to flow. All electrons in the atoms cannot be removed from atoms easily.

Semiconductors, such as Silicon (Si), and Germanium (Ge), have conductivity between that of conductors and insulators. They are near the border of metallic elements and nonmetallic elements in the periodic table. They are used as electronic parts because their conductivity changes according to factors such as temperature and light.

３２　電流

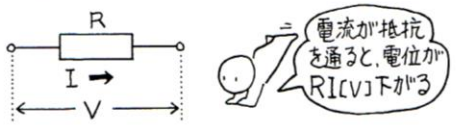
1　電流の強さ　導体のある断面を1 s 間あたりに通過する電気量。t〔s〕間に Q〔C〕の電気量が通過したとき，電流の強さ I は，

$$I=\frac{Q}{t}$$　単位：〔A〕(アンペア)

2　オームの法則　加わる電圧 V と流れる電流 I は比例する。比例定数 R として，

$$V=RI$$

R：電気抵抗　単位：〔V/A〕⇨〔Ω〕(オーム)とする。

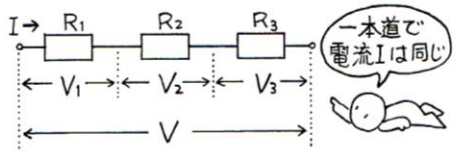


抵抗率　電気抵抗 R〔Ω〕は導体の長さ L〔m〕に比例し，導体の断面積 S〔m²〕に反比例する。比例定数を ρ(ロー)として，

$$R=\rho\frac{L}{S}$$　ρ：抵抗率〔Ω·m〕

3　抵抗の接続

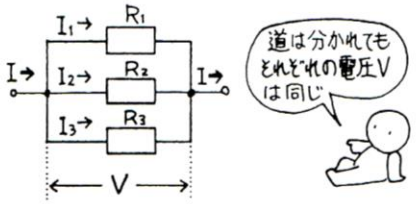
①　**直列接続**　各抵抗を流れる電流は等しく，全体の電圧は各抵抗の電圧の和になる。



全電圧　$V=V_1+V_2+V_3$

合成抵抗　$R=R_1+R_2+R_3$

②　**並列接続**　各抵抗にかかる電圧は等しく，全体の電流は各抵抗の電流の和になる。



全電流　$I=I_1+I_2+I_3$

合成抵抗の逆数　$\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}$

32. Electric Current

The electric current intensity is the amount of charge that passes through a conductor's cross section at any point per second. The current intensity I [A] is defined as

$$I=\frac{Q}{t}$$　unit: (A)

where Q [C] is the amount of charge during the time interval t [s].

Ohm's law tells us that there is a proportional relationship between the applied voltage V and the electric current I.

$$V=RI$$

where R, the constant of proportionality, is the electric resistance. The unit of resistance is ohm (Ω).

The electric resistance R [Ω] is directly proportional to the length L [m] of the object and inversely proportional to the cross-sectional area S [m^2].

$$R=\rho\frac{L}{S}$$

where ρ [Ω·m], the constant of proportionality, is called the resistivity.

As for resistors in series, all the currents through each resistor is the same, and the total voltage is the sum of the voltages across each resistor.

Total voltage:　$V=V_1+V_2+V_3$

Total resistance:　$R=R_1+R_2+R_3$

As for resistors in parallel, all the voltages for each resistor is the same, and the total current through all resistors is the sum of the currents through each resistor.

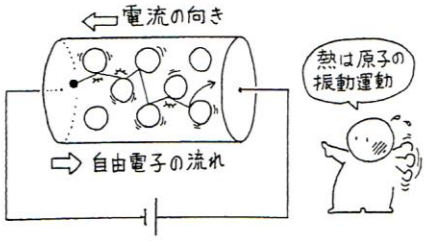
Total current:　$I=I_1+I_2+I_3$

Reciprocal of total resistance:　$\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}$

３３　電力と電力量

33. Electric Power and Electric Energy

1 **電流の熱作用**　抵抗線に電圧を加えると自由電子が動き，抵抗線をつくる原子に衝突しながら進む。そして原子の熱運動が激しくなり発熱する(**ジュール熱**)。



V〔V〕の電圧を加え，I〔A〕の電流を t〔s〕間流したときの発熱量 Q〔J〕は，1 s あたり VI だから，

$\boldsymbol{Q=VIt}$　(**ジュールの法則**)

When the voltage is applied to the resistance wires, free electrons move and collide with metal atoms. The thermal motion of atoms becomes more violent and metal wires generate heat (Joule heat).

The generated heat for t [s] when the applied voltage is V [V] and the current is I [A] is

$Q = VIt$　(Joule's Law)

2 **電力 P**　単位時間あたりに電流がする仕事(電流の仕事率)で，電気器具の消費電力のこと。

電圧 V〔V〕で電流 I〔A〕のとき，電力 P は，

$\boldsymbol{P=VI=RI^2=\dfrac{V^2}{R}}$　単位：〔ワット(W)〕

(オームの法則 $V=RI$ を利用して変形)

Electric power is the work done by the electric current per second (Power of electric current) or power consumption by an electric appliance.
When the voltage is V [V], and the current is I [A], the electric power P is

$$P = VI = RI^2 = \frac{V^2}{R}$$　unit: (W)

(derived using Ohm's law $V = RI$)

3 **電力量 Q**　電源が与えたエネルギーのことで，P〔W〕の電力で時間 t〔s〕間に与えられるエネルギー量(電力量) Q〔J〕は，

$\boldsymbol{Q=Pt}$　単位：〔W・s〕=〔J〕

Electric energy is the energy supplied by the battery. The electric energy supplied by the power P [W] for t [s] is

$Q = Pt$　unit: (W・s)=(J)

日常生活では，1 kW (1000 W) の電力を 1 h (時間) 使ったときの電力量を用い，これを 1 kWh (キロワット時) とする。

$1\ \mathrm{kWh} = 1\times10^3\ \mathrm{W}\times1\ \mathrm{h}$
$= 1\times10^3\ \mathrm{J/s}\times3600\ \mathrm{s}$
$= 3600000\ \mathrm{J}$

In daily life, we use the unit kilowatt-hour for electric energy. It is the electric energy consumed by the power of 1kW per hour, that is ($1\mathrm{kWh} = 3.6\times10^6\mathrm{J}$).