DC electricity 直流电

- def. (current & voltage)
  - 电：运输能量/信息
  - charge (Q): physical property of matter that causes it to experience a force when placed in an electromagnetic field.
    单位: coulomb (C) $Q = 电子数 \times 1.6 \times 10^{-19}$
  - current (A): the rate of flow of charge $I = \frac{\Delta Q}{\Delta t}$ $\Delta Q = I\Delta t$
    是scalar但有方向，流向与正电荷相同，负电荷相反
  - potential: energy carried on per unit charge 电流从势差高→低
  - potential difference (V): energy transfered from each unit
    $1\ J\,C^{-1}$ $V = \frac{W}{Q}$ ← work done by charge
  - electromagnetic force: energy transfered to each unit 电流从势差高到低

电池 —emf→ 电荷 —pd→ 用电器

能量损失

命题术语：① current through ...
② voltage across ...
③ emf of ...

- def. (power & efficiency)
  power (W): rate of energy transfer $P = \frac{W}{t} = \frac{W}{Q} \times \frac{Q}{t} = IV$
  $efficiency = \frac{E_{in}}{E_{out}}$

- 电子在迁移过程中的能量变化
  金属内的free e: $hf_{thres} = \phi + \frac{1}{2}mv^2$
  半导体内的价带e: $eV_{thres} = hf + \frac{1}{2}mv^2$
  气体原子内的e: $hf\,(eV) = \Delta E_n$

- Resistance

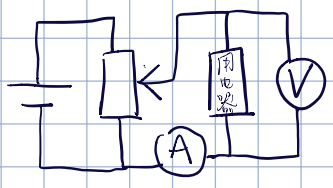
def: $R=\frac{V}{I}$ unit: ohm (Ω)

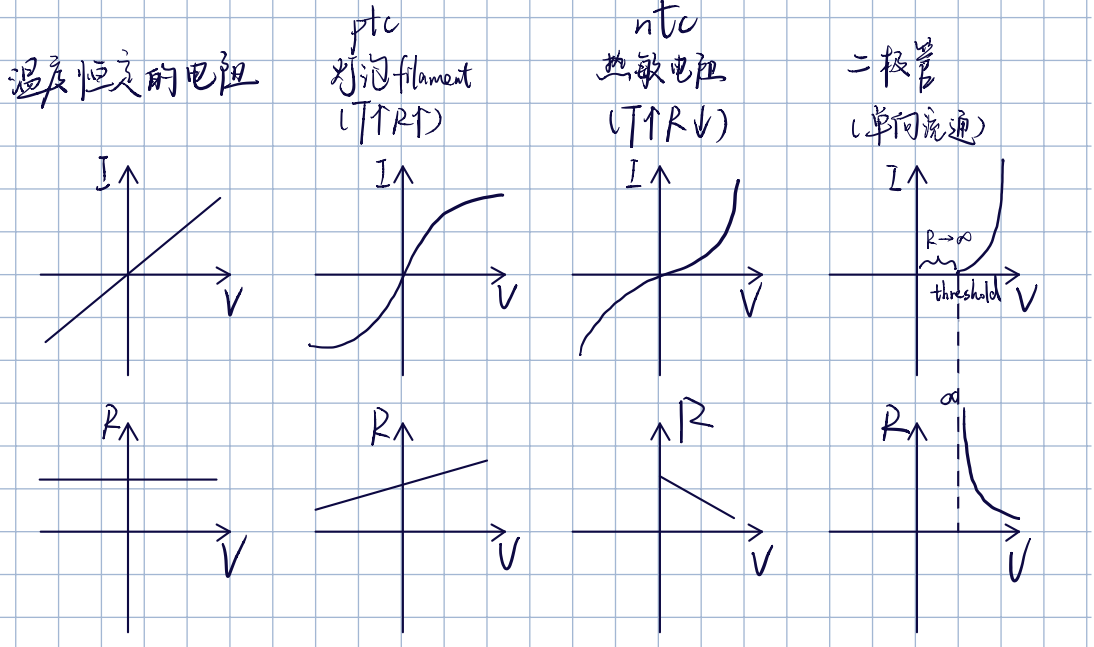
↳ 大小由材料内能决定，内能大，扰动剧烈，时被干扰大，R大

$P=IV=I^2R=\frac{V^2}{R}$

欧姆定律:

the current through a component is directly proportional to the voltage across it.





一些答题思路:

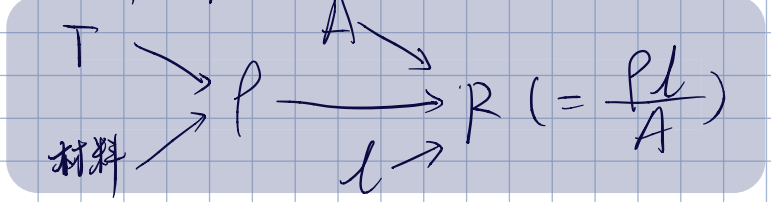
$I\uparrow \rightarrow E\uparrow (e^- \rightarrow \text{lattice}) \rightarrow \text{lattice vibration}\uparrow \rightarrow f \text{ of collision}\uparrow \rightarrow v\downarrow \xrightarrow{I=nqAv} I\downarrow \rightarrow R\uparrow$

热敏: $V\uparrow \rightarrow E\uparrow \rightarrow n_{free}\uparrow \xrightarrow{I=nqVA} I\uparrow \xrightarrow{R=\frac{V}{I}} R\downarrow \rightarrow \circ I\uparrow$

(穿过in电子能量格in能量)

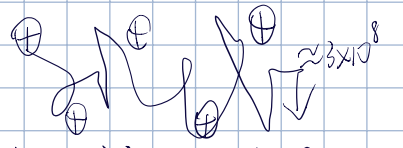
- Resistivity (ρ): $R=\frac{\rho l}{A}$ ← 横截面积 unit: Ωm

由材料和温度决定



Condition of different material

- transport equation



(方向不一定完全→) 仅在电场中扰动

影响因素 → emf↑ → V↑ / T↑ → V↑

def drift velocity: the average overall speed of the electrons in material (受电场操控)

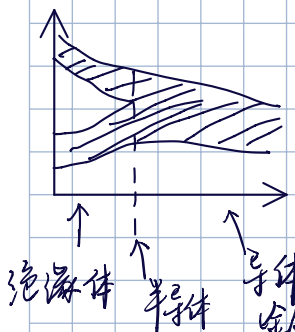
电流公式
- 定式: $I = \frac{\Delta Q}{\Delta t}$ (定义)
- $I = \frac{V}{R}$
- $I = nqvA$ ($q = 1.6\times10^{-19}$)

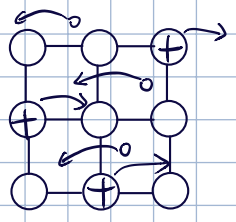
n: charge carrier density, m^{-3}; v: drift velocity

- Conductions in metal & semiconductor

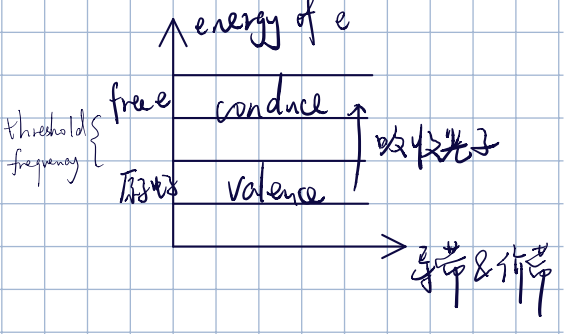
分类标准↓

三者本质区别：导带和价带间的距离

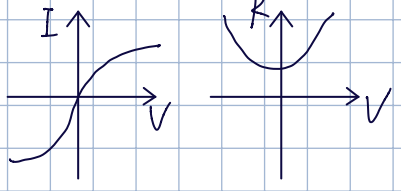




电场中电子离子不动.
绝缘体：电子离子不动
导体：电子离子乱跑



金属

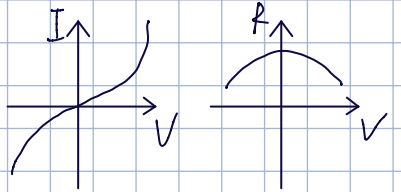


T↑ ⇌ 晶格 vibration↑ ⇌ 电子&晶格 rate of collision↑ ⇌ Vd↓ ⇌ I↓ (V↑)

R↑

collision多, Vd变小(电子受阻)

半导体 (热敏)

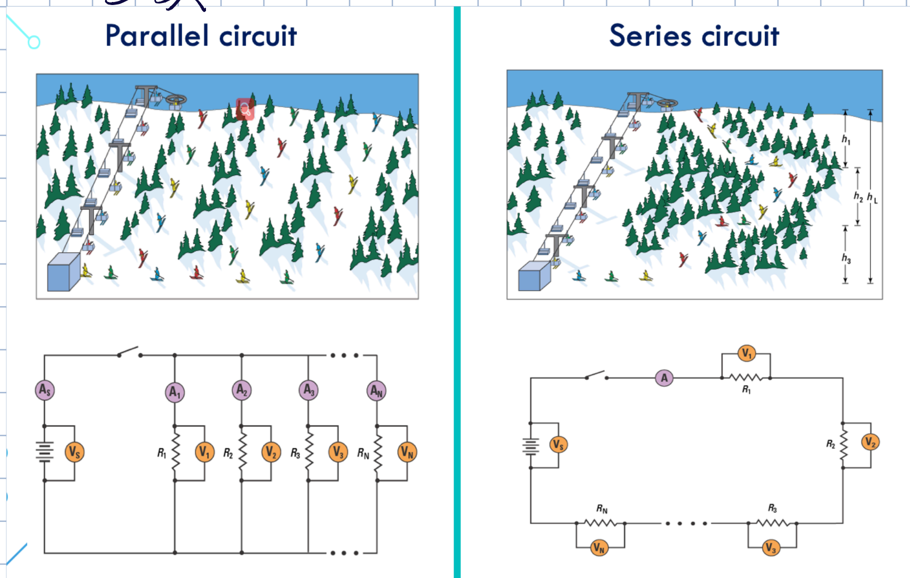


热 temperature ↑ / 光 intensity ↑ → n↑ → $I=nAqV$ → I↑ → $R=\frac{V}{I}$ → R↓

如求电阻直接用 $\frac{V}{I}$, 不可求斜率, 电和态状态变

串联&并联

- 一些类比.



人 — electron
mass — charge
ΔGPE — ΔEPE
ΔGPE — p.d.
ΔEPE — emf.

并联 In parallel
$$\begin{cases} I_s = I_1 + I_2 + \cdots \\ V_s = V_1 = V_2 = \cdots \\ \frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots \end{cases}$$
→ 解释: $R_{total} < R_n$
$R_n \uparrow$ $R_{total} \uparrow$

串联 In series
$$\begin{cases} I_s = I_1 = I_2 = \cdots \\ V_s = V_1 + V_2 + \cdots \\ \frac{V_1}{R_1} = \frac{V_2}{R_2} = \cdots \end{cases}$$

- Kirchhoff's Rules

First rule: current rule 遵守 charge conservation
At any junction point, the sum of all currents entering the junction must equal to the sum of all currents leaving the junction.

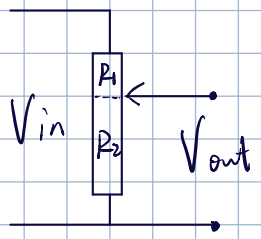
Second rule: voltage rule 遵守 Δpotential conservation
In closed loop, changes in potential must be 0
↳ 包括无电源

计算步骤
① 假设电流方向
② K_2 找 (n−1) 个 loop 关系式
③ K_1 补齐式子
④ 求解

电池时: —| |— → I : +5V

·其它用电器 $-IR$.

● 分压电路



$$V_{out} = V_{in} \times \frac{R_2}{R_1 + R_2}$$

总述：the ratio of potential difference is the ratio of resistance

解释题（电表对电路的干扰）

internal 内阻 resistance　voltage drop　energy dissipated

$r \longrightarrow V_{drop} \longrightarrow E_{in}/P_{内}$

$V_{term} = \mathcal{E} - V_{drop}$

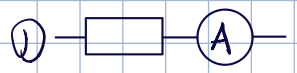
$V_{term} \longrightarrow E_{in}/P_{外}$

load resistance

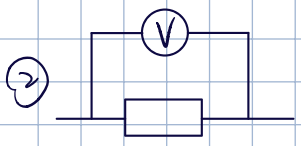
$$\mathcal{E} = Ir + IR$$

$\mathcal{E}$：emf of cell　Ir：voltage drop（内部电压）　IR：terminal voltage

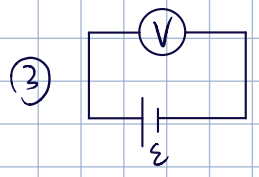
$$\mathcal{E}I = I^2r + I^2R$$

① 

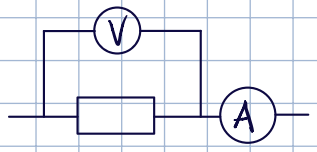
R_A 小　$R_A \approx 0$ 并联 → R总减 → I增

② 

R_V 大　$R_V \approx 0$ 并联 → $R_{parallel} \approx R$ → V减

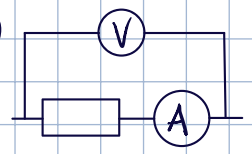
③ 

R_V 大　$R_V \approx 0$ 串内阻 → $V \approx \mathcal{E}$

④ 

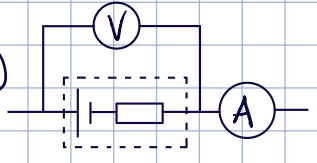
R_V 大　$R_V \approx \infty$ 并联 → $I_V \approx 0$ → $I_A = I_V + I_R$ → $I_A \approx I_R$

R_A 大　R_A 大 串联 → V_A 大　V_V 不影响

⑤ 

R_A 小　$R_A \approx 0$ 串联 → $V_A \approx 0$ → $V_V = V_R + V_A$ → $V_{总} \approx V_R$

R_V 无影响　R_V 小 并联 → I_V 大　I_A 不影响

⑥ 

$R_V \approx \infty$ 并联 → $I_V \approx 0$ → $I_A = I_{总} - I_V$ → $I_A \approx I_{总}$

实验

{ process / accuracy

1. object → equation
2. measurements { variable { independant 自变量 / dependant 因变量 / constants
3. apparatus
4. measure & average (少见)
4. measure y for various x

	x	y	a	b	…
1					
2					
3					
⋮					

5. plot y-x graph
6. determine gradient
7. 测得的量=斜率

● 测电阻率

$\rho = \frac{RA}{L}$

2. inde var: l de var: I constant: V. diameter
3. ruler. A-meter. micrometer. V-meter
4. $x-y$ $\frac{1}{I}-L$
5. gradient linear point $= \frac{1}{Il} = \frac{\rho}{VA}$
6. $\rho = \frac{VA}{IL}$

● 误差

① measure

length { 夹子: use clap with small size (夹子下方长度算在阻值内)
缺丝拉直 (strengthen the wire)
尺子: 金属条 // 尺子 parallex error.

diameter (micrometer) { not uniform 多测取平均
zero error

resistivity { contact: resistance of circuit wire
small R for V-meter → Ⓐ会比实际大，因为Ⓥ有电阻. 选阻值尽量大的电压表
zero error

② 物系

③ error { systematic: 校0. 夹差. contact R
random: reseat & aver~e