编号：　　班级：

4.1.

$dq = 2\pi r \cdot \rho \cdot ds = 2\pi r \frac{Q}{\frac{4}{3}\pi R^3} \cdot ds$

$i = \frac{dq}{dt}$

$j = \frac{i}{ds} = 2\pi r \frac{Q}{\frac{4}{3}\pi R^3} \cdot \frac{\omega}{2\pi} = \frac{3Q\omega r}{4\pi R^3}$

4.2.

(1). $I = SnqV$

$n = \frac{2.7\,g\cdot cm^{-3}}{27} \times 6\times10^{23} \times 3 = 1.8\times10^{23}\text{个}/cm^3 = 1.8\times10^{29}\text{个}/m^3$.

$q = e = 1.6\times10^{-19}C$.

$u = \frac{I}{Snq} = \frac{5\times10^{-4}A}{0.1\times10^{-6}m^2 \cdot 1.8\times10^{29}\text{个}/m^3 \cdot 1.6\times10^{-19}C/\text{个}} \approx 1.74\times10^{-7}\,m/s$

(2). $V = \sqrt{\frac{3kT}{m}}$. $k = 1.38\times10^{-23}\,J\cdot K^{-1}$. $T = 273+25 = 298K$. $m = 9.1\times10^{-31}kg$.

$V = 1.16\times10^{5}\,m/s$

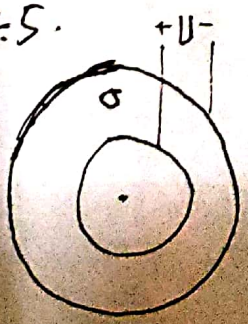
(3). $u = \frac{e\tau E}{2m}$. $E = \rho j = \rho\frac{I}{S}$

$\tau = \frac{2um}{eE} = \frac{ums}{e\rho I} = \frac{2\times1.74\times10^{-7}\times9.1\times10^{-31}\times0.1\times10^{-6}}{1.6\times10^{-19}\times2.8\times10^{-8}\times5\times10^{-4}} \approx 1.4\times10^{-14}\,s$

(4). $\bar{\lambda} = \tau \cdot V \approx 1.6\times10^{-9}\,m$

(5). $E = \rho j = \rho\frac{I}{S} = 1.4\times10^{-4}\,V/m$.

4.5.



$\vec{j} = \sigma\vec{E}$.

$\int_a^b \vec{E}\cdot d\vec{r} = U$

$j\cdot 4\pi r^2 = I = \oint \sigma E \cdot 4\pi r^2$

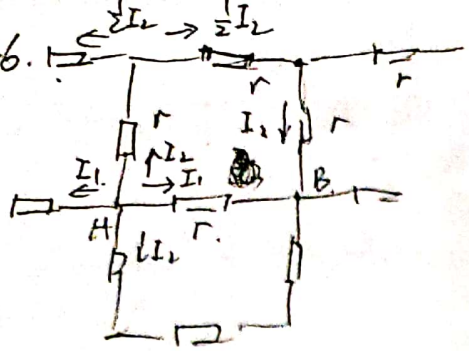
$\rightarrow E = \frac{I}{\sigma 4\pi r^2}$.

$\int_a^b \frac{I}{\sigma 4\pi r^2} dr = \frac{I}{4\pi\sigma}\left(\frac{1}{a}-\frac{1}{b}\right) = U$.

$R = \frac{U}{I} = \frac{b-a}{4\pi\sigma ab}$.

△

4.6.



向A点注入电流I.

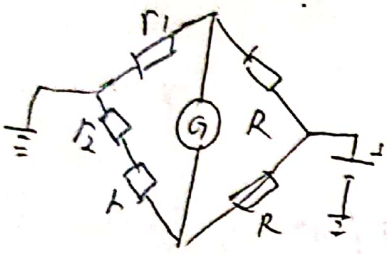
$U_{AB} = I_1 r = (\frac{1}{2}+1+1) I_2 r = \frac{5}{2}(I - I_1) r$

$I_1 = \frac{5}{7} I$

$U_{AB} = \frac{5}{7} I r$.

$R_{AB} = \frac{5}{7} r$.

4.7.



$r_1 = r_2 + r$

$r_1 = (50+50-x) \times 6\ \Omega$.

$r_2 = x \times 6\ \Omega$.

$\rightarrow 600 - 6x = 6x + 360$.

$12x = 240$

$x = 20\ km$.

4.8.

(1) $j \cdot 2\pi r \cdot l = I = \frac{E}{\rho} \cdot 2\pi r l$

$\rightarrow E = \frac{I\rho}{2\pi r l}$.

$\int_a^b E \cdot dr = \frac{I\rho}{2\pi l} \ln\frac{b}{a} = U$

$R = \frac{U}{I} = \frac{\rho}{2\pi l} \ln\frac{b}{a}$.

(2).

$2\pi r \cdot l \cdot \varepsilon E = Q \rightarrow E = \frac{Q}{2\pi r l \varepsilon}$.

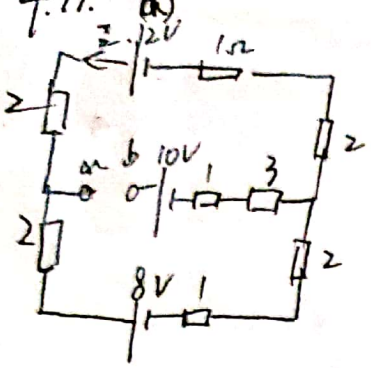
$\int_a^b E \cdot dr = \frac{Q}{2\pi l \varepsilon} \ln\frac{b}{a} = U$.

$C = \frac{Q}{U} = \frac{2\pi l \varepsilon}{\ln\frac{b}{a}}$.

(3). $C \cdot R = \varepsilon\rho$.

4.11.

4.11. (1)



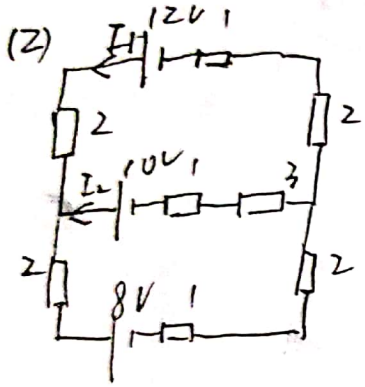
$(2+2+1+2+2+1)I + 8 - 12 = 0$

$\rightarrow I = 0.4A$

$U_{ab} = -2I + 12 - I - 2I - 10$

$= 0$

(2)



$2I_1 + (2+1+2)(I_1+I_2) + 8 + (2+1)I_1 - 12 = 0$

$\rightarrow 10I_1 + 5I_2 - 4 = 0$

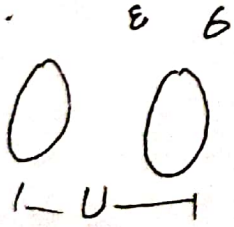
$2I_1 + 10 - (1+3)I_2 + (2+1)I_1 - 12 = 0$

$\rightarrow 5I_1 - 4I_2 - 2 = 0.$　$10I_1 - 8I_2 - 4 = 0$

$\begin{cases} I_1 = 0.4A. \\ I_2 = 0 \end{cases}$

通过R1的电流为0.4A. 向下.

4.15.



$U = \int \vec{E}(\vec{x}) \cdot d\vec{x} = \int \frac{\vec{j}(\vec{x})}{6} \cdot d\vec{x} = \int \frac{\vec{I}}{6S_1} \cdot d\vec{x} = \frac{I}{6} \int \frac{1}{S_1} d\vec{x}$

$= \int \frac{Q}{S_1 \varepsilon} \cdot d\vec{x} = \frac{Q}{\varepsilon} \int \frac{1}{S_1} d\vec{x}.$

$R = \frac{U}{I}.\ C = \frac{Q}{U}.$

$R \cdot C = \frac{Q}{I} = \frac{\varepsilon U \int \frac{1}{S_1} d\vec{x}}{6U \int \frac{1}{S_1} d\vec{x}} = \frac{\varepsilon}{6}$

$C = \frac{\varepsilon}{6R} = \frac{80 \times 8.85 \times 10^{-12}}{10^{-4} \cdot 10^5} \approx 7.08 \times 10^{-11} F.$