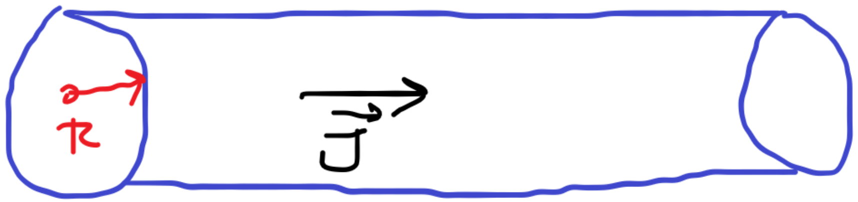
Ηλεκτρικό Ρεύμα (συνέχεια)

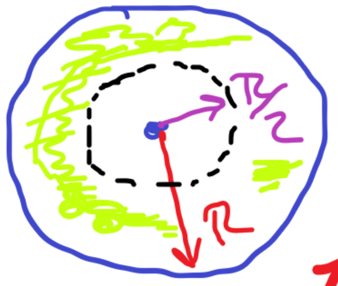
ΠΑΡΑΔΕΙΓΜΑ



$R = 2.0\ mm$

$J = 2.0\ 10^5 \frac{A}{m^2}$

$i = ?\quad \frac{R}{2} \le r \le R$ (α)



(β) $J = a r^2$

$a = 3\times 10^{11} \frac{A}{m^4}$

$i = \frac{15}{32}\pi a R^4$

α) $J = \frac{i}{A} \Rightarrow i = J \cdot A_\Sigma$ (1)

$A = \pi r^2$

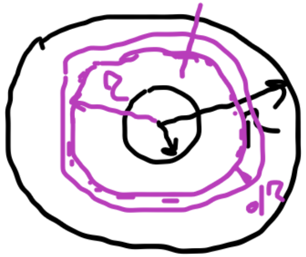
επιφάνεια κύκλου

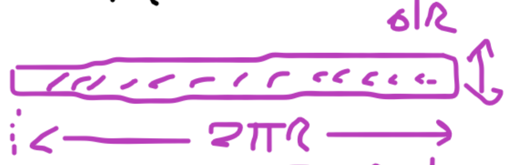
$A_\Sigma = \pi R^2 - \pi\left(\frac{R}{2}\right)^2$

$A_\Sigma = \pi R^2\left(1 - \frac{1}{4}\right) = \frac{3}{4}\pi R^2$ (2)

(1) (2) $\Rightarrow i = J\,\frac{3}{4}\pi R^2 = 1.9\ A$

β) $\int di = \int_A \vec{J} \cdot d\vec{A} = \int_{R/2}^{R} a r^2\, 2\pi r\, dr = 2\pi a \int_{R/2}^{R} r^3\, dr = 2\pi a \left.\frac{r^4}{4}\right|_{R/2}^{R} = \frac{2\pi a}{4}\left(R^4 - \frac{R^4}{16}\right) = \frac{15}{32}\pi a R^4$

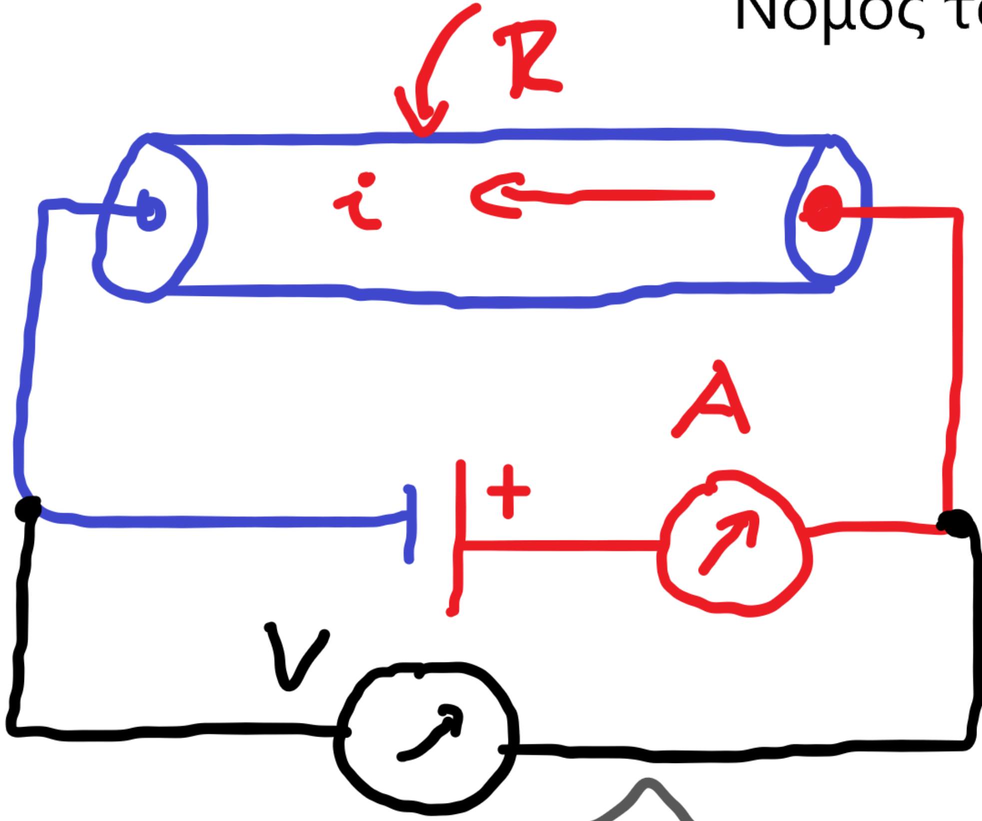


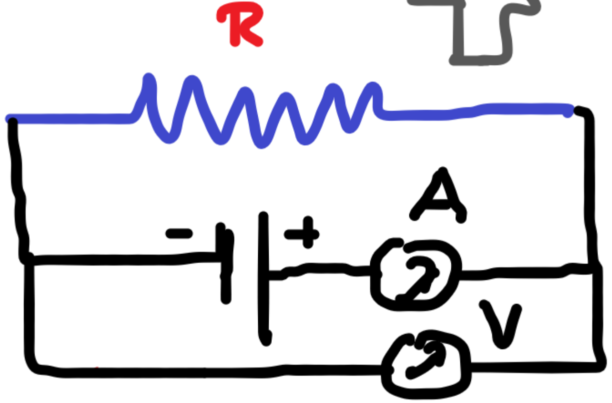


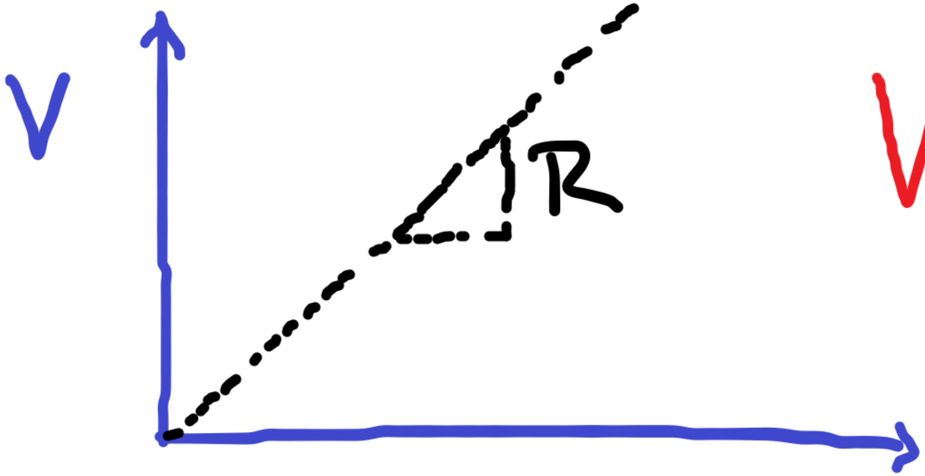
$dA = 2\pi r\, dr$

Νόμος του Ohm

15.4.2020 (2)







$V = R \cdot i$

↓

ΑΝΤΙΣΤΑΣΗ

$[R] = \frac{[V]}{[i]} = \frac{Volt}{Ampere}$

$1\ OHM = \frac{1V}{1A}$

$\vec{E} = \rho \vec{J} \rightarrow [E] = [\rho][J] \rightarrow \Omega = OHM$

↓

ΕΙΔΙΚΗ ΑΝΤΙΣΤΑΣΗ

$\frac{V}{m} = [\rho] \frac{A}{m^2} \rightarrow [\rho] = \frac{V\,m}{A}$

$\rightarrow [\rho] = \Omega \cdot m$

Ειδική αντίσταση, ειδική αγωγιμότητα και αντίσταση

15.4.20 (3)

$\rho_{Cu} = 1.69\ 10^{-8}\ \Omega\cdot m$ (ΜΕΤΑΛΛΟ/ΑΓΩΓΟΣ) Περναει ρεύμα

$\rho_{Si} = 2.5\ 10^{+3}\ \Omega m$ (ΗΜΙΑΓΩΓΟΣ)

$\rho_{ΧΑΛΑΖΙΑΣ} = 10^{16}\ \Omega m$ (ΜΟΝΩΤΗΣ) δεν περνάει ρευμα

$\sigma = \frac{1}{\rho}$

↑ ΕΙΔΙΚΗ ΑΓΩΓΙΜΟΤΗΤΑ

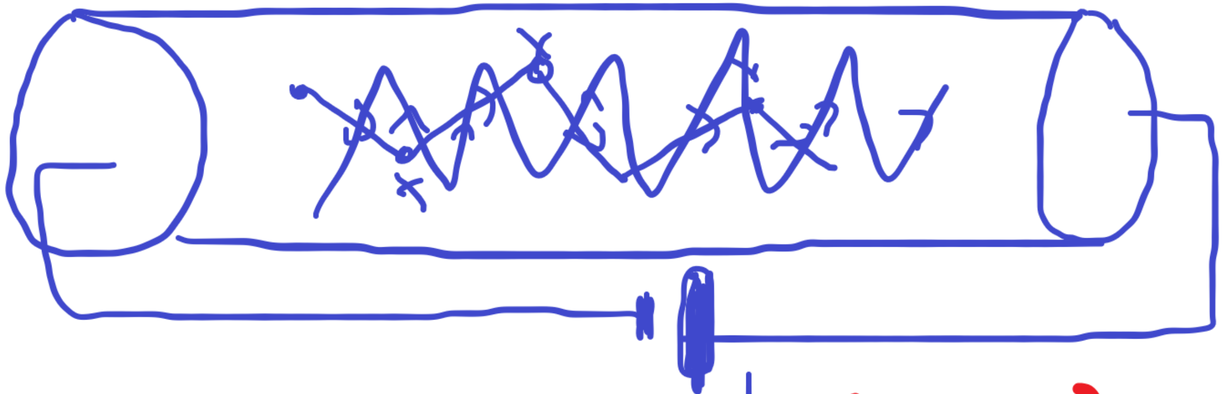
$\boxed{\vec{E} = \rho \vec{J}} \rightarrow \vec{J} = \frac{1}{\rho}\vec{E} \Rightarrow \boxed{\vec{J} = \sigma \vec{E}}$

$E = \rho J \Rightarrow \frac{V}{\ell} = \rho \frac{i}{A} \Rightarrow V = \rho \frac{\ell}{A} i$ (1) (2)→

(2) $\boxed{R = \rho \frac{\ell}{A}}$

$V = R \cdot i$

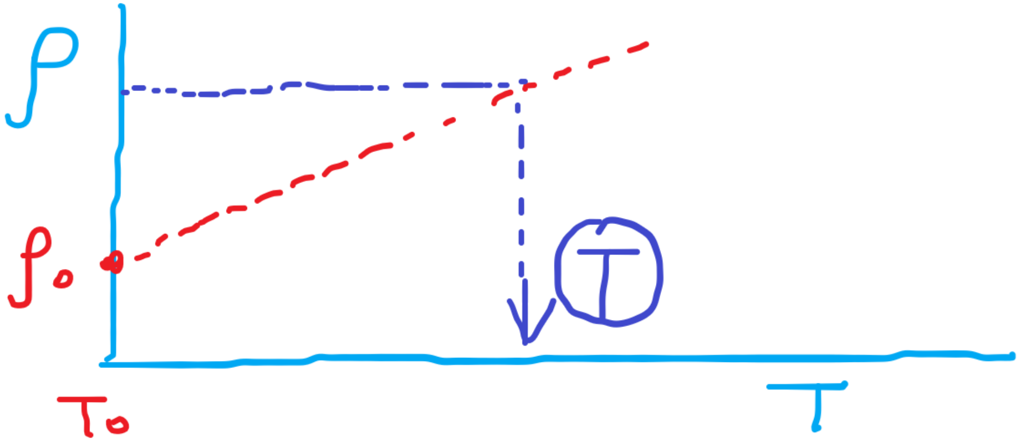
Θερμικές ιδιότητες και μικροσκοπική θεώρηση του νόμου του Ohm

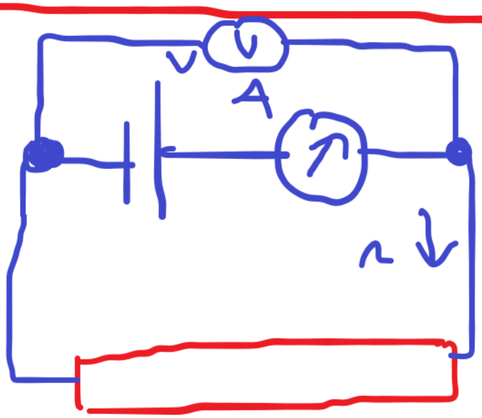


Η ΠΥΘΑΝΟΤΗΤΑ ΣΥΓΚΡΟΥΣΕΩΝ ΑΥΞΑΝΕΙ ΜΕ ΤΗ ΘΕΡΜΟΚΡΑΣΙΑ

ΣΥΓΚΡΟΥΣΕΙΣ ↔ R

$$\rho = \rho_0 + \rho_0 \alpha^{+} (T - T_0)$$





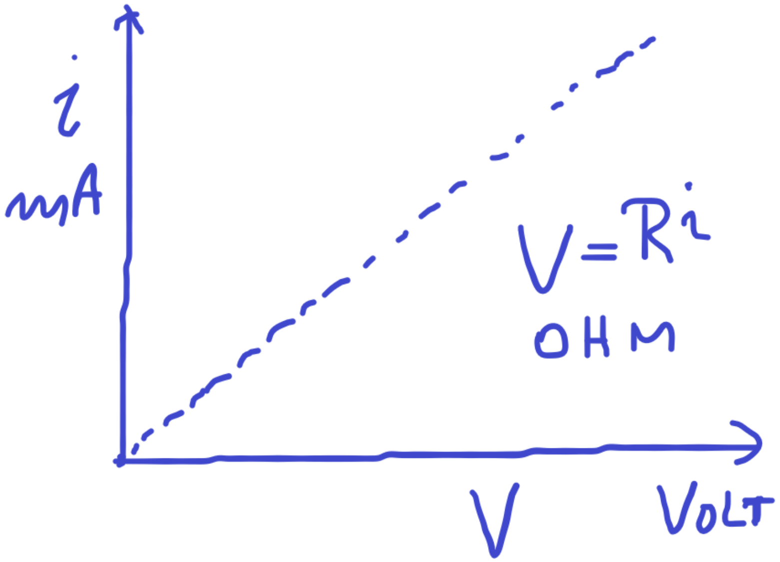
$$R = \frac{V}{i}$$

$$R = \rho \frac{\ell}{A}$$

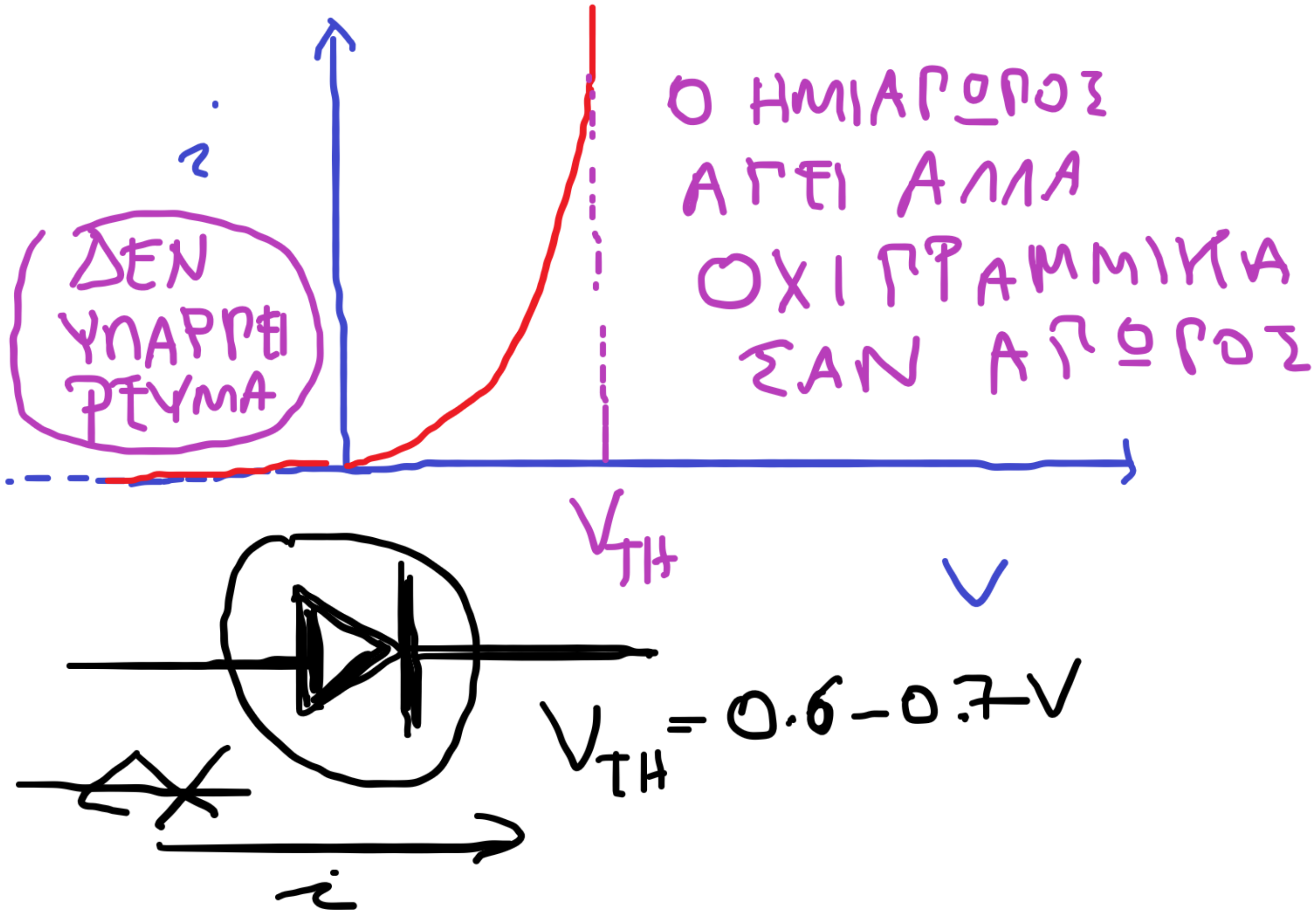
↑ ΥΛΙΚΟ ΤΟΥ ΟΠΟΙΟΥ Η ΑΝΤΙΣΤΑΣΗ ΑΛΑΖΕΙ ΜΕ ΤΗ ΘΕΡΜΟΚΡΑΣΙΑ

Αγωγοι - Ημιαγωγοι

ΑΓΩΓΟΙ



ΗΜΙΑΓΩΓΟΙ



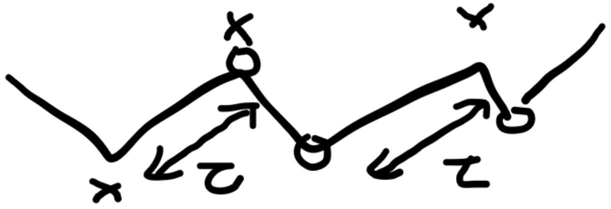
ΜΙΚΡΟΣΚΟΠΙΚΗ ΘΕΩΡΗΣΗ ΤΟΥ ΝΟΜΟΥ ΤΟΥ Ohm

15.4.2020 (6)

- ΣΤΑ ΜΕΤΑΛΛΑ ΤΑ ΗΛΕΚΤΡΟΝΙΑ ΣΘΕΝΟΥΣ ΚΙΝΟΥΝΤΑΙ ΕΛΕΥΘΕΡΑ ΑΚΡΙΒΩΣ ΟΠΩΣ ΤΑ ΜΟΡΙΑ ΕΝΟΣ ΑΕΡΙΟΥ
- $v \sim 1.6 \times 10^6$ m/s

$\vec{E}$ → , F ← , $q<0$

$$a = \frac{F}{m} = \frac{eE}{m}$$



Ο ΜΕΣΟΣ ΧΡΟΝΟΣ ΜΕΤΑΞΥ ΣΥΓΚΡΟΥΣΕΩΝ ΕΙΝΑ τ

$$v_d = a\tau = \frac{eE\tau}{m}$$

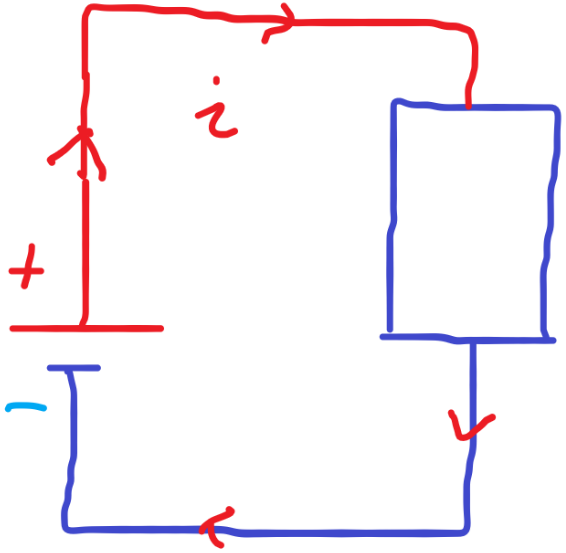
$$v_d = \frac{eE\tau}{m} \quad (1)$$

$$J = n e v_d \Rightarrow v_d = \frac{J}{ne} \quad (2)$$

$$(1),(2) \rightarrow \frac{J}{ne} = \frac{eE\tau}{m} \Rightarrow \vec{E} = \left[\frac{m}{ne^2\tau}\right]\vec{J} \Rightarrow \rho = \frac{m}{ne^2\tau}$$

Ηλεκτρική Ισχύς

15.4.2020 (7)



$$dU = dq\, V = i\, dt \cdot V = i V\, dt \Rightarrow$$

dU: Joule

$$\frac{dU}{dt} = i V \Rightarrow \text{Ohm} \quad \frac{dU}{dt} = \frac{V^2}{R}, \quad \frac{dU}{dt} = R i^2$$

$$\frac{\text{Joule}}{\text{sec}} = \text{Watt}$$

ΗΛΕΚΤΡΙΚΗ ΙΣΧΥΣ

$$P = \frac{dU}{dt} = V \cdot i = R \cdot i^2 = \frac{V^2}{R}$$

$R = 3\,mm$

$J = \underbrace{2.75 \cdot 10^{10} \frac{A}{m^4}}_{K} r^2$

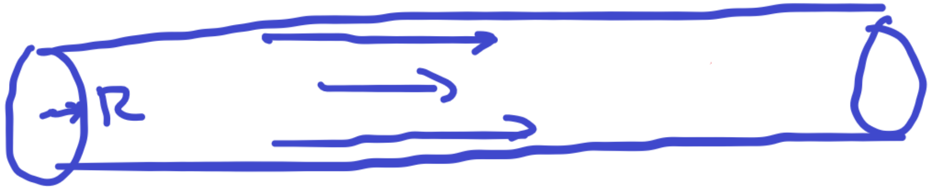
$V = 60\,V$

$t = 1\,h$

↳ $U = P \cdot t$

$P = V \cdot i \rightarrow ?$

↑ ΔΙΔΕΤΑΙ



$$i = \int_0^R J \cdot dA = \int_0^R K R^2 \underbrace{2\pi R \cdot dR}_{dA} \Rightarrow$$

$$i = 2\pi K \int_0^R R^3 \, dR = 2\pi K \left[\frac{R^4}{4} \right]_0^R \Rightarrow$$

$$i = 2\pi K \frac{R^4}{4} = \frac{\pi K R^4}{2} = 3.5\,A$$

$$P = i V = 3.5\,A \; 60\,V = 210\,\text{WATT}$$

$$U = P \cdot t = 210\,\text{WATT} \times 3600\,\text{sec}$$

$$U = 7.56 \times 10^5\,\text{JOULES}$$

22.4.20

9

11.15 – 14:00