FİZİK II

Elektrik ve Manyetizma

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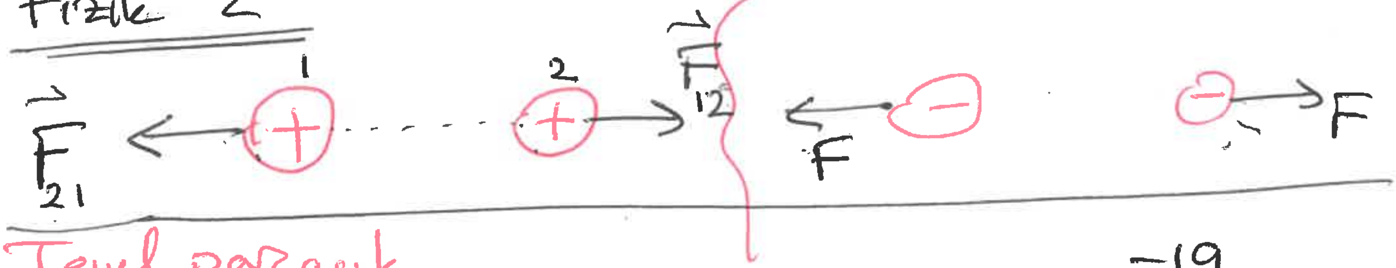
Fizik 2



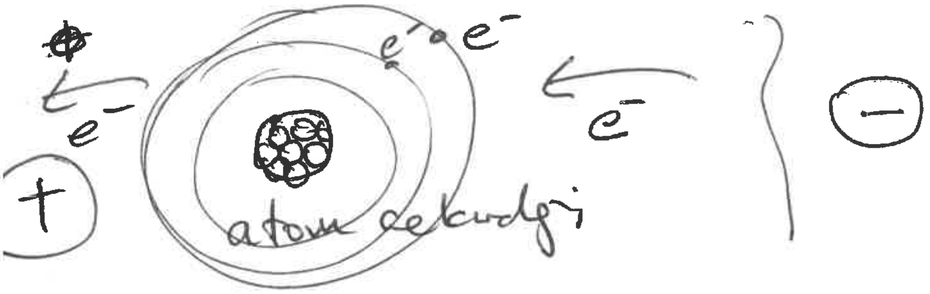
Temel parçacık

⊖ ⇒ e^- = elektron

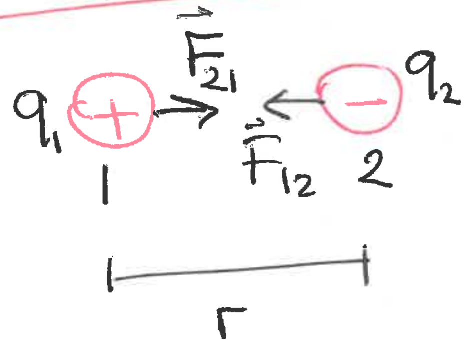
⊕ ⇒ proton

$$|e| = 1.6 \times 10^{-19}\ \underline{C}$$ Coulomb

$$\boxed{|p| = 1.6 \times 10^{-19} C}$$



$N_p = N_e \Rightarrow \underline{\text{nötr}}$



etki – tepki çifti

$$\boxed{\vec{F}_{12} = -\vec{F}_{21}}$$

$$\boxed{\varepsilon_0 = 8.85 \times 10^{-12} \frac{C^2}{Nm^2}}$$

$$F = k \frac{q_1 q_2}{r^2}$$

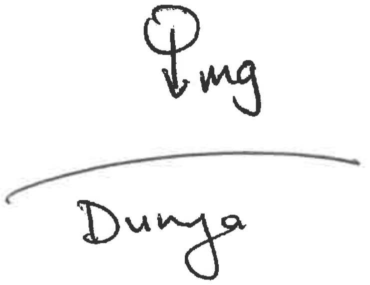
Coulomb kuv.

$$\boxed{k: 8.98 \times 10^9 \frac{Nm^2}{C^2}}$$

$$F = \left[\frac{N\cancel{m^2}}{\cancel{C^2}}\right] \frac{\cancel{C}\,\cancel{C}}{\cancel{m^2}}$$

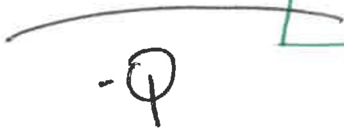
$$k = \frac{1}{4\pi\varepsilon_0}$$ → uzayın geçirgenliği

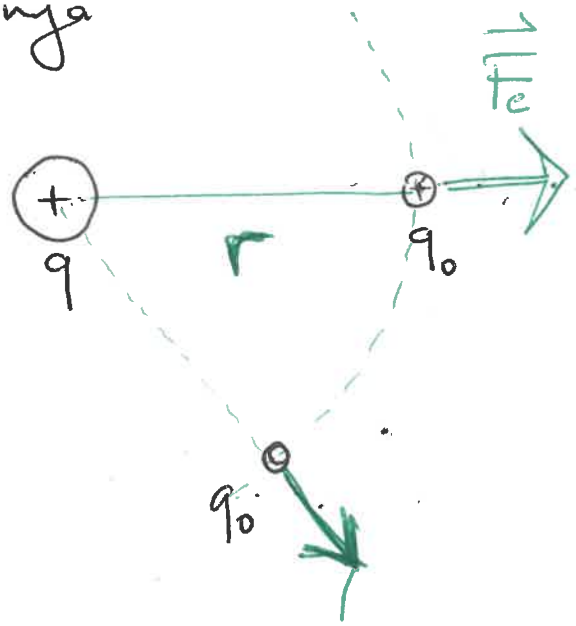
Elektrik Alan ; $\vec{E}$



$\vec{g} = \frac{\vec{F}}{m}$

$$\boxed{\vec{E} = \frac{\vec{F_e}}{q}}$$





$$\vec{E} = \frac{\vec{F_e}}{q_0}$$

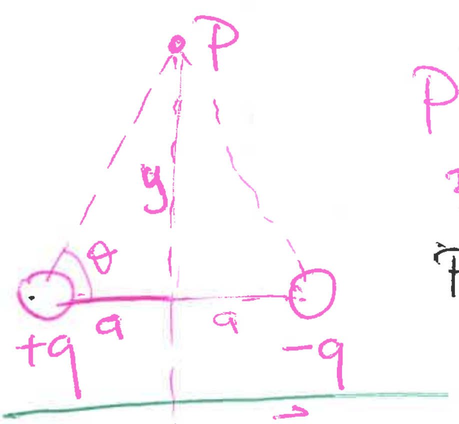
$$\vec{E} = \frac{\frac{kq\cancel{q_0}}{r^2}}{\cancel{q_0}}$$

$$\vec{F_e} = \frac{kqq_0}{r^2}\hat{r} \qquad \vec{E} = \frac{kq}{r^2}\hat{r}$$

$\Updownarrow$

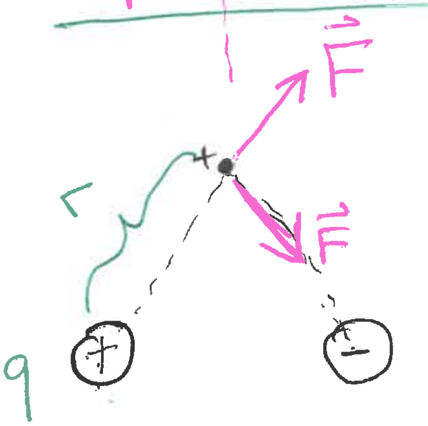
q yükünün q_0 da oluşturduğu Elektrik Alanı

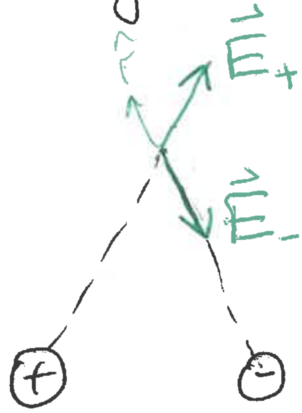
Ör



P noktasındaki E alan?

P noktasında $+q_0$ yükü varmış gibi

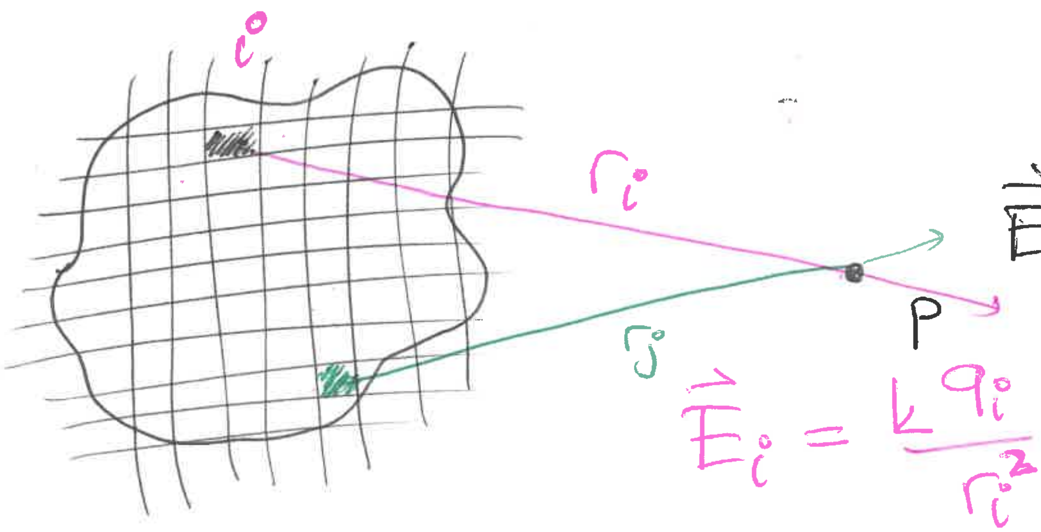




$$E_+ = \frac{kq}{r^2} = E_-$$

$$\vec{E}_- = \frac{k(-q)}{r^2}\hat{r}$$

$$E_- = +\frac{kq}{r^2}$$

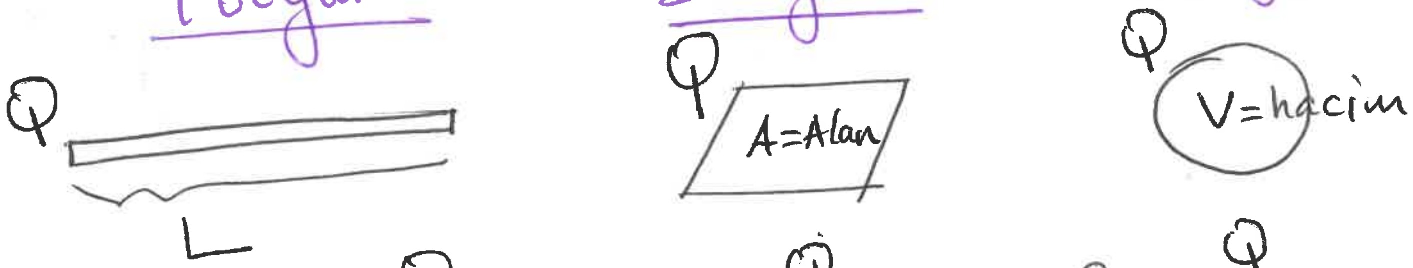


$\vec{E} = ?$

$$\vec{E}_i = k\frac{q_i}{r_i^2}\hat{r}_i$$

$$\sum \vec{E}_i$$

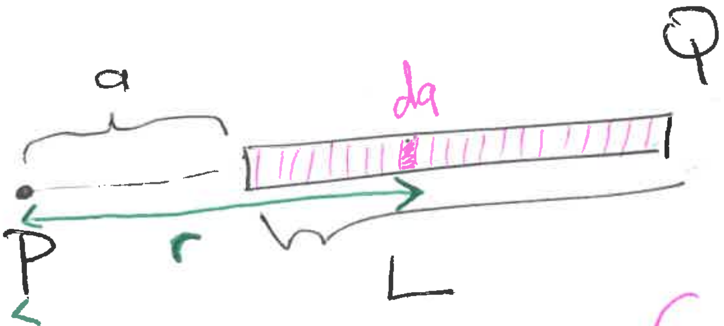
Düzgün dağılımlı ; yük yoğunluğu sabit olanlı



yük yoğunluğu $\equiv \lambda = \frac{Q}{L}$; $\sigma = \frac{Q}{A}$; $\rho = \frac{Q}{V}$

lambda sigma ro

ör



P deki E alan büyüklüğü?

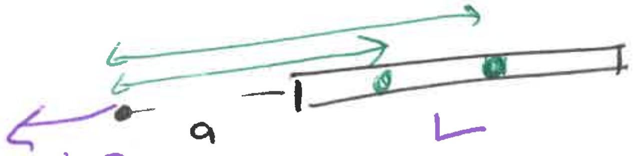
$$\sum \Delta q \rightarrow \int dq$$

$$\int dE = \int k\frac{dq}{r^2} \quad \lambda$$

$$k\lambda\left[\frac{1}{a}-\frac{1}{a+L}\right] = k\lambda\left[\frac{a+L-a}{a(a+L)}\right]$$

$$E = k\lambda\,\frac{L}{a(a+L)}$$

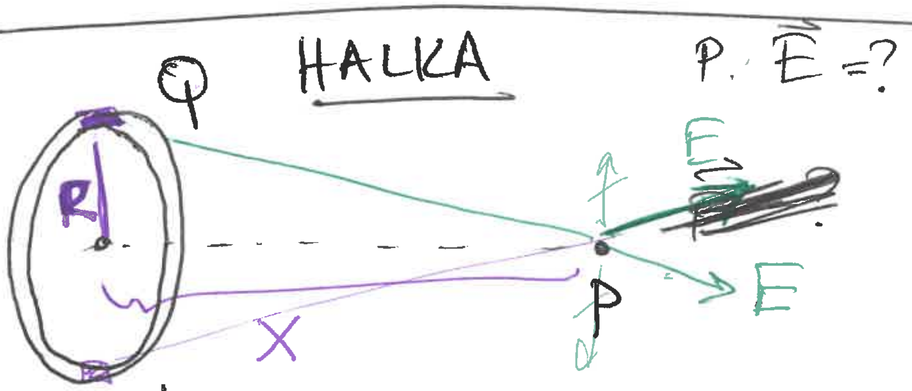
$$\lambda = \frac{Q}{L} \qquad = k\,\frac{Q}{L}\,\frac{L}{(a+L)a} = \frac{kQ}{a(a+L)}$$



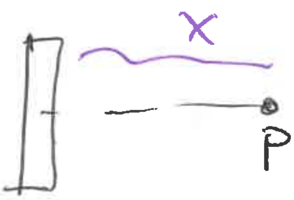
$E = \frac{kQ}{a(a+L)}$

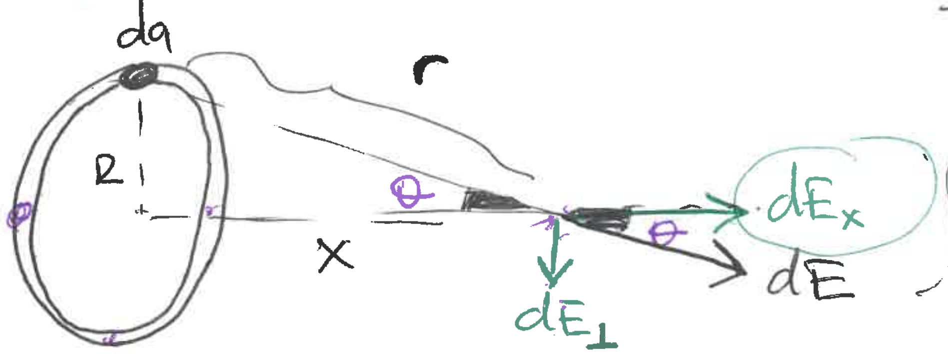
$E = \frac{kq}{r^2}$

ör HALKA P. $\vec{E}$ = ?



yandan





$\int dE_x = \int dE\cos\theta$

$$\int dE = \int k\,\frac{dq}{r^2}\,;$$

dq = çok küçük yük

dq her zaman r mesafesinde

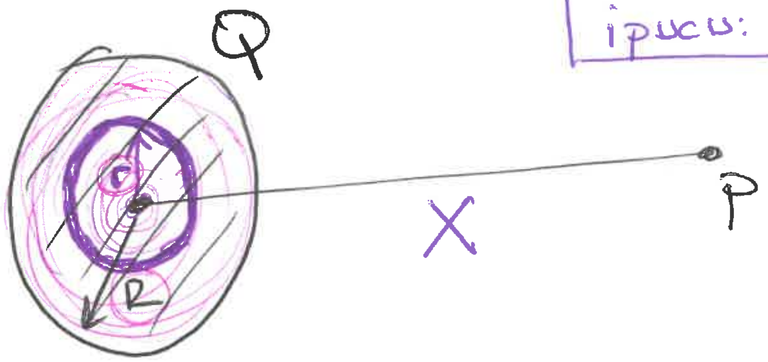
dq; r bağımsız

$$\int dE_x = \cos\theta\,\frac{k}{r^2}\int dq = \frac{k}{r^2}\cos\theta\int dq$$

Disk

$$E_x(\text{halka}) = \frac{k Q x}{(x^2+R^2)^{3/2}}$$ ⑤

ipucu:



$E = ?$

R = diskin yarıçapı

r = halkanın "

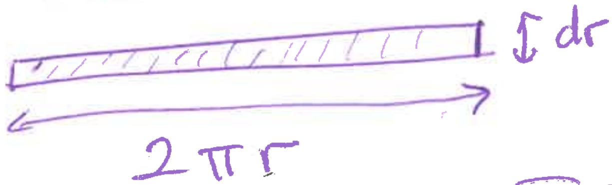
$\sum E_x(\text{halka}) = \underline{\text{Disk}}$

dq = halkanın yükü ; Q = diskin yükü

$Q \to dq$
$R \to r$

$$dE = k\frac{dq\, x}{(x^2+r^2)^{3/2}}$$; dq ve r ilişkili

$$\underline{\sigma} = \frac{Q}{\pi R^2} = \frac{dq}{(\text{Alan halka})}$$ σ = yük yoğunluğu



$\Rightarrow$ Alan $= 2\pi r\, dr$

$$\sigma = \frac{dq}{2\pi r\, dr} ; \quad \boxed{dq = \sigma 2\pi r\, dr}$$

$$\int dE = \int \frac{k(\sigma 2\pi r\, dr)\, x}{(x^2+r^2)^{3/2}}$$

$$= k\sigma\pi x \int_0^R \frac{2r\,dr}{(x^2+r^2)^{3/2}} = (\;)\int_0^R \frac{d(r^2)}{(x^2+r^2)^{3/2}}$$

$$\int x^{n-1}dx = \frac{x^n}{n}$$

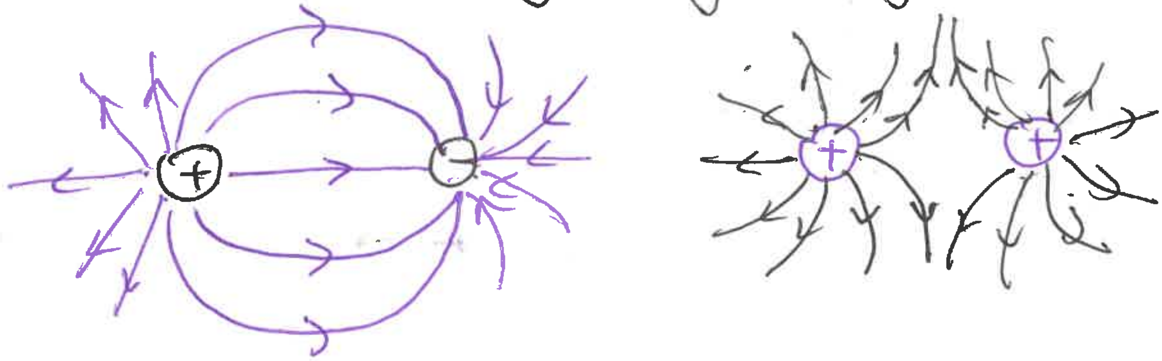
$$= k\sigma\pi x \left[\frac{(x^2+r^2)^{-1/2}}{(-1/2)}\right]_0^R = 2\pi k\sigma\left[\frac{x}{|x|} - \frac{x}{(x^2+R^2}\right.$$

Elektrik Alan Çizgileri

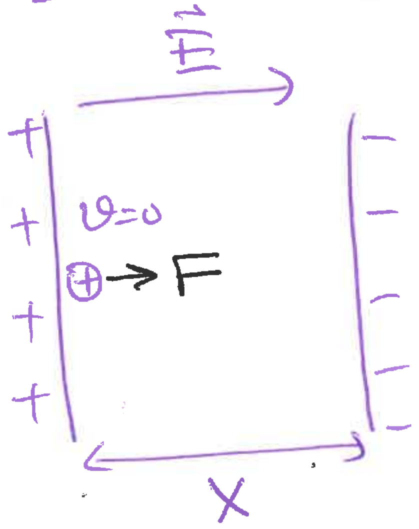
→ ⊕ çıkar ⊖ girer

→ birbirini kesmez

→ El. Alan çizgi sayısı ; yük ile ORANTILI



$\vec{E}$ altında yüklü parçacık hareketi



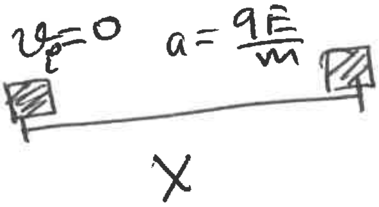
ivme $a = ?$

$v_s = ?$ (son hız)

$\vec{g}$ ihmal et

$$\vec{F} = m\vec{a}$$

$$qE = F = ma$$



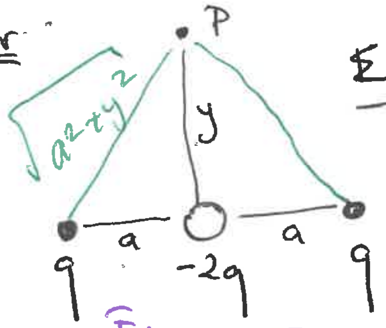
$$\boxed{\frac{qE}{m} = a}$$

$$v_s^2 = v_i^2 + 2a(x_s - x_i)$$

$$v_s^2 = 0^2 + 2\frac{qE}{m}X$$

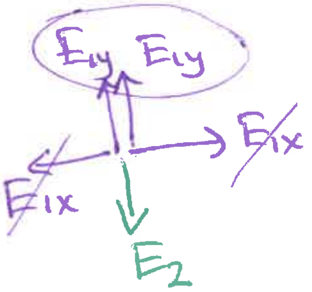
$$v_s = \sqrt{\frac{2qEX}{m}}$$

Ör:



$\Sigma \vec{E} = ?$

$$E_1 = \frac{kq}{a^2+y^2}$$



$$E_2 = \frac{k(2q)}{y^2}$$

$$E_{1y} = \frac{kq}{a^2+y^2} \sin\theta = \frac{kq}{a^2+y^2} \frac{y}{\sqrt{a^2+y^2}}$$

$$\frac{2kq\,y}{(a^2+y^2)^{3/2}} \hat{j} + \frac{2kq}{y^2}(-\hat{j})$$

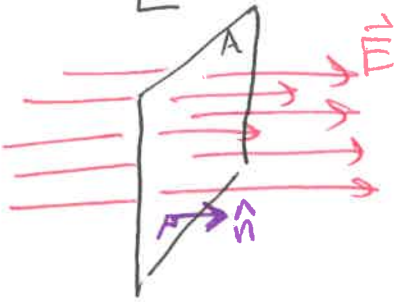
GAUSS yasası

Elektrik Akısı → $\Phi_E = \vec{E}\cdot\vec{A}$

$\vec{E}$: elektrik alanı

$\vec{A}$: yüzey alanı

$\Phi = \left[\frac{N}{C} m^2\right]$



$E = k\frac{q}{r^2}$

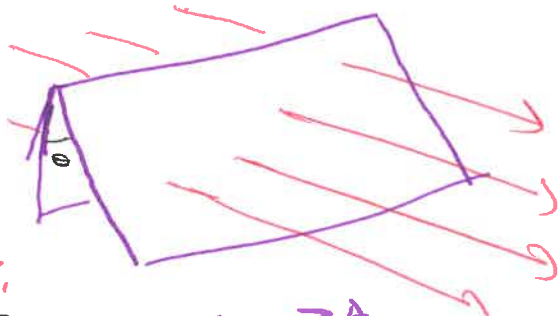
$F = qE$

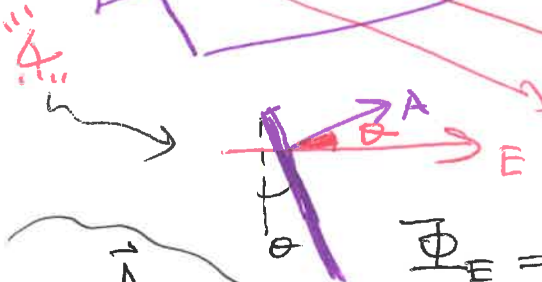
kuvv. (N) — yük (C) — El. Alanı

Skaler çarpım

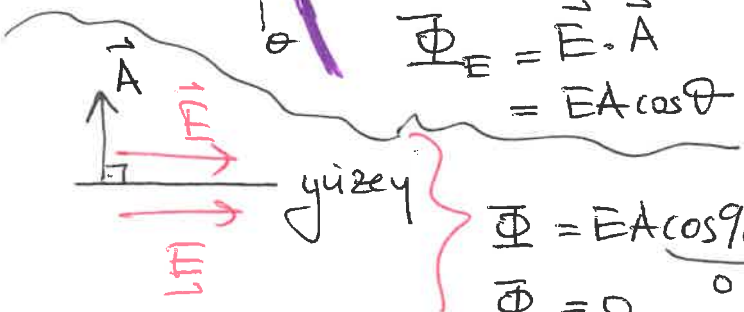
$\vec{E}\cdot\vec{A} = EA\cos 0$, $\cos 0 = 1$

$\vec{A} \Rightarrow$ büyüklüğü A yönü alana dik bir vektör



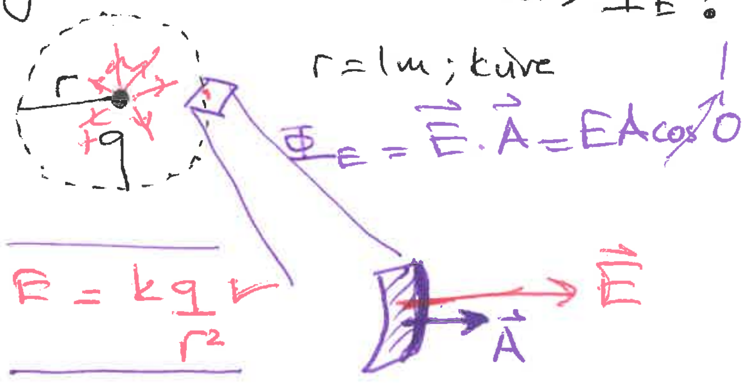


$\Phi_E = \vec{E}\cdot\vec{A}$
$= EA\cos\theta$



$\Phi = EA\cos 90$
$\Phi = 0$

Ör: merkezinde $1\mu C$ yük bulunduran 1m yarıçaplı küreden geçen elektrik akısı, $\Phi_E = ?$ (1)



r = 1m ; küre

$\Phi_E = \vec{E}\cdot\vec{A} = EA\cos 0$

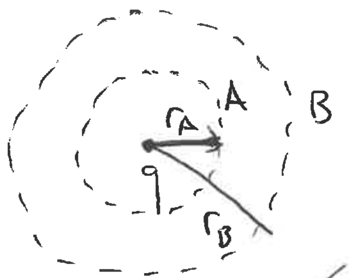
$E = k\frac{q}{r^2}$

$A = 4\pi r^2$ küre

$\Phi = EA$
$= k\frac{q}{r^2}4\pi r^2$

$k = \frac{1}{4\pi\varepsilon_0}$

$\Phi = k4\pi q = \frac{q}{\varepsilon_0}$



A küresinden geçen $\Phi = \frac{q}{\varepsilon_0}$

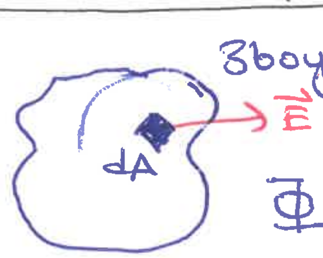
B küresinden geçen $\Phi = q/\varepsilon_0$

eşit!

$\Phi = k4\pi q = 1.13\times10^5 \frac{Nm^2}{C}$

$k = 8.99\times10^9 \frac{Nm^2}{C^2}$; $1\mu C = 10^{-6} C$

3boyutlu hacim



$\Phi = \oint_{\text{yüzey}} \vec{E}\cdot d\vec{A}$

$\Phi = ?$ 0 SIFIR

$EdA\cos(180-\theta)$
$-EdA\cos\theta$

$EdA\cos\theta$

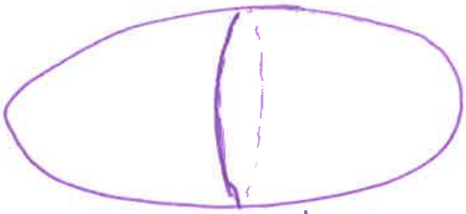
GAUSS kanunu ②

kapalı yüzey için

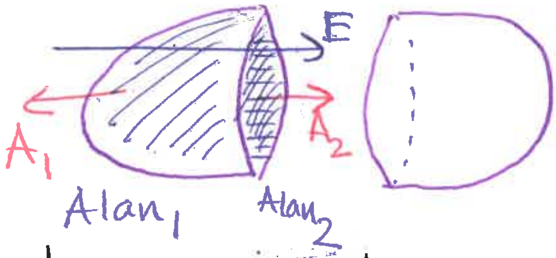
$$\Phi_E = \oint \vec{E}\cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0}$$

① ⟷ ② ⟷ ③

$\oint$ bütün yüzey için integral al



ikiye kes



$$\left|\int \vec{E}\cdot d\vec{A}\right| = \left|\int \vec{E}\cdot d\vec{A}\right|$$

Alan$_1$ izdüşüm Alan$_2$

$$\int_{Alan_1} E\cdot dA = -\int_{A_2} \vec{E}\cdot d\vec{A}$$

Kapalı 3 boyutlu bir cisimden geçen akı miktarı $\Phi = 0$!

$E = sbt$

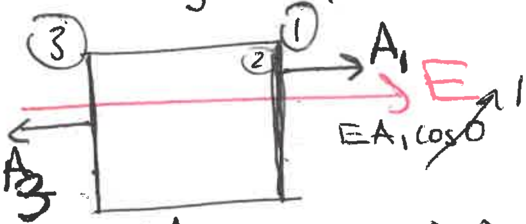
ör

$\vec{E} = E\hat{x}$

$\Phi = ?$ SIFIR

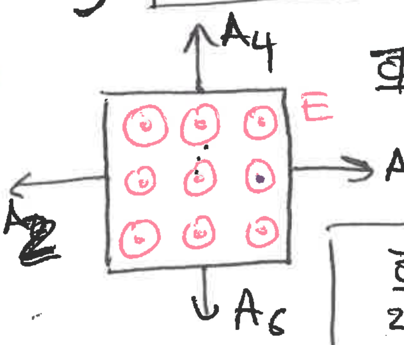
$-EA_3 + EA_1 = 0$

yandan



$EA_3\cos 180$ (-1) $\quad EA_1\cos 0$ (1)

önden

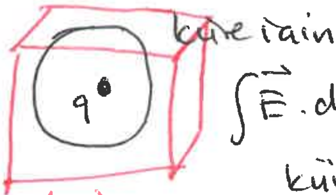


$\Phi = \vec{E}\cdot\vec{A}$

$= EA\cos\theta$

$\theta = 90$

$$\boxed{\Phi_{2,4,5,6} = 0}$$



$$\int_{küre} \vec{E}\cdot d\vec{A} = \frac{q}{\varepsilon_0} = \Phi$$

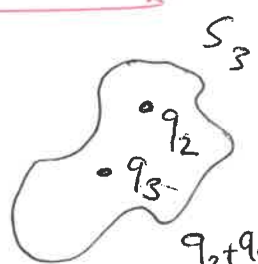
$$\int_{küp} \vec{E}\cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0} = \Phi$$

$$\boxed{\Phi_{küp} = \Phi_{küre} \ !}$$

ör

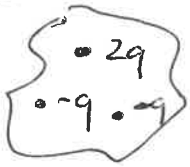
$\Phi_E = \frac{q_1}{\varepsilon_0}$

$\Phi_E = \frac{0}{\varepsilon_0}$



$\Phi_E = \frac{q_2+q_3}{\varepsilon_0}$

Bir cismin; 3 boyutlu içinde yük YOKSA; El. AKISI $\Phi = 0$ SIFIRdır



$$\Phi = \frac{2q-q-q}{\varepsilon_0} = 0$$

ör küre, r yarıçaplı, q yükünü sarıyor. Aşağıdaki durumlarda Φ ne olur.

a) $q \to 3q$

$\Phi = \frac{q_{iç}}{\varepsilon_0} = \frac{3q}{\varepsilon_0}$

$\Phi \uparrow$

b) $r \to 2r$

Φ değişmez

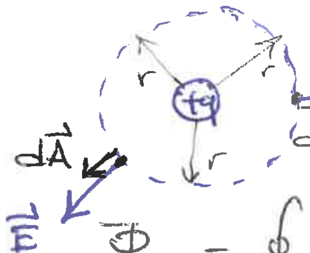
c) küre-küpe dönüşürse

Φ değişmez

d) yük küre içinde farklı bir noktaya taşınırsa, Φ değişmez.

GAUSS yasası yüklü yalıtkanlarda uygulanması

Ör +q noktasal (yalıtkan) yükün oluşturduğu Elektrik Alanı?



$\vec{E} = ?$ $\theta = 0$

$$\Phi_E = \oint \vec{E} \cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0} = \frac{q}{\varepsilon_0}$$

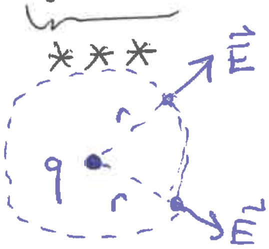
$$\oint E\, dA \cos\theta = \frac{q}{\varepsilon_0}$$

$$\oint E\, dA = \frac{q}{\varepsilon_0}$$

sbt

Şekil ⇒ KÜRE
merkezde q yükü var.
r uzaklıkta $\vec{E}$ büyüklüğü aynı.

***



$$\oint E\, dA = E \oint dA = \frac{q}{\varepsilon_0}$$

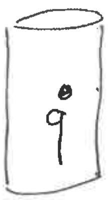
$\boxed{E = sbt}$ Kürenin Alanı Toplam

$$\Phi = E\, 4\pi r^2 = \frac{q}{\varepsilon_0}$$

$$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2} = k\frac{q}{r^2}$$

X olmaz!!

E = sbt ✓



X olmaz!! silindir

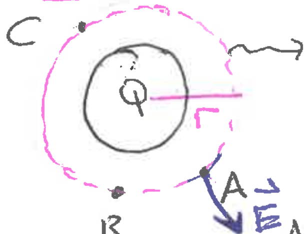
Ör Düzgün yük dağılımlı (3) yalıtkan kürenin Elektrik Alanı

Q
R

r > R (DIŞ)

r < R (İÇ)

DIŞ r > R



$$\Phi = \oint \vec{E} \cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0} = \frac{Q}{\varepsilon_0}$$

A, B, C noktalarından bakıldığında manzara aynı ⇒ simetrik

Gauss yüzeyi boyunca
$|\vec{E}|$ sbt
$\vec{E} \Rightarrow \hat{r}$ yönünde

$$\Phi = \oint \vec{E} \cdot d\vec{A} = \frac{Q}{\varepsilon_0}$$

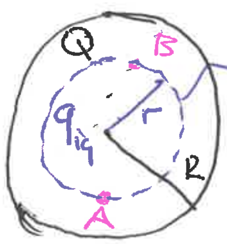
$$\oint E\, dA \cos 0$$

$$E \oint dA = \frac{Q}{\varepsilon_0}$$

$$E\, 4\pi r^2 = \frac{Q}{\varepsilon_0}$$

$$\rightarrow E = \frac{Q}{4\pi\varepsilon_0 r^2}$$

İÇ r < R



Gauss

$$\Phi = \oint \vec{E} \cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0}$$

$q_{iç} \neq Q$!

$q_{iç} = ?$

Yük yoğunluğu (ρ) $\rho = \frac{Q}{V} = \frac{Q}{\frac{4}{3}\pi R^3}$

$$\rho = \frac{Q}{V} = \frac{q_{iç}}{V_{iç}} \quad ; \quad q_{iç} = Q\,\frac{\frac{4}{3}\pi r^3}{\frac{4}{3}\pi R^3}$$

$$\boxed{q_{iç} = Q\,\frac{r^3}{R^3}}$$

Küreden devam

$$\oint \vec{E}\cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0} \; ; \; q_{iç} = Q\,\frac{r^3}{R^3}$$

$$\oint E\,dA\,\cancel{\cos 0}^{\,1} = \frac{Q}{\varepsilon_0}\,\frac{r^3}{R^3}$$

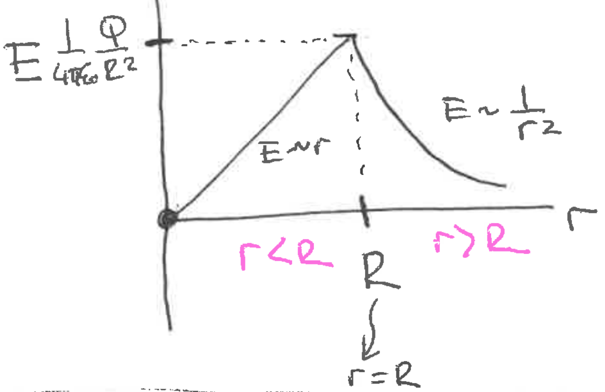
E → sbt

$$E\underbrace{\oint dA} = \frac{Q}{\varepsilon_0}\,\frac{r^3}{R^3}$$

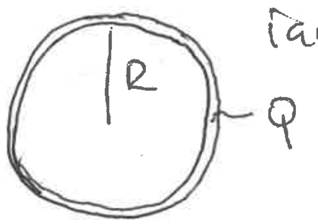
$$E\,4\pi \cancel{r^2} = \frac{Q}{\varepsilon_0}\,\frac{\cancel{r^3}}{R^3}$$

$$\boxed{E = \frac{1}{4\pi\varepsilon_0}\,\frac{Q\,r}{R^3}} \quad r<R \quad \text{iç}$$

$$\boxed{E = \frac{Q}{4\pi\varepsilon_0 r^2}} \quad r>R \quad \text{DIŞ}$$



ör



İçi boş küre kabuk

$\vec{E} = ?$

$r<R$; $r>R$

r>R

simetrik ; E = sbt

$$\oint \vec{E}\cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0}$$

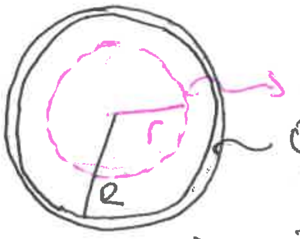
$$\oint E\,dA\cos 0 = \frac{Q}{\varepsilon_0}$$

$$E\underbrace{\oint dA}_{4\pi r^2} = \frac{Q}{\varepsilon_0}$$

$$E = \frac{Q}{4\pi\varepsilon_0 r^2} \quad r>R \text{ (DIŞ)}$$

④

r<R



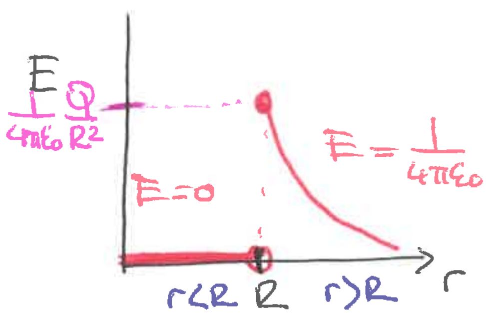
Gauss içinde ne kadar yük var? ↙?

$$\Phi_E = \oint \vec{E}\cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0}$$

$q_{iç} = 0$;

$$\oint \underbrace{\vec{E}\cdot d\vec{A}}_{\text{SIFIR değil}} = 0 \Rightarrow \boxed{E = 0} \quad r<R$$

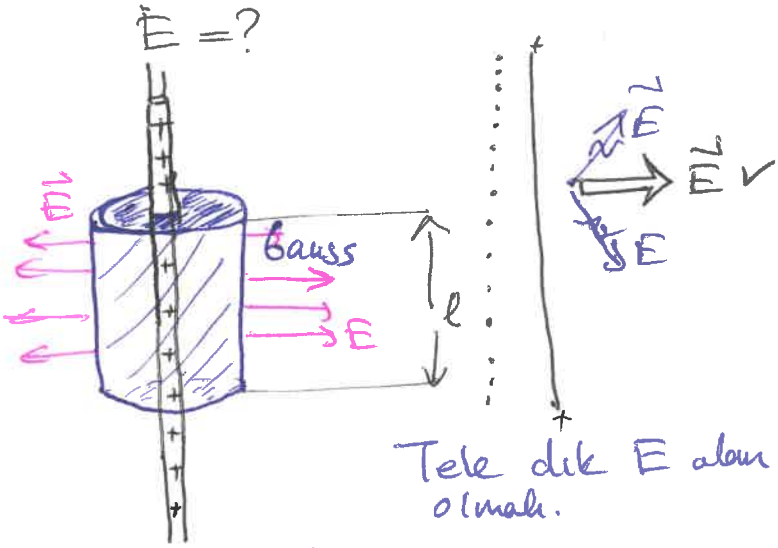
KABUK



noktasal yük ; küresel yük ⇒ Gauss yüzeyleri KÜRESEL

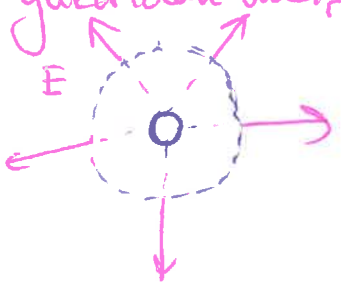
ör çok uzun bir tel yük yoğunluğu λ ; bu telden dik doğrultuda r uzaklıkta

$\vec{E} = ?$



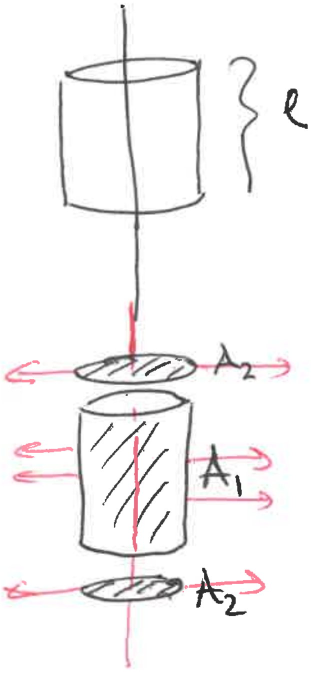
Tele dik E alanı olmalı.

yukarıdan bakış



$$\oint \vec{E}\cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0} = \Phi$$

$$\lambda = \frac{Q_{\to\infty}}{L_{\to\infty}}$$

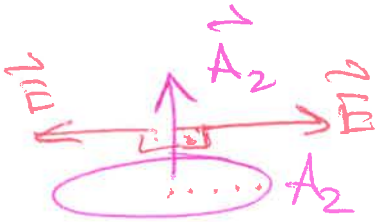


$q_{iç} = \lambda \ell$

$$\oint \vec{E}\cdot d\vec{A} = \frac{\lambda \ell}{\varepsilon_0}$$

?

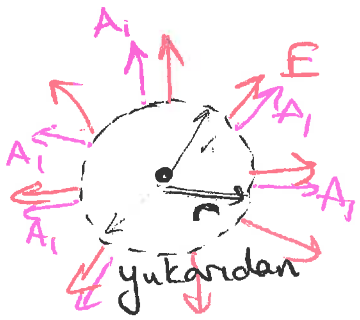
$$\oint_{A_1} \vec{E}\cdot d\vec{A} + 2\underbrace{\oint_{A_2} \vec{E}\cdot d\vec{A}}_{\text{SIFIR}}$$



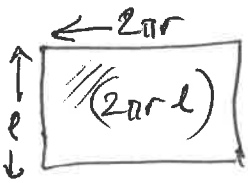
$$\oint_{A_2} \vec{E}\, dA \cos 90 = 0 = \text{SIFIR}$$

$$\oint_{A_1} E\, dA \cancel{\cos 0}^{\,1}$$

$\underline{\underline{E = \text{sbt}}}$

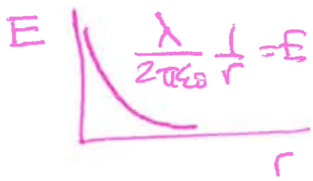


$$E \oint_{A_1} dA = \frac{\lambda \ell}{\varepsilon_0}$$

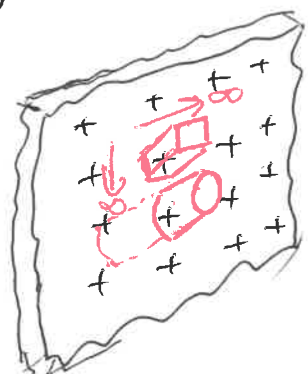


$$E\, 2\pi r \cancel{\ell} = \frac{\lambda \cancel{\ell}}{\varepsilon_0}$$

$$\boxed{E = \frac{\lambda}{2\pi \varepsilon_0 r}}$$



Yalıtkan Düzlem yük tabakası



→ σ yük yoğunluklu

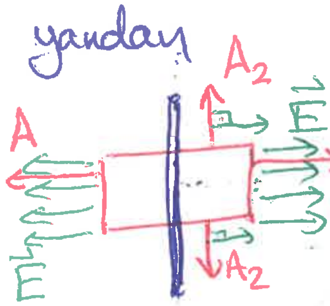
→ sonsuz büyüklükte

→ sonsuz yükte

E = ?

Gauss → Dikdörtgen prizma veya silindir olabilir.

yandan



$\underline{\underline{A = \text{alan}}}$

$\underline{\underline{q_{iç} = \sigma A}}$

$$\oint \vec{E}\cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0} = \frac{\sigma A}{\varepsilon_0}$$

$$\oint_{A_2} \vec{E}\cdot d\vec{A} = 0 = E\, dA \cancel{\cos 90}^{\,0}$$

$$2\oint_{A} \underline{\underline{E}}\, dA \cancel{\cos 0}^{\,1} = \frac{\sigma A}{\varepsilon_0}$$

$$2E \oint dA = \frac{\sigma A}{\varepsilon_0}$$

$$2EA = \frac{\sigma A}{\varepsilon_0}$$

$$\boxed{E = \frac{\sigma}{2\varepsilon_0}} \quad \text{sbt}$$

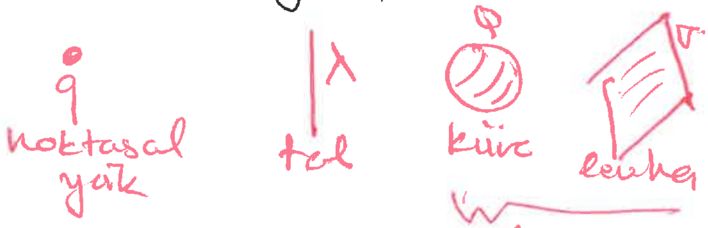
∞ yalıtkan levha; tabaka

Elektrik AKISI

26.7.16

$$\Phi_E = \oint \vec{E}\cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0}$$

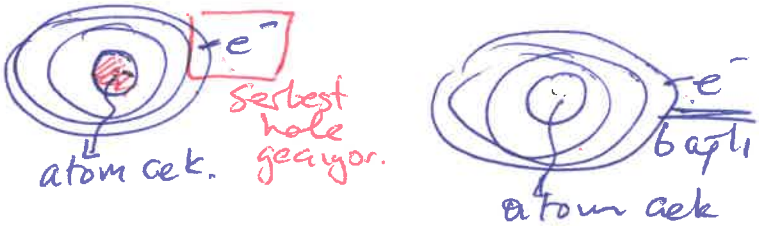
Gauss Yasası

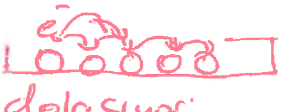


yalıtkan

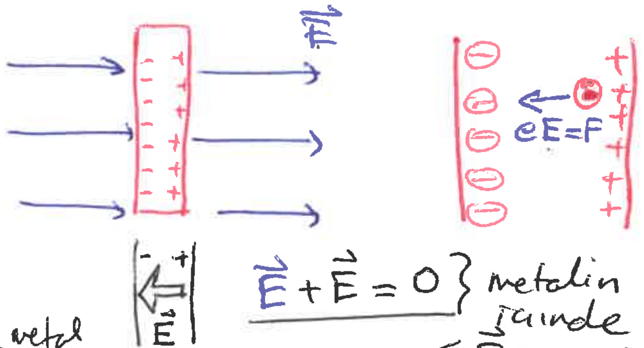
İletken

Yalıtkan

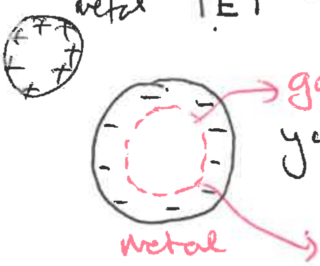




iletkende e⁻ serbest dolaşır!!



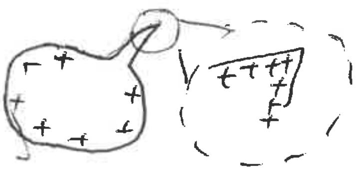
$\vec{E}+\vec{E}=0$ } metalin içinde $\Sigma\vec{E}=0$!



yükler; kabukta duracaklar

$$\Phi = \oint \vec{E}\cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0} = 0$$

0!



sivri uçlarda yükler daha fazla.

Elektrostatik Denge:

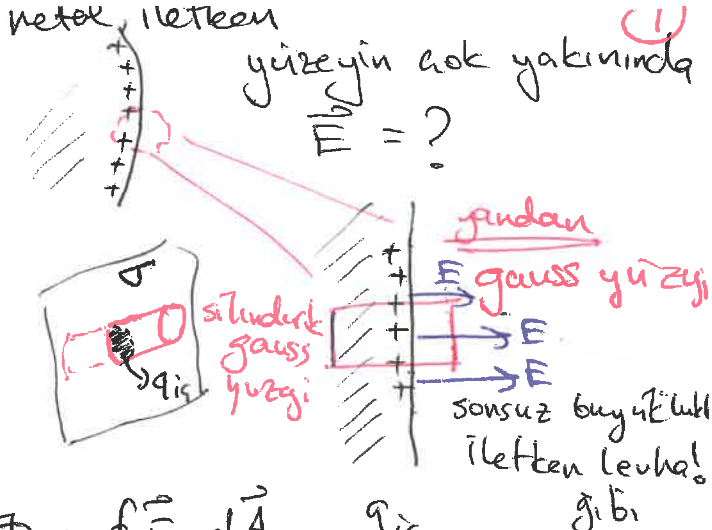
yüklerin sbt; hareket etmemesi!!

Dengeye ulaşması için geçen süre

10^{-16} s

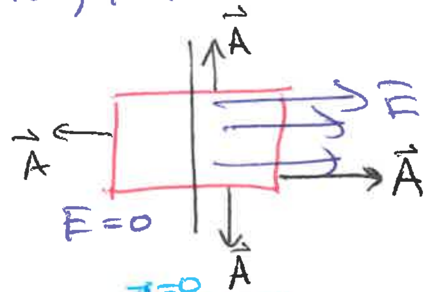
metal, iletken

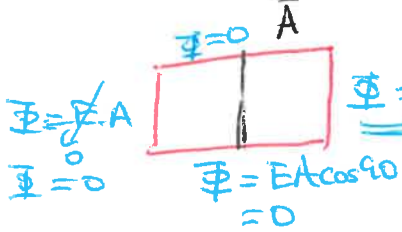
1



$$\Phi = \oint \vec{E}\cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0}$$

Metal; İletken içinde Elektrik Alanı SIFIRDIR.





$\Phi = EA\cos 0$ ✓

$$\Phi = EA = \frac{\sigma A}{\varepsilon_0}\ ;\ \boxed{E=\frac{\sigma}{\varepsilon_0}}$$

iletkenin yüzeyine yakın E alanı

Yalıtkan levhada

$$E = \frac{\sigma}{2\varepsilon_0}$$ ✓

İletken ile alakalı

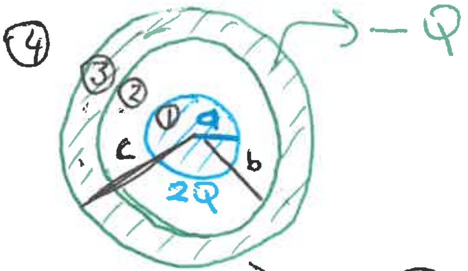
→ iletkenin içinde $\vec{E}=0$!

→ yükler kabuktadır.

→ yüzeye yakın yerlerde $E=\frac{\sigma}{\varepsilon_0}$

→ yükler sivri yerlerde daha fazladır.

ör: Bir metal küre daha büyük bir başka metal kabuk içine konmuştur.



① $r<a$ $\vec{E}=?$

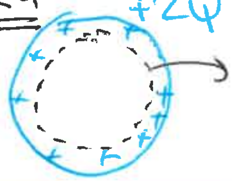
② $a<r<b$ $\vec{E}=?$

③ $b<r<c$ $\vec{E}=?$

④ $c<r$ $\vec{E}=?$

---

① $r<a$ +2Q

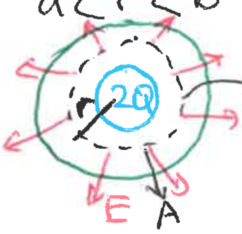


① $\vec{E}=0$!

$\oint \vec{E}\cdot d\vec{A} = \frac{q_{iç}\to 0}{\varepsilon_0}$

---

② $a<r<b$



$\oint \vec{E}\cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0} = \frac{2Q}{\varepsilon_0}$

sbt

$E \oint dA = \frac{2Q}{\varepsilon_0}$

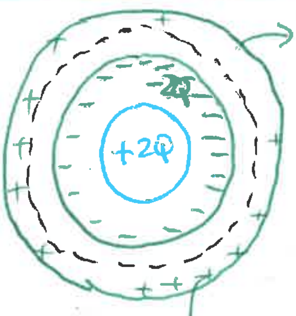
$E A = \frac{2Q}{\varepsilon_0}$

gauss yüzeyinin alanı

$E\,4\pi r^2 = \frac{2Q}{\varepsilon_0}$

$E = \frac{Q}{2\pi\varepsilon_0 r^2}$

$a<r<b$



iletken ; $E=0$!

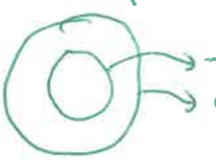
−Q

$\Phi = \oint \vec{E}\cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0}$

$\oint \vec{E}\cdot d\vec{A} = \frac{2Q-2Q}{\varepsilon_0}$

$E=0$! $[0 = q_{iç}]$

+Q



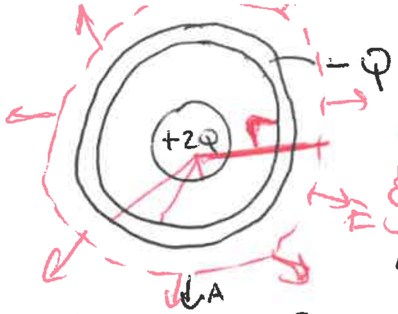
$\left.\begin{matrix}-2Q \\ Q\end{matrix}\right\} -Q$ ✓

$b<r<c$

$E=0$ metalin içi.

---

②



$c<r$

$\oint \vec{E}\cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0}$

$q_{iç} = 2Q - Q = Q$

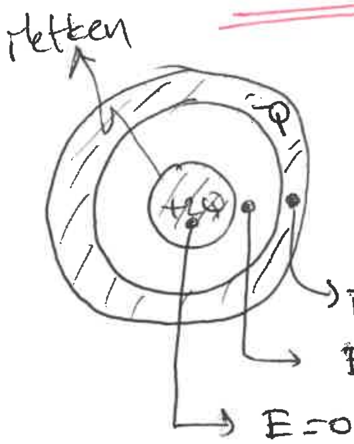
$\oint \vec{E}\cdot d\vec{A} = \frac{Q}{\varepsilon_0}$

sbt

$E \underbrace{\oint dA}_{A} = \frac{Q}{\varepsilon_0} \Rightarrow E\,4\pi r^2 = \frac{Q}{\varepsilon_0}$

$E = \frac{Q}{4\pi\varepsilon_0 r^2}$

$c<r$



• $\frac{Q}{4\pi\varepsilon_0 r^2} = E$

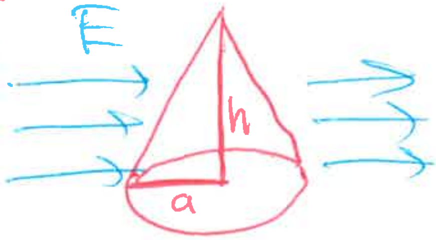
$E=0$

$E = \frac{2Q}{4\pi\varepsilon_0 r^2}$

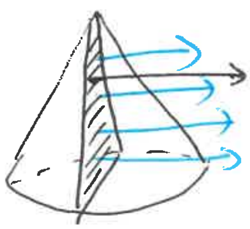
$E=0$

ör #9

Koni

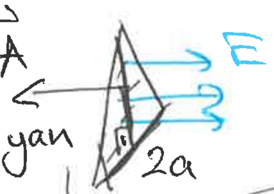


Koninin sol yanından giren Elektrik Akısı?



$\vec{A}$ (sağ yan), $EA\cos 0$

$Eah = \Phi$



$\Phi = \oint \vec{E}\cdot d\vec{A}$

$\oint E\,dA \cos 180$ (-1)

$\Phi = -E \underbrace{\oint dA}_{\text{üçgenin alanı}}$

$\Phi = -E\,\frac{2ah}{2} = -Eah$

Elektriksel Potansiyel

Hatırlatma:

$q_1 \xleftrightarrow{r} q_2 \qquad \vec{F} = k\dfrac{q_1 q_2}{r^2}\hat{r}$

$q_1 \xrightarrow{r} p \qquad \vec{E}_p = k\dfrac{q_1}{r^2}\hat{r}$

Elektrik Alanı → geometrik cisimler
integral ✓
→ Gauss
$\Phi \qquad \oint \vec{E}\cdot d\vec{A}$

Elektriksel Potansiyel (V)
Volt

Elektrik Potansiyel Enerji ⇒ U

$U = qV$

Joule = (Coulomb)(Volt)

$Nm = J = CV$
Fiz I

$V = \dfrac{J}{C}$

A (m)
d
B (m) ..... y=0
$\downarrow\downarrow\downarrow\downarrow \vec{g}$

$\Delta U = U_s - U_i$
$= mg(0) - mgh$
$\Delta U = -mgh$

(q) A ilk
d
(q) B son y=0
$\downarrow\downarrow\downarrow\downarrow \vec{E}$

$\Delta U = U_s - U_i$
$= qE(0) - qEd$
$\Delta U = -q\underbrace{Ed}_{\text{Volt}}$

$$\Delta V = \frac{\Delta U}{q_0} = -\int_A^B \vec{E}\cdot d\vec{s} = \Delta V$$

→ yol
→ El. Alanı

q₀ (test yükü)
∞ → P
Q

3

$$\Delta V = -\int_\infty^P \vec{E}\cdot d\vec{s} = V_s - V_i$$

(yakında) $\Delta V = V_s(P) - V_i(\infty)$, $V_i(\infty) \to 0$

$$\Delta V = -\int \vec{E}\cdot d\vec{s} \qquad \vec{F} = q\vec{E}$$

$$[V] = \left[\frac{N}{C}\right][m] \qquad [N] = [C]\vec{E}$$

$$\frac{V}{m} = \frac{N}{C}$$

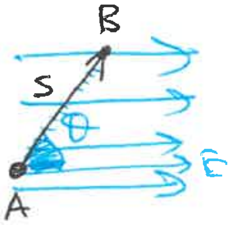
e^- $\quad q_e = 1.6\times10^{-19}\,C$

$qV = U$

1eV $\{ q_e V = 1.6\times10^{-19}\,CV$ = Joule

$1eV = 1.6\times10^{-19}\,J$

$$\Delta V = -\int_A^B \vec{E}\cdot d\vec{s}$$



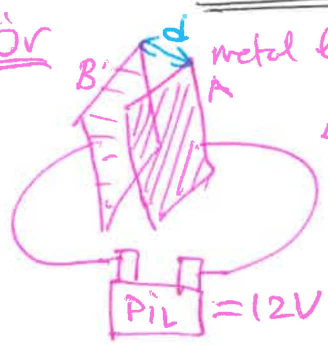
$\Delta V = V_s - V_i$
$= V_B - V_A = -\int \vec{E}\cdot d\vec{s}$

$-\int \vec{E}\cdot d\vec{s} = -\int E\,ds\cos\theta$ (E sbt)

$= -E\cos\theta \int_A^B ds$ $\quad (= S)$

$\Delta V = -ES\cos\theta$
Eye izdüşüm

Ör

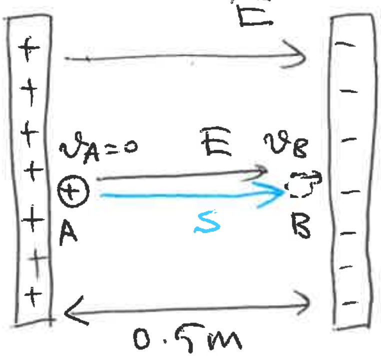


$\Delta V = 12$ Volt

$d = 3\,cm = 0.03\,m$

$E = ?\quad \dfrac{\Delta V}{d} = \dfrac{12V}{0.03m}$

$E = 400\,V/m$



proton

$\vec{E} = 8\times10^4 \frac{V}{m}$

durgun halden serbest bırakılıyor.

a) A - B noktaları arası Elek. potansiyel farkı?

$$\Delta V = -\int_A^B \vec{E}\cdot d\vec{s} = -\int E\, ds \cos 0$$

E sbt

$$\Delta V = -E\int ds$$

$$= -ES = -\left[8\times10^4 \frac{V}{\cancel{m}}\right] 0.5\,\cancel{m}$$

$$\Delta V = -4\times10^4 V = -40000\,V$$

b) protonun pot. enerji değişimi?

$$\Delta U = q\Delta V$$

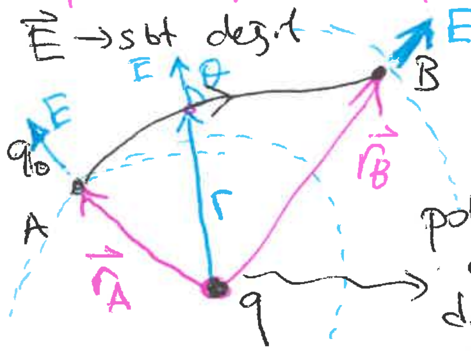
$$= (1.6\times10^{-19} C)(-4\times10^4 V)$$

$$\Delta U = -6.4\times10^{-15}\ \text{Joule}$$

E sbt $\Rightarrow$ $-\int E\cdot ds$

Noktasal yüklerin oluşturduğu El. potansiyel ve pot. enerji

$\vec{E} \rightarrow$ sbt değil



potansiyel q yükünden dolayı oluşur.

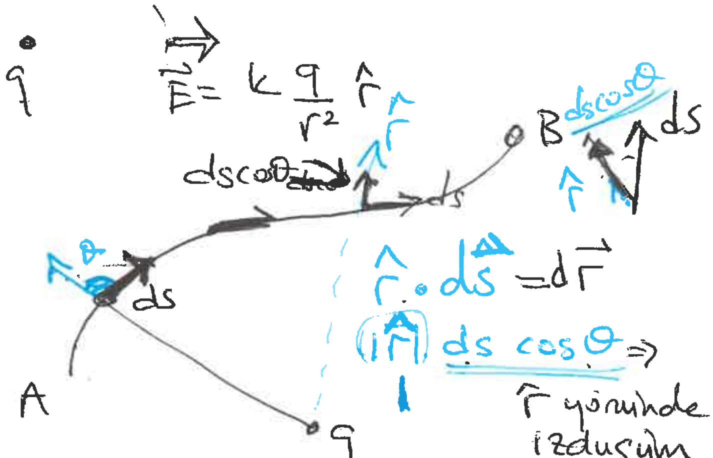
$$\int \vec{E}\cdot d\vec{s}$$

$E\,ds\cos\theta$

değişiyor

$$-\int \vec{E}\cdot d\vec{s} = -\int_A^B \frac{kq}{r^2}\underbrace{\hat{r}\cdot d\vec{s}}_{dr}$$

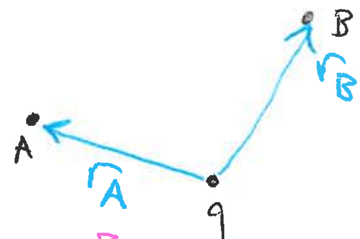
$$\vec{E} = k\frac{q}{r^2}\hat{r}$$



$\hat{r}\cdot d\vec{s} = d\vec{r}$

$|\hat{r}|\, ds\cos\theta \Rightarrow$ $\hat{r}$ yönünde izdüşüm

Aldığınız yol $\hat{r}$ yönünde izdüşümdür!



$\hat{r}\cdot d\vec{s} = d\vec{r}$

$$\Delta V = -\int_A^B \vec{E}\cdot d\vec{s} = -kq\int_A^B \frac{dr}{r^2} = -kq\left[-\frac{1}{r}\right]_A^B$$

$$d(x^n) = n x^{n-1}$$

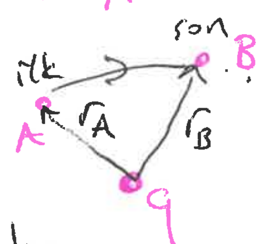
$$\int x^{n-1} = \frac{x^n}{n}\ ; \int r^{-2} = \frac{r^{-2+1}}{-1}$$

$$\boxed{d(r^{-1}) = (-1)r^{-1-1} = -\frac{1}{r^2}}$$

$$\int r^{-2} = -\frac{1}{r}$$

$$\Delta V = -kq\left[-\frac{1}{r}\right]_A^B = \frac{kq}{r}\Big]_A^B$$

$$\Delta V = \frac{kq}{r_B} - \frac{kq}{r_A}$$



$$\Delta V = V_s - V_i$$

$$= V_B - V_A = \frac{kq}{r_B} - \frac{kq}{r_A}$$

B noktasının potansiyeli

$$V_B = \frac{kq}{r_B}\ ; \quad V_A = \frac{kq}{r_A}$$

$$k = \frac{1}{4\pi\varepsilon_0}$$

$$V_p = k\frac{q}{r}$$

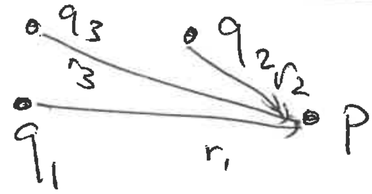
skaler

$$\vec{E}_p = \frac{kq}{r^2}\hat{r}$$

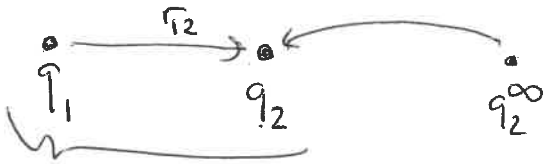
vektör

$-q$ $\xrightarrow{r}$ p

$$V_p = -\frac{kq}{r}$$



$$V_p = \sum k\frac{q_i}{r_i} = k\frac{q_1}{r_1} + k\frac{q_2}{r_2} + k\frac{q_3}{r_3}$$



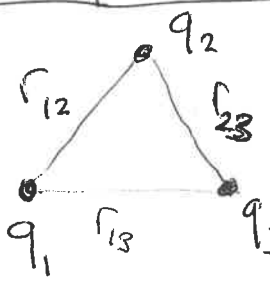
potansiyel enerji $= U = ?$

q_1'in oluşturduğu potansiyel

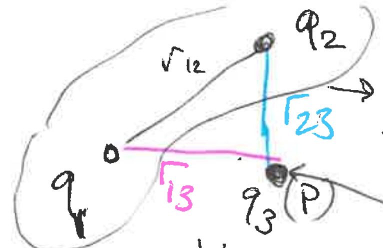
$$V_1 = k\frac{q_1}{r_{12}} \; ; \; U = q_2 V_1$$

$$\boxed{U = k\frac{q_1 q_2}{r_{12}}}$$

noktasal yükleri bir araya getirmek için gereken enerji



Bu üçlü parçacığın bir araya gelmesinde enerji $U = ?$



$$U = k\frac{q_1 q_2}{r_{12}}$$

V_1 pot, V_2 pot } hissediliyor q_3 ∞

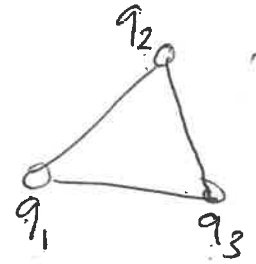
$$V_{13} = k\frac{q_1}{r_{13}}$$

q_3 ün bulunduğu yerdeki pot.

$$\boxed{V_{23} = k\frac{q_2}{r_{23}}}$$

$$U = k\frac{q_1 q_3}{r_{13}} + k\frac{q_2 q_3}{r_{23}}$$

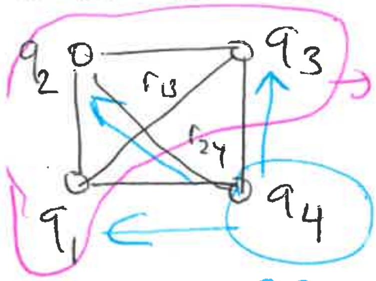
q_3 ün ∞'dan p noktasına taşınması.



pot. enerjisi

$$U = \frac{kq_1q_2}{r_{12}} + \frac{kq_1q_3}{r_{13}} + \frac{kq_2q_3}{r_{23}}$$

3 parça. 3 terim

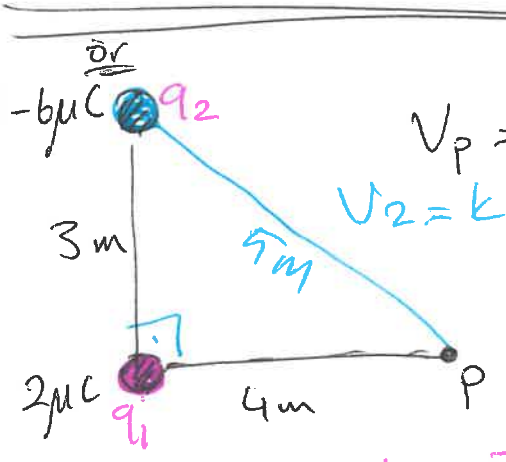


$$U = \frac{kq_1q_2}{r_{12}} + \frac{kq_1q_3}{r_{13}} + \frac{kq_2q_3}{r_{23}}$$

$+$ $U = $ 6 terim

$$U = k\frac{q_1q_4}{r_{14}} + k\frac{q_2q_4}{r_{24}} + k\frac{q_3q_4}{r_{34}}$$

ör:



$V_p = ?$ $V_1 + V_2$

$$V_2 = k\frac{q_2}{5} = k\frac{(-6\times10^{-6})C}{5m}$$

$$V_1 = k\frac{q_1}{4} = k\frac{2\times10^{-6}}{4}\frac{C}{m}$$

$$V_p = (k\times10^{-6})\left[\frac{1}{2} - \frac{6}{5}\right]\frac{C}{m}$$

$$V_p = \left[-\frac{7}{10}\right] \ldots$$

Elektrik Potansiyeli

28.7.16

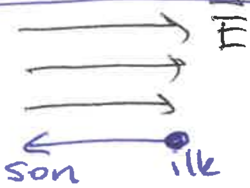
$$\Delta V = -\int \underbrace{\vec{E}}_{\text{El. alan}} \cdot \underbrace{d\vec{s}}_{\text{yol}}$$

$\Delta V = V_s - V_i$

$V_s < V_i$

$\Delta V < 0$

potansiyel $\vec{E}$ alan çizgileri YÖNÜNDE AZALIR. **



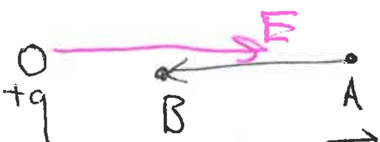
$\Delta V = V_s - V_i$

$V_s > V_i$

$\Delta V > 0$

noktasal yük için potansiyel

$+q \xrightarrow{\;r\;} p \qquad V_p = k\dfrac{q}{r}$

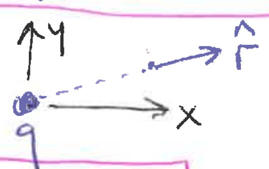


$V_B > V_A$

$\Delta V \to +\,?$ / $-\,?$

$\Delta V = V_B - V_A > 0$

$$\boxed{dV = -d\vec{E} \cdot d\vec{s}} = -dE\,\underbrace{\hat{r} \cdot d\vec{s}}_{dr}$$



$$\boxed{dE_x = -\frac{dV}{dx}}$$

$$\boxed{dE_y = -\frac{dV}{dy}}$$

$dV = -dE\,dr$

$dE = -\dfrac{dV}{dr}$

→ $\vec{E}$ verilirse integral ⇒ ΔV

→ Eğer V verilirse TÜREV $\vec{E}$ bulabilirsiniz

Ör (1)

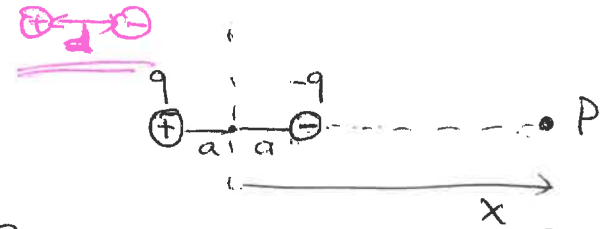
$V = 3x^2y + y^2 + yz$

$\vec{E} = ? \qquad -\dfrac{dV}{dr} = E$

$$\vec{E} = -\frac{dV_x}{dx}\hat{i} - \frac{dV_y}{dy}\hat{j} - \frac{dV_z}{dz}\hat{k}$$

$$\boxed{\vec{E} = -3y(2x)\,\hat{i} - (3x^2 + 2y + z)\,\hat{j} - (y)\,\hat{k}}$$

Dipolün Potansiyeli



P noktasının potansiyeli?

$V = \dfrac{kq}{r} \qquad \Sigma V = V_+ + V_-$

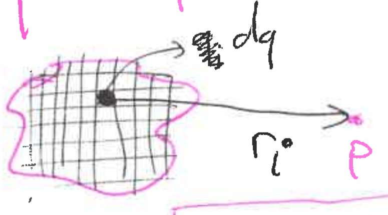
$$= \frac{kq}{x+a} + \frac{k(-q)}{x-a}$$

$$= kq\left(\frac{1}{x+a} - \frac{1}{x-a}\right)$$

$$V_p = kq\left(\frac{x-a-(x+a)}{x^2-a^2}\right)$$

$$V_p = \frac{kq(-2a)}{x^2-a^2} = -\frac{2kqa}{x^2-a^2} = V_p$$

$V_p = \dfrac{kq}{r}$

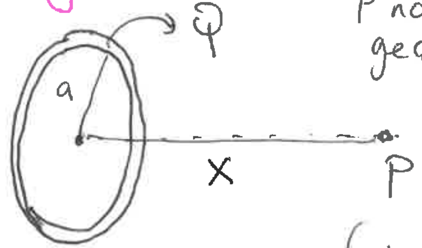


$V_p = ?$

$$\boxed{dV = k\frac{dq}{r}}$$

Düzgün Yüklü Halkanın Potansiyeli

ör:

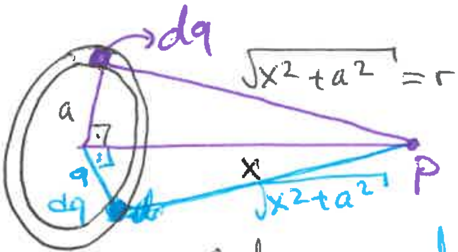


P noktası merkezden geçen eksen üzerinde.

yandan

$$\int dV = \int k \frac{dq}{r}$$

* hatırlatma $\int \frac{dq}{r}$ ilişki



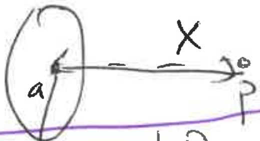
yer

$$\int dV = k \int \frac{dq}{\sqrt{x^2+a^2}}$$; dq değiştikçe r değişmiyor

$\sqrt{x^2+a^2}$; dq' bağlı değil $r \Rightarrow sbt$

$$\int dV = k \frac{1}{\sqrt{x^2+a^2}} \underbrace{\int dq}_{Q} = \frac{kQ}{\sqrt{x^2+a^2}}$$

$$V = \frac{kQ}{\sqrt{x^2+a^2}}$$



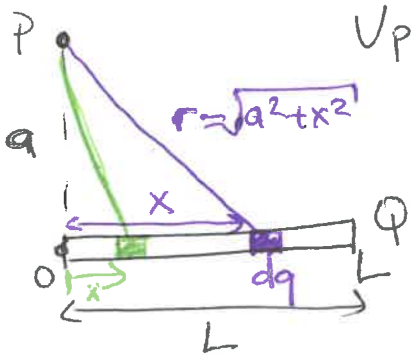
merkezde $x = 0$ $\quad V = \frac{kQ}{\sqrt{a^2}} = \frac{kQ}{a}$

$$E_x = -\frac{dV}{dx} \Rightarrow E_x = -\frac{d}{dx}\left(kQ(x^2+a^2)^{-1/2}\right)$$

$$E_x = -kQ \frac{d}{dx}(x^2+a^2)^{-1/2}$$

$$= -kQ\left(-\frac{1}{\cancel{2}}\right)(x^2+a^2)^{-\frac{1}{2}-1}(\cancel{2}x)$$

$$E = \frac{+kQx}{(x^2+a^2)^{3/2}} = \frac{kQx}{(x^2+a^2)^{3/2}}$$

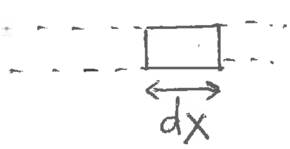


$V_P = ?$

λ = yük yoğunluğu

$$\lambda = \frac{Q}{L}$$

$$dV = k \int \frac{dq}{r}$$; dq değişirse r de değişiyor



$$\underbrace{\lambda = \frac{dq}{dx}} = \frac{Q}{L}$$

$dq = \lambda dx \Rightarrow$ integrale koy.

$$\int dV = k \int_0^L \frac{\lambda\, dx}{\sqrt{a^2+x^2}}$$

$$= k\lambda \int_0^L \frac{dx}{\sqrt{a^2+x^2}}$$ integral tablo

$$= k\lambda \left[\ln\left(x + \sqrt{x^2+a^2}\right)\right]_0^L$$

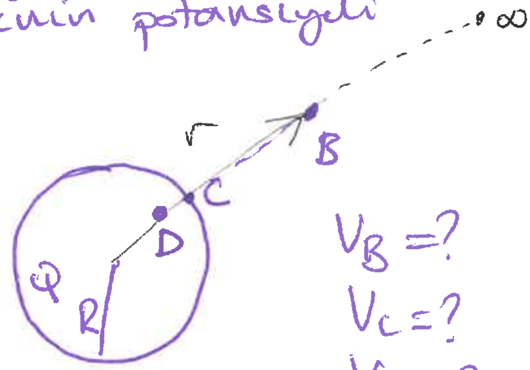
$$= k\lambda \left[\ln\left(L + \sqrt{L^2+a^2}\right) - \ln\left(0 + \sqrt{0+a^2}\right)\right]$$

$$= k\lambda \ln\left(\frac{L+\sqrt{L^2+a^2}}{a}\right)$$

$$\ln A - \ln B = \ln \frac{A}{B}$$

$$\lambda = \frac{Q}{L} \; ; \; V = \frac{kQ}{L} \ln\left(\frac{L+\sqrt{L^2+a^2}}{a}\right)$$

Düzgün yüklü yalıtkan kürenin potansiyeli



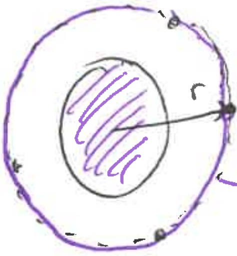
$V_B = ?$
$V_C = ?$
$V_D = ?$

$E_r = k\frac{Q}{r^2}$; $r > R$ için

$$V_B = -\int_{\infty}^{r} \vec{E}\cdot d\vec{s} = -\int_{\infty}^{r} E_r = -\int \frac{kQ\,dr}{r^2}$$

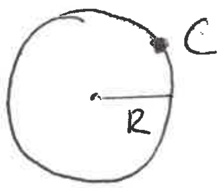
$$V_B = -kQ\int_{\infty}^{r} \frac{dr}{r^2} = -kQ\left[-\frac{1}{r}\right]_{\infty}^{r}$$

$$V_B = \frac{kQ}{r} - \cancel{\frac{kQ}{\infty}}^{\,0} = \frac{kQ}{r}$$



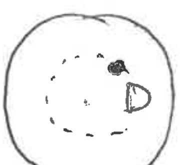
$V = \frac{kQ}{r}$ $\equiv$ $q \overset{r}{\longrightarrow} \circ$ $\frac{kq}{r}$ noktasal

eş potansiyel yüzeyi



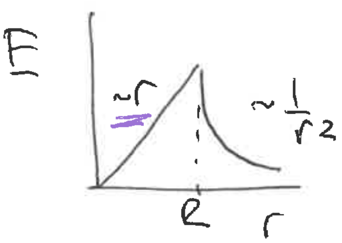
$V_C = ? = \frac{kQ}{R}$

İçi dolu yalıtkan küre.



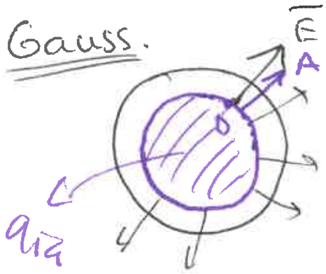
$V_D = ?$

$E_D = \frac{kQ}{R^3}r$ (hatırla)



yaptık

Gauss.



$$\oint \vec{E}\cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0}$$

$E\,dA\cos 0$ → sbt

$$E\underbrace{\int dA}_{\text{kürenin alanı}} = \frac{q_{iç}}{\varepsilon_0} \Rightarrow E(4\pi r^2) = \frac{q_{iç}}{\varepsilon_0}$$

$\frac{Q}{V} = \rho$ → yük yoğunluğu

$$\rho = \frac{q_{iç}}{V_{iç}} = \frac{Q}{V} \Rightarrow q_{iç} = Q\frac{V_{iç}}{V}$$

$$q_{iç} = Q\frac{\cancel{\frac{4}{3}\pi} r^3}{\cancel{\frac{4}{3}\pi} R^3}$$

$$E\,4\pi \cancel{r^2} = \left(\frac{Q\,r^{\cancel{3}}}{R^3}\right)\frac{1}{\varepsilon_0}$$

$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R^3}r = k\frac{Q}{R^3}r$$

$$\Delta V = -\int_{R}^{r} E_r\,dr$$

$$\Delta V = -\frac{kQ}{R^3}\int_{R}^{r} r\,dr$$

$$= -\frac{kQ}{R^3}\left[\frac{r^2}{2}\right]_{R}^{r} = \frac{-kQ}{R^3}\left[\frac{r^2}{2} - \frac{R^2}{2}\right]$$

$$= \frac{kQ}{R^{\cancel{3}}}\frac{\cancel{R^2}}{2} - \frac{kQ}{R^3}\frac{r^2}{2}$$

$$= \boxed{\frac{kQ}{2R} - \frac{kQ}{2R^3}r^2} = \Delta V$$

EŞİT

$$\Delta V = V_D - V_C = \boxed{V_D - \frac{kQ}{R}}$$

$$V_D = \frac{kQ}{R} + \frac{kQ}{2R} - \frac{kQ}{2R^3}r^2 = \frac{3kQ}{2R} - \frac{kQr^2}{2R^3}$$

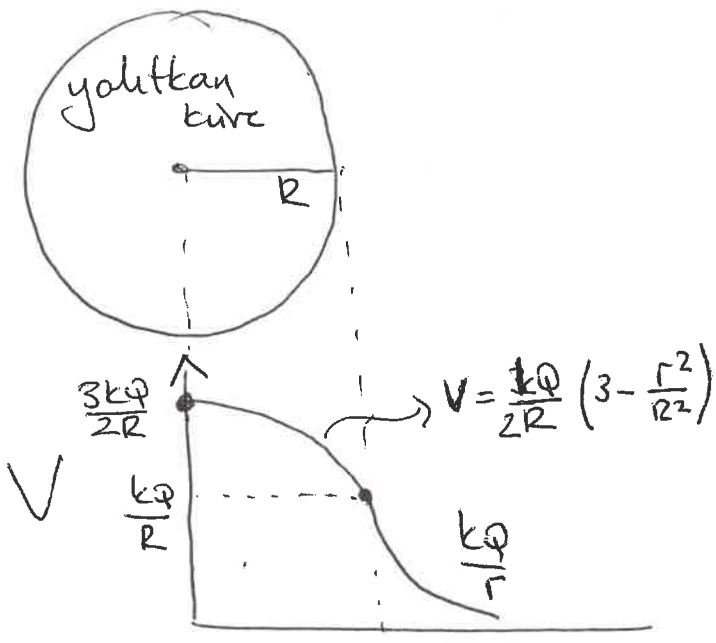
$$V_B = \frac{kQ}{r}$$

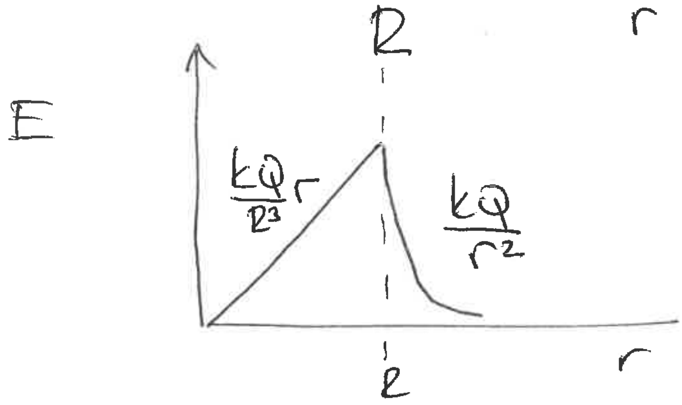
$$V_C = \frac{kQ}{R}$$

$$V_D = \frac{3}{2}\frac{kQ}{R} - \frac{kQ}{2R^3} r^2$$

$r=0$ merkezdeki

$$V_D(r=0) = \frac{3kQ}{2R} = V_0$$





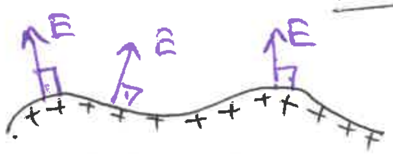
İLETKENLERDE POTANSİYEL

→ yükler kabukta

→ $\vec{E}$ alan yüzeye dik

→ metal içinde $\vec{E} = 0$

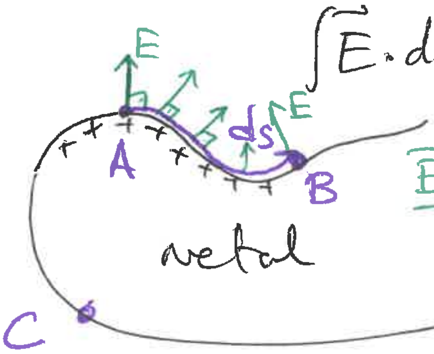
} Elektrostatik denge durum



$$\Delta V = -\int \vec{E} \cdot d\vec{s}$$

ds ⇒ yükün gittiği yol : $\vec{E}$ DİK

$$\int \vec{E} \cdot d\vec{s} = E\, ds \cos 90$$



$\vec{E}$ $d\vec{s}$ DİK

$$\Delta V = -\int \underbrace{\vec{E} \cdot d\vec{s}}_{0}$$

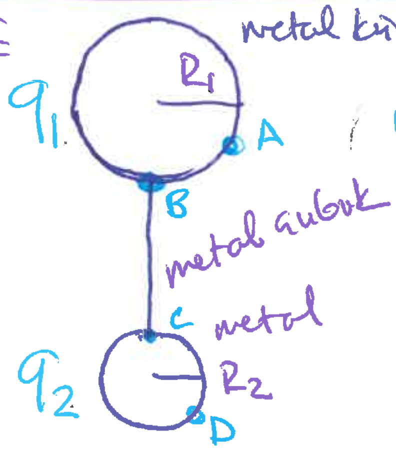
$$\Delta V = V_B - V_A = 0 \qquad V_A = V_B$$

metallerin yüzeylerindeki POTANSİYEL AYNIDIR.

metal yüzeyi EŞ POTANSİYELdi

$$V_A = V_B = V_C$$

Ör



$$V_A = V_B = V_C = V_D$$

Elektrostatik denge durumda

Kürelerin yüzeyindeki Elektrik Alan şiddetleri?

$$\frac{E_1}{E_2} = ? \qquad E = \frac{kQ}{R^2}$$

$$V_1 = k\frac{Q_1}{R_1} = k\frac{Q_2}{R_2} = V_2 = V$$

$$\boxed{\frac{Q_1}{R_1} = \frac{Q_2}{R_2}} \Rightarrow \frac{Q_1}{Q_2} = \boxed{\frac{R_1}{R_2}}$$

$$\frac{E_1}{E_2} = \frac{kQ_1/R_1^2}{kQ_2/R_2^2} = \frac{\boxed{Q_1}\, R_2^2}{\boxed{Q_2}\, R_1^2}$$

$$\frac{E_1}{E_2} = \frac{R_1}{R_2} \cdot \frac{R_2^2}{R_1^2} = \frac{R_2}{R_1} = \frac{E_1}{E_2}$$

Potansiyel özet

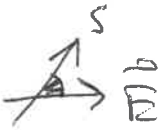
$$\Delta U = -q \underbrace{\int \vec{E}\cdot d\vec{s}}_{\Delta V \ \text{potansiyel}}$$

pot. enerji

$$V = \text{Volt} = \frac{\text{Joule}}{\text{Coulomb}}$$

$$\Delta V = -\int \vec{E}\cdot d\vec{s}$$

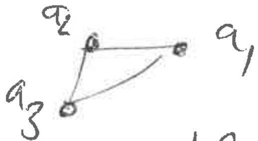
Düzgün $\vec{E}$ altında



$$\Delta V = -E s \cos\theta$$

noktasal yük

$$V = \frac{kq}{r} \ ;$$



$$U = \frac{kq_1q_2}{r_{12}} + \dots$$

enerji

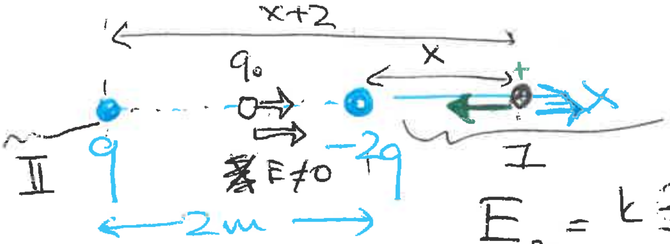
$$+ \dots$$

$$E_r = -\frac{dV}{dr} \qquad V = \int \frac{k\,dq}{r}$$

#18: +q orijindedir.
-2q yükü 2m x ekseni üzerindedir.

a) X'in sonlu değerleri için $\vec{E}$ = sıfır olur mu?

b) V = potansiyel sıfır olur mu?

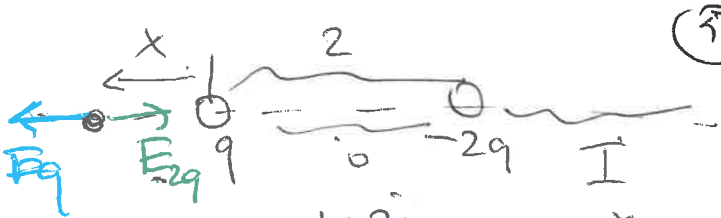


$$E_{-2q} = k\frac{2q}{x^2}(-\hat{i})$$

$$E_q = k\frac{q}{(x+2)^2} \qquad \Sigma E = 0 = E_q + E_{-2q}$$

I: $E_{2q} > E_q$ $\quad \Sigma E \neq 0$

~~potansiyel~~



$$E_{-2q} = k\frac{2q}{(x+2)^2}$$

$$E_q = k\frac{q}{x^2}$$

$$\sqrt{\frac{k2q}{(x+2)^2}} = \sqrt{\frac{kq}{x^2}} \Rightarrow \frac{\sqrt{2}}{x+2} = \frac{1}{x} \ ✓$$

$$V = V_q + V_{-2q}$$

$$0 \stackrel{?}{=} \frac{kq}{x} + \frac{k(-2q)}{x+2}$$

$$\left.\frac{2}{x+2} = \frac{1}{x}\right\} \ x \ ✓$$

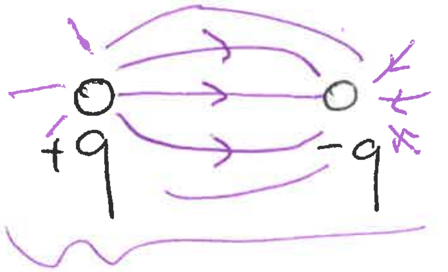
1.8.16

Sığa ve Dielektrikler

Sığa = (capacitance) =
= yük tutma kapasitesi

$$\boxed{C \equiv \frac{Q}{\Delta V} = \frac{\to \text{yük}}{\to \text{pot. fark}}}$$

$C > 0$; $Q, \Delta V > 0$

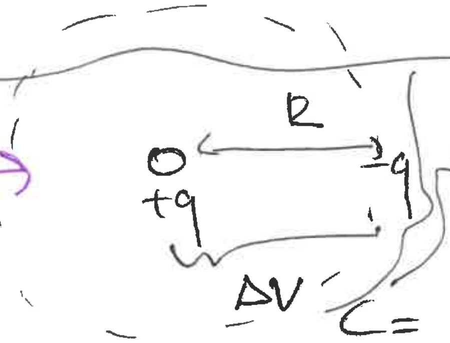


C tanımlanabilir

sığa
$$C = \frac{Q}{\Delta V} = \frac{\text{Coulomb}}{\text{Volt}} \Rightarrow \text{Farad}$$

$[F] = \left[\frac{C}{V}\right]$; Devre elemanları
1pF, 1µF
1×10^{-12}F ; 1×10^{-6}F

Farad



$$\boxed{C = \frac{R}{k}}$$

$$C = \frac{Q}{\Delta V} = \frac{q}{k\frac{q}{R}}$$

P
q R

$$\boxed{V_p = \frac{kQ}{R}}$$

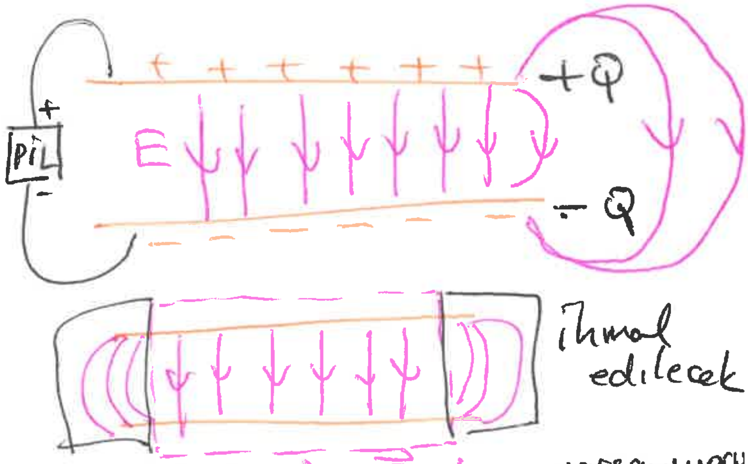
$\varepsilon_0 = \left[\frac{F}{m}\right]$

$$\boxed{C = 4\pi\varepsilon_0 R}$$

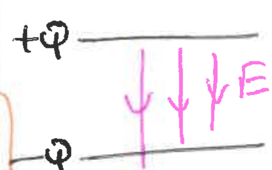
$$k = \frac{1}{4\pi\varepsilon_0}$$

① Paralel Plakalı Kondansatör

Kondansatör → yük depolayan devre elemanı.



Düzgün $\vec{E}$ alanı varsayılıyor



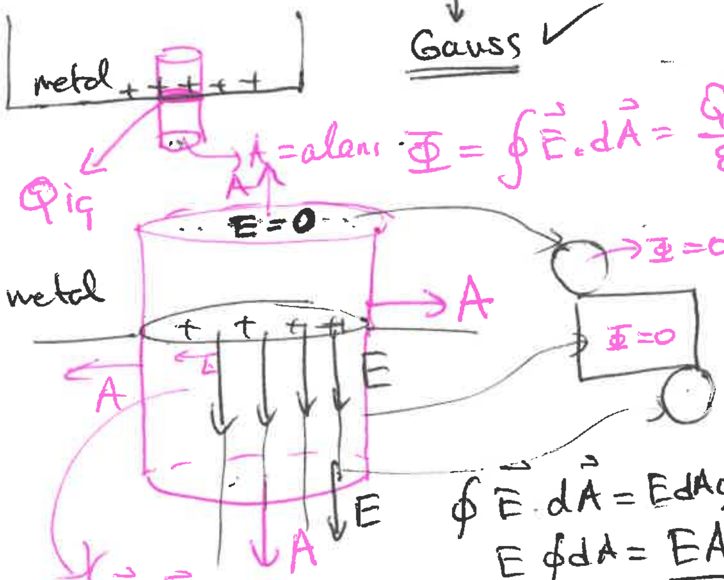
$\boxed{C = ?}$ +Q

$\boxed{? = \frac{Q}{\Delta V ?}}$ -Q

E

$$\Delta V = -\int \vec{E}\cdot d\vec{s}$$

Gauss ✓



A = alanı $\Phi = \oint \vec{E}\cdot d\vec{A} = \frac{Q_{iç}}{\varepsilon_0}$

$\oint \vec{E}\cdot d\vec{A} = EdA\cos 0$
$E\oint dA = EA$

$\vec{E}\cdot\vec{A} =$
$EA\cos 90 = 0$

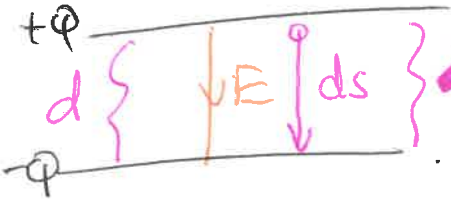
Gauss: $\oint \vec{E}\cdot d\vec{A} = EA = \frac{\sigma A}{\varepsilon_0}$ ($Q_{iç}$)

metal yüzeyin $\vec{E}$ alanı

$$\boxed{E = \frac{\sigma}{\varepsilon_0}}$$

$$\boxed{E = \frac{\sigma}{\varepsilon_0}} \; ; \quad \Delta V = -\int \vec{E}\cdot d\vec{s}$$

sbt ; $\cos\theta \to 1$



$$\Delta V = -E\int ds \quad (\text{yol})$$

$$\Delta V = -Ed$$

$$C = \frac{Q}{\Delta V} = \frac{Q}{Ed} = \frac{Q}{\frac{\sigma}{\varepsilon_0}d}$$

$$C = \frac{\varepsilon_0 Q}{\sigma d} \; ; \quad \boxed{\sigma = \frac{Q}{A}} \text{ yük yoğunluğu}$$

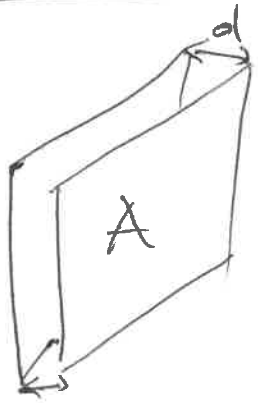
$$C = \frac{\varepsilon_0 Q}{\frac{Q}{A}d}$$

$$C = \varepsilon_0 \frac{A}{d}$$

paralel plakalı kond. sığası

sonuç: C = Q'ya bağlı değil!

$$C = \varepsilon_0 [m]$$



A↑ ; C↑

d↑ ; C↓

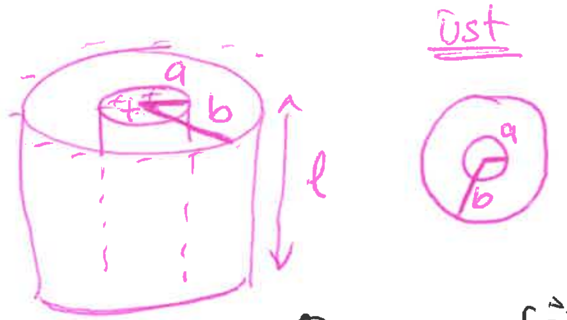
ör: $A = 2\times10^{-4}\,m^2$; $d = 1\,mm$ paralel plakalı kond. $C = ?$

$$C = \varepsilon_0 \frac{A}{d} = \left(8.85\times10^{-12}\,\frac{C^2}{Nm^2}\right)\frac{2\times10^{-4}\,m^2}{10^{-3}\,m}$$

$$= 1.77\times10^{-12}\,F$$

$$\boxed{C = 1.77\,pF}$$

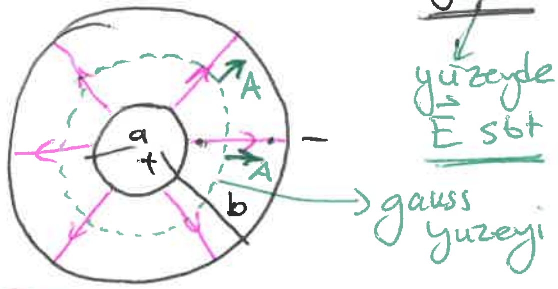
Silindirik Kondansatör (2)

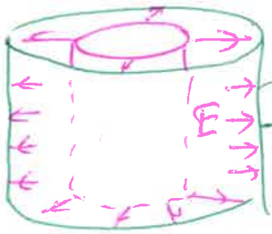


$C = ?$

$$C = \frac{Q}{\Delta V} \; ; \quad \Delta V = -\int \vec{E}\cdot d\vec{s}$$

gauss → yüzeyde $\vec{E}$ sbt





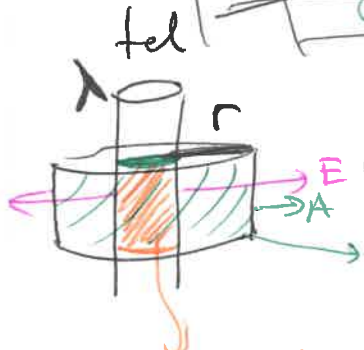
$\vec{E}$ alanı yan yüzeyle DİK

$$\oint \vec{E}\cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0}$$

$\to E$, $\to A$; $\cos\theta = 1$

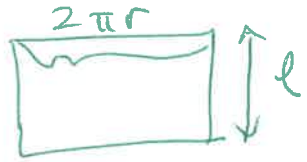
$\cos\theta = 1$

~~$E\oint dA = \frac{q_{iç}}{\varepsilon_0}$ Alan = silindirin yan yüzey alanı~~ l ; $2\pi b$



$$q_{iç} = \lambda l$$

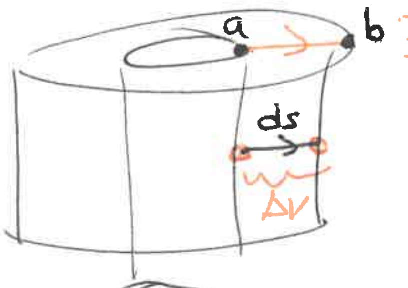
$$\int E\, dA \cos\theta = \frac{q_{iç}}{\varepsilon_0}$$



$$\oint E\, 2\pi r \cancel{l} = \frac{\lambda \cancel{l}}{\varepsilon_0}$$

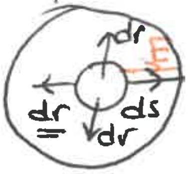
$$\boxed{E = \frac{\lambda}{2\pi\varepsilon_0 r}}$$

tel; silindirin oluşturduğu E.



$$E = \frac{\lambda}{2\pi\varepsilon_0 r}$$

$$\Delta V = -\int \vec{E}\cdot d\vec{s}$$



$$\Delta V = -\int_b E\, ds \cos 0 \quad (\cos 0 = 1)$$

$$= \int_a -\frac{\lambda}{2\pi\varepsilon_0 r}\, dr$$

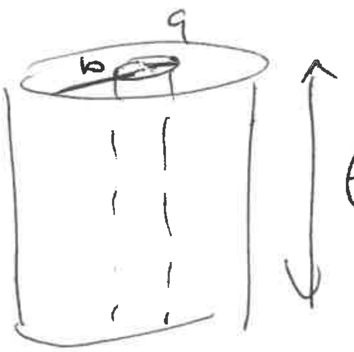
$$\Delta V = -\frac{\lambda}{2\pi\varepsilon_0}\int \frac{dr}{r} = -\frac{\lambda}{2\pi\varepsilon_0}\left[\ln r\right]_a^b$$

$$\boxed{= -\frac{\lambda}{2\pi\varepsilon_0}\ln\left(\frac{b}{a}\right) = \Delta V}$$

$$\boxed{\ln b - \ln a = \ln\frac{b}{a}}$$

$$C = \frac{Q}{\Delta V} = \frac{\lambda \ell}{\frac{\lambda}{2\pi\varepsilon_0}\ln\left(\frac{b}{a}\right)} = \frac{2\pi\varepsilon_0 \ell}{\ln\left(\frac{b}{a}\right)}$$

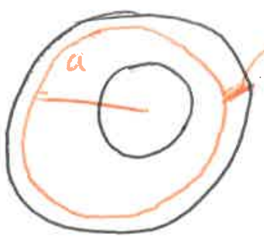
$$C = 2\pi\varepsilon_0 \frac{\ell}{\ln\left(\frac{b}{a}\right)} \;;\; C = \varepsilon_0 [m]$$



$\ell\uparrow;\ C\uparrow$

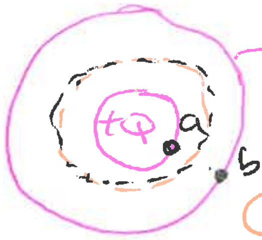
[redacted]

$b\downarrow, a\uparrow;\ C\uparrow$



mesafe azalıyor

Küresel Kondansatör



$$C = ? = \frac{Q}{\Delta V}$$

$$\Delta V = -\int \vec{E}\cdot d\vec{s}$$

$$= -\int E\, dr \;;\; E = \frac{kq}{r^2}$$

$$= -kq\int_a^b \frac{dr}{r^2} = -kq\left[-\frac{1}{r}\right]_a^b$$

$$\Delta V = kq\left[\frac{1}{b} - \frac{1}{a}\right] = kq\frac{(a-b)}{ab}$$

$b>a;$

$$|\Delta V| = kq\,\frac{b-a}{ab}$$

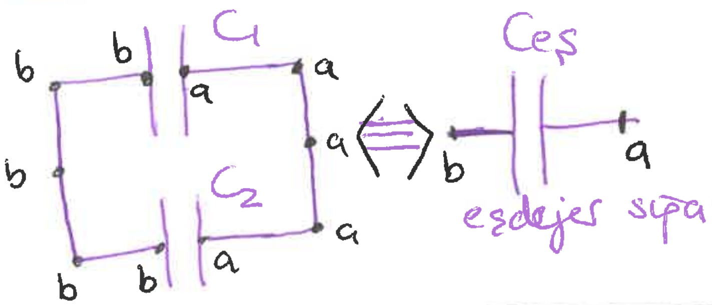
$$C = \frac{Q}{\Delta V} = \frac{q}{kq\frac{b-a}{ab}} = \frac{1}{k}\frac{ab}{(b-a)}$$

$$\boxed{C = 4\pi\varepsilon_0 \frac{ab}{(b-a)}}$$ küresel kondansatör

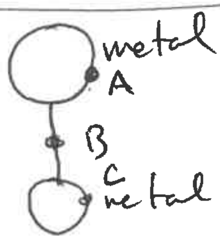
$(b-a)\downarrow;\ C\uparrow \qquad C \stackrel{?}{=} \varepsilon_0 [m]$

Kondansatörlerin Bağlanması

Paralel Bağlama



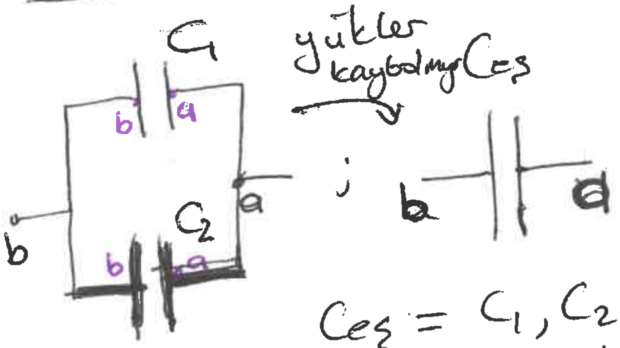
hatırlatma *



$V_A = V_B = V_C$

$V_B - V_A = 0$

Metal ~~tel~~ boyunca başka bir devre elemanı yoksa, potansiyel aynıdır!



$C_{eş} = C_1, C_2$ cinsinden bulmak.

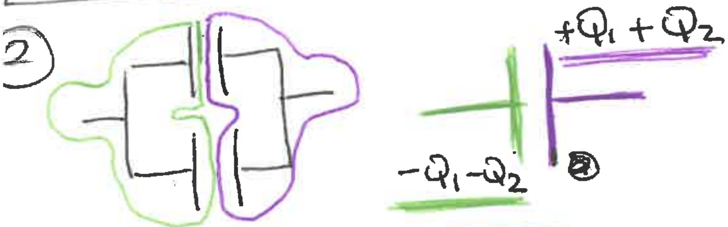
$C_1 = \frac{Q_1}{\Delta V_1}$; $C_2 = \frac{Q_2}{\Delta V_2}$ $C_{eş} = \frac{Q_{eş}}{\Delta V_{eş}}$

$\Delta V_1 = V_{ab}$; $\Delta V_2 = V_{ab}$; $\Delta V_{eş} = V_{ab}$

a-b noktaları arasındaki pot. farkı

$\boxed{V_{ab} = \Delta V_1 = \Delta V_2 = \Delta V_{eş}}$ (1)

(2)



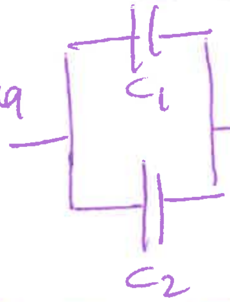
$\boxed{Q_{eş} = Q_1 + Q_2}$ (2)

$C_1 = \frac{Q_1}{V_{ab}}$; $C_2 = \frac{Q_2}{V_{ab}}$; $C_{eş} = \frac{Q_1 + Q_2}{V_{ab}}$

$C_{eş} = C_1 + C_2$

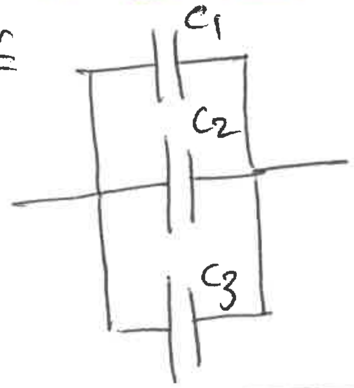
$$\frac{Q_1 + Q_2}{V_{ab}} = \frac{Q_1}{V_{ab}} + \frac{Q_2}{V_{ab}}$$

paralel bağlama **



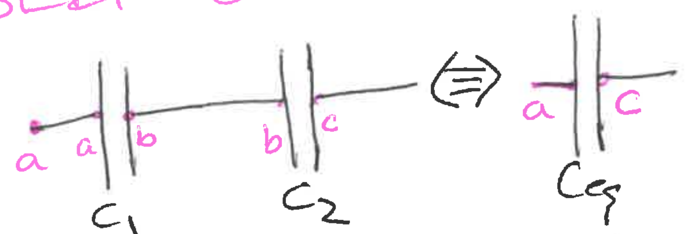
$\boxed{C_{eş} = C_1 + C_2}$

ör

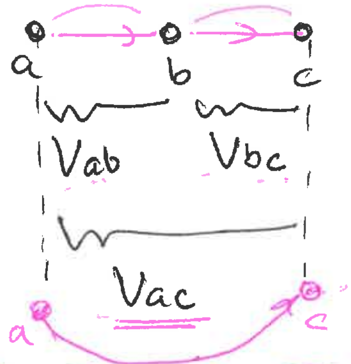


; $C_{eş} = C_1 + C_2 + C_3$

SERİ BAĞLAMA



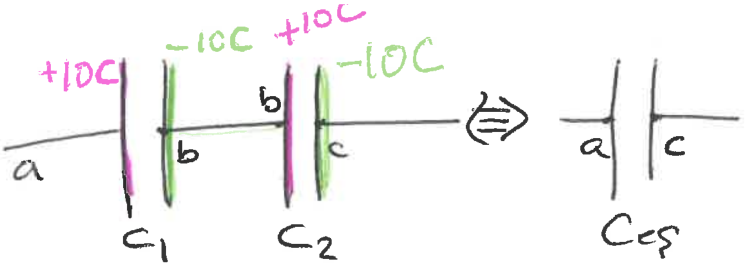
$C_1 = \frac{Q_1}{V_{ab}}$; $C_2 = \frac{Q_2}{V_{bc}}$; $C_{eş} = \frac{Q_{eş}}{V_{ac}}$



(1)

$V_{ac} = V_{ab} + V_{bc}$

yük = ?



nötr = toplam yük = 0

$Q_1 = Q \qquad Q_2 = Q \quad (2) \qquad Q_{eş} = Q$

$V_{ac} = V_{ab} + V_{bc}$ (1); $V_{eş} = V_1 + V_2$

$C_{eş} = ? = (C_1, C_2)$

$V_1 = V_{ab}$
$V_2 = V_{bc}$
$V_{eş} = V_{ac}$

$C_1 = \frac{Q_1}{V_{ab}}$; $C_2 = \frac{Q_2}{V_{bc}}$; $C_{eş} = \frac{Q_{eş}}{V_{ac}}$

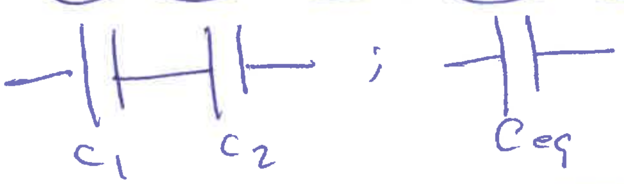
$Q_1 = Q_2 = Q_{eş} = \boxed{Q = C_1 V_{ab}} = \boxed{C_2 V_{bc}}$

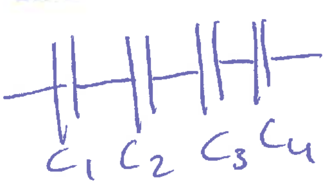
$\boxed{Q = C_{eş} V_{ac}}$

(1) $V_{ac} = V_{ab} + V_{bc}$

$$\frac{\cancel{Q}}{C_{eş}} = \frac{\cancel{Q}}{C_1} + \frac{\cancel{Q}}{C_2}$$

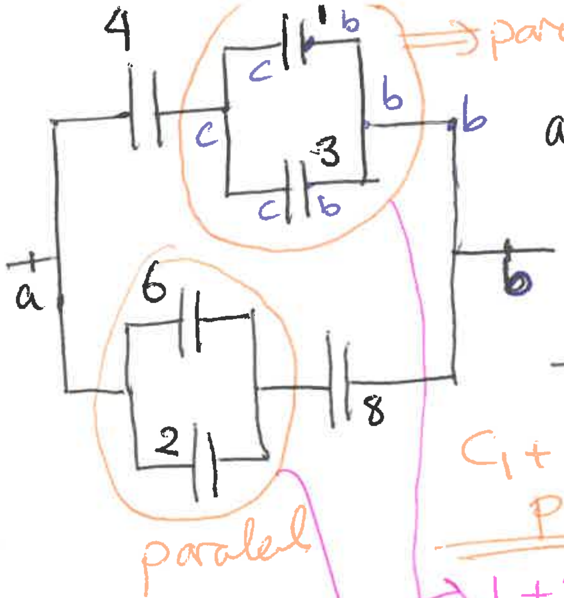
** $\frac{1}{C_{eş}} = \frac{1}{C_1} + \frac{1}{C_2}$ SERİ BAĞLAMA





$\frac{1}{C_{eş}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4}$

(5)



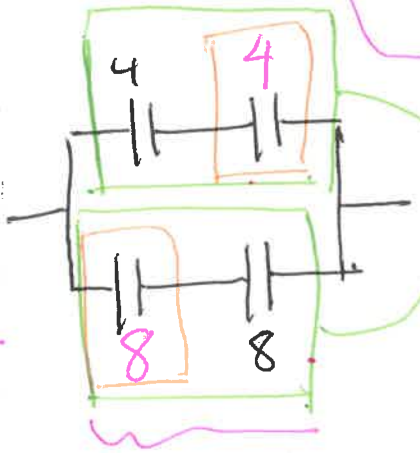
ab arası $C_{eş} = ?$

µF

$C_1 + C_2 = C_{eş}$ paralel

$1 + 3 = 4\mu F$

$6 + 2 = 8\mu F$



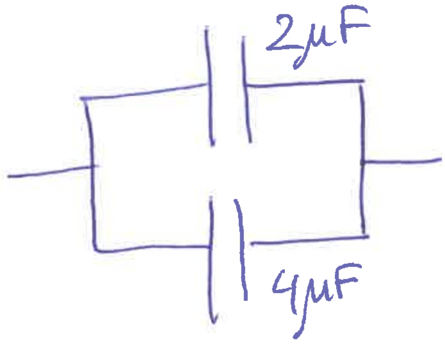
seri

$\frac{1}{C_{eş}} = \frac{1}{4} + \frac{1}{4} = \frac{2}{4}$

$C_{eş} = \frac{4}{2} = 2\mu F$

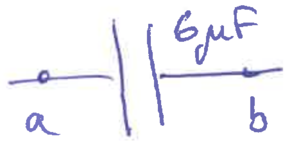
$\left(\frac{1}{8} + \frac{1}{8}\right)^{-1} = C_{eş}$

$\left(\frac{2}{8}\right)^{-1} = 4\mu F = C_{eş}$



paralel

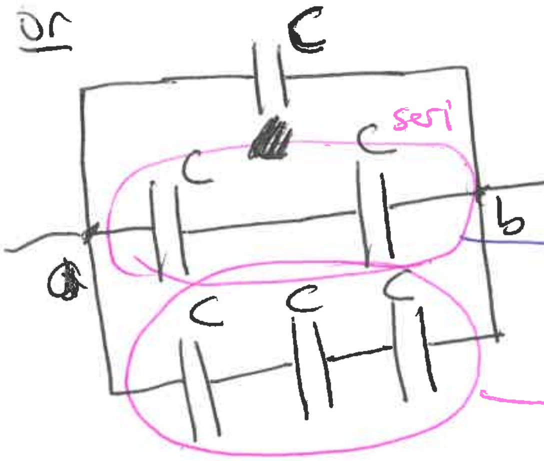
$\underbrace{2+4}_{6\mu F}$



$C_{eş} = 6\mu F$

Ör

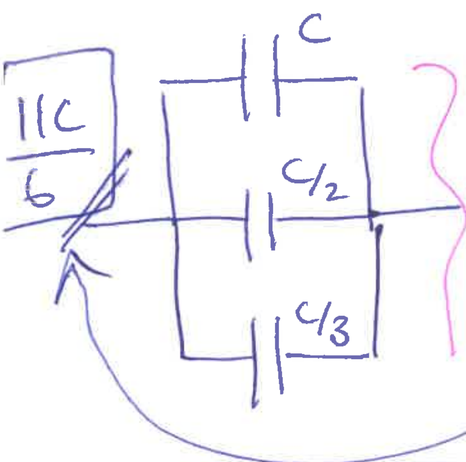
$C_{ab} = C_{eş}$?



$$\frac{1}{C_{eş}} = \frac{1}{c} + \frac{1}{c} + \frac{1}{c} = \frac{3}{c}$$

$$C_{eş} = c/3$$

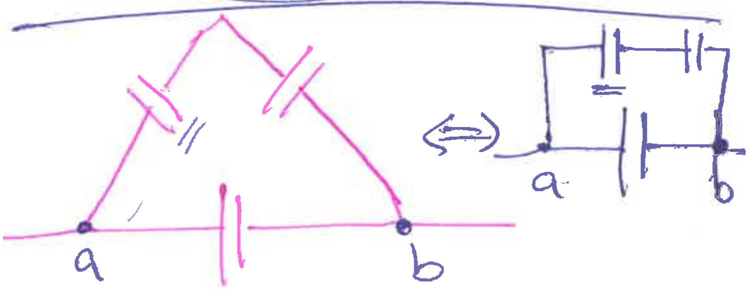
$$\left(\frac{1}{C_{eş}}\right)^{-1} = \left(\frac{1}{c} + \frac{1}{c}\right)^{-1} = \frac{c}{2} = C_{eş}$$

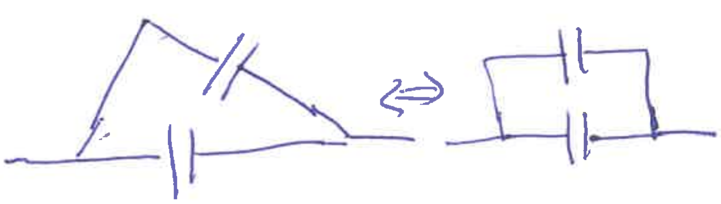


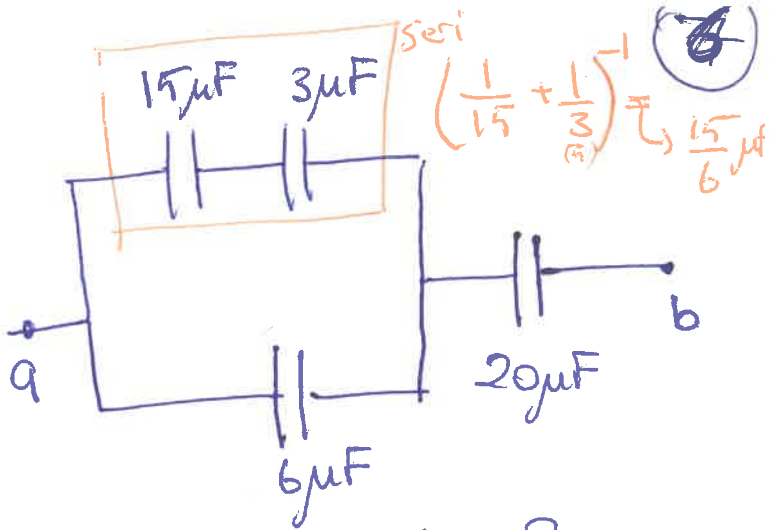
paralel

$$c + \frac{c}{2} + \frac{c}{3}$$

$$\frac{(6+3+2)c}{6}$$





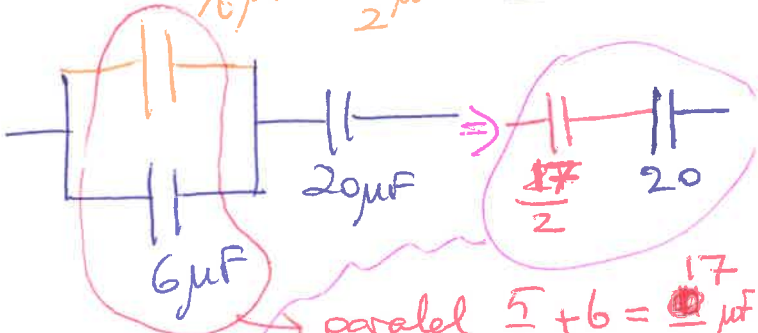


$$\left(\frac{1}{15} + \frac{1}{3}\right)^{-1} \to \frac{15}{6}\,\mu F$$

a) eşdeğer sığa; $C_{eş} = ?$

b) $V_{ab} = 15V$ ise, her bir kondansatörün yükü?

$15/6\,\mu F = \frac{5}{2}\,\mu F$



paralel $\frac{5}{2} + 6 = \frac{17}{2}\,\mu F$

seri $\left(\frac{2}{17} + \frac{1}{20}\right)^{-1} = \left(\frac{40+17}{340}\right)^{-1} = \left(\frac{57}{340}\right)^{-1}$

$C_{eş} = 5.96\,\mu F$ ✓

(b) yükü?

$C_{eş} = 5.96\mu$

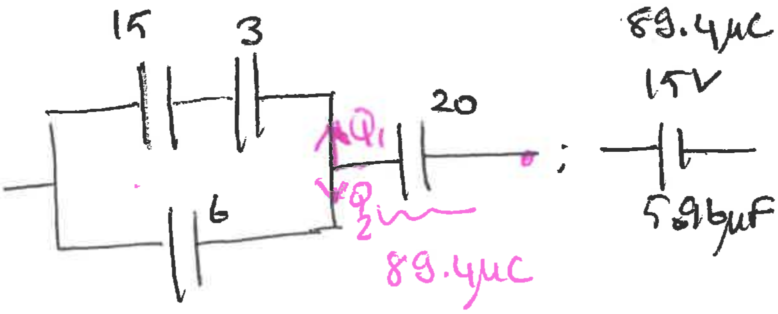
$V_{ab} = 15V$

$C = \frac{Q}{V_{ab}}$ ✓

$Q = (15)(5.96)\,V\mu F$ — μC

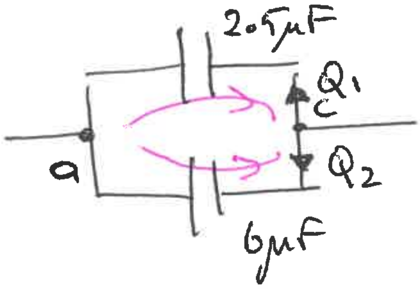
$= 89.4\,\mu C$

Alıştırma



$Q_1 + Q_2 = 89.4\mu C$

$C = \frac{Q}{\Delta V}$



$V_{ac} = \frac{Q_1}{2.5}$

$V_{ac} = \frac{Q_2}{6}$

$V_{ac} = V_{ac}$

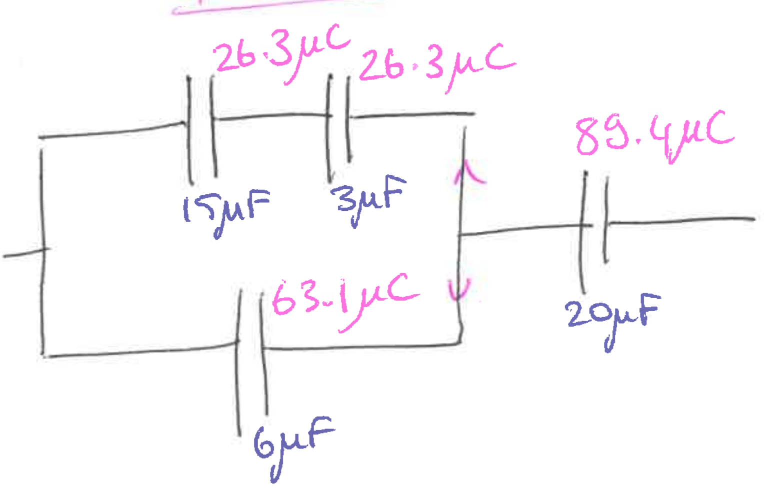
$$\boxed{\frac{Q_1}{2.5} = \frac{Q_2}{6}} \; ; \; Q_1 + Q_2 = 89.4$$

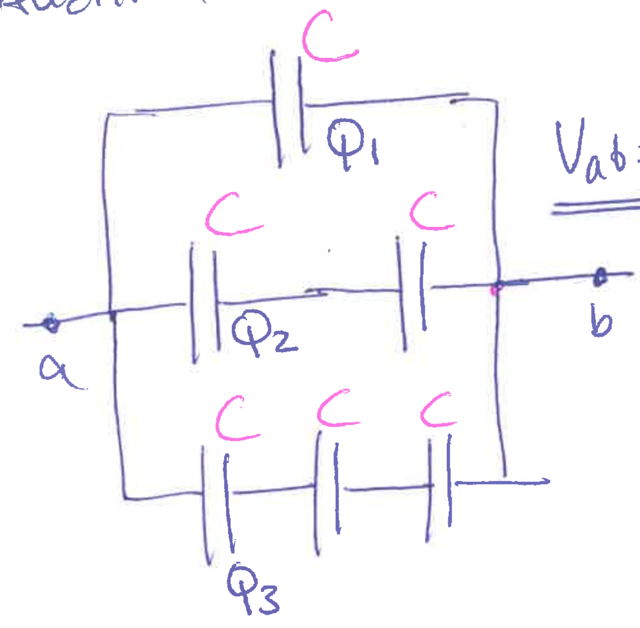
$$\frac{2.5}{6} Q_2 + Q_2 = 89.4$$

$$Q_2 \frac{8.5}{6} = 89.4\mu C$$

$$Q_2 = 63.1\mu C$$

$$Q_1 = 89.4 - 63.1 = \underline{26.3\,\mu C}$$





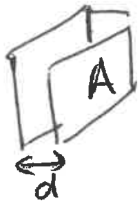
$V_{ab} = V$

$\frac{Q_1}{Q_2} = ?$; $\frac{Q_2}{Q_3} = ?$, $\frac{Q_1}{Q_3} = ?$

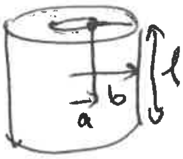
2.8.16

sığa (kapasite)

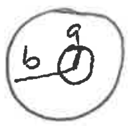
$$C = \frac{Q}{\Delta V} = \left[\frac{C}{V}\right] = [F]$$



$$C = \varepsilon_0 \frac{A}{d} \;;\; C = \varepsilon_0 [m]$$



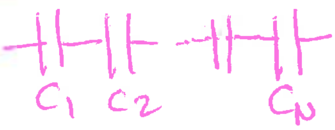
$$C = 2\pi\varepsilon_0 \frac{\ell}{\ln\left(\frac{b}{a}\right)} \;;\; \varepsilon_0 [m]$$



küre

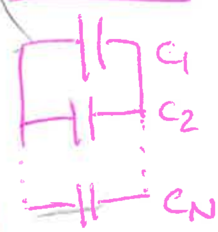
$$C = 4\pi\varepsilon_0 \frac{ab}{(b-a)} \;;\; \varepsilon_0 [m]$$

Seri



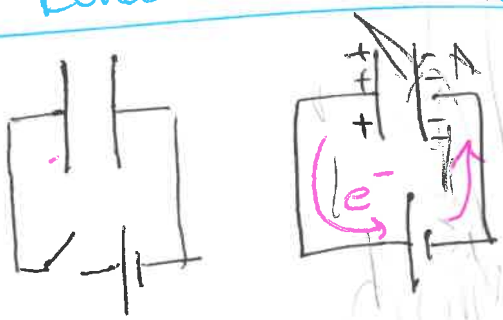
$$C_{eş} = \left(\frac{1}{C_1} + \frac{1}{C_2} + \cdots \frac{1}{C_N}\right)^{-1}$$

Paralel



$$C_{eş} = C_1 + C_2 + \cdots C_N$$

Yüklü Kondansatörde Enerji



Yapılan iş $dW = (\Delta V)\,dq$

Joule = (Volt)(Coulomb)

$$J = V\,C$$

$\Delta V, q \Rightarrow$ bağlı q arttıkça ΔV artacak

$$\int dW = \int_0^Q \Delta V\, dq \;;\; \boxed{C = \frac{q}{\Delta V}}$$

$$W = \int_0^Q \frac{q}{C}\, dq = \frac{1}{C}\int_0^Q q\, dq$$

$$W = \frac{1}{C}\left[\frac{q^2}{2}\right]_0^Q = \frac{1}{C}\left[\frac{Q^2}{2} - \frac{0}{2}\right]$$

$$\boxed{W = \frac{Q^2}{2C}}$$

Q yükü ile yüklenek için harcanan enerji

$$Q = (C\Delta V)$$

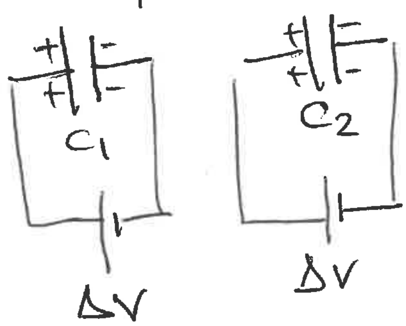
$$W = \frac{(C\Delta V)^2}{2C}$$

$$\boxed{W = \frac{(\Delta V)^2}{2C}}$$

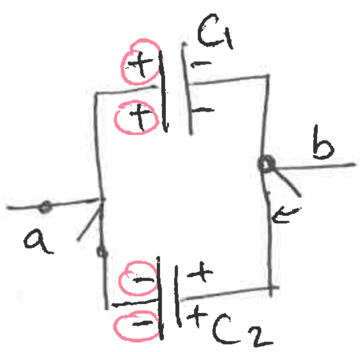
$$W = \frac{Q^2}{2C} = \frac{Q^2}{2\left(\frac{Q}{\Delta V}\right)} = \boxed{\frac{Q\Delta V}{2} = W}$$

$$\boxed{W = \frac{Q^2}{2C} = \frac{(\Delta V)^2}{2C} = \frac{Q\Delta V}{2} = \text{iş}}$$

Ör: İki yüklü kondansatörün bağlanması

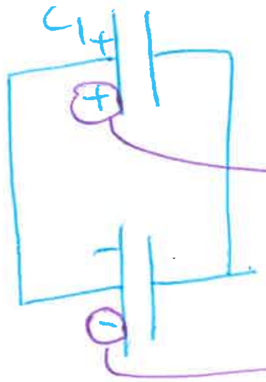


C_1 ve C_2 pilden ayrılıp ~~ters~~ ~~yüklü~~ olarak tekrar bağlanıyorlar



Son durumda

$V_{ab} = ?$



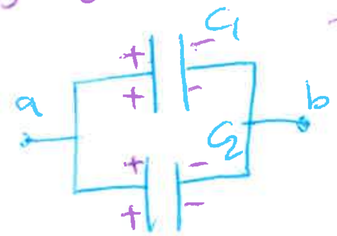
$Q_{1i} = +C_1 \Delta V$

$Q_{2i} = -C_2 \Delta V$

Toplam yük $= Q_{1i} + Q_{2i}$

$Q_{1s} + Q_{2s} = Q_T = C_1\Delta V - C_2 \Delta V$
$= (C_1 - C_2)\Delta V$

son durum



$V_{ab} = ?$

$Q_T \to Q_{1s}$, $Q_T \to Q_{2s}$

$C_{eş} = C_1 + C_2$

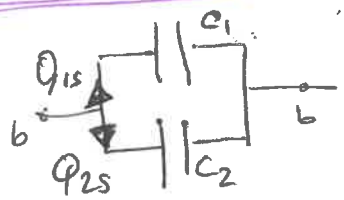
$Q_T = Q_{son} = Q_{1s} + Q_{2s}$

$$C_{eş} = \frac{Q}{\Delta V} = \frac{Q_T}{V_{ab}} = \frac{(C_1 - C_2)\Delta V}{V_{ab}} = C_{eş}$$

$$\frac{(C_1 - C_2)\Delta V}{C_1 + C_2} = V_{ab}$$

$V_{ab} < \Delta V$!

$Q_{1s} = ?$

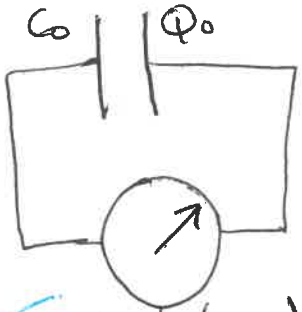


$$C_1 = \frac{Q_{1s}}{V_{ab}}$$

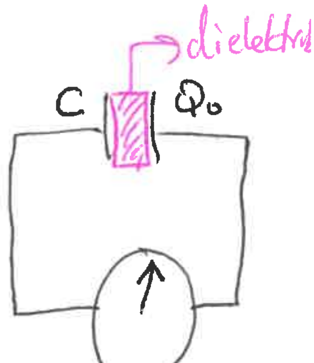
$$Q_{1s} = (V_{ab})\, C_1 = \frac{(C_1 - C_2)}{(C_1 + C_2)} \Delta V\, C_1$$

Dielektrikli Kondansatörler (8)

(yalıtkan)



voltmetre $= V_0$



ΔV

$$\boxed{\Delta V = \frac{V_0}{\kappa}} \quad ; \quad \kappa > 1$$

(kappa) (dielektrik sbt)

$$C_0 = \frac{Q_0}{V_0} \qquad C = \frac{Q_0}{\Delta V}$$

$$Q_0 = C_0 V_0 = C \boxed{\Delta V} \to \frac{V_0}{\kappa}$$

$$C_0 \cancel{V_0} = C \frac{\cancel{V_0}}{\kappa}$$

Bir yalıtkan koyulursa,
C ; κ kadar ARTAR!

$$\boxed{C = \kappa C_0} \;**$$

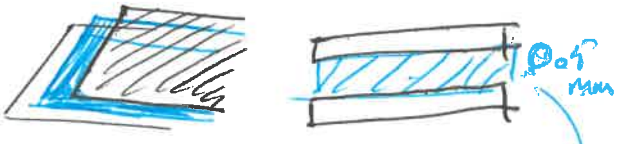
madde	κ (dielektrik sbt)
Hava (kuru)	1.00059
Eritilmiş kuartz	3.78
Boşluk	1.0000000
Naylon	3.4
Kağıt	3.7
silikon yağı	2.5
su	80
Stronsiyum titanate	233

Dielektrik kullanmanın Avantajı

1) $C = C_0 K$; C artıyor.

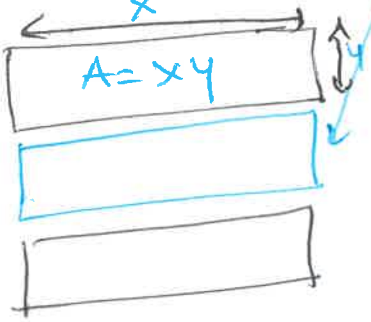
2) $\Delta V = \frac{V_0}{K}$; Kondansatörün max. çalışma voltajı artar.

3) mekanik destek.



ör paralel plaka

$C_0 = \varepsilon_0 \frac{A}{d}$; $C = K \varepsilon_0 \frac{A}{d}$



plaka boyutları 3cm x 2cm

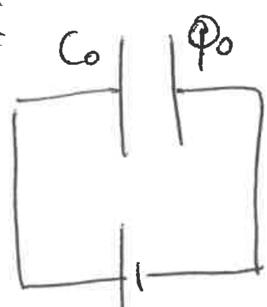
$d = 1mm$; $K = 3.7$

$C = ?$ $C = K \varepsilon_0 \frac{A}{d}$

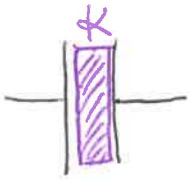
$$C = (3.7)\left(8.85 \times 10^{-12} \frac{C^2}{Nm^2}\right)\left(\frac{6 \times 10^{-4} m^2}{10^{-3} m}\right)$$

$$= 20 \times 10^{-12} F = 20 pF$$

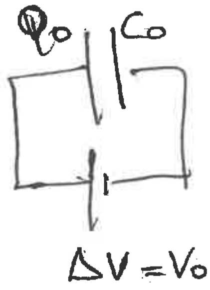
ör



pilden ayır. arasına K dielektrik koy



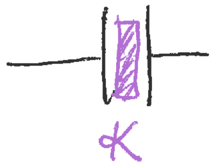
$U_0 = ?$; $U_s = ?$ depolanan enerji



$C_0 = \frac{Q_0}{V_0}$

$U = W = \frac{Q_0^2}{2C_0} = \frac{Q_0 V_0}{2}$

$= \frac{\cancel{Q_0^2}}{2C_0}$



$Q_s = ?$ $\quad Q_s = Q_0$!

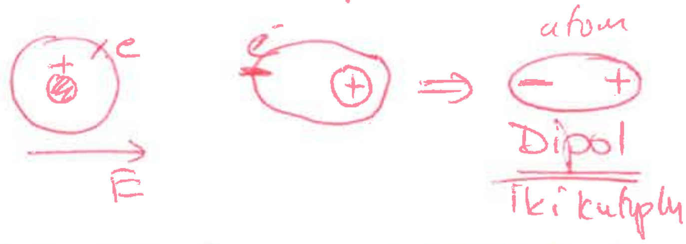
$C = K C_0$

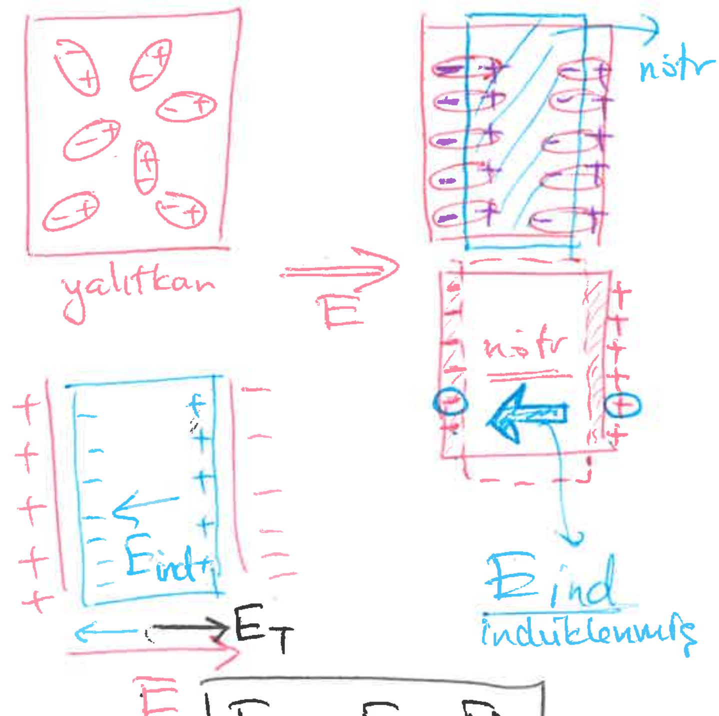
$U_s = \frac{Q_0^2}{2C} = \frac{Q_0^2}{2KC_0} = \frac{1}{K} \underbrace{\boxed{\frac{Q_0^2}{2C_0}}}_{}$ $\quad$ (U_0)

$$\boxed{U_s = \frac{U_0}{K}}$$

Yalıtkan - Dielektrik

↳ e^- lar serbest değil. atoma bağlı

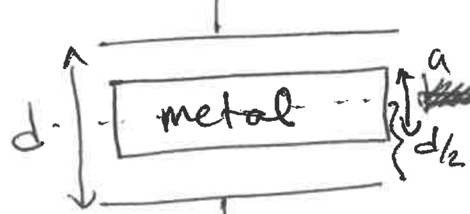




$$\boxed{E_T = E - E_{ind}}$$

ör

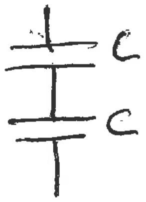
C_o; C_s



metal levha yerleştirdikten sonra

$C_s = ?$

metal levha ortaya yerleştiriliyor.



$$C_{eş} = \left(\frac{1}{c} + \frac{1}{c}\right)^{-1}$$

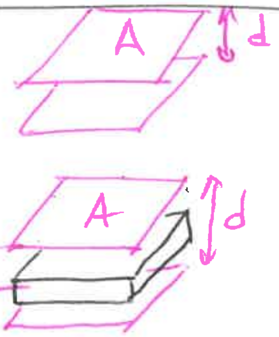
$$C_{eş} = \frac{c}{2}$$

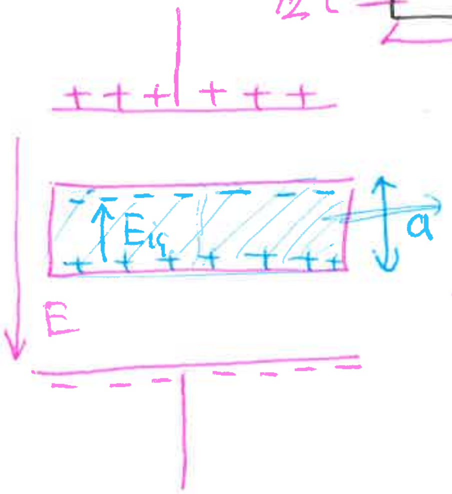
$$C = \varepsilon_0 \frac{A}{\left(\frac{d-a}{2}\right)}$$

$$C_o = \varepsilon_0 \frac{A}{d} \text{ (metal koymadan önce)}$$

$$C_s = \frac{C}{2} = \frac{\varepsilon_0 \cancel{2} A}{\cancel{2}(d-a)} = \varepsilon_0 \frac{A}{(d-a)}$$

$$C_o = \varepsilon_0 \frac{A}{d}$$

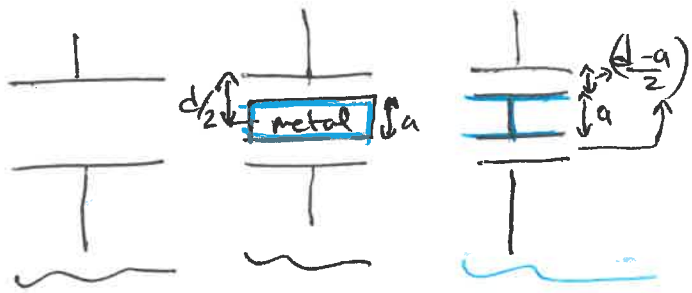




$E - E_{iç} = 0$

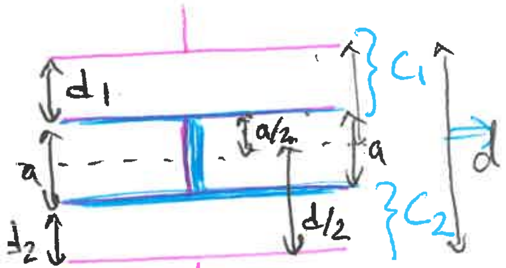
potansiyel fark $\Delta V = 0$

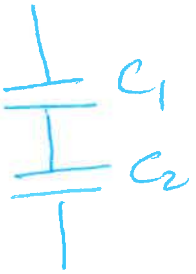
Bütün yüzeyde aynı.



ilk   son

$$\underset{\boxed{\varepsilon_0 \frac{A}{d}}}{C_o} < \underset{\boxed{\varepsilon_0 \frac{A}{(d-a)}}}{C_s}$$



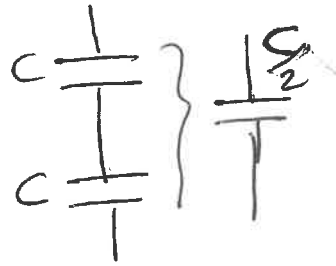


$$C_1 = \varepsilon_0 \frac{A}{d_1} \quad ; \quad \frac{a}{2} + d_1 = \frac{d}{2}$$

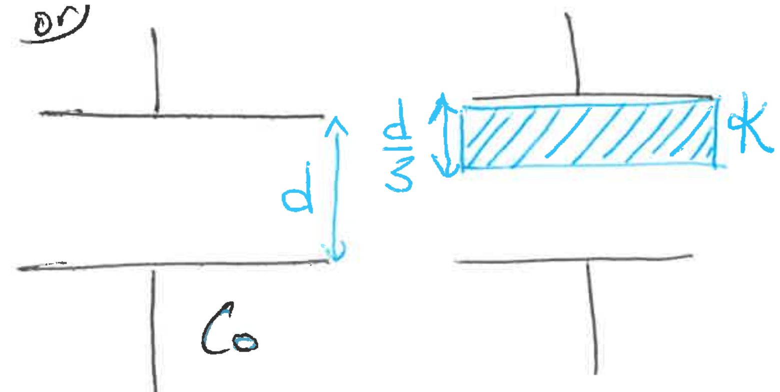
$$C_2 = \varepsilon_0 \frac{A}{d_2} \qquad d_2 = d_1 = \left(\frac{d-a}{2}\right)$$

$$C_1 = \varepsilon_0 \frac{A}{\frac{(d-a)}{2}} = C_2$$

$$C_1 = C_2 = C$$



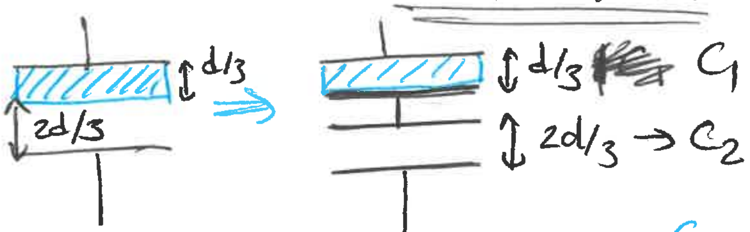
örn



$C_s = ?$

$$\boxed{C_0 = \varepsilon_0 \frac{A}{d}}$$

2 seri Kond.



$$C_1 = K \varepsilon_0 \frac{A}{(d/3)} = 3K \underbrace{\varepsilon_0 \frac{A}{d}}_{C_0}$$

$$2d/3 ; \quad C_2 = \varepsilon_0 \frac{A}{(2d/3)} = \frac{3}{2} \underbrace{\varepsilon_0 \frac{A}{d}}_{C_0}$$

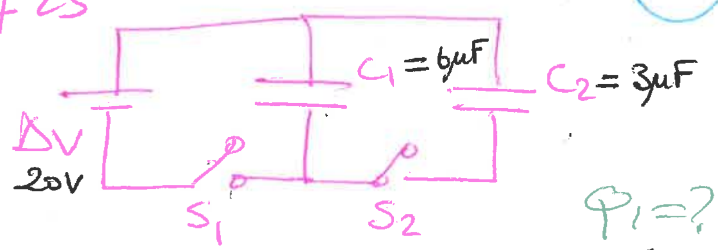
C_1, C_2

$$C_{eş} = \left(\frac{1}{C_1} + \frac{1}{C_2}\right)^{-1} = \frac{(C_1)(C_2)}{(C_1 + C_2)}$$

$$\left.\begin{array}{l} C_1 = 3K C_0 \\ C_2 = \frac{3}{2} C_0 \end{array}\right\} \quad C_{eş} = \frac{(3K C_0)(\frac{3}{2} \cancel{C_0})}{(3K + \frac{3}{2}) \cancel{C_0}}$$

$$\boxed{C_{eş} = \frac{9K}{(6K+3)} C_0}$$

#23



$Q_1 = ?$

önce S_1 anahtarı kapatılıp C_1 yükleni

→ S_1 açılıyor

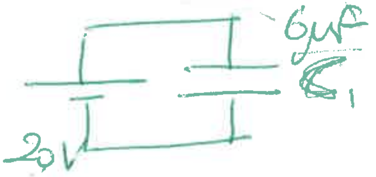
→ S_2 kapatılıyor. $C_1 - C_2$'ye bağlan

a) C_1'in başlangıçtaki yükü?

b) C_1; $Q_{1s} = ?$

$C_2 \rightarrow Q_{2s} = ?$

a) S_1 kapanınca

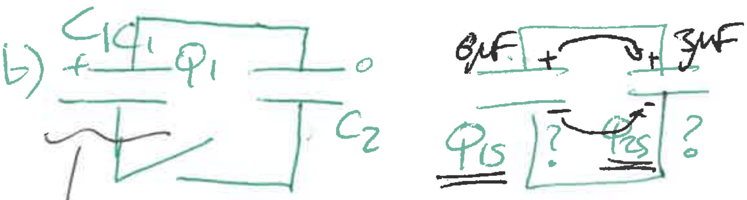


$$C_1 = \frac{Q_1}{\Delta V} \quad \hookrightarrow \quad Q_1 = C_1 \Delta V$$

$$= 120 \mu F V$$

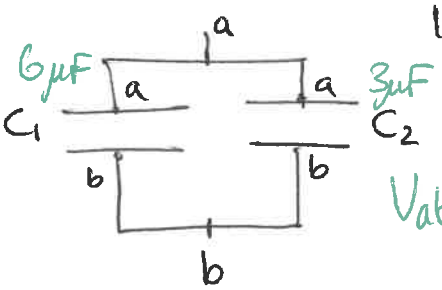
İlk yük { $Q_1 = 120 \mu C$

b)



$$Q_1 = 120\mu C = Q_{Toplam} = Q_{1s} + Q_{2s}$$

$$120\mu C = Q_{1s} + Q_{2s}$$



$$\boxed{V_{ab} = \frac{Q_{1s}}{C_1} = \frac{Q_{2s}}{C_2}}$$

$$C_1 = \frac{Q_{1s}}{V_{ab}} \quad ; \quad C_2 = \frac{Q_{2s}}{V_{ab}}$$

$$Q_T = \boxed{120\mu C = Q_{1s} + Q_{2s}} \qquad \frac{Q_{1s}}{6} = \frac{Q_{2s}}{3}$$

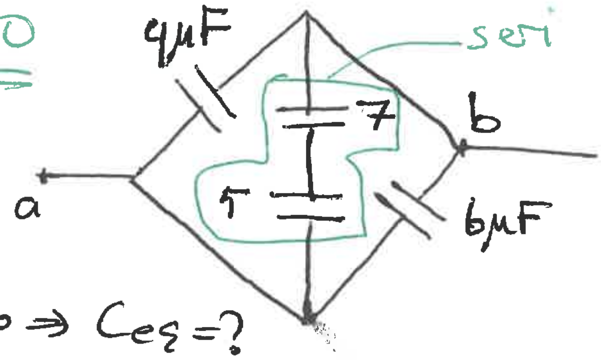
$$120\mu C = 2Q_{2s} + Q_{2s}$$

$$\boxed{Q_{1s} = 2Q_{2s}}$$

$$\boxed{Q_{2s} = 40\mu C}$$

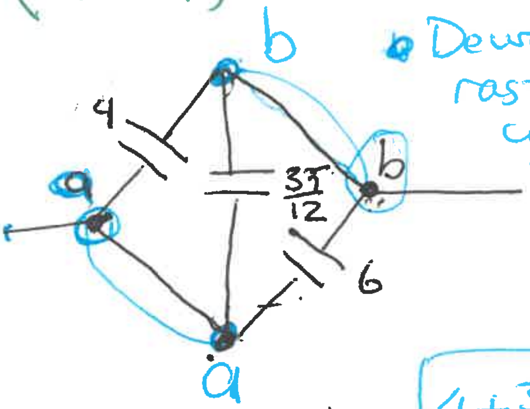
$$\boxed{Q_{1s} = 80\mu C}$$

#30

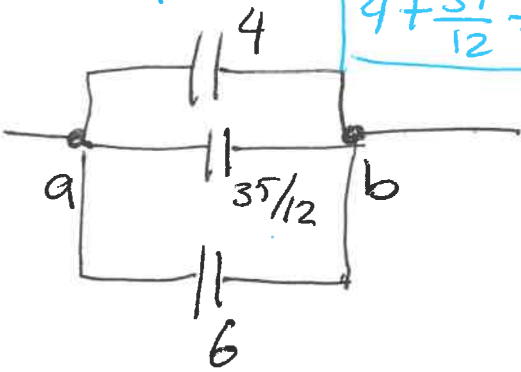


ab ⇒ $C_{eş} = ?$

$$\left(\frac{1}{7}+\frac{1}{5}\right)^{-1} = \frac{35}{12}\,\mu F$$

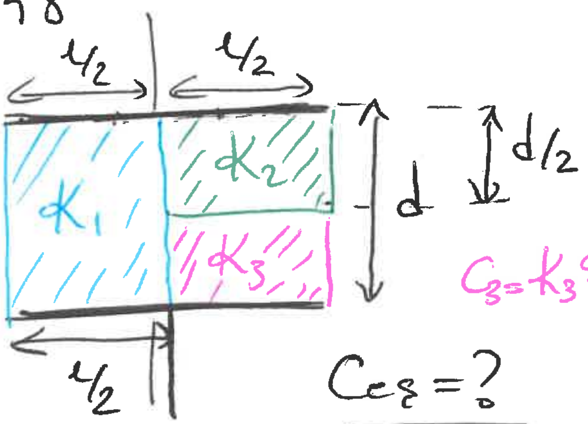


Devre elemanı rastlanadıkça çizgi pek AYNIDIR



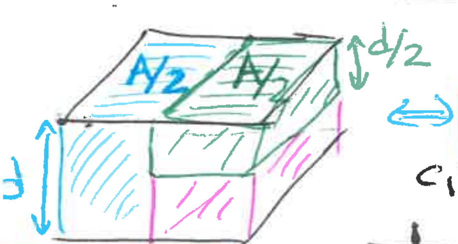
$$\boxed{4+\frac{35}{12}+6\ \mu F}$$

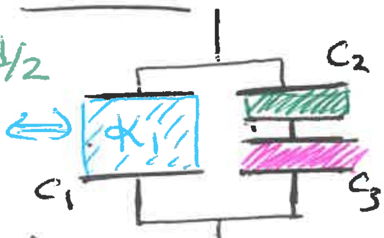
#58



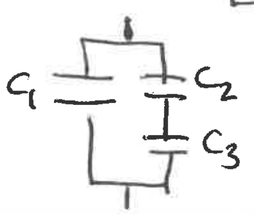
$$C_3 = K_3 \varepsilon_0 \frac{A/2}{d/2}$$

$C_{eş} = ?$





$$\boxed{C_1 = K_1 \varepsilon_0 \frac{A/2}{d}}$$



$$C_2 = K_2 \varepsilon_0 \frac{A/2}{d/2}$$

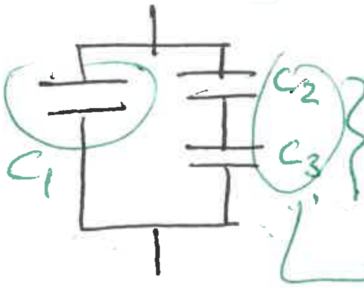
(6)

$$C_1 = K_1 \varepsilon_0 \frac{A/2}{d} \qquad C_3 = K_3 \varepsilon_0 \frac{A/\cancel{2}}{d/\cancel{2}}$$

$$C_2 = K_2 \varepsilon_0 \frac{A/\cancel{2}}{d/\cancel{2}}$$

$$C_1 = \frac{K_1}{2}\left(\varepsilon_0 \frac{A}{d}\right)_{C_0} ; \quad C_2 = K_2 \left(\varepsilon_0 \frac{A}{d}\right)_{C_0}$$

$$C_3 = K_3 \left(\varepsilon_0 \frac{A}{d}\right)_{C_0}$$



$$\boxed{C_{eş}' = \frac{C_2 C_3}{C_3 + C_2}}$$

$$C_{eş}' = \frac{K_2 K_3 C_0^{\cancel{2}}}{(K_2+K_3)\cancel{C_0}}$$

$$C_{eş} = C_1 + C_{eş}'$$

$$= \frac{K_1}{2} C_0 + \frac{K_2 K_3}{(K_2+K_3)} C_0$$

$$\boxed{C_{eş} = \left(\frac{K_1}{2} + \frac{K_2 K_3}{K_2+K_3}\right) C_0}$$

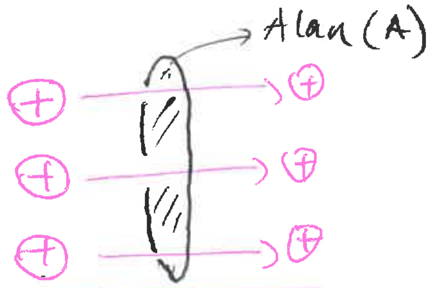
4.8.16

①

Akım ve Direnç

Şimdiye kadar yükler sbt durumda idi; elektrostatik Denge durumu vardı.

Dinamik; $\oplus \longrightarrow \oplus$ yerdeğiştirmesi

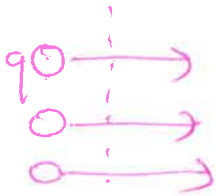


Akım $\equiv I = \dfrac{\Delta Q}{\Delta t}$; birim zamanda geçen yük miktarı.

$$\boxed{I = \frac{dq}{dt}} = \frac{\text{Coulomb}}{\text{saniye}} = \text{AMPER}$$

$\Rightarrow [A] = \left[\dfrac{C}{s}\right]$

$\Rightarrow$ Akımın yönü = $\oplus$ yüklerin gidiş yönü aynı



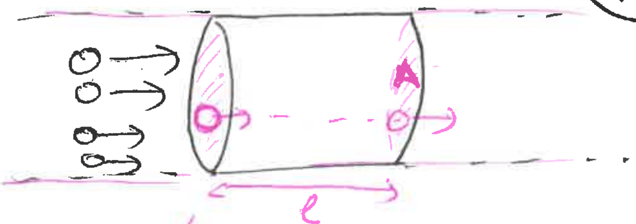
yükler taşınıyor

$I = \dfrac{\Delta Q}{\Delta t}$

$\Delta Q = \left(\text{taşıyıcı sayısı}\right) \times \left(\text{parçacık başına yük sayısı}\right)$

$Fe^{+2} \Rightarrow +2e$

1 taşıyıcı; $+2e$ yükünü taşır



$\text{taşıyıcı sayısı} = \left(\text{taşıyıcı yoğunluğu}\right)\left(\text{Hacim}\right)$

$\dfrac{(\text{sayı})\ \#}{\text{hacim}}\ n$ hacim $= \#$ (sayı)

Hacim $= A\,l = (A\, v_s\, \Delta t)$

Eğer; yüklerin ortalama sürati

v_s = sürükleme sürati

$l = (v_s\ \Delta t)$

$\left(\text{taşıyıcı sayısı}\right) q = \underbrace{(n\, A\, v_s\, \Delta t)\, q}_{\Delta Q} = \text{toplam yük sayısı}$

$$I = \frac{\Delta Q}{\Delta t} = \frac{n\, A\, v_s\, \cancel{\Delta t}\, q}{\cancel{\Delta t}} = \underline{n q v_s A}$$

AKIM

$n = \dfrac{\#}{\text{hacim}}$ = yoğunluk

$$\boxed{\text{ortalama akım} = I = n q v_s A}$$

ör) A B C D

Akımları sıralayınız.

$I_A = 4$ yük ; $I_B = 3$ yük

$I_C = 4$ yük ; $I_D = 2$ yük

$$I_A = I_C > I_B > I_D$$

Ör) Bakır telin kesit alanı

$A = 3.31 \times 10^{-6}\ m^2$

$I = 10 A$

$\rho = 8.95 \frac{g}{cm^3}$

Her bir Bakır atomu 1 tane e^- veriyor.

Elektronların sürüklenme hızı v_s?

$I = n q v_s A$

1 mol Bakır $= \frac{63.5 g}{mol} = M$

$n = ?$ taşıyıcı yoğunluk.

birim hacimde kaç tane Cu atomu?

↳ avogadro sayısı kullanılacak

$\rho = 8.95 \frac{g}{cm^3}$

1 mol için

$\rho = \frac{M}{V} = \frac{63.5}{V} = 8.95$

$V = \frac{63.5}{8.95} = 7.09\ cm^3$ 1 mol Cu hacmi

kaç tane e^- var? 7.09 cm^3 içinde

$N_A = 6 \times 10^{23}$ tane e^-; 7.09 cm^3 içinde.

$\boxed{n = \frac{\#}{V}} \left(\frac{\#}{m^3}\right) = \frac{6 \times 10^{23}}{7.09\ cm^3}$

$\frac{1 cm}{1 m} = 10^{-2}$; $\left(\frac{1m}{1cm}\right)^3 = (10^2)^3 \frac{m^3}{cm^3}$

$n = 8.5 \times 10^{22} \frac{\#}{cm^3}$

$1\ cm^3 \rightarrow 8.5 \times 10^{22}$

$m^3 \rightarrow 8.5 \times 10^{22} \times 10^6$

$n = 8.5 \times 10^{28}$ tane e^- var (2)

$I = n q v_s A$

$10 A = (8.5 \times 10^{28})(1.6 \times 10^{-19} C)\, v_s\, (3.3 \times 10^{-6} m^2)$

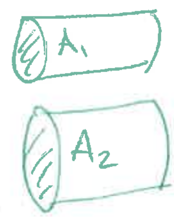
$v_s = 2.2 \times 10^{-4}\ m/s$

$= 0.2\ \frac{mm}{s}$

1 s; 0.2 mm yol gidiyor.

DİRENÇ ve OHM kanunu

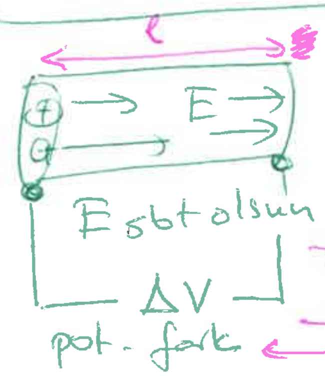
$I = n q v_s A$



Alana bağlı olmadan yeni bir terim tanımlarsak

Akım yoğunluğu $= \vec{J} = \frac{I}{A} = n q \vec{v_s}$

↳ $\boxed{\vec{J} = \sigma \vec{E}}$ elektrik alan, yük yoğunluğu



$\Delta V = -\int \vec{E} \cdot d\vec{s}$ sbt

$\boxed{\Delta V = E \ell}$

$\vec{J} = \boxed{\frac{I}{A}} = n q v_s = \sigma E = \boxed{\sigma \frac{\Delta V}{\ell}}$

DİRENÇ

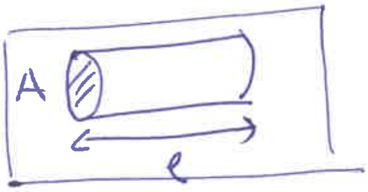
OHM kanunu

$I \frac{\ell}{A \sigma} = \Delta V$

$I\ R = \Delta V$

OHM kanunu $\Delta V = I R$

$R = \frac{1}{\sigma}\frac{\ell}{A}$;



~~İletkenlik sbt~~
İletkenlik sbt

R ; DİRENÇ

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

↳ özdirenç

$$\boxed{R = \rho\,\frac{\ell}{A}} \;**$$

$\Delta V = I R$

ρ

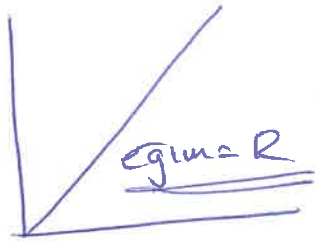
Altın → 2.44×10^{-8}
Gümüş → 1.59×10^{-8}
Bakır → 1.7×10^{-8}
Alüminyum → 2.82×10^{-8}

} çok iyi iletken

Nikrom → 1.5×10^{-6}
Cam → $10^{10} - 10^{14}$
Kuartz → 75×10^{16}

} çok iyi yalıtkan

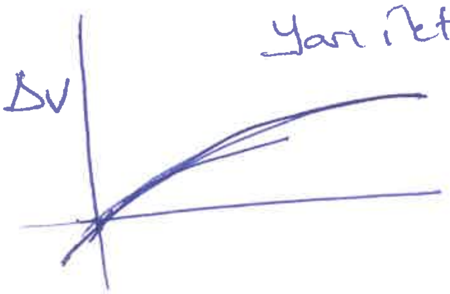
nikrom ⇒ nickel + krom
↳ ısıtmada kullanılır.



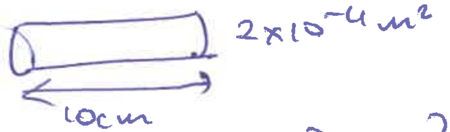
$\Delta V = I (R)$

İletkenler için

Yarı iletken – diyot



ör) Boyu 10 cm
$A = 2 \times 10^{-4}\,m^2$



Al direnç? Cam Direnç?

$(\rho_{Al} = 2.8 \times 10^{-8}\,\Omega \cdot m)$

$\rho_{cam} = 10^{10}\,\Omega \cdot m$

$R = \rho\,\frac{\ell}{A} = R_{Al} = (2.8 \times 10^{-8})\,\frac{0.1}{2 \times 10^{-4}}$

$\boxed{R_{Al} = 1.4 \times 10^{-5}\,\Omega}$

$R_{cam} = 10^{10}\left(\frac{0.1}{2 \times 10^{-4}}\right)$

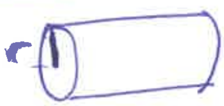
$\boxed{R_{cam} = 5 \times 10^{12}\,\Omega}$

$\Delta V = I R$

$R = \frac{\Delta V}{I} \Rightarrow \boxed{\underset{\text{ohm}}{\Omega} = \frac{V}{A}}$

ör) yarıçapı 0.321 mm olan Nikrom telinin birim uzunluk başına düşen direnç?

$\rho = 1.5 \times 10^{-6}\,\Omega m$



$R = \rho\,\frac{\ell}{A}$; $\frac{R}{\ell} = \frac{\rho}{A} \rightarrow \pi r^2$

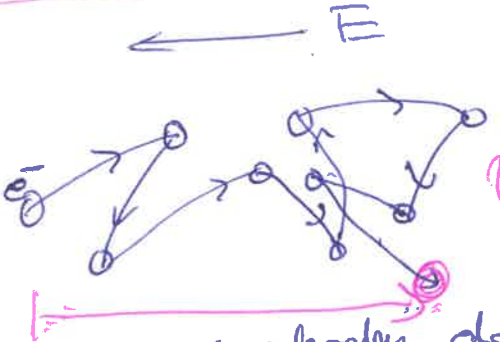
$\frac{R}{\ell} = \frac{1.5 \times 10^{-6}\,\Omega m}{\pi\,(0.321 \times 10^{-3} m)^2} = 4.6\,\frac{\Omega}{m}$

(3.14)

Sürüklenme Hızı

e^- lar düz ~~yolda~~ doğrultuda ilerlemiyorlar

metal atom → $1e^-$ serbest



$V_s = 10^{-4}$ m/s

çarpışmalardan dolayı düz ~~arzgi~~ doğrultuda yol almıyor.

E = 0 olsa

net hız SIFIR

çarpışma arası ortalama zaman

$\Delta t \cong 10^{-14}$ s

$\Delta x \cong$ çarpışma arası yol $\cancel{4}\,10^{-8}$ m $= 10$ nm $= \Delta x$

e^- aslında çok kalabalık bir ortamda ilerliyor; çarpışma sayısı saniyede $\sim 10^{14}$ kere.

$V_s \sim 10^{-4}$ m/s dolayı V_s düşük

Direnç ve Sıcaklık (4)

$$R = R_0\left(1 + \alpha(\underbrace{T - T_0}_{\Delta T})\right)$$

R_0 (T_0 sıcaklığındaki direnç)

R (T " ")

α = sbt

Ör) 20°C $R_0 = 50\,\Omega$

$T = ?$ $R = 76.8\,\Omega$

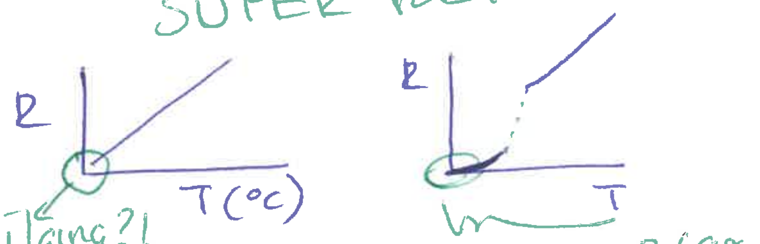
$$\boxed{\alpha = 3.92\times10^{-3}\ 1/C°}$$

$$76.8 = 50\left(1 + (3.92\times10^{-3})\Delta T\right)$$

$$\frac{26.8}{50(3.92\times10^{-3})} = \Delta T = (T - 20)$$

$T = 157°C$

SÜPER İLETKENLER



4K = −269°C

Civa için

Çok düşük sıcaklıkta

$R \to 0$; (kuantum-fiziği)

süper iletken tel

sonsuza kadar I akımı devam eder.

T ~ −270°C

yeni süperiletkenler malzemeler T ~ −120°C

Elektrik Enerjisi ve GÜÇ

$$\Delta U = \Delta Q \, \Delta V$$

ΔU: enerji (Joule); ΔQ: (C); ΔV: (V)

Birim zamandaki enerji ⇒ GÜÇ

$$P = \frac{\Delta U}{\Delta t} = \frac{\Delta Q}{\Delta t}\Delta V = I \Delta V$$

$\frac{\Delta Q}{\Delta t}$ → Akım

↳ power

$$P = I \Delta V$$

[W = Watt = A V]

$$\boxed{P = I\Delta V = I^2 R = \frac{(\Delta V)^2}{R}} \quad **$$

$$\Delta V = IR$$

Sr) Isıtıcıda; $R = 8\,\Omega$; $\Delta V = 120\,V$

$I = ?$ $\quad P = ?$

$\Delta V = IR$; $I = \frac{\Delta V}{R} = \frac{120}{8} \frac{V}{\Omega}$

$$I = 15\,A$$

$$P = \frac{(\Delta V)^2}{R} = \frac{120^2}{8} = I\Delta V = 15(120) = I^2 R = (15^2)8$$

$P = 1800\,W$

$P = 1.8\,kW$

Sr) 20A; 240V altında çalışan bir fırında 4 saat pişirme yaparsanız; ~~ne kadar P~~ maliyet? TL?

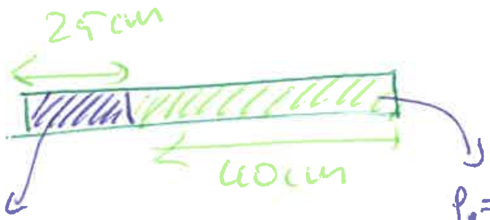
$P = I \Delta V = 4800\,W$

$P = W = \frac{Joule}{sn} = 4800 \frac{J}{s}$

4 saat; toplam enerji $= (4800W) 4sa = 19200\,Wsa = 19.2\,kWsa$

$1\,kWsa = 50\,krş = 0.5\,TL$

maliyet $= 19.2 \times 0.5 = 9.6\,TL$



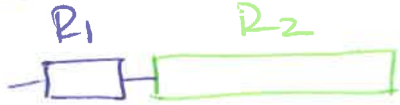
$\rho_2 = 6\times10^{-3}\,\Omega.m$

$\rho_1 = 4\times10^{-3}\,\Omega.m$

$A = 9\,mm^2$

Direnç?

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



$$R_1 = \rho_1 \frac{\ell_1}{A} \; ; \; R_2 = \rho_2 \frac{\ell_2}{A}$$

$$R_T = R_1 + R_2 = \frac{1}{A}\left(\rho_1 \ell_1 + \rho_2 \ell_2\right)$$

8.8.16

Doğru Akım Devreleri

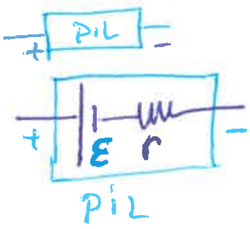
pil, batarya, akım, direnç
seri - paralel

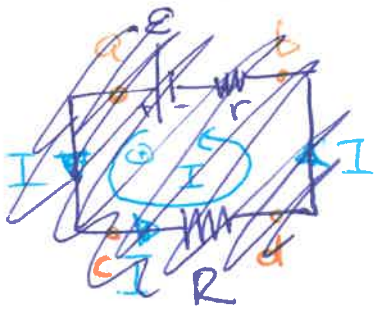
→ Kirchoff kuralları

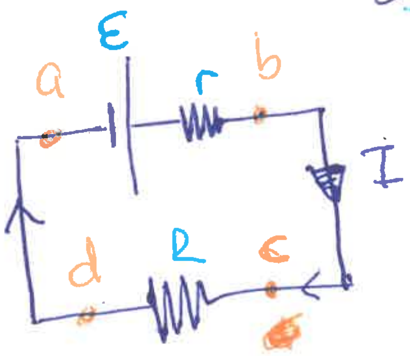
Elektromotor kuvveti = yük pompası

Batarya, akü, pil → EMK ⇒ volt

normal hayatta pillerin iç direnci var.







ab arası pot fark
⇓
$V_{ab} = \mathcal{E} - Ir$
pilin etkin pot. değeri

a=d ; c=b

$V_a = V_d$ $V_c = V_b$

$V_{cd} = IR$
ba

$V_{cd} = V_{ab}$

$IR = \mathcal{E} - Ir$

$\mathcal{E} = I(r+R)$

$I = \frac{\mathcal{E}}{(r+R)}$

r↑; I↓

İç enerji

$P = I\Delta V = I\mathcal{E} = \frac{\mathcal{E}^2}{(r+R)} = I^2(r+R)$

Ör): Bataryanın $\mathcal{E} = 12V$ ①
0.05 Ω iç direnç
3 Ω dirence bağlanırsa;

a) I=? Bataryanın çıkış voltajı?

$I = \frac{\mathcal{E}}{r+R} = \frac{12}{3.05}$

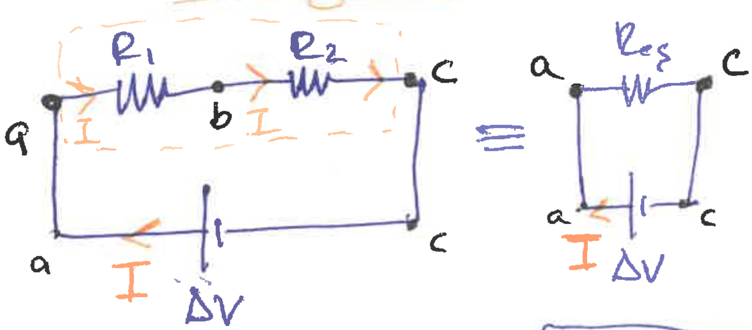
$I = 3.93A$

$\Delta V = IR = \mathcal{E} - Ir$

$(3.93)(3) = 12 - (3.93)(0.05)$

↳ 11.8V → çıkış voltajı.

SERİ ve PARALEL BAĞLI DİRENÇLER



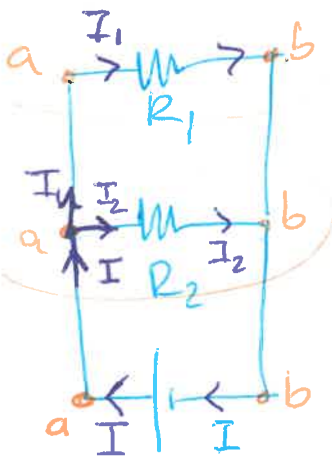
$V_{ab} + V_{bc} = V_{ac}$; $\boxed{\Delta V = IR}$

$IR_1 + IR_2 = I R_{eş}$

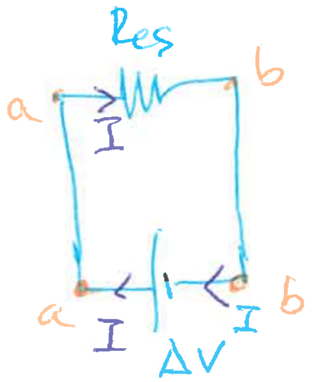
$\boxed{R_1 + R_2 = R_{eş} \quad \text{SERİ}}$

$R_1 + R_2 + \dots + R_N = R_{eş}$

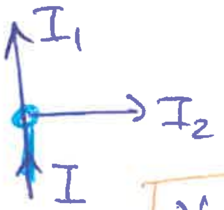
PARALEL BAĞLAMA



=



$$\boxed{\Delta V = IR}$$



$$I = I_1 + I_2$$

$$\boxed{V_{ab} = I_1 R_1 = I_2 R_2 = I R_{eş}}$$

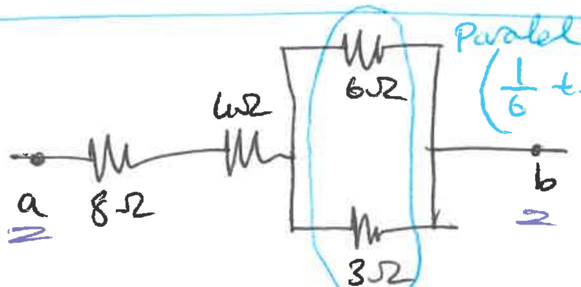
$$I = I_1 + I_2$$

$$\frac{\cancel{V_{ab}}}{R_{eş}} = \frac{\cancel{V_{ab}}}{R_1} + \frac{\cancel{V_{ab}}}{R_2}$$

$$\boxed{\frac{1}{R_{eş}} = \frac{1}{R_1} + \frac{1}{R_2}}$$ PARALEL DİRENÇ.

$$\frac{1}{R_{eş}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_N}$$

ör)

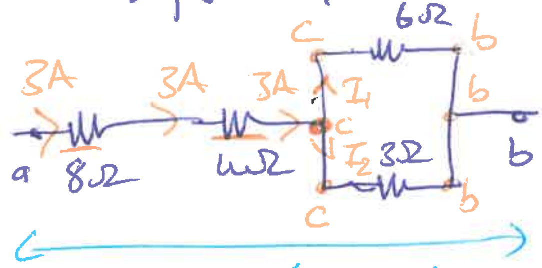


Paralel $\left(\frac{1}{6} + \frac{1}{3}\right)^{-1} \rightarrow 2\Omega$

ab arası eşdeğer direnç

seri $14\Omega = R_{eş}$

b) $V_{ab} = 42V$ ise tüm dirençlerdeki akım değerleri?



$V_{ab} = 42V$

$$V_{ab} = I R_{eş}$$

$$42V = I(14\Omega); \quad \underline{I = 3A}$$

$$V_{cb} = I_1 6 = I_2 3 \; ; \; I = I_1 + I_2$$

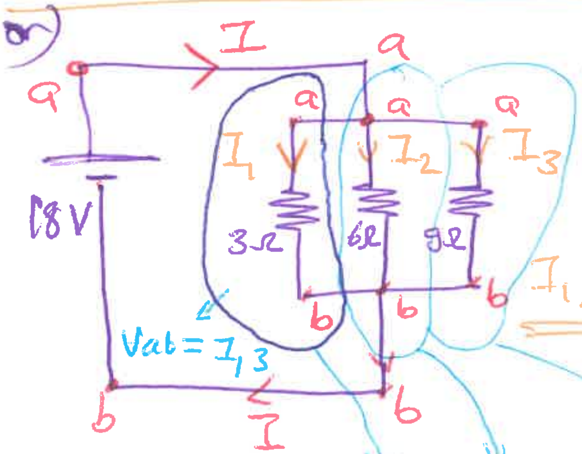
$$2I_1 = I_2$$

$$I = I_1 + 2I_1 = 3I_1 = 3A$$

$$\underline{I_1 = 1A}$$

$$\underline{I_2 = 2A}$$

ör)



$I_1, I_2, I_3 = ?$

$$V_{ab} = 18V = 3I_1 = 6I_2 = 9I_3$$

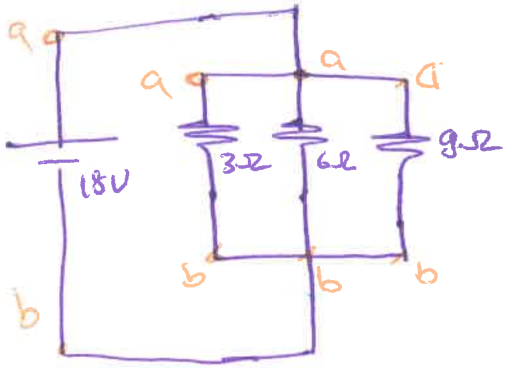
$$I_1 = \frac{18}{3} = 6A; \quad I_2 = 3A; \quad I_3 = 2A$$

$$I = I_1 + I_2 + I_3$$

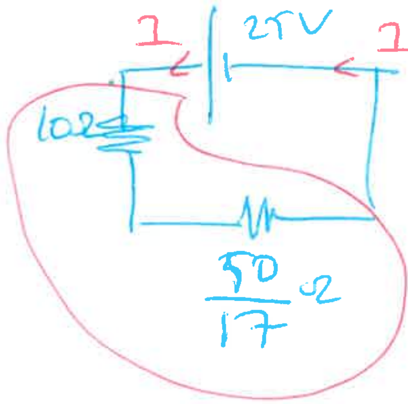
$$I = 6 + 3 + 2 = \underline{11A}$$

b) $P_1 = ?$ $P_2 = ?$ $P_3 = ?$ ÖDEV

3



$V_{ab} = 18V$



seri

$10 + \frac{50}{17} = \frac{220}{17}$ R_{eq}

$P = I\,\Delta V = \frac{(\Delta V)^2}{R} = I^2 R$

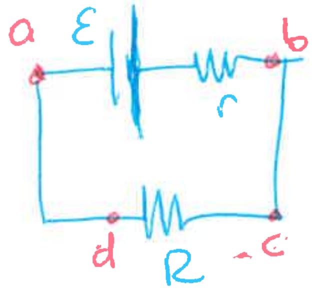
$P_1 = \frac{(\Delta V)^2}{3\Omega} = \frac{(18)^2}{3} = 110\,W$

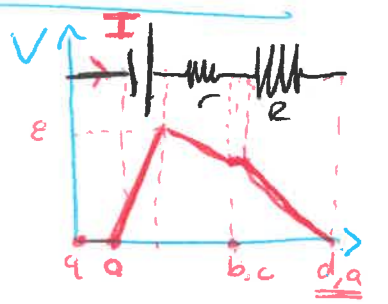
$P_2 = \frac{(18)^2}{6} = 54\,W$

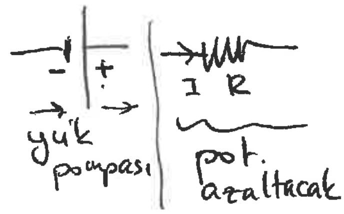
$P_3 = \frac{(18)^2}{9} = 36\,W$

$I = \frac{\Delta V}{R_{eq}} = \frac{25}{(220/17)} = 1{,}93\,A$

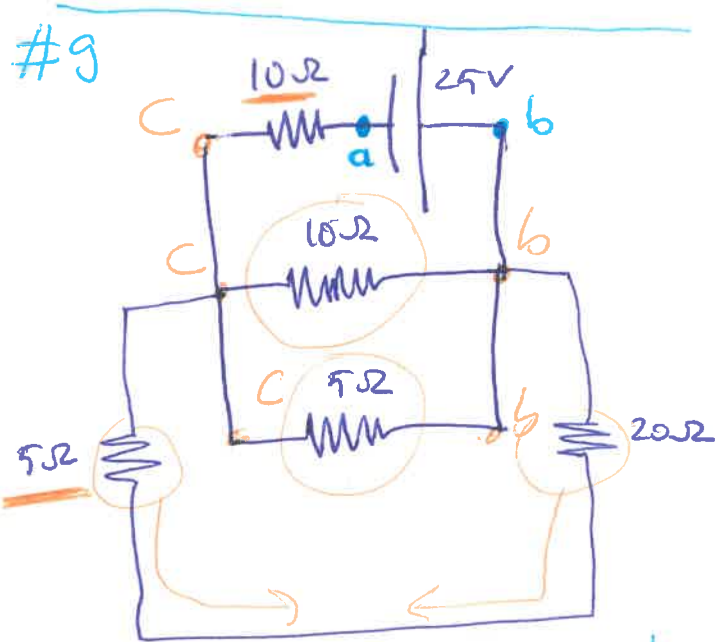
KİRCHOFF kuralları



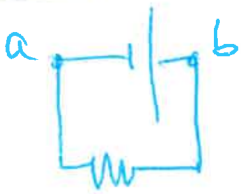




#9

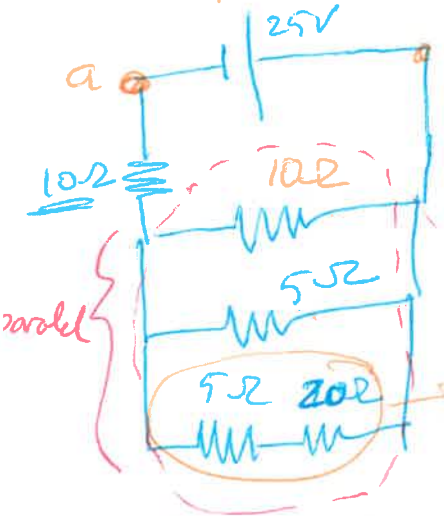


ab arası $R_{eq} = ?$



$R_{eq} = ?$

$V_{cb} \Rightarrow$ paralel



seri $20+5 = 25\Omega$

$\left(\frac{1}{10} + \frac{1}{5} + \frac{1}{25}\right)^{-1}$

$\hookrightarrow \frac{50}{17}\,\Omega$

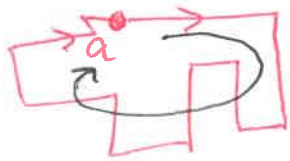
Kirchoff

1) $\Sigma I_{gel} = \Sigma I_{çıkan}$

gelen akım = çıkan akım

$I_4 + I_1 = I_2 + I_3$

2) Kapalı ilmek $\Rightarrow$ başlangıç noktasına geri dönmek

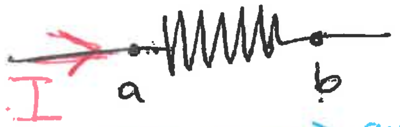


$\Sigma \Delta V = 0$

kapalı ilmek

$V_{aa} = 0$

DİRENÇ AKIM YÖNÜNDE POTANSİYELİ AZALTIR!



gidiş ve akım yönü AYNI

gidiş yönü

$\Delta V = V_{son} - V_{ilk}$

$\Delta V = \underset{son}{V_b} - \underset{ilk}{V_a} = V_{ab}$

$V_b < V_a$

$\Delta V < 0$!

$\boxed{\Delta V = -IR}$

gidiş yönü

gidiş yönü; Akım yönü ZIT

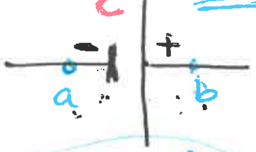
$\Delta V = V_s - V_i$

$\Delta V = V_b - V_a$; $V_b > V_a$

$\Delta V > 0$

$\boxed{\Delta V = +IR}$

PİL akım yönü ÖNEMSİZ



gidiş yönü

$\Delta V = V_s - V_i$

$= V_b - V_a$

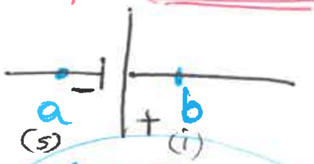
$V_b > V_a$

$\Delta V > 0$

$\boxed{\Delta V = +\varepsilon}$

− yönünden girerseniz

$\Delta V = +\varepsilon$



gidiş yönü

$\Delta U = V_s - V_i$

$\Delta U = V_a - V_b$

$V_a < V_b$

$\Delta V < 0$

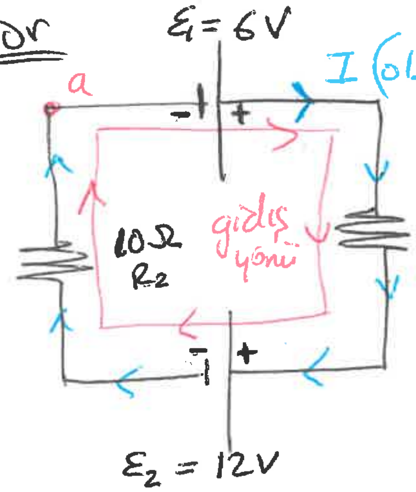
$\boxed{\Delta V = -\varepsilon}$

+ ~~taraf~~ yönünde girerseniz

$\Delta V = -\varepsilon$

(4)

Ör



$I = ?$

− I akımını belirtin

$\Sigma \Delta V = 0$

− gidiş yönü seç.

$\Sigma \Delta V = a \to a$

$=$

$\Delta V =$

$+\varepsilon_1 - IR_1$

$-\varepsilon_2 - IR_2$

$= 0$

$a \to a$

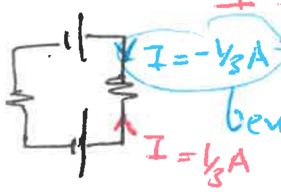
$V_{aa} = \Delta V = 0$

$\varepsilon_1 - IR_1 - \varepsilon_2 - IR_2 = 0$

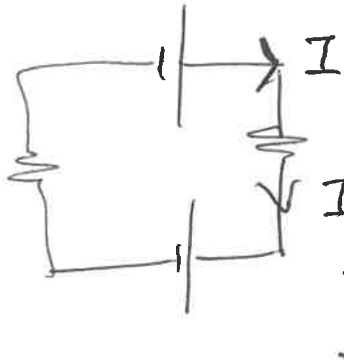
$6 - I(8) - 12 - I(10) = 0$

$-6 - I(18) = 0$

$I = \frac{-6}{18} = -\frac{1}{3}\,A$



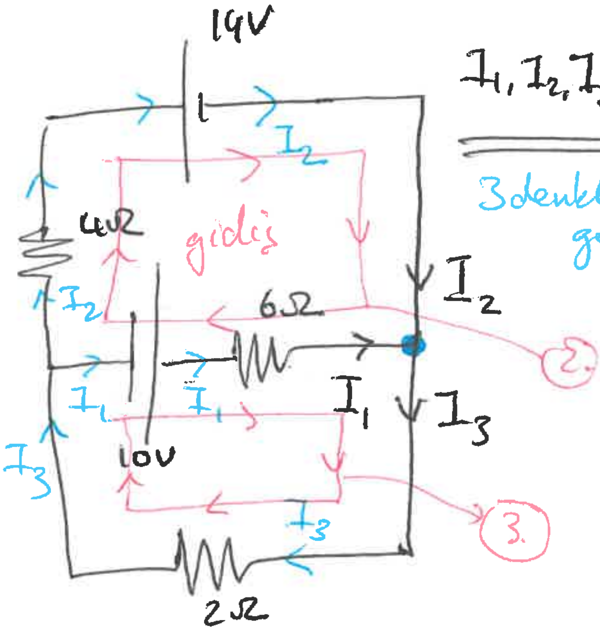
benim seçtiğim yönün tersi yönünde



I (verilmiş olsun)

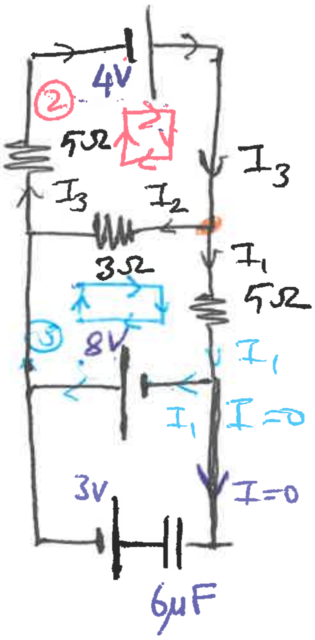
$I = -1/3\,A$ ✓

$\boxed{I \cancel{=} 1/3\,A}$



$I_1, I_2, I_3 = ?$

3 denklem gerekli



(4)

$I_3 = I_1 + I_2$

$I_1, I_2, I_3 = ?$

kararlı durumda

kondansatör üzerinden akım geçmez $I = 0$

1. $\Sigma I_{gel} = \Sigma I_{çık}$

$I_1 + I_2 = I_3$ (1)

2. $-14 + I_1 6 - 10 - I_2 4 = 0$ (2)

$10 - I_1 6 - I_3 2 = 0$ (3)

$6I_1 - 4I_2 = 24$ (2)

$6I_1 + 2I_3 = 10$ (3)

$I_1 + I_2 = I_3$ (1)

$6I_1 + 2I_1 + 2I_2 = 10$

$2/\ 8I_1 + 2I_2 = 10$

$+\ 6I_1 - 4I_2 = 24$

$22I_1 = 44$

$I_1 = 2A$

$12 - 4I_2 = 24$

$-4I_2 = 12$

$\boxed{I_2 = -3A}$

$I_1 + I_2 = I_3$

$2 + (-3) = -1 = \boxed{I_3 = -1A}$

(2) $+4 - I_2 3 - I_3 5 = 0$

(3) $+I_2 3 - I_1 5 + 8 = 0$

$3I_2 + 5I_3 = 4$

$5I_1 - 3I_2 = +8$

$I_3 = I_1 + I_2$

$3I_2 + 5I_1 + 5I_2 = 4$

$5I_1 + 8I_2 = 4$

$-/\ 5I_1 - 3I_2 = 8$

$11 I_2 = -4$

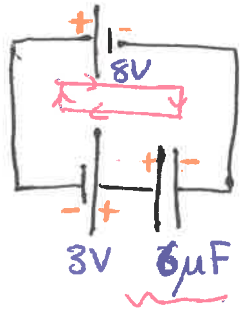
$\boxed{I_2 = -4/11\ A} = 0.36$ A

$5I_1 - 3\left(\frac{-4}{11}\right) = 8$

$I_1 = \frac{\left(8 - \frac{12}{11}\right)}{5} = 1.38A$

$\boxed{I_3 = I_1 + I_2 = 1.02A}$

b) Kondansatör üzerindeki yük?



$-8V + \Delta V_K - 3V = 0$

$= \Delta V_K = 11V$

$C = \frac{Q}{\Delta V_K}$?

$\boxed{Q = 66\mu C}$

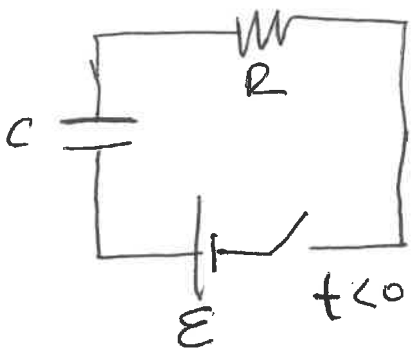
$Q = C \Delta V$

$(6)(11)\mu C$

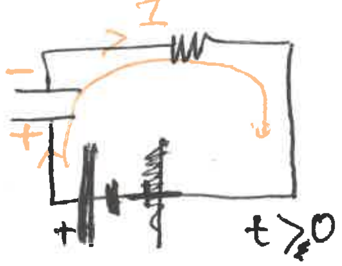
ΔV_K = kond. potansiyeli

9.8.16

RC devreleri



anahtar kopandıktan hemen sonraki durumu

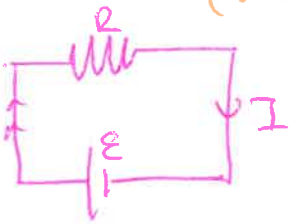


I akımı > 0
$t > 0$
t çok küçük ms, μs zamanında
$I > 0$

Bir süre bekledikten sonra

$I = 0$; C doluyor yük taşıma son buluyor.

İlk anlarda ($t \simeq 0s$)

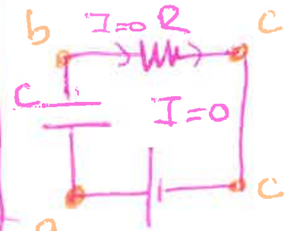


C yokmuş gibi

$I_0 = \frac{\varepsilon}{R}$ (maksimum akım)

$t >> 0$

bir süre sonra



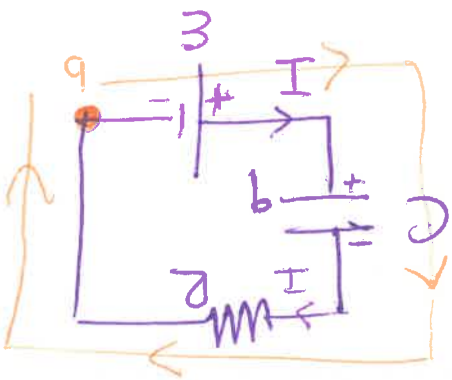
$V_{ac} = V_{ab} + V_{bc}$

$\varepsilon = \frac{q_{max}}{C} + IR$

$I = 0$

$q_{max} = C\varepsilon$

1



$\frac{q}{C} = V_c$

$\boxed{\frac{dq}{dt} = I}$

$V_{bb} = \Sigma \Delta V = 0$

$\varepsilon - \underbrace{V_c}_{\text{kondansatör pot. fark}} - \underbrace{IR}_{\text{direnç pot. fark}} = 0$

$\varepsilon - \frac{q}{C} - \frac{dq}{dt} R = 0$

$\frac{dq}{dt} = \frac{\varepsilon}{R} - \frac{q}{RC} = \frac{-q + \varepsilon C}{RC} = -\frac{(q - \varepsilon C)}{RC}$

$\int_0^{q} \frac{dq}{q - \varepsilon C} = \int_0^{t} -\frac{1}{RC} dt$

$\left[\ln(q - \varepsilon C)\right]_0^q = -\frac{t}{RC}$

$\ln(q - \varepsilon C) - \ln(-\varepsilon C) = \frac{-t}{RC}$

$\ln\left(\frac{q - \varepsilon C}{-\varepsilon C}\right) = -\frac{t}{RC}$

$$\boxed{q(t) = C\varepsilon\left(1 - e^{-t/RC}\right)}$$

herhangi t zamanında ; sığanın yükü $\rightarrow q(t)$

$t = 0 \quad q(t=0) = C\varepsilon(1 - e^{0})$

$q(t=0) = 0$

②

$$Q(t) = C\varepsilon\left(1 - e^{-t/RC}\right) \quad a$$

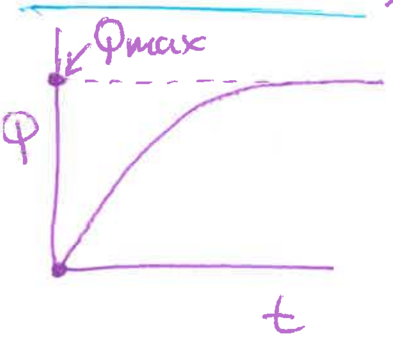
$$I = \frac{dQ}{dt} \; ; \quad \frac{d(e^{ax})}{dx} = a e^{ax}$$

$$I = \frac{dQ}{dt} = -\cancel{C}\varepsilon\left(-\frac{1}{R\cancel{C}}\right) e^{-t/RC}$$

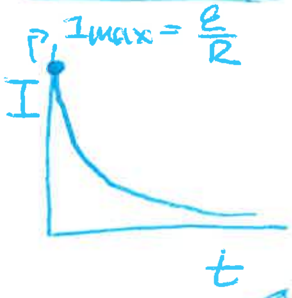
$$\boxed{I(t) = \frac{\varepsilon}{R} e^{-t/RC}}$$

herhangi t zamanında devredeki I (akım) miktarı

$$Q = C\varepsilon\left(1 - e^{-t/RC}\right)$$



$$I = \frac{\varepsilon}{R} e^{-t/RC}$$



$I(t=0) = \frac{\varepsilon}{R} e^{0}$ 1

RC devresinde Kondansatör (sığa) dolarken Q, I = değerleri

mesaj: sığa eksponansiyel bir şekilde (hızlı) dolar; I akımı hızlı 0'a ulaşır.

$$Q = C\varepsilon\left(1 - e^{-t/RC}\right)$$

$t = RC$ özel durum

$$= C\varepsilon\left(1 - e^{-1}\right)$$

$$= C\varepsilon\left(1 - \frac{1}{2.71}\right)$$

$$Q = C\varepsilon\,[0.63]$$

yüzde 63

$t = RC$; Q %63 yüklendi

$$I = \frac{\varepsilon}{R} e^{-t/RC}$$

$t = RC$ özel durum

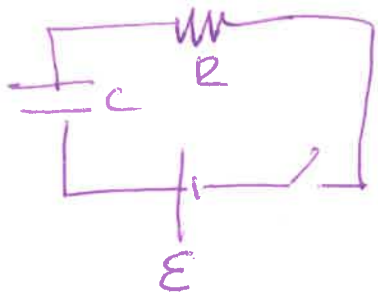
$$I = \frac{\varepsilon}{R} e^{-1} = \frac{\varepsilon}{R}\left(\frac{1}{2.71}\right)$$

0.37

$$I = \frac{\varepsilon}{R}[0.37]$$

$t = RC$; I akımı yüzde 37'ye düşer.

ör)

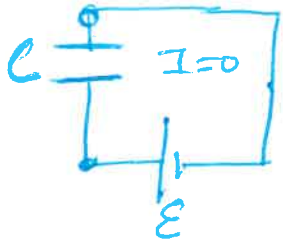


$\varepsilon = 12\,V$

$C = 5\,\mu F$

$R = 8 \times 10^5\,\Omega$

$Q_{max} = ?$



$$C = \frac{Q}{\Delta V} = \frac{Q_{max}}{\varepsilon}$$

$$Q_{max} = C\varepsilon$$

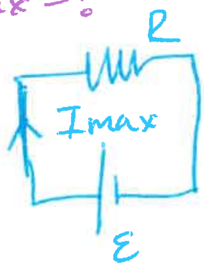
$$Q_{max} = (12V)(5\mu F)$$

$$= 60\,\mu(VF)$$

Coulomb

$$\boxed{Q_m = 60\mu C}$$

$I_{max} = ?$



$Q = 0$

$$\varepsilon = I_m R$$

$$I_m = \frac{\varepsilon}{R}$$

$$= \frac{12V}{8\times10^5\,\Omega}$$

$$I_m = 1.5\times10^{-5}\left(\frac{V}{\Omega}\right)$$

Amper

$$\boxed{I_m = 1.5\times10^{-5}\,A}$$

$$\boxed{I_m = 15\mu A}$$

$t = RC$ (zaman sbt) durumunda

$Q = ?$ $\quad I = ?$

$$Q(t=RC) = C\varepsilon\left(1 - e^{-\frac{t}{RC}}\right)$$

$$Q = C\varepsilon\underbrace{\left(1 - e^{-1}\right)}_{0.63}$$

$$= (0.63)\, C\varepsilon$$

$$= (0.63)(5\mu F)(12V)$$

$$= (0.63)(60\mu C)$$

$$\boxed{Q = 37.8\mu C}$$

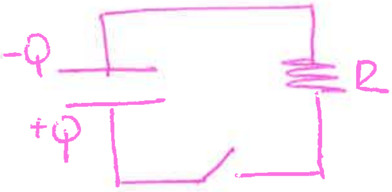
$$I(t=RC) = \frac{\varepsilon}{R}\left(e^{-\frac{t}{RC}}\right)$$

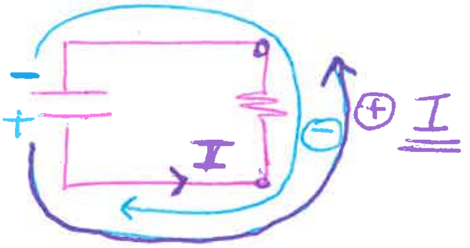
$$I = \frac{\varepsilon}{R} e^{-1} = 0.37\left(\frac{\varepsilon}{R}\right)$$

$$I = (0.37)\,15\mu A$$

$$\boxed{I = 5.55\mu A}$$

Dolu Kondansatörün Boşalması





$\downarrow V_c = \dfrac{Q\downarrow}{C}$

$V_c - IR = 0$

$q\downarrow ; V_c\downarrow$

$-\dfrac{Q}{C} - IR = 0$

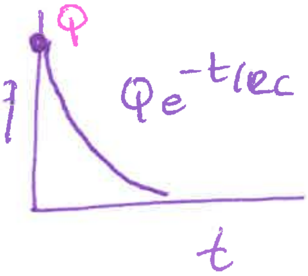
$$\boxed{-\frac{q}{C} - \frac{dq}{dt}R = 0}$$

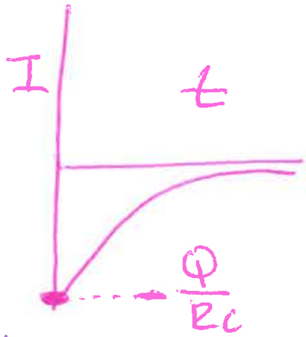
$$\boxed{q(t) = Q e^{-t/RC}}$$ yük

$I = dq/dt$

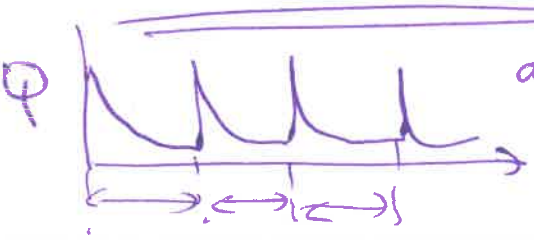
$$\boxed{I(t) = -\frac{Q}{RC} e^{-t/RC}}$$

⇐ sığa boşalırken AKIM





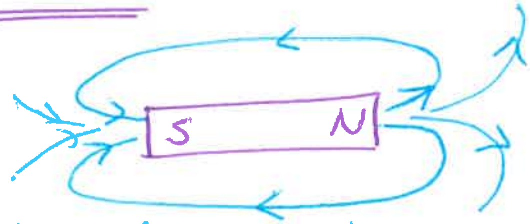
* RC devrelerinde
C dolup-boşalması
çok hızlı (exponansiyel)
olur!



alternatif akım RC

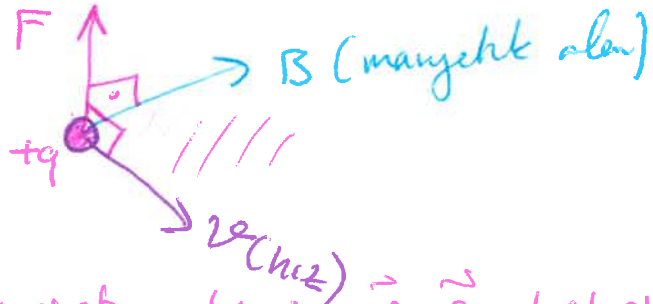
Manyetik Alanlar (3)

Mıknatıs



manyetik alan çizgileri

yüklü cisim/parçacık manyetik alan ile etkileşiyor.



$\vec{F}$ kuvvet vektörü $\vec{v}$, $\vec{B}$ oluşturduğu Düzleme Dik

$$\vec{F}_B = q\,\vec{v} \times \vec{B}$$

vektörel çarpım.

$\vec{F}_B$ → manyetik kuvvet; q → yük; $\vec{v}$ → hız; $\vec{B}$ → man. alan

$\vec{A} \times \vec{B} = \vec{C}$ (vektörel çarpım) → vektör

$|\vec{C}| = AB\sin\theta$ → büyüklük

yönü ⇒ sağ el kuralı.

$\vec{A} \times \vec{B} = \vec{C}$ (sağ el)

$\vec{A}$ → baş; $\vec{B}$ → ~~orta~~ işaret; $\vec{C}$ → orta

Büyüklüğü

$$F_B = |q|\, v B \sin\theta$$

4313

(4)

Manyetik Alan

$F_B = q v \underline{B}$

$B = \dfrac{F}{qv} = \left[\dfrac{N}{C \cdot m/s}\right] = \underline{\text{Tesla}}$

$\boxed{1\,T = 1\,\dfrac{Ns}{Cm}} = \dfrac{N}{\frac{C}{s}m} = \dfrac{N}{Am}$

A

$\boxed{1\,T = 10^4\ \text{Gauss}}$ (eski)

↳ manyetik alan birimi

Sinir atımlarından kaynaklanan Beynin Manyetik Alanı $\rightarrow 10^{-13}\,T$

Dünya yüzeyi $\rightarrow 0.5 \times 10^{-4}\,T$

Çubuk mıknatıs $\rightarrow 10^{-2}\,T$

MR görüntüleme $\rightarrow 1.5\,T$

süperiletkenli mıknatıs $\rightarrow 30\,T$

---

or) e^- TV ramda tüplü X ekseni boyunca $8 \times 10^6\,m/s$ süratle tüpün önüne doğru hareket ediyor

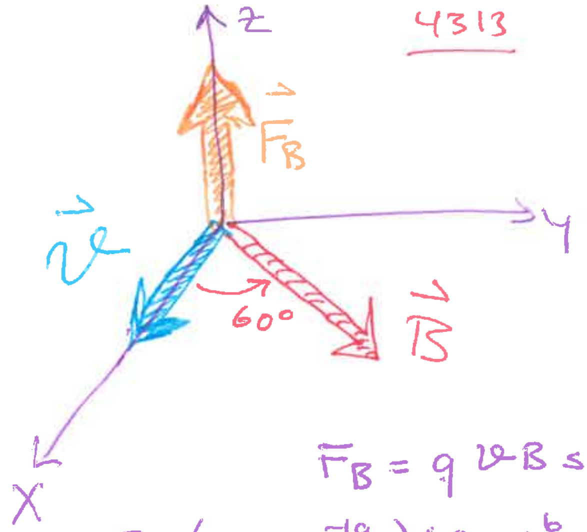
$B = 0.025\,T$; xy düzleminde ve X ekseni ile $60°$ açı.

$F_B = ?$; e^- nun yönü?

$q_e = 1.6 \times 10^{-19}\,C$

$v = 8 \times 10^6\,m/s\ \hat{i}$

$\hat{B} = (\cdots)\hat{i} + (\cdots)\hat{j}$



$F_B = q v B \sin\theta$

$F_B = (1.6 \times 10^{-19}\,C)(8 \times 10^6\,m/s)(0.025\,T)\left(\frac{\sqrt{3}}{2}\right)$

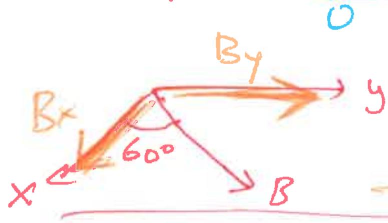
$F_B = 2.8 \times 10^{-14}\,N$

$\underline{F_B}$ yönü? (sağ el $\hat{z}$; $\hat{k}$) ✓

$\vec{F}_B = q\, \vec{v} \times \vec{B}$

$= q\, v(\hat{i}) \times \left[B_x \hat{i} + B_y \hat{j}\right]$

$\vec{F}_B = q v B_x \underbrace{\hat{i} \times \hat{i}}_{0} + q v B_y \underbrace{\hat{i} \times \hat{j}}_{\hat{k}}$



$B_y = B \sin 60$

$\boxed{\vec{F}_B = q v B \sin 60\ \hat{k}}$

Fizik 2

$$* \vec{F}_E = k \frac{q_1 q_2}{r^2} \hat{r}$$

El. Alan $\vec{F} = q\vec{E}$

$$* \vec{E} = \frac{kq}{r^2}\hat{r}$$

Gauss → belli başlı simetrik

③ $q_{iç}$ ① $\vec{E}$ alanını bulmak

② Elektrik Akısı Φ_E

$$* \boxed{\Phi_E = \oint \vec{E} \cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0}}$$

② ① ③

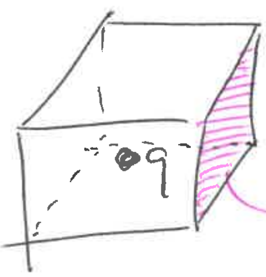
Simetrik şart!!

Simetri aranmıyor

gauss yüzeyi

$$\Phi = ? = \frac{q_{iç}}{\varepsilon_0}$$

$$\Phi = \frac{q_{iç}}{\varepsilon_0}$$



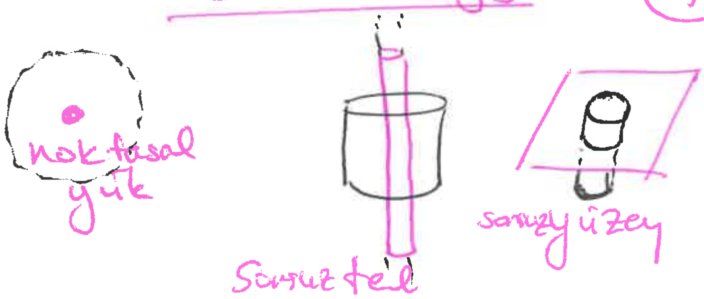
q ortada; simetrik

tek bir yüzeyden geçen akı

$\Phi = ?$

$\Phi = \frac{q}{\varepsilon_0} \Rightarrow$ 6 yüzeydeki akı toplamı ; $\boxed{\frac{q}{6\varepsilon_0}}$

Gauss Uyg. ⑤



Tekrar Edin! Gauss KESİNLİKLE çıkacak

potansiyel V (skaler)

$$\boxed{V_P = k\frac{q}{r}}$$

$V_P = ?$

$\vec{E}_P = ?$

↳ iki vektörün toplamı

$r = \sqrt{y^2+d^2}$

$V_+ + V_- = V_P$ $\quad \underline{E_P \neq 0}$

$$\frac{kq}{r} + \frac{k(-q)}{r} = 0 = \underline{V_P}$$

$E_P = ?$

$V_P = ?$

Çok zor integral çıkmayacak.

$$\boxed{dE = \int k \frac{dq}{r^2} \; ; \; dV = \int k \frac{dq}{r}}$$

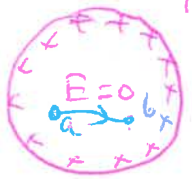
yük yoğunluğu $\lambda = \frac{Q}{L}$ $\quad \rho = \frac{Q}{V}$

$$\sigma = \frac{Q}{A}$$

İletken ve yalıtkan

içindeki $E = 0$ — çünkü yükler kabukta

içi dolu küre iletken



$$\Phi = \oint \vec{E}\cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0}$$

$\vec{E} = 0$

$V \Leftrightarrow E$

$$V_{ab} = \Delta V = -\int_a^b \vec{E}\cdot d\vec{s}$$

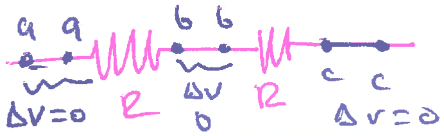
metal içinde $E = 0$; $\Delta V = \int 0 \cdot d\vec{s}$, $\Delta V = 0$

$\Delta V = V_s - V_i$

$0 = V_b - V_a \Rightarrow \boxed{V_a = V_b}$

$\Delta V = \int E\cdot ds$ $\cos 90$

yüzeyinde de $\Delta V = 0$, $V_b = V_a$

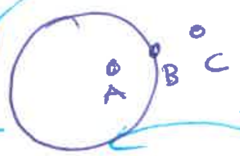


Tavsiye: iletken küre, yalıtkan küre için

Gauss $E = ?$ $V = ?$

TEKRAR EDİN!

$$E = -\frac{dV}{dx}$$



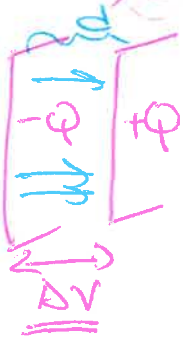
türev

E_A E_B E_C — V_A V_B V_C

$\Delta V = -\int \vec{E}\cdot d\vec{s}$ — integral

KONDANSATÖR (SIĞA) C

$$C = \frac{Q}{\Delta V}$$



$\Delta V = Ed$

metal levha

$$E = \frac{\sigma}{\varepsilon_0} \quad \text{(Gauss)}$$

$$C = \frac{(\sigma A)}{\left(\frac{\sigma}{\varepsilon_0}\right) d} = \varepsilon_0 \frac{A}{d} = \frac{Q}{\Delta V}$$

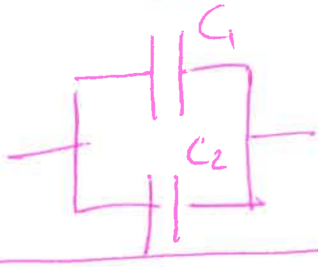
paralel plaka

birim?

$$F = \varepsilon_0 \frac{m^2}{m} \Rightarrow \boxed{\varepsilon_0 = \left[\frac{F}{m}\right]}$$

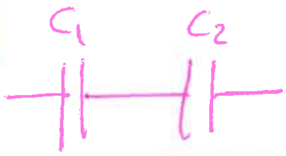
$$\boxed{k = \frac{1}{4\pi\varepsilon_0}}$$

Paralel – Seri



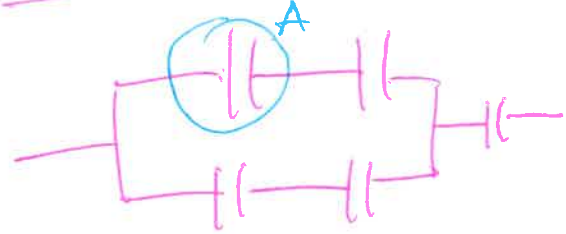
$$\boxed{C_{eş} = C_1 + C_2} \ *$$

Paralel



$$\left(\frac{1}{C_1} + \frac{1}{C_2}\right)^{-1} = C_{eş} \ *$$

seri $\quad C_{eş} = \frac{C_1 C_2}{C_1 + C_2}$

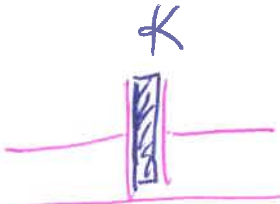


$C_{eş} = ?$; C_A; $Q_A = ?$ $V_A = ?$

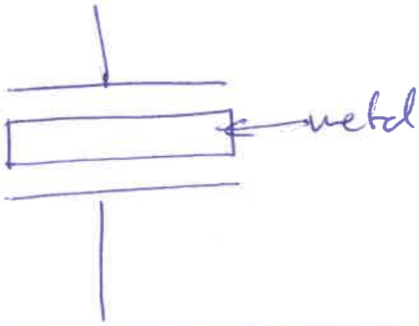
Enerji $\quad q\,\Delta V \neq$ enerji

$$\frac{q\Delta V}{2} = E_{enerji} \quad \left(\frac{q}{C}\right) \quad \frac{q^2}{2C} = \frac{1}{2}C(\Delta V)^2$$

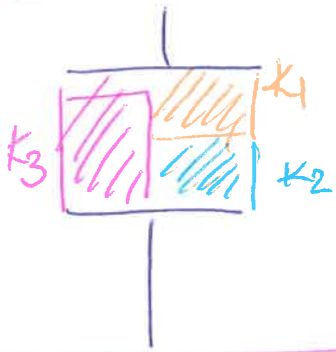
7



$\boxed{C = K C_0}$; $\underline{K > 1}$



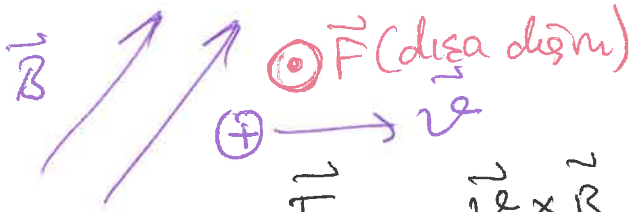
$C_{eq} = ?$



$C_{eq} = ?$

15-8-16

Mıknatıs ⇒ çift kutuplu



$$\vec F_B = q\,\vec v \times \vec B$$

sağ el kuralı ⇒ yönü verir.

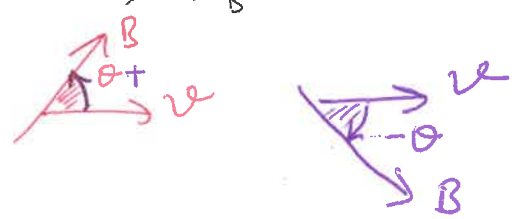
$\vec v$ → başparmak
$\vec B$ → işaret
$\vec F$ → orta parmak

Birim   Tesla = T

$$B = \frac{F}{q v} \Rightarrow \left[T = \frac{N}{C\,m/s} \right]$$

$$T = \frac{N}{\underbrace{\frac{C}{s}}_{Amper} m} = \boxed{\frac{N}{A.m} = Tesla}$$

$$\vec F_B = q\,\vec v \times \vec B \;; \quad |\vec F_B| = q v B \sin\theta$$

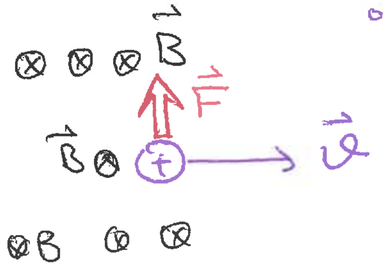


Hızı olan yükle cisme kuvvet etki ederse;

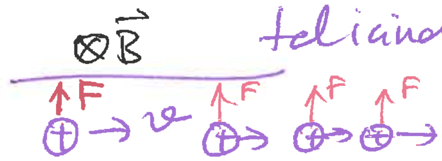
Yükleri bir tel içinde geçirirsek

Tele net bir kuvvet etki eder.

$\vec F = q\,\vec v \times \vec B$ (orta, baş, işaret)



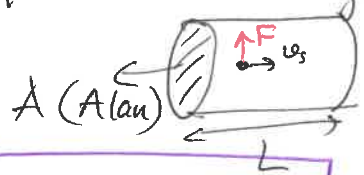
tel içinde yük



Tel içinde ~~...~~ v_s: sürüklenme hızı ile sürüklenen bütün yüklere kuvvet uygulanıyor.

$\underbrace{(\Sigma q)}_{yük}$ kuvvet ⇒ Tele ~~uygula~~ uygulanır.

$$\vec F_B = q\,\vec v_s \times \vec B \qquad n \Rightarrow \text{tane yük}$$



$$\boxed{I = n q v_s A \ (\text{akım})}$$

$\underbrace{n\underbrace{AL}_{hacim}}_{toplam\ yük\ sayısı}$; n = yük yoğunluğu (birim hacimde)

$$\vec F_B = q(\vec v_s \times \vec B)\, n A L$$

$$\boxed{\vec F_B = I\,\vec L \times \vec B}$$

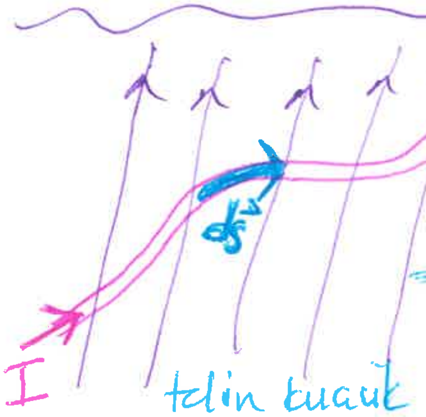
L = uzunluk

Akım taşıyan tele etki eden kuvvet

$$\vec F_B = q\,\vec v \times \vec B \Longleftrightarrow \vec F = I\,\vec L \times \vec B$$

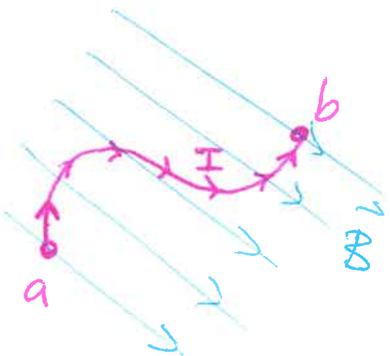
$I = 0$

$\vec{F} = 0$



$$d\vec{F} = I\, d\vec{s} \times \vec{B}$$

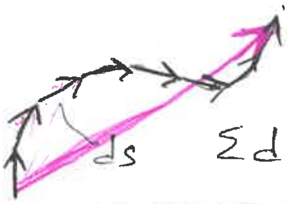
telin küçük kısmına etki eden kuvvet



$$\vec{F}_B = I \int_a^b d\vec{s} \times \vec{B}$$

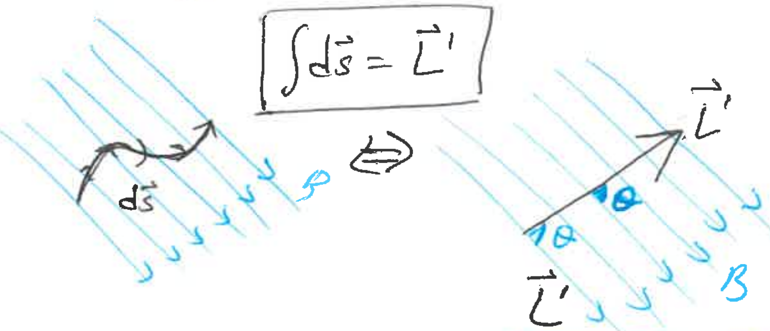
$$\vec{B} = sbt$$

$$\vec{F}_B = I \left(\int_a^b ds \right) \times \underset{sbt}{\vec{B}}$$

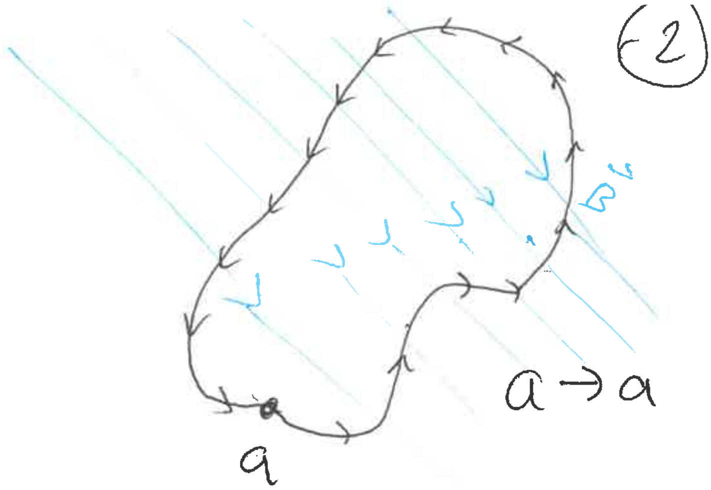


$$\Sigma d\vec{s} = \int d\vec{s}$$

$$\boxed{\int d\vec{s} = \vec{L}'}$$

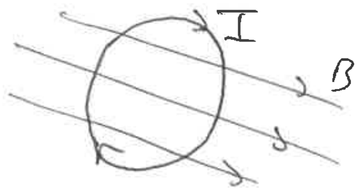


$$\boxed{\vec{F} = I\, \vec{L}' \times \vec{B}}$$



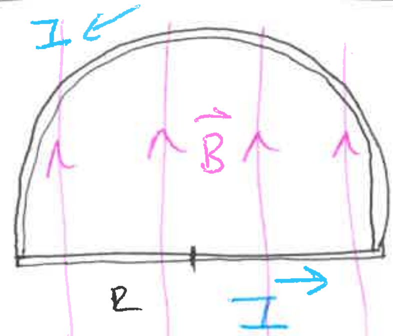
$$\vec{F} = I \underbrace{\left(\oint d\vec{s} \right)}_{\text{SIFIR } (a \to a)} \times \vec{B} = \underline{0}$$

Düzgün $\vec{B}$ altında; kapalı ilmeğe etki eden kuvvet sıfırdır



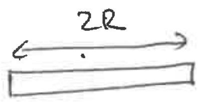
$$\vec{F} = 0$$

örnek



Yarıçapı R olan, yarım çember biçiminde bükülmüş telde kapalı devre var. I akımı var.

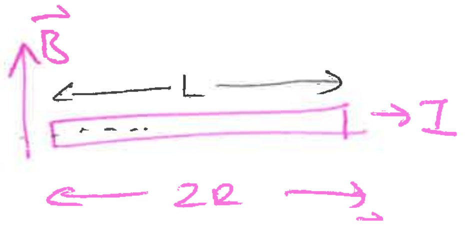
Telin doğru ve eğri parçalarına etki eden kuvvetler nedir?



$\vec{F} = ?$

$\vec{F} = ?$

I. yol



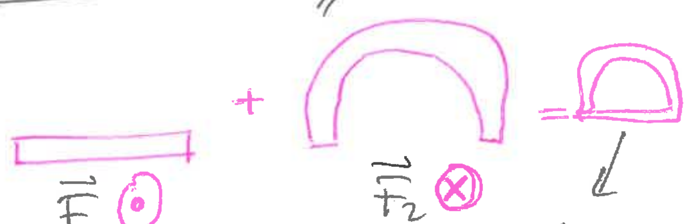
$\vec{F}_B = I\vec{L}\times\vec{B}$

$F_B = ILB\sin 90 = ILB$

$F_B = I(2R)B$

$\hat{j}$ $\hat{i}$ $\odot\hat{k}$ (dışarı)

$\vec{F} = 2IRB\hat{k}$



$\Sigma F = 0$ olmalı çünkü kapalı ilmek

$\vec{F}_1 + \vec{F}_2 = 0$

$2IRB\hat{k} + \vec{F}_2 = 0$

$\vec{F}_2 = -2IRB\hat{k}$

II yol

+ $\vec{F} = 2IRB\hat{k}$ integral al.

$$I\int_a^b d\vec{s}\times\vec{B} = \int_0^\pi IB\,ds\sin\theta$$

$\boxed{ds = R\,d\theta}$?

$s = R\,\theta \rightarrow$ radyan

$\theta = \pi$ $\quad \boxed{s = R\pi}$ $\quad 180° = \pi$

$$F = \int_0^\pi \underbrace{IBR}_{sbt}\sin\theta\, d\theta$$

$= IRB\left[-\cos\theta\right]_0^\pi$

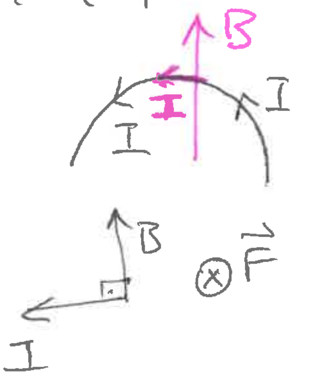
$= IRB\left[-\underbrace{\cos\pi}_{(-1)} - (-\cos(0))\right]$

$= IRB\left[-(-1) + \cos 0\right]$

$1 + 1$

$F = IRB(2)$

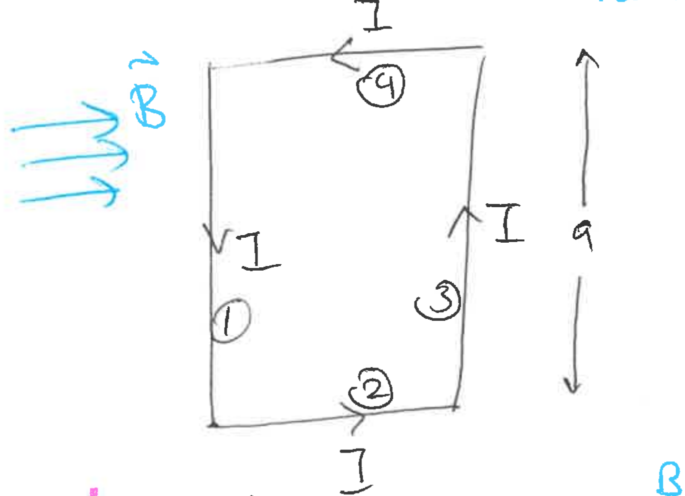
yönü?

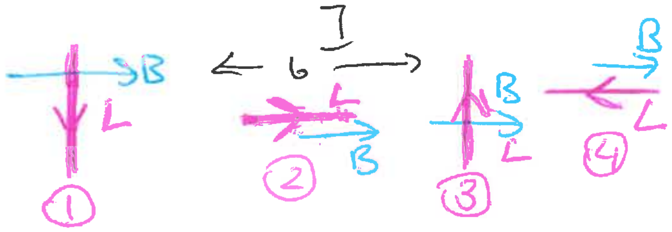


$\vec{F} = -2IRB\hat{k}$

Düzgün Manyetik Alan içinde Akım İlmeğine Etki eden TORK

döndürür

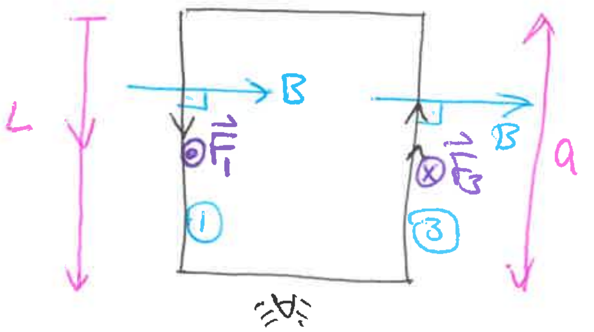




$\vec{F} = I\vec{L}\times\vec{B}$, $\quad |\vec{F}| = ILB\sin\theta$

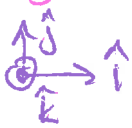
(4) $\theta = 180$, $\sin\theta = 0$, $F_4 = 0$

(2) $\theta = 0$, $\sin\theta = 0$, $F_2 = 0$



$F_1 = ILB\sin 90 = ILB$
$= IaB$

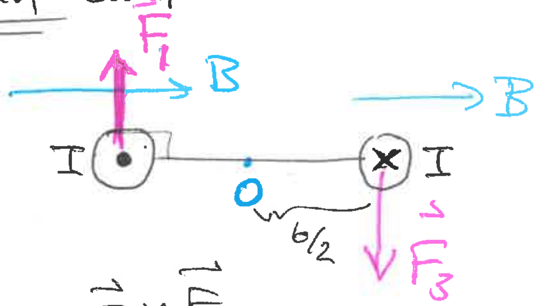
F_1 yönü? $\odot \vec{F}_1$



$\vec{F}_1 = ILB\hat{k} = IaB\hat{k}$

$F_3 = ILB\sin 90 = IaB$
$\vec{F}_3 = IaB(-\hat{k})$

Alttan Bakış

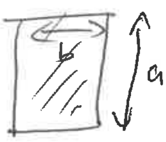


$\vec{\text{Tork}} = \vec{r} \times \vec{F}$

$\text{Tork} = \tau = F_1 \frac{b}{2} + F_3 \frac{b}{2}$

$= IaB\frac{b}{2} + IaB\frac{b}{2}$

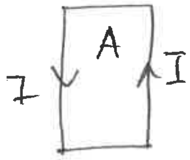
$\text{Tork} = I\underbrace{ab}_{\text{alan}}B$



$\text{Tork} = I\underbrace{A}_{\text{alan}}B$

$\underbrace{\vec{\tau}}_{\text{tork}} = \underbrace{I\vec{A}}_{\mu = \text{manyetik dipol momenti}} \times \vec{B}$

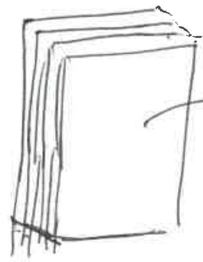
$\boxed{\mu = IA}$



tek sarım

$\mu = IA$

$\mu = NIA$



Ör) 5.4 cm X 8.5 cm dikdörtgen bir bobin (kangal) 25 sarımlı telden oluşuyor. $I = 15\,mA$.

a) Bobinin manyetik momenti?

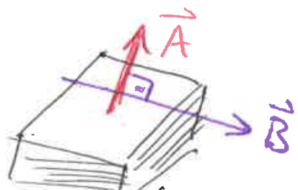
$\mu = NIA$
$= 25\,\underbrace{(15\times10^{-3})}_{A}\,(5.4\times8.5)\times10^{-4}\,m^2$

$\mu = 1.72\times10^{-3}\ A\cdot m^2$

b) Bobin $\vec{B} = 0.35\,T$ alana ilmek düzleme paralel olacak şekilde yerleşirse Tork=?

$\text{Tork} = \mu B \sin 90$

$\vec{\mu} = I\vec{A}$



$\text{Tork} = \underbrace{(1.72\times10^{-3})}_{Am^2}\,\underbrace{(0.35)}_{T}$

$\text{Tork} \simeq 6\times10^{-4}\ Nm$

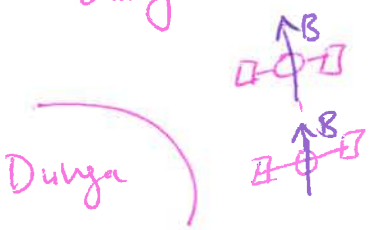
Yön bulma = GPS'ite kullanılıyor!

öv) Uydu davranış kontrolü

torquers = ~~g~~ tork yapıcı
bobin

$\mu_{bobin} = 250\ Am^2$

$B_{dünya} = 3\times10^{-5}\ T$



$Tork = \mu B$

$= 7.5\times10^{-3}\ Nm$

ör) proton hızına dik ⑤

$\vec{B} = 0.35\ T$ büyüklüğünde alanda 14 cm yarıçaplı çember üzerinde hareket ediyor

$v = ?$

$F = ma$

$q v B = m \frac{v^2}{R}$

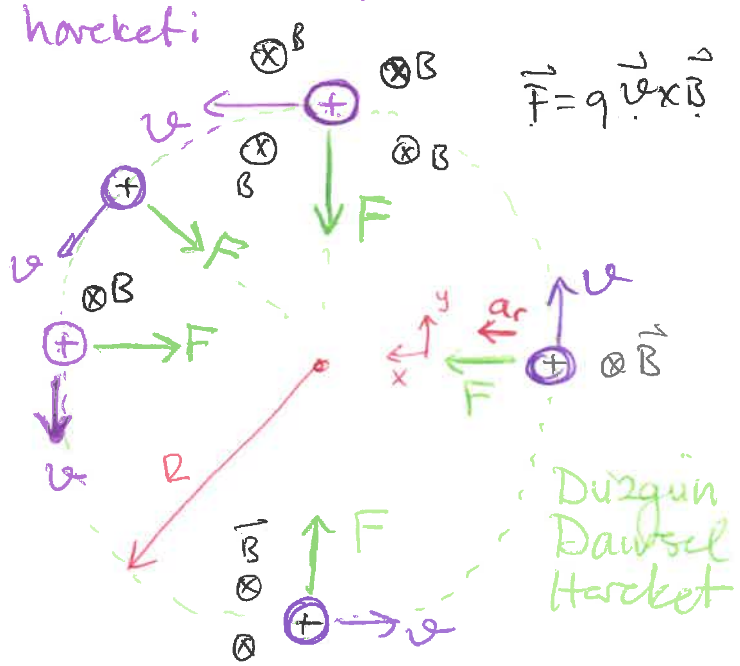
$v = \frac{qBR}{m} =$

$= \frac{(1.6\times10^{-19} C)(0.35\ T)(0.14\ m)}{1.67\times10^{-27}\ kg}$

$v = 4.7\times10^{6}\ m/s$

Yüklü paraacığın $\vec{B}$ altında hareketi

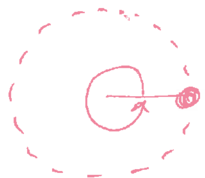
$\vec{F} = q\vec{v}\times\vec{B}$



$\Sigma F_x = m a_x$

$F = m a_r = m \frac{v^2}{R}$

$q v B = m \frac{v^2}{R}$; $R = \frac{mv}{qB}$



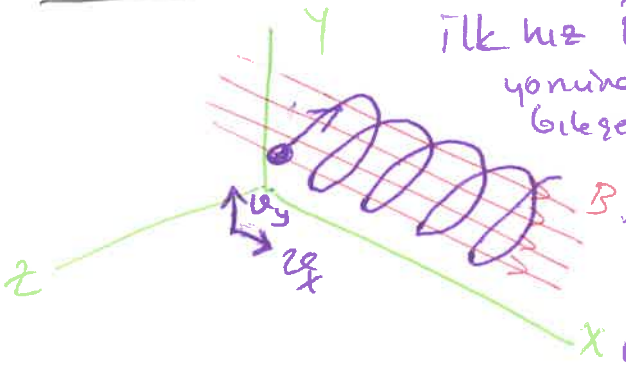
$v\uparrow$ $R\uparrow$

$B\uparrow$ $R\downarrow$

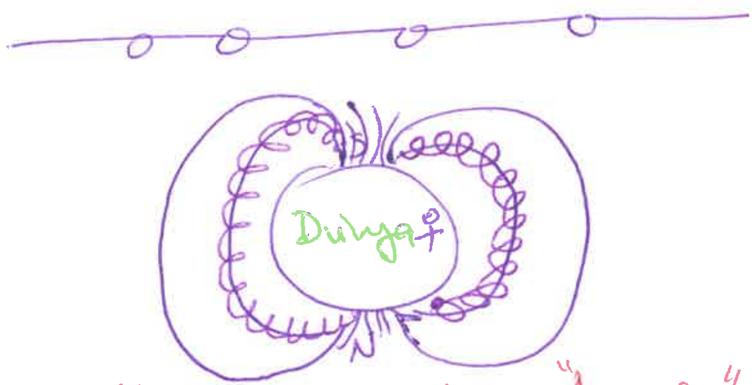
2π açı ~~dönüş~~ T zamanda taradığı

$v = \frac{\Delta x}{\Delta t} = \frac{2\pi R}{T}$; $\boxed{T = \frac{2\pi m}{qB}}$

[Tam bir tur için süre]



İlk hız $\vec{B}$ nin yönünde bileşeni varsa HELİS biçimli bir yörünge meydana gelir.



Kuzey Işınımları "Aurora"
yüklü parçacıkların
Dünyanın $\vec{B}$ hapsolması ve
Atmosferdeki atomlarla çarpışıp
ışık yaymaları olayı.

$$\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}$$

Elektrik ve manyetik alanlar yüklü parçacıkların kontrolünde kullanılır.

Katot tüpü

Kitap sonundaki sorular

ÖZET

$\otimes B$

$\oplus \rightarrow v$ $\quad q\vec{v} \times \vec{B} = \vec{F}$

Tel $\quad I\vec{L} \times \vec{B} = \vec{F}$

↳ kapalı tel $F = 0$

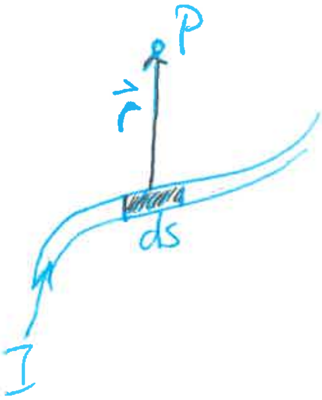
$$\boxed{I\int d\vec{s} \times \vec{B} = \vec{F}}$$

Manyetik Alan Kaynakları

16.8.16 ①

Elektrik Akımı ile manyetik alan oluşturulur.

Biot - Savart Yasası



$$d\vec{B}_p = \frac{\mu_0}{4\pi}\,\frac{I\, d\vec{s} \times \hat{r}}{r^2}$$

I: akım

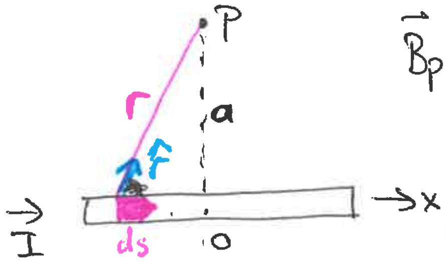
$\mu_0 = 4\pi \times 10^{-7}\, T\,\frac{m}{A}$

$\hat{r}$: birim vektör

r: P noktası ile ds parçası arasında mesafe.

$$B = \frac{\mu_0 I}{4\pi}\int \frac{d\vec{s} \times \hat{r}}{r^2}$$

Ör)



$\vec{B}_p = ?$

$$\int \frac{d\vec{s} \times \hat{r}}{r^2}$$

$ds = dx$

$$dx \sin\theta = |d\vec{s} \times \hat{r}| = |\underbrace{d\vec{s}}_{dx}|\,|\underbrace{\hat{r}}_{1}| \sin\theta$$

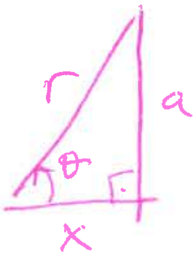
$\vec{B}$ yönü $\hat{k}$ (sağ el)

$$B = \frac{\mu_0 I}{4\pi}\int \frac{dx \sin\theta}{r^2}$$

$a = r\sin\theta$

$r = \left(\frac{a}{\sin\theta}\right)$

$$B = \frac{\mu_0 I}{4\pi}\int \frac{dx\, \sin^3\theta}{a^2}$$

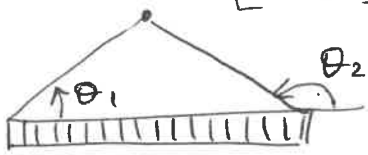


$\frac{a}{x} = \tan\theta$; $\frac{x}{a} = \cot\theta$

$$\int \frac{dx\, \sin^3\theta}{a^2} \qquad \begin{array}{l} x = a\cot\theta \\ dx = +a\csc^2\theta \end{array}$$

$$\int a \frac{1}{\sin^2\theta}\frac{\sin^3\theta}{a^2} = \int \frac{\sin\theta\, d\theta}{a}$$

$$B = \frac{\mu_0 I}{4\pi a}\underbrace{\int_{\theta_1}^{\theta_2} \sin\theta\, d\theta}_{[\cos\theta]_{\theta_1}^{\theta_2}}$$



$$\boxed{B = \frac{\mu_0 I}{4\pi a}(\cos\theta_1 - \cos\theta_2)}$$

Tel sonsuz uzunlukta olsaydı

$$B = \frac{\mu_0 I}{4\pi a}\left(\cos 0 - (\cos 180)\right)$$
$$[1 - (-1)]$$

$$B = \frac{\mu_0 I}{2\pi a}$$

tel uzunluğu ∞ sa

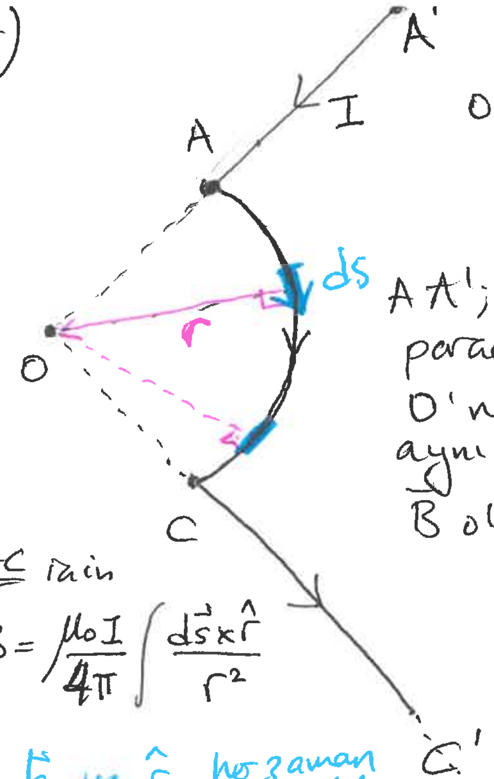
Bir telin çok yakınında bulunan noktadaki manyetik alan - sonsuz tel.

Ör): sonsuz uzunlukta telde I = 5A akım taşıyor. 4cm uzaklıktaki B = ?

$$B = \frac{(4\pi \times 10^{-7})(5)}{(2\pi)(0.04)} = 2.5 \times 10^{-5}\, T$$

Buzdolabı magnetleri ~ 10^{-3} T,

or)



O noktasındaki $\vec{B} = ?$

AA'; CC' parçaları O noktası ile aynı hizada $\vec{B}$ oluşturamaz.

AC için

$$dB = \frac{\mu_0 I}{4\pi} \int \frac{d\vec{s} \times \hat{r}}{r^2}$$

$d\vec{s}$ ve $\hat{r}$ her zaman dik

$$|d\vec{s} \times \hat{r}| = |d\vec{s}|\,|\hat{r}| \sin 90 = \underline{d\vec{s}}$$

$$\int dB = \frac{\mu_0 I}{4\pi} \int \frac{ds}{r^2} \quad ; \text{ ds, r'ye bağlı mı?}$$

ds değiştikçe; mesafe HER r'ye eşit.
$r \Rightarrow$ sbt

$$\int dB = \frac{\mu_0 I}{4\pi R^2} \underbrace{\int ds}_{\text{yayın uzunluğu}}$$

$\underline{R\theta}$

$$B = \frac{\mu_0 I}{4\pi R^2} R\theta = \boxed{\frac{\mu_0 I}{4\pi R}\theta = B}$$

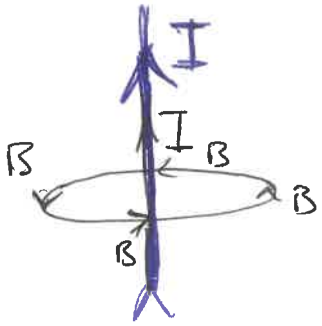
$\theta = \frac{\pi}{2}$ çeyrek daire

$\theta = \pi$; yarım daire

μ_0'ın birimi nedir?

$\theta, 4\pi$ sbt

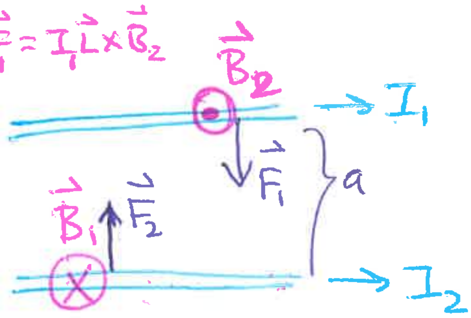
$$\mu_0 \approx \frac{BR}{I} = \left[\frac{T\,m}{A}\right]$$



üstten

İKİ PARALEL İLETKEN ARASINDAKİ KUVVETLER

$\vec{F}_1 = I_1 \vec{L} \times \vec{B}_2$



I_1 akımı I_2'nin bulunduğu telde B alanı oluşturacak

I_2'de I_1 üstünde B oluşturacak

I_2'ı tele etkiyen kuvvet

$\vec{F}_2 = I_2 \vec{L} \times \vec{B}_1$

sonsuz uzunlukta tel

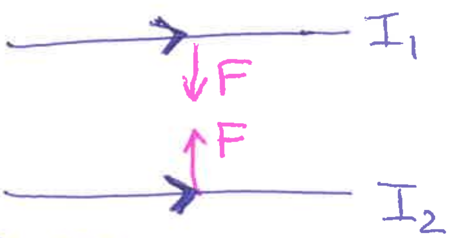
$$\vec{B}_1 = \frac{\mu_0 I_1}{2\pi a}(-\hat{k})$$

$$\vec{F}_2 = I_2 L \frac{\mu_0 I_1}{2\pi a}(+\hat{j})$$

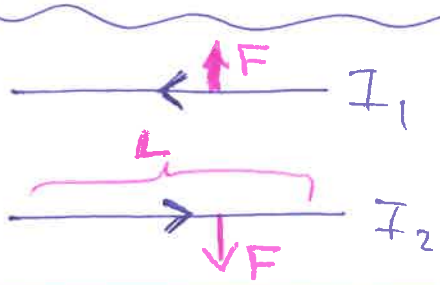
I_2 akımı taşıyan tele etki eden kuvvet

$$\vec{B}_2 = \frac{\mu_0 I_2}{2\pi a}(\hat{k})$$

$$\vec{F}_1 = I_1 \vec{L} \times \vec{B}_2 = I_1 L \frac{\mu_0 I_2}{2\pi a}(-\hat{j})$$



yukarıdaki durum



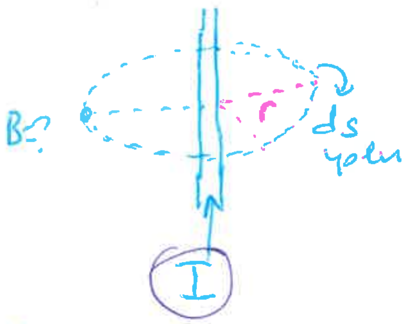
$$\boxed{F = \frac{\mu_0 I_1 I_2}{2\pi a} L} \; ; \frac{F}{L} = sbt$$

Amper Yasası

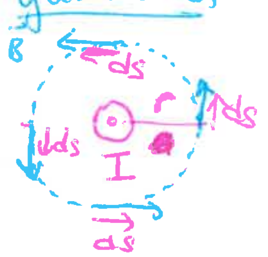
↳ Gauss yasası kullanarak $\vec{E}$ kolayca buluyorduk

→ Amper yasasını kullanarak $\vec{B}$ kolayca bulunabilir

$$\oint \vec{B}\cdot d\vec{s} = \mu_0 I_{iç}$$



yukarıdan



ds yolunun tele uzaklığı aynı

B ds üzerinde SBT

B ve ds paralel

$\oint_a^a \underbrace{\vec{B}\cdot d\vec{s}}_{B\,ds\cos 0}$ başlangıca dön

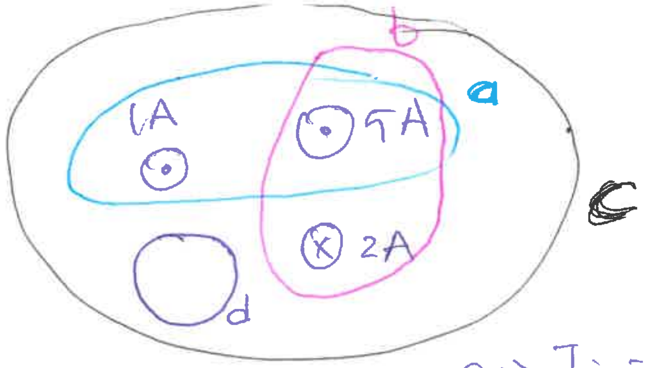
$$\oint \underset{\text{sbt}}{\vec{B}}\cdot d\vec{s} = \mu_0 I_{iç}$$

$$B \underbrace{\oint ds}_{\text{ds çemberinin uzunluğu}} = \mu_0 I_{iç}$$

ds çember içinde bulunan akım

$$\boxed{B\, 2\pi r = \mu_0 I}$$

$$\boxed{B = \frac{\mu_0 I}{2\pi r}}$$ sonsuz uzunluktaki telin oluşturduğu $\vec{B}$ alan.



$\underbrace{\oint \vec{B}\cdot d\vec{s}}$ $= \mu_0 I_{iç}$ büyüklüğünü sıralarsak

$a \Rightarrow I_{iç} = 6A$

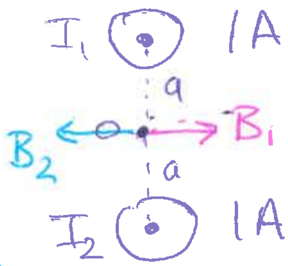
$b \Rightarrow I_{iç} = 3A$

$c \Rightarrow I_{iç} = 4A$

$d \Rightarrow I_{iç} = \underline{0}$

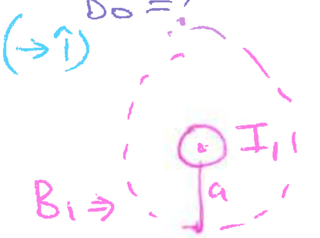
$a > c > b > d$

ör



$B_0 = ?$

$B_1 (\to \hat{i})$



$\vec{B}_0 = \vec{B}_1 + \vec{B}_2$

$B_1\, 2\pi a = \mu_0 I_1$

$B_1 = \dfrac{\mu_0 I_1}{2\pi a}$

$B_2\, 2\pi a = \mu_0 I_2$

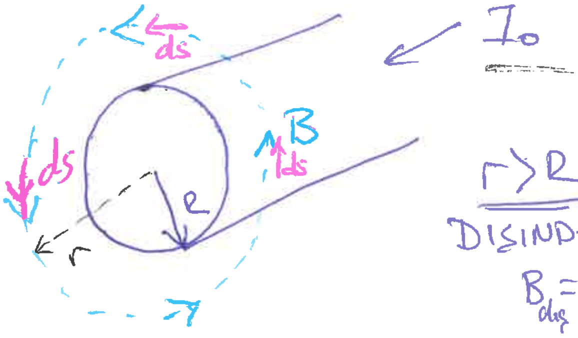
$B_2 = \dfrac{\mu_0 I_2}{2\pi a}$

$\vec{B}_1 = \dfrac{\mu_0 I_1}{2\pi a}\hat{i}$ $\quad \vec{B}_2 = \dfrac{\mu_0 I_2}{2\pi a}(-\hat{i})$

$I_1 = I_2 = 1A$

$\vec{B}_0 = \vec{B}_1 + \vec{B}_2 = 0$

Uzun - Akım taşıyan telin B alanı



$r > R$ DIŞINDAKİ $B_{dış} = ?$

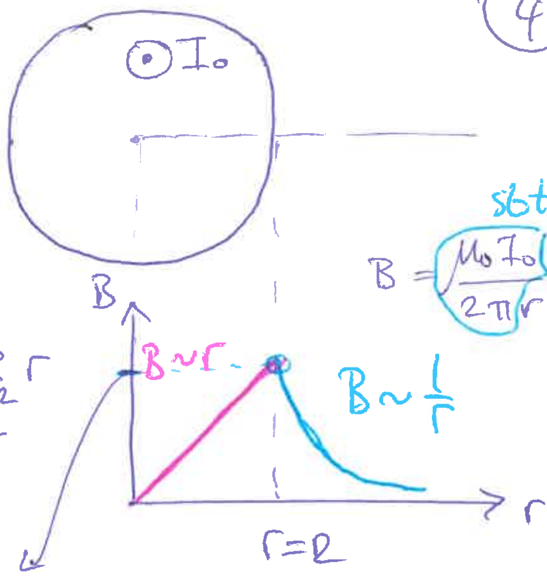
$r < R$ $B_{iç} = ?$

$\oint \vec{B} \cdot d\vec{s} = \mu_o I_{iç}$

$\oint \underbrace{B}_{sbt} ds \cos 0 = B \oint ds = \mu_o I_o$

$B \, 2\pi r = \mu_o I_o$

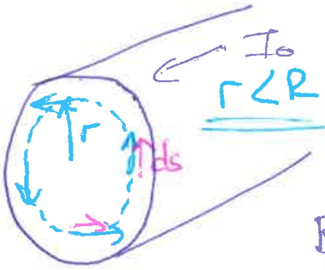
$$\boxed{B = \frac{\mu_o I_o}{2\pi r}} \quad \boxed{r > R}$$



$B = \underbrace{\frac{\mu_o I_o}{2\pi R^2}}_{sbt} r$

$B = \underbrace{\frac{\mu_o I_o}{2\pi r}}_{sbt}$

$\frac{\mu_o I_o}{2\pi R} = B_o$



$\oint \vec{B} \cdot d\vec{s} = \mu_o \underbrace{I_{iç}}_{?}$

$B \oint ds = \mu_o I_{iç}$

$B \, 2\pi r = \mu_o I_{iç}$

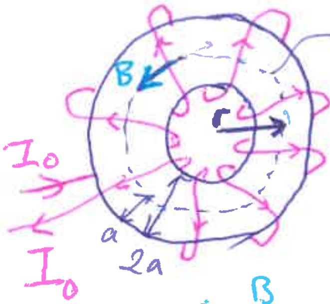
$\frac{I_{iç}}{I_o} = \frac{A_{iç}}{A_o} = \frac{alan_{iç}}{alan_o}$

$\frac{I_{iç}}{I_o} = \frac{\pi r^2}{\pi R^2} \Rightarrow I_{iç} = \boxed{I_o \frac{r^2}{R^2}}$

$B \, 2\pi \cancel{r} = \mu_o \frac{I_o r^{\cancel{2}}}{R^2}$

$$\boxed{\begin{array}{l} B = \frac{\mu_o I_o}{2\pi R} r \; ; \; r < R \\ r = 0 \; ; \; B = 0 \end{array}}$$

TOROID



ds ; B = ?

B alanı ds üzerinde SBT

tam orta noktası

N tane tel varsa

$I_{iç} = N I_o$

$\oint \vec{B} \cdot d\vec{s} = \mu_o I_{iç}$

$B \, 2\pi r = \mu_o N I_o$

TOROID

$$\boxed{B = \frac{\mu_o I_o}{2\pi r} N}$$

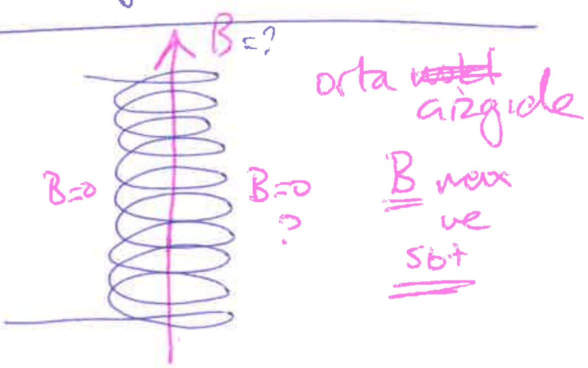
N: sarım sayısı

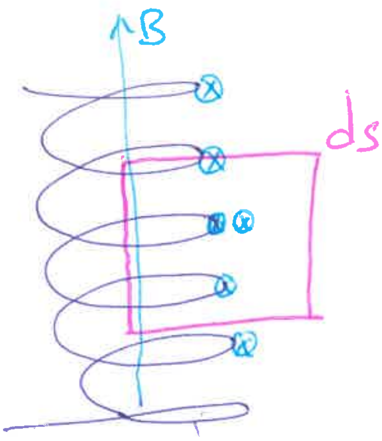
N↑ ; B↑

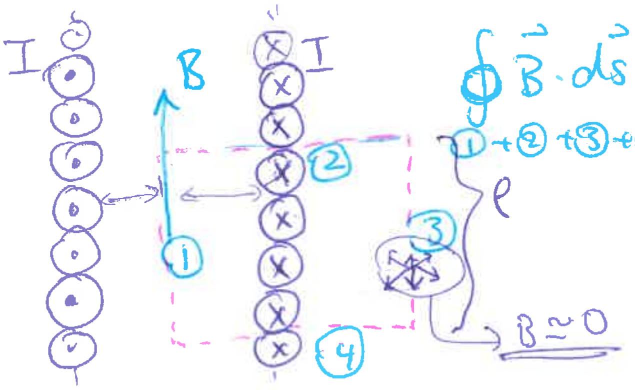
r↓ ; B↑

SOLENOID (akım makarası)

Manyetik Alan







$\oint \vec{B} \cdot d\vec{s}$

① + ② + ③ + ④

ds ⇒ 4 kısma ayır.

$$\oint_{\textcircled{1}} B\,ds + \int_{\textcircled{2}} \cancel{Bds}^{\,0} + \int_{\textcircled{3}} \cancel{Bds}^{\,0} + \int_{\textcircled{4}} \cancel{Bds}^{\,0}$$

sbt

$B\ell$

② ve ④ te $B=0$ ⊗ •$B=0$ ⊗

③ $B \simeq 0$

$$\oint \vec{B}\, d\vec{s} = \mu_0 I_{iç}$$

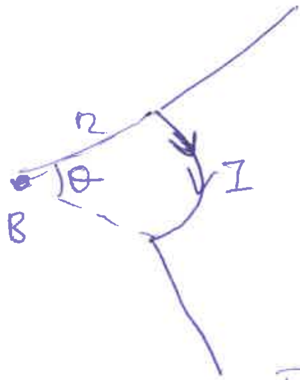
$$B\ell = \mu_0 N I_0$$

Selonoid $\boxed{B = \mu_0 I \frac{N}{\ell}}$

N → sarım sayısı

ℓ → uzunluk

$\frac{N}{L} = n$ birim uzunl. sarım sayısı



$$B = \frac{\mu_0 I}{4\pi} \int \frac{d\vec{s} \times \hat{r}}{r^2}$$

sbt

$$\frac{\mu_0 I}{4\pi r^2}\, r\theta$$

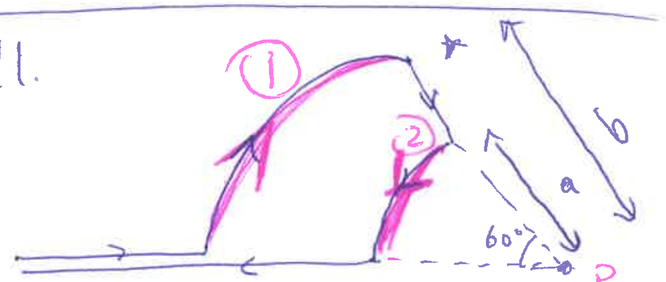
$$\boxed{B = \frac{\mu_0 I}{4\pi r}\,\theta}$$

Çember/yayın B alanı

$\theta = 2\pi$

$$B = \frac{\mu_0 I}{4\pi r}\, 2\pi = \frac{\mu_0 I}{2r}$$ = çemberin ortasında oluşan manyetik alan.

#11.



$B_p = ?$

$$B = \frac{\mu_0 I}{4\pi r}\,\theta \qquad 60° = \frac{\pi}{3}$$

$$\vec{B}_1 = \frac{\mu_0 I}{4\cancel{\pi} b}\left(\frac{\cancel{\pi}}{3}\right)(-\hat{k})$$

$$\vec{B}_2 = \frac{\mu_0 I}{4\cancel{\pi} a}\left(\frac{\cancel{\pi}}{3}\right)(+\hat{k})$$

$$\vec{B}_1 + \vec{B}_2 = \frac{\mu_0 I}{12}\left(\frac{1}{a} - \frac{1}{b}\right)\hat{k}$$

18-8-16

manyetik alan → amper kanunu akım taşıyan telin oluş. $\vec{B}$

kuv.

$$\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}$$

→ akım taşıyan tele etki eden manyetik kuvv.

$$\vec{F}_B = I\vec{L} \times \vec{B}$$

Formüller verilecek

zor olay

$$\oint \vec{B} \cdot d\vec{s} = \mu_0 I_{iç}$$

$$\vec{B} = \frac{\mu_0}{4\pi} \int \frac{I d\vec{s} \times \hat{r}}{r^2}$$

kolay metod

• $B = ?$

düz tel; sonlu tel, sonsuz tel → Amper yasası

→ Toroid
→ Solenoid } B ✓

$$B = \frac{\mu_0 N I}{2R} \ (\text{toroid})$$

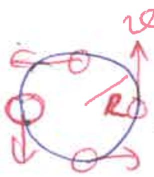
$$B = \mu_0 \frac{N}{\ell} I \ (\text{solenoid})$$

$$\vec{F}_B = q\vec{v} \times \vec{B}$$

$$\vec{F} = I\vec{L} \times \vec{B} = I \int d\vec{s} \times \vec{B}$$

$\mu = IA$ (manyetik dipol moment)

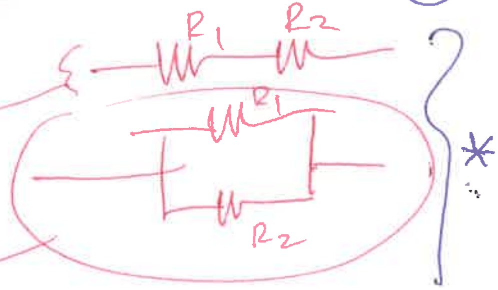
$\tau = \text{Tork} = \vec{\mu} \times \vec{B}$ } GPS nasıl çalışır



DDH $\boxed{qvB = m\frac{v^2}{R}}$

Doğru Akım Devreleri (1)

R



$R_1 + R_2 = R_{eş}$

$$\frac{1}{R_{eş}} = \frac{1}{R_1} + \frac{1}{R_2}$$

* Kirchoff ① $\Sigma \Delta V = 0$ ② $\Sigma I_{gel} = \Sigma I_{çıkan}$

RC – devreleri formüller verilecek

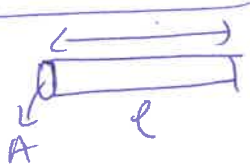
Akım ve Direnç

$\Delta V = IR$ (Ohm kanunu)

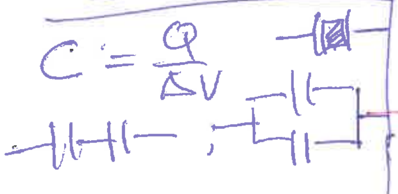
güç $P = I\Delta V = I^2 R = \frac{(\Delta V)^2}{R}$

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

özdirenç

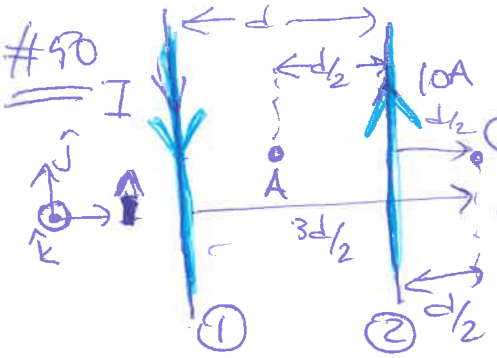


ARASINAV	FINAL
$\vec{F}_E = k\frac{q_1 q_2}{r^2}\hat{r}$	R devre
>%50 $\vec{F} = q\vec{E}$	Kirchoff %50<
$\vec{E} = \frac{kq}{r^2}\hat{r}$	$\vec{B}$ • yüke • tele etki eden kuvvet
$\Delta V = -\int \vec{E} d\vec{s}$	• akım taşıyan telin oluşturduğu $\vec{B}$
gauss $\Phi_E = \oint \vec{E} \cdot d\vec{A} = \frac{q_{iç}}{\varepsilon_0}$	
$C = \frac{Q}{\Delta V}$	



manyetik alan kaynakları

#50



$$\boxed{\vec B_1 = \frac{\mu_0 I_1}{2\pi \frac{3d}{2}}\hat k}$$

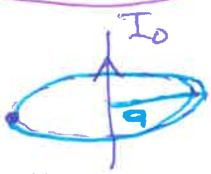
$$\boxed{B_2 = \frac{\mu_0 I_2}{2\pi d/2}\,(-\hat k)}$$

I akımı öyle bir değerde ki

$B_c = 0$ $\quad I = ?$ $\quad d = 18\,cm$

$\vec B_A = ?$

$B_c = \vec B_1 + \vec B_2 = 0$



üstten

amper yasası

$$\oint \vec B \cdot d\vec s = \mu_0 I_{iç}$$

$$B\, 2\pi a = \mu_0 I_0$$

$$\boxed{B = \frac{\mu_0 I_0}{2\pi a}}$$

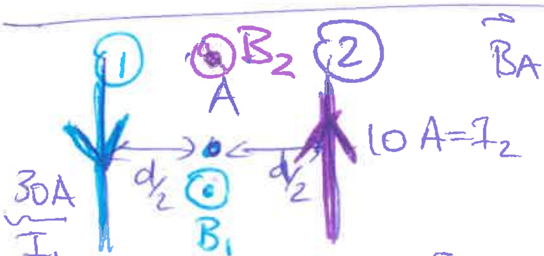
$$\vec B_c = \vec B_1 + \vec B_2 = \frac{\mu_0 I_1}{2\pi \frac{3d}{2}}\hat k - \frac{\mu_0 I_2}{2\pi \frac{d}{2}}\hat k$$

$\Downarrow$

0

$$\frac{\cancel{\mu_0} I_1}{\cancel{\pi}\, 3\cancel{d}} = \frac{\cancel{\mu_0} I_2}{\cancel{\pi}\cancel{d}} \Rightarrow \boxed{I_1 = 3I_2}$$

$$I_2 = 10A \Rightarrow \boxed{I_1 = 30A}$$



$\vec B_A = ?$

$\oint B \cdot ds = \mu_0 I_0$

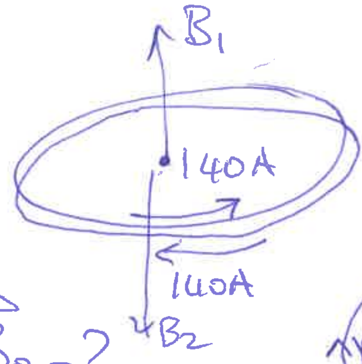
$T \cdot m = \mu_0 A$

$$\vec B_A = \vec B_1 + \vec B_2 = \frac{\mu_0 I_1}{2\pi \frac{d}{2}}\hat k + \frac{\mu_0 I_2}{2\pi \frac{d}{2}}\hat k$$

$$\vec B_A = \mu_0 \frac{40A}{\pi d} \; ; \; d = 0.18\,m \quad \mu_0 = 4\pi\times 10^{-7}\,\frac{Tm}{A}$$

59

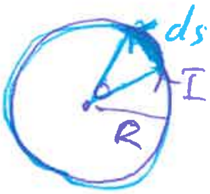
2



$\vec B_0 = ?$

$\vec B_1 + \vec B_2 = 0$

$B_1 = \frac{\mu_0 I}{2R}$



$$B = \frac{\mu_0}{4\pi}\int \frac{I\, d\vec s \times \hat r}{r^2}$$

$$= \frac{\mu_0 I}{4\pi R^2}\int_0^{2\pi} ds$$

$2\pi R$

$$B = \frac{\mu_0 I}{\cancel{4}\pi R^{\cancel{2}}}\, 2\pi \cancel{R} = \boxed{\frac{\mu_0 I}{2R}}$$

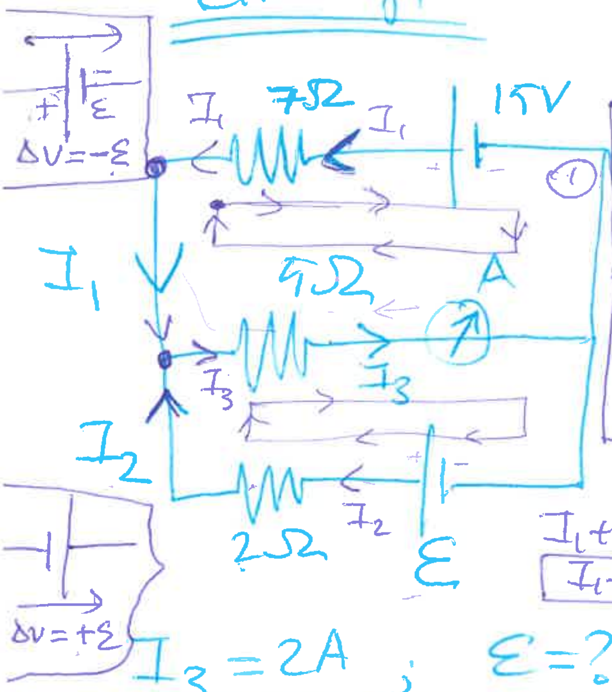
Dairesel telin ortasında $\vec B$

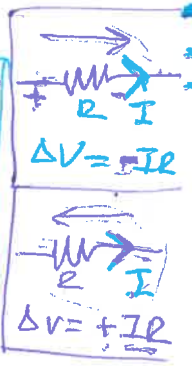
$$\frac{\mu_0 I}{4\pi R^{\cancel{2}}}(\cancel{R}\theta) = \frac{\mu_0 I\theta}{4\pi R}$$

$\theta = 2\pi$ tam çember

Kirchoff

$\frac{88}{7}$





$I_1 + I_2 = I_3$

$\boxed{I_1 + I_2 = 2A}$

$I_3 = 2A$; $\varepsilon = ?$

① $(+I_1 7) - 15V + I_3 5 = 0$

② $(-I_3 5) + \varepsilon - I_2 2 = 0$

③ $I_1 + I_2 = 2$

$7I_1 - 15 + 10 = 0$ $\quad 7I_1 = 5$

$-10 + \varepsilon - 2I_2 = 0$ $\quad \boxed{I_1 = \frac{5}{7}A}$

$I_1 + I_2 = 2$

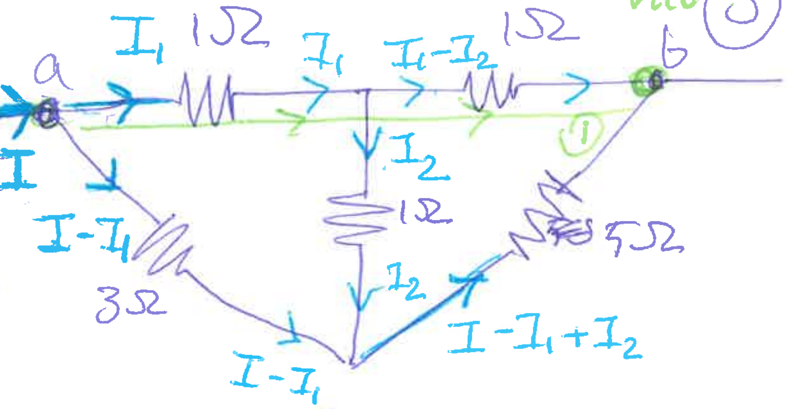
$\frac{5}{7} + I_2 = 2$; $I_2 = 2 - \frac{5}{7}$

$\boxed{I_2 = \frac{9}{7}A}$

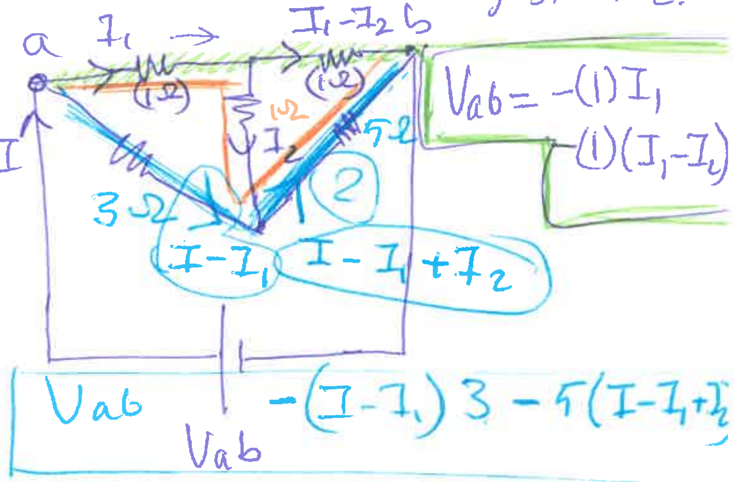
$-10 + \varepsilon - 2\frac{9}{7} = 0$

$\varepsilon = \frac{18}{7} + 10 = \frac{88}{7} V$

Vab ③



$R_{ab} = \frac{27}{17} \Omega$ olduğunu gösteriniz.



① $V_{ab} = -I_1 - I_1 + I_2 = \boxed{-2I_1 + I_2}$

$V_{ab} = -3I + 3I_1 - 5I + 5I_1 - 5I_2$

② $V_{ab} = -8I + 8I_1 - 5I_2$

$V_{ab} = -1I_1 - 1I_2 - 5(I - I_1 + I_2)$

$= -I_1 - I_2 - 5I + 5I_1 - 5I_2$

③ $V_{ab} = +4I_1 - 6I_2 - 5I$

$V_{ab} = I(\underbrace{\cdots}_{\frac{27}{17}})$

$\underbrace{4①+②}$

$V_{ab} = \quad I, I_2 \}$

$\underbrace{2①+③}$

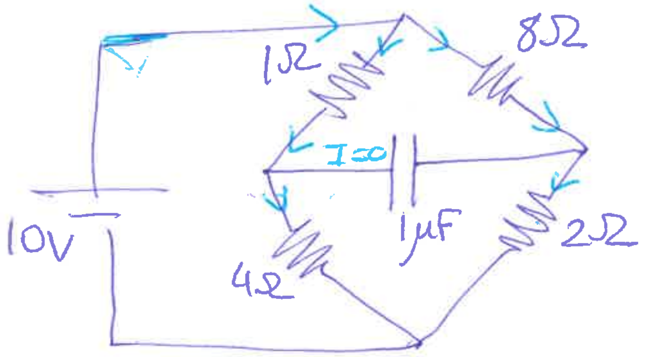
$V_{ab} \quad I \quad I_2 \}$

I_2 yi yok eder

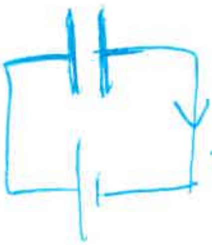
$V_{ab} = I(\cdots)$

Deuse 33

4



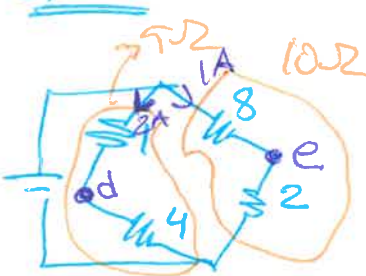
Kondansatörün uçları arasındaki potansiyel fark? $V_c = ?$

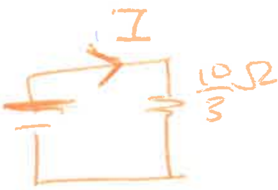


çok bekledikten sonra

$I = ?$ $\quad$ $I = 0$

Kondansatör dolduktan sonra



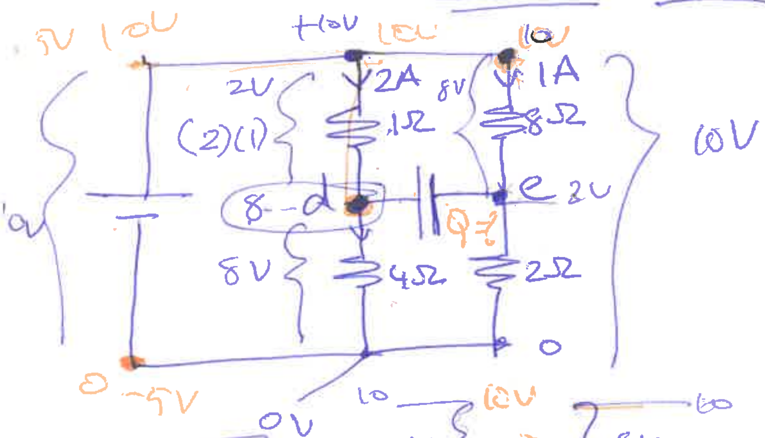


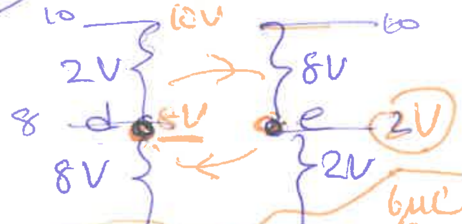
$V_{de} = ?$

$$\frac{10}{3}\Omega = \left(\frac{1}{5} + \frac{1}{10}\right)^{-1}$$

$$V_{ab} = 10V = I_1 5 = I_2 10$$

$$I_1 = 2A \qquad I_2 = 1A$$





$\boxed{V_{de} = 6V}$

$V_{de} \neq V_{ed}$
6V $\quad$ −6V

$C = \frac{Q}{\Delta V} \Rightarrow Q = (1\mu F)(6V)$