

D. Klín

referáty x laboratorní - 40 bodů,
hodnotí se 4 kursy

aldebaran. feld. cour. cz + herodes

jme paralelka 213

Fy I., II. praktikum

+ skripta na semináře

<http://pitbou.wz.cz>

měření válečku (váleček 76)

ϕ	12,96	12,88	12,86	12,83	12,89	12,99	12,89	12,80
mm	12,99	12,82	12,80	12,90	13,00	12,80	12,94	
v	32,16	32,10	32,10	32,12	32,20	32,16	32,10	32,20
mm	32,14	32,10	32,14	32,20	32,12	32,16	32,16	

chyby (nejistoty)

- hrubé chyby (čtení špatné stupnice, ...)
- systematické ch. (špatná metoda, nepřesný přístroj, ...)
- náhodné ch. (vše na co se dá vymluvit)

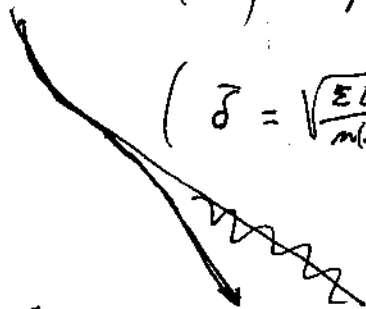
1. naměření x_i

2. $\bar{x} = \frac{1}{n} \sum x_i$ průměr

diskutovat systematické,
náhodné chyby

3. $\Delta_i = \bar{x} - x_i$ odchylka od $\bar{x}$

4. $\bar{\sigma} = \frac{2}{3} \sqrt{\frac{\sum \Delta^2}{n(n-1)}}$ pravděpodobná chyba



($\sigma = \sqrt{\frac{\sum \Delta^2}{n(n-1)}}$.. směrodat. odchylka od průměru)

5

6. $\bar{x} = \bar{x} \pm \bar{\sigma}(x)$

např. $x = (1,63 \pm 0,02) \text{ mm}$

stejný počet d. míst,
chyba obvykle na max 2 plat. cifry

7. $\sigma(V)$... srovnání se skriptem

$\sigma_{x_1}, \sigma_{x_2}$

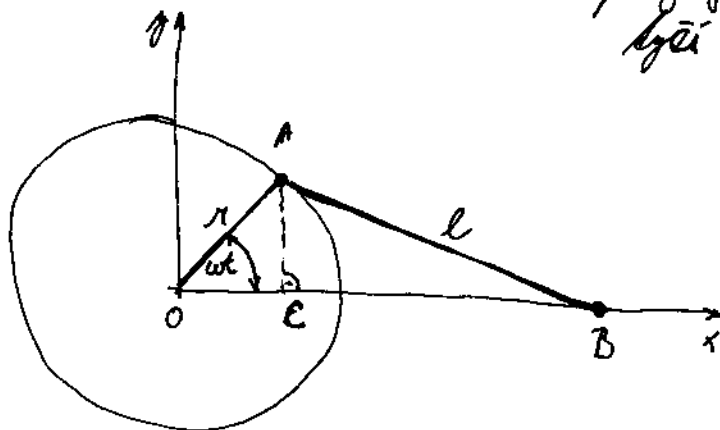
$$\sigma_V = \sqrt{\sigma_{x_1}^2 (2\pi n \cdot T)^2 + \sigma_{x_2}^2 (\pi n^2)^2}$$

nejak tak

úloha 3

výpočet polohy bodu B

B se pohybuje po ose x, svázan s A
kyč



$$\overline{OC} = r \cos \omega t$$

$$\overline{CB} = \sqrt{l^2 - (r \sin \omega t)^2}$$

$$x_B(t) = r \cos \omega t + \sqrt{l^2 - (r \sin \omega t)^2}$$

$$\uparrow$$

$$\text{max. } \sqrt{l^2 - r^2} \quad \dots \quad l \geq r$$

$$l > r \quad \dots \quad \langle l - r, l + r \rangle$$

$$\begin{aligned} l = r \quad x_B(t) &= r \cos \omega t \pm \sqrt{r^2 - r^2 \sin^2 \omega t} = \\ &= r \cos \omega t \pm r \sqrt{1 - \sin^2 \omega t} = \\ &= r \cos \omega t \pm r |\cos \omega t| = \\ &= r (\cos \omega t \pm |\cos \omega t|) \end{aligned}$$

úloha 4

přímácar. pohyb z klidu se zrychlením, které rovnoměrně roste, až o $t_1 = 90\text{ s}$ je $a_1 = 95\text{ m}\cdot\text{s}^{-2}$
určit $v(t) = ?$, $s(t) = ?$

$$a(t) = k \cdot t$$

$$a_1 = k \cdot t_1 \Rightarrow k = \frac{a_1}{t_1}$$

$$a(t) = \frac{a_1}{t_1} \cdot t$$

$$a = \frac{dv}{dt}$$

$$dv = a dt$$

$$\int_0^t dv = \int_0^t a dt'$$

$$v(t) - \underbrace{v(0)}_{=0} = \frac{a_1}{t_1} \int_0^t t' dt'$$

$$\boxed{v(t) = \frac{a_1}{t_1} \cdot \frac{t^2}{2}}$$

$$\int_0^t ds = \int_0^t v dt'$$

$$\int_0^t ds = \int_0^t \frac{a_1}{t_1} \cdot \frac{t'^2}{2} dt'$$

$$s(t) = \frac{a_1}{2t_1} \cdot \frac{t^3}{3}$$

úloha 18:

obrotačnick

$$t=0, \dots n = 1500 \text{ ot/min} \rightarrow f = 25 \text{ s}^{-1} = 25 \text{ Hz}$$

rovněměrně zpomalení

$$t_1 = 30 \text{ s} \quad \dots f_1 = 0$$

kolik otáček udělá do zastavení?

$$\varepsilon = \frac{d\omega}{dt} \quad \text{úhl. zrychlení}$$

$\Downarrow$

$$d\omega = \varepsilon dt$$

$$\int_0^{t_1} d\omega = \omega(t_1) - \omega_0 = \int_0^{t_1} \varepsilon dt = \varepsilon t_1$$

$$\omega(t_1) = \omega_0 + \varepsilon t_1$$

$$\omega(t_1) = \omega_1 = \omega_0 + \varepsilon t_1$$

$$\boxed{\varepsilon = -\frac{\omega_0}{t_1}}$$

$$N = \frac{\alpha(t_1)}{2\pi} =$$

$$= \frac{\omega_0 t_1}{4\pi} = 375 \text{ otáček}$$

$$\alpha(t_1) = \int_0^{t_1} \omega(t) dt$$

$$\alpha(t_1) = \int_0^{t_1} \left(\omega_0 - \frac{\omega_0}{t_1} t \right) dt$$

$$\alpha(t_1) = \omega_0 t_1 - \frac{\omega_0}{t_1} \cdot \frac{t_1^2}{2} = \frac{\omega_0 t_1}{2}$$

$$a \dots \varepsilon$$

$$v \dots \omega$$

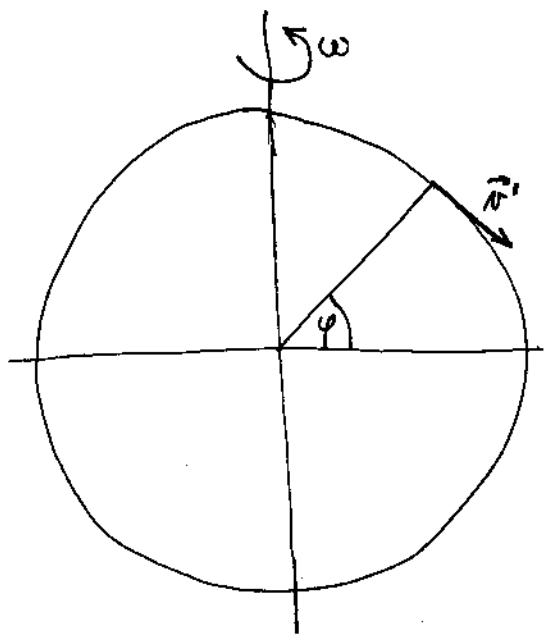
$$A \dots \alpha$$

úloha 60

vlak $m = 5 \cdot 10^5 \text{ kg}$ jede od 5 po palatníkach

$$v = 72 \text{ km} \cdot \text{h}^{-1}$$

~~Abex~~ Coriolisova sila



$$\vec{F}_c^* = 2m \vec{v}' \times \vec{\omega}$$

$$|\vec{v}' \times \vec{\omega}| = v' \cdot \omega \cdot \underbrace{\sin(\pi - \varphi)}_{\sin \varphi}$$

$$F \sim \sin \varphi$$

možno podívať na 64

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pohyb v rovině x, y po parabole, $\vec{F}(x, y)$

$$[F_x(x, y), F_y(x, y)]$$

$$A = \int \vec{F} d\vec{r}$$

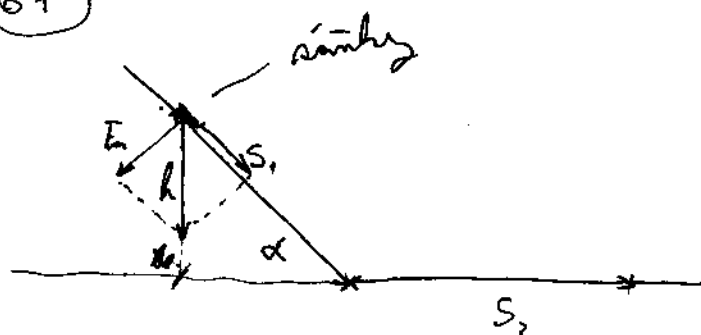
$$\int F_x dx + \int F_y dy$$

parametrický vyjádření parabol. $y=t^2, x=t$

$$dy = 2t dt$$

$\vec{L} = \vec{r} \times \vec{p}$
 jedn. vektoru ve
 směru x

(67)



$$F_L = f \cdot F_m$$

$$L = s_1 \sin \alpha$$

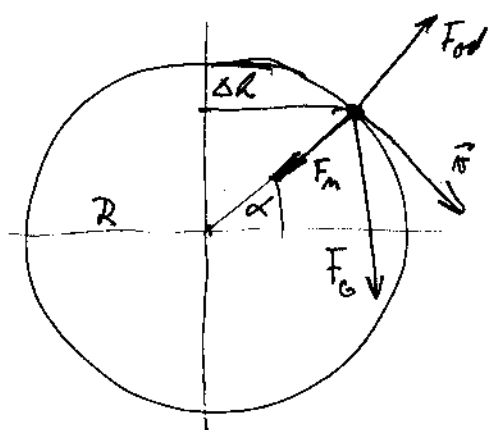
$$W_x = mg s_1 \sin \alpha$$

$$A = f F_m s_1 + f F_G s_2$$

$$mg s_1 \sin \alpha = f F_m s_1 + f mg \cos \alpha s_2 + f mg s_2$$

$$f = \frac{s_1 \sin \alpha}{s_2 + s_1 \cos \alpha}$$

69 hladká koule o poloměru 1,5 m,
a visí se začne pohybovat hmotný bod



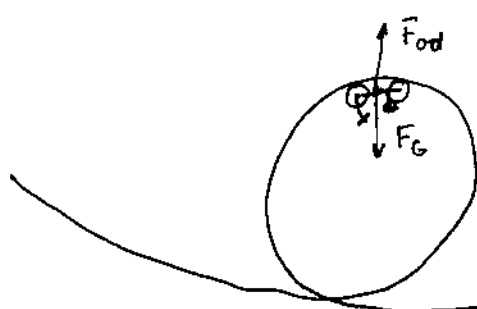
$$F_m = mg \cos \alpha$$

$$F_{od} = \frac{mv^2}{R}$$

$$\frac{1}{2} mv^2 = mg \Delta h \quad \text{v daném místě}$$

$$\Delta h = R - R \sin \alpha$$

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cykliska a musí se tam
adřít :))

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mat. kyvadlo

a)

ZZ ME

$$0: W_p^0 = mgh = mg(L - \cos \varphi_0) \quad \text{pocatek}$$

$$t: W_p = mgL(1 - \cos \varphi) \quad \varphi(t)$$

$$W_k = \frac{1}{2} mv^2$$

$$W_k = \Delta W_p$$

$$\frac{1}{2} mv^2 = mgL(\cos \varphi - \cos \varphi_0)$$

$$v = \sqrt{2gL(\cos \varphi - \cos \varphi_0)}$$

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$$m, v \xrightarrow{\uparrow \text{ZZH}} (m+n); V \xrightarrow{\text{ZZME}} mgl$$

Ariz. 402248

$$\left(\frac{1}{2} m v^2 = \frac{1}{2} (m + M) V^2 + Q \right)$$

$$\frac{1}{2}(m+M)V^2 = (m+M)gh$$

$$V = \sqrt{2gh}$$

srážka
matematika

$$\begin{array}{l} m_1, m_2 \\ n_1, n_2 \end{array} \Rightarrow \begin{array}{l} m_1, m_2 \\ n_1, n_2 \end{array}$$

①. $\mathbb{Z} \oplus \mathbb{H} \quad m_1 v_1 + m_2 v_2 = m_1 u_1 + m_2 u_2$

② dok. pruvření - ZZE
nepuvření - $\mu_1 = \mu_2$

(91)



lodičky, vyprání si pytel o stejné m

známe m_1, m_2, M, u_1, u_2 ; ? v_1, v_2

$$u_2 = 0$$

1) v ose x : ZZH

$$m_1 v_1 + m_2 v_2 = m_1 u_1$$

$$2) (m_2 - M) v_2 + M v_1 = 0$$

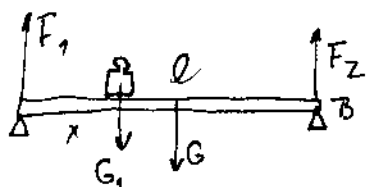
(96)

podmínky rovnováhy

$$\sum_{i=1}^N \vec{F}_i = \vec{0}$$

$$\sum_{i=1}^N \vec{M}_i = \vec{0}$$

$$\vec{r} \times \vec{F} = \vec{M}$$



$$G \cdot \frac{l}{2} + G_1 - F_2 \cdot l = 0$$

nebo počátek v B

$$G \cdot \frac{l}{2} + G_1 (l - x) - F_1 \cdot l = 0$$

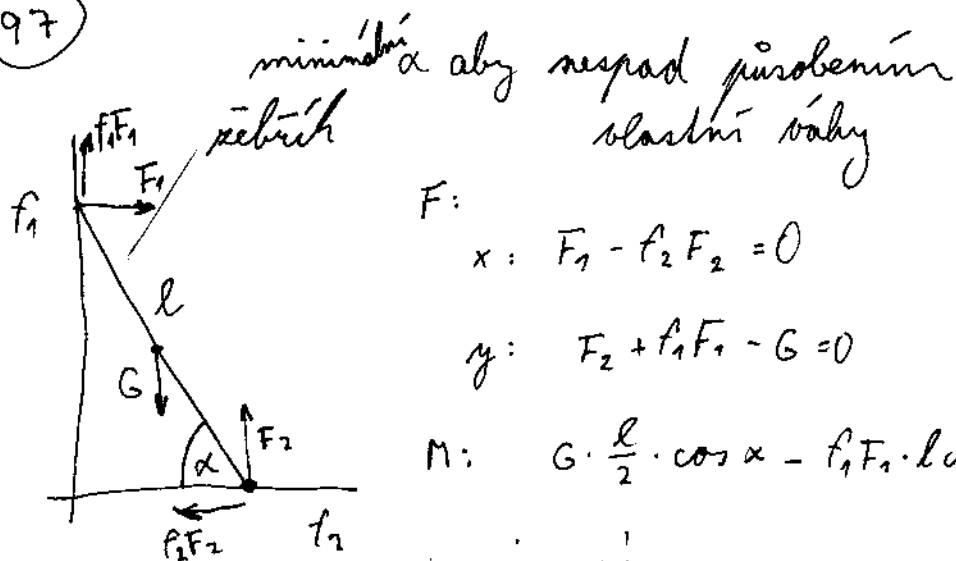
vektorové rovnice



$$x: T_{1x} + T_{2x} = 0$$

$$y: T_{1y} + T_{2y} + T_{3y} = 0$$

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100

těžiště

$$\bar{R}_T = \frac{\int_{(m)} \vec{r} dm}{\int_{(m)} dm}$$

$$\frac{\int_{(v)} \vec{r} dV}{V}$$

polokoule



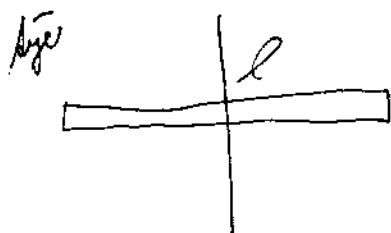
$$y_T = \frac{\int y dV}{V}$$

$$dV = \pi(R^2 - y^2) \cdot dy$$

$$y_T = \frac{1}{\frac{2}{3}\pi R^3} \cdot \int_0^R \pi(R^2 - y^2) y dy = \underline{\underline{\frac{3}{8} R}}$$

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$$J = \int_m x^2 dm$$



$$dm = \rho \cdot S \cdot dx$$

$$m = \rho S l$$

$$J_0 = 2 \int_0^{l/2} x^2 \rho S dx = \frac{1}{12} m l^2$$

$$J = J_0 + m |OT|^2$$

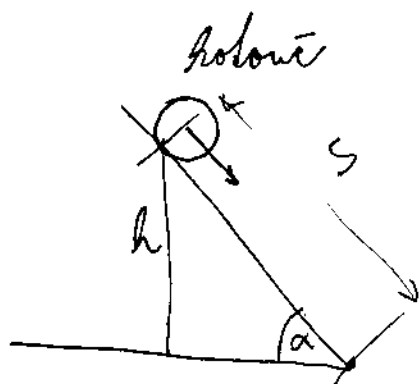
osa-kvadrát

$$J = \frac{1}{3} m l^2$$



ovčiče 105, 106

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$$mgh = \frac{1}{2} m v^2 + \frac{1}{2} J \omega^2$$

$$J = \frac{1}{2} m R^2$$

$$\omega = \frac{v}{R} \quad \text{prosti plati ak nemí to tak posny}$$

$$mgh = \frac{3}{4} m v^2$$

$$v = \sqrt{\frac{4}{3} gh} = \sqrt{\frac{4}{3} g S \sin \alpha}$$

$$v = \frac{ds}{dt}$$

$$dt = \frac{ds}{v}$$

nebo

$$a = \text{konst}$$

$$v_{\max} = ?$$

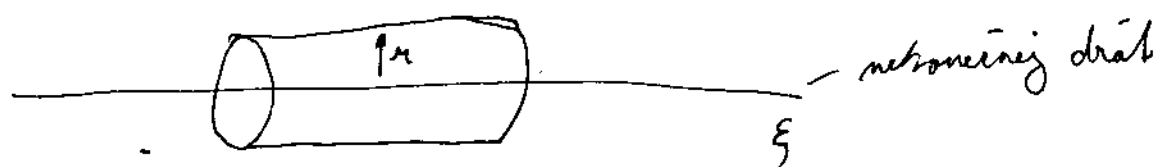
$$s = \frac{1}{2} a t^2$$

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jinak
Gauss.

$$\oint \vec{E} \cdot d\vec{S} = \frac{Q}{\epsilon}$$



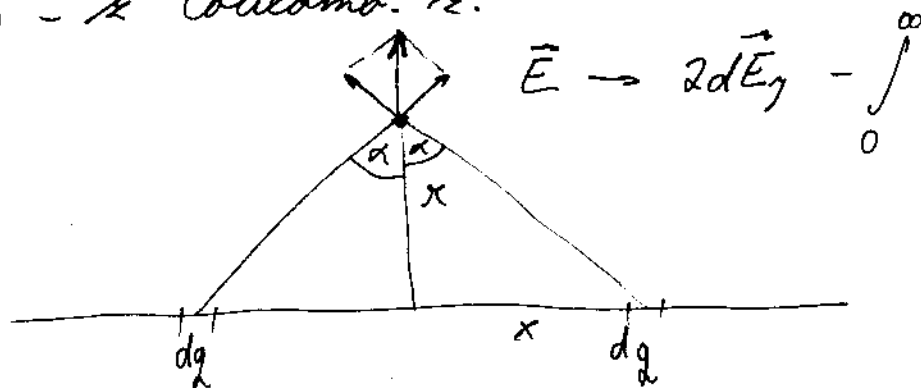
$\vec{E} \cdot d\vec{S}$ - na podstavách 0
 $\downarrow$
 $E dS$
 $\oint$
 ES

$$ES = \frac{Q}{\epsilon}$$

$$E \cdot 2\pi r l = \frac{Q}{\epsilon}$$

$$E = \frac{Q}{2\pi \epsilon r \cdot l} = \frac{\xi}{2\epsilon \pi r}$$

jinak - Coulomb. z.



figl - $\int_0^{\frac{\pi}{2}} d\alpha$

$$E = \frac{1}{4\pi \epsilon} \cdot \frac{\xi \cdot dx}{a^2}$$

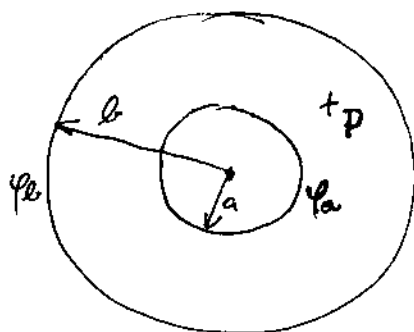
$$a = \frac{r}{\cos \alpha}$$

$$x = r \lg \alpha$$

$$dx = \frac{r}{\cos^2 \alpha} d\alpha$$

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podlínal



válcové elektrody, jejich potenciál
? potenciál v lib. bodě P

v tomto případě

$$\varphi(r) = - \int \vec{E} d\vec{r} = - \int E dr = - \frac{Q}{2\pi\epsilon l} \cdot \ln r + K$$

$$\oint \vec{E} d\vec{s} = \frac{Q}{\epsilon}$$

↓ - E konst., ... viz minule

$$E \cdot 2\pi r l = \frac{Q}{\epsilon}$$

$$E = \frac{Q}{2\pi\epsilon r l}$$

$$\varphi = K_1 \ln r + K_2$$

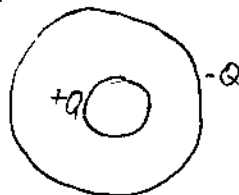
$$\varphi_a = K_1 \ln a + K_2$$

$$\varphi_b = K_1 \ln b + K_2 \quad \text{dop } K_1, K_2$$

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kondenzátor válcový

$$C = \frac{Q}{U}$$



$$\varphi \longrightarrow E = \frac{Q}{2\pi\epsilon r l}$$

$$\varphi = - \frac{Q}{2\pi\epsilon l} \cdot \ln r + K$$

$$U = \varphi_2 - \varphi_1 = \frac{Q}{2\pi\epsilon l} \cdot \ln \frac{r_2}{r_1} = \frac{Q}{C}$$

$$C = \frac{2\pi\epsilon l}{\ln \frac{r_2}{r_1}}$$

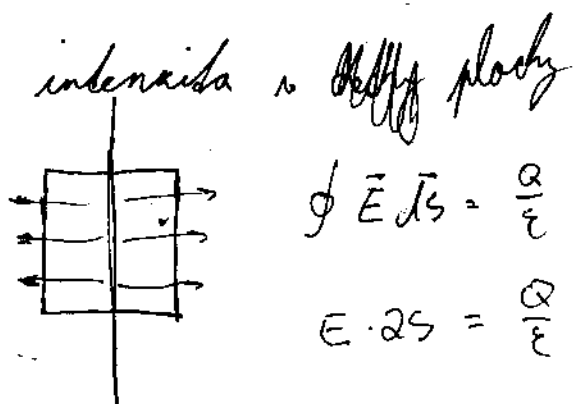
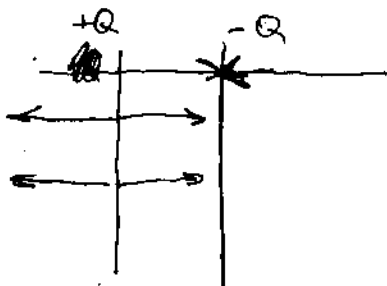
kondenzátor kulový



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

jako účinek bodového náboje

k. deskový



indukční plocha

$$\oint \vec{E} \cdot d\vec{s} = \frac{Q}{\epsilon}$$

$$E \cdot 2S = \frac{Q}{\epsilon}$$

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

$$E = \frac{\sigma}{2\epsilon}$$

platí v blízkosti plochy
(ta není nekonečná)

$$E = \frac{Q}{\epsilon S}$$

$$U = E \cdot d = \frac{Q}{\epsilon S} d = \frac{Q}{C}$$

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$$E = \frac{D}{\epsilon}$$

přecit

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$$\dot{q} = \frac{I}{\pi \frac{d^2}{4}} = \frac{5}{3 \cdot \frac{9^2 \cdot 10^{-6}}{4}} \approx 10^6 \text{ A m}^{-2}$$

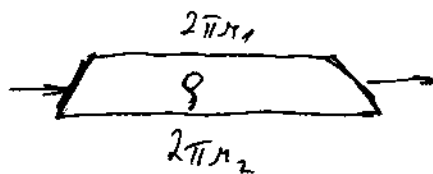
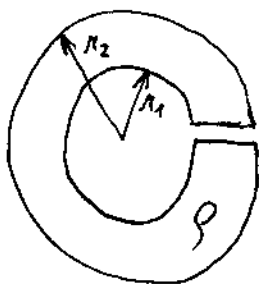
$$\dot{q} = n \cdot n_2 \cdot e$$

$$n = \frac{\rho \cdot N_A}{M_{Cu}} = 8 \cdot 10^{28}$$

$$n = \frac{\dot{q}}{n_2 \cdot e} = \frac{10^6}{8 \cdot 10^{28} \cdot 1.6 \cdot 10^{-19}} \approx 10^{-4} \text{ m} \cdot \text{s}^{-1}$$

$$n_T = \sqrt{\frac{3kT}{m_e}} = 10^5 \text{ m} \cdot \text{s}^{-1}$$

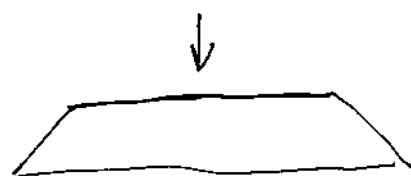
280 přerušný prstenec



$$dG = \frac{1}{\rho} \cdot \frac{h dr}{2\pi r}$$

$$G = \int_{r_1}^{r_2} dG = \frac{h}{\rho} \cdot \frac{\ln \frac{r_2}{r_1}}{2\pi}$$

b)



$$\int dR = \int \rho \cdot \frac{dr}{h \cdot 2\pi r} = \rho \cdot \frac{h \ln \frac{r_2}{r_1}}{2\pi h}$$

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vodičem $R = 5 \Omega$ přel náboj $Q = 40 C$
 jaká práce se vykonala?
 proud klesal na polovinu každých $\tau = 16 s$

$$I = I_0 e^{-\frac{t}{\tau}}$$

$$A = RI^2 t$$

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$$\oint (j_k + j_p) dS \quad \nearrow \frac{\partial D}{\partial t}$$

$$D = \epsilon E$$

$$\nabla U = I$$

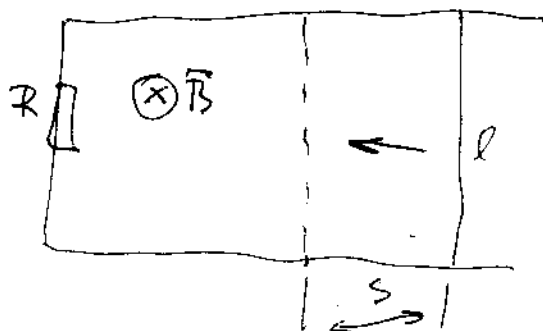
$$\nabla E = j$$

$$j_p = \frac{\partial D}{\partial t} = \frac{\epsilon \partial E}{\partial t} = \frac{\epsilon}{r} \cdot \frac{\partial j_k}{\partial t} \quad j_k = \sin \omega t$$

$$j_p = \frac{\epsilon}{r} j_{k0} 2\pi f \cdot \cos \omega t$$

$$\frac{j_p}{j_k} = 10^{-10} f$$

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$$S = l s t$$

$$U_{AB} = - \frac{d\Phi}{dt} = - \frac{B ds}{dt} = - \frac{B l v dt}{dt} \cos \gamma$$

$$U_{AB} = |-B l v| \cos \gamma = \frac{B l v}{2} = 0,1 mA$$

304

$$\oint H \cdot dl = \sum I$$

295
298