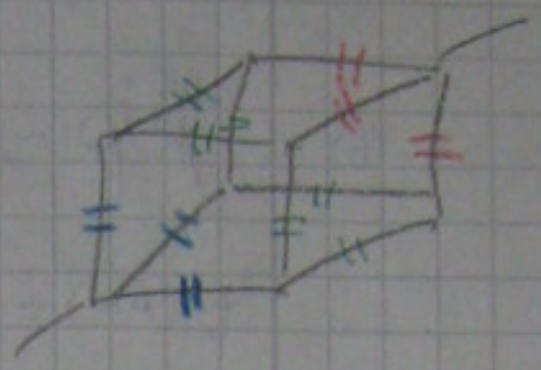
Explus ⑤

14

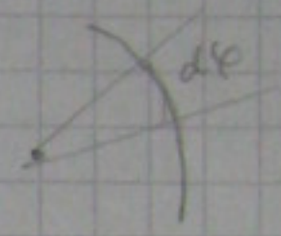
3C 6C 3C



$$\frac{1}{C_{ges}} = \frac{1}{3C} + \frac{1}{6C} + \frac{1}{3C}$$

$$= \frac{5}{6C}$$

$$C_{ges} = \frac{6}{5}C$$

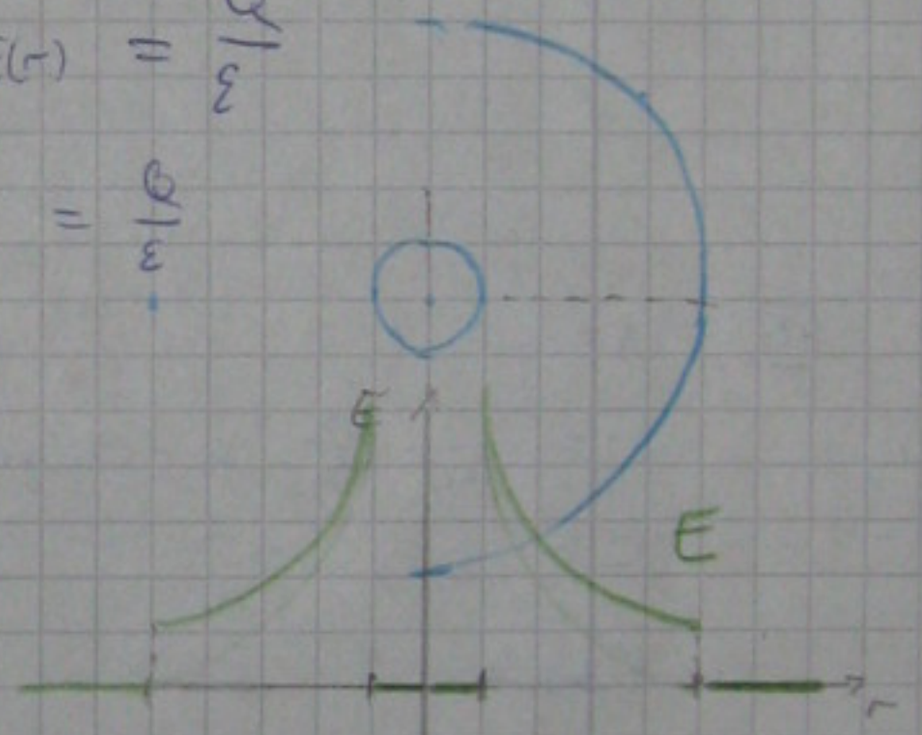


15 (a) $\Phi = \varepsilon \oint_A \vec{E}\, d\vec{A} = \frac{Q}{\varepsilon_0 \varepsilon_r}$

$$A(\omega) = \int_0^{2\pi} d\varphi \int_0^{L} dz \; r \cdot E(r) = \frac{Q}{\varepsilon}$$

$$= 2\pi r L \cdot E = \frac{Q}{\varepsilon}$$

$$E(r) = \frac{Q}{2\pi\varepsilon L \cdot r}$$



(b) $C = \frac{Q}{U}$

$$U = \int_a^b E\, dr = \int_a^b \frac{Q}{2\pi\varepsilon L \cdot r} \cdot dr = \frac{Q}{2\pi\varepsilon L} \ln \frac{b}{a}$$

$$C = \frac{Q}{\frac{Q}{2\pi\varepsilon L} \cdot \ln \frac{b}{a}} = \frac{2\pi\varepsilon L}{\ln \frac{b}{a}} \approx 1{,}265 \cdot 10^{-11}\ \mathrm{F} \qquad \varepsilon_0 = 8{,}85 \cdot 10^{-12} \frac{\mathrm{F}}{\mathrm{m}}$$

$\hat{=}$ 12,65 pF

16 (a) $F = \frac{1}{4\pi\varepsilon} \cdot \frac{q^2}{r^2}$

$$W = \int_{r=0{,}1\,\mathrm{nm}}^{\infty} F\, dr = -\frac{1}{4\pi\varepsilon} \frac{q^2}{r}\Big|_{r=0{,}1\,\mathrm{nm}}^{\infty} = \frac{q^2}{16\pi\varepsilon \cdot r_0} \approx 5{,}77 \cdot 10^{-19}\ \mathrm{J}$$

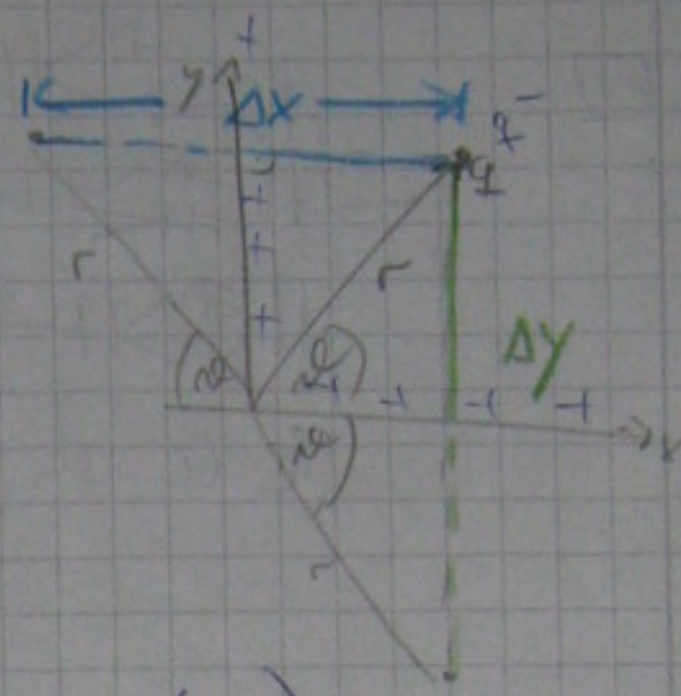
576,9 zJ

$\hat{=}$ 3,6 eV

$q = 1{,}602 \cdot 10^{-19}$

$\varepsilon \approx \varepsilon_0$

(b) ~~Lsg~~: $\varphi(r) = -\frac{1}{4\pi\varepsilon} \cdot \frac{q^2}{r}$



$\varphi_1(\Delta x) = -\frac{1}{4\pi\varepsilon} \cdot \frac{q^2}{\Delta x}$

$\varphi_2(\Delta y) = -\frac{1}{4\pi\varepsilon} \cdot \frac{q^2}{\Delta y}$

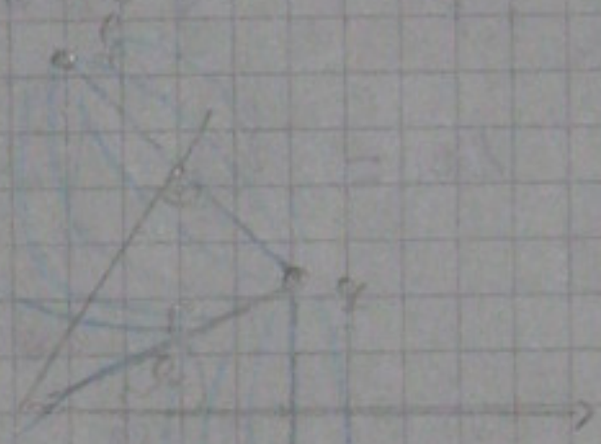
$\Delta x = 2r \cdot \cos\alpha$

$\Delta y = 2 \cdot r \cdot \sin\alpha$

$\varphi_{ges} = \varphi_1 + \varphi_2 = -\frac{q^2}{4\pi\varepsilon}\left(\frac{1}{2r\cos\alpha} + \frac{1}{2r\sin\alpha}\right)$

$\varphi_{ges}(r,\alpha) = \frac{q^2}{8\pi r\varepsilon}\left(\frac{\sin\alpha + \cos\alpha}{\sin\alpha\cos\alpha}\right)$

(c)

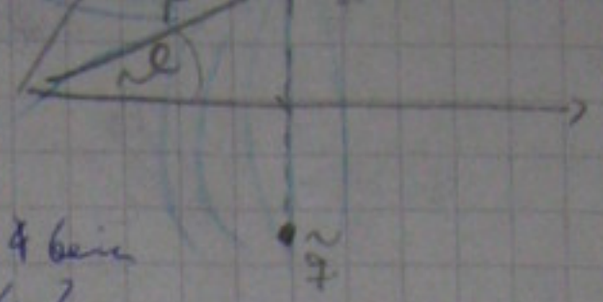


17 $U = \text{const.}$

$W = \frac{1}{2C} Q^2$ (Energie im Platten kond. d. beim Einschalten)

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

$W_{pot} =$



17 $U = \text{const.}$

$W = \frac{1}{2C} Q^2$ (Energie im Platten kond. & beim Einschalten)

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$W_{pot} =$

Schwerpunkt of halber Höhe

$W_{pot_{öl}} = \frac{1}{2} \cdot mgh = \frac{1}{2} \rho \cdot (hbd) \cdot h = \frac{1}{2} h^2 \rho \cdot bd$

$W = \frac{1}{2} C U^2 = \frac{1}{2} \varepsilon_0 \varepsilon_r \frac{A}{d} \cdot U^2$ $\quad dW_{pot} = -dW_C$

$W = \int_Q C(u) u \, du = \int_0^U \frac{1}{2} \varepsilon_0 \varepsilon_r \frac{A}{d} \hat{u} \, d\hat{u}$

$C(h) = \frac{h \cdot b}{d} \cdot \varepsilon_0 \cdot \varepsilon_r + \frac{(b-h) \cdot b}{d} \cdot \varepsilon_0 = \frac{b}{d} \varepsilon_0 [h \varepsilon_r + b - h]$

$\frac{1}{2} C U^2$

17

(b) $W_{ges} = W_C + W_{pot} = \int_0^U C \hat{u} \, d\hat{u} + \frac{1}{2} U^2 \rho b d g$

$= \frac{1}{2} C U^2 + \frac{1}{2} h \rho b d$

$W_{ges}(h) = \frac{1}{2} \frac{b}{d} \varepsilon_0 [h \varepsilon_r + b - h] \cdot U^2 + \frac{1}{2} h^2 \rho b d g$

Für welches h ist $W_{ges}(h)$ min?

$0 = \frac{1}{2} \frac{b}{d} \varepsilon_0 [\varepsilon_r - 1] \cdot U^2 + h \rho b d g$

$- \frac{b \varepsilon_0 U^2 [\varepsilon_r - 1]}{2 d \rho b d g} = h$

$h = \frac{[1 - \varepsilon_r] \varepsilon_0 \cdot U^2}{2 d^2 \rho g}$

$h(U, d) = \Psi \cdot \left(\frac{U}{d}\right)^2$

(a)