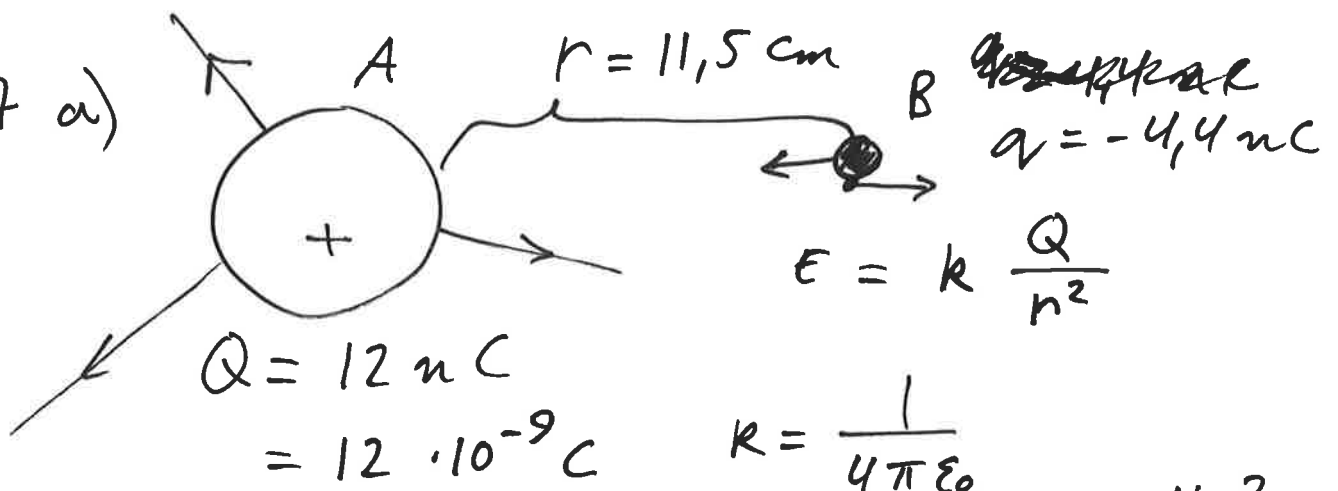


1.7 a)



$$E = k \frac{Q}{r^2} = 8,89 \cdot 10^9 \frac{\text{Nm}^2}{\text{C}^2} \cdot \frac{12 \cdot 10^{-9} \text{C}}{(0,115 \text{m})^2}$$
$$= \frac{8,89 \cdot 12}{0,115^2} \cdot \underbrace{10^9 - 9}_{=10^0} \frac{\text{N}}{\text{C}}$$

$$= 8157 \frac{\text{N}}{\text{C}}$$

$$\approx \underline{\underline{8,2 \frac{\text{kN}}{\text{C}}}}$$

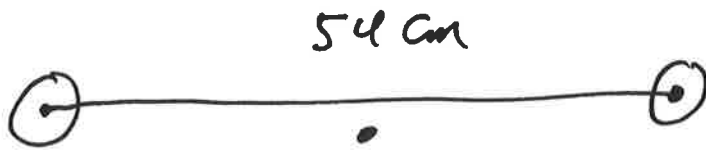
$$F = Eq = 8157 \frac{\text{N}}{\text{C}} \cdot 4,4 \cdot 10^{-9} \text{C}$$

$$= 35892 \cdot 10^{-9} \text{N}$$

$$= 35,892 \cdot 10^{-6} \text{N}$$

$$\approx \underline{\underline{36 \mu\text{N}}}$$

1.8



$$Q = 9,9 \mu\text{C}$$

$$q = 8,7 \mu\text{C}$$

$$E_1 \quad \rightarrow \quad E = E_2 - E_1$$



27 cm 27 cm

$$E_2 = k \frac{Q}{r^2} = 8,98 \cdot 10^9 \frac{9,9 \cdot 10^{-9} \text{ C}}{0,27^2 \text{ m}^2}$$

$\frac{\text{N m}^2}{\text{C}^2}$

$$= \frac{8,98 \cdot 9,9}{0,27^2} \frac{\text{N}}{\text{C}}$$

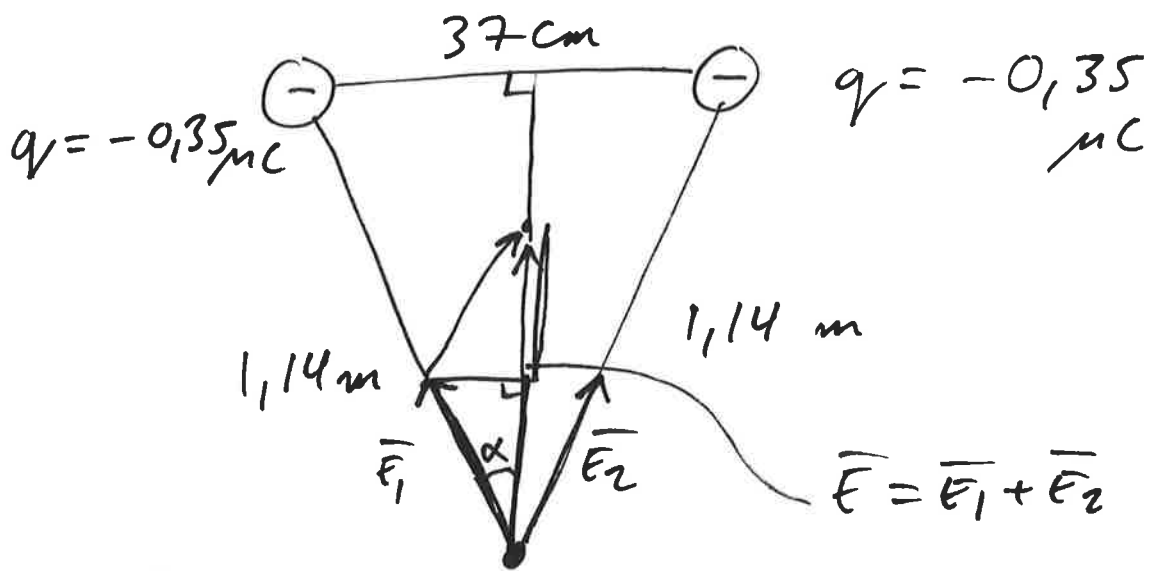
$$= 1220 \frac{\text{N}}{\text{C}}$$

$$E_1 = \frac{8,98 \cdot 8,7}{0,27^2} \frac{\text{N}}{\text{C}} = 1072 \frac{\text{N}}{\text{C}}$$

$$E = E_2 - E_1 = 1220 \frac{\text{N}}{\text{C}} - 1072 \frac{\text{N}}{\text{C}}$$

$$= \underline{\underline{148 \frac{\text{N}}{\text{C}}}}$$

1.9



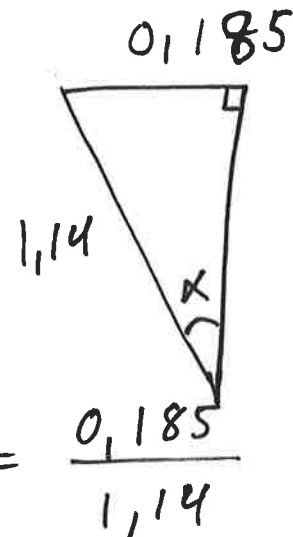
$$E = 2 E_1 \cos \alpha$$

$$E_1 = k \frac{q}{r^2} = 8,98 \cdot 10^9 \cdot \frac{0,35 \cdot 10^{-6}}{1,14^2}$$

$$= \frac{8,98 \cdot 1000 \cdot 0,35}{1,14^2}$$

$$= 2421 \frac{N}{C}$$

~~2421~~



$$\sin \alpha = \frac{0,185}{1,14}$$

$$\alpha = \sin^{-1} \left(\frac{0,185}{1,14} \right)$$

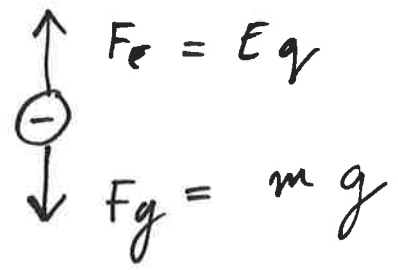
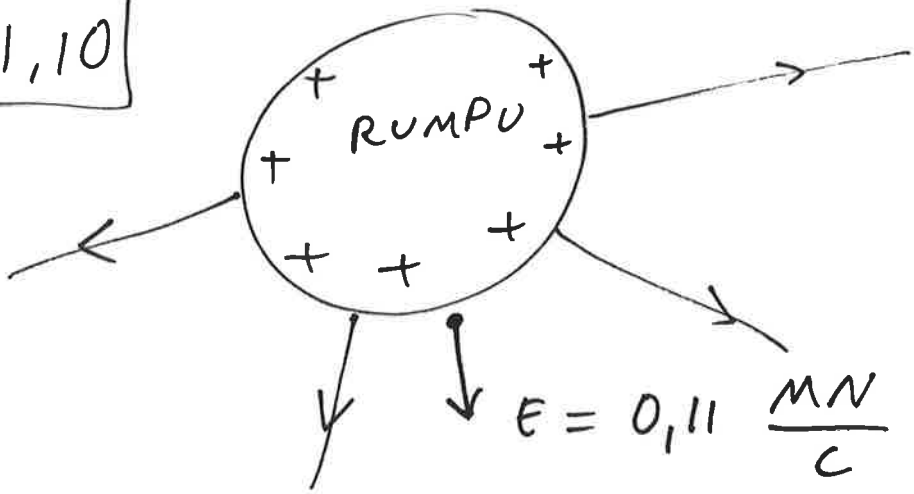
$$= 9,33^\circ$$

$$E = 2 E_1 \cos \alpha$$

$$= 2 \cdot 2421 \frac{N}{C} \cdot \cos(9,33^\circ)$$

$$= 4777 \frac{N}{C} \approx \underline{\underline{4,8 \frac{kN}{C}}}$$

1,10



$\frac{q}{m}$?
	.

$$F_E = 10 F_g$$

$$Eq = 10 mg \quad || : Em$$

$$\frac{q}{m} = 10 \frac{g}{E}$$

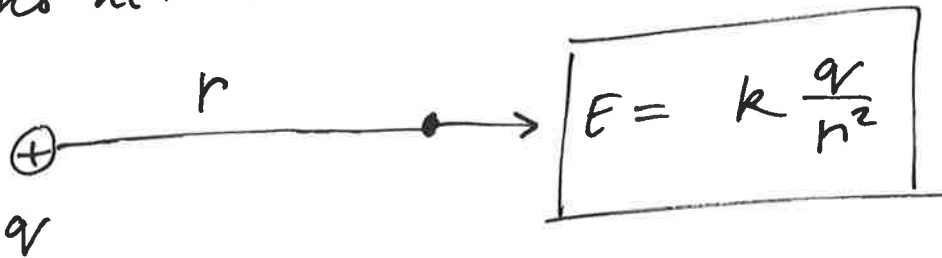
$$= 10 \cdot \frac{9,81 \text{ m/s}^2}{0,11 \cdot 10^6 \frac{\text{N}}{\text{C}}} \quad \frac{\text{C}}{\text{kg}}$$

$$= \frac{10 \cdot 9,81}{0,11} \cdot 10^{-6} \frac{\text{C}}{\text{kg}}$$

$$= 89,18 \cdot 10^{-6} \frac{\text{C}}{\text{kg}}$$

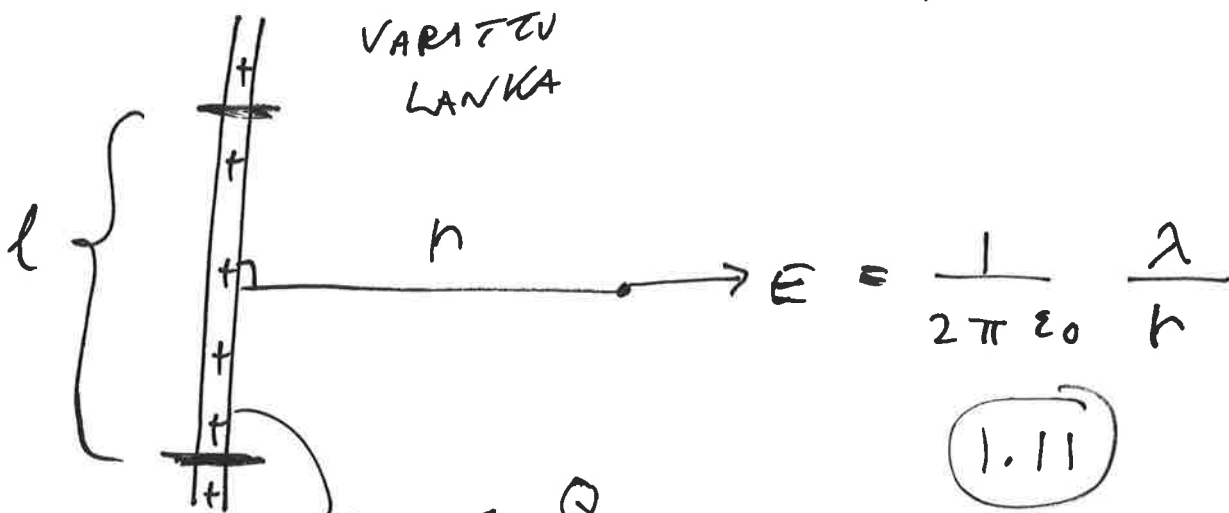
$$\approx \underline{\underline{890 \frac{\mu\text{C}}{\text{kg}}}}$$

SÄHKÖ KENTTÄ



PISTEVARAUS

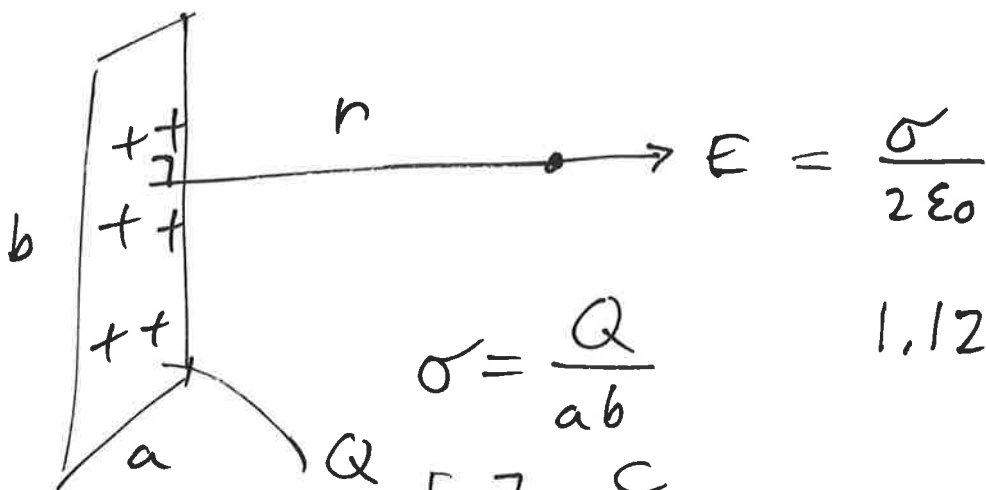
$$= \frac{1}{4\pi\epsilon_0} \frac{q}{r^2}$$



VARITTU LANKKA

VARAUS Q
 PITVUSVARAUS $\lambda = \frac{Q}{l}$
 $[\lambda] = \frac{C}{m}$

VARITTU TASOPINTA

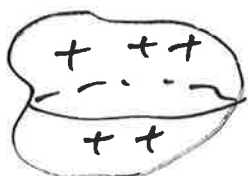


$$\sigma = \frac{Q}{ab}$$

1.12 (b)

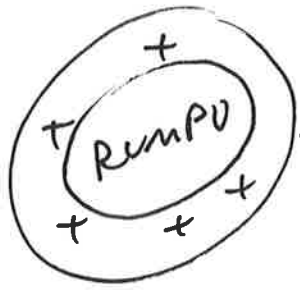
$$[\sigma] = \frac{C}{m^2}$$

AVARUUSVARAUS



$$\rho = \frac{Q}{V}$$

$$[\rho] = \frac{C}{m^3}$$



$$E = 0,142 \frac{MN}{C}$$

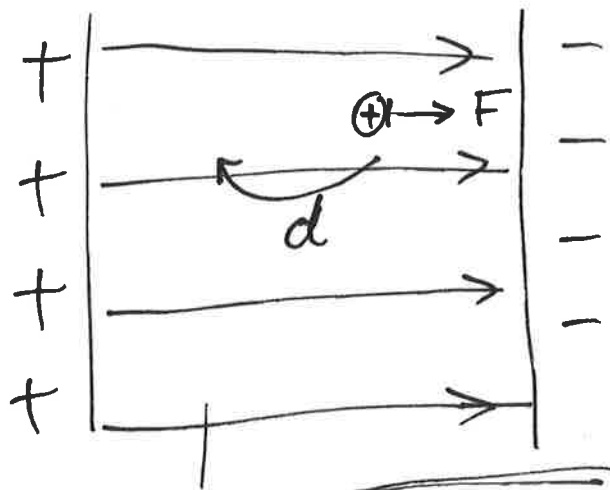
$$E = \frac{\sigma}{2\epsilon_0} \rightarrow \boxed{\sigma = 2\epsilon_0 E}$$

$$\sigma = \frac{Q}{A} \quad || \cdot A$$

$$\rightarrow \boxed{Q = \sigma A}$$

~~Handwritten scribbles~~

HO MOGEE NI NEN SÄHKÖKENTTÄ



$$F = Eq$$

$$W = Fd$$

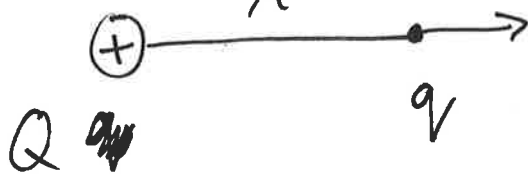
$$= Eqd$$

$$= \underbrace{Ed}_U q$$

$$U = Ed$$

$$W = Uq$$

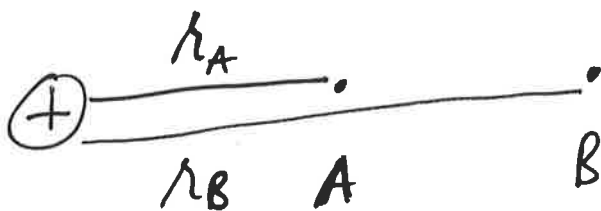
PISTEVARAUS



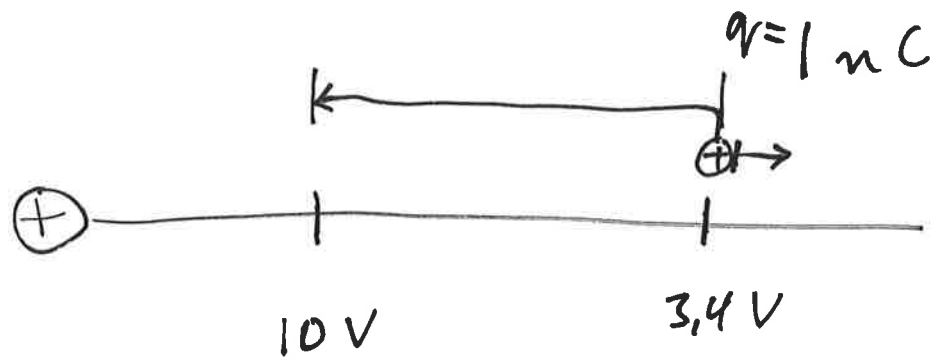
$$F = k \frac{Qq}{r^2}$$

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

$$V = k \frac{Q}{r}$$



$$U_{AB} = V_A - V_B = k \frac{Q}{r_A} - k \frac{Q}{r_B}$$



SIIRTO TYÖ

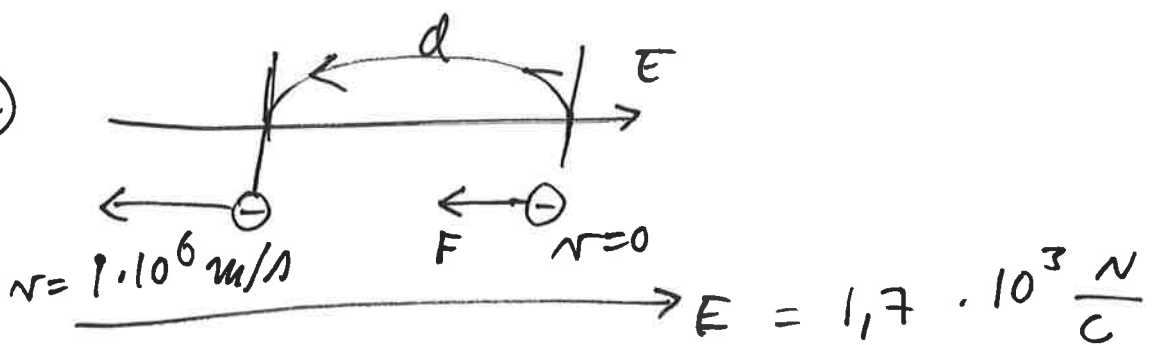
$$\begin{aligned}
 W &= (10 \text{ V} - 3,4 \text{ V}) \cdot 1 \text{ nC} \\
 &= 6,6 \text{ V} \cdot 1 \cdot 10^{-9} \text{ C} \\
 &= 6,6 \cdot 10^{-9} \text{ J} \\
 &= \underline{\underline{6,6 \text{ nJ}}}
 \end{aligned}$$

~~TA~~ POTENTIAALIERO $10 \text{ V} - 3,4 \text{ V}$

= U = ALKU JA LOPPUPISTEEN
VÄLINEN JÄNNITE

$$W = Uq$$

1,17 a)



$$F = E q = \underline{\underline{E e}}$$

$$[e = 1,6022 \cdot 10^{-19} \text{ C}]$$

NEWTON 2:

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

$$E e = m a \quad || : m$$

$$a = \frac{E e}{m}$$

$$= \frac{1,7 \cdot 10^3 \cdot 1,6022 \cdot 10^{-19}}{9,11 \cdot 10^{-31}}$$

$$= \frac{1,7 \cdot 1,6022}{9,11} \cdot 10^{3-19+31}$$

$$= \underline{\underline{2,99 \cdot 10^{14} \text{ m/s}^2}} \quad 10^{15}$$

b) HOMOGEENINEN SÄHKÖKENTTI

$$U = \underline{E d}$$

$$W = U q = E d q = \text{KIIHOYDEN TYÖ}$$

$$= \frac{1}{2} m v^2$$

$$\Rightarrow E d q = \frac{1}{2} m v^2 \quad || : E q$$

$$\Rightarrow d = \frac{m v^2}{2 E q}$$

$$= \frac{9,11 \cdot 10^{-31} \cdot (10^6)^2 \cdot 10^{2 \cdot 6} = 10^{12}}{2 \cdot 1,7 \cdot 10^3 \cdot 1,6022 \cdot 10^{-19}}$$

$$= \frac{9,11}{2 \cdot 1,7 \cdot 1,6022} \cdot 10^{-31 + 2 \cdot 6 - 3 + 19}$$

$$= 1,6723 \cdot 10^{-3} \text{ m} \quad = 10^{-31 + 12 + 16}$$

$$= 10^{-31 + 28}$$

$$= 10^{-3}$$

$$\approx \underline{\underline{1,67 \text{ mm}}}$$