16.1, 3, 5, 25, 37, 71, 75, 87, 104

~~Copper rod gains −1.0 μC (electrons).~~

~~How much mass is this?~~

$$\cancel{-1.0\,\mu C \left| \frac{1\,C}{1\times10^{6}\,\mu C} \right| \frac{1\ \text{electron}}{1.602\times10^{-19}\,C} \left| \frac{9.1\times10^{-31}\,kg}{1\ \text{electron}} \right. = -5.69\times10^{-18}\,kg}$$

16.1

$$\frac{\Delta PE}{q_o} = \Delta V \qquad q_o = 20.0\ nC$$

$$W = 60\ nJ$$

$$\Delta V = \frac{\Delta PE}{q_o} = \frac{W}{q_o} = \frac{60\ nJ}{20.0\ nC} = \boxed{3.0\ V = \Delta V}$$

16.3

$q_o = 50.0\ nC$

$V_i = 500\ V$

$W = -200.0\ \mu J$ (work in)

$V_f = ?$

$$\Delta V = \frac{\Delta PE}{q_o} \Longrightarrow \Delta PE = q_o(V_f - V_i)$$

$$\Longrightarrow \frac{\Delta PE}{q_o} = V_f - V_i \Longrightarrow V_f = \frac{\Delta PE}{q_o} + V_i$$

$$\frac{W}{q_o} + V_i = \frac{-200\ \mu J}{50.0\ nC} + 500\ V$$

$$\boxed{V_f = -3500\ V = -3.5\ kV}$$

16.5

$V = 0\,V$ $\quad$ $-25.0\,nC$

$d = 100\,cm$

$V = 100\,V$

$$\frac{\Delta PE}{q_0} = \Delta V$$

$$\Delta W = q_0 \Delta V$$

$$= (-25.0\,nC)(100 - 0\,V)$$

$$= -2.5\times 10^{-6}\ J$$

$$\boxed{\Delta W = -2.5\,\mu J}$$

negative means applied force does negative work
($\vec{E}$-field does positive work on charge)

16.25

Eq. (16.8):

$$V = \frac{k_0 q}{r}$$

$q = 25\,\mu C$

(1) $\times$ 20m

$$V_1 = \frac{(9.0\times 10^9\ N\cdot m^2/C^2)(25\,\mu C)}{20\,m}$$

$V_1 = 11250\ V$

$V_2 = 225000\ V$

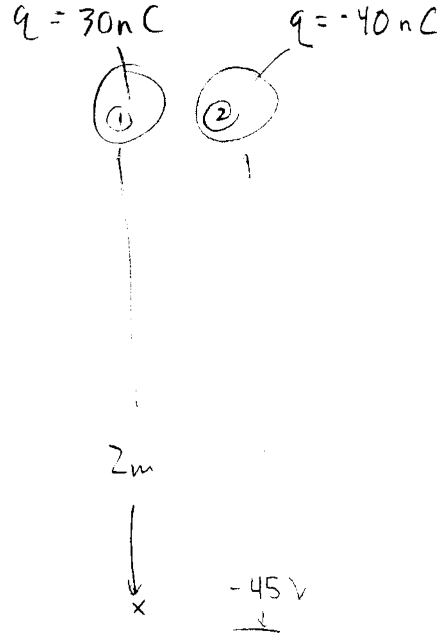
(2) $\times$ 1m

$$\Delta V = 213750\ V$$

$$\boxed{\Delta V = 2.14\times 10^5\ V}$$

the one 1m away is @ higher voltage.

$\boxed{16.39}$



$$V = V_1 + V_2$$

$$= \frac{k_0 q_1}{r_1} + \frac{k_0 q_2}{r_2} \qquad r_1 \cong r_2$$

$$= \frac{k_0}{r}(q_1 + q_2)$$

$$= \frac{(9.0 \times 10^9 \ N m^2/C^2)(-10 nC)}{2m}$$

$$\boxed{V = -45 \ V}$$

$\boxed{16.71}$ $C = 100 \ pF$

$C = \frac{Q}{V}$ $V = 1.5 V$

pico	$p = 10^{-12}$
nano	$n = 10^{-9}$
micro	$\mu = 10^{-6}$
milli	$m = 10^{-3}$

$$\Rightarrow Q = CV$$

$$= (100 \times 10^{-12} \ F)(1.5 \ V)$$

$$\boxed{Q = 1.5 \times 10^{-10} \ C} = 0.15 nC$$

$\boxed{16.75}$

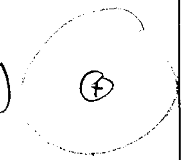
What is radius of sphere in air

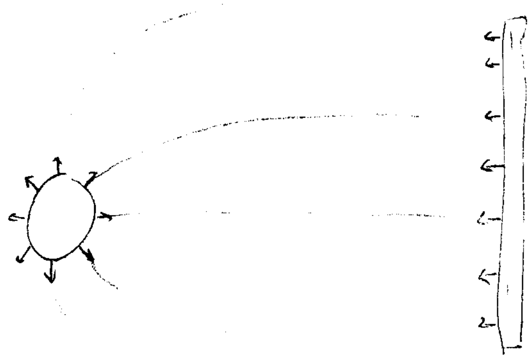
if it has $C = 10\,pF$

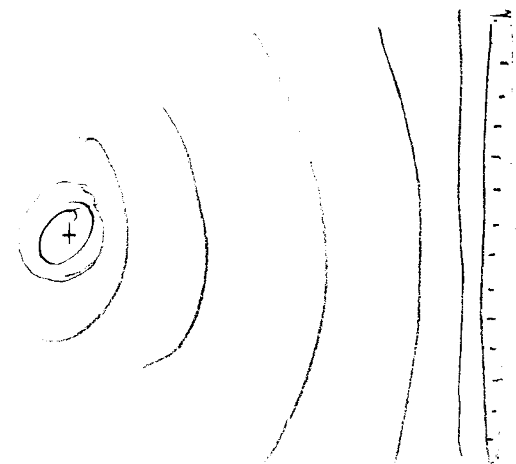
(sphere) $C = 4\pi\varepsilon_0 R = \dfrac{R}{k_0} \implies R = k_0 C$

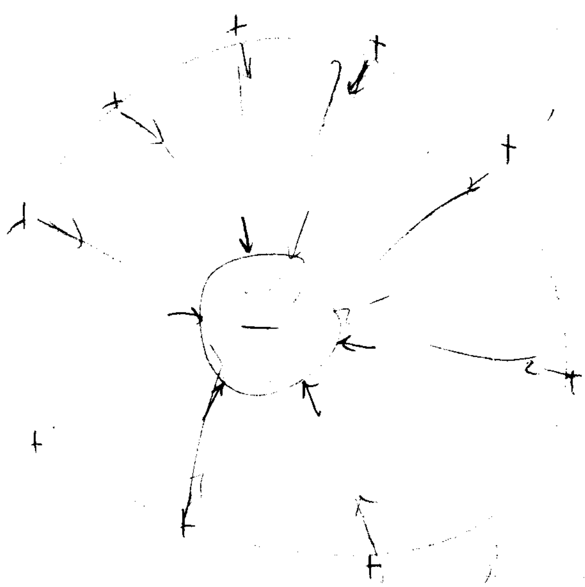
$= (9.0\times10^{9}\ N\cdot m^2/C^2)(10\,pF)$

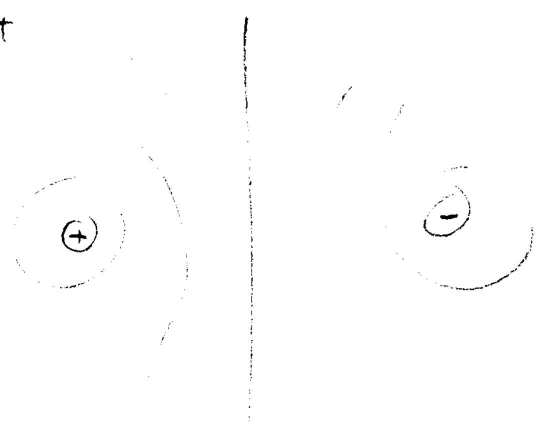
$\boxed{R = 0.09\,m = 9\,cm}$











$\Delta PE = W = F \times d$

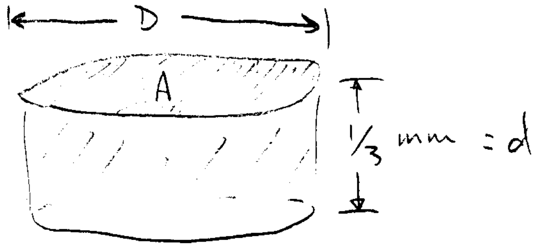
$\boxed{16.87}$

GIVEN

$D = 0.50$ cm

$d = \frac{1}{3}$ mm

$\varepsilon / \varepsilon_0 = 4.8$



K_e = relative permittivity = $\varepsilon / \varepsilon_0$

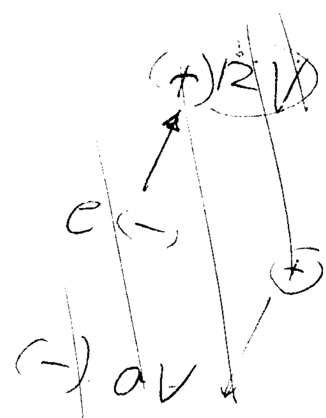
$$\boxed{C = \frac{\varepsilon A}{d}}$$ (parallel-plate capacitor).

$\varepsilon = 4.8\,\varepsilon_0$

$\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/N \cdot m^2$

$$C = \frac{(4.8\varepsilon_0)(\frac{\pi}{4})D^2}{d}$$

$$= \frac{(4.8)(8.85 \times 10^{-12}\ C^2/N\cdot m^2)(\pi/4)(0.005\,m)^2}{0.33 \times 10^{-3}\ m}$$

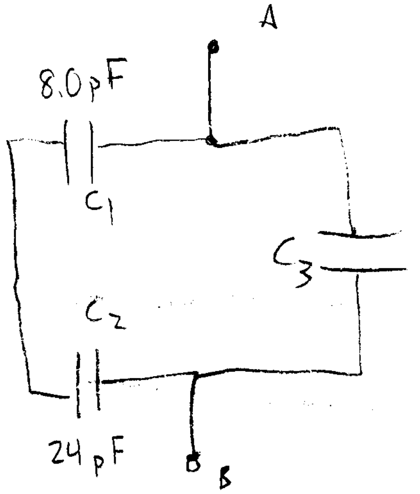


$C = 2.53 \times 10^{-12}$ F

$$\boxed{C = 2.53\ pF}$$

$\boxed{16.104}$

What is C_{eq} between A and B?

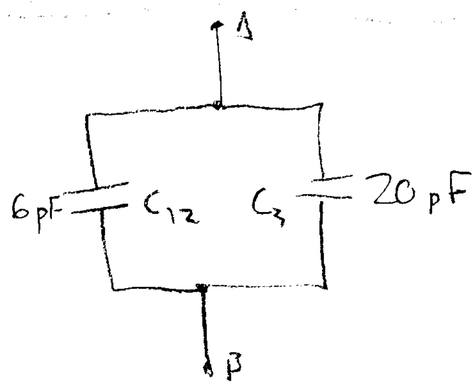


C_1 and C_2 in series:

$$\frac{1}{C_{12}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{8} + \frac{1}{24} = \frac{1}{6}$$

$C_{12} = 6 \text{ pF}$

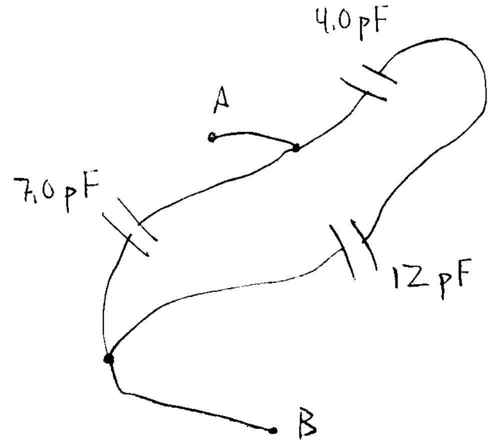
C_{12} and C_3 in parallel



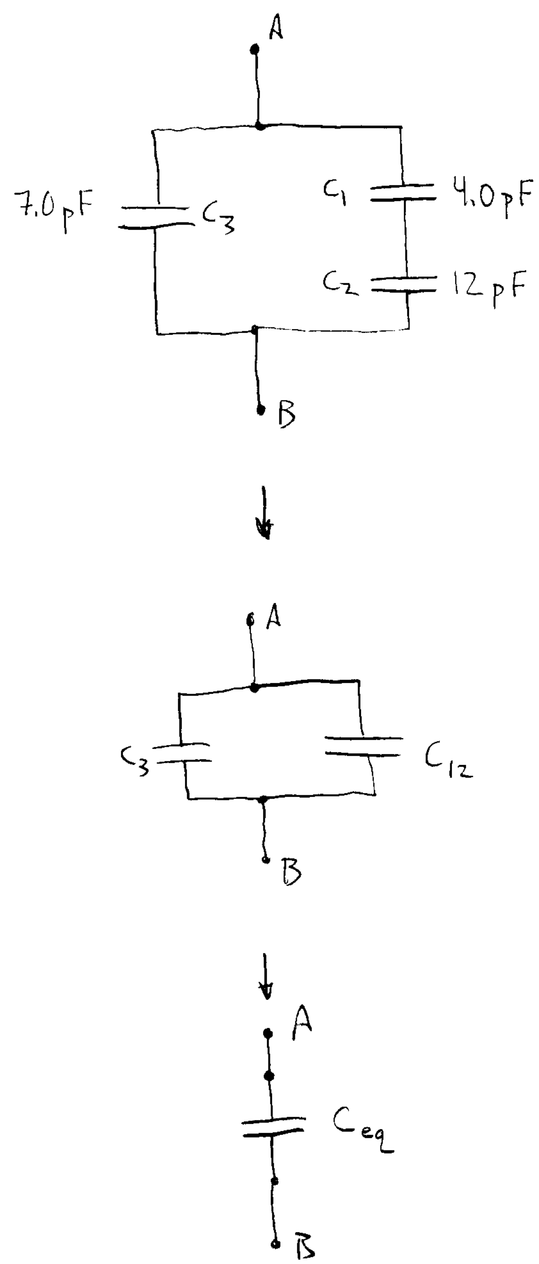
$C_{123} = C_{12} + C_3$

$\boxed{C_{123} = 26 \text{ pF}}$

$\boxed{16.105}$ Equivalent capacitance:



(1) Redraw circuit



C_1 and C_2 are in series:

$$\Rightarrow \frac{1}{C_{12}} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$= \frac{1}{4.0\,pF} + \frac{1}{12\,pF} = \frac{1}{3\,pF}$$

$$\boxed{C_{12} = 3\ pF}$$

C_{12} is in parallel with C_3:

$$\Rightarrow \quad C_{eq} = C_{12} + C_3$$

$$= (3\,pF) + (7\,pF)$$

$$\boxed{C_{eq} = 10\ pF}$$