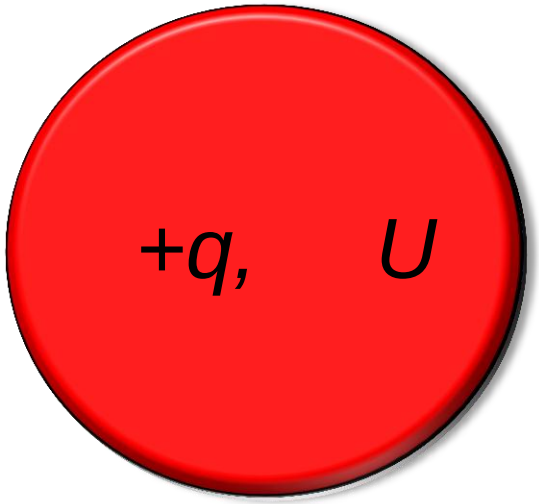
Electric capacitance calculation with QuickField

1. Single conductor. Capacitance of sphere.

2. Two conductors: plane, spherical, cylindrical capacitors. Parallel wires capacitance. Ideal and real capacitor.

3. Complex system: transmission line capacitance, winding capacitance.

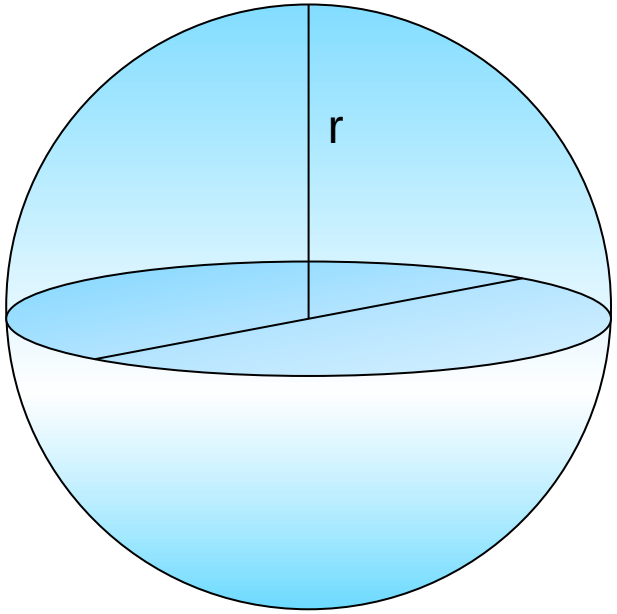
Single conductor capacitance



U - potential
q - charge
W - energy
C - capacitance

$$C = q / U \qquad C = q^2 / 2W$$

Sphere capacitance



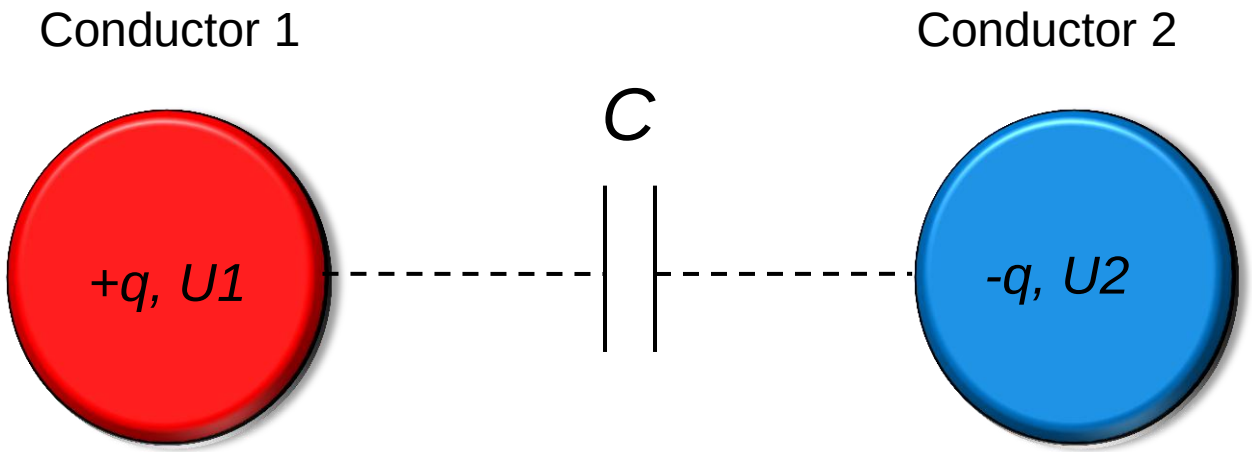
Given:

r = 100 mm
$q = 10^{-9}$ C

$$C = 4\pi\varepsilon\varepsilon_0 r = 11{,}13 \text{ pF}$$

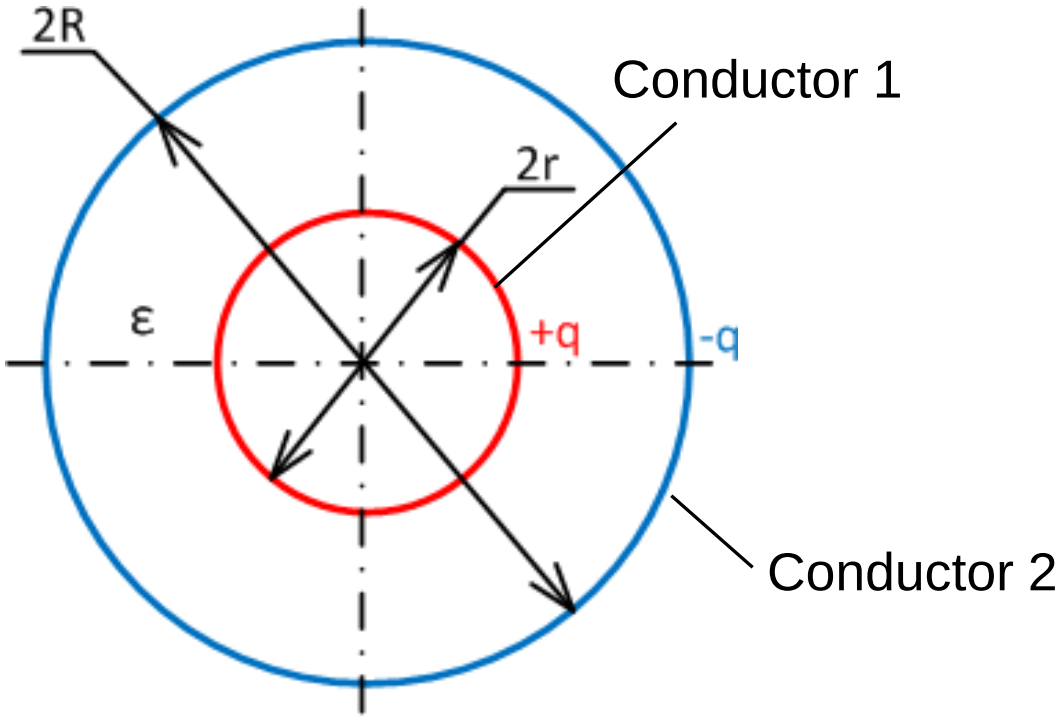
Capacitance between two conductors

$U = 0$



$$C = q / (U2 - U1)$$

Spherical capacitor

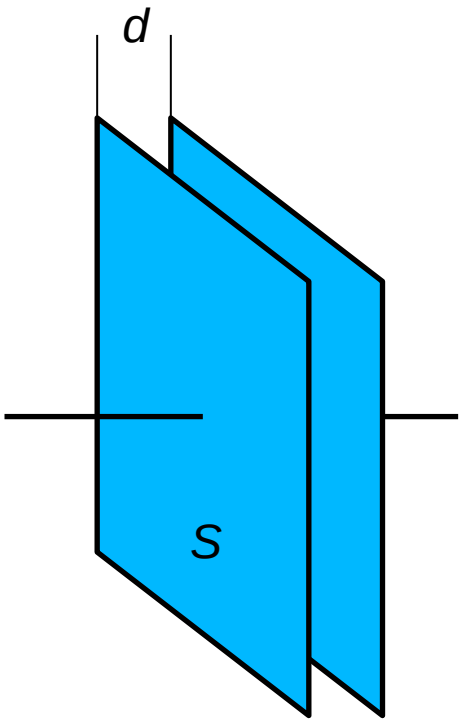


Given:

r = 100 mm
R = 200 mm
$q = 10^{-9}$ C

$$C = 4\pi\varepsilon\varepsilon_0 / (1/r - 1/R) = 22.253 \text{ pF}$$

Plane capacitor

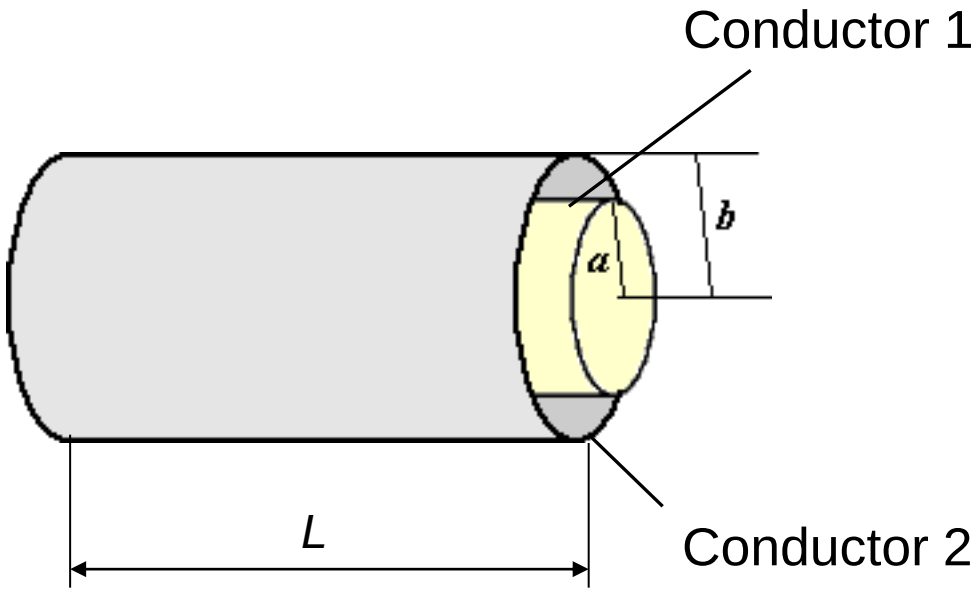


Given:

$S = 1\ m^2$
$d = 0{,}1\ m$
$q = 10^{-9}\ C$

$$C = \varepsilon\varepsilon_0 S / d = 88.542\ pF$$

Cylindrical capacitor

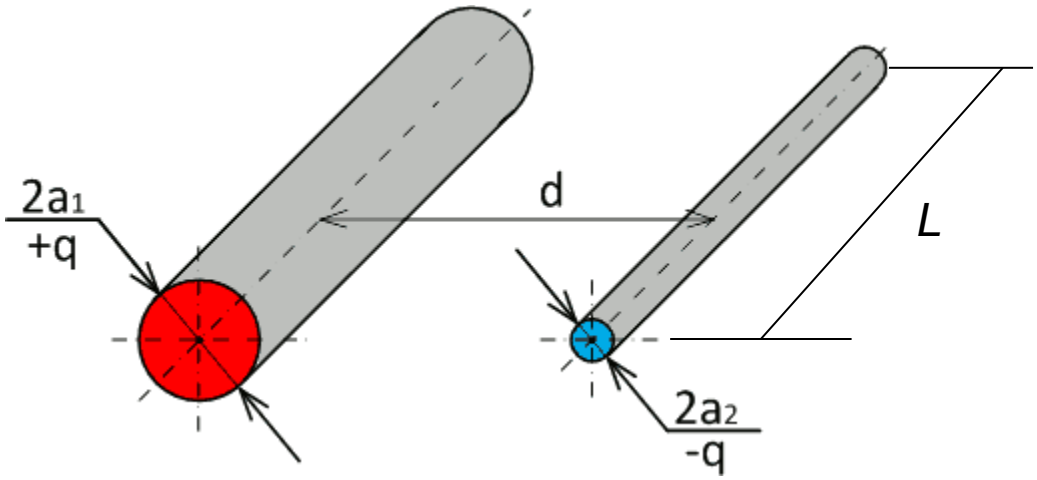


Given:

a = 50 mm
b= 100 mm
$q = 10^{-9}$ C
$L = 1\ m$

$$C = 2\pi\varepsilon\varepsilon_0 \cdot L \,/\, \ln(a/b) = \ 80.26\ \text{pF}$$

Parallel wires capacitance

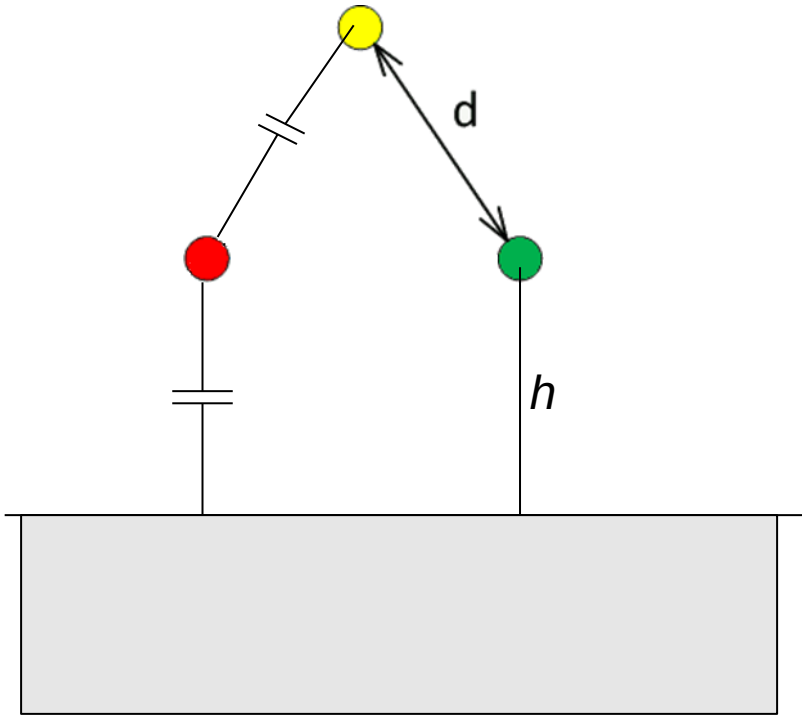


Given:

a1 = 10 mm
a2 = 5 mm
d = 100 mm
q = 10^{-9} C
L = 1 m

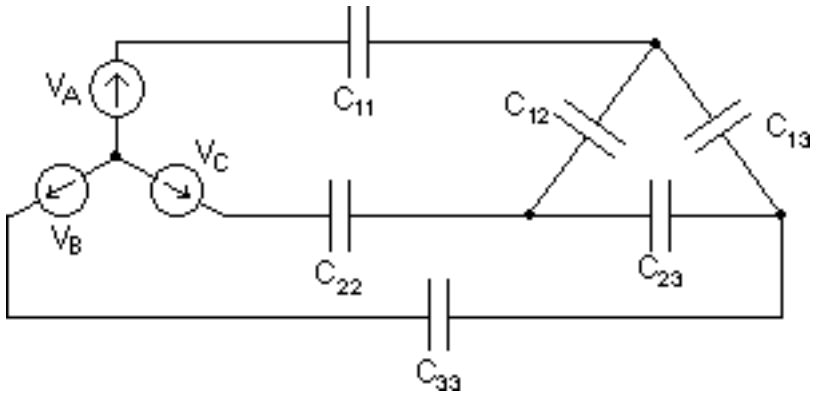
$$C = 2\pi\varepsilon\varepsilon_0 L / \operatorname{arch}[(d^2 - a_1^2 - a_2^2)/2a_1 \cdot a_2] =$$
$$= 10.53 \text{ pF}$$

Transmission line capacitance



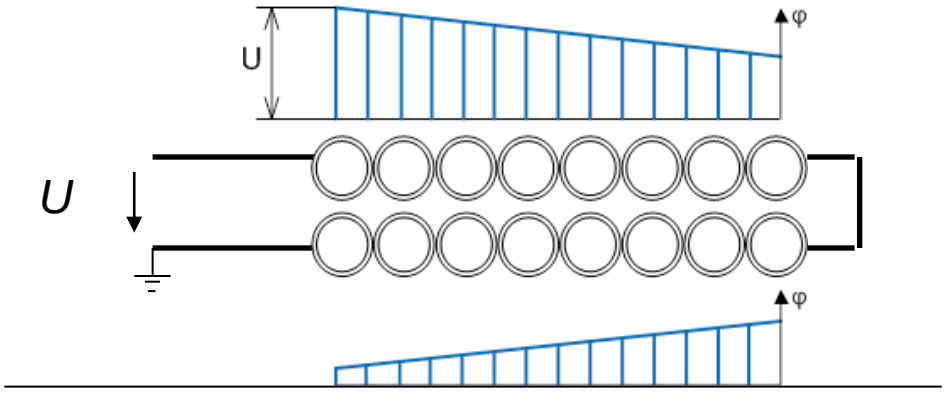
Given:

d = 0.5 m
h = 5 m
f = 50 Hz
L = 4 km



$$U_1 = q_1/C_{11} + q_2/C_{12} + q_3/C_{13}$$

Winding capacitance



$$C = 2 \cdot W / U^2$$