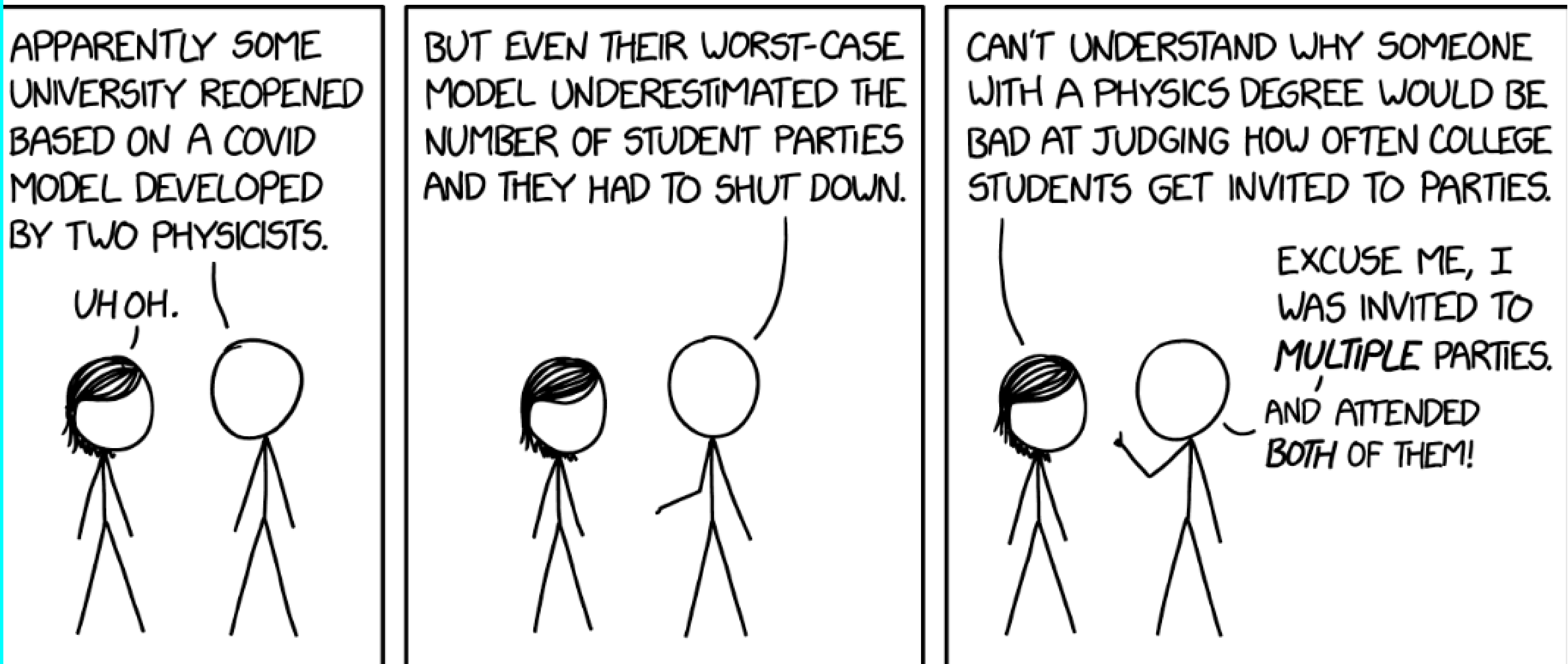


Randall Munroe/xkcd.com

Lecture 11 outline:

- Comments on homework and knowing when to approximate.
- Field of a plate
- Behavior of conductors
- Definition of Capacitance
- Capacitance of parallel plates
- Coaxial capacitors

SPN 2-09b: A square conductor has Q = 15 C, s = 3 km. Calculate the electric field at y = 100 m.

SPN 2-09c:
Calculate the electric field at y = 100 km.

SPN 2-09b: A square conductor has Q = 15 C, s = 3 km. Calculate the electric field at y = 100 m.

WolframAlpha computational intelligence.

integrate 1/((a^2+x^2)(b^2+x^2)^(1.5))

Extended Keyboard | Upload | Examples | Random

Indefinite integral:

$$\int \frac{1}{(a^2+x^2)(b^2+x^2)^{1.5}}\,dx = -\left(\left(0.0666667\,x\sqrt{b^2+x^2}\left(-4x^4(a^2-b^2)^2(b^2+x^2)\sqrt{-\frac{a^2x^2(a^2-b^2)(b^2+x^2)}{b^4(a^2+x^2)^2}}\;{}_2F_1\!\left(2,2;3.5;\frac{(b^2-a^2)x^2}{b^2(a^2+x^2)}\right)-15b^2(a^2+x^2)(3b^2+2x^2)\left(b^2(a^2+x^2)\sqrt{-\frac{a^2x^2(a^2-b^2)(b^2+x^2)}{b^4(a^2+x^2)^2}}-a^2(b^2+x^2)\sin^{-1}\!\left(\sqrt{\frac{x^2(b^2-a^2)}{b^2(a^2+x^2)}}\right)\right)\right)\right)\Big/\left(b^{10}(a^2+x^2)^3\left(\frac{x^2}{a^2}+1\right)\left(\frac{a^2x^2(b^2-a^2)(b^2+x^2)}{b^4(a^2+x^2)^2}\right)^{3/2}\right)\right) + \text{constant}$$

$\sin^{-1}(x)$ is the inverse sine function

${}_2F_1(a, b; c; x)$ is the hypergeometric function

Discontinuity of a field at a boundary
You cross a surface with a charge density sigma.

A) The normal component (En) changes by Sigma / epsilon_0, and the tangential component (Et) may change too.

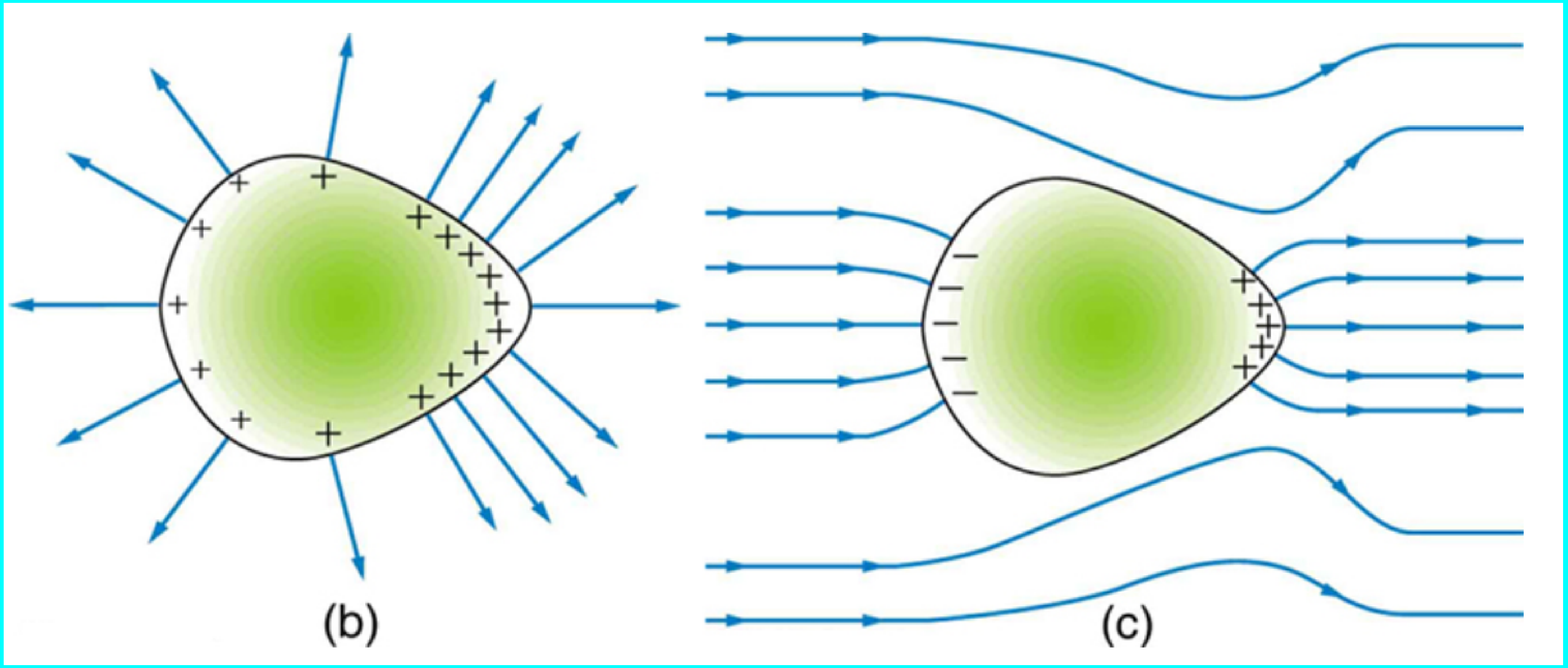
B) En changes by sigma/2 eps0, and Et may change.

C) Et changes by sigma/eps0

D) En changes by sigma/eps0, and Et does not change

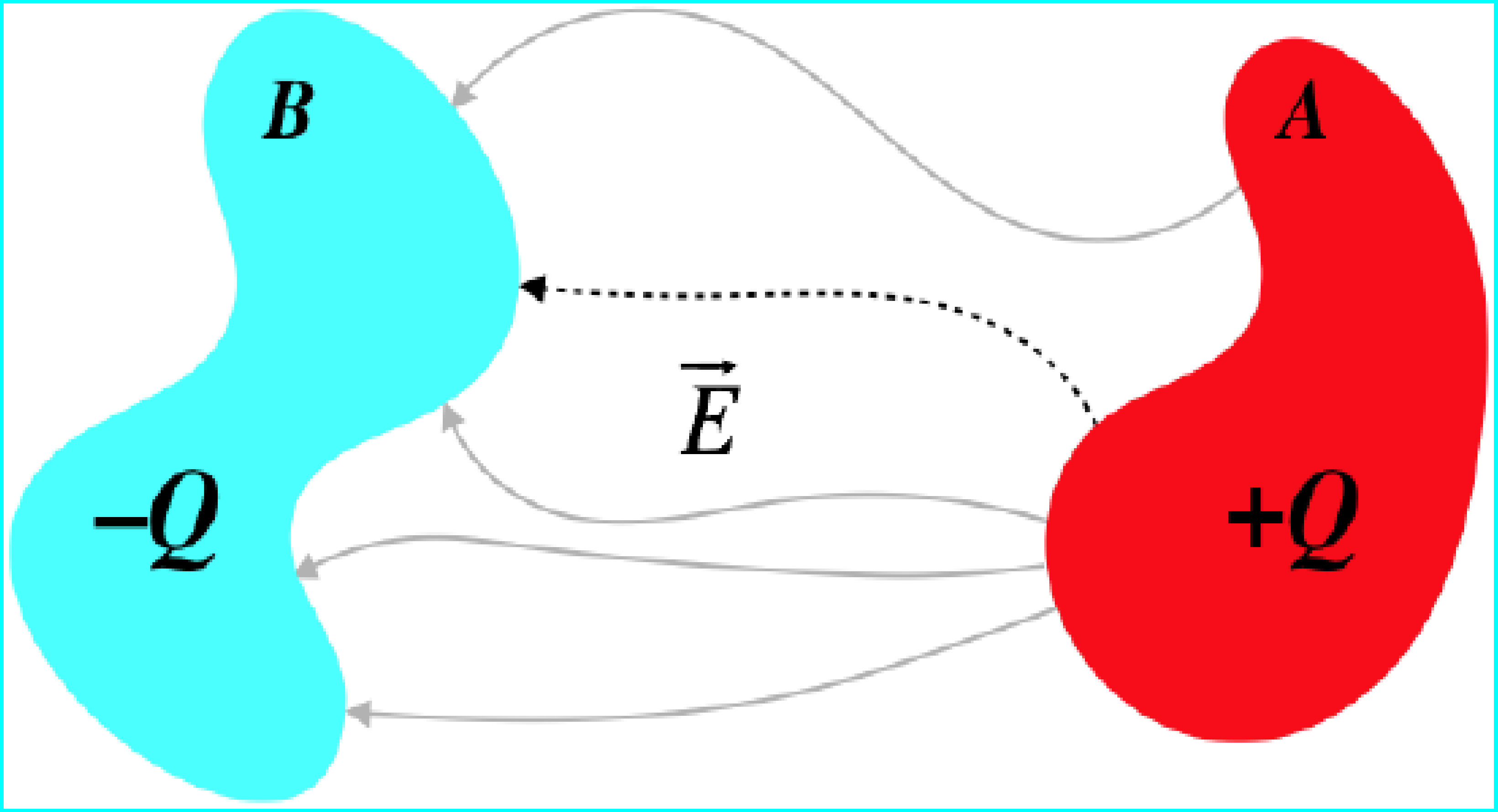
CONDUCTORS

"Conduction electrons" are not bound to their atoms.
 (A conductor is a tube of free electrons)
Excess charges go to surface of conductors
Field inside a conductor is zero
Conductors placed in external fields polarize

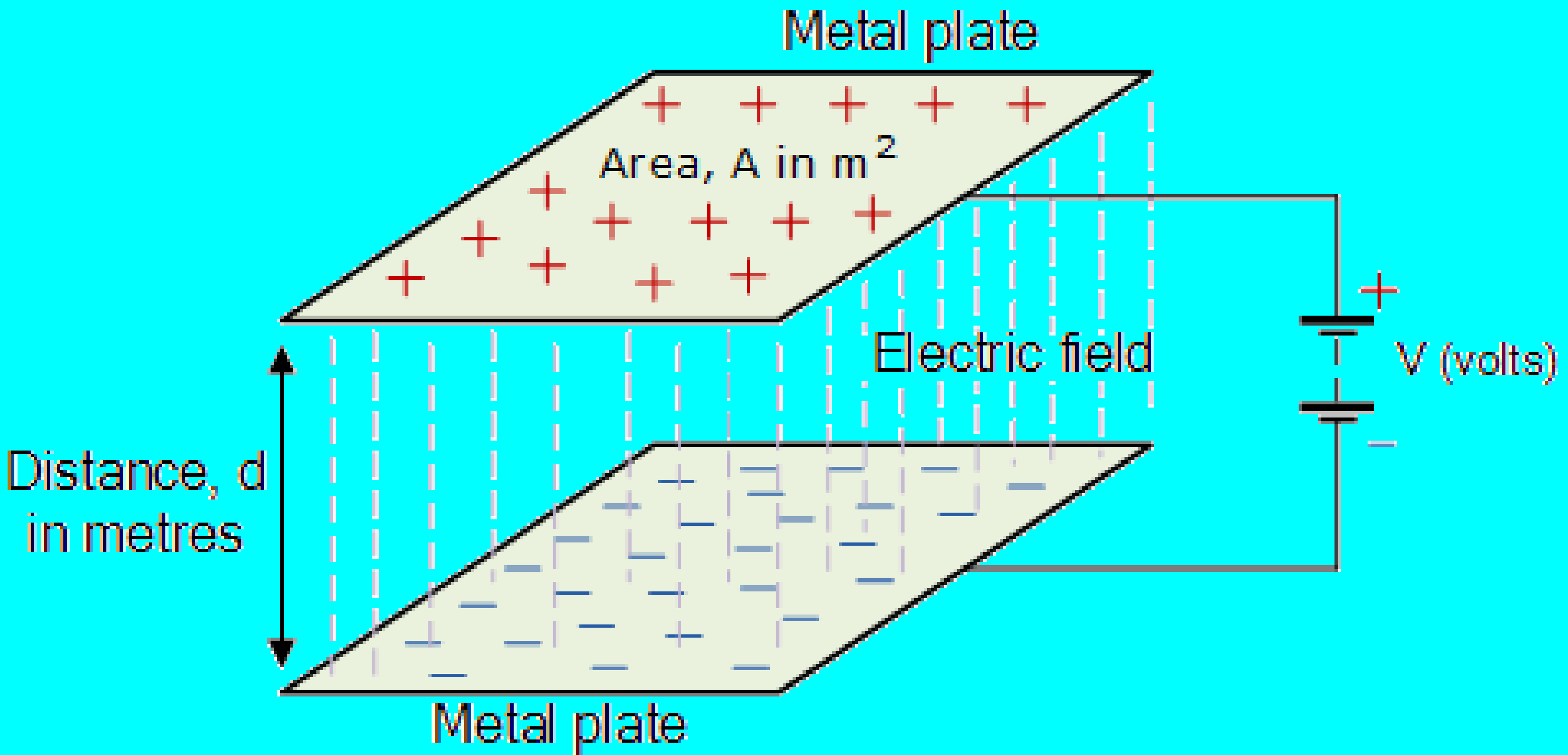


CAPACITANCE

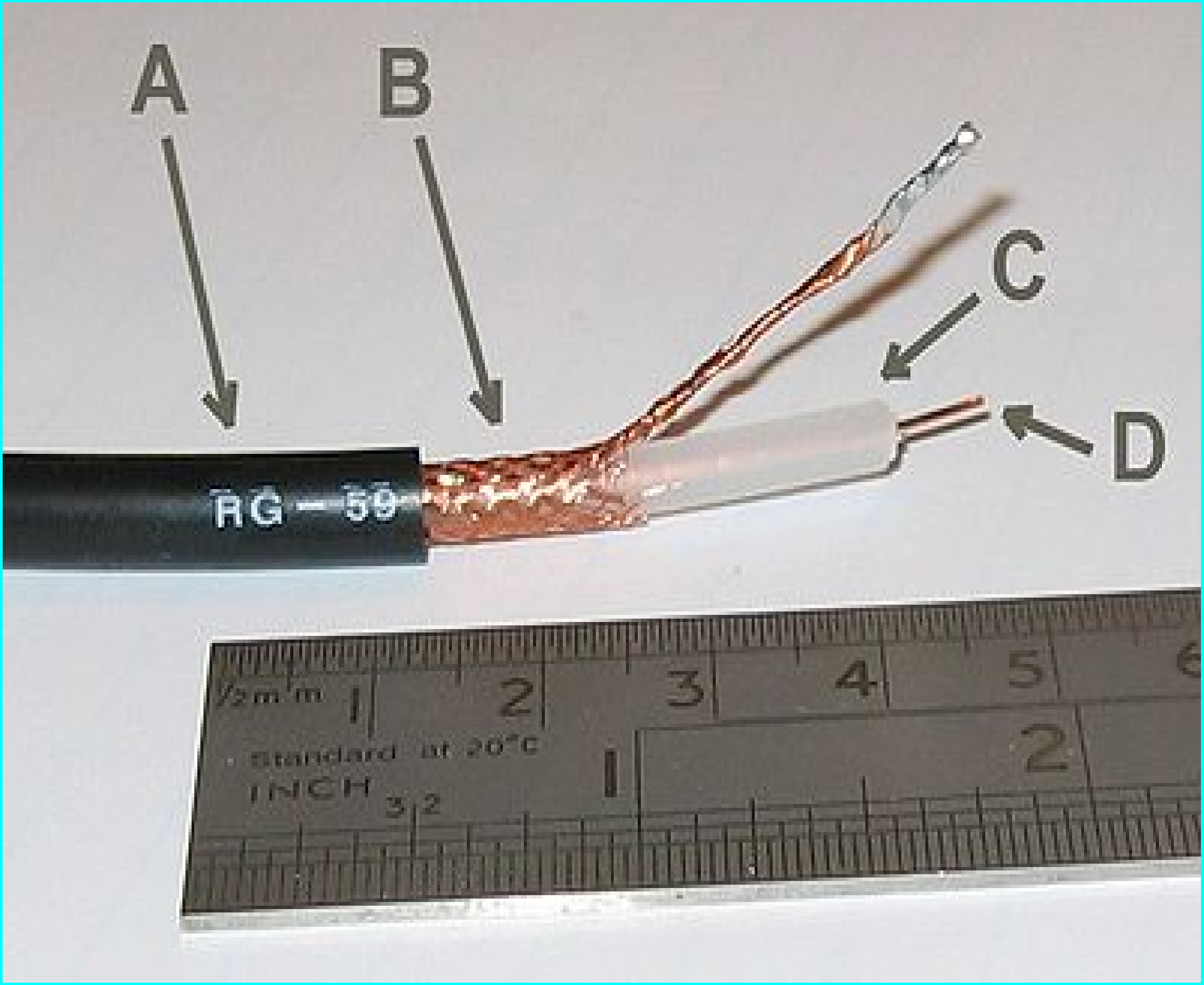
Arbitrary conductors charged equal and opposite
Calculate potential: C = Q / V



Parallel Plate Capacitor



Parallel Plate Capacitor


A
B
C
D
RG — 59
½m/m
Standard at 20°C
INCH
32

RG 58/U Type

Product Construction:

Conductors:
- Copper per ASTM B-3
- Tinned copper per ASTM B-33

Insulation/Core:
- Solid and foam polyethylene (PE) designs
- Solid and foam fluoropolymer (FEP) design

Shield:
- Tinned copper braid

Jacket:
- Premium PVC compound

Packaging:
- Please contact Customer Service for packaging and color options

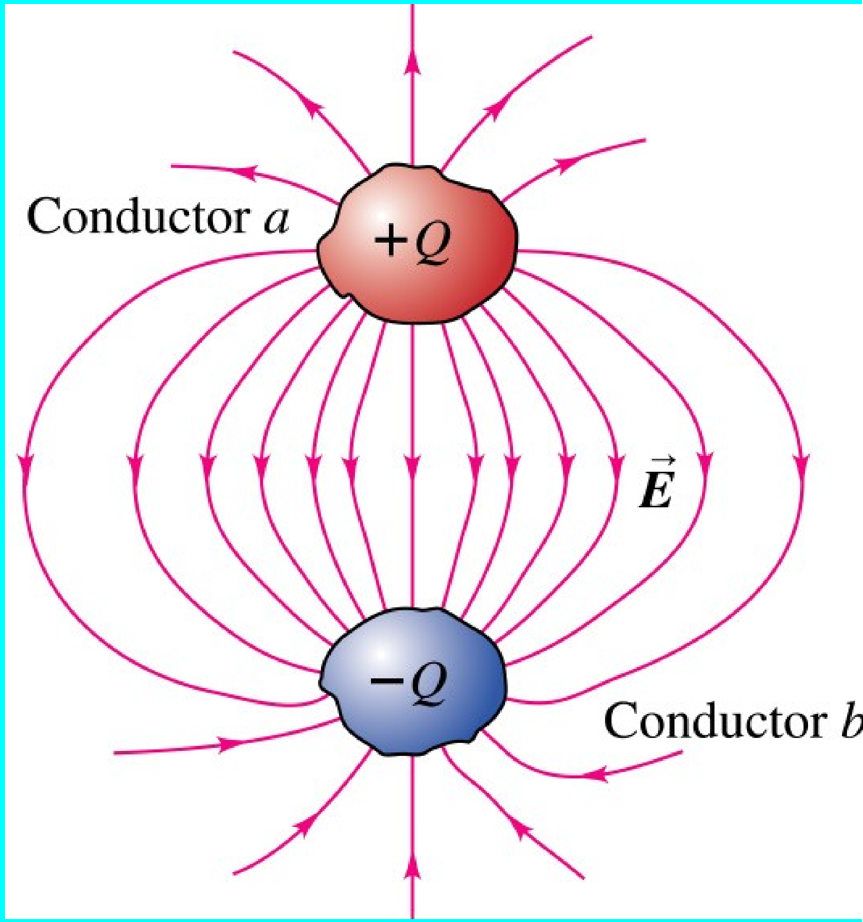
Applications:
- Suitable for RF signal transmission
- Broadcast
- LAN & data transmission
- See Coax Connector Cross Reference, pages 192-199

CATALOG NUMBER	AWG SIZE NOM. DCR	INSULATION MATERIAL INCHES	INSULATION MATERIAL mm	SHIELD COVERAGE NOM SHLD DCR	NOMINAL O.D. INCHES	NOMINAL O.D. mm	NOMINAL CAPACITANCE pF/ft	NOMINAL CAPACITANCE pF/m	VELOCITY OF PROPAGATION, %	NOMINAL IMPEDANCE, Ω	NOMINAL ATTENUATION MHz	NOMINAL ATTENUATION dB/100'
C1117 **RG 58/U Type** 	20 Ga. Solid Bare Copper 10.1 Ω/Mft.	Solid PE 0.116	2.95	70% Tinned Copper Braid 6.0 Ω/Mft.	Black PVC 0.195	4.95	28.50	93.51	66	53	1 10 50 100 200 500 1000	0.40 1.20 2.90 4.20 6.00 10.17 16.50
C1155 **RG 58 C/U Type** **MIL-C-17G Type** 	20 Ga. (19/.0071) Tinned Copper 10.8 Ω/Mft.	Solid PE 0.116	2.95	95% Tinned Copper Braid 4.3 Ω/Mft.	Non-Contaminating Black PVC 0.195	4.95	30.80	101.05	66	50	1 10 50 100 200 500 1000	0.42 1.50 3.70 5.40 8.10 13.86 22.80

Conductors a and b are insulated from each other, forming a capacitor. You increase the charge on a to $+2Q$ and increase the charge on b to $-2Q$, while keeping the conductors in the same positions.

What effect does this have on the capacitance C?

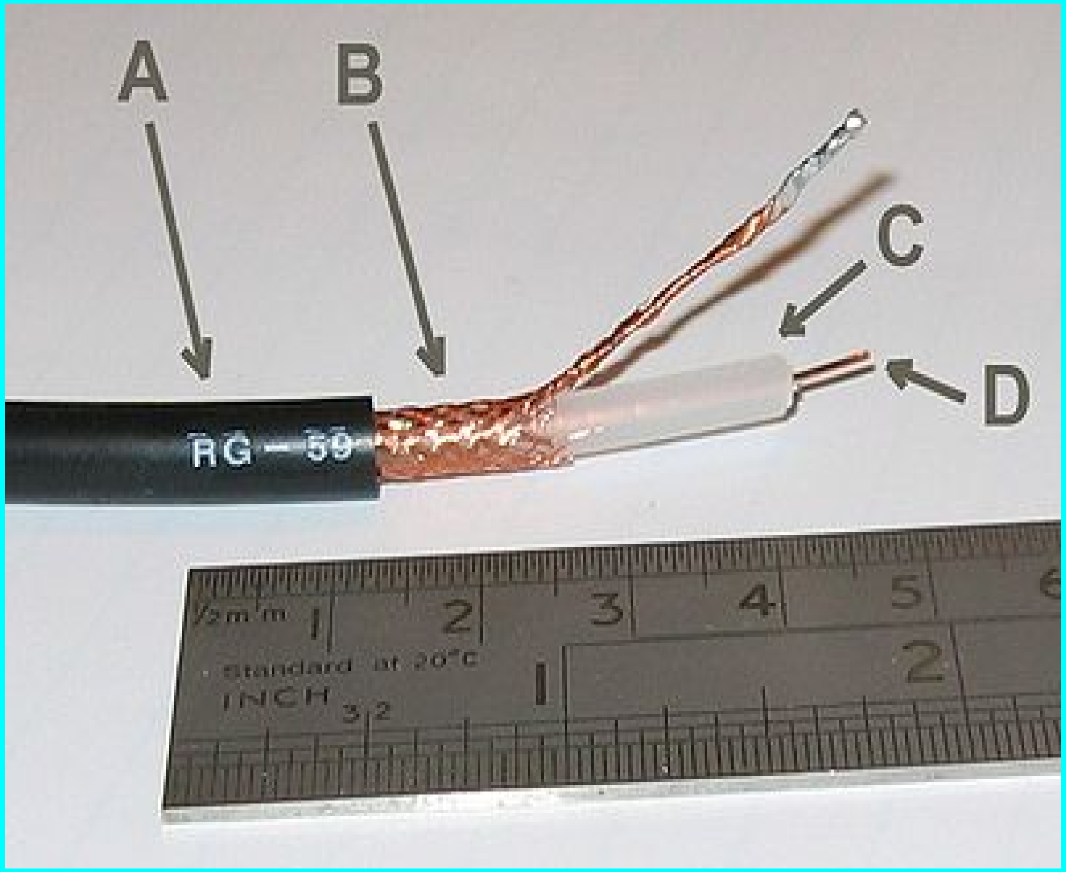
A) C is multiplied by 4
B) C is multiplied by 2
C) C remains the same
D) C is multiplied by ½
E) C is multiplied by ¼



You reposition the two plates of a capacitor so that the capacitance doubles. The charges $+Q$ and $-Q$ on the two plates are kept constant in this process.

What happens to the potential difference V between the two plates?

A) V is multiplied by 4
B) V is multiplied by 2
C) V remains the same
D) V is multiplied by ½
E) V is multiplied by ¼



$$C = \frac{2\pi \epsilon_0 \epsilon_r L}{\ln\left(R_2/R_1\right)}$$

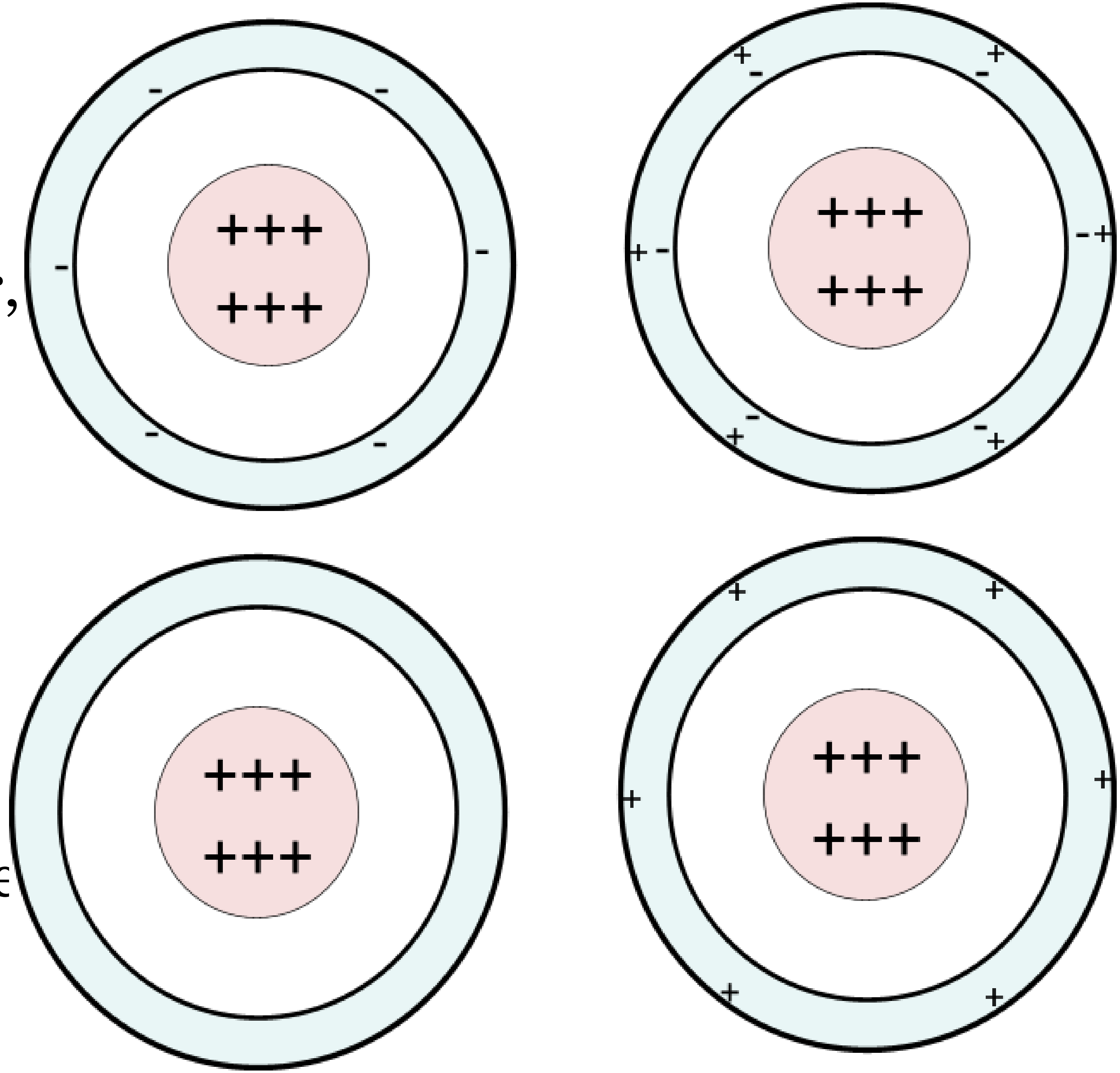
$$R_2 = 1.5\,\text{mm}$$

$$R_1 = 0.406\,\text{mm}$$

$$\epsilon_r = 2.3\left(\text{polyethylene}\right)$$

$$C = \frac{2\pi\, 8.85\times 10^{-12}\, 2.3}{\ln\left(1.5/0.4\right)} = 97\,\text{pf/m}$$

Six charges are placed on a spherical conductor, which is then surrounded by an initially uncharged thick spherical "shell". How will the charges rearrange themselves once the two objects are put together?



Conducting sphere of radius r_0 has surface charge density σ_0.

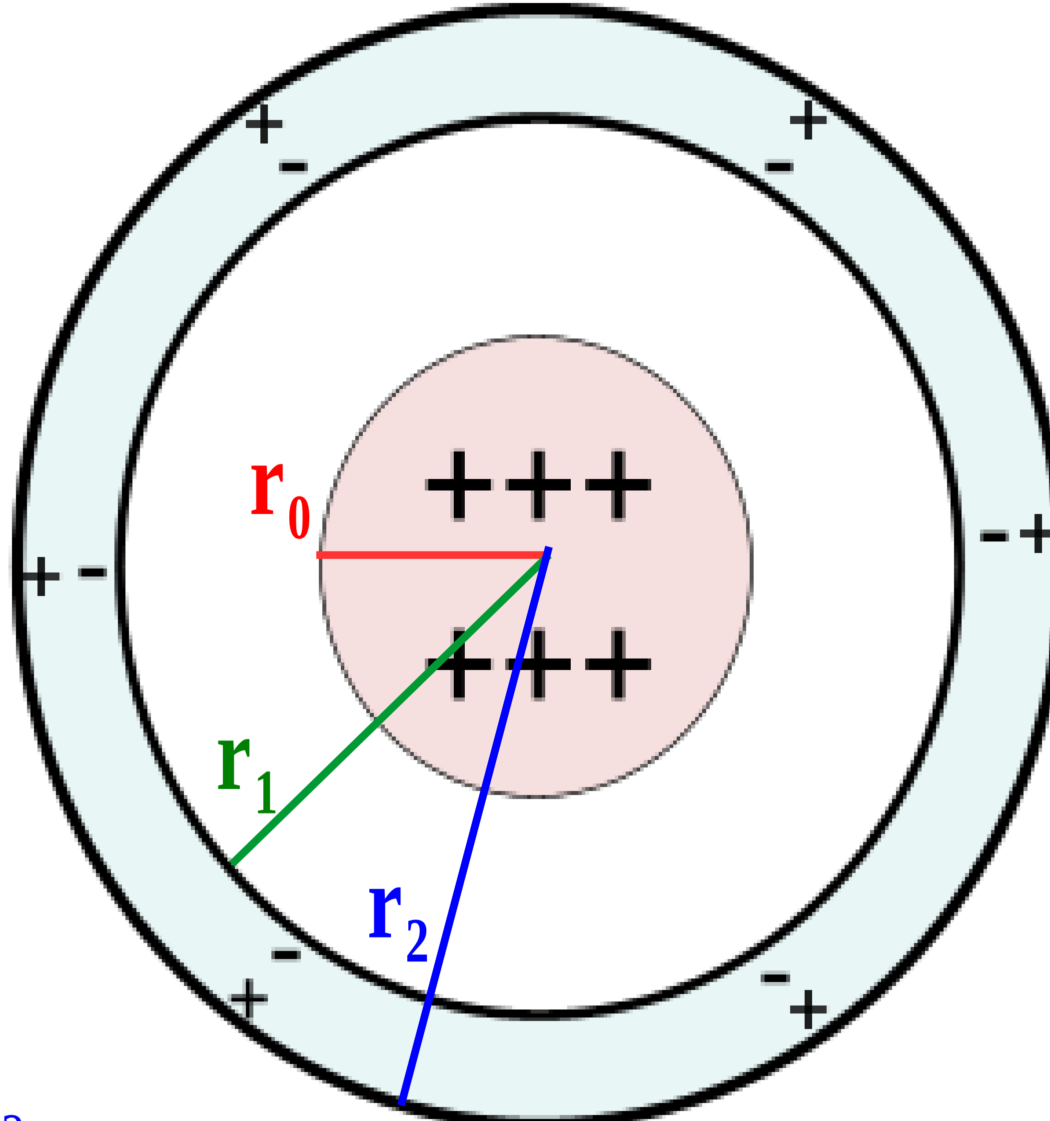
It is then surrounded by a neutral spherical conductor. What are the charge densities at r_1 and r_2

(A) σ_0 and σ_0

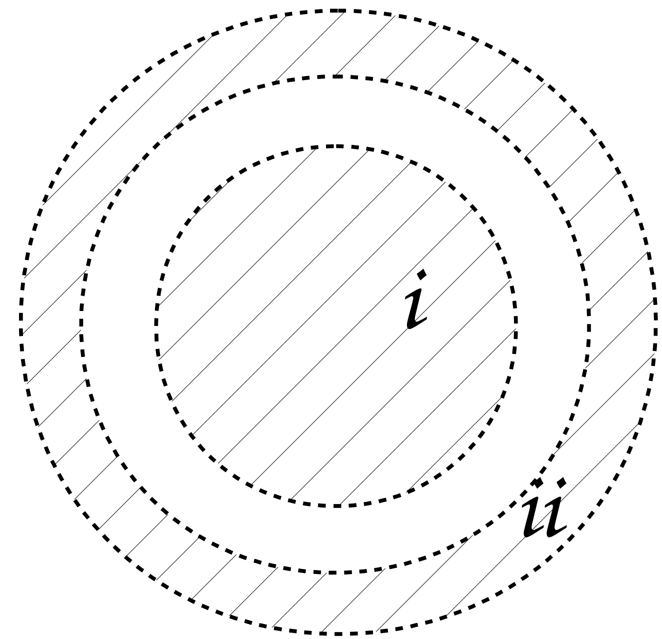
(B) $\sigma_0 r_0/r_1$ and $\sigma_0 r_0/r_2$

(C) $\sigma_0 r_1^2/r_0^2$ and $\sigma_0 r_1^2/r_0^2$

(D) $\sigma_0 r_0^2/r_1^2$ and $\sigma_0 r_0^2/r_2^2$



Object *i* and *ii* are concentric spherical conductors as shown. Object *i* has a net charge of Q_0 and surface charge σ_0.
Object *ii* has zero net charge.
What is true about inner and outer surfaces of *ii?*



(A) $Q_{inner} = -Q_{0}, Q_{outer} = +Q_0$

(B) $\sigma_{inner} = -\sigma_{0}, \sigma_{outer} = +\sigma_0$

(C) $Q_{inner} = -Q_{0}, Q_{outer} = 0$

(D) $Q_{inner} = -Q_{outer} < Q_0$