Electrostatic levitation of a conducting mass surrounded by asymmetric electrodes, a minimum effort proof.

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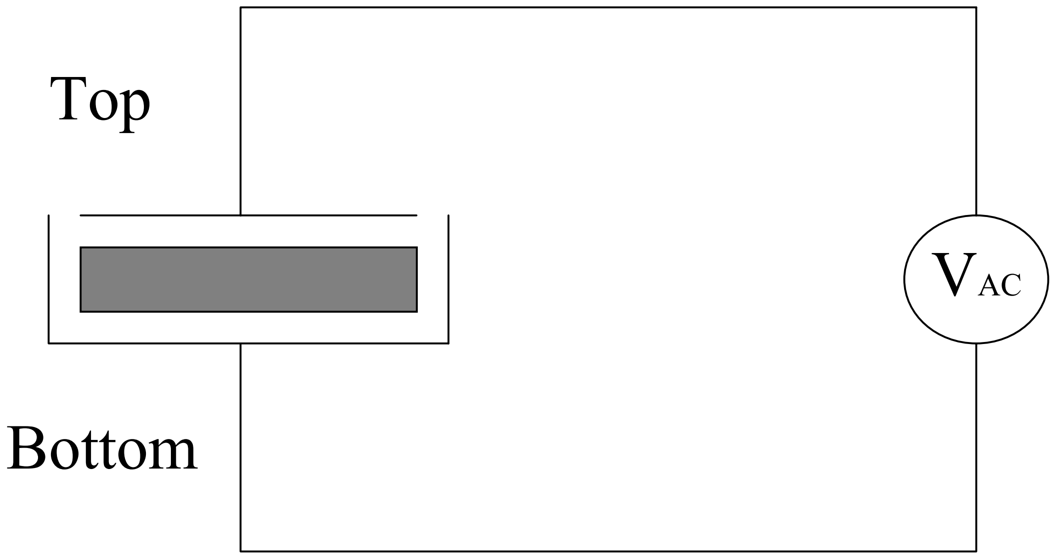
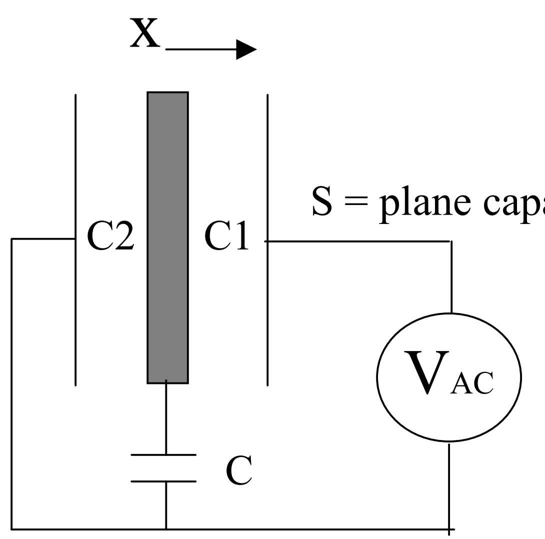
Can this isolated conducting mass be levitated electrostatically ?

(assuming one degree of freedom and plane top and bottom electrodes.)



Exciting electrodes are the coordinate reference system.



S = plane capacitor area

$$V_{C1} = V\frac{C + C_2}{C + C_1 + C_2} \qquad V_{C2} = V\frac{C_1}{C + C_1 + C_2}$$

$$Q_{C1} = V_{C1} C_1 = V\frac{C_1 (C + C_2)}{C + C_1 + C_2}$$

$$Q_{C2} = V_{C2} C_2 = V\frac{C_1 C_2}{C + C_1 + C_2}$$

$$F = F_{C1} - F_{C2} = \frac{Q_{C1}^2 - Q_{C2}^2}{2\varepsilon\ S} = \frac{V^2}{4\varepsilon\ S}\frac{(CC_1 + C_1 C_2)^2 - C_1^2 C_2^2}{(C + C_1 + C_2)^2} = \frac{V^2}{4\varepsilon\ S}\frac{C_1^2 C (C + 2C_2)}{(C + C_1 + C_2)^2}$$

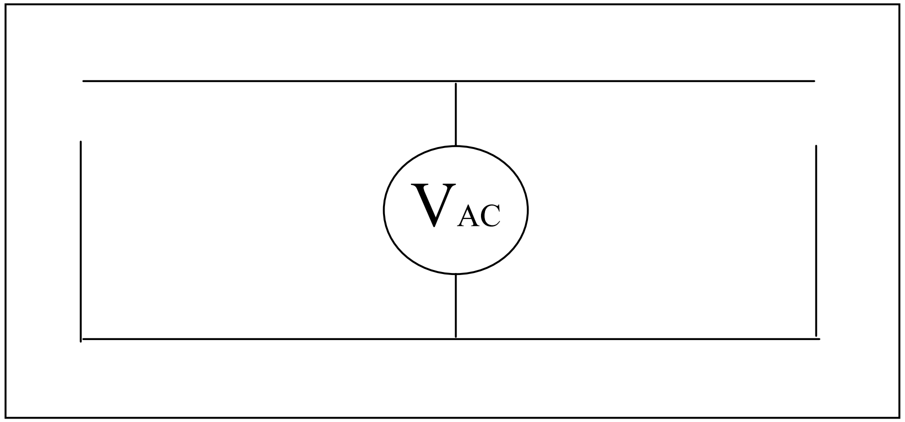
$$F>0 \quad \text{if} \quad C>0,\ C1>0,\ C2<\infty,\ V>0,\ 0<S<\infty$$

Using plane capacitor approximation.

Assuming C1=C2, C/C1 is a measure of the asymmetry of the configuration. Please note that the force does not depend on the frequency: DC or transient operation is possible.

Can this isolated structured conducting mass in a conducting box be levitated electrostatically ?

Top



Bottom

The conducting box is the coordinate reference system.

Yes, please refer to the preceding example, which has identical solution.