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Institution: Beijing-Dublin International College
Module: University Physics 2 (BDIC2008J)
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Problem Set 4

Conductors, Dielectrics and Capacitor

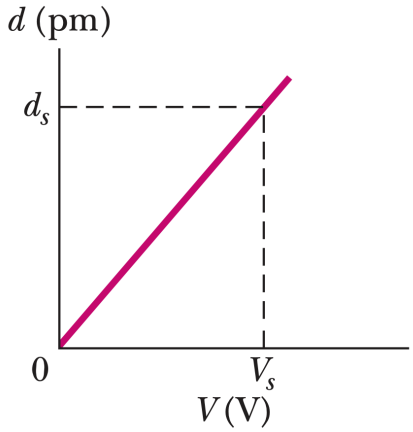
Problem 1. *An isolated conductor has net charge* $+10 \times 10^{-6}$C *a cavity with a particle of charge* $q = +3.0 \times 10^{-6}$C. *What is the charge on* ***(a)*** *the cavity wall and* ***(b)*** *the outer surface?*

Problem 2. *The two metal objects in the figure below have net charges of* $+70\text{pC}$ *and* -70pC*, which result in a* $20V$ *potential difference between them.* ***(a)*** *What is the capacitance of the system?* ***(b)*** *If the charges are changed to* $+200\text{pC}$ *and* -200pC*, what does the capacitance become?* ***(c)*** *What does the potential difference become?*

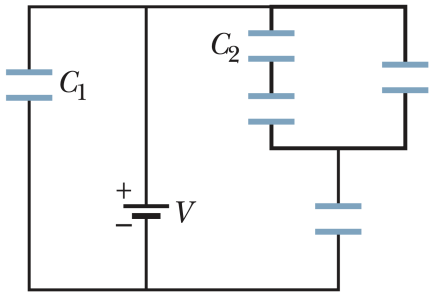
Problem 3. *The plates of a spherical capacitor have radii* 38.0mm *and* 40.0mm. ***(a)*** *Calculate the capacitance.* ***(b)*** *What must be the plate area of a parallel-plate capacitor with the same plate separation and capacitance?*

Problem 4. *What is the capacitance of a drop that results when two mercury spheres, each of radius* $R = 2.00\text{mm}$*, merge?*

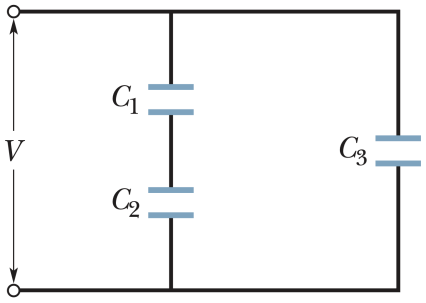
Problem 5. *If an uncharged parallel-plate capacitor (capacitance C) is connected to a battery, one plate becomes negatively charged as electrons move to the plate face (area A). In the figure below, the depth d from which the electrons come in the plate in a particular capacitor is plotted against a range of values for the potential difference V of the battery. The density of conduction electrons in the copper plates is* $8.49 \times 10^{28}\text{electrons/m}^3$. *The vertical scale is set by* $d_s = 1.00\text{pm}$, *and the horizontal scale is set by* $V_s = 20.0\text{V}$. *What is the ratio C/A?*



Problem 6. *In this figure, the battery has a potential difference of* $V = 10.0V$ *and the five capacitors each have a capacitance of* $10.0\mu\text{F}$. *What is the charge on* ***(a)*** *capacitor 1 and* ***(b)*** *capacitor 2?*

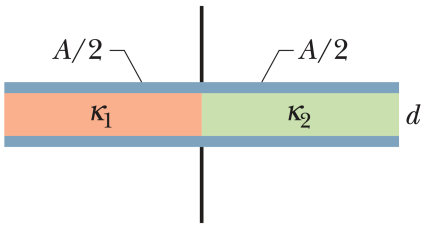


Problem 7. *In the figure below, a potential difference* $V = 100\text{V}$ *is applied across a capacitor arrangement with capacitances* $C_1 = 10.0\mu\text{F}$, $C_2 = 5.00\mu\text{F}$, *and* $C_3 = 4.00\mu\text{F}$. *What are* ***(a)*** *charge* q_3, ***(b)*** *potential difference* V_3, *and* ***(c)*** *stored energy* U_3 *for capacitor 3,* ***(d)*** q_1, ***(e)*** V_1, *and* ***(f)*** U_1 *for capacitor 1, and* ***(g)*** q_2, ***(h)*** V_2, *and* ***(i)*** U_2 *for capacitor 2?*



Problem 8. *A parallel-plate air-filled capacitor has a capacitance of* 50pF. ***(a)*** *If each of its plates has an area of* 0.35m^2*, what is the separation?* ***(b)*** *If the region between the plates is now filled with material having the relative permittivity (or dielectric constant)* $\varepsilon_r = 5.6$*, what is the capacitance?*

Problem 9. *This figure shows a parallel-plate capacitor with a plate area* $A = 5.56\text{cm}^2$ *and separation* $d = 5.56\text{mm}$*. The left half of the gap is filled with material of relative permittivity (or dielectric constant)* $\kappa_1 = 7.00$*; the right half is filled with material of relative permittivity (or dielectric constant)* $\kappa_2 = 12.0$*. What is the capacitance?*



Problem 10. *A parallel-plate capacitor has a capacitance of* 100pF*, a plate area of* 100cm^2*, and a mica relative permittivity (or dielectric constant) (*$\varepsilon_r = 5.4$*) completely filling the space between the plates. At* $50V$ *potential difference, calculate* ***(a)*** *the electric field magnitude* E *in the mica,* ***(b)*** *the magnitude of the free charge on the plates, and* ***(c)*** *the magnitude of the induced surface charge on the mica.*