Electrostatics

Coulomb's Law	$\vec{F}_{12} = \frac{kq_1q_2}{r_{12}^2}\hat{r}_{12}$
Electric field	$\vec{E} = \frac{\vec{F}}{q_0}$
Electric field due to point charge	$\vec{E}_{iP} = \frac{kq_i}{r_{iP}^2}\hat{r}_{iP}$
Electric field due to a system of points	$\vec{E}_P = \sum_i \vec{E}_{iP}$
Dipole moment	$\vec{p} = q\vec{L}$
Torque on a dipole	$\tau = pE\sin\theta$
Potential energy of a dipole	$U = -pE\cos\theta + U_0$
Electric field for continuous charge distribution	$\vec{E} = \int \frac{k\hat{r}}{r^2}dq$
Electric flux	$\phi = \int_S \vec{E}\cdot\hat{n}\,dA$
Electric flux for uniform flield	$\phi = EA\cos\theta$
Gauss's law	$\phi_{net} = \frac{Q_{inside}}{\varepsilon_0}$
Electric field due to a line of charge of infinite length	$E_R = 2k\frac{\lambda}{R}$
Electric field on the axis of a charged ring	$E_z = \frac{kQz}{\left(z^2+a^2\right)^{3/2}}$
Electric field on the axis of a charged disk	$E_z = \text{sign}(z)\frac{\sigma}{2\varepsilon_0}\left[1-\left(1^2+\frac{R^2}{z^2}\right)^{-1/2}\right]$
Electric field due to an infinite plane	$E_z = \text{sign}(z)\frac{\sigma}{2\varepsilon_0}$
Electric field due to a thin spherical shell	$E_r = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2} \quad r > R$ $E_r = 0 \quad r < R$

Constants

Magnitude of electron charge	$e = 1.60\times10^{-19}$ C
Coulomb's constant	$k = 8.99\times10^{9}\ \text{N}\cdot\text{m}^2/\text{C}^2$
Permittivity of free space	$\varepsilon_0 = \frac{1}{4\pi k} = 8.85\times10^{-12}\text{C}^2/(\text{N}\cdot\text{m}^2)$
Mass of electron	$m_e = 9.11\times10^{-31}$ kg

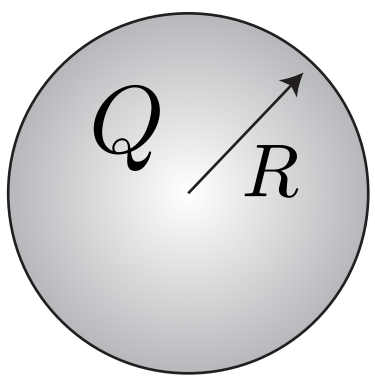
Equations from 121

Kinematic equations	$v_x = v_{0x} + a_xt$ $v_{\text{av}\,x} = \frac{1}{2}\left(v_{0x}+v_x\right)$ $\Delta x = x - x_0 = v_{\text{av}\,x}t = \frac{1}{2}\left(v_{0x}+v_x\right)t$ $\Delta x = \frac{1}{2}a_xt^2 + v_{0x}t$ $v_x^2 = v_{0x}^2 + 2a_x\Delta x$
Kinetic energy	$K = \frac{1}{2}mv^2$
Newton's second law	$\vec{F}_{net} = m\vec{a}$
Newton's third law	$\vec{F}_{12} = -\vec{F}_{21}$

Eq sheet, practice midterm, Lecture notes, Wiggins Mon.

Capacitance

- ***Capacitance***: *Capacity (or efficiency)* of conductor to hold charge at a potential difference.



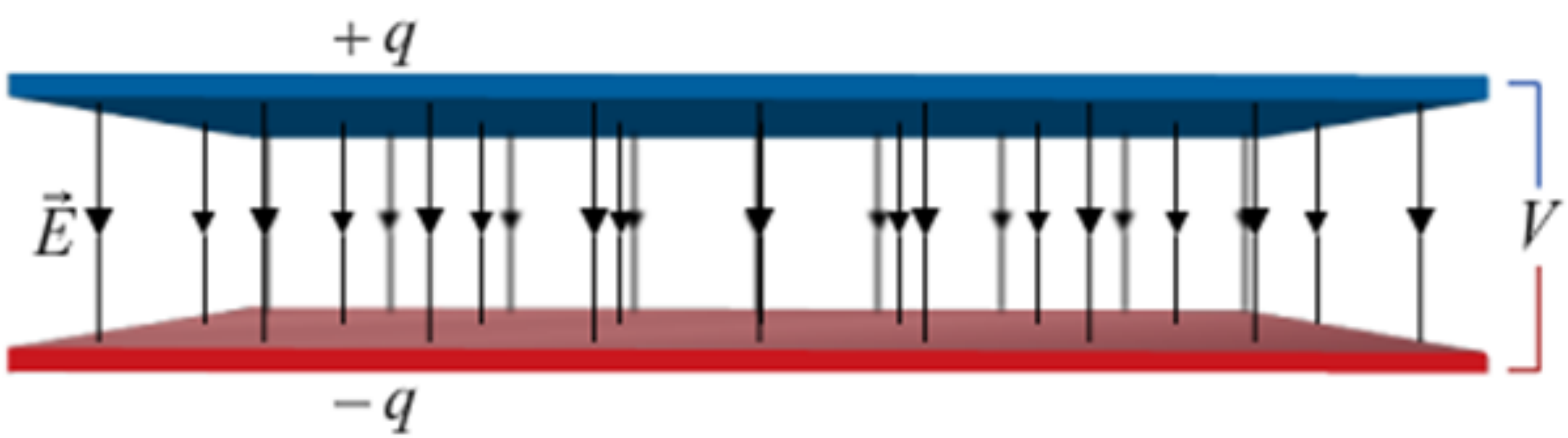
$$V(R) = \frac{kQ}{R}$$

- In general, we always find that whatever the geometry of the conductor:

$$V = Q/C$$

- where the **capacitance C** depends on the geometry

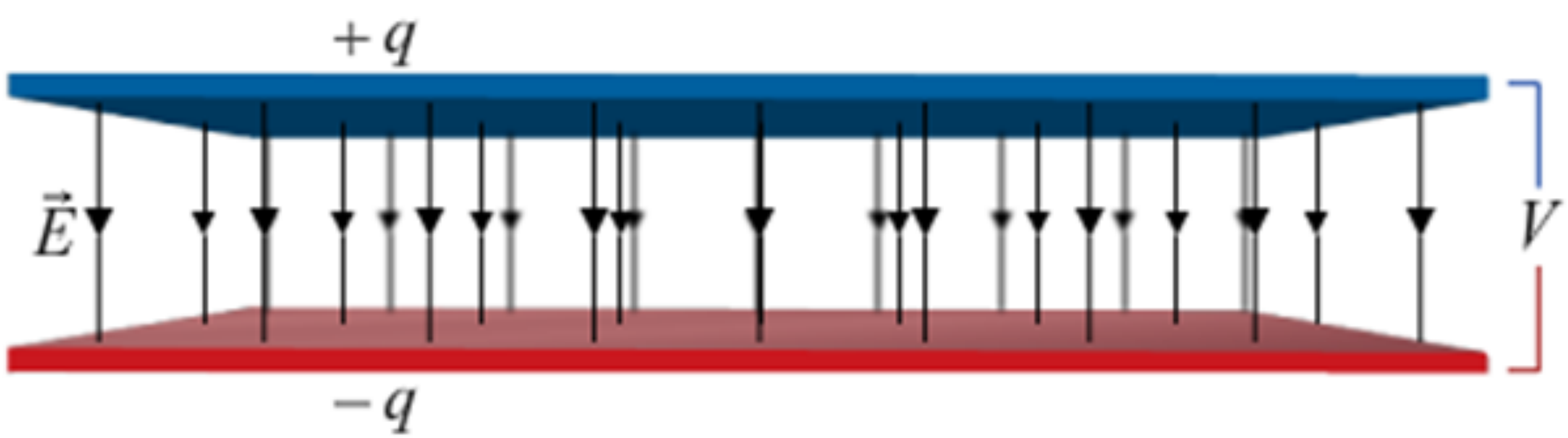
Compute C for a plate capacitor…



$$Q = CV$$

work it out…

Compute C for a plate capacitor…

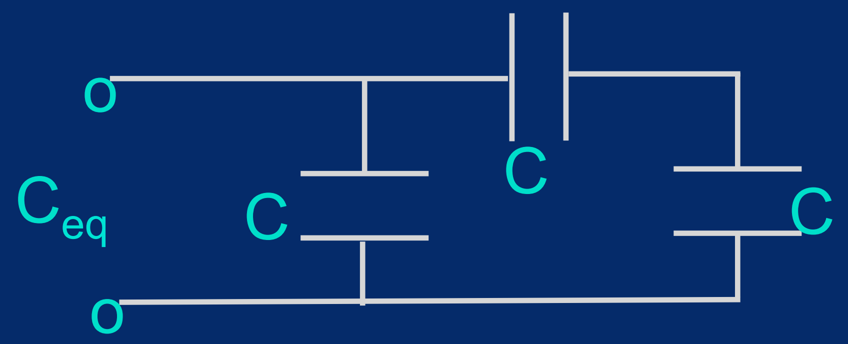


$$Q = CV \qquad C = \frac{A\epsilon_0}{d}$$

Intuitive meaning…

Adding capacitors (pictorially)

What is the equivalent capacitance, C_{eq}, of the combination shown?



(a) $C_{eq} = (3/2)C$ (b) $C_{eq} = (2/3)C$ (c) $C_{eq} = 3C$

Clicker 11-3

Which of the following is NOT necessarily true:

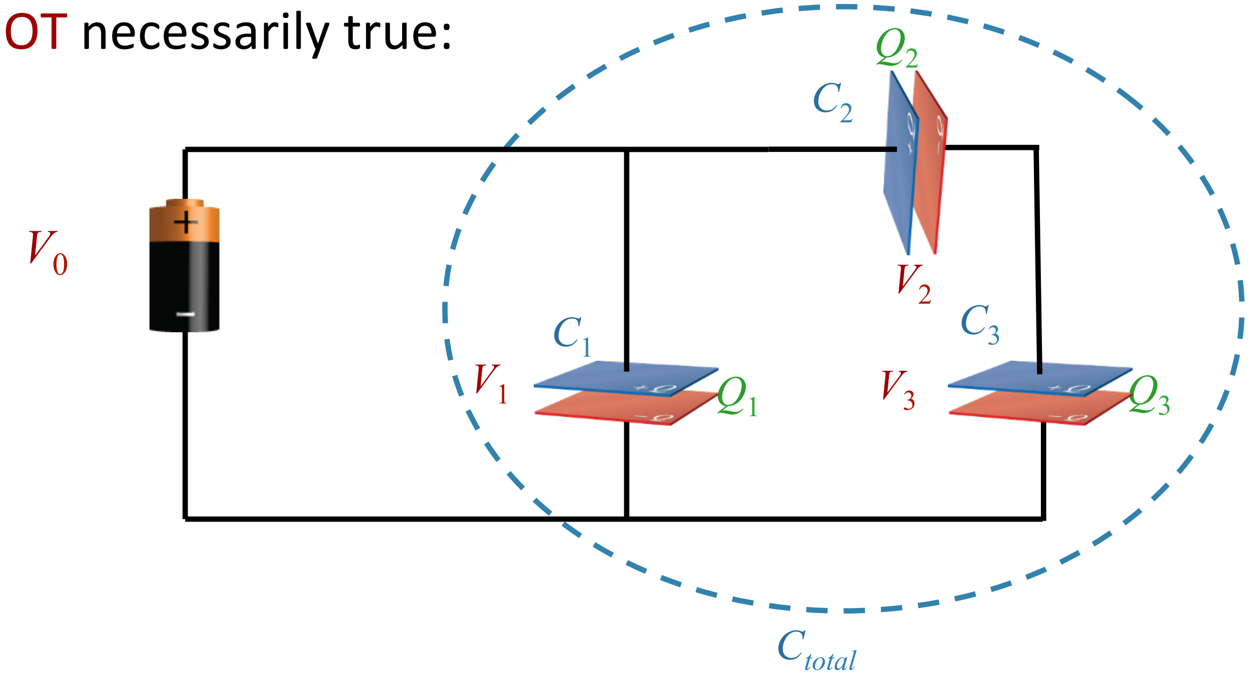
A) $V_0 = V_1$

B) $C_{total} > C_1$

C) $V_2 = V_3$

D) $Q_2 = Q_3$

E) $V_1 = V_2 + V_3$



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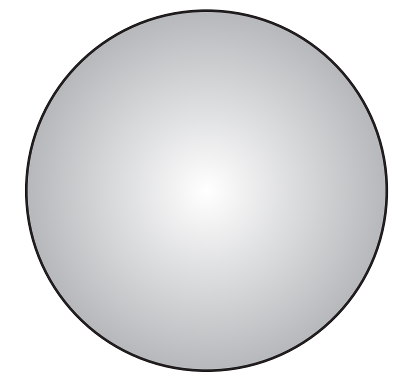
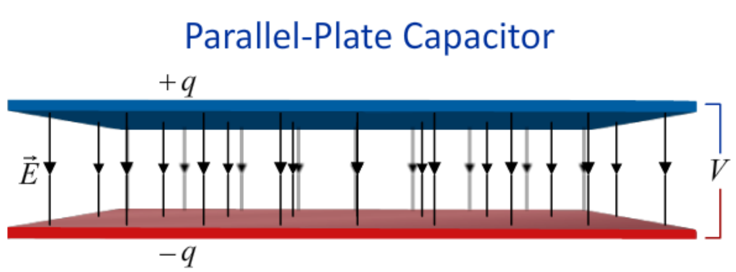
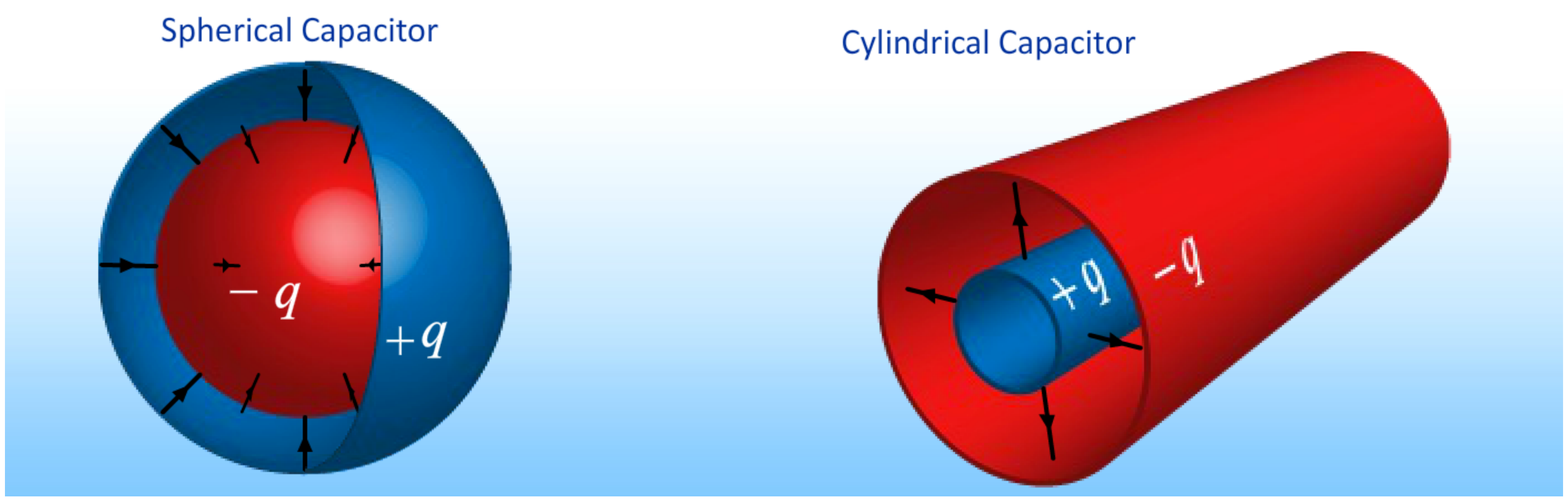
Capacitors

- Not just planes…
  spheres, cylinders, plates,
  isolated conductor…







Capacitance depends only on geometry (not charge).

Messing with capacitors