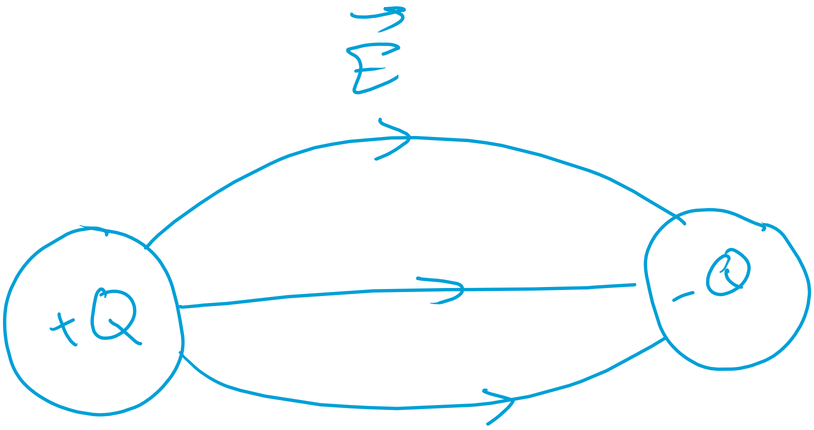
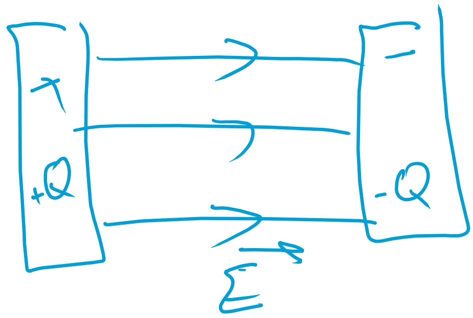




$$\Delta V = -\vec{E}\cdot\vec{d}$$

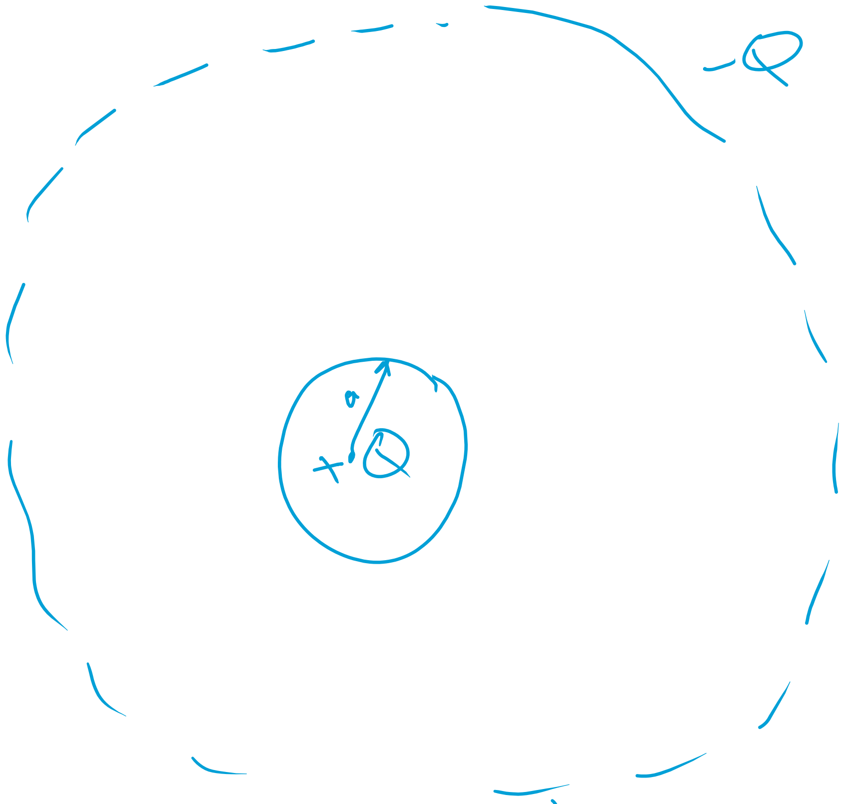
capacitance

positive

$$C = \frac{Q}{\Delta V} \Rightarrow C\ (\text{Farad},\ F)$$

$$1\,F = 1\,C/V$$

applies for all capacitor types



$$C = \frac{Q}{\Delta V} = \frac{Q}{k_e Q/a} = \boxed{\frac{a}{k_e}}$$

capacitance of isolated sphere

8.85×10^{9}

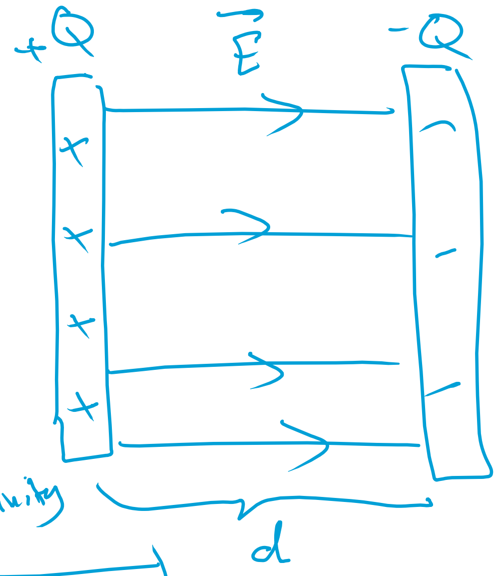
$$C = \frac{Q}{\Delta V} = \frac{Q}{E d}$$

$$= \frac{Q}{\frac{\sigma}{\epsilon_0}\, d}$$

$$= \frac{Q}{\frac{Q}{A}\cdot\frac{1}{\epsilon_0}\cdot d} = \boxed{\frac{\epsilon_0 A}{d}}$$

$8.\times 10^{-12}$ permittivity

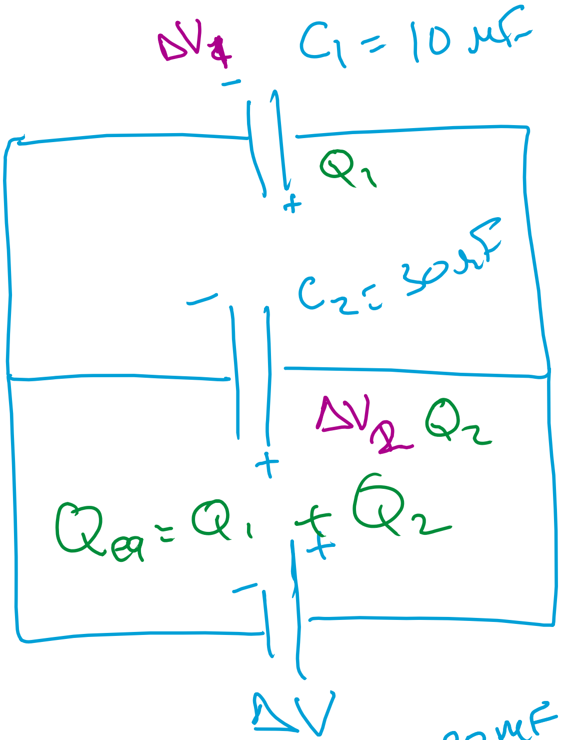
Area of the plate



Capacitors in Parallel

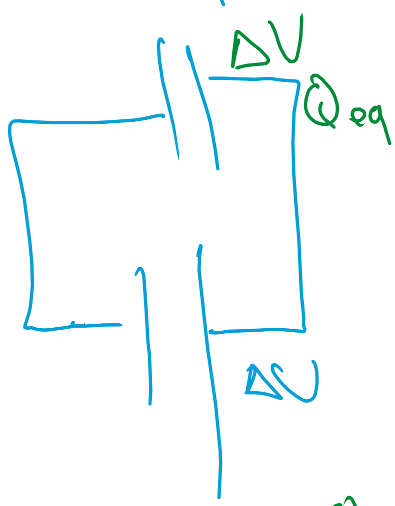
$\Delta V_1 = \Delta V_2$

$C_{eq} = C_1 + C_2$



$Q_{eq} = Q_1 + Q_2$

$C_{eq} = 40\,\mu F$



$$\frac{3}{20} = \frac{1}{C_{eq}} \Rightarrow C_{eq} = \frac{20}{3}$$

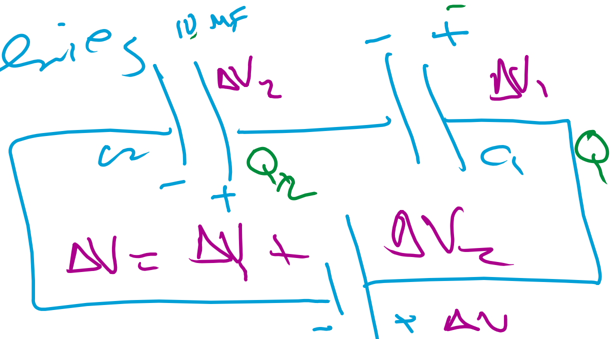
$$\frac{1}{10} + \frac{1}{20} = \frac{1}{C_{eq}}$$

$Q_{eq} = Q_1 = Q_2$

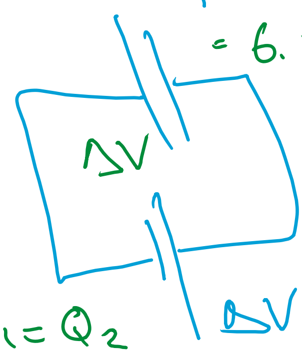
$$C_{eq} = \frac{20}{3} = 6.67$$

Capacitors in series

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2}$$



$\Delta V = \Delta V_1 + \Delta V_2$



$Q_1 = Q_2$

Energy stored in a capacitor

$$U_E = \boxed{\frac{Q^2}{2C}} = \frac{Q^2}{2Q/\Delta V} = \boxed{\frac{1}{2} Q \Delta V}$$

$$C = \frac{Q}{\Delta V}$$

$$Q = C\Delta V \qquad \frac{(C\Delta V)^2}{2C} = \boxed{\frac{1}{2} C (\Delta V)^2}$$

parallel plate:

$$C = \frac{\epsilon_0 A}{d} \Rightarrow U_E = \frac{Q^2}{2C}$$

$$U_E = \frac{Q^2}{2\epsilon_0 A/d} = \frac{d\,Q^2}{2\epsilon_0 A}$$

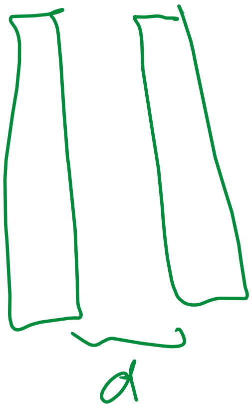
↳ Potential energy

$$U_E = \frac{1}{2} C \Delta V^2 = \frac{1}{2}\left[\frac{\epsilon_0 A}{d}\right]\left[E d\right]^2 = \frac{1}{2}\epsilon_0 A d E^2$$

$$\text{Energy density} = \frac{U_E}{V} = \frac{\frac{1}{2}\epsilon_0 A d E^2}{A d}$$

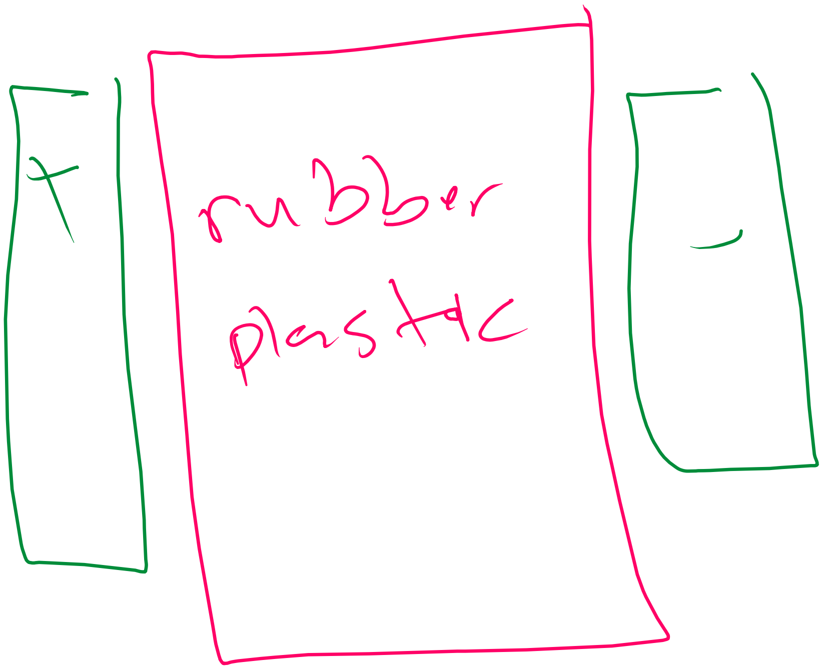
$$= \boxed{\frac{1}{2}\epsilon_0 E^2}$$

J/m^3



Dielectric (insulator)

$$C = \frac{\epsilon_0 A}{d}$$

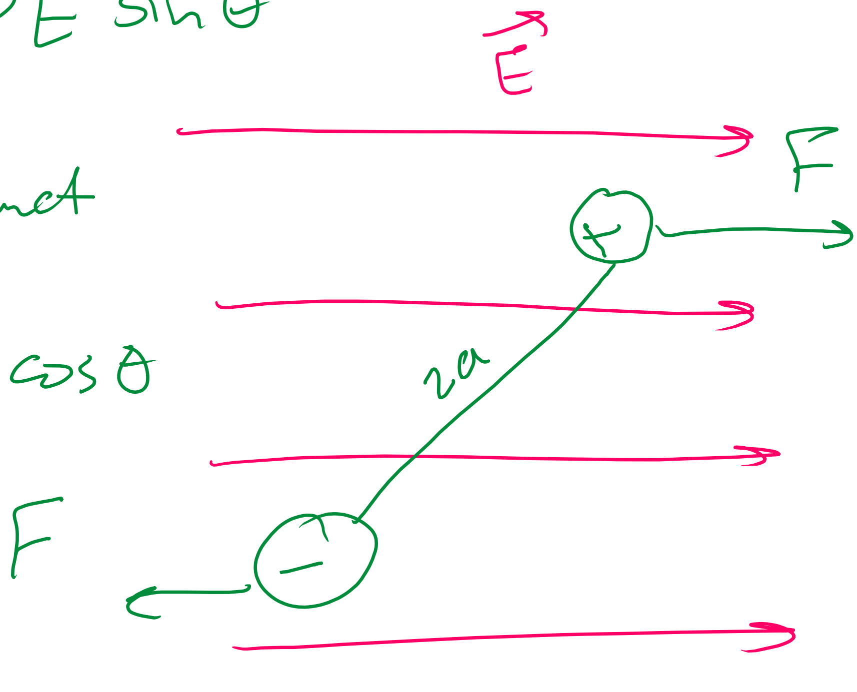


dielectric constant

$$C = \frac{\kappa\,\epsilon_0 A}{d}$$

$$\vec{\tau} = \vec{P} \times \vec{E} = PE\sin\theta$$

↓ vector product



$$U_E = -\vec{P}\cdot\vec{E} = PE\cos\theta$$

↓ dot Product

$\vec{P}$ electric dipole moment $= 2a\,q$