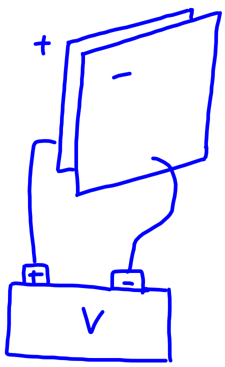
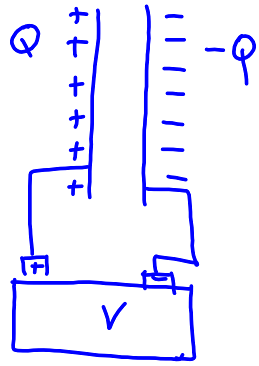
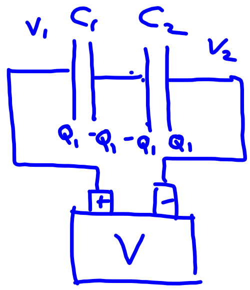
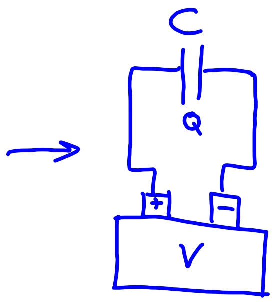




Capacitors

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





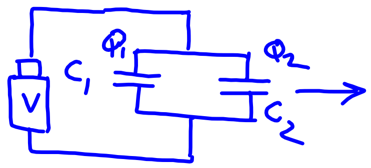
$$Q_1 = Q_2 = Q$$

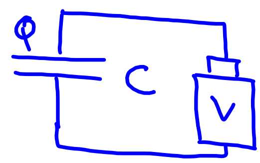
$$C = \frac{Q}{V} \qquad C_1 = \frac{Q_1}{V_1} \qquad C_2 = \frac{Q_2}{V_2}$$

$$C = \frac{Q}{V_1 + V_2} = \frac{Q}{\frac{Q_1}{C_1} + \frac{Q_2}{C_2}} = \frac{Q}{\frac{Q}{C_1} + \frac{Q}{C_2}}$$

$$= \frac{1}{\frac{1}{C_1} + \frac{1}{C_2}} \rightarrow \boxed{\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}}$$ series

Parallel





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

$$V = \frac{Q_1}{C_1} \qquad V = \frac{Q_2}{C_2}$$

$$C_1 = \frac{Q_1}{V} \qquad C_2 = \frac{Q_2}{V}$$

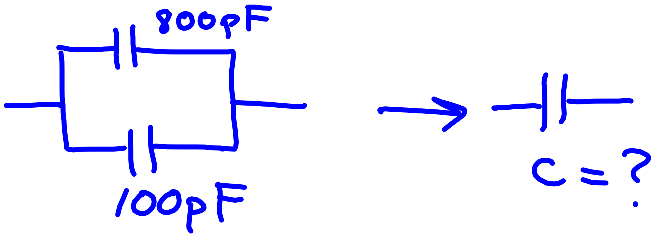
$$Q_1 + Q_2 = Q$$

$$C = \frac{Q_1 + Q_2}{V} = \frac{Q_1}{V} + \frac{Q_2}{V}$$

$$= C_1 + C_2$$

$$\boxed{C = C_1 + C_2}$$ parallel

Example

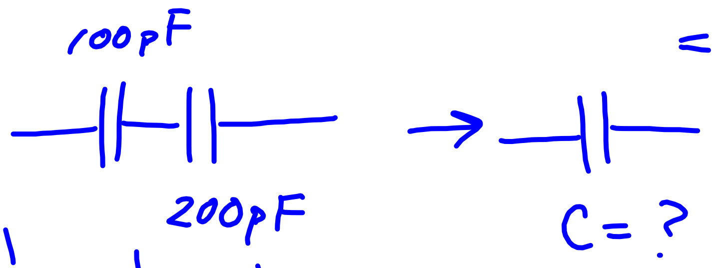


$C = C_1 + C_2$

$= 800 + 100 = 900\,pF$

pico Farads $= 10^{-12}$ Farads

Ex

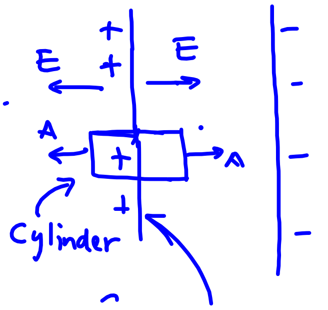


$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$

$= \frac{1}{100} + \frac{1}{200} = \frac{2}{200} + \frac{1}{200} = \frac{3}{200}$

$C = \frac{200}{3} = 66.7\,pF$

Field Between Parallel Plate Capacitors



Gauss' Law

$$\begin{pmatrix}\text{electric flux}\\ \text{thru surface}\end{pmatrix} = 4\pi k Q_{enclosed}$$

$\sigma = \frac{\text{charge}}{\text{area}}$

$(-E)(-A) + EA$

$2EA = 4\pi k A\sigma \qquad A\sigma = Q$

$E = 2\pi k\sigma$

$\longleftrightarrow$ d

$V = Ed$

$W = F \cdot d$

$\frac{W}{q} = \frac{F}{q} d$

$V = Ed$

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

$$= \frac{\sigma A}{E \cdot d} = \frac{\sigma A}{2\pi k \sigma d} = \frac{A}{2\pi k d} =$$

$$C = \frac{1}{2\pi k}\frac{A}{d}$$

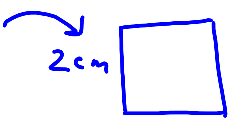
$$\boxed{C = \frac{1}{4\pi k} \cdot \frac{A}{d}}$$

because $E = E_+ + E_- = 2E$

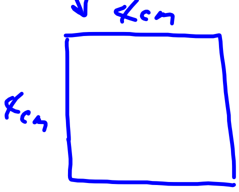
(E_+ due to + plate; E_- due to − plate)

↑ Capacitance of a Parallel plate capacitor

Ex Parallel plate capacitor #1



" " " #2



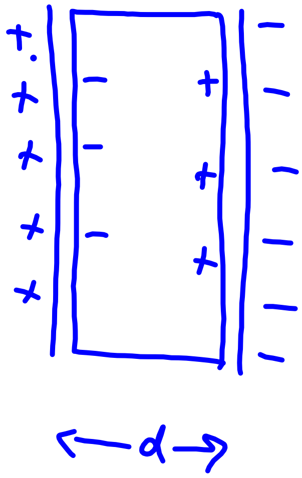
Same separation between plates. 2cm

How does C_2 compare to C_1?

A. $C = \frac{1}{4\pi k}\frac{A}{d}$ $\qquad C_1 = \frac{1}{4\pi k}\frac{2^2}{d} \propto 4$

$C_2 = 4C_1$ $\qquad C_2 = \frac{1}{4\pi k}\frac{4^2}{d} \propto 16$

Dielectrics



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

If material has dielectric constant K, $V \to \frac{V}{K}$

$$C \to KC$$

$$E = \frac{V}{d} \Rightarrow E \to \frac{E}{K}$$