

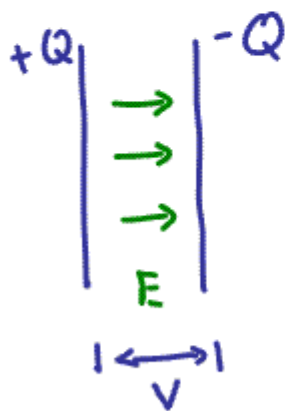
# Physics 114 - February 23, 2006

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Last lecture

$$Q = CV$$

Capacitance

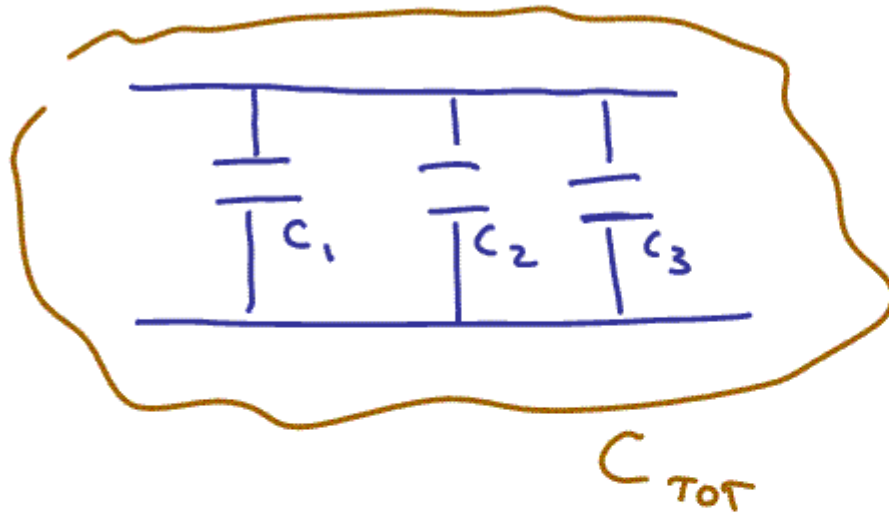


depends only on geometry

for // plate geometry  
plates of Area  $A$   
Separation  $d$

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

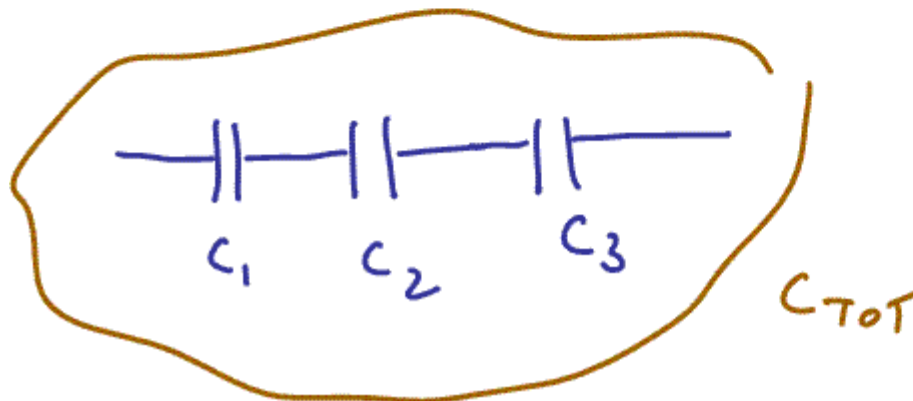
for Capacitors in parallel



$$C_{TOT} = \sum_i C_i$$

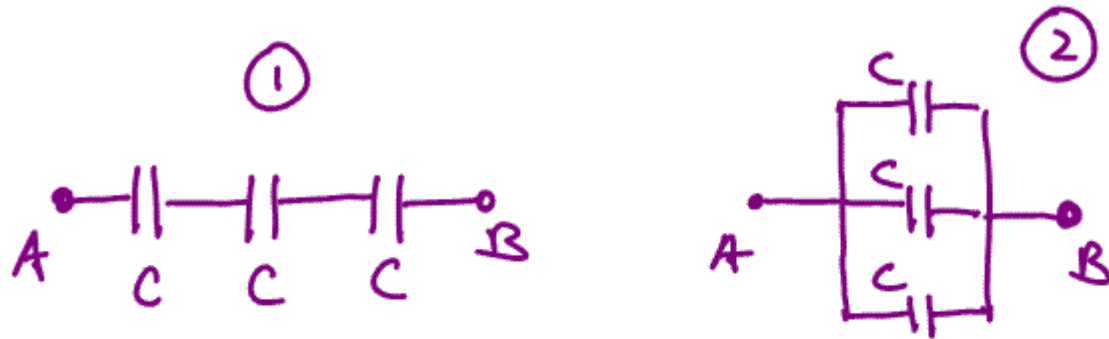
Useful

for Capacitors in Series



$$\frac{1}{C_{TOT}} = \frac{1}{C_i}$$

3 identical capacitors are connected in two different configurations



A voltage is applied between pts A + B

Some time passes

$V_{AB}$

how does the Amount of charge stored in the LH config. compare to that on the right?

①  $Q_1 > Q_2$

②  $Q_2 > Q_1$

③  $Q_1 = Q_2$

$$Q_1 = C_1 V_{AB \text{ TOT}}$$

$$Q_2 = C_2 V_{AB \text{ TOT}}$$

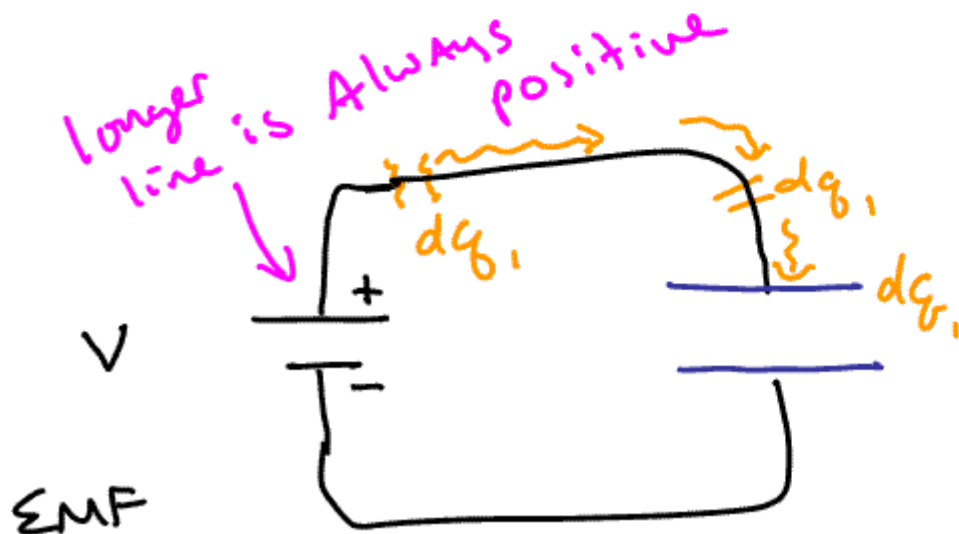
cap. in series

$$\frac{1}{C_{\text{TOT}}} = \frac{1}{C} + \frac{1}{C} + \frac{1}{C}$$

$$C_{\text{TOT}} = \frac{C}{3}$$

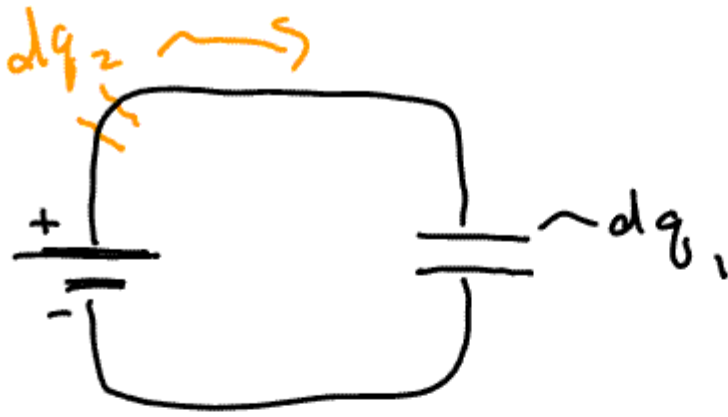
Cap. in //

$$C_{\text{TOT}} = 3C$$



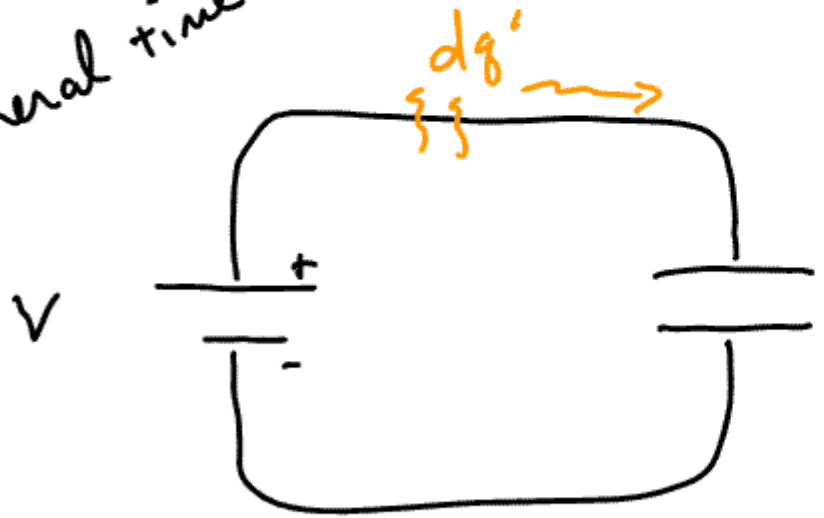
↓ TIME

No work to move  $dq_1$  to capacitor



work must be done by EMF to move  $dq_2$  against repulsion from  $dq_1$

general time



$q', V'$

$C$  depends only on geom.

→  $dW = V' dq'$

work required to transfer  $dg'$   
when the pot. diff across capacitor  
plates is  $v'$

$$dw = v' dg'$$

$$dw = \frac{q'}{c} dg'$$

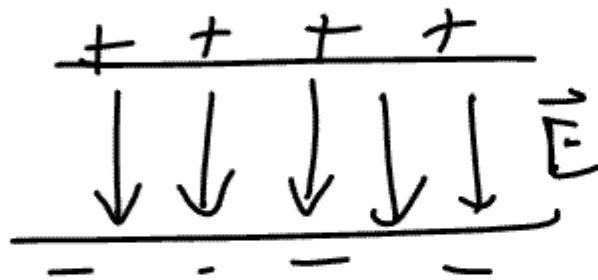
$$\int dw = \text{Total work} = \int_0^Q \frac{q'}{c} dq'$$

To chg  
capacitor

$$W = \frac{1}{c} \left[ \frac{q'^2}{2} \right]_0^Q = \frac{Q^2}{2c}$$

$$\text{Energy to chg. capacitor} \equiv W \equiv U = \frac{Q^2}{2C} = \frac{1}{2} CV^2$$

$$Q = CV$$



created  
an electric  
field

Capacitor stores energy in the form  
of an electric field

$$\text{Energy density in } \vec{E} \equiv \mathcal{U} = \frac{U}{\text{Volume bet. the plate}}$$

plates are of Area  $A$

$$\text{Vol} = A d$$

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

$$U = \frac{1}{2} C V^2$$

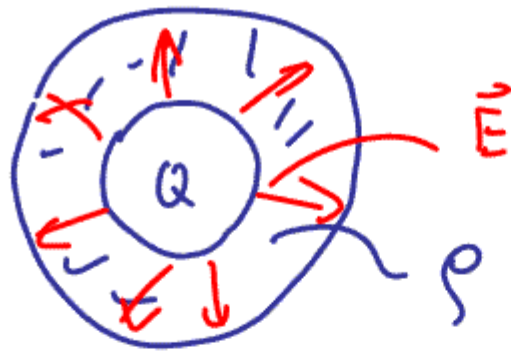
$$u = \frac{U}{\text{Vol}} = \frac{\frac{1}{2} C V^2}{A d} = \frac{\frac{1}{2} \frac{\epsilon_0 A}{d} V^2}{A d}$$

$$u = \frac{\epsilon_0}{2} \frac{V^2}{d^2} = \frac{\epsilon_0}{2} E^2$$

$$\frac{V}{d} \equiv |\vec{E}|$$

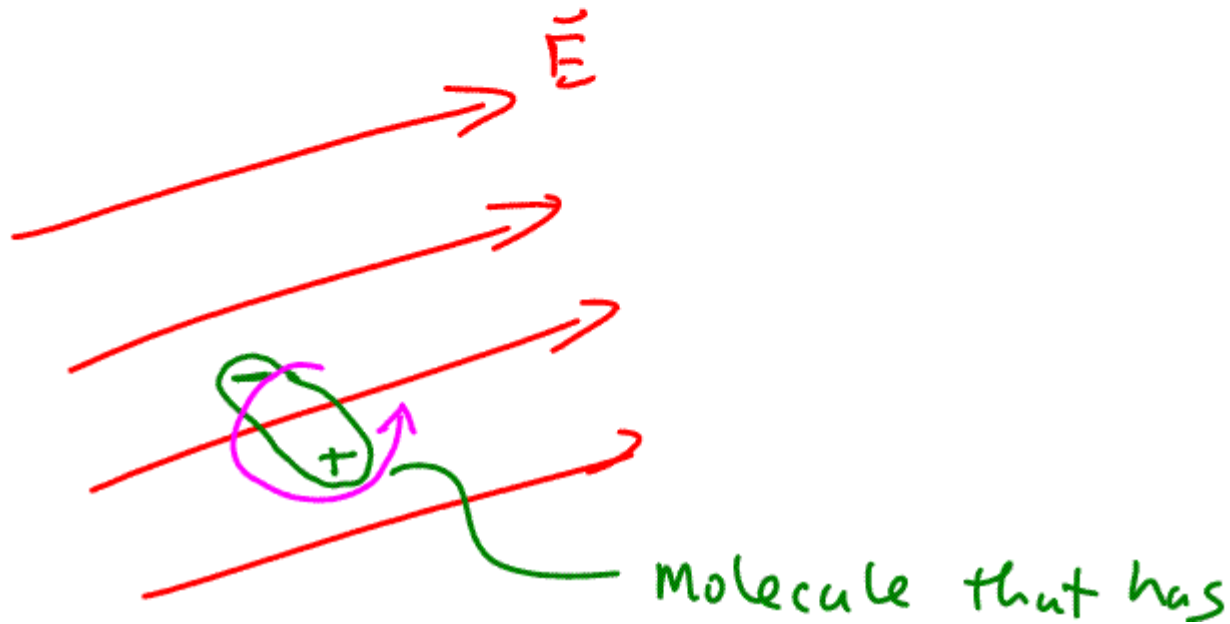
$$u = \frac{\epsilon_0}{2} E^2$$



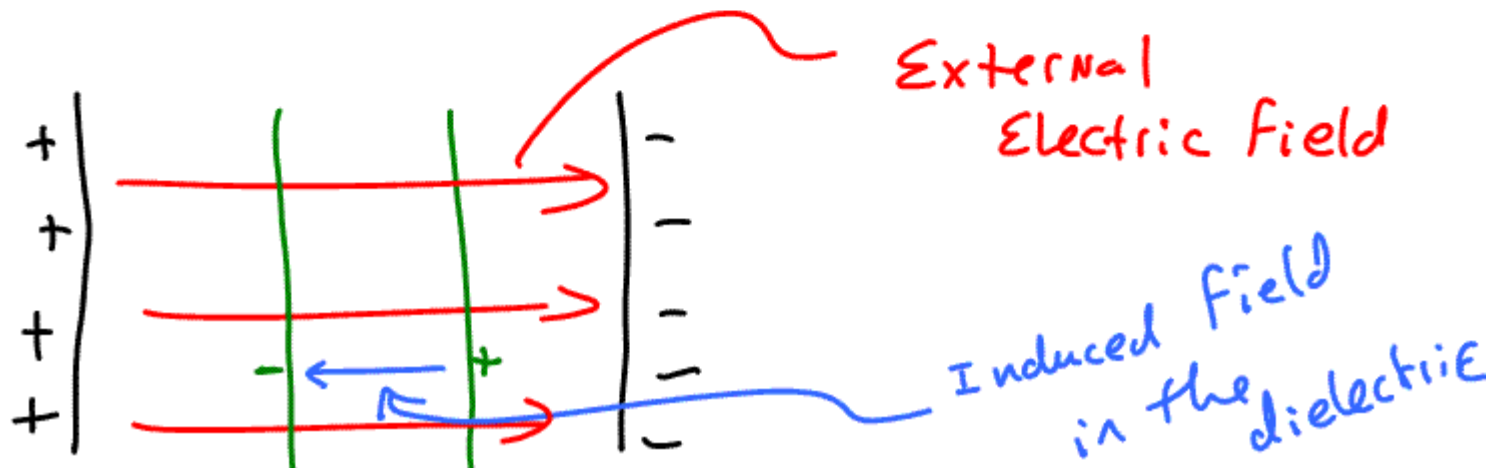
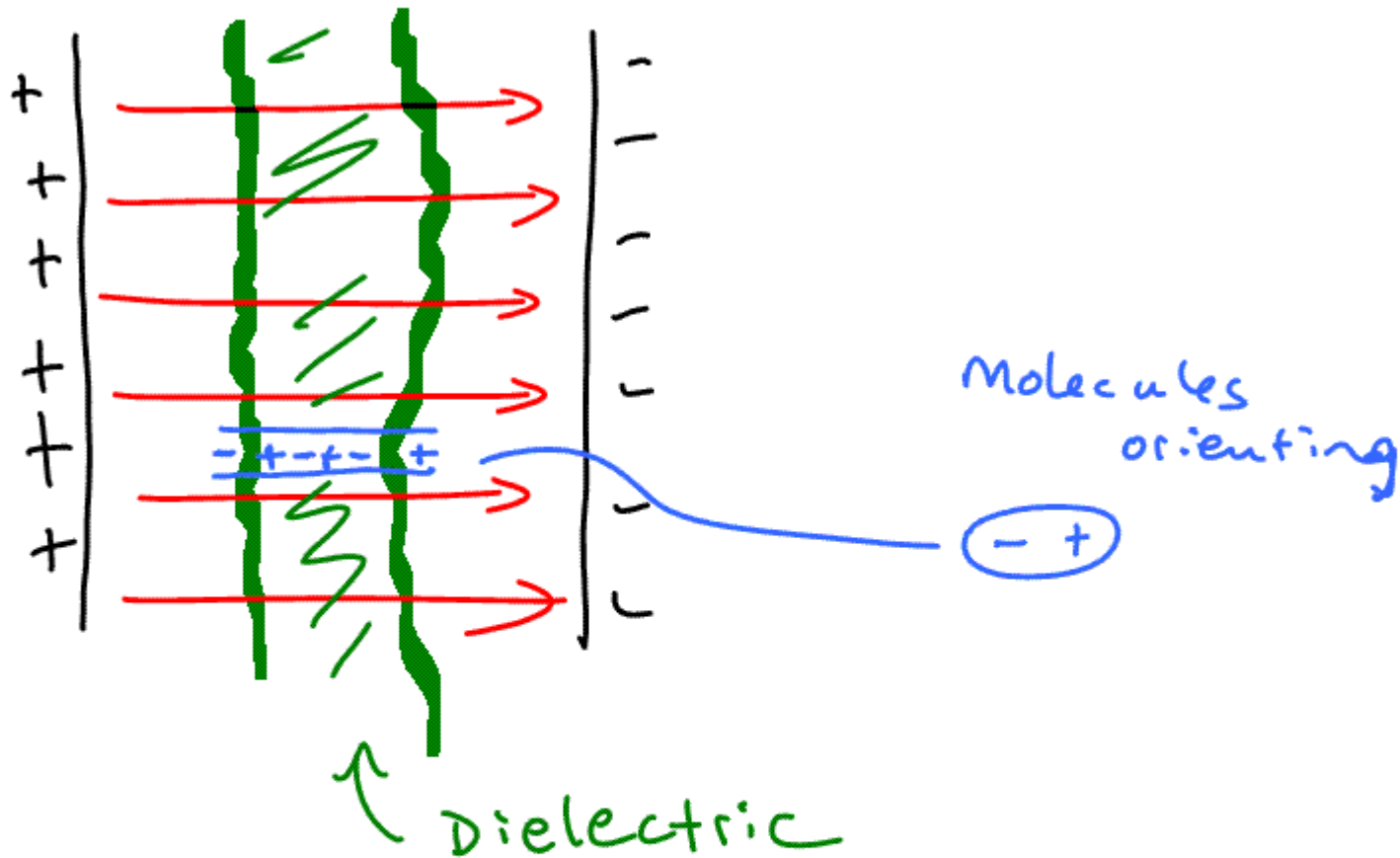


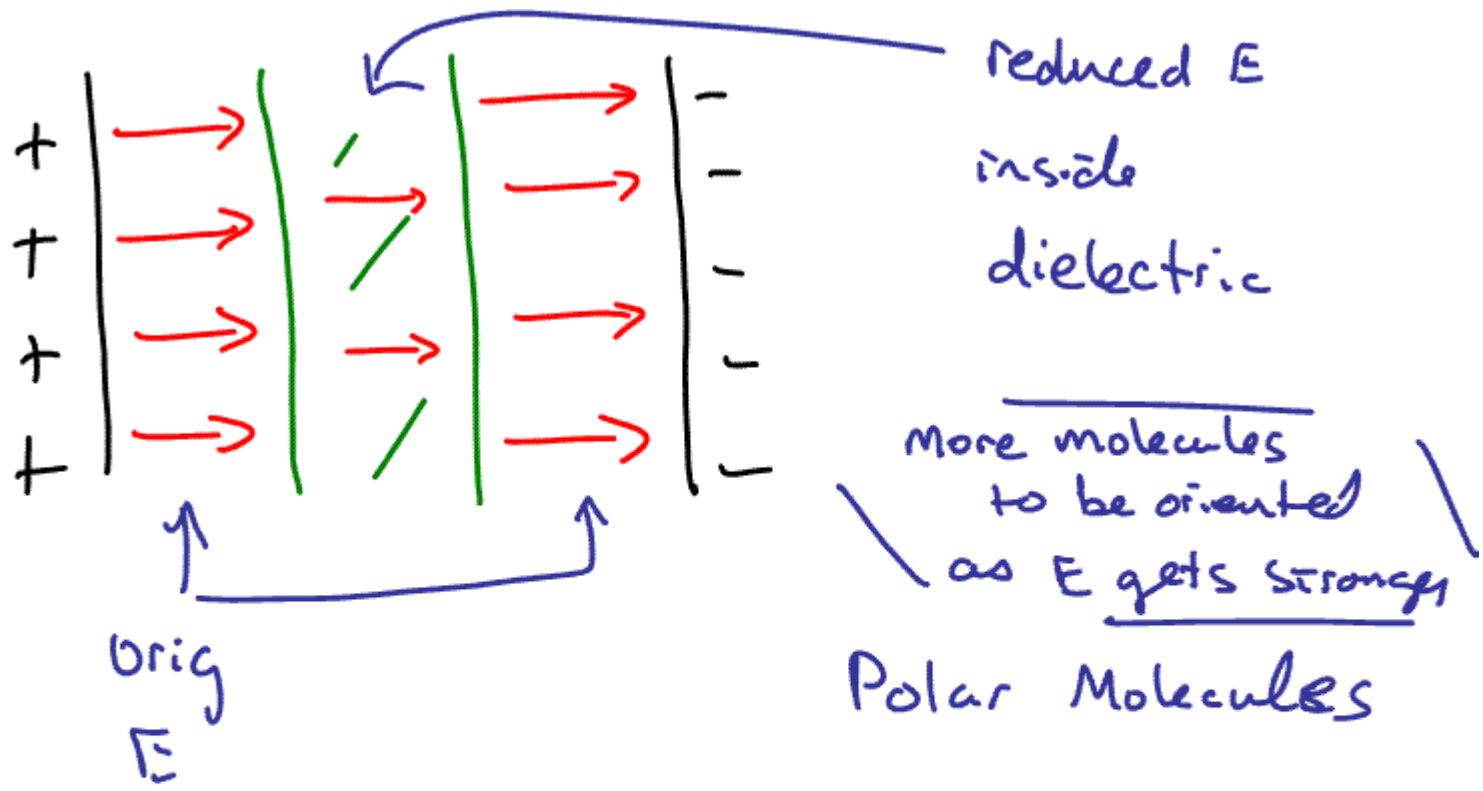
$$U = \int_{\text{vol}} u \, dv$$

non conductor  
insulators  $\equiv$  Dielectric



inherent dipole





non polar molecule

