Physics 212 lecture 24 f01

Physics 212 F01 Lecture 24

- record
- Quiz Friday
- HW due Friday (chapters 24 & 25)
- HW session tonight (zoom) @ 5:30
- videos posted (from Monday & supplemental)
- read chapters 25 & 26
- online this week

Today: Review electric potential energy ⟷ electric potential, mapping equipotential surfaces, conservation of mechanical energy, charged spheres, conductors, E from V

Electric potential

$$\vec{F} = q\vec{E} \Rightarrow \vec{E} = \frac{\vec{F}}{q_{test}}$$

For electric potential energy

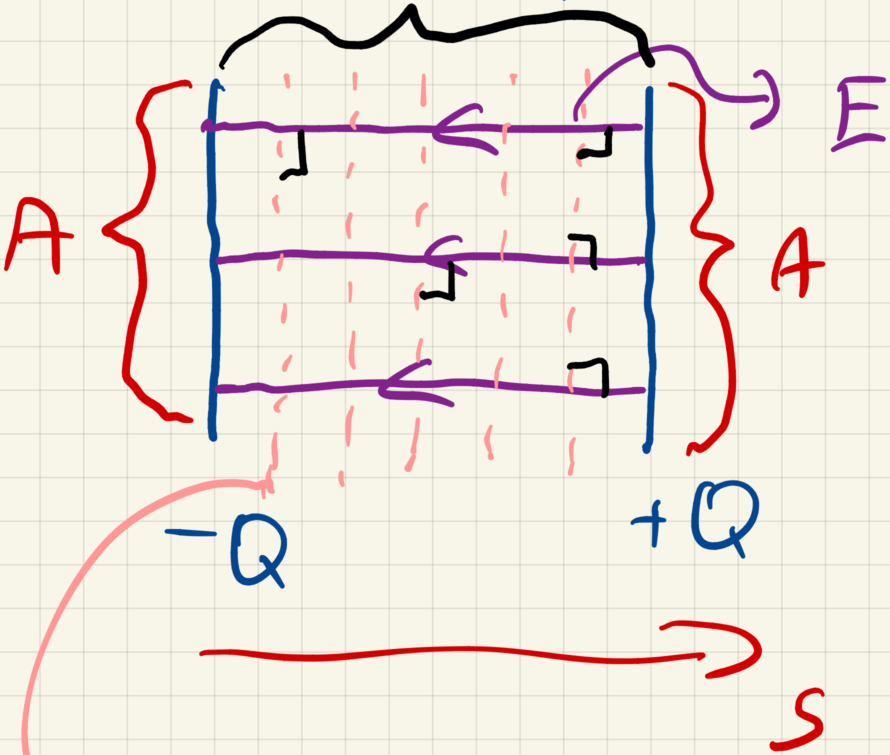
$U_{elc} = qV \rightsquigarrow$ electric potential

↳ electric potential energy

$$\Rightarrow V = \frac{U_{elec}}{q_{test}}$$

V is electric potential and its units are volts $\quad 1V = 1\frac{J}{C}$

parallel plate capacitors



$$U = qEs$$

$$\Rightarrow V = \frac{U}{q} = Es$$

equipotential surfaces

$$\vec{E} \perp V$$

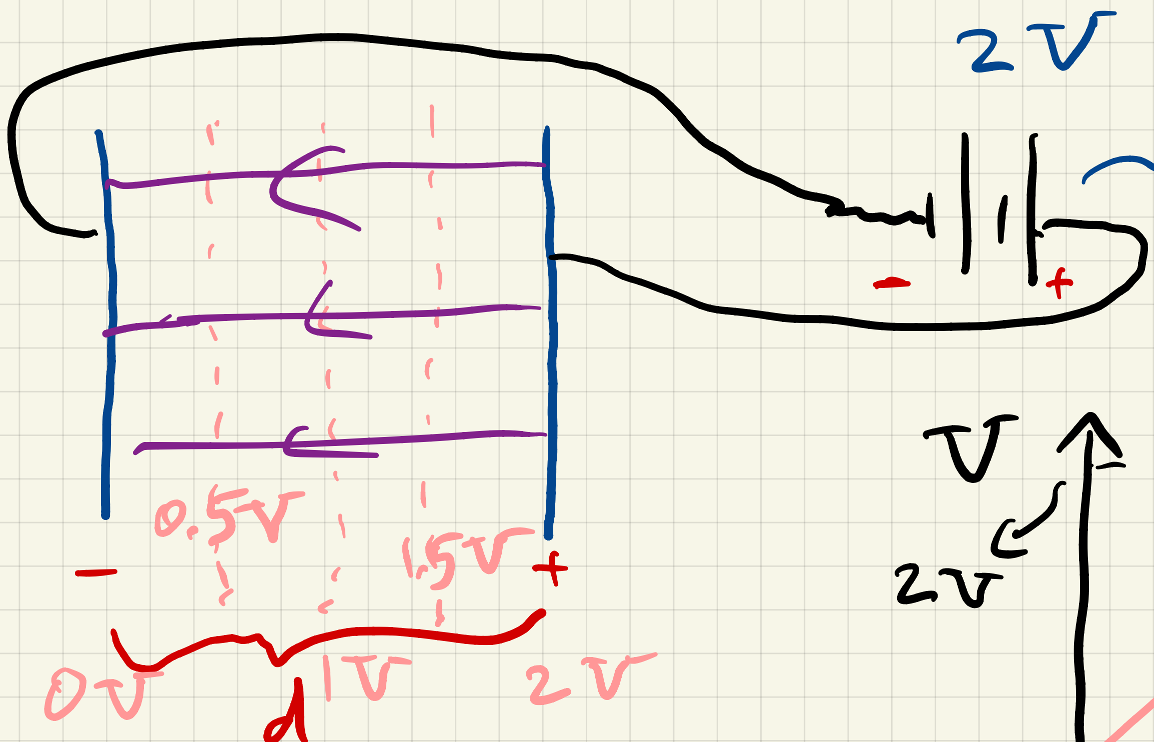
$$E_{pp} = \frac{\eta}{\epsilon_0} \qquad \eta = \frac{Q}{A}$$

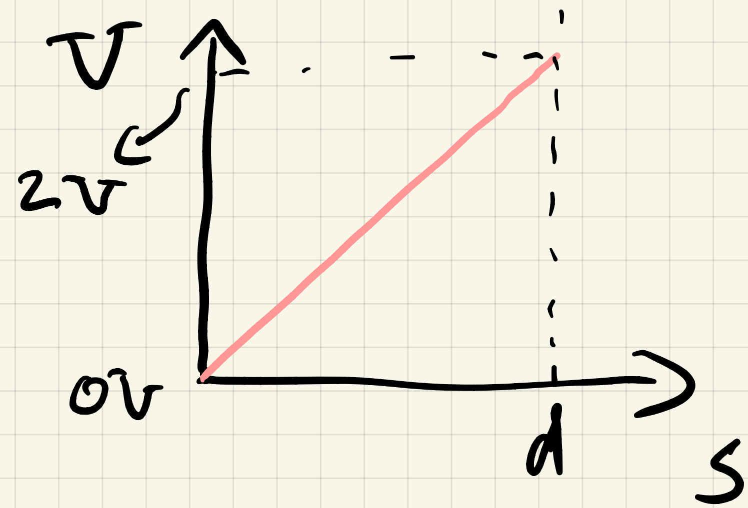
$$V = Es = \frac{Qs}{\epsilon_0 A} \Rightarrow \Delta V_{pp} = \frac{Qd}{\epsilon_0 A}$$

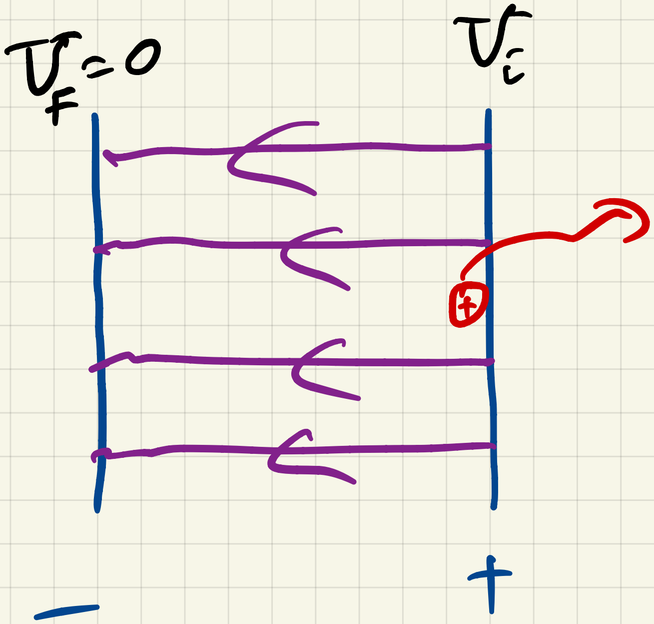
$$\Delta V_{\text{across capacitor}} = E\, d$$

↳ plate seperation

or $$E = \frac{\Delta V_c}{d}$$







charge $+q$ at rest, release, what is its speed when it hits the other wall

electric Force is conservative

$\Rightarrow \Delta U$ is path independent and only depends on initial & final positions

conservation of mechanical energy

$$\Delta U_{ele} + \Delta K = 0 \Rightarrow q\underbrace{V_f}_{0} - qV_i = \tfrac{1}{2}m\underbrace{v_i^2}_{0} - \tfrac{1}{2}mv_f^2$$

$V_F = 0$ & $v_i = 0$

$\Rightarrow -q V_i = -\frac{1}{2} m v_F^2$

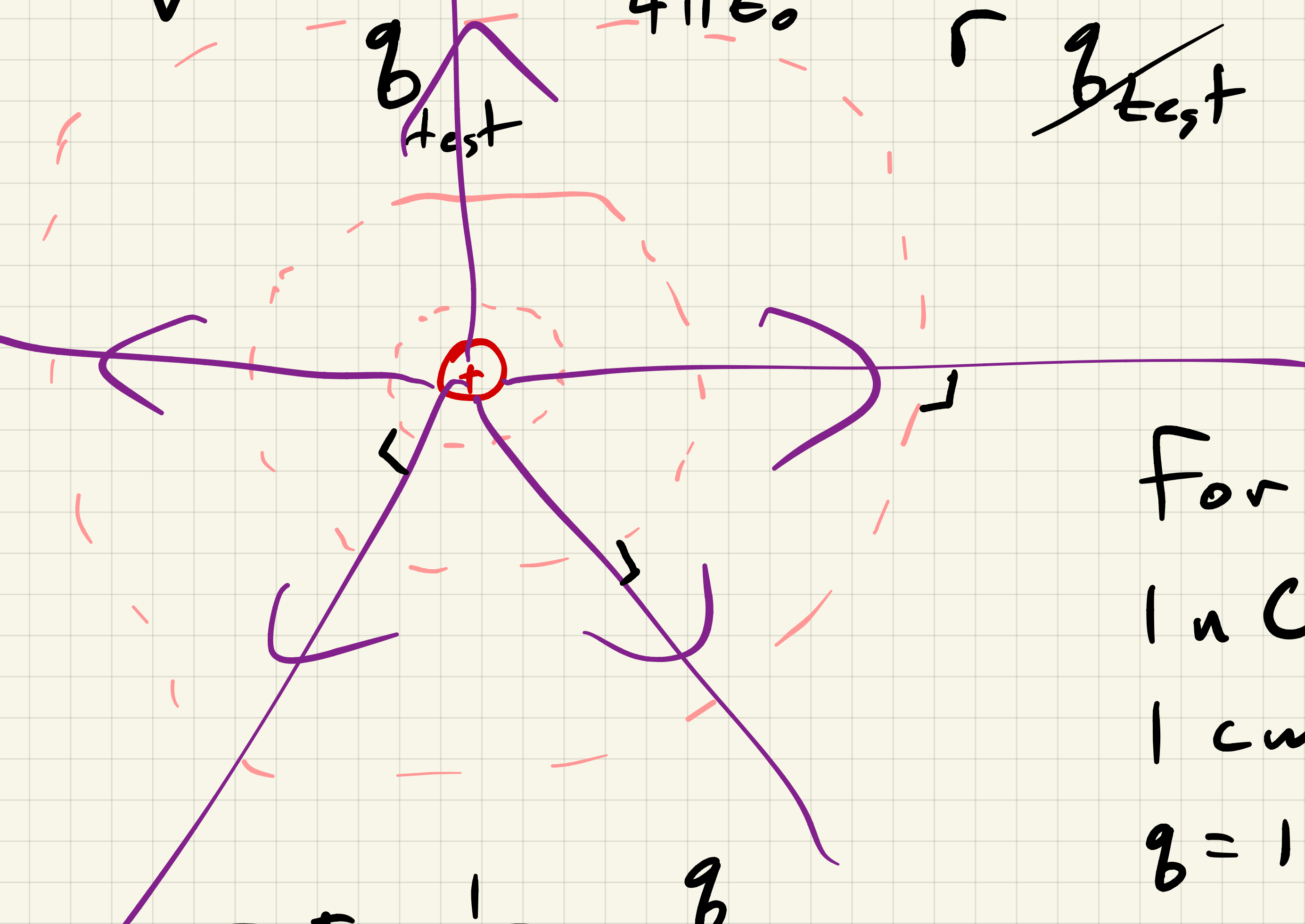
$\Rightarrow v_f = \sqrt{\frac{2 q V_i}{m}}$ → this is really just ΔV

use SI units $v \equiv \frac{m}{s}$ $V \equiv$ volts

$q \equiv C$ & $m \equiv kg$

potential from a point charge

$$V = \frac{U}{q_{test}} = \frac{1}{4\pi\epsilon_0}\frac{q\,\cancel{q_{test}}}{r\,\cancel{q_{test}}} = \frac{1}{4\pi\epsilon_0}\frac{q}{r}$$



$$V = \frac{1}{4\pi\epsilon_0}\frac{q}{r}$$

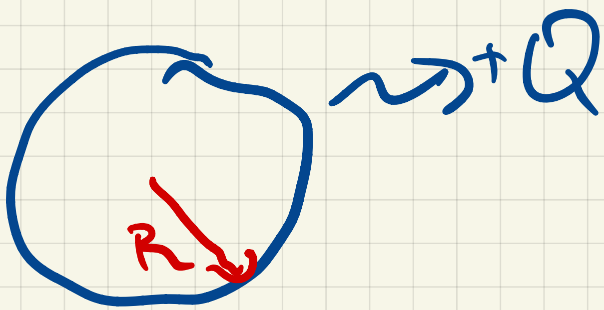
For a pt charge 1 nC the voltage 1 cm away is ?

$q = 1\times10^{-9}\,C$, $r = 1\times10^{-2}\,m$

$$V = 9\times10^{9}\,\frac{Nm^2}{C^2}\times\frac{1\times10^{-9}\,C}{1\times10^{-2}\,m} = 900\,V$$

potential From a charged sphere

charged sphere acts like a pt charge when outside sphere



outside sphere
$(r > R)$

$$V = \frac{1}{4\pi\epsilon_0}\frac{Q}{r}$$

at the surface

$$V = \frac{1}{4\pi\epsilon_0}\frac{Q}{R}$$

inside conducting sphere
all same potential

because $E = 0$ in conductor in electrostatics

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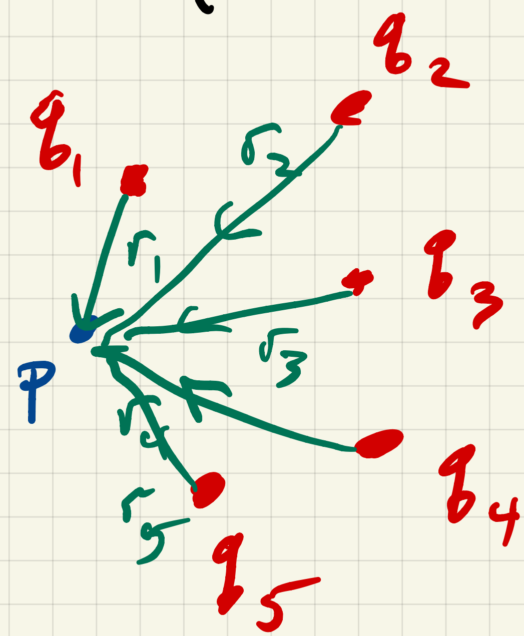
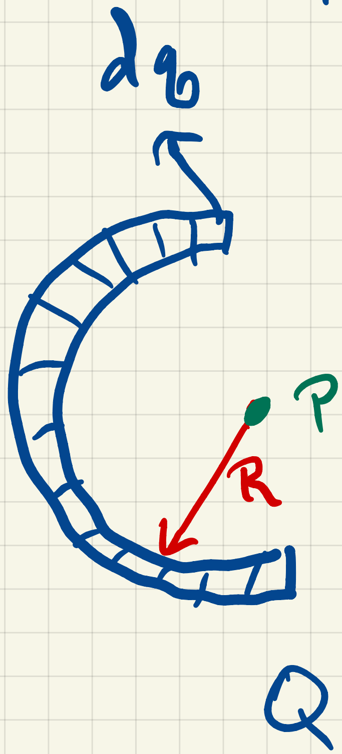
potential From multiple charges

$$V_{total} = \sum_i \frac{1}{4\pi\epsilon_0} \frac{q_i}{r_i}$$



For continuous charge distribution



Find V @ P

$dq = \lambda\, ds$ & $ds = R\, d\theta$

$r = R$

$$V = \int \frac{dq}{4\pi\epsilon_0 r} = \frac{1}{4\pi\epsilon_0 R} \underbrace{\int dq}_{Q}$$

$$V_{@P} = \frac{Q}{4\pi\epsilon_0 R}$$

Find E From V

$V = \frac{U}{q}$ & $\Delta U = -W = -\int \vec{F} \cdot d\vec{s}$

& $\vec{F} = q\vec{E}$

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

$\Rightarrow \quad dV = -\vec{E} \cdot d\vec{s}$

$\Rightarrow \quad \boxed{E_s = -\frac{dV}{ds}}$