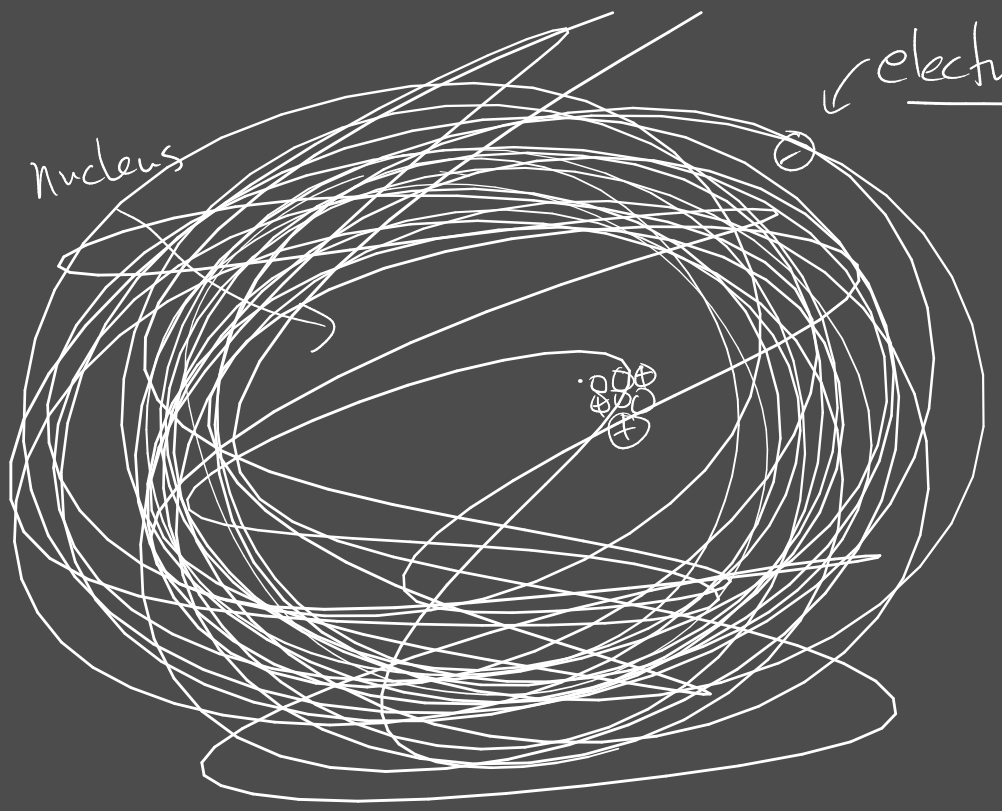
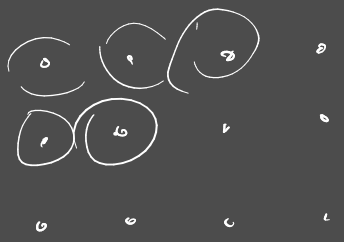
Chapter 12

Atom

- nucleus
  - protons - positive
  - electrons - negative
  - neutrons - no charge



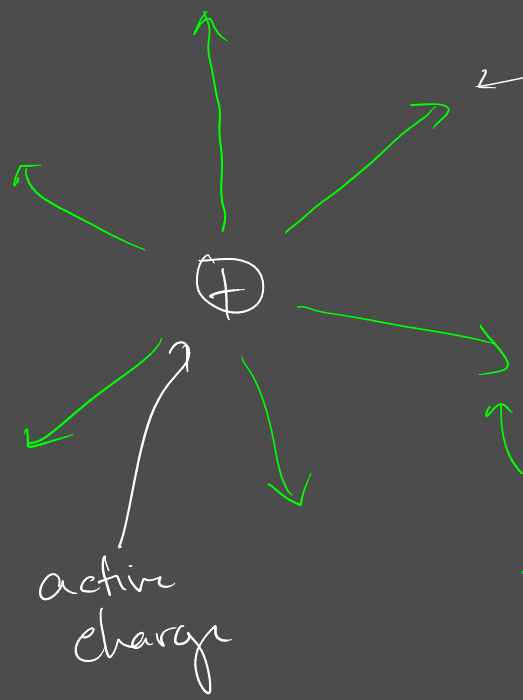


Electric Field → force field that results from charge

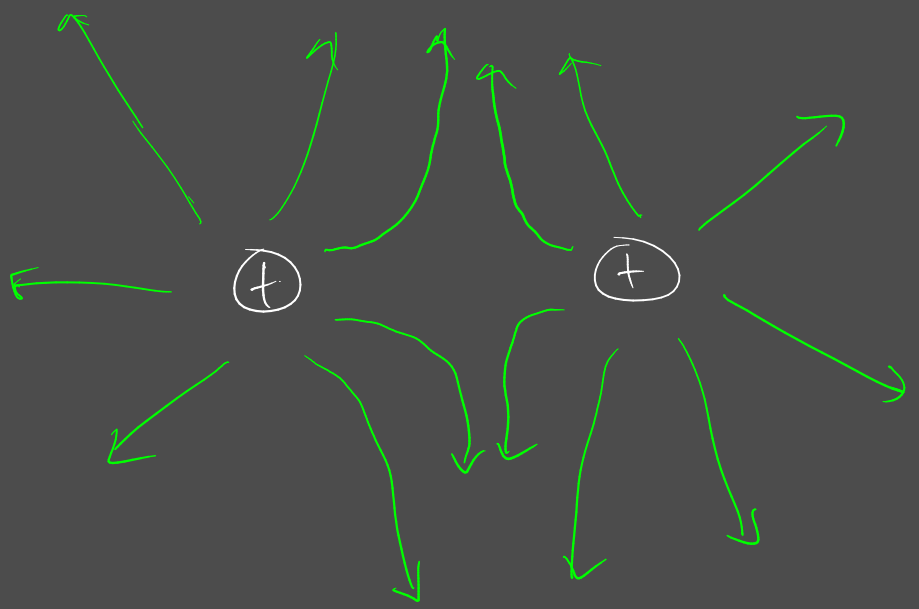
Electric Force = charge in a field × Field caused by another charge

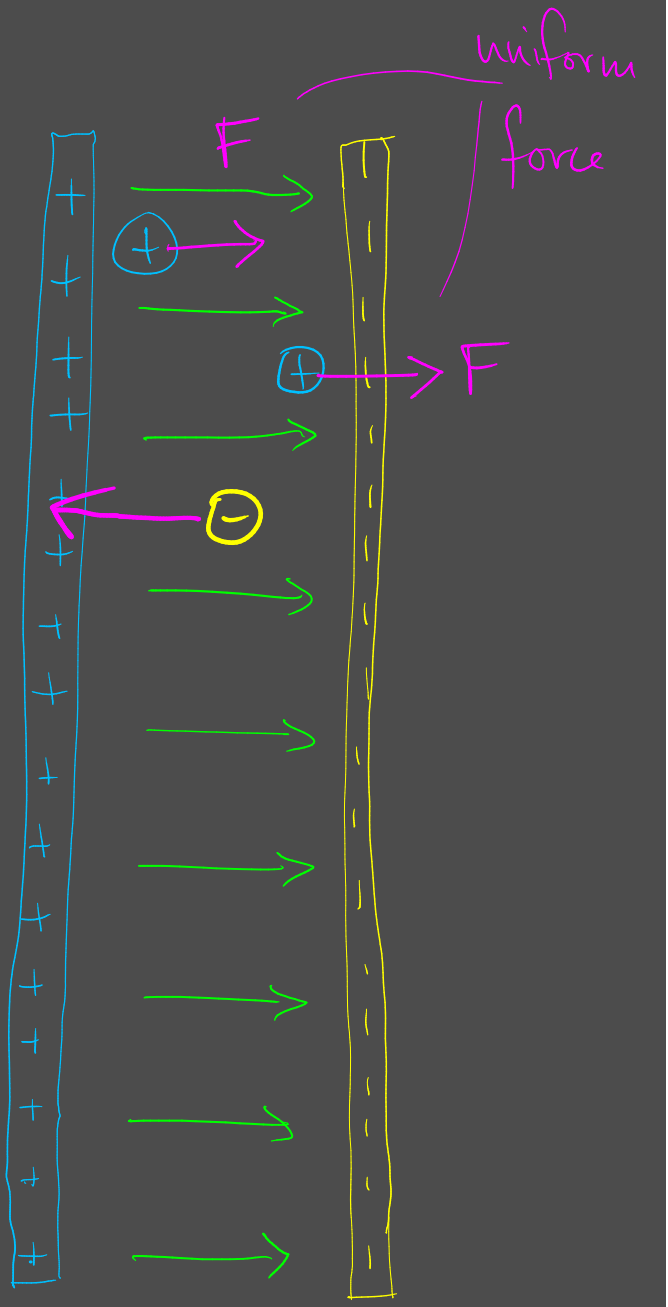
"passive" charge being acted on by the field.

"active" charge ↓ producing an electric field



← direction of field lines is direction of force on a positive passive test charge.





charge → 1 unit of charge

→ 1 Coulomb

1 elementary charge → charge of one electron or proton

fundamental

6.24×10^{18} electrons = 1 Coulomb

What is the charge of 1 electron in terms of Coulomb?

$$1 \text{ elementary charge} = \frac{1\,C}{6.24 \cdot 10^{18}\,e} = 1.6 \times 10^{-19}\,C/\text{elementary charge}$$

always true | Electric Field can be complicated

$$\text{Force} = \text{passive charge} \times \text{Field}$$

q_2

$q_1 = 10C$ $\quad$ $q_2 = 2C$

(+) ..... (+)

10 m

Coulomb's Law

$$F = \frac{k \cdot q_1 \cdot q_2}{r^2}$$

only true for two point charges

$$k = 9 \cdot 10^9 \frac{N m^2}{C^2}$$

↳ Coulomb constant

Electric Field

point charge

$$E = \frac{k q_1}{r^2}$$

$2\,\mu C = 2 \cdot 10^{-6}\,C$

$0.6\,\mu C = 0.6 \cdot 10^{-6}\,C$

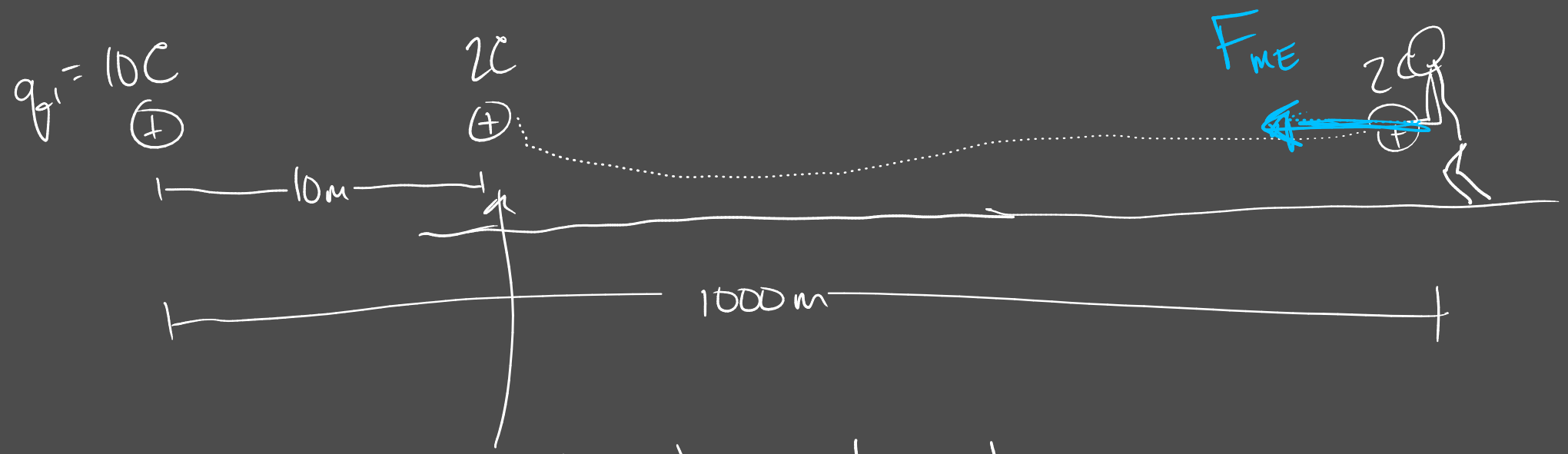
$10\,mC = 10 \cdot 10^{-3}\,C$

Electric field

$E \left[\frac{N}{C}\right]$

$F = q \cdot E$

$[N] = [C] \cdot \left[\frac{N}{C}\right]$

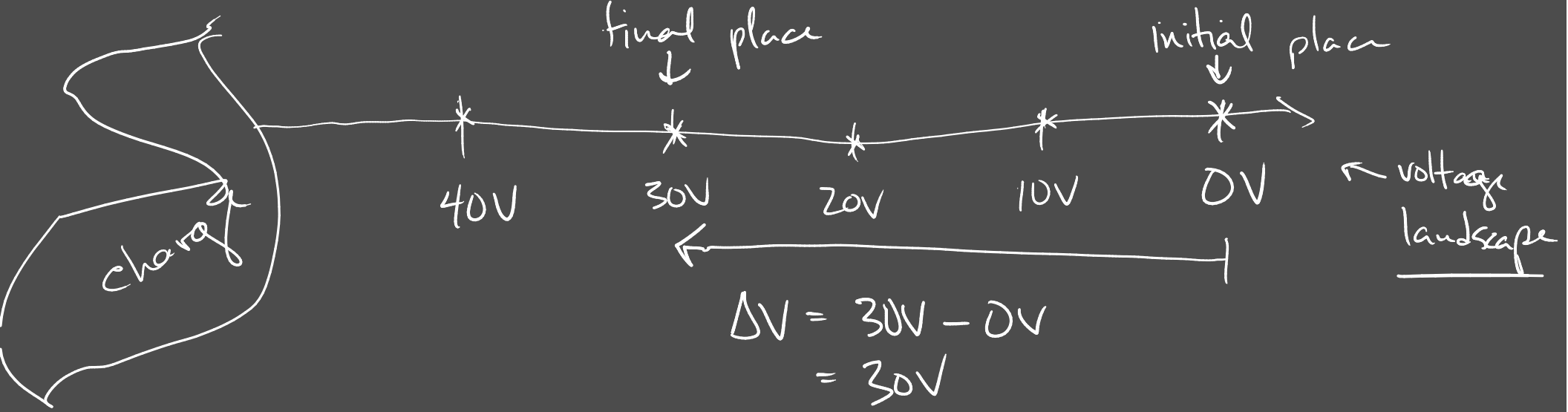


Work has been done to get the charge to here.

The charge now has potential energy

$$\frac{\text{Potential Energy}}{\text{unit of charge}} = \text{Voltage} \quad \text{(Electric Potential)}$$

$$\frac{[\text{Joule}]}{[\text{Coulomb}]} = [\text{Volts}]$$



$$\Delta V = 30V - 0V$$
$$= 30V$$

important thing is change in voltage

always need a reference point.

$$V = \frac{U_E}{q}$$

$$\Delta V = \frac{\Delta U_E}{q} \qquad \left[\frac{\text{Joule}}{\text{Coulomb}}\right] = [\text{Volt}]$$

$$\boxed{\Delta U_E = \Delta V \cdot q}$$

Joules Volts Coulomb

#1 $q_f = 1.6 \cdot 10^{-19} C$ ← fundamental charge

$$\frac{10.4 \cdot 10^{-5} C}{1.6 \cdot 10^{-19} C} = 6.5 \cdot 10^{14} \text{ charges}$$

#2 $F = 24N$

$d_2 = \frac{1}{3} d_1$

$$F = \frac{k q_1 q_2}{d^2} = 24N$$

$$F = \frac{k q_1 q_2}{\left(\frac{d}{3}\right)^2} = \frac{k q_1 q_2}{\frac{d^2}{9}} = k q_1 q_2 \cdot \frac{9}{d^2}$$

$$= 9 \cdot \underbrace{\frac{k q_1 q_2}{d^2}}_{24N}$$

#4 $q_1 = 10 \cdot 10^{-6}\ C$

$d = 12\ cm$

$.12\ m$

$$F = \frac{k q_1 \cdot q_2}{d^2}$$

$$F = \frac{9 \cdot 10^9 \cdot 10 \cdot 10^{-6} \cdot 10 \cdot 10^{-6}}{(.12)^2} = 62.5\ N$$

#7 $E = 30\ \frac{N}{C}$ upward

$q = -6\ C$

#8 $q = 12 \cdot 10^{-6}\ C$

$F = 41\ N$ down

$E = ?$

Electric Force = charge · Electric Field

$$30\ \frac{N}{\cancel{C}} \cdot 6\cancel{C} = 180\ N$$

$$F = q \cdot E$$

$$\frac{41\ N}{12 \cdot 10^{-6}\ C} = \frac{12 \cdot 10^{-6}\ C \cdot E}{12 \cdot 10^{-6}\ C}$$

$E =$

5 C

12 V → 0 V

$$\Delta U_E = q \cdot \Delta V$$

$$= q \cdot (V_f - V_i)$$

$$= 5C \cdot (0V - 12V)$$

$$= 5C \cdot -12V$$

$$\Delta U_E = -60\,J$$