Charged Particles in Electric Fields

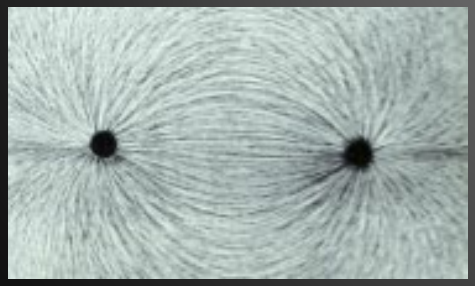
Lesson 6

Behaviour of Particles and Newton's Laws

- **An electric field shows the direction and relative magnitude of an electric force. (Field theory, E = F/q)**
- **The electric force will cause an acceleration. (Newton's Second Law)**
- **An acceleration will cause an object to start moving one direction or another. (Newton's First Law)**
- **So, if we place a charged particle in an electric field, it will start to accelerate!**

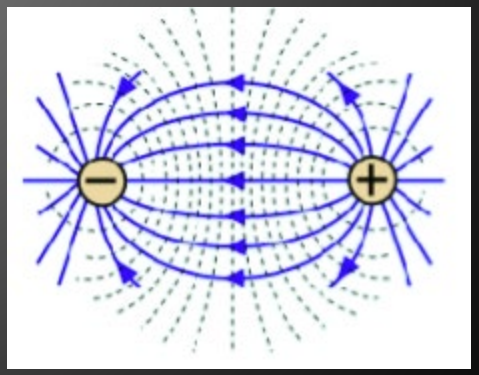
Recall the two categories of fields:

1. Non-uniform fields
   - Produced by single point charges or spheres
   - The field changes as the position of the test charge changes
   - Described by the equation



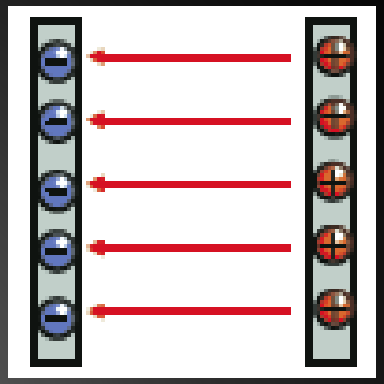
$$|\vec{E}| = \frac{kq}{r^2}$$

Electric Field Strength



**In a non-uniform field, the field strength is constantly changing. This makes a full analysis of the motion beyond our scope (needs calculus).

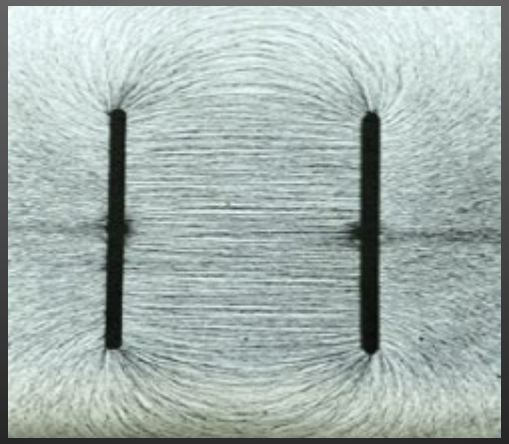
- 2. **Uniform Fields**
  - **Produced by parallel plates field**
  - **has the same strength everywhere**
  - **Described by eqns:**



$$V = \frac{\Delta E}{q}$$

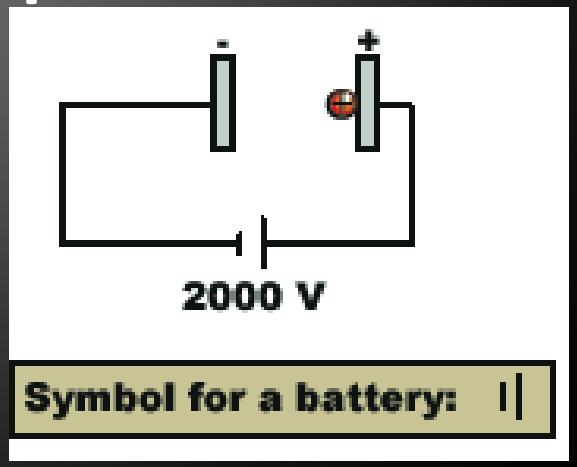
$$|\vec{E}| = \frac{V}{d}$$

E-field produced by parallel plates



Examples

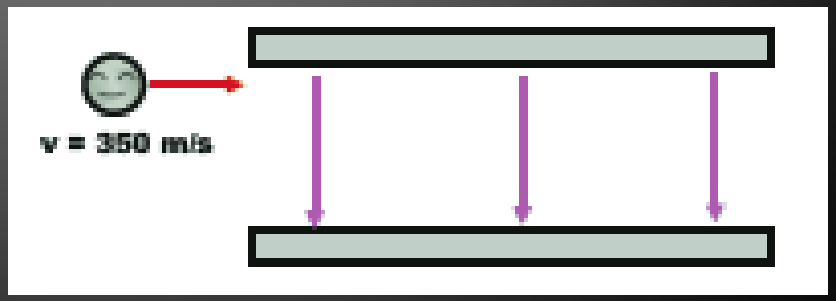
- **Two parallel plates are connected to a battery as shown. The battery supplies a potential of 2000 V. A sphere of mass 3.0 x 10^{-15} kg and q = +2.6 x 10^{-12} C is placed on the +ive plate and released. Ignoring gravity,**
- **a) what is the motion of the sphere?**

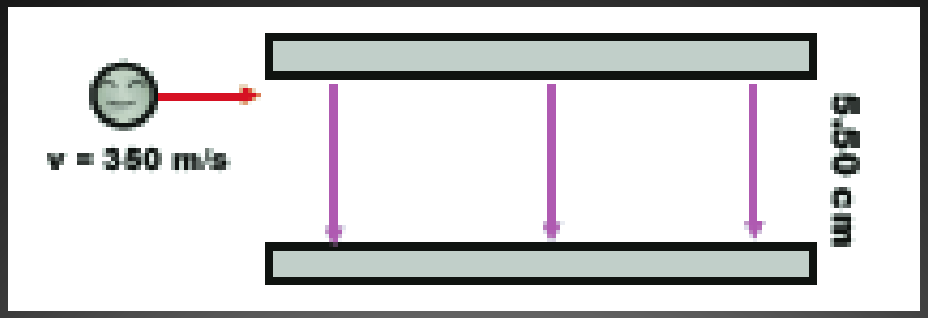


- b) if the separation between the plates is 4.5 cm, what is the electric field strength?

Examples

- **A small charge of mass 5.0 x 10^{-4} kg traveling at 350 m/s goes into a parallel plate capacitor as shown. The separation between plates is 5.50 cm and the potential difference between plates is 1000 V. The test charge has a q = +3.00 µC.**
- **a) Which plate is the positive plate in the capacitor?**





b) Assuming the charge enters at the top of the capacitor how far from the entrance will the charge hit the bottom plate?

c) What is the final velocity of the particle when it hits the bottom plate?