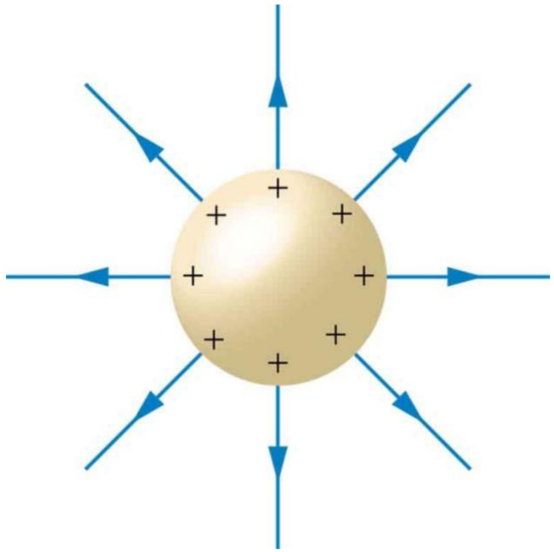
Electric Field: Examples

• Electric field determines the electric force acting on a charge q:

$$\vec{F}_{elect} = q\vec{E}$$

• Electric field of a point charge **Q** or a sphere with the same charge (**outside**), at distance **R**:



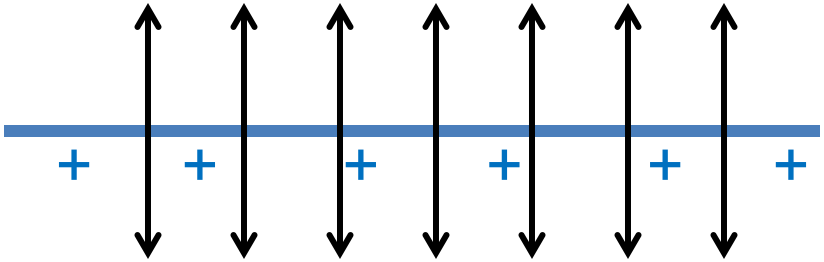
$$E = \frac{kQ}{R^2}$$

• Electric field **inside** the **hollow** charged sphere is ZERO!

$$E = 0$$

•Electric field of a plate with total charge Q, and area A:

$$E = \frac{2\pi kQ}{A}$$



Electrostatic Potential

• Reminder: **Electric Field** = electric force acting on a probe charge q, divided by q:

$$\vec{E} = \frac{\vec{F}_{elect}}{q}$$

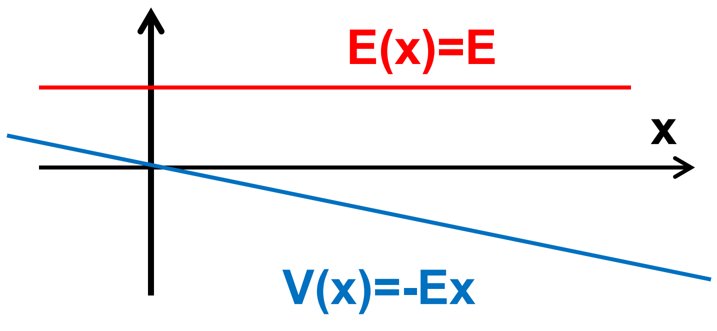
• Similarly, **Electrostatic Potential** = electrostatic potential energy divided by charge. It is also known as Voltage, since SI unit of potential is Volt (V):

$$V = \frac{U_{elect}}{q}$$

• **Example.** Consider constant electric field E(x)=E,(as inside a capacitor). Potential energy change = - Work:

$$\Delta U_{elect} = -F_{elect}\Delta x = -Eq\Delta x$$

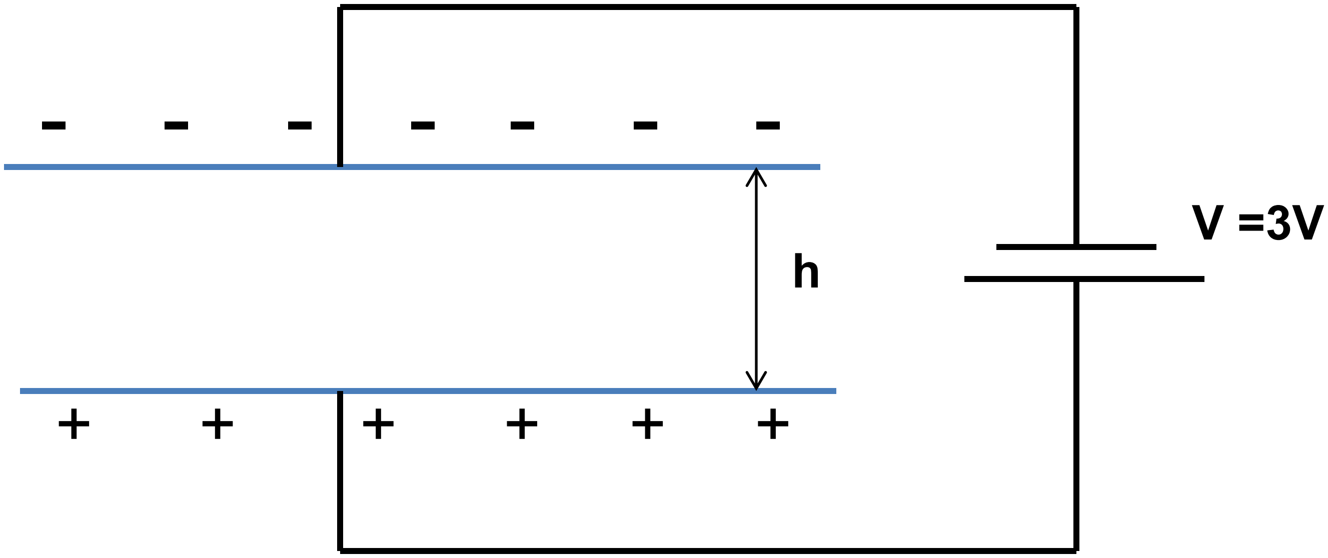
$$V(x) = \frac{U_{elect}}{q} = -Ex$$



Homework

Problem 1: A capacitor is made of two parallel metallic plates separated by distance **h=1mm**. Area of each plate is A=1cm. The capacitor is attached to a 3 Volt battery as shown below. Find the charge Q at each of the plates.

Note: electric field inside a capacitor is $4\pi kQ/A$.



Problem 2: A capacitor is made of two parallel metallic plates separated by distance **h**. There is vacuum inside. An electron enters the capacitor moving parallel to the plates with speed **u**. Due to the electric field, its trajectory bends towards the positive plate. Find the minimal voltage **V** that needs to be applied to the capacitor so that electron hits the plate before escaping. The length it needs to travel across the capacitor to exit is L (see the Figure for details). Electron charge and mass are **e** and **m**, respectively.