Gravity and Electrostatics

- **Newton's Law of Gravity.** Two masses, m_1 and m_2 , experience *gravitational attractive force* to each other, that depends on distance between them, r:

$$F = -\frac{Gm_1m_2}{r^2}; \qquad G = 6.7\times10^{-11}\frac{m^3}{kg\cdot s^2}$$

G is called Gravitational Constant. In this equation, '-' sign stands for attraction (positive direction is "away") .

- **Coulomb's Law.** Two electric charges, q_1 and q_2 , at distance r, act onto each other with *electrostatic force* given by Coulomb's formula:

$$F = \frac{kq_1q_2}{r^2}; \qquad k = 9\cdot10^9\frac{Nm^2}{C^2}$$

Here k is called Coulomb's constant . SI unit of electric charge is 1 Coulomb (1C), which is a very large charge. Coulomb's Law is very similar to Newton's, but

  - Electric charges can be positive or negative, unlike masses.
  - Note that the signs in two laws are different. As a result, charges of the same sign repel, while the opposite ones attract each other.

Fields

- A **Field** is a physical quantity that has certain value at any point of physical space (x,y,z), and time, t. In other words, it's a function defined in physical space & time.

- A field can be vector or scalar, but there are also other types.

- Electric field **E**, and Newtonian gravity **g**, are examples of vector fields.

- Electric force acting on a charge q:

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

here electric field does not depend on the charge q itself, but depends on other charges in space.

- Gravitational force:

$$\vec{F}_{grav} = m\vec{g}$$

Mass m is the gravitational charge, g is the local gravity field. g is also an acceleration of a freely falling object, but of course it does not have to have the familiar value of 9.8 m/s^2, as on the surface of Earth.

Homework 1

An electric capacitor is made of two parallel metallic plates that are oppositely charged. Let electric field inside this capacitor be **E=1000N/C** (Newton per Coulomb), directed from the positive to negative electrode. When the negative plate is illuminated with UV light, electrons may escape the metal. At moment **t=0s** one such electron appears right near the negative surface, with no initial velocity.

What will be its acceleration, if electron charge is **e=-1.6 x 10^{-19} C,** and mass is **m=0.9 x 10^{-30}**kg.

Calculate the time it will take this electron to reach the positive plate, due to electric force. Distance between the plates is **h=0.001m**.