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.

Electric Field

• 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.

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

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

• Once the electric field is known at certain point (x,y,z), one can find the electric force acting on any charge Q placed at that point:

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

Homework

Problem 1

a) By using Newton's law of gravity, find the gravitational acceleration on the surface of a planet with mass M and radius R. For doing this, consider an apple of mass m. Its weight is mg. But it also must be equal to Newton's gravitational force.
b) Imagine that you discovered a planet with the same density as Earth, but its radius is twice as big. What will be the value of g on that planet?

Problem 2

Find the magnitude of the electric field E at the point half way between two charges, q_1 and q_2 placed at distance **d** from each other.