Few things will happen before we start this next topic. First, we will solve homework problems. Second, we will discuss Millikan's experiment with some "believe me" formula in the middle – we will use it but not prove it – the reason we will spend time on it is that this formula is a relative of a formula which comes later in our course and which we will derive – the Ohm's law.

Dielectrics.

In SI units

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

where $k = \frac{1}{4\pi\epsilon_0}$ and ϵ_0 is sometimes called "permittivity of free space".

Different from the gravity, the force of electric interaction depends on the media around charges. Why – we will discuss later in the course, but for now I will just tell you that even in Gaussian units, k is not equal to one if you are not in vacuum.

Vacuum	1.0000
Air (1 atm)	1.0006
Paraffin	2.2
Polystyrene	2.6
Vinyl (plastic)	2–4
Paper	3.7
Quartz	4.3
Oil	4
Glass, Pyrex	5
Rubber, neoprene	6.7
Porcelain	6–8
Mica	7
Water (liquid)	80
Strontium titanate	300

$$k = \frac{1}{4\pi\epsilon_0\epsilon} \quad \text{(SI)} \qquad \text{or} \qquad k = \frac{1}{\epsilon} \quad \text{(CGSE)}$$

This ϵ is called ***permittivity*** or ***dielectric constant***. We will discuss where it comes from and why later. For now – just know it is there,

On the left is a table of some permittivity values at 20 degrees Celsius.

Homework problem. *A ball is hanging on a string. Volume of the ball is $V = 2\times10^{-6}\ m^3$ and density of the ball is $\rho = 9\times10^3\ \frac{kg}{m^3}$. The charge of the ball is $q = 2\times10^{-7}C$. We are bringing another small ball with the same by the value, but opposite by the sign charge and placing it below the first ball. How far below the first ball do we need to place the second one to make the tension force in the string double (i.e. twice stronger)? Consider two cases*

a) *Balls are in the air*
b) *The whole system is submerged into petroleum with density $\rho = 800\ kg/m^3$ and dielectric constant $\epsilon = 2.1$*