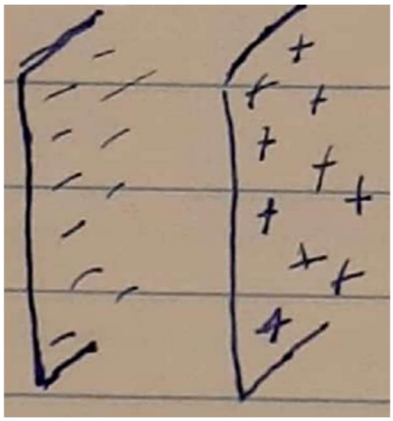
Homework 6

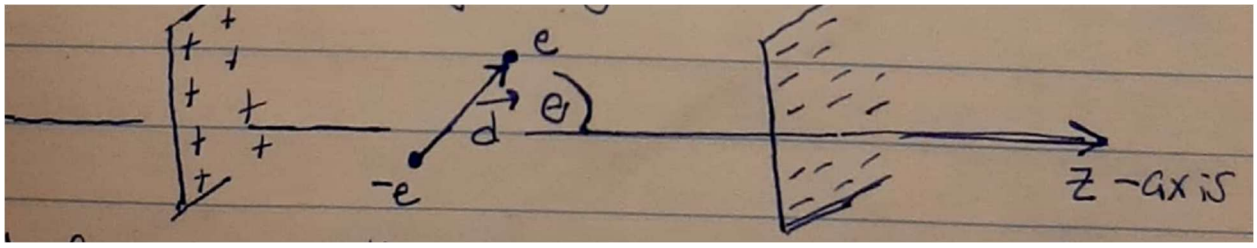
Physics 1320, Spring 2022

Due Friday, 3/4/2022

1. A flat metal plate has a uniform surface charge density of 3E-9 C/m^2. A second flat metal plate, parallel to the first, has an equal and opposite surface charge density. The two are close enough together that they can be modeled as infinite planes. How much pressure (force per square meter of surface) is required to pull them apart? How much work (per square meter of surface) is required to separate the plates by a distance of 1 cm?

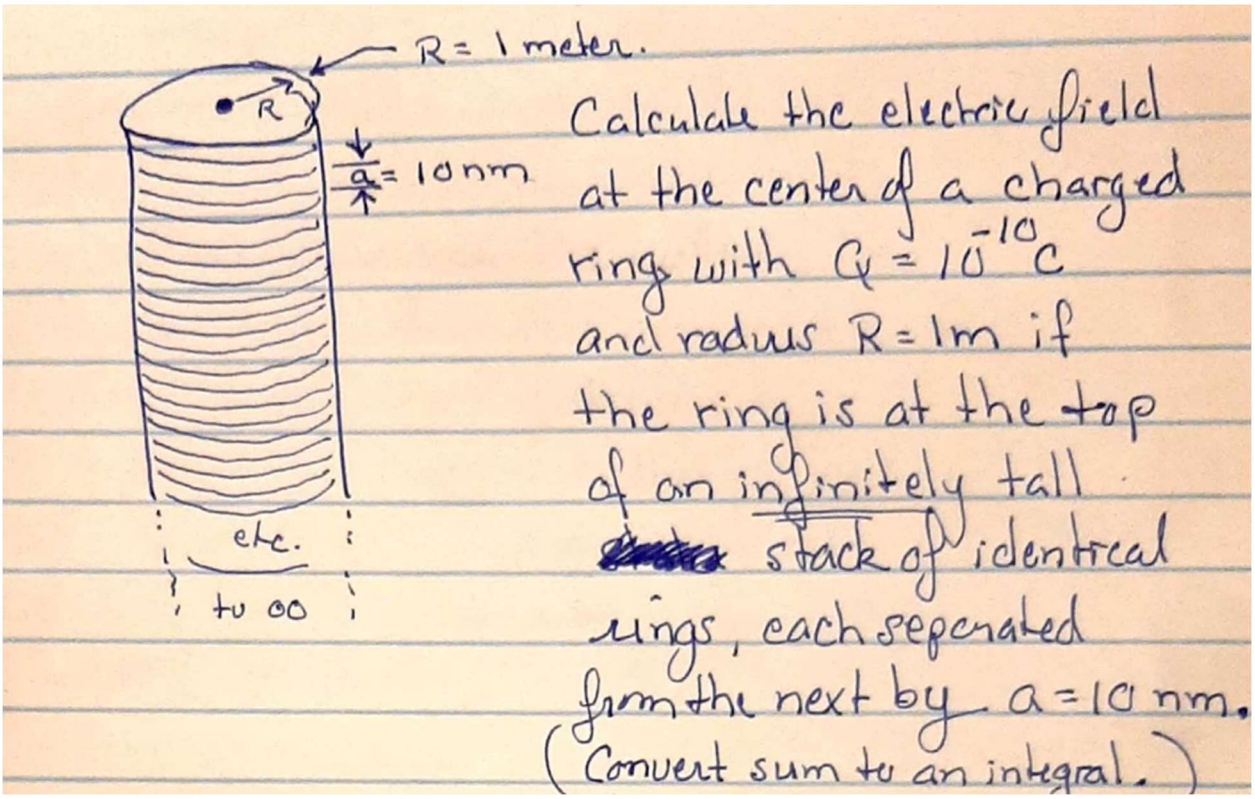


2. A dipole consists of charges +e and -e separated from one another by a distance d=0.2 angstroms. The vector $\vec{d}$ in the figure points from -e to +e and the "dipole moment" $\vec{p} = e\vec{d}$ is the product of the charge and this vector.



The dipole is placed between the infinite charged planes described in the previous problem. If the dipole moment makes an angle of $\theta = 38^{\circ}$ degrees with the z axis, what is the torque on the dipole?

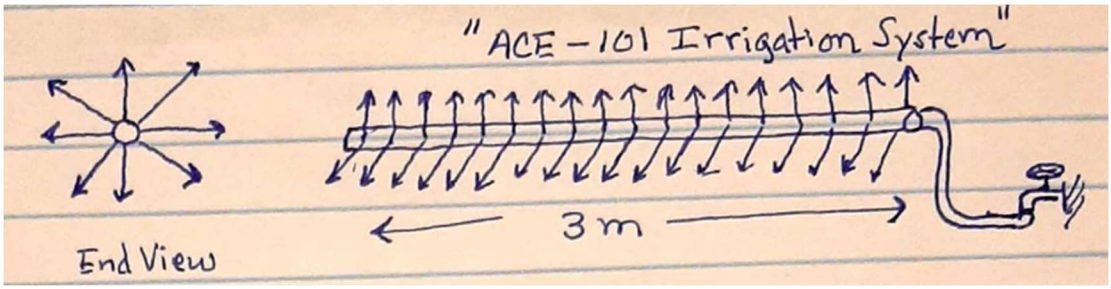
3.



4. Two infinite line charges, both positively charged with a uniform linear charge density of 10 micro Coulombs per meter, lie in planes that are parallel to the xy plane. They are separated from one another by 1 meter in the z direction.
    a. What is the force (per meter) between the two if they are parallel to one another?
    b. What is the <u>total</u> force between the two if they are perpendicular to one another?
5. The spherical globe of the van de Graaf generator in Regener Hall has a radius of 15 cm. It can be charged until the electric field at the surface reaches the dielectric strength of dry air (3E6 N/C). Suppose that it is positively charged. A nitrogen atom at the surface loses an electron, becomes a positive ion, and is accelerated away from the globe. Assuming no collisions, how fast will the nitrogen ion be moving when it reaches infinity?

6. The intensity of sunlight striking the earth is 1.4 kW/m^2. What is the maximum power that could possibly be absorbed by the earth? (The earth's radius is 4000 miles). How does this compare with the power demands of humankind? Given that the earth-sun distance is 93 million miles, and the pluto-sun distance is 4 billion miles, what is the intensity of sunlight striking pluto?

7. According to the advertisement appearing in the Albuquerque newspaper this morning, the ACE – 101 Sprinkler is this year's must-have law care device, in stock now at a hardware store near you. While a bit pricey, this is not your every-day lawn sprinkler. This is a complete "irrigation system", meeting all DEP soil and water conservation requirements.



A three meter pipe squirts water out of tiny holes uniformly in all directions perpendicular to the pipe (see figure), at a rate of 10 gallons/min. If the pipe is suspended 1 meter above the lawn, about how many teaspoons of water will strike a 1 square inch patch of grass directly below the pipe after watering for 1 hour? Ignore the deflection of the water stream by gravity, to first approximation.