Physics 1010 Homework 8 (21+ points)
Due Mon 11/5 midnight

1) (2 pts) **HW Correction.** Each week you should review both your answers and the answer key for the previous week's homework. Often (including this week) you will get to submit one homework correction. Select one problem for which you had the wrong answer. In the text box below, 1) identify the question number you are correcting, 2) state (copy) your original wrong answer, 3) explain where your original reasoning was incorrect, the correct reasoning for the problem, and how it leads to the right answer. If you got all the answers correct!!! bling bling... state which was your favorite / most useful homework problem, and why.

Electrostatics

2.) (0.5pt) You have two initially uncharged dust particles. Each dust particle has a mass of 2.0×10^{-12} kg. They are each 1.0×10^{-4} m in diameter and are 0.001 m apart. You take 10 electrons off of one and put them onto the other. The two dust particles are now

a. Attracted to each other
b. Repelled by each other
c. Neither attracted to nor repelled by each other.

3.) (1pt) If the dust particles now exert a force on each other, how big is the force that one particle exerts on the other particle?

a. 0.015 N
b. 2.0×10^{-23} N
c. 1.0×10^{-17} N
d. 2.3×10^{-20} N
e. No force is acting.

4.) (0.5 pt) If you take another 10 electrons off the same particle and put them on the other, by what factor does the force between the 2 particles change?

a. 0.5
b. 1
c. 2
d. 4
e. 10

5.) (0.5 pt) If you now double the distance between the dust particles to 0.002m, by what factor does the force between them change?

a. 0.25
b. 0.5
c. 1
d. 2
e. 4

6.) (0.5 pt) As you pull the 2 particles apart (horizontally) you have to apply a force and do work on them. What form of energy is that work stored as?

a. Gravitational potential energy
b. Kinetic energy
c. Electrostatic potential energy
d. Thermal energy
e. Pressure potential energy

Just before getting hit, or being very close to a lightning strike, many people (assuming they survive) report feeling a 'tingling feeling on the back of the neck like their hairs standing up on end'. This feeling is real and not to be ignored if you are at a high exposed location. What is causing it? (Hint: this effect has much in common with one of the Van de Graaff experiments that we did in class).

7.) (0.5pt) Prior to a lightning strike, various processes cause an excess of electrons to accumulate at the bottom part of a cloud. This means that the bottom part of the cloud is

a) Positively charged
b) Negatively charged
c) Neutral

8.) (0.5pt) At the surface of the earth, immediately below the cloud, the ground and anything on it, like you and your neck hair, will become

a) Positively charged
b) Negatively charged
c) Neutral

9.) (1 pt) Once your hair is charged, what force(s) are acting on each hair?

a) Gravity
b) Electrostatic force
c) Normal force
d) A and B
e) A and C

10.) (1 pt) Using your answer to Question 9, explain why you feel your neck hairs stand on end just before (a second or so before) a nearby lightning strike.

Over the past decade there has been a revolution in the cleaning products line with the introduction of new dusting cloths (Swiffer, Grab-it, and other electrostatic dry cloths). These cloths use electrostatic forces to attract dust, dirt, and hair. The cloths are made of polyester and polypropylene, and like to grab electrons from any material (e.g. Dust, dirt, hair) that they come in contact with.

11.) (1 pt) Select which type(s) of dirt, dust, and hair will be effectively picked up by the duster. (Select **all** that apply.)

a) dirt, dust, and hair with an initial excess positive charge
b) dirt, dust, and hair with an initial neutral charge
c) dirt, dust, and hair with an initial excess negative charge

12.) (1.5 pt) Explain how the cloth's own affinity for electrons (that is its ability to take electrons from other objects) enhances its performance over a cloth that simply has a fixed number of excess negative charges. (Be sure to include your reasoning.)

13.) (1 pt) Consider the case where we have a dusting cloth that is 10 inches by 6 inches and the maximum negative charge that the cloth can acquire is -5×10^{-8} Coulombs. Let's look at how many dog hairs this cloth can hold. Consider a whole pile of dog hairs where each piece of dog hair is 1 inch long and has a thickness of 0.00007 meters. If each dog hair has a slight positive charge of 2×10^{-12} Coulombs, how many hairs can the cloth hold?

a. 18000
b. 350
c. 25000
d. 4800
e. Need more information to calculate

14.) The next few questions consider what happens when you rub a balloon on your hair.

(0.5pt) After you have rubbed a balloon on your hair, your hair is

a. Attracted to the balloon
b. Repelled from the balloon
c. Neither attracted or repelled
d. Can't determined without more information

15.) (0.5pt) Why does the effect observed in Question 14 occur?

a. Rubbing creates negative charges on both the balloon and your hair
b. Rubbing takes negative charges from one object and adds them to the other leaving one positively charged and one negatively charged
c. Rubbing creates positive charges on both the balloon and your hair
d. The balloon has an excess of negative charge and gives some to your hair.
e. Your hair has an excess of negative charge and gives some to the balloon.

16.) (0.5pt) (T/F) You take the balloon away from your hair. Your hairs will now try to repel each other.

17.) (0.5pt) You take the balloon and stick it to the ceiling. Why does it stick to the ceiling?

a. Because the ceiling is charged with the same charge as the balloon.
b. Because the ceiling is charged with the opposite charge to the balloon.
c. Because the ceiling is electrically neutral, but charges in the ceiling become polarized when the charged balloon is nearby, allowing it to attract balloon.
d. Because there must be some chewing gum on the ceiling.

18.) (0.5 pt) How does the force between ceiling and balloon change as the balloon approaches the ceiling?

a. Increases as balloon gets closer
b. Independent of separation distance
c. Decreases as balloon gets closer
d. No force until the balloon and ceiling are in contact.

19.) (0.5 pt) You hold the balloon near a second balloon that you also rubbed on your hair. The 2 balloons will

a. Attract each other
b. Repel each other
c. No force between them
d. Can't tell without more information

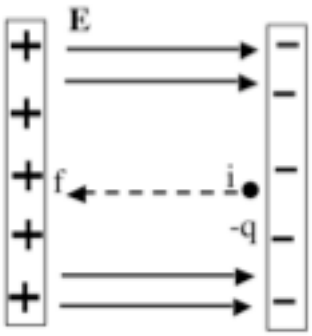
20.) (0.5 pt) If the balloon has a mass of 5g, what is the minimum electrostatic force needed to keep it stuck to the ceiling?

a. 0.005 N
b. 0.05 N
c. 0.5 N
d. 5 N
e. Can't tell without more information

21.) (1 pt) Approximately what number of charges will be required to produce that amount of force? Make regular assumptions.. e.g. for instance you can assume the charges are 0.5mm (5×10^{-4} m apart)

22.) (1 pt) Play around with the charges and fields simulation:
http://phet.colorado.edu/en/simulation/charges-and-fields
Is it possible to have a place where there's zero voltage with 3 charges of the same type on the screen? Describe why or why not using the simulation. (Hint: use the visualization of V.)

23.) (1 pt) On the same simulation, is it possible to have a place where there's zero voltage with 2 charges of one type and one of the other? Describe why or why not in terms of the simulation.



24.) (1.5 pts) A negative charge -q is released from position "i" and travels to position "f" between the charged plates (see diagram).
Did the potential energy (PE) increase, decrease, or stay the same? Why?

25.) (1.5 pts) Did the voltage (V) at the position of the test charge increase, decrease, or stay the same? Why?

BONUS:

Scotch Tape Experiment:

- Tear of two decent size strips (e.g. 10 cm) pieces of scotch tape and fold the first few centimeters of sticky sides together to make a handle. Place the two strips sticky side down on a table parallel to each other. Rub the tape then pull off the table quickly.
- Then hold the two strips apart from each other and gradually bring closer together and record what happens.
- Next place one strip on the table sticky side down and then place the second strip on top of it and rub the top strip. Pull the two strips off together, then separate, hold apart and then gradually bring closer together. Record on the Worksheet what happens.
- What happens if you have three layers of tape?