

Electric Charges and Fields

Homework Problems

- Two charges, q_1 and q_2 , are separated by a distance, d , and exert a force, F , on each other. What new force will exist if a) q_1 is doubled b) q_1 and q_2 are cut in half c) d is tripled d) d is cut in half e) q_1 is tripled and d is doubled?
- How many excess electrons are on a ball with a charge of $-4 * 10^{-17}$ C?
- Two electrons in an atom are separated by $1.5 * 10^{-10}$ m. What is the force between them?
- Object A has a charge of $+1.8 * 10^{-6}$ C. Object B has a charge of $-1 * 10^{-6}$ C. They are 0.015 m apart. What is the force on A? What is the force on B?
- A positive and a negative charge, each of magnitude $1.5 * 10^{-5}$ C, are separated by a distance of 15 cm. Find the force on each of the particles.
- Two negative charges of $-3 * 10^{-6}$ C exert a repulsive force of 2 N on each other. By what distance are they separated?
- How far apart are two electrons if they exert a force of repulsion of 1 N on each other?
- A force of $-4.4 * 10^3$ N exists between a positive charge of $8 * 10^{-4}$ C and a negative charge of $-3 * 10^{-4}$ C. What distance separates the charges?
- Two identical positive charges exert a repulsive force of $6.4 * 10^{-9}$ N when separated by a distance of $3.8 * 10^{-10}$ m. Calculate the charge of each.
- The two pith balls shown each have a mass of 1 g and equal charges. One pith ball is suspended by an insulating string. The other is brought to 3 cm from the suspended ball. The suspended ball is now hanging with the thread forming an angle of 30° with the vertical. The ball is in equilibrium with F_E , mg , and T adding vectorally to yield zero. Calculate a) mg b) F_E c) the charge on the balls.

- A positive charge of $1 * 10^{-5}$ C experiences a force of 0.2 N when located at a certain point. What is the electric field intensity at that point?
- What charge exists on a test charge that experiences a force of $1.4 * 10^{-8}$ N at a point where the electric field intensity is $2 * 10^{-4}$ N/C?
- A test charge has a force of 0.2 N on it when it is placed in an electric field intensity of $4.5 * 10^5$ N/C. What is the magnitude of the charge?
- The electric field in the atmosphere is about 150 N/C downward. a) What is the direction of the force on a positively charged particle? b) Find the electric force on a proton
- Electrons are accelerated by the $1 * 10^5$ N/C electric field in a television picture tube. a) Find the force on the electron. b) If the field is constant, find the acceleration of the electron
- Carefully sketch the electric fields produced by a 1 microCoulomb charge and a 2 microCoulomb charge.
- A positive test charge of $8 * 10^{-5}$ C is placed in an electric field of 50 N/C intensity. What is the strength of the force exerted on the test charge?

18. If 120 J of work are done to move one coulomb of charge from a positive plate to a negative plate, what voltage difference exists between the plates?
19. How much work is done to transfer 0.15 C of charge through a potential difference of 9 V?
20. An electron is moved through a potential difference of 500V. How much work is done on the electron?
21. A 12 V battery does 1200 J of work transferring charge. How much charge is transferred?
22. Two positive charges of 3.0×10^{-7} C each are 0.2 m apart. What is the potential energy of the charges? If one of the charges is kept fixed while the other is allowed to move under their mutual repulsion, how much kinetic energy will be imparted to the moving charge when it is infinitely far from the fixed charge?
23. A proton is accelerated over a difference of potential of 50,000 V. How much kinetic energy does the proton acquire? What velocity does it acquire?
24. An electron in an electron gun is accelerated by a voltage of 20,000 V. What kinetic energy does it acquire? What is its velocity?
25. What kinetic energy does an electron moving at 3.0×10^6 m/s possess? What voltage must be applied to the electron to give it this velocity?
26. At what distance from a proton must an electron be to have a potential energy of 8×10^{-19} J. If the distance between the electron and the proton is doubled, what is its new potential energy?

27. A force of 0.053 N is required to move a charge of 37 microCoulombs a distance of 25 cm in an electric field. What is the size of the potential difference between the points?
28. The electric field intensity between two charged plates is 1.5×10^3 N/C. The plates are 0.08 m apart. What is the potential difference, in Volts, between the plates?
29. A voltmeter indicates that the difference in potential between two plates is 50 V. The plates are 0.02 m apart. What electric field intensity exists between them?
30. A constant electric field of 750 N/C is between a set of parallel plates. What is the potential difference between the parallel plates if they are 1.5 cm apart?

31. A spark will jump between two people if the electric field exceeds 4×10^6 V/m. You shuffle across a rug and a spark jumps when you put your finger 0.15 cm from another person's arm. Calculate the potential difference between your body and the other person's arm.
32. A potential difference of 0.9 V exists from one side to the other side of a cell membrane that is 5 nanometers thick. What is the electric field across the membrane?

33. An oil drop having a charge of 8×10^{-19} C is suspended between two charged parallel plates. The plates are separated by a distance of 8 mm, and there is a potential difference of 1200 V between the plates. What is the weight of the suspended oil drop?
34. A negatively charged oil drop weighs 8.5×10^{-15} N. The drop is suspended in an electric field intensity of 5.3×10^3 N/C. a) What is the charge on the drop? b) How many extra electrons does it carry?

1. double, quartered, one ninth as much, quadrupled, three-fourths as much	2. 250 electrons	3. $1.02 \times 10^{-8} \text{ N}$	4. -71.92 N	5. -89.9 N
6. 0.2011 m	7. $1.5 \times 10^{-14} \text{ m}$	8. 0.7 m	9. $3.2 \times 10^{-19} \text{ C}$	10. 0.0098 N, 0.005658 N, $2.38 \times 10^{-8} \text{ C}$
11. 20000 N/C	12. $7 \times 10^{-5} \text{ C}$	13. $4.4 \times 10^{-7} \text{ C}$	14. down, $2.4 \times 10^{-17} \text{ N}$	15. $1.6 \times 10^{-14} \text{ N}$ $1.758 \times 10^{16} \text{ m/s}^2$
16. diagram	17. 0.004 N	18. 120 V	19. 1.35 J	20. $8 \times 10^{-17} \text{ J}$
21. 100 C	22. 0.00405 J	23. $3.095 \times 10^6 \text{ m/s}$	24. $8.386 \times 10^7 \text{ m/s}$	25. 25.59 V
26. $2.88 \times 10^{-10} \text{ m}$ $-4 \times 10^{-19} \text{ J}$	27. 358 V	28. 120 V	29. 2500 V/m	30. 11.25 V
31. 6000 V	32. $1.8 \times 10^8 \text{ V/m}$	33. $1.2 \times 10^{-13} \text{ N}$	34. $-1.6 \times 10^{-18} \text{ C}$	