

Assignment 1

Physics 205/4-03

(Do any 8 problems)

1. Each of two small spheres is positively charged, the combined charge totaling $4 \times 10^{-8} \text{C}$. What is the charge on each sphere if they are repelled with a force of $27 \times 10^{-5} \text{N}$ when placed 0.1 m apart? ($3.0 \times 10^{-8} \text{C}$, $1.0 \times 10^{-8} \text{C}$)
2. Two small spheres carrying unequal positive charges repel each other with a force of 0.12 N when 3 cm apart. If the charge on each sphere is doubled and the distance between them is tripled, what is the force of repulsion? (ans: 0.053 N)
3. Charges of +5 and +10 μC and 1m apart. What is the force between them? (ans: 0.45N)
4. How far apart in a vacuum must two electrons be if the force of electrostatic repulsion on each electron is just equal in magnitude to the weight of the electron? (ans: 5.09 m)
5. Two charges of +15 and +5 μC are 6 cm apart, where must a third charge be placed in order that the resultant force acting on it be zero? (ans: 3.8 cm)
6. What are the magnitude and direction of the electric intensity at a point 18 cm from a point charge of $-50 \mu\text{C}$? (ans: $-1.39 \times 10^7 \text{ N/C}$)
7. An oil drop has a net negative charge of $-3e$, representing an excess of three electrons. It remains at rest under the action of the force of gravity and the electric force when it is placed in a downward electric field of $3.0 \times 10^5 \text{ N/C}$. Find the mass of the droplet. (ans: $1.47 \times 10^{-14} \text{ kg}$)
8. What is the acceleration of an electron in a field of $5 \times 10^5 \text{ N/C}$? Express this in terms of the acceleration of gravity. (ans: $8.8 \times 10^{16} \text{ m/s}^2$, $8.95 \times 10^{15} \text{ g}$)
9. 6.02×10^{23} atoms of monatomic hydrogen have a mass of one gram. How far would the electron of a hydrogen atom have to be removed from the nucleus for the force of attraction to equal the weight of the atom. (ans: $1.19 \times 10^{-1} \text{ m}$)
10. If all the positive charges in a molecule of hydrogen atoms were lumped into a single charge, and all the negative charges into a single charge, what force would the two lumped charges exert on each other at a distance of (a) 1 m, (b) 10^7 m . (ans: $8.35 \times 10^{19} \text{ N}$, $8.35 \times 10^5 \text{ N}$)
11. Point charges of $2 \times 10^{-9} \text{ C}$ are situated at each of the three corners of a square whose side is 0.20 m. What would be the magnitude and direction of the resultant force on a point charge of $-1 \times 10^{-9} \text{ C}$ if it were placed (a) at the center of the square? (b) at the vacant corner of the square? (ans: $9.0 \times 10^{-9} \text{ N}$, at 45° with x-axis, $8.6 \times 10^{-7} \text{ N}$ at 225° with x-axis)
12. A certain metal sphere of volume 1 cm^3 has a mass of 7.5g and contains 8.2×10^{22} electrons. (a) How many electrons must be removed from each of two such spheres so that the electrostatic force of repulsion between them just balances the force of gravitational attraction? (treat the charges on the spheres as point charges), (b) express the number of electrons removed as a fraction of the total number of free electrons. (ans: 4.03×10^6 , 4.92×10^{-17})
13. Two small balls, each of mass 10g, are attached to silk threads 1m long and hung from a common point. When the balls are given equal quantities of negative charge, each thread makes an angle of 4° with the vertical. (a) Draw a diagram showing all the forces on each ball, (b) Find the magnitude of the charge on each ball. (ans: $1.24 \times 10^{-7} \text{ C}$)
14. A botany professor is in an electric field. The uniform electric field has a magnitude of 500 N/C. An electrical force of magnitude 6.0 N is found to act on the professor of mass 75 kg in the direction opposite to that of the field. What is the charge of the professor? (ans: $-1.2 \times 10^{-2} \text{ C}$)
15. A small charged sphere of mass 20.0 gram is suspended at rest making 10° angle to the right of the vertical, by means of a thin (massless) thread of length 50.0 cm in a uniform electric field of magnitude 100 N/C directed in the horizontal direction to the left. (a) What is the sign of the charge on the sphere? (b) Find the charge on the sphere. (ans: -ve, $-3.5 \times 10^{-4} \text{ C}$)
16. At what distance from a proton is the magnitude of its electric field equal to $3.0 \times 10^6 \text{ N/C}$? (ans: $2.2 \times 10^{-8} \text{ m}$)
17. Assume the electron in the ground state of the hydrogen atom is located $5.29 \times 10^{-11} \text{ m}$ from the nuclear proton. (a) what is the magnitude of the electric field of the proton at the position of the electron? (b) What is the magnitude of the electrical force on the electron? (c) What is the magnitude of the electric field of the electron at the position of the proton? (d) What is the magnitude of the electric force on the proton? (ans: $5.15 \times 10^{11} \text{ N/C}$, $8.25 \times 10^{-8} \text{ N}$, $5.15 \times 10^{11} \text{ N/C}$, $8.25 \times 10^{-8} \text{ N}$)