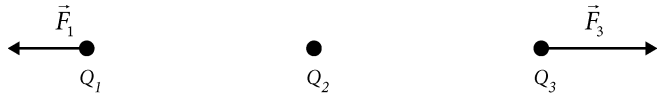
Basic Phenomena in Electrostatics and Coulomb's Law

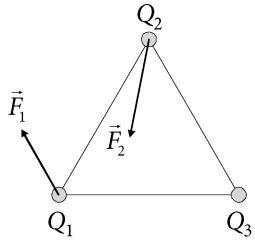
Basic Problems

1. A charged rod attracts both positively and negatively charged objects. What is the charge on the rod? Give reasons for your answer.
2. A rubber rod is rubbed with a cat's fur and thereby charged to − 3 μC. How many electrons are added to the rod? How does this change the rod's mass?
3. A metal ball carries + 6 μC of charge. It is touched by a second ball of the same size carrying a charge of − 4 μC. Calculate the final charge on each of the balls.
4. Two balls carry charges of + 1 μC and + 2 μC. The distance between their centres is 35 cm. Calculate the force acting between them. Is it attractive or repulsive?
5. The force acting between two balls carrying charges of + 1.5 μC and − 2.5 μC has a magnitude of 25 mN. Calculate the distance between the two balls.
6. Two charges of equal magnitude and with a distance of 5 cm attract each other with a force of magnitude 2 mN. Calculate the magnitude of the charges.
7. The distance between two point charges is decreased to one third of its initial value. How does this affect the magnitude of the force acting between them?
8. The force acting between two charged balls at distance r has magnitude F. Calculate the distance at which it is only $F/2$.
9. The distance between two point charges is increased from r to r'. The force acting between consequently decreases by 10 %. Determine the ratio $r' : r$.
10. Three charges Q_1, Q_2 and Q_3 are placed along a straight line. $\vec{F}_1$ and $\vec{F}_3$ are the resultant forces acting on Q_1 and Q_3, respectively. Find the resultant force acting on the charge Q_2.



Supplementary Problems

11. A metal ball is charged to + 15 μC. How does this affect the ball's mass?
12. The distance between the proton and the electron in a hydrogen atom is some 10^{-10} m. Calculate the electrostatic force acting between the two particles. Why does the electron not crash into the nucleus? Compare the electrostatic force to the gravitational force acting between the two particles.
13. Two point charges $q_1 = + 2$ μC and $q_2 = + 8$ μC are fixed at a distance of 1 m.
    a) Calculate the resultant force acting on a proton placed exactly at the centre between the two point charges.
    b) Find a point where the resultant force on the proton is zero.
14. Three charges Q_1, Q_2 and Q_3 are placed at the corners of an equilateral triangle. $\vec{F}_1$ and $\vec{F}_2$ are the resultant forces acting on the first two charges. Determine the resultant force acting on Q_3.



Solutions to Basic Problems: 2. $2 \cdot 10^{13}$, $1.8 \cdot 10^{-17}$ kg; 3. 1 μC; 4. 0.15 N (repulsive); 5. 1.16 m; 6. 24 nC; 7. nine times greater; 8. $\sqrt{2}\,r$; 9. 1.05 : 1; 10. $\vec{F}_2 = -\left(\vec{F}_1 + \vec{F}_3\right)$