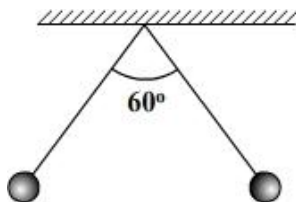


Electric charges and Fields

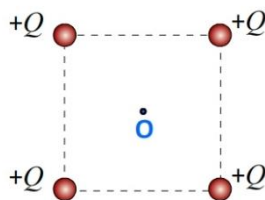
1. A point charge of 2nC is placed at a distance of 10 cm from another point charge of 4nC . Find the electrostatic force between them.
2. The force between two charges Q_1 and Q_2 is F . Another charge of $-Q$ is brought near the two charges. Find the force between Q_1 and Q_2 .
3. Two equal unlike charges separated by a distance of 10cm in air attract each other with a force of 0.009 N . Find the magnitude of each charge.
4. Two point charges separated by a distance R attract each other with a force F . If the charges are doubled and the medium between them is replaced with a material of relative permittivity 4 then what would be the force between the charges.
5. A charge q is placed at the centre of the line joining two identical charges Q . If all the charges are free to move then what should be charge on the q such that the system is in equilibrium.
6. A charge q is placed in between two charges of magnitude Q and $4Q$ fixed at a distance of d from each other. Find the distance of q from the charge Q such that the system of charges is in equilibrium.
7. Find the centripetal force provided by the electrostatic interaction to keep an electron in a circular orbit of radius $0.4\text{\AA}$ around a proton.
8. The force acting between two particles remains unchanged if the distance between them is decreased by 4 times and the medium between them is filled with a dielectric of constant K . What is the value of the dielectric constant of the medium?
9. Two small metallic spheres, each carrying a charge of $10\mu\text{C}$, and mass 100 g are suspend using insulating threads of length 1m each as shown in the figure. If the spheres are in equilibrium, find the tension in each string. ($g = 10\text{ ms}^{-2}$)



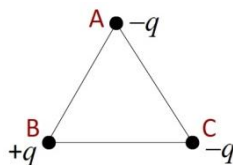
10. Two bodies carrying charges $3Q$ and $2Q$ are placed at a distance a from each other. A certain amount of charge q is the charge transferred from one body to another such that the force between them becomes the maximum. Find the value of q .

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11. A lump of charge Q is to be divided into two parts such that the force between the two parts is the maximum, when kept at a fixed distance. What should be the charge of each part?
12. Calculate the electrostatic force between an electron and a proton separated by a distance of 1 angstrom and compare this force with the gravitational force between them.
13. A point object of mass 2g and charge $6\mu\text{C}$ is held at a height of 10 cm above another point charge. Find the charge of the second point charge. ($g = 10 \text{ ms}^{-2}$)
14. Plot the graph of electrostatic force as a function of the charge of a point charge kept at a certain (fixed) distance from another point charge.
15. Plot the graph of electrostatic force between two charges as a function of distance between the charges.
16. Two point charges (q) are placed at ($0, a$) and ($0, -a$). Another identical point charge is placed at ($2a, 0$). Find the net force acting on the third charge.
17. Four charges are placed at the four corners of a square of length 1m. Find the net force acting on any one of the charges.



18. Three charges are placed at the corners of a triangle of side length 1m as shown in the figure. Find the net force acting on the charge located at A.



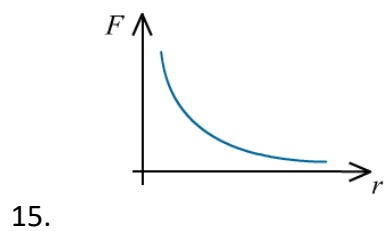
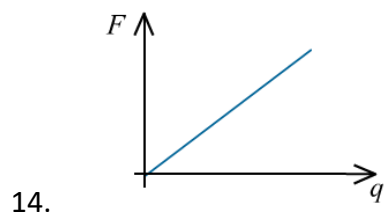
19. Consider two identical charges placed at a certain (fixed) distance from each other. Plot the graph of force acting on another charge, as a function of its distance from the origin, along the line joining the charges.

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20. Consider two charges Q_1 and Q_2 of equal magnitude, located at $(-a, 0)$ and $(a, 0)$. In the three dimensional space around the charges identify the points where (excluding infinite distances) the net force on a third charge (q) would be zero if
- (a) Q_1 and Q_2 are both positive
 - (b) Q_1 is positive and Q_2 is negative

Answers and Hints

1. 7.2×10^{-6}
2. F
3. $0.1 \mu\text{C}$
4. F
5. $-Q/4$
6. $d/3$
7. 1.44×10^{-7}
8. 16
9. 1.8
10. $0.5Q$
11. $Q/2$
12. $2.3 \times 10^{-8} \text{ N}$ (attractive) , $1.01 \times 10^{-47} \text{ N}$ (attractive)
13. $3.70 \times 10^{-9} \text{ C}$

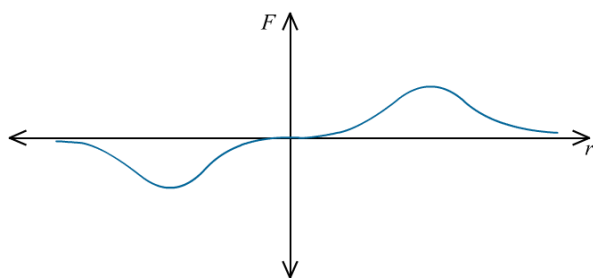


Electric charges and Fields

16. $\frac{4}{5\sqrt{5}} \frac{Kq^2}{a^2}$

17. $\frac{q^2}{4\pi\epsilon_0} \left(\sqrt{2} + \frac{1}{2} \right)$

18. $\frac{\sqrt{3} q^2}{4\pi\epsilon_0}$



19.

20. (a) mid-point (b) no where