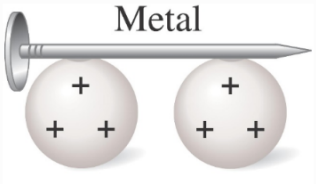
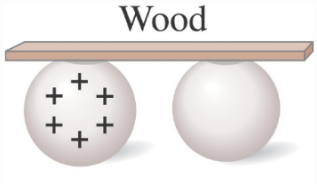
Chapter 21: Electric Charge and Electric Field

There are two types of charges in nature "positive" and "negative".

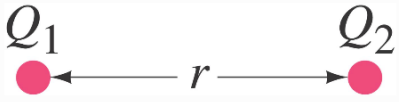
* Like charges repel each other, opposite charges attract each other.
* The electric charge is conserved in any interaction.
* In conductor, charge can freely flow, in insulators, it cannot!





Coulomb's Law

Experiments show that the electric force F:



$F \propto Q_1 Q_2$ and $F \propto 1/r^2 \Rightarrow F \propto \frac{Q_1 Q_2}{r^2}$

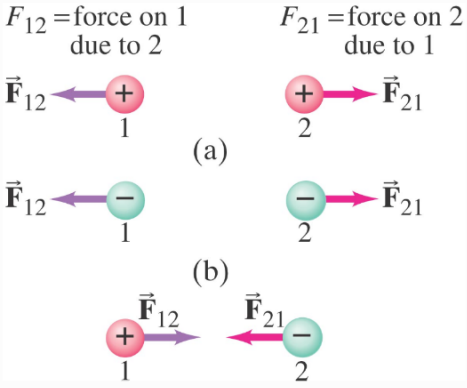
Therefore, experimentally determining the proportionality constant k, we have

$$F = k\frac{Q_1 Q_2}{r^2}$$

↓ magnitude

* The force is along the line connecting the charges!

$k = 8.99 \times 10^9\ N m^2/C^2 = 1/4\pi\varepsilon_0$



charge of the electron: $e = 1.602 \times 10^{-19}\ C$

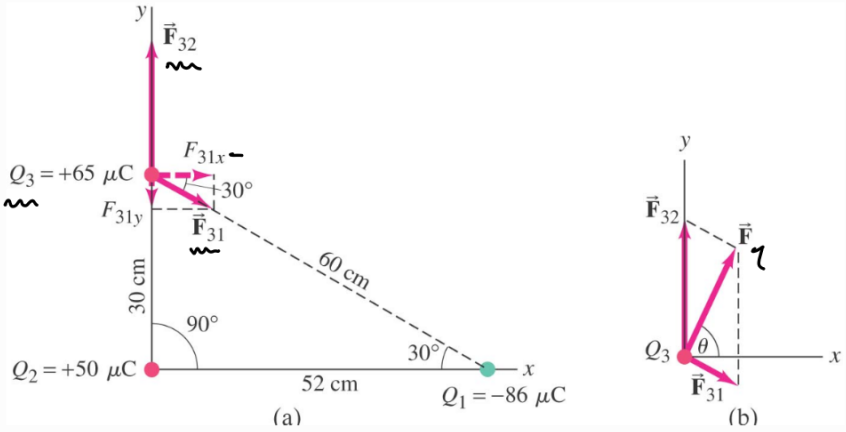
Conceptual Example 21-1

$$F_{12} = k\frac{Q_1 Q_2}{r^2}$$

$$F_{21} = k\frac{Q_2 Q_1}{r^2}$$

} same magnitude!

Example 21-3



$$F_{31} = k\frac{Q_3 Q_1}{r_{31}^2}$$

$$F_{32} = k\frac{Q_3 Q_2}{r_{32}^2}$$

$$F_{31} = (9.0\times10^9)\frac{(6.5\times10^{-5})(8.6\times10^{-5})}{(0.60)^2}\ N \Rightarrow F_{31} = 140\ N$$

$$F_{32} = (9.0\times10^9)\frac{(6.5\times10^{-5})(5.0\times10^{-5})}{(0.30)^2}\ N \Rightarrow F_{32} = 330\ N$$

Determine the components of $\vec{F}_{31}$,

$$F_{31x} = F_{31}\cos 30^\circ = (140\ N)\cos 30^\circ = 120\ N,\quad F_{31y} = -F_{31}\sin 30^\circ = -70\ N$$

Summing the two vectors component by component,

$$F_x = F_{31x} = 120\ N \quad \text{and} \quad F_y = F_{32} + F_{31y} = 330\ N - 70\ N = 260\ N$$

$$F = (F_x^2 + F_y^2)^{1/2} \Rightarrow F = 290\ N,\quad \theta = \arctan\left(\frac{F_y}{F_x}\right) = 65^\circ$$