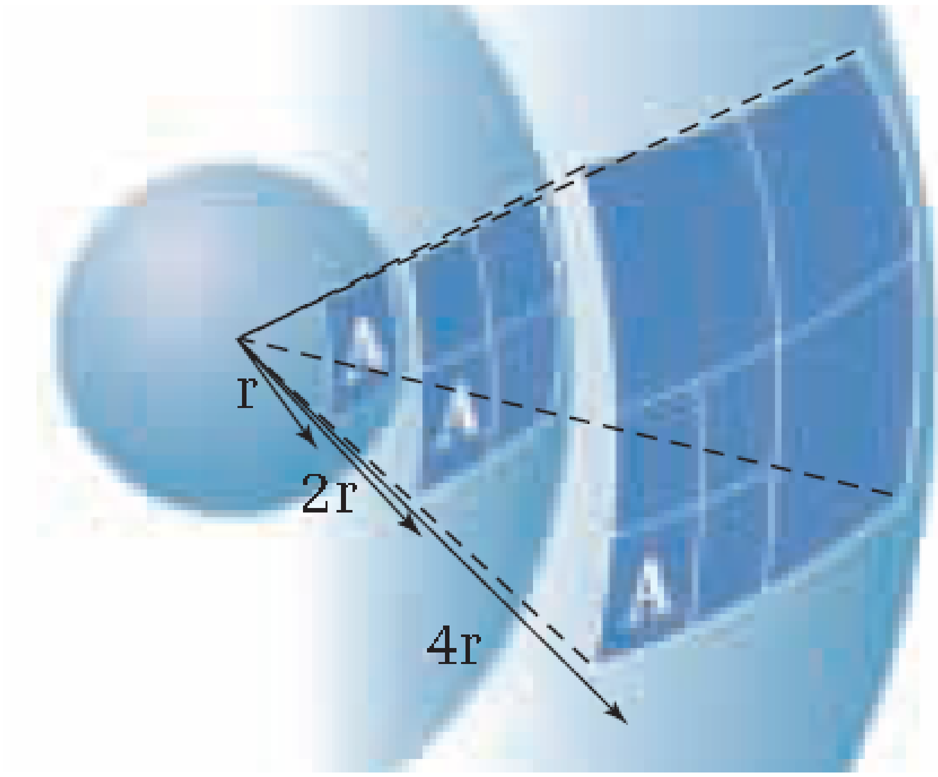
14.1 Laws of Force

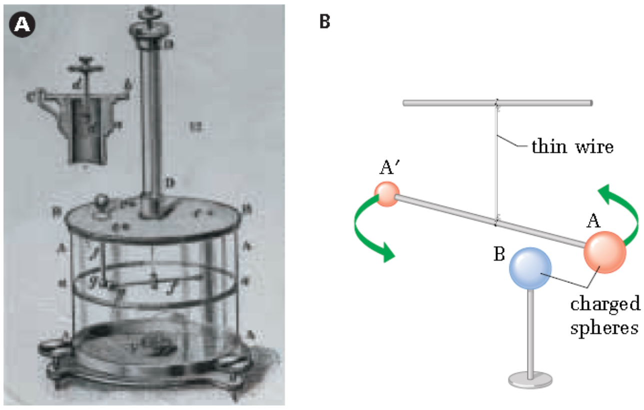
Gravity and The Inverse Square Law

$F_g \propto \frac{1}{r^2}$

magnitude of the force of gravity is proportional to the inverse of the square of the distance seperating their centres



Coulombs Experiment



$F_Q \propto q_1 q_2$ but, $F_Q \propto \frac{1}{r^2}$ therefore,

$$F_Q \propto \frac{q_1 q_2}{r^2}$$

Coulombs Law

Any proportionality can be written as an equality by using a 'constant'.

Therefore, $F_Q \propto \frac{q_1 q_2}{r^2}$ becomes

$$F_Q = k\frac{q_1 q_2}{r^2}$$

$$k = 9.00 \times 10^9 \; \frac{N{\cdot}m^2}{C^2}$$

COULOMB'S LAW

The magnitude of the electrostatic force between two point charges, q_1 and q_2, distance r apart, is directly proportional to the magnitudes of the charges and inversely proportional to the square of the distance between their centres.

$$F_Q = k\frac{q_1 q_2}{r^2}$$

Quantity	Symbol	SI unit
electrostatic force between charges	F_Q	N (newtons)
Coulomb's constant	k	$\frac{N \cdot m^2}{C^2}$ (newton · metres squared per coulomb squared)
electric charge on object 1	q_1	C (coulombs)
electric charge on object 2	q_2	C (coulombs)
distance between object centres	r	m (metres)

Applying Coulombs Law

A small sphere, carrying a charge of –8.0 μC, exerts an attractive force of 0.50 N on another sphere carrying a charge with a magnitude of 5.0 μC.

(a) What is the sign of the second charge?

(b) What is the distance of separation of the centres of the spheres?

Calculations

$$F = k\frac{q_1 q_2}{r^2}$$

$$r^2 = \frac{kq_1 q_2}{F}$$

$$r = \sqrt{\frac{kq_1 q_2}{F}}$$

$$r = \pm\sqrt{\frac{\left(9.0 \times 10^9 \frac{N \cdot m^2}{C^2}\right)(8.0 \times 10^{-6}\ C)(5.0 \times 10^{-6}\ C)}{5.0 \times 10^{-1}\ N}}$$

$$r = \pm 0.84853\ m$$

$$r \cong 0.85\ m$$