Forces in nature

How many forces are there in nature?

Four known forces.

What are they?

1. Gravitational force
2. Electromagnetic force
3. Strong nuclear force
4. Weak nuclear force

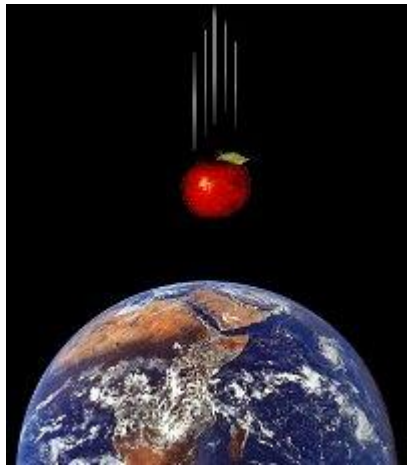
Gravitational force

Weak or strong? Weak.

Long or short range? Any range.

Attractive or repulsive? Attractive.

Additive, force increases with larger mass.



$$F_{m_1 \text{ on } m_2} = F_{m_2 \text{ on } m_1} = G\frac{m_1 m_2}{r^2}$$

How is the force oriented? Along the line connection the masses.

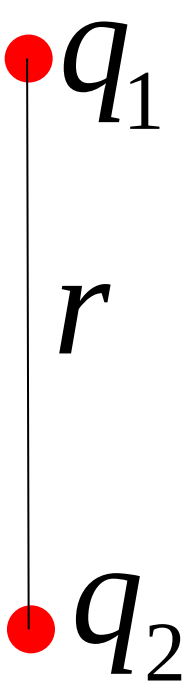
G is called the universal gravitational constant.
It represents the strength of the gravitational force.
G = 6.673×10^{-11} N m^2 kg^{-2} small!

Electromagnetic force

Weak or strong? Strong.

Long or short range? Any range.

Attractive or repulsive? Both.



$$F_{q_1 \text{ on } q_2} = F_{q_2 \text{ on } q_1} = k_e \frac{q_1 q_2}{r^2}$$

How is the force oriented? Along the line connection the charges.

$$k_e = 8.987\ 551\ 787\ 368\ 176\ 4 \times 10^9\ \text{N.m}^2/\text{C}^2$$

It represents the strength of the electromagnetic force.

k_e is 20 orders of magnitude larger than *G*.