Torque and rotational motion

Meaning of angular vectors

$$\tau = \vec{r} \times \vec{F}$$

$\vec{F}$

$\vec{r}$

O

Rotating the object
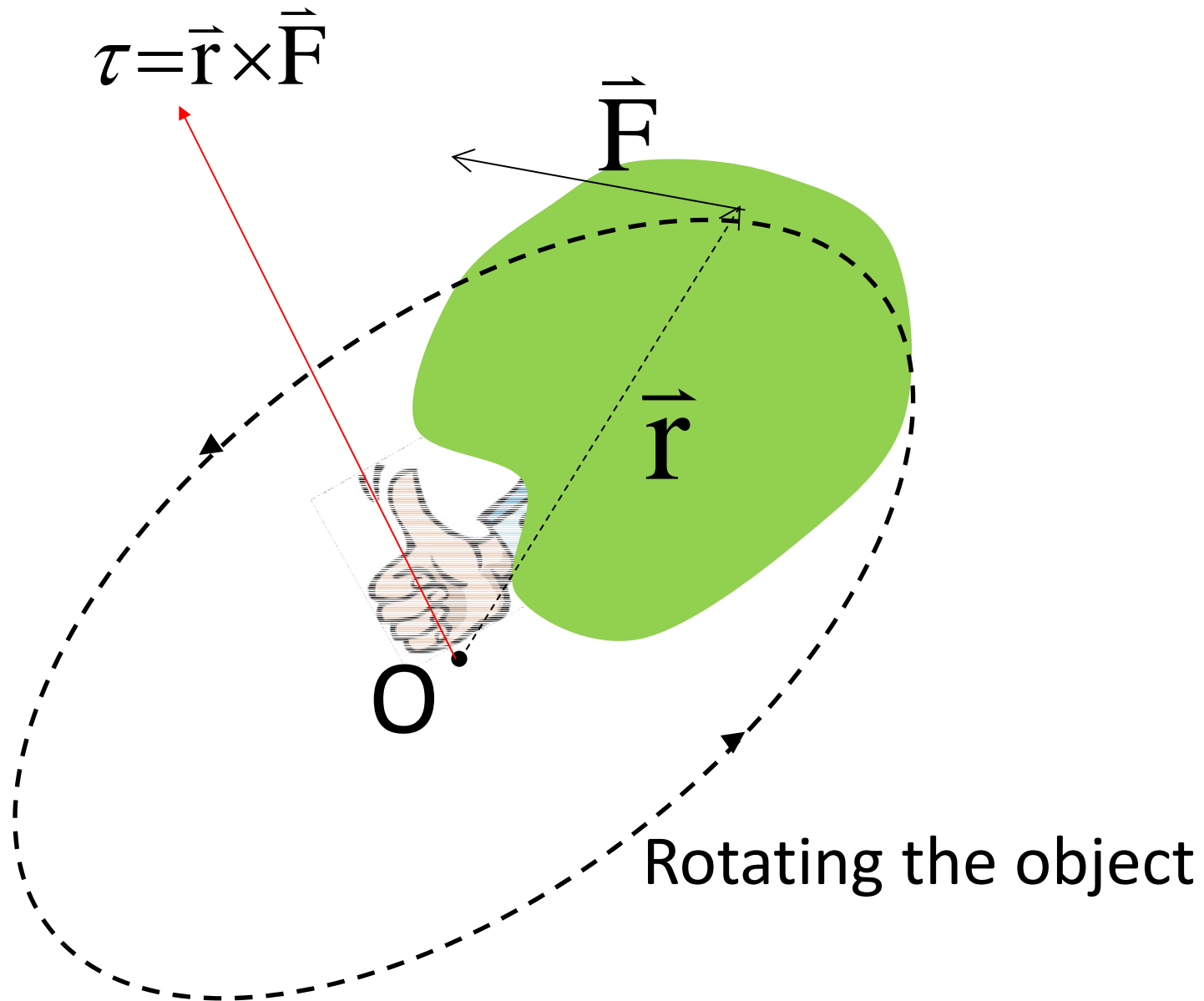
Class 4: Charges and Coulomb's Law

The four fundamental interactions of nature

(From Wikipedia: Fundamental interaction)

			Electric	Magnetic		

| Property/Interaction	Gravitation	Weak	Electromagnetic		Strong	
		(Electroweak)			Fundamental	Residual
Acts on:	Mass - Energy	Flavor	Electric charge		Color charge	Atomic nuclei
Particles experiencing:	All	Quarks, leptons	Electrically charged		Quarks, Gluons	Hadrons
Particles mediating:	None Graviton hypothesised	$W^+ \, W^- \, Z^0$	γ		Gluons	Mesons
Strength in the scale of quarks:	10^{-41}	10^{-4}	1		60	Not applicable to quarks
Strength in the scale of protons/neutrons:	10^{-36}	10^{-7}	1		Not applicable to hadrons	20

All this course about ⟶

Charges

Units for charge: Coulomb (C)

Charge has sign: positive (+) or negative (-)
Basic charge: 1.602×10^{-19} C

Charge of an electron = -1.602×10^{-19} C
Charge of a proton = $+1.602 \times 10^{-19}$ C

Neutron

Nucleus
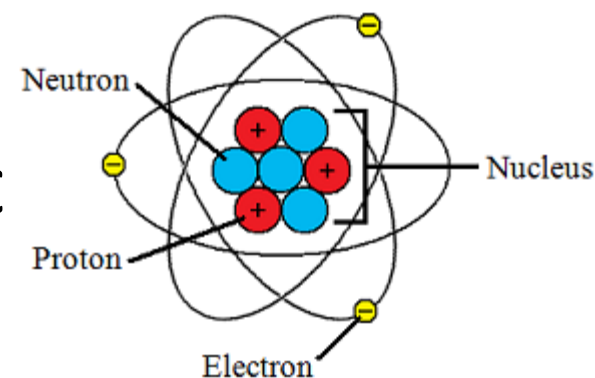
Proton

Electron

A neutral atom/molecule must have equal numbers of proton and electron.
An atom/molecule can be made positive or negative by removing or adding electrons to it.

Conservation of charges

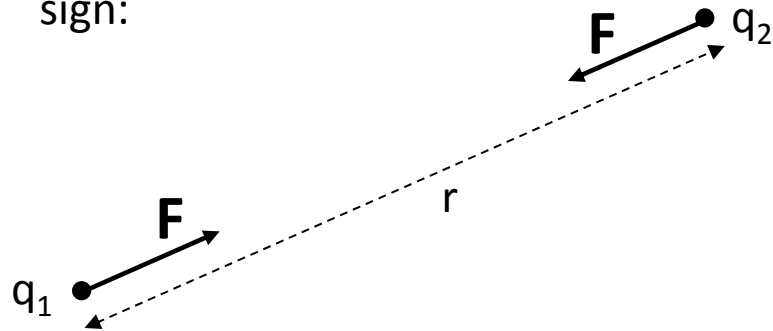Total charge is constant in any process

Attraction and repulsion between charges

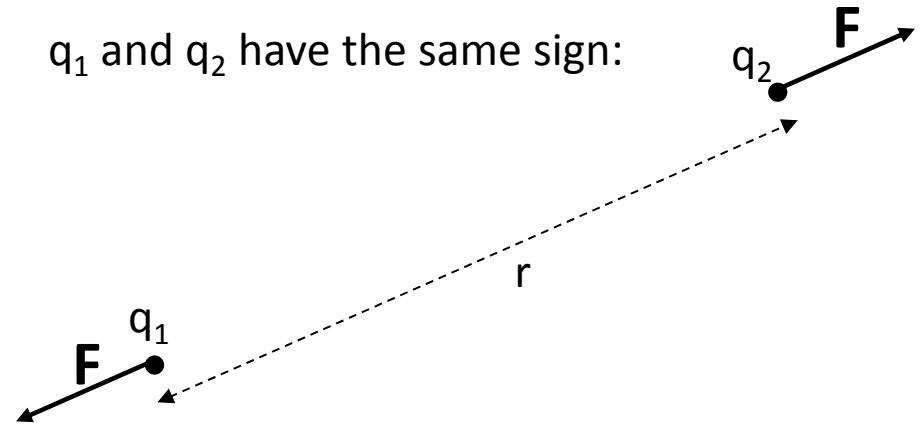Two charges repel if they have the same sign.

Two charges attract if they have the opposite sign.

Coulomb's Law

q_1 and q_2 have the opposite sign:

F q_2

F

r

q_1

q_1 and q_2 have the same sign:

q_2 **F**

r

q_1

F

$$F = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2}$$

⟵ Magnitude equation

$\varepsilon_0 = 8.8542 \times 10^{-12}$ C²/Nm²

1. In SI units (aka MKS system), charge q is a new dimension and it has no mechanical equivalence, i.e. you can not express Coulomb in terms of kg, m, and s. So now we have four basic units: C, kg, m, and s.
2. There is a (4π) here so that there is no (4π) in the Maxwell's Equations. For this reason, the SI units is called the "rationalized" units.