What is A force?

A force is a push or a pull.

Does moon exert a force on Earth?

Yes ⇒ Tides!

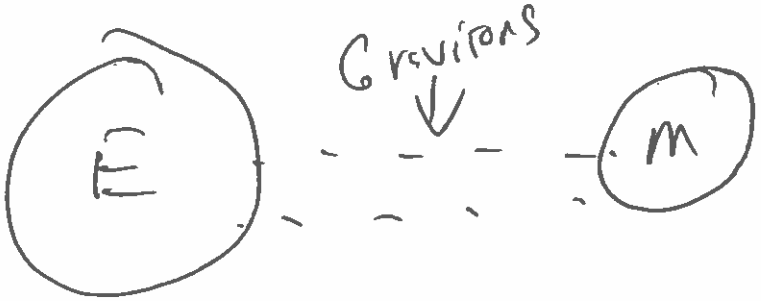
How does moon push or pull on Earth?

To explain this two Big ideas

1) EXChange of Particles

Gravity ⇒ Gravitons

These are ~~INVISIBLE~~ small particles that are emitted and received by the objects interacting



For electromagnetic Phenomena

These Particles are Photons.

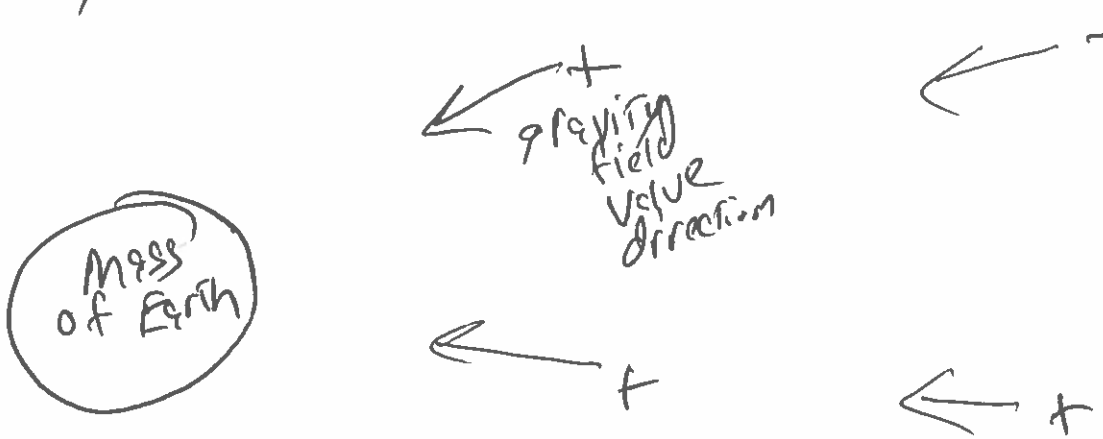
2) concept of "field".

A field is a mathematical construct that assigns a number (vector, or scaler) to every point in space providing the field strength at that point.

Force is product of (quantity)(Field strength)

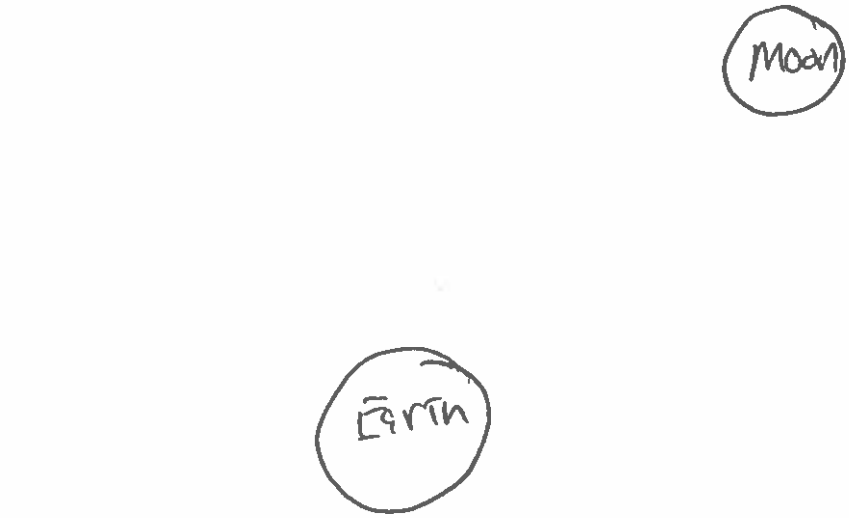
Quantity is the physical property of matter that is the source of the field.

Gravity source of field is mass.



Earth creates Gravitational field throughout space

Moon feels force due to Earth's Gravity field



Earth creates Gravity

$$\vec{F} = m_m \left(\begin{array}{c} \text{Gravitational} \\ \text{field} \\ \text{of Earth} \end{array} \right)$$

$$\vec{F}_{grav} = G \frac{M_1 M_2}{r_{12}^2} (-\hat{r})$$

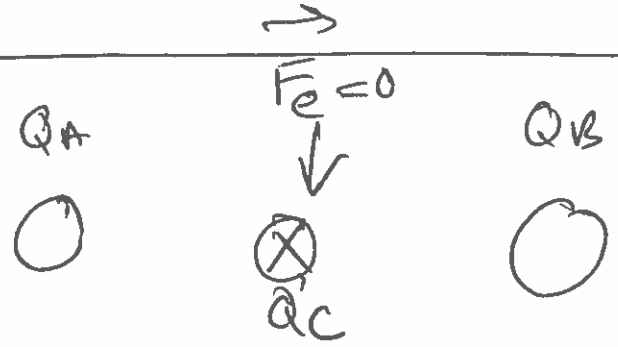
$$\vec{F}_{E \to m} = m_m \underbrace{\left(\frac{G M_E}{r_{EM}^2} \right)}_{\text{Gravitational field}} (-\hat{r})$$

$$\vec{E}_G = \frac{GM}{r^2}(-\hat{r})$$ — Gravity field of point mass

$$W = mg = \frac{mGM_E}{r^2}$$

$\vec{g} = 9.80\ m/s^2$ down is gravitational field near surface of Earth

$$\vec{F} = m\vec{g} \qquad \vec{g} = \frac{\vec{F}}{m}$$



$$F_{AC} = F_{BC}$$

$$\frac{kQ_AQ_C}{r_{AC}^2} = \frac{kQ_BQ_C}{r_{BC}^2}$$

$$\frac{k Q_A}{r_{AC}^2} = \frac{k Q_B}{r_{BC}^2}$$

$$E_A = E_B$$

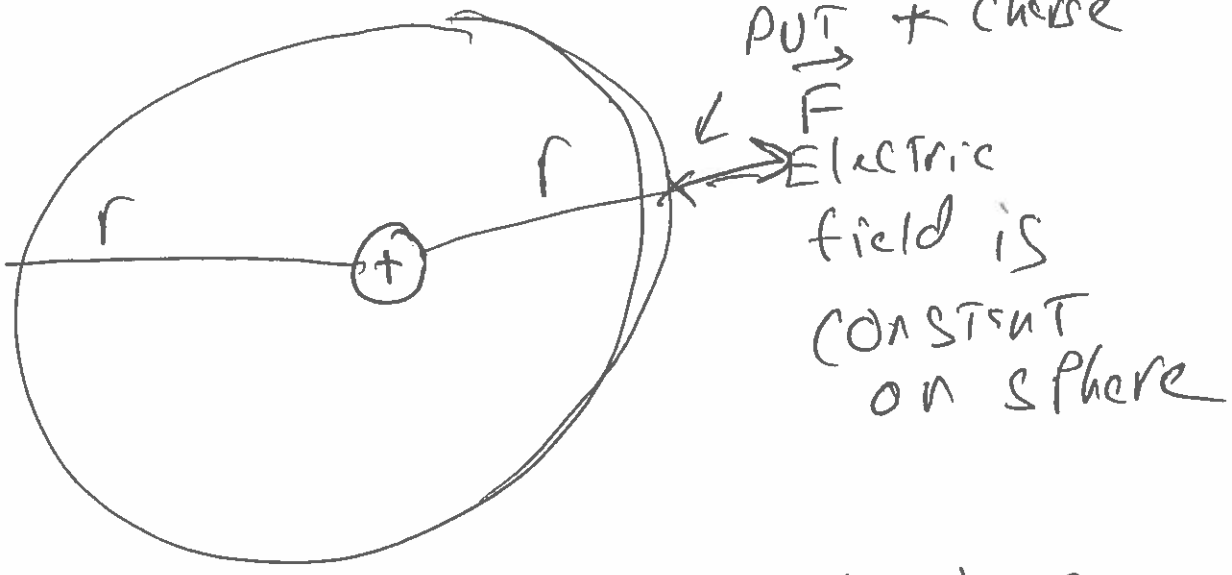
$\vec{F} = Q\vec{E}$ E is electric field

If $\vec{E}_{Net} = 0 \Rightarrow$ Electric Force $\vec{F} = 0$

Electric ~~force~~ field is Electric force divided by a TEST charge.

Electric field is a mathematical construct that assigns to all points in space a vector value giving the electric force that results when a charge is placed at that point.

$$\vec{E}_{\substack{PT \\ charge}} = \frac{kQ}{r^2}(\hat{r})$$



For test charges Assume + charge

$$\vec{F}_{1\to 2} = Q_2\vec{E}_1 = Q_2\frac{kQ_1}{r_{12}^2}\hat{r}$$

$$\vec{F}_{12} = \frac{kQ_1Q_2}{r_{12}^2}\hat{r}$$

Law of superposition

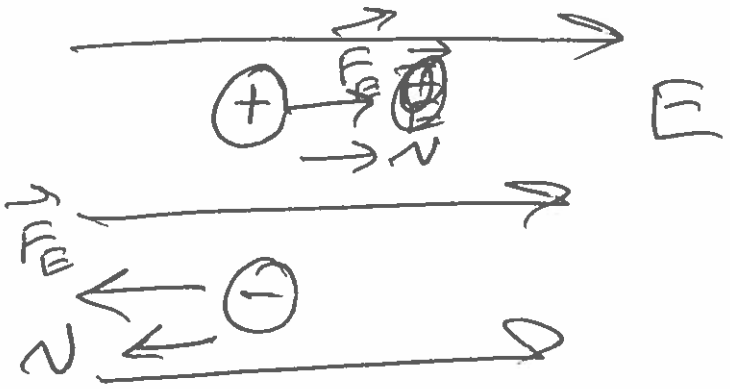
$$\vec{F}_{Net\to q} = \Sigma\vec{F}_{iq} = \vec{F}_{1\to q} + \vec{F}_{2\to q} + \cdots + \vec{F}_{N\to q}$$

$$\vec{E}_{Net} = \Sigma\vec{F}_i = \vec{E}_1 + \vec{E}_2 + \cdots + \vec{E}_N$$

Electric field lines

1) start on ⊕ charges, end on ⊖ charges.

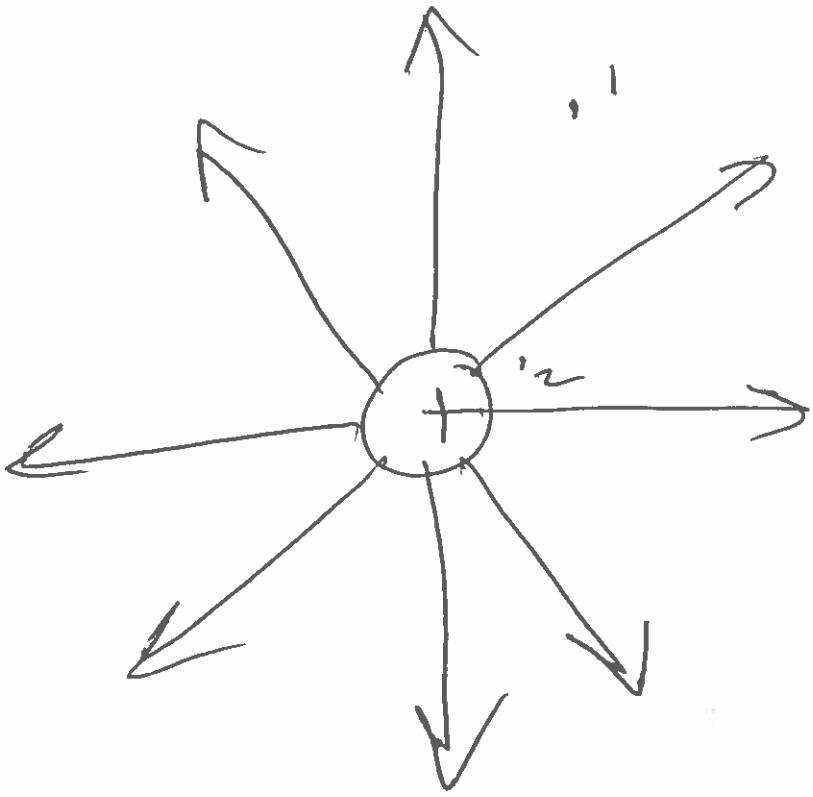
2) ⊕ charges move in direction pointed by Electric field line, while ⊖ charges move in opposite direction

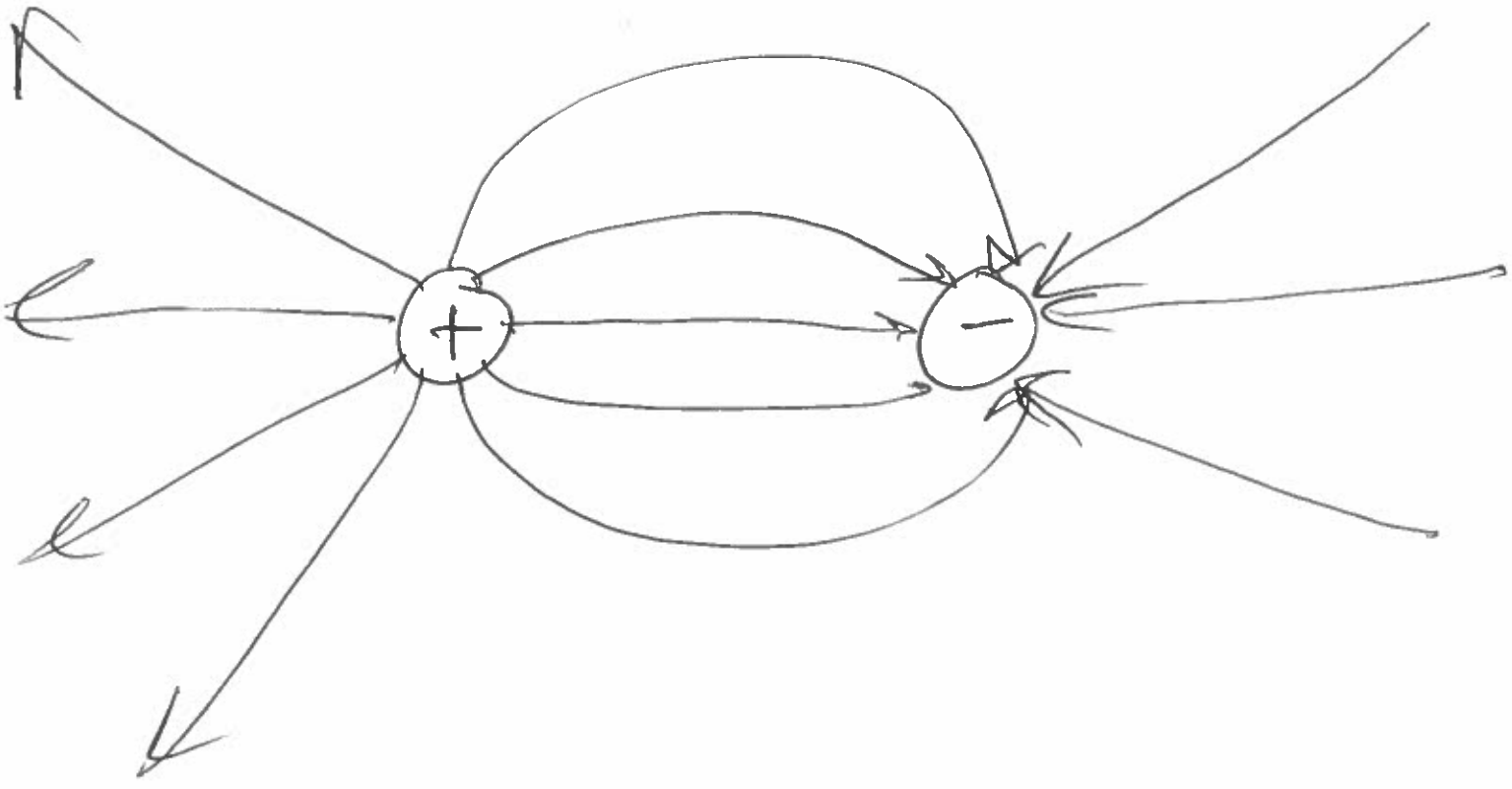


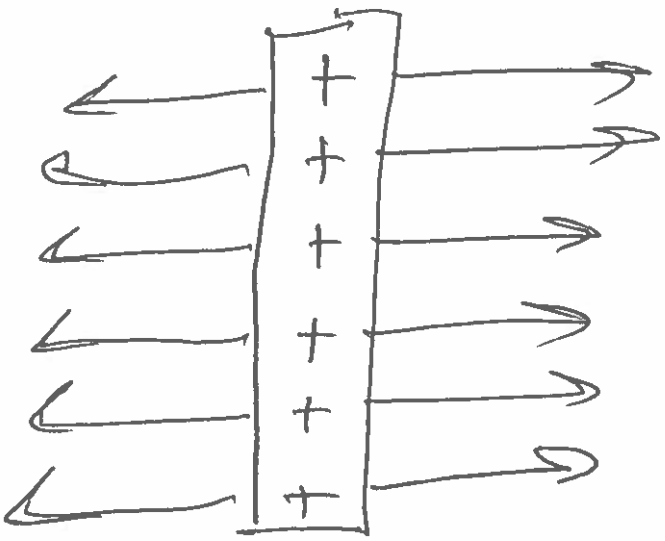
3) Density of field lines indicates strength of field

A B

For a point charge







Line of Charge

$\vec{E}$ = CONSTANT

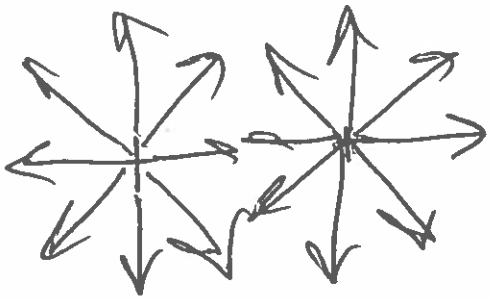


Plate (2nd Dimension) of Charge

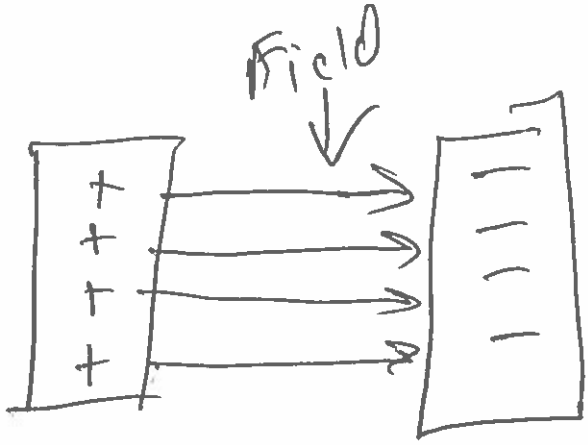
$$\vec{E} = \frac{\sigma}{\varepsilon_0}$$

$$k = \frac{4\pi}{\varepsilon_0}$$

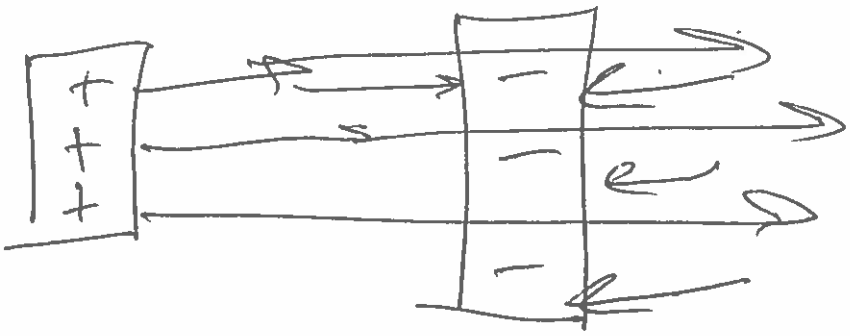
$$\sigma = \frac{\text{charge}}{\text{Area}} = \frac{Q}{\text{Area}}$$

ε_0 = Permittivity of free space

No field



No field



Parallel plate capacitor