Campo gravitatorio :→ T1, T2 libro

masa

Fuerza = Interacción → DOS cuerpos

Newton $\vec{F} = -G \frac{m_1 \cdot m_2}{r^2} \vec{u}_r$

VECTORES

m_1, m_2 en kg

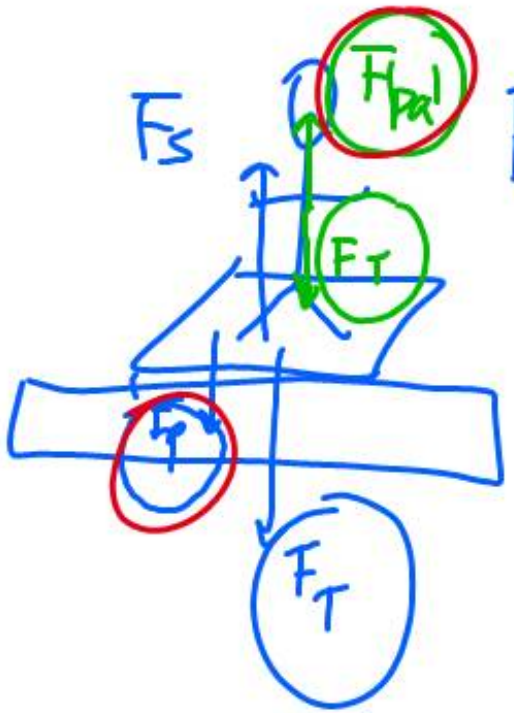
r en m

G en $\frac{N m^2}{kg^2}$

F en N

$\vec{u}_r$ → vector unitario = módulo 1, dirección de la recta que une los masas

Peso - F que ejerce la Tierra.



$F_S = F_{Peso} + F_T$

Campo gravitatorio

$$\vec{F} = G\frac{M_1 M_2}{r^2}\vec{u}_r$$

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

$$\vec{g} = -G\frac{M}{r^2}\vec{u}_r$$

$$|F| = G\frac{m_1 m_2}{r^2} \quad N$$

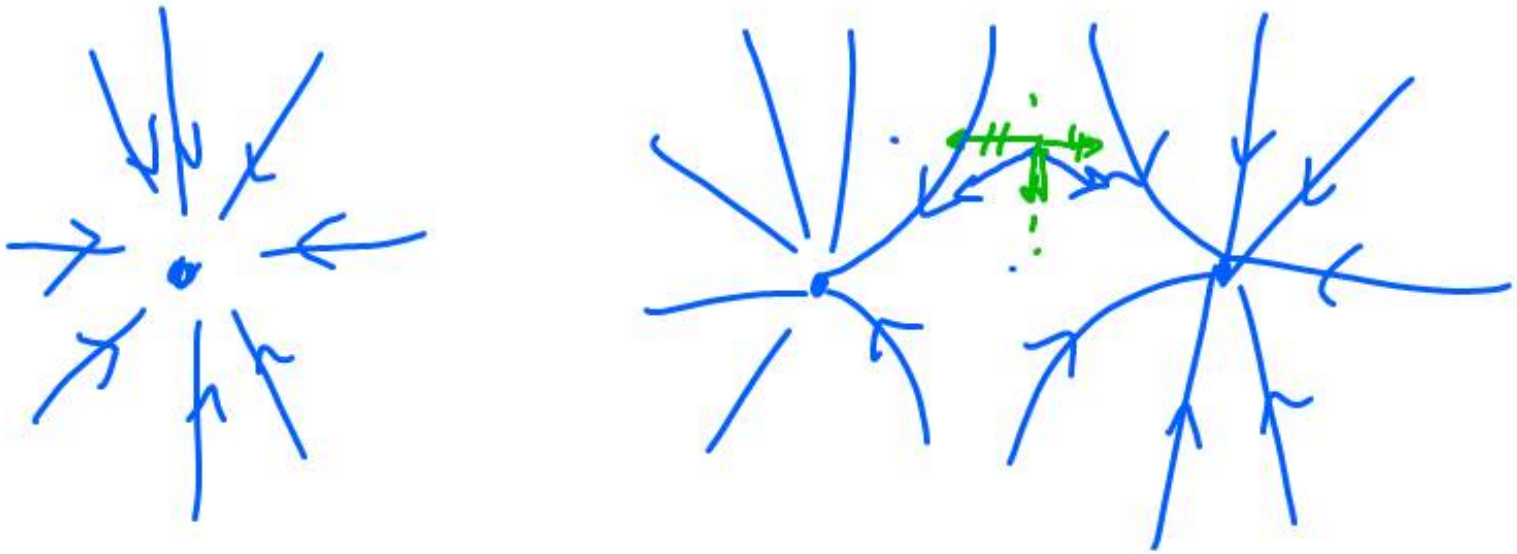
$$|\vec{g}| = G\frac{M}{r^2}\vec{u}_r$$

$$|g| = 6{,}67 \cdot 10^{-11} \cdot \frac{5{,}96 \cdot 10^{24}}{(6370 \cdot 10^3)^2} = 9{,}8 \ N\,kg^{-1}$$

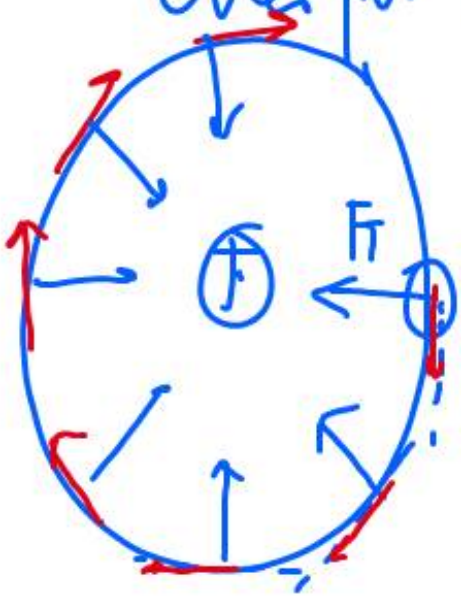
Pico $g = G\dfrac{M}{(R_T + h)^2}$

Líneas de campo gravitatorio

Líneas imaginarias q indican la trayectoria q seguiría una masa colocada en cualquier punto



Cuerpo en órbita



$$F = G\frac{Mm}{r^2} \qquad \Sigma F = m.a$$

$$G\frac{Mm}{r^2} = m\,a_n$$

$$G\frac{Mm}{r^2} = m\frac{v^2}{r}$$

$$v = \frac{2\pi r}{T}$$

$$v = \sqrt{\frac{GM}{r}}$$

$$\frac{2\pi r}{T} = \sqrt{\frac{GM}{r}}$$

$$T = 2\pi r\sqrt{\frac{r}{GM}}$$

6) $G\frac{Mm}{r^2} = m\frac{v^2}{r}$

$v = \sqrt{\frac{GM}{r}}$ $\quad v_A = \sqrt{\frac{GM}{r_A}}$ $\quad r_A < r_B \Rightarrow v_A > v_B$

$v_B = \sqrt{\frac{GM}{r_B}}$

a) $v = \frac{2\pi r_A}{T_A}$ $\quad T_A < T_B$ $\quad v = \frac{2\pi R}{T}$; $T = \frac{2\pi R}{v}$

(7) $r = 1.10^{8}\ km$

$T = 2\ años$

$$G\frac{M_{\odot}}{r^2} = M\frac{v^2}{r}$$

$$v = \frac{2\pi r}{T} = \frac{2\pi \cdot 10^{11}}{2.365\,24.3600}$$

$$v = 9{,}97.10^{3}\ m s^{-1}$$

$$M = \frac{r v^2}{G} = \frac{10^{11}\left(9{,}97.10^{3}\right)^2}{6{,}67\cdot 10^{-11}} = 1{,}5.10^{29}\ kg$$

$G = 6{,}67\cdot 10^{-11}$

(10)

$$g = G \cdot \frac{M}{R^2} = G \frac{M}{\left(\frac{R}{2}\right)^2} = 4 \underbrace{\left(G \frac{M}{R}\right)}_{g_0} = 4 g_0$$

$$G \frac{M m}{r^2} = m \frac{v^2}{r}$$

$$r = \frac{GM}{v^2}$$

$$=$$

(13) $R_T = 3000\ Km$

$g = 6\ m\,s^{-2} = N\,Kg^{-1}$ $\quad g = G\dfrac{M}{R^2}$

densidad

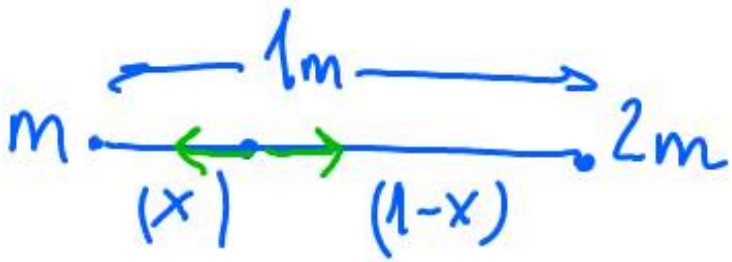
$d = \dfrac{M}{\frac{4}{3}\pi R^3}$

$d = \dfrac{8,1\cdot 10^{23}}{\frac{4}{3}\pi (3\cdot 10^6)^3} = 7158\ Kg\,m^{-3}$

$6 = 6,67\cdot 10^{-11}\cdot \dfrac{M}{(3\cdot 10^6)^2}$

$M = 8,1\cdot 10^{23}\ Kg$

17



A 0,41m de m

ya 0,59m de 2m

$$|F_{(2m)}| = |F_{(m)}|$$

$$G \cdot \frac{2m \cdot 1}{(1-x)^2} = G \cdot \frac{m}{x^2}$$

$$2x^2 = (1-x)^2$$

$$x = 0{,}41\,m$$

(18) $T_{lua} = 28 \text{ dias} = 2{,}46 \cdot 10^6 \text{ s}$

$M_T = 6{,}0 \cdot 10^{24} \text{ kg}$

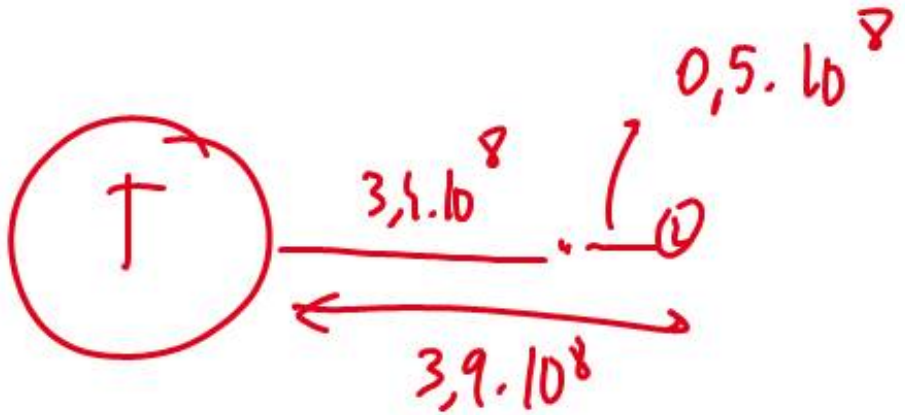
$d_{T-L} \rightarrow$ r de centro a centro

$$\begin{cases} F_{T-L} = m\dfrac{v^2}{r} \\ G\dfrac{M_T \cdot m_L}{r^2} = m_L \cdot \dfrac{v^2}{r} \end{cases}$$

$v = \dfrac{2\pi r}{T}$

$$6{,}67 \cdot 10^{-11} \cdot \frac{6 \cdot 10^{24}}{r} = \frac{4\pi^2 \cdot r^2}{(2{,}46 \cdot 10^6)^2}$$

$$r = \sqrt[3]{\frac{6{,}67 \cdot 10^{-11} \cdot 6 \cdot 10^{24} \cdot (2{,}46 \cdot 10^6)^2}{4\pi^2}} = 3{,}9 \cdot 10^8 \text{ m}$$



$$|F_T| = |F_L|$$

$$\not{G}\frac{M_T \not{m}}{(3{,}4\cdot 10^8)^2} = \not{G}\frac{M_L \not{m}}{(0{,}5\cdot 10^8)^2}$$

$$M_L = \frac{6\cdot 10^{24}\cdot (0{,}5\cdot 10^8)^2}{(3{,}4\cdot 10^8)^2} = 1{,}38\cdot 10^{23}\ \text{Kg Luna}$$

(21) ~~h~~ $= 330.10^3$ m

$r = 6370.10^3 + 330.10^3 = 6700.10^3$ m

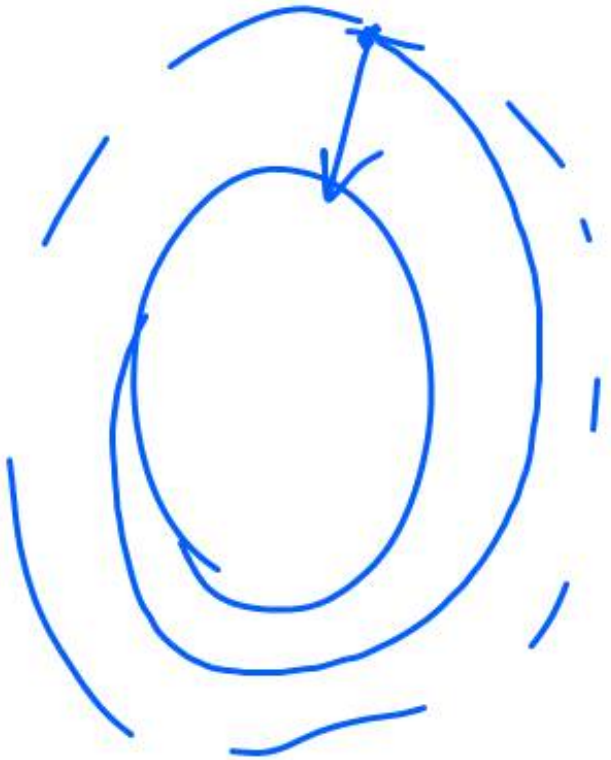
T, r

$G\frac{M.m}{r^2} = m\frac{v^2}{r}$

$v = \frac{2\pi r}{T}$

$v = \sqrt{\frac{6,67.10^{-11} \cdot 5,98.10^{24}}{6700.10^3}} = 7,7.10^3 \, ms^{-1}$

$T = \frac{2\pi \cdot 6700.10^3}{7,7.10^3} = 5,4.10^3 s : 1,5h$



(22) $r = 2R_T$

¿V?

Peso en la órbita

en la sup Tierra $P = 5000\,N$

$R_T = 6400.10^3\,m$ → $F = G\frac{Mm}{R_T^2}$

$g = G\frac{M}{R_T^2}$ $\quad 9{,}8 = 6{,}67.10^{-11}\frac{M}{(6400.10^3)^2}$

$M = 5{,}98.10^{24}$

$F = G\frac{Mm}{r^2} = \frac{GM.\frac{5000.R_T^2}{GM}}{(2R_T)^2}$

$F = \frac{5000}{4} = 1250\,N$

$G\frac{M_T m}{r^2} = m\frac{v^2}{r}$

$v = \sqrt{\frac{6{,}67.10^{-11}.M_T}{2.6.4.10^3}} = 5591\,ms^{-1}$

$$g = G\frac{M}{r^2}$$

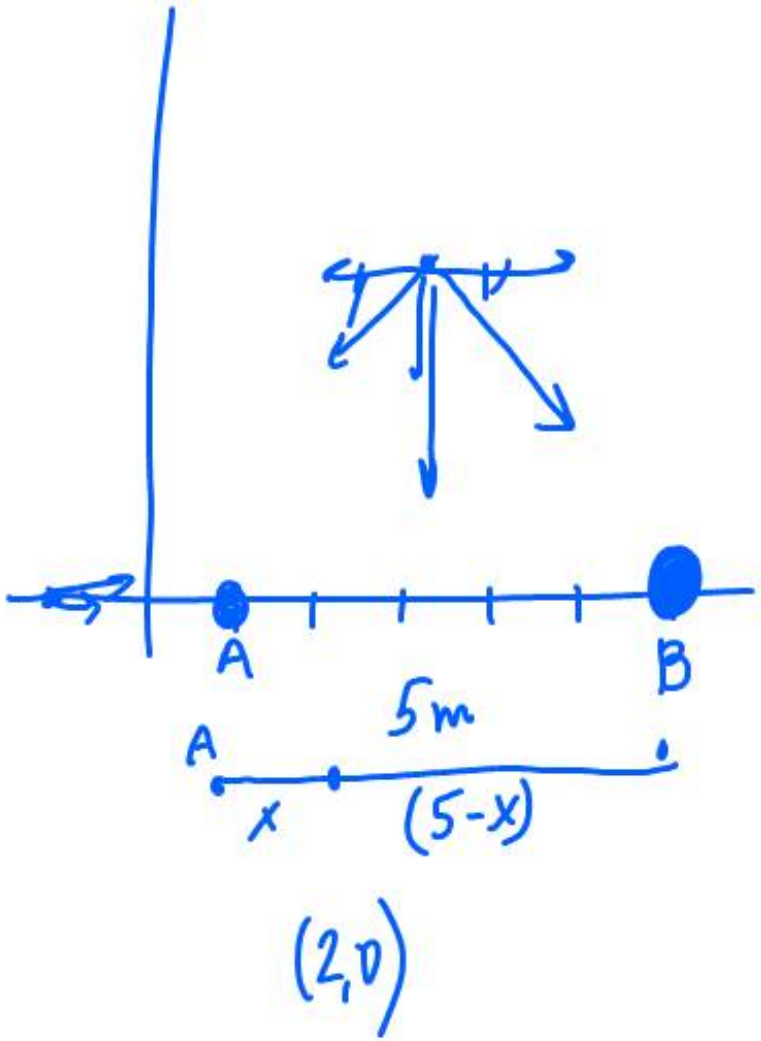
$$\frac{9,8}{2} = 6,67\,10^{-11}\,\frac{5,98.10^{24}}{r^2}$$

$$r = R + h \qquad h = 2,62.10^6\ m$$

$$R \downarrow 6370.10^3$$

(6) $m_A = 4\,kg$

$m_B = 9\,kg$



(2,0)

$G\,\frac{m_A}{x^2} = G\,\frac{m_B}{(5-x)^2}$

$4(5-x)^2 = 9x^2$

$x = 2$

(11)

$R = 2000\ Km$

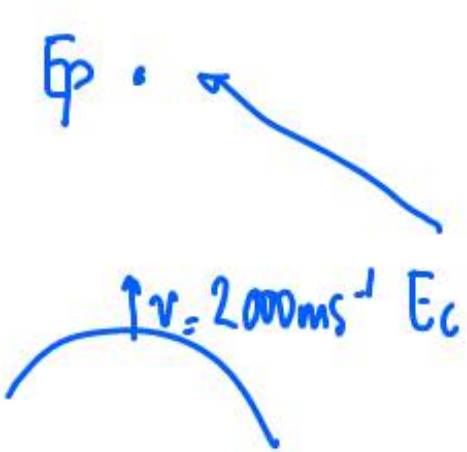
$g = 3\ ms^{-2}$

$M_{planète}$

$3 = 6{,}67.10^{-11} \cdot \dfrac{M}{(2.10^6)^2}$

$M_p = 1{,}8.10^{23}\ Kg$

$V = 2\ Kms^{-1}$



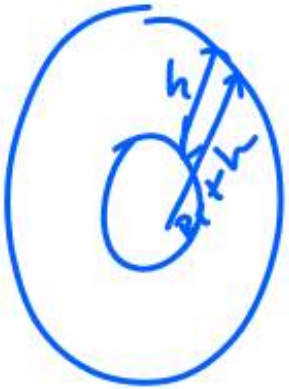
$\frac{1}{2} m v^2 = mgh$

$\frac{1}{2}(2.10^3)^2 = 3h$

$h = \frac{2.10^6}{3} = 6{,}6 \cdot 10^5\ m$

① $R_T = 6370\,Km = 6370.10^3\,m$

$g = G\dfrac{M_T}{r^2}$



$9,8 = \dfrac{G M_T}{(6370.10^3)^2}$

$(V_{2\,R})^2$

2_{R^2}

$4,9 = G\dfrac{M_T}{r^2}$

$r^2 = \dfrac{G M_T}{4,9} = \dfrac{9,8.(6370.10^3)^2}{4,9}$

r

$$g = G\frac{M_T}{R_T^2}$$

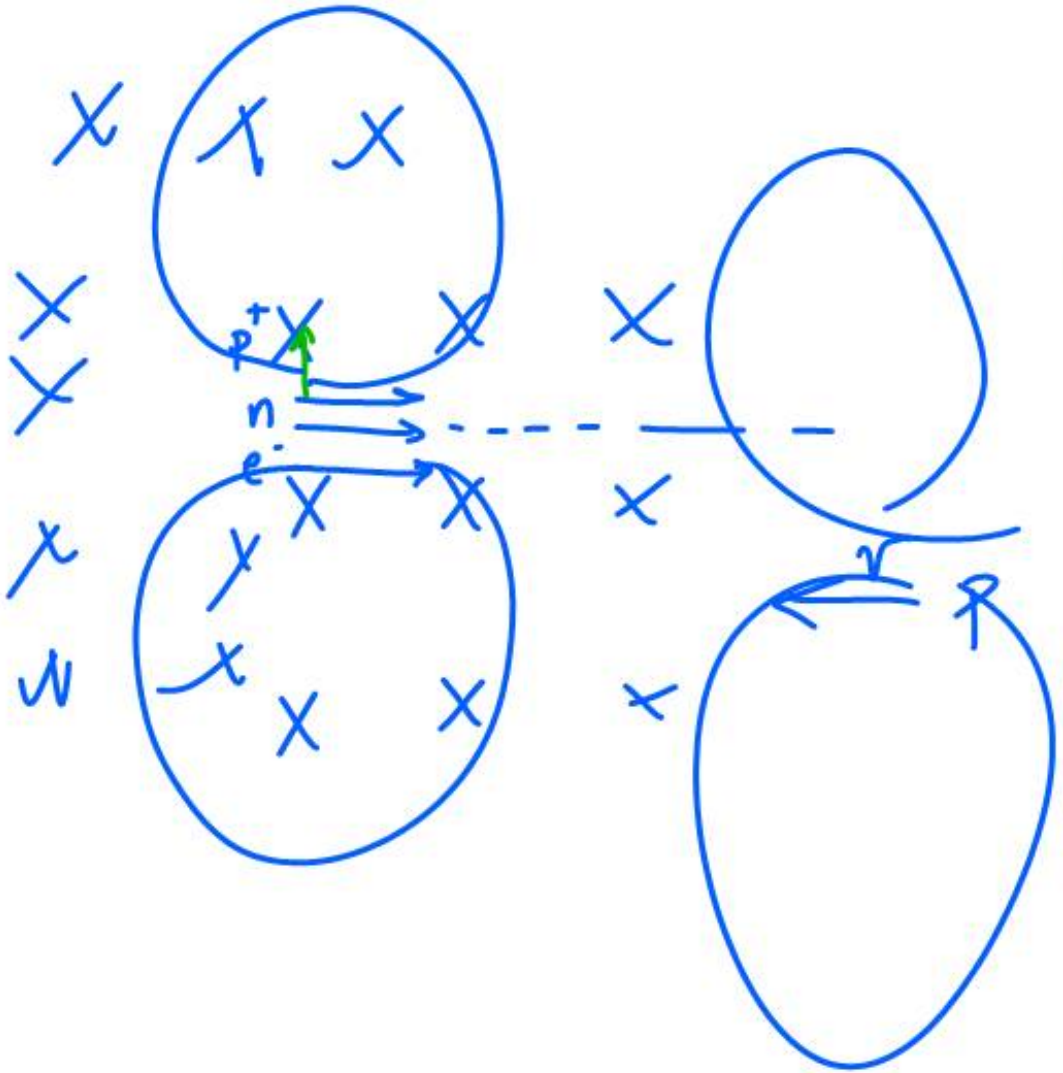
$$\frac{g}{2} = G\frac{M_T}{r^2}$$

$$2 = \frac{r^2}{R_T^2}$$

$$r = \sqrt{2R_T^2} = \sqrt{2}\ R_T$$

$$r = \sqrt{2} \cdot 6400 = 9051\ \text{Km}$$

$$h = 9051 - 6400 = 2651\ \text{Km}$$



$$\vec{F} = q\,\vec{v} \wedge \vec{B}$$

Campo Eléctrico → U 6

Propiedad → carga

Ley de Coulomb $|\vec{F}| = K \cdot \frac{q_1 \cdot q_2}{r^2}$

$|\vec{F}|$ → N

$q_1 \cdot q_2$ → C^2

r^2 → m^2

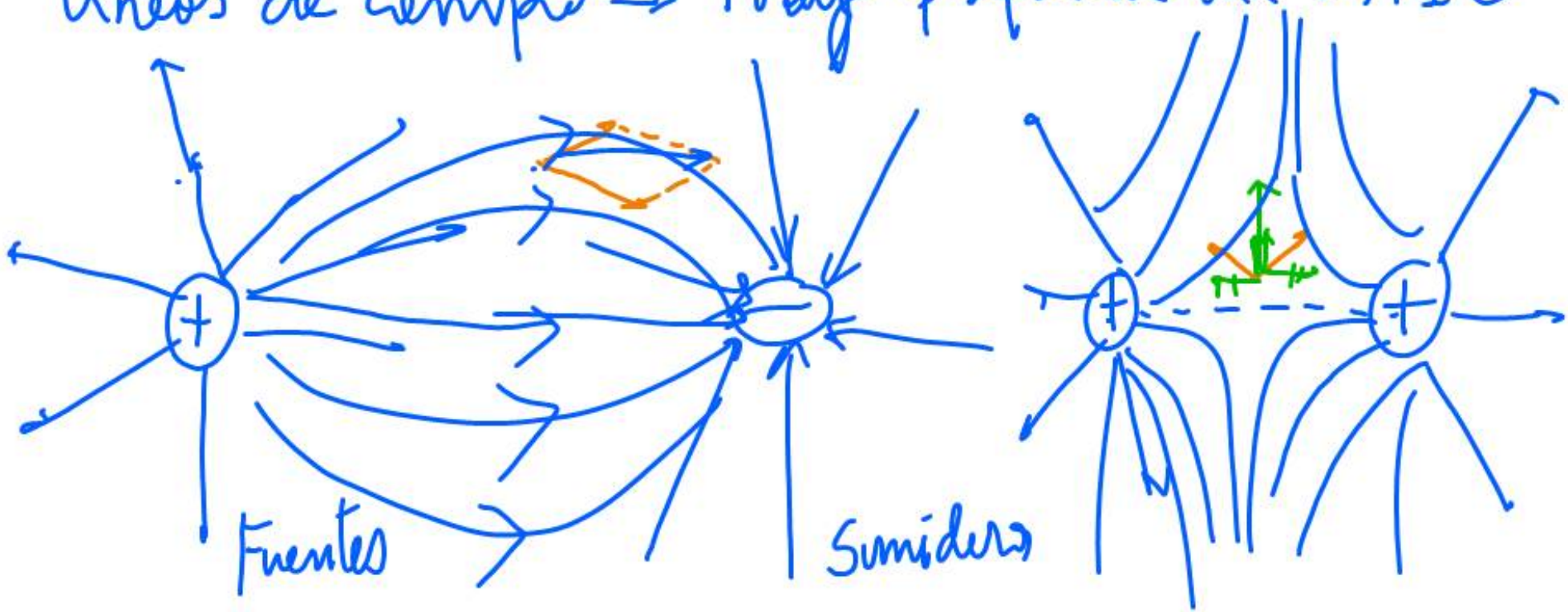
K no es universal → depende del medio

vacío ≈ aire $9 \cdot 10^9\ N m^2 C^{-2}$

Comparar con G: $6{,}67 \cdot 10^{-11}\ N m^2 C^{-2}$

$$\vec{F} = K \frac{q_1 q_2}{r^2} u_r$$

Líneas de campo → Trayectoria que sequiría una carga +1 C



$$|E| = \frac{|F|}{q} \qquad |E| = K\frac{q}{r^2} \qquad \vec{E} = K\frac{q}{r^2}\vec{u_r}$$

$$\downarrow$$

$$N\,C^{-1}$$

1, 3, 6 (1ª parte)

(26) $r = 20.000.10^3\ m$

$R_T = 6370\ km$

$g = 9{,}8\ ms^{-2}$

$\Rightarrow M_T$

$g_{orb} = G\frac{M_T}{r^2} = 6{,}67.10^{-11} \cdot \frac{5{,}98.10^{24}}{(2.10^7)^2}$

$g_{orb} = 0{,}997\ N\,kg^{-1}$

g_{orbita}

$\omega = \frac{v}{r}$

$\omega = \frac{2\pi}{T}$

$a_n = \frac{v^2}{r}$

$a_n = \omega^2 r$

$g = \omega^2 r$

$\omega = \sqrt{\frac{g}{r}} = \sqrt{\frac{0{,}997}{2.10^7}} = 2{,}23.10^{-4}\ rad\,s^{-1}$

$G\frac{Mm}{r^2} = m\frac{v^2}{r}$

$v = \sqrt{\frac{6{,}67.10^{-11}.5{,}98.10^{24}}{2.10^7}} = 4{,}5.10^3\ ms^{-1}$

$\omega = \frac{4{,}5.10^3}{2.10^7} = 2232{,}9^{-4}\ rad\,s^{-1}$

$$\vec{F} = K \frac{q_1 q_2}{r^2} \vec{u}_r \qquad \vec{E} = \frac{\vec{F}}{q} = K \frac{q_1}{r^2} \vec{u}_r$$

Trabajo realizado por una F eléctrica

$$W = \vec{F} \cdot d\vec{r} = |F| \cdot |dr| = K \cdot \frac{q_1 q_2}{r^2} dr$$

$$\downarrow$$

$$dE = \int_A^B K \frac{q_1 q_2}{r_2} dr = K q_1 q_2 \int_A^B \frac{1}{r^2} dr = K q_1 q_2 \left[-\frac{1}{r} \right]_A^B$$

$$W = dE = -\left(\frac{K q_1 q_2}{r_B} \right) - \left(-\frac{K q_1 q_2}{r_A} \right) = E_{p_A} - E_{p_B} = -\Delta E_p$$

E_{p_B} E_{p_A}

$$E_p = K \frac{q_1 q_2}{r}$$

Potencial $\rightarrow V$

$$V = \frac{E_p}{q} = \frac{K \frac{q_1 q_2}{r}}{q} = K \frac{q}{r}$$

$$E_p = q V \quad (V)$$

$$W = -\Delta E_p$$

$$= -\left(E_{pB} - E_{pA}\right) = -\left(q V_B - q V_A\right) = -q\left(V_B - V_A\right)$$

$$W = -q\left(V_B - V_A\right)$$

$t = t \quad t$

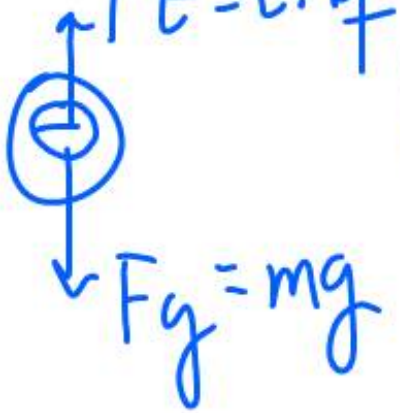
$$\vec{F} = k \frac{q_1 q_2}{r^2} \vec{u}_r$$

$$\vec{E} = k \frac{q_1}{r^2} \vec{u}_r$$

$$\sigma_p = k \frac{q_1 q_2}{r}$$

$$V = k \frac{q}{r}$$

1



E ↓

g m

$G \frac{M m}{R_T^2} = K \frac{Q q}{r^2}$

$|9,8 \cdot 1,5 \cdot 10^{-3}| = |E \cdot q|$ $\quad q = (24 \cdot 10^{-6})\,C$

$F = K \frac{Q q}{r^2}$ $\quad E = \frac{F}{q}$

$\vec{E} = 612\,N\,C^{-1}$ dirigido ↓

~~3~~ 6) $+1.10^{-6}$ C, 3.10^{-6} C, $+4.10^{-6}$ C

A · x · 0,06 − x · B

0,06 m

$|F_A| = |F_B|$

$K \cdot \frac{10^{-6} \cdot 3.10^{-6}}{x^2} = K \frac{4.10^{-6} \cdot 3.10^{-6}}{(0,06-x)^2}$

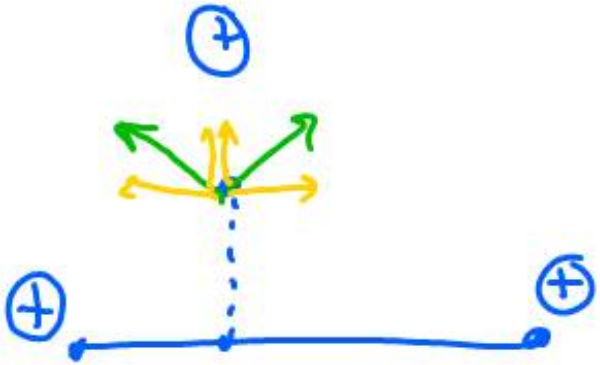
$x = 0,02$ m

Ep

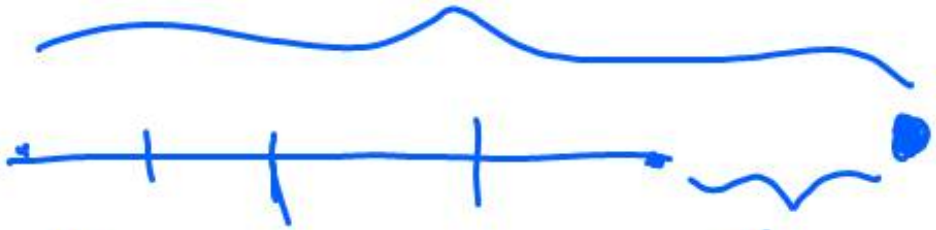
Del sistema: $Ep_{1-2} + Ep_{2-3} + Ep_{1-3}$

De la carga $3\,10^{-6}$:

$Ep = K \cdot \frac{3.10^{-6} \cdot 10^{-6}}{0,02} + K \frac{3.10^{-6} \cdot 4.10^{-6}}{0,04} = 4$ J



(3)



$+27 \cdot 10^{-9}\,C$ $\quad -3 \cdot 10^{-9}\,C$

(6) (10)

$$\vec{E}_1 + \vec{E}_2 = 0$$

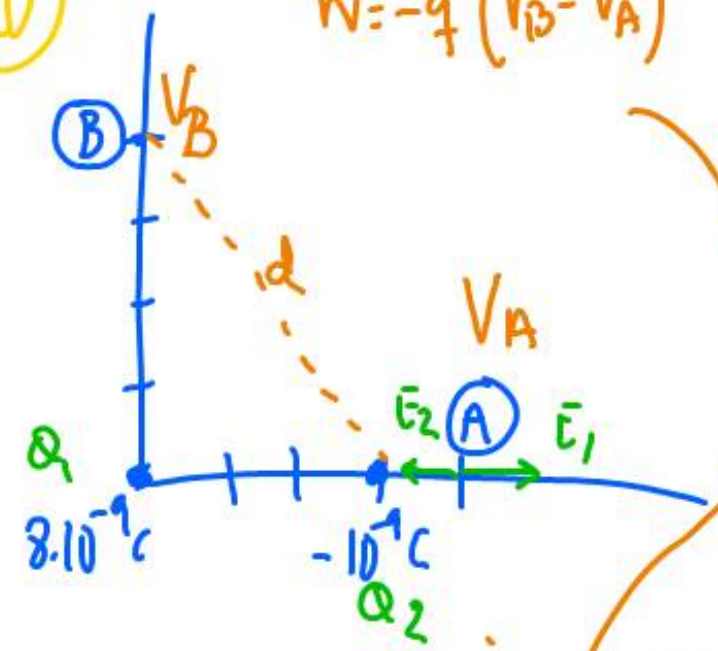
$$9 \cdot 10^9 \cdot \frac{27 \cdot 10^{-9}}{r_A^2} + \left(-9 \cdot 10^9 \cdot \frac{3 \cdot 10^{-9}}{r_B^2} \right)$$

$$\underbrace{r_A}_{(4 + r_B)^2}$$

$r_B = -1$

$r_B = +2 \quad (6,0)$

10



$W = -q(V_B - V_A)$

$|E_1| = 9.10^9 \cdot \frac{8.10^{-9}}{4^2} = 4,5\ NC^{-1}$

$|E_2| = 9.10^9 \cdot \frac{10^{-9}}{1^2} = 9\ NC^{-1}$

$|E_R| = |E_2| - |E_1| = 4,5\ NC^{-1}$

$\vec{E}_R = -4,5\ \vec{i}\ NC^{-1}$

$V_A = V_1 + V_2 = 9.10^9 \cdot \frac{8.10^{-9}}{4} + 9.10^9 \cdot \frac{(-10^{-9})}{1} = 9V$

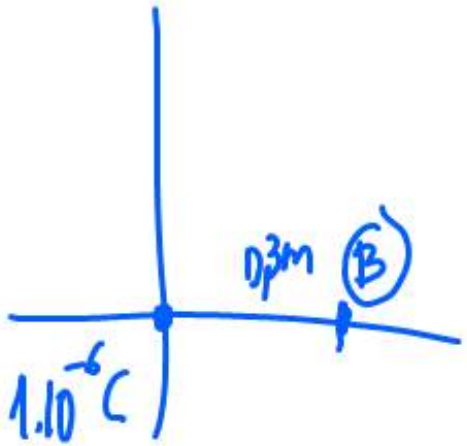
$V_B = V_1 + V_2 = 9.10^9 \cdot \frac{8.10^{-9}}{4} + 9.10^9 \cdot \frac{(-10^{-9})}{5} = 16V$

$q = -2.10^{-9}C$

$d = \sqrt{4^2 + 3^2} = 5m$

$W = -(-2.10^{-9})(16 - 9) = 14.10^{-8}\ J \rightarrow$ Espontâneo

19



$q = 10^{-8}\,C$

W desde ∞ a 30 cm

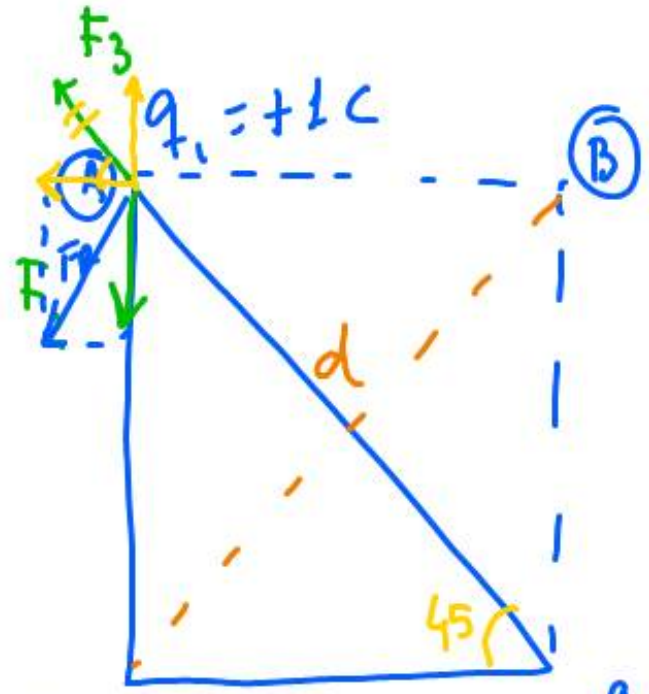
$W = -q(V_B - V_A)$

$W = -10^{-8}(3.10^4 - 0) = -3.10^{-4}\,J$

A
∞

$V_B = 9.10^9 \cdot \frac{1.10^{-6}}{0,3} = 3\,10^4\,V$

(15)



$l = 8\,m$

$|F_2| = 9 \cdot 10^9 \cdot \frac{4 \cdot 1}{8^2} = 0{,}563 \cdot 10^9\ N$

$|F_3| = 9 \cdot 10^9 \cdot \frac{3 \cdot 1}{(11{,}3)^2} = 2{,}11 \cdot 10^8\ N$

$q_3 = +3C$

$\begin{cases} \vec{F}_x = -2{,}11 \cdot 10^8 \cos 45 = -1{,}48 \cdot 10^8\ \vec{i}\ N \\ \vec{F}_y = 2{,}11 \cdot 10^8 \sin 45 = 1{,}48 \cdot 10^8\ \vec{j}\ N \end{cases}$

$\vec{F}_2 = -0{,}563 \cdot 10^9\ \vec{j}\ N$

$\vec{F}_R = -1{,}48 \cdot 10^8\ \vec{i} - 4{,}15 \cdot 10^8\ \vec{j}$

$d = \sqrt{8^2 + 8^2} = 11{,}313\,m$

$W = -1\left(1{,}93 \cdot 10^8 - (-2{,}11 \cdot 10^9)\right) = -2{,}3 \cdot 10^9\ J$

$V_A = V_2 + V_3 = 9 \cdot 10^9 \frac{-4}{8} + 9 \cdot 10^9 \cdot \frac{3}{11{,}3} = -2{,}11 \cdot 10^9\ V$

$\begin{cases} V_B = V_2 + V_3 = 9 \cdot 10^9 \cdot \frac{-4}{11{,}3} + 9 \cdot 10^9 \cdot \frac{3}{8} \\ = 1{,}93 \cdot 10^8\ V \end{cases}$

16 $\Delta V \rightarrow$ v ?

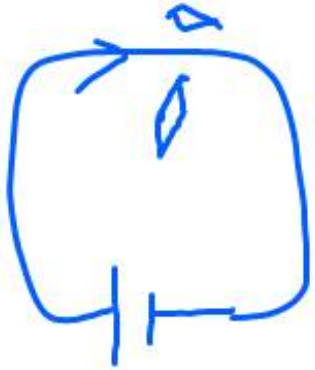
$\Delta E_p \rightarrow \Delta E_c$

$q . \Delta V = \frac{1}{2} m v^2 - 0$

$v = 3,1 . 10^6 \ m \ s^{-1}$

Campo magnético

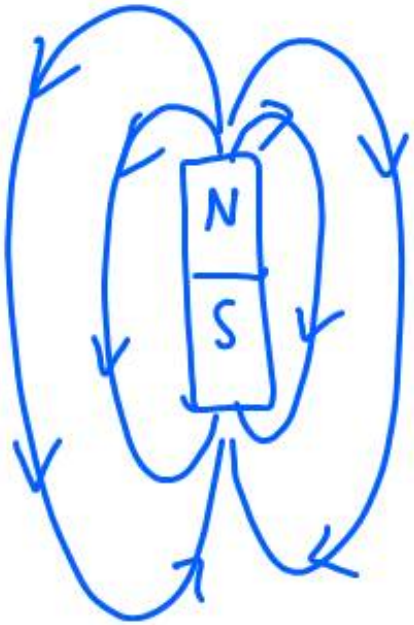
Oersted



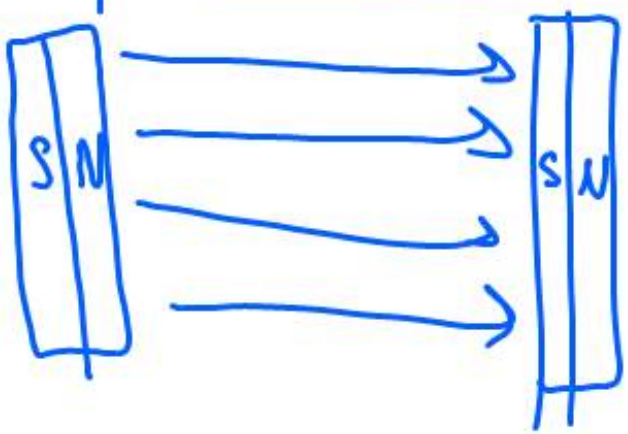
Ampère

Las cargas en movimiento están relac con el magnetismo

Líneas de campo



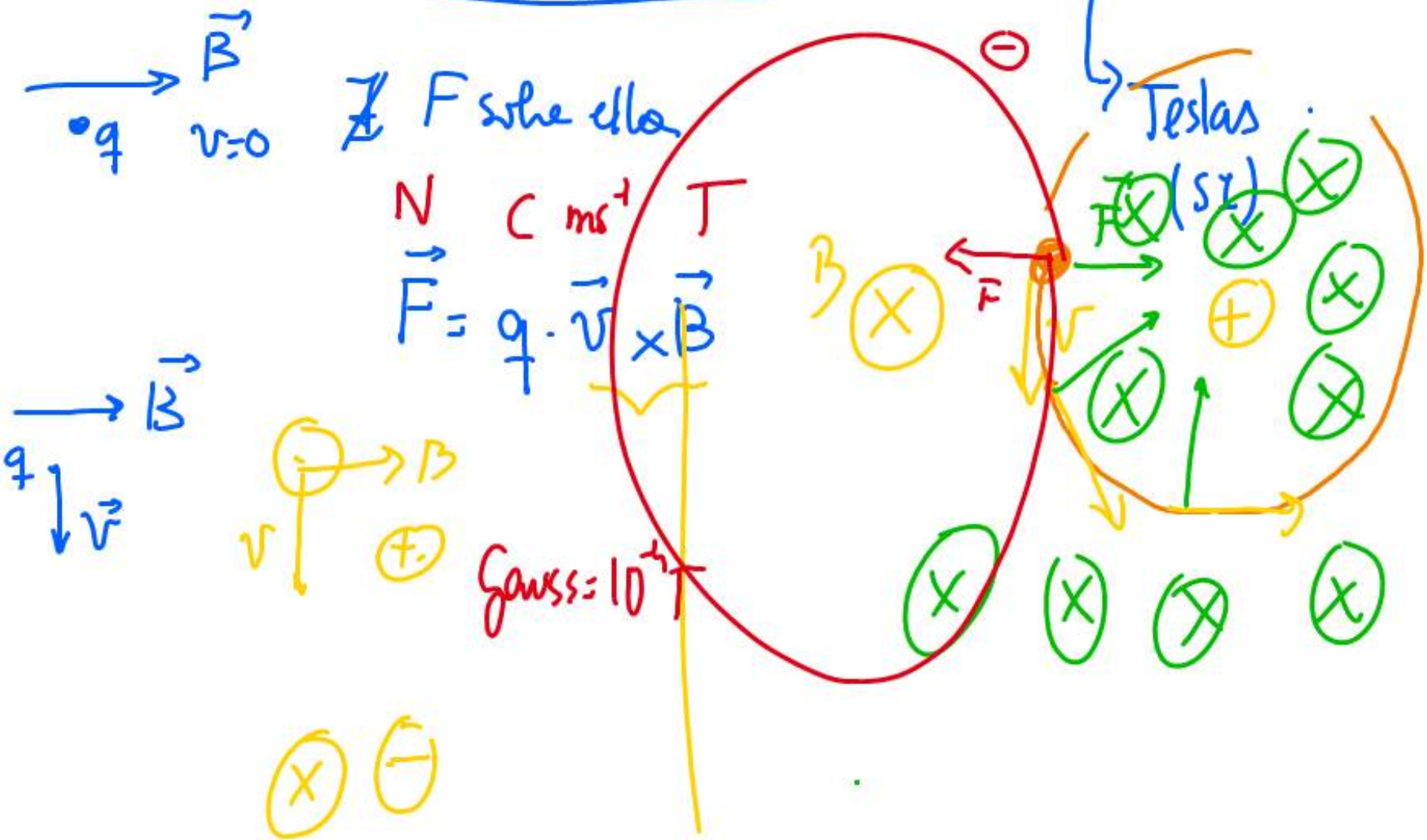
Representación B



Si entra al papel ⊗

Si sale del papel ⊙

Fuerza sobre una q que se mueve en un $\vec{B}$



$|F_B| = F_n$

$q v B \operatorname{sen}\alpha = m \frac{v^2}{R}$

$R = \frac{m v}{q B \operatorname{sen}\alpha}$

* Cuando $\alpha = 90°$

$R = \frac{m v}{q B}$

Espectrometro de masas

Ajustamos v y B

ΔV

$q \Delta V = \frac{1}{2} m v^2$

$v = \frac{2\pi R}{T}$

3,4,7.

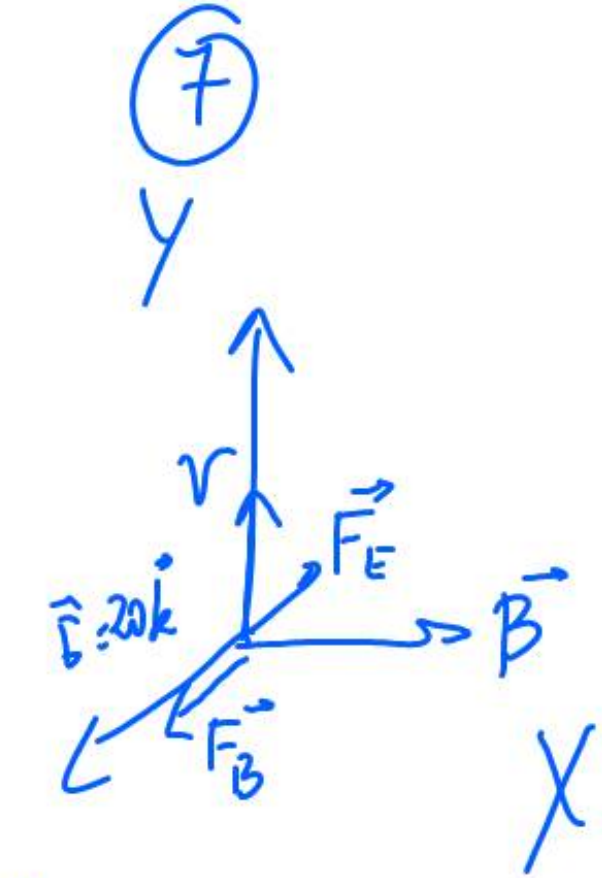
④ $q\Delta V = E_c$

$\frac{1}{2}mv^2$

$v = 9,9 \cdot 10^4 \, m s^{-1}$

$R = \frac{mv}{qB} = 0,496 \, m$

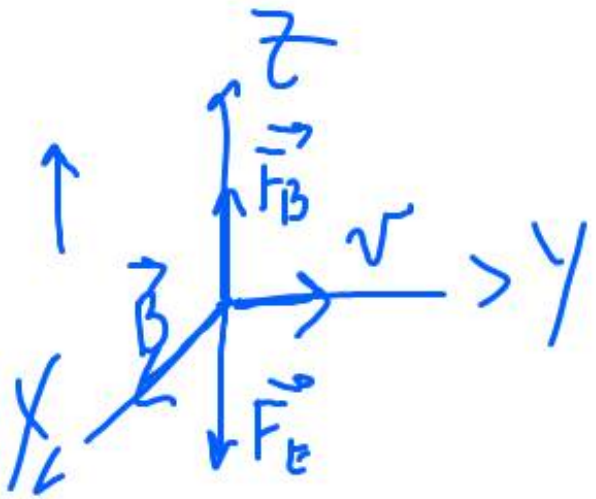
(7)



$|F_E| = |F_B|$

$q \cdot 20 = q\, 10\, B$

$B = 2\ T \qquad \vec{B} = 2\vec{i}\ T$



10) $L = 0{,}05\ m$

$I = 5\ A$

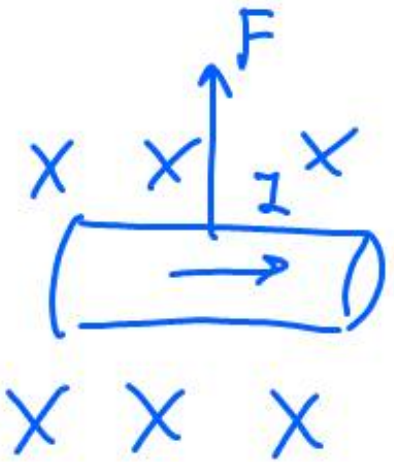
$F = 0{,}1\ N$

$\vec{F}_B = I\,\vec{L} \wedge \vec{B}$

$|F_B| = I\,L\,B$

$B = \frac{F}{IL} = 0{,}4\ T$

(1L)



$\vec{F} = I\,\vec{L} \times \vec{B}$

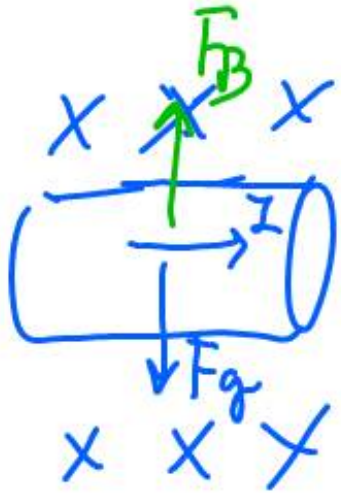
$\vec{F} = 0{,}25\,N$

$L = 0{,}5\,m$

$I = 2\,A$

$B = 0{,}25\,T$

(12)



$$|F_g| = |F_B|$$

$$m.g = I L B$$

$$G\frac{M m}{R^2}$$

$$B : 7,8.10^{-2}\ T$$

(13) $\vec{F} = 1 \cdot 0,09 \cdot 0,02 \cdot \operatorname{sen} 30 = 9 \cdot 10^{-4} \vec{k}\ N$