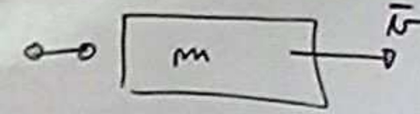
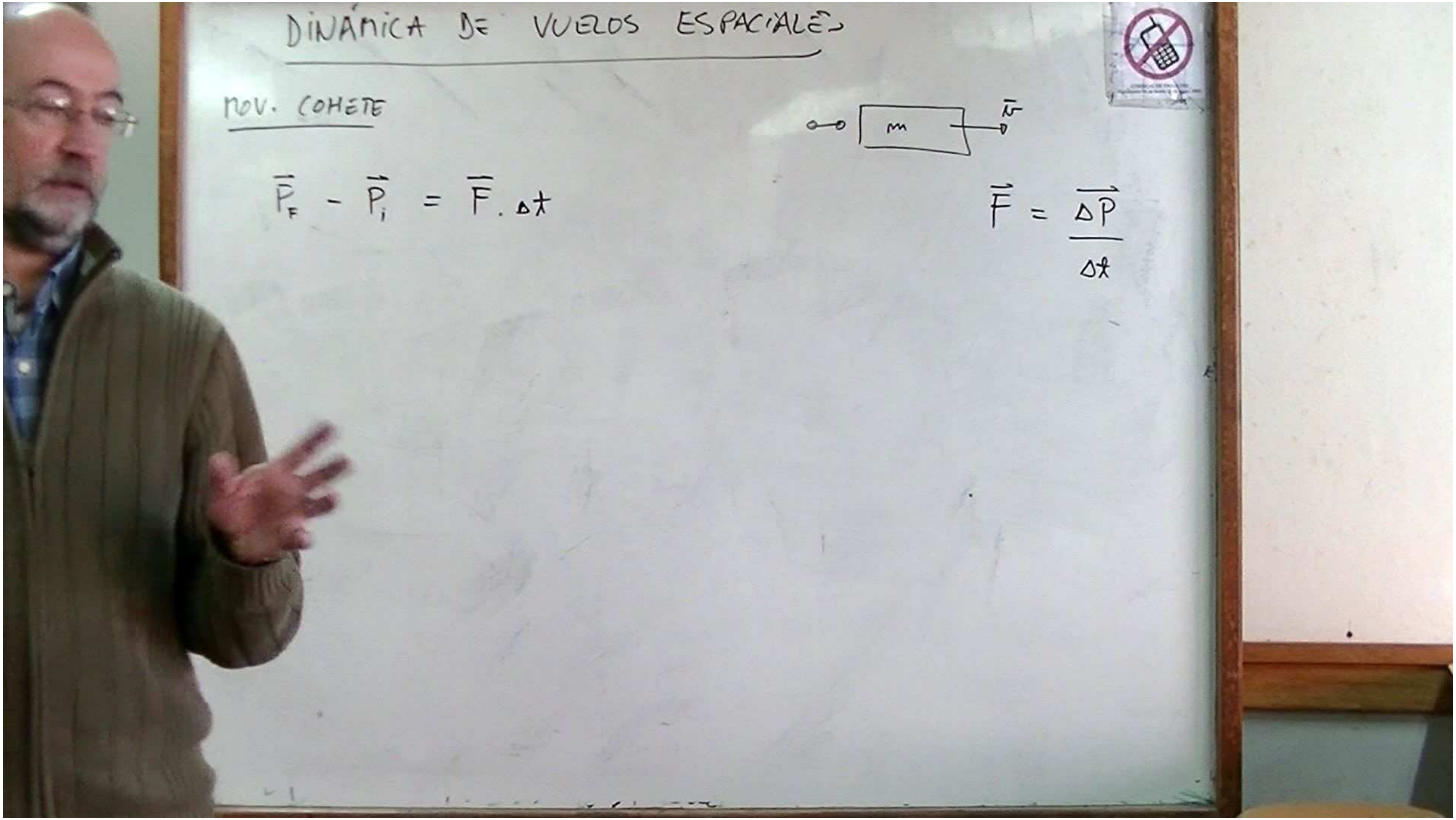
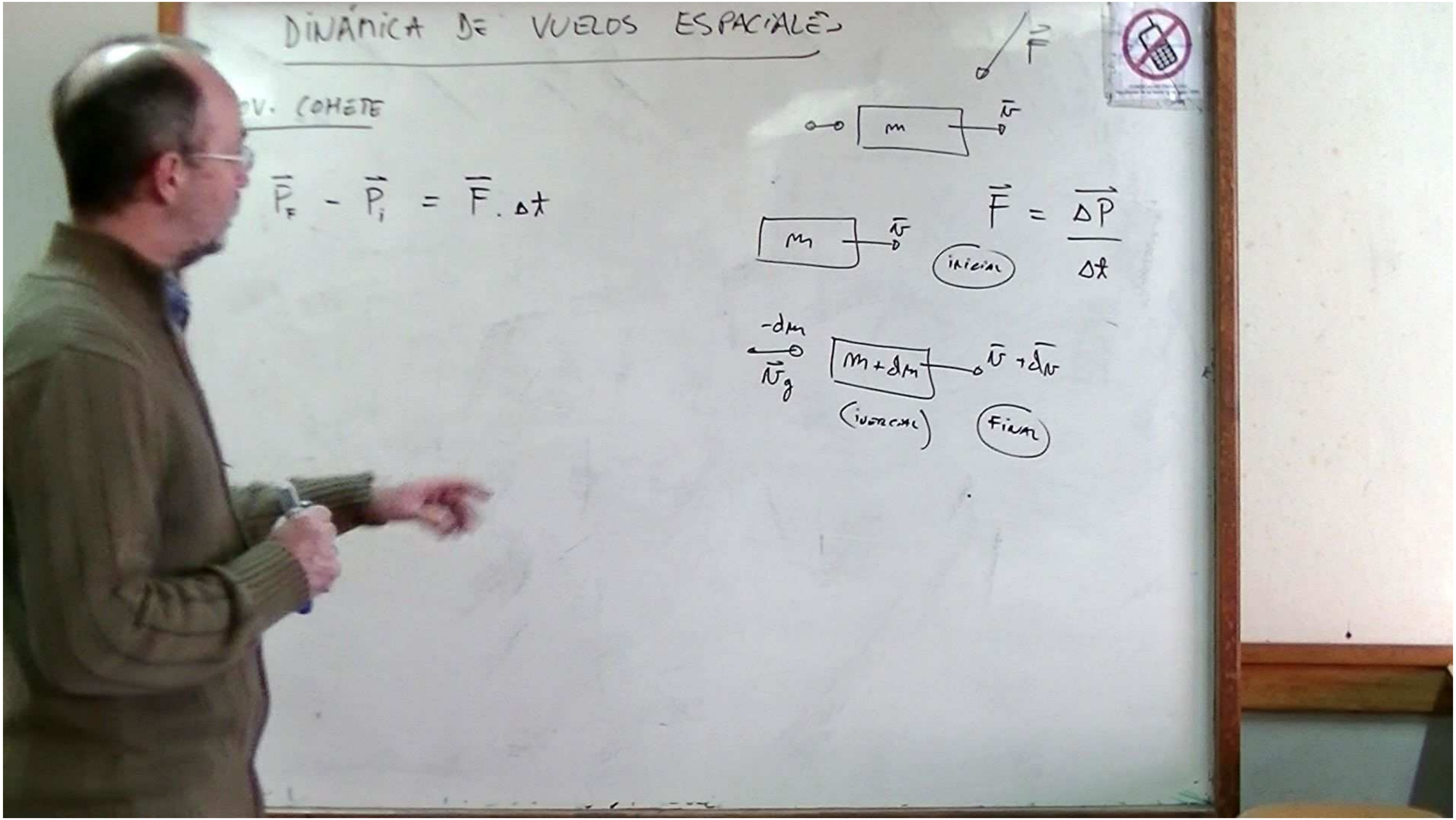
DINÁMICA DE VUELOS ESPACIALES

MOV. COHETE



$$\vec{F} = \frac{\Delta \vec{P}}{\Delta t}$$

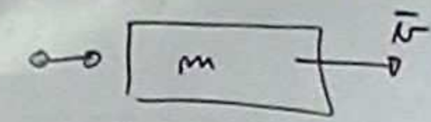

DINÁMICA DE VUELOS ESPACIALES
MOV. COHETE
$\vec{P}_F - \vec{P}_i = \vec{F} . \Delta t$
m
$\vec{v}$
$\vec{F} = \frac{\Delta \vec{P}}{\Delta t}$


DINÁMICA DE VUELOS ESPACIALES
V. COHETE
P_F - P_i = F . Δt
F
m
v
F = ΔP / Δt
inicial
-dm
v_g
m + dm
v + dv
Final

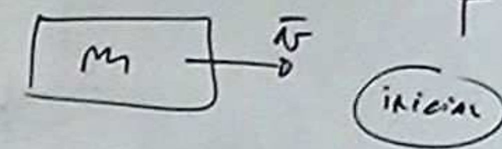
DINÁMICA DE VUELOS ESPACIALES

MOV. COHETE

$\longrightarrow \hat{i}$ $\qquad$ $\vec{F}$

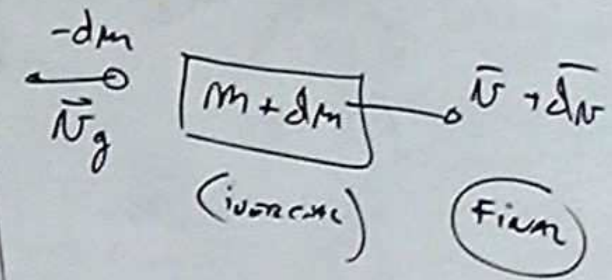


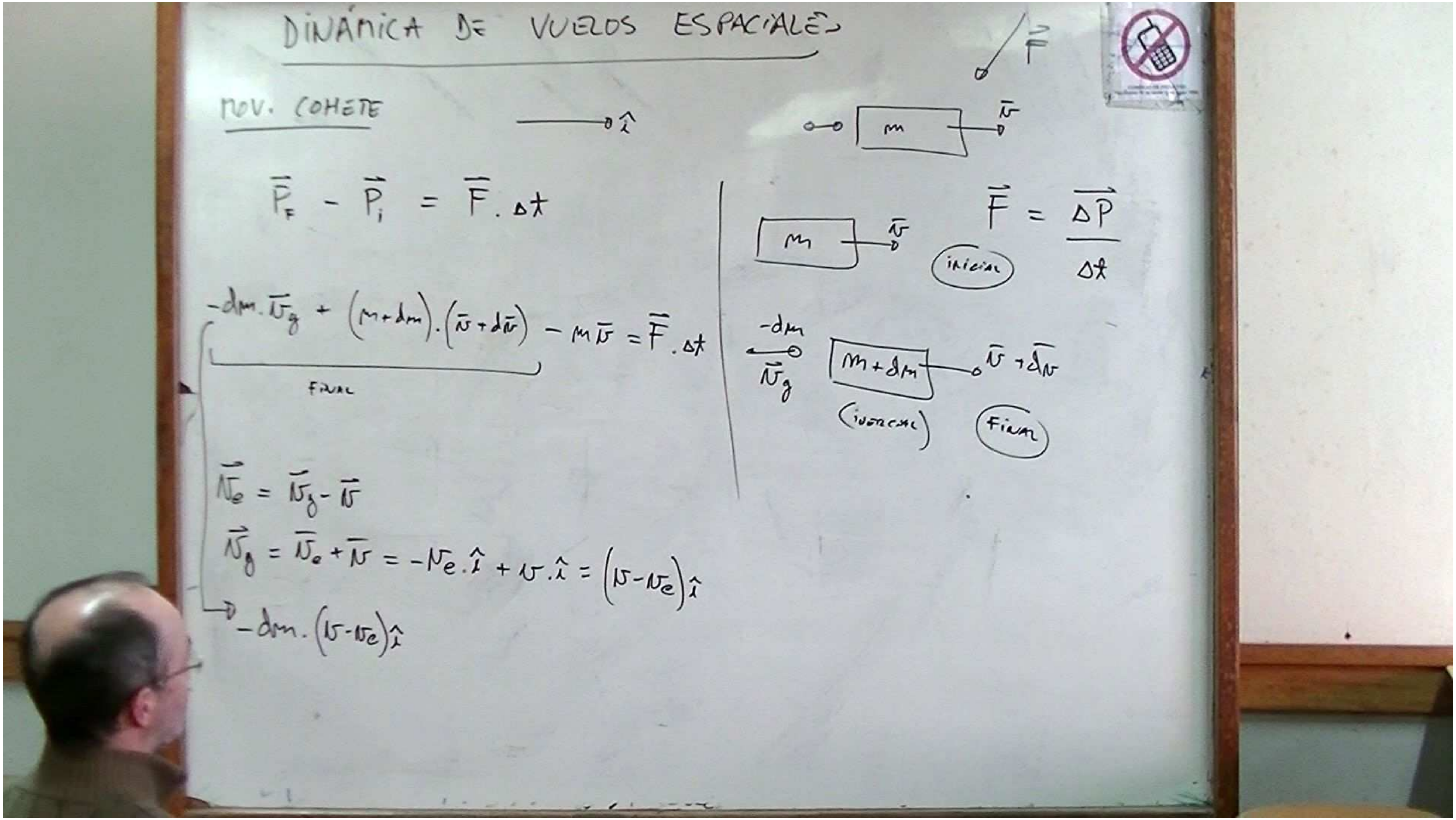
$$\vec{P}_F - \vec{P}_i = \vec{F} \, . \, \Delta t$$

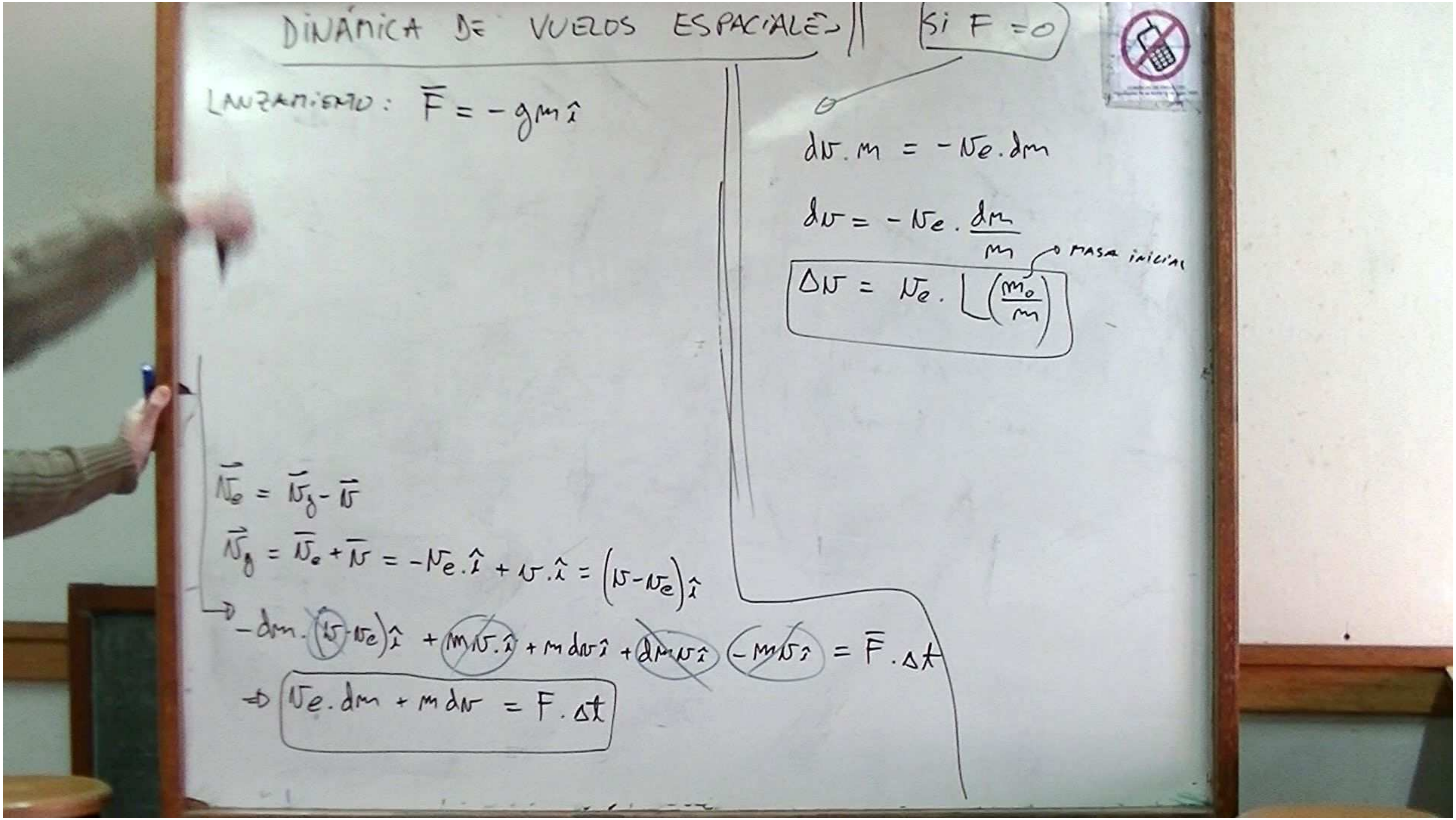


$$\vec{F} = \frac{\Delta \vec{P}}{\Delta t}$$

$$\underbrace{-dm.\bar{v}_g + (m+dm).(\bar{v}+d\bar{v})}_{\text{FINAL}} - m\bar{v} = \vec{F} \, . \, \Delta t$$

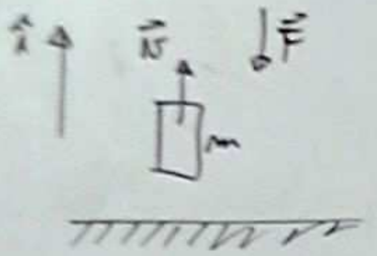



DINÁMICA DE VUELOS ESPACIALES
$\vec{F}$
MOV. COHETE
$\hat{i}$
m
$\vec{v}$
$\vec{P}_F - \vec{P}_i = \vec{F}.\Delta t$
m
$\vec{v}$
$\vec{F} = \frac{\Delta \vec{P}}{\Delta t}$
INICIAL
$-dm.\vec{v}_g + (m+dm).(\vec{v}+d\vec{v}) - m\vec{v} = \vec{F}.\Delta t$
FINAL
$-dm$
$\vec{v}_g$
$m+dm$
$\vec{v}+d\vec{v}$
(INERCIAL)
FINAL
$\vec{v}_e = \vec{v}_g - \vec{v}$
$\vec{v}_g = \vec{v}_e + \vec{v} = -v_e.\hat{i} + v.\hat{i} = (v-v_e)\hat{i}$
$-dm.(v-v_e)\hat{i}$


DINÁMICA DE VUELOS ESPACIALES
Si $F = 0$
LANZAMIENTO: $\bar{F} = -gm\,\hat{\imath}$
$dv \cdot m = -v_e \cdot dm$
$dv = -v_e \cdot \frac{dm}{m}$
masa inicial
$\Delta v = v_e \cdot L\left(\frac{m_0}{m}\right)$
$\vec{v}_e = \vec{v}_g - \vec{v}$
$\vec{v}_g = \bar{v}_e + \bar{v} = -v_e \cdot \hat{\imath} + v \cdot \hat{\imath} = (v - v_e)\hat{\imath}$
$-dm \cdot (v - v_e)\hat{\imath} + m v \cdot \hat{\imath} + m\,dv\,\hat{\imath} + dm\,v\,\hat{\imath} - m v\,\hat{\imath} = \bar{F} \cdot \Delta t$
$\Rightarrow v_e \cdot dm + m\,dv = F \cdot \Delta t$

DINÁMICA DE VUELOS ESPACIALES

LANZAMIENTO: $\bar{F} = -gm\,\hat{\imath}$



$$\vec{v}_e = \vec{v}_g - \vec{v}$$

$$\vec{v}_g = \bar{v}_e + \bar{v} = -v_e.\hat{\imath} + v.\hat{\imath} = (v - v_e)\hat{\imath}$$

$$\to -dm.(v - v_e)\hat{\imath} + \cancel{m v.\hat{\imath}} + m\,dv\,\hat{\imath} + \cancel{dm\,v\,\hat{\imath}}\ \cancel{- m v\,\hat{\imath}} = \bar{F}.\Delta t$$

$$\Rightarrow \boxed{v_e.dm + m\,dv = F.\Delta t}$$

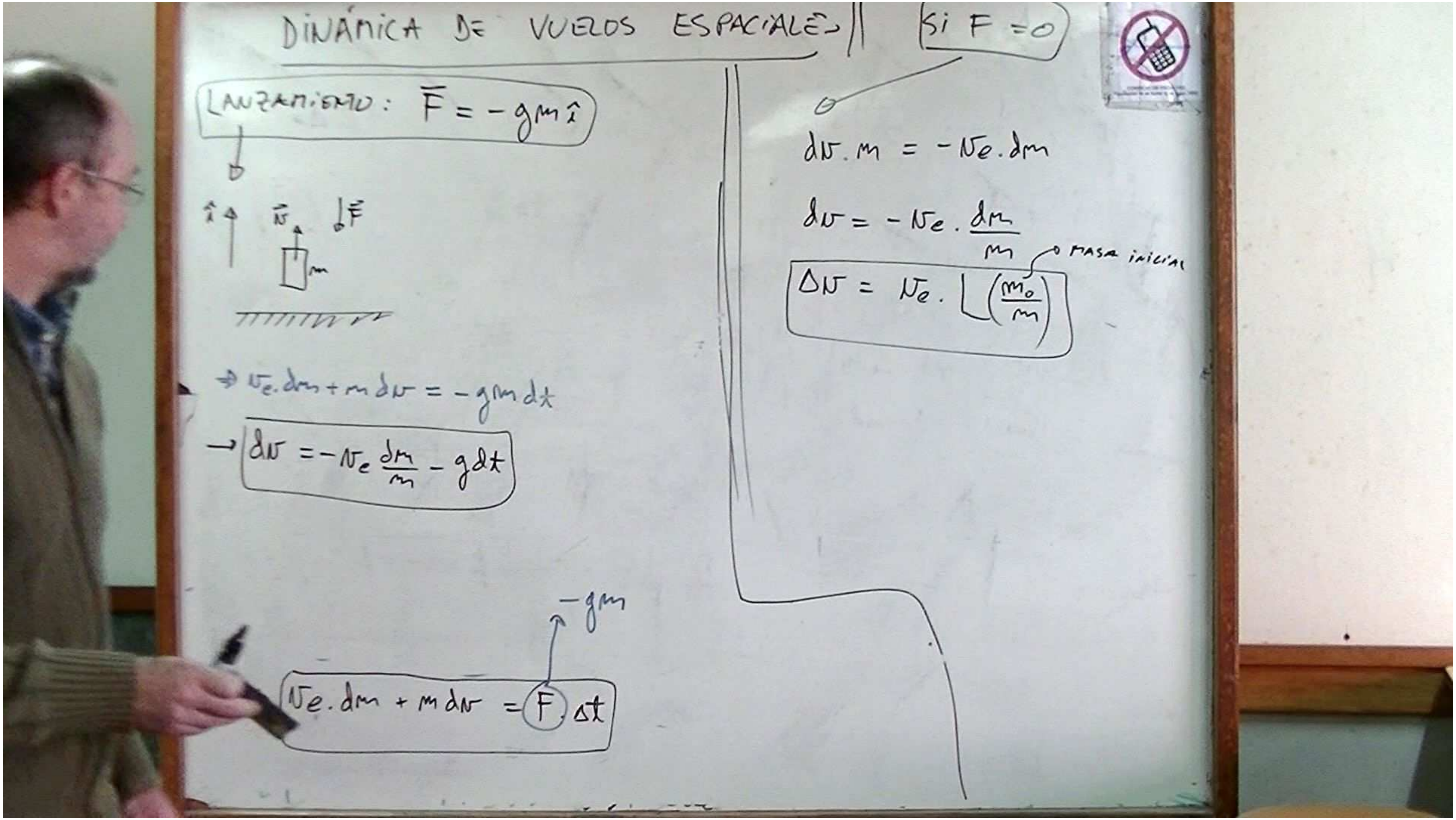
Si $F = 0$

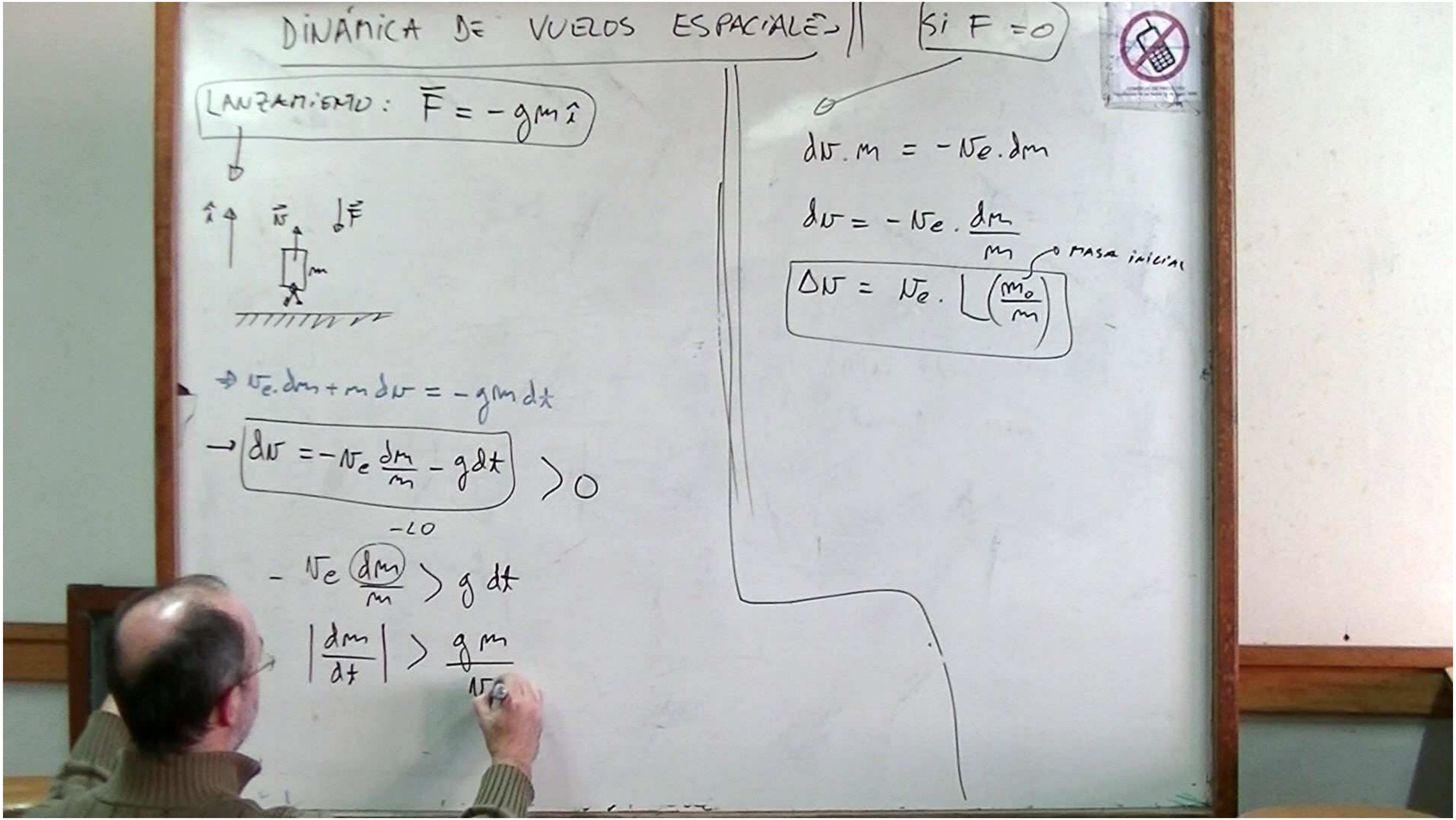
$$dv.m = -v_e.dm$$

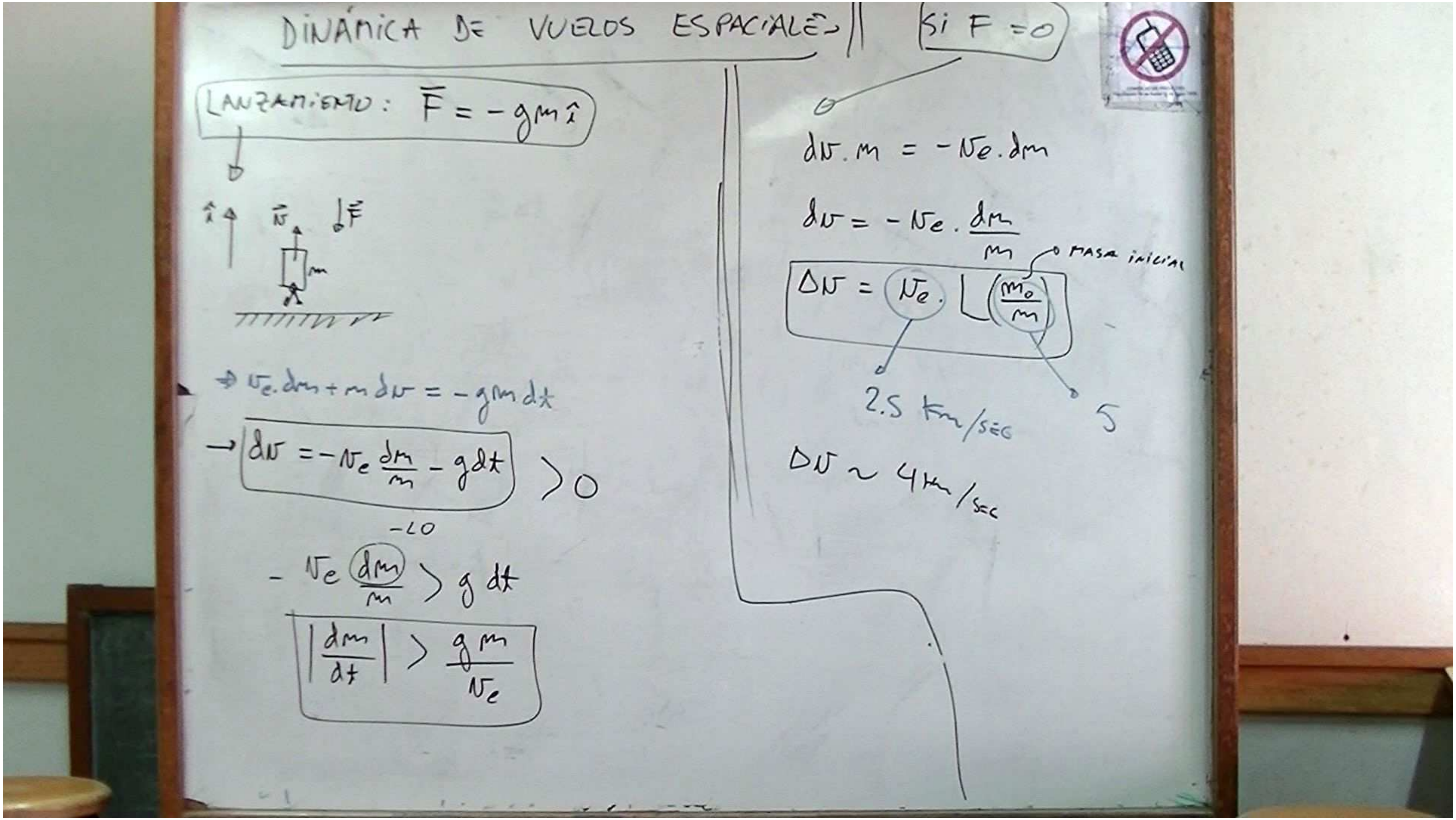
$$dv = -v_e.\frac{dm}{m}$$

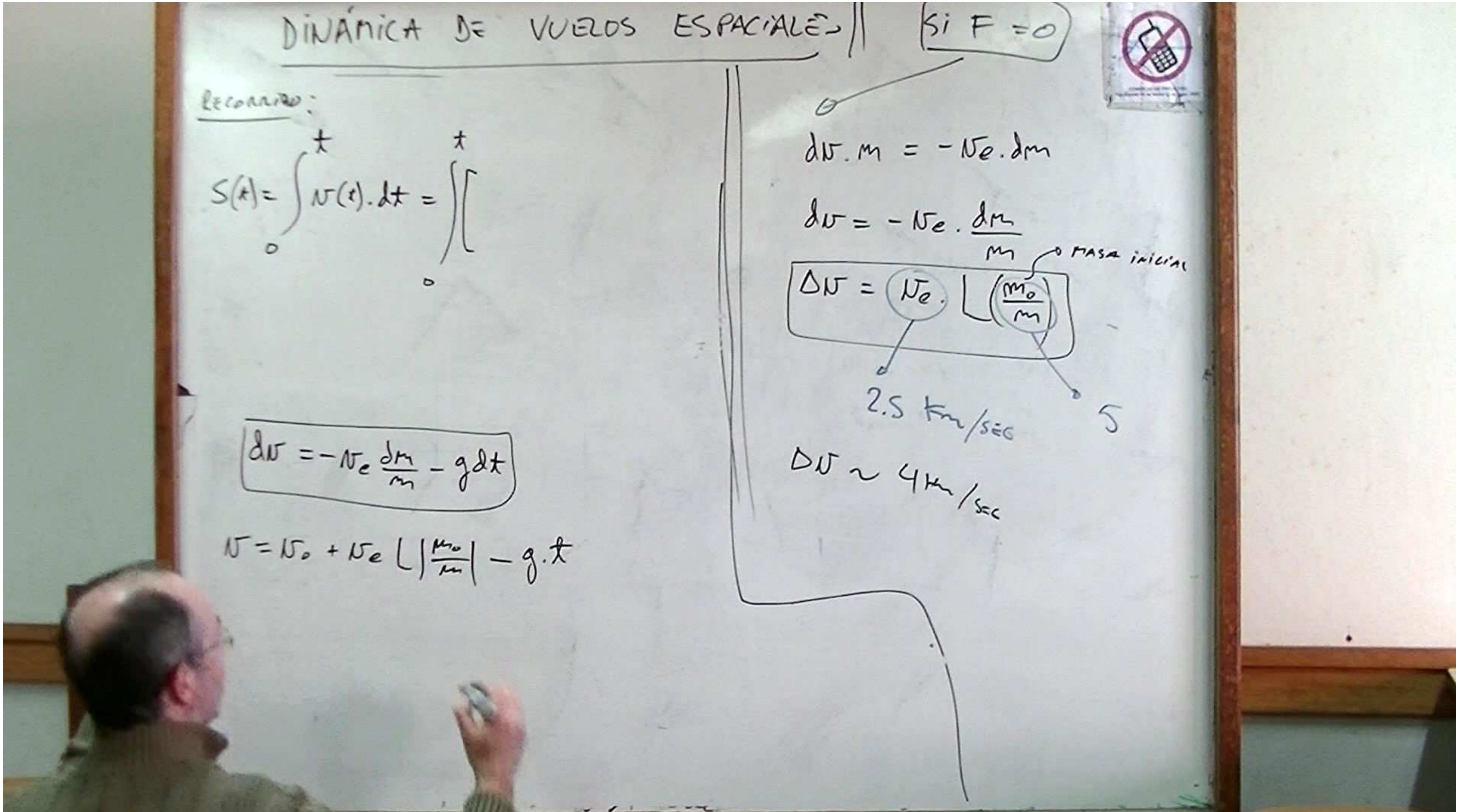
masa inicial

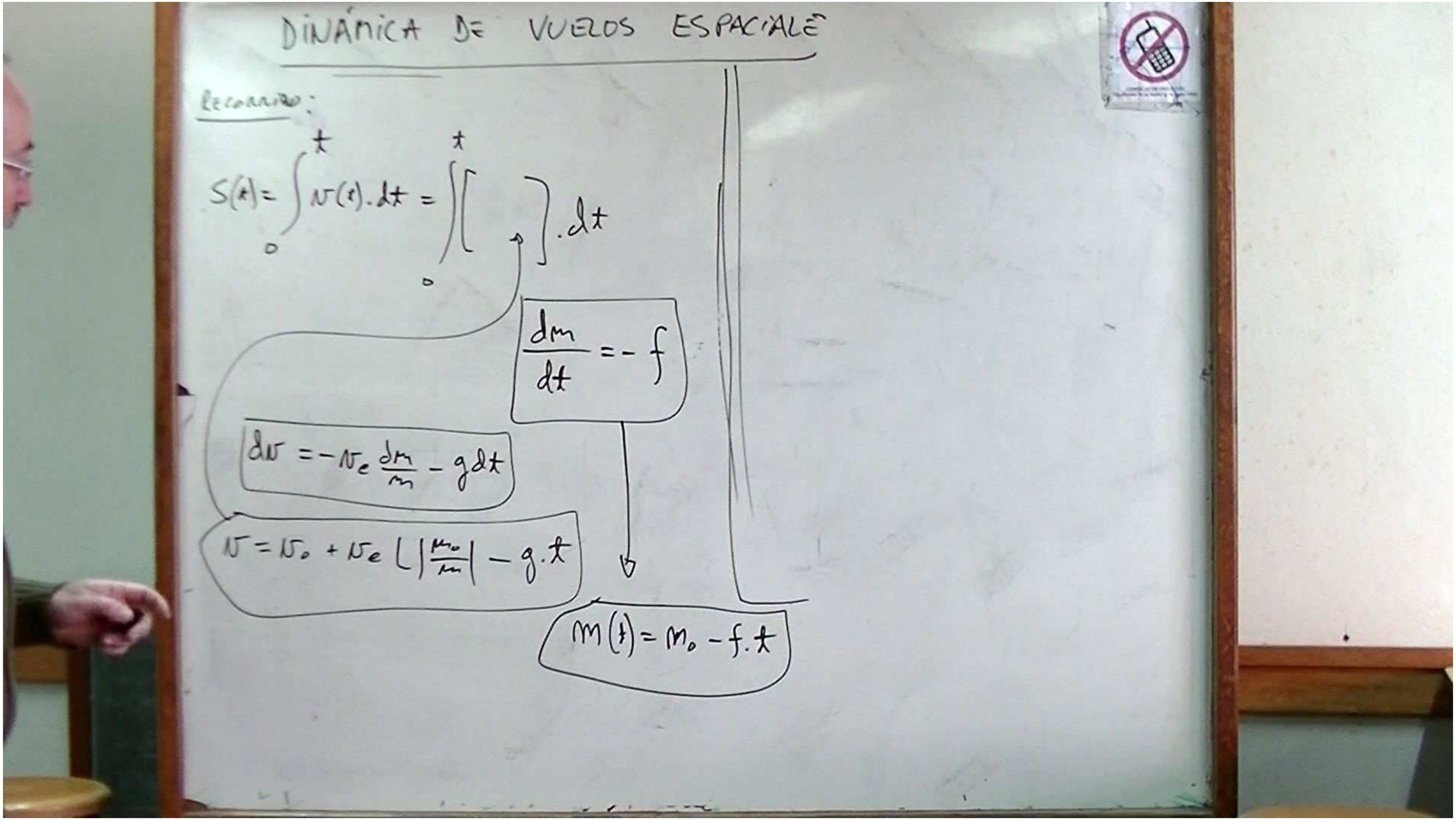
$$\boxed{\Delta v = v_e.\,L\left(\frac{m_0}{m}\right)}$$

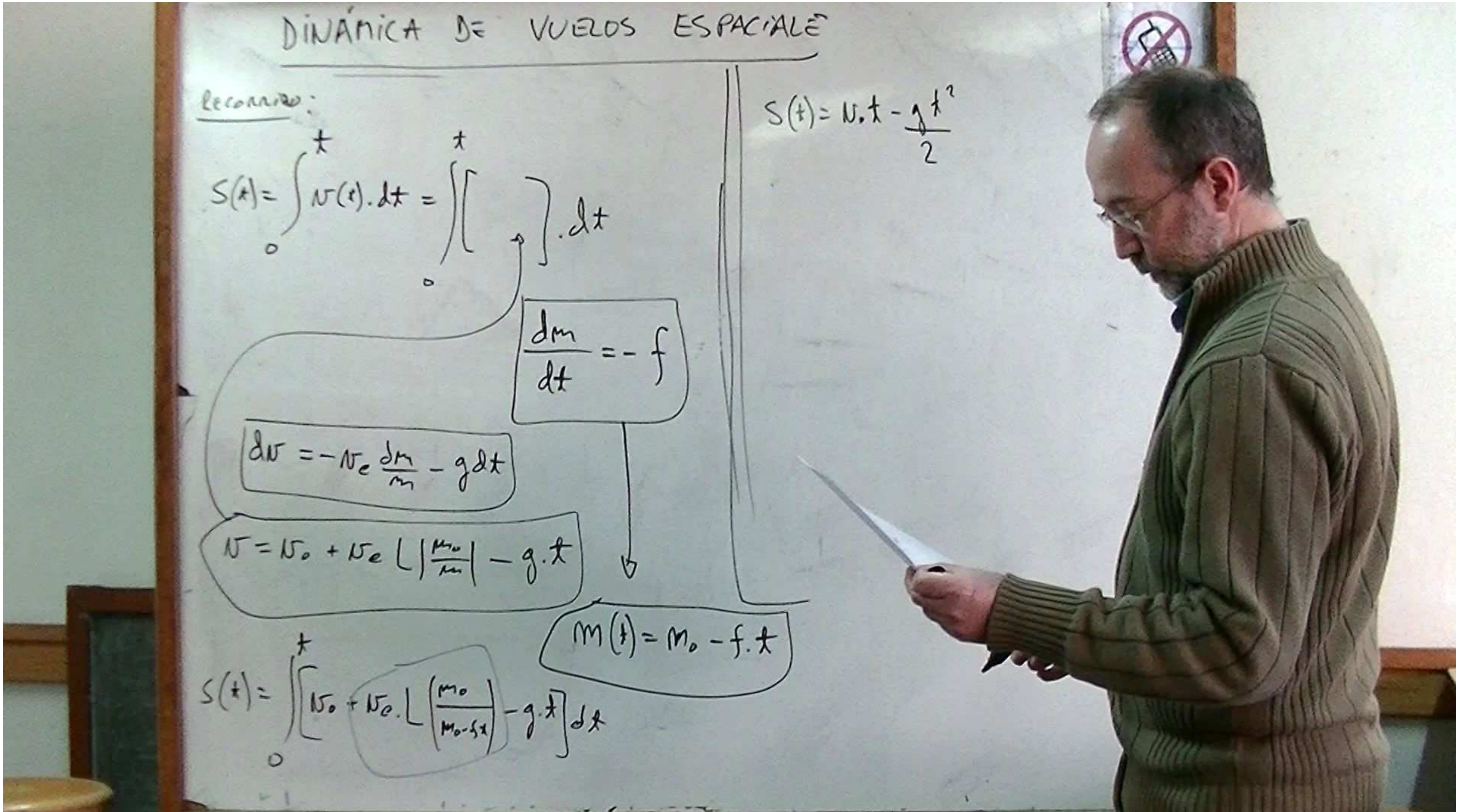

DINÁMICA DE VUELOS ESPACIALES
LANZAMIENTO: $\bar{F} = -gm\,\hat{\imath}$
$\hat{\imath}$ $\vec{v}$ $\vec{F}$ m
$v_e . dm + m\,dv = -gm\,dt$
$dv = -v_e \frac{dm}{m} - g\,dt$
$v_e . dm + m\,dv = F\,\Delta t$
$-gm$
SI $F = 0$
$dv . m = -v_e . dm$
$dv = -v_e . \frac{dm}{m}$
$\Delta v = v_e . \ln\left(\frac{m_0}{m}\right)$
MASA INICIAL


DINÁMICA DE VUELOS ESPACIALES
LANZAMIENTO: F = −gm î
î v F m
⇒ ve.dm + m dv = −gm dt
→ dv = −ve dm/m − g dt > 0
<0
− ve dm/m > g dt
|dm/dt| > gm/ve
Si F = 0
dv.m = −ve.dm
dv = −ve . dm/m
MASA INICIAL
Δv = ve . L(m0/m)


DINÁMICA DE VUELOS ESPACIALES
LANZAMIENTO: $\bar{F} = -gm\hat{i}$
$\hat{i}$
$\vec{v}$
$\vec{F}$
m
$v_e\,dm + m\,dv = -gm\,dt$
$dv = -v_e \frac{dm}{m} - g\,dt > 0$
<0
$-v_e \frac{dm}{m} > g\,dt$
$\left|\frac{dm}{dt}\right| > \frac{gm}{v_e}$
SI F = 0
$dv \cdot m = -v_e \cdot dm$
$dv = -v_e \cdot \frac{dm}{m}$
MASA INICIAL
$\Delta v = v_e \cdot L\left(\frac{m_0}{m}\right)$
2.5 km/seg
5
$\Delta v \sim 4$ km/sec


DINÁMICA DE VUELOS ESPACIALES
Si F = 0
RECORRIDO:
$S(t) = \int_0^t v(t).dt = \int_0^t [$
$dv = -v_e \frac{dm}{m} - g\,dt$
$v = v_0 + v_e\, L\left|\frac{m_0}{m}\right| - g.t$
$dv.m = -v_e.dm$
$dv = -v_e . \frac{dm}{m}$
$\Delta v = v_e . L\left(\frac{m_0}{m}\right)$
MASA INICIAL
2.5 km/sec
5
$\Delta v \sim 4$ km/sec


DINÁMICA DE VUELOS ESPACIALES
RECORRIDO:
$S(t) = \int_0^t v(t) \cdot dt = \int_0^t [\quad] \cdot dt$
$\frac{dm}{dt} = -f$
$dv = -v_e \frac{dm}{m} - g\,dt$
$v = v_0 + v_e L\left|\frac{m_0}{m}\right| - g \cdot t$
$m(t) = m_0 - f \cdot t$


DINÁMICA DE VUELOS ESPACIALES
Recorrido:
$S(t) = \int_0^t v(t).dt = \int_0^t [\quad].dt$
$\frac{dm}{dt} = -f$
$dv = -v_e \frac{dm}{m} - g\,dt$
$v = v_0 + v_e L\left|\frac{m_0}{m}\right| - g.t$
$m(t) = m_0 - f.t$
$S(t) = \int_0^t \left[v_0 + v_e.L\left(\frac{m_0}{m_0 - ft}\right) - g.t\right] dt$
$S(t) = v_0.t - \frac{g t^2}{2}$

DINÁMICA DE VUELOS ESPACIALES

RECORRIDO:

$$S(t) = \int_0^t v(t)\,dt = \int_0^t [\quad]\,dt$$

$$\frac{dm}{dt} = -f$$

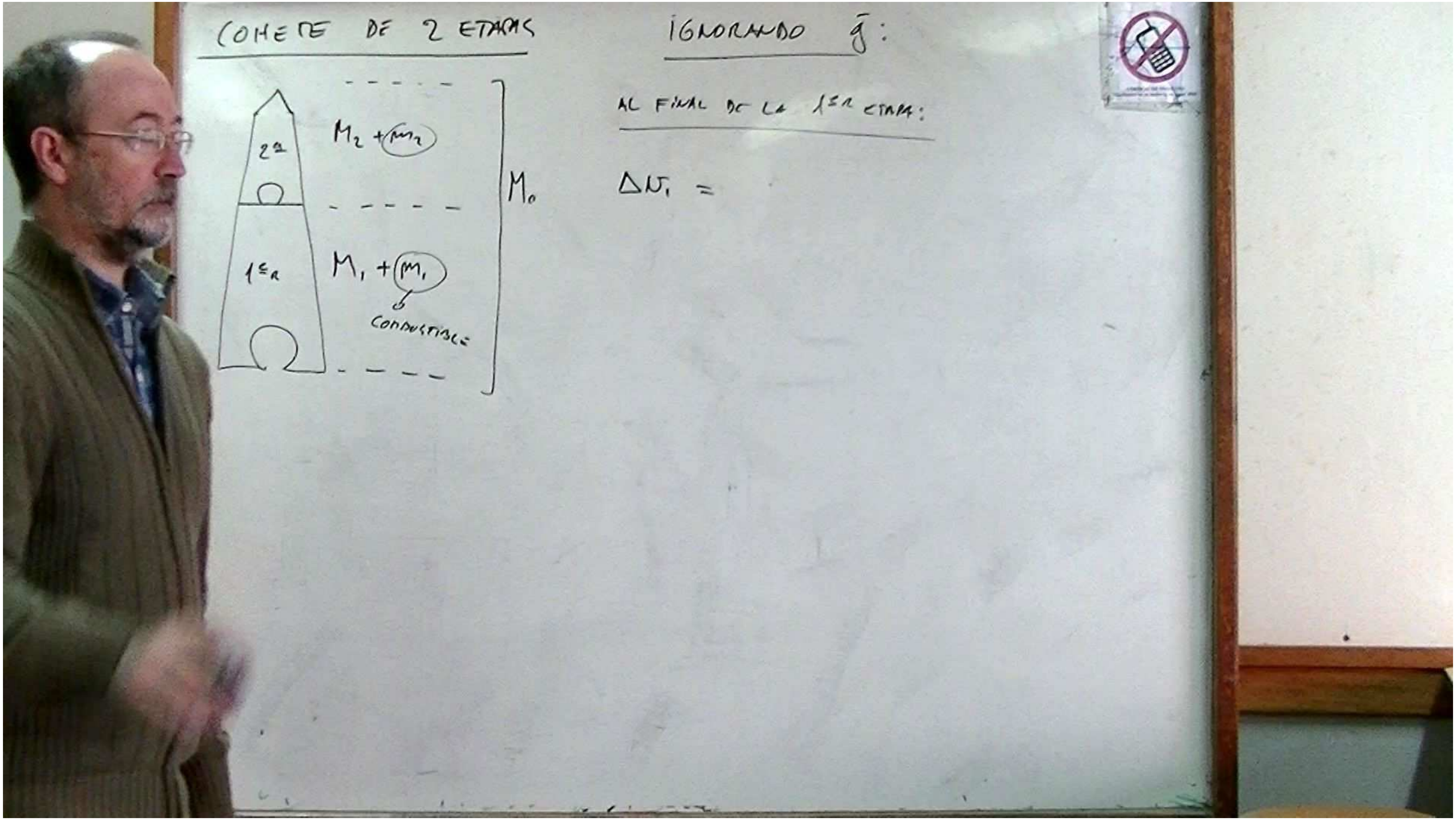
$$dv = -v_e \frac{dm}{m} - g\,dt$$

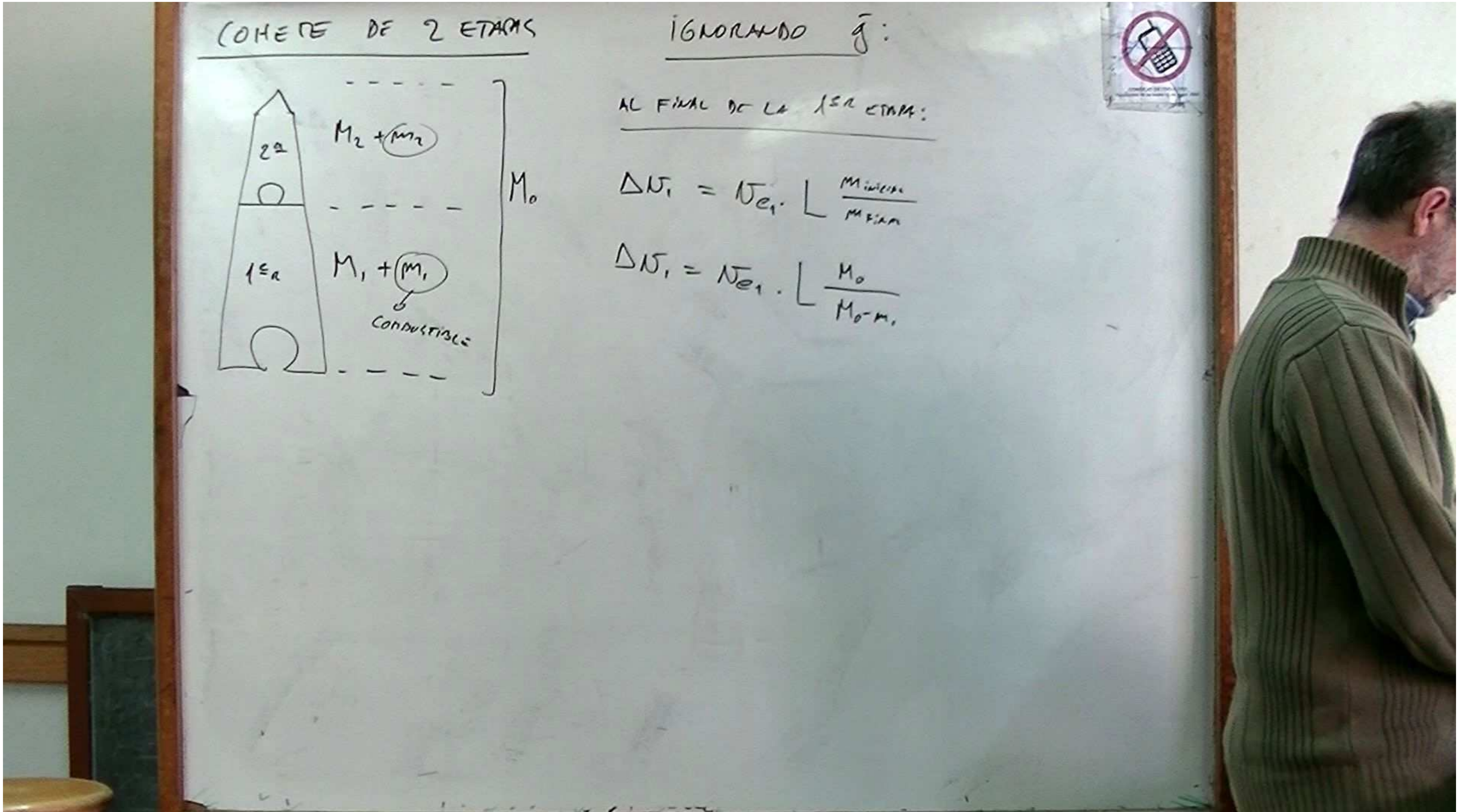
$$v = v_0 + v_e \, L\left|\frac{m_0}{m}\right| - g.t$$

$$m(t) = m_0 - f.t$$

$$S(t) = \int_0^t \left[v_0 + v_e . L\left(\frac{m_0}{m_0 - ft}\right) - g.t \right] dt$$

$$S(t) = v_0 . t - \frac{g t^2}{2} + \frac{v_e}{f}\left[m_0 - m . L \frac{m_0}{m} - m \right]$$


COHETE DE 2 ETAPAS
2ª
1ER
M2 + M2
M1 + M1
COMBUSTIBLE
M0
IGNORANDO g:
AL FINAL DE LA 1ER ETAPA:
ΔV1 =


COHETE DE 2 ETAPAS
2ª
1ERA
$M_2 + m_2$
$M_1 + m_1$
COMBUSTIBLE
M_0
IGNORANDO $\vec{g}$:
AL FINAL DE LA 1ER ETAPA:
$\Delta V_1 = V_{e_1} \cdot L \frac{m_{inicial}}{m_{final}}$
$\Delta V_1 = V_{e_1} \cdot L \frac{M_0}{M_0 - m_1}$

COHETE DE 2 ETAPAS

$M_2 + m_2$

$M_1 + m_1$

combustible

M_0

IGNORANDO $\vec{g}$:

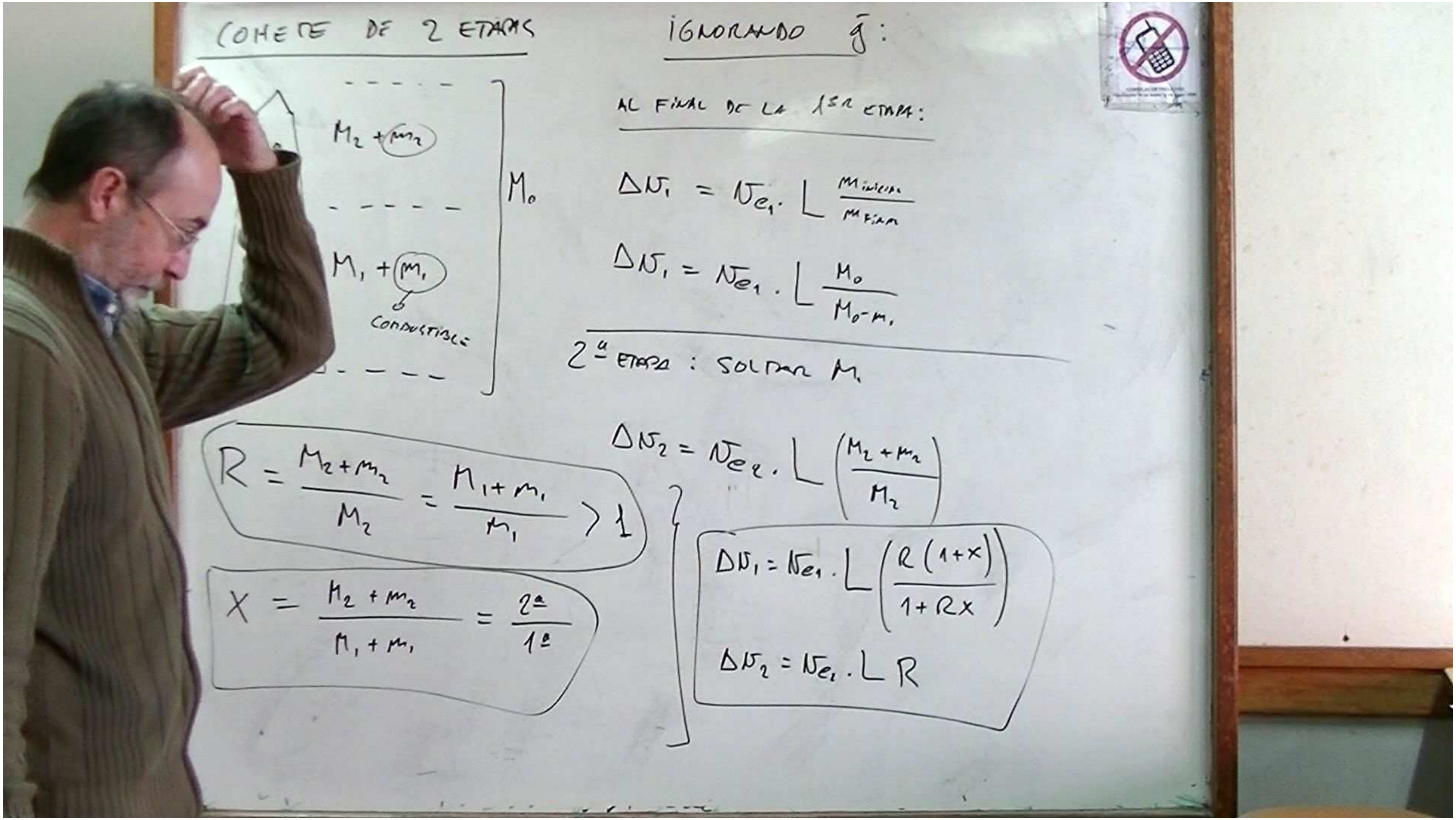
AL FINAL DE LA 1ER ETAPA:

$$\Delta v_1 = v_{e_1} \cdot L \frac{m_{inicial}}{m_{final}}$$

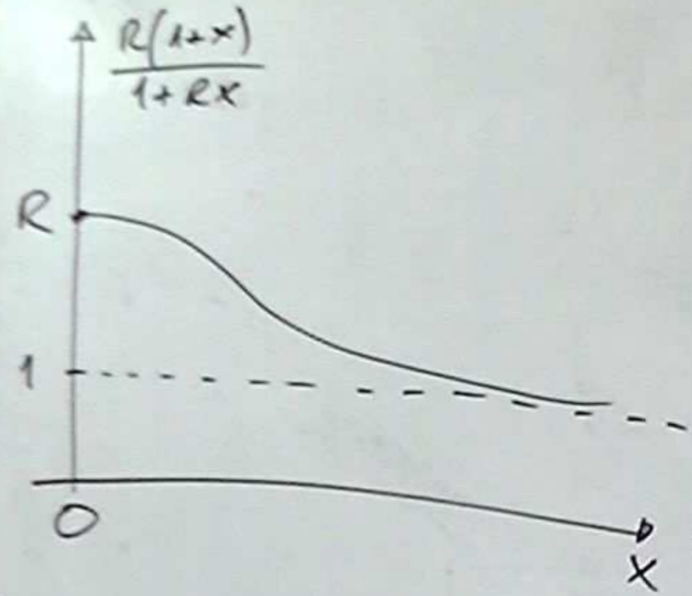
$$\Delta v_1 = v_{e_1} \cdot L \frac{M_0}{M_0 - m_1}$$

2ª ETAPA : SOLTAR M_1

$$\Delta v_2 = v_{e_2} \cdot L \left(\frac{M_2 + m_2}{M_2} \right)$$


COHETE DE 2 ETAPAS
$M_2 + m_2$
M_0
$M_1 + m_1$
COMBUSTIBLE
$R = \frac{M_2+m_2}{M_2} = \frac{M_1+m_1}{m_1} > 1$
$X = \frac{M_2+m_2}{M_1+m_1} = \frac{2^a}{1^a}$
IGNORANDO $\vec{g}$:
AL FINAL DE LA 1ER ETAPA:
$\Delta v_1 = v_{e_1} \cdot L \frac{m_{inicial}}{m_{final}}$
$\Delta v_1 = v_{e_1} \cdot L \frac{M_0}{M_0 - m_1}$
2^a ETAPA : SOLTAR M_1
$\Delta v_2 = v_{e_2} \cdot L \left(\frac{M_2+m_2}{M_2}\right)$
$\Delta v_1 = v_{e_1} \cdot L \left(\frac{R(1+X)}{1+RX}\right)$
$\Delta v_2 = v_{e_2} \cdot L R$

COHETE DE 2 ETAPAS



Si $X \to 0 \Rightarrow \Delta v_1 = v_{e1} \cdot L(R)$

2^{a} etapa: soltar M_1

$$\Delta v_2 = v_{e2} \cdot L\left(\underbrace{\frac{M_2+m_2}{M_2}}_{R}\right)$$

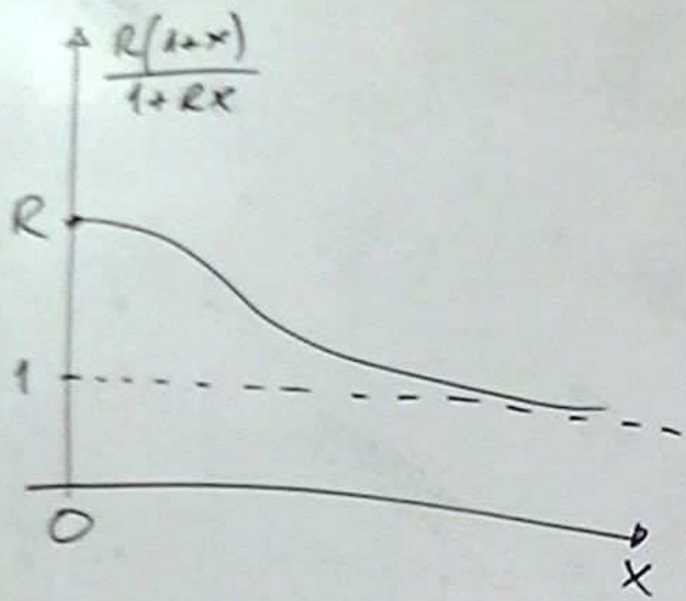
$$R = \frac{M_2+m_2}{M_2} = \frac{M_1+m_1}{M_1} > 1$$

$$X = \frac{M_2+m_2}{M_1+m_1} = \frac{2^{a}}{1^{a}}$$

$$\Delta v_1 = v_{e1} \cdot L\left(\frac{R(1+x)}{1+Rx}\right)$$

$$\Delta v_2 = v_{e2} \cdot L\,R$$

COHETE DE 2 ETAPAS



Si $X \to 0 \Rightarrow \Delta v_1 = v_{e1} \cdot L(R)$

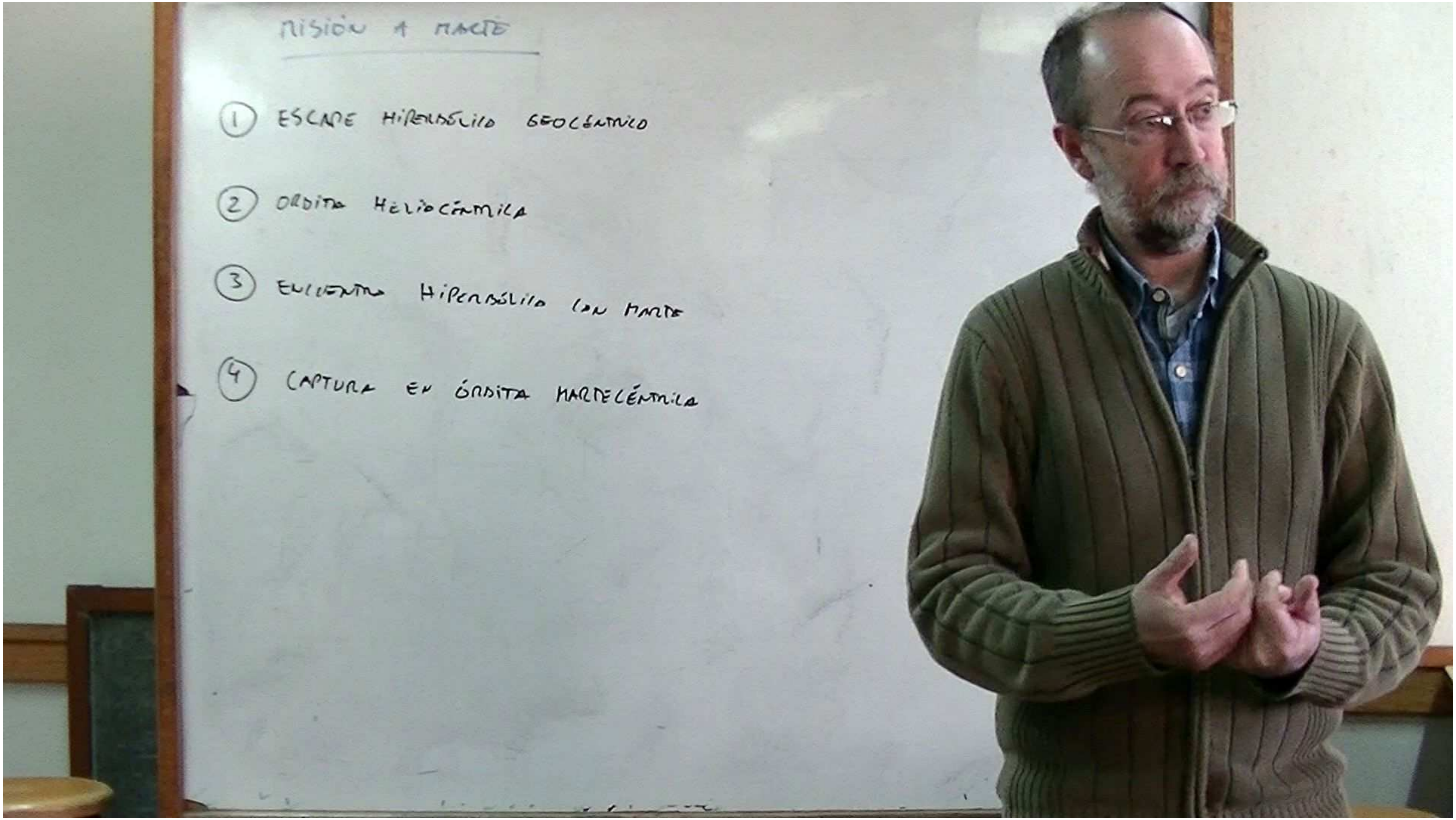
2ª etapa: soltar M_1

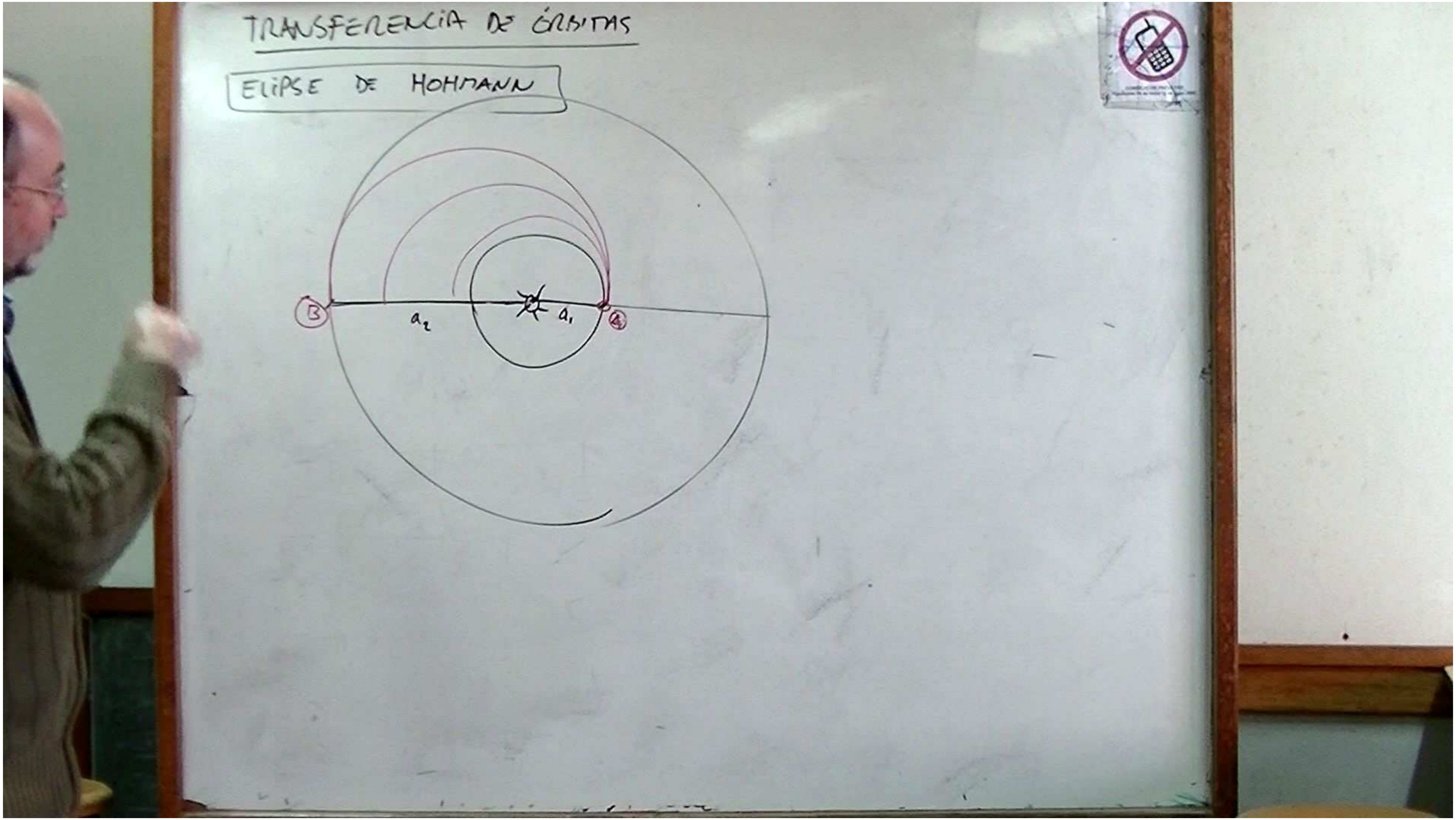
$$\Delta v_2 = v_{e2} \cdot L\left(\underbrace{\frac{M_2 + m_2}{M_2}}_{R}\right)$$

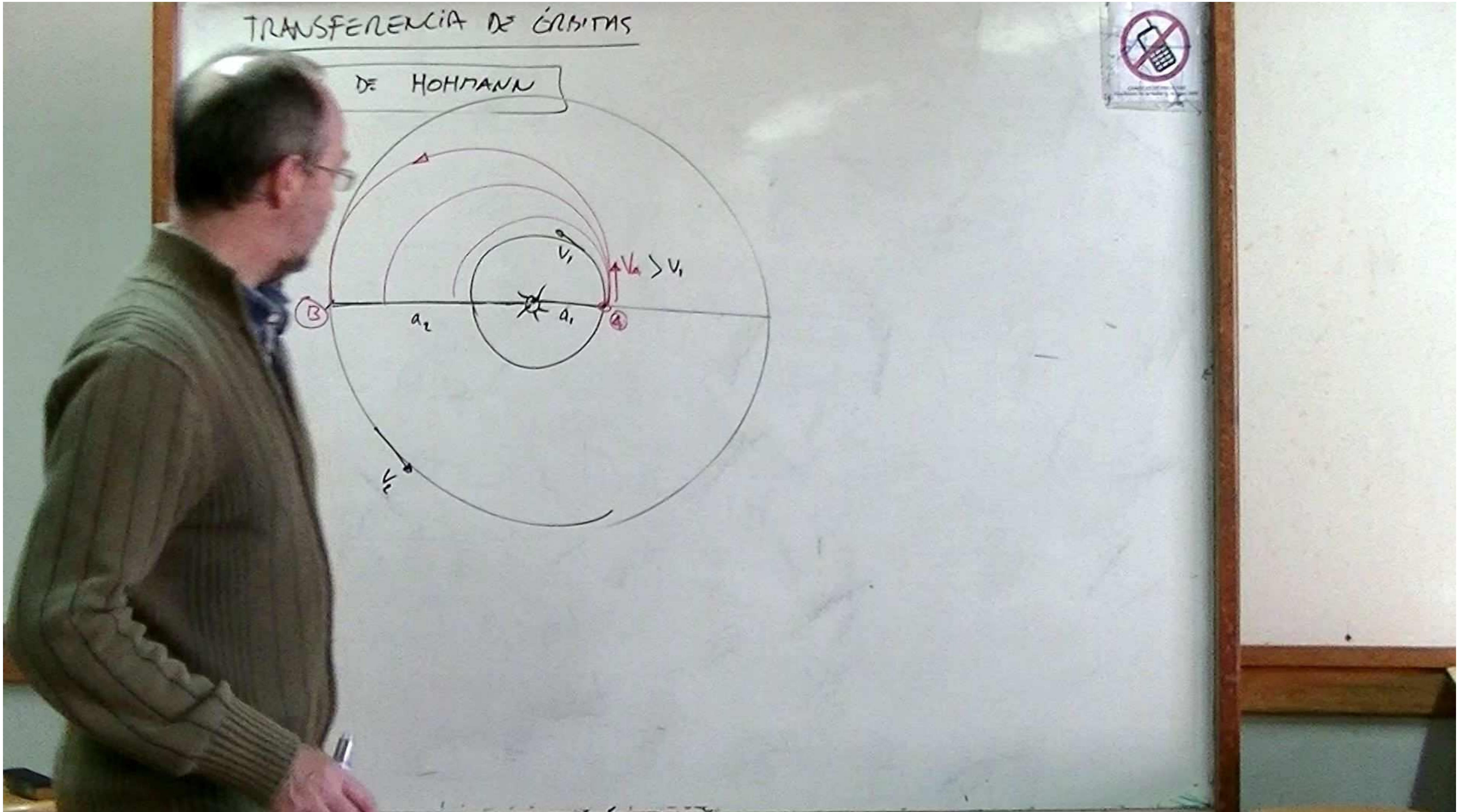
$$\boxed{R = \frac{M_2 + m_2}{M_2} = \frac{M_1 + m_1}{m_1} > 1}$$

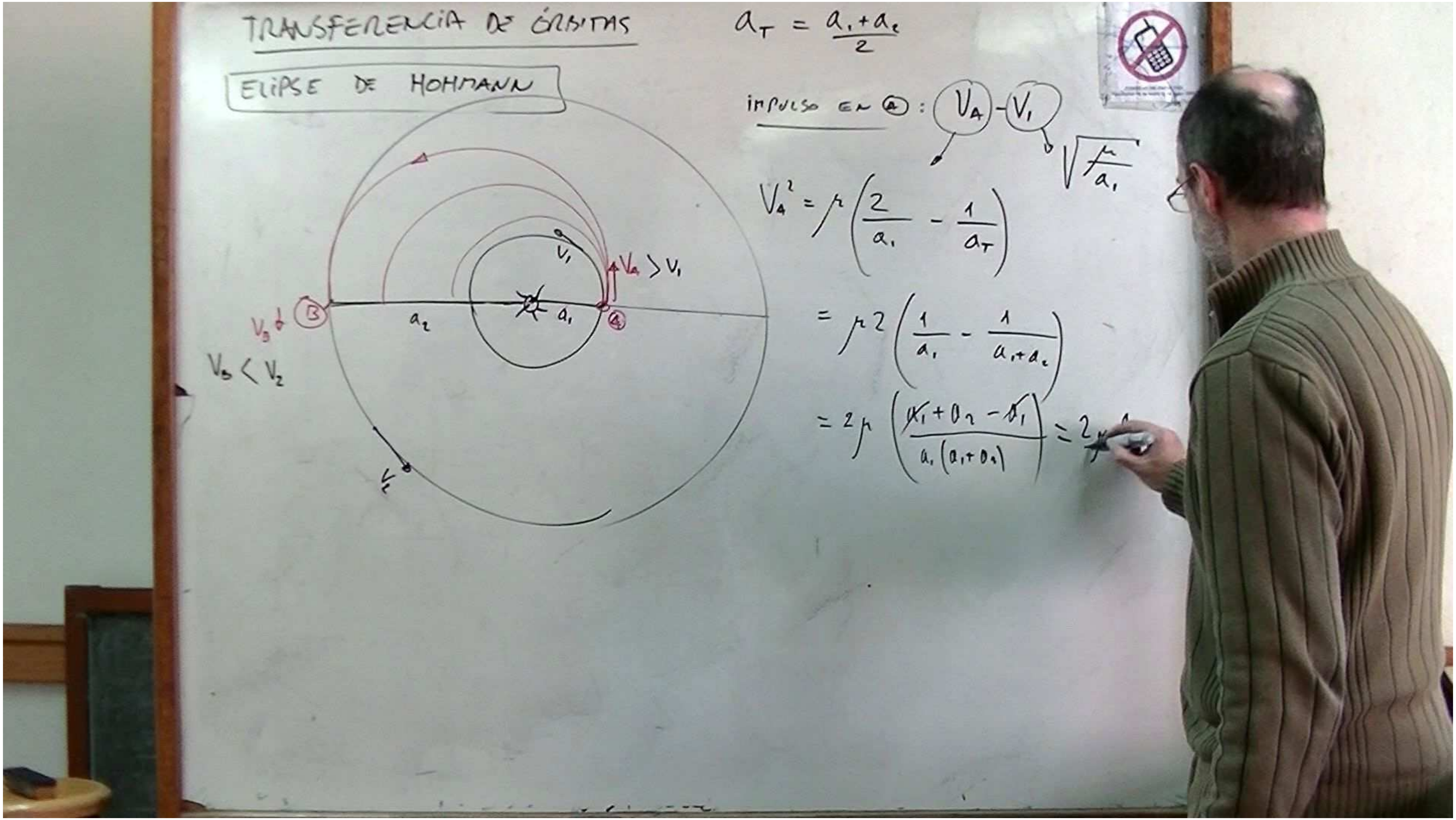
$$\boxed{X = \frac{M_2 + m_2}{M_1 + m_1} = \frac{2^a}{1^a}}$$

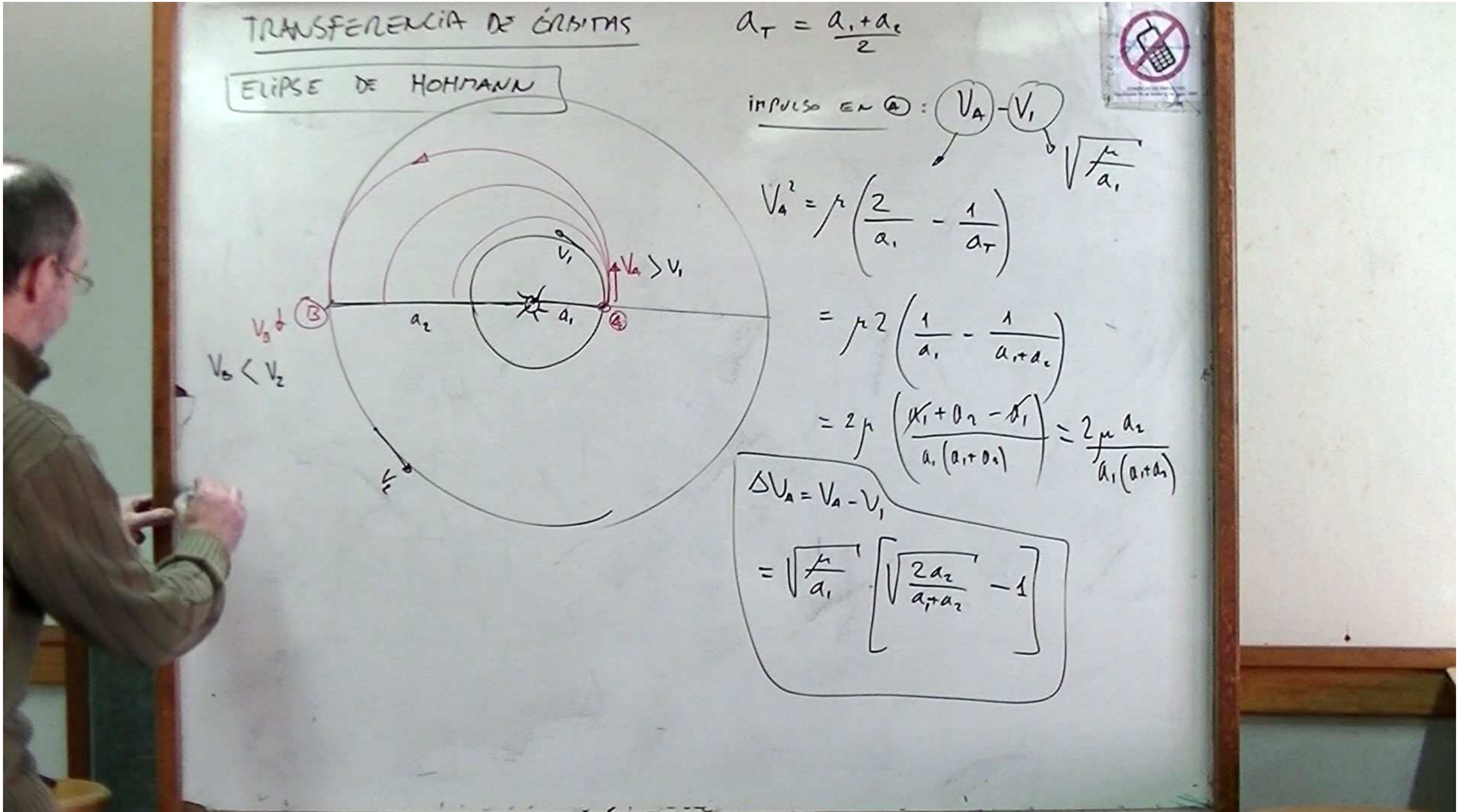
$$\boxed{\begin{aligned} \Delta v_1 &= v_{e1} \cdot L\left(\frac{R(1+x)}{1+Rx}\right) \\ \Delta v_2 &= v_{e2} \cdot L\,R \end{aligned}}$$

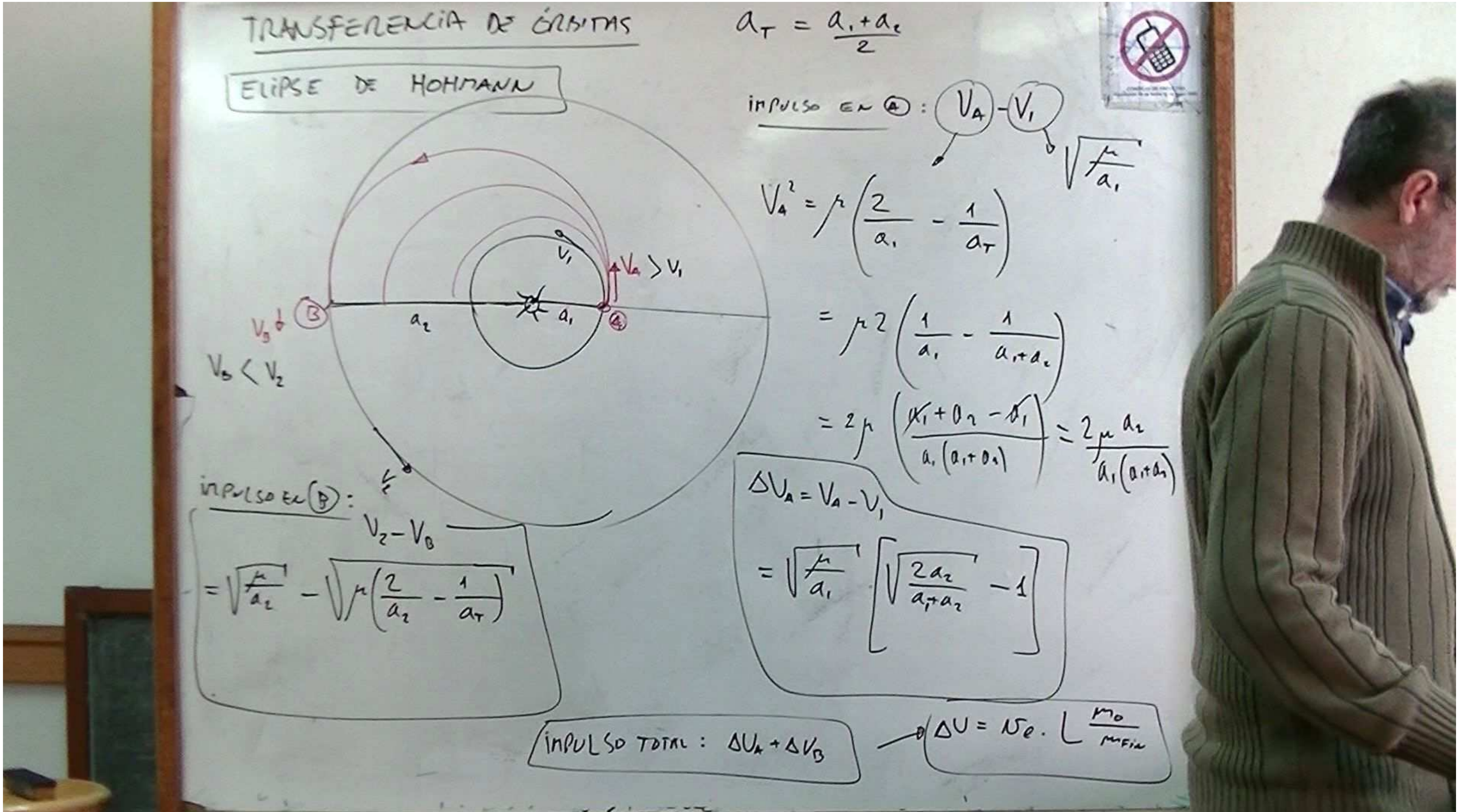

MISIÓN A MARTE
1 ESCAPE HIPERBÓLICO GEOCÉNTRICO
2 ÓRBITA HELIOCÉNTRICA
3 ENCUENTRO HIPERBÓLICO CON MARTE
4 CAPTURA EN ÓRBITA MARTECÉNTRICA


TRANSFERENCIA DE ÓRBITAS
ELIPSE DE HOHMANN
B
a_2
a_1
A

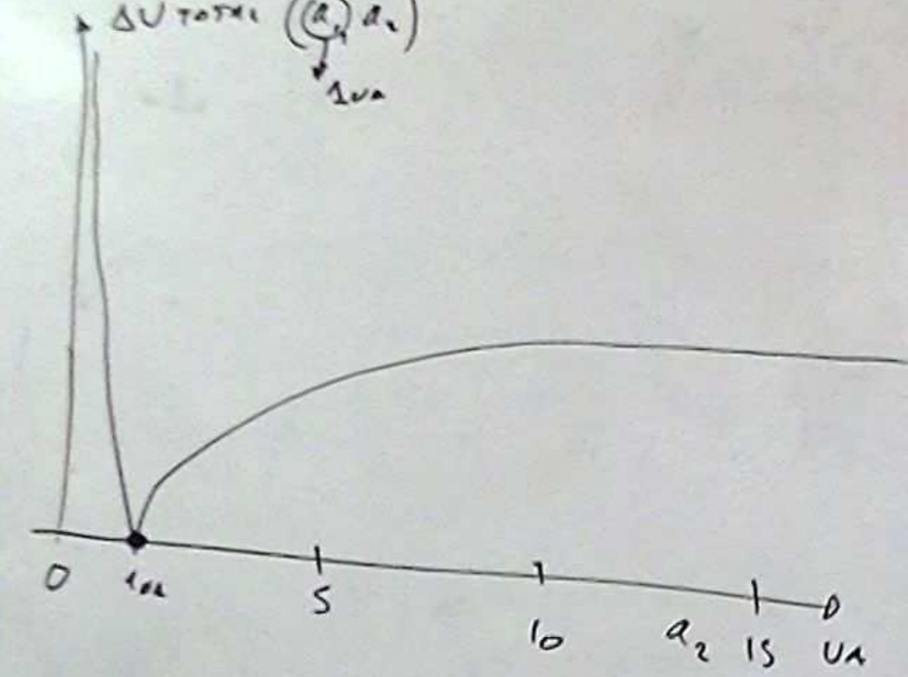

TRANSFERENCIA DE ÓRBITAS
DE HOHMANN
V_1
$V_a > V_1$
B
a_2
a_1
A
V_c


TRANSFERENCIA DE ÓRBITAS
ELIPSE DE HOHMANN
$a_T = \frac{a_1 + a_2}{2}$
IMPULSO EN A : $V_A - V_1$
$\sqrt{\frac{\mu}{a_1}}$
$V_A^2 = \mu \left(\frac{2}{a_1} - \frac{1}{a_T} \right)$
$= \mu 2 \left(\frac{1}{a_1} - \frac{1}{a_1 + a_2} \right)$
$= 2\mu \left(\frac{\cancel{a_1} + a_2 - \cancel{a_1}}{a_1 (a_1 + a_2)} \right)$
V_1
$V_A > V_1$
V_B
B
A
a_2
a_1
$V_B < V_2$
V_2


TRANSFERENCIA DE ÓRBITAS
ELIPSE DE HOHMANN
$a_T = \frac{a_1 + a_2}{2}$
IMPULSO EN A : $V_A - V_1$
$\sqrt{\mu / a_1}$
$V_A^2 = \mu \left(\frac{2}{a_1} - \frac{1}{a_T} \right)$
$= \mu 2 \left(\frac{1}{a_1} - \frac{1}{a_1 + a_2} \right)$
$= 2\mu \left(\frac{\cancel{a_1} + a_2 - \cancel{a_1}}{a_1 (a_1 + a_2)} \right) = \frac{2\mu a_2}{a_1 (a_1 + a_2)}$
$\Delta V_A = V_A - V_1$
$= \sqrt{\frac{\mu}{a_1}} \left[\sqrt{\frac{2 a_2}{a_1 + a_2}} - 1 \right]$
$V_A > V_1$
V_1
V_B
$V_B < V_2$
a_2
a_1
B
A


TRANSFERENCIA DE ÓRBITAS
ELIPSE DE HOHMANN
$a_T = \frac{a_1 + a_2}{2}$
IMPULSO EN A : $V_A - V_1$
$\sqrt{\frac{\mu}{a_1}}$
$V_A^2 = \mu\left(\frac{2}{a_1} - \frac{1}{a_T}\right)$
$= \mu 2\left(\frac{1}{a_1} - \frac{1}{a_1+a_2}\right)$
$= 2\mu\left(\frac{\cancel{a_1} + a_2 - \cancel{a_1}}{a_1(a_1+a_2)}\right) = 2\mu \frac{a_2}{a_1(a_1+a_2)}$
$\Delta V_A = V_A - V_1$
$= \sqrt{\frac{\mu}{a_1}}\left[\sqrt{\frac{2a_2}{a_1+a_2}} - 1\right]$
V_1
$V_A > V_1$
a_1
a_2
A
B
V_B
$V_B < V_2$
V_2
IMPULSO EN B :
$V_2 - V_B$
$= \sqrt{\frac{\mu}{a_2}} - \sqrt{\mu\left(\frac{2}{a_2} - \frac{1}{a_T}\right)}$
IMPULSO TOTAL : $\Delta V_A + \Delta V_B$
$\Delta V = v_e . L \frac{m_0}{m_{FIN}}$

TRANSFERENCIA DE ÓRBITAS



$$a_T = \frac{a_1 + a_2}{2}$$

Impulso en (A): $V_A - V_1$

$$V_1 = \sqrt{\frac{\mu}{a_1}}$$

$$V_A^2 = \mu\left(\frac{2}{a_1} - \frac{1}{a_T}\right)$$

$$= \mu 2\left(\frac{1}{a_1} - \frac{1}{a_1 + a_2}\right)$$

$$= 2\mu\left(\frac{\cancel{a_1} + a_2 - \cancel{a_1}}{a_1(a_1 + a_2)}\right) = \frac{2\mu a_2}{a_1(a_1 + a_2)}$$

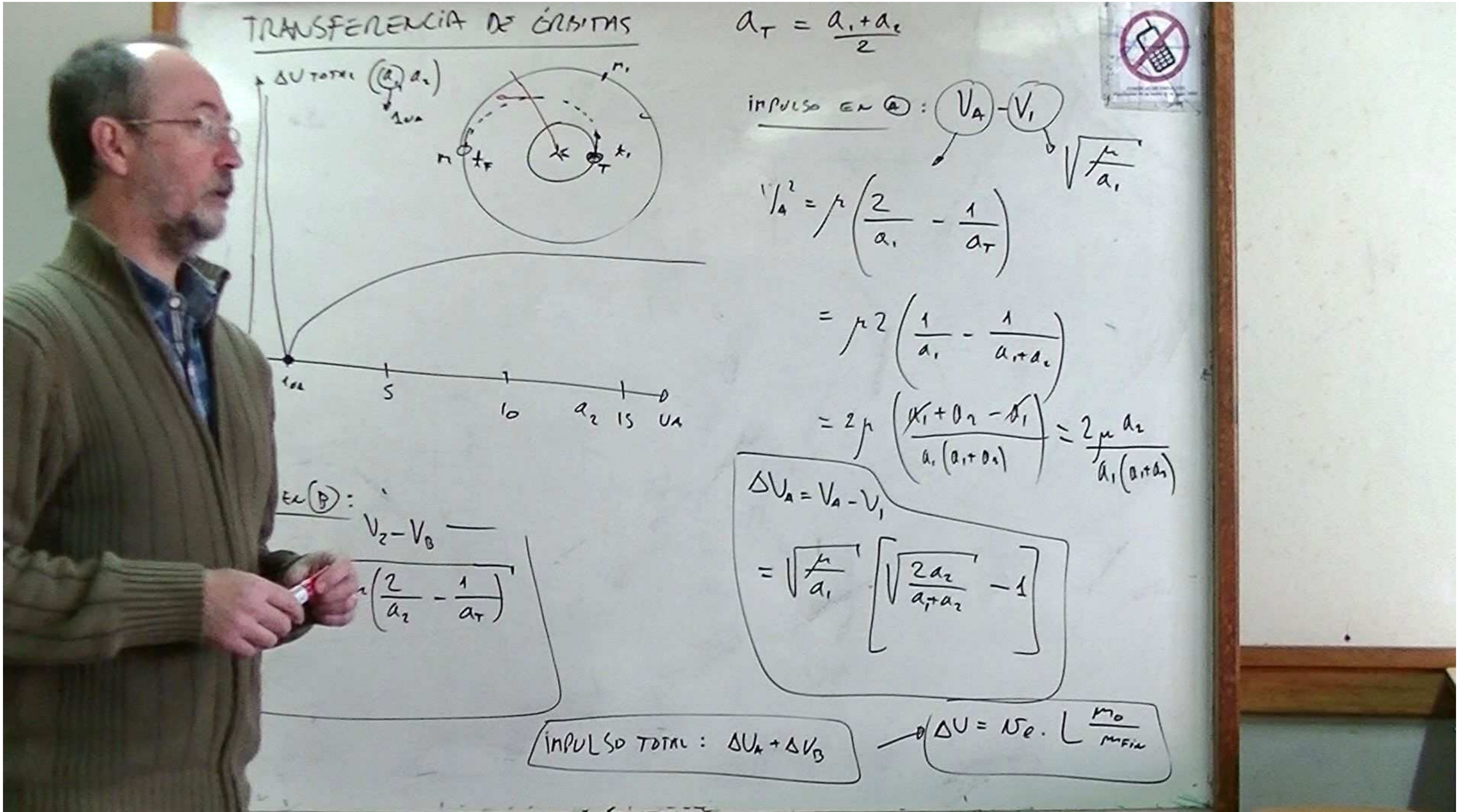
$$\Delta V_A = V_A - V_1$$

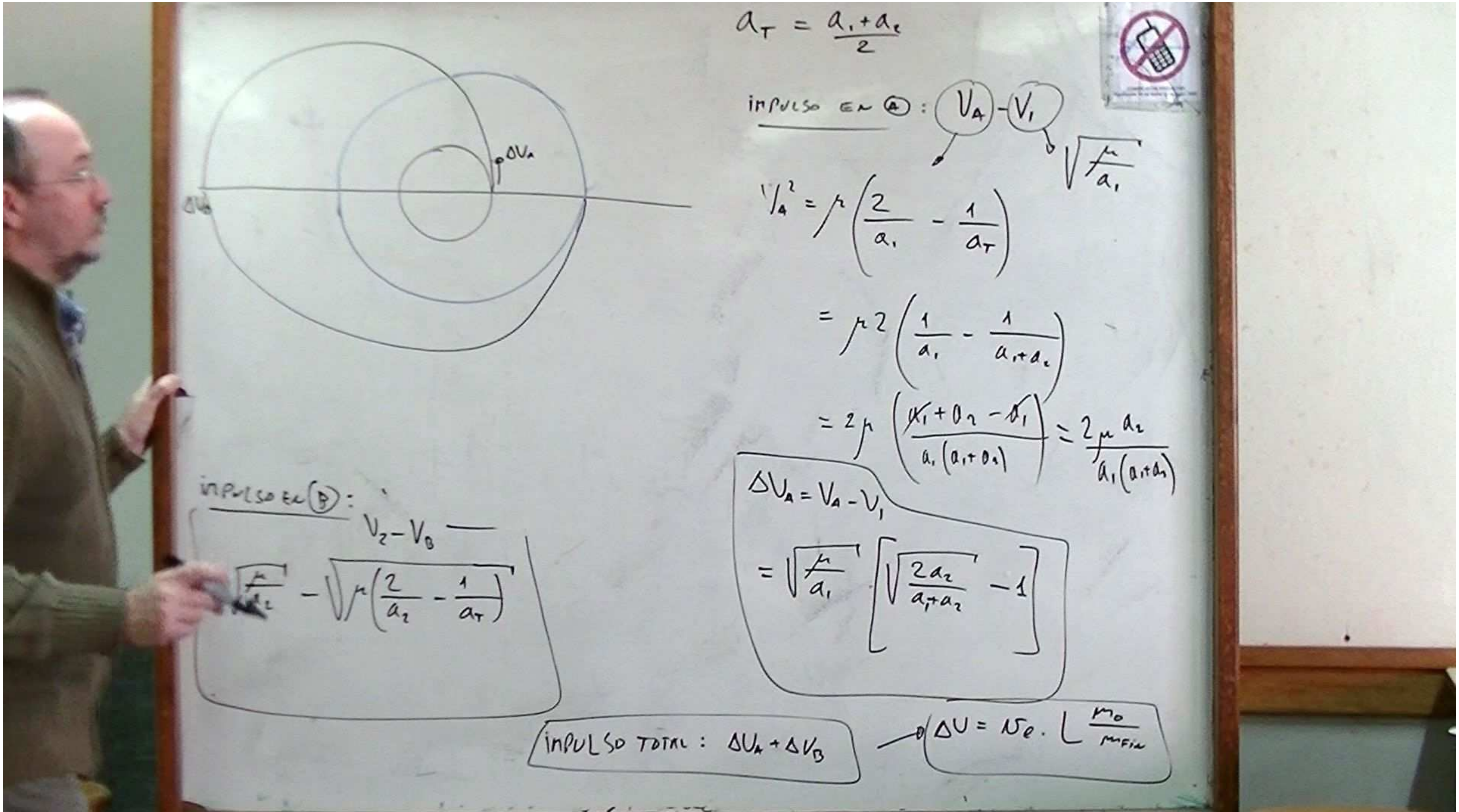
$$= \sqrt{\frac{\mu}{a_1}}\left[\sqrt{\frac{2a_2}{a_1 + a_2}} - 1\right]$$

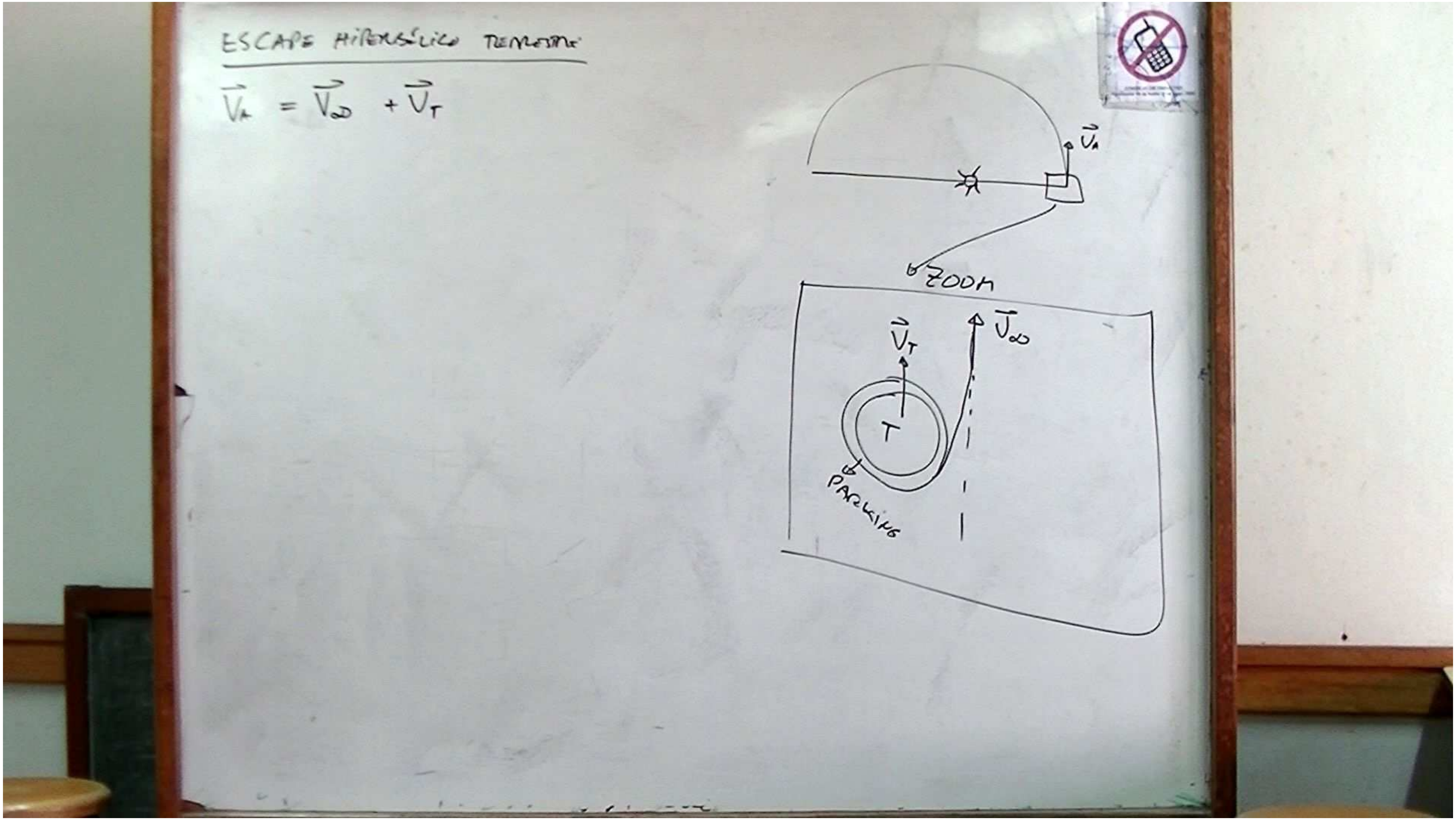
Impulso en (B): $V_2 - V_B$

$$= \sqrt{\frac{\mu}{a_2}} - \sqrt{\mu\left(\frac{2}{a_2} - \frac{1}{a_T}\right)}$$

Impulso total: $\Delta V_A + \Delta V_B$ → $\Delta V = v_e \cdot L \frac{m_0}{m_{fin}}$


TRANSFERENCIA DE ÓRBITAS
$a_T = \frac{a_1 + a_2}{2}$
ΔV TOTAL (a_1, a_2)
1UA
t_F
t_1
T
5
10
a_2
15
UA
IMPULSO EN A : $V_A - V_1$
$\sqrt{\frac{\mu}{a_1}}$
$V_A^2 = \mu\left(\frac{2}{a_1} - \frac{1}{a_T}\right)$
$= \mu 2\left(\frac{1}{a_1} - \frac{1}{a_1+a_2}\right)$
$= 2\mu\left(\frac{\cancel{a_1} + a_2 - \cancel{a_1}}{a_1(a_1+a_2)}\right) = 2\mu\frac{a_2}{a_1(a_1+a_2)}$
$\Delta V_A = V_A - V_1$
$= \sqrt{\frac{\mu}{a_1}}\left[\sqrt{\frac{2a_2}{a_1+a_2}} - 1\right]$
EN B : $V_2 - V_B$
$\left(\frac{2}{a_2} - \frac{1}{a_T}\right)$
IMPULSO TOTAL : $\Delta V_A + \Delta V_B$
$\Delta V = v_e \cdot L \frac{m_0}{m_{FIN}}$


$a_T = \frac{a_1 + a_2}{2}$
IMPULSO EN (A) : $V_A - V_1$
$\sqrt{\frac{\mu}{a_1}}$
$V_A^2 = \mu\left(\frac{2}{a_1} - \frac{1}{a_T}\right)$
$= \mu 2\left(\frac{1}{a_1} - \frac{1}{a_1 + a_2}\right)$
$= 2\mu\left(\frac{\cancel{a_1} + a_2 - \cancel{a_1}}{a_1(a_1 + a_2)}\right) = 2\mu \frac{a_2}{a_1(a_1+a_2)}$
$\Delta V_A = V_A - V_1$
$= \sqrt{\frac{\mu}{a_1}}\left[\sqrt{\frac{2a_2}{a_1+a_2}} - 1\right]$
ΔV_A
ΔV_B
IMPULSO EN (B) :
$V_2 - V_B$
$\sqrt{\frac{\mu}{a_2}} - \sqrt{\mu\left(\frac{2}{a_2} - \frac{1}{a_T}\right)}$
IMPULSO TOTAL : $\Delta V_A + \Delta V_B$
$\Delta V = v_e \cdot L \frac{m_0}{m_{FIN}}$


ESCAPE HIPERBÓLICO TERRESTRE
$\vec{V}_A = \vec{V}_\infty + \vec{V}_T$
$\vec{V}_A$
ZOOM
$\vec{V}_T$
$\vec{V}_\infty$
T
PARKING

ESCAPE HIPERBÓLICO TERRESTRE

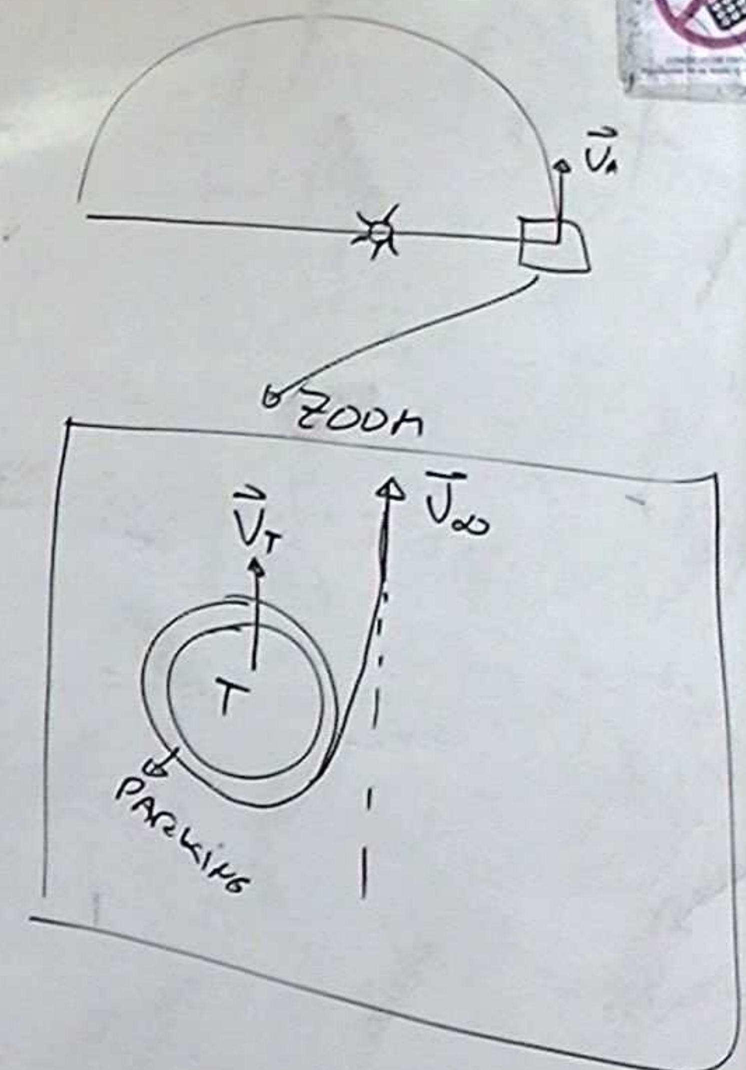
$$\vec{V}_1 = \vec{V}_\infty + \vec{V}_T$$

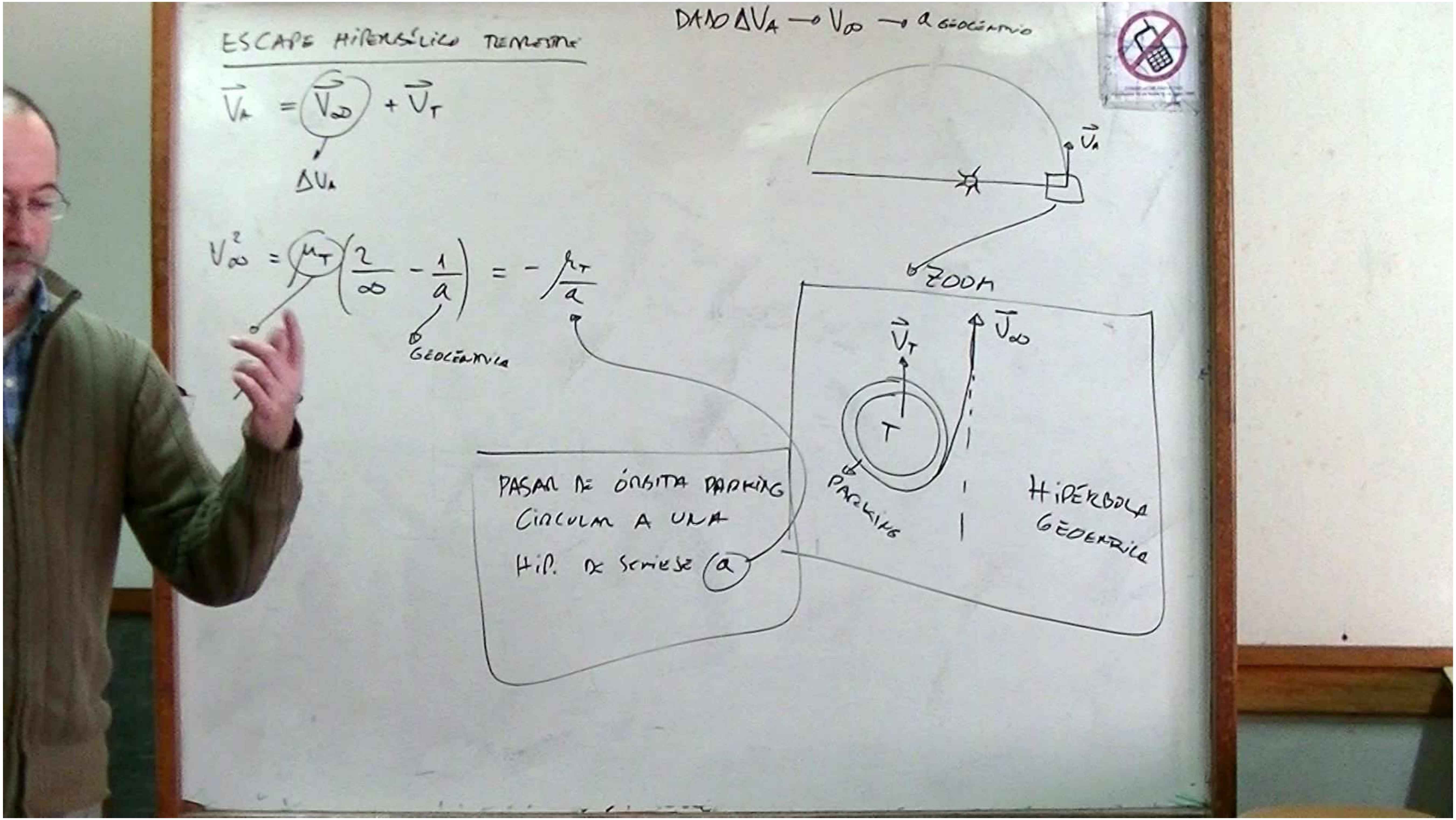
ΔV_1

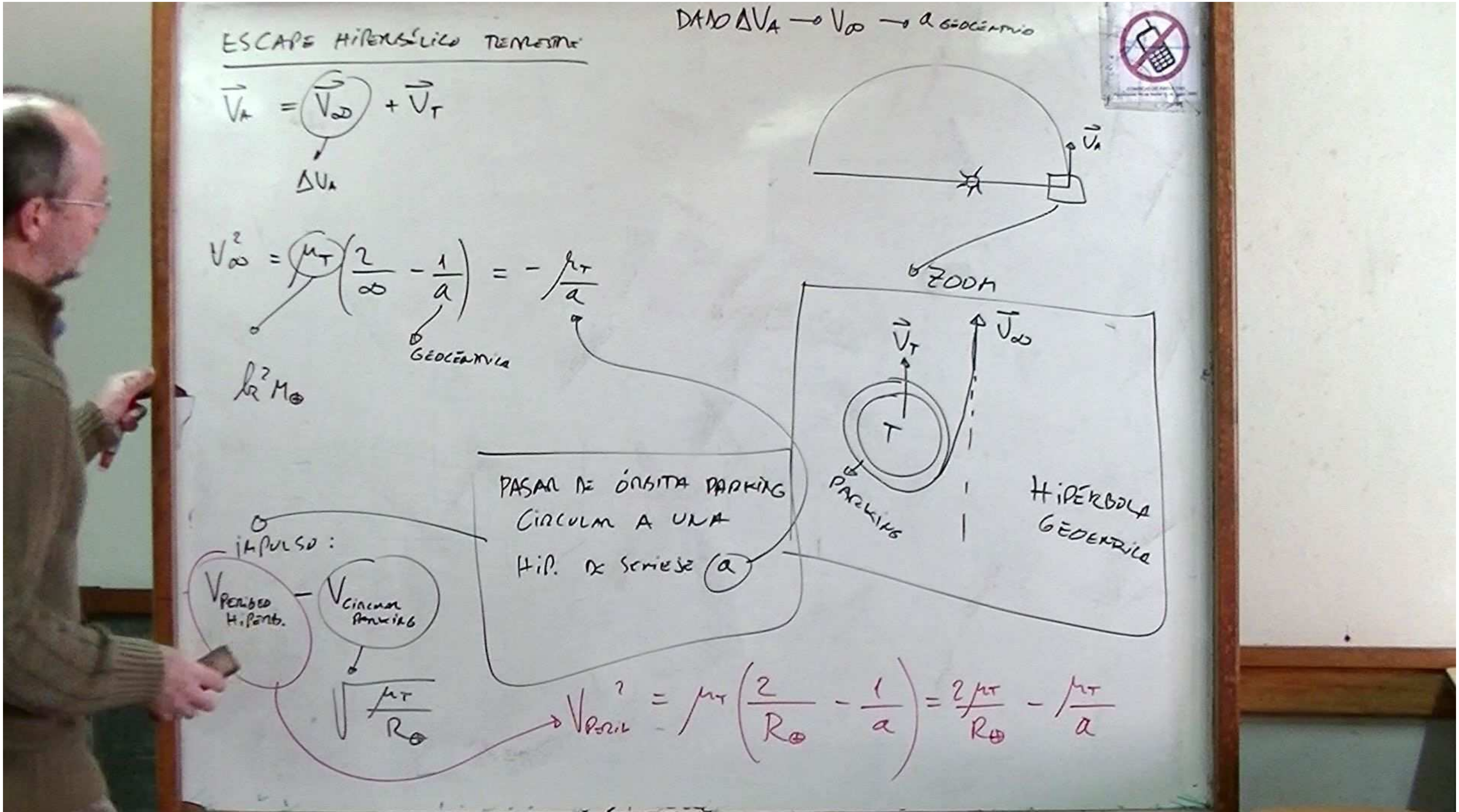
$$V_\infty^2 = \mu_T \left(\frac{2}{\infty} - \frac{1}{a} \right) = -\frac{\mu_T}{a}$$

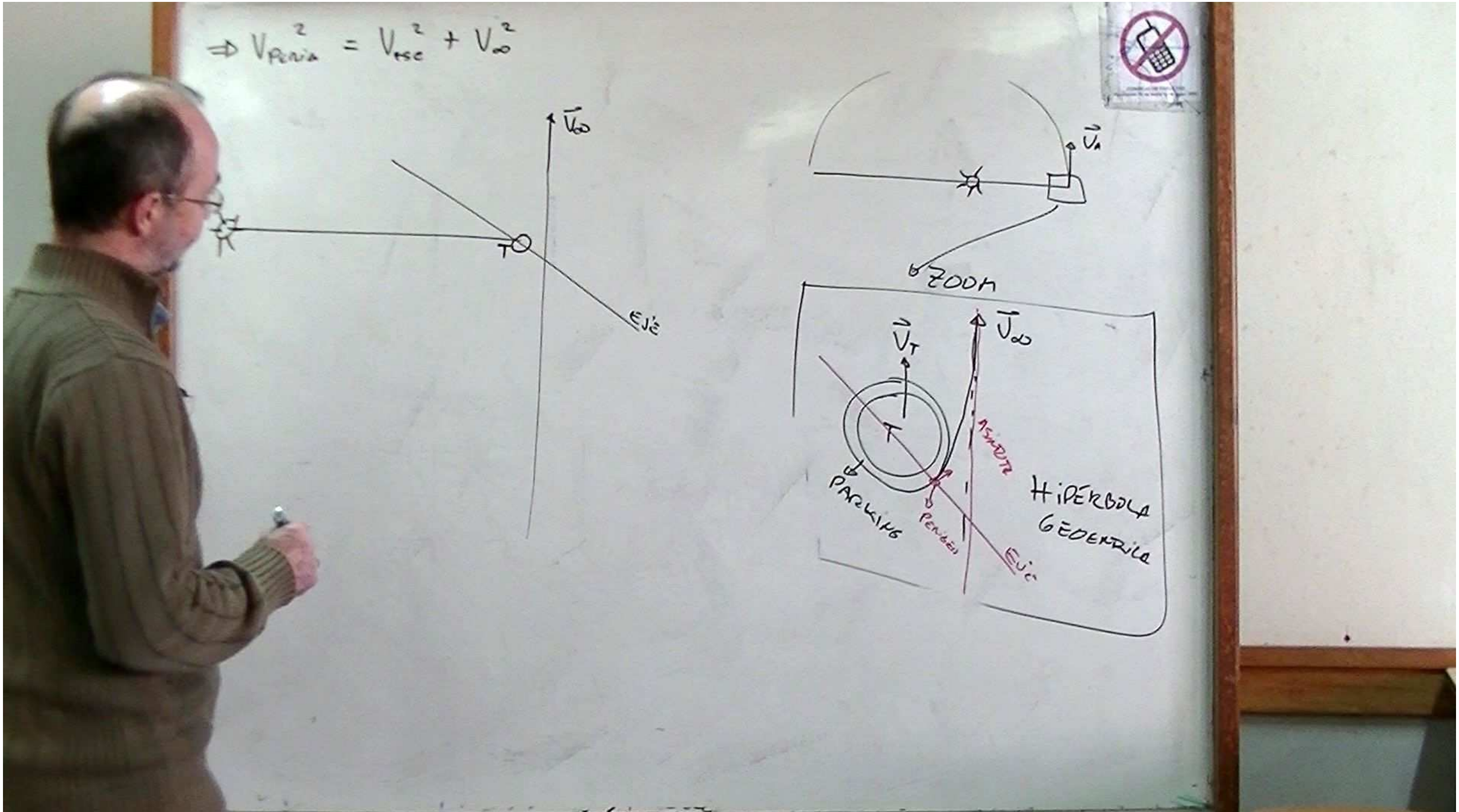
GEOCÉNTRICA

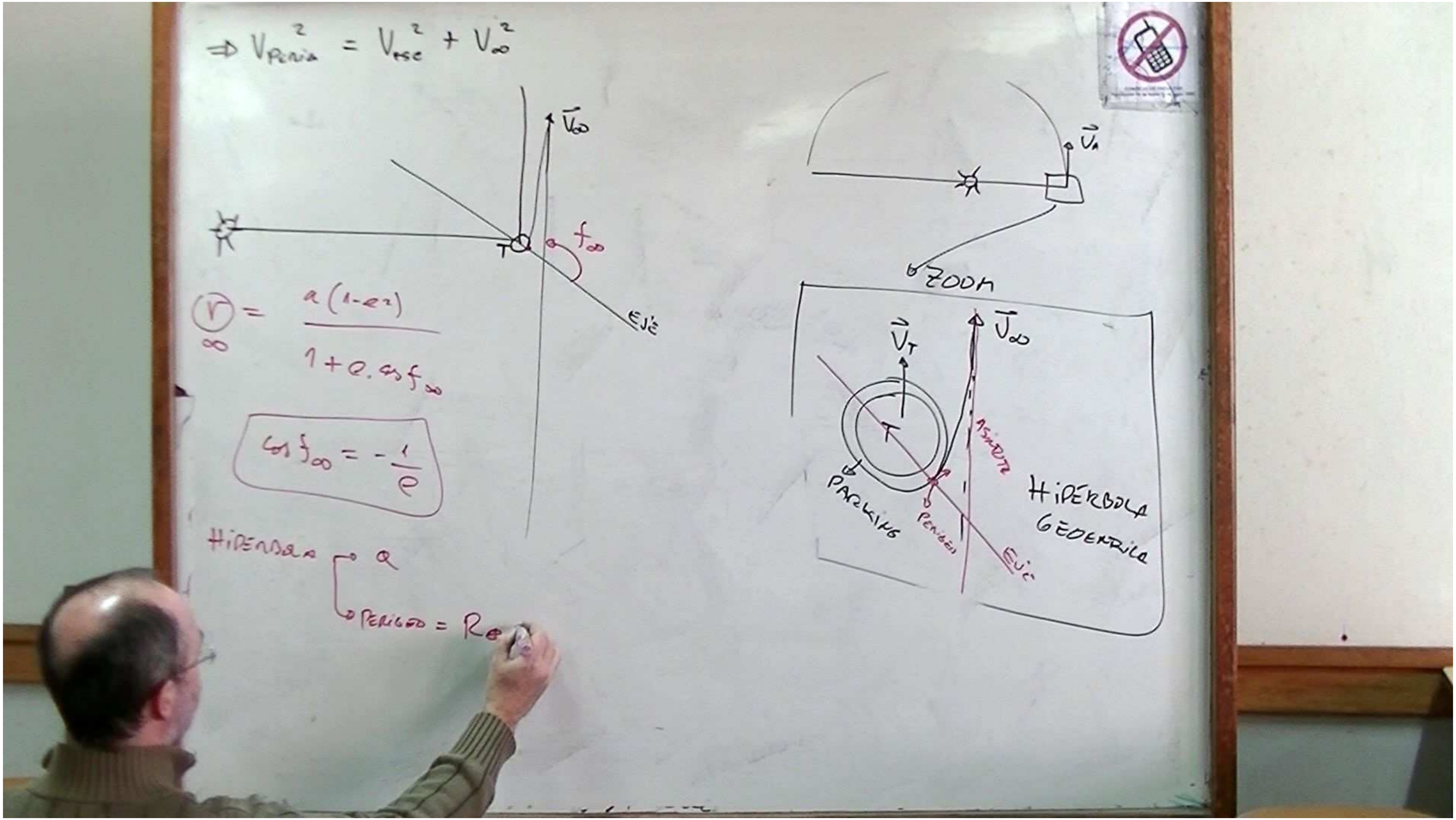
$k^2 M_\oplus$

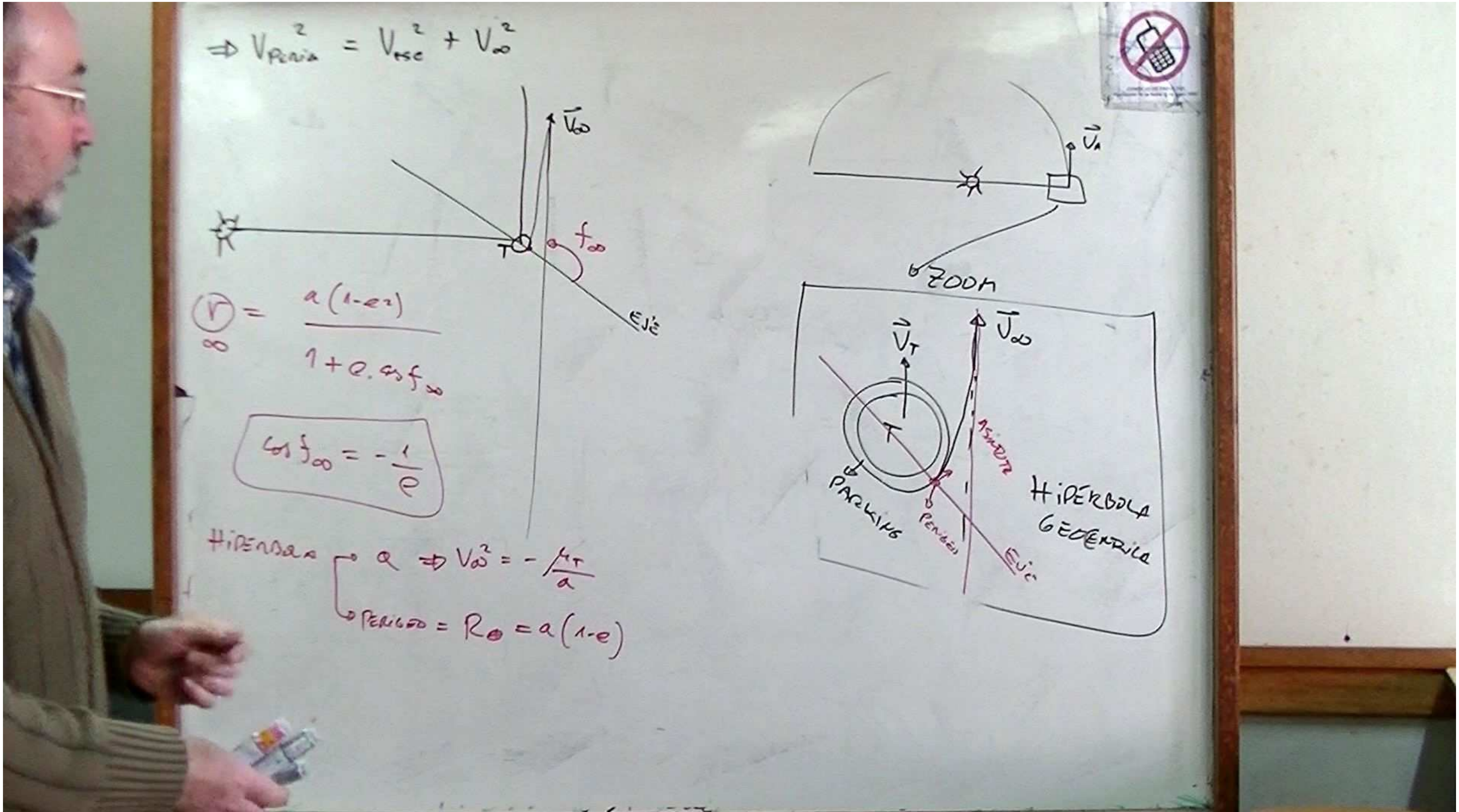


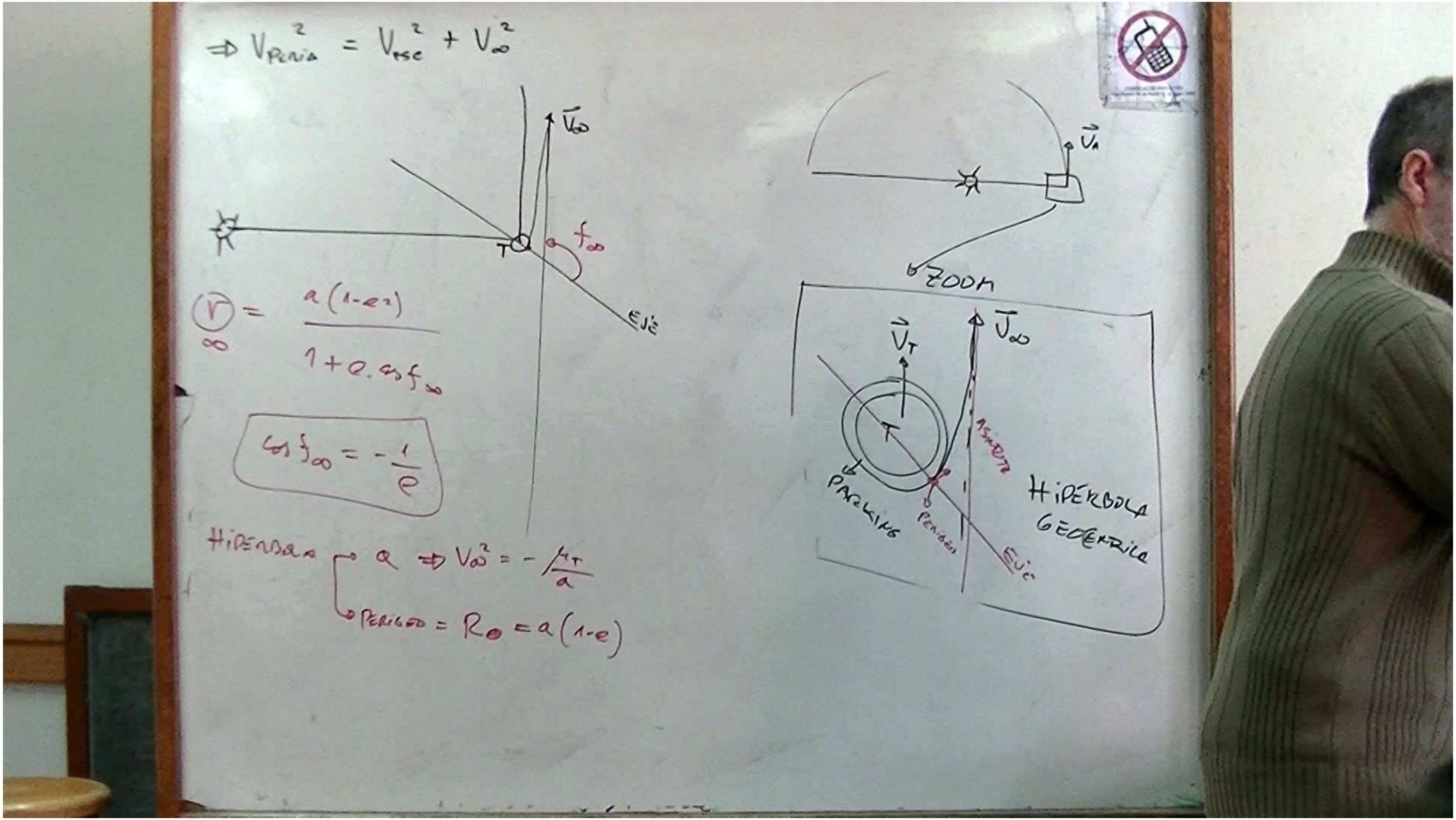

ESCAPE HIPERBÓLICO TERRESTRE
$\vec{V}_A = \vec{V}_\infty + \vec{V}_T$
ΔV_A
$V_\infty^2 = \mu_T \left(\frac{2}{\infty} - \frac{1}{a} \right) = -\frac{\mu_T}{a}$
GEOCÉNTRICA
DADO $\Delta V_A \to V_\infty \to a$ GEOCÉNTRICO
$\vec{V}_A$
ZOOM
$\vec{V}_T$
$\vec{V}_\infty$
T
PARKING
HIPÉRBOLA GEOCÉNTRICA
PASAR DE ÓRBITA PARKING CIRCULAR A UNA HIP. DE SEMIEJE a

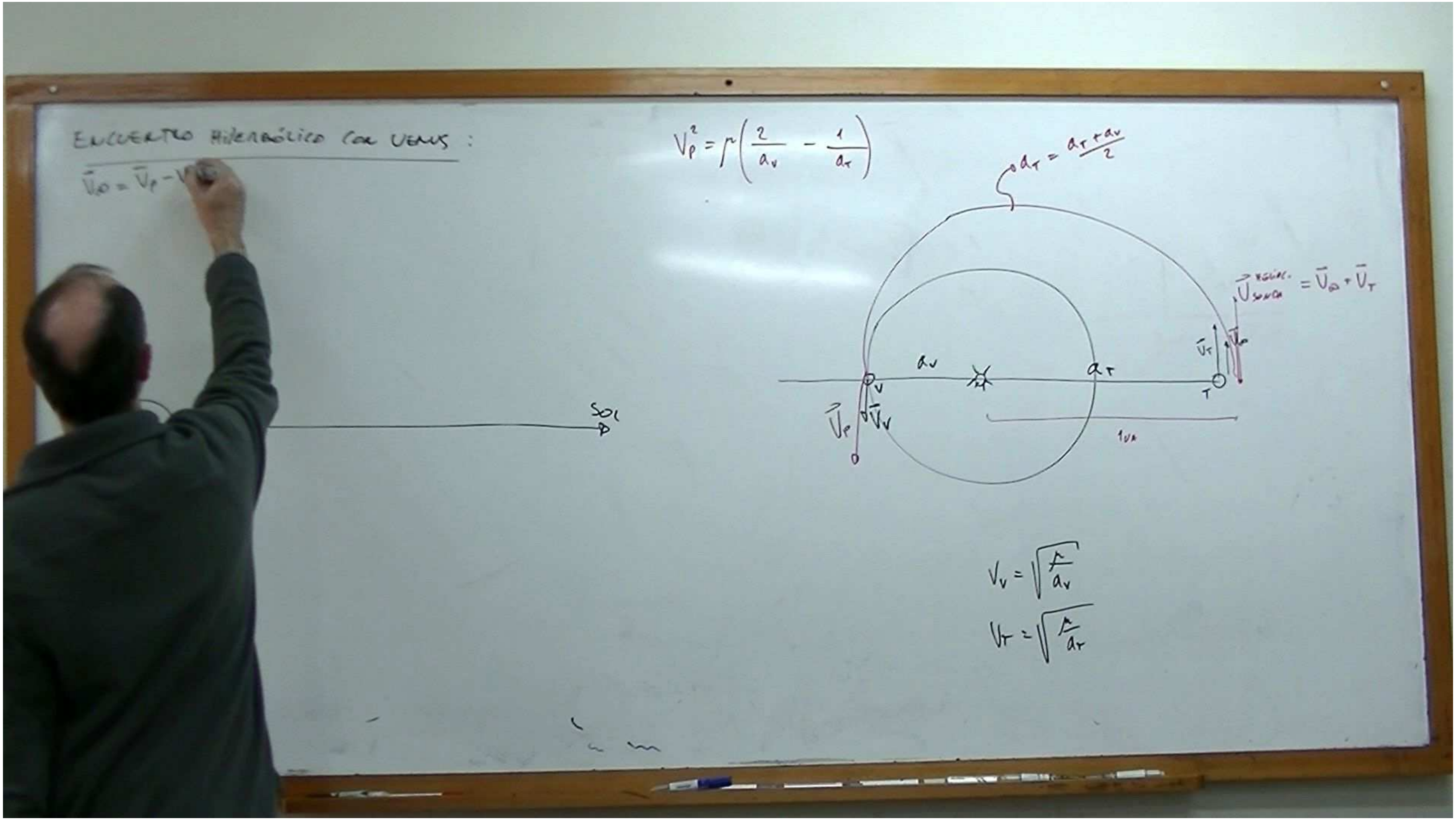

ESCAPE HIPERBÓLICO TERRESTRE
$\vec{V}_A = \vec{V}_\infty + \vec{V}_T$
ΔV_A
$V_\infty^2 = \mu_T\left(\frac{2}{\infty} - \frac{1}{a}\right) = -\frac{\mu_T}{a}$
$k^2 M_\oplus$
GEOCÉNTRICA
DADO $\Delta V_A \to V_\infty \to a$ GEOCÉNTRICO
$\vec{V}_A$
ZOOM
$\vec{V}_T$
$\vec{V}_\infty$
T
PARKING
HIPÉRBOLA GEOCÉNTRICA
PASAR DE ÓRBITA PARKING CIRCULAR A UNA HIP. DE SEMIEJE a
IMPULSO:
$V_{\text{PERIGEO HIPERB.}} - V_{\text{CIRCULAR PARKING}}$
$\sqrt{\frac{\mu_T}{R_\oplus}}$
$V_{\text{PERIG}}^2 = \mu_T\left(\frac{2}{R_\oplus} - \frac{1}{a}\right) = \frac{2\mu_T}{R_\oplus} - \frac{\mu_T}{a}$

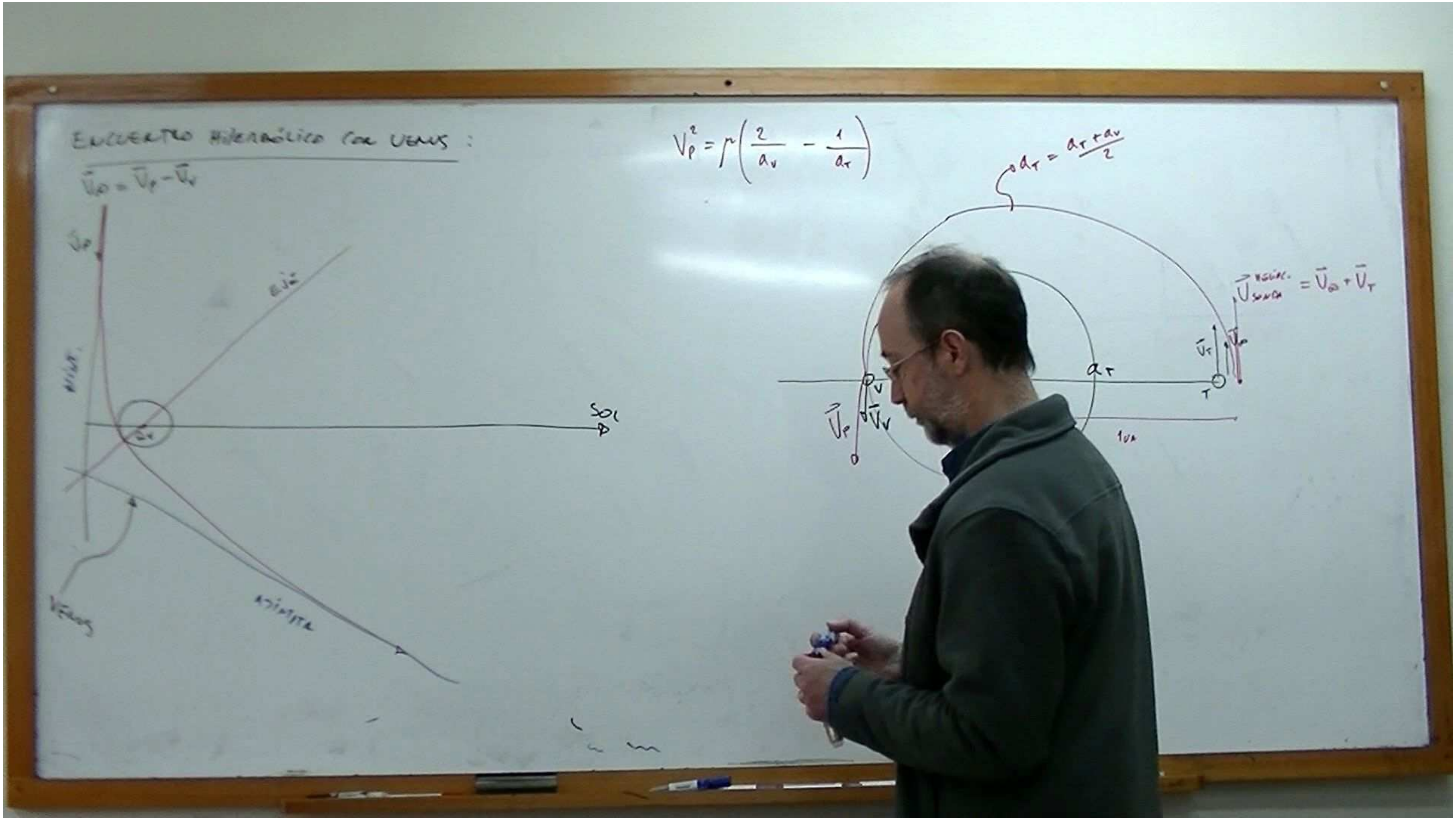

$\Rightarrow V_{Perig}^2 = V_{esc}^2 + V_\infty^2$
$\vec{V}_\infty$
T
Eje
$\vec{V}_A$
ZOOM
$\vec{V}_T$
$\vec{V}_\infty$
T
Parking
Perigeo
Asintota
Hiperbola
Geocentrica
Eje

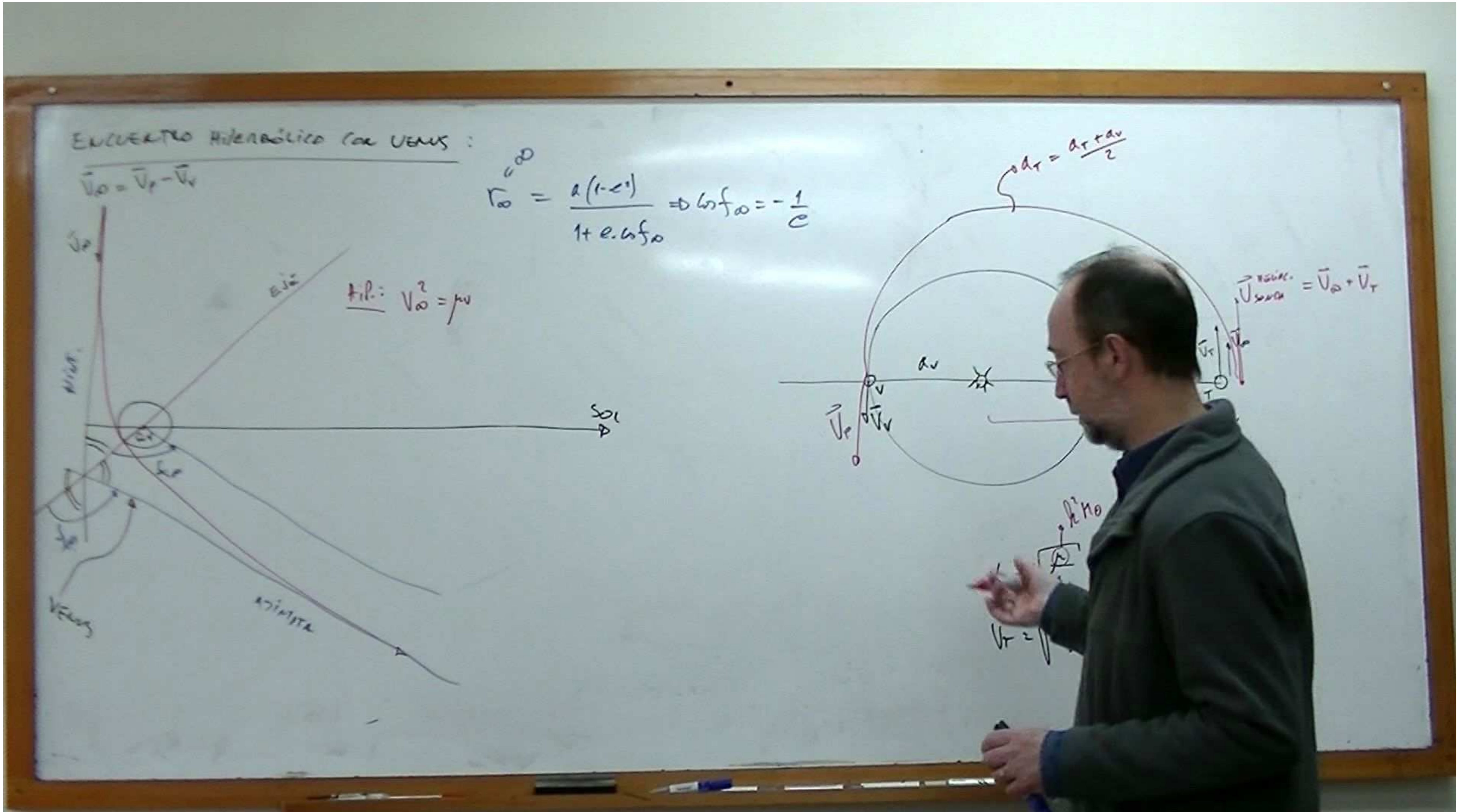

⇒ $V_{Peria}^2 = V_{esc}^2 + V_\infty^2$
$\vec{V}_\infty$
T
f_∞
EJE
$r_\infty = \frac{a(1-e^2)}{1+e.\cos f_\infty}$
$\cos f_\infty = -\frac{1}{e}$
HIPERBOLA
a
PERIGEO = R⊕
$\vec{V}_A$
ZOOM
$\vec{V}_T$
$\vec{V}_\infty$
ASINTOTA
PARKING
PERIGEO
EJE
HIPERBOLA GEOCENTRICA

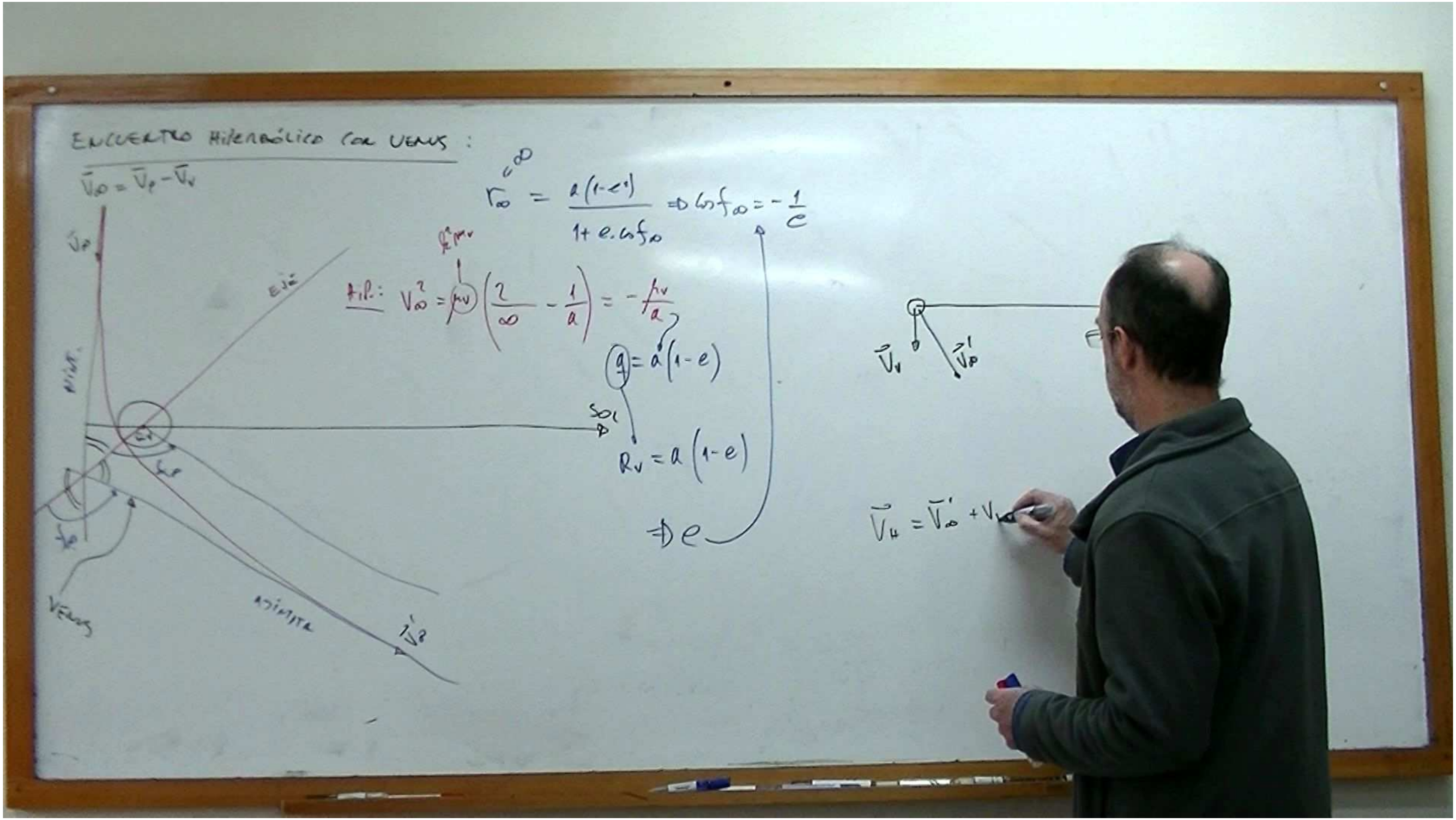

⇒ V²perig = V²esc + V²∞
V∞
T
f∞
EJE
r∞ = a(1-e²) / (1 + e.cos f∞)
cos f∞ = -1/e
HIPERBOLA
a ⇒ V∞² = -μT/a
PERIGEO = R⊕ = a(1-e)
Va
ZOOM
VT
V∞
T
ASINTOTA
PARKING
PERIGEO
EJE
HIPERBOLA
GEOCENTRICA

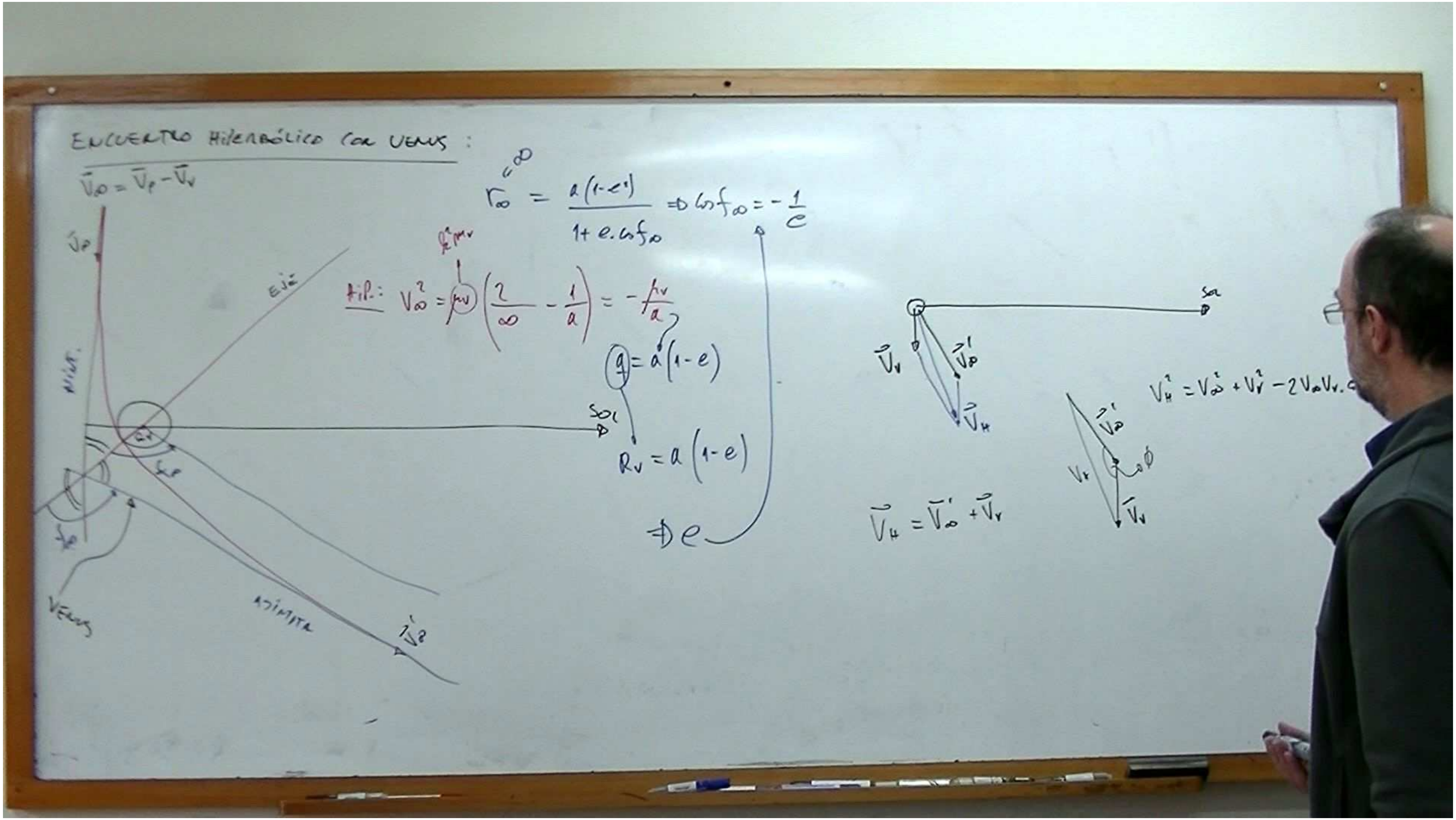

⇒ V_perig² = V_esc² + V_∞²
V∞
T
f∞
EJE
r∞ = a(1-e²) / (1+e.cos f∞)
cos f∞ = -1/e
HIPERBOLA → a ⇒ V∞² = -μT/a
→ PERIGEO = R⊕ = a(1-e)
VA
ZOOM
VT
V∞
ASINTOTA
PARKING
PERIGEO
EJE
HIPERBOLA GEOCENTRICA

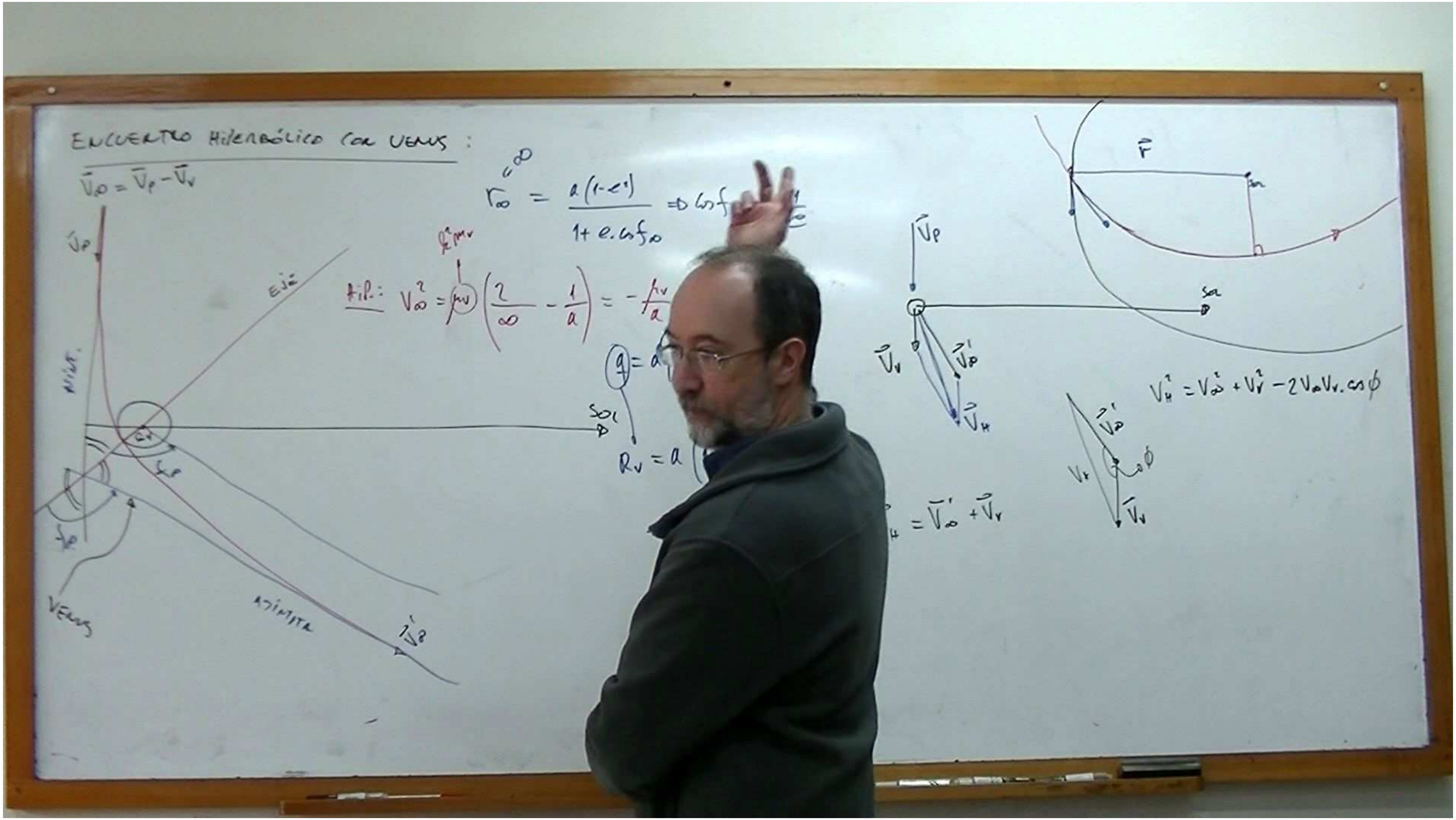

ENCUENTRO HIPERBÓLICO CON VENUS :
SOL
$V_p^2 = \mu\left(\frac{2}{a_V} - \frac{1}{a_T}\right)$
a_V
a_T
V
T
1UA
$V_V = \sqrt{\frac{\mu}{a_V}}$
$V_T = \sqrt{\frac{\mu}{a_T}}$

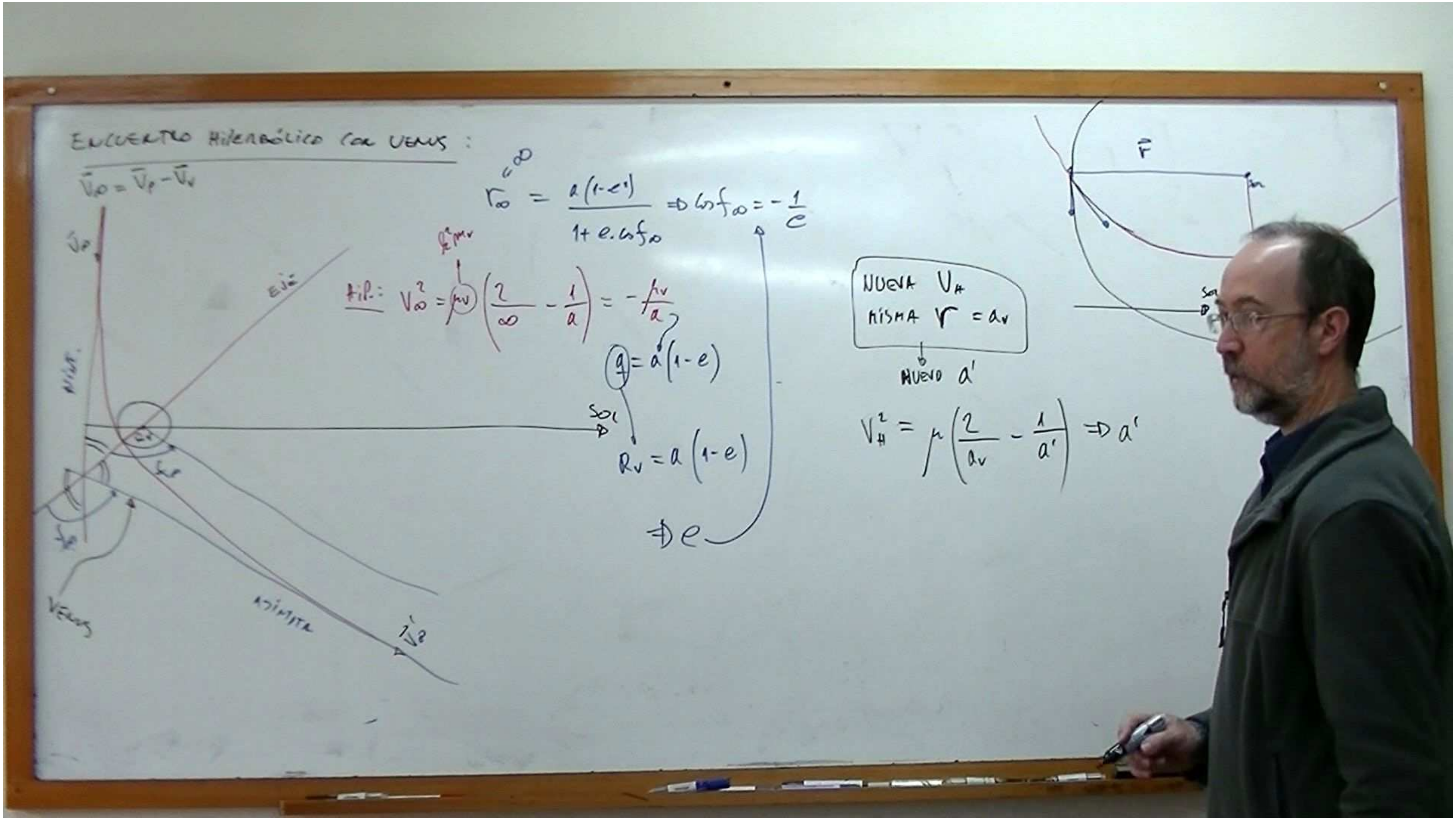

ENCUENTRO HIPERBÓLICO CON VENUS :
$\vec{V}_\infty = \vec{V}_p - \vec{V}_V$
$V_p^2 = \mu\left(\frac{2}{a_V} - \frac{1}{a_T}\right)$
$a_T = \frac{a_T + a_V}{2}$
$\vec{V}_{sonda} = \vec{V}_\infty + \vec{V}_T$
SOL
ASÍNTOTA
VENUS
1UA

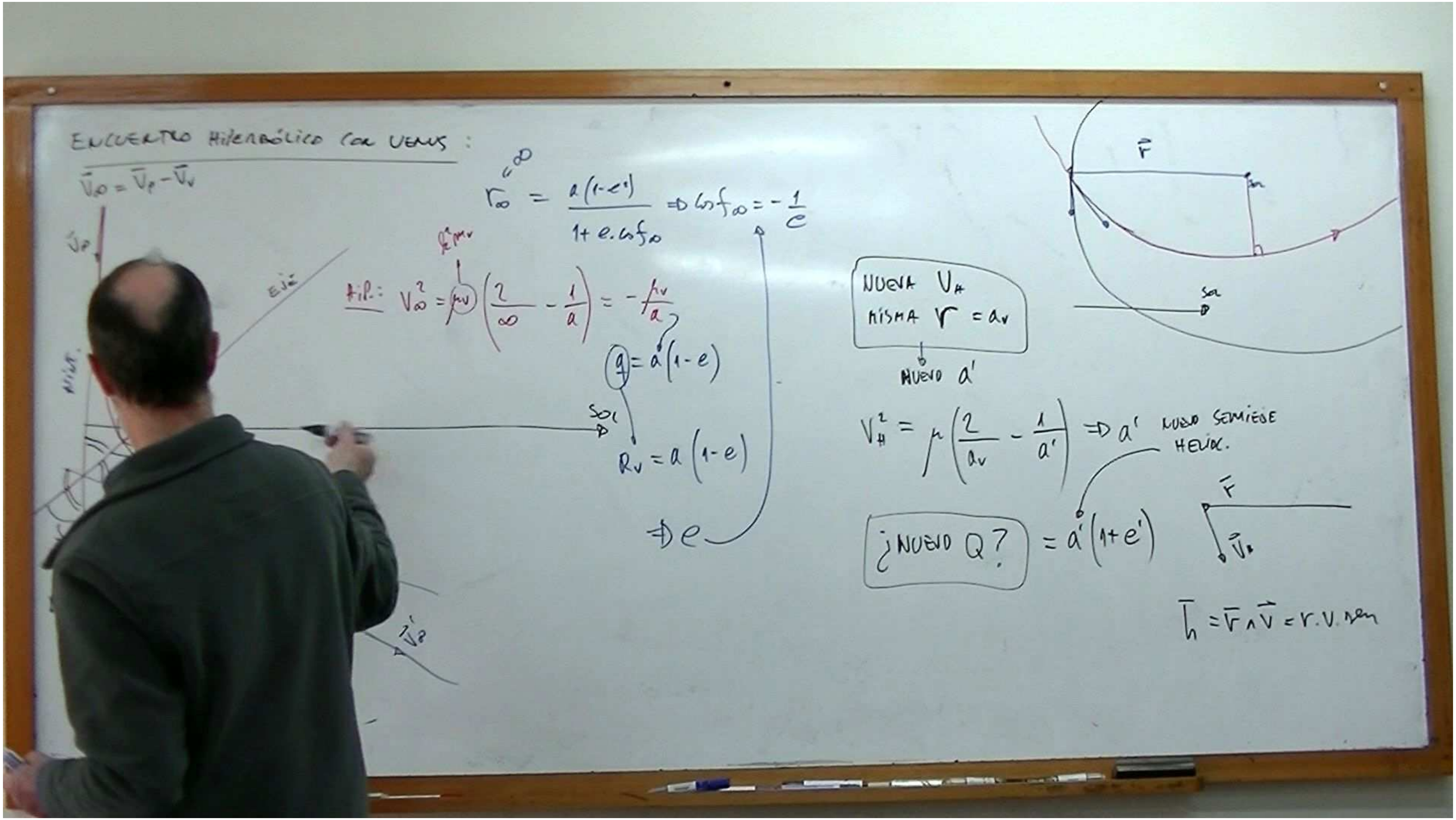

ENCUENTRO HIPERBÓLICO CON VENUS :
Sol
Venus
Asíntota
Eje

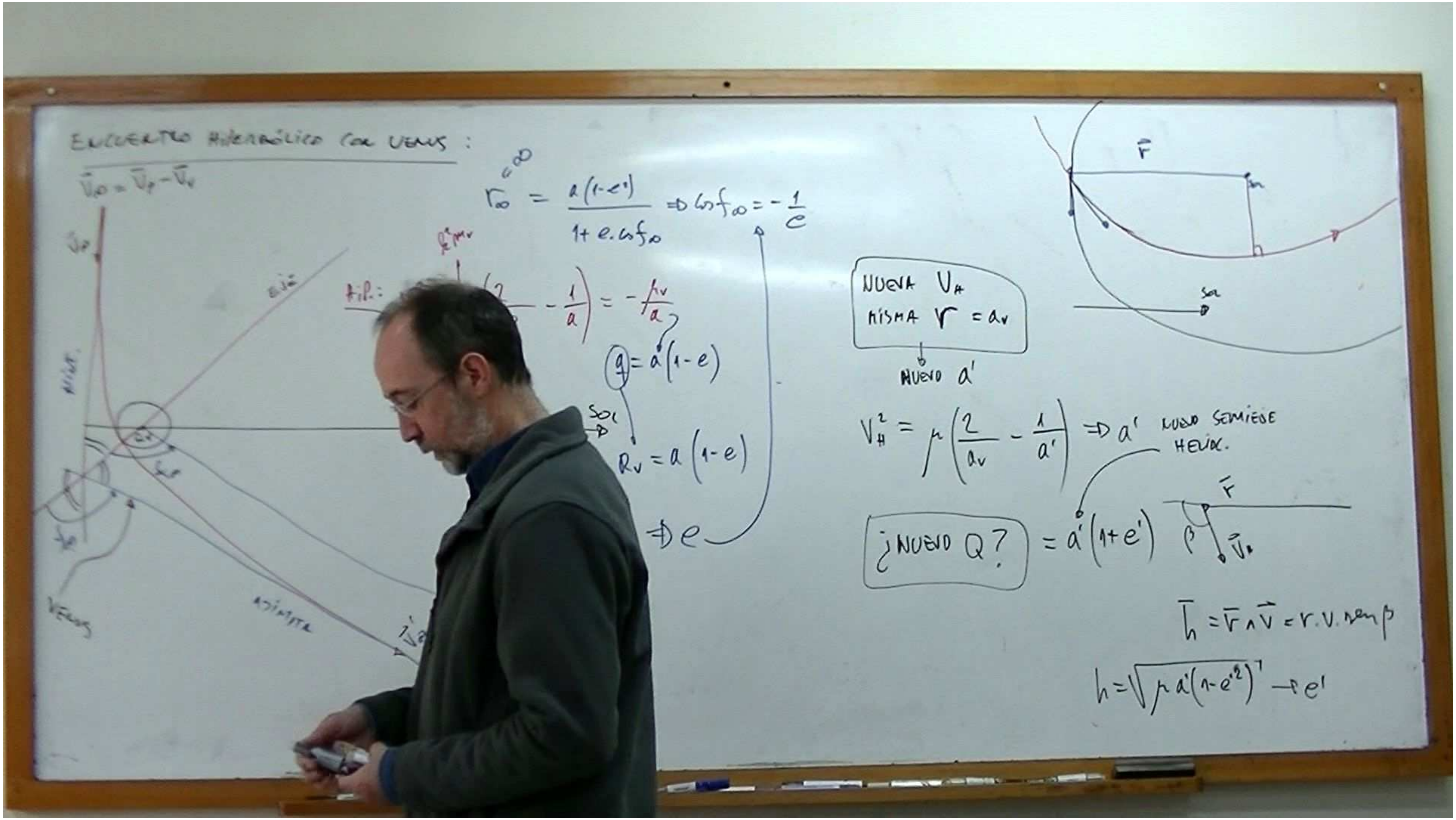

ENCUENTRO HIPERBÓLICO CON VENUS :
$\vec{V}_\infty = \vec{V}_p - \vec{V}_v$
$r_\infty = \frac{a(1-e^2)}{1+e \cos f_\infty} \Rightarrow \cos f_\infty = -\frac{1}{e}$
Hip.: $V_\infty^2 = \mu_v \left(\frac{2}{\infty} - \frac{1}{a} \right) = -\frac{\mu_v}{a}$
$q = a(1-e)$
$R_v = a(1-e)$
$\Rightarrow e$
SOL
EJE
ASÍNTOTA
VENUS
$\vec{V}_H = \vec{V}'_\infty + V_v$

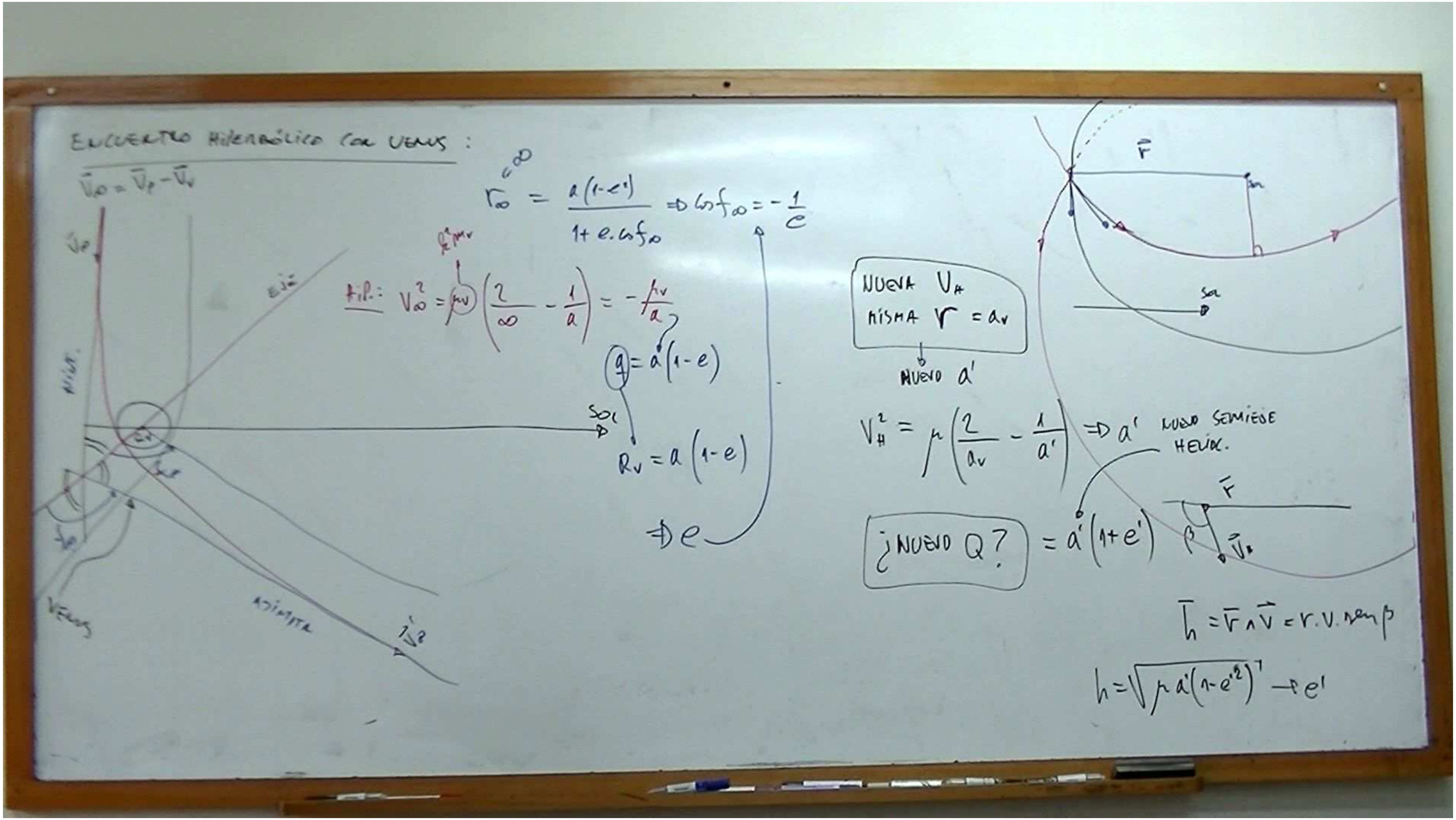

ENCUENTRO HIPERBÓLICO CON VENUS :
$\vec{V}_\infty = \vec{V}_p - \vec{V}_v$
$r_\infty = \frac{a(1-e^2)}{1+e\cos f_\infty} \Rightarrow \cos f_\infty = -\frac{1}{e}$
Hip.: $V_\infty^2 = \mu_v\left(\frac{2}{\infty} - \frac{1}{a}\right) = -\frac{\mu_v}{a}$
$q = a(1-e)$
$R_v = a(1-e)$
$\Rightarrow e$
EJE
Sol
ASÍNTOTA
VENUS
$\vec{V}_H = \vec{V}_\infty' + \vec{V}_v$
$V_H^2 = V_\infty^2 + V_v^2 - 2V_\infty V_v$

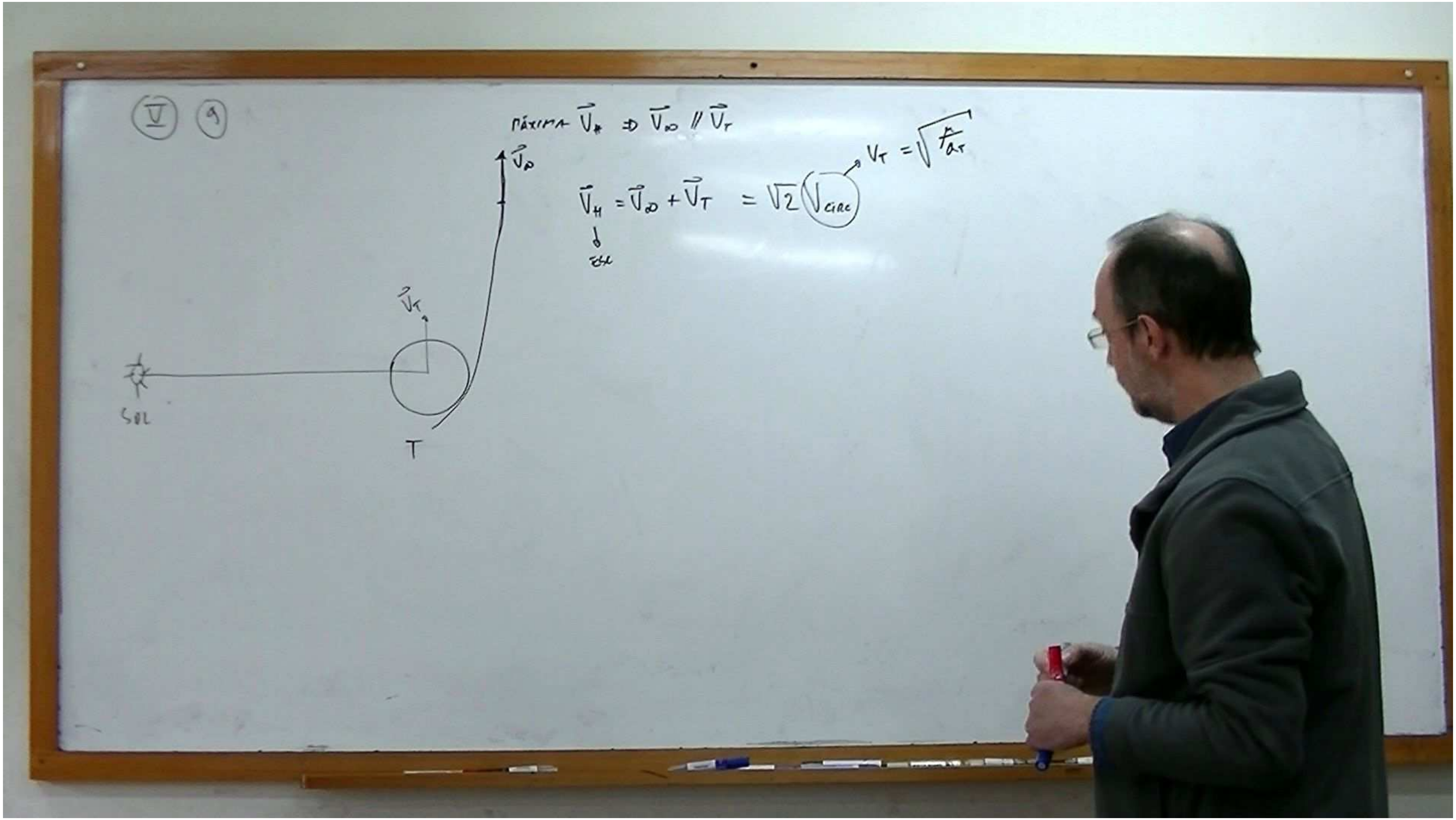

ENCUENTRO HIPERBÓLICO CON VENUS :
V∞ = Vp − Vv
EJE
SOL
VENUS
ASÍNTOTA
Hip.: V∞² = μv (2/∞ − 1/a) = −μv/a
Vp
Vv
Vp'
VH
V∞'
Sol
F
VH² = V∞² + Vv² − 2V∞Vv.cos φ
VH = V∞' + Vv

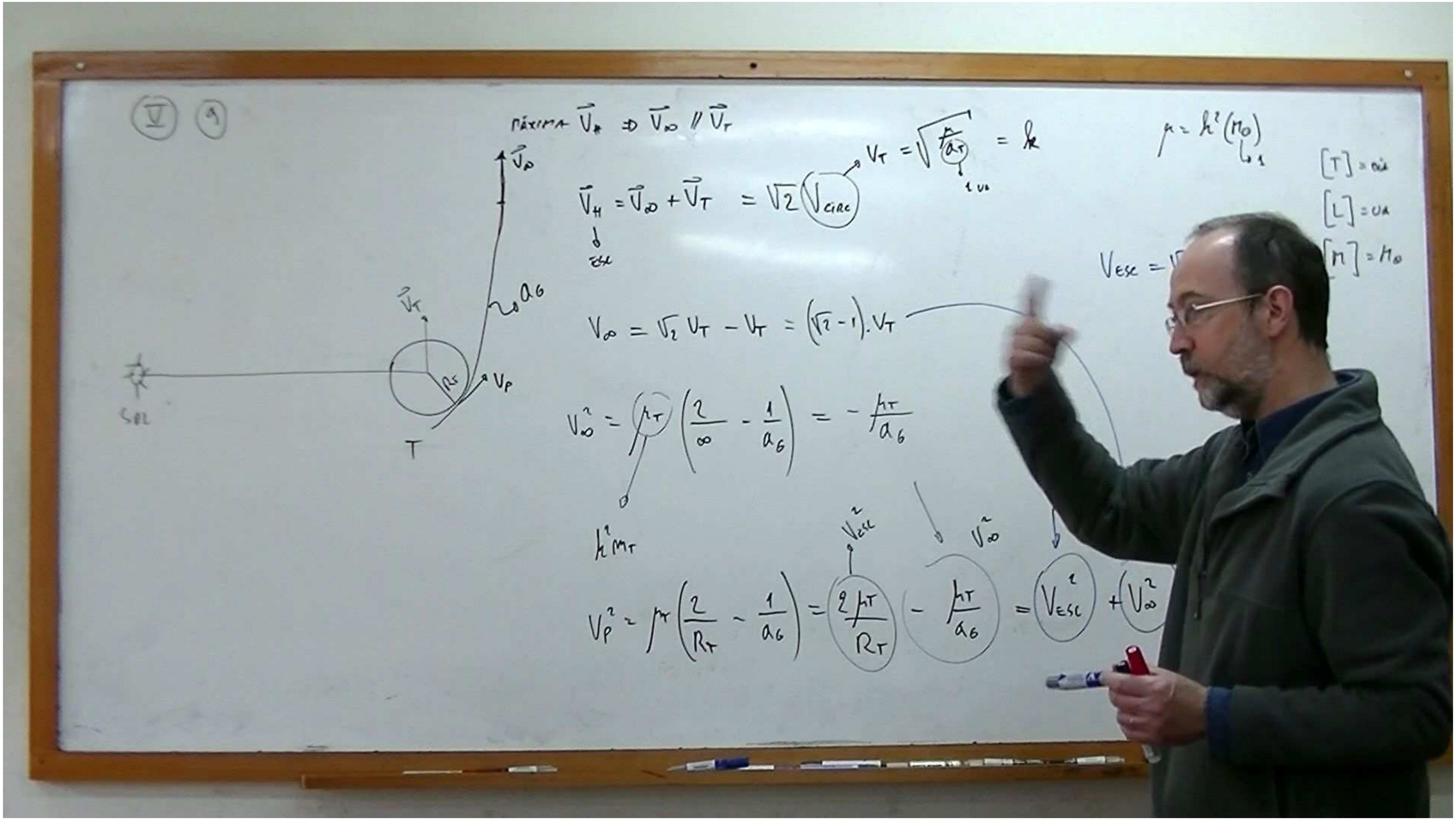

ENCUENTRO HIPERBÓLICO CON VENUS :
EJE
SOL
VENUS
NUEVA V_H
MISMA r = a_V
NUEVO a'
=> a'
=> e


ENCUENTRO HIPERBÓLICO CON VENUS :
V∞ = Vp − Vv
EJE
HIP.: V∞² = μv (2/∞ − 1/a) = −μv/a
q = a(1 − e)
SOL
Rv = a(1 − e)
⇒ e
r∞ = a(1 − e²)/(1 + e.cos f∞) ⇒ cos f∞ = −1/e
NUEVA VH
MISMA r = av
NUEVO a'
VH² = μ(2/av − 1/a') ⇒ a' NUEVO SEMIEJE HELIOC.
¿NUEVO Q? = a'(1 + e')
F
SOL
h = r ∧ v = r.v.sen

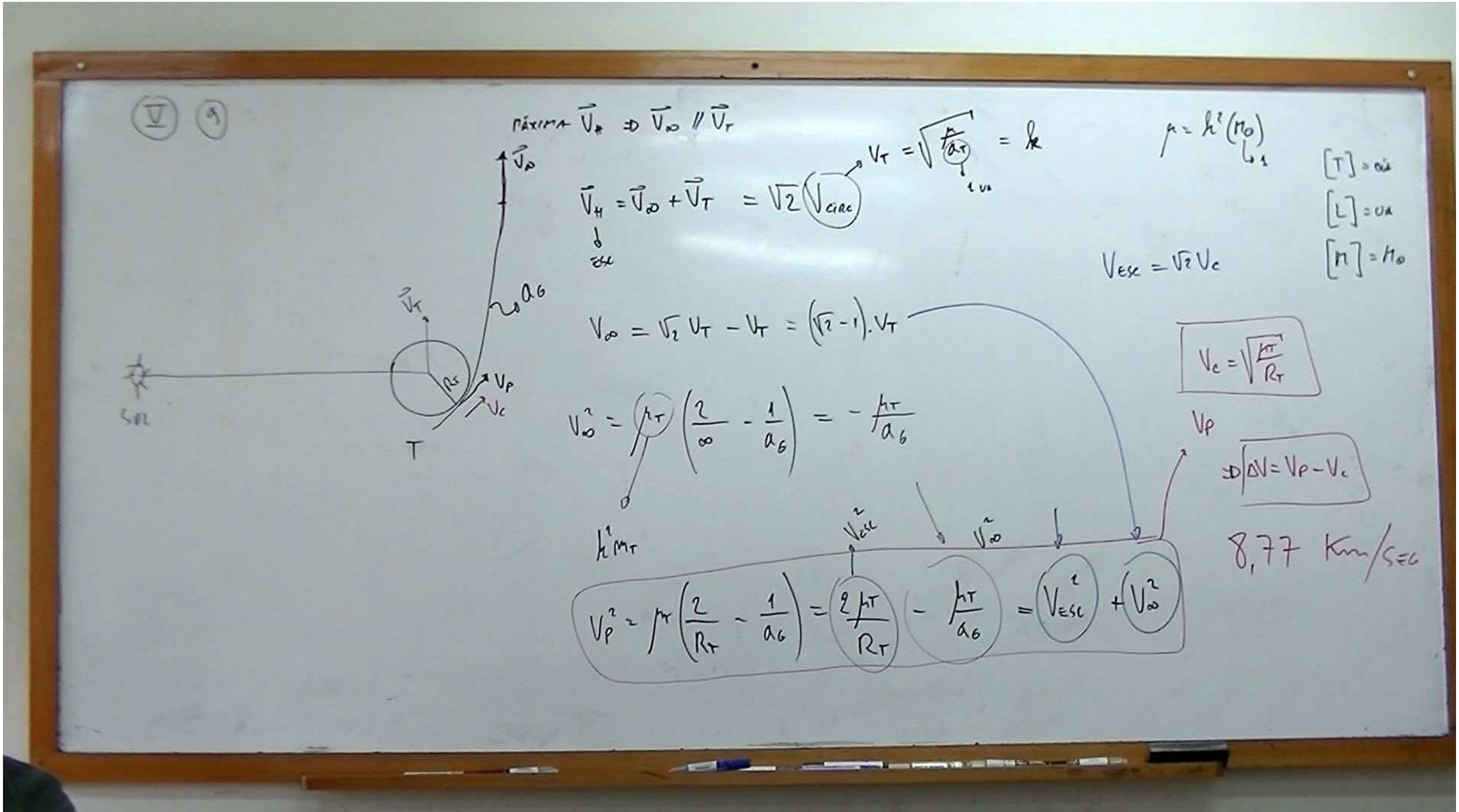

ENCUENTRO HIPERBÓLICO CON VENUS :
NUEVA V_H
MISMA r = a_V
NUEVO a'
NUEVO SEMIEJE HELIOC.
¿NUEVO Q?
= a'(1+e')
Sol
EJE
ASÍNTOTA
VENUS
Q = a(1-e)
R_V = a(1-e)
cos f_∞ = -1/e
h = r ∧ v = r.v.sen β
h = √(μ a'(1-e'^2)) → e'

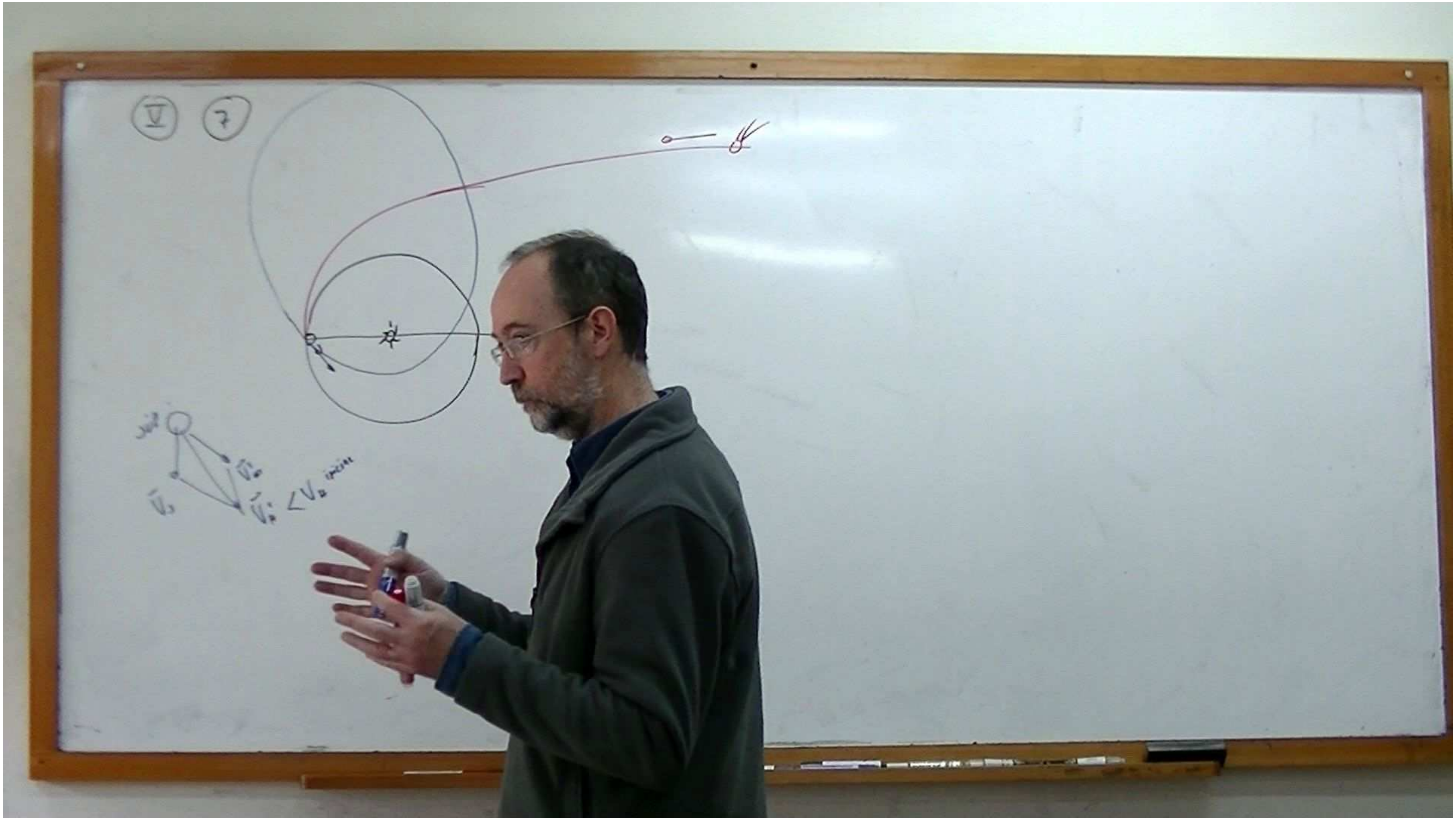

ENCUENTRO HIPERBÓLICO CON VENUS :
$\vec{V}_\infty = \vec{V}_P - \vec{V}_V$
$r_\infty = \dfrac{a(1-e^2)}{1+e\cos f_\infty} \Rightarrow \cos f_\infty = -\dfrac{1}{e}$
HIP.: $V_\infty^2 = \mu_V \left(\dfrac{2}{\infty} - \dfrac{1}{a}\right) = -\dfrac{\mu_V}{a}$
$q = a(1-e)$
$R_V = a(1-e)$
$\Rightarrow e$
SOL
EJE
ASÍNTOTA
VENUS
NUEVA V_H
MISMA $r = a_V$
NUEVO a'
$V_H^2 = \mu\left(\dfrac{2}{a_V} - \dfrac{1}{a'}\right) \Rightarrow a'$ NUEVO SEMIEJE HELIOC.
¿NUEVO Q? $= a'(1+e')$
$\vec{F}$
β
$\vec{h} = \vec{r} \wedge \vec{V} = r.V.\mathrm{sen}\,\beta$
$h = \sqrt{\mu a'(1-e'^2)} \rightarrow e'$

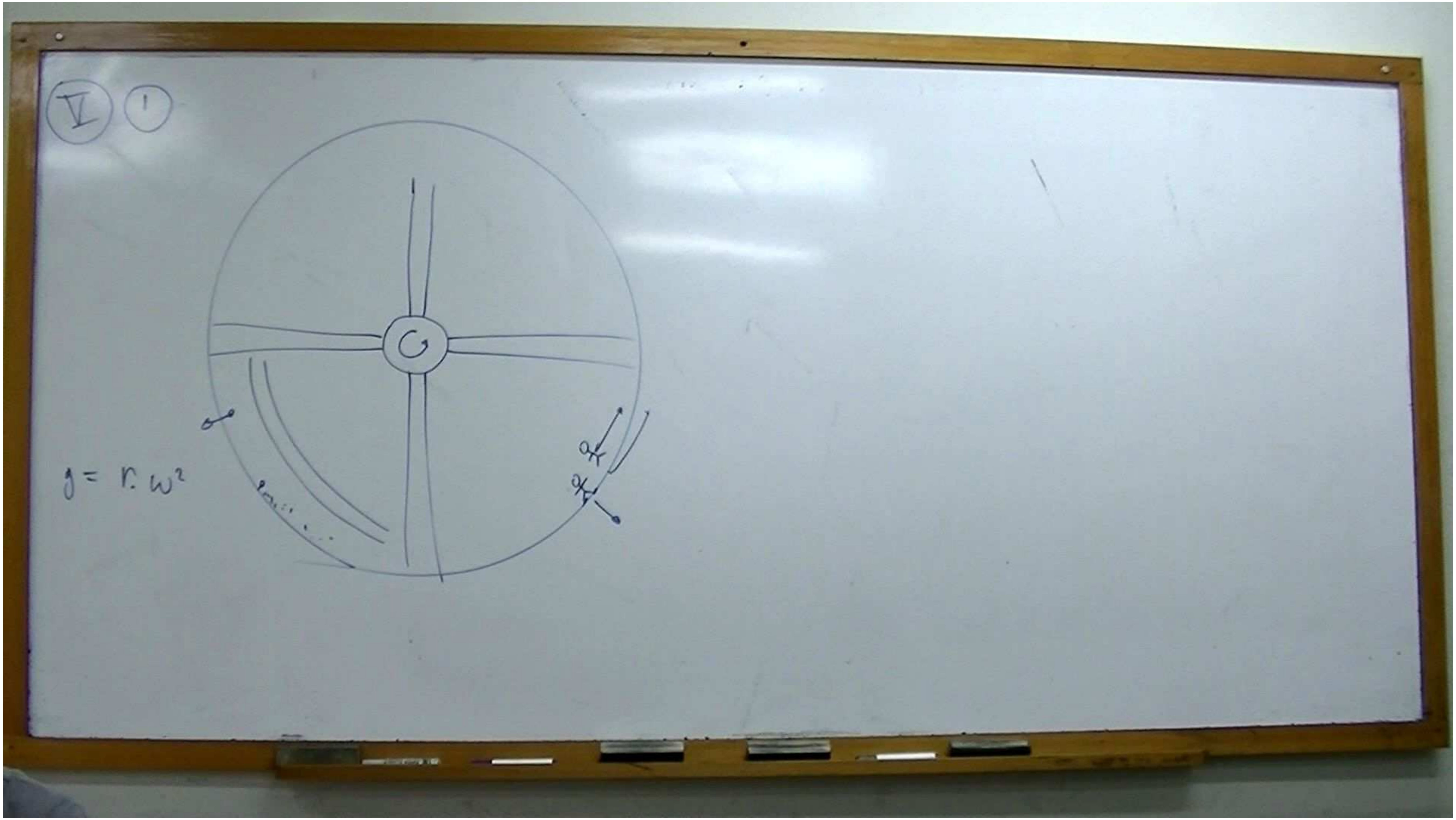

V
9
MÁXIMA $\vec{V}_H \Rightarrow \vec{V}_\infty \parallel \vec{V}_T$
$\vec{V}_\infty$
$V_T = \sqrt{\mu / a_T}$
$\vec{V}_H = \vec{V}_\infty + \vec{V}_T = \sqrt{2}\, V_{circ}$
ESC
$\vec{V}_T$
SOL
T

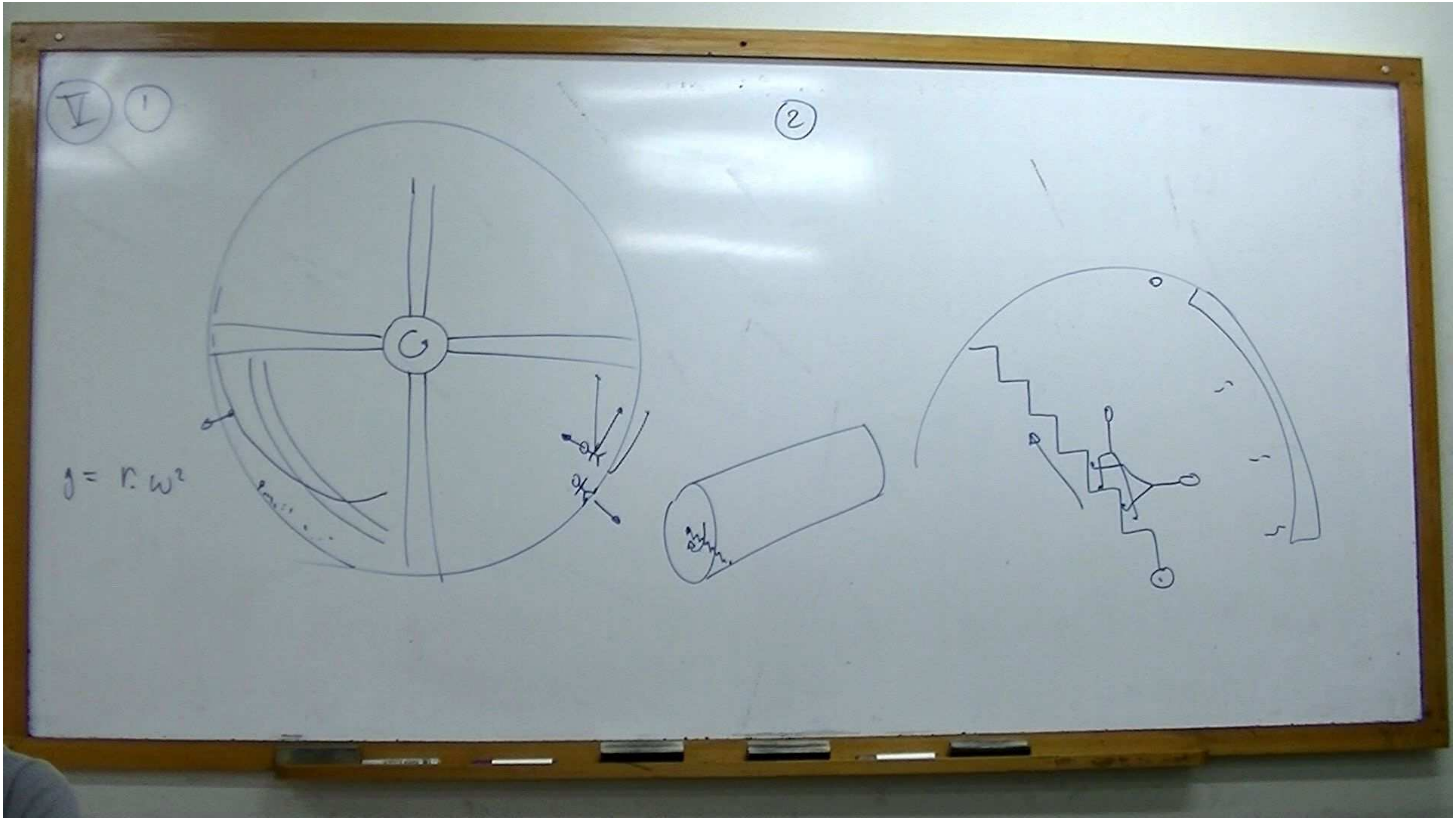


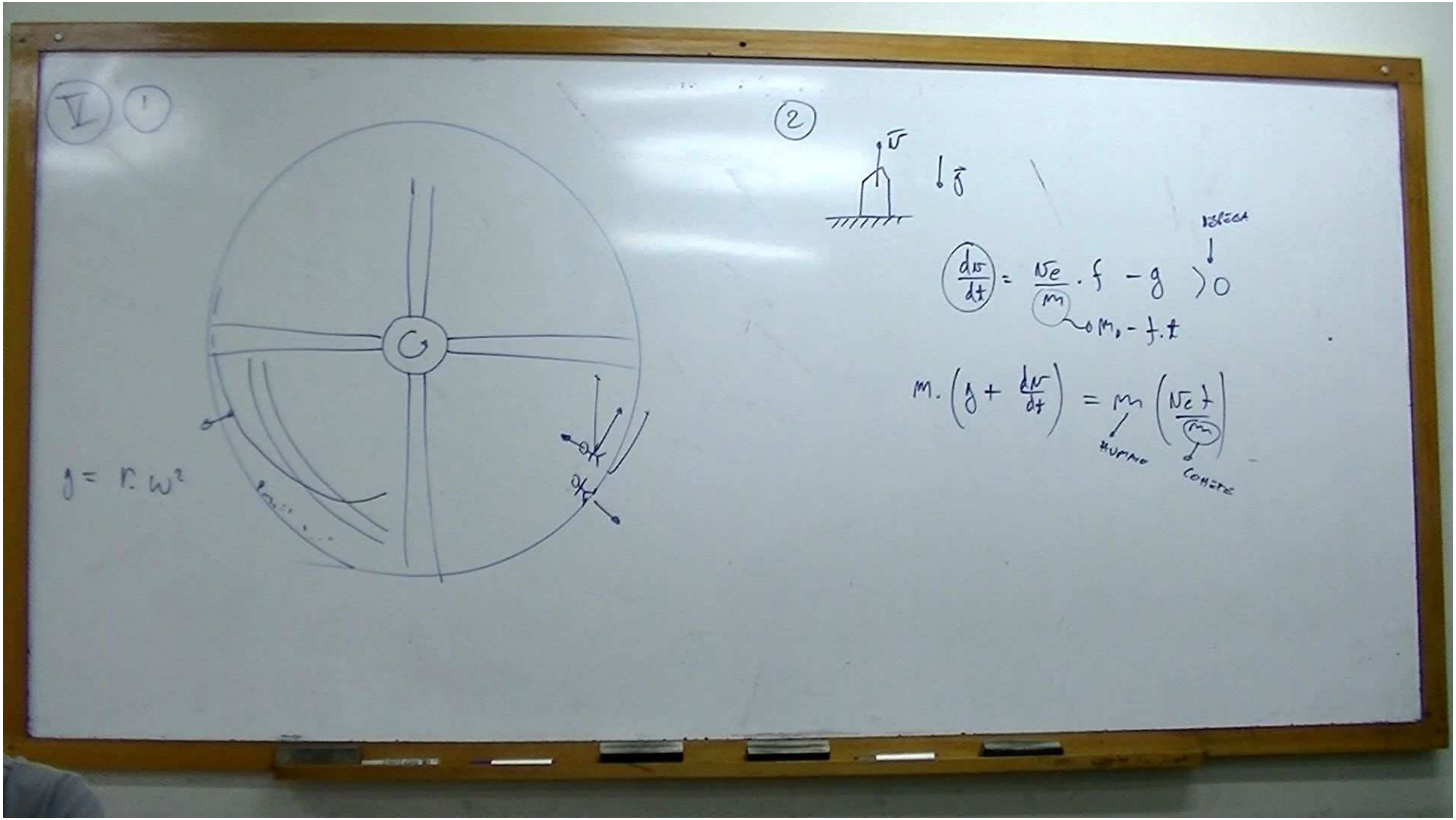
máxima V∞ ⇒ V∞ // VT
VT = √(μ/aT) = k
μ = k²(M⊙)
[T] = día
[L] = UA
[M] = M⊙
VH = V∞ + VT = √2 Vcirc
esc
V∞ = √2 VT − VT = (√2 − 1).VT
V∞² = μT (2/∞ − 1/aG) = − μT/aG
k² MT
V²esc
V∞²
VP² = μT (2/RT − 1/aG) = 2μT/RT − μT/aG = VESC² + V∞²
Vesc =
Sol
T
VP
RT
aG

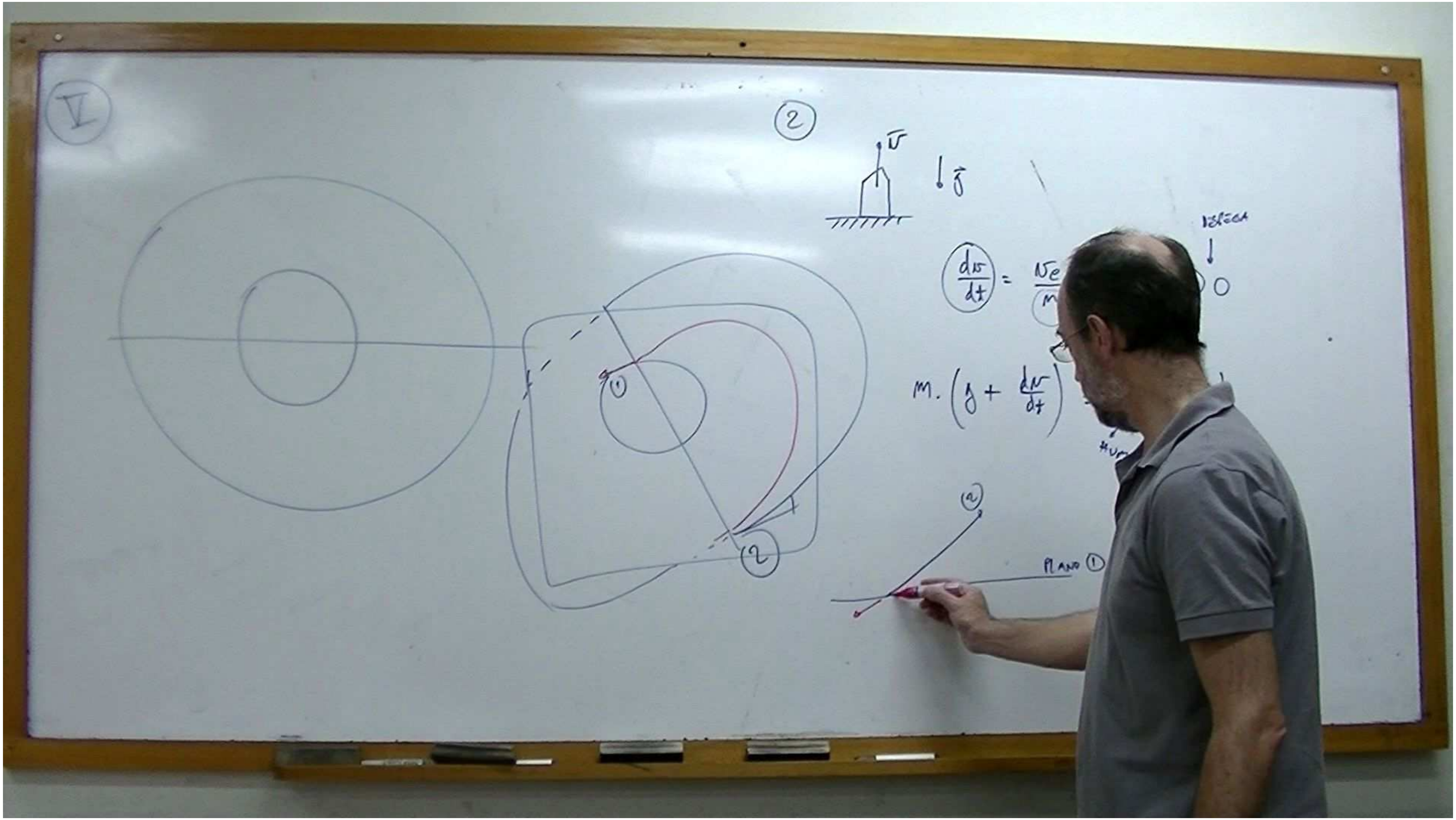

V
9
MÁXIMA $\vec{V}_* \Rightarrow \vec{V}_\infty \parallel \vec{V}_T$
$V_T = \sqrt{\frac{\mu}{a_T}} = k$
1 UA
$\mu = k^2 (M_\odot)$
1
$[T] = $ día
$[L] = $ UA
$[M] = M_\odot$
$\vec{V}_H = \vec{V}_\infty + \vec{V}_T = \sqrt{2}\, V_{circ}$
esc
$V_{esc} = \sqrt{2}\, V_c$
$\vec{V}_\infty$
$\vec{V}_T$
a_G
SOL
R_T
V_P
V_c
T
$V_\infty = \sqrt{2}\, V_T - V_T = (\sqrt{2} - 1) . V_T$
$V_c = \sqrt{\frac{\mu_T}{R_T}}$
$V_\infty^2 = \mu_T \left(\frac{2}{\infty} - \frac{1}{a_G} \right) = - \frac{\mu_T}{a_G}$
$k^2 M_T$
V_{esc}^2
V_∞^2
V_P
$\Rightarrow \Delta V = V_P - V_c$
8,77 Km/sec
$V_P^2 = \mu_T \left(\frac{2}{R_T} - \frac{1}{a_G} \right) = \frac{2 \mu_T}{R_T} - \frac{\mu_T}{a_G} = V_{esc}^2 + V_\infty^2$

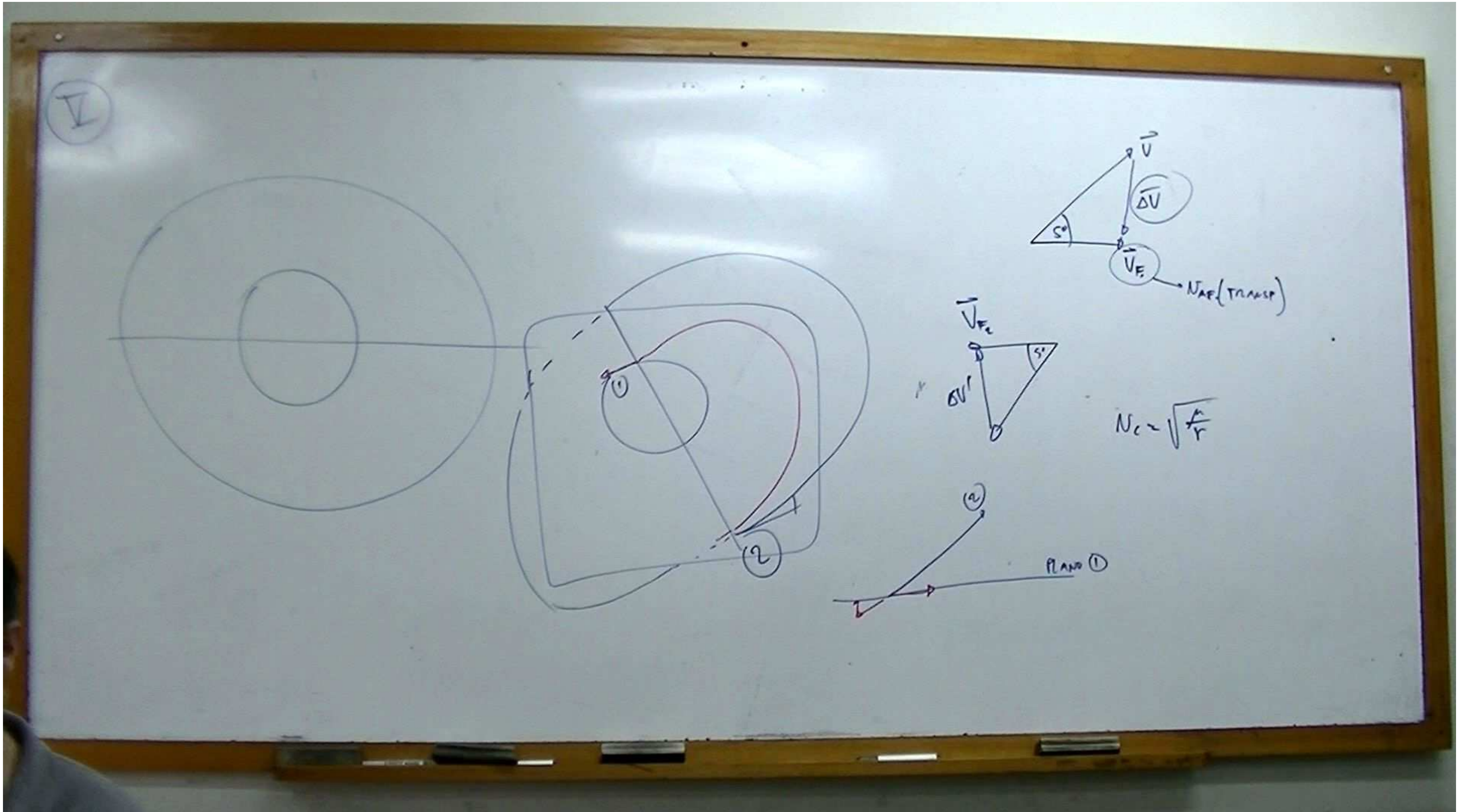


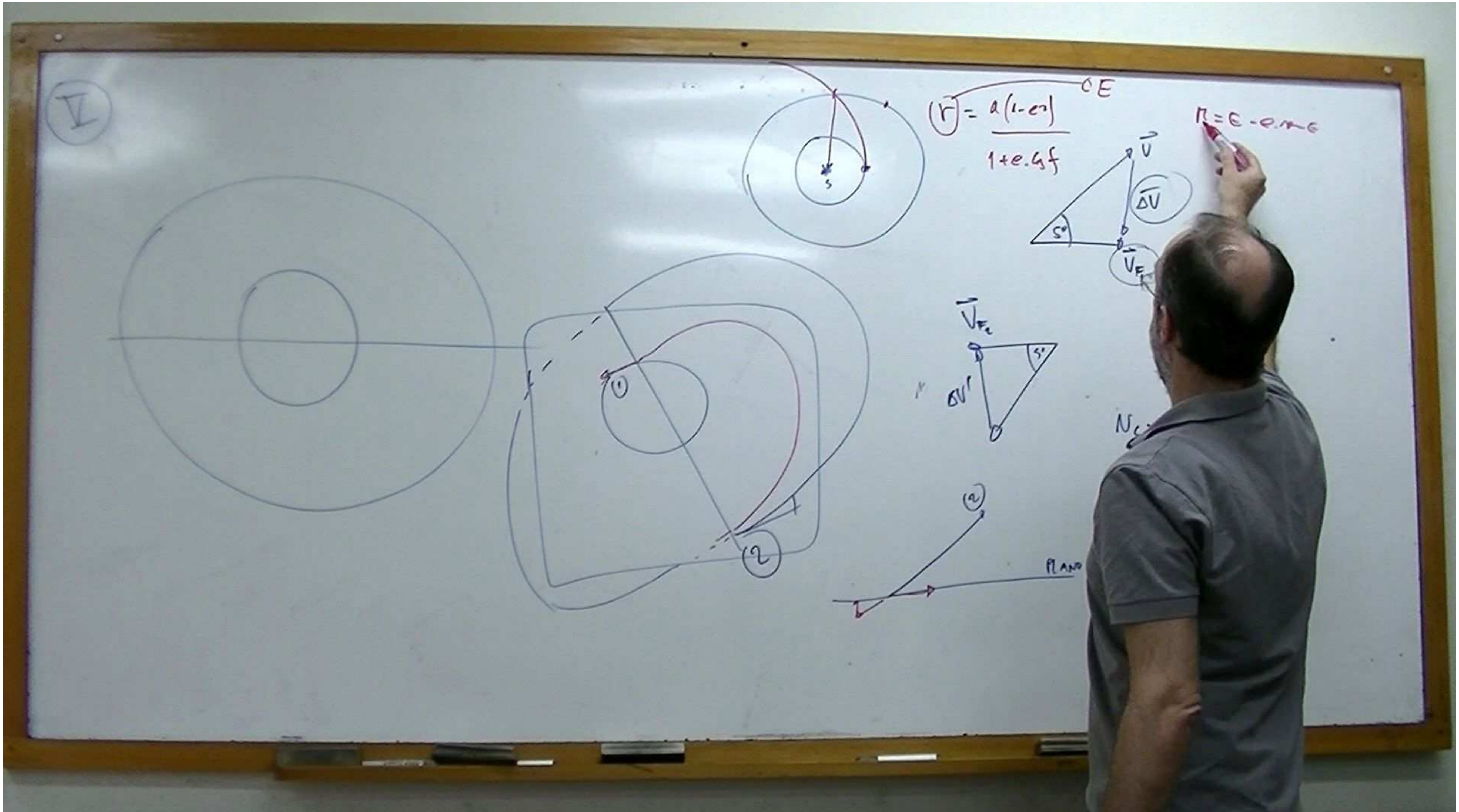

V
1
$g = r \cdot \omega^2$

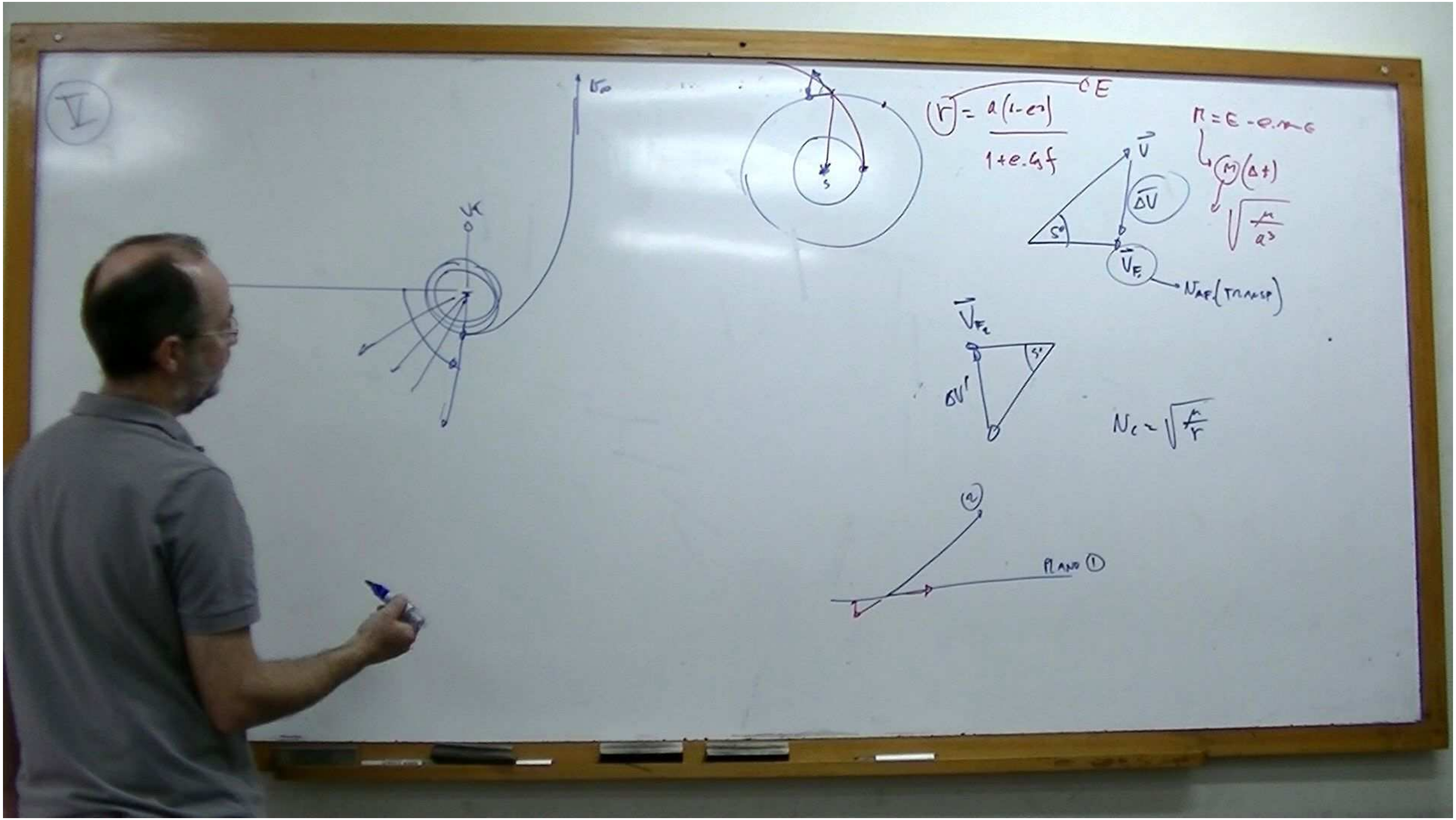

V
1
2
g = r. ω²

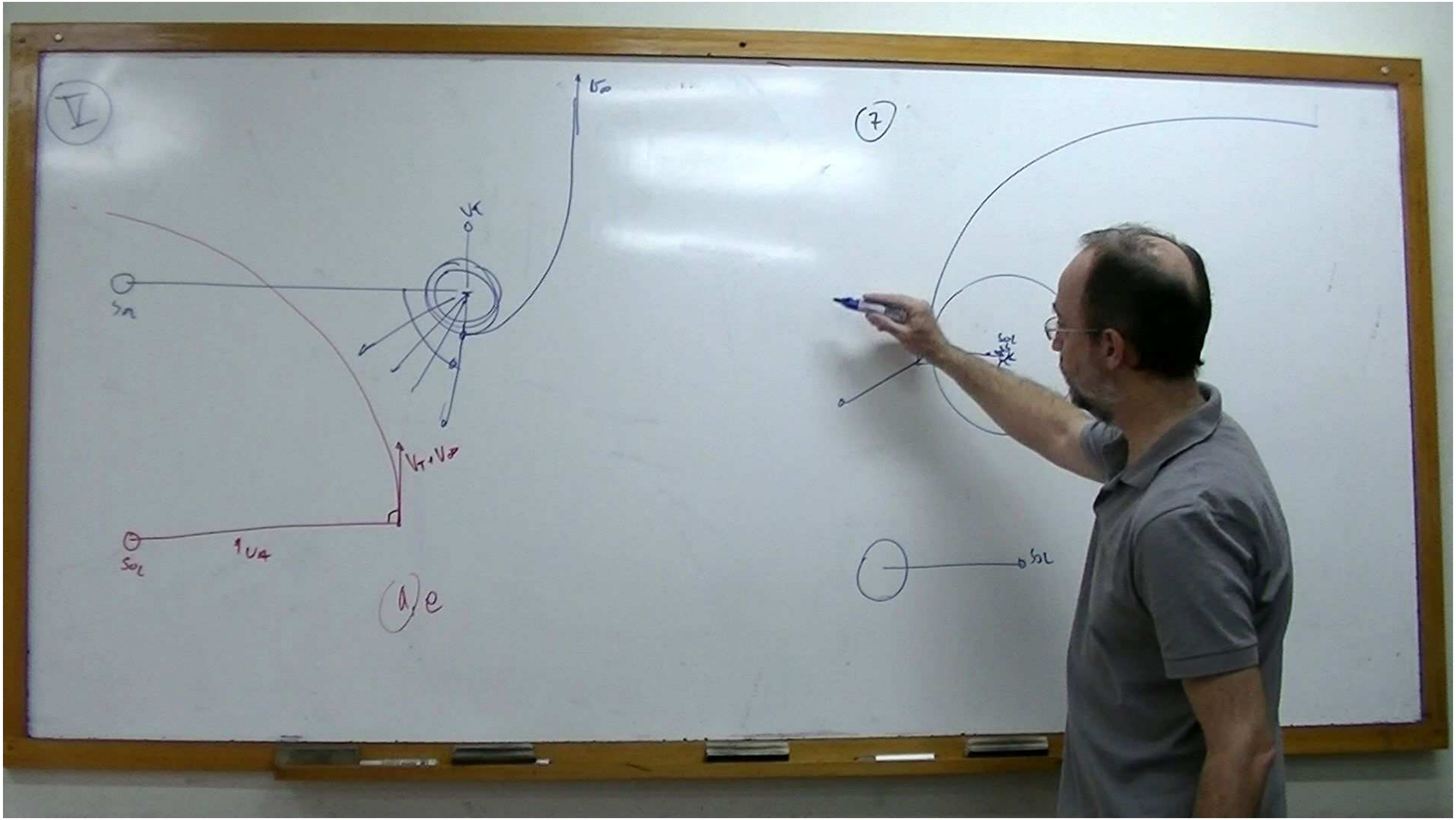

V
1
2
g = r. w²
dv/dt = Ve/m . f - g > 0
m₀ - f.t
m. (g + dv/dt) = m (Ve f / m)
HUMANO
COHETE

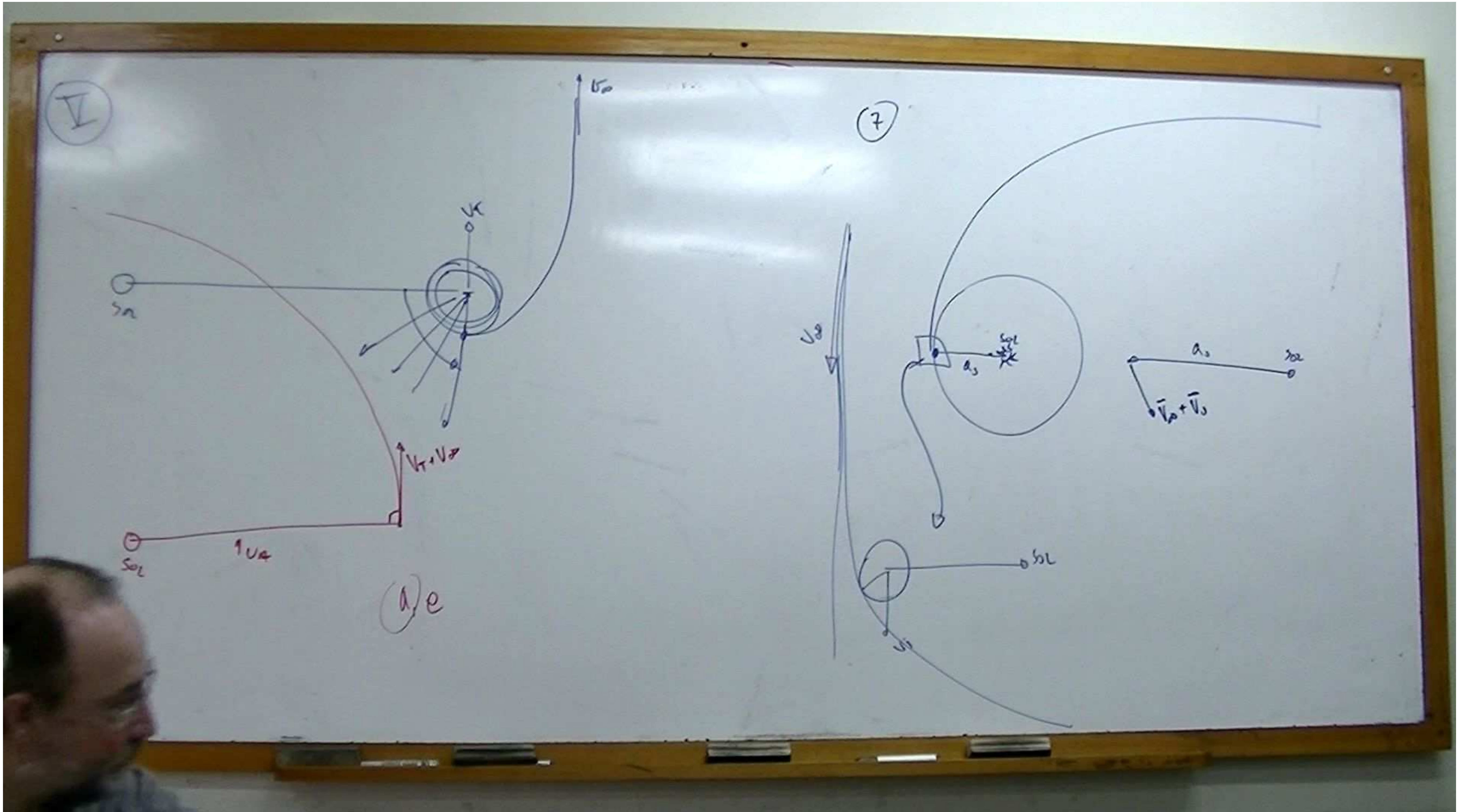

V
2
PLANO 1

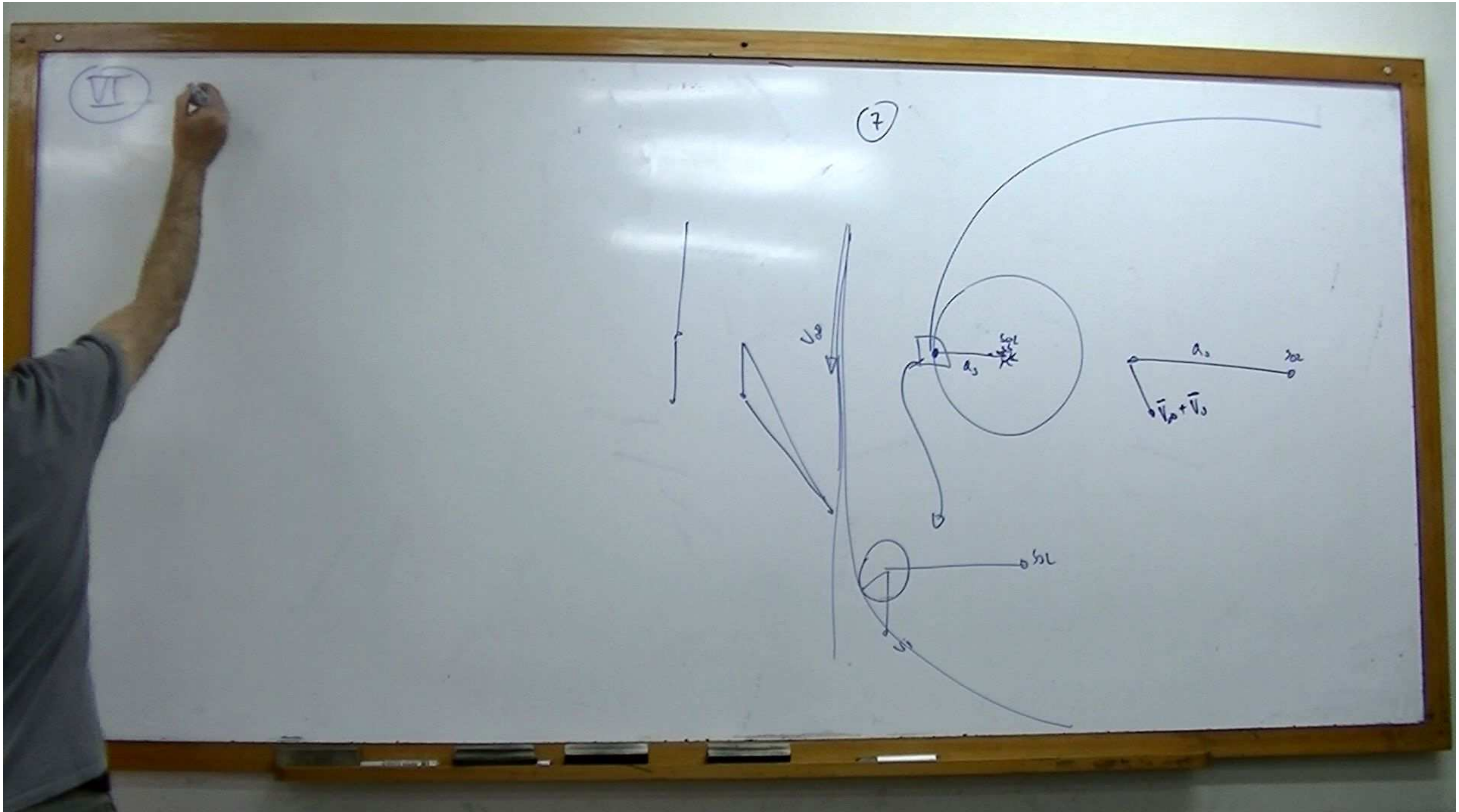

V
$\vec{V}$
$\Delta\vec{V}$
5°
$\vec{V}_E$
N_{AF} (TRANSF)
$\vec{V}_{F_2}$
5°
$\Delta V'$
$N_c = \sqrt{\frac{\mu}{r}}$
1
2
PLANO 1








V
7
Sol
Sol
a, e
a₀
Sol



VI
7
sol
a_s
a_0
sol
$\bar{V}_p + \bar{V}_0$
sol