

η
T. SIDÉREO → DÍA SIDÉREO : 2 CULMINACIONES DE η = 24 HORAS SIDÉREAS

S. FICTICIO
T. SOLAR MEDIO → DÍA SOLAR MEDIO : 2 CULN. DEL S. FICTICIO = 24 HORAS

T. SOLAR APARENTE → DÍA SOLAR VERDADERO : 2 CULN. DE $\odot$

= 365.2

PARCIAL :

20 abril

VER WEB CURSO:

- ESP. CELESTE INTER.
- MOV. SOL

η
T. SIDÉREO → DÍA SIDÉREO : 2 CULMINACIONES DE η = 24 Horas sidéreas

MEDIO → DÍA SOLAR MEDIO : 2 CULN. DEL S. FICTICIO = 24 Horas

APARENTE → DÍA SOLAR VERDADERO : 2 CULN. DE $\odot$

1 AÑO = 365.25 DÍAS SOLARES (medios)
 365.25 + 1 DÍAS SIDÉREOS

DÍA SIDÉREO = $\frac{365.25}{366.25}$ DÍAS SOLARES

= 0.997269... = $(1.002737)^{-1}$

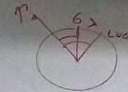
1 DÍA SIDÉREO = 23^h 56^m 4^s DE T. SOLAR MEDIO

PALCIAL :
 20 Abril

VER WEB CURSO:
 - ESP. CELESTE INTER.
 - MOV. SOL

T. Solm Medio Greenwich =

$$T_{Sol L} = \underbrace{TSG}_{\text{Reloj}} + \lambda$$



$$\boxed{1 \text{ año}} = 365.25 \text{ DÍAS SOLARES (medios)}$$

$$365.25 + 1 \text{ DÍAS SIDEREOS}$$

$$\text{DÍA SIDEREO} = \frac{365.25}{366.25} \text{ DÍAS SOLARES}$$

$$= 0.997269 \dots = (1.002737)^{-1}$$

$$\boxed{1 \text{ DÍA SIDEREO} = 23^h 56^m 4^s \text{ DE T. SOLM MEDIO}}$$

PALCIAL:

20 Abril

VÉR WEB CURSO:

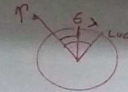
- ESP. CELESTE INTER.
- NOV. SOL

$$T. \text{ Solar Medio GREENWICH} = H_{SF}(\text{GREENWICH}) + 12^h = T. \text{ UNIVERSAL (TU)}$$

$$HLU = TU - 3^h$$

E
S
A
L
U
S
O
L
A
R
Y
Δ

$$TS_{10L} = \underbrace{TS_G}_{\text{RAOI}} + \lambda$$



$$1 \text{ año} = 365.25 \text{ DÍAS SOLARES (medios)}$$

$$365.25 + 1 \text{ DÍAS SIDEREOS}$$

$$\text{DÍA SIDEREAL} = \frac{365.25}{366.25} \text{ DÍAS SOLARES}$$

$$= 0.997269 \dots = (1.002737)^{-1}$$

$$1 \text{ DÍA SIDEREAL} = 23^h 56^m 4^s \text{ DE T. SOLAR MEDIO}$$

PALCIAL:
20 abril

VÉR WEB CURSO:
- ESP. CELESTE INTER
- MOV. SOL

$$T. \text{ SOLAR MEDIO GREENWICH} = H_{SF}(\text{GREENWICH}) + 12^h = T. \text{ UNIVERSAL (TU)}$$

$$H L U = \boxed{TU - 3^h}$$

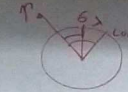
$$T_{SM} = \boxed{T_S}$$

Greenwich
SFICILIO

$$T_{Sol Ap (Mon)} - \lambda_{MON}$$

$$\boxed{T_{Sol L} = T_{SG} + \lambda}$$

RAOS



$$\boxed{1 \text{ AÑO}} = 365.25 \text{ DÍAS SOLARES (medios)}$$

$$365.25 + 1 \text{ DÍAS SIDERALES}$$

$$\text{DÍA SIDERAL} = \frac{365.25}{366.25} \text{ DÍAS SOLARES}$$

$$= 0.997269 \dots = (1.002737)^{-1}$$

$$\boxed{1 \text{ DÍA SIDERAL} = 23^h 56^m 4^s \text{ DE T. SOLAR MEDIO}}$$

PALCIAL:

20 abril

VER WEB CURSO:

- ESP. CELESTE INTER.
- MOV. SOL

$$T. \text{ Solar Medio GREENWICH} = H_{SP}(\text{GREENWICH}) + 12^h = T. \text{ UNIVERSAL (TU)}$$

$$HLU = TU - 3^h$$

ESTAD
SOLAR
Y
Δ

$$T_{SM} = T_{SMAP} - ET$$

GREENWICH

SFICILIZO

$$T_{SAp}(G) = T_{SAp}(Mon) - \lambda_{MON}$$

$$\Rightarrow HLU = T_{SAp}(Mon) - \lambda_{Mon} - ET - 3^h = T_{SAp}(Mon) + 3^h + 44^m - ET - 3^h$$

RELOS SOLAR

$$HLU = T$$

PALCIAL:

20 Abril

VER WEB CURSO:

- ESP. CELESTE INTER.
- NOV. SOL

$$T. \text{ Solar Medio Greenwich} = H_{ST}(\text{Greenwich}) + 12^h = T. \text{ Universal (TU)}$$

$$HLU = TU - 3^h$$

ER
6
AL
DAY

$$T_{SM} = T_{SMAP} - ET$$

RELOJ SOLAR

SFICIAL

$$\Rightarrow HLU = T_{SMAP}(\text{now}) - \lambda_{\text{now}} - ET - 3^h = T_{SMAP}(\text{now}) + 3^h + 44^m - ET - 3^h$$

$$T_{SAp}(G) = T_{SAp}(\text{Mon}) - \lambda_{\text{Mon}}$$

$$HLU = T_{SAp}(\text{now}) + 44^m - ET$$

RELOJ

RELOJ SOLAR

$$T_{SID} \text{ Greenwich} = f(\dots)$$

PARCIAL:

20 Abril

WEB CURSO:

CELESTE INTER.

SOL

$$T. \text{ Greenwich} = H_{SP}(\text{Greenwich}) + 12^h = T. \text{ Universal (TU)}$$

$$TU - 3^h$$

$$M = T_{Sun AP} - ET$$

Greenwich
Ficilia

$$T_{SAp}(G) = T_{Sun AP}(Mon) - \lambda_{Mon}$$

$$- \cancel{12^h} - ET - 3^h = T_{SAp}(Mon) + \cancel{3^h} + 44^m - ET - \cancel{3^h}$$

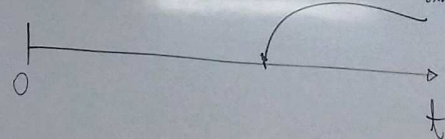
(3h 44m)

$$HLU = T_{SAp}(Mon) + 44^m - ET$$

RELOJ RELOJ SUN

$$T_{Sid Greenwich} = f(TU)$$

INSTANTE EXPOSADO



PALCIAL:
20 Abril

VÉR WEB CURSO:
- ESP. CELESTE INTER.
- NOV. SOL

T. Solar Medio GREENWICH = $H_{SM}(\text{GREENWICH})$

T. UNIVERSAL (TU)

$$HLU = TU - 3^h$$

E
S
T
A
D
O
N
A
L

GREENWICH

$$T_{SM} = (T_{SM} - T_{SM}(\text{Mon})) - \lambda_{MON}$$

STANDARD

RELOJ SOLAR

$$\Rightarrow HLU = T_{SM}(\text{Mon}) - \lambda_{MON} - ET - 4^h 44^m$$

0

$$T_{SM}(\text{Mon}) - \lambda_{MON}$$

$$HLU = T_{SM}(\text{Mon}) + 44^m - ET$$

RELOJ

RELOJ SOLAR

$$F(\text{Ano}, \text{Mes}, \text{Dia}, \text{TU})$$

JD

PALCIAL:
20 abril

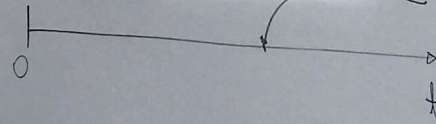
VER WEB CURSO:
- ESP. CELESTIAL INTER.
- NOV. SOL

$$T_{SM}(\text{GREENWICH}) = f(TU)$$

INSTANTE EXISTENTE

1 Enero 12 TU
- 4713

JD = 0



FECHA JULIANA
JD

$$T. \text{ Solar Medio Greenwich} = H_{SE}(\text{Greenwich}) + 12^h = T. \text{ Universal (TU)}$$

$$HLU = TU - 3^h$$

E
6
A
L
A
Y
A

$$T_{SAp(G)} = T_{SAp(Mon)} - \lambda_{Mon}$$

Greenwich

$$T_{SAp} = T_{SAp} - ET$$

SFICIZO

RELOJ SOLAR

$$\Rightarrow HLU = T_{SAp(Mon)} - \lambda_{Mon} - ET - 3^h = T_{SAp(Mon)} + 3^h + 44^m - ET - 3^h$$

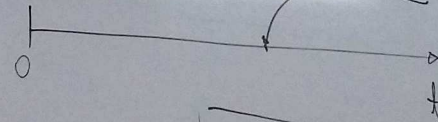
$$HLU = T_{SAp(Mon)} + 44^m - ET$$

RELOJ

RELOJ SOLAR

1 Enero 12 TU
-4713

JD = 0



$$T_{SID} \text{ Greenwich} = f(TU)$$

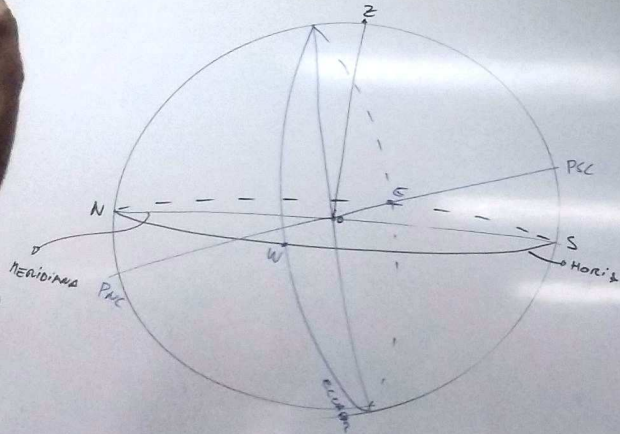
$$F(KD, Mes, Dia, TU) \rightarrow JD$$

PARCIAL:
20 Abril

VER WEB CURSO:
- ESP. CELESTE INTER.
- NOV. SOL

FECHA JULIANA
JD

$$\alpha(PAC) = 0$$



PALCIAL:

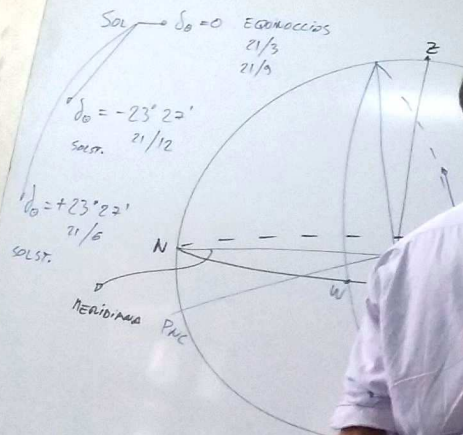
20 abril

VÉR WEB CURSO:

- ESP. CELESTE INTER.
- MOV. SOL

FECHA JULIANA

JD



$$\alpha(PNC) = 0$$

$$21/3 \text{ a } 21/9 \rightarrow \delta_0 > 0$$

21

PALCIAL:

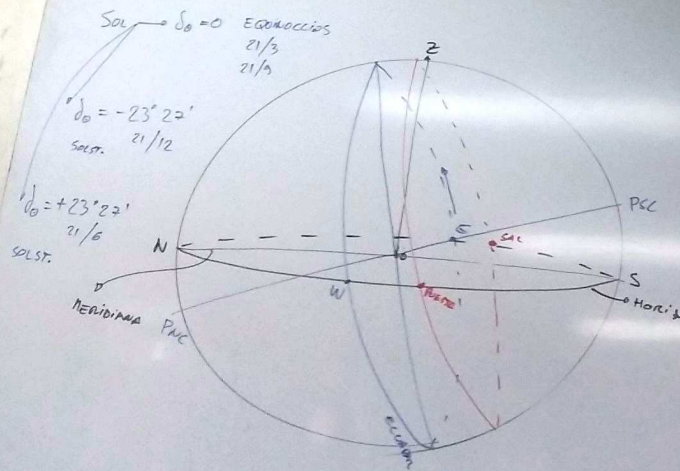
20 abril

VER WEB CURSO:

- ESP. CELESTE INTER.
- MOV. SOL

FECHA JULIANA

JD



$$a(PNC) = 0$$

$$21/3 \text{ al } 21/9 \rightarrow \delta_0 > 0$$

$$21/9 \text{ al } 21/3 \rightarrow \delta_0 < 0$$

$\delta_0 \rightarrow$ VARIACIÓN EN DURACIÓN
DEL DÍA
 $\downarrow$
VARIACIÓN ANUAL
DE LA
INSOLACIÓN

PARCIAL:

20 abril

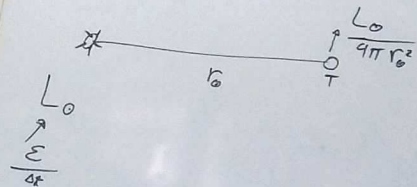
VÉR WEB CURSO:

- ESP. CELESTE INTER.
- MOV. SOL

FECHA JULIANA

JD

CÁLCULO DE INSOLACIÓN

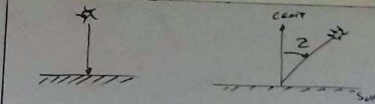
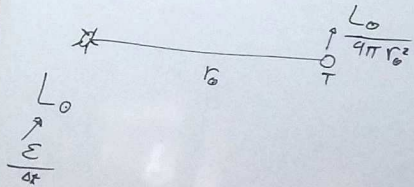


$J_0 \rightarrow$ VARIACIÓN EN DURACIÓN
DEL DÍA
 $\downarrow$
VARIACIÓN ANUAL
DE LA
INSOLACIÓN

PARCIAL:
20 abril

VÉR WEB CURSO:
- ESP. CELESTE INTER.
- MOV. SOL

FECHA JULIANA
JD

CÁLCULO DE INSOLACIÓN

$$\Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \Delta t \cdot \cos z$$

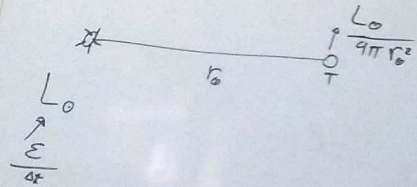
↑
ENERGÍA TOTAL RECIBIDA

$$\Delta Q = \frac{L_0}{4\pi r_0^2} \int_{t_{\text{sun}}}^{t_{\text{horizon}}} \cos z(\ast) \cdot dt$$

PARCIAL:
20 abril

VER WEB CURSO:
- ESP. CELESTE INTER.
- NOV. SOL

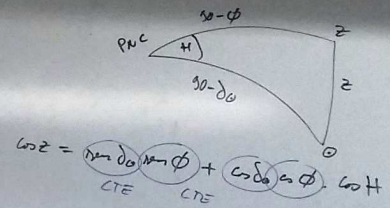
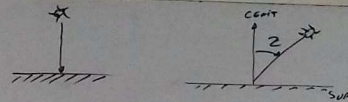
FECHA JULIANA
JD

CÁLCULO DE INSOLACIÓN

$$\Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \Delta t \cdot \cos z$$

↑
ENERGÍA TOTAL
RECIBIDA

$$\Delta Q = \frac{L_0}{4\pi r_0^2} \int_{t_{\text{sun}}}^{t_{\text{horizon}}} \cos z(\ast) \cdot dt$$



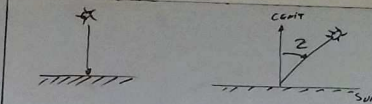
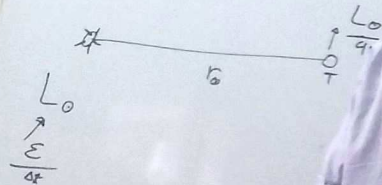
$$\cos z = \cos \delta_0 \cos \phi + \sin \delta_0 \sin \phi \cdot \cos H$$

CTE CTE

$$\Delta H = \frac{2\pi}{N_A}$$

CÁLCULO DE INSOLACIÓN

$$\Rightarrow \Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{D_{ia}}{2\pi} \int_{H_{min}}^{H_{max}} (\sin \delta_0) d\delta_0$$



$$\Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \Delta t \cdot \cos z$$

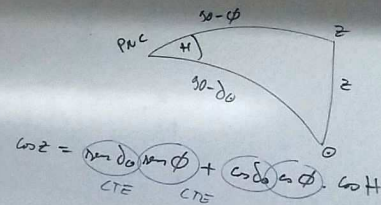
↑
ENERGÍA TOTAL
RECIBIDA

$$\Delta Q = \frac{L_0}{4\pi r_0^2} \int_{t_{min}}^{t_{max}} \cos z(\star) \cdot dt$$

$$= \frac{L_0}{4\pi r_0^2} \int_{t_{min}}^{t_{max}} \left(\sin \delta_0 \sin \phi + \cos \delta_0 \cos \phi \cdot \cos H \right) dt$$

CTE CTE

→ $\frac{dH}{dt} \cdot \frac{D_{ia}}{2\pi}$



$$\Delta H = \frac{2\pi}{D_{ia}} \cdot \Delta t$$

→ 24^h

CÁLCULO DE INSOLACIÓN

$$\Rightarrow \Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{D \omega}{2\pi}$$

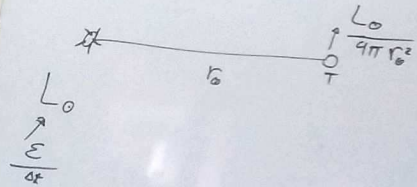
$$\left(\cos \delta_0 \sin \phi + \sin \delta_0 \cos \phi \cdot \cos H \right) dH$$

 H_{sue}

$$\cos \delta_0 \sin \phi \cdot (H_p - H_{sue})$$

 $2 H_p$

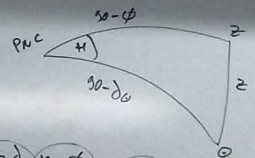
$$\cos \delta_0 \cos \phi \cdot \cos H \Big|_{H_{sue}}^{H_p} = \cos \delta_0 \cos \phi \left(\sin H_p - \sin H_{sue} \right)$$

 $2 \sin H_p$


$$\Rightarrow \Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{D \omega}{2\pi}$$

$$\cos z = \sin \delta_0 \sin \phi + \cos \delta_0 \cos \phi \cdot \cos H$$

$$\Delta H = \frac{2\pi}{D \omega} \cdot \Delta t$$



CÁLCULO DE INSOLACIÓN

$$\Rightarrow \Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{D_{ia}}{2\pi} \int_{H_{sac}}^{H_{pmax}} (\cos \delta_0 \sin \phi + \sin \delta_0 \cos \phi \cdot \cos H) dH$$

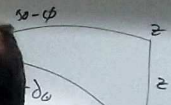
$$\cos \delta_0 \sin \phi \cdot (H_p - H_{sac})$$

$$\cos \delta_0 \cos \phi \cdot \tan H \Big|_{H_{sac}}^{H_p} = \cos \delta_0 \cos \phi \left(\tan H_p - \tan H_{sac} \right)$$

$$\Rightarrow \Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{D_{ia}}{2\pi} \left[\sin \delta_0 \sin \phi \cdot 2 H_p + \cos \delta_0 \cos \phi \cdot 2 \cdot \tan H_p \right]$$

$$\Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{D_{ia}}{2\pi} \cdot 2 \left(\sin \delta_0 \sin \phi \cdot H_p + \cos \delta_0 \cos \phi \cdot \tan H_p \right)$$

$$H_p(\delta)$$



$$\frac{1}{2} \phi$$

CÁLCULO DE INSOLACIÓN

$$\Rightarrow \Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{D_{ia}}{2\pi} \int_{H_{sac}}^{H_{pmax}} (\cos \delta_0 \sin \phi + \sin \delta_0 \cos \phi \cdot \cos H) dH$$

$$\cos \delta_0 \sin \phi \cdot (H_p - H_{sac})$$

$$\cos \delta_0 \cos \phi \cdot \cos H \Big|_{H_{sac}}^{H_p} = \cos \delta_0 \cos \phi (H_p - H_{sac})$$

$$2 H_p$$

$$\Rightarrow \Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{D_{ia}}{2\pi} \left[\sin \delta_0 \sin \phi \cdot 2 H_p + \cos \delta_0 \cos \phi \cdot 2 \sin H_p \right]$$

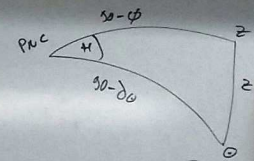
$$\Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{D_{ia}}{2\pi} \cdot 2 \left(\sin \delta_0 \sin \phi \cdot H_p + \cos \delta_0 \cos \phi \cdot \sin H_p \right)$$

$$\Delta Q(\delta_0, \phi, r_0)$$

$$+23^\circ 27'$$

$$-23^\circ 27'$$

$$H_p(\delta_0, \phi)$$



$$\cos H_p = -\frac{1}{2} \sin \delta_0 \frac{1}{\sin \phi}$$

CÁLCULO DE INSOLACIÓN

$$\Rightarrow \Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{D_A}{2\pi} \left(\cos \delta_0 \sin \phi + \sin \delta_0 \cos \phi \cdot \cos H \right) dH$$

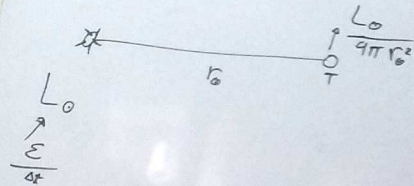
H_{sac} H_{max}

$$\cos \delta_0 \sin \phi \cdot (H_p - H_{sac})$$

$2 H_p$

$$\cos \delta_0 \cos \phi \cdot \tan H \Big|_{H_{sac}}^{H_p} = \cos \delta_0 \cos \phi \left(\tan H_p - \tan H_{sac} \right)$$

$2 \tan H_p$

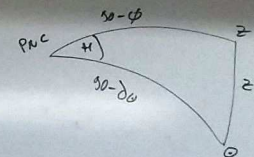
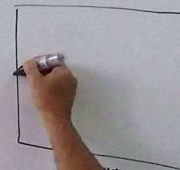


$$\Rightarrow \Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{D_A}{2\pi} \left[\sin \delta_0 \sin \phi \cdot 2 H_p + \cos \delta_0 \cos \phi \cdot 2 \tan H_p \right]$$

$$\Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{D_A}{2\pi} \cdot 2 \left(\sin \delta_0 \sin \phi \cdot H_p + \cos \delta_0 \cos \phi \cdot \tan H_p \right)$$

$$\Delta Q(\delta_0, \phi, r_0)$$

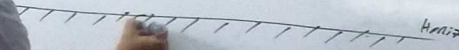
$+23^\circ 27'$ $-23^\circ 27'$



$$\cos H_p = -\frac{1}{\tan \delta_0 \tan \phi}$$

$$\cos \delta_0 = \sin \delta_0 \sin \phi + \cos \delta_0 \cos \phi \cdot \cos H$$

CREPÚSCULOS



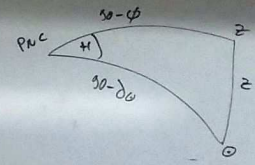
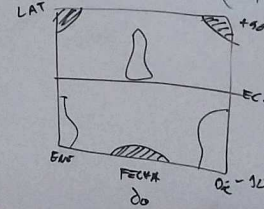
$$\Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{y_{ia}}{2\pi} \left[\sin \delta_0 \sin \phi \cdot 2H_p + \cos \delta_0 \cos \phi \cdot 2 \sin H_p \right]$$

$$\Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{y_{ia}}{2\pi} \cdot 2 \left(\sin \delta_0 \sin \phi \cdot H_p + \cos \delta_0 \cos \phi \cdot \sin H_p \right)$$

$$\Delta Q(\delta_0, \phi, r_0)$$

$$+23^\circ 26'$$

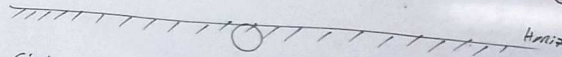
$$-23^\circ 26'$$



$$\cos H_p = -\frac{1}{2} \delta_0 \frac{1}{2} \phi$$

$$\cos \delta_0 = \sin \delta_0 \sin \phi + \cos \delta_0 \cos \phi \cdot \cos H$$

CREPÚSCULOS



CIVIL

NAÚTICO

ASTRONÓMICO

$$\Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{r_a}{2\pi} \left[\sin \delta_0 \sin \phi \cdot 2H_p + \cos \delta_0 \cos \phi \cdot 2 \cdot \sin H_p \right]$$

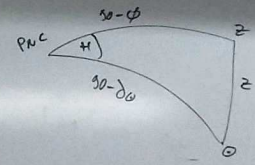
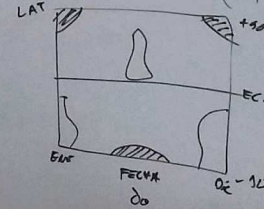
$$\Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{r_a}{2\pi} \cdot 2 \left(\sin \delta_0 \sin \phi \cdot H_p + \cos \delta_0 \cos \phi \cdot \sin H_p \right)$$

$$\Delta Q(\delta_0, \phi, r_0)$$

$$+23^\circ 27'$$

$$-23^\circ 27'$$

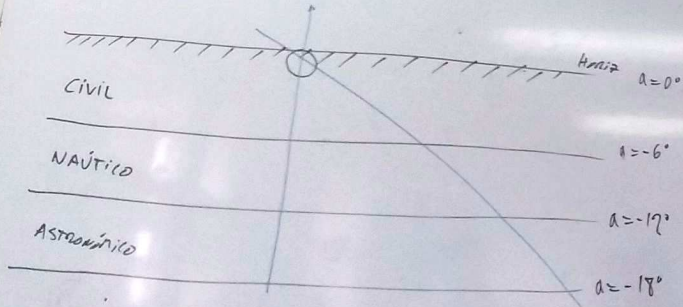
$$-35^\circ$$



$$\cos H_p = -\frac{1}{2} \sin \delta_0 \sin \phi$$

$$\cos \delta_0 = \sin \delta_0 \sin \phi + \cos \delta_0 \cos \phi \cdot \cos H$$

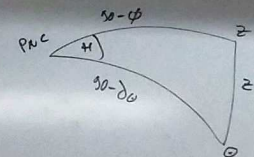
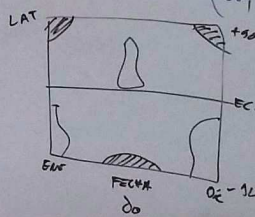
CREPÚSCULOS



$$\Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{y_{ia}}{2\pi} \left[\sin \delta_0 \sin \phi \cdot 2H_p + \cos \delta_0 \cos \phi \cdot 2 \cdot \sin H_p \right]$$

$$\Delta Q = \frac{L_0}{4\pi r_0^2} \cdot \frac{y_{ia}}{2\pi} \cdot 2 \left(\sin \delta_0 \sin \phi \cdot H_p + \cos \delta_0 \cos \phi \cdot \sin H_p \right)$$

$$\Delta Q(\delta_0, \phi, r_0)$$



$$\cos H_p = -\frac{1}{2} \sin \delta_0 \sin \phi$$

$$\cos \delta_0 = \sin \delta_0 \sin \phi + \cos \delta_0 \cos \phi \cdot \cos H$$