

EASYSEXTANT



Sun Sight Reduction Training Material

Intercept and Sun Azimuth Calculation
with a Scientific Calculator

8 exercises with solutions:

1. La Rochelle
2. Madagascar
3. Perth
4. San Francisco
5. Galapagos
6. Tokyo
7. Pointe-a-Pitre
8. Rotterdam

$$H_s = 20^\circ 19', 2$$

$$\varepsilon = 4', 2$$

$$\text{Dip} = \underline{-2', 5} +$$

$$H_a = 20^\circ 20', 9$$

$$+ \text{sun correct. LL/UL} = \underline{+13', 6} +$$

$$H_o = 20^\circ 34', 5$$

La Rochelle

Date 26/01/2022

UT 10h 40m 19s

$$\text{index error} = + 3'$$

$$+ \text{non adjust. error} = \underline{+ 1', 2} +$$

$$\varepsilon = + 4', 2$$

$L = 46^\circ 12' \text{ N}$

$G = 004^\circ 31' \text{ W}$

Height of the eye = 2 m

lower limb upper limb

$$\text{GHA} = 326^\circ 52', 8$$

$$+ pp = \underline{10^\circ 04', 8} \quad \text{increment)$$

$$\text{GHA} = 336^\circ 57', 6$$

$$G = \underline{004^\circ 31'} \text{ W} \quad G = \text{East} \rightarrow \text{add}$$

$$\text{LHA} = 332^\circ 26', 6 \quad G = \text{West} \rightarrow \text{subtract}$$

$LHA < 180^\circ$; sun in the west; $P = LHA$
 $LHA > 180^\circ$; sun in the east; $P = 360 - LHA$

$$P = 27^\circ 33', 4$$

$$(d \uparrow \text{ or } \downarrow = 0', 6 \downarrow)$$

$$D = 18^\circ 40', 1 \text{ S}$$

$$\text{corr. } d = \underline{0', 4}$$

$$D = 18^\circ 39', 7 \text{ S}$$

$$H_c = \arcsin (\sin (L : 46^\circ 12') \times \sin (D : - 18^\circ 39', 7)$$

$$+ \cos (L : 46^\circ 12') \times \cos (D : - 18^\circ 39', 7)$$

$$\times \cos (P : 27^\circ 33', 4))$$

$$H_c = 20^\circ 30', 8$$

$$Z = \arccos ((\sin (D : - 18^\circ 39', 7) - \sin (L : 46^\circ 12')$$

$$\times \sin (H_c : 20^\circ 30', 8)) \div (\cos (L : 46^\circ 12')$$

$$\times \cos (H_c : 20^\circ 30', 8))) = 152^\circ, 1$$

sun in the east $Z_v = Z$ / sun in the west $Z_v = 360 - Z$ $Z_v = 152^\circ, 1$

$$H_o = 20^\circ 34', 5$$

$$H_c = \underline{20^\circ 30', 8} -$$

$$\text{intercept} = 3', 7$$

+ Intercept towards the sun

- Intercept away from the sun

$$H_s = 50^{\circ}43',8$$

$$\varepsilon = -2',2$$

$$\text{Dip} = \underline{-3',6} +$$

$$H_a = 50^{\circ}38,0'$$

$$+ \text{sun correct. LL/UL} = \underline{+15',4} +$$

$$\mathbf{H_o} = \mathbf{50^{\circ}53',4}$$

Madagascar

Date 05 / 02 / 2022

UT 11h 55m 29s

$$\text{index error} = -4'$$

$$+ \text{non adjust. error} = \underline{+1',8} +$$

$$\varepsilon = -2',2$$

$$L = 30^{\circ}24' \text{ S}$$

$$G = 044^{\circ}13' \text{ E}$$

Height of the eye = 4 m

lower limb upper limb

$$\text{GHA} = 341^{\circ}30',6$$

$$+ pp = \underline{13^{\circ}52',3} \quad \text{increment)$$

$$\text{GHA} = 355^{\circ}22',9 \quad G = \text{West} \rightarrow \text{subtract}$$

$$G = \underline{044^{\circ}13' \text{ E}} \quad G = \text{East} \rightarrow \text{add}$$

$$\text{LHA} =$$

$$039^{\circ}35',9$$

$LHA < 180^{\circ}$; sun in the west; $P = LHA$

$LHA > 180^{\circ}$; sun in the east; $P = 360 - LHA$

$$\mathbf{P} = \mathbf{039^{\circ}35',9}$$

$$(d \uparrow \text{ or } \downarrow = 0',8 \downarrow)$$

$$D = 15^{\circ}51',4 \text{ S}$$

$$\text{corr. } d = \underline{0',7}$$

$$\mathbf{D} = \mathbf{15^{\circ}50',7 \text{ S}}$$

$$H_c = \arcsin (\sin (L : -30^{\circ}24') \times \sin (D : -15^{\circ}50',7)$$

$$+ \cos (L : -30^{\circ}24') \times \cos (D : -15^{\circ}50',7)$$

$$\times \cos (P : 039^{\circ}35',9))$$

$$\mathbf{H_c} = \mathbf{51^{\circ}02'}$$

$$Z = \arccos ((\sin (D : -15^{\circ}50',7) - \sin (L : -30^{\circ}24')$$

$$\times \sin (H_c : 51^{\circ}02')) \div (\cos (L : -30^{\circ}24')$$

$$\times \cos (H_c : 51^{\circ}02'))) = 77^{\circ},2$$

sun in the east $Z_v = Z$ / sun in the west $Z_v = 360 - Z$ $\mathbf{Z_v} = \mathbf{282^{\circ},8}$

$$H_o = 50^{\circ}53',4$$

$$- H_c = \underline{51^{\circ}02'}$$

$$\text{intercept} = -8',6$$

+ Intercept towards the sun

— Intercept away from the sun

$$H_s = 36^{\circ}54',1$$

$$\varepsilon = 2',7$$

$$\text{Dip} = \underline{\quad - 2',5 \quad} +$$

$$H_a = 36^{\circ}54',3$$

$$+ \text{sun correct. LL/UL} = \underline{\quad 14',7 \quad} +$$

$$\mathbf{H_o} = \mathbf{37^{\circ}09',0}$$

Perth

Date 16/08/2022

UT 07h 14m 35s

$$\text{index error} = +1'$$

$$+ \text{non adjust. error} = \underline{\quad + 1',7 \quad} +$$

$$\varepsilon = 2',7$$

$L = 27^{\circ}25' \text{ S}$

$G = 106^{\circ}39' \text{ E}$

Height of the eye = 2 m

lower limb upper limb

$$\text{GHA} = 283^{\circ}54',8$$

$$+ pp = \underline{\quad 3^{\circ}38',8 \quad} \text{ increment)$$

$$\text{GHA} = 287^{\circ}33',6 \quad G = \text{West} \rightarrow \text{subtract}$$

$$G = \underline{\quad 106^{\circ}39' \quad} \text{ E} \quad G = \text{East} \rightarrow \text{add}$$

$$\text{LHA} = 034^{\circ}12',6$$

$$LHA < 180^{\circ}; \text{ sun in the West; } P = LHA$$

$$LHA > 180^{\circ}; \text{ sun in the East; } P = 360 - LHA$$

$$\mathbf{P} = \mathbf{034^{\circ}12',6}$$

$$(d \uparrow \text{ or } \downarrow = 0',8 \downarrow)$$

$$D = 13^{\circ}42',9 \text{ N}$$

$$\text{corr. } d = \underline{\quad 0',2 \quad} \downarrow$$

$$\mathbf{D} = \mathbf{13^{\circ}42',7 \text{ N}}$$

$$H_c = \arcsin (\sin (L : - 27^{\circ}25') \times \sin (D : 13^{\circ}42',7)$$

$$+ \cos (L : - 27^{\circ}25') \times \cos (D : 13^{\circ}42',7)$$

$$\times \cos (P : 034^{\circ}12',6))$$

$$\mathbf{H_c} = \mathbf{37^{\circ}09',5}$$

$$Z = \arccos ((\sin (D : 13^{\circ}42',7) - \sin (L : - 27^{\circ}25')$$

$$\times \sin (H_c : 37^{\circ}09',5)) \div (\cos (L : - 27^{\circ}25')$$

$$\times \cos (H_c : 37^{\circ}09',5))) = 43^{\circ},3$$

sun in the east $Z_v = Z$ / sun in the west $Z_v = 360 - Z$ $\mathbf{Z_v} = \mathbf{316^{\circ},7}$

$$H_o = 37^{\circ}09'$$

$$- H_c = \underline{\quad 37^{\circ}09',5 \quad}$$

$$\text{intercept} = \mathbf{- 0',5}$$

+ Intercept towards the sun
- Intercept away from the sun

$$H_s = 27^{\circ}31',6$$

$$\varepsilon = -1',5$$

$$\text{Dip} = \underline{\quad - 3',6 \quad} +$$

$$H_a = 27^{\circ}26',5$$

$$+ \text{sun correct. LL/UL} = \underline{\quad 14',5 \quad} +$$

$$\mathbf{H_o = 27^{\circ}41',0}$$

San Francisco

Date 06 / 01 / 2022

UT 18h 34m 54s

$$\text{index error} = - 3'$$

$$+ \text{non adjust.error} = \underline{+ 1',5} +$$

$$\varepsilon = - 1',5$$

$L = 34^{\circ}40' \text{ N}$

$G = 123^{\circ}15' \text{ W}$

Height of the eye = 4 m

lower limb upper limb

$$\text{GHA} = 088^{\circ}31'$$

$$+ pp = \underline{8^{\circ}43',5} \quad \text{increment)$$

$$\text{GHA} = 097^{\circ}14',5 \quad G = \text{West} \rightarrow \text{subtract}$$

$$G = \underline{123^{\circ}15' \text{ W}} \quad G = \text{East} \rightarrow \text{add}$$

$$\text{LHA} = 333^{\circ}59',5$$

$$LHA < 180^{\circ}; \text{ sun in the West; } P = LHA$$

$$LHA > 180^{\circ}; \text{ sun in the East; } P = 360 - LHA$$

$$\mathbf{P = 026^{\circ}00',5}$$

(d ↑ or ↓ = 0',3 ↓)

$$D = 22^{\circ}25',9 \text{ S}$$

$$\text{corr. } d = \underline{\quad 0',2 \quad} \downarrow$$

$$\mathbf{D = 22^{\circ}25',7 \text{ S}}$$

$$H_c = \arcsin (\sin (L : 34^{\circ}40') \times \sin (D : - 22^{\circ}25',7)$$

$$+ \cos (L : 34^{\circ}40') \times \cos (D : - 22^{\circ}25',7)$$

$$\times \cos (P : 026^{\circ}00',5))$$

$$\mathbf{H_c = 27^{\circ}47',5}$$

$$Z = \arccos ((\sin (D : - 22^{\circ}25',7) - \sin (L : 34^{\circ}40')$$

$$\times \sin (H_c : 27^{\circ}47',5)) \div (\cos (L : 34^{\circ}40')$$

$$\times \cos (H_c : 27^{\circ}47',5))) = \mathbf{152^{\circ},7}$$

sun in the east $Z_v = Z$ / sun in the west $Z_v = 360 - Z$ $\mathbf{Z_v = 152^{\circ},7}$

$$H_o = 27^{\circ}41'$$

$$- H_c = \underline{27^{\circ}47',5}$$

$$\text{intercept} = \mathbf{- 6',5}$$

+ Intercept towards the sun

— Intercept away from the sun

$$H_s = 52^{\circ}18'$$

$$\varepsilon = 2',8$$

$$\text{Dip} = \underline{-2',5} +$$

$$H_a = 52^{\circ}18',3$$

$$+ \text{sun correct. LL/UL} = \underline{15',3} +$$

$$H_o = 52^{\circ}33',6$$

Galapagos

Date 06 / 06 / 2022

UT 15h 58m 54s

$$\text{index error} = + 1'$$

$$+ \text{non adjust. error} = \underline{+ 1',8} +$$

$$\varepsilon = 2',8$$

$L = 03^{\circ}58' S$

$G = 086^{\circ}54' W$

Height of the eye = 2 m

lower limb upper limb

$$\text{GHA} = 045^{\circ}18',9$$

$$+ pp = \underline{14^{\circ}43',5} \quad \text{increment)$$

$$\text{GHA} = 060^{\circ}02',4 \quad G = \text{West} \rightarrow \text{subtract}$$

$$G = \underline{086^{\circ}54' W} \quad G = \text{East} \rightarrow \text{add}$$

$$\text{LHA} = 333^{\circ}08',4$$

$LHA < 180^{\circ}$; sun in the West; $P = LHA$

$LHA > 180^{\circ}$; sun in the East; $P = 360 - LHA$

$$P = 026^{\circ}51',6$$

$$(d \uparrow \text{ or } \downarrow = 0',3 \uparrow)$$

$$D = 22^{\circ}41',5 N$$

$$\text{corr. } d = \underline{0',3} \uparrow$$

$$D = 22^{\circ}41',8 N$$

$$H_c = \arcsin (\sin (L : - 03^{\circ}58') \times \sin (D : 22^{\circ}41',8)$$

$$+ \cos (L : - 03^{\circ}58') \times \cos (D : 22^{\circ}41',8)$$

$$\times \cos (P : 026^{\circ}51',6))$$

$$H_c = 52^{\circ}35',7$$

$$Z = \arccos ((\sin (D : 22^{\circ}41',8) - \sin (L : - 03^{\circ}58')$$

$$\times \sin (H_c : 52^{\circ}35',7)) \div (\cos (L : - 03^{\circ}58')$$

$$\times \cos (H_c : 52^{\circ}35',7)) = 43^{\circ},3$$

$$\text{sun in the east } Z_v = Z \quad / \quad \text{sun in the west } Z_v = 360 - Z \quad Z_v = 43^{\circ},3$$

$$H_o = 52^{\circ}33',6$$

$$- H_c = \underline{52^{\circ}35',7}$$

$$\text{intercept} = - 2',1$$

+ Intercept towards the sun

- Intercept away from the sun

$$H_s = 42^\circ 11',5$$

$$\varepsilon = 3',9$$

$$\text{Dip} = \underline{\quad - 3',6 \quad} +$$

$$H_a = 42^\circ 11',8$$

$$+ \text{sun correct. LL/UL} = \underline{\quad - 15',1 \quad} +$$

$$H_o = 42^\circ 26',9$$

Tokyo

Date 06 / 03 / 2022

UT 20h 16m 54s

index error = + 2'

$$+ \text{non adjust. error} = \underline{\quad + 1',9 \quad} +$$

$$\varepsilon = 3',9$$

$$L = 33^\circ 21' \text{ N}$$

$$G = 150^\circ 18' \text{ W}$$

Height of the eye = 4 m

lower limb *upper limb*

$$\text{GHA} = 117^\circ 12',5$$

$$+ pp = \underline{\quad 4^\circ 13',5 \quad} \quad \text{increment)$$

$$\text{GHA} = 121^\circ 26',0 \quad G = \text{West} \rightarrow \text{subtract}$$

$$G = \underline{\quad 150^\circ 18' \quad} \text{ W} \quad G = \text{East} \rightarrow \text{add}$$

$$\text{LHA} = 331^\circ 08',0$$

$LHA < 180^\circ$; sun in the West; $P = LHA$

$LHA > 180^\circ$; sun in the East; $P = 360 - LHA$

$$P = 028^\circ 52',0$$

(d ↑ or ↓ = 1' ↓)

$$D = 05^\circ 26',1 \text{ S}$$

$$\text{corr. } d = \underline{\quad - 0',3 \quad} \downarrow$$

$$D = 05^\circ 25',8 \text{ S}$$

$$H_c = \arcsin (\sin (L : 33^\circ 21') \times \sin (D : - 05^\circ 25',8)$$

$$+ \cos (L : 33^\circ 21') \times \cos (D : - 05^\circ 25',8)$$

$$\times \cos (P : 028^\circ 52',0))$$

$$H_c = 42^\circ 33'$$

$$Z = \arccos ((\sin (D : - 05^\circ 25',8) - \sin (L : 33^\circ 21')$$

$$\times \sin (H_c : 42^\circ 33')) \div (\cos (L : 33^\circ 21')$$

$$\times \cos (H_c : 42^\circ 33'))) = 139^\circ,3$$

sun in the east $Z_v = Z$ / sun in the west $Z_v = 360 - Z$ $Z_v = 139^\circ,3$

$$H_o = 42^\circ 26',9$$

$$- H_c = \underline{\quad 42^\circ 33' \quad}$$

$$\text{intercept} = - 6',1$$

+ Intercept towards the sun

— Intercept away from the sun

$$\begin{aligned}
 H_s &= 56^\circ 17',5 \\
 \varepsilon &= -0',4 \\
 \text{Dip} &= \underline{-2',5} + \\
 H_a &= 56^\circ 14',6 \\
 \underline{\text{sun correct. LL/UL}} &= \underline{15',3} +
 \end{aligned}$$

$$H_o = 56^\circ 29',9$$

Pointe -à- Pitre

Date 26 / 09 / 2022

UT 13h 54m 01s

$$\begin{aligned}
 \text{index error} &= -2' \\
 + \text{non adjust.error} &= \underline{+1',6} + \\
 \varepsilon &= -0',4
 \end{aligned}$$

L = 16°34' N

G = 059°25' W

Height of the eye = 2 m

lower limb upper limb

$$\begin{aligned}
 \text{GHA} &= 017^\circ 10',2 \\
 + pp &= \underline{13^\circ 30',3} \quad (\text{increment})
 \end{aligned}$$

GHA = 030°40',5 G = West → subtract

G = 059°25',0 W G = East → add

LHA = 331°15',5

LHA < 180° ; sun in the West; P = LHA

LHA > 180° ; sun in the East; P = 360 - LHA

$$P = 028^\circ 44',5$$

(d ↑ or ↓ = 1' ↑)

D = 01°21',8 S

corr. d = 0',9 ↑

D = 01°22',7 S

$$H_c = \arcsin (\sin (L : 16^\circ 34') \times \sin (D : -01^\circ 22',7)$$

$$+ \cos (L : 16^\circ 34') \times \cos (D : -01^\circ 22',7)$$

$$\times \cos (P : 028^\circ 44',5))$$

$$H_c = 56^\circ 26',3$$

$$Z = \arccos ((\sin (D : -01^\circ 22',7) - \sin (L : 16^\circ 34')$$

$$\times \sin (H_c : 56^\circ 26',3)) \div (\cos (L : 16^\circ 34')$$

$$\times \cos (H_c : 56^\circ 26',3)) = 119^\circ,6$$

sun in the east Zv = Z / sun in the west Zv = 360 - Z **Zv = 119°,6**

$$H_o = 56^\circ 29',9$$

$$- H_c = \underline{56^\circ 26',3}$$

$$\text{intercept} = + 3',3$$

+ Intercept towards the sun

- Intercept away from the sun

$$\begin{aligned}
H_s &= 46^\circ 07',3 \\
\varepsilon &= 7' \\
\text{Dip} &= \underline{\quad - 3',6 \quad} + \\
H_a &= 46^\circ 10',7 \\
+ \text{sun correct. LL/UL} &= \underline{\quad 15',1 \quad} + \\
\mathbf{H_o} &= \mathbf{46^\circ 25',8}
\end{aligned}$$

Rotterdam

Date 11 / 06 / 2022

UT 08h 54m 01s

$$\begin{aligned}
& \text{index error} = + 5' \\
+ \text{non adjust. error} &= \underline{+ 2'} + \\
\varepsilon &= 7'
\end{aligned}$$

$L = 52^\circ 08' \text{ N}$

$G = 003^\circ 54' \text{ E}$

Height of the eye = 4 m

lower limb upper limb

$$\begin{aligned}
\text{GHA} &= 300^\circ 05',2 \\
+ pp &= \underline{13^\circ 30',3} \quad \text{increment) } \\
\text{GHA} &= 313^\circ 35',5 \quad \text{G = West} \rightarrow \text{subtract} \\
G &= \underline{003^\circ 54',0 \text{ E}} \quad \text{G = East} \rightarrow \text{add} \\
\text{LHA} &= 317^\circ 29',5 \\
\text{LHA} < 180^\circ &; \text{ sun in the West; } P = \text{LHA} \\
\text{LHA} > 180^\circ &; \text{ sun in the East; } P = 360 - \text{LHA} \\
\mathbf{P} &= \mathbf{042^\circ 30',5}
\end{aligned}$$

(d ↑ or ↓ = 0',2 ↑)

$$\begin{aligned}
D &= 23^\circ 05',4 \text{ N} \\
\text{corr. } d &= \underline{\quad 0',2 \quad} \uparrow \\
\mathbf{D} &= \mathbf{23^\circ 05',6 \text{ N}}
\end{aligned}$$

$$\begin{aligned}
H_c &= \arcsin (\sin (L : 52^\circ 08') \times \sin (D : 23^\circ 05',6) \\
&+ \cos (L : 52^\circ 08') \times \cos (D : 23^\circ 05',6) \\
&\times \cos (P : 042^\circ 30',5)) \\
\mathbf{H_c} &= \mathbf{46^\circ 32',5}
\end{aligned}$$

$$\begin{aligned}
Z &= \arccos ((\sin (D : 23^\circ 05',6) - \sin (L : 52^\circ 08') \\
&\times \sin (H_c : 46^\circ 32',5)) \div (\cos (L : 52^\circ 08') \\
&\times \cos (H_c : 46^\circ 32',5))) = \mathbf{115^\circ,4}
\end{aligned}$$

sun in the east $Z_v = Z$ / sun in the west $Z_v = 360 - Z$ **$Z_v = 115^\circ,4$**

$$\begin{aligned}
H_o &= 46^\circ 25',8 \\
- H_c &= \underline{46^\circ 32',5} \\
\text{intercept} &= - \mathbf{6',7}
\end{aligned}$$

+ Intercept towards the sun

— Intercept away from the sun