

Tähtitieteellinen merenkulku Tehtävien mallivastaukset

- Eksymän määrittäminen ja taivaankappaleen suuntimat

J



Päivitetty 10.3.2025

Tehtävä J1

Eksymän määrittäminen

Päivä	klo =	KrT =	Merkintäpaikka DR
	klk =	krk =	Lat ϕ 60° 00,0' N
10.9. →	ZT =	KrT = 10:16:14	Lon λ 025° 09,0' E
	zc =	12h 9:00	
10.9. →	UT =	UT = 10:25:14	Lon =
			-15
TT =	12:00:00	GHA = 330° 47,0'	ΔT =
$\pm ET$ =	-3:10	k^{ms} = +6° 18,5'	
LMT =	11:56:50	GHA = 337° 05,5'	
ΔT =	-1:40:36	$\pm \lambda$ = +25° 09,0'	d = -0,9
UT =	10:16:14	LHA = 362° 14,5'	Dec = +4° 44,7' N
		$\pm 360^\circ$ -360°	dk = -0,4'
Aluksen KS =	200°	LHA = 002° 14,5'	Dec = +4° 44,3' N
$\sin H_L = 0,5694481212$			Vast. J1 a)
HL = 34,7117505275°	ks = 200°	KS = 187°	
$\cos Z = -0,9988714755$	+eks = -10°	+eks = -10°	
$Z_d = 177,2777126156^\circ$	ms = 190°	MS = 177°	
$Z_d = 177,3^\circ$	+er = +6°	+er = +6°	
ts = 182,7°	ts = 196°	TS = 183°	
TS = Z, kun $\tau LHA > 180^\circ$ ja TS = 360° - Z, kun $\tau LHA < 180^\circ$			
Vast. J1 b)			
$\sin(H_L) = \sin(Lat) \cdot \sin(Dec) + \cos(Lat) \cdot \cos(Dec) \cdot \cos(LHA)$			
$\cos(Z) = (\sin(Dec) - \sin(Lat) \cdot \sin(H_L)) / (\cos(Lat) \cdot \cos(H_L))$			

Päivä	klo =	KrT =	Merkintäpaikka DR
	klk =	krk =	Lat ϕ
→	ZT =	KrT =	Lon λ
	zc =	12h	
→	UT =	UT =	Lon =
			-15
TT =		GHA =	ΔT =
$\pm ET$ =		k^{ms} =	
LMT =		GHA =	
ΔT =		$\pm \lambda$ =	d =
UT =		LHA =	Dec =
		$\pm 360^\circ$	dk =
Aluksen KS =		LHA =	Dec =
$\sin H_L =$			
HL =	ks =	KS =	
$\cos Z =$	+eks =	+eks =	
$Z_d =$	ms =	MS =	
$Z_d =$	+er =	+er =	
ts	ts =	TS =	
TS = Z, kun $\tau LHA > 180^\circ$ ja TS = 360° - Z, kun $\tau LHA < 180^\circ$			
$\sin(H_L) = \sin(Lat) \cdot \sin(Dec) + \cos(Lat) \cdot \cos(Dec) \cdot \cos(LHA)$			
$\cos(Z) = (\sin(Dec) - \sin(Lat) \cdot \sin(H_L)) / (\cos(Lat) \cdot \cos(H_L))$			

Tehtävä J2 (1. havainto)

5

Eksymän määrittäminen

Päivä	klo =	KrT =	Merkintäpaikka DR
	klk =	krk =	Lat ϕ 61° 35,4' N
4.5. →	ZT = 13:30	KrT =	Lon λ 027° 47,5' E
	zc = -2	12h	
4.5. →	UT = 11:30	UT =	Lon =
			-15
TT =	GHA = 345° 49,0'		
± ET =	k^{ms} = +7° 30,0'	ΔT =	
LMT =	GHA = 353° 19,0'		
ΔT =	± λ = +27° 47,5'	d = +0,7	
UT =	LHA = 381° 06,5'	Dec = +16° 07,4' N	
	± 360° -360°	dk = +0,4'	
Aluksen KS = 280°	LHA = 021° 06,5'	Dec = +16° 07,8' N	
sin H_L = 0,6707396362			
HL = 42,1241759685°	ks = 280°	KS = 200°	
cos Z = -0,8845907724	+eks = +1°	+eks = +1°	
Z_d = 152,2012036123°	ms = 281°	MS = 201°	
Z_d = 152,2°	+er = +7°	+er = +7°	
ts = 207,8°	ts = 288°	TS = 208°	
TS = Z, kun $\tau LHA > 180^\circ$ ja TS = 360° - Z, kun $\tau LHA < 180^\circ$			
sin(H_L) = sin(Lat) • sin(Dec) + cos(Lat) • cos(Dec) • cos(LHA)			
cos(Z) = (sin(Dec) - sin(Lat) • sin(HL)) / (cos(Lat) • cos(HL))			

Päivä	klo =	KrT =	Merkintäpaikka DR
	klk =	krk =	Lat ϕ
→	ZT =	KrT =	Lon λ
	zc =	12h	
→	UT =	UT =	Lon =
			-15
TT =	GHA =		
± ET =	k^{ms} =	ΔT =	
LMT =	GHA =		
ΔT =	± λ =	d =	
UT =	LHA =	Dec =	
	± 360°	dk =	
Aluksen KS =	LHA =	Dec =	
sin H_L =			
HL =	ks =	KS =	
cos Z =	+eks =	+eks =	
Z_d =	ms =	MS =	
Z_d =	+er =	+er =	
ts	ts =	TS =	
TS = Z, kun $\tau LHA > 180^\circ$ ja TS = 360° - Z, kun $\tau LHA < 180^\circ$			
sin(H_L) = sin(Lat) • sin(Dec) + cos(Lat) • cos(Dec) • cos(LHA)			
cos(Z) = (sin(Dec) - sin(Lat) • sin(HL)) / (cos(Lat) • cos(HL))			

Tehtävä J2 (2. havainto)

5

Eksymän määrittäminen

Päivä	klo =	KrT =	Merkintäpaikka DR	
	klk =	krk =	Lat φ	61° 35,4' N
4.5. →	ZT = 13:45	KrT =	Lon λ	027° 47,5' E
	zc = -2	12h		
4.5. →	UT = 11:45	UT =	Lon =	
			-15	
TT =	GHA = 345° 49,0'			
± ET =	k ^{ms} = +11° 15,0'	ΔT =		
LMT =	GHA = 357° 04,0'			
ΔT =	± λ = +27° 47,5'	d = +0,7		
UT =	LHA = 384° 51,5'	Dec = +16° 07,4' N		
	± 360° -360°	dk = +0,5'		
Aluksen KS = 190°	LHA = 024° 51,5'	Dec = +16° 07,9' N		
sin H _L = 0,6590825937				
HL = 41,2299436505°	ks = 190°	KS = 210°		
cos Z = -0,8436167889	+eks = -4°	+eks = -4°		
Z _d = 147,5240377265°	ms = 186°	MS = 206°		
Z _d = 147,5°	+er = +7°	+er = +7°		
ts = 212,5°	ts = 193°	TS = 213°		
TS = Z, kun τLHA > 180° ja TS = 360° - Z, kun τLHA < 180°				
sin(H _L) = sin(Lat) • sin(Dec) + cos(Lat) • cos(Dec) • cos(LHA)				
cos(Z) = (sin(Dec) - sin(Lat) • sin(H _L)) / (cos(Lat) • cos(H _L))				

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Päivä	klo =	KrT =	Merkintäpaikka DR	
	klk =	krk =	Lat φ	
→	ZT =	KrT =	Lon λ	
	zc =	12h		
→	UT =	UT =	Lon =	
			-15	
TT =	GHA =			
± ET =	k ^{ms} =	ΔT =		
LMT =	GHA =			
ΔT =	± λ =	d =		
UT =	LHA =	Dec =		
	± 360°	dk =		
Aluksen KS =	LHA =	Dec =		
sin H _L =				
HL =	ks =	KS =		
cos Z =	+eks =	+eks =		
Z _d =	ms =	MS =		
Z _d =	+er =	+er =		
ts =	ts =	TS =		
TS = Z, kun τLHA > 180° ja TS = 360° - Z, kun τLHA < 180°				
sin(H _L) = sin(Lat) • sin(Dec) + cos(Lat) • cos(Dec) • cos(LHA)				
cos(Z) = (sin(Dec) - sin(Lat) • sin(H _L)) / (cos(Lat) • cos(H _L))				

Tehtävä J2b

Huom: Magneettinen suunta on sama kaikissa kompassseissa tietyllä paikalla

	ks	eks	ms	er	ts
ohjaus (280°)	280	+1	281	+7	288
vara (280°)	278	+3	281		
	ks	eks	ms	er	ts
ohjaus (190°)	190	-4	186	+7	193
vara (190°)	192	-6	186		

Tehtävä J3

Eksymän määrittäminen

Päivä	klo =	KrT =	Merkintäpaikka DR
	klk =	krk =	Lat ϕ -60° 08,0' S
21.11.→	ZT = 14:30	KrT =	Lon λ -024° 59,0' W
	zc = +2	12h	
21.11.→	UT = 16:30	UT =	Lon =
			-15
TT =	GHA = 63° 30,1'		
± ET =	k ^{ms} = +7° 30,0'		ΔT =
LMT =	GHA = 71° 00,1'		
ΔT =	± λ = -24° 59,0'	d = -0,5	
UT =	LHA = 46° 01,1'	Dec = -20° 04,5' S	
	± 360°	dk = -0,3'	
Aluksen KS = 275°	LHA = 46° 01,1'	Dec = -20° 04,8' S	
sin H _L = 0,6225258633			
HL = 38,5008219199°	ks = 275°	KS = 303°	
cos Z = 0,5042121604	+eks = +2°	+eks = +2° ← a)	
Z _d = 59,7209322279°	ms = 277° ← c)	MS = 305°	
Z _d = 59,7°	+er = -5°	+er = -5°	
ts = 300,3°	ts = 272° ← c)	TS = 300°	
TS = Z, kun τLHA > 180° ja TS = 360° - Z, kun τLHA < 180°			
sin(H _L) = sin(Lat) • sin(Dec) + cos(Lat) • cos(Dec) • cos(LHA)			
cos(Z) = (sin(Dec) - sin(Lat) • sin(HL)) / (cos(Lat) • cos(HL))			

Aluksen tosisuunta

(MS=sama)

Päivä	klo =	KrT =	Merkintäpaikka DR
	klk =	krk =	Lat ϕ
→	ZT =	KrT =	Lon λ
	zc =	12h	
→	UT =	UT =	Lon =
			-15
TT =	GHA =		
± ET =	k ^{ms} =		ΔT =
LMT =	GHA =		
ΔT =	± λ =	d =	
UT =	LHA =	Dec =	
	± 360°	dk =	
Aluksen KS =	LHA =	Dec =	
sin H _L =			
HL =	ks =	KS =	
cos Z =	+eks =	+eks =	
Z _d =	ms =	MS =	
Z _d =	+er =	+er =	
ts =	ts =	TS =	
TS = Z, kun τLHA > 180° ja TS = 360° - Z, kun τLHA < 180°			
sin(H _L) = sin(Lat) • sin(Dec) + cos(Lat) • cos(Dec) • cos(LHA)			
cos(Z) = (sin(Dec) - sin(Lat) • sin(HL)) / (cos(Lat) • cos(HL))			

Varakompassi

282°
-5° ← b)
277°

Tehtävä J4

Eksymän määrittäminen

Päivä	klo =	KrT =	Merkintäpaikka DR
	klk =	krk =	Lat ϕ +58° 30,0' N
20.3.→	ZT = 10:30	KrT =	Lon λ -020° 59,0' W
	zc = +1	12h	
20.3.→	UT = 11:30	UT =	Lon =
			-15
TT =	GHA = 343° 09,1'		
± ET =	k^{ms} = +7° 30,0'	ΔT =	
LMT =	GHA = 350° 39,1'		
ΔT =	± λ = -20° 59,0'	d = +1,0	
UT =	LHA = 329° 40,1'	Dec = +0° 03,4' N	
	± 360°	dk = +0,5'	
Aluksen KS = 260°	LHA = 329° 40,1'	Dec = +0° 03,9' N	
sin H_L = 0,4519441695			
HL = 26,8684884304°	ks = 146°	KS = 260°	
cos Z = -0,8243179080	+eks = +5°	+eks = +5°	
Z_d = 145,5193984797°	ms = 151°	MS = 265°	
Z_d = 145,5°	+er = -5°	+er = -5°	
ts = 145,5°	ts = 146°	TS = 260°	
TS = Z, kun $\tau LHA > 180^\circ$ ja TS = 360° - Z, kun $\tau LHA < 180^\circ$			
sin(H_L) = sin(Lat) • sin(Dec) + cos(Lat) • cos(Dec) • cos(LHA)			
cos(Z) = (sin(Dec) - sin(Lat) • sin(HL)) / (cos(Lat) • cos(HL))			

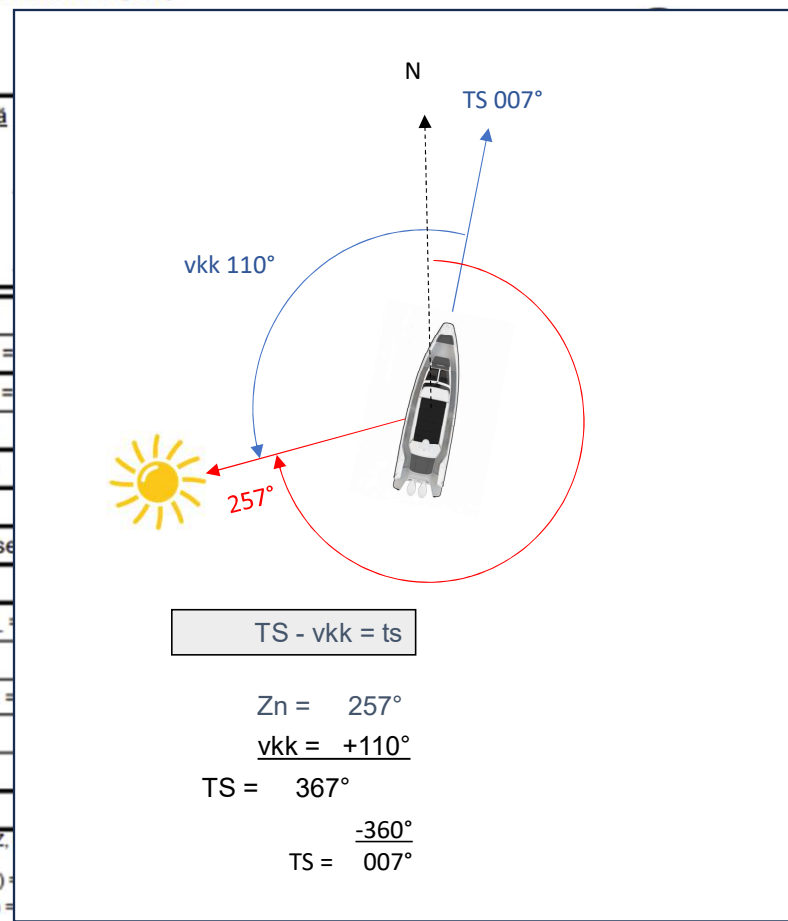
Päivä	klo =	KrT =	Merkintäpaikka DR
	klk =	krk =	Lat ϕ
→	ZT =	KrT =	Lon λ
	zc =	12h	
→	UT =	UT =	Lon =
			-15
TT =	GHA =		
± ET =	k^{ms} =	ΔT =	
LMT =	GHA =		
ΔT =	± λ =	d =	
UT =	LHA =	Dec =	
	± 360°	dk =	
Aluksen KS =	LHA =	Dec =	
sin H_L =			
HL =	ks =	KS =	
cos Z =	+eks =	+eks =	
Z_d =	ms =	MS =	
Z_d =	+er =	+er =	
ts =	ts =	TS =	
TS = Z, kun $\tau LHA > 180^\circ$ ja TS = 360° - Z, kun $\tau LHA < 180^\circ$			
sin(H_L) = sin(Lat) • sin(Dec) + cos(Lat) • cos(Dec) • cos(LHA)			
cos(Z) = (sin(Dec) - sin(Lat) • sin(HL)) / (cos(Lat) • cos(HL))			

Tehtävä J5

Eksymän määrittäminen

Päivä	klo =	KrT =	Merkintäpaikka DR	
	klk =	krk =		
	6.9. → ZT = 16:33	KrT =		Lat ϕ +55° 20,6' N
	zc = -1	12h		Lon λ +016° 52,0' E
6.9. →	UT = 15:33	UT =	Lon =	
TT =		GHA = 45° 27,3'	-15	
± ET =		k ^{ms} = +8° 15,0'	ΔT =	
LMT =		GHA = 53° 42,3'		
ΔT =		± λ = +016° 52,0'	d = -0,9	
UT =		LHA = 70° 34,3'	Dec = +6° 10,4' N	
		± 360°	dk = -0,5'	
Aluksen KS =		LHA = 70° 34,3'	Dec = +6° 09,9' N	
sin H _L = 0,2726713487				
HL = 15,8232896974°		ks =	KS =	
cos Z = -0,2242494228		+eks =	+eks =	
Z _d = 102,9587454590°		ms =	MS =	
Z _d = 103,0°		+er =	+er =	
ts = 257,0°		ts =	TS =	
TS = Z, kun τ LHA > 180° ja TS = 360° - Z, kun τ LHA < 180°				
sin(H _L) = sin(Lat) • sin(Dec) + cos(Lat) • cos(Dec) • cos(LHA)				
cos(Z) = (sin(Dec) - sin(Lat) • sin(H _L)) / (cos(Lat) • cos(H _L))				

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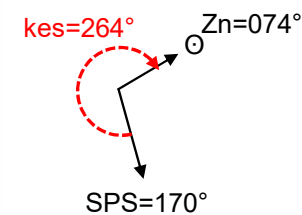
10/03/2025

Eksymän määrittäminen

Päivä	klo =	KrT =	Merkintäpaikka DR	
	klk =	krk =	Lat ϕ -18° 18,0' S	
21.3.→	ZT = 14:20	KrT = 11:20:20	Lon λ -037° 12,0' W	
	zc = +3	12h		
21.3.→	UT = 11:20	UT = 11:20:20	Lon = -37° 12,0'	
			-15	
TT =	GHA = 343° 13,6'		$\Delta T = +2,48$	
$\pm ET =$	$k^{ms} = +5^{\circ} 05,0'$			
LMT =	GHA = 348° 18,6'			
$\Delta T =$	$\pm \lambda = -037^{\circ} 12,0'$	$d = +1,0$		
UT =	LHA = 311° 06,6'	Dec = +0° 27,1' N		
	$\pm 360^{\circ}$	dk = +0,3'		
Aluksen KS =	LHA = 311° 06,6'	Dec = +0° 27,4' N		
sin $H_L = 0,6217312399$				
HL = 38,4426692922°	ks =	KS =		
cos Z = 0,2732499467	+eks =	+eks =		
$Z_d = 74,1422504739^{\circ}$	ms =	MS =		
$Z_d = 74,1^{\circ}$	+er =	+er =		
ts = 074,1°	ts =	TS =		
TS = Z, kun $\tau LHA > 180^{\circ}$ ja TS = $360^{\circ} - Z$, kun $\tau LHA < 180^{\circ}$				
sin(H_L) = sin(Lat) • sin(Dec) + cos(Lat) • cos(Dec) • cos(LHA)				
cos(Z) = (sin(Dec) - sin(Lat) • sin(HL)) / (cos(Lat) • cos(HL))				

Päivä	klo =	KrT =	Merkintäpaikka DR	
	klk =	krk =	Lat ϕ	
→	ZT =	KrT =	Lon λ	
	zc =	12h		
→	UT =	UT =	Lon =	
			-15	
TT =	GHA =		$\Delta T =$	
$\pm ET =$	$k^{ms} =$			
LMT =	GHA =			
$\Delta T =$	$\pm \lambda =$	$d =$		
UT =	LHA =	Dec =		
	$\pm 360^{\circ}$	dk =		
Aluksen KS =	LHA =	Dec =		
sin $H_L =$				
HL =	ks =	KS =		
cos Z =	+eks =	+eks =		
$Z_d =$	ms =	MS =		
$Z_d =$	+er =	+er =		
ts =	ts =	TS =		
TS = Z, kun $\tau LHA > 180^{\circ}$ ja TS = $360^{\circ} - Z$, kun $\tau LHA < 180^{\circ}$				
sin(H_L) = sin(Lat) • sin(Dec) + cos(Lat) • cos(Dec) • cos(LHA)				
cos(Z) = (sin(Dec) - sin(Lat) • sin(HL)) / (cos(Lat) • cos(HL))				

N = 360°
SPS = -170°
Zn = +74°
kes = 264°



Eksymän määrittäminen

Päivä	klo =	KrT =	Merkintäpaikka DR	
	klk =	krk =	Lat ϕ +28° 45,0' N	
24.5.→	ZT = 17:00:30	KrT =	Lon λ -090° 45,0' W	
	zc = +6	12h		
24.5.→	UT = 23:00:30	UT =	Lon = -090° 45,0'	
			-15	
TT =	GHA = 165° 46,9'		ΔT = +6,05	
$\pm ET$ =	k^{ms} = +7,5'			
LMT =	GHA = 165° 54,4'			
ΔT =	$\pm \lambda$ = -090° 45,0'	d = +0,4		
UT =	LHA = 75° 09,4'	Dec = +20° 57,4' N		
	$\pm 360^\circ$	dk = 0,0'		
Aluksen KS =	LHA = 75° 09,4'	Dec = +20° 57,4' N		
sin H_L = 0,3817716073				
HL = 22,4434633409°	ks =	KS =		
cos Z = 0,2147727297	+eks =	+eks =		
Z_d = 77,5978057955°	ms =	MS =		
Z_d = 77,6°	+er =	+er =		
ts = 282,4°	ts =	TS =		
TS = Z, kun $\tau LHA > 180^\circ$ ja TS = $360^\circ - Z$, kun $\tau LHA < 180^\circ$				
sin(H_L) = sin(Lat) • sin(Dec) + cos(Lat) • cos(Dec) • cos(LHA)				
cos(Z) = (sin(Dec) - sin(Lat) • sin(HL)) / (cos(Lat) • cos(HL))				

Päivä	klo =	KrT =	Merkintäpaikka DR	
	klk =	krk =	Lat ϕ	
→	ZT =	KrT =	Lon λ	
	zc =	12h		
→	UT =	UT =	Lon =	
			-15	
TT =	GHA =		ΔT =	
$\pm ET$ =	k^{ms} =			
LMT =	GHA =			
ΔT =	$\pm \lambda$ =	d =		
UT =	LHA =	Dec =		
	$\pm 360^\circ$	dk =		
Aluksen KS =	LHA =	Dec =		
sin H_L =				
HL =	ks =	KS =		
cos Z =	+eks =	+eks =		
Z_d =	ms =	MS =		
Z_d =	+er =	+er =		
ts =	ts =	TS =		
TS = Z, kun $\tau LHA > 180^\circ$ ja TS = $360^\circ - Z$, kun $\tau LHA < 180^\circ$				
sin(H_L) = sin(Lat) • sin(Dec) + cos(Lat) • cos(Dec) • cos(LHA)				
cos(Z) = (sin(Dec) - sin(Lat) • sin(HL)) / (cos(Lat) • cos(HL))				

Tehtävä J7
Kartta
nro extra

Mittakaava(Mi)
10 mm = 1mpk
10, 5 tai 2mm

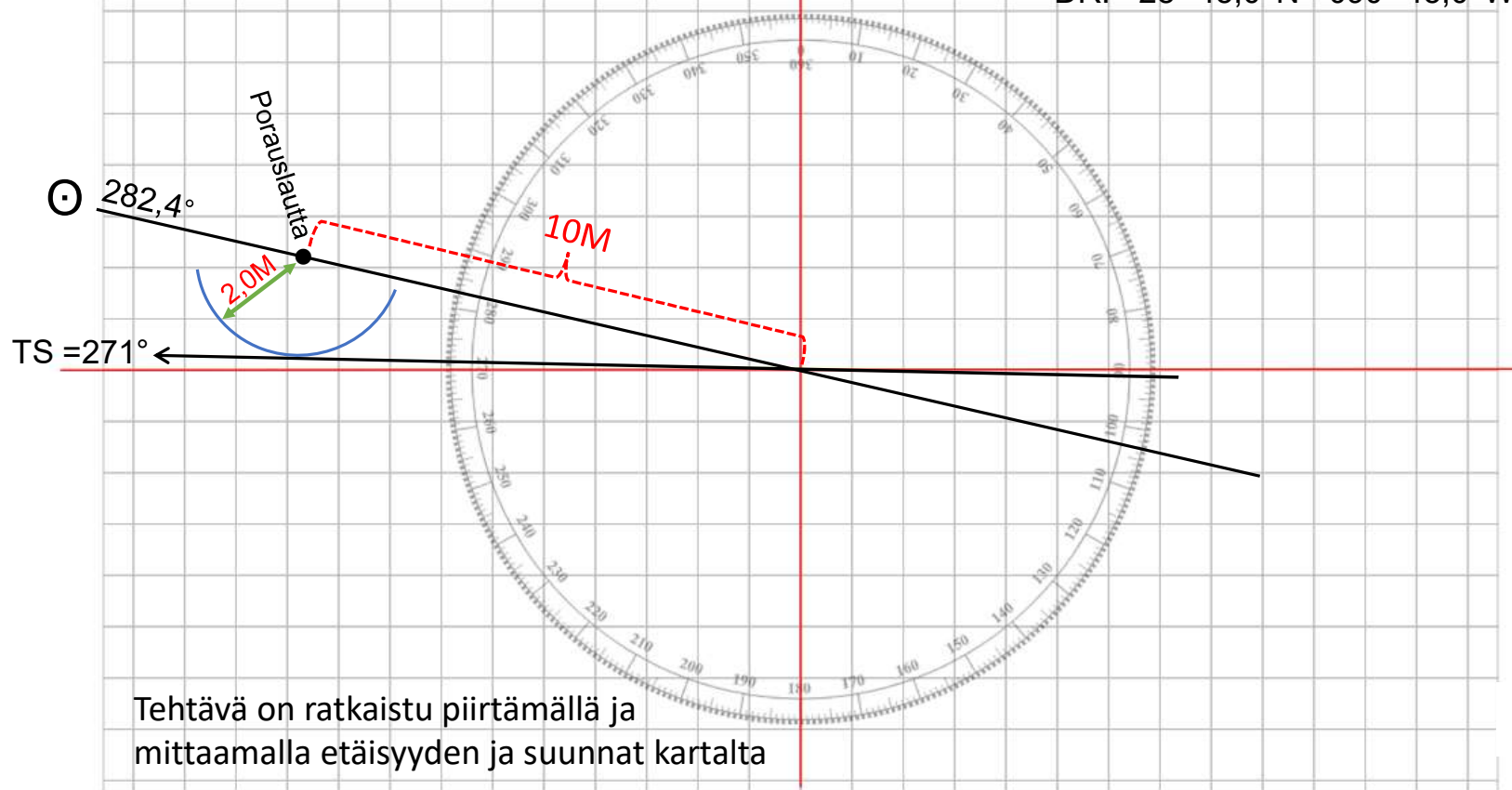
Mittakaava(Mi)
1"=10 mm

$\Delta \varphi = \frac{\Delta \varphi}{(Mi)} \text{ mm} =$

$\Delta \lambda = \frac{\Delta \lambda}{(Mi)} \text{ mm} \cos \varphi =$

$\varphi =$

DR: +28° 45,0' N -090° 45,0' W



Tehtävä J7
Kartta VE2
nro extra

Mittakaava(Mi)
10 mm = 1mpk
10, 5 tai 2mm

Mittakaava(Mi)
1"=10 mm

$$\Delta \varphi = \frac{\Delta \varphi}{(\text{Mi})} \frac{\text{mm}}{\text{mm}} = \text{---}$$

$$\Delta \lambda = \frac{\Delta \lambda}{(\text{Mi})} \frac{\text{mm}}{\text{mm}} \cos \varphi = \text{---}$$

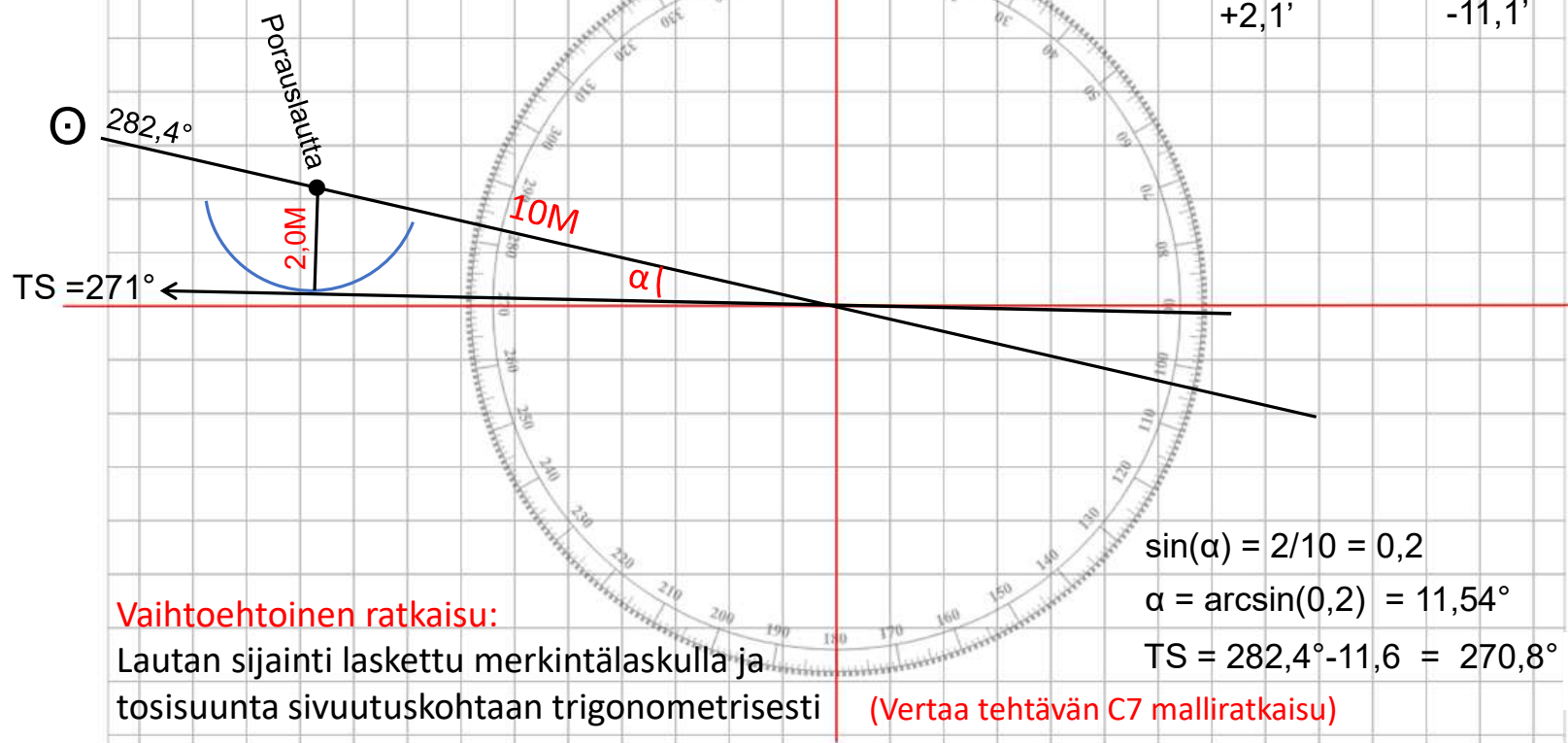
$$\varphi = \text{---}$$

Porauslautta: +28° 47,1' N -090° 56,1' W

DR: +28° 45,0' N -090° 45,0' W

+2,1'

-11,1'



MERKINTÄLASKU (tunnetaan matka ja suunta)

$\Delta\varphi = D \times \cos TS$	10	$M \cdot \cos$	282,4	$^{\circ}$	=	+2,147	$'$
$dep = D \times \sin TS$	10	$M \cdot \sin$	282,4	$^{\circ}$	=	-9,767	M
$\Delta\lambda = dep / \cos\varphi_k$	-9,767	$M / \cos$	28°46,1'	$^{\circ}$	=	-11,142	$'$

Keskitalitudi

φ_1	+28° 45,0'	N
$\Delta\varphi/2$	+1,1'	
φ_k	+28° 46,1'	N

Latitudi

φ_1	+28° 45,0'	N
$\Delta\varphi$	+2,1'	
φ_2	+28° 47,1'	N

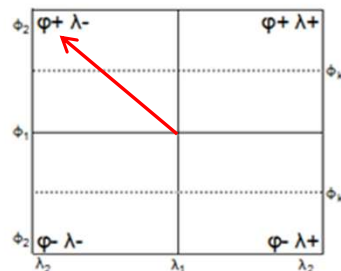
Longitudi

λ_1	+090° 45,0'	E
$\Delta\lambda$	-11,1'	
λ_2	+090° 56,1'	E

(N77,6°W)

Nopeus f	kn
Suunta K	°
Ajoaika Δt	h
Matka D	M

$t_2 =$	
$t_1 =$	
$\Delta t =$	



$\Delta\varphi = D \times \cos TS$	$M \cdot \cos$	$^{\circ}$	=		$'$
$dep = D \times \sin TS$	$M \cdot \sin$	$^{\circ}$	=		M
$\Delta\lambda = dep / \cos\varphi_k$	$M / \cos$	$^{\circ}$	=		$'$

Keskitalitudi

φ_1		
$\Delta\varphi/2$		
φ_k		

Latitudi

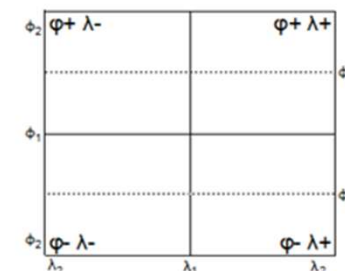
φ_1		
$\Delta\varphi$		
φ_2		

Longitudi

λ_1		
$\Delta\lambda$		
λ_2		

Nopeus f	kn
Suunta K	°
Ajoaika Δt	h
Matka D	M

$t_2 =$	
$t_1 =$	
$\Delta t =$	



Havaittu taivaankappale		Merkintä- paikka	Lat ϕ	S	-28° 49,8'
Aurinko (1)			Lon λ	W	-035° 35,0'
$H_i = 37^\circ 42,1'$	Päivä 21.7. →	klo _i =			KrT _i =
$ik = +3,3'$		klok =			krk =
$H_n = 37^\circ 45,4'$		ZT = 11:11:15			KrT =
Dip = -7,5'		zc = +2			+12h
$H_s = 37^\circ 37,9'$	21.7. →	UT = 13:11:15			UT =
rk = -17,0'	γ GHA =			HP =	
HPK =	★SHA =			v =	
pk =	GHA _i = 13° 24,0'			d = -0,5	
$\Delta R =$	$k^{ms} = 2^\circ 48,8'$			Dec _i = + 20° 20,8'	N
Uk =	vk =			$\pm dk = -0,1'$	
$H_t = 37^\circ 20,9'$	GHA = 16° 12,8'			Dec = + 20° 20,7'	N
$H_L = 37^\circ 23,5'$	$\pm \lambda = -035^\circ 35,0'$			Lon $\lambda =$	
$\Delta H = -2,6'$	LHA = -19° 22,2'			-15°	
kehti pois 2,6 mpk	$\pm 360^\circ +360^\circ$			$\Delta T =$	
Zn = 023,0°	LHA = 340° 37,8'			zc =	

$Z_n = z^\circ$ kun LHA $\geq 180^\circ$
 $Z_n = 360^\circ - z^\circ$ kun LHA $< 180^\circ$

$\sin(H_L) =$	0,6072565335
$H_L =$	37,3913957359°
$\cos(z) =$	0,9202228483
$z =$	23,0413174036°
$z^\circ =$	23,0°

$$\sin(H_L) = (\sin \text{Lat}) \cdot (\sin \text{Dec}) + (\cos \text{Lat}) \cdot (\cos \text{Dec}) \cdot (\cos \text{LHA}) \quad \cos(z) = ((\sin \text{Dec}) - (\sin \text{Lat}) \cdot (\sin H_L)) / ((\cos \text{Lat}) \cdot (\cos H_L))$$

Havaittu taivaankappale		Merkintä- paikka	Lat ϕ	S	-28° 58,6'
Aurinko (ennakko)			Lon λ	W	-036° 31,9'
$H_i =$	36° 41,2'	Päivä	klo _i =	KrT _i =	
ik =	+3,3'		klok =	krk =	
$H_n =$	36° 44,5'	21.7. →	ZT = 14:00:00	KrT =	
Dip =	-7,5'		zc = +2	+12h	
$H_a =$	36° 37,0'	21.7. →	UT = 16:00:00	UT =	
rk =	-17,1'	γ GHA =	HP =		
HPK =		★SHA =	v =		
pk =		GHA _i = 58° 24,0'	d = -0,5		
$\Delta R =$	②	k ^{ms} = ①	Dec _i = +20° 19,3'		N
Uk =		vk =	± dk = -0,0'		
$H_t =$	36° 19,9'	GHA = 58° 24,0'	Dec = +20° 19,3'		N
$H_L =$	36° 22,6'	± λ = -036° 31,9'	Lon λ =		
$\Delta H =$	-2,7'	LHA = 21° 52,1'	-15°		
kehti pois	2,7 mpk	± 360°	ΔT =		
Zn =	334,3°	LHA = 21° 52,1'	zc =		

$Z_n = z^\circ$ kun LHA $\geq 180^\circ$
 $Z_n = 360^\circ - z^\circ$ kun LHA $< 180^\circ$

$\sin(H_L) =$	0,5930887416
$H_L =$	36,3765024167°
$\cos(z) =$	0,9009990792
$z =$	25,7102959224°
$z^\circ =$	25,7°

Vyöhykeikalasku (1):

$$\frac{-35^\circ 35'}{-15^\circ} = +2,37222$$

zc = -2

Vyöhykeikalasku(2):

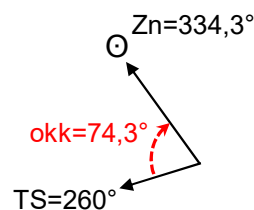
$$\frac{-36^\circ 31,9'}{-15^\circ} = +2,4354$$

zc = -2

Zn = 334,3°

TS = 260,0°

kk = +74,3°



MERKINTÄLASKU (tunnetaan matka ja suunta)

$\Delta\varphi = D \times \cos TS$	50,625	$M \cdot \cos$	260	$^{\circ}$	=	-8,7909	$'$
$dep = D \times \sin TS$	50,625	$M \cdot \sin$	260	$^{\circ}$	=	-49,856	M
$\Delta\lambda = dep / \cos\varphi_k$	-49,856	$M / \cos$	28°54,2'	$^{\circ}'$	=	-56,9499	$'$

Keskitatitudi

φ_1	-28° 49,8'	S
$\Delta\varphi/2$	-4,4'	
φ_k	-28° 54,2'	S

Latitudi

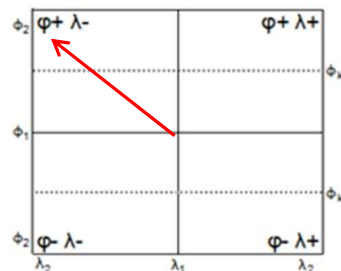
φ_1	-28° 49,8'	S
$\Delta\varphi$	-8,8'	
φ_2	-28° 58,6'	S

Longitudi

λ_1	-035° 35,0'	W
$\Delta\lambda$	-56,9'	
λ_2	-036° 31,9'	W

Nopeus f	18	kn
Suunta K	260	$^{\circ}$
Ajoaika Δt	2:48:45	h
Matka D	50,625	M

$t_2 =$	14:00:00
$t_1 =$	11:11:15
$\Delta t =$	2:48:45



(S102,4°W)

$\Delta\varphi = D \times \cos TS$	$M \cdot \cos$	$^{\circ}$	=		$'$
$dep = D \times \sin TS$	$M \cdot \sin$	$^{\circ}$	=		M
$\Delta\lambda = dep / \cos\varphi_k$	$M / \cos$	$^{\circ}'$	=		$'$

Keskitatitudi

φ_1		
$\Delta\varphi/2$		
φ_k		

Latitudi

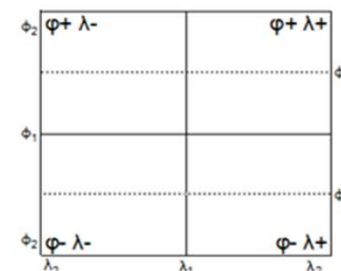
φ_1		
$\Delta\varphi$		
φ_2		

Longitudi

λ_1		
$\Delta\lambda$		
λ_2		

Nopeus f		kn
Suunta K		$^{\circ}$
Ajoaika Δt		h
Matka D		M

$t_2 =$	
$t_1 =$	
$\Delta t =$	



Tehtävä 3 (kirjan sivu 125)

Eksymän määrittäminen

Päivä	klo =	KrT =	Merkintäpaikka DR
	klk =	krk =	Lat ϕ +59° 38,0' N
25.5.→	ZT =	KrT =	Lon λ +023° 00,0' E
	zc =	12h	
25.5.→	UT = 04:52	UT =	Lon =
			-15
TT =	GHA = 240° 46,6'		ΔT =
$\pm ET$ =	k^{ms} = +13° 00,0'		
LMT =	GHA = 253° 46,6'		
ΔT =	$\pm \lambda$ = +023° 00,0'	d = +0,4	
UT =	LHA = 276° 46,6'	Dec = +20° 59,6' N	
	$\pm 360^\circ$	dk = +0,3'	
Aluksen KS = 045°	LHA = 276° 46,6'	Dec = +20° 59,9' N	
sin H_L = 0,3648703498			
HL = 21,3996040303°	ks = 078°	KS =	
cos Z = 0,0924669843	+eks = +3°	+eks =	
Z_d = 84,6944531291°	ms = 081°	MS =	
Z_d = 84,7°	+er = +4°	+er =	
ts = 084,7°	ts = 085°	TS =	
TS = Z, kun $\tau LHA > 180^\circ$ ja TS = 360° - Z, kun $\tau LHA < 180^\circ$			
sin(H_L) = sin(Lat) • sin(Dec) + cos(Lat) • cos(Dec) • cos(LHA)			
cos(Z) = (sin(Dec) - sin(Lat) • sin(HL)) / (cos(Lat) • cos(HL))			

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Päivä	klo =	KrT =	Merkintäpaikka DR
	klk =	krk =	Lat ϕ
→	ZT =	KrT =	Lon λ
	zc =	12h	
→	UT =	UT =	Lon =
			-15
TT =	GHA =		ΔT =
$\pm ET$ =	k^{ms} =		
LMT =	GHA =		
ΔT =	$\pm \lambda$ =	d =	
UT =	LHA =	Dec =	
	$\pm 360^\circ$	dk =	
Aluksen KS =	LHA =	Dec =	
sin H_L =			
HL =	ks =	KS =	
cos Z =	+eks =	+eks =	
Z_d =	ms =	MS =	
Z_d =	+er =	+er =	
ts =	ts =	TS =	
TS = Z, kun $\tau LHA > 180^\circ$ ja TS = 360° - Z, kun $\tau LHA < 180^\circ$			
sin(H_L) = sin(Lat) • sin(Dec) + cos(Lat) • cos(Dec) • cos(LHA)			
cos(Z) = (sin(Dec) - sin(Lat) • sin(HL)) / (cos(Lat) • cos(HL))			

LT = 7:52
st = -1
ST = 6:52
Sc = -2
UT = 4:52

Tehtävä 4 (kirjan sivu 125)

Eksymän määrittäminen

Päivä	klo =	KrT =	Merkintäpaikka DR
	klk =	krk =	Lat ϕ +60° 27,0' N
11.9. →	ZT = 17:24	KrT =	Lon λ +027° 14,0' E
	zc = -2	12h	
11.9. →	UT = 15:24	UT =	Lon = +27° 14,0'
			-15
TT =	GHA = 045° 53,4'		$\Delta T = -1,8155556$
$\pm ET =$	$k^{ms} = +6° 00,0'$		
LMT =	GHA = 051° 53,4'		
$\Delta T =$	$\pm \lambda = +027° 14,0'$		d = -0,9
UT =	LHA = 079° 07,4'		Dec = +4° 17,2' N
	$\pm 360°$		dk = -0,4'
Aluksen KS =	LHA = 079° 07,4'		Dec = +4° 16,8' N
$\sin H_L = 0,1577249907$			
HL = 9,0748711329°	ks = 260°	KS =	
$\cos Z = -0,1284991261$	+eks = -4°	+eks =	
$Z_d = 97,3828711574°$	ms = 256°	MS =	
$Z_d = 97,4°$	+er = +7°	+er =	
ts = 262,6°	ts = 263°	TS =	
TS = Z, kun $\tau LHA > 180°$ ja TS = 360° - Z, kun $\tau LHA < 180°$			
$\sin(H_L) = \sin(Lat) \cdot \sin(Dec) + \cos(Lat) \cdot \cos(Dec) \cdot \cos(LHA)$			
$\cos(Z) = (\sin(Dec) - \sin(Lat) \cdot \sin(H_L)) / (\cos(Lat) \cdot \cos(H_L))$			

Päivä	klo =	KrT =	Merkintäpaikka DR
	klk =	krk =	Lat ϕ
→	ZT =	KrT =	Lon λ
	zc =	12h	
→	UT =	UT =	Lon =
			-15
TT =	GHA =		$\Delta T =$
$\pm ET =$	$k^{ms} =$		
LMT =	GHA =		
$\Delta T =$	$\pm \lambda =$		d =
UT =	LHA =		Dec =
	$\pm 360°$		dk =
Aluksen KS =	LHA =		Dec =
$\sin H_L =$			
HL =	ks =	KS =	
$\cos Z =$	+eks =	+eks =	
$Z_d =$	ms =	MS =	
$Z_d =$	+er =	+er =	
ts =	ts =	TS =	
TS = Z, kun $\tau LHA > 180°$ ja TS = 360° - Z, kun $\tau LHA < 180°$			
$\sin(H_L) = \sin(Lat) \cdot \sin(Dec) + \cos(Lat) \cdot \cos(Dec) \cdot \cos(LHA)$			
$\cos(Z) = (\sin(Dec) - \sin(Lat) \cdot \sin(H_L)) / (\cos(Lat) \cdot \cos(H_L))$			