# Formula Sight Reduction Method

**Scenario**
D.R. Position: 51° 54'N 21° 55'W.
Date: 18 July 2009
Zone Time: $16^h$ $44^m$ (+1)
DWT: $17^h$ $50^m$ $28^s$
DWE $40^s$ fast
Body observed: Sun L.L.
Sextant Alt: 32° 10.'4. Azimuth: 261°
Index error: +0'.54
Ht. of eye: 8m.
Temperature: 28°C. Pressure: 991mb.

| **Sight Reduction Form for use with Cosine Formula Method** |
|---|
| **Observation Notes.**<br>**Date:** 18 July. 2009<br>**DR Pos:** 51° 54'N, 21° 55'W<br>**Zone:** $+1^h$<br>**Zone Time**: $16^h$ $44^m$<br>**Ht:** 8m.<br>**IE:** +0'.54<br>**DWT:** $17^h$ $50^m$ $28^s$ **DWE:** $-40^s$<br>**Temp:** 28°C. **Pressure:** 991mb.<br>**Body Observed:** Sun L.L.<br>**Sext. Alt:** 32° 10.'4 **Compass bearing:** 261° |
| |
| **Step 1. Convert DR lat and long to decimals.**<br>**Lat:** 51°.9N **Long:** 21°.9W<br>(Assumed positions are not used with formula method) |
| |
| **Step 2. Calculate PZ. (90 - Lat).**<br>**PZ = 38.1** |
| |
| **Step 3. Calculate Greenwich Date at time of observation.** |
| **Date:** 18 July. 2009 |
| **Zone time:** $16^h$ $44^m$ |
| **Zone correction:** $+1^h$ |
| **Universal Time (GMT):** $17^h$ $44^m$ |
| **Deck watch time:** $17^h$ $50^m$ $28^s$ |
| **Deck watch error:** $-40^s$ |

**Step 4.Calculate Greenwich Hour Angle and Declination.**

**Date:**

| | **GHA** | **Dec** |
|---|---|---|
| **UT:** $17^h$ | 73° 26′.1 | N20° 54′.7 (d:0′.5) |
| **Inc:** $49^m$ $48^s$ | +12° 27′.0 | -0′.4 |
| | 85° 53′.1 | N20° 54′.3 |
| **Decimalize:** | 85°.885 | N20°.9 |

**Step 5. Determine if Lat and Dec are 'Same' or 'Contrary'.**

**Lat:** 51°.9N **Dec:** N20°.9

**Same / Contrary** (select)

**Step 6. Calculate PX.** (90 - Dec if same) (90 + Dec if contrary).

**PX** = 69°.1

**Step 7 Calculate LHA:** **Long East, LHA = GHA + LONG** (- 360° as necessary)
**Long West, LHA = GHA – LONG** (+ 360° as necessary)

**GHA:** 85°.885

**DR Long:** 21°.9W West (-) East (+)

**LHA=** 63.98

**Step 8. Determine Angle ZPX.**

**ZPX = LHA** = 63.98

**Step 9. Calculate True Altitude at True Position**

| | | |
|---|---|---|
| **Sextant Altitude:** | 32° 10.′4 | |
| **Index error (IE):** | +0′.54 | |
| **Observed Altitude:** | 32° 10.′94 | |
| **Dip (ht.** 8m.**):** | -5′.0 | (table 6a) |
| **Apparent Altitude** | 32° 05.′94 | |
| **Altitude correction:** | +14′.50 | (table 6d) |
| **Added refraction:** | +0′.10 | (table 6c) |
| **True Altitude:** | 32° 20′.54 | |
| **Decimalize:** | 32°.342 | |

**Note compass bearing at time of observation:** 261°

**Step 10. Calculate Zenith Distance at True Pos. (90° - Altitude).**

**Zenith Dist** = 90° - 32°.342 = 57°.658

**Step 11. Calculate Zenith Distance at DR Position. (ZX).**

**ZPX :** 63.98 (From Step 7)

**PZ :** 38.1 (From Step 2)

**PX :** 69°.1 (From Step 6)

**Reminder:** The formula for calculating Zenith Distance (ZX) is:
Cos (ZX) = [Cos(PZ) x Cos(PX)] + [Sin(PZ) x Sin(PX) x Cos(ZPX)]
Substituting the values of PZ, PX, and ZPX in this formula, we have:
ZX =[Cos(38.1) x Cos(69°.1)] + [Sin(38.1) x Sin(69°.1) x Cos(63.98)]
=[0.7869 x 0.3567] + [0.6170 x 0.9342 x 0.4387]
= 0.2807 + 0.2528
= 0.5335
ZX = $Cos^{-1}$ (0.5335) = 57.7577
∴ **Zenith Distance at DR position** = 57.7577

**Step 12. Calculate Azimuth Angle at DR Position (PZX)**
**PZ** = 38.1 (From Step 2)
**PX** = 69°.1 (From Step 6)
**ZX** = 57.7577 (From Step 11)
**Reminder:** The formula for calculating azimuth angle (PZX) is:

$$\text{Cos PZX} = \frac{\text{Cos(PX)} - [\text{Cos(ZX)} \times \text{Cos(PZ)}]}{[\text{Sin(ZX)} \times \text{Sin(PZ)}]}$$

Substituting the values of PZ, PX and ZX in the above formula, we have:

$$\text{PZX} = \frac{\text{Cos(69.1)} - [\text{Cos(57.7577)} \times \text{Cos(38.1]}}{[\text{Sin(57.7577)} \times \text{Sin(38.1)}]}$$

$$= \frac{0.3567 - [0.5335 \times 0.7869]}{0.8458 \times 0.6170}$$

$$= \frac{0.3567 - 0.4198}{0.5219}$$

$$= \frac{-0.0631}{0.5219}$$

= -0.1209
PZX = $Cos^{-1}$(-0.1209) = 96.944
∴ **Calculated azimuth Angle at DR position = 096.944**

**Step 13. Convert azimuth angle (Z) to true azimuth (ZN):**

| **Rules for converting Azimuth Angle (Z) to True Azimuth (Zn)** | | |
|---|---|---|
| | **Lat. North** | **Lat. South** |
| **LHA>180°** | **Zn = Z** | **Zn = 180° - Z** |
| **LHA<180°** | **Zn = 360°-Z** | **Zn = 180° + Z** |

**DR Lat:** 51°.9N (from step 1)
**Azimuth Angle (Z):** 096.944 (from step 12)
**LHA :** 63.98 (from step 7)
**ZN** = 360°- 96.944 = 263° (calculate from the table above)
**Therefore calculated true azimuth at DR position** = 263°

**Step 14. Calculate intercept.**
**Reminder**: Subtract the ZD at the true position (a) from the ZD at the DR position (b).
- If the result is positive, the intercept is towards the azimuth.
- If the result is negative, the intercept is from the azimuth.

**a. Zen. Dist. at DR Pos:** 57°.7577 (from step 11)
**b. Zen. Dist. at True Pos:** 57°.658 (from step 10)

| | |
|---|---|
| **Intercept: a - b = 0°.0997 Convert to minutes:** 5.982' (multiply by 60) | |
| **True Azimuth:** 263° | |
| **Intercept:** 5.982 to 263° | |
| | |

**Step 15. Plot the position line.**
(Reminder: Plot intercept from DR position along azimuth line).
**DR Lat:** 51°.9N **DR Long:** 21°.9W (from step 1)
**Intercept:** 5.982' to 263° (from step 14)