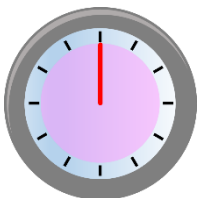
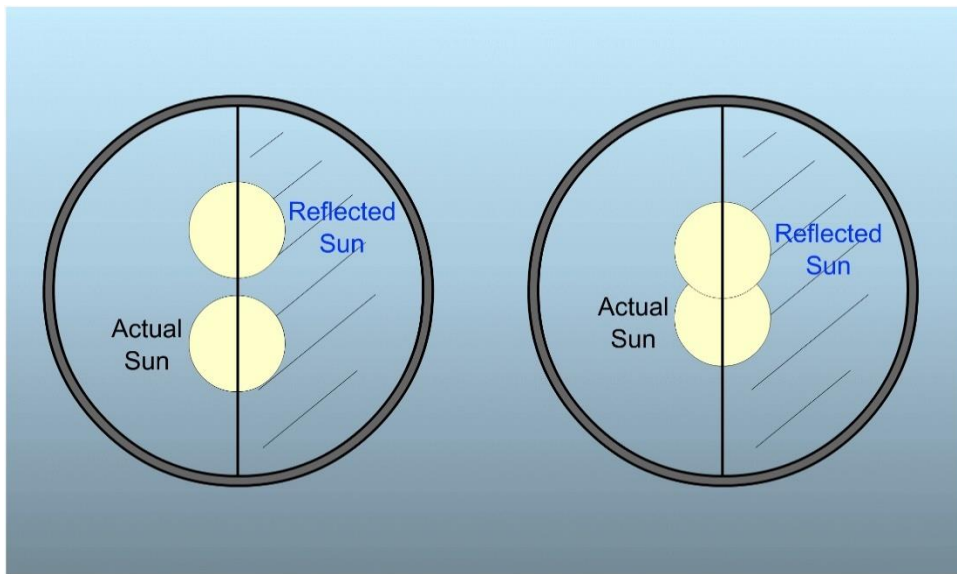


Celestial Navigation

Lesson 1.6

Evaluation of Index Error



Note

Knowledge of how to verify the sextant Index Error could be asked in the oral examination.

Lesson 1.6

Evaluation of Index Error



*You **MUST** have a sextant and a copy of the Nautical Almanac available to practice the techniques described in this Lesson.*

Checking the Index Error

The term *Index Error* is used to represent the residual errors, i.e. those remaining after the three *adjustable errors* have been removed.

The residual errors are determined by the manufacturer at the time the instrument is manufactured. This is done at various altitudes, usually every 10° or 15°. A Certificate is issued, dated and the sextant serial number noted.

Index Error is termed 'On the Arc' or 'Off the Arc'.



*Index error **ON THE ARC**: TAKE IT OFF (subtract)*

*Index error **OFF THE ARC**: PUT IT ON (add)*

If the navigator wishes to have the sextant Index Error re-checked then it should be returned to the manufacturer. A check can be made by the user as to confirm the Index Error value, however, this can only check the value for an altitude of 0° and an assumption is then made that the error is constant throughout the Arc which may not be the case.

There are a variety of methods of checking the Index Error. A good method is by observation of the Sun.



The shades must be used when looking at the Sun!

The following procedure should be followed:

- (1) Set the Micrometer to about 32' OFF the arc (actual reading 28' on the Micrometer drum).

- (2) Hold the sextant vertically looking directly at the Sun. The reflected Sun and the true Sun will appear one above the other; see figure 1.

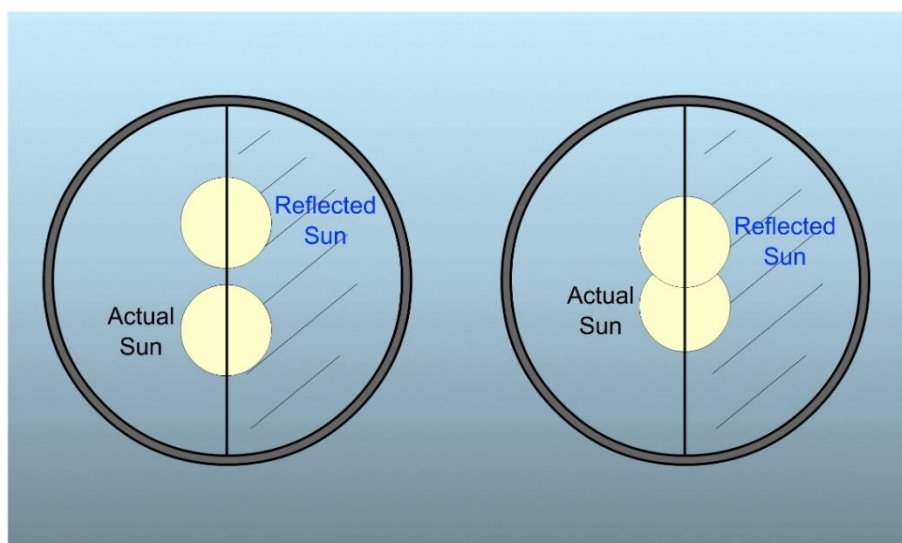


Fig. 1 - Sextant set 32' OFF the arc; initially the images may not be touching each other.

- (3) Adjust the Micrometer knob until the limbs of the two Suns are just touching each other and note the reading - figure 2.

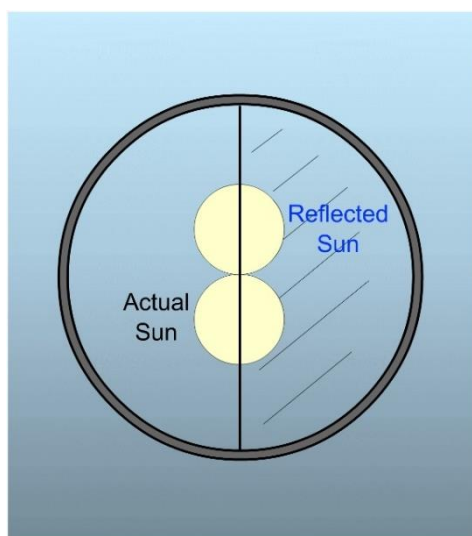


Fig. 2 - Adjust the Micrometer until the limbs of the two Suns are just touching.

- (4) Repeat this operation but this time with the Index Bar set at about 32' ON the arc and again note the reading.
- (5) Subtract the lesser reading from the greater; divide by 2 and name the Index Error according to which of the readings obtained is the larger; either ON or OFF the arc.

Example 1

Using the above method readings of 0° 34.5' OFF the arc and 0° 30.5' ON the arc were obtained. Determine the Index Error of the sextant and the semi-diameter of the Sun on the day of observation.

Solution

Reading OFF the arc	0° 34.5'
Reading ON the arc	0° 30.5'
Difference	0° 04.0'

$$\text{Index Error} = \frac{4.0'}{2} = 2.0' \text{ OFF the arc}$$

Reading OFF the arc	0° 34.5'
Reading ON the arc	0° 30.5'
Total	65.0'

$$\text{The observed semi-diameter (SD)} = \frac{65.0'}{4} = 16.25'$$

The advantage of this method of Index Error determination is in the ability to check its validity.

The sum of the readings divided by 4 gives the observed semi-diameter of the Sun, which can be checked in the Nautical Almanac for the date in question - see bottom of the daily pages.

0000 DECEMBER 27, 28, 29 (TUES., WED., THURS.)																
G.M.T. (UT)	SUN				MOON				Lat.	Twilight		Sunrise	Moonrise			
	G.H.A.	Dec.	G.H.A.	U	Dec.	d	H.P.	Naut.		Civil	27		28	29	30	
27 00	179 47.1 S23	20.4	343 21.3 12.6	N16 55.7	4.0 54.1	N 72	08 27	10 53	■	h m	h m	h m	h m	h m	h m	h m
01	194 46.8 20.3	357 52.9 12.7	16 51.7 4.2 54.1	68	07 51	09 20	■	16 17	17 47	19 19	20 52					
02	209 46.5 20.2	12 24.6 12.6	16 47.5 4.2 54.1	66	07 38	08 55	10 34	16 44	18 07	19 32	20 59					
03	224 46.2 20.1	26 56.2 12.7	16 43.3 4.2 54.2	64	07 27	08 36	09 53	17 05	18 22	19 42	21 05					
04	239 45.9 20.0	41 27.9 12.7	16 39.1 4.4 54.2	62	07 18	08 20	09 25	17 21	18 34	19 51	21 10					
05	254 45.6 19.9	55 59.6 12.7	16 34.7 4.4 54.2	60	07 10	08 06	09 04	17 34	18 45	19 58	21 14					
06	269 45.3 S23	19.8	70 31.3 12.8	N16 30.3	4.5 54.2	N 58	07 02	07 55	08 46	17 55	19 01	20 10	21 21			
07	284 45.0 19.7	85 03.1 12.7	16 25.8 4.6 54.2	56	06 55	07 44	08 32	17 46	18 54	20 05	21 18					
17	74 27.3 12.3	208 10.8 13.6	10 08.9 8.2 55.0	S 60	21 25	23 07		05 11	06 17	07 27	08 39					
18	89 27.0 S23	12.2	222 43.4 13.6	N10 00.7	8.3 55.0	Day	SUN		MOON							
19	104 26.7 12.0	237 16.0 13.6	9 52.4 8.3 55.0	Eqn. of Time 00 ^h	Mer. Pass.		Mer. Pass.		Age	Phase						
20	119 26.4 11.9	251 48.6 13.6	9 44.1 8.4 55.0				Upper	Lower								
21	134 26.1 11.7	266 21.2 13.6	9 35.7 8.4 55.0													
22	149 25.8 11.6	280 53.8 13.6	9 27.3 8.5 55.1	27	m s	m s	h m	h m	h m	d						
23	164 25.5 11.4	295 26.4 13.7	9 18.8 8.5 55.1	28	00 51	01 06	12 01	01 09	13 32	17						
	S.D. 16.3	d 0.1	S.D. 14.8 14.8 14.9	29	01 20	01 35	12 02	01 55	14 18	18						

Fig. 3 - The value of the Sun's SD is given in the Nautical Almanac for the middle day on the daily pages.

Note that the actual diameter of the Sun's disc changes throughout the year slightly as the Earth follows an elliptical orbit around the Sun which means that the distance between the Earth and the Sun varies, see Lesson 2.1.

Example 2

Two readings to determine the Index Error by Sun observation gave 32.8' ON the arc and 33.0' OFF the arc on 23rd January 0000.

Calculate the Index Error and check your answer by use of the Nautical Almanac.

Solution

Reading OFF the arc	0° 33.0'
Reading ON the arc	0° 32.8'
Difference	0° 00.2'

$$\text{Index Error} = \frac{0.2'}{2} = 0.1' \text{ OFF the arc}$$

Reading OFF the arc	0° 33.0'
Reading ON the arc	0° 32.8'
Total	65.8'

$$\text{The observed semi-diameter} = \frac{65.8'}{4} = 16.45'$$

From the Nautical Almanac the actual semi-diameter (SD) = 16.3'

This means that the Index Error as determined by observation was unacceptable!



If the observed and tabulated values DO NOT AGREE then the observation was INACCURATE and the obtained Index Error MUST NOT BE USED.

REDO THE OBSERVATION AND RECALCULATE THE INDEX ERROR!



If you have a Nautical Almanac on board use it to verify the Index Error of the sextant by observation of the Sun as described.