Master (Yachts)

Celestial Navigation

Lesson 1.1

The Principles and Parts of the Sextant

Note
Knowledge of the parts and principles of the sextant will be examined during the oral examination.

Lesson 1.1

The Principles and Parts of the Sextant

It would be beneficial if you have a sextant to hand whilst studying this Lesson.

Introduction

The marine sextant is an optical instrument used for measuring angles. It can measure angles in *one plane* only, this being known as the *plane of the instrument*. Thus, if the sextant is held horizontally it will measure horizontal angles and if held vertically it will measure vertical angles. It's most common marine use is in the measuring of vertical angles, or *altitudes*, of celestial bodies such as the Sun, Moon, planets and stars above the *visible* horizon. If, for any reason, the horizon is obscured, due to mist or bad light say, then no altitude can be taken.

The sextant is so called since the Arc, or measuring part of the instrument, is one sixth of a circle's circumference. There are other instruments, such as quintants (one fifth of a circle) and octants (one eighth of a circle), but these are not used nowadays for marine astronomical observations.

Fig. 1 - The marine sextant

Principles

Although the Arc of a sextant comprises *one sixth* of a circle the scale graduated on the Arc is about *one third* of a circle, or 120°. This is due to the second principle on which the instrument works.

The two basic principles of operation of the sextant are:

(1) The angle of *incidence* of a ray of light = the angle of *reflection* of the ray of light;

(2) If a ray of light suffers *two successive reflections* in the *same plane* by *two* plane mirrors, the angle between the first incident ray and the second reflected ray is *twice the angle between the mirr*ors.

These principles are illustrated in figure 2.

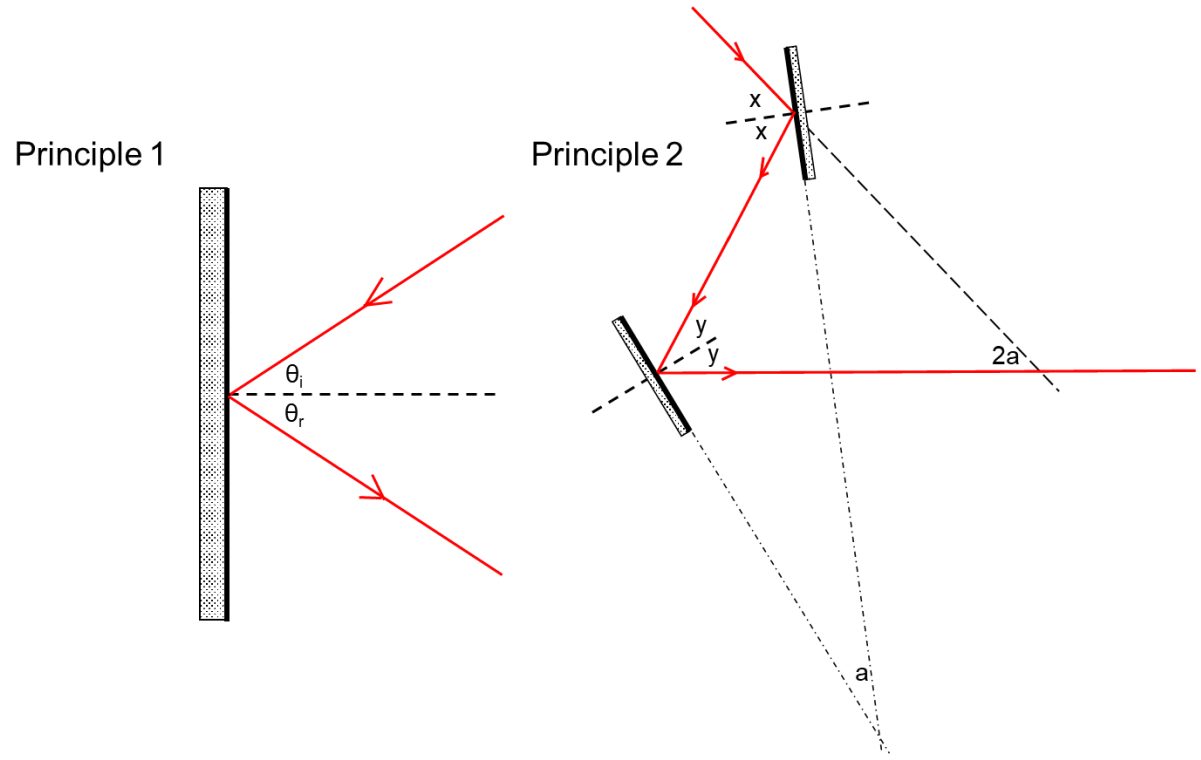

Fig. 2 - Principles of the sextant.

Consider also figure 3.

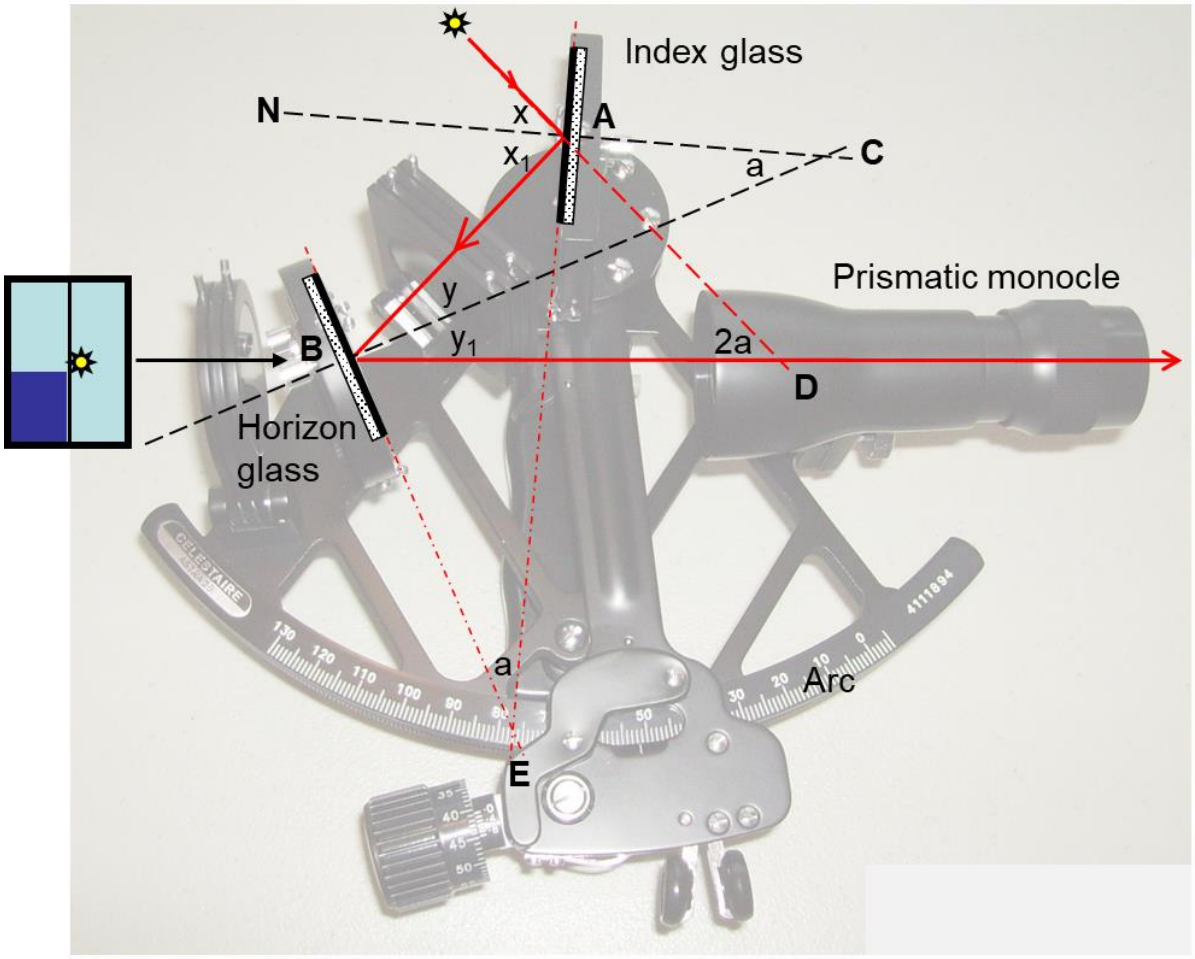

Fig. 3 - Principles of the sextant.

Angle between mirrors ***AEB*** = angle between normals of the two mirrors ***ACB***.

Angles $x_1 = x$ and $y_1 = y$ (angles of incidence and reflection).

In Δ ***ABC***, $x = ACB + y$ (exterior angle = the sum of the interior opposites)

$\therefore ACB = x - y$

In Δ ***ADB***, $2x = ADB + 2y$ (exterior angle = the sum of the interior opposites)

$\therefore ADB = 2x - 2y = 2(x-y)$

Since $x - y = ACB$,

then $ADB = 2ACB$.

You do not need to prove or remember this derivation, however, you DO NEED TO KNOW the two principles.

Thus, the Arc is graduated to indicate *twice* the angle through which the Index Bar and Index Mirror rotates from the zero mark on the scale (when the Index Mirror is parallel to the Horizon Mirror) to 120º (when the angle between the Index Mirror and Horizon Mirror is 60º or one sixth of a circle which is termed a sextant).

When the sextant is set at exactly zero the Index Mirror and Horizon Mirror *should* be parallel to each other.

This is often NOT the case; see Index Error later!

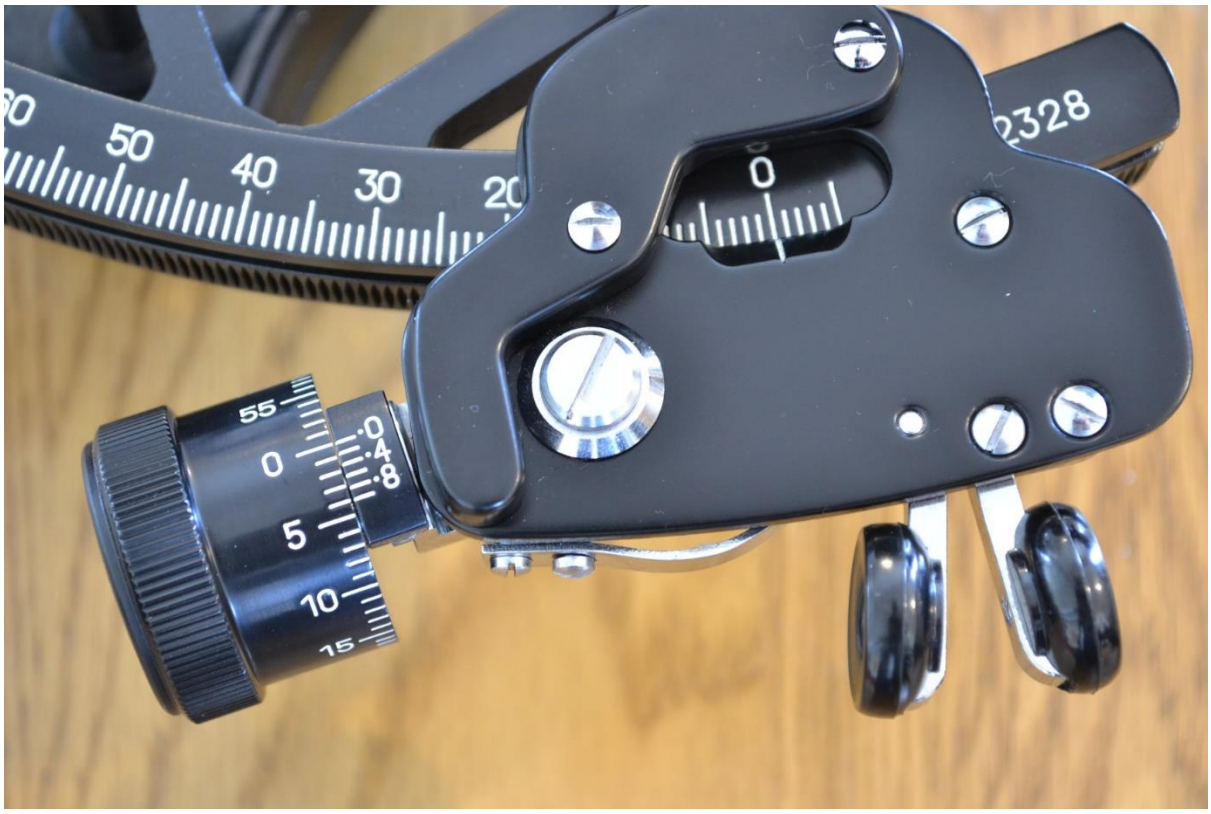

Fig. 4 - When the sextant is set at exactly zero the Index Mirror and Horizon Mirror should be parallel to each other.

The Horizon Mirror is fixed and any rotation of the Index Mirror does not alter the ray path from the index glass to the Horizon Mirror to the telescope. The image of the body is thus reflected from the Index Mirror to appear in the Horizon Mirror. In order for the horizon to be seen as well as the body, the Horizon Mirror is vertically divided so that it is silvered on the right hand side and left clear on the left hand side. The reflected body image is seen in the silvered part of the Horizon Mirror and the horizon in the clear part; the Index Bar is adjusted until the body and horizon are in line and the altitude can then be read from the Arc and the Micrometer drum.

Parts of the sextant

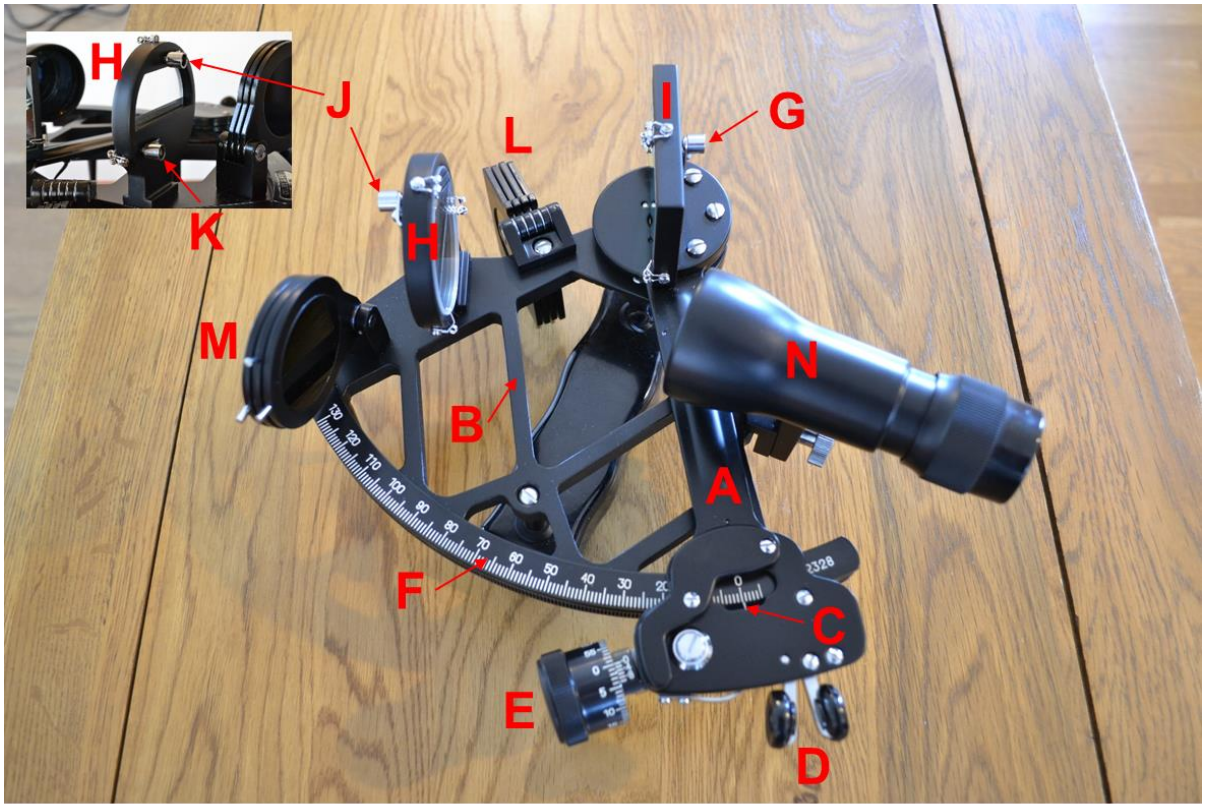

Fig. 5 - Parts of the sextant

KEY

A	Index Arm	F	Arc	K	Adjustment Screw
B	Frame	G	Adjustment Screw	L	Index Shades
C	Index Mark	H	Horizon Mirror	M	Horizon Shades
D	Clamp	I	Index Mirror	N	Prismatic Monocle
E	Micrometer Drum	J	Adjustment Screw		

Note
The Index Mirror has ONE adjustment screw; the Horizon Mirror has TWO adjustment screws.

Great care must be taken when using the sextant for altitude observations of the Sun!

The Index Shades must be used to prevent the user looking directly at the Sun through the Index Mirror; the Horizon Shades are to protect the observer from any reflective glare of the Sun from the sea; particularly when the Sun is low in the sky.

ALWAYS use maximum shading initially and remove the shades progressively until the Sun's disc can be seen with no glare that may otherwise damage your eyesight.

The Prismatic Monocle serves two purposes:

(1) To act as a telescope to make the image of the celestial body larger (for stars and planets) and thus improve accuracy of the sight, and;

(2) To allow corrective vision adjustment in the way that a pair of glasses would focus the image for the wearer.

Complete the Tutorial Exercise that accompanies this lesson.