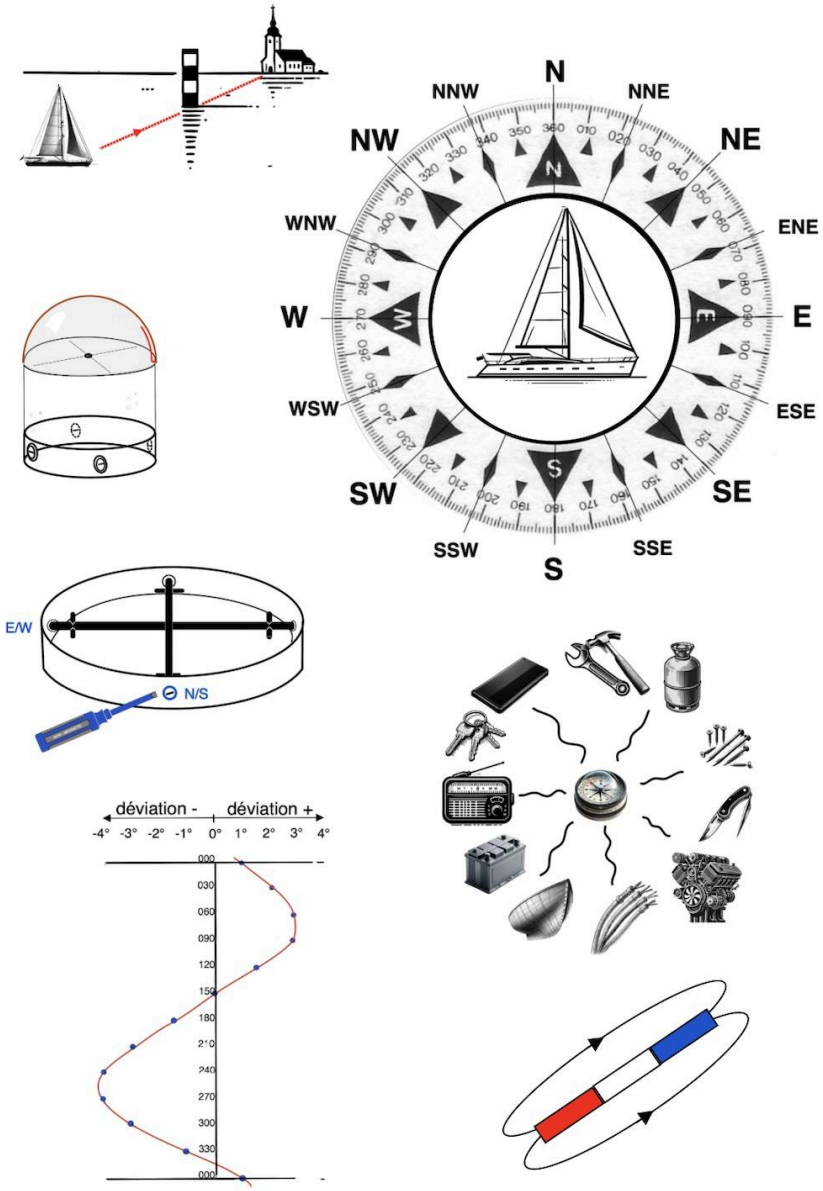
Measurements to Create a Deviation Card for Magnetic Steering Compasses

Illustrated Methods for Cruising Yachts from 9 to 18 Meters (30 to 60 feet)



A. Creating Deviation Cards (or Deviation Curves)

A.1 Creating a Deviation Card by Taking Simultaneous Readings from the Bearing Compass and the Steering Compass at Heading Intervals of 10°, 15°, 20°, 22.5°, or 30° (as per your choice).

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A.2 Creating a Deviation Card Using a Pelorus by Crossing a Known Alignment at Compass Headings Spaced 10°, 15°, 20°, 22.5°, or 30° — your choice — as Indicated by the Steering Compass.

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A.3 Creating a Deviation Card by Comparing the Steering Compass with the GPS Course at Compass Headings Spaced 10°, 15°, 20°, 22.5°, or 30° — your choice — as Indicated by the Steering Compass.

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There is a second guide available on my website, www.easysextant.com, titled *Adjustment of Magnetic Steering Compasses*, intended to correct significant deviations before creating the deviation card.

A1

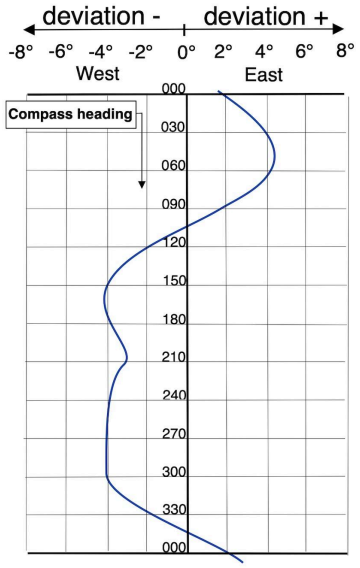
A.1

Deviation card for small ocean-going sailing vessels.

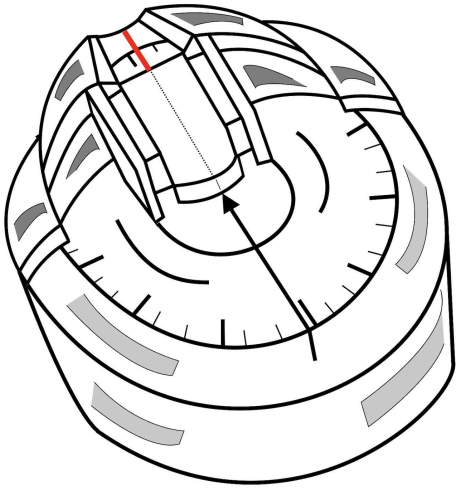
CH	MH	deviation.	CH	MH	deviation.
000°	....	....	180°	....	....
030°	....	....	210°	....	....
060	....	....	240°	....	....
090°	....	....	270°	....	....
120°	....	....	300°	....	....
150°	....	....	330°	....	....

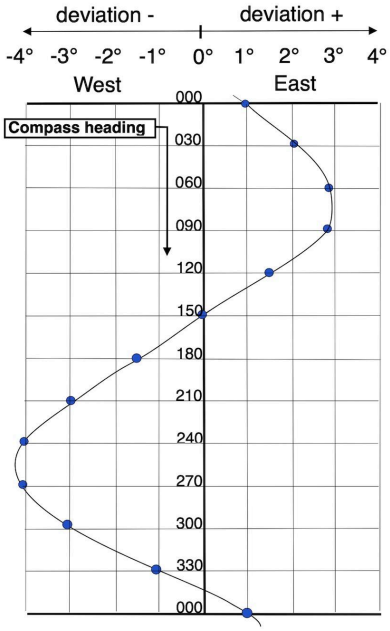
Ship's name:
Compass - Type & Serial Number:
Date of inspection:
Sea state & vessel position:
Method used:
Remarks:
Ship's Owner or inspector's name/signature:

From the completed deviation card, a compass deviation curve can be generated.



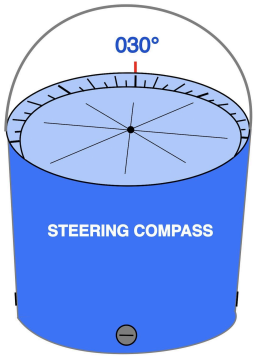
A.1 Creating a Deviation Card by Taking Simultaneous Readings from the Bearing Compass and the Steering Compass at Heading Intervals of 10°, 15°, 20°, 22.5°, or 30° (as per your choice).

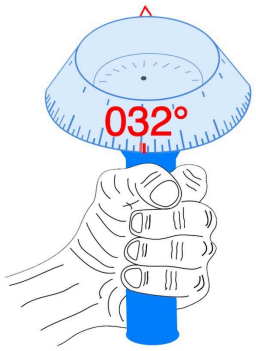




The main difficulty with this method lies in the fact that the reading of the hand-bearing compass must be taken precisely along the vessel's axis or strictly parallel to it.

A1 example 1

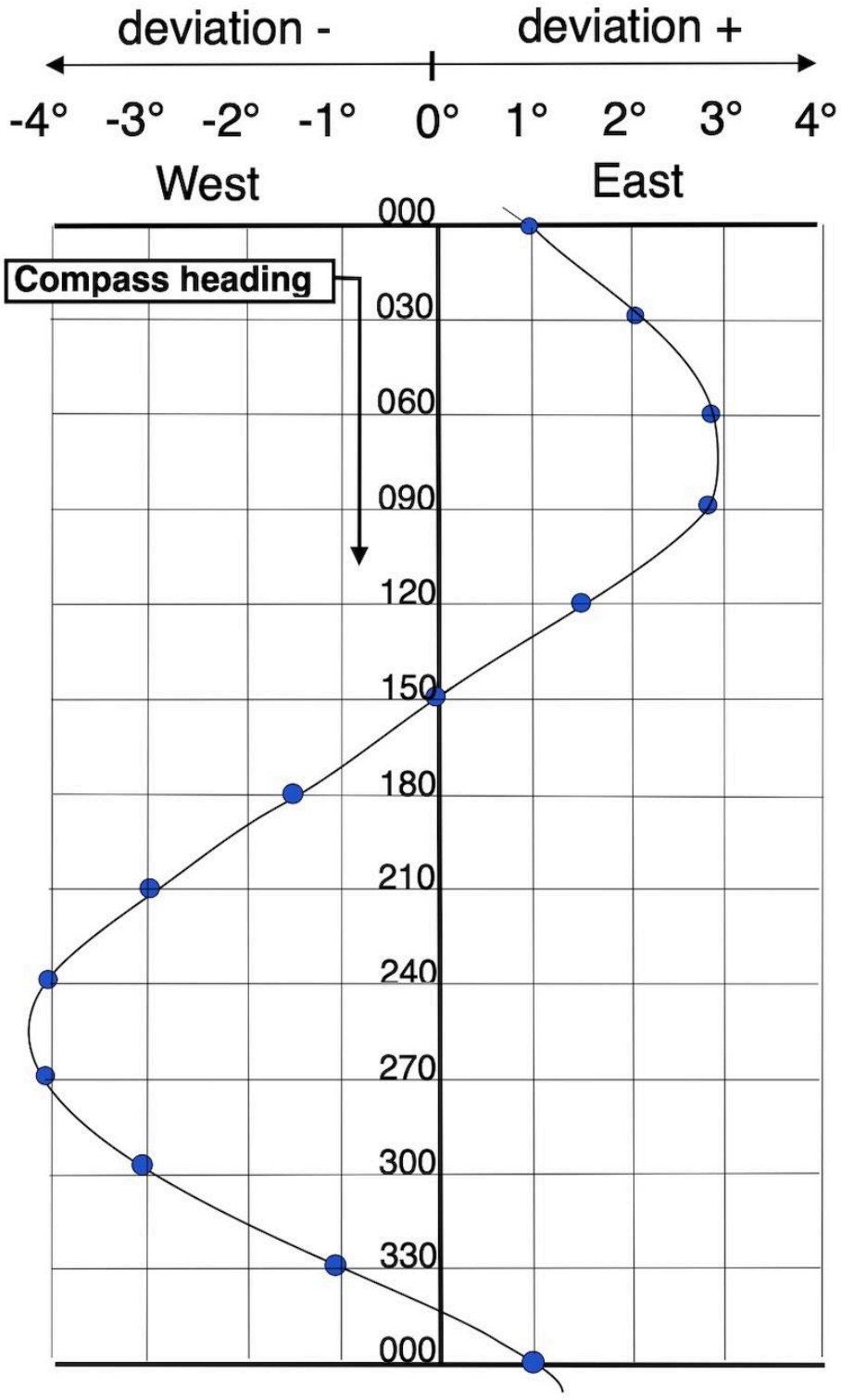




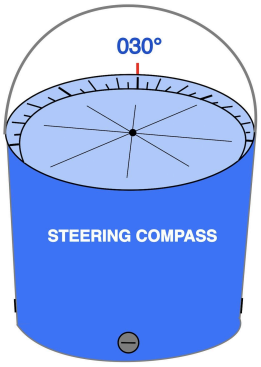
d = MH - CH

Compass heading CH	Magnetic heading MH	deviation (d)
000°	001°	+1°
030°	032°	**+2°**
060°	063°	+3°
090°	093°	+3°
120°	121,5°	+1,5°
150°	150°	0°
180°	178,5°	-1,5°
210°	207°	-3°
240°	236°	-4°
270°	266°	-4°
300°	297°	-3°
330°	329°	-1°

A.1 example 1


deviation -
deviation +
-4° -3° -2° -1° 0° 1° 2° 3° 4°
West
East
Compass heading
000
030
060
090
120
150
180
210
240
270
300
330
000

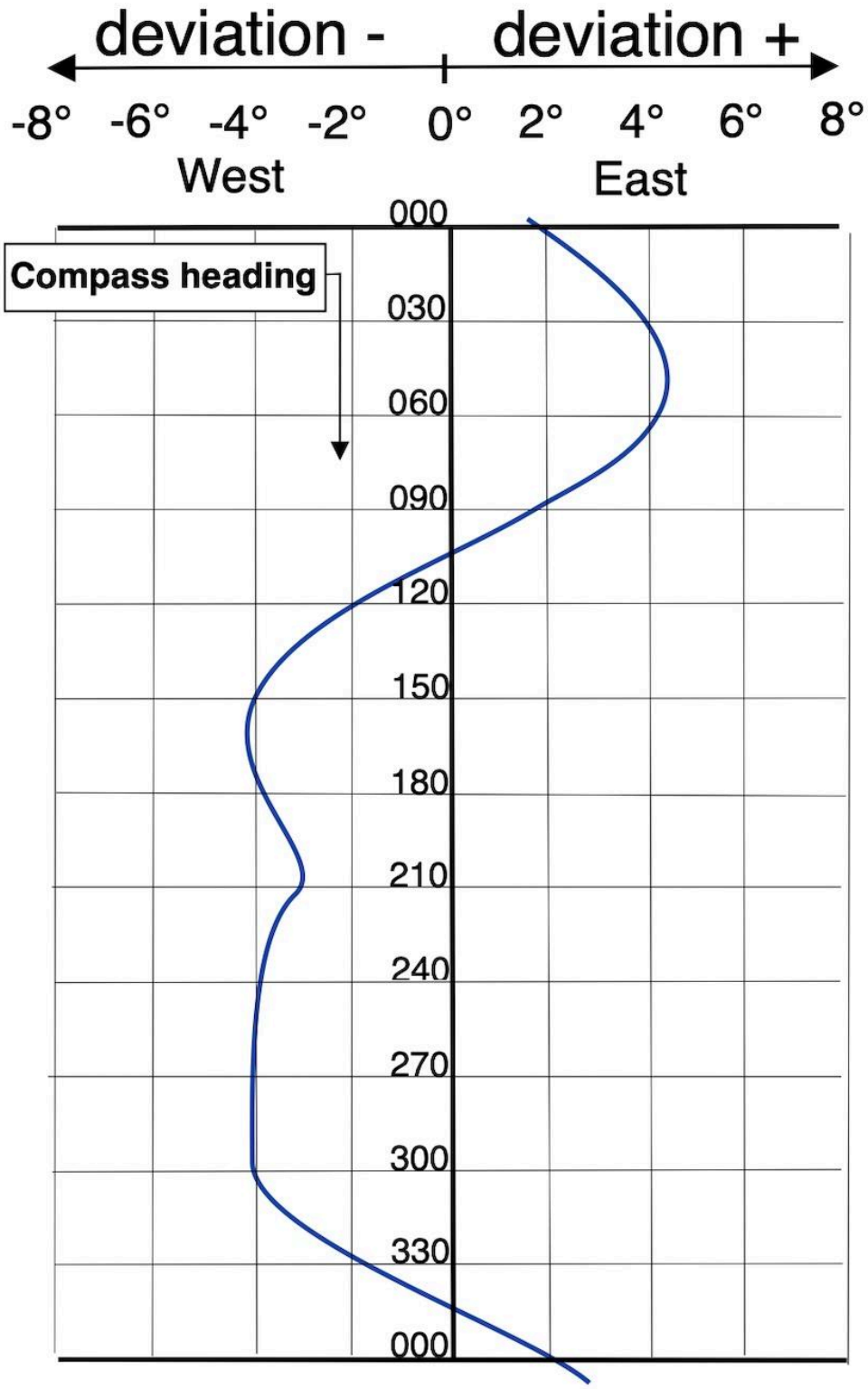
A.1 example 2



d = MH - CH

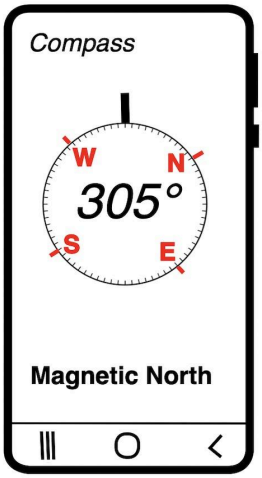
Compass heading CH	Magnetic heading MH	déviation (d)
000°	002°	+2°
030°	034°	**+4°**
060°	064°	+4°
090°	092°	+2°
120°	118°	-2°
150°	146°	-4°
180°	176°	-4°
210°	207°	-3°
240°	236°	-4°
270°	266°	-4°
300°	296°	-4°
330°	328°	-2°

A.1 example 2


deviation -
deviation +
-8° -6° -4° -2° 0° 2° 4° 6° 8°
West
East
Compass heading
000
030
060
090
120
150
180
210
240
270
300
330
000

A.1 Can a smartphone be used as a substitute for a hand-bearing compass?

A smartphone compass can serve as a preliminary tool to detect major deviations before carrying out a full adjustment.



It must be used in magnetic heading mode only, for comparison with the steering compass..

Use it in areas with low magnetic interference.

Accuracy depends on the quality of the sensors and their calibration.

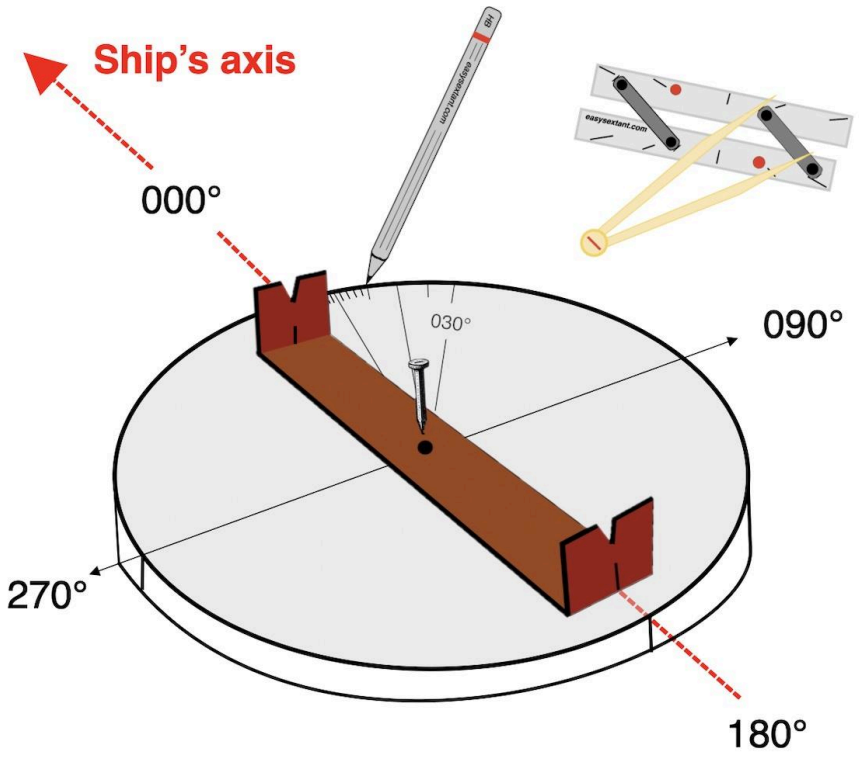
It is easy to align the lubber line parallel to the vessel's axis.

But, as always, critical navigation requires professionally calibrated compasses and appropriate equipment.

A2

A.2 Creating a Deviation Card Using a Pelorus by Crossing a Known Alignment at Compass Headings Spaced 10°, 15°, 20°, 22.5°, or 30° — your choice — as Indicated by the Steering Compass.

Artisanal pelorus



A.2 Creating a Deviation Card: using a pelorus to cross a bearing line on multiple different headings

On many boats, the steering compass can hardly be used as a bearing compass. This may be due to a flush-mounted compass or a non-flush-mounted one with limited visibility of the horizon. Obstacles such as the companionway hatch, cockpit bulkhead, solar panels, or a bimini top, for example, can also obstruct the view.

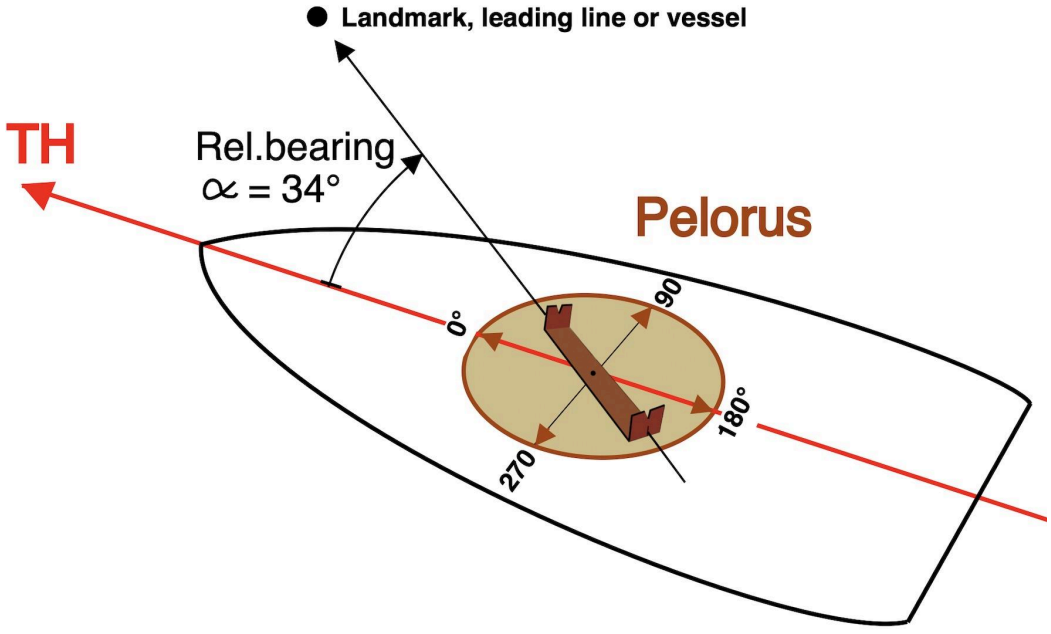
In addition, the domed shape of the compass housing often makes taking bearings difficult for several reasons:

-**Light reflections**, which interfere with reading the graduations and aiming accurately at the target.
-**Visual distortion** caused by the dome's curvature, which slightly alters angles and distorts the appearance of objects viewed through it.
-**Incompatibility with a sighting device**, which requires a flat surface for precise alignment.

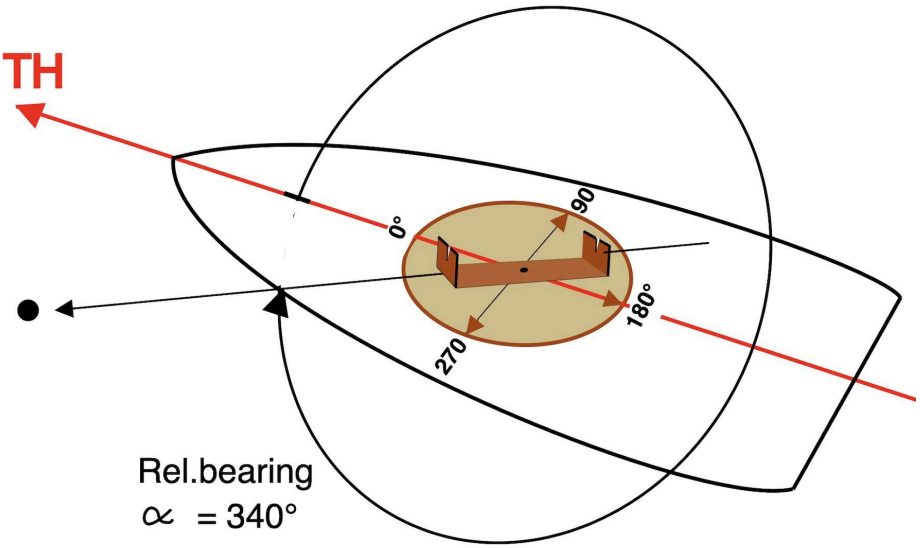
In such cases, a marine pelorus is used — a tool specifically designed for taking accurate bearings and placed in a location on the boat that offers an unobstructed line of sight. The pelorus itself contains no magnetic components.

Pelorus AUTONAUTIC

A pelorus is a measuring instrument used in marine navigation. It provides directional information known as the relative bearing (α), measured clockwise from 0° to 360° relative to the ship's heading.



A.2



The pelorus consists of:

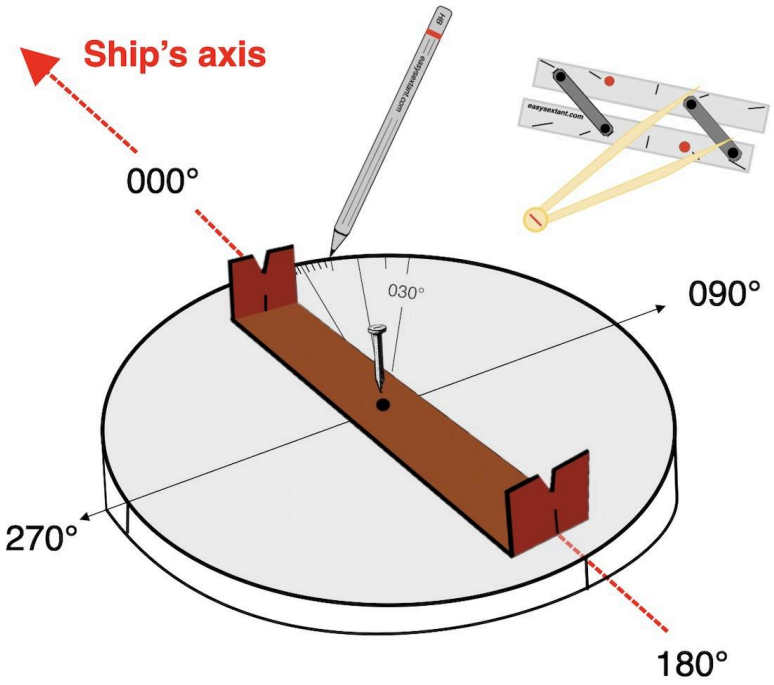
- **a fixed ring, graduated in degrees from 0° to 360° in a clockwise direction, with 0° aligned with the ship's forward axis;**

- **and a mounting system that allows it to be positioned in a stable, horizontal, and accessible manner.**

A sighting device (alidade) is mounted on the ring, allowing the user to aim at a fixed landmark or a moving object while reading the graduated scale.

The pelorus is a simple instrument that requires no power supply and allows the bearing of any object or landmark to be taken.

A.2 It is easy to make one yourself. You can download a compass rose (see illustration below).

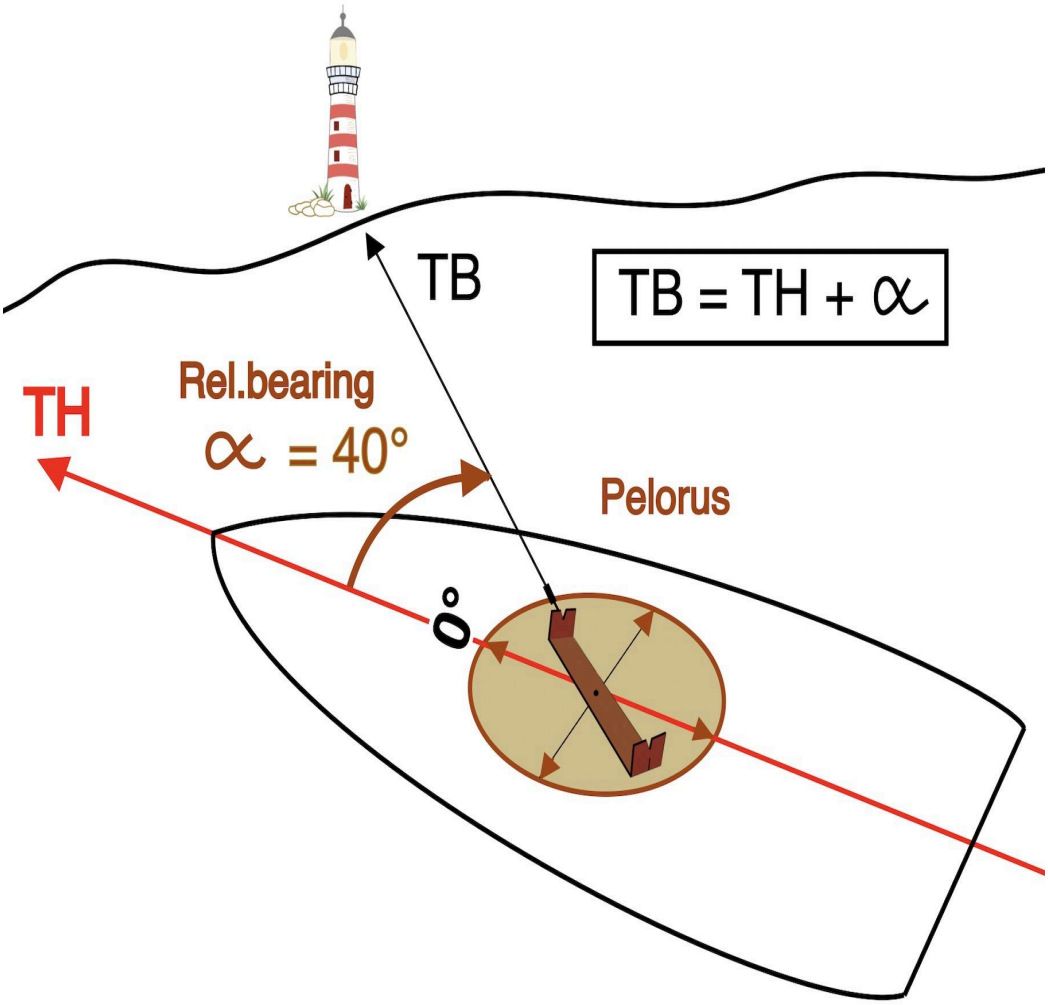


In our use of the pelorus, where the 0°/180° axis is aligned with or parallel to the ship's axis, the cardinal directions (North, East, South, West) are not used — only the degree graduations matter. However, the cardinal points may be used in other configurations.

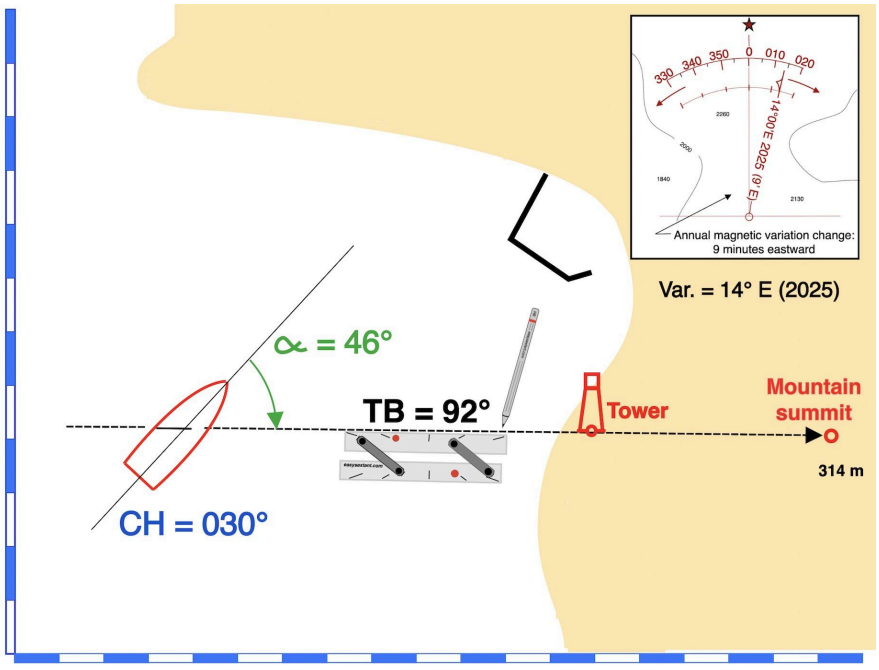
Building a pelorus on a wooden board, with an embedded compass rose and a sighting device (alidade) made of wood or metal, can turn it into a highly valuable tool.

A.2 In addition to its use for compass adjustment, the pelorus is also valuable in coastal navigation. It allows you to plot bearings on landmarks to determine your position, and to monitor the risk of collision — for example, when the bearing of an approaching vessel remains constant.

True bearing = true heading + relative bearing :



A.2 Using a Pelorus to Cross a Bearing Line : Step-by-Step Method



Choose a suitable bearing line of any kind, as long as it offers a clear and stable alignment. For example, perform twelve crossings using compass headings spaced 30° apart.

It is best to have two people: one at the helm and one operating the pelorus as the observer. However, using the autopilot is also an option.

A.2 Relation Relative bearing (α):

TB = TH + α ⇔ TH = TB - α
MB = MH + α ⇔ MH = MB - α
CB = CH + α ⇔ CH = CB - α

Relation deviation (d) and variation (Var.)

TH = MH + Var. ⇔ MH = TH - Var. ⇔ Var. = TH - MH
MH = CH + d ⇔ CH = MH - d ⇔ d = MH - CH

TB = MB + Var. ⇔ MB = TB - Var. ⇔ Var. = TB - MB
MB = CB + d ⇔ CB = MB - d ⇔ d = MB - CB

Certainly, the formulas can be a bit intimidating, but only one of the two tables—with the formulas included—is sufficient when creating the deviation card.

table 1

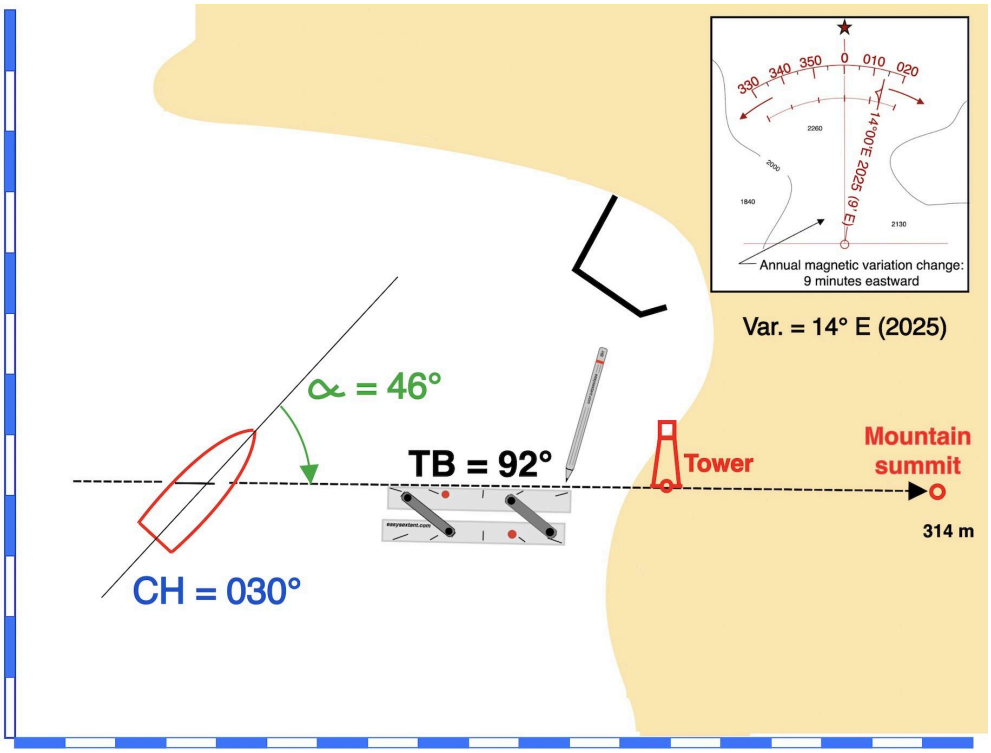
CH	α	TB	Var.	TH = TB - α	MH = TH - Var.	d = MH -CH

table 2

CH	α	TB	Var.	CB = CH + α	MB = TB - Var	d = MB - CB

A.2 EXAMPLE 1: When crossing a bearing line, for example with a compass heading (CH) of 30°, the relative bearing (α) is taken <u>simultaneously</u> using the pelorus.

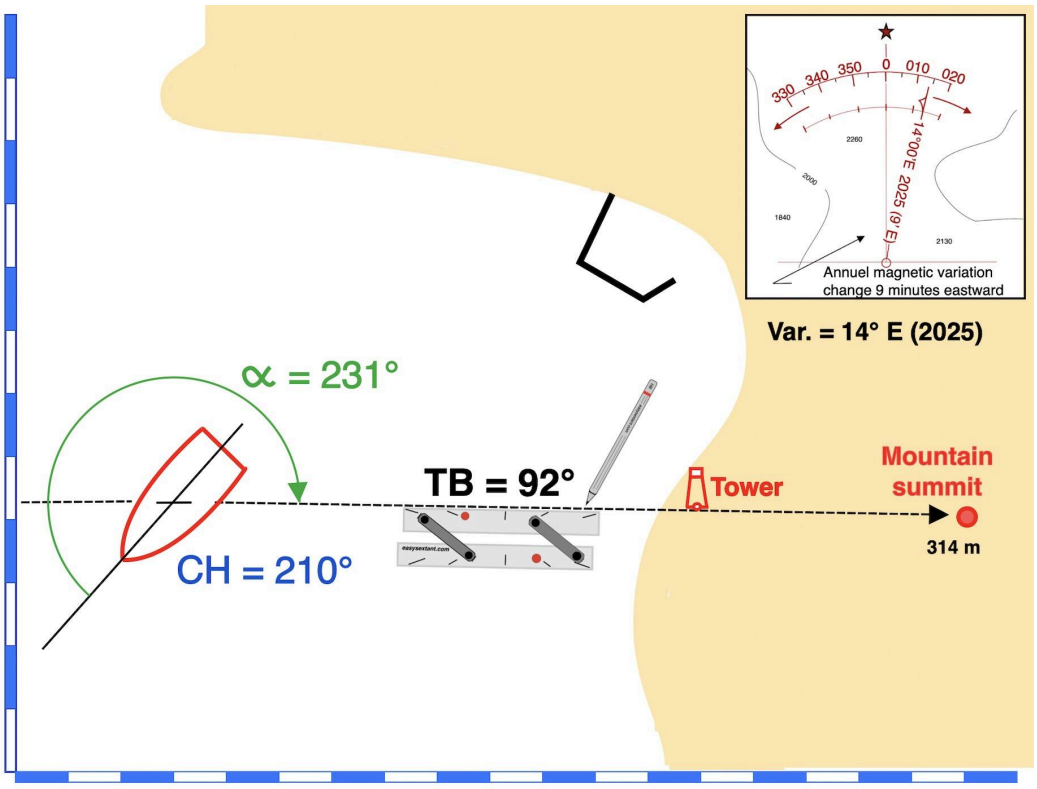
-Magnetic variation (Var.) in 2025: 14° E
-True bearing (TB) of the bearing line: 92°



CH	α	TB	Var.	TH = TB - α	MH = TH - Var.	d = MH -CH
030°	046°	092°	+ 14°	046°	032°	**+2°**

A.2 EXAMPLE 2: When crossing a bearing line, with a compass heading (CH) of 210° and a relative bearing (α) of 231°, both taken simultaneously — the relative bearing being measured using the pelorus:

-Magnetic variation (Var.) in 2025: 14° E
-True bearing (TB) of the bearing line: 92°



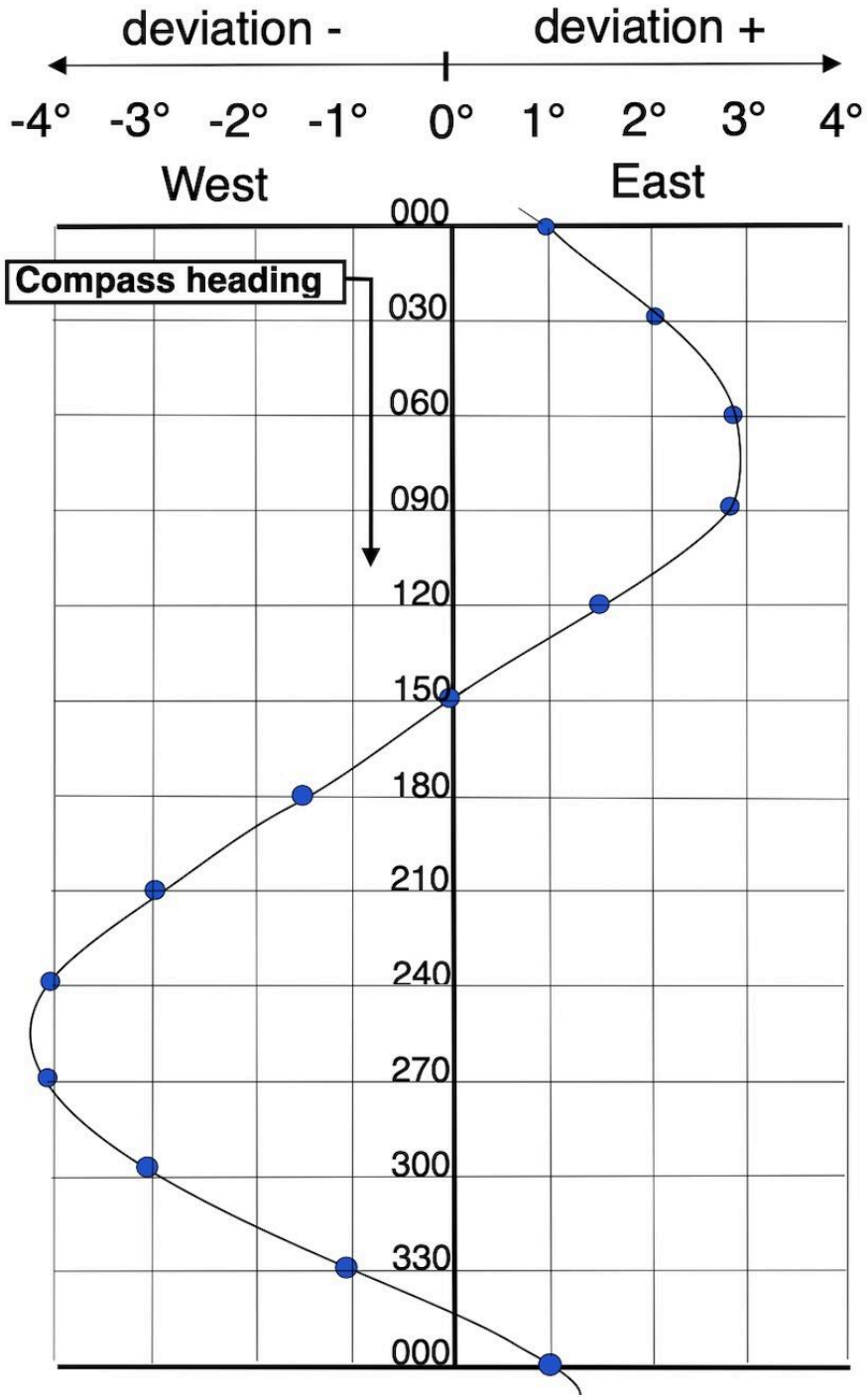
CH	∝	TB	Var.	TH = TB - ∝	MH = TH - Var.	d = MH -CH
210°	231°	092°	+ 14°	221°	207°	**-3°**

A.2 This page shows two tables computed using different methods, yet arriving at the same result.

CH	α	TB	Var.	TH = TB - α	MH = TH - Var.	d = MH -CH
000°	077°	092°	+ 14°	015°	001°	**+1°**
030°	046°	092°	+ 14°	046°	032°	**+2°**
060°	015°	092°	+ 14°	77°	063°	**+3°**
090°	345°	092°	+ 14°	107°	093°	**+3°**
120°	316,5°	092°	+ 14°	135,5°	121,5°	**+1,5°**
150°	288°	092°	+ 14°	164°	150°	**0°**
180°	259,5°	092°	+ 14°	192,5°	178,5°	**-1,5°**
210°	231°	092°	+ 14°	221°	207°	**-3°**
240°	202°	092°	+ 14°	250°	236°	**-4°**
270°	172°	092°	+ 14°	280°	266°	**-4°**
300°	141°	092°	+ 14°	311°	297°	**-3°**
330°	109°	092°	+ 14°	343°	329°	**-1°**

CH	α	TB	Var.	CB = CH + α	MB = TB - Var	d = MB - CB
000°	077°	092°	+ 14°	077°	078°	+1°
030°	046°	092°	+ 14°	076°	078°	+2°
060°	015°	092°	+ 14°	075°	078°	+3°
090°	345°	092°	+ 14°	075°	078°	+3°
120°	316,5°	092°	+ 14°	076,5°	078°	+1,5°
150°	288°	092°	+ 14°	078°	078°	0°
180°	259,5°	092°	+ 14°	079,5°	078°	-1,5°
210°	231°	092°	+ 14°	081°	078°	-3°
240°	202°	092°	+ 14°	082°	078°	-4°
270°	172°	092°	+ 14°	082°	078°	-4°
300°	141°	092°	+ 14°	081°	078°	-3°
330°	109°	092°	+ 14°	079°	078°	-1°

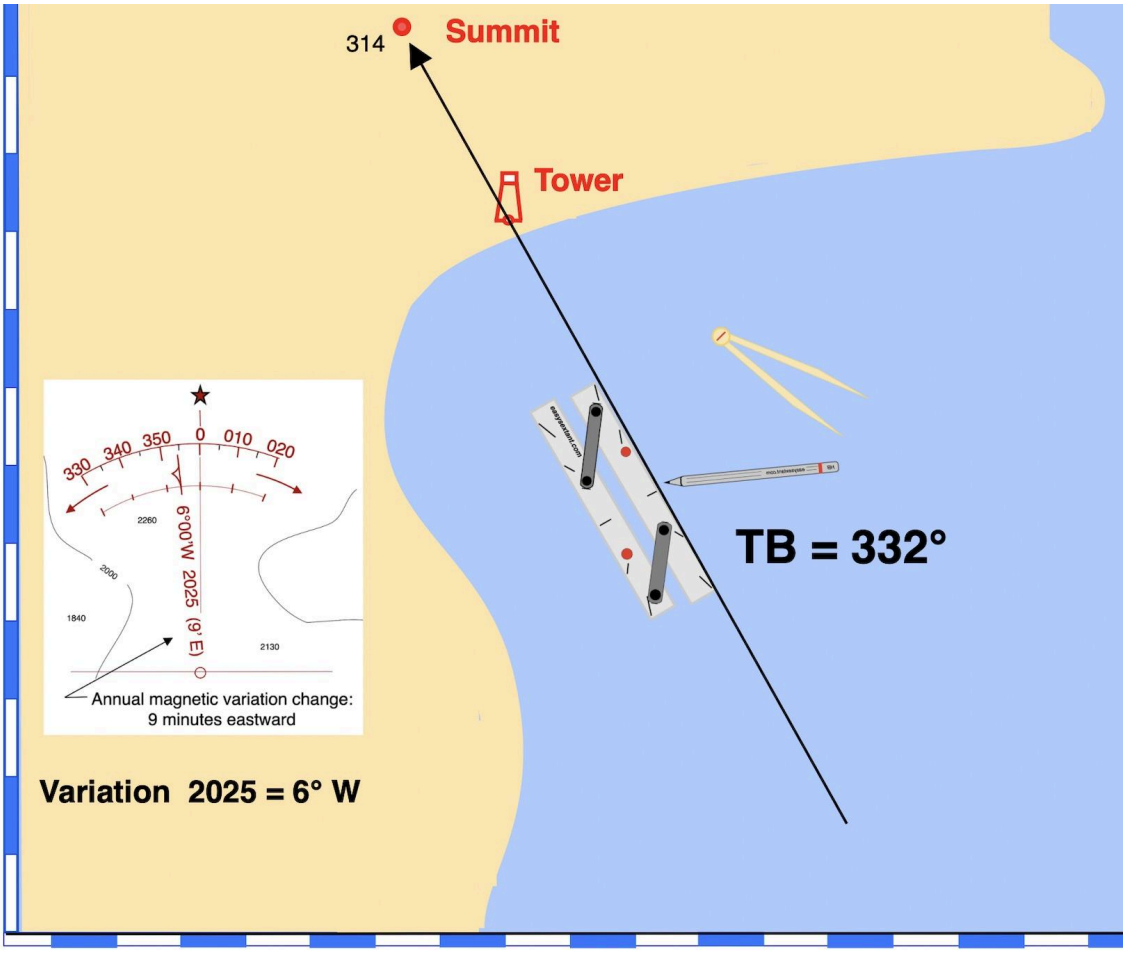
A.2 The deviation curve is illustrated with the example above.



A.2 Exercise (1): Crossing a bearing line on various headings using a pelorus.

Complete the table and plot the deviation curve.

- **True bearing (TB)** of the bearing line: 332°
- **Magnetic variation (Var.)** (2025): 6° W



A.2 Exercise 1 (continued):

Here, for example, we can see that at the moment of crossing, the compass heading was not exactly 30°, but 32°. This is not a problem — what matters is that the compass heading (CH) and the relative bearing (α) are measured simultaneously.

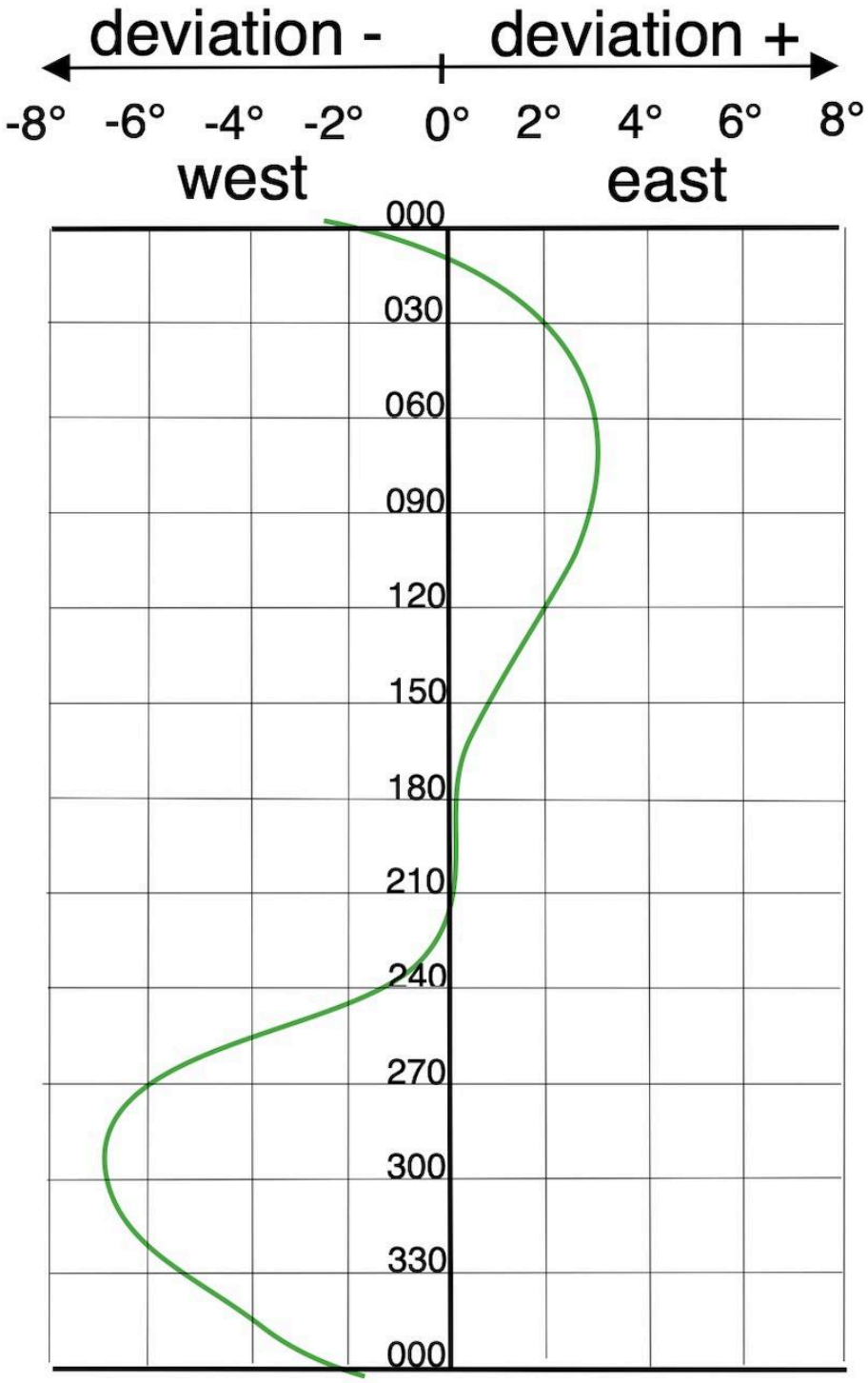
CH	α	TB	Var.	TH = TB - α	MH = TH - Var.	d = MH -CH
002°	338°					
032°	304°					
060°	275°					
088°	247°					
120°	216°					
148°	189°					
182°	156°					
210°	128°					
238°	101°					
271°	073°					
300°	045°					
333°	010°					

A.2 Exercise 1 (continued):

Answer:

CH	α	TB	Var.	TH = TB - α	MH = TH - Var.	d = MH -CH
002°	338°	332°	-6°	354°	000°	**-2°**
032°	304°	332°	-6°	028°	034°	**+2°**
060°	275°	332°	-6°	057°	063°	**+3°**
088°	247°	332°	-6°	085°	091°	**+3°**
120°	216°	332°	-6°	116°	122°	**+2°**
148°	189°	332°	-6°	143°	149°	**+1°**
182°	156°	332°	-6°	176°	182°	**0°**
210°	128°	332°	-6°	204°	210°	**0°**
238°	101°	332°	-6°	231°	237°	**-1°**
271°	073°	332°	-6°	259°	265°	**-6°**
300°	045°	332°	-6°	287°	293°	**-7°**
333°	010°	332°	-6°	322°	328°	**-5°**

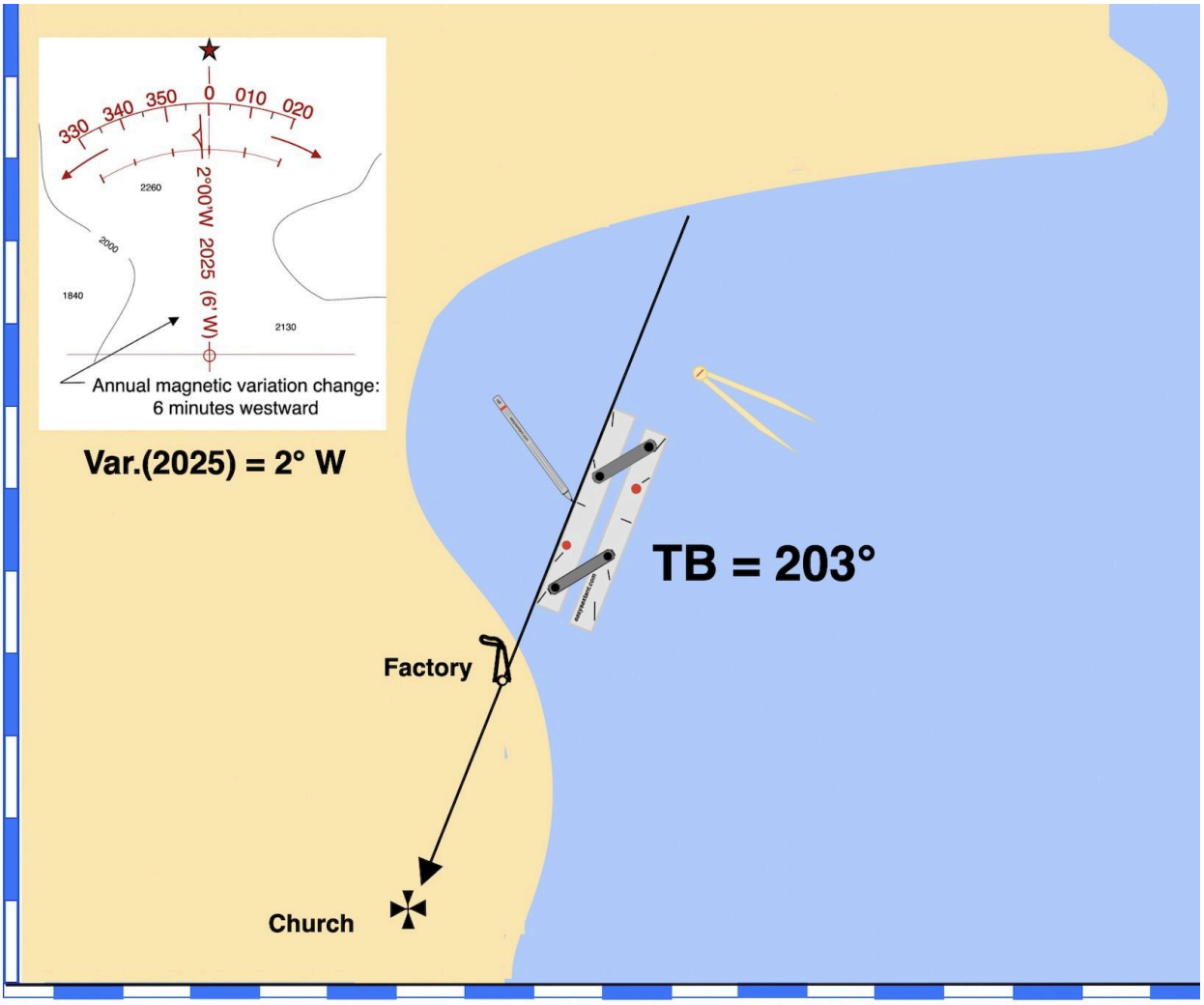
A.2 Exercise 1 (continued): deviation curve



A.2 Exercise (2): Crossing a bearing line on various headings using a pelorus.

Complete the table and plot the deviation curve below.

- **True bearing (TB) of the bearing line: 203°**
- **Magnetic variation (Var.) (2025): 2° W**



A.2 Exercise 2 (continued):

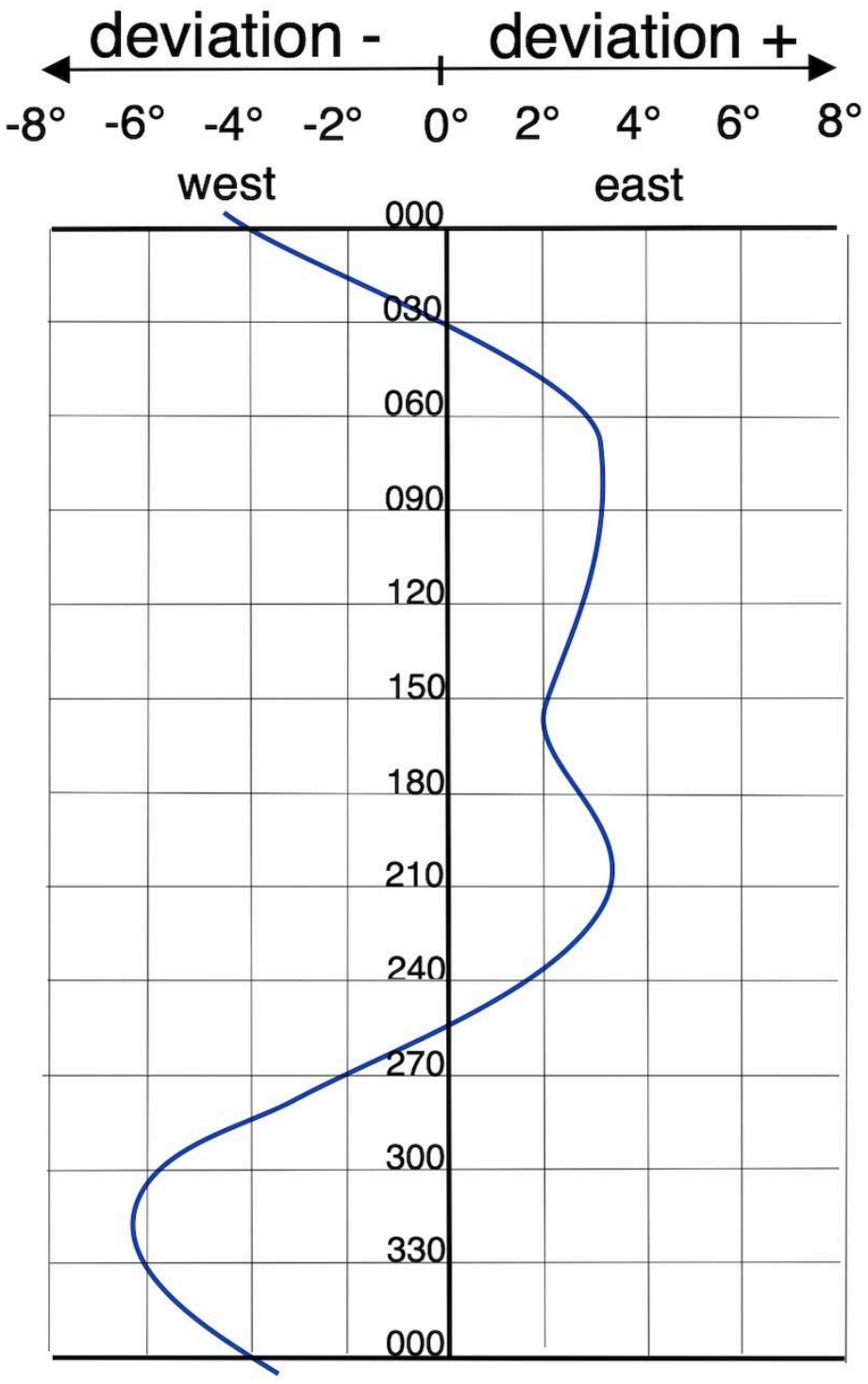
CH	α	TB	Var.	TH = TB - α	MH = TH - Var.	d = MH -CH
000°	209°					
032°	173°					
060°	142°					
090°	112°					
122°	080°					
148°	055°					
180°	022°					
210°	352°					
239°	324°					
271°	296°					
300°	271°					
330°	241°					

A.2 Exercise 2 (continued):

Answer:

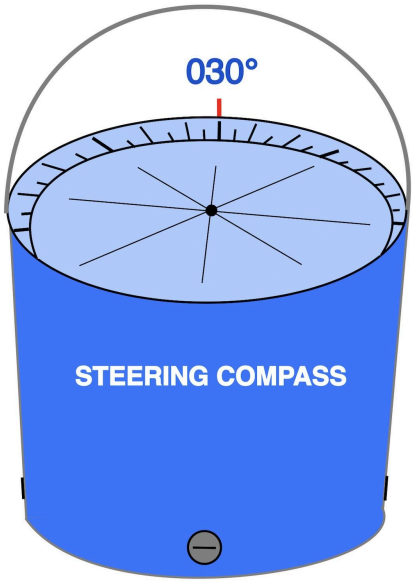
CH	α	TB	Var.	TH = TB - α	MH = TH - Var.	d = MH -CH
000°	209°	203°	-2°	354°	356°	**-4°**
032°	173°	203°	-2°	030°	032°	**0°**
060°	142°	203°	-2°	061°	063°	**+3°**
090°	112°	203°	-2°	091°	093°	**+3°**
122°	080°	203°	-2°	123°	125°	**+3°**
148°	055°	203°	-2°	148°	150°	**+2°**
180°	022°	203°	-2°	181°	183°	**+3°**
210°	352°	203°	-2°	211°	213°	**+3°**
239°	324°	203°	-2°	239°	241°	**+2°**
271°	296°	203°	-2°	267°	269°	**-2°**
300°	271°	203°	-2°	292°	294°	**-6°**
330°	241°	203°	-2°	322°	324°	**-6°**

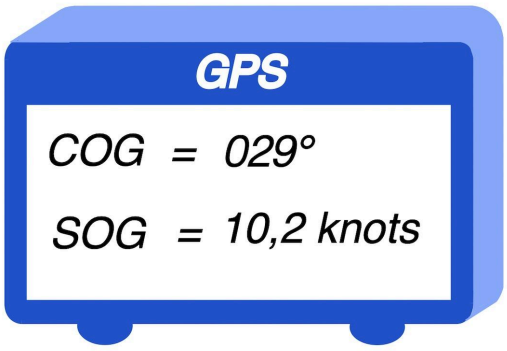
A.2 Exercise 2 (continued): deviation curve



A3

A.3 Creating a Deviation Card by Comparing the Steering Compass with the GPS Course at Compass Headings Spaced 10°, 15°, 20°, 22.5°, or 30° — your choice — as Indicated by the Steering Compass.

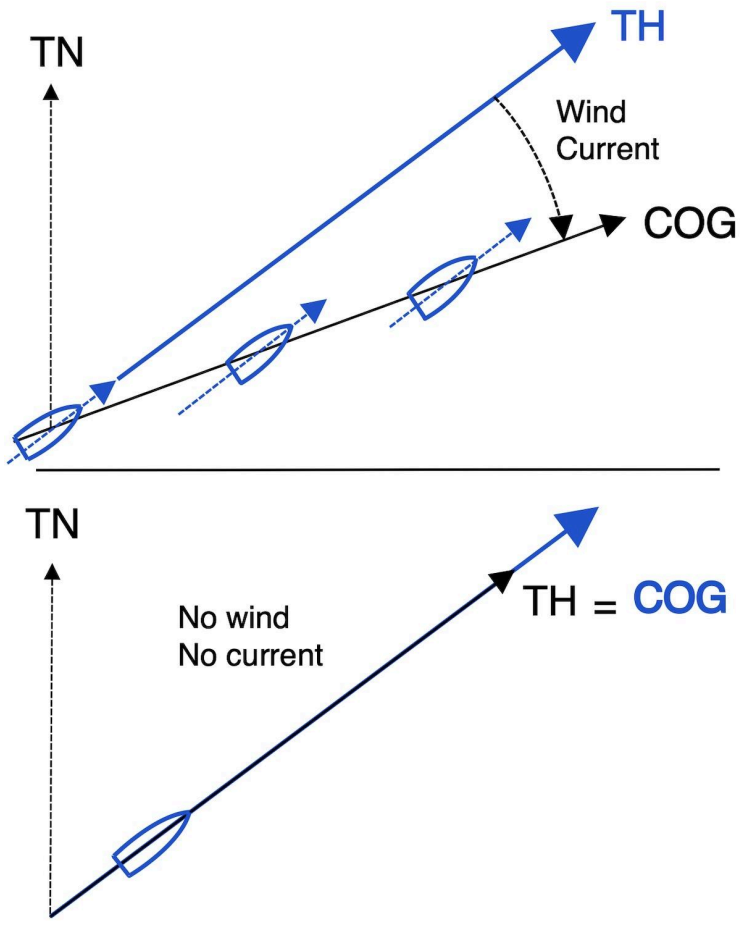




No wind, no current.

TH = COG

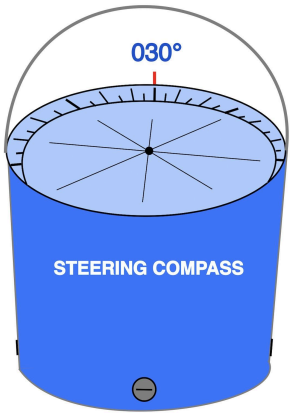
A.3 Creating a Deviation Card by Comparing the Steering Compass with the GPS

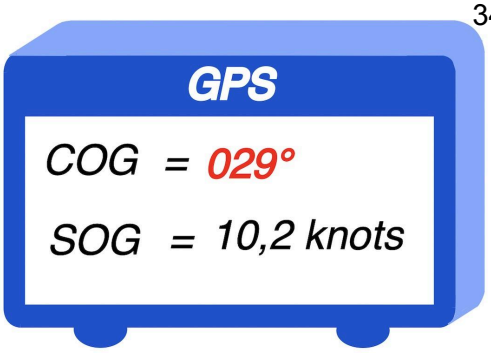


If there is neither wind nor current, the true heading is equal to the course over ground indicated on the GPS.

Choose a calm day, with no wind or current, and sail at around 10 knots. A higher speed improves the accuracy of the course over ground on your GPS.

A.3





No wind, no current.
TH = COG

CH = 030°

TH = COG = 029°

Table

Creating a deviation card by comparing the GPS course over ground with the steering compass on compass headings spaced 30° apart. **Under calm conditions, with no wind or current, and sailing at approximately 10 knots: true heading (TH) equals course over ground (COG).**				
Maintain compass headings spaced 30° apart.	**COG indication on GPS: in calm conditions**	**Var. to be taken from the chart: 6° W**	Calculation of magnetic heading **(MH).**	Calculation of deviation **(d).**
CH	**COG = TH**	**Var.**	**MH = TH - Var.**	**d = MH - CH**
example: **030°**	**029°**	**– 6°**	**035°**	**+5°**

A.3 The absence of wind is easy to observe. You can check for the absence of current by throwing a cork near a buoy and watching for any movement.

Indeed, GPS can detect a vessel's drift when it is stationary. By recording its position over a given period, it is possible to measure the speed and direction of movement caused solely by the current. However, it is important to ensure that the vessel is not influenced by other forces (such as wind or residual motion) in order to ensure the accuracy of the measurement.

In the presence of wind or current, it is not recommended to use GPS for compensation.

A.3 Exercise :Complete the table and plot the deviation curve.

Creating a deviation card by comparing the GPS course over ground with the steering compass on compass headings spaced 30° apart. **Under calm conditions, with no wind or current (SOG ≈ 10 kts)**				
Maintain compass headings spaced 30° apart.	**COG indication on GPS:**	Variation **7°E**	Calculation of magnetic heading **(MH).**	Calculation of deviation **(d).**
CH	**COG = TH**	**Var.**	**MH = TH - Var.**	**d = MH - CH**
000°	**005°**	**7°**		
030°	**037°**	**7°**		
060°	**069°**	**7°**		
090°	**100°**	**7°**		
120°	**129°**	**7°**		
150°	**153°**	**7°**		
180°	**179°**	**7°**		
210°	**208°**	**7°**		
240°	**238°**	**7°**		
270°	**269°**	**7°**		
300	**301°**	**7°**		
330°	**333°**	**7°**		

A.3 Here is the answer to this exercise:

Creating a deviation card by comparing the GPS course over ground with the steering compass on compass headings spaced 30° apart.

Under calm conditions, with no wind or current (SOG ≈ 10 kts)

Maintain compass headings spaced 30° apart.	**COG indication on GPS:**	Variation **7°E**	Calculation of magnetic heading **(MH).**	Calculation of deviation **(d).**
CH	**COG = TH**	**Var.**	**MH = TH - Var.**	**d = MH - CH**
000°	**005°**	+7°	358°	**-2°**
030°	**037°**	+7°	030°	**0°**
060°	**069°**	+7°	062°	**+2°**
090°	**100°**	+7°	093°	**+3°**
120°	**129°**	+7°	122°	**+2°**
150°	**153°**	+7°	146°	**-4°**
180°	**179°**	+7°	172°	**-8°**
210°	**208°**	+7°	201°	**-9°**
240°	**238°**	+7°	231°	**-9°**
270°	**269°**	+7°	262°	**-8°**
300	**301°**	+7°	294°	**-6°**
330°	**333°**	+7°	326°	**-4°**

A.3 corresponding deviation curve :