

# SECTION 3 NAVIGATION EQUIPMENT

See also pages 63 and 64 for GPS and Radar

## The magnetic compass

If a small magnet is pivoted at a point or is free to turn, it will tend to align itself with the magnetic field of Earth and therefore show a direction.

Consequently, one of the most important navigational aids on a vessel is the compass.

There are two main types of compass:

- a. magnetic — which points to Magnetic North
- b. gyro — which points to True North

If a magnet were simply placed on a float in a bowl of water it would be of very little use in a vessel at sea in rough conditions. Thus the magnetic compass is constructed using a bowl commonly made of brass or non-magnetic metal with a glass top. The bowl is weighted at the bottom and is suspended in gimbals so that it remains fairly horizontal as the vessel is moved by the seas.

Since vessels are in constant motion when at sea, the magnetic needle (which is made of several magnets united parallel to each other) is located in a liquid that reduces or dampens the needle's movement. The liquid that is placed in the bowl is mostly water with some alcohol added to prevent freezing.

Since this compass has a magnetic needle it is important to choose the location of the compass carefully. The position should be-

- As far away from metal objects as possible
- Located well away from electrical wiring and instruments requiring electricity
- Have as stable a location as possible thus preventing vibration
- Be protected from the elements (rain, sun and sea spray)

## The compass card

A compass card is a compass rose that is graduated in 360 degrees and is mounted in the bowl.

The compass card within a compass (the compass rose) is a circle marked off in a clockwise direction in 360 equal units (360 degrees). North is marked at 0°, east at 90°, south at 180° and west at 270°.

These are called the cardinal points of the compass. Mid-way between these cardinal points are the inter-cardinal points – north-east (45°), south-east (135°), south-west (225°) and north-west (315°). These can once again be subdivided giving another eight points e.g. north-north-east. The compass card normally has thirty-two points shown in a clockwise order and is known as 'boxing the compass'.



Wet Paper (Courtesy Sea World)

Figure 1.1 Binnacle mounted compass. Note — A binnacle is the pedestal in which a compass is mounted.

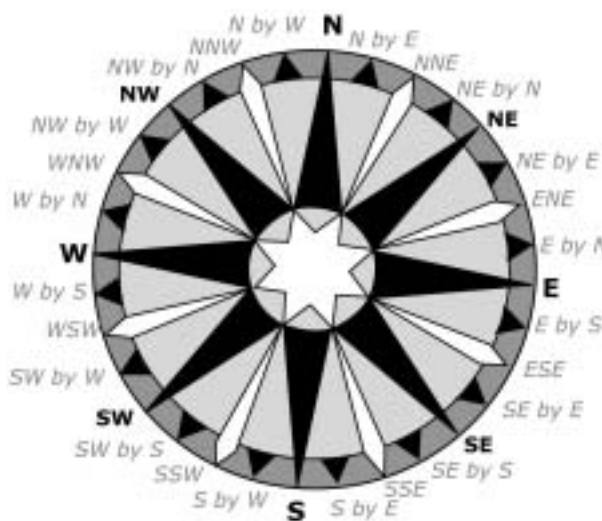


Figure 1.2 A compass card  
Wet Paper

### Statement

The marine magnetic compass was perfected in 1862 and was first used by the United States navy.



# ACTIVITY 11 CHART FEATURES

## 1. Lights

Suggest what you would observe at night if the chart features below were sighted:

- F1 R2s \_\_\_\_\_
- F1 (3) 10s \_\_\_\_\_
- F1 (2) G5s \_\_\_\_\_
- F1 (2) 6s 33m 7M \_\_\_\_\_
- F1 G 6s \_\_\_\_\_
- F1 (2) WRG 10s \_\_\_\_\_

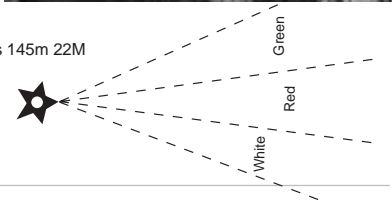


## 2. Nature of Seabed

Describe the nature of the seabed in areas labelled

- |    |     |       |
|----|-----|-------|
| Cy | Co  | _____ |
| M  | Si  | _____ |
| Wk | S/M | _____ |
| Wd | St  | _____ |

FI (3) WRG 10s 145m 22M



## 3. Complete the sentences by drawing the following features:

- a. Coral reef which is always covered  
\_\_\_\_\_
- b. A flood tide of 3 knots  
\_\_\_\_\_
- c. A submerged hazard  
\_\_\_\_\_
- d. A rock which will be uncovered at low tide  
\_\_\_\_\_
- e. A rock which will be 2 metres above at high side  
\_\_\_\_\_
- f. An underwater rock which is considered dangerous  
\_\_\_\_\_

## 4. Make up a chart below using the correct symbols

Rocky area	Coral reef	breakers
	Submerged hazard	foreshore coral

# Compass conversions

In any location, the Earth's magnetic field is at an angle to the meridians of longitude, and so your compass (either steering or hand-bearing) does not point to the True North of the longitude lines on the chart.

Because of this we end up with three types of angular bearings which need to be interpreted for navigation.

## True bearings

These are relative to True North and are taken off the compass rose on the chart or measured with a protractor against the grid lines of the chart.

- These are usually written with a T after the angle, eg 32°T means an angle of 32° to the True North of the chart.

## Compass bearings

Compass bearings are relative to the Earth's magnetic field lines in the area, and are read off the hand bearing compass or the steering compass.

- Usually written with a C after the angle, eg 165°C means an angle of 165° to the Earth's magnetic field in that area.
- The bearing (or direction) from one position to another on a chart is found by drawing a line through the compass rose that is parallel to the line joining the position.

## Variation

This is the local *variation* (for the particular year). It is taken off the compass rose information on your chart, and is always given in the direction of east or west to indicate which way the magnetic field lines are pointing as well as how far. Figure 43.1 shows the variation.

- Variation in 2002 for the compass rose shown in Figure 43.1 is as follows:

The variation was measured in 1964 as 8° 00'E

The number of years between 2002 - 1964 = 38 years

Therefore variation 2002 = 8° 00'E + (38 x 2.75)

$$= 8° 00'E + 104.5'$$

$$= 8° 00'E + 1° 44'$$

$$= 9° 44'E$$

## Conversion rules

### Rule 1

To convert between true and compass bearings we use the rule:

*Error East - Compass Least*

*Error West - Compass Best* (best means the bigger number)

The table below shows some examples.

Example	a.	b.	c.	d.	e.
True bearing	40°T	85°T	243°T	5°T	356°T
Variation (error)	8°E	5°W	10°E	10°E	12°W
Compass bearing	32°C	90°C	233°C	355°C	8°C

In example d. think of 5°T as 365°T before you subtract the 10°.

In example e. 356° + 12° = 368°, which becomes 8°C.

### Rule 2

To find out which course to steer a boat.

This rule indicates the steps to be taken in changing from Compass to True (left column) and True to Compass (right column).

The rule can be remembered by writing the letters CDMVT in either the forward or reverse direction as shown below.

The end result is the ship's head or direction in which the ship is steered. Figures 3.1 and 43.2 summarise this process.

Conversions from compass to true		Conversions from true to compass	
<b>C</b> an	<b>Compass</b>	<b>T</b> ele	<b>True</b>
<b>D</b> ead	<b>Deviation</b>	<b>V</b> ision	<b>Variation</b>
<b>M</b> en	<b>Magnetic</b>	<b>M</b> akes	<b>Magnetic</b>
<b>V</b> ote	<b>Variation</b>	<b>D</b> ull	<b>Deviation</b>
<b>T</b> wice	<b>True</b>	<b>C</b> ompany	<b>Compass</b>

### Worked example

Which direction do you steer a boat if you want to go 50° True North out of Sydney heads if the deviation is 8°E?

Because you are working from True to Compass, Rule 2 — CDMVT is written backwards. Total error is 18°E and because it is east, Rule 1 says to take it away.

So you steer your boat 32° by compass.

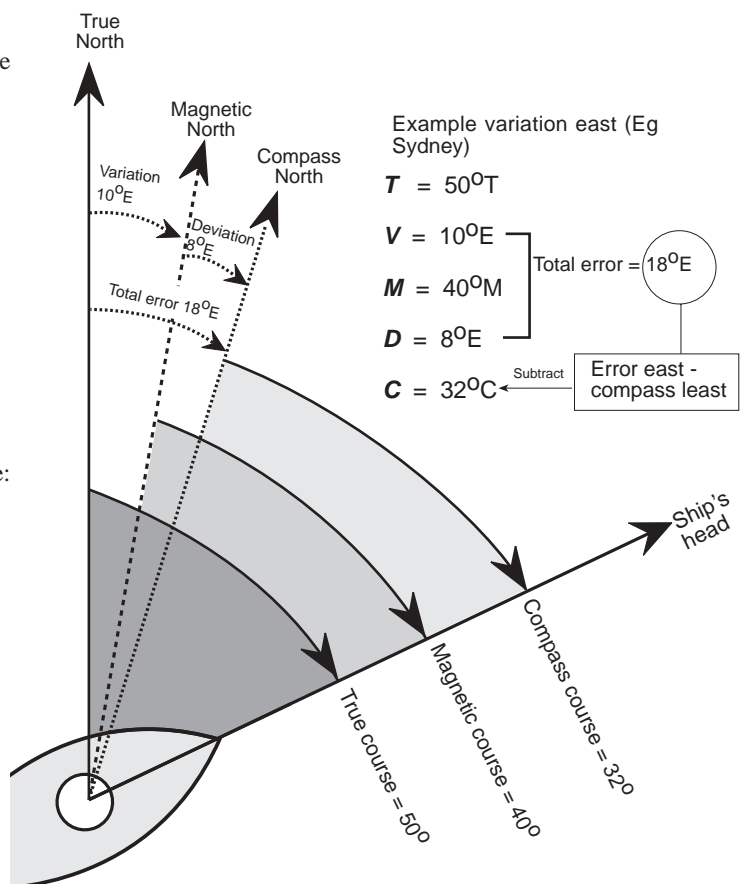


Figure 3.1 Variation east (The illustration for variation west is on Page 43)

# ACTIVITY 18 POSITION FIXING

Its nice to know where you are and this exercise lets us use our chart to find out where we are.

## Worked example

Having travelled out for 45 minutes from the marina in Lynch River, the skipper of *Wet Paper I* wants her first mate to plot their position. She takes three bearings, as follows, using a hand-bearing compass.

- Bearing 1 to Pamela's Light CB = 88°C
- Bearing 2 to Trent's Light CB = 163°C
- Bearing 3 to Mt James CB = 202°C

These convert using error east compass least rule.

- Step 1 Do conversion for bearing 1  
To Pamela's Light CB = 88°C TB = 96°T
- Step 2 Place rule or square on compass rose from the centre to Pamela's light. (See figure 4.1)
- Step 3 Walk rule or square to Pamela's Light and draw a line back towards the mainland.
- Step 4 Do conversions for bearings 2 and 3 respectively and repeat as described in steps 2 and 3.
- Step 5 Shade in your cocked hat as described in your textbook.

## Questions

Find the latitude and longitude of the following positions and mark them on your chart. Check your answer with the suggested answer given. Note all bearings have been made with a hand-bearing compass.

1. Position A.  
Bearing to Pamela's Light 20°  
Bearing to Mark's Light 257°  
Bearing to Trent's Light 314°

(Suggested answer 24°11' S, 162°02'E)

2. Position B.  
Bearing to Pamela's Light 20°  
Bearing to Paula's Light 327°  
Bearing to Reid Light 244°

(Suggested answer 24°07'S, 162°04.5'E)

3. Position C.  
Bearing to Halpin Hill 178°  
Bearing to Mt James 306°  
Bearing to Trent's Light 013°

(Suggested answer 24°10' S, 161°54'E)

4. Position D.  
Bearing to Trent's Light 222°  
Bearing to Pamela's Light 175°  
Bearing to Critchley Hill 263°

(Suggested answer 23°55' S, 162°07'E)

5. Position E.  
Bearing to Pamela's Light 357°  
Bearing to Trent's Light 281°  
Bearing to Paula's Light 320°

(Suggested answer 24°07' S, 162°06'E - you are on the beach)

6. Position F.  
Bearing to Halpin Hill 302°  
Bearing to South Cardinal Mark Perry Shoals 74°  
Bearing to Mark's Light 20°

(Suggested answer 24°14' S, 161°55'E)

7. Position F.  
Bearing to Trent's Light 242°  
Bearing to Fairway Beacon 310°  
Bearing to Clubhouse at Batestown 285°

(Suggested answer 24°02' S, 162°01'E)

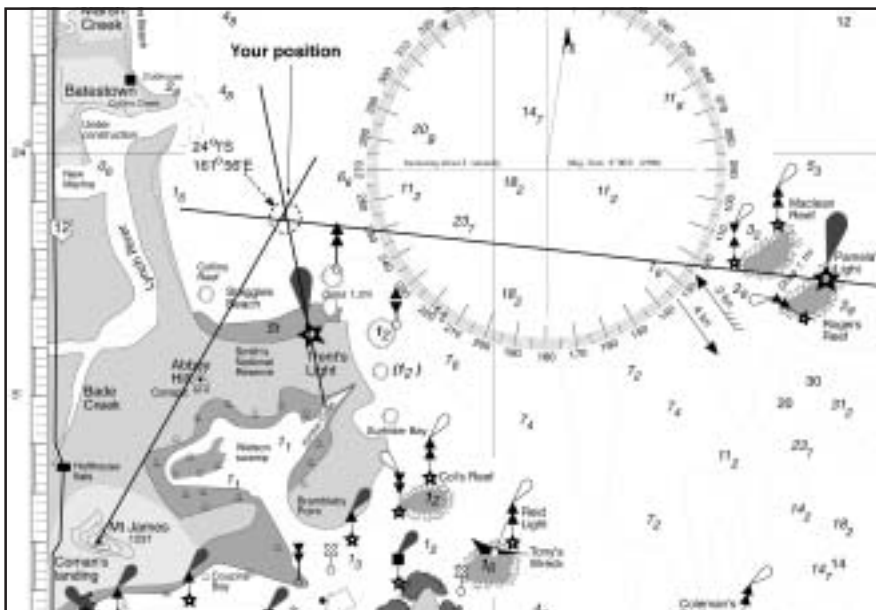
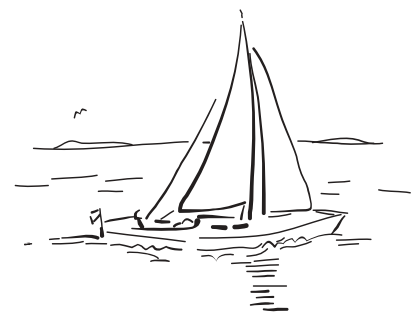


Figure 4.1 Worked example



Note: It is not good practice taking two bearings along the same line