MARN019 Command and manage a voyage on a vessel up to 45 metres

Student Handout

CERT IV Maritime Operations (Master up to 45 Metres Near Coastal)

Nationally Recognised Training

ECA Maritime College Student Manual

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EXERCISE SHEET #1

Exercise Chart No: AUS 252

1. Find the geographical position of the following

    1. Hayman Is Lt (2F.BU)
    2. Coppersmith Rk. Lt.
    3. Linderman I Lf. (Piccaninny point)
    4. Dent I. Lt. (Fl 5S37m11M)
    5. Pioneer Rks.
    6. Bird I.
    7. Hayman I Peak (247)
    8. Rocky Point (Repulse Beach)
    9. Long I. Peak (123)
    10. Shaw Peak

2. Measure the distance in nautical miles in a direct line:

    1. From Whitsunday Cairns to Whitsunday Craig (Peaks)
    2. From Coppersmith Rock LT to Double Cone I Peak (104)
    3. From IO Reef LT to Rocky MT Peak (117) (Stewart Penninsula)

3. What is the direction from:

    1. Hayman I Lt to Pioneer Rks Lt.
    2. Lindeman I, Lt (Piccaninny Point) to Wirrainbeia Island (33)
    3. Dent I Lt (Fl.5s.37m11M) to Lindeman I Lt. (Piccaninny Point)
    4. Bullion Rks, (N) to Gould I.

4. Draw a line from Coppersmith Rk Lt in a direction 260°T for

    5.0 miles, What is the Latitude and Longitude of this position?

5. Find the direction and distance from the first to the second position:

    a) 20° 01'.5S;148° 58'.6E
    20° 10'.3S; 149° 06.4É

    b) 20° 20'.3S; 149° 01'.6E
    20° 35'.1S; 148° 54'.5E

    c) 20° 30'.0S; 148° 46'.9E
    20° 45'.7S; 148° 59′.0E

Answers

1. a) 20° 03'.6S; 148° 52'.9'E
   b) 20° 36'.0S; 149° 07.0É
   c) 20° 27'.7S; 149° 02'.1E
   d) 20° 22'.2S; 148° 55'.8E
   e) 20° 13'.6S; 148° 45'.4E
   f) 20° 05'.4S; 148° 52'.3E
   g) 20° 03′.0S; 148° 53'.5E
   h) 20° 28'.8S; 148° 45'.8E
   i) 20° 19'.25S; 148° 51'.0E
   j) 20° 28'.3S; 149° 05'.0E

2. a) 8.6 NM
   b) 37.4 NM
   c) 18.3 NM

3. a) 215°T
   b) 024°T
   c) 133°T
   d) 280°T

4. 20° 36.8'S 149° 01.8'E

5. a) 140°T; 11.5NM
   b) 205°T; 16.3NM
   c) 144°T 19.4NM

EXERCISE SHEET #3

TRUE TO COMPASS

	(a)	(b)	(c)	(d)	(e)
True Co	308°	345°	013°	110°	267°
Var	015°W	005°E	004°W	013°E	001°E
Mag Co					
Dev	003°E	004°W	010°E	005°W	002°w
Comp Co					

	(f)	(g)	(h)	(i)	(j)
True Co	271°	184°	171°	173°	084°
Var	013°E	002°w	010°E	010°w	007°E
Mag Co					
Dev	004°W	005°E	004°E	005°E	005°E
Comp Co					

	(i)	(ii)	(iii)	(iv)	(v)
True Co	010°	005°	310°	354°	196°
Var	013°E	010°w	015°E	014°E	010°E
Mag Co					
Dev	004°W	015°E	010 E	013°w	004°W
Comp Co					

	(vi)	(vii)	(viii)	(ix)	(x)
True Co	168°	142°	106°	056°	162°
Var	010°W	003°E	015°E	010°W	005°E
Mag Co					
Dev	013°E	005°E	001°w	003°E	007°W
Comp Co					

ANSWERS TO EXERCISE #3

	(a)	(b)	(c)	(d)	(e)
True Co	308°	345°	013°	110	267°
Var	015°W	005°E	004°W	013°E	001°E
Mag Brg	323°	340°	017°	097°	266°
Dev	003°E	004°W	010°E	005°W	002°w
Comp Co	320°	344°	007°	102°	268°

	(f)	(g)	(h)	(i)	(j)
True Co	271°	184°	171°	173°	084°
Var	013°E	002°W	010°E	010°w	007°E
Mag Brg	258°	186°	161°	183°	077°
Dev	004°W	005°E	004°E	005°E	005°E
Comp Co	262°	181°	157°	178°	072°

	(i)	(ii)	(iii)	(iv)	(v)
True Co	010°	005°	310°	354°	196°
Var	013°E	010°W	015°E	014°E	010°E
Mag Brg	357°	015°	295°	340°	186°
Dev	004°W	015°E	010°E	013°w	004°W
Comp Co	001°	000°	285°	353°	190°

	(vi)	(vii)	(viii)	(ix)	(x)
True Co	168°	142°	106°	056°	162°
Var	010°w	003°E	015°E	010°W	005°E
Mag Brg	178°	139°	091°	066°	157°
Dev	013°E	005°E	001°W	003°E	007°W
Comp Co	165°	134°	092°	063°	164°

EXERCISE SHEET #4

COMPASS TO TRUE

	(a)	(b)	(c)	(d)	(e)
Comp Brg	276°	183°	123°	162°	092°
Dev	003°E	005°W	000°	005°W	010°E
Mag Brg					
Var	015°W	010°E	005°E	005°E	003°W
True Brg					

	(f)	(g)	(h)	(i)	(j)
Comp Brg	172°	045°	352°	132°	172°
Dev	005°W	002°E	010°E	005°W	005°E
Mag Brg					
Var	002°E	010°W	008°W	010°E	015°W
True Brg					

	(i)	(ii)	(iii)	(iv)	(v)
Comp Brg	062°	032°	054°	002°	358°
Dev	010°E	010°W	000°	005°W	010°E
Mag Brg					
Var	015°W	003°E	010°W	010°E	006°W
True Brg					

	(vi)	(vii)	(viii)	(ix)	(x)
Comp Brg	108°	085°	206°	210°	160°
Dev	016°W	013°E	010°E	000°	005°E
Mag Brg					
Var	015°E	000°	016°W	015°E	010°W
True Brg					

ANSWERS TO EXERCISE #4

	(a)	(b)	(c)	(d)	(e)
Comp Brg	276°	183°	123°	162°	092°
Dev	003°E	005°W	000°	005°W	010°E
Mag Brg	279°	178°	123°	157°	102°
Var	015°W	010°E	005°E	005°E	003°W
True Brg	264°	188°	128°	162°	099°

	(f)	(g)	(h)	(i)	(j)
Comp Brg	172°	045°	352°	132°	172°
Dev	005°W	002°E	010°E	005°W	005°E
Mag Brg	167°	047°	002°	127°	177°
Var	002°E	010°W	008°W	010°E	015°W
True Brg	169°	037°	354°	137°	162°

	(i)	(ii)	(iii)	(iv)	(v)
Comp Brg	062°	032°	054°	002°	358°
Dev	010°E	010°w	000°	005°W	010°E
Mag Brg	072°	022°	054°	357°	008°
Var	015°W	003°E	010°W	010°E	006°W
True Brg	057°	025°	044°	007°	002°

	(vi)	(vii)	(viii)	(ix)	(x)
Comp Brg	108°	085°	206°	210°	160°
Dev	016°W	013°E	010°E	000°	005°E
Mag Brg	092°	098°	216°	210°	165°
Var	015°E	000°	016°W	015°E	010°W
True Brg	107°	098°	200°	225°	155°

EXERCISE SHEET #5
COMPASS TRUE, TRUE COMPASS

1. What is the true bearing of a lighthouse if the variation is 12°E and the bearing 120° (M) is taken with a HAND-BEARING COMPASS?

2. What is the compass course to steer if the true course is 050°T and the compass error is 11°E?

3. Variation is 12°E and the deviation is 3°W. What is the compass error?

4. Compass error is 14°W and variation 12°E. What is the deviation?

5. Complete the following table:

TRUE	VARIATION	MAGNETIC	DEVIATION	COMPASS	ERROR
105°	15°E		5°W		
			5°E	215°	14°E
	12°W			067°	7°W
156°		166°		160°	
222°		216°	3°W		
009°		357°			10°E
	2°W		6°E	015°	
		210°		212°	1°W
	5°W		2°E	318°	
183°	5°E			178°	

ANSWERS TO EXERCISE #5

1. 132°(T)

2. 039°(C)

3. 90(E)

4. 26°(W)

5.

TRUE	VARIATION	MAGNETIC	DEVIATION	COMPASS	ERROR
105°	15°E	090°	5°W	095°	10°E
229°	9E	220°	5°E	215°	14°E
060°	12°W	072°	5°E	067°	7°W
156°	10°W	166°	6°E	160°	4°W
222°	6°E	216°	3°W	219°	3°E
009°	12°E	357°	2°W	359°	10°E
019°	2°W	021°	6°E	015°	4°E
211°	1°E	210°	2°W	212°	1°W
315°	5°W	320°	2°E	318°	3°W
183°	5°E	178°	NIL	178°	5°E

EXERCISE SHEET #6
Chartwork
Chart AUS 252 NE Version 2 - 30.08.05

1. At 1230 you fix your position by hand bearing compass of the following features:

Sth West Pt of Hook Isl.	116.5°C
Baird Pt	045°C
Bird Isl. Lt. Q (9) 15s	016.5°C

2. 1300 you fix your position by hand bearing compass of the following features:

Planton Isl. (East Side)	18S°C
Cid Isl. (Nth side)	112.5°C
Nth Molle Isl. (Sth end)	230°c

What is your position in Lat/Long?
Find the True course to steer from this position to the next waypoint.

3. 1330 you fix your position by hand bearing compass and radar range of the following features:

South Head 231°C Range 1,8Nm.

What is your position in Lat/Long?

Chartwork Answers
Chart AUS 252 NE
Version 2 - 30.08.05

1. At 1230 you fix your position by hand bearing compass of the following features:

Sth West Pt of Hook Isl. **116.5°C + 8.5°E = 125°T**
Baird Pt **045°c + 8.5°E = 053.5°T**
Bird Isl. Lt. Q (9) 15s **016.5°C + 8.5°E = 025°T**

Lat 20°08.68 **Long 148°50.6 E**

2. 1300 you fix your position by hand bearing compass of the following features:

Planton Isl. (East Side) **185°C + 8.5°E = 193.5°T**
Cid Isl. (Nth side) **112.5°C + 8.5°E = 121°T**
Nth Molle Isl. (Sth end) **230°C + 8.5°E = 238.5°T**

What is your position in Lat/Long? **20°13.3 S, 148° 51.8 E**
Find the True course to steer from this position to the next waypoint. **164°T**

3. 1330 you fix your position by hand bearing compass and radar range of the following features:

South Head **231°C = 239.5°T** **Range 1,8Nm.**

What is your position in Lat/Long? **20°18.1 S, 148° 52.9 E**

Master 5 Chartwork Questions
Chart AUS 252 NE
Version 2 - 30.08.05

You are planning a voyage leaving Hayman Island at 1200 Blacksmith Island, via the following waypoints:

Depaiture point	20° 04' S		148° 52' E	
Waypoint I	Hannah Point		4.0 nm	200°T
Waypoint 2	Dent Island (South point)		1.0nm	090°T
Waypoint 3	Platypus Rock Light		1.0 nm	090°T
Waypoint 4	Coppersmith Rock Light		.7 nm	050°T
Waypoint 5	Anchorage	20°38'S	149°04.3'E	

Vessel speed 9 knots
Fuel consumption 23 litres per hour

1. Find course and distance for each leg of the voyage

Leg 1
Leg 2
Leg 3
Leg 4
Leg 5

2. Find total distance to steam.

3. Find ETA (estimated time of arrival),

4. Total fuel required.

Master 5 Chartwork Answers
Chart AUS 252 NE
Version 2 - 30.08.05

You are planning a voyage leaving Hayman Island at 1200 Blacksmith Island, via the following waypoints:

Depaiture point	20° 04' S		148° 52' E	
Waypoint I	Hannah Point		4.0 nm	200°T
Waypoint 2	Dent Island (South point)		1.0nm	090°T
Waypoint 3	Platypus Rock Light		1.0 nm	090°T
Waypoint 4	Coppersmith Rock Light		.7 nm	050°T
Waypoint 5	Anchorage	20°38'S	149°04.3'E	

Vessel speed 9 knots
Fuel consumption 23 litres per hour

1. Find course and distance for each leg of the voyage

Leg 1	**5.4nm**	**200°T**	**190½C**
Leg 2	**14.6 nm**	**160°T**	**148½C**
Leg 3	**10.1 nm**	**146°T**	**133½C**
Leg 4	**7.1 nm**	**136°T**	**124½C**
Leg 5	**2.5nm**	**231°T**	**219½C**

2. Find total distance to steam.

39.7 nm

3. Find ETA (estimated time of arrival).

4. 41 hours **4 hours 25 minutes** **1625**

4. Total fuel required.

101.5 litres **121.8 litres**

COMPASS ADJUSTER'S DECLARATION
M.V. NOTFREE
TABLE OF DEVIATIONS OF THE STANDARD COMPASS

Ship's Head by Standard Compass	Deviation	Ship's Head by Standard Compass	Deviation
000°	2°W	180°	0°
010°	3°W	190°	1°E
020°	3°W	200°	1½°E
030°	4°W	210°	2°E
040°	4°W	220°	3°E
050°	4½°W	230°	4°E
060°	3°W	240°	5°E
070°	2°W	250°	3½°E
080°	1°W	260°	2°E
090°	0	270°	1°E
100°	½ E	280°	0°
110°	1°E	290°	0°
120°	2°E	300°	½°W
130°	3°E	310°	1°W
140°	4°E	320°	2°W
150°	3°E	330°	3°W
160°	2°E	340°	2½°W
170°	1°E	350°	1°W

EXERCISE SHEET #7
Chartwork Chart AUS 252 NE
Deviation Card MV Notfree
Version 2 - 31.08.05

You have left a position, Baynham Island (south point) bearing 325° T range, 1 n.m. at 0600, steering a course of 010° T at 7 knots.

1. Find the standard compass course to steer and compass error.

At 0630 you fix your position by the following standard compass bearings:

Maher Island (north east point)	215.5 C
Nicholson Island 108.	340.5 C
Surprise Rock	287.5 C

2. What is your position in latitude and longitude?

You then decide to immediately (0630) alter course to 015° T.

3. Find the new compass course to steer and compass error.

At 0715 you observe the south end of Nicholson Island in transit with the south end of Haselwood Island. At the same time a radar range of 2.0 n.m. was obtained from the Southern end of Lupton Island. Transit@ 285°T

4. What is your position in latitude and longitude?

5. The observed standard compass bearing of the transit was 281° C. Find the compass error

At 0745 you fix your position by the following standard compass bearings:

Pallion Point	291 C
Lupton Island (south point)	235 C
Workington Island 9 I.	265 C

6. Find the hue bearings of the above standard compass bearings and state the position of the fix in latitude and longitude.

Chartwork #7 Answers
Chart AUS 252 NE
Deviation Card MV Notfree
Version 2 - 31.08.05

You have left a position, Baynham Island (south point) bearing 325° T range, 1 n.m. at 0600, steering a course of 010° T at 7 knots.

1. Find the standard compass course to steer and compass error.
003.5° 6.5° E

At 0630 you fix your position by the following standard compass bearings:

Maher Island (north east point)	**215.5° C + 6.5°E = 222°T**
Nicholson Island 108.	**40.5° C + 6.5°E = 347°**
Surprise Rock	**287.5 ° C + 6.5°E = 294°**

2. What is your position in latitude and longitude?
20° 23.6 S 149° 07.1' E

You then decide to immediately (0630) alter course to 015° T.

3. Find the new compass course to steer and compass error.
009° 6 ° E

At 0715 you observe the south end of Nicholson Island in transit with the south end of Haselwood Island. At the same time a radar range of 2.0 n.m. was obtained from the Southern end of Lupton Island. Transit@ 285°T

4. What is your position in latitude and longitude?
20° 19 S 149° 07,8' E

5. The observed standard compass bearing of the transit was 281° C. Find the compass error
4°E (Transit 285°T)

At 0745 you fix your position by the following standard compass bearings:

Pallion Point	**291° C + 4 °E = 295° T**
Lupton Island (south point)	**235° C+ 4 °E = 239°T**
Workington Island 9 I.	**265° C'+ 4 °E = 269° T**

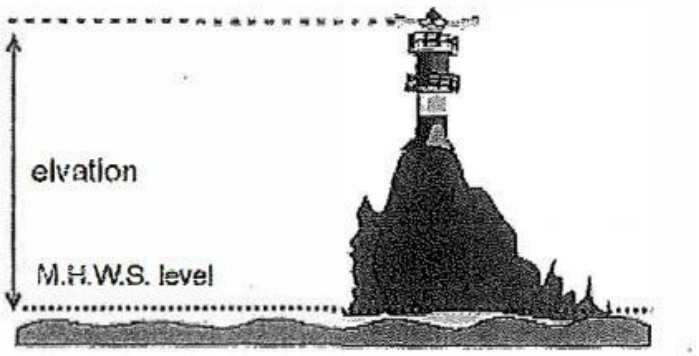
6. Find the hue bearings of the above standard compass bearings and state the position of the fix in latitude and longitude. **20° 16.1' S 149° 08.8 E**

EXERCISE SHEET #8
Position Lines

rising and dipping distance

When a light is raised, that is when it first appears above the horizon, or when it 'dips' below the horizon when going away from it, the distance from an observer to the light can be found using tables or formula. This range can be marked on the chart as a position circle in the same manner as a radar range. But first a few definitions.

definitions



Elevation of a light.

Intensity of lights

The intensity of a light is expressed in candelas, the international unit of luminous intensity.

Elevation

Elevation is the vertical distance between the focal plane of the light and the level of Mean High Water Springs or Mean Higher High Water or Highest Astronomical Tide whichever is given in the chart or Tide Tables

Luminous range

This is the maximum distance at which a light can be seen, taking account of the intensity of the light and the meteorological visibility only. It does not take into account elevation, observer's height of eye or the curvature of the earth.

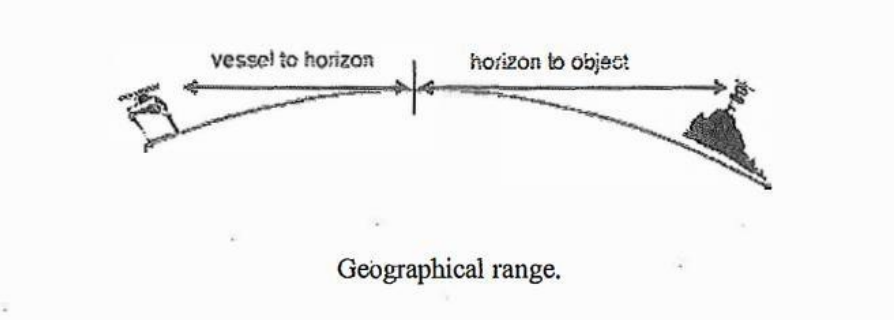
Nominal range

This is the luminous range when the meteorological visibility is 10 nautical miles. The nominal range is generally used in all new charts.

Geographical range

The maximum distance, at which an observer can theoretically see a light, taking into account elevation, observer's height of eye, curvature of the earth and the refraction of light caused by the atmosphere .

Loom The diffused glow from a light observed from below the horizon or hidden by an obstacle, because of atmospheric scattering. The loom of a light can often be seen at ranges very much more than its geographical range and affords the opportunity of taking a bearing.



Geographical range.

practical activity Think about the infonnation provided by the definitions that you have just learnt. List the factors that will influence the range at which a light will be sighted.

Practical Activities Answer

practical activity	The range at which a light would be sighted depends upon the intensity of light, visibility, elevation of light, height of eye of observer, curvature of earth, and refraction.

Position Lines

calculating rising and dipping distances

When calculating the "rising" or "dipping" range, you must take into account the luminous range and the geographical range of the light. The range given for the light on the chart is its nominal range. that is the range you could expect to see it if the "visibility" was 10 nautical miles. The light can never by seen at a range greater than either its geographical (dipping) range (because of the earth's curvature) or its luminous range (because of its brightness). Hence the smaller of these two (geographical and luminous ranges) is the maximum range at which you would expect to see the light.

The Admiralty List of Lights and Fog Signals gives a table for calculating geographical range, and a diagram for obtaining luminous range.

example

A light is charted as 18 metres high, with a nominal range of 12 miles. At what range would you expect to see it if your height of eye was 5 metres, and the visibility was 5 miles? To find the geographical range, enter the table with height of light 18 metres, and height of eye 5 metres. Geographical range = 13.2 miles.

Elevation in metres

GEOGRAPHICAL RANGE TABLE

Height of eye of observer In metres

	1	2	3	4	5	6	7	8	9	10	12	14	16	18	20
0	2.0	2.9	3.5	4.1	4.5	5.0	5.4	5.7	6.1	6.4	7.0	7.6	8.1	8.6	9.1
1	4.1	4.9	5.5	6.1	6.6	7.0	7.4	7.8	8.1	8.5	9.1	9.6	10.2	10.6	11.1
2	4.9	5.7	6.4	6.9	7.4	7.8	8.2	8.6	9.0	9.3	9.9	10.5	11.0	11.5	12.0
3	5.5	6.4	7.0	7.6	8.1	8.5	8.9	9.3	9.6	9.9	10.6	11.1	11.6	12.1	12.6
4	6.1	6.9	7.6	8.1	8.6	9.0	9.4	9.8	10.2	10.5	11.1	11.7	12.2	12.7	13.1
5	6.9	7.4	8.1	8.6	9.1	9.5	9.9	10.3	10.6	11.0	11.6	12.1	12.7	**13.2**	13.6
6	6.6	7.8	8.5	9.0	9.5	9.9	10.3	10.7	11.1	11.4	12.0	12.6	13.1	13.6	14.1
7	7.0	8.2	8.9	9.4	9.9	10.3	10.7	11.1	11.5	11.8	12.4	13.0	13.5	14.0	14.5
8	7.4	8.6	9.3	9.8	10.3	10.7	11.1	11.5	11.8	12.2	13.1	13.3	13.9	14.4	14.8
9	7.8	9.0	9.6	10.2	10.6	11.1	11.5	11.8	12.2	12.5	13.5	13.7	14.2	14.7	15.2
10	8.1	9.3	9.9	10.5	11.0	11.4	11.8	12.2	12.5	12.8	13.8	14.0	14.5	15.0	15.5

11	8.5	9.6	10.3	10.8	11.3	11.7	12.1	12.5	12.8	13.2	14.1	14.3	14.9	15.4	15.8
12	9.1	9.9	10.6	11.1	11.6	12.0	12.4	12.8	13.1	13.5	14.4	14.6	15.2	15.7	16.1
13	9.4	10.2	10.8	11.4	11.9	12.3	12.7	13.1	13.4	13.7	14.6	14.9	15.4	15.9	16.4
14	9.6	10.5	11.1	11.7	12.1	12.6	13.0	13.3	13.7	14.0	14.9	15.2	15.7	16.2	16.7
15	9.9	10.7	11.4	11.9	12.4	12.8	13.2	13.6	14.0	14.3	15.2	15.5	16.0	16.5	17.0
16	10.2	11.0	11.6	12.2	12.7	13.1	13.5	13.9	14.2	14.5	15.4	15.7	16.2	16.7	17.2
17	10.4	11.2	11.9	12.4	12.9	13.3	13.7	14.1	14.5	14.8	15.7	16.0	16.5	17.0	17.4
18	10.6	11.5	12.1	12.7	13.2	13.6	14.0	14.4	14.7	15.0	15.9	16.2	16.7	17.2	17.7
19	10.9	11.7	12.4	12.9	13.4	13.8	14.2	14.6	14.9	15.3	16.1	16.5	17.0	17.5	17.9
20	11.1	12.0	12.6	13.1	13.6	14.1	14.5	14.8	15.2	15.5	16.6	16.7	17.2	17.7	18.2

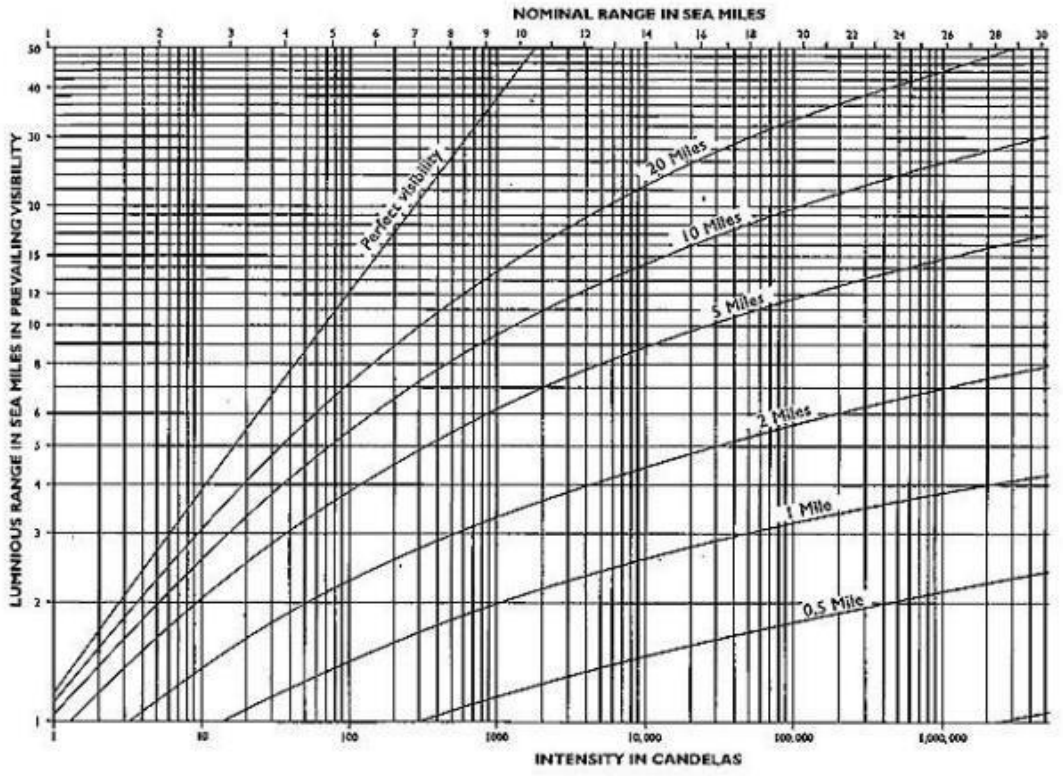
example

To find the luminous range, enter the luminous range diagram with the nominal range 12 miles, at the top. Drop straight down to the curve of 5 miles visibility, and from the point where you hit the curve go left horizontally to the scale, and read off the luminous range.

Luminous range = 7.7 miles.

The light will be seen at the lesser of these two, that is, at 7. 7 miles. The geographical range can also be found by using the following formula:

Distance = $2.09\sqrt{\text{Height of eye}}$ (m) + $2.09\sqrt{\text{Elevation of object}}$ (m)



Examination Paper E-Campus Australia

Course: **Master <24m & 45m**

Examination: **Goegraphical & Luminous range**

Instructions to candidates

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1. Chart AUS252. At what maximum range would a yacht sight the Pinnacle Point Light (height 21 metres) (approximate Latitude 20° 03.8'S) in meteorological visibility of 2 miles? The observer's height of eye is l metre.

   a 5 miles
   b 10 miles
   c 11.35 miles
   d 3.3 miles

Positon Fixing Review

practical activities

Complete these activities and check your answers against the feedback provided.

practical activities 4

A vessel observed Pioneer Rocks Lt bearing 135° T . At the same timethe echo sounder indicated a charted depth of 6.9 M

Fix the vessel's position and express it as latitude and longitude

practical activities 5

At what range would you expect to see Coppersmith Lt. if the visibility was 5 miles and your height of eye was 7 metres?

Positon Fixing Review Answer

practical activities 4

Latitude 20° 11' S
Longitude 148° 42.6' E

practical activities 5

Geographical range = 13.3 nm
Luminous range = 6.6 nm
The light will be seen at the lesser of these two ranges at 6.6 nm.

GEOGRAPHICAL RANGE TABLE (Fig 17.48)

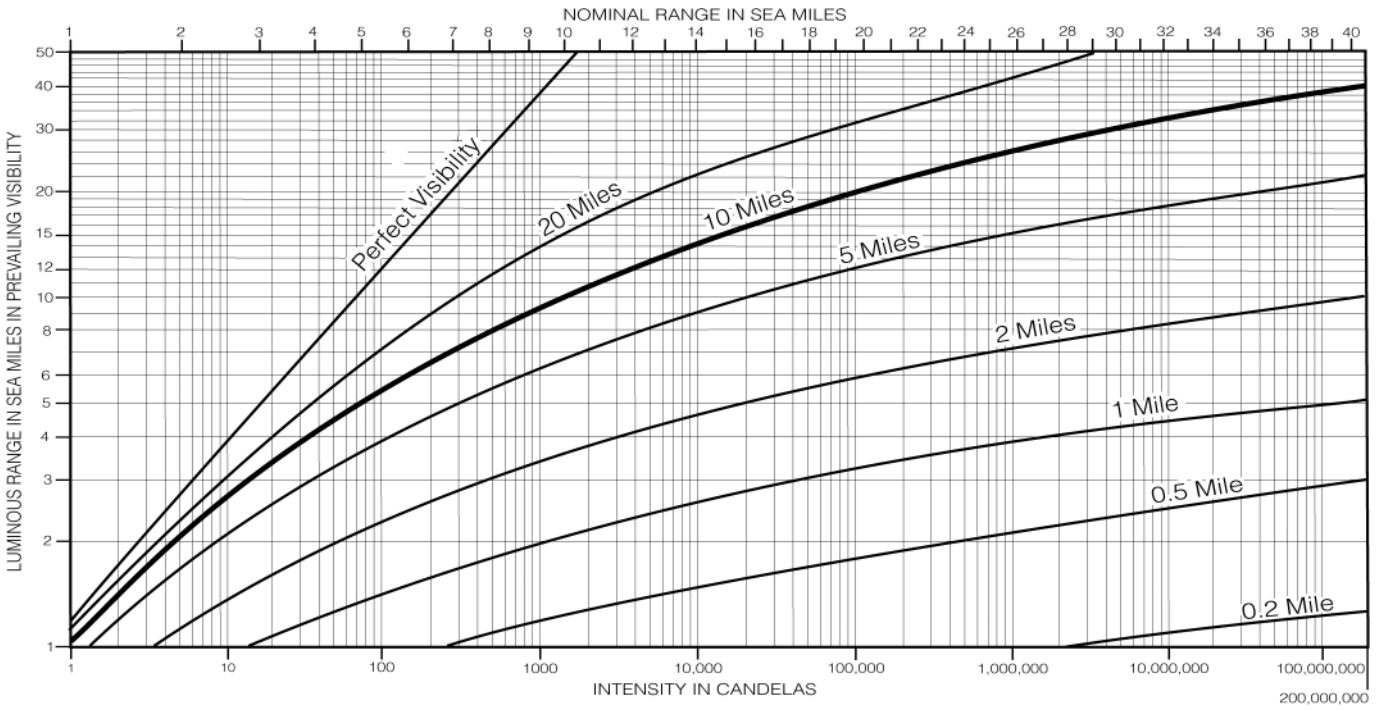
If the earth were flat, we would be able to see coastlines, lighthouses and ships at sea as far as we can see objects in space with powerful telescopes. But, the "hump" of the round earth limits the sighting distance or GEOGRAPHICAL RANGE of terrestrial objects. The greater the height of the object and/or our height of eye, the greater the geographical range.

The formula for calculating geographical range is shown under Radar in Chapter 16. However, most nautical tables and navigation exercise books contain a GEOGRAPHICAL RANGE TABLE, a sample of which is illustrated here. It shows, for example, that from a height of eye (above water) of 2 metres, we should be able to see an object of 100 metres high at a distance of 23.2 miles.

Elevation in		Height of Eye of Observer in feet/metres									
ft		3	7	10	13	16	20	23	26	30	33
	m	1	2	3	4	5	6	7	8	9	10
		Range in Sea Miles									
0	0	2.0	2.9	3.5	4.1	4.5	5.0	5.4	5.7	6.1	6.4
3	1	4.1	4.9	5.5	6.1	6.6	7.0	7.4	7.8	8.1	8.5
7	2	4.9	5.7	6.4	6.9	7.4	7.8	8.2	8.6	9.0	9.3
10	3	5.5	6.4	7.0	7.6	8.1	8.5	8.9	9.3	9.6	9.9
13	4	6.1	6.9	7.6	8.1	8.6	9.0	9.4	9.8	10.2	10.5
16	5	6.6	7.4	8.1	8.6	9.1	9.5	9.9	10.3	10.6	11.0
20	6	7.0	7.8	8.5	9.0	9.5	9.9	10.3	10.7	11.1	11.4
23	7	7.4	8.2	8.9	9.4	9.9	10.3	10.7	11.1	11.5	11.8
26	8	7.8	8.6	9.3	9.8	10.3	10.7	11.1	11.5	11.8	12.2
30	9	8.1	9.0	9.6	10.2	10.6	11.1	11.5	11.8	12.2	12.5
33	10	8.5	9.3	9.9	10.5	11.0	11.4	11.8	12.2	12.5	12.8
36	11	8.8	9.6	10.3	10.8	11.3	11.7	12.1	12.5	12.8	13.2
39	12	9.1	9.9	10.6	11.1	11.6	12.0	12.4	12.8	13.1	13.5
43	13	9.4	10.2	10.8	11.4	11.9	12.3	12.7	13.1	13.4	13.7
46	14	9.6	10.5	11.1	11.7	12.1	12.6	13.0	13.3	13.7	14.0
49	15	9.9	10.7	11.4	11.9	12.4	12.8	13.2	13.6	14.0	14.3
52	16	10.2	11.0	11.6	12.2	12.7	13.1	13.5	13.9	14.2	14.5
56	17	10.4	11.2	11.9	12.4	12.9	13.3	13.7	14.1	14.5	14.8
59	18	10.6	11.5	12.1	12.7	13.2	13.6	14.0	14.4	14.7	15.0
62	19	10.9	11.7	12.4	12.9	13.4	13.8	14.2	14.6	14.9	15.3
66	20	11.1	12.0	12.6	13.1	13.6	14.1	14.5	14.8	15.2	15.5
72	22	11.6	12.4	13.0	13.6	14.1	14.5	14.9	15.3	15.8	15.9
79	24	12.0	12.8	13.5	14.0	14.5	14.9	15.3	15.7	16.0	16.4
85	26	12.4	13.2	13.9	14.4	14.9	15.3	15.7	16.1	16.4	16.8
92	28	12.8	13.6	14.3	14.8	15.3	15.7	16.1	16.5	16.8	17.2
98	30	13.2	14.0	14.6	15.2	15.7	16.1	16.5	16.9	17.2	17.5
115	35	14.0	14.9	15.5	16.1	16.6	17.0	17.4	17.8	18.1	18.4
131	40	14.9	15.7	16.4	16.9	17.4	17.8	18.2	18.6	18.9	19.3
148	45	15.7	16.5	17.1	17.7	18.2	18.6	19.0	19.4	19.7	20.0
164	50	16.4	17.2	17.9	18.4	18.9	19.3	19.7	20.1	20.5	20.8

Elevation in		Height of Eye of Observer in feet/metres									
ft		3	7	10	13	16	20	23	26	30	33
	m	1	2	3	4	5	6	7	8	9	10
		Range in Sea Miles									
180	55	17.1	17.9	18.6	19.1	19.6	20.0	20.4	20.8	21.2	21.5
197	60	17.8	18.6	19.3	19.8	20.3	20.7	21.1	21.5	21.8	22.2
213	65	18.4	19.2	19.9	20.4	20.9	21.4	21.7	22.1	22.5	22.8
230	70	19.0	19.9	20.5	21.1	21.5	22.0	22.4	22.7	23.1	23.4
246	75	19.6	20.5	21.1	21.7	22.1	22.6	23.0	23.3	23.7	24.0
262	80	20.2	21.0	21.7	22.2	22.7	23.1	23.5	23.9	24.3	24.6
279	85	20.8	21.6	22.2	22.8	23.3	23.7	24.1	24.5	24.8	25.1
295	90	21.3	22.1	22.8	23.3	23.8	24.2	24.6	25.0	25.4	25.7
312	95	21.8	22.7	23.3	23.9	24.3	24.8	25.2	25.5	25.9	26.2
328	100	22.3	23.2	23.8	24.4	24.9	25.3	25.7	26.1	26.4	26.7
361	110	23.3	24.2	24.8	25.4	25.8	26.3	26.7	27.0	27.4	27.7
394	120	24.3	25.1	25.8	26.3	26.8	27.2	27.6	28.0	28.3	28.7
427	130	25.2	26.0	26.7	27.2	27.7	28.1	28.5	28.9	29.2	29.6
459	140	26.1	26.9	27.6	28.1	28.6	29.0	29.4	29.8	30.1	30.5
492	150	26.9	27.7	28.4	28.9	29.4	29.9	30.2	30.6	31.0	31.3
525	160	27.7	28.6	29.2	29.8	30.2	30.7	31.1	31.4	31.8	32.1
558	170	28.5	29.4	30.0	30.5	31.0	31.5	31.9	32.2	32.6	32.9
591	180	29.3	30.1	30.8	31.3	31.8	32.2	32.6	33.0	33.3	33.7
623	190	30.0	30.9	31.5	32.1	32.5	33.0	33.4	33.7	34.1	34.4
656	200	30.8	31.6	32.2	32.8	33.3	33.7	34.1	34.5	34.8	35.1
722	220	32.2	33.0	33.6	34.2	34.7	35.1	35.5	35.9	36.2	36.5
787	240	33.5	34.3	35.0	35.5	36.0	36.4	36.8	37.2	37.6	37.9
853	260	34.8	35.6	36.3	36.8	37.3	37.7	38.1	38.5	38.8	39.2
919	280	36.0	36.9	37.5	38.0	38.5	39.0	39.4	39.7	40.1	40.4
984	300	37.2	38.1	38.7	39.2	39.7	40.2	40.6	40.9	41.3	41.6
1050	320	38.4	39.2	39.9	40.4	40.9	41.3	41.7	42.1	42.4	42.8
1115	340	39.5	40.3	41.0	41.5	42.0	42.4	42.8	43.2	43.5	43.9
1181	360	40.6	41.4	42.1	42.6	43.1	43.5	43.9	44.3	44.6	45.0
1247	380	41.6	42.5	43.1	43.7	44.1	44.6	45.0	45.3	45.7	46.0
1312	400	42.7	43.5	44.1	44.7	45.2	45.6	46.0	46.4	46.7	47.0

USING THE LUMINOUS RANGE DIAGRAM (Fig 17.49)



The ranges of lights printed on navigational charts are their NOMINAL RANGES, which indicates their intensity in candelas, as shown in the above diagram. For example, the intensity of a 14-mile light is 10,000 candelas.

The diagram also provides the LUMINOUS RANGE of a light for a given state of visibility. This is the range at which the light will be seen (<u>if the earth were flat</u>) for a given meteorological visibility. It should be remembered that the STANDARD METEOROLOGICAL VISIBILITY (for an unlit object) is 10 miles. Therefore, on the 10-mile visibility curve, the Nominal Range of any light is the same as its Luminous Range.

EXERCISE SHEET #9
RUNNING FIX

Examination Paper — E-Campus Australia

Course: **Master <24m & 45m**

Examination: **Running Fix**

Instructions to candidates

1. Chart AUS252, At I 100 hours Hammer Island (131) (approx, Lat 20° 38,8'S) bore 025°T, At 1130 Blacksmith Island (157) (approx. Lat 20° 38.1 'S) bore 076°T, The vessel was steering 349°T at 11 knots. Find her position at 1130 hours by the running fix method.

   a 20° 39.9'S 148° 58.2'E
   b 20° 40.7'S 149° 01.6'E
   c 20° 37,8'S 149° 00.3'E
   d 20° 39.1S 148° 59.7'E

2. Chart AUS252, You have depaited from an anchorage south of Defiance Is. (in Repulse Bay) on a course of 104°C at 12 knots. At 1010 hours, East Repulse Island (62) (approx, Lat 20° 36.1 'S) bears 150°C. What is your position at 1034 hours when the same peak bears 252°C? (Dev 4.5°E)

   a 20° 34.8'S 148° 56.6'E
   b 20° 35.9' S 148° 56,6'E
   c 20° 35,9's 148° 57.9'E
   d 20° 36.7'S 148° 55.l'E

3. Chart AUS252, A vessel is steering 000°C at a speed of 11.5 knots. At 0112 hours, she observed the easternmost edge of Cape Conway (approx, Lat 20° 32.2'S) at 7.5 miles radar range on her port bow. At 0148, the same landmark was found to be at 3.1 miles. Fix the vessel's position at 0148 hours, stating it in relation to Cape Conway. (Deviation 3.5°E).

   a C, Conway brg. 280° x 3.1'
   b C. Conway brg. 260° x 3. 1'
   c C. Conway brg, 100° x 4.2'
   d C, Conway brg. 280° x 7.5'

4. Chart AUS252. A vessel is steering 165°C at a speed of 9.5 knots. At 0800 Hayman Island Summit (247) (approx, Lat 20° 03.1 'S) bore 068°C. At 0848 Whitsunday Peak Summit (approx, Lat 20° 16.0'S) bore 123°C. Find her position at 0848 hours. (Deviation 1 °W).

   a 20° 1 1.5'S 148° 50.6'E
   b 20° 10.6' S 148° 52.2 'E
   c 20° 11.1'S 148° 50.2'E
   d 20° 11.4'S 148° 51.5'E

Course: **Master <24m & 45m**

Examination: **Running Fix**

Instructions to candidates

5. Chart AUS252. Your vessel is steering 358°C at a speed of 10 knots. At 2112 the radar range of the easternmost edge of Cape Conway (approx. Lat 20° 32.2'S) was 6.9 miles. At 2148 the range had decreased to 4.1 miles. Find the vessel's position at 2148 and determine the compass course to steer to enter Kennedy Sound, keeping 0.7 miles clear of Seaforth Island (approx. Lat 20° 28.4'S). (Deviation is 3.5°E on the given course, and 4.5°E on the course to find).

   a 20° 32.3'S 149° 00.4'E; 047°C
   b 20° 31.5'S 148° 59.6'E; 035°C
   c 20° 32.4'S 149° 00.3'E; 021 °C
   d 20° 32.4'S 149° 59.0'E; 022°C

Marking Sheet E-Campus Australia

Course: **Master <24m & 45m**

Examination: **Running Fix**

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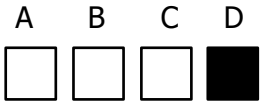
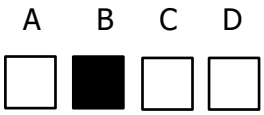
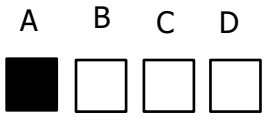
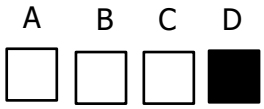
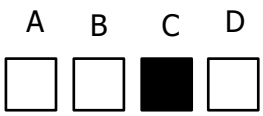
1. 

2. 

3. 

4. 

5. 

EXERCISE SHEET #10
SET + DRIFT
MASTER <24m & 45m : FINDING SET & DRIFT

1. Your fixed position at 1350 hrs is 1.0 Nm north east of Pioneer Point. You set a course for the eastern edge of Double Cone Island at 12.0 knots by ships log. At 1420 hrs you fix yourself with the following radar ranges:

Grimston Point 2.4 NM
Armit Island (29) 3.4 NM
Bluff Point 5.15 NM

Find
a) The set, drift and rate of the current
b) Course made good
c) Speed made good

2. At 1145 hrs your position is Lat 20° 05' .0 S due south of Double Rock (NE Hook Island). You set a course to clear Dumbell Island by 8 cables to port at a speed of 12 knots by log. At 1205 you fix with the following Hand Held compass bearings:

Hill 265 (Hook Is) 236½°C
Hill 52 (Dumbell ls) 148½°C
Mostrooper Peak 216 (Border Is) 108½°C

Find
a) Your lat/long at 1205
b) Course made good
c) Speed made good
d) Set, drift and rate of current

3. At 0425 hrs your fixed position is Lat 20° 39'.4 S Long 148° 47'.0 E and you steer 037° Tat 7.5 knots. At 0500 hrs you fix using **Hand Held** compass bearings:

Western Edge of North Repulse Is 047½°C
Southern Edge of East Repulse Is 112°C
Eastern Edge of Defiance Is 335°C

a) What depth of water does the chart indicate you are in?
b) What course have you made good?
c) What speed have you made good?
d) Find the set, drift and rate of the current?

4. At 0340 hrs you are 1.6 NM due west of Platypus Rock steering 343° COMPASS at 10 knots. At 0410 you fix by radar ranges:

Round Head 4.25 NM
Cole Island 2.2 NM
Spitfire Rock 3.0 NM

a) What true course were you steering?
b) What Is your position at 041 0 hrs?
c) What course have you made good?
d) What speed have you made good?
e) What is the set, drift and rate of the current?
f) Is the tide ebbing or flooding?

5. At 1640 hrs from a position 6 cables due west of the Dent Island Light (Fl.5s 37m 10M) you steer a course of 329° COMPASS at 6.5 knots by ships log. At 1710 hrs you fix with radar using:

NW Point Dent Island	2.95 NM
Southern Point of Denham Is	2.5NM
Northern Tip of Henning Is	2.65 NM

a) What true course were you steering?
b) What true course have you made good?
c) What speed have you made good?
d) What is the set, drift and rate of the current?

MASTER <24m & 45m : FINDING SET & DRIFT ANSWERS

1. Your fixed position at 1350 hrs is 1.0 Nm north east of Pioneer Point. You set a course for the eastern edge of Double Cone Island at 12.0 knots by ships log. At 1420 hrs you fix yourself with the following radar ranges:

Grimston Point 2.4 NM
Armit Island (29) 3.4 NM
Bluff Point 5.15 NM

Find

a) The set, drift and rate of the current **232° 2.05 NM 4.1 knots**
b) Course made good **318½0 T**
c) Speed made good **11.6 Knots**

2. At 1145 hrs your position is Lat 20° 05' .0 S due south of Double Rock (NE Hook Island). You set a course to clear Dumbell Island by 8 cables to port at a speed of 12 knots by log. At 1205 you fix with the following Hand Held compass bearings:

Hill 265 (Hook Is) 236½°C
Hill 52 (Dumbell ls) 148½°C
Mostrooper Peak 216 (Border Is) 108½°C

Find

a) Your lat/long at 1205 **20° 08'.05 S** **148° 59' .65 E**
b) Course made good **60° T**
c) Speed made good **9.76 Knots**
d) Set, drift and rate of current **025°** **0.95NM** **2.85 knots**

3. At 0425 hrs your fixed position is Lat 20° 39'.4 S Long 148° 47'.0 E and you steer 037° Tat 7.5 knots. At 0500 hrs you fix using **Hand Held** compass bearings:

Western Edge of North Repulse Is 047½°C
Southern Edge of East Repulse Is 112°C
Eastern Edge of Defiance Is 335°C

a) What depth of water does the chart indicate you are in? **4.6 metres**
b) What course have you made good? **042° T**
c) What speed have you made good? **9.4 knots**
d) Find the set, drift and rate of the current? **059° 1.2 NM 2.06 knots**

4. At 0340 hrs you are 1.6 NM due west of Platypus Rock steering 343° COMPASS at 10 knots. At 0410 you fix by radar ranges:

Round Head 4.25 NM
Cole Island 2.2 NM
Spitfire Rock 3.0 NM

a) What true course were you steering? **349° T**
b) What Is your position at 041 0 hrs? **20° 27'.23 S 148° 58'.9 E**
c) What course have you made good? **338°**
d) What speed have you made good? **8.6 knots**
e) What is the set, drift and rate of the current? **217° 1.15 NM 2.3 knots**
f) Is the tide ebbing or flooding? **Flooding**

5. At 1640 hrs from a position 6 cables due west of the Dent Island Light (Fl.5s 37m 10M) you steer a course of 329° COMPASS at 6.5 knots by ships log. At 1710 hrs you fix with radar using:

NW Point Dent Island	2.95 NM
Southern Point of Denham Is	2.5NM
Northern Tip of Henning Is	2.65 NM

a) What true course were you steering?	**335° T**
b) What true course have you made good?	**322° T**
c) What speed have you made good?	**7.8 knots**
d) What is the set, drift and rate of the current?	**278° 1.0 NM 2.0 knots**

EXERCISE SHEET #11
SET + DRIFT
MASTER <24m & 45m : FINDING SET & DRIFT
COMBINATION WITSUNDAY CHART NOTFREE DEVIATION

1. At 0420 hrs your fixed position is 20° 40'.00 S 149° 00'.0 E
You set a course for a position 0.6NM due west of the Dent Island light (Fl.5s37m10M) at a boat speed of 7.5 knots.

a) What true and compass courses are you steering?

At 0520 you fix yourself with the following STANDARD compass bearings:

Platypus Rock	044°C
Northern tip of Silversmith Is	103°C
Spitfire Rock	012°c

b) What is your position in LAT/ LONG?
c) What course have you made good?
d) What speed have you made good?
e) What is the set, drift and rate of the current?
f) What compass course do you need to steer to counter the current to make good your original destination?

2. You are anchored 1.0 NM South East of the eastern tip of Esk Island in Whitehaven Bay. At 0915 hrs you set a course to 20° 00' .8 S, 149° 02' .75E at 12 knots by ships log.

a) What true and compass course are you steering?

At 0935 hrs you fix by radar ranges.

Deloraine Is (Southern tip)	2.0 NM
Pallion Point	4.1 NM
Petrel Islet	2.9 NM

b) What is your fixed position at 0935 hrs?

c) What course have you made good?

d) What speed have you made good?

e) What is the set, drift and rate of the current?

f) What compass course do you need to steer to your original destination to counter the current experienced?

g) What is your ETA at your destination?

ANSWERS
MASTER <24m & 45m : FINDING SET & DRIFT
COMBINATION WITSUNDAY CHART NOTFREE DEVIATION

1. At 0420 hrs your fixed position is 20° 40'.00 S 149° 00'.0 E
You set a course for a position 0.6NM due west of the Dent Island light (Fl.5s37m10M) at a boat speed of 7.5 knots.

a) What true and compass courses are you steering?
T 346° V 8½°E M 337½ D 2½°W C 340° T E 6 °E

At 0520 you fix yourself with the following STANDARD compass bearings:

Platypus Rock	044°C	**050° T**
Northern tip of Silversmith Is	103°C	**109° T**
Spitfire Rock	012°c	**018° c**

b) What is your position in LAT/ LONG? **20° 32'.95 S 149° 00'.2 E**

c) What course have you made good? **001½° T**

d) What speed have you made good? **7.1 KNOTS**

e) What is the set, drift and rate of the current? **095° 2.1 nm 2.1 KNOTS**

f) What compass course do you need to steer to counter the current to make good your original destination? **T 321° V 8½0E M 312½° D 1°W C 313½°**

2. You are anchored 1.0 NM South East of the eastern tip of Esk Island in Whitehaven Bay. At 0915 hrs you set a course to 20° 00' .8 S, 149° 02' .75E at 12 knots by ships log.

a) What true and compass course are you steering?
T 357½° V 8½°E M 349° D 1°W C 350½ TE 7½°E

At 0935 hrs you fix by radar ranges.

Deloraine Is (Southern tip)	2.0 NM
Pallion Point	4.1 NM
Petrel Islet	2.9 NM

b) What is your fixed position at 0935 hrs? **20° 11'.6 E 149° 03'.85 E**

c) What course have you made good? **008° T**

d) What speed have you made good? **9.15 KNTS**

e) What is the set, drift and rate of the current? **148° T 1.15 NM 3.45 KNTS**

f) What compass course do you need to steer to your original destination to counter the current experienced?
T 344° V 8½°E M 335½° D 2½°W C 338°

g) What is your ETA at your destination?
10.85 NM = 1HR 11 MINS
9.15 KNTS

ETA 1046 HRS

EXERCISE SHEET #12
SET & DRIFT

Examination Paper E-Campus Australia

Course: **Master <24m & 45m**

Examination: **Leeway, Sey & Drift Combo**

Instructions to candidates

1. Chart AUS252. What is the compass course to steer f rom a position with Dent Island west coast Light (approx. Latitude 20° 22,2'S) bearing 082°M at a range of 0.8 miles, to make good a course of 340°T, while counteracting a current setting 140°T at 1. 7 knots and leeway of 8° from a strong westerly wind? Vessel's speed through the water is IO knots. (Deviation 1°w)

   a 347°C
   b 339°C
   c 321°C
   d 354°C

2. Chart AUS252. A vessel is 2.2 miles due east of South Repulse Island (60) (approximate Latitude 20° 36.8'S). She wishes to pass 1.5 miles off Hammer Island (131) (approximate Latitude 20° 38,8'S), counteracting a current setting 150°T at 2 knots and a leeway of 5 ° from a southerly wind. Her log speed is 6 knots. Find her compass course to steer and speed made good. (Use Deviation Card 2 in the Australian Boating Manual and Variation of 8°E)

   a CTS 102°C; SMG 7.6 knots
   b CTS 114°C; SMG 7.4 knots
   c CTS 108°C; SMG 5.6 knots
   d CTS 111°C; SMG 9.1 knots

3. Chait AUS252. From a position with South Repulse Island (60) (approximate Latitude 20° 36.8'S) bearing 024°M when Gould Island and Midge Point (approximate Latitude 20° 39.8'S) were in transit, a vessel steered 107°C for 13 miles when Bellows Island bore 061 °M, range 2.4 miles. What are the CMG and set and drift of the current experienced? (Use deviation 25°W and variation 8°E).

   a CMG 085°T; Set 122°T; Drift 0.7'
   b CMG 176°T; Set 090°T; Drift 2.4'
   c CMG 086°T; Set 302°T; Drift 1.5'
   d CMG 226°T; Set 301°T; Drift 1.4'

Course: **Master <24m & 45m**

Examination: **Leeway, Set & Drift Combo**

Instructions to candidates

4. Chart AUS252. A vessel was steering 156°C at 7 knots. At 0900, she observed Double Cone Island (104) (approximate Latitude 20° 06.2' S) bearing 211°M and at 0945 it bore 292°M. What was the vessel's position at 0945 if a current set 000°T at 3.5 knots and a leeway of 5° from a NE'ly wind? (Use deviation 19°W and variation 8 °E)

   a 20° 08.7'S 148° 46.2'E
   b 20° 05.6'S 148° 45.3'E
   c 20° 07.8'S 148° 48.9'E
   d 20° 07.8'S 148° 46.1'E

5. Chart AUS252. A vessel steering 092°C at 7.5 knots observed Pinnacle Point Light bearing 119°M at a range of 2.7 miles. 35 minutes later, it bore 218°M at a range of 2.2 mile. What were the CMG and the set and rate of current experienced? (Use deviation 0° and variation 8°E)

   a 091°T;Set 318°T x 0.9 knots
   b 100°T; Set 138°T x 0.9 knots
   c 091 °T; Set 320°T x 1.5 knots
   d 092°T; Set 090°T x 2.1 knots

Marking Sheet E-Campus Australia

Course: **Master <24m & 45m**

Examination: **Leeway, Set & Drift Combo**

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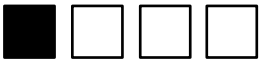
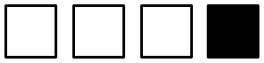
1. A B C D

2. A B C D



3. A B C D

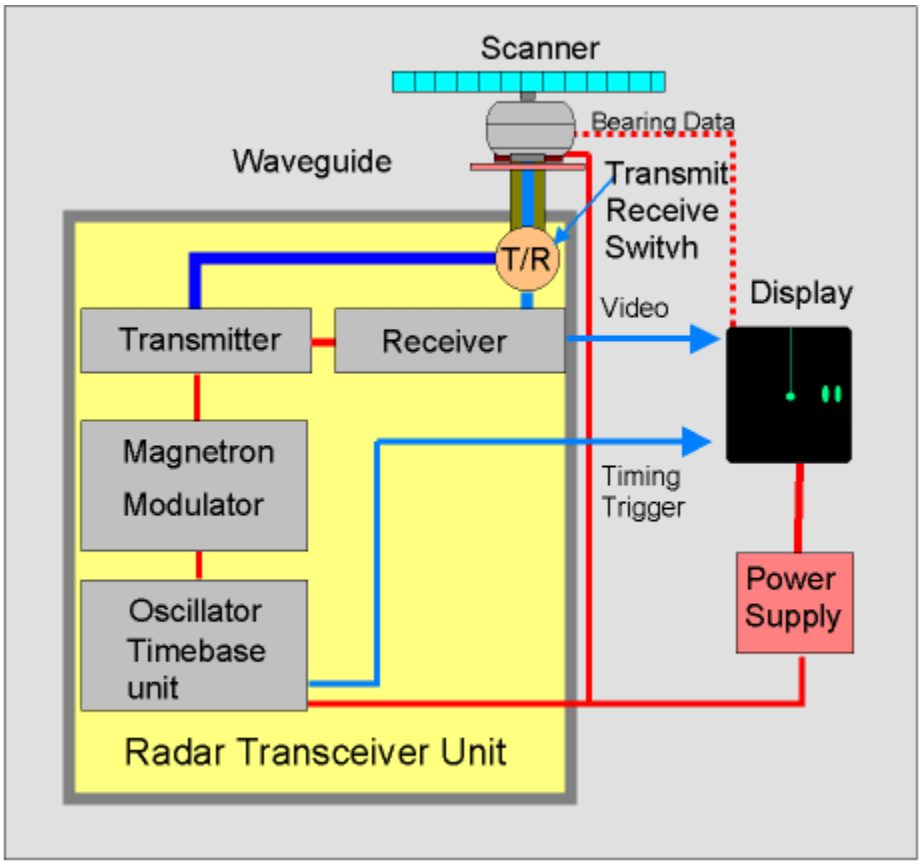
4. A B C D



5. A B C D

Major Components of typical radar

major components of a typical radar



power supply

Supplies the power to the radar. It is a small solid state power-pack or motor alternator.

transmitter

Super high frequencies of electromagnetic energy waves (3000 to 10000 MHz, these are wavelengths of 3 and 10 cm, respectively), are produced in the oscillator. The operating cycle of the oscillator is initiated by the trigger, which determines the **pulse repetition frequency (PRF)**. The pulses are shaped in the **modulator**, which determines the pulse length, then passed to the magnetron, which converts the energy into radio waves and determines the radar frequency. They are then passed to the transmitter, which in modern radars is usually combined with the receiver and called the transceiver.

The transceiver is usually located within the scanner unit.

waveguide

The pulses are transmitted to the scanner unit by the waveguide. A waveguide is hollow copper tubing, usually rectangular in cross section, having dimensions according to the wavelength of the carrier frequency. An electronic switch in the waveguide, called the transmit/receive cell (T/R) isolates the receiver during transmission to protect it from the high power of the transmission. In modern radars the waveguide and the T/R switch are usually located within the scanner unit.

scanner

The scanner unit radiates the radar pulses and passes returning target echoes to the receiver. The scanner also focuses the outgoing microwaves into a tight beam in much the same way as a torch reflector focuses the light from a bulb. This is done in most marine radars by feeding the microwaves into a hollow tube inside the rotating scanner that is also called a waveguide. The waveguide is sealed at both ends but has a series of small slots in one side. Each slot acts like a small aerial but their combined effect is to focus the microwaves into a narrow beam. This type of scanner is called a horizontal slotted wave-guide.

The width of the scanner will determine the horizontal beamwidth of the radar. A wider scanner will result in a narrower beamwidth that will produce better bearing discrimination.

In every revolution of the scanner, radar pulses hit the target not once but many times during the time it is aimed at the target. The effect on the screen is cumulative, the more hits the brighter the target appears on the screen. Should insufficient pulses hit the target only a weak echo will be displayed and it will disappear quickly. The number of scanner revolutions should be between 20 and 30 revolutions per minute in order to both display the target brightly and prevent the disappearance of the picture between scanner revolutions.

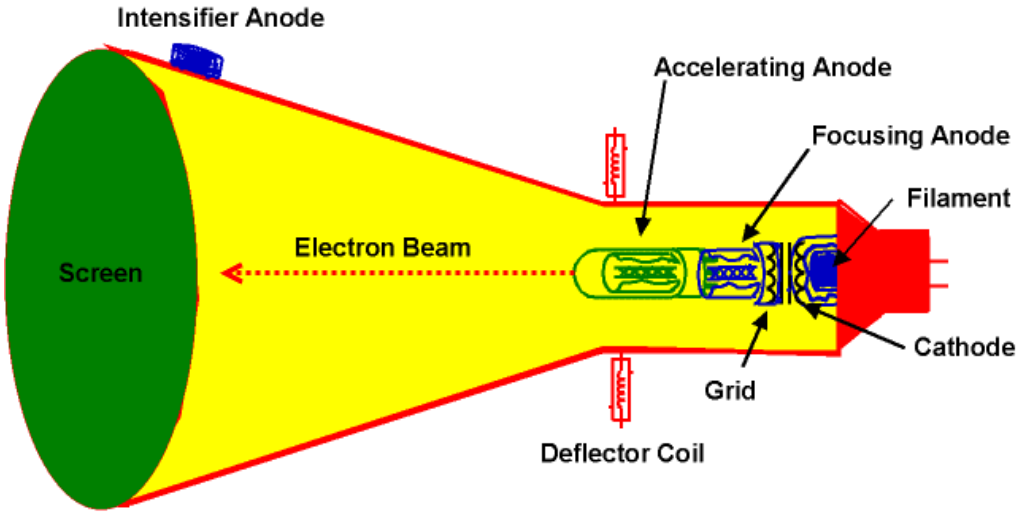
Most scanners operate at 24 rpm. Although some radars designed for high speed operations rotate at more than 40 rpm.

A more recent innovation is the patch aerial. This aerial uses a printed circuit consisting of an array of copper pads, to focus the beam.

The figure on the left shows a conventional radar scanner.

Radomes are particularly suited to yachts as the rotating scanner is enclosed within the dome, allowing it to turn without fouling sails and rigging. **radome**. The outer casing is made of GRP (fibreglass) which is transparent to radar energy.

time-base unit	With analogue radar (older scope radar's), a motor rotates the scanner at approximately 24 rpm and a signal from the time base unit to the display unit causes the trace to rotate in synchronisation with the scanner. As the scanner passes the fore-and-aft line, a heading marker will appear on the display. Digital radar's (modern raster scan radar) use microprocessors (computers) to add heading and time-base information to the display.
receiver	The receiver unit detects incoming echoes that are at more or less the same frequency as the outgoing frequency and mixes them with a signal from the local oscillator to reduce them to an intermediate frequency, usually about 60MHz. The I.F. amplifier then amplifies the signal; weaker distant targets are amplified more than stronger closer targets and then passed to the video amplifier, which converts the signal to a suitable form for video display. The signals are then passed on to the display unit, with the addition of range and bearing marker signals. The receiver in modern radars is combined with the transmitter, called the transceiver and usually located within the scanner unit.
analogue display units	Analogue type radars consist essentially of a cathode ray tube (CRT), the face or screen of which is commonly referred to as the scope, and various timing circuits and controls. In the scope a stream of electrons is directed towards a fluorescent screen. The phosphorus glows when illuminated by the electrons while internal circuitry forms the trace or sweep. A beam begins at the centre and sweeps out again and again, each sweep corresponding to the progress of a microwave pulse going out and back, and each successive sweep moving a little further around the screen in time with the rotating scanner. A returning echo is added to the sweep signal so that the screen is more brightly illuminated at a point corresponding to the bearing and range of the targets echo. This produces a very clear but very dim picture and the scope is fitted with a cowling to allow daylight viewing.



cathode ray tube

The above diagram shows a cathode ray tube (CRT) using magnetic deflection obtained from coils placed around the neck of the CRT. Other CRT's use electrostatic deflection, by use of deflection plates.

analogue radar

The figure on the left shows a Furuno 72 mile analogue radar. The scope radars are characterised by their circular display and daylight viewing hood.

effects of weather

Weather conditions affect radar performance, in three ways:

- non-standard atmospheric conditions
- **attenuation**
- unwanted echoes

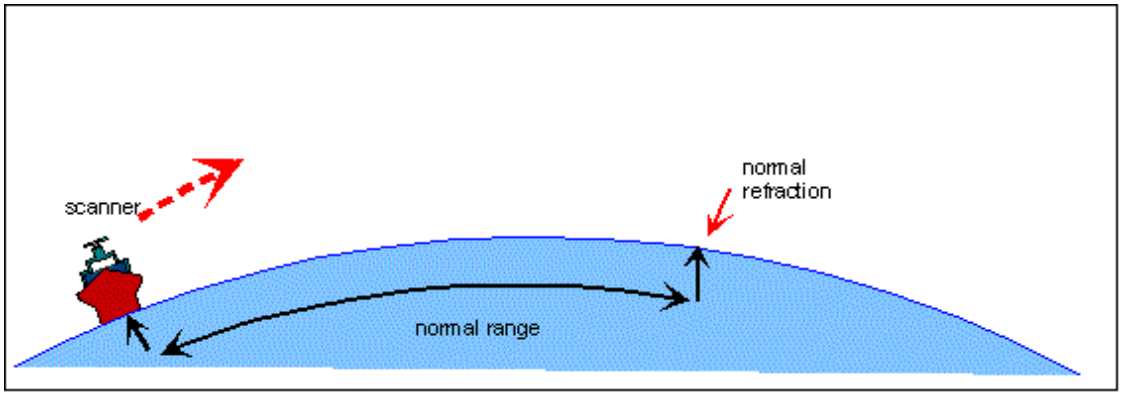
The radar horizon assumes standard atmospheric conditions. Which are:

- pressure = 1013 hpa decreasing with height at the rate of approximately 100 hpa per 1000 metres
- temperature = at sea level 30° C decreasing with height at a rate of 6.5° C per 1000 metres
- relative humidity = 60% and constant with height

In the standard atmosphere the temperature and moisture content decrease relatively slowly with height and the radars range will be normal. In **non-standard atmospheric conditions** the radars range will differ from normal.

normal radar horizon

The radar wave being longer than light waves will be refracted more than light waves. Typically the radar horizon will be about 6% greater than the visible horizon.

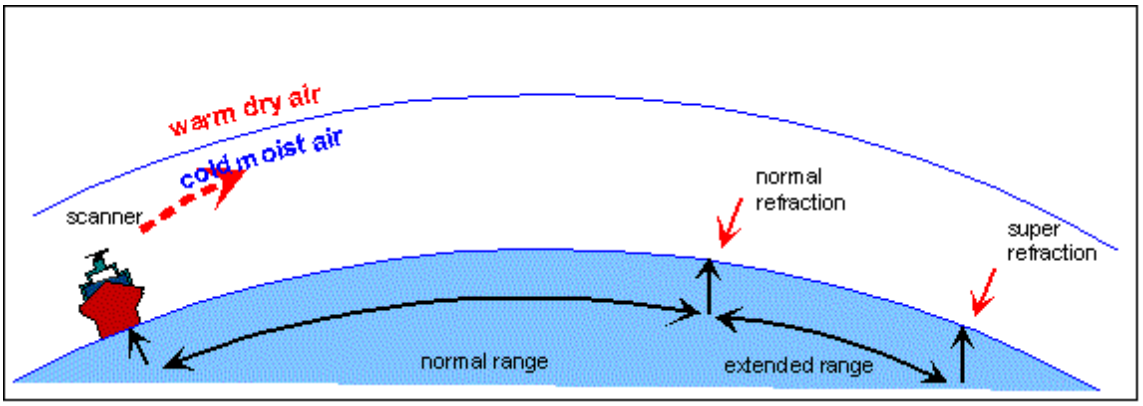


super-refraction

Super-refraction will occur when a warm air layer overlies a cooler sea surface (ie. temperature inversion) or when there is a decrease in relative humidity with increased height (moisture lapse). Often these two conditions will occur together.

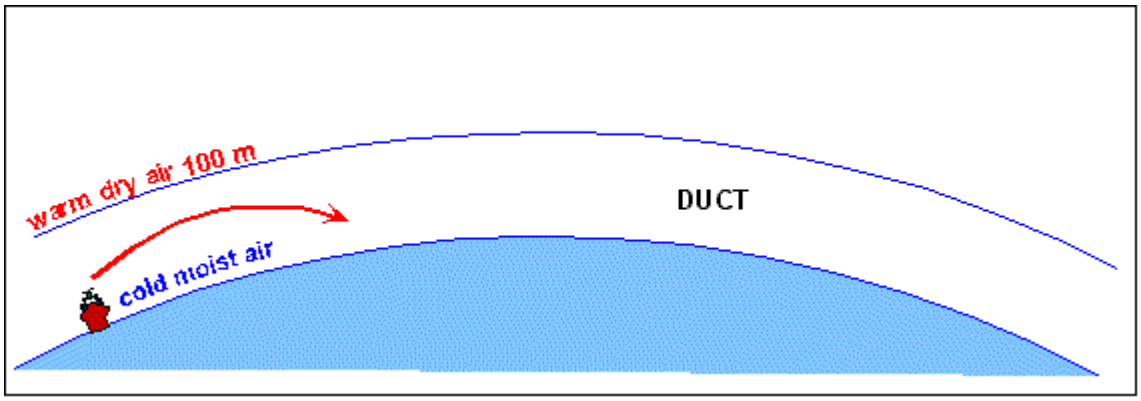
For super-refraction conditions to exist the weather must be calm with no turbulence to mix the layers of different densities. In Australia super-refraction conditions often occur in the Gulf of Carpentaria.

The radar beam is refracted more than normal causing considerably increased target detection ranges, typically up to 25%.



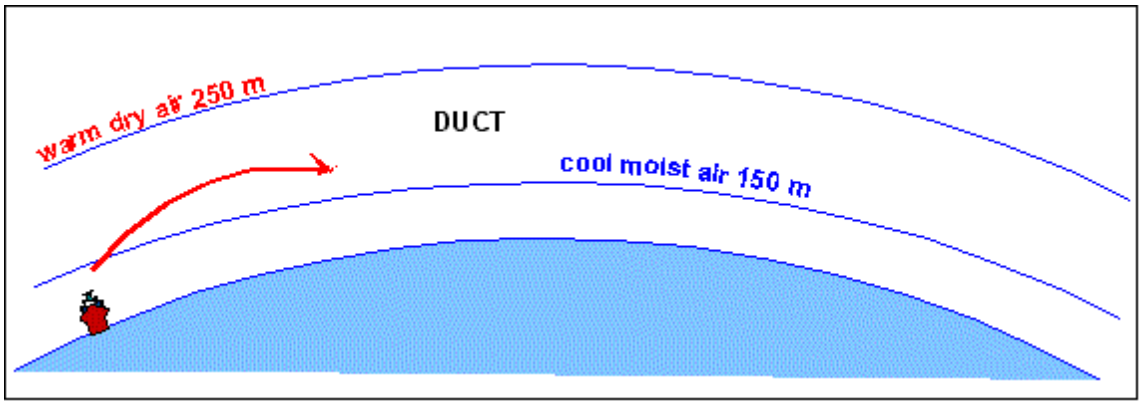
surface ducting

An extreme form of super-fraction is known as ducting, when the radar beam is conducted for long periods within a **waveguide** shaped by the Earth's surface and a slightly higher warm air layer. When this occurs, unusually long detection ranges of targets may be experienced. It is during periods of ducting that second trace echoes may appear. This phenomenon is known as surface ducting and is common in the tropics.



elevated ducting

A second form of ducting can occur where there is a reflecting layer of warm air elevated above the Earth's surface (temperature inversion). These conditions often occur during calm weather in trade winds regions near land in the afternoon when warm air from over the land drifts out over a cooler sea surface.



sub-refraction

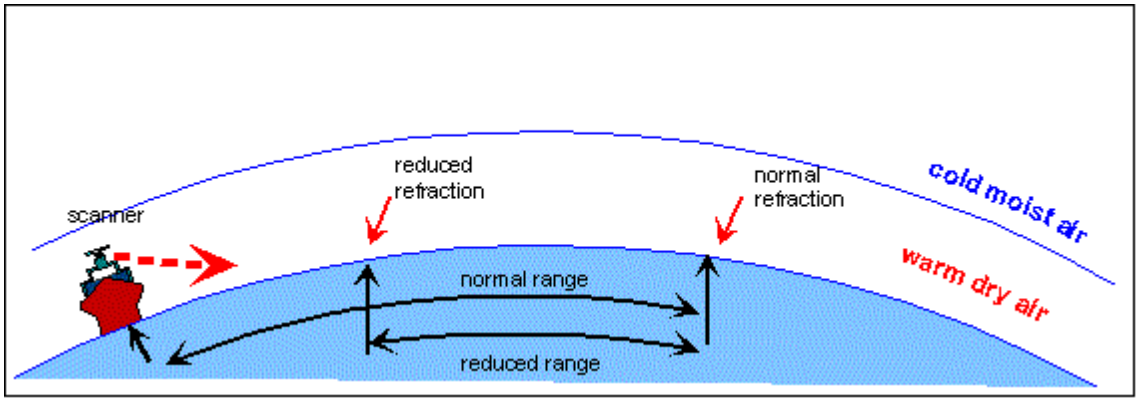
Sub-refraction can occur when there is an:

- increase in relative humidity with height and (or)
- abnormal decrease of temperature with increased height.

The radar beam is refracted at less than normal, causing reduced target detection range.

Such conditions can occur in polar regions where cold winds blow over a warm ocean current. Conditions must be calm with no turbulence to mix the layers of different densitys. Sub-refraction is not as common as super-refraction.

The effects of sub-refraction will be very noticeable to the radar observer near land. There will be a sense that something is not right with the radar. Echoes of buoys and low land will disappear and only echoes of high land will be visible.



When sub-refraction conditions exist the radar lobe is bent upwards (lifted). This lifting of the radar lobe will affect the radar's minimum range which could result in close and low targets like small vessels being missed. Extreme care should be exercised in conditions where sub-refraction exists.

PLOTTING CPA / TPCA EXERCISE FIVE

1 Your ship is on a course of 130° T and its speed is 28 kts. At 1500 a contact was observed bearing 090° T at 12.0 miles at 1505 the bearing was 091.5° T at 9.0 miles, and at 1510 the bearing was 095° T and the range 6.0miles. Find: CPA, time of CPA and the bearing of CPA.

2 Your ship is on a course of 050° T and its speed is 12 kts. At 1000 a contact was observed bearing 226° T at 2.5 miles at 1005 the bearing was 220° T at 2.0 miles, and at 1010 the bearing was 212.5° T and the range 1.5 miles.
Find: CPA, time of CPA and the bearing of CPA.

3 Your ship is on a course of 250° T and its speed is 10kts. At 1206 a contact was observed bearing 176° T at 9.8 miles at 1209 the bearing was 174° T at 9.0 miles, and at 1212 the bearing was 172° T and the range 8..2 miles.

Find: CPA, time of CPA and the bearing of CPA.

Plotting 1answers

1 CPA 1.1mn, TCPA 1520,BCPA 175.5°T
2 CPA 0.8 run, TCPA 1021, BCPA 154°T
3 CPA 3.4 mn, TCPA 1240, BCPA 107°T

FIND COURSE AND SPEED QUESTIONS TWO

1 Your course 320°T, speed 18 knots; radar observations:
1000: true bearing 000° distance 10 miles
1010: true bearing 000° distance 8
miles Find course and speed of other vessel at
1010.

2 Your course 020°T, speed 25 knots; radar observations:
1100: true bearing 078° distance 10 miles
1112: true bearing 076° distance 8.5miles
Find course and speed of other vessel at 1112.

3 Your course 350°T, speed 22 knots; radar observations:
2100: true bearing 290° distance 6 miles
2112: true bearing 280° distance 4 miles
Find course and speed of other vessel at 2112.

PLOTTING ANSWERS 1

1 course 278°T, speed 12 knots
2 course 000°T, speed 24 knots
3 course 018°T, speed 15.5 knots

THE FULL REPORT QUESTIONS THREE

1. Your course 330°T, speed 9 knots; radar
observations: 1900: 009° T, distance 10.5 miles
1905: 008.5° T, distance *9.5* miles
1910: 008° T, distance 8.7 miles
   a) Find: CPA,TCPA, course and speed of other ship and aspect.
   b) State what action if any are you going to take.

2. Your course 250°T, speed 9 knots; radar
observations: 2310: 217° T, distance 5.8 miles
2315: 214.5° T, distance 4.9 miles
2320: 211° T, distance 4.0 miles
   a) Find: CPA,TCPA, course and speed of other ship and aspect.
   b) State what action ifany are you going to take.

3. Your course 050°T, speed 11 knots; radar
observations: 0311: 261° Rel, distance 5.6 miles
0316: 262° Rel, distance 4.8 miles
0321: 263° Rel, distance 4.0 miles
   a) Find: CPA,TCPA, course and speed of other ship and aspect.
   b) State what action if any are you going to take.

4. Your course 350°T, speed 7 knots; radar
observations: 1703: 131° Rel, distance 5.2 miles
1706: 131.5° Rel, distance 4.75 miles
1709: 132° Rel, distance 4.3 miles
   a) Find: CPA,TCPA, course and speed of other ship and aspect.
   b) State what action if any are you going to take.

5. Your course l 70°T, speed 6 knots; radar
observations: 1910: 10° Rel, distance 5.6 miles
1916: 10° Rel, distance 4.7 miles
1922: 10° Rel, distance 3.9 miles
   a) Find: CPA,TCPA, course and speed of other ship and aspect.
   b) State what action if any are you going to take.

6. Your course 350°T, speed 9 knots; radar
observations: Target A
2010: 336.5 ⁰T,distance 11.0miles
2020: 332° T, distance 9.5 miles
Target B
2010: 020° T, distance 10.8 miles
2020: 021° T, distance 9.0 miles
   a) Find: CPA,TCPA, course, speed and aspect of the other vessels

b) Identify the vessels that may pose a risk of collision and state what action if any are you going to take.

7. Your course 330°T, speed 11 knots; radar observations: Target A
2210: 226° T, distance 3.2 miles
2216: 235° T, distance 4.2 miles
Target B
2212: 151° T, distance 4.2 miles
2222: 152° T, distance 3.5miles
a) Find: CPA,TCPA, course, speed and aspect of the other vessels
b) Identify the vessels that may pose a risk of collision and state what action if any are you going to take.

8. Your course 210°T, speed 8 knots; radar observations: Target A
0551: l IO.5⁰ T, distance 5.2 miles 0601:
112° T, distance 4.3 miles
Target B
0550: 234.5⁰ T, distance 3.3 miles 0600: 248.5⁰ T,
distance 2.2miles

a) Find: CPA,TCPA, course, speed and aspect of the other vessels
b) Identify the vessels that may pose a risk of collision and state what action if any are you going to take.

9. Your course 200°T, speed 14 knots; radar observations: Target A
1611: 187° T, distance 7.0 miles
1621: 197° T, distance 3.4
miles Target B
1615: 191° T, distance 8.0 miles
1621: 177° T, distance 3.7miles
a) Find: CPA,TCPA, course, speed and aspect of the other vessels
b) Identify the vessels that may pose a risk of collision and state what action if any are you going to take.

PLOTTING ANSWERS 3

The solutions given here are not necessarily the only correct answers, rather it is opinion offered after careful consideration of the practical aspects of the encounters as well as the content and intent of the collision regulations.

1 CPA 1.0 miles, TCPA, 1958, Course 250°T, Speed 8 Knots, Aspect Red 62°.
Alter course 60° to starboard

2 CPA 1.2 miles TCPA 2339, Course 005°T, Speed 4.5 Knots, Aspect Green 25°.
Alter course 60° to starboard

3 CPA 0.5 miles, TCPA 0344, Course 086°T, Speed 16.0 Knots, Aspect Green 48°.
Reduce speed

4 CPA 0.3, TCPA, 1737, Course 319°T, Speed 14.5 Knots. Aspect, Red 13°.
Alter course 30° to port or stand on in normal visibility

5 CPA Collision, TCPA 1950, Course 024°T, Speed 2.7 Knots, Aspect Red 24°.
Alter to Starboard 60° immediately

6 **Target** A, CPA 4.4. TCPA 2110, Course 229°T, Speed 2.9 Knots, Aspect Red 77°, **Target B,** CPA 1.1, TCPA 2111, Course 249°T, Speed 4.1 knots, Aspect Red 49°.
Alter course 60° to starboard

7 **Target** A is moving away so CPA has already passed, Course 294°T, Speed 19 Knots, Aspect Green 121°, **Target B** CPA 0.2, TCPA 2313, Course 329°T, Speed 15.3 Knots, Aspect Green 3°.
Alter course 30° to starboard – in clear visibility stand on

8 **Target** A, CPA 0.6, TCPA 0649, Course 239°T,Speed 10.6 Knots Aspect Green 53°
Target B, CPA 1.4, TCPA, 0614, stopped.
Reduce speed or 60° to STB in restricted visibility and stand on in clear visibility

9 **Target** A, CPA 1.2, TCPA 1630, Course 326°T,Speed 10.6 Knots Aspect Green 52°
Target B, CPA 1.7, TCPA, 1625,Course 027°T,Speed 31 Knots, Aspect Red 29°. Alter course to STB 60° reduce speed Or stop