ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL FOUR

INSTRUCTIONAL GUIDE

SECTION 1

EO M437.01 – DEFINE AIR NAVIGATION TERMS

Total Time: 60 min

PREPARATION

PRE-LESSON INSTRUCTIONS

Resources needed for the delivery of this lesson are listed in the lesson specification located in A-CR-CCP-804/PG-001, *Proficiency Level Four Qualification Standard and Plan*, Chapter 4. Specific uses for said resources are identified throughout the instructional guide within the TP for which they are required.

Review the lesson content and become familiar with the material prior to delivering the lesson.

Photocopy the handout located at Attachment A for each cadet.

Prepare slides of the figures located at Attachment B.

Photocopy the Headings and Bearings Worksheet located at Attachment C for each cadet.

PRE-LESSON ASSIGNMENT

Nil.

APPROACH

An interactive lecture was chosen for TPs 1–3 to clarify, emphasize, and summarize navigation terms.

An in-class activity was chosen for TP 4 as it is an interactive way to reinforce bearings and headings, and confirm the cadets' comprehension of navigation terms.

INTRODUCTION

REVIEW

Nil.

OBJECTIVES

By the end of this lesson the cadet shall be expected to define air navigation terms.

IMPORTANCE

It is important for cadets to define air navigation terms to ensure a firm foundation in navigation before learning more advanced material. Knowledge of air navigation terms is essential for future aviation training and potential instructional duties at the squadron.

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Teaching point 1 **Define meridians of longitude, parallels of latitude, geographical co-ordinates, and the relationship between time and longitude.**

Time: 25 min Method: Interactive Lecture



Use a large globe to point out the meridians of longitude and parallels of latitude.

MERIDIANS OF LONGITUDE

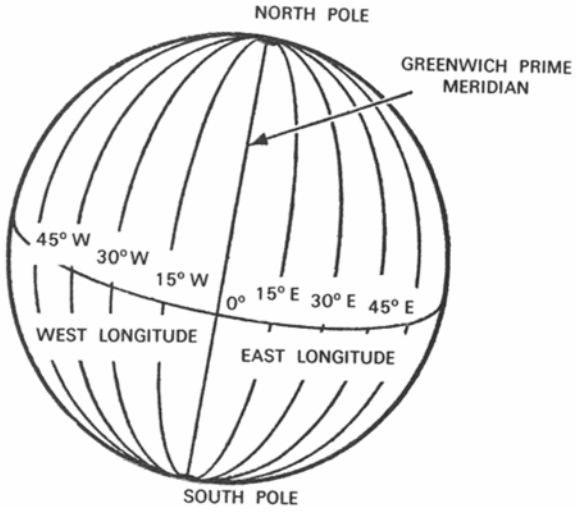
Meridians of longitude. Semicircles joining the true / geographic poles of the Earth.

Longitude is measured from 0–180 degrees east and west of the prime meridian. The prime meridian is the meridian which passes through Greenwich, England and is numbered zero degrees. The meridian on the opposite side of the Earth to the prime meridian is the 180th and is called the international date line (the time changes a day).

Longitude is measured in degrees (°), minutes ('), and seconds ("). There are 60 minutes in a degree and 60 seconds in a minute.



When dealing with longitude and latitude, seconds and minutes are not measurements of time but rather divisions of a degree. This can be compared to the way that a metre is divided into 100 cm and each centimetre is divided into 10 mm.



Note. From "Air Cadet Master Lesson Plans", 2007, Cadets Canada: RCSU Pacific. Retrieved November 14, 2007, from http://www.regions.cadets.ca/pac/aircad/resources/mlp_air_e.asp

Figure 1 Meridians of Longitude

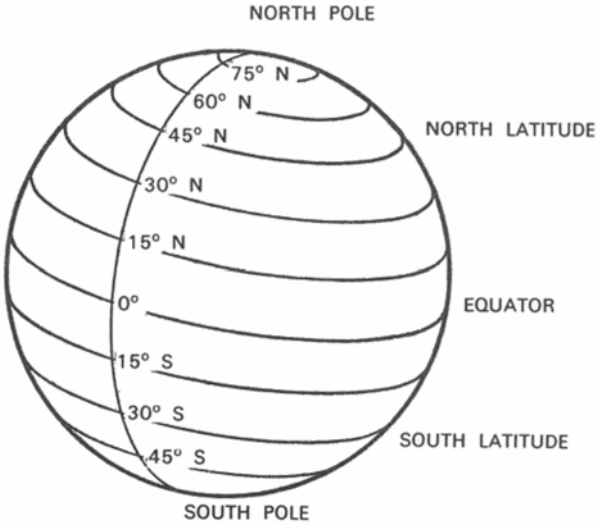
PARALLELS OF LATITUDE

Parallels of latitude. Circles on the Earth's surface that lie parallel to the equator.

Equator. An imaginary line on the surface of the Earth equidistant from the poles.

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Latitude is measured from 0–90 degrees north and south of the equator, which is numbered zero degrees. Like longitude, latitude is measured in degrees, minutes, and seconds.



Note. From "Air Cadet Master Lesson Plans", 2007,Cadets Canada: RCSU Pacific. Retrieved November 14, 2007, from http://www.regions.cadets.ca/pac/aircad/resources/mlp_air_e.asp

Figure 2 Parallels of Latitude

Remember the difference between latitude and longitude using one of the following mnemonics:

- Lat is flat / fat; longitude is long.
- Latitude is like climbing up a ladder because it is north / south; longitude is like swinging across because it is east / west.

GEOGRAPHICAL CO-ORDINATES

Geographical co-ordinates. The intersection of lines of latitude and longitude. Geographical co-ordinates mark the position of places (eg, cities, towns, airports) on a chart.

On a chart, there are black lines representing longitude and latitude, every 30 minutes. Small marks represent 1 minute. There are slightly larger marks for 5 minute and 10 minute increments.

Distribute the handout located at Attachment A to each cadet.

Have the cadets find markings on a line of latitude or longitude to represent 1 minute, 5 minutes, and 10 minutes using a local VFR Navigation Chart (VNC).

Co-ordinates express latitude first, in degrees north or south of the equator and longitude second, in degrees east or west of the prime meridian. For example, the geographical coordinates of the military airport at Trenton, Ont. are 44°07' N, 77°32' W.

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The location of the military airport at Trenton, Ont. has been chosen as an example because it appears on the sample VNC provided in the back of *From The Ground Up: Millennium Edition*.

The grid surrounding this airport can be found at Attachment A.



Select a major airport in the area and have the cadets find the coordinates using a local VNC.

THE RELATIONSHIP BETWEEN TIME AND LONGITUDE

The Earth rotates about its axis as it revolves in an elliptical orbit around the Sun. This creates the illusion that the Sun is revolving around the Earth. The time between one apparent passage of the Sun over a meridian of longitude is called an apparent solar day and varies throughout the year. To provide a convenient method of measuring time, it has been averaged to a mean solar day, divided into 24 hours. During the mean solar day, the Sun is assumed to travel once around the Earth, thereby travelling through 360 degrees of longitude. Hence, mean time can be expressed in terms of longitude and vice versa.

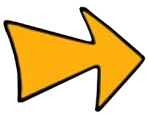
For example:

- 24 hours = 360 degrees of longitude
- 1 hour = 15 degrees of longitude
- 1 minute = 15 minutes of longitude
- 1 second = 15 seconds of longitude

- 360 degrees of longitude = 24 hours
- 1 degree of longitude = 4 minutes
- 1 minute of longitude = 4 seconds
- 1 second of longitude = 1/15 second

Local mean time (LMT). The mean time on any particular meridian.

Co-ordinated universal time (UTC). An atomically measured global standard time, calculated from midnight on the zero meridian. UTC is also referred to as Zulu (Z) time.



UTC replaced Greenwich mean time (GMT) which was the universally accepted standard for the measurement of time until December, 1985.

UTC is the LMT for the prime meridian.

The LMT of any place east of the prime meridian is ahead of UTC. For example, 1200 hours LMT in Cairo is 1000Z.

The LMT of any place west of the prime meridian is behind UTC. For example, 1200 hours LMT in Halifax is 1600Z.

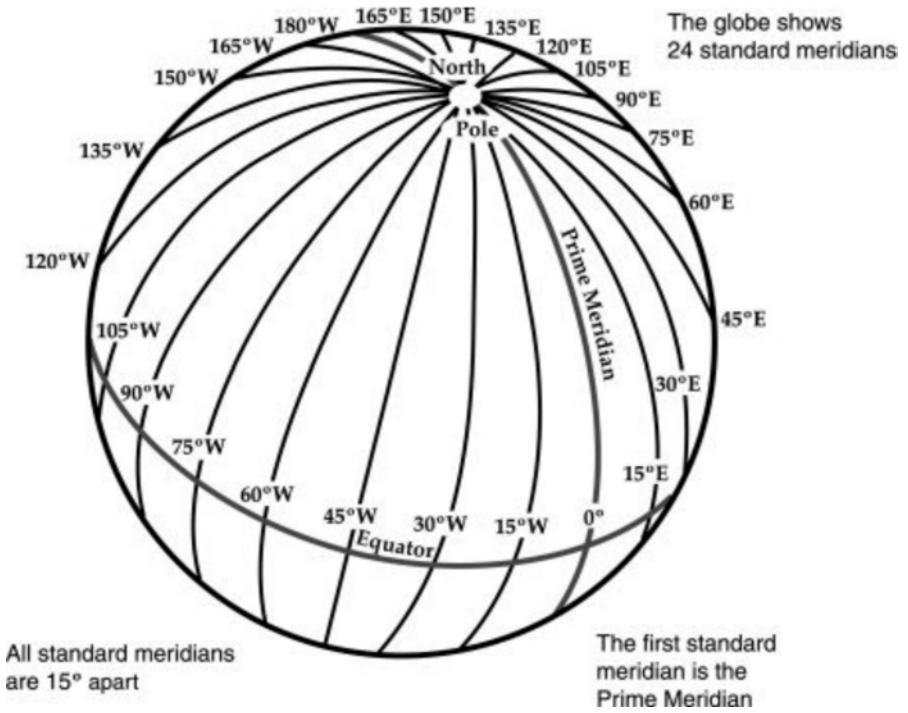
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Verify against the official publication.

Tell the cadets how many hours are added to LMT to find UTC in their location.

Use a large globe to indicate the time zones.

The world is divided into 24 time zones, each 15 degrees of longitude (one hour) wide. When travelling westward into a new time zone, time is turned back one hour. When travelling eastward into a new time zone, time is turned ahead one hour.

One exception to this is Newfoundland Standard Time, which is 1/2 hour ahead of Atlantic Standard Time.



Note. From "Globe Lesson 12", 1-World Maps Online, Copyright 2008 by 1-World Maps Online. Retrieved November 25, 2008, from http://www.worldmapsonline.com/LESSON-PLANS/6-global-time-globe-lesson-12.htm

Figure 3 Meridians of Longitude

Part of our heritage: Sir Sandford Fleming, a Canadian railway planner and engineer, outlined a plan for worldwide standard time in the late 1870s. Following this initiative, in 1884, delegates from 27 nations met in Washington, D.C. for the Meridian Conference and agreed on a system basically the same as that now in use.

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CONFIRMATION OF TEACHING POINT 1

QUESTIONS:

Q1. What are meridians of longitude?

Q2. How are parallels of latitude measured?

Q3. What must be done to LMT in Canada to convert it to UTC?

ANTICIPATED ANSWERS:

A1. Semicircles joining the true / geographic poles of the Earth.

A2. From 0–90 degrees north and south of the equator.

A3. The appropriate number of hours must be added.

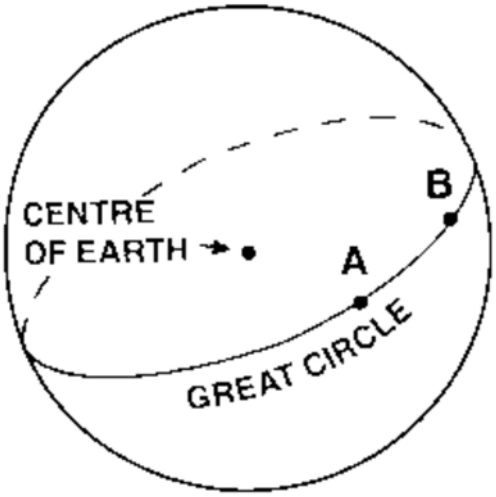
Teaching point 2 **Define great circles and rhumb lines.**

Time: 10 min Method: Interactive Lecture

GREAT CIRCLES



Show the slide of Figures B-1 and B-2 to the cadets.



Note. From From the Ground Up: Millennium Edition (p. 177), by A. F. MacDonald and I. L. Peppler, 2000, Ottawa, ON: Aviation Publishers Co. Limited. Copyright 2000 by Aviation Publishers Co. Limited.

Figure 4 Great Circle

Great circle. A circle on the surface of a sphere that passes through the centre of the sphere, cutting it into two equal parts.

The equator is a great circle. The meridians of longitude are semi-great circles as they run from pole to pole and do not completely encircle the Earth.

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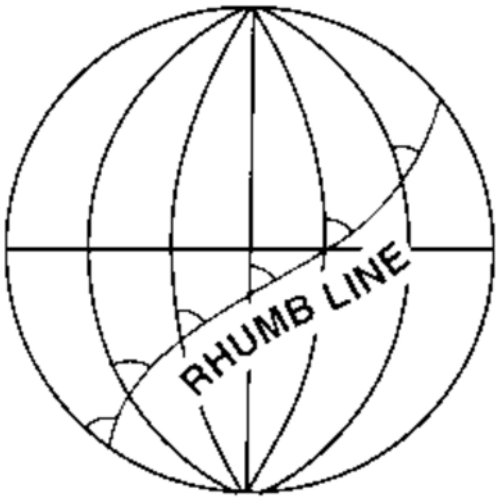
Only one great circle can be drawn through two places that are not diametrically opposite each other. The shortest distance between these two points is the shorter arc of the great circle joining them. Therefore, most long-distance flights are flown over great circle routes.

A great circle does not cross the meridians it meets at the same angle. Therefore, the heading must be changed at frequent intervals to enable the airplane to maintain a great circle route.

RHUMB LINES



Show the slide of Figures B-3 and B-4 to the cadets.



Note. From From the Ground Up: Millennium Edition (p. 177), by A. F. MacDonald and I. L. Peppler, 2000, Ottawa, ON: Aviation Publishers Co. Limited. Copyright 2000 by Aviation Publishers Co. Limited.

Figure 5 Rhumb Line

Rhumb line. A curved line on the surface of the Earth, cutting all the meridians it meets at the same angle.

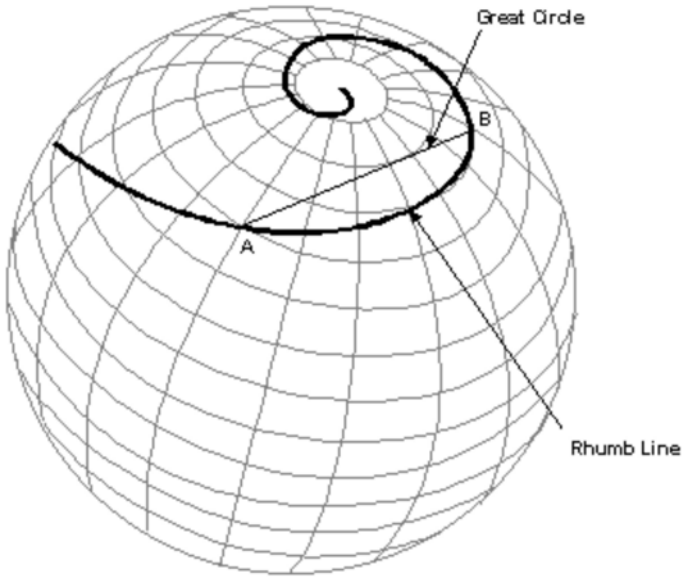
All parallels of latitude are rhumb lines. The meridians of longitude and the equator are rhumb lines as well as great circles.



Show the slide of Figures B-5 and B-6 to the cadets.

When two places are not situated on the equator or on the same meridian of longitude, the distance measured along the rhumb lines joining them will not be the shortest distance between them. The advantage of the rhumb line route is that the direction is constant, allowing a navigator to follow a constant heading.

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Verify against the official publication.



Note. From "Flights", Navworld. Retrieved November 26, 2008, http://www.navworld.com/navcerebrations/flights.htm

Figure 6 Great Circle and Rhumb Line

CONFIRMATION OF TEACHING POINT 2

QUESTIONS:

Q1. What is a great circle?

Q2. What is a rhumb line?

Q3. What is the advantage of following a rhumb line route?

ANTICIPATED ANSWERS:

A1. A circle on the surface of a sphere that passes through the centre of the sphere, cutting it into two equal parts.

A2. A curved line on the surface of the Earth, cutting all the meridians it meets at the same angle.

A3. The direction is constant, allowing a navigator to follow a constant heading.

Teaching point 3 **Define headings and bearings.**

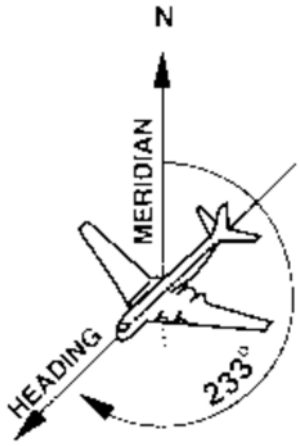
Time: 5 min Method: Interactive Lecture

HEADINGS AND BEARINGS

Direction is measured in degrees clockwise from north, which is zero degrees (or 360 degrees). East is 90 degrees, south is 180 degrees, and west is 270 degrees.

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Show the slide of Figure B-7 to the cadets.

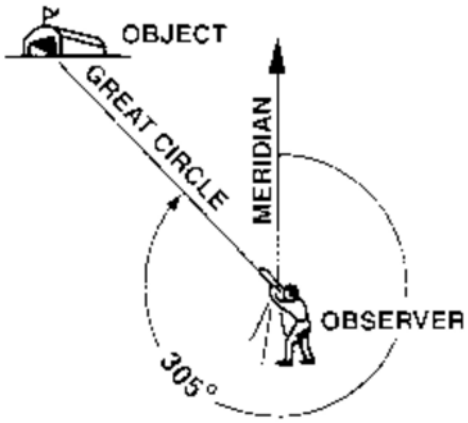


Note. From From the Ground Up: Millennium Edition (p. 177), by A. F. MacDonald and I. L. Peppler, 2000, Ottawa, ON: Aviation Publishers Co. Limited. Copyright 2000 by Aviation Publishers Co. Limited.

Figure 7 Heading

True heading. The angle between the meridian of longitude over which an airplane is flying and the line representing the direction the airplane's nose is pointing, measured clockwise from the meridian.

Show the slide of Figure B-8 to the cadets.



Note. From From the Ground Up: Millennium Edition (p. 177), by A. F. MacDonald and I. L. Peppler, 2000, Ottawa, ON: Aviation Publishers Co. Limited. Copyright 2000 by Aviation Publishers Co. Limited.

Figure 8 Bearing

The direction of any point on the surface of the Earth from an observer is known by measuring the bearing.

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Bearing. The angle between the meridian of longitude passing through the observer and the great circle that joins the observer to the object, measured clockwise from the meridian.

Headings and bearings are found using a compass.

CONFIRMATION OF TEACHING POINT 3

QUESTIONS:

Q1. How is direction measured?

Q2. Define true heading.

Q3. Define bearing.

ANTICIPATED ANSWERS:

A1. In degrees clockwise from north.

A2. The angle between the meridian of longitude over which an airplane is flying and the line representing the direction the airplane's nose is pointing, measured clockwise from the meridian.

A3. The angle between the meridian of longitude passing through the observer and the great circle that joins the observer to the object, measured clockwise from the meridian.

Teaching point 4 **Have the cadets take headings and bearings.**

Time: 10 min Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadets take headings and bearings.

RESOURCES

- Douglas Protractor,
- Pen / Pencil, and
- Headings and Bearings Worksheet located at Attachment C.

ACTIVITY LAYOUT

Nil.

ACTIVITY INSTRUCTIONS

1. Distribute a Douglas protractor to each cadet.
2. Distribute a Headings and Bearings Worksheet to each cadet.
3. Designate an object in the room as representing magnetic north.
4. Have the cadets take the magnetic headings of the aircraft in Section 1 of the worksheet.
5. Review and correct the answers.

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Verify against the official publication.

6. Designate a different object in the room as representing true north.
7. Have the cadets take the bearing of the tower from the aircraft in Section 2 of the worksheet.
8. Review and correct the answers.

SAFETY

Nil.

CONFIRMATION OF TEACHING POINT 4

The cadets' participation in the activity will serve as the confirmation of the TP.

END OF LESSON CONFIRMATION

QUESTIONS:

Q1. How many degrees of longitude are equal to one hour?

Q2. What is the shortest distance between two places on the surface of the Earth?

Q3. How are headings and bearings found?

ANTICIPATED ANSWERS:

A1. Fifteen.

A2. The shorter arc of the great circle joining them.

A3. Using a compass.

CONCLUSION

HOMEWORK / READING / PRACTICE

Nil.

METHOD OF EVALUATION

This EO is assessed IAW A-CR-CCP-804/PG-001, *Proficiency Level Four Qualification Standard and Plan*, Chapter 3, Annex B, Aviation Subjects–Combined Assessment PC.

CLOSING STATEMENT

Future aviation training and instructional duties require knowledge of air navigation terms.

INSTRUCTOR NOTES / REMARKS

Cadets who are qualified Advanced Aviation may assist with this instruction.

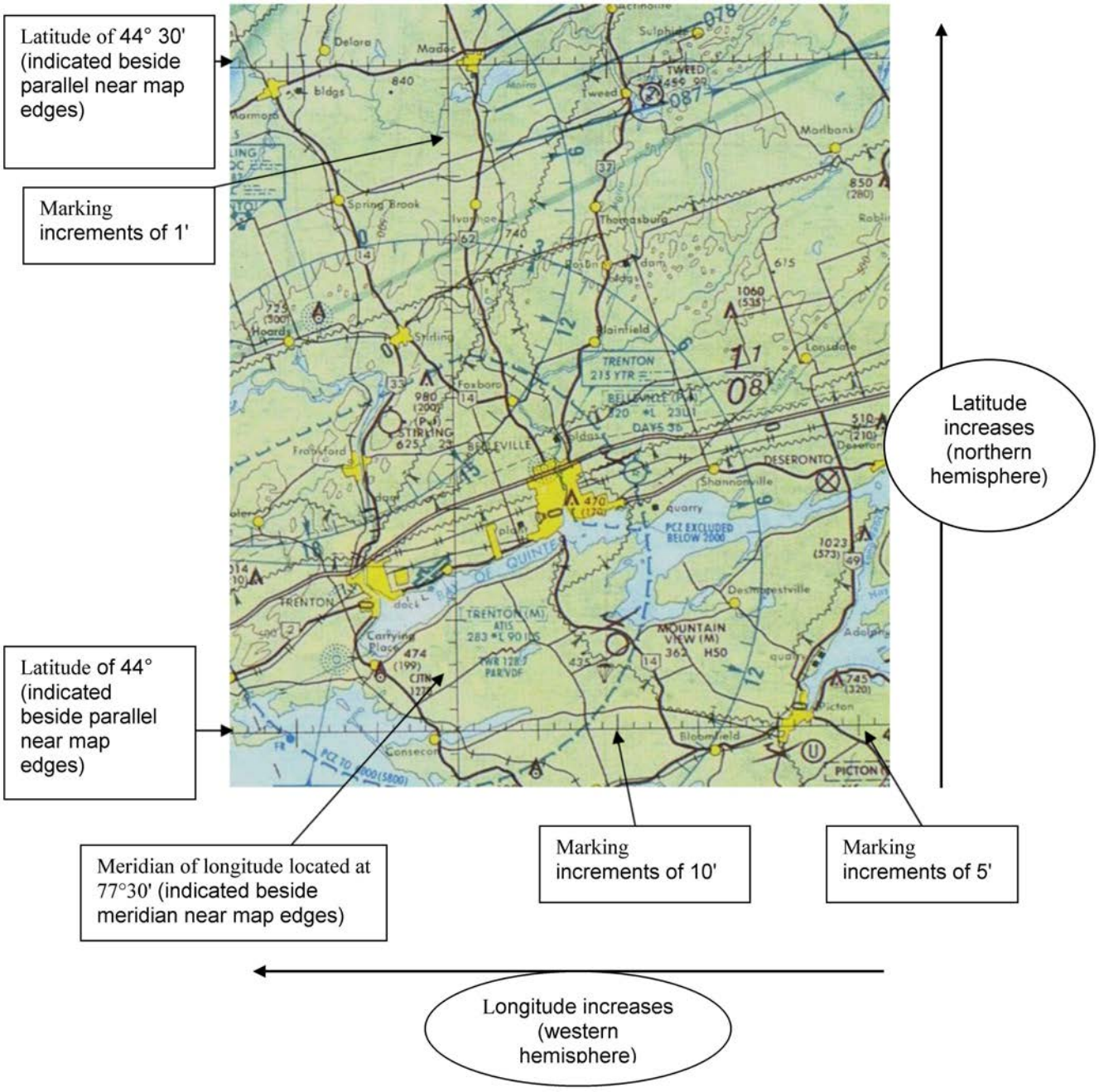
REFERENCES

C3-116 ISBN 0-9680390-5-7 MacDonald, A. F., & Peppler, I. L. (2000). *From the ground up: Millennium edition*. Ottawa, ON: Aviation Publishers Co. Limited.

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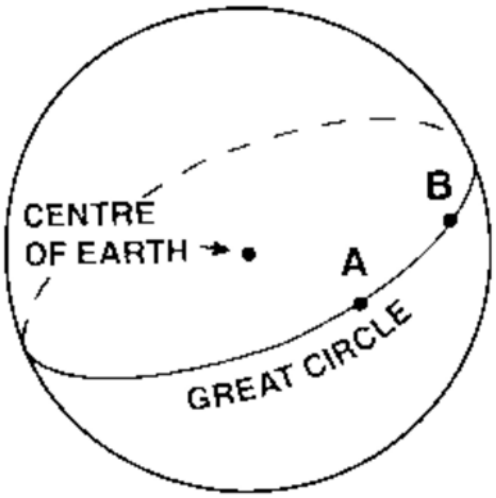
Note. From Toronto VFR Navigation Chart, by Geomatics Canada, 2001, Ottawa, ON: Geomatics Canada Department of Natural Resources. Copyright 2001 by NAV CANADA and Her Majesty the Queen in Right of Canada.

Figure A-1 Example of a VNC

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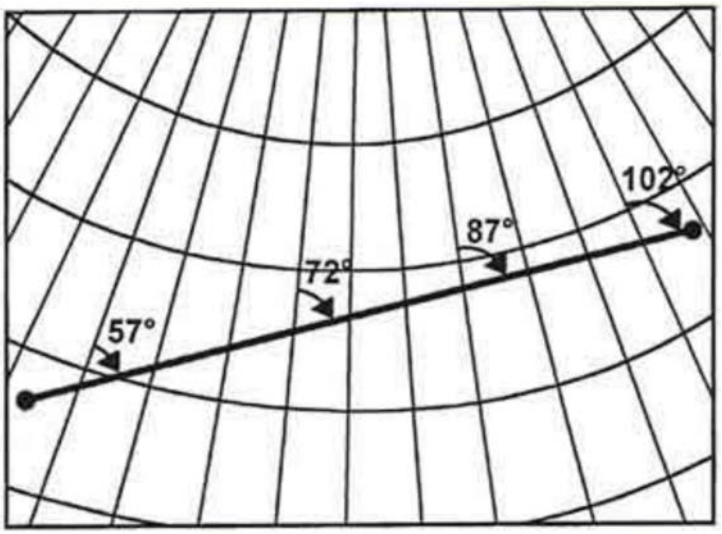
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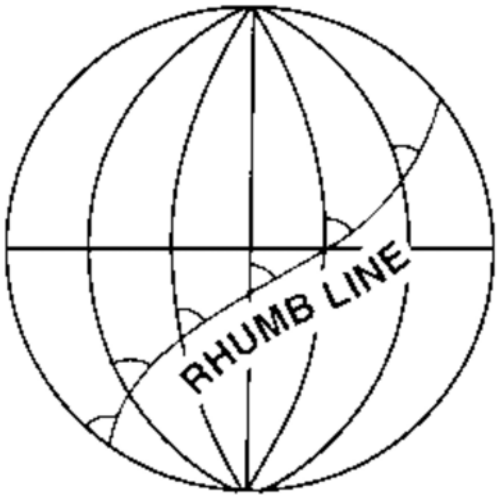
Figure B-1 Great Circle



Note. From "Navigation Basics", Free Online Private Pilot Ground School. Retrieved November 26, 2008, http://www.free-online-private-pilot-ground-school.com/navigation-basics.html

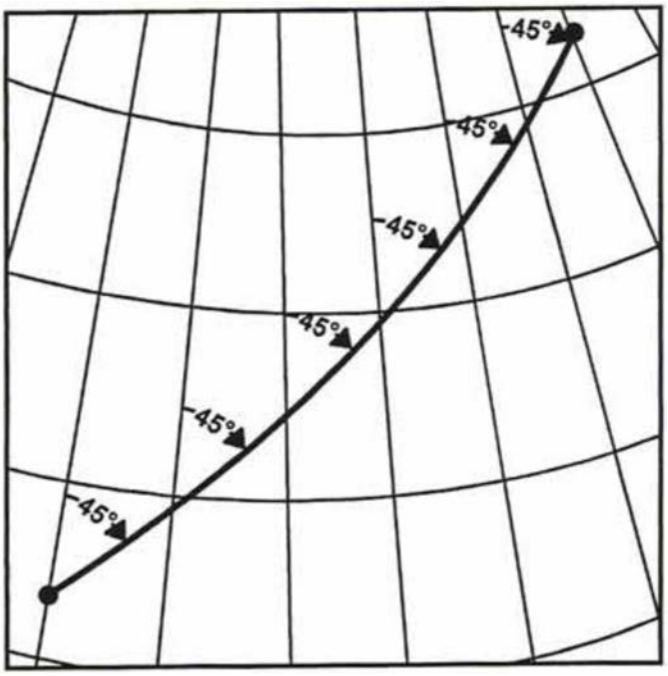
Figure B-2 Great Circle

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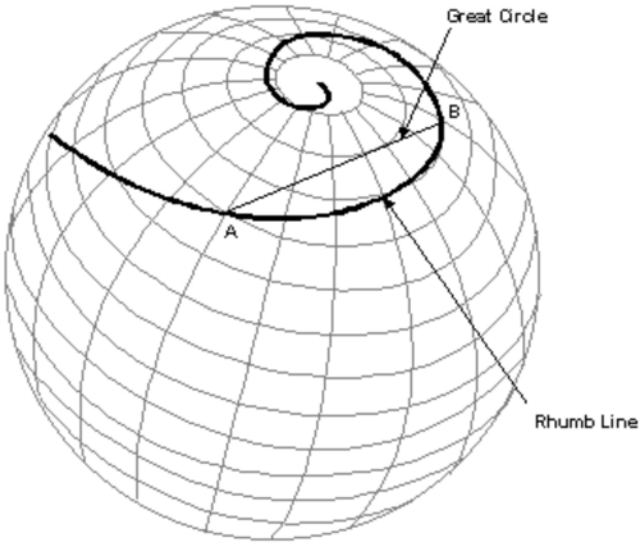
Figure B-3 Rhumb Line



Note. From "Navigation Basics", Free Online Private Pilot Ground School. Retrieved November 26, 2008, http://www.free-online-private-pilot-ground-school.com/navigation-basics.html

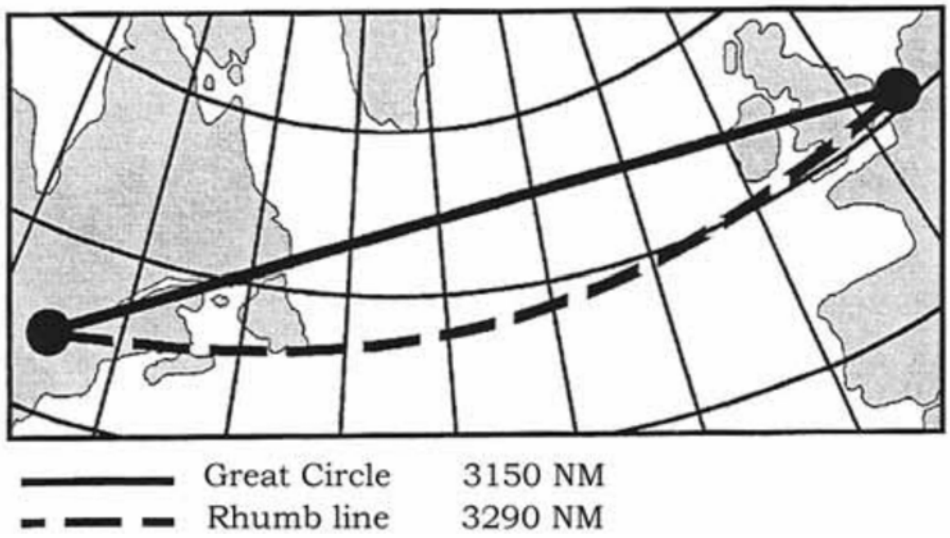
Figure B-4 Rhumb Line

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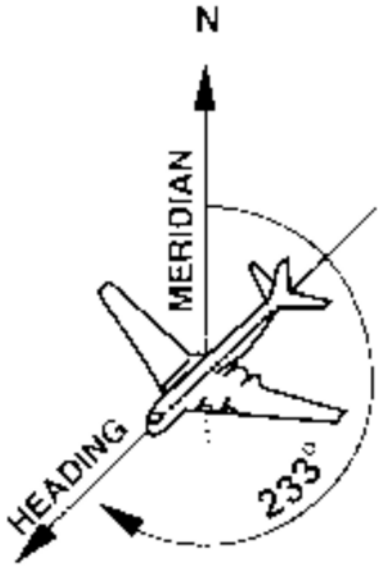
Figure B-5 Great Circle and Rhumb Line



Note. From "Navigation Basics", Free Online Private Pilot Ground School. Retrieved November 26, 2008, http://www.free-online-private-pilot-ground-school.com/navigation-basics.html

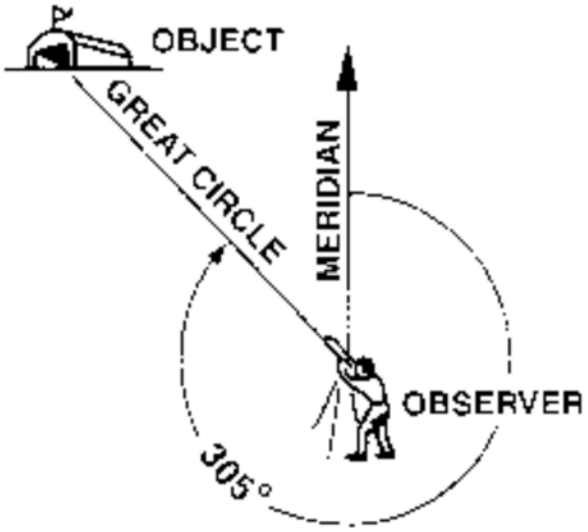
Figure B-6 Great Circle and Rhumb Line

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Figure B-7 Heading



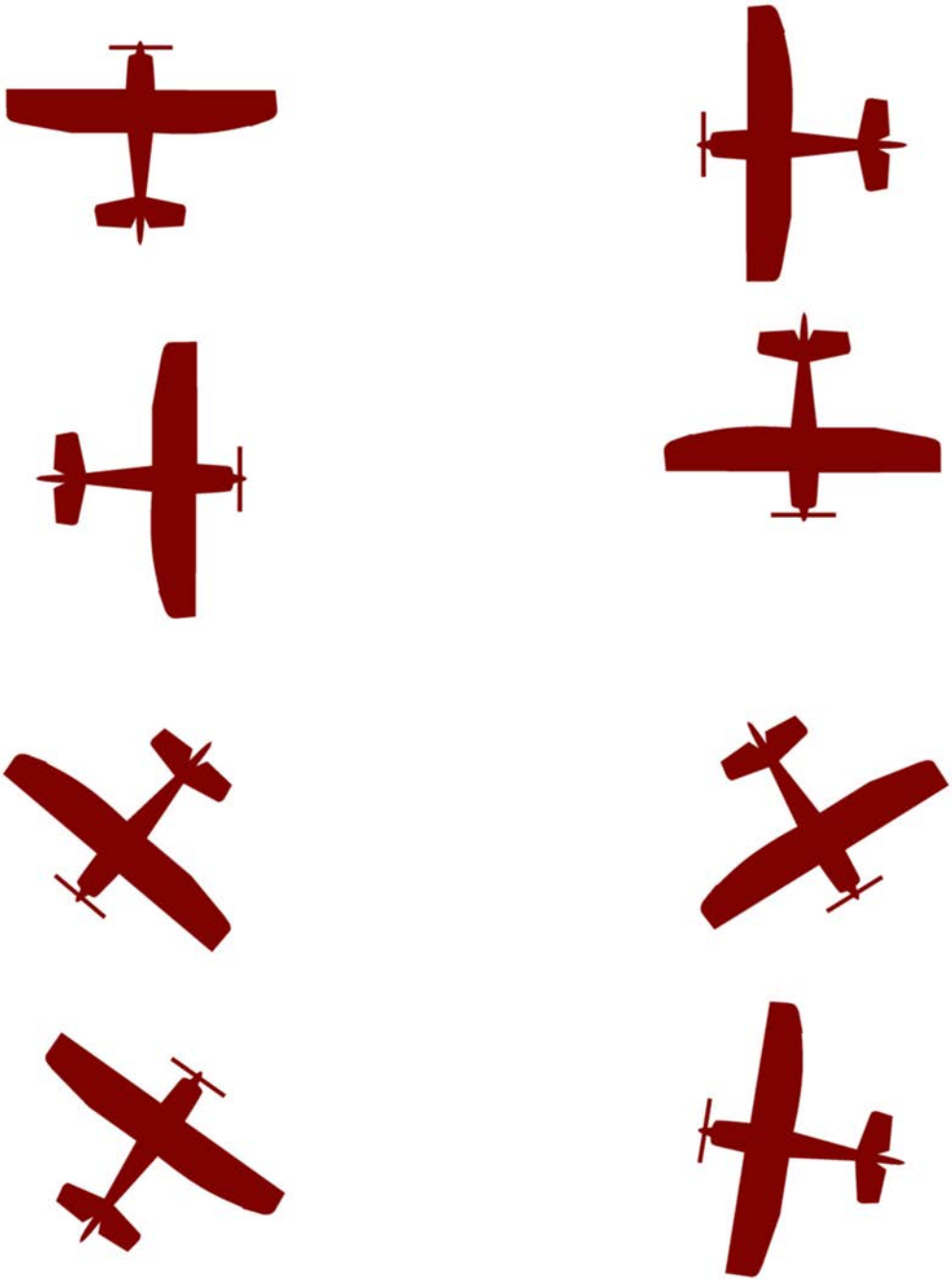
Note. From From the Ground Up: Millennium Edition (p. 177), by A. F. MacDonald and I. L. Peppler, 2000, Ottawa, ON: Aviation Publishers Co. Limited. Copyright 2000 by Aviation Publishers Co. Limited.

Figure B-8 Bearing

Unofficial convenience copy of A-CR-CCP-804/PF-001, cached 2026-11-08 from https://app.cadets.gc.ca/cadet-publications/A-CR-CCP-804-PF-001/A-CR-CCP-804-PF-001.pdf.
Verify against the official publication.

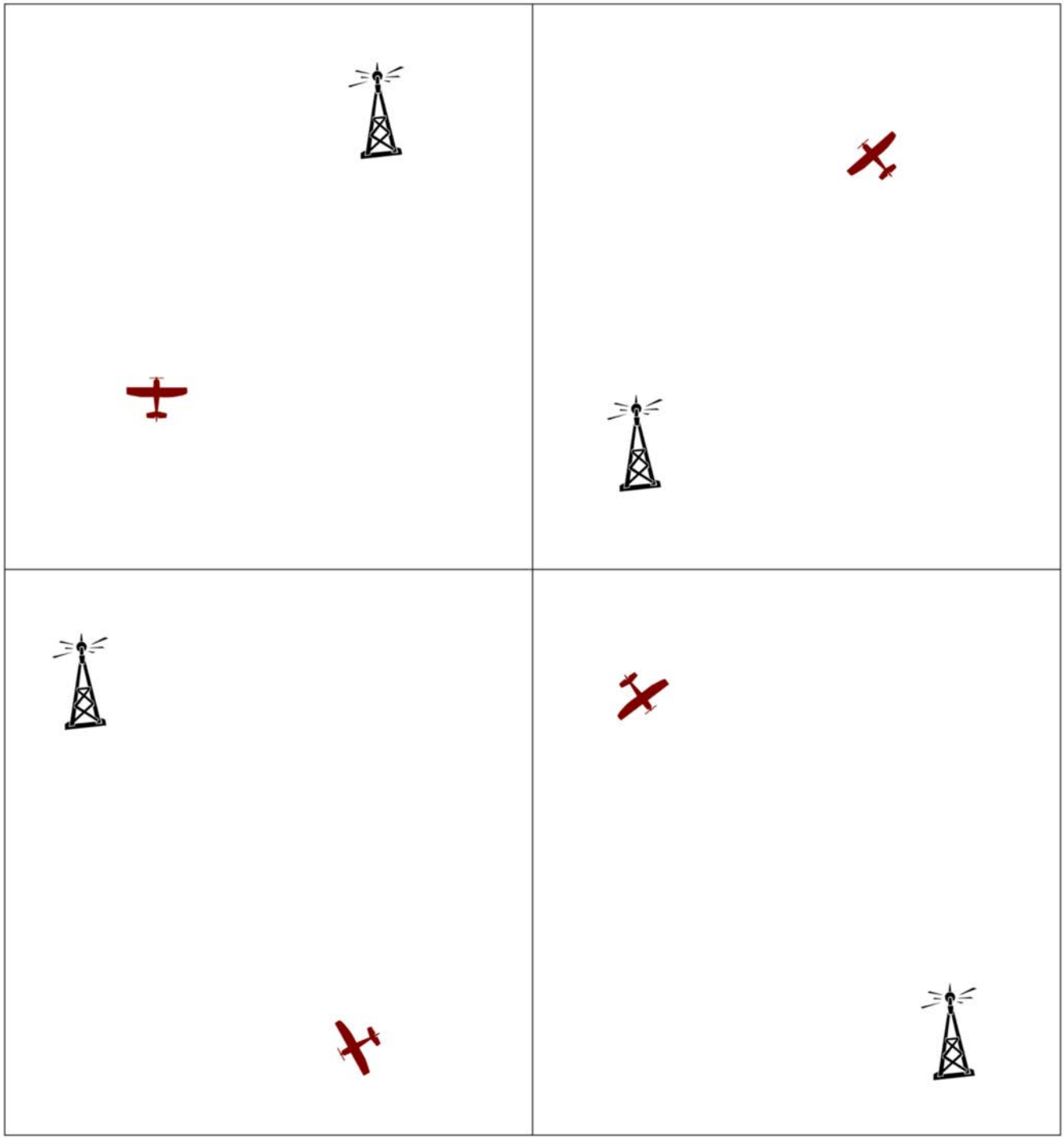
HEADINGS AND BEARINGS WORKSHEET

Section 1 – Take the Heading of Each Aircraft



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Section 2 – Take the Bearing of the Tower from the Aircraft



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Verify against the official publication.