ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 5

EO M390.05 – DETERMINE BEARINGS ON A MAP AND ON THE GROUND

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-803/PG-001, 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.

Ensure sufficient topographical maps of the exercise area are available.

Create a list of points (designated by description and by grid reference [GR]) from the topographical map of the exercise area for the cadets to determine in TP 5.

A reconnaissance (recce) of the exercise area should be made to determine a site with several distinctive features to be used as prominent objects for the cadets to take bearings.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TPs 1–4 to introduce the cadets to the compass, the degree system, the three norths, and bearings.

Demonstration and performance was chosen for TPs 5 and 6 as it allows the instructor to explain and demonstrate determining bearings on a map and on the ground while providing an opportunity for the cadets to practice these skills under supervision.

INTRODUCTION

REVIEW

The following questions are a review of EO M390.04 (Determine Distance on a Map and on the Ground, Section 4).

QUESTIONS

Q1. After marking a map to assist in determining distance, what should be done with the marks?

Q2. Define personal pace.

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Q3. What effect does weather have on a person's pace?

ANTICIPATED ANSWERS

A1. All marks should be carefully erased from the map after each distance is determined.

A2. The number of paces a person walks over a distance of 100 m.

A3. Snow and rain will shorten a person's pace while wind will increase/decrease the pace length if a person is travelling with/against the wind.

OBJECTIVES

By the end of this lesson the cadet shall have determined bearings on a map and on the ground.

IMPORTANCE

It is important for cadets to be able to determine bearings on a map and on the ground as this is one of the key skills required to navigate using a map and compass.

Teaching point 1 **Identify and Explain the 16 Points of a Compass**

Time: 10 min Method: Interactive Lecture

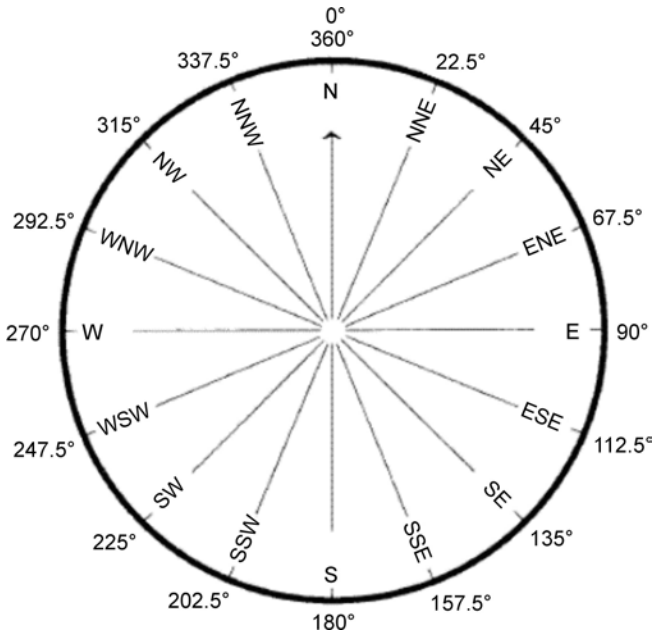

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Figure 1 Compass Rose

FOUR CARDINAL POINTS

The four cardinal points of the compass, measured at right angles clockwise from north are:

- north (N) at 0 and 360 degrees,
- east (E) at 90 degrees,
- south (S) at 180 degrees, and

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- west (W) at 270 degrees.

FOUR INTER-CARDINAL POINTS

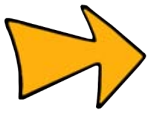
The four inter-cardinal points are located halfway between each of the cardinal points. Measured clockwise from north, they are:

- northeast (NE) at 45 degrees,
- southeast (SE) at 135 degrees,
- southwest (SW) at 225 degrees, and
- northwest (NW) at 315 degrees.

EIGHT INTERMEDIATE POINTS

The eight intermediate points are located halfway between each cardinal point and inter-cardinal point. Measured clockwise from north, they are:

- north-northeast (NNE) at 22.5 degrees,
- east-northeast (ENE) at 67.5 degrees,
- east-southeast (ESE) at 112.5 degrees,
- south-southeast (SSE) at 157.5 degrees,
- south-southwest (SSW) at 202.5 degrees,
- west-southwest (WSW) at 247.5 degrees,
- west-northwest (WNW) at 292.5 degrees, and
- north-northwest (NNW) at 237.5 degrees.



As an aid to remember the different types of points:

- cardinal points are designated by one letter;
- inter-cardinal points are designated by two letters; and
- intermediate points are designated by three letters.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Which two degree values may be used for north?

Q2. How many inter-cardinal points are there?

Q3. Name one of the intermediate points.

ANTICIPATED ANSWERS

A1. 0 and 360 degrees.

A2. Four.

A3. Either NNE, ENE, ESE, SSE, SSW, WSW, WNW, or NNW.

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Teaching point 2 **Explain the Degree System on a Compass**

Time: 5 min Method: Interactive Lecture

The cardinal, inter-cardinal, and intermediate points describe directions only to within one-sixteenth of a full circle. For a more precise indication of direction it is necessary to use the sub-divisions of the circle called degrees. This measurement starts and ends at north (top) and is measured in a clockwise rotation.

Degrees. The most common method of dividing a circle is by degrees. These degrees represent 360 equal angles in a complete circle and they are represented by the symbol "°" (eg, 222°).



It is important to emphasize that degrees should always be measured clockwise and always using north as the start point.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. Degrees are measured in which direction?

Q2. What is the most common method of dividing a circle?

Q3. How many degrees are in a full circle?

ANTICIPATED ANSWERS

A1. Degrees are measured clockwise from north.

A2. Degrees.

A3. 360 degrees.

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Teaching point 3 **Identify and Explain the Three Norths**

Time: 5 min Method: Interactive Lecture

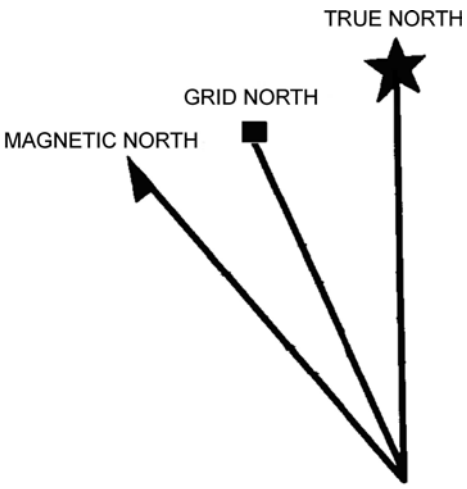

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Figure 2 The Three Norths

THE THREE NORTHS

The relationship between the three norths, especially grid and magnetic, is key to using a compass on both a map and on the ground.

True North. True north is located at the top of the earth where the geographic North Pole is located, where all lines of longitude meet. In the declination diagram on the map, true north is represented by the symbol of a star, which represents the North Star, Polaris.

Grid North. Grid north is the north indicated by the grid lines (eastings) on a topographical map. The easting lines run parallel to each other and will never meet at the geographic North Pole; because of this, grid north points off slightly from true north. In the declination diagram on the map, grid north is represented by a square, which represents a map grid.

Magnetic North. Magnetic north is the location of the north magnetic pole, where the Earth's magnetic field bends back into the Earth toward the south magnetic pole. It is located in the Canadian arctic and is different from true north. It is the direction in which the compass needle points. In the declination diagram on the map, magnetic north is represented by a needle as on a compass.

The differences between the three norths affect navigation for the map and compass user, in the form of magnetic declination. Magnetic declination is the difference in bearing either between true north and magnetic north or between grid north and magnetic north.



Cadets will normally use the magnetic declination value between grid north and magnetic north when navigating using a map and compass. By setting the magnetic declination on the compass, magnetic bearings are converted to grid bearings which allow bearings taken from the map to be used on the ground and vice versa.

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CONFIRMATION OF TEACHING POINT 3

QUESTIONS

Q1. Which north is represented by a star?

Q2. Which north does a compass needle point towards?

Q3. Which magnetic declination value is most important to topographical map users?

ANTICIPATED ANSWERS

A1. True north.

A2. Magnetic north.

A3. The magnetic declination value between grid north and magnetic north.

Teaching point 4 **Explain Bearings**

Time: 5 min Method: Interactive Lecture

DEFINITION OF A BEARING

Bearing. A bearing is an angle that is measured clockwise, from north. It is measured in degrees and is relative to the observer.



In geometry, an angle is based on three points; a vertex, and two points, each of which designates a ray. For a bearing, the vertex is the point where the bearing is taken from, another point is north, and the last point is where the bearing is directed to. The north (either true, grid or magnetic) used identifies the type of bearing.

In ground navigation, one ray of the angle points north (usually grid north) and the other ray, known as a plotting ray, points to the object/direction.

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TYPES OF BEARINGS

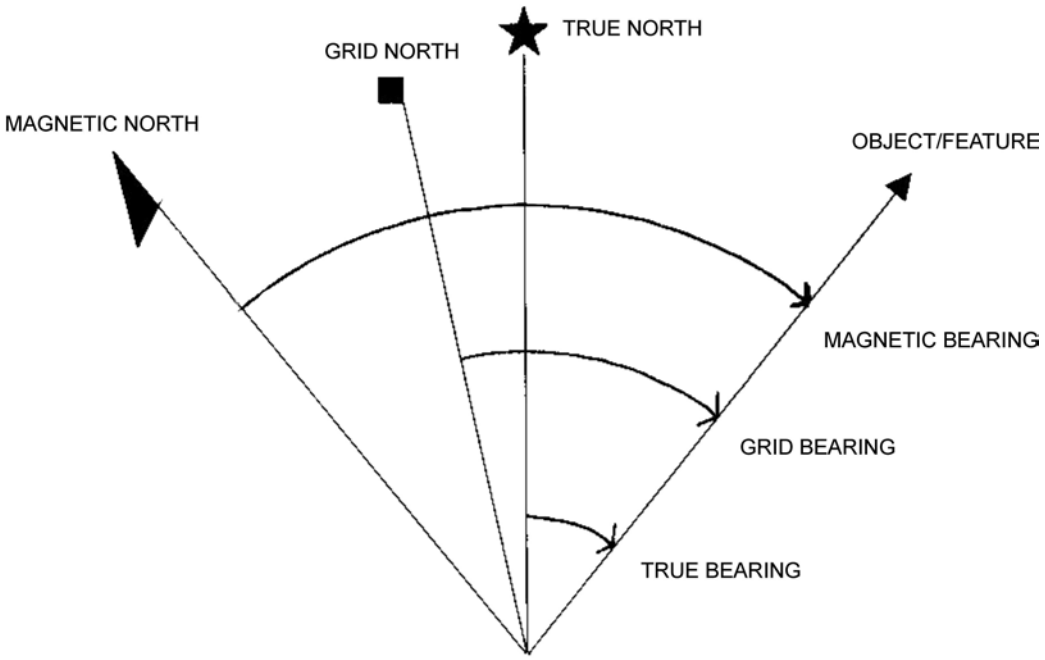

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Figure 3 Types of Bearings

True Bearings. A true bearing is a bearing measured from true north. While map users rarely use them, directions determined using the sun, moon and stars are true bearings. Global Positioning System (GPS) receivers also use true bearings.

Grid Bearings. A grid bearing is a bearing measured from grid north. The ability to determine a bearing from a map allows a map user to plan routes or activities before going into the field, and allows an easy method of communicating information about movement or location.

Magnetic Bearings. A magnetic bearing is measured from magnetic north and is measured using a compass, which either has no option of setting magnetic declination or has the magnetic declination set to zero. A magnetic bearing is a quick and efficient method of describing a route when a map is not being used.



If a compass has its declination set to zero, bearings to objects on the ground determined by that compass are magnetic bearings. Setting the magnetic declination on a compass converts the magnetic bearings determined by that compass into grid bearings for the map being used.

Back Bearing. A back bearing is a bearing that is in exactly the opposite direction of the bearing that has been measured. A back bearing can be useful for different reasons: to return to the start location after a hike, or to calculate the bearing from an object to one's current location. The steps to calculate a back bearing are:

- if the bearing is less than 180 degrees, add 180 degrees; and
- if the bearing is greater than 180 degrees, subtract 180 degrees.

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CONFIRMATION OF TEACHING POINT 4

QUESTIONS

Q1. A bearing is another name for what?

Q2. Directions determined using the sun, moon and stars are what type of bearing?

Q3. How is knowing a back bearing useful?

ANTICIPATED ANSWERS

A1. A bearing is another name for an angle.

A2. True bearings.

A3. A back bearing can be useful for different reasons: to return to the start location after a hike, or to calculate the bearing from an object to one's current location.

Teaching point 5 — **Explain, Demonstrate and Have the Cadets Practice Determining a Bearing on a Map**

Time: 15 min — Method: Demonstration and Performance

The ability to determine a bearing from a map allows cadets to plan routes or activities before going into the field, and allows an easy method of communicating information about movement or location. When a compass is adjusted to compensate for magnetic declination, it will allow bearings taken on the map to be used on the ground and vice versa.



For this skill lesson, it is recommended that instruction take the following format:

(1) Explain and demonstrate the complete skill while cadets observe.

(2) Explain and demonstrate each step required to complete the skill. Monitor cadets as they imitate each step.

(3) Monitor the cadets' performance as they practice the complete skill.

Note: Assistant instructors may be employed to monitor cadet performance.

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Figure 4 Measuring a Bearing on a Map



A cadet will accidentally measure a back bearing if they determine the bearing in the wrong direction (eg, bearing from point B to point A instead of point A to point B).

Prior to measuring a bearing on a map it is good practice to first estimate the bearing by drawing a compass rose and looking at where the bearing would be on the compass rose. This serves as a good check to ensure the cadet has not accidentally measured the back bearing.

To measure a bearing on a map:

1. Set the predetermined declination on the compass.

2. Identify and mark the start (point A) and finish (point B) points on a map.

3. Draw a plotting ray from point A to point B.

4. Lay the fully opened compass with the edge of the compass base plate along the plotting ray, and the sighting arrow pointed in the direction of travel (point A to point B).

5. Hold the compass in place, rotate the compass dial so that the compass meridian lines align with the easting lines on the map, ensuring north on the dial indicates north on the map.

6. Read the number on the compass dial at the luminous index pointer.

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If the bearing is taken from point B to point A, the compass will be pointing 180 degrees in exactly the opposite direction of travel wanted. This is called a back bearing.



Have the cadets practice determining bearings on a map from the list created (before the lesson) from the topographical map of the exercise area.

CONFIRMATION OF TEACHING POINT 5

The cadets' participation in determining bearings on a map will serve as the confirmation of this TP.

Teaching point 6 **Explain, Demonstrate, and Have Cadets Determine the Bearing of a Prominent Object**

Time: 10 min Method: Demonstration and Performance



For this skill lesson, it is recommended that instruction take the following format:

(1) Explain and demonstrate the complete skill while the cadets observe.

(2) Explain and demonstrate each step required to complete the skill. Monitor the cadets as they imitate each step.

(3) Monitor the cadets' performance as they practice the complete skill.

Note: Assistant instructors may be employed to monitor the cadets' performance.

A compass can be used to determine the bearing for a direction of travel and from one's current location to a prominent object. The ability to take a bearing of a prominent object also allows the cadet to look for a prominent object as a steering point when they need to follow a given bearing. A bearing is a quick and accurate method for describing the direction of travel.

A prominent object is something that is usually tall and easily recognizable (eg, church steeple, tall tree or hilltop).

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Figure 5 Determining a Bearing



After the cadets have demonstrated the skill, have them practice determining the bearings of other prominent objects. This location should be predetermined by the recce IAW the pre-lesson instructions.

To determine the bearing of a prominent object:

1. Set the predetermined declination on the compass.

2. Hold the compass at eye level and at arm's length, and turn to face the prominent object (as illustrated in Figure 18-5-5).

3. Aim at the object using the compass sight, ensuring the sighting line is in line with the index pointer.

4. Adjust the compass cover so the compass dial is seen in the sighting mirror.

5. Look in the mirror and turn the compass dial until the magnetic needle is over the orienting arrow (put the red in the bed).

6. Read the number on the compass dial at the luminous index pointer.



Inform the cadets that when taking a bearing of a prominent object they will get different readings than other cadets unless they are all using the same line of sight to that prominent object (eg, standing in the same spot).

CONFIRMATION OF TEACHING POINT 6

The cadets' participation in determining bearings on the ground will serve as the confirmation of this TP.

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END OF LESSON CONFIRMATION

The cadets' participation in determining bearings on a map and on the ground will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

N/A.

METHOD OF EVALUATION

This EO is assessed IAW A-CR-CCP-803/PG-001, Chapter 3, Annex B, Appendix 5 (390 PC).

CLOSING STATEMENT

It is important for cadets to be able to determine bearings on a map and on the ground as this is one of the key skills required to navigate using a map and compass. Experience in this skill will give the cadets confidence in their ability to navigate in the field.

INSTRUCTOR NOTES/REMARKS

To preserve and reuse the maps, the maps should be covered or coated to allow the use of wet-erase markers instead of pencils or pens.

REFERENCES

A2-041 B-GL-382-005/PT-001 Canadian Forces. (2006). *Maps, Field Sketching, Compasses and the Global Positioning System*. Ottawa, ON: Department of National Defence.

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