ROYAL CANADIAN ARMY CADETS

SILVER STAR

INSTRUCTIONAL GUIDE

SECTION 2

EO M322.02 – CALCULATE MAGNETIC DECLINATION

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-703/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.

Photocopy the handout located at Annex A for each cadet.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

An interactive lecture was chosen for TP 1 to orient the cadet to calculating magnetic declination and to present basic material.

Demonstration and performance was chosen for TP 2 as it allows the instructor to explain and demonstrate calculating magnetic declination while providing an opportunity for the cadets to practice calculating magnetic declination under supervision.

An in-class activity was chosen for TP 3 as it is an interactive way to reinforce calculating magnetic declination.

INTRODUCTION

OBJECTIVES

By the end of this lesson the cadet shall have calculated magnetic declination.

IMPORTANCE

It is important for cadets to know how to calculate magnetic declination and set it on a compass as it provides the cadet with confidence that they will arrive at their destination when navigating on a bearing. Not accounting for declination may affect navigation, as the cadet may travel off route. For every one degree of error in declination setting, a person would be approximately 52 m off of for every km travelled.

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Teaching point 1 **IAW M222.02 (Describe Bearings) Review Magnetic Declination and the Three Norths**

Time: 5 min Method: Interactive Lecture



Magnetic declination was identified in M222.03 (Identify Compass Parts, A-CR-CCP-702/PF-001, Chapter 12, Section 3) however, it must be discussed again to support calculating magnetic declination.

Magnetic Declination

Magnetic declination is the difference between true north (map) and magnetic north (compass). It is caused by the different locations of the geographic north pole and the magnetic north pole plus any local anomalies such as iron deposits.

Map users will identify the declination in the marginal information through a declination diagram depicting the true, grid, and magnetic bearing of any line within the area of the map sheet.

Declination will change annually due to the shifting magnetic pole. There are only two lines in the northern hemisphere where magnetic and true north line up equalling declination of zero degrees. One line runs through central Canada and the other through Russia.

Grid Magnetic Angle

Grid magnetic angle is the horizontal angular difference between grid north and magnetic north. This is the number that is applied when converting from magnetic to grid bearings.

Annual Magnetic Change

Due to the dynamic forces on the earth, magnetic north continually migrates. Subsequently an annual adjustment/calculation must be made to obtain the correct grid angle at the date of use. The amount of adjustment, to be made, is provided in the declination diagram.

This change is significant as adjustments to a compass may be required. This is known as “setting the declination.” Bearings and directions taken from the map would not be accurate if the magnetic change is not taken into account. All maps have the required information to calculate the declination and this information is found in the margin of the map.



Review the three norths. This material was covered in M222.02 (Describe Bearings, A-CR-CCP-702/PF-001, Chapter 12, Section 2).

In navigation, there are three different norths – true north, grid north and magnetic north. Each north varies from each other and must be known for navigation. A diagram representing the three norths can be found in the margin of the map being used.



Draw Figure 1 on a visual aid and draw the symbol for each north as it is explained to the cadets.

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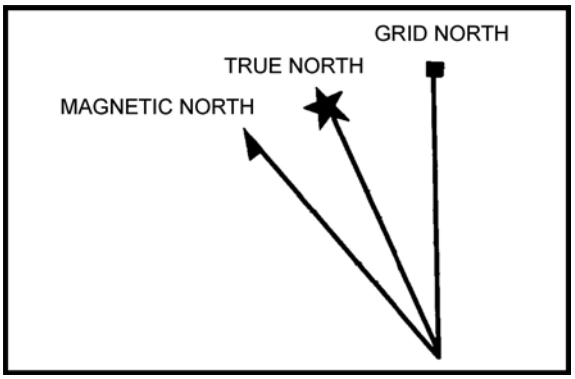

B-GL-382-005/PT-001, Canadian Forces, Maps, Field Sketching, Compasses and the Global Positioning System (p. 51)

Figure 1 Three Norths

True North. True north is located at the top of the earth where the geographic North Pole is found. It is the point at which the earth rotates on its axis and is where all lines of longitude meet. In the diagram on the map, true north is represented by a star (Polaris).

Grid North. Grid north is the north indicated by the grid lines (eastings) on a topographical map. Eastings are lines that run parallel to each other and will never meet at the North Pole; because of this, grid north points off slightly from true north. Grid north is symbolized by a square on the declination diagram.

Magnetic North. Magnetic north is the direction in which the compass needle points. This direction is to the magnetic pole which is located in the Canadian arctic and is slightly different from true north (North Pole). Magnetic north is symbolized by an arrow or half arrow head on the declination diagram.

CONFIRMATION OF TEACHING POINT 1

QUESTIONS

Q1. Explain true north.

Q2. What symbol on a declination diagram represents magnetic north?

Q3. What is annual magnetic change?

ANTICIPATED ANSWERS

A1. It is the point at which the earth rotates on its axis. The geographic north pole or true north is located at the top of the earth where the lines of longitude converge. On a map, the direction of true north is shown by the lines of longitude. True north is symbolized by a star on the declination diagram.

A2. Magnetic north is represented by an arrow.

A3. Due to the dynamic forces on the Earth magnetic north continually migrates. Subsequently an annual adjustment/calculation must be made to obtain the correct grid angle at the date of use.

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Teaching point 2 **Demonstrate, Explain and Have the Cadet Practice Calculating Magnetic Declination**

Time: 20 min Method: Interactive Lecture



Provide guidance to the cadets when learning to calculate magnetic declination. Use the provided steps and follow the sample calculations provided below.

CALCULATE THE MAGNETIC DECLINATION

Locate the Declination Diagram and Information

Calculating current declination uses the information provided by the declination diagram on a map and the information printed directly underneath. This diagram is most often found, on the right side of the map in the marginal information.

Calculate Declination

To calculate declination use the angle between magnetic north and grid north – ignoring true north. This is because bearings taken from a map use grid north as their point of reference. The annual change noted under the diagram will be either “increasing” (the declination is getting larger), or “decreasing” (getting smaller). The total annual change will then be added or subtracted from the declination printed on the map, to get the current declination.

The degree system of bearings shares some structure and terminology with units of time. There are:

- 360 degrees in a circle, written as **360°**,
- 60 minutes in a degree, written as **60'**, and
- 60 seconds in a minute, written as **60"**.

It is common to divide degrees into minutes, instead of seconds (eg, 1.5' instead of 1'30").

The steps to calculate magnetic declination are:

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Step 1. Identify how long it has been since the map information was current by:

1. **Identifying the Current Year**. This is the actual current calendar year.
2. **Identifying Year of Declination Information**. This date is found under the declination diagram defined as the “approximate mean declination”.
3. **Recording the Difference in Years**. Subtract the approximate mean declination year from the current year.

Step 2. Determine how much declination has changed since the map was current by:

4. **Multiplying the Difference in Years by the Annual Change**. Take the difference in years and multiply it by the annual change.

Step 3. Update the map declination with the amount of change calculated by:

5. **Determining if the Annual Change is Increasing or Decreasing**. The annual change found under the declination diagram also indicates whether the annual change is increasing or decreasing in degrees and minutes.
6. **Adding or Subtracting the Annual Change from the Original Declination**. The original declination is found on the declination diagram. It is the numbers represented in minutes and degrees between grid north and magnetic north. Were the change is increasing add to the map declination, if the change is decreasing subtract from the map declination.

Step 4. Set the current declination on the compass by:

7. **Determining if Declination is East or West**. This determines what direction the declination must be set on a compass. East or west is determined by looking at the declination diagram and identifying true north and magnetic north. The side magnetic north falls on represents east or west declination. Right side is east, left side is west.
8. **Setting the Calculated Declination on a Compass**. On the back side of the compass there is a declination adjusting screw, adjust the declination adjusting screw to the calculated declination east or west.



The zero declination line (agonic line) runs west of Hudson Bay, near Churchill, Manitoba. Therefore, maps east of here can assume a declination to the west and maps west will assume a declination to the east.

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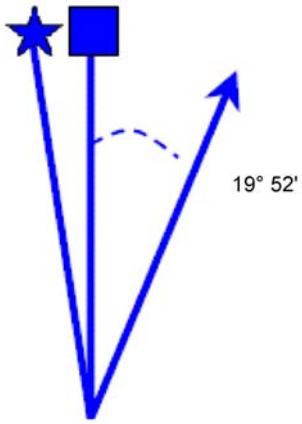

USE DIAGRAM TO OBTAIN NUMERIC VALUES
APPROXIMATE MEAN DECLINATION 1991
FOR CENTRE OF MAP
ANNUAL CHANGE (DECREASING) 7.0'

Department of National Defence, Instructional Guide (IG) DP1–Cadet Instructors Cadre (CIC) Environmental Performance Requirements–Land, Department of National Defence (p. 84)

Figure 2 Declination Diagram Sample



When the declination is recorded in writing, it is written in degrees and minutes. Degrees is represented by a number followed by a small circular symbol (eg, 19°) The same is true for minutes as the number is followed by an apostrophe (eg, 52').

Example With East Declination (Figure 2). The declination as of 1991 is 19° 52' East and the annual change is decreasing 7.0'. The magnetic declination is calculated as:

Current year:	2010
Year of declination information:	- 1991
Difference in years:	19
Difference in years:	19
Annual change:	x 7.0'
Total change:	133' or 2°13'



The total change is converted from 133' minutes to 2°13' because there are 60' in a degree.

Annual change is decreasing so it is subtracted from the original declination:

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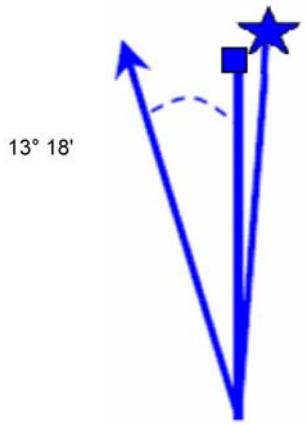
Original declination:	E 19° 52'
Total change:	- 2° 13'
Current declination:	E 17° 39'

This tells us that the magnetic needle on a compass will point to the east of grid north by 17 degrees and 39 minutes, for the area depicted on this map in 2010.



Department of National Defence, Instructional Guide (IG) DP1–Cadet Instructors Cadre (CIC) Environmental Performance Requirements–Land, Department of National Defence (p. 84)

Figure 3 Declination Diagram Sample



Convert to degrees and minutes when there are 60' (minutes) or more.

Example With West Declination (Figure 3). The declination as of 1993 is 13° 18' West and the annual change increasing 1.7'. The magnetic declination is calculated as:

Current year:	2010
Year of declination information:	- 1993
Difference in years:	17
Difference in years:	17
Annual change:	x 1.7'
Total change:	28.9'

Annual change is increasing so it is added to the original declination:

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Verify against the official publication.

Original declination:	W 13° 18'	
Total change:	+ 28.9'	
Current declination:	W 13° 46.9'	(rounded to 47)



Round minutes up or down as required during calculations. (eg, at or over 0.5 minutes round up, under 0.5 minutes round down).

This tells us that the magnetic needle on a compass will point to the west of grid north by 13 degrees and 47 minutes, for the area depicted by this map in 2010.

It is possible to have a very small original declination and a larger total annual change, so that when calculated the current declination actually changed from what was originally a West declination to an East declination, or vice versa.



When subtracting, there are times when the equation cannot be completed without borrowing from the next figure in the line.

13° 12'

- 45'

To complete this equation, one degree (sixty minutes) must be borrowed from 13° to allow subtraction from 12'. When borrowing a degree (1° equals 60') reduce the degree portion by one and add 60' to the minute numbers.

12° 72'

- 45'

= 12° 27'

The equation can now be completed as seen above.

CONFIRMATION OF TEACHING POINT 2

QUESTIONS

Q1. Where is the declination diagram found on a topographical map?

Q2. How many minutes are in a degree?

Q3. When the annual change is decreasing what difference will this make to your calculations?

ANTICIPATED ANSWERS

A1. The declination diagram is located on the right side of the map in the marginal information.

A2. There are 60 minutes.

A3. When the annual change is decreasing it is subtracted from the original declination.

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Verify against the official publication.

Teaching point 3 **Have the Cadet Calculate Magnetic Declination Using East and West Declination Examples**

Time: 30 min Method: In-Class Activity

ACTIVITY

OBJECTIVE

The objective of this activity is to have the cadets practice calculating magnetic declination.

RESOURCES

Declination problem worksheet located at Annex A.

ACTIVITY LAYOUT

N/A.

ACTIVITY INSTRUCTIONS

1. Distribute a worksheet to each cadet.
2. Have the cadets individually complete as many problems on the worksheet as possible in 20 minutes.
3. Correct the declination worksheet with the cadets using the answer key located at Annex B.
4. Answer questions, and calculate declination on a visual aid to clarify questions.

SAFETY

N/A.

CONFIRMATION OF TEACHING POINT 3

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

END OF LESSON CONFIRMATION

The cadets' calculation of magnetic declination will serve as the confirmation of this lesson.

CONCLUSION

HOMEWORK/READING/PRACTICE

Cadets are encouraged to complete or retry any problems that they have experienced trouble with.

METHOD OF EVALUATION

This EO will be assessed IAW A-CR-CCP-703/PG-001, Chapter 3, Annex B, Appendix 5 (322 PC).

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CLOSING STATEMENT

Knowing how to calculate magnetic declination adds to basic map and compass skills and will allow cadets to plan route marches and navigate confidently during field training exercises. Calculating magnetic declination builds on the essential navigation skills required of a cadet in the expedition stream.

INSTRUCTOR NOTES/REMARKS

Cadets may use a calculator for calculating declination.

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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