ROYAL CANADIAN AIR CADETS

PROFICIENCY LEVEL THREE

INSTRUCTIONAL GUIDE

SECTION 10

EO C390.05 – 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-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.

Photocopy the handouts located at Annexes L and N for each cadet.

Create slides of Annex M.

PRE-LESSON ASSIGNMENT

N/A.

APPROACH

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

REVIEW

N/A.

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 as it provides the cadet with confidence that they will arrive at their destination when navigating on a bearing. Not accounting for magnetic declination

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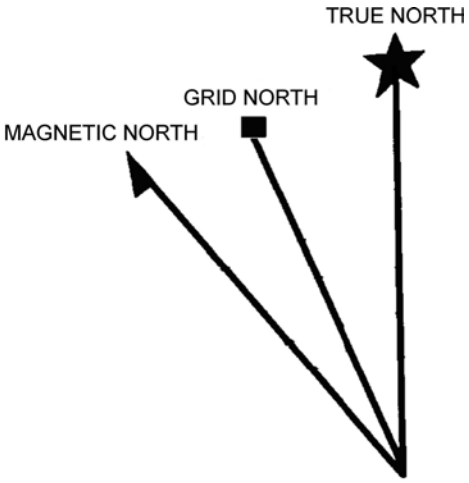
may affect navigation, as the cadet may travel off the intended route. For every one degree of magnetic declination not accounted for, a person would be approximately 17 m off for each kilometre travelled.

Teaching point 1 **Discuss the Three Norths and Magnetic Declination**

Time: 5 min Method: Interactive Lecture



Director Cadets 3, 2008, Ottawa, ON: Department of National Defence

Figure 1 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 and 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 magnetic north 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.

MAGNETIC DECLINATION

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.

The line of zero declination, as of 2008, runs through Baker Lake, Nunavut, Churchill, Man., and Sioux Lookout, Ont.

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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.

CONFIRMATION OF TEACHING POINT 1

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 2 **Explain, Demonstrate and Have Cadets Calculate Magnetic Declination**

Time: 15 min Method: Demonstration and Performance



Distribute Fact Sheet located at Annex L. When using the slides from Annex M, cover the right section (the equations) and reveal each step as required. Example 1 should be used as the demonstration and Example 2 to be performed step-by-step by the cadets. If more examples are required, use the questions from the worksheet. However, Question 9 should not be used as an example, only as a question for the cadets to calculate as it involves an east/west declination switch.

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.

LOCATING DECLINATION DIAGRAM

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.

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IDENTIFING THE FORMULA USED TO CALCULATE MAGNETIC DECLINATION

Several mathematical principles are used in the formula to calculate magnetic declination. Understanding of the mathematical order of operations is essential.

Formula: Grid Magnetic Angle + [(Current Year - Year of Declination Information) × (Annual Change)] = Current Declination

Grid Magnetic Angle. The angle between grid north and magnetic north, found on the declination diagram. Written in degrees and minutes.



1 degree (°) = 60 minutes ('), similar to calculating time (eg, 1 hour = 60 minutes).

This ratio is very important to remember when adjusting the grid magnetic angle to the current declination. This is where many errors occur.

Current Year. The current calendar year.

Year of Declination Information. Found below the declination diagram.

Annual Change. Found below the declination diagram and is written in minutes.



It is important that the annual change be inserted into the formula correctly:

- If annual change is **increasing**, insert into formula as a **positive** number.
- If annual change is **decreasing**, insert into formula as a **negative** number.

Current Declination. This is the result of the formula. It is the magnetic declination to be set on the compass.

West Declination. When magnetic north is west (to the left) of grid north on the declination diagram.

East Declination. When magnetic north is east (to the right) of grid north on the declination diagram.



If the current declination calculates to a negative number, an east declination changes to a west declination and vice versa.

CALCULATING MAGNETIC DECLINATION

Steps to calculate magnetic declination:

1. Identify grid magnetic angle.
2. Identify current year.
3. Identify year of declination information.
4. Identify annual change.
5. Determine whether the annual change is positive or negative.
6. Input the information into the formula.
7. Solve for current declination.
8. Determine whether the magnetic declination is east or west.

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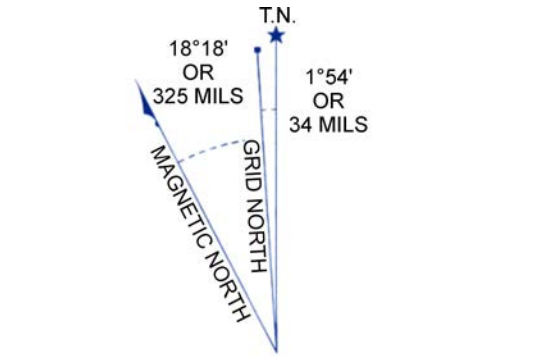
Show slide of Example 1 of Calculating Magnetic Declination located at Annex M.

Example 1:



Natural Resources Canada, 2008, Topo Declination Diagram. Retrieved April 11, 2008, from http://gsc.nrcan.gc.ca/geomag/field/magdec_e.php?p=1

Figure 2 Declination Diagram

From Figure 18-10-2:

1. Grid Magnetic Angle: 18° 18'
2. Current Year: 2008 (used for this example)
3. Year of Declination Information: 1975
4. Annual Change: decreasing 1.4'
5. Decreasing means 1.4' becomes -1.4'
6. Input the information into the formula:
7. 18° 18' + [(2008 - 1975) x (-1.4')] = Current Declination
8. Solve for current declination.
    a. 18° 18' + [(33) x (-1.4')] = Current Declination
    b. 18° 18' + [-46.2'] = Current Declination
    c. 18° 18' - 46.2' = Current Declination

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Since 46.2' cannot be easily subtracted from 18° 18', 1° is converted into 60' (similar to time calculations), which converts 18° 18' to 17° 78'.

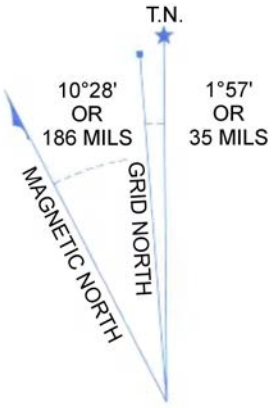
d. 17° 78' - 46.2' = Current Declination

e. 17° 31.8' = Current Declination

9. Since magnetic north is west of grid north and the result is positive, the magnetic declination for the topographical map in 2008 is 17° 31.8' west declination.

Show slide of Example 2 of Calculating Magnetic Declination located at Annex M.

Example 2:



USE DIAGRAM ONLY TO OBTAIN NUMERICAL VALUES
APPROXIMATE MEAN DECLINATION 1996
FOR CENTRE OF MAP
ANNUAL CHANGE INCREASING 2.7'

ONE THOUSAND METRE
UNIVERSAL TRANSVERSE MERCATOR GRID
ZONE 18

Canada Centre for Mapping, Bancroft 31 F/4, Natural Resources Canada

Figure 3 Declination Diagram

From Figure 18-10-3:

1. Grid Magnetic Angle: 10° 28'
2. Current Year: 2008 (used for this example)
3. Year of Declination Information: 1996
4. Annual Change: increasing 2.7'
5. Increasing means 2.7' becomes +2.7'
6. Input the information into the formula:

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7. 10° 28' + [(2008 - 1996) x (+2.7')] = Current Declination

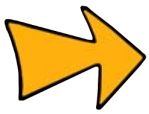
8. Solve for current declination.

   a. 10° 28' + [(12) x (+2.7')] = Current Declination

   b. 10° 28' + [+32.4'] = Current Declination

   c. 10° 28' + 32.4' = Current Declination

   d. 10° 60.4' = Current Declination



Since 60.4' is greater than 1°, 60' is converted into 1° (similar to time calculations), which converts 10° 60.4' to 11° 0.4'.

   e. 11° 0.4' = Current Declination

9. Since magnetic north is west of grid north and the result is positive, the magnetic declination for the topographical map in 2008 is 11° 0.4' west declination.

CONFIRMATION OF TEACHING POINT 2

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

Teaching point 3 **Have Cadets Calculate Magnetic Declination**

Time: 30 min Method: In-Class Activity

ACTIVITY

OBJECTIVE

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

RESOURCES

- Magnetic declination worksheet located at Annex N, and
- Pen/pencil.

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 worksheet with the cadets using the answer key located at Annex O.
4. Answer any questions the cadets may have on calculating magnetic declination.

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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

N/A.

METHOD OF EVALUATION

N/A.

CLOSING STATEMENT

Knowing how to calculate magnetic declination provides the cadet with confidence that they will arrive at their destination when navigating on a bearing.

INSTRUCTOR NOTES/REMARKS

Cadets may use a calculator if they wish.

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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