Laboratory 1
TOPOGRAPHIC MAPS AND NAVIGATION

Assignment Due Date: *Start* of next week's lab!

Objectives: To gain experience interpreting and using topographic maps.

Text Reference: Chapter 1 and Appendix A

Introduction
Topography means "the shape of the land" and thus topographic maps illustrate the scale, width, length, and height of land surface features. Topographic maps also show a number of cultural features (land survey system, roads, houses, etc.). Topographic maps are extensively used in Physical Geography to evaluate locations, landform types, elevations, characteristics of stream flow, and other physical data. Topographic maps are also useful for other purposes such as planning a backpacking trip, orienteering, or evaluating real estate.

Materials
31 G/5 topographic map of the Ottawa area (provided by your TA), ruler, paper, pencil, calculator, string, and protractor.
Do not put any marks on the maps, in pencil or otherwise. Others will need to make use of them so please be sure to leave them in the shape they were found.
Answer all questions on the provided sheets.

Part 1) Introduction to Topographic Maps
The purpose of this assignment is for you to become familiar with the fundamentals of topographic map interpretation. When you are finished, you should be comfortable working with the concepts of *scale*, *location* (*latitude and longitude*), *elevations* and *contour lines*. You should also be able to identify the direction and steepness of land slope and visualize the form of the land.

Answer questions 1 - 17 in short sentences or one word answers where applicable. **Marked out of 12**.

Map names
Topographic maps are named after a prominent town or physical feature that appears on the map. The names of adjacent maps are printed in the *bottom right corner* of the map, to allow you to easily determine other maps in the area that you may need.

1. What is the name and index number of the map with which you are working? **(0.5 marks)**
2. What is the index number of the adjoining map to the west? **(0.5 marks)**

Latitude and longitude, and UTM reference systems
National Topographic System (NTS) Maps of Canada provide three systems for determining position. The first of these systems, also the most internationally accepted, uses latitude and longitude measured in degrees (°), minutes (') and seconds ("). Degrees are the largest units of latitude or longitude. Latitude extends from 0° at the equator to 90° north or south at the north and south poles, respectively. Longitude is also measured relative to a 0° line, the prime meridian, which runs north-south from the North Pole, through Greenwich, England, to the South Pole. Degrees of longitude extend from 180° east or west away from the prime meridian. A degree can be divided into 60 minutes. Minute intervals are indicated along the edges of the map you are using for this assignment as a series of black and white bars. A minute can be further divide into 60 seconds. For example, the precise latitude of a location exactly half way between 40° and 41° north would be 40 degrees, 30 minutes, and 0 seconds north, also written as 40°30'00" N.
The other two coordinate systems used on NTS map sheets are rectangular-grid-based:

- Universal Transverse Mercator (UTM) Grid Reference System
- Military Grid Reference System (MGRS)

Both UTM and MGRS have certain advantages and disadvantages over one another, but overall both are very similar. For this assignment, we use the UTM system only. For more information on MGRS, refer to the following URL: http://maps.nrcan.gc.ca/topo101/mil_ref_e.php.

Compared to the geographic latitude/longitude system, the UTM system uses real distance units (metres) to reference locations using an 'easting' or x-coordinate and a 'northing' or y-coordinate. UTM was first developed in the 1940's by the U.S. Army Corps of Engineers as a system to allow fast calculation of distances between locations (using the Pythagorean theorem), a task that could not be readily carried out using traditional geographic coordinates. In the UTM system, Earth is divided into 60 'zones' of 6° of longitude. For example, Zone 1 spans 180°W (the International Date Line) to 174°W. UTM zones are also divided into 20 bands of 8° of latitude spanning 80°S to 84°N. These bands are given letters starting from "C" at 80°S and finishing with letter "X" which is a special band starting at 72°N and covering 12° of latitude; the letters "I" and "O" are omitted. For example, the City of Ottawa, and much of eastern Ontario, is found in Zone 18T. The central meridian (vertical axis) of each UTM zone is assigned a value of 500,000 m, and the coordinates of locations west or east of the central meridian are given in meters west or east of the central meridian; the horizontal coordinate of a location is referred to as its "easting." For example, if point A was 200 m west of a given zone's central meridian its easting coordinate would be 499,800m. E., or if it was 200 m east of the central meridian its easting would be 500,200m E; Ottawa has an easting of 446,000m. E. The northing coordinate (vertical position) is the distance from the Equator. In the northern hemisphere, the Equator is given a reference of 0 m and as you go north, values increase. In the southern hemisphere, locations are also relative to the Equator which is now designated 10,000,000 m and as you go south, values decrease. For example, the City of Ottawa has a northing of 5,028,000m N.

3. What features are found at the following UTM coordinates (all in Zone 18T)? **(2.5 marks)**

a) 433250m E, 5019250m N

b) 452100m E, 5020350m N

c) 445200m E, 5027850m N

d) 446400m E, 5019750m N

e) 448975m E, 5028350m N

4. What is the latitude and longitude of the Bayshore Shopping Centre to the nearest minute? **(0.5 marks)**

5. What is the latitude and longitude of the center of the map to the nearest second? **(0.5 marks)**

Map series and scale

Scale expresses the relationship between distances on the map and corresponding distances on the ground (in the "real world"). There are 5 different series of NTS topographic maps which cover some to all of Canada at different scales: 1:500,000, 1:250,000, 1:125,000, 1:50,000, and 1:25,000. The only current NTS series are 1:250,000 and 1:50,000. Topographic map scales on NTS maps are indicated with a graphic (scale bar) and a ratio. Ratio or fractional scales have no units associated with them, because the same units must be used on both sides of the ratio (or fraction). For example a scale of 1:10,000 indicates that one centimetre on the map corresponds to 10,000 cm (100 m) on the ground.

6. What is the ratio scale of the Ottawa map? **(0.5 marks)**

7. Four *centimetres* on the map represents how many *metres* on the ground? **(0.5 marks)**

8. Eleven *kilometres* on the ground represents how many *centimetres* on the map? **(0.5 marks)**

9. Locate the Canadian National Railway at the western edge of the map near Constance Lake. Measure the map distance from the western edge to where these tracks merge with another section of CN Railway (hint – use a piece of string and ruler). How long is this stretch of railway in *kilometers*? **(0.5 marks)**

10. How many kilometers does the northern edge of the map represent? Round your answer to the nearest *kilometer*. **(0.5 marks)**

11. Using your answer from the previous question, and assuming the eastern edge represents 28 km, calculate the distance between the northwest and southeast corner of the map? Show your calculation, and round your answer to the nearest kilometer. **(1 mark)**

Contour lines

A *contour line* on the map (shown in brown) connects points of equal elevation above or below a reference plane (usually mean sea level, MSL). These lines allow us (with some training) to visualize the shape of the land; that is, topography. The contour interval is the vertical difference in elevation between adjacent contour lines (e.g. if the contour interval is 20 m, lines might correspond to 420 m, 440 m, 460 m, etc.). *Index contours* may be shown with a heavier brown line and are labeled with the corresponding elevation. Some general rules for contour lines are as follows:

- A contour line denotes areas of equal elevation.
- A contour line never branches or splits.
- Steep slopes are shown by closely spaced contours, flat areas are shown with widely spaced contours (a completely flat area would not have any contours).
- Contour lines never cross, except to show an overhanging cliff, where hidden contours are dashed. Contour lines merge only to show a vertical cliff.
- Hills are represented by a concentric series of closed contour lines.
- A closed depression (basin) is shown by concentric contour lines with hachures on the downhill side.
- Where contour lines cross a stream or a dry stream channel, they form a "V" that points upstream.

Relief refers to the *difference* in elevation between two points. Total relief is the difference between the highest and lowest points in an area (or on a map), while local relief refers to the difference in elevation between two nearby points (e.g. a hilltop and nearby valley).

12. What is the contour interval on your map? **(0.5 marks)**

13. What is the difference in elevation between index contours? **(0.5 marks)**

14. How can you tell if an area has a steep slope? **(0.5 mark)**

15. What is the highest point in Gatineau Park? Is it a precise elevation or only an estimate? How do you know? **(1 mark)**

16. Estimate the elevation of Lac Kingsmere in Gatineau Park to within +/- 5 m? **(0.5 marks)**

17. What is the relief of the Ottawa River between Lac Deschêne and Île Kettle? Given this information, which direction is the Ottawa River flowing? **(1 mark)**

Part 2) Transects and Topography

On the Ottawa map, navigate along transects defined by points A, B, C, and D and provide the geographic information requested.

Answer questions 1-3. Marked out of 4.

1. A → B

Point A: The golf course below Grotte Mackenzie King in Gatineau Park

Point B: The center of Lac Kingsmere.

a) What is the aspect of the hill you first ascend on your way to point B? **(0.5 marks)**

b) What is the azimuth (in degrees) when traveling from point A to point B? **(0.5 marks)**

2. B → C

Point C: Constance Lake seaplane base to the northwest of Kanata

a) What is the *azimuth* (in *degrees*) when traveling from point B to point C? **(0.5 marks)**

b) What is the *elevation* (within 5 *metres*) for point C? **(0.5 mark)**

c) What is the *straight line distance* (in *kilometres*) between points B and C? **(0.5 marks)**

d) What is the highest elevation contour line encountered when measuring straight line distance between points B and C? **(0.5 marks)**

3. C → D

Point D: to the center of Mud Pond

a) What is the *azimuth reading* (in *degrees*) when traveling from point C to D? **(0.5 marks)**

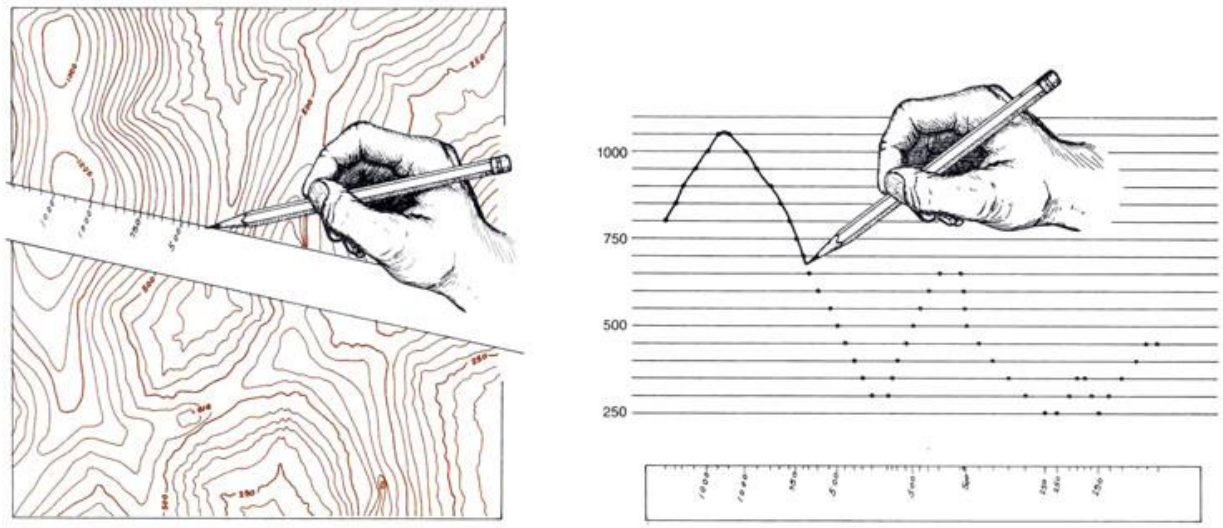
b) What is the *straight line distance* (in *metres*) between points C and D? **(0.5 marks)**

Part 3) Constructing contour lines and a topographic profile

Present Figures 1 & 2 making sure to include appropriate *figure captions* and *axis labels* (refer to the Lab Manual Appendices on cuLearn). Marked out of 7.

1. On Figure 1, draw a contour map with a contour interval of 10 metres between 310 m and 340 m. You will have to estimate the elevations between the known points. *Label each of your lines with the elevation.* **(3.5 marks)**

2. Topographic maps depict the earth from a 'bird's-eye-view'. A side-view *topographic profile* or *cross-section* can help translate this bird's-eye-view into a ground-level observer's perspective. The process of creating such a profile is illustrated below. On Figure 1, draw a line between points A and B. Lay a piece of paper along the edge of this line. Mark each place where a contour line intersects the edge of the paper and note its elevation. Note the distance between points A and B, and determine the distance value that corresponds to each elevation along the transect. On Figure 2, the y-axis represents elevation. Select a *vertical scale* that begins slightly below the lowest elevation on your map and ends just above the highest elevation. Mark the vertical scale on the y-axis, and provide a title for the axis (remember to note the units of measurement). Label the x-axis based on the distance between points A and B. Use the elevation and distance data you gathered to plot the topographic profile (see illustration below). When all contours have been transferred, connect the dots with a smooth line to produce the side-view. Label the x-axis with the appropriate horizontal distance in metres. Point A should have a value of 0 m, and point B should have a value of 6000 m (n.b., the vertical exaggeration of the landforms will vary depending on the y-axis scale you select). **(3.5 marks)**



An illustration that demonstrates how to create a topographic profile from a topographic map.

Other useful information about topographic maps

Topographic Map Symbols and Colours:
The symbols and colors used on topographic maps are fairly straight forward:

•Black - man-made, "cultural," features such as roads, buildings, etc. It is also used to show geographical names (toponyms), certain symbols, geographic coordinates, precise elevations, border information and surrounding information.
•Blue –water, lakes, rivers, streams, etc. The names of bodies of water and water courses are also shown in blue, as are magnetic declination and UTM (Universal Transverse Mercator) grid information.
•Brown - contour lines, contour elevations, spot elevations, sand.
•Green - areas with substantial vegetation like a forest, orchard, or vineyard
•Grey - used on the back of the map where the different symbols and a glossary of terms and abbreviations can be found.
•Orange - unpaved roads and unclassified roads and streets.
•Purple - features added to the map since the original survey. These features are based on aerial photographs but have not been checked on land.
•Red - major highways; boundaries of public land areas. A red tint is used to show an urban development.
•White - areas with little or no vegetation; also used to depict permanent snowfields and glaciers

Topographic Maps Glossary:

•Bearing - Angular direction expressed in degrees.
•Contour Lines – A line on a map joining points of equal elevation. These lines are used to illustrate relief on a map.
•Distortion - The difference in shape between the actual curved surface of the earth and the flat representation of a topographic map.
•Grid - A system of horizontal and vertical lines that provide coordinates for locating points on an image.
•Magnetic Declination - The angle between magnetic north and true north, expressed in degrees and minutes, east or west from true north.
•Magnetic North - The direction your compass needle points.
•Projection - A method by which the curved shape of the earth is represented on a flat surface, overcoming distortion.
•Relief – The variations in elevation of the earth's surface.
•Scale – The relationship between distance on a map and the corresponding distance on the ground. For example, a map with a scale of 1:50,000 means that 1 unit of measurement on the map equals 50,000 equivalent units on the ground.
•Topographic Map – An illustration of the earth's different elevation levels by means of contour lines. They present both natural and manmade features.
•True North - Direction of the northern rotational axis of the earth – the North Pole.

Student Name _____ TA Name _____ Lab Section _____

Lab 1 Answer for Part 1

1. Name _____ Index number _____

2. Index number _____

3. What features are found at the following UTM coordinates (all in Zone 18T)?

a) 433250m E, 5019250m N_____ b) 452100m E, 5020350m N_____
c) 445200m E, 5027850m N_____ d) 446400m E, 5019750m N_____
e) 448975m E, 5028350m N_____

4. Latitude _____ Longitude _____

5. Latitude _____ Longitude _____

6. Ratio Scale _____

7. _____m **8.** _____cm

9. _____km **10.** _____km

11. Calculation:

Final answer _____km

12. Interval: _____ **13.** Difference: _____

14. _____

_____

15. Highest point: _____

Precise or estimate and why? _____

_____

16. _____m **17.** Relief: _____ Direction of flow _____

Lab 1 Answer for Part 2

1. a)_____ b)_____

2. a)_____ b)_____ c)_____ d)_____

3. a)_____ b)_____

Lab 1 Answer for Part 3

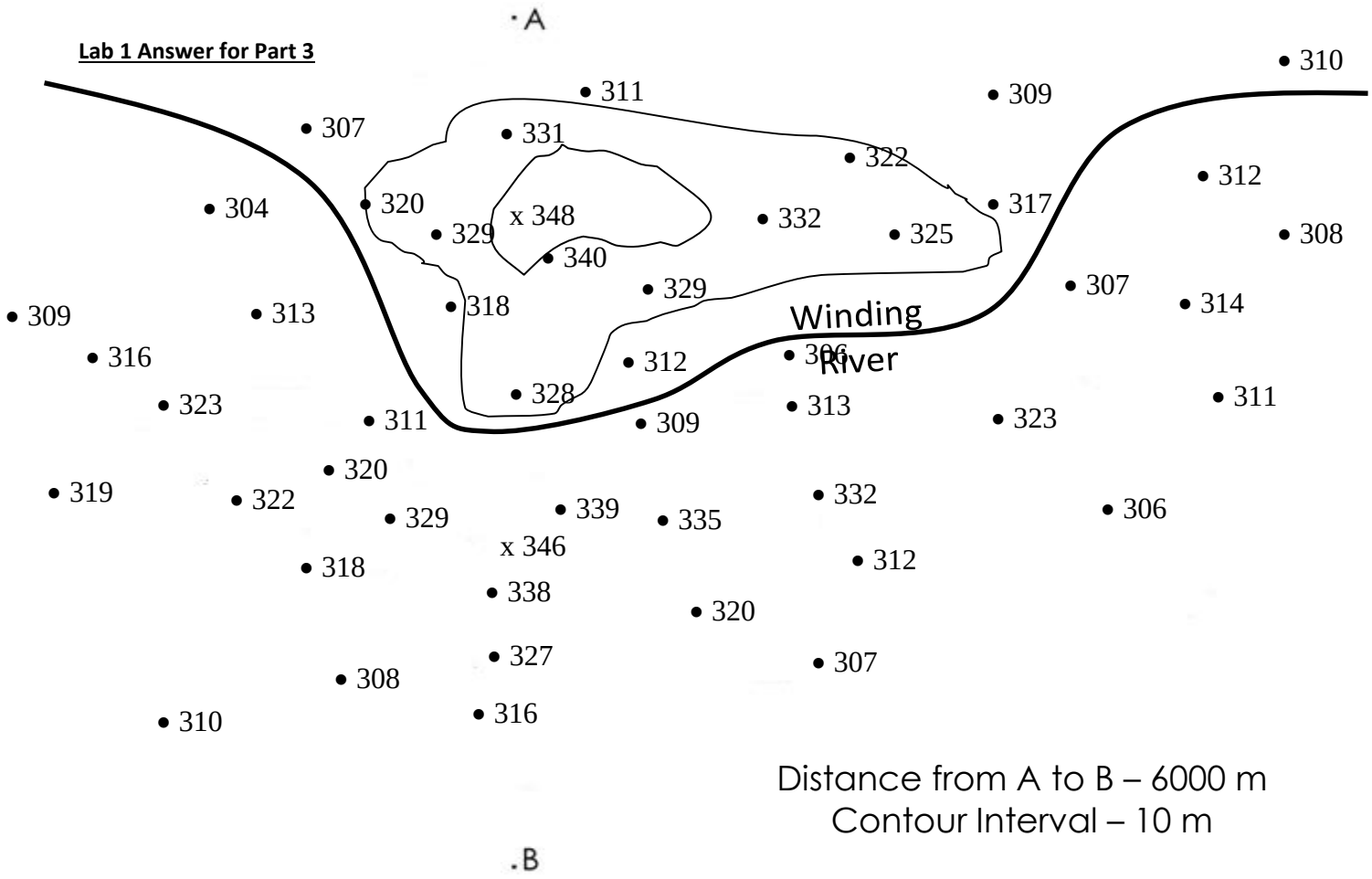


Figure 1.

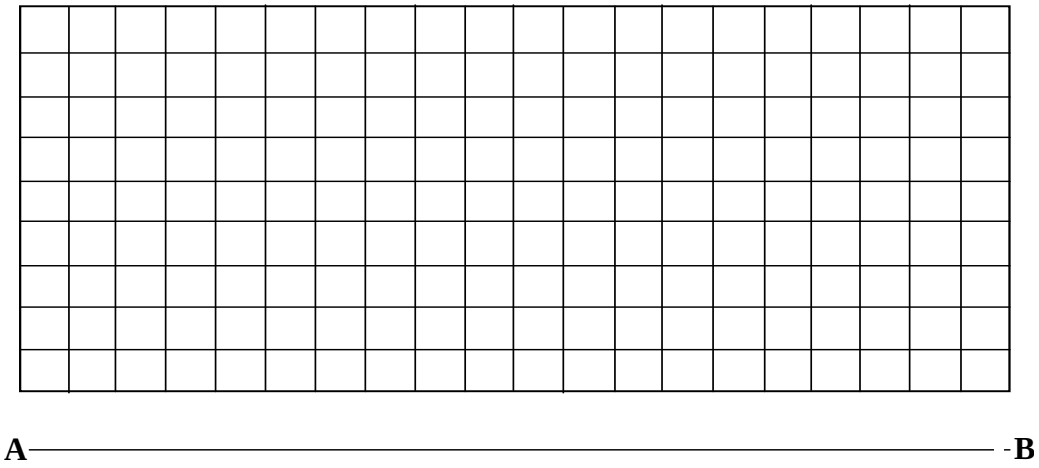


Figure 2.