HANDBOOK FOR CARTOGRAPHY

A Thesis

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in Partial Fulfillment of the Requirements for the Degree of

Master of Education

by

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ABSTRACT

There is very little cartography taught at the high school level. Furthermore material on cartography for this level is extremely limited. This handbook is designed to fill part of the gap caused by this lack of material. By making this material available probably more teachers will attempt some cartography in the classroom.

The chapter headings show the scope of the handbook, map projections, base map, and statistical maps and diagrams. These will give a basic cartography course at the grade nine or ten level. Complete instructions are given for drawing the map projections and for the diagrams. The appendices are directed toward the teacher who will be responsible for setting up the programme. Suggestions have been given to help in the selection of equipment and where funds are low, designs are given for the manufacture of drafting and light tables.

ACKNOWLEDGEMENTS

The author would like to express his appreciation to the following people. To Professor Eric Winter for his guidance and valuable criticism during the preparation of this handbook. To Mr. Dave Thomas, Head of the Graphics department at Riverdale High School, Pierrefonds for his assistance and technical advice in printing the maps and diagrams. To Mrs. Susan Sherlaw for typing the text and to my wife Wendy for her patience and encouragement over the last three years.

J.C. Marriott

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CHAPTER 1

Introduction for the Teacher.

This is strictly a handbook on some aspects of cartography. It is not intended to serve as a textbook. The limits of the assignments are,

a) to be within the capabilities of a grade nine or ten student,

b) to give the child a tool which he would find useful to express himself graphically in geography.

Mapping prepared by students in high school classes is pretty poor stuff. It is an area which loses out to tectonic forces, drumlins and rivers in youth, and more recently to hexagonal patterns of service centres and bid-rent curves. Very few teachers seem to spend more than two lessons a year on the preparation and drawing of maps. A great deal of time is spent very busily copying maps.

The size of the handbook has put a limit on the topics chosen. Other areas of cartography, such as surveying, could be introduced into the course. Students enjoy doing compass traverses and simple plane table surveying. Students amaze themselves by producing a surveyed drawing of their house lot, complete with house outline, using a drawing board balanced on a borrowed bar stool.

Map Projections

Construction of a map projection is an excellent medium for putting the imagined lines of latitude and longitude into something real which the student can grasp. The meridians and parallels are mathematical necessities for locating any geographical phenomena. How many students really understand the words when discussed in a lesson on topographic maps? After constructing the graticule itself the mental picture will sharpen. A study of various projections will give the child a changing view of the world.

The choice of projections is very easy. There are very few simple ones. First is the zenithal projections, polar case, which may be produced mechanically with drawing instruments. The second is the Mollweide projection chosen because it is fairly easy to draw, is equal area and is good for comparing areas and locations. It may be interrupted also to cut down on the amount of distortion.

If the oceans are to be featured the interruptions are placed in the land masses. On the other hand, to show the land masses with less distortion, the oceans are interrupted.

It is not suggested that each student should do all the projections. On an average it takes two to three weeks to do one. One method that works well is to allocate a zenithal projection to each student. This way all the projections are produced and a comparison can be made in a class discussion. Then the students may do a Mollweide. If a blueprint machine is available, copies may be made. The students own projection could be used for a future assignment.

Base Map

The production of a good base map is a fundamental skill in geography. The chapter on the base map is just the bare essentials. Individual teacher's own personal requirements can be added. The unit is, however, complete in itself.

Putting statistical data into a graphic form can be treated in two ways. The first would be to cover cartograms (diagrams) and maps separately. The second way is to deal with one method, say bar graphs, first as a cartogram, and then on the map. The value of the second way is that it brings out the point that location is important in one context but not in another.

Suitable statistics must be duplicated and issued to the students. The assignment is then drawn. It must be brought out why this particular set of statistics show best in the way demonstrated. Each student will experience this method of showing statistics. At the end of this section of the course, an assignment may be given whereby the student can use his newly acquired skills to show statistics of his own choosing. An example would be:

> Prepare maps or cartograms using four methods of statistical mapping. At least two of these assignments must be maps.

One of the major problems is the availability of suitable statistical material. Yearbooks are excellent. The United Nations Yearbook is very good but expensive. Some industries such as pulp and paper produce information pamphlets with good material in them. The rounding up of statistics must be done well before the first lesson of the course.

Some raw data can be obtained by the students. Counts can be made in the local shopping centres. Two examples here could be:

a) the number of people using a certain store over the course of a week,

b) the counts done over the course of a month with the shopping days being chosen at random.

A really enthusiastic group may wish to try a door to door survey. This does lead to problems with the reliability of the data but at this level of sophistication it can be successful.

There are numerous textbooks on cartography but they are all written for university students. A good selection for the teacher undertaking to teach a course on cartography is as follows.

Greenhood, David, Mapping, Chicago: University of Chicago Press 1964.

Hodgkiss, A.G., Maps for Books and Theses, Newton Abbot: David and Charles, 1970. (Canadian source, Griffin Press Ltd., 455, King Street West, Toronto 2b).

Monkhouse, F.J. and H.R. Wilkinson, Maps and Diagrams, London: Methuen, 1966.

Robinson, A.H. and Randall Sale, Elements of Cartography, 3rd. ed. New York: John Wiley, 1969.

The design of the handbook is such that the teacher can make spirit masters of the instruction sheets and the maps and diagrams. Wherever possible different methods have been used. Student discussions could centre on these different methods. In figure 5.10 the boundaries of the municipalities have been drawn. For figures 5.11 and 5.12 they were left out. Which is best? When is it necessary to show the boundaries? The students can work out quite a few thorny cartographic problems in this way.

CHAPTER 2

Map Projections

Teacher's Information Sheet

The aim of this chapter is to present the problems of map projection in a very simplified manner. Most map projections are very difficult to draw and beyond the capabilities of the young child. The projections suggested here are all described in a step by step manner with a drawing that shows the finished product. The first five are different azimuthal projections, polar case. The last two are the Mollweide and Interrupted Mollweide.

It is not suggested that the students try every one. They could do one of the azimuthal projections and one of the Mollweide. The different types of azimuthal projections could be distributed around the class. Some students could do the south pole projection and some the north pole projection. If it is possible to judge the abilities of the students beforehand the south pole projections should be allotted to the less able students. The plotting of the south pole continents is a little easier. When the projections are completed the various qualities of each could form a class discussion or a written assignment. It is difficult to suggest a time factor as this will depend on the availability of drawing instruments and the skill of the students. They do take a long time to construct but are an excellent teaching medium.

The drawings on pp 8 - 11 have been produced as a set. They are masters for making overhead transparencies. They could also be used for the production of spirit masters and duplicated so that each child may receive them.

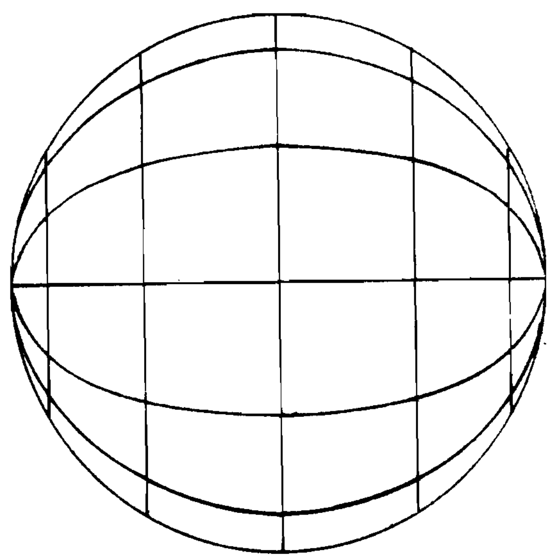


fig. 3.1a.

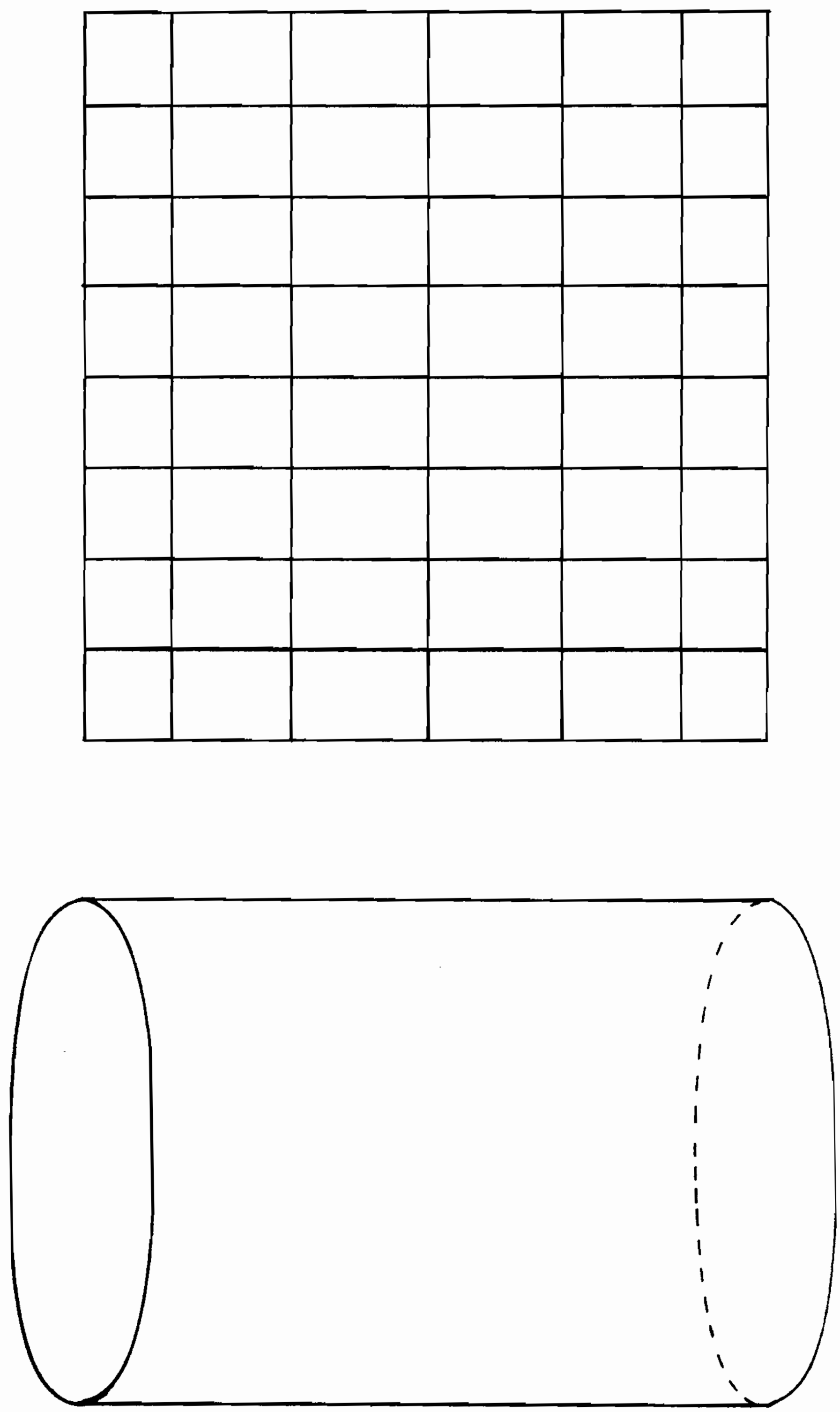


fig. 3.1b.

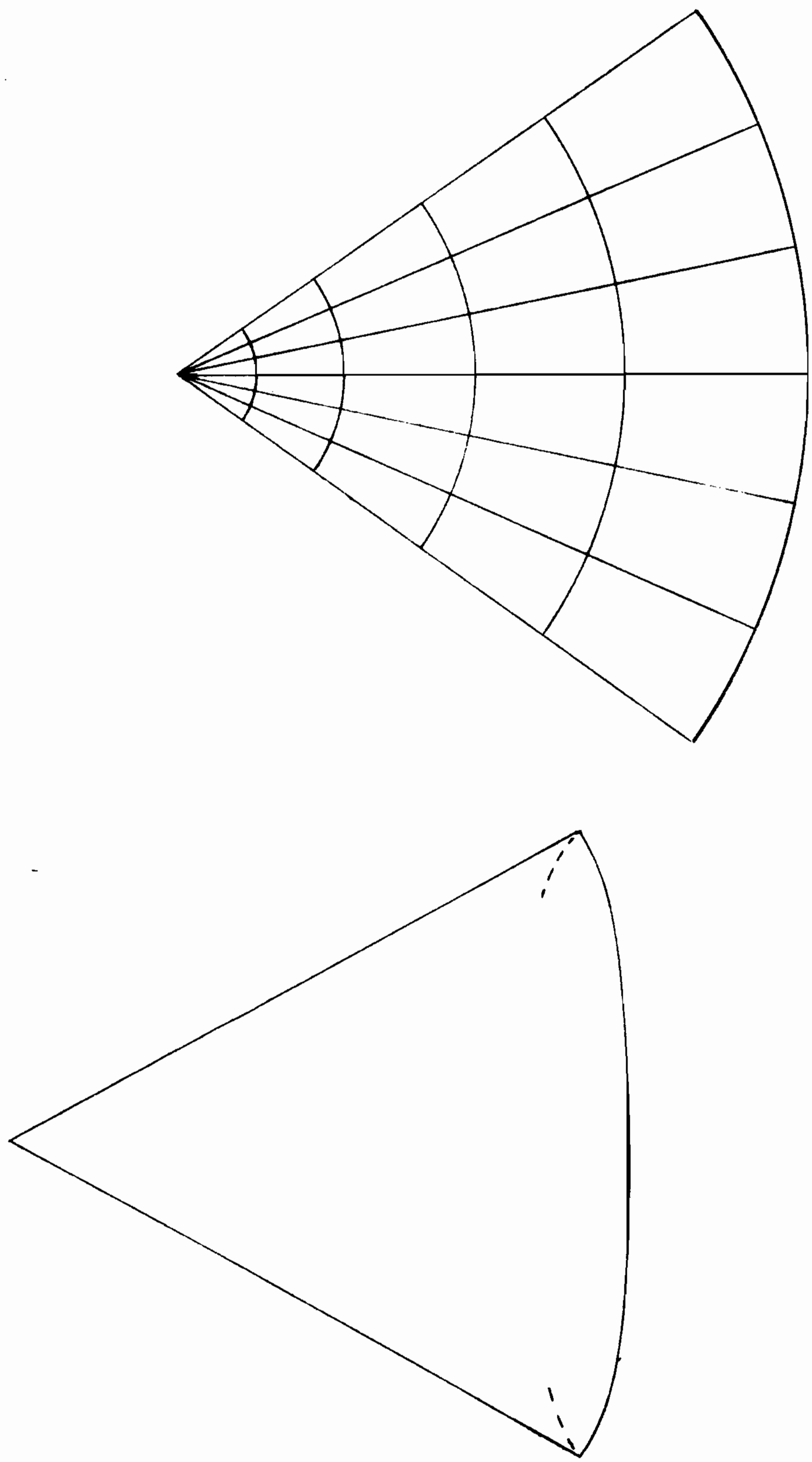


fig. 3.2.

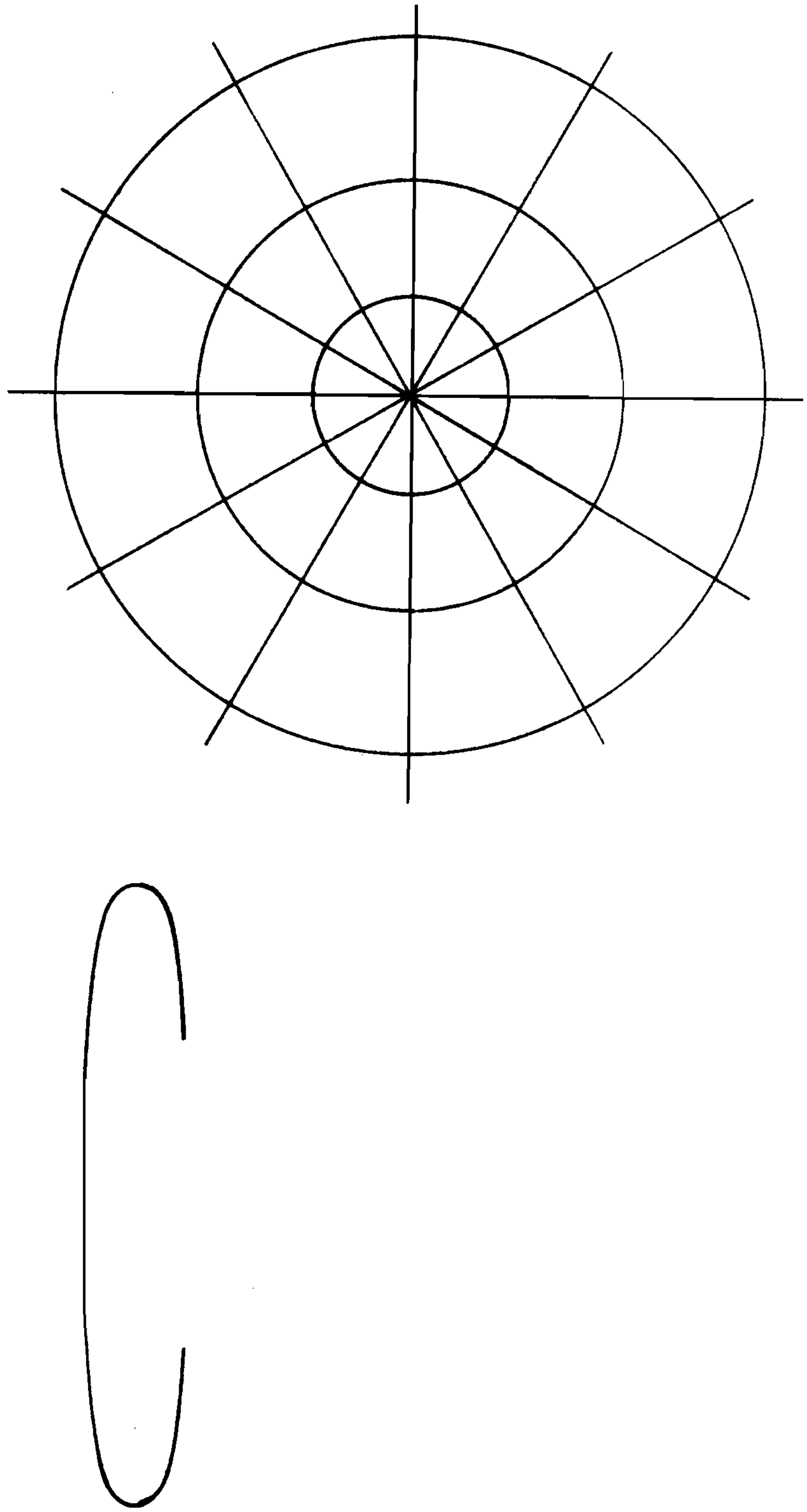


fig. 3.3.

Map Projections

Student's Information Sheet

There are three major types of projections. They may be best described by thinking of the globe as a glass sphere in which a light is placed. The lines of latitude and longitude are drawn on the surface of the glass sphere. By placing a sheet of paper in certain positions around the globe the three major types may be shown.

With the paper wrapped around the globe in a cylinder, the lines projected by the light from the surface of the globe, will show a certain pattern on the paper. When the paper is unwrapped and smoothed flat the projection will be similar to the drawing in fig. 3.1b. This is known as a cylindrical projection. The Mercator is a well-known example.

The paper may now be formed into a cone and placed on the globe. It may rest on the globe, touching it once, or it may actually cut through the globe and touch the circumference at two positions. When the paper is opened out flat, the projection will look similar to the drawing in fig. 3.2. This is a conic projection.

The final projection is the azimuthal projection. The paper is flat and just touches the globe. It may touch the globe anywhere but by far the easiest to draw are those centred over the poles. The drawing in fig. 3.3 shows an example.

Student's Information Sheet

Preparation for the Construction of Azimuthal Projections

The size of the globe must be first determined before starting the construction of the projection. The projection should be as large as the sheet of paper will allow. The size of the paper then is the determining factor. The drawing in fig. 3.4, page 14 shows sectors of the five azimuthal projections. They have all been drawn to a globe size of 2 1/2" diameter. It can be seen that the radii of the projections vary a great deal.

This drawing may be used to work out the size of the globe for any given radius of projection.

Example;

To draw a stereographic projection.

Size of paper for the finished projection is 18" wide.

The size of the projection should be around 16" diameter.

Measure radius of stereographic from fig. 3.4, it is 2 1/2".

Therefore for a 2 1/2" diameter globe the stereographic projection's diameter is 5".

2 1/2" diameter globe = 5" diameter projection.

therefore:

8" diameter globe = 16" diameter projection.

Draw the 8" diameter globe for the stereographic projection.

Diagram shows the relative spacing of the lines of latitude.

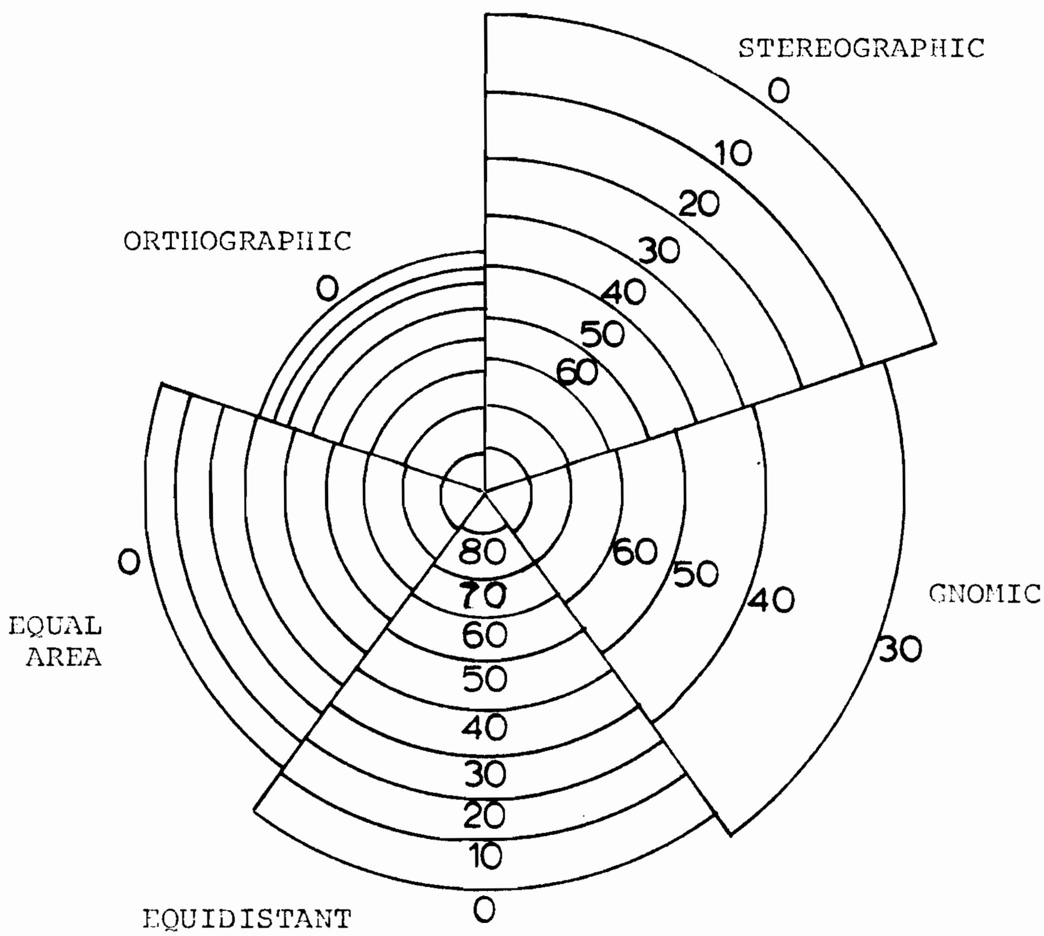
The size of the globe is 2 1/2" diameter.

Note. This drawing may be used to estimate the size of the projection from the given diameter of a globe.

e.g. Stereographic globe 10" diam. = 20" diam. projection.

Equidistant globe 10" diam. = 16" diam. projection.

Orthographic globe 10" diam. = 10" diam. projection.



after Greenhood p164.

fig. 3.4.

Student Instruction Sheet for Polar Azimuthal Projections.

ORTHOGRAPHIC

1. Set the compasses to the radius of the globe and draw a circle to represent it, fig. 3.5.
2. Draw a line to represent the equator (A B).
3. With a protractor, divide the globe's northern hemisphere into 10^{o} divisions, starting from 0^{o} at the equator. (This is necessary on one hemisphere only).
4. Draw lines, from the 10^{o} divisions on the circumference, parallel to the equator A B. These represent the lines of latitude and also give the diameters of the circles of latitude on the projection.

   i.e. the equator circle on the projection has the same diameter as the globe.
5. Set the compasses to the diameter of the globe, and with a suitable centre, scribe the equator circle. For the radii of the other circles of latitude, take them from the lines of latitude on the globe.
6. With a protractor divide the equator circle up into 10^{o} divisions, (or any other suitable divisions). Number the Prime meridian (0^{o}), and the 180^{o} meridian. Number the other divisions east and west of the Prime meridian.
7. Join up the opposite divisions along the equator.

   e.g. 0^{o} to 180^{o}; 10^{o}W to 170^{o}E and so on.

   When finishing off a polar projection, it is normal to leave out the part of the meridians poleward of the smallest circle of latitude.

8. The lines of latitude and longitude are known as the graticule. The graticule is now ready for the plotting of the continents. Obtain a good atlas with polar projections. Work on one continent at a time. Study the map in the atlas and note where the coastline crosses the graticule. Locate this on the projection, making sure that the area is the correct latitude and longitude, and the continent is oriented in the correct direction. It will be easier if one section is done at a time. After locating the coastline crossing the graticule, fill in the section from the atlas, to the next graticule line. It may be necessary to subdivide the 10^{o} division to get a more accurate coastline shape. This may be done by eye or by measuring.

9. Treat all continents in similar manner. Place on any prominent physical features.

10. To complete the map, provide on it,

    a) a margin.

    b) an indication of direction.

    c) the names of the continents.

    d) the name of the projection.

    e) the size of the globe.

    f) the name of the cartographer.

Orthographic Azimuthal Projection - Polar Case

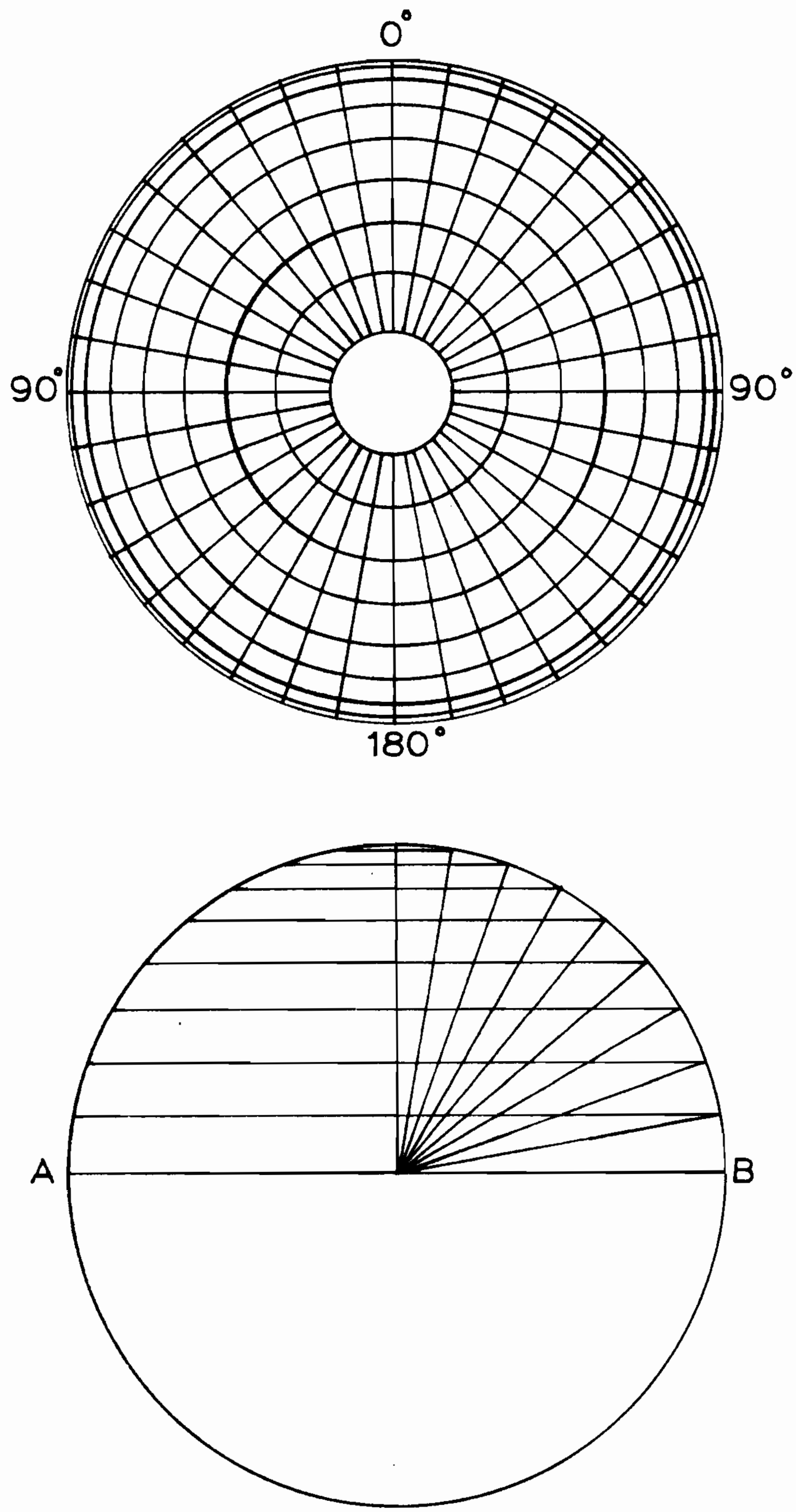


fig. 3.5.

Student Instruction Sheet for Polar Azimuthal Projections.

STEREOGRAPHIC

1. Set the compasses to the radius of the globe and draw a circle to represent it, fig. 3.6.
2. Draw a line to represent the equator (A B).
3. With a protractor, divide the globe's northern hemisphere into 10° divisions, starting from 0° at the equator. (This is necessary on one hemisphere only).
4. Draw a line tangential to the globe at the pole and parallel to the equator A B. This is the line X Y on the drawing.
5. On to the line X Y project the 10° latitude divisions from the opposite pole. (Imagine a light shining from this pole. The shadows of the circles of latitude will fall on to X Y).
6. The line X Y is now divided up and gives the radii for drawing the circles of latitude on the projection. Set the compasses to the radius from the pole to the equator. With a suitable centre scribe the equator circle. Draw the other circles of latitude using the same centre and the radii from X Y. With a protractor, divide the equator circle up into 10° divisions, (or any other suitable division). Number the Prime meridian (0°), and the 180° meridian. Number the other divisions east and west of the Prime meridian.
7. Join up the opposite divisions along the equator.

e.g. 0° to 180°; $10^{\circ}W$ to $170^{\circ}E$ and so on.

When finishing off a polar projection, it is normal to leave out the part of the meridians poleward of the smallest circle of latitude.

8. The lines of latitude and longitude are known as the graticule. The graticule is now ready for the plotting of the continents. Obtain a good atlas containing polar projections. Work on one continent at a time. Study the map in the atlas, and note where the coastline crosses the graticule. Locate this on the projection, making sure that the area is the correct latitude and longitude, and that the continent is oriented in the correct direction. It will be easier if one section is done at a time. After locating the coastline crossing the graticule, fill in the section from the atlas, to the next graticule line. It may be necessary to subdivide the 10° division to get a more accurate coastline shape. This may be done by eye or by measuring.

9. Treat all the continents in a similar manner. Place on any prominent physical features.

10. To complete the map, provide on it,

    a) a margin.

    b) an indication of direction.

    c) the names of the continents.

    d) the name of the projection.

    e) the size of the globe.

    f) the name of the cartographer.

Stereographic Azimuthal Projection - Polar Case

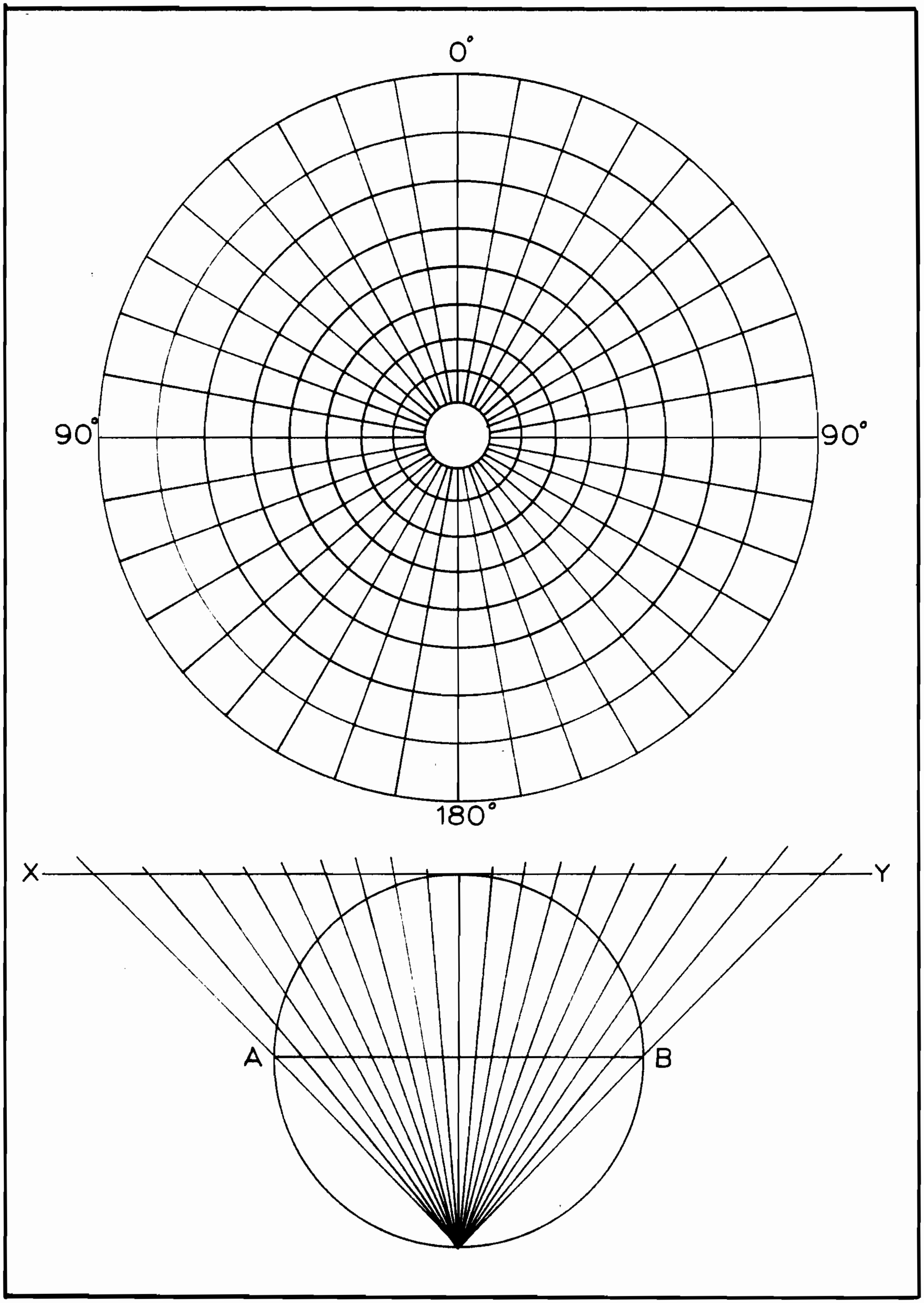


fig. 3.6.

Student Instruction Sheet for Polar Azimuthal Projection.

GNOMIC

1. Set the compasses to the radius of the globe and draw a circle to represent it, fig. 3.7.
2. Draw a line to represent the equator (A B).
3. With a protractor, divide the globe's northern hemisphere into 10^{o} divisions, starting from 0^{o} at the equator. (This is necessary on one hemisphere only).
4. Draw a line tangential to the globe at the pole and parallel to the equator A B. This is the line X Y on the drawing.
5. On to the line X Y, project the 10^{o} latitude divisions from the centre of the globe. (Imagine a light shining from the centre of the globe. The shadows of the circles of latitude will fall on to X Y). The equator may not be drawn, as the projected line from the centre of the globe through the 0^{o} on the circumference, is parallel to X Y. The 10^{o} and 20^{o} lines of latitude will be so distorted that they are not drawn.
6. The line X Y is now divided up and gives the radii for drawing the circles of latitude on the projection. Set the compasses to the radius from the pole to the 30^{o} latitude. (This will be the largest circle if the 10^{o} and 20^{o} circles of latitude are to be left out). With a suitable centre, scribe the circle of 30^{o} latitude. Draw the other circles of latitude using the same centre

and radii from X Y. With a protractor, divide the circle of 30° latitude up into 10° divisions, (or any other suitable divisions). Number the Prime meridian (0°), and the 180° meridian. Number the other divisions east and west of the Prime meridian.

7. Join up the opposite divisions along the 30° circle of latitude.
   e.g. 0° to 180°; 10°W to 170°E and so on.
   When finishing off a polar projection, it is normal to leave out the part of the meridians poleward of the smallest circle of latitude.

8. The lines of latitude and longitude are known as the graticule. The graticule is now ready for the plotting of the continents. Obtain a good atlas containing polar projections. Work on one continent at a time. Study the map in the atlas, and note where the coastline crosses the graticule. Locate this on the projection, making sure that the area is the correct latitude and longitude, and that the continent is oriented in the correct direction. It will be easier if one section is done at a time. After locating the coastline crossing the graticule, fill in the section from the atlas, to the next graticule line. It may be necessary to subdivide the 10° division to get a more accurate coastline shape. This may be done by eye or by measuring.

9. Treat all the continents in a similar manner. Place on

any prominent physical features.

10. To complete the map, provide on it,

    a) a margin.

    b) an indication of direction.

    c) the names of the continents.

    d) the name of the projection.

    e) the size of the globe.

    f) the name of the cartographer.

Gnomic Azimuthal Projection - Polar Case

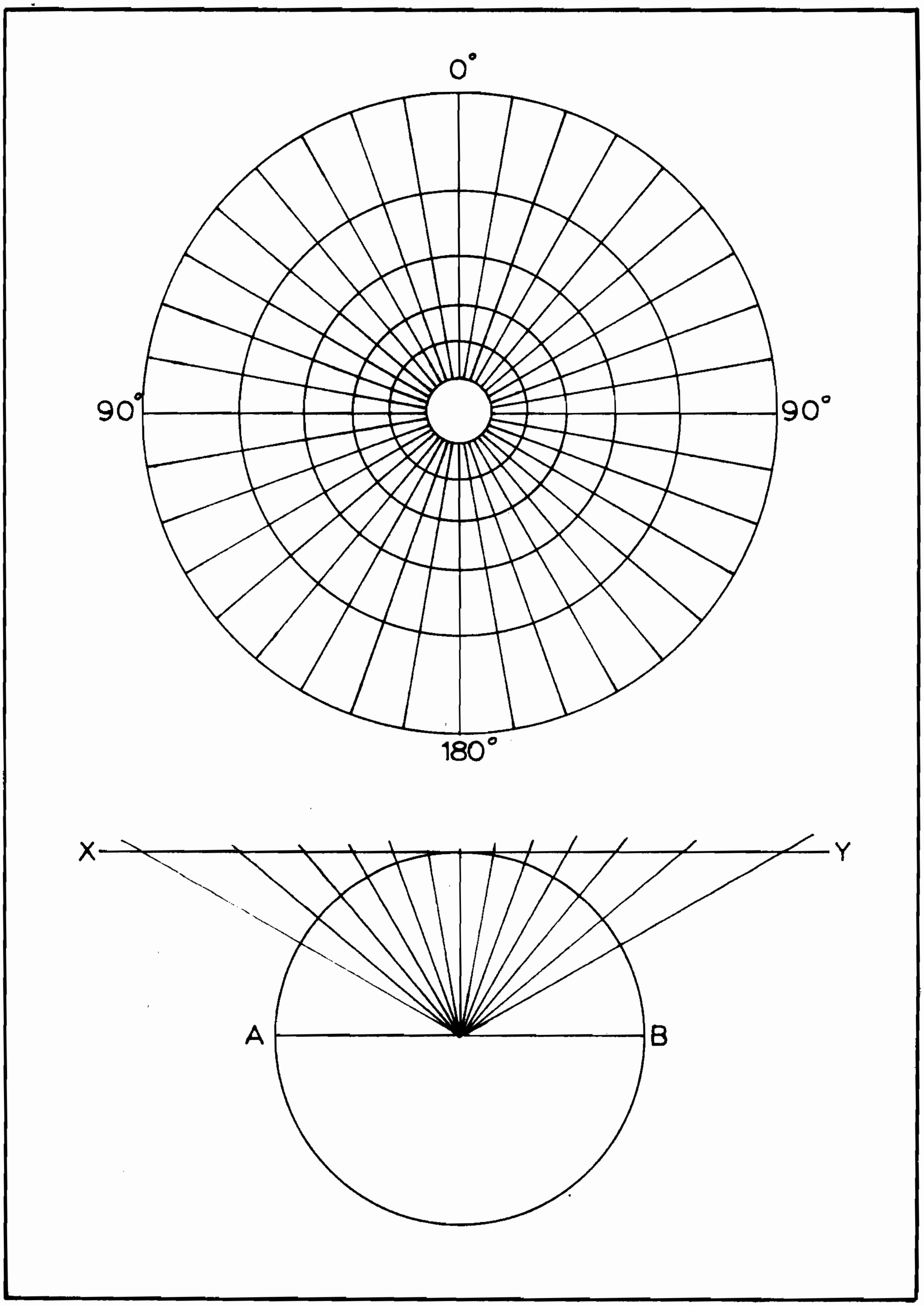


fig. 3.7.

Student Instruction Sheet for Polar Azimuthal Projections.

EQUIDISTANT

1. Set the compasses to the radius of the globe and draw a circle to represent it, fig. 3.8.
2. Draw a line to represent the equator (A B).
3. With a protractor, divide the globe's northern hemisphere into 10^{o} divisions, starting from 0^{o} at the equator. (This is necessary on one hemisphere only).
4. Draw a line tangential to the globe at the pole and parallel to the equator A B. This is the line X Y on the drawing.
5. Set the compasses to the distance between the pole and the first 10^{o} latitudinal division along the circumference. This distance is stepped off 9 times either side of the pole along X Y. There should be 18 equal divisions on X Y.
6. The line X Y is now divided up and gives the radii for drawing the circles of latitude on the projection. Set the compasses to the radius from the pole to the equator. With a suitable centre scribe the equator circle. Draw the other circles of latitude using the same centre and radii from X Y. With a protractor, divide the circle up into 10^{o} divisions, (or any other suitable division). Number the Prime meridian (0^{o}), and the 180^{o} meridian. Number the other divisions east and west of the Prime meridian.

7. Join up the opposite divisions along the equator. e.g. 0^{o} to 180^{o}; 10^{o}W to 170^{o}E and so on. When finishing off a polar projection, it is normal to leave out the part of the meridians poleward of the smallest circle of latitude.
8. The lines of latitude and longitude are known as the graticule. The graticule is now ready for the plotting of the continents. Obtain a good atlas containing polar projections. Work on one continent at a time. Study the map in the atlas and note where the coastline crosses the graticule. Locate this on the projection, making sure that the area is the correct latitude and longitude, and that the continent is oriented in the correct direction. It will be easier if one section is done at a time. After locating the coastline crossing the graticule, fill in the section from the atlas, to the next graticule line. It may be necessary to subdivide the 10^{o} division to get a more accurate coastline shape. This may be done by eye or by measuring.
9. Treat all the continents in a similar manner. Place on any prominent physical features.
10. To complete the map, provide on it,
    a) a margin.
    b) an indication of direction.
    c) the names of the continents.
    d) the name of the projection.

e) the size of the globe.

f) the name of the cartographer.

Equidistant Azimuthal Projection - Polar Case

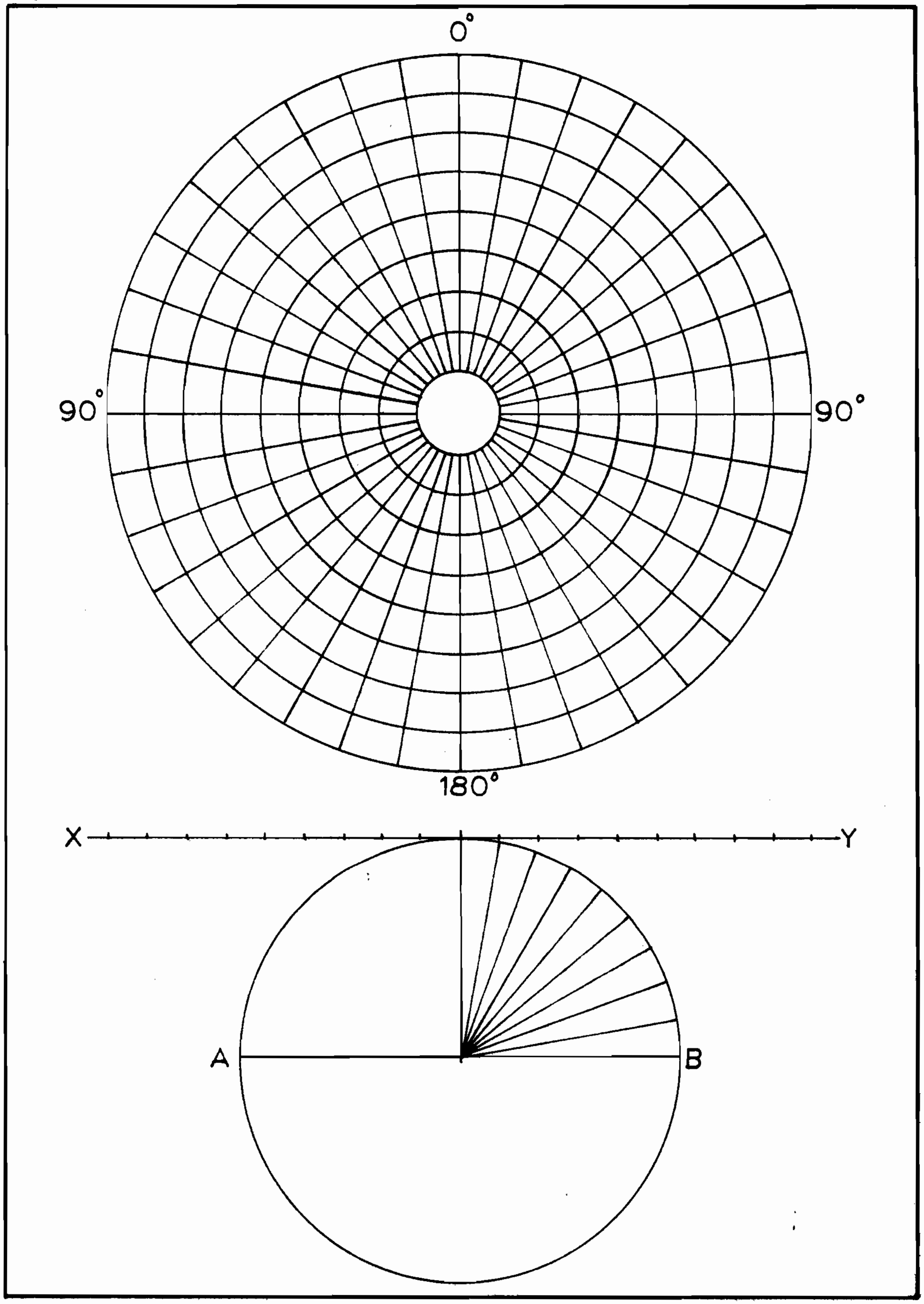


fig. 3.8.

Student Instruction Sheet for Polar Azimuthal Projections.

EQUAL AREA

1. Set the compasses to the radius of the globe and draw a circle to represent it, fig. 3.9.
2. Draw a line to represent the equator (A B).
3. With a protractor, divide the globe's northern hemisphere into 10^{o} divisions, starting from 0^{o} at the equator. (This is necessary on one hemisphere only).
4. Draw a line tangential to the globe at the pole and parallel to the equator A B. This is the line X Y on the drawing.
5. In this projection, the radii for the circles of latitude, are obtained by placing the point of the compasses at the pole, and then setting them to each 10^{o} division in turn and rebating them on to X Y. (See the dashed lines in the drawing, fig. 3.9.).
6. The line X Y is now divided up and gives the radii for drawing the circles of latitude on the projection. Set the compasses to the radius from the pole to the equator. With a suitable centre scribe the equator circle. Draw the other circles of latitude using the same centre and the radii from X Y. With a protractor, divide the equator circle up into 10^{o} divisions, (or any other suitable division). Number the Prime meridian (0^{o}), and 180^{o} meridian. Number the other divisions east and west of the Prime meridian.

7. Join up the opposite divisions along the equator. e.g. 0° to 180°; 10°W to 170°E and so on. When finishing off a polar projection, it is normal to leave out the part of the meridians poleward of the smallest circle of latitude.

8. The lines of latitude and longitude are known as the graticule. The graticule is now ready for the plotting of the continents. Obtain a good atlas containing polar projections. Work on one continent at a time. Study the map in the atlas, and note where the coastline crosses the graticule. Locate this on the projection, making sure that the area is the correct latitude and longitude, and that the continent is oriented in the correct direction. It will be easier if one section is done at a time. After locating the coastline crossing the graticule, fill in the section from the atlas, to the next graticule line. It may be necessary to subdivide the 10° division to get a more accurate coastline shape. This may be done by eye or by measuring.

9. Treat all continents in a similar manner. Place on any prominent physical features.

10. To complete the map, provide on it,

    a) a margin.

    b) an indication of direction.

    c) the names of the continents.

    d) the name of the projection.

e) the size of the globe.

f) the name of the cartographer.

Equal Area Azimuthal Projection - Polar Case

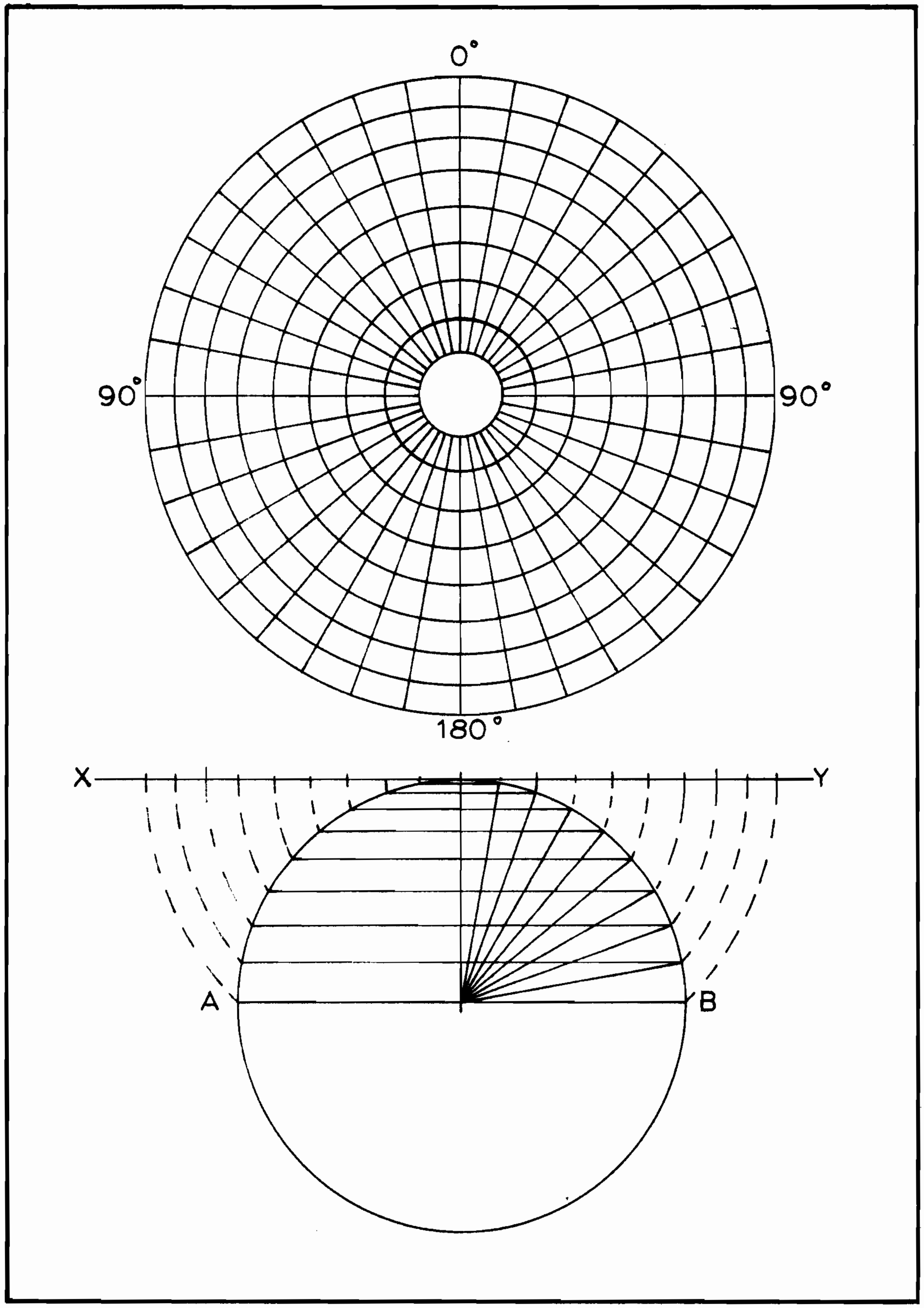


fig. 3.9.

Student Instruction Sheet for Mollweide Projection.

Fig. 3.10 shows the completed graticule. The sequence of construction is shown in fig. 3.11. This should be referred to constantly when reading the instructions. It is a good idea to read through the instructions completely before putting pencil to paper.

1. Draw the vertical line A B as the central meridian. This should be 2.8284 times the radius of the globe.

   e.g. With a globe of 4" diameter,

   radius = r = 2"

   ∴ central meridian = 2 x 2.8284 = 5.6568

2. Bisect the line A B with the line X Y which will represent the equator.

3. With the point of the compasses at the intersection C, set the compasses to the distance A C and scribe a circle.

4. With the compasses set at the same distance, layoff from where the circle cuts X Y, along the line X Y. The line X Y is now twice the length of the central meridian.

5. To obtain the spacing of the parallels of latitude along A B, refer to the table below.

   Distance to the equator from the pole is 1 (one).

Latitude	Distance of the parallels from the equator
0	0.000
10	0.137
20	0.272

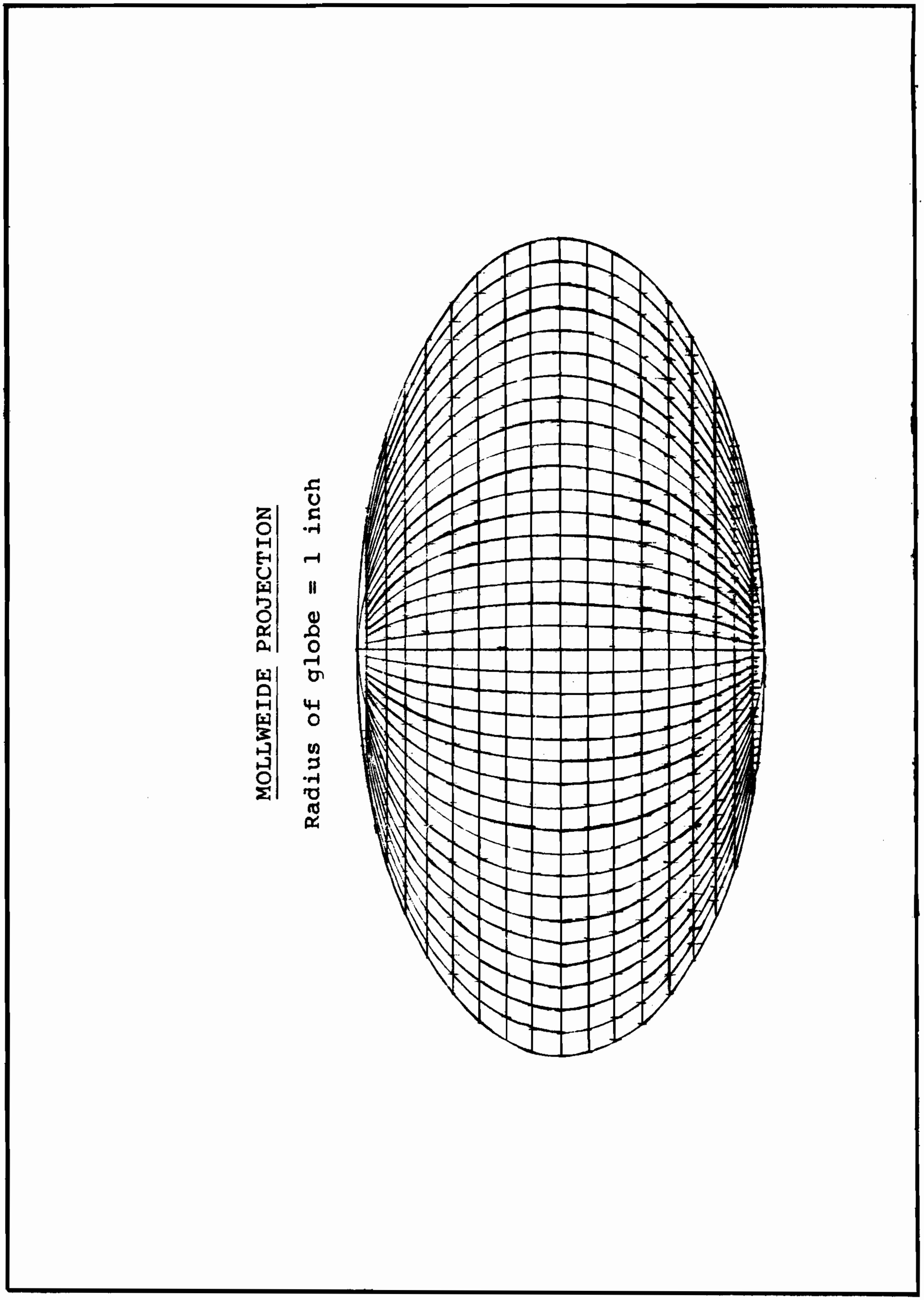


fig. 3.10.

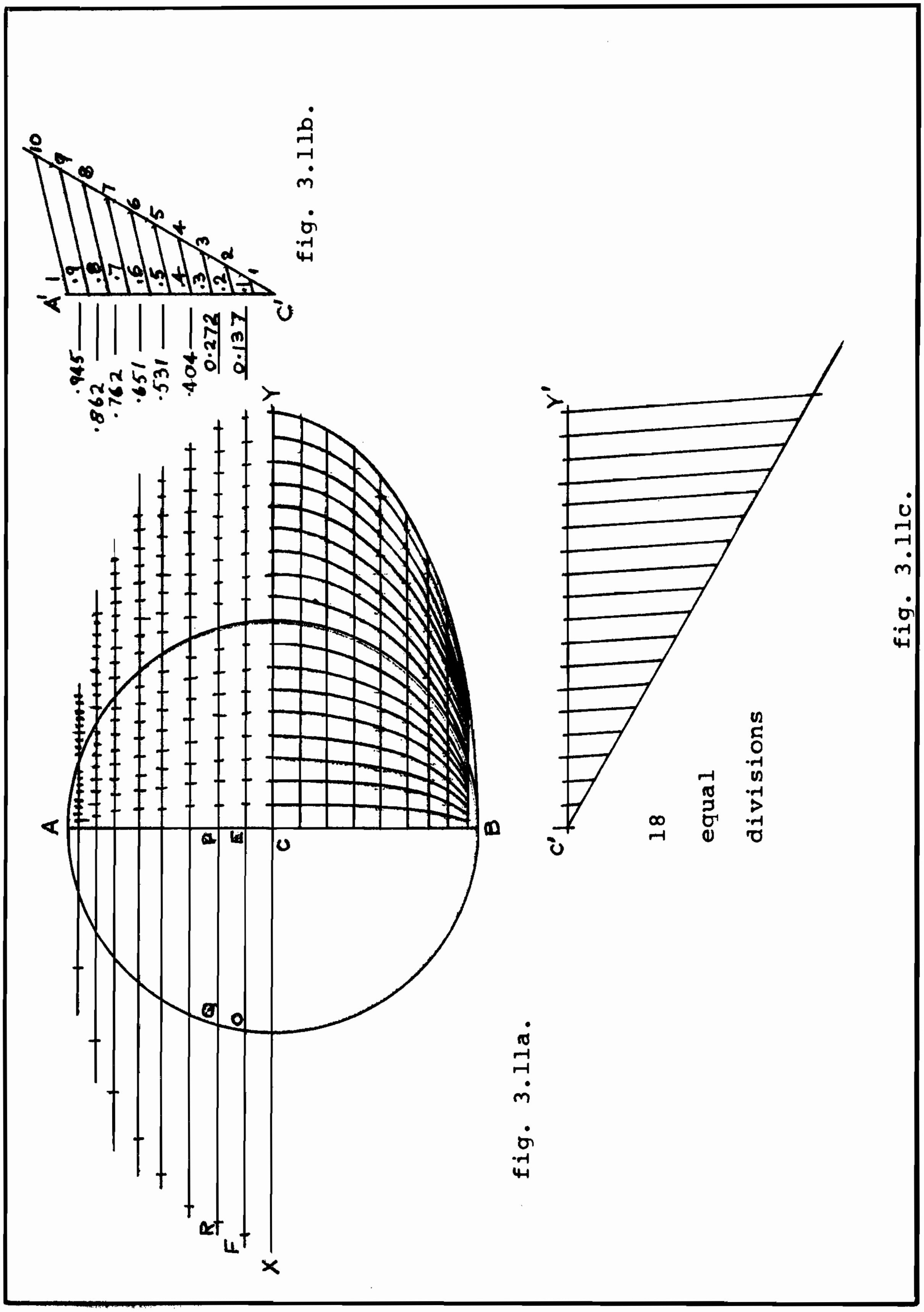


fig. 3.11a.
fig. 3.11b.
fig. 3.11c.
18
equal
divisions
A
B
C
P
E
Q
O
R
F
X
Y
A'
C'
Y'
.945
.862
.762
.651
.531
.404
0.272
0.137

fig. 3.11.

Latitude	Distance of the parallels from the equator
30	0.404
40	0.531
50	0.651
60	0.762
70	0.862
80	0.945
90	1.000

The spacing may be found quite simply by construction, (fig. 3.11b).

a) Draw a line to represent A C (A' C').

b) From C' draw a line at 60° and layoff 10 equal divisions.

c) Join 10 up with A'. Then draw lines parallel to A' 10 from 9, 8, 7, 6, 5, 4, 3, 2 and 1. The line A' C' is now divided up into 10 equal divisions.

d) Now use the line A' C' as a scale to obtain the distances, from the equator, of the parallels of latitude. The 10° latitude is 0.137, (from the table) from the equator. Find this distance up the scale.
The 20° latitude is 0.272. This also is found on the scale. Do the same for all the parallels as shown in fig. 3.11b.

e) Use the spacings found on A' C' in the southern hemisphere also by stepping them off with the compasses.

6. Draw in the parallels of latitude.

7. The parallels are extended outside the circle, the same distance, as they are from the central meridian to the circle.

e.g. E O = O F

P Q = Q R

8. The parallels are now divided up into 36 equal parts for the meridians, which will be 10^{o} apart. Each line may be divided up in a similar manner to that used to divide up A' C'.

9. The equatorial line C' Y' is shown in fig. 3.11c as an example. This is divided up into 18 equal divisions. Do a similar construction for all the lines of latitude.

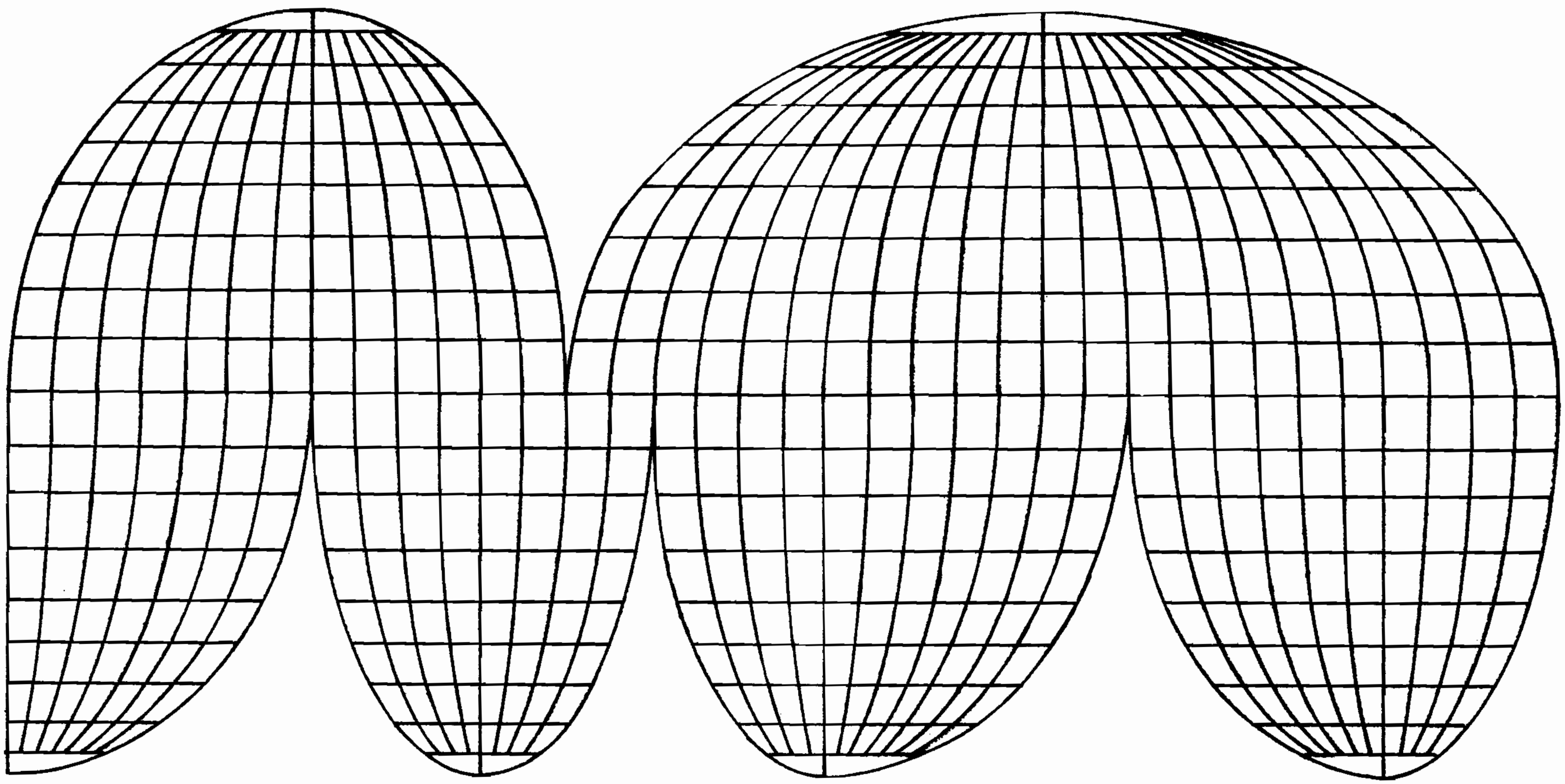
10. When all the parallels are divided up into 36, join up the meridian points with irregular curves. The graticule is now ready for the plotting of the continents.

Student Instruction Sheet for an Interrupted Mollweide Projection for Continental Masses

Fig. 3.12 shows the completed graticule. The sequence of construction is similar to that of the uninterrupted Mollweide. There are some changes, however. A sequence of construction is given below. Refer to fig. 3.11 for the construction details.

The perpendicular meridians are 2.8284 times the radius of a given globe. The length of the equator is twice the length of the perpendicular meridian.

1. Construct a horizontal line as the equator. Layoff on this line, twice the length of the perpendicular meridians.
2. Divide this up evenly into 36 equal parts, (for meridians 10° apart).
3. Number the meridians after deciding where the join is to be. In fig. 3.12 the join is on the 170° meridian west. No major land mass will be cut.
4. Now select the meridians which will be perpendicular in the northern and southern hemispheres. These decisions will be determined by the intended use of the map. If land data is to be plotted the oceans will be interrupted. If the oceans are to be featured, then the interruptions will be over land masses. A great deal of thought must be put into this. Construct the perpendicular meridians north and south of the equator line half as long as the



INTERRUPTED MOLLWEIDE PROJECTION FOR CONTINENTAL MASSES

Radius of the globe = 1.5 inches

fig. 3.12

computed central perpendicular meridian. Note also where the interruptions will be. Refer to fig. 3.12. The following interruptions and perpendicular meridians were used for this drawing.

Perpendicular meridian	170°W to the south
Perpendicular meridian	100°W to the north
Interruption	100°W to the south
Perpendicular meridian	60°W to the south
Interruption	40°W to the north
Interruption	20°W to the south
Perpendicular meridian	20°E to the south
Perpendicular meridian	70°E to the north
Interruption	90°E to the south
Perpendicular meridian	150°E to the south

5. At one of the perpendicular meridians, (70°E), scribe a semi-circle. This not only gives the meridians in the northern hemisphere 20°W and 160°E, but is also required to obtain the lengths of the parallels in one hemisphere.
6. Space out the parallels along the perpendicular meridians according to the table below. (See fig. 3.11b for construction details).

Latitude	Distance of the parallels from the equator
0	0.000
10	0.137
20	0.272
30	0.404

Latitude	Distance of the parallels from the equator
40	0.531
50	0.651
60	0.762
70	0.862
80	0.945
90	1.000

7. From the perpendicular meridian, measure off the length of each parallel within the semi-circle, (drawn in 5 above). Divide each of these distances into 9 equal divisions, (for 10° divisions). Use the divisions found to step off along the parallels from each perpendicular meridian, the required number of spaces.

   e.g. in fig. 3.12 from the perpendicular meridian 20°E in the southern hemisphere, step off 7 spaces east and 4 spaces west.

   Join up the points of the meridians with irregular curves.
8. The graticule is now ready for the plotting of the continents.

CHAPTER 3

Base Map

Design

The cartographer must always assume that the reader is quite unfamiliar with the area. This means therefore that a great deal of relevant material must be displayed on the map in such a way that it remains in the background. The featured area should always be as large as the paper will allow. A margin should be drawn and the space within it filled with relevant material. The legend boxes may be placed in the spaces not occupied by the featured area (figs. 4.1 and 4.2). The orientation of the area may be changed so that the space available is effectively used. It is normal practice to put north to the top of the page but there is no logical reason for this. There are areas that offer great problems. A country such as Chile for instance will not occupy a full page. The remaining space could be used for the text. Another typical problem area is a string of islands. The use of insets may be advisable in which the most important islands are drawn at a larger scale.

Sources of a base map

A good atlas or a topographic map are the best sources of a base map. It is a rare occasion that the source map chosen will fit into the limits of the size of paper. There are two simple methods of reducing or enlarging the source map to the size required. For both methods it is

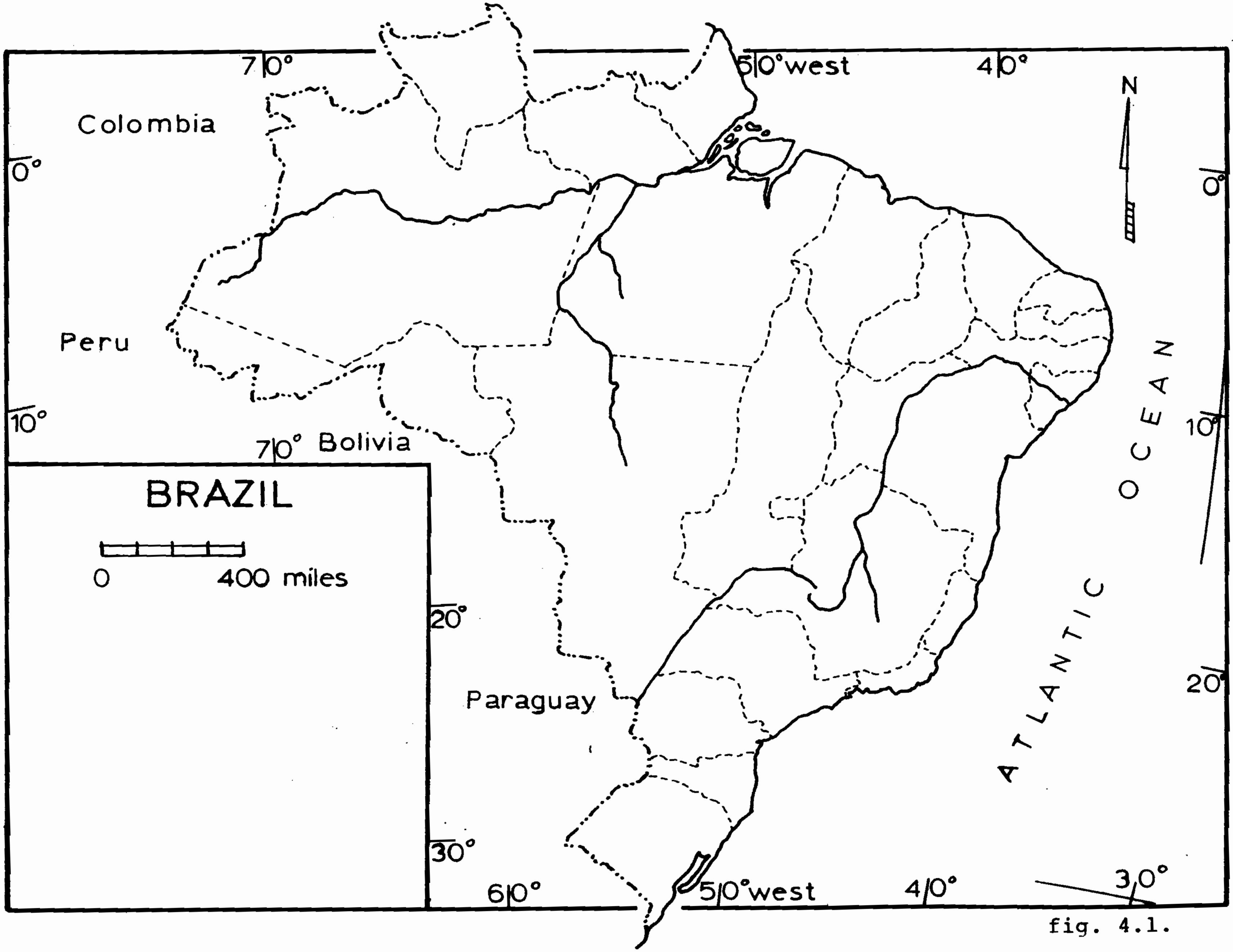

BRAZIL
0 400 miles
Colombia
Peru
Bolivia
Paraguay
ATLANTIC OCEAN
N
70°
50°west
40°
0°
10°
20°
30°
60°

fig. 4.1.

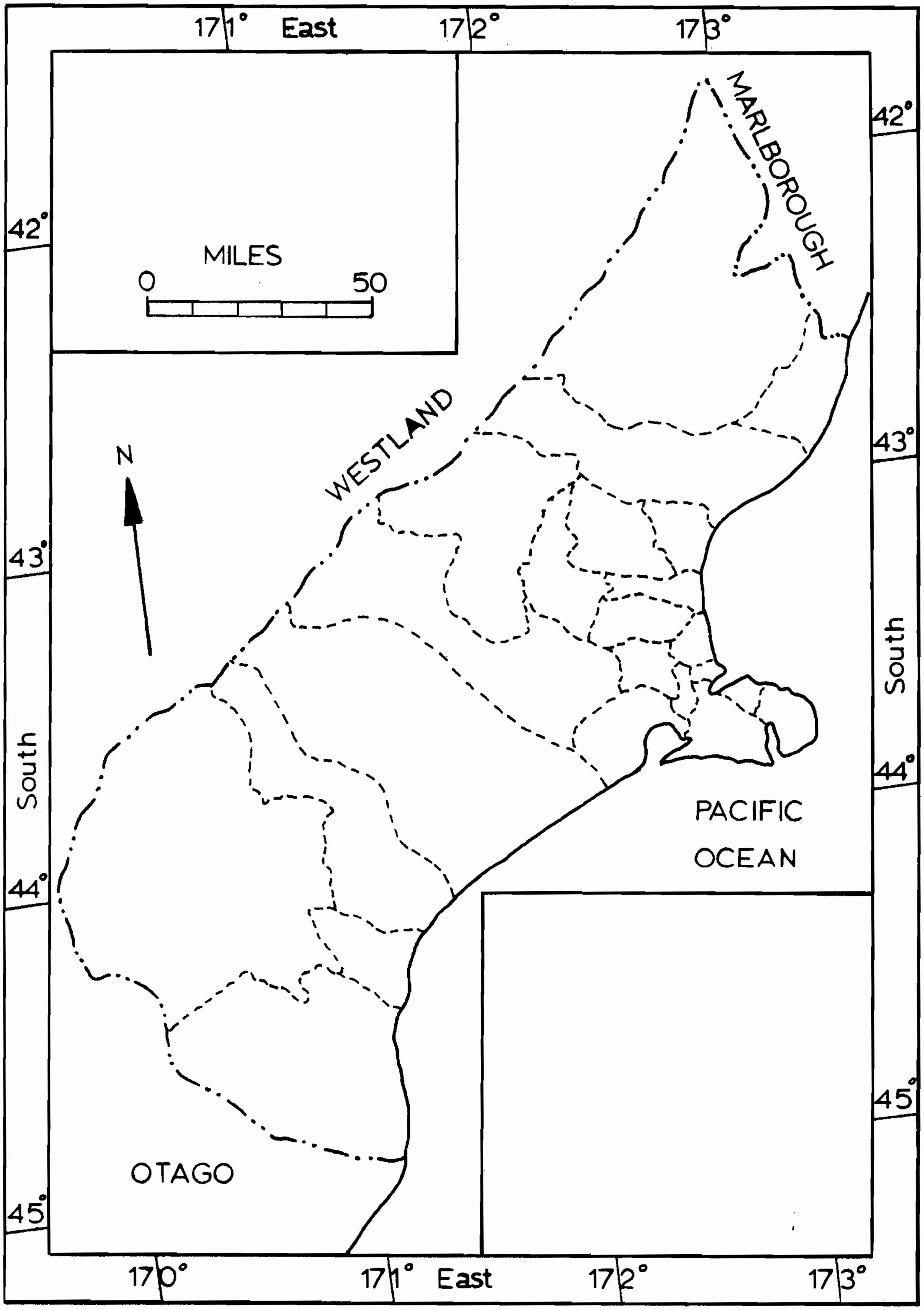

171° East
172°
173°
42°
43°
44°
45°
South
MILES
0
50
N
WESTLAND
MARLBOROUGH
PACIFIC
OCEAN
OTAGO
170°

fig. 4.2.

advisable to make a tracing first of the source map. Include all the details necessary to complete the map.

Proportional square method

A grid of squares or rectangles is super-imposed on to the source map tracing. The outside rectangle has the same proportions as the margin on the base map. The base map paper is now divided up into the same number of squares or rectangles as the source map. The sides of the squares or rectangles are proportional but they can be smaller or larger.

It may be easier if the lines are identified by numbers across the top and by letters down the side. Now the details in the source map squares are reproduced in the appropriate base map squares. Work faintly in pencil as it will be easier to rectify the mistakes.

Pantograph method

Parts of the pantograph (fig. 4.3.).

(A) Bracket fixed to the desk. A hole in the pantograph fits over a pin on the bracket.

For enlargements.

(B) Metal tracer point over the source map tracing.

(C) Pencil point over the blank map sheet.

For reductions.

(B) Pencil point over blank base map sheet.

(C) Metal tracer point over the source map tracing.

(D) Metal rider, stays at this point at all times, keeping the pantograph level.

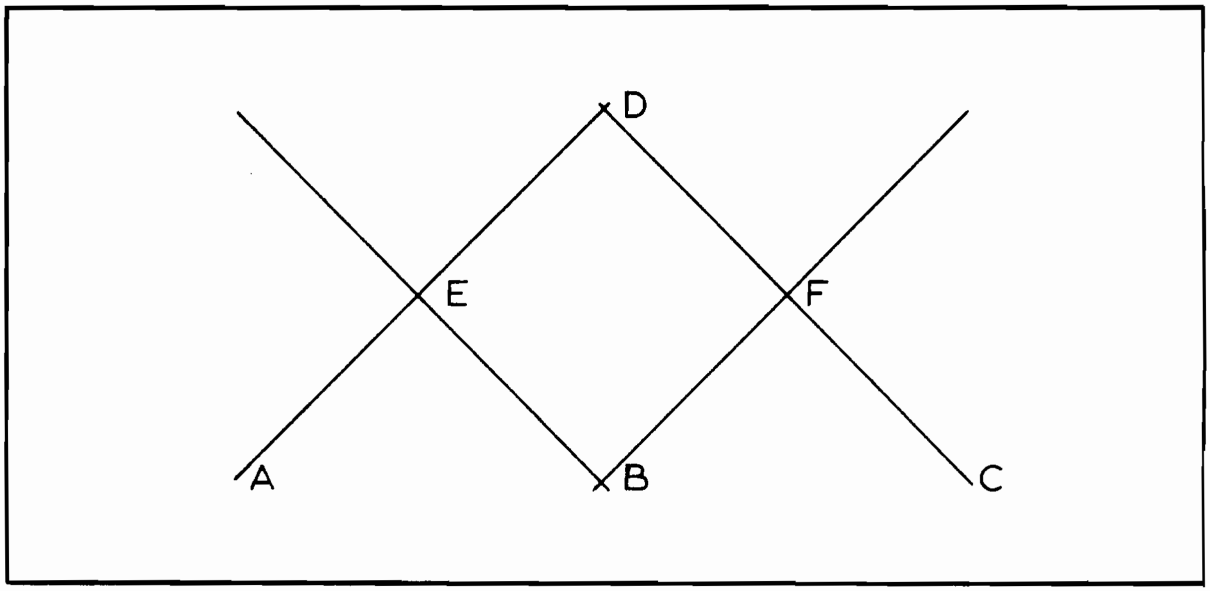


fig. 4.3.

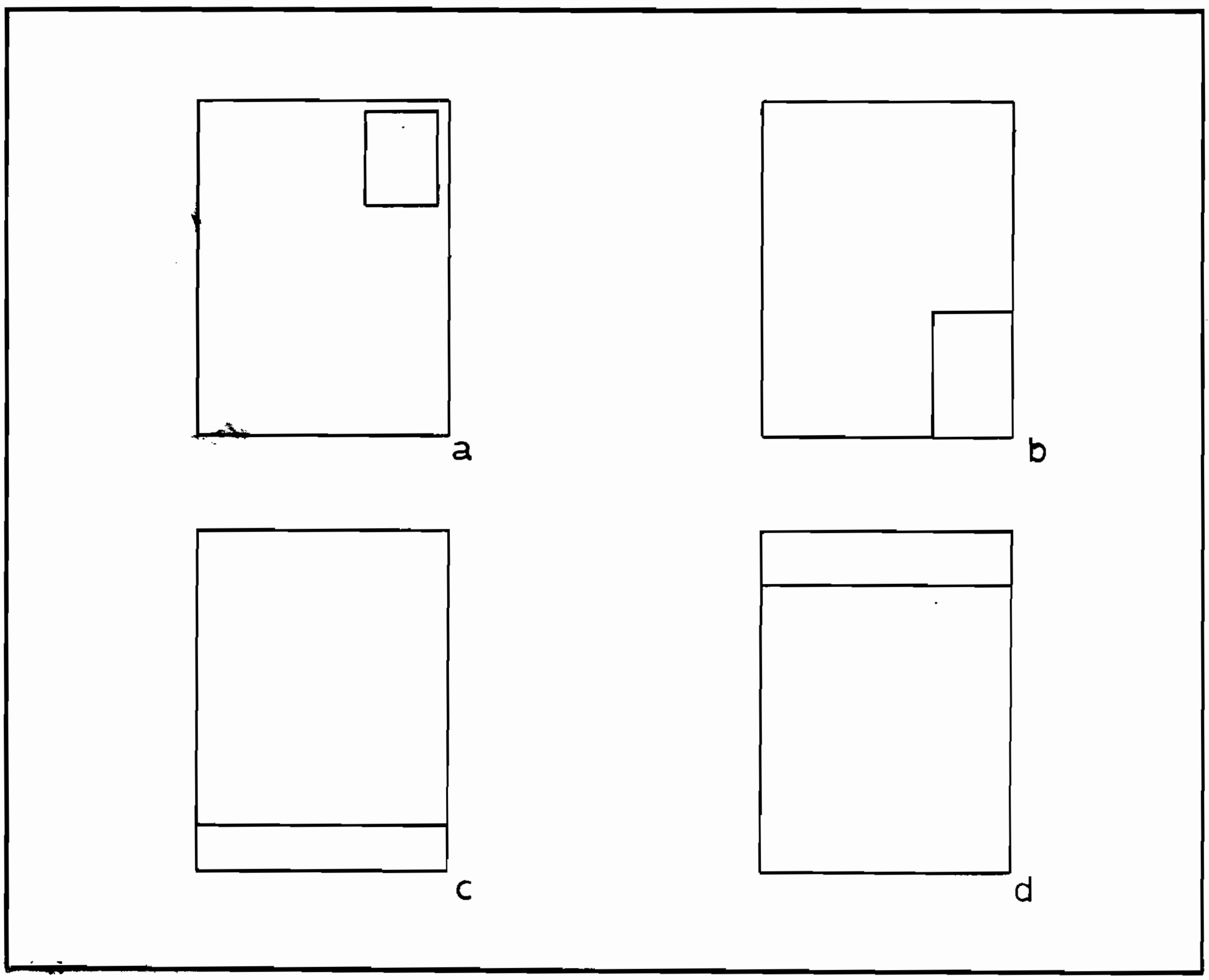


fig. 4.4.

(E) and (F) These screws are adjusted to give different degrees of reduction or enlargement. Numbers are stamped along the arms of the pantograph. The screws must always fit into the holes with a similar number or the map will be distorted.

Preparation for drawing the map.

1) Fasten the bracket to the desk top.

2) Take the source map tracing and the base map sheet with the margin drawn in pencil. Manoeuvre the two sheets around underneath the pantograph until they are in the correct position for drawing. Tape both sheets down to the desk. They may overlap. This is where the tracing comes in useful rather than trying to use the book the source map was in originally.

Requirements of a Base Map

The basic requirements are dealt with here in a very brief form. Various examples should be sought in atlases and text books to illustrate each of these requirements.

Margin (or neat line)

Every map that students produce should have a margin. Nothing should appear in the margin except for breaks as in fig. 4.1. Some areas have projections which may break into the margin to allow the area to be drawn at a larger scale.

The margin line may be one line as in fig. 4.1. or it can be quite elaborate. In fig. 4.2., because there was ample space, the margin line was enlarged and the latitude and longitude lettered between two neat lines. The margin line should not stand out but be functional.

Orientation

As was explained earlier it has become common practice to put north to the top of the paper. This may not be possible and in some cases undesirable. To orientate the map an arrow should be located in a suitable space and the points of the compass shown. The arrow can be drawn in many ways but the style should not be too ornate.

Location

Some indication should be made of the latitude and longitude. The lines of latitude and longitude may be drawn but to avoid clutter should not pass through the land masses. If the lines are straight they should be drawn with a straight edge. Curved lines should be drawn with a suitable irregular curve. If the solid lines are undesirable small ticks may be made on the inside of the margin line as in fig. 4.1.

Boundaries

All state, provincial, county, and municipal boundaries should be shown with a different symbol. If it is not obvious to which political boundary the symbol relates, a full description should appear in the legend. On some base maps the political boundaries are not required.

Surrounding Areas

To clarify the location of the map the surrounding areas should be labelled. In fig. 4.1, several countries around Brazil are not named because of insufficient space. All the provincial districts around Canterbury are labelled in fig. 4.2 because there is adequate space.

Title

Every map is to have a title block. The size of the lettering and the make up of the title differs with the use of the map.

Example (1) If only one area is being described in a set of maps the name of the area may be very small or left off entirely. If the study is on Brazil, and every map is the same, it is not necessary to name Brazil in the title. The name Brazil will appear in the title of the study.

Example (2) If several countries are being compared on separate maps, the name of the country will be small. The main title will state the type of data being shown.

Example (3) When only one map is being produced to show data at a given area the name of that area should be prominent in the title.

Legend

The legend occupies the empty spaces in the map. Figs. 4.1 and 4.2 show two examples of placing the legend boxes. The aim in placing the boxes is to create equilibrium and stability. They should not dominate the attention of the reader. In fig. 4.4, page 46, four locations are shown. The example shown at d is to be avoided as it is top heavy. The legend box must be large enough to contain all the relevant material that is required to read the map.

Scale

All maps should show the scale to which they were drawn. This assists the reader in assessing distances and appreciating the size of the area. The three methods of showing scale on a map are verbal, representative fraction, and linear.

Verbal. The verbal method just makes a statement such as one inch equals one mile. If the source map only gives this type of scale it will be difficult to compute the enlarged or reduced scale of a base map. This type of scale on a souree map is to be avoided.

Representative fraction. This is a simple fraction or ratio and may be written for example as 1:50,000. This means 1 unit of measurement on the map equals 50,000 measurements of the unit on the actual ground. The units may be any value. This method of indicating scale is international as no particular unit of measurement is stated. A useful conversion table is given on the next page.

Conversion Table for Representative Fraction

R.F.	One inch represents	One cm represents	One mile is represented by	One km is represented by
1: 10,000	0.158 miles	0.1 km	6.34 ins.	10.0 cm
1: 25,000	0.395 miles	0.25 km	2.53 ins.	4.0 cm
1: 50,000	0.789 miles	0.5 km	1.27 ins.	2.0 cm
1: 63,360	1.00 miles	0.634 km	1.00 ins.	1.58 cm
1:100,000	1.58 miles	1.0 km	0.634 ins.	1.0 cm
1:125,000	1.97 miles	1.25 km	0.507 ins.	8.0 mm
1:250,000	3.95 miles	2.50 km	0.253 ins.	4.0 mm
1:500,000	7.89 miles	5.0 km	0.127 ins.	2.0 mm

after Robinson and Sale p.37

It is possible to compute the number of inches to a mile but this is long and involved. Usually a linear scale is drawn on atlas maps so it is not necessary to work this out.

Linear. This type of scale is excellent for reductions or enlargements as the length of the scale can be taken off with the pantograph. A line is drawn and divided up as in figs. 4.1 and 4.2.

Lettering

Poor lettering and the untidy arrangement of the labelling can spoil an otherwise excellent map. Use a lettering guide if one is available. Put lined paper underneath the base map to act as guide lines for the lettering.

Try to follow these suggestions when arranging the lettering.

a) Towns. Put the names on one side of the symbol and slightly above or below it. If the town is on the east bank of the river put the name on the eastern side. When the towns are on the coast, put the names in the sea.

b) Rivers. The bottom of the letters should go towards the river. Try to locate the name along a straight stretch. Do not spread the letters out but repeat the name if the river is long.

c) Lakes and Islands. Put the entire name inside the feature. If there is not sufficient space, put it completely outside the feature.

d) Large features. Some physical features, such as mountain ranges, cover a large area on the map. Spread the letters out but not too far apart otherwise it makes the name difficult to read.

Preparations for mapping

Students should be warned in advance when given a mapping assignment in which they have to supply the statistics, that these must be obtained first. When the appropriate statistics are found only then should a base map be prepared. Work should be done in pencil and the statistics plotted before inking in the lines. All excess lines should be carefully erased. The lettering should be put on the map and then the colour shading if necessary.

Work outline; a) Gather the data.

b) Decide on the technique of representation.

c) Draw a suitable base map.

d) Plot the statistical data.

e) Ink in the lines.

CHAPTER 4

STATISTICAL MAPS AND DIAGRAMS

Teacher's Information Sheet

Introduction

Not all methods of representing statistical material are included in this chapter. The choice has been dictated by the observed skill of children, and the type of material they may have to deal with. Isopleths are not included as contour line assignments should be included in junior geography classes. Dot maps are excluded because they are tedious and difficult to draw.

Non-quantitative mapping is usually covered very adequately in general and regional geography courses with the study of topographical maps. It is left out of this chapter for this reason.

When location is not important, the statistics should be shown in a diagram without a map. If it is necessary to show location, a suitable base map should be drawn according to the outline in chapter four. The symbols are then placed on the map.

Points to consider when the location is important are,

a) the value should be easy to measure by referring to a scale.

b) the value should be easy to measure visually.

c) the symbol should be easy to draw.

d) the symbol is all important and the map is background material only.

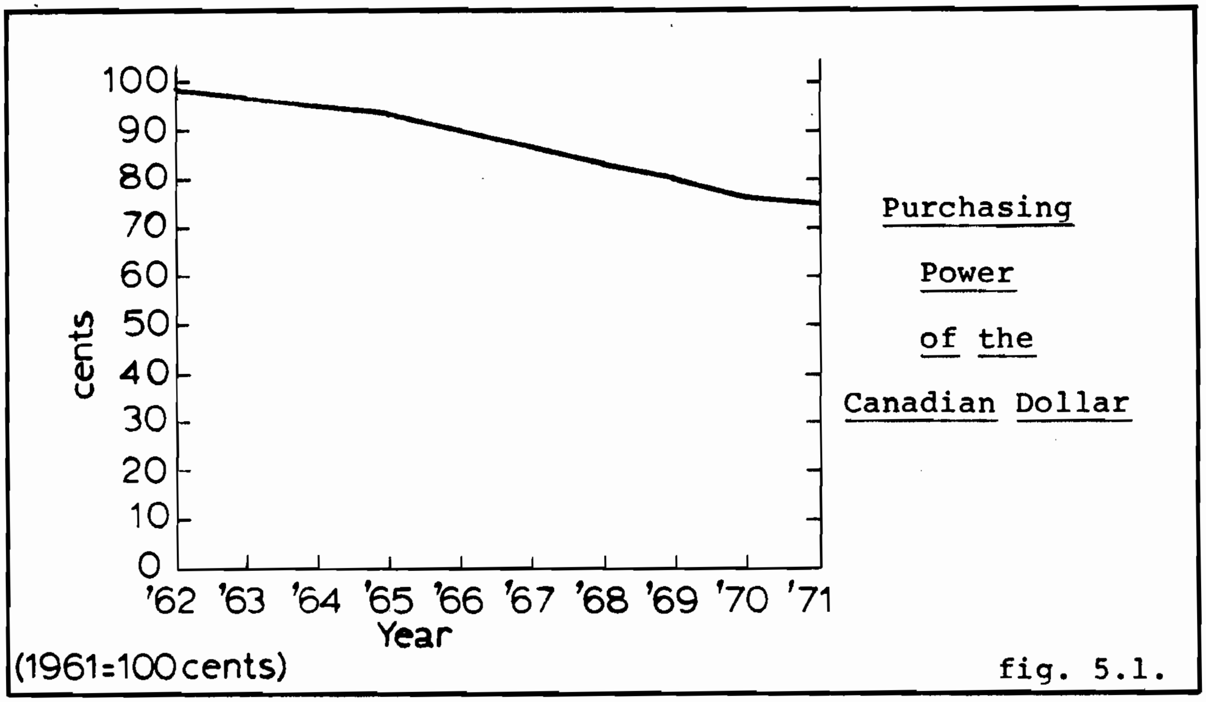


fig. 5.1.

LINE GRAPH

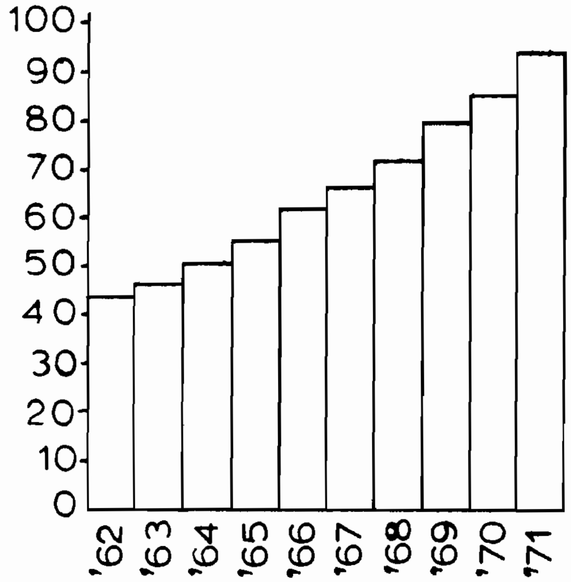
The variable change is measured along the vertical axis and the regular change along the horizontal axis (see fig. 5.1). Two or more sets of data may be placed on the same graph. The lines are drawn in different colours. A legend must be provided.

Construction

1) Draw the horizontal and vertical axes. Choose a suitable scale for the regular changing values, and lay this off along the horizontal axis. Label the divisions.

2) Choose a suitable scale for the variable changing values and lay this off along the vertical axis. Label the divisions.

3) Plot with dots the data on the graph. Join up the dots with a line.



Canada's Gross National Product in Billions of Dollars

fig. 5.2.

BAR GRAPH

Bars may be placed vertical or horizontal. They may show one set of data or several sets of data in parallel. The bars may be touching or separated by a small gap. Suitably lined graph paper may be set underneath the paper on which the map is to be drawn. The lines will show through and may be traced easily.

Construction.

1) Draw the base line for the graph.
2) Draw a line, vertical to the base line, and along it set up a scale to suit the data to be plotted.
3) Layoff along the base line the widths of the bars. These must all be equal.
4) Draw the length of the bars to scale from the data.
5) Colour the bars. If there are several sets of data provide a key.

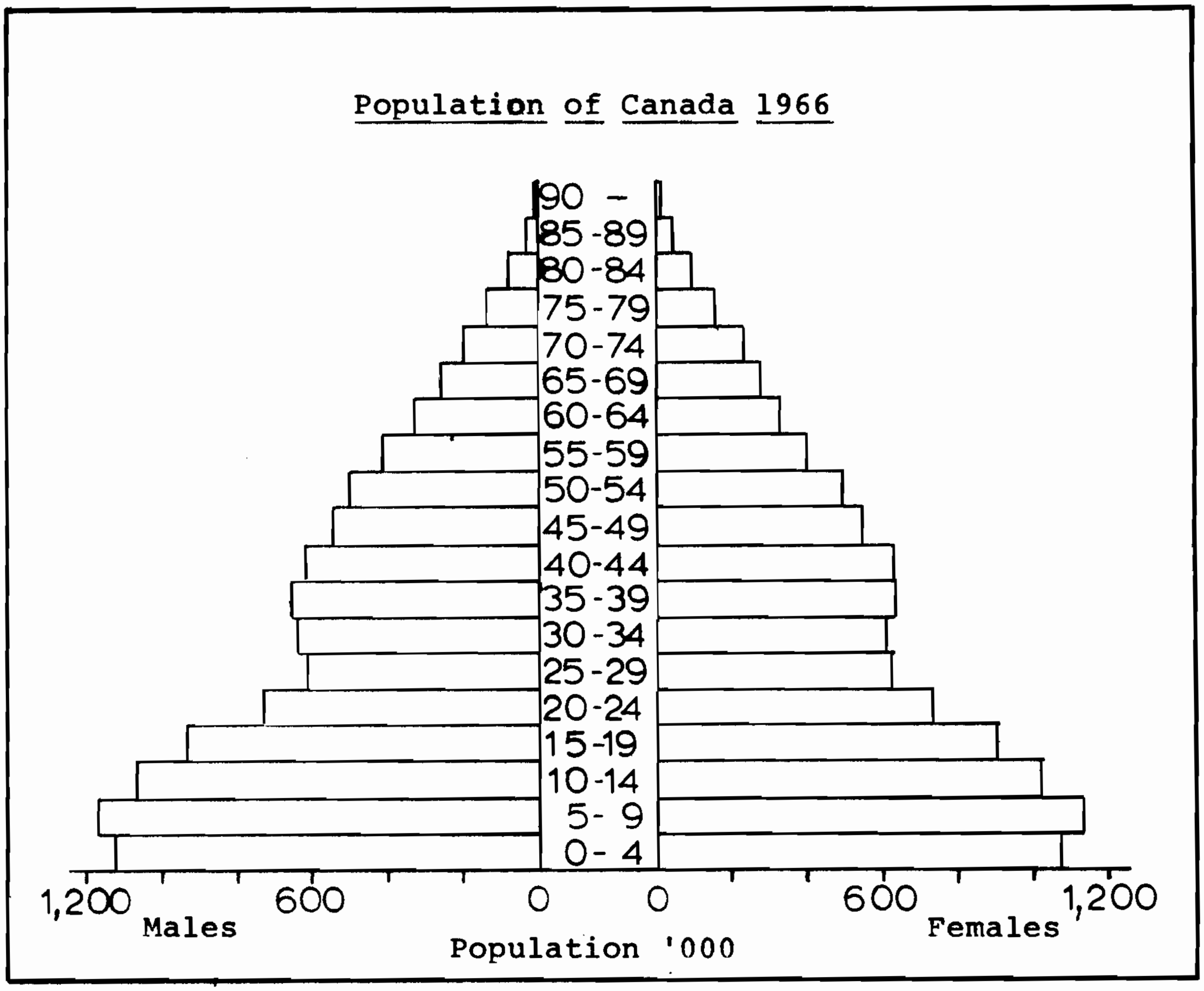


fig. 5.3.

POPULATION PYRAMID BY AGE AND SEX

Horizontal bar graphs are drawn as in fig. 5.3. The regular changing values are vertical (age groups), and the variable changing values are horizontal (number of population). Females are shown on the right hand side and males on the left hand side. There is a space in between of 1/2 inch or 1 c.m. In this space the age scale is lettered neatly. Data is obtained by age groups. The age groupings do vary with the source of the information. Check this carefully before starting the graph.

If there are to be several pyramids drawn for comparison, the percentage of the total population in each group has to be found. For example the total number of males is divided into the number of males in one group.

Suitable lined graph paper may be set under the paper on which the pyramid is to be drawn. The lines showing through can be traced as required.

Construction

1) Draw a base line for the pyramid. In the centre, draw two vertical lines 1/2 inch or 1 c.m. apart.
2) Along these vertical lines layoff equal divisions from 1/8 inch to 1/4 inch apart. Draw horizontal lines through these points.
3) Along the bottom line layoff a suitable scale for the data. Start at 0 (zero) at the two centre lines and layoff the scale to the right of the right hand line, and to the left of the left hand line. The scales should be the same.
4) Mark off the lengths of the bars using the horizontal scale.
5) Label the scale.

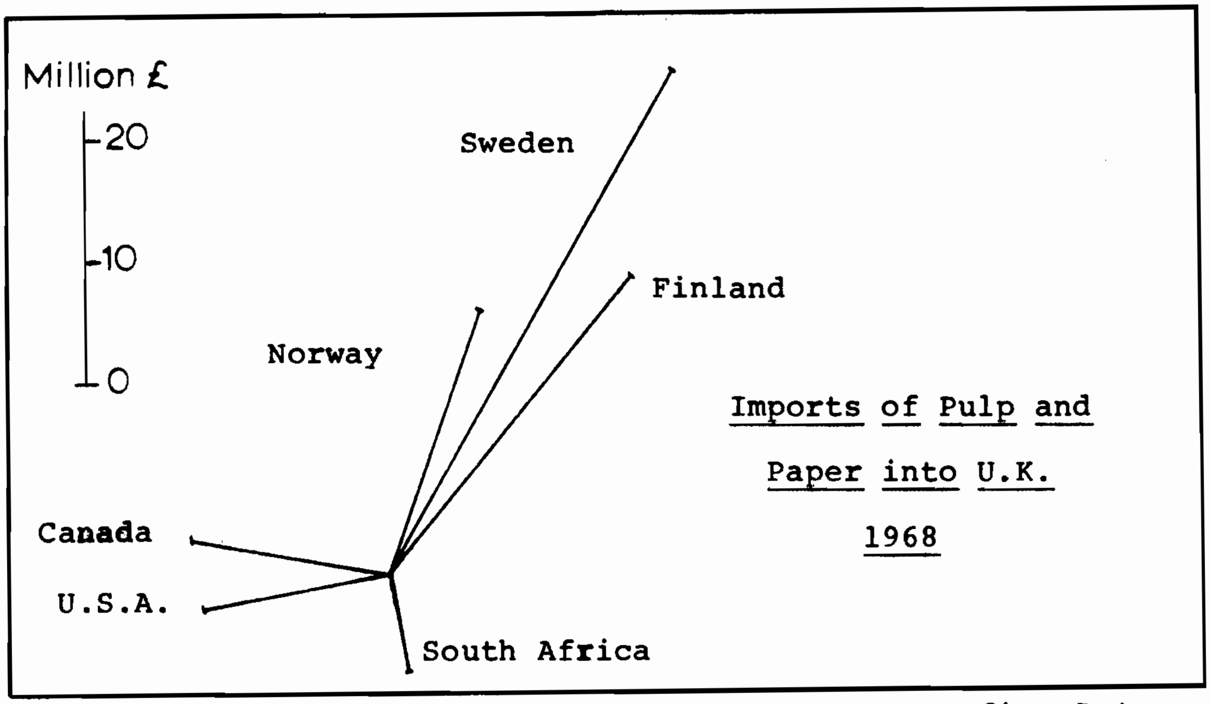


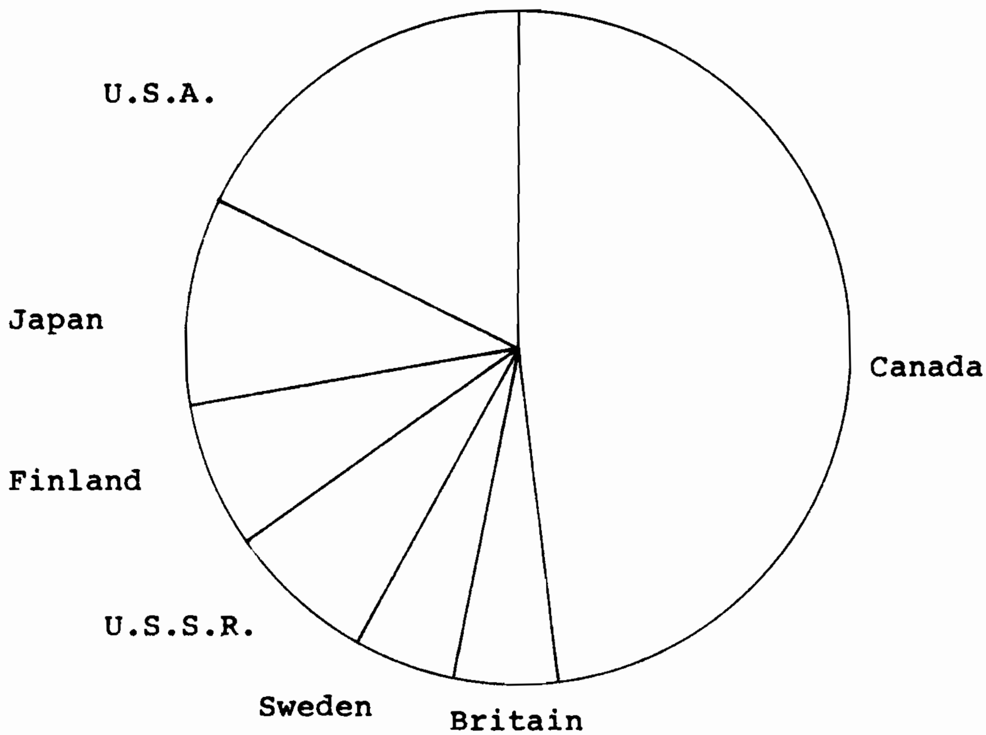
fig. 5.4.

RADIAL GRAPHS

This type of graph is used to show the wind direction at a particular location. Another use, as the example shows in fig. 5.4, is to graph goods moving into or out of a location by volume and direction (imports or exports).

Construction

1) Study the data. Decide on a scale for the values bearing in mind the size of the space the graph has to fit.
2) Locate a dot for the centre in the available space.
3) With a protractor, locate the direction of the lines (refer to an atlas).
4) Draw the radiating lines and scale off the values along them.
5) Provide a scale.



World Newsprint Production

by Leading Countries 1968.

Source; Newsprint Association of Canada.

fig. 5.5.

PIE GRAPH (DIVIDED CIRCLE)

The circle is divided up into sectors proportional to the component parts of the total amount. If one diagram only is required the circle may be of any size. If several circles are to be compared, it may be necessary to compute the diameters of the circles. The method of drawing proportional circles is shown on page 66.

An easy method of finding the size of each sector is to convert the component parts into percentages of the total amount. This is done by dividing the total amount into each component part.

e.g. In the example fig. 5.5. on page 60, the figures are as follows.

In '000 tons.

Canada	8,031
U.S.A.	2,935
Japan	1,622
Finland	1,227
U.S.S.R.	1,120
Sweden	844
Britain	811

a) Find the total amount 16,590.

b) To find the percentage of Canada's production divide Canada's production 8,031 by the total amount 16,590

c) Canada's percentage = 48%

d) This can be done for each component part. Use the percentage protractor on page 84 underneath the circle to be divided when constructing the sectors.

There are certain points to keep in mind when making pie diagrams.

1) Do not have too many sectors. Combine some components if necessary. The small sectors will be difficult to draw, and will not show clearly.

2) Keep the smaller sectors around the 6 o'clock position.

3) The larger sectors should be around the 12 o'clock position. The largest to the right of 12 o'clock.

4) If the smaller sectors are very small, they should be shaded in solid colours.

5) Should more than one circle be drawn, the components are placed in the same order around the circle.

Student Instruction Sheet

Bar Graphs

Bars are drawn with the length of the bar proportional to the value it is to represent, page 65 fig. 5.6. The bar graphs greatest disadvantage is that it can only show a limited range of values.

1) First draw a suitable base map. If the data refers to towns or cities, locate these with a small dot. If it refers to areas (county or statistical areas), the boundaries must be shown.

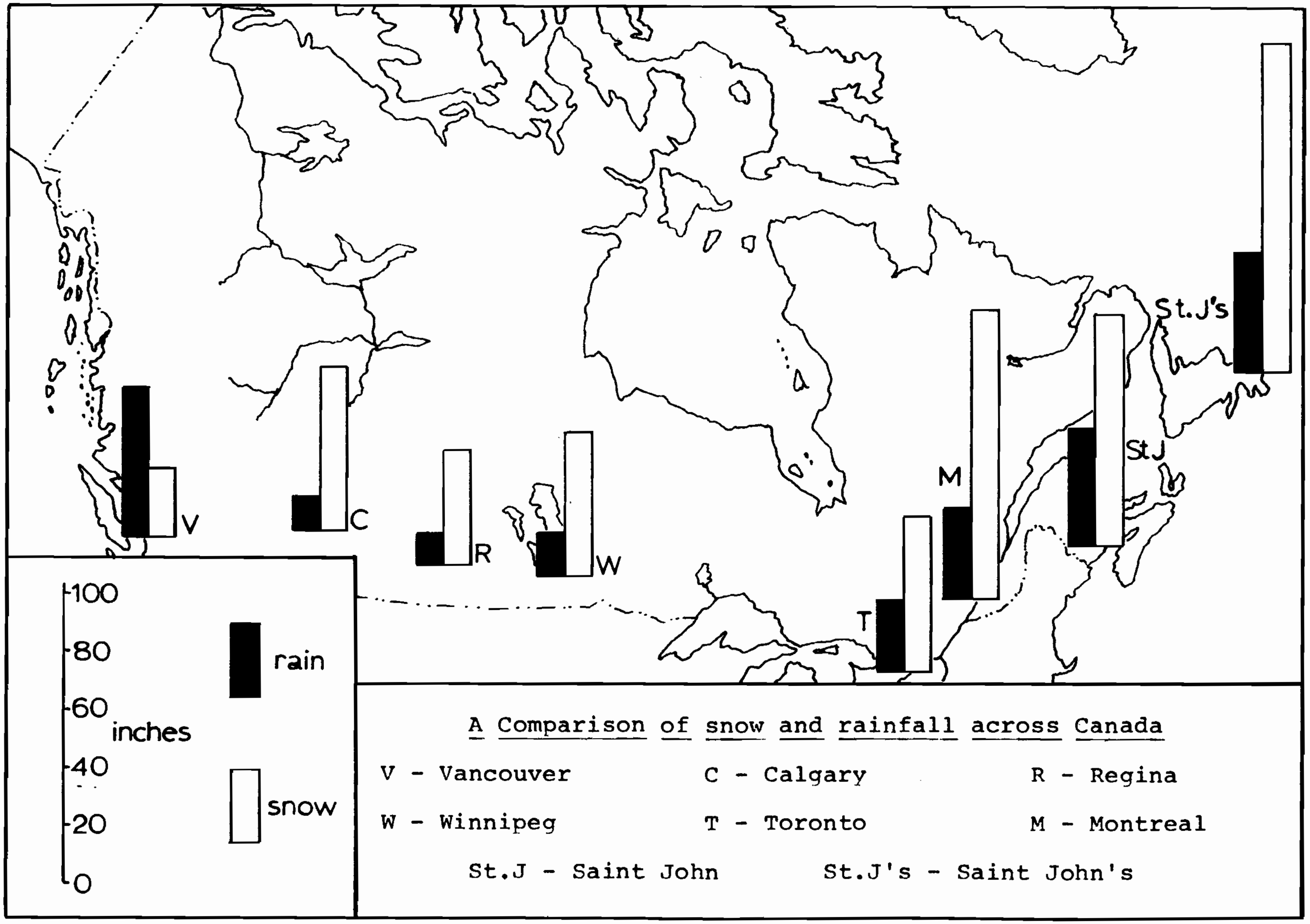
2) Study the map carefully. Crowding is a problem on this type of map. The symbols must not overlap and the base of the bar must be in the area it is related to or at the location of the town or city. Now decide on a suitable scale for the bars.

3) Draw a vertical scale inside the legend. Start with 0 at the bottom and divide the line into the scale previously decided. Make sure the scale is easily divisible.

4) Using the scale, construct bars on the map equal to the given values. Start in the crowded areas and work faintly in pencil. Remember, do not overlap and the bases of the bars must be located accurately.

5) If two or more sets of data are used make sure the bars are always in the same order. Draw the bars neatly and the same width. Colour or shading may be used for the different data.

6) Provide in the legend a full explanation of the data as well as the scale.



A Comparison of snow and rainfall across Canada

V - Vancouver C - Calgary R - Regina

W - Winnipeg T - Toronto M - Montreal

St.J - Saint John St.J's - Saint John's

fig. 5.6.

Student Instruction Sheet

Proportional Circles

With this symbol the area is proportional to the value of the data. By introducing a second dimension the symbol does not occupy so much room. This makes the locating of the symbol much easier. Unlike the bar graph a wide range of values is possible. The bar graph uses the actual value of the data, whereas the circle uses the square root of the value.

i.e. the square root of 100 is 10 (10 x 10 = 100)

5 is the square root of 25 (5 x 5 = 25)

One method of obtaining the square root of a number is by using mathematical tables. The method is not explained here but may be found on page 73.

The major disadvantage with proportional circles is that the value of the circles is not easy to estimate visually.

1) Draw a suitable base map.

2) Compute the square roots for the values in the data. Use a worksheet similar to the one on page 69.

3) Using the square roots, construct a scale from which all the diameters may be obtained for the given values. This is done in the following manner. Refer to fig. 5.7, page 67.

a) Draw the line A B in proportion to the square root of the largest value.

In the example, page 69, it would be Montreal North with a square root of 260.4. The length of the line could be 2.6 inches or 2.6 cms or any multiple of either. The longer the line the greater the accuracy

Method of constructing a scale for the proportional circles.

See the text page 66, 3(a) for the instructions.

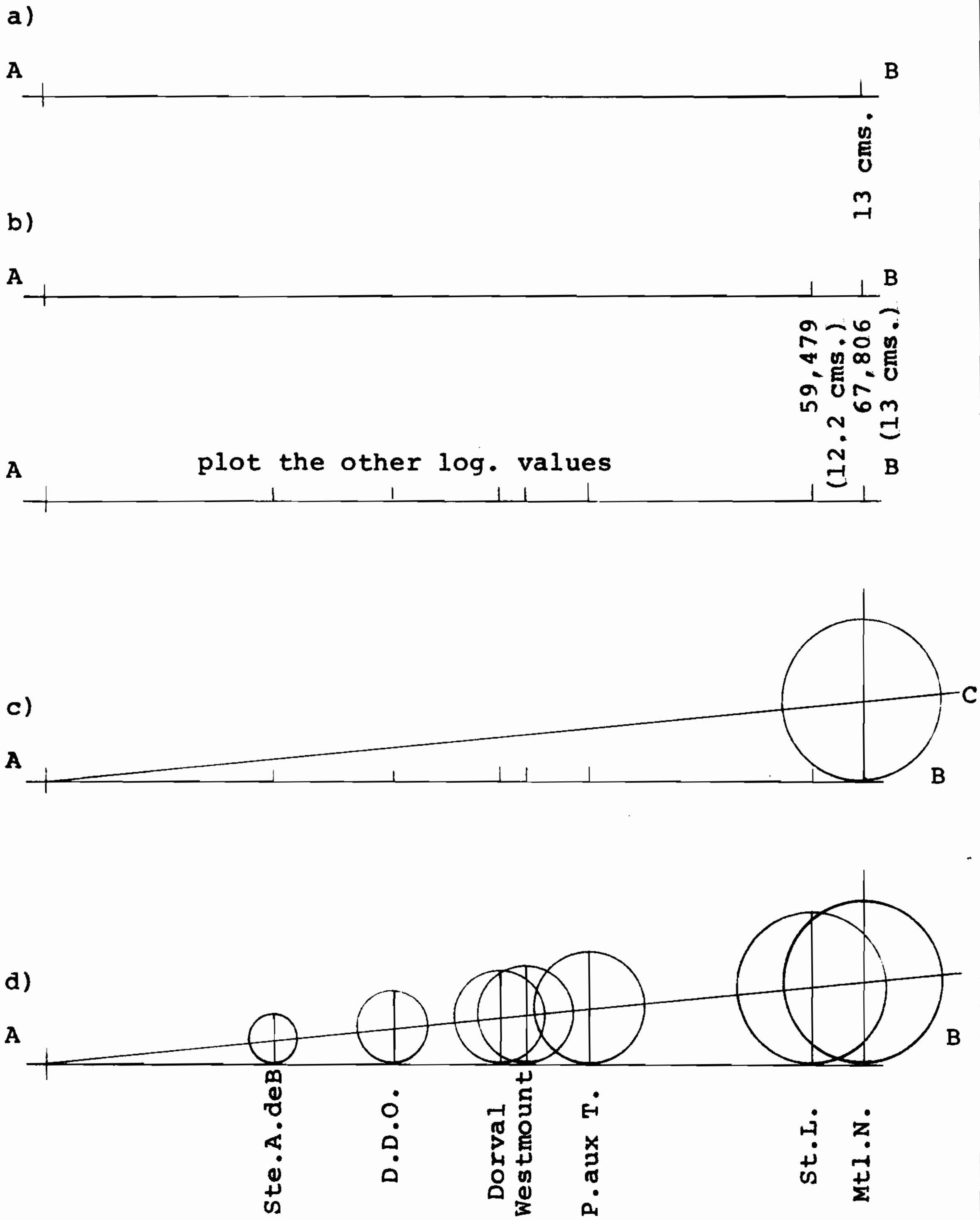


fig. 5.7.

in dividing it up.

In the example the line is 13 cms. long.

b) Now mark off along the line the square roots of the other values.

From the example, St. Laurent is first with a log of 243.9. The measurement is 12.2 cms with the 2 mm for the 3.9.

Continue plotting the other log values along A B.

c) Study the base map and decide on the size of the largest circle. Take into consideration crowding and overall neatness. Circles may overlap although this is to be avoided if at all possible. Methods of overlapping circles are shown on page 70, fig. 5.8.

Draw a perpendicular to the line A B at the location of the greatest value so that the perpendicular is equal to the diameter of the largest circle.

Draw a line A C from 0 to the centre of the circle.

d) Erect perpendiculars now from all the intermediate square root values. The radii for the other circles are the distances from A B to A C along the perpendiculars.

4) Using the radii found in 3d) the circles may now be placed on the base map. Locate the circles carefully, centering them on the area or location they refer to.

5) In the legend indicate the scale. Two possible suggestions are given at fig. 5.9, page 71.

Worksheet for a proportional circles assignment

The figures for this assignment are from the Canadian 1966 census. (Canada Year Book 1971-72 pp. 226-228).

Dollard des Ormeaux 12,297

Dorval 20,905

Pointe aux Trembles 29,888

Montreal North 67,806

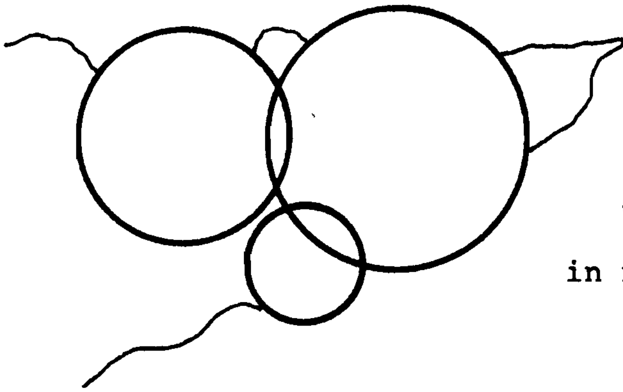
St. Laurent 59,479

Ste. Anne-de-Bellevue 5,334

Westmount 24,107

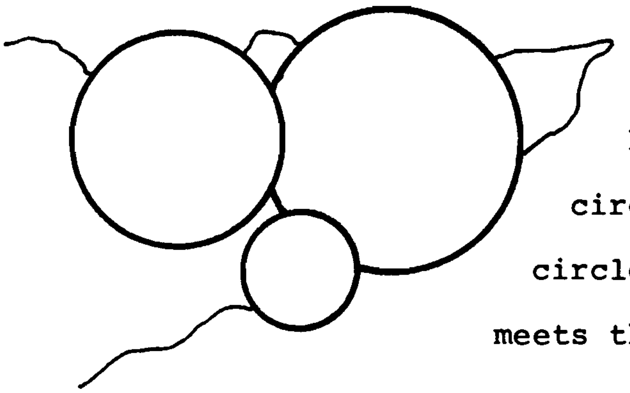
The municipalities were chosen for their linear distribution around the island of Montreal.

Municipality	No.	Log.	$\frac{\text{Log.}}{2}$	$\sqrt{\text{No.}}$ using anti-logs
Dollard des Ormeaux	12,297	4.0896	2.0448	110.9
Dorval	20,905	4.3201	2.1600	144.5
Pointe aux Trembles	29,888	4.4754	2.2377	172.9
Montreal North	67,806	4.8312	2.4156	260.4
St. Laurent	59,479	4.7743	2.3871	243.9
Ste. Anne-de-Bellevue	5,334	3.7270	1.8635	73.03
Westmount	24,107	4.3820	2.1910	155.2

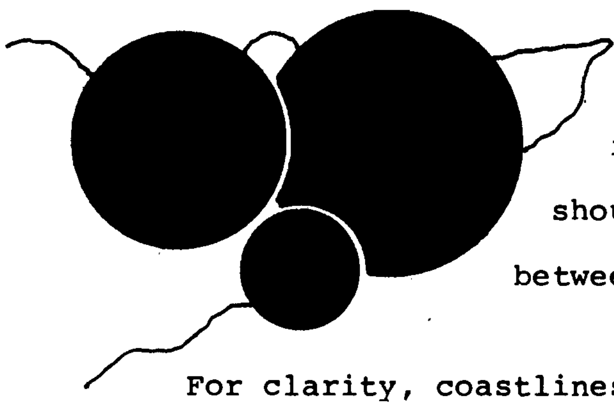


Methods of overlapping proportional circles

Circles that are not filled in may be lapped as shown.

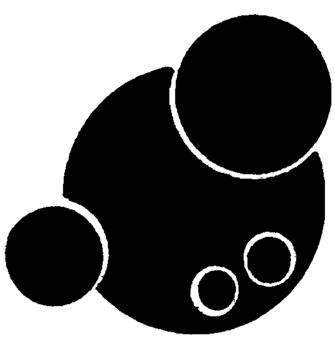


When the circles are to be shaded with colour, the circumference of the larger circle should be stopped when it meets the smaller one.



Circles which are filled in solid with a dark colour should have a small space left between them as shown.

For clarity, coastlines should not pass through the circles.



Where a large city swamps smaller towns the smaller centre may be superimposed on the larger circle. If a dark colour is used, leave a small space around the smaller circles.

fig. 5.8.

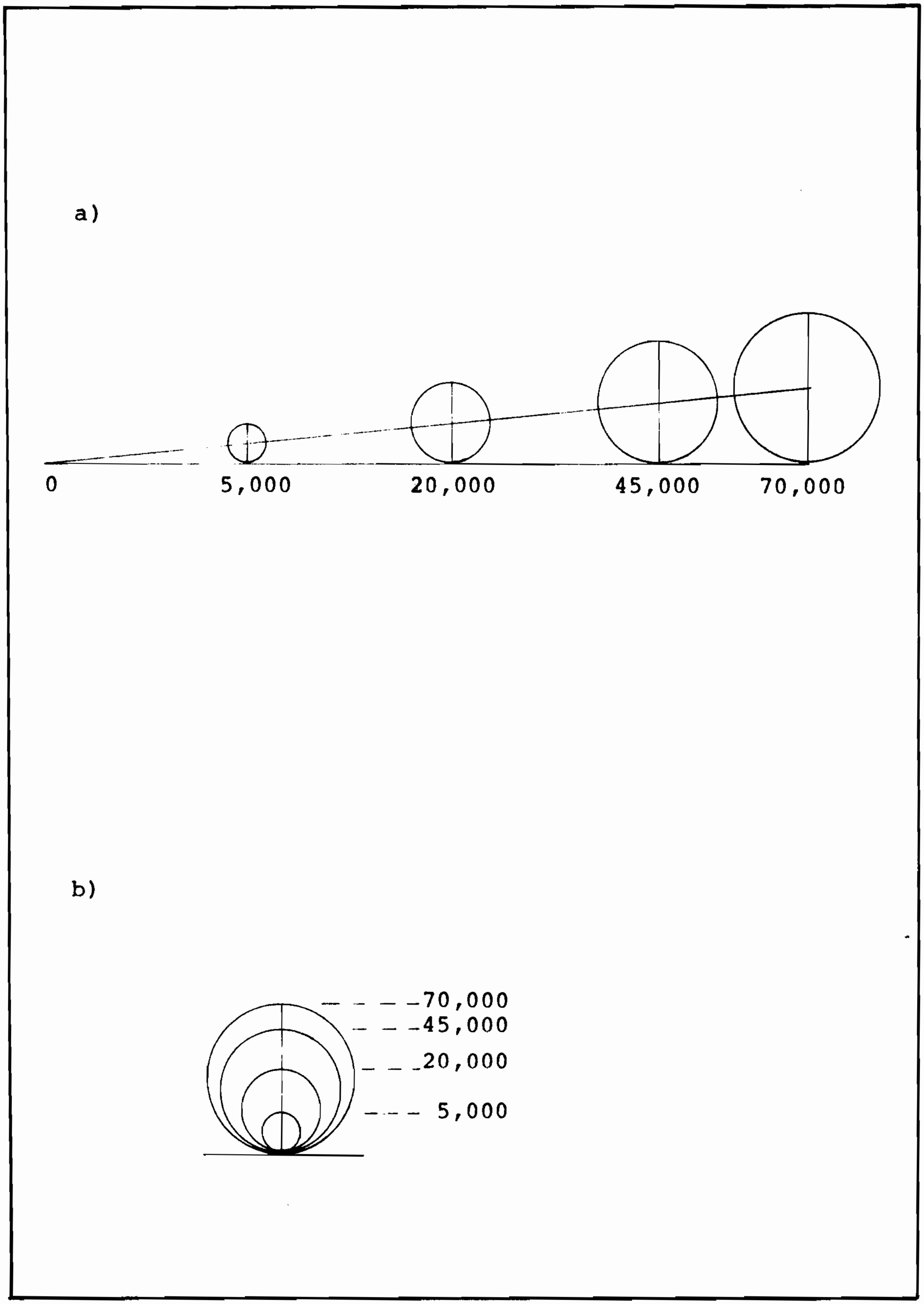


fig. 5.9.

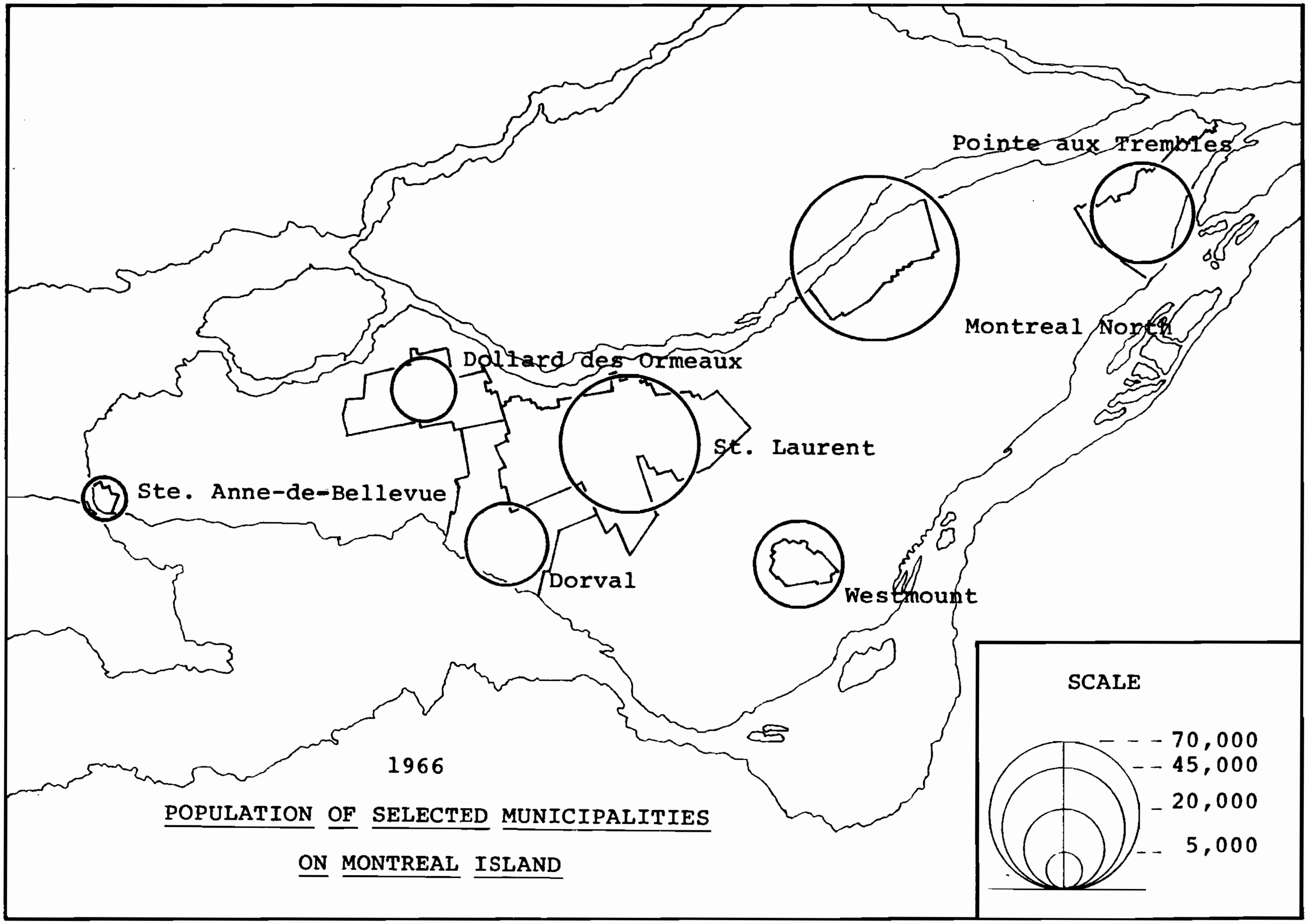

Pointe aux Trembles
Montreal North
Dollard des Ormeaux
St. Laurent
Ste. Anne-de-Bellevue
Dorval
Westmount
SCALE
70,000
45,000
20,000
5,000
1966
POPULATION OF SELECTED MUNICIPALITIES
ON MONTREAL ISLAND

fig. 5.10.

Student Instruction Sheet

To find a square root ($\sqrt{\ }$) of a number.

A square root of a number multiplied by itself equals the original number.

e.g. $5 \times 5 = 25$

$\therefore$ 5 is the square root of 25

If a calculating machine is not available the square root of a number may be found by using log tables. Log tables are to be found in books of mathematical tables. To find the square root of a number, the log of that number is found. The log is divided by 2 and the answer is obtained in the table of antilogs.

Read through the following carefully.

To find the square root of 84,329

First find the log of 84,329

The log of a number consists of two parts.

1) The numbers to the left of the decimal point, known as the characteristic, are found by observation. It is the number of digits to the left of the decimal point less one.

   In our example the characteristic is 4.

   There are five digits to the left of the decimal, less one, equals 4.

   Characteristic of 8432.9 is 3

   Characteristic of 843.29 is 2

   Characteristic of 84329000.0 is 7

2) The second part of the log, known as the mantissa, is found in the log tables. Only the first four digits are used -8432. The diagram below shows the layout of a typical page of logs.

A	B										C								
	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
10																			
11																			
12																			

The first two digits, 84 are found in section A. Put a straightedge underneath the 84 line when it is found. Find the next digit 3 in section B. Go across to column 3, the number is 9258. Now move across to find the last digit's column in section C. The last digit is 2 so go across to column 2 in section C. The number is 1. Add the number in section B to the one in section C.

9258 + 1 = 9259

9259 is the mantissa.

Now put the characteristic and the mantissa together to form the log.

Log of 84,329 is 4.9259

To find the square root, divide the log by 2.

$$\frac{4.9259}{2} = 2.4629$$

To find the answer use the antilog tables. These are usually

found immediately after the log tables in the book.
They are used in a similar manner to the log tables.
Find the first two digits (.46) in section A. On the same line go across to section C to the next digit's column. It will be column 2 in the example. The number is 2897. Add on to this the number from column 9 in section C, which is 6.
The answer is 2903.
To locate the decimal point, use the number to the left of the decimal point obtained after the log was divided by 2.
The position of the decimal is this number of digits to the left plus one.
The number was 2 so there will be 3 digits to the left of the decimal point.
The answer is 290.3.
This is the square root of 84,329.

The next sheet has two worked examples. Work through them in the manner described above. Next try the two unworked examples. The answers are given.

	No.	Log.
Find the square root of 329		
	329.0	2.5172
divide the log by 2		1.2586
look up antilog	1813	
$\sqrt{329} = 18.13$		
Find the square root of 734,981		
	734981	5.8662
		2.9331
	8572	
$\sqrt{734,981} = 857.2$		
Find the square root of 62,111		
$\sqrt{62,111} = 249.2$		
Find the square root of 3,994,520		
$\sqrt{3,994,520} = 1998.0$		

Proportional Squares

These may be constructed in a similar manner to the circles. The height of the radius of the circle would be equal to one side of the square. The size of the squares are much easier to visualize than the size of circles. The drawing of the squares is much more difficult unless a square template is available.

Proportional Spheres

When a large range of values is given in the data to be plotted a third dimension is often introduced. The symbol to represent a value may be drawn as a sphere or a cube. The cube root is obtained for the value (the log is divided by 3) and a sphere or a cube is drawn. These are difficult to draw and are not recommended as an exercise for young children.

Proportional Half Circles

Two related features at a location may be shown by half circles. Exports and imports at the location for example. The method of calculating the diameters is the same as a full circle. The flat sides face each other.

An example is shown in fig. 5.11, page 79.

<u>Worksheet for the proportional half circle assignment</u>

The figures for this assignment are from the 1961 Census of Canada. Bulletin CT-4 Catalogue 95-519. Table 3.

		Labour Force Male	Female
1.	Dorval	5,276	1,805
2.	Pointe aux Trembles	5,016	1,589
3.	Montreal North	11,516	2,909
4.	St. Laurent	13,232	5,298
5.	Ste. Anne-de-Bellevue	1,126	528
6.	Westmount	6,609	4,904

		No.	log.	$\frac{\log}{2}$	#
1.	M.	5,276	3.7223	1,8611	72.63
	F.	1,805	3.2565	1.6282	42.48
2.	M.	5,016	3.7003	1.8501	70.81
	F.	1,589	3,2011	1.6005	39.86
3.	M.	11,516	4.0611	2.0305	107.30
	F.	2,909	3.4637	1.7318	53.93
4.	M.	13,232	4.1216	2.0608	115.00
	F.	5,248	3.7242	1.8621	72.80
5.	M.	1,126	3.0515	1.5257	33.55
	F.	528	2.7226	1.3613	22.98
6.	M.	6,609	3.8201	1.9100	81.28
	F.	4,904	3.6906	1.8453	70.03

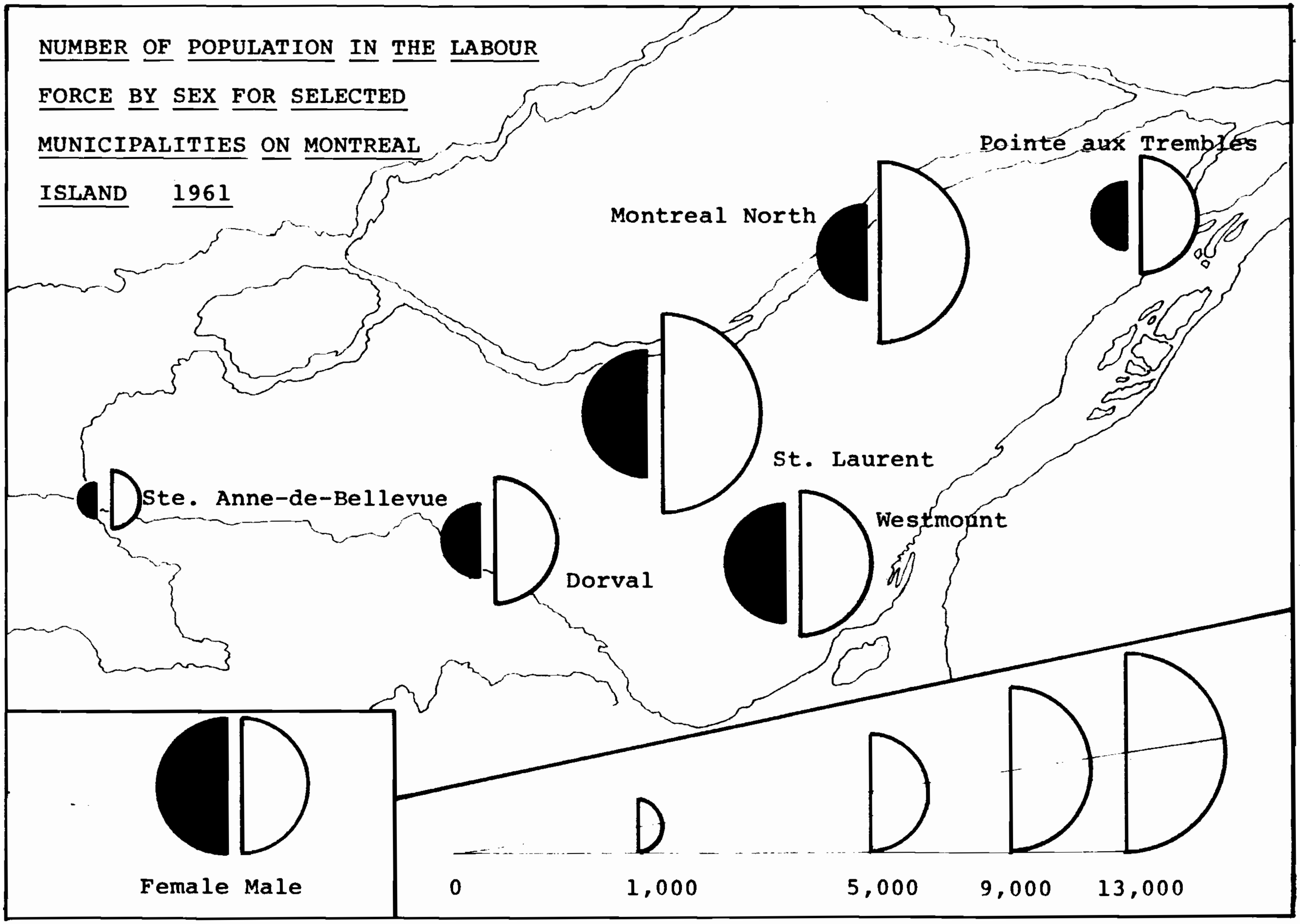

NUMBER OF POPULATION IN THE LABOUR
FORCE BY SEX FOR SELECTED
MUNICIPALITIES ON MONTREAL
ISLAND 1961
Pointe aux Trembles
Montreal North
St. Laurent
Ste. Anne-de-Bellevue
Westmount
Dorval
Female Male
0
1,000
5,000
9,000
13,000

fig. 5.11.

Student Instruction Sheet

Proportional Divided Circles

It may be necessary to show the total value, represented by the proportional circle, divided up into its component parts. This is achieved by dividing up the circle into pie shaped sections. A pie section is proportional to the component's value.

For example, the circles may be divided up to show the types of manufacturing in the town. This could be shown in value or in the number of people employed in the type of manufacturing.

There are certain points to keep in mind.

a) No more than six divisions should be attempted. Any more divisions may not show up too clearly on the smaller circles.

b) The largest division should be placed to the right of the '12 o'clock' position.

c) The smallest divisions should be clustered around the '6 o'clock' position.

d) The smallest division should be shown in a solid colour, in black or in white. Shading may be indistinct.

e) The order in which the components appear around the proportional circle must be uniform throughout the map.

The example on page 82 fig. 5.12, deals with the number of people in a household in some selected municipalities on the island of Montreal. First of all the size of the circles are calculated (page 66). Then the percentage of the total that each group accounts for is calculated. The percentage protractor on page 84 is used to divide up·each circle. A worksheet similar to the one on page 83 should be made when doing the calculations.

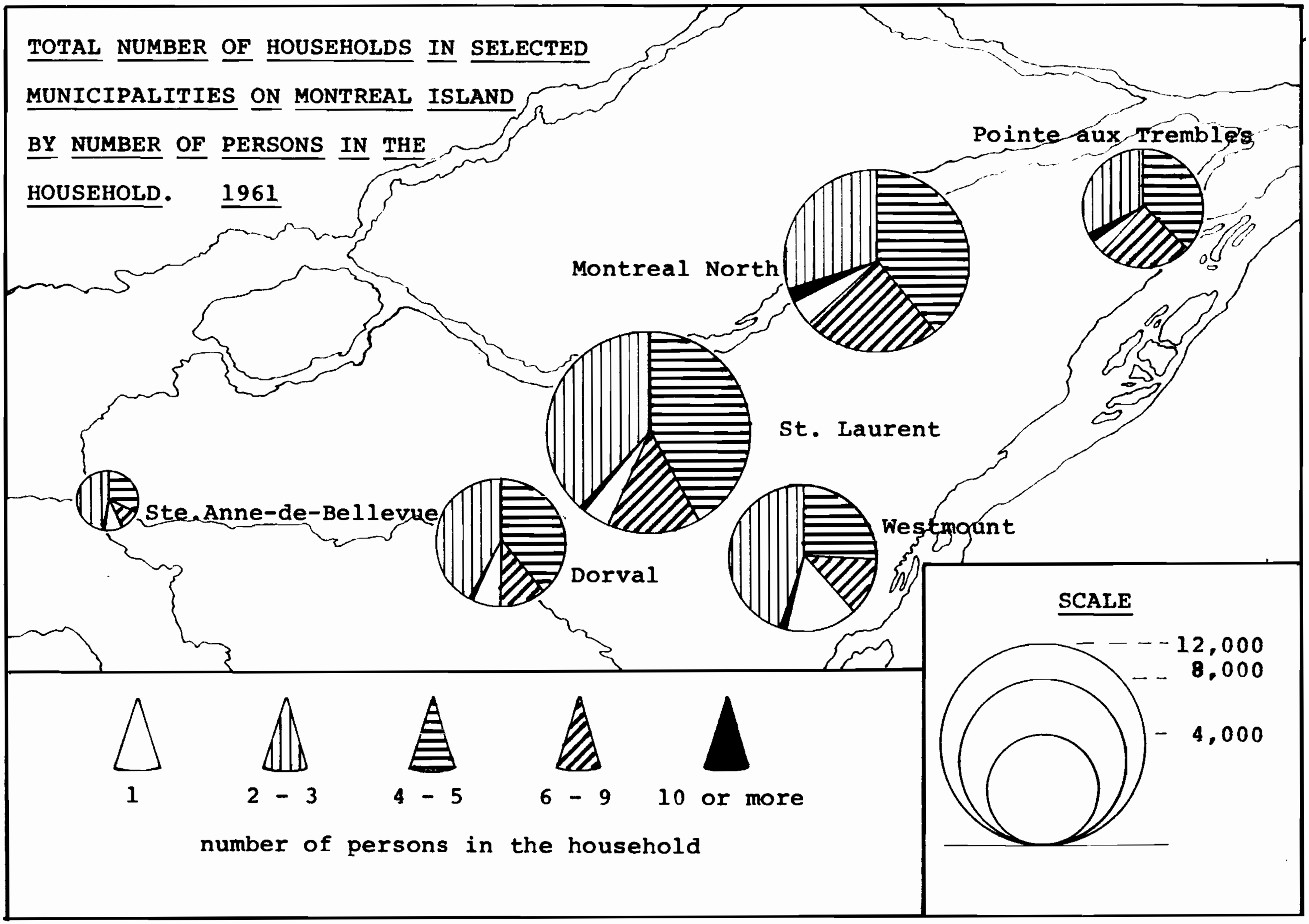

TOTAL NUMBER OF HOUSEHOLDS IN SELECTED MUNICIPALITIES ON MONTREAL ISLAND BY NUMBER OF PERSONS IN THE HOUSEHOLD. 1961
Pointe aux Trembles
Montreal North
St. Laurent
Ste.Anne-de-Bellevue
Dorval
Westmount
SCALE
12,000
8,000
4,000
1
2 - 3
4 - 5
6 - 9
10 or more
number of persons in the household

fig. 5.12.

<u>Worksheet for proportional divided circles</u>

Total # of Households calculations.

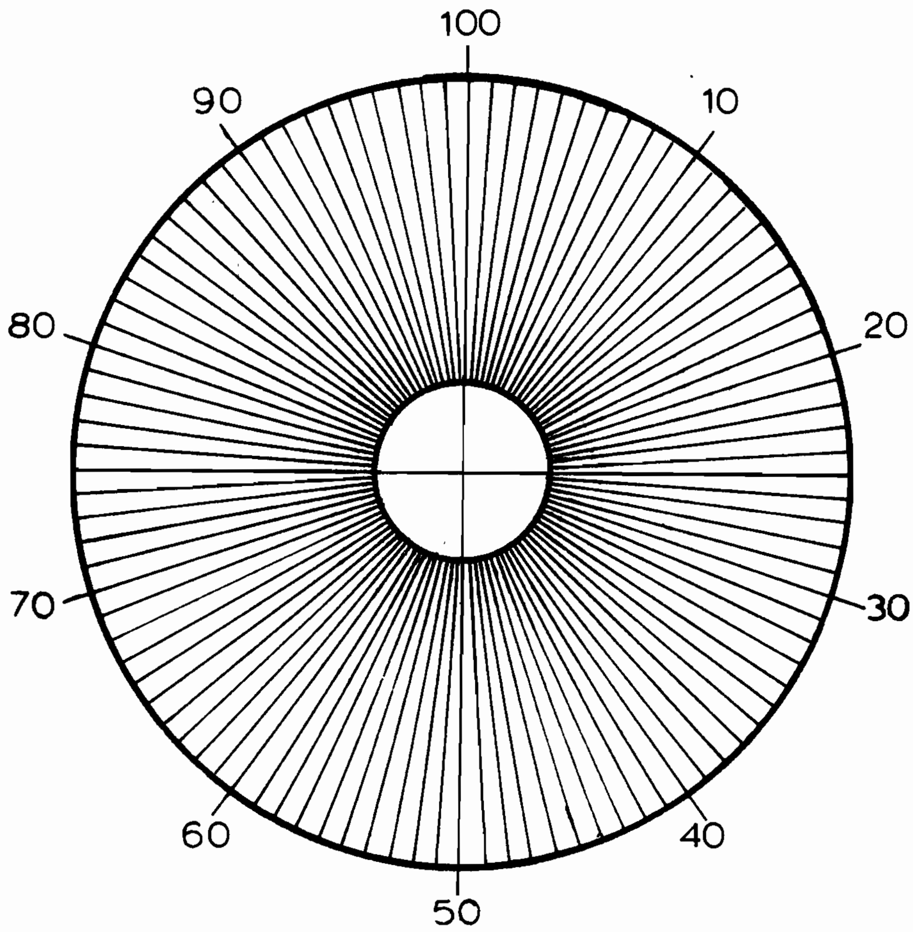
	No.	log.	$\frac{\text{log.}}{2}$	#
Dorval	4,932	3.6930	1.8465	70.23
Pointe aux Trembles	4,608	3.6635	1.8317	67.87
Montreal North	10,669	4.0281	2.0140	103.30
St. Laurent	12,306	4.0899	2.0449	110.90
Ste.Anne-de-Bellevue	1,123	3.0504	1.5252	33.52
Westmount	6,932	3.8408	1.9204	83.26

Households by # of persons calculations.

To find the percentage, divide the larger number into the smaller.

	Dorval	P.auxT	Mtl.N.	St. L.	S.A.d.B	Westmt.
Total # of Households	4,932	4,608	10,669	12,306	1,123	6,932
1	294 $\frac{294}{4,932}$ =5.9%	170 $\frac{170}{4,608}$ =3.6%	405 =3.7%	452 =3.67%	98 =8.7%	1,024 =14.7%
2-3	2,088 =42%	1,475 =32%	3,274 =30.6%	4,686 =38%	529 =47%	3,147 =45%
4-5	1,935 =39%	1,735 =37.6%	4,171 =39%	5,241 =42.5%	364 =32.4%	1,811 =26%
6-9	584 =11%	1,112 =24%	2,583 =24%	1,835 =14.9%	127 =11.3%	903 *13%
10 or more	31 =0.6%	116 =2.5%	236 =2.2%	92 =0.7%	5 =0.4%	47 =0.6%

Percentage Protractor Graph



Student Instruction Sheet

FLOW LINE MAP

Fig. 5.13 on page 87 shows an example of a flow line map. The line thickness indicates the quantity moving along this route way. This method of statistical mapping can be used to show for example,

a) number of trips along a route.

b) number of passengers along a route.

c) and as in the example, fig. 5.13, the volume or value of goods along a route.

The lines do not have to flow exactly to the actual route. The bends may be straightened out.

Construction

1) Study the data and produce a suitable base map.

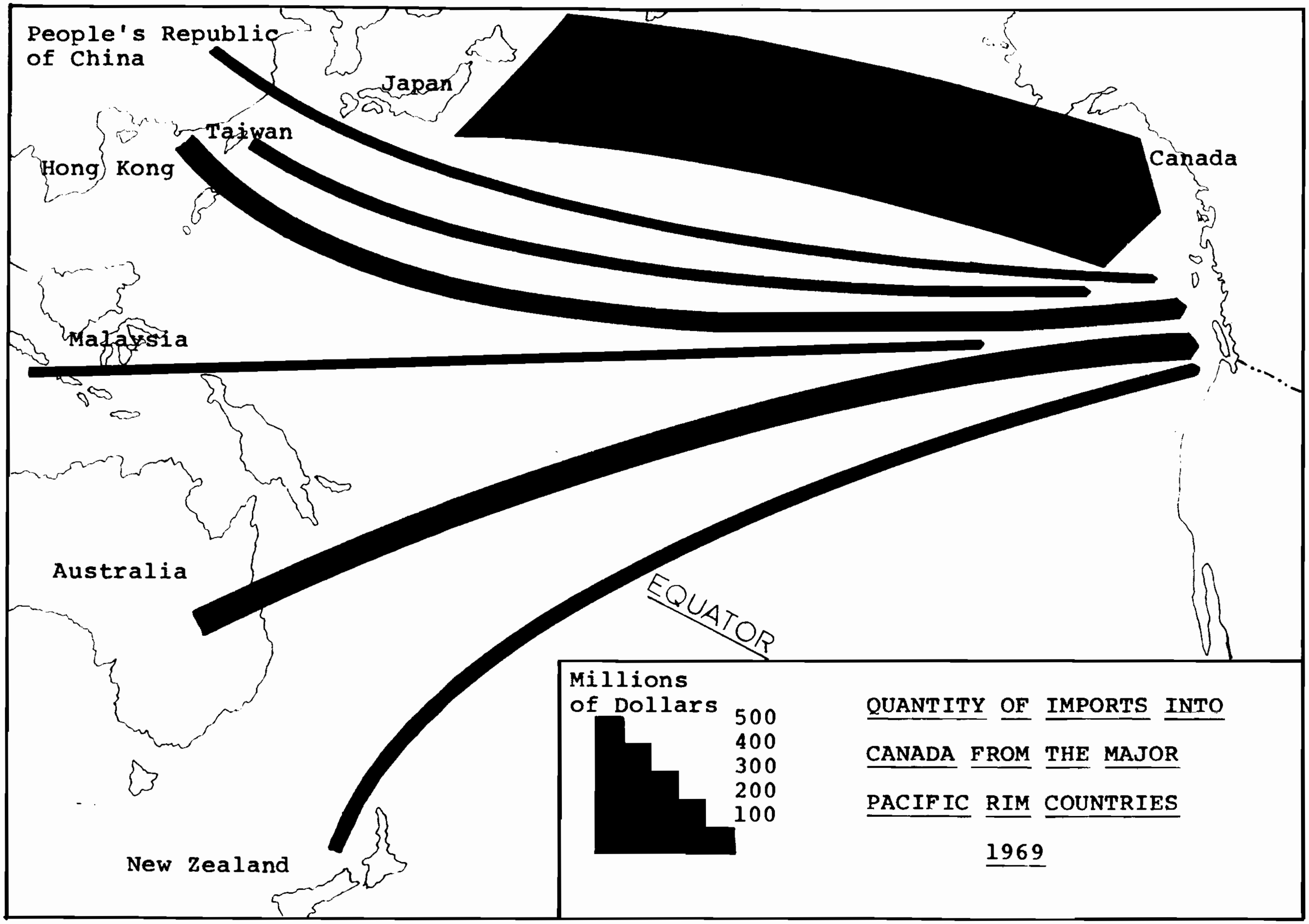
2) Prepare a scale. When small values fall below a certain point, a standard line is drawn and the actual figures are lettered on it. Or as an alternative, the range of values are given in the legend.

3) The lines may be drawn in one of two ways. The second method is suggested for young students.

   a) A double nib pen (railroad pen).

   b) The lines are drawn with irregular curves and the space in between is filled in.

   Draw a suitable curve with the aid of an irregular curve. Measure the thickness of the line to scale from this curve. Make several measurements along the curve. Match up the same irregular curve to the points and draw another curve. Fill in the space between the two lines. Put an arrowhead to show the direction of movement.



QUANTITY OF IMPORTS INTO CANADA FROM THE MAJOR PACIFIC RIM COUNTRIES 1969

fig. 5.13

Student Instruction Sheet

CHOROPLETH MAPS

The choropleth map is a density map taking the statistics of an administrative area and expressing them as density per unit of area. There are two weaknesses in this method of statistical mapping.

a) The administrative boundaries take on a far greater role than they do in reality. The abrupt change shown by the boundary does not happen as there is always a region of transition.

b) The administrative area coloured all the same does not show the variations in density which occur within the area.

The variation in the colour of the areas is all important and not the location of the boundaries. The calculations for the densities are quite easy. The density is found by dividing the area into the population.

A scale should show the classes chosen. The classes must be regular and the scale should show them all, even though they may not appear on the map. There should not be any gaps in the classes.

Construction

1) Draw a suitable base map showing the administrative boundaries.

2) List the names of the statistical areas as in the worksheet, page 91. Opposite each area put a locating number. Put this same number on the area on the working copy of the map, page 93, fig. 5.14.

3) List the population of each area and the area in square miles. Calculate the population per square mile for each area.

4) Now list the population per square mile in increasing order as shown on the second worksheet page 92. Study the figures and decide on the class boundaries. The figures in this problem show the largest number of values between 0 and 19. One area goes up to 1213.1 but this is obviously way out of the general pattern. This really applies to the bottom five numbers also. Aim at six or seven classes with this number of areas. Classes of 4 were selected for this map.

0 - 3.9
4 - 7.9
8 - 11.9
12 - 15.9
16 - 19.9
20 - and over up to 1214.0

Bracket the list into classes. Identify each bracket with a letter. On the working copy of the base map, locate each area referring to the list on the first worksheet. Using a pencil, put the appropriate letter in each area. The pencil mark can be erased easily if the classes are not correct. Study the pattern and decide if this gives the result desired. If not, reorganize the classes again and repeat the procedure described.

4) A scheme of shading has now to be devised. Students are

recommended to use colour with coloured drawing pencils. The example, on page 94, fig. 5.15, of a choropleth map has been shaded because the printing process only allowed black on white. On the worksheet draw enough boxes for the number of classes and try out the colour scheme.

A colour such as blue is recognized universally as the colour used to depict area covered with water. It is not recommended to use it anywhere else. Colours which are dominant, reds, oranges and yellows should be reserved for the higher densities. The receding colours of browns and greens should be used for the lower densities. The darker shades of a colour also dominate over the lighter shades of the same colour. Great care must be taken over the preparation of a colour scheme.

Worksheet for the choropleth map

Name	Total Pop.	area in sq. miles	pop. per sq. mile	location # on base map
Mackenzie	3,293	2,853	1.2	1
Waimate	5,926	1,883	4.3	2
Levels	4,797	260	18.5	3
Geraldine	5,057	774	6.5	4
Ashburton	11,617	2,367	4.9	5
Ellesmere	7,151	444	16.1	6
Halswell	4,314	39	110.6	7
Wairewa	756	170	4.4	8
Akaroa	1,620	170	9.5	9
Mt. Herbert	600	66	9.1	10
Heathcote	7,119	12	593.3	11
Waimairi	52,164	43	1213.1	12
Malvern	5,667	980	5.8	13
Paparua	18,362	113	138.1	14
Eyre	2,240	175	12.8	15
Oxford	1,521	318	4.8	16
Rangiora	4,008	96	41.8	17
Ashley	605	309	2.0	18
Kowai	2,239	157	14.8	19
Tawera	710	942	0.8	20
Waipara	2,962	937	3.2	21
Amuri	2,940	2,285	1.8	22
Cheviot	1,526	327	4.7	23

The data for this example was taken from the New Zealand 1966 Census, Increase and location of population, volume I page 18, table 11.

<u>Worksheet for the choropleth map</u>

List the population per square mile in increasing order.

A
- 0.8
- 1.2
- 1.8
- 2.0
- 3.2

B
- 4.3
- 4.4
- 4.7
- 4.8
- 4.9
- 5.8
- 6.5

C
- 9.1
- 9.5

D
- 12.8
- 14.8

E
- 16.1
- 18.5

F
- 41.8
- 110.6
- 138.1
- 593.3
- 1213.1

Study the list and decide on the class boundaries.

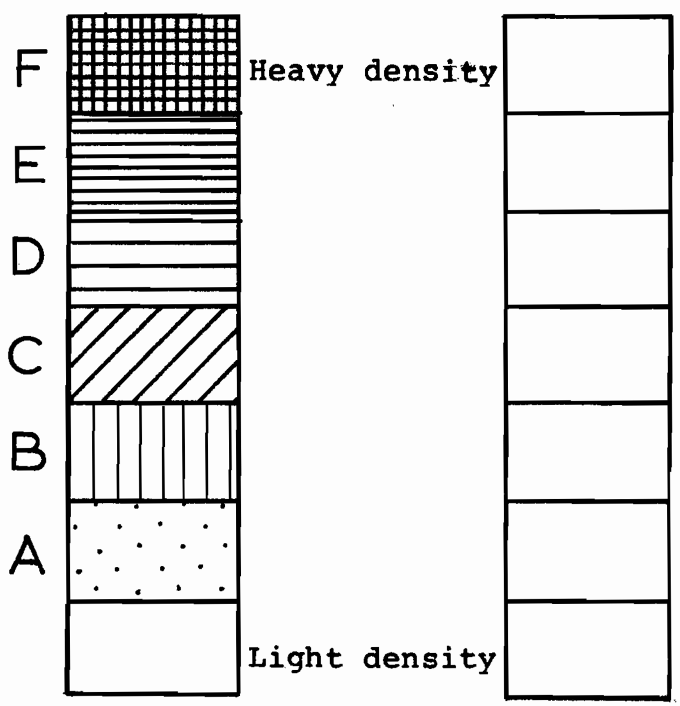
Bracket these and letter them.

Put the letter on the statistical area on the 'working map'.

Decide if the pattern obtained is suitable for the map's use.

Rearrange the class boundaries if it is not suitable.

Draw a set of boxes and work out a system of colouring.



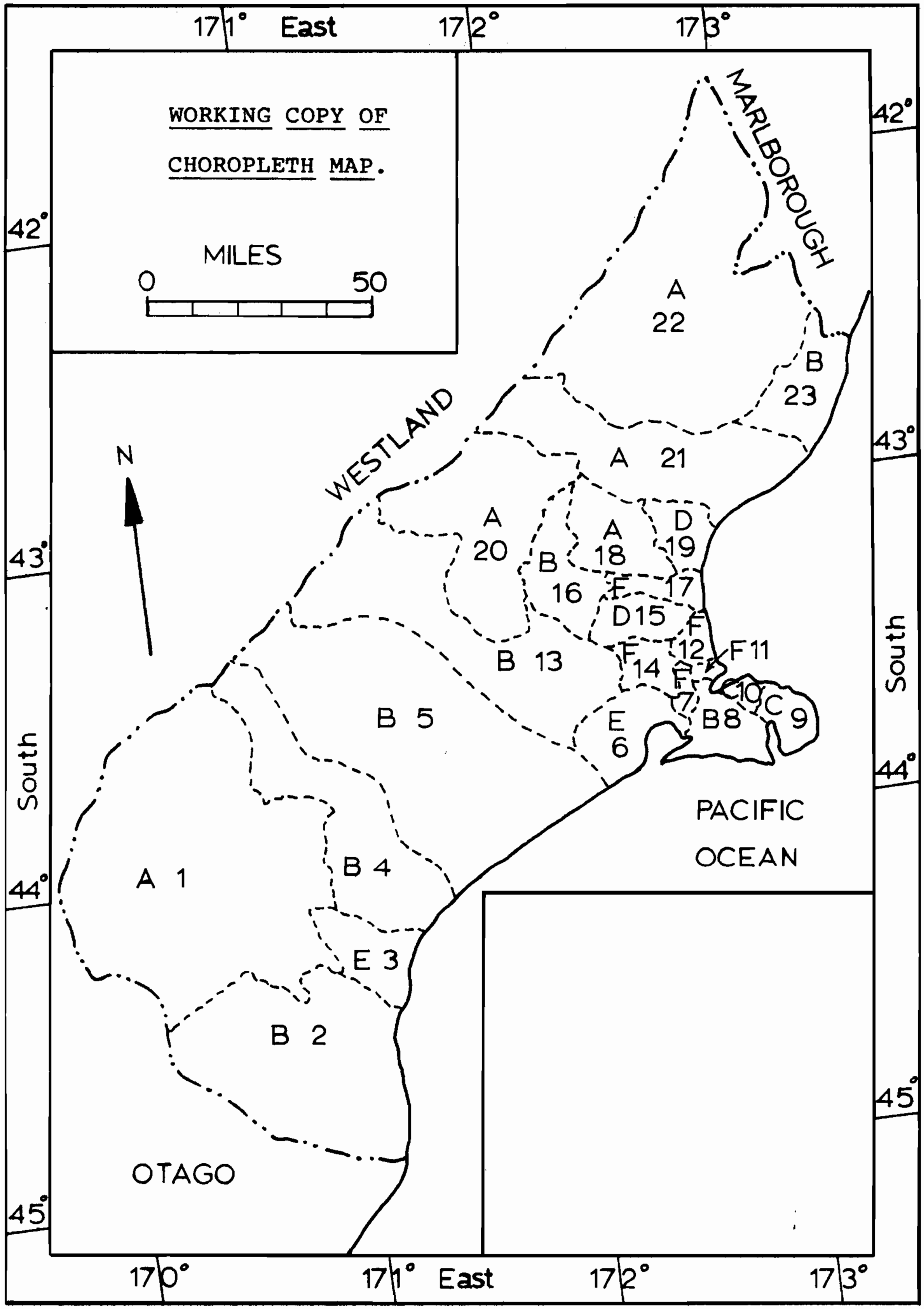

WORKING COPY OF
CHOROPLETH MAP.
MILES
0
50
171° East
172°
173°
170°
171° East
172°
173°
42°
43°
44°
45°
South
N
WESTLAND
MARLBOROUGH
OTAGO
PACIFIC
OCEAN
A 1
B 2
E 3
B 4
B 5
E 6
7
B8
C 9
C10
F11
F 12
B 13
F 14
D15
B 16
17
A 18
D 19
A 20
A 21
A 22
B 23

fig. 5.14.

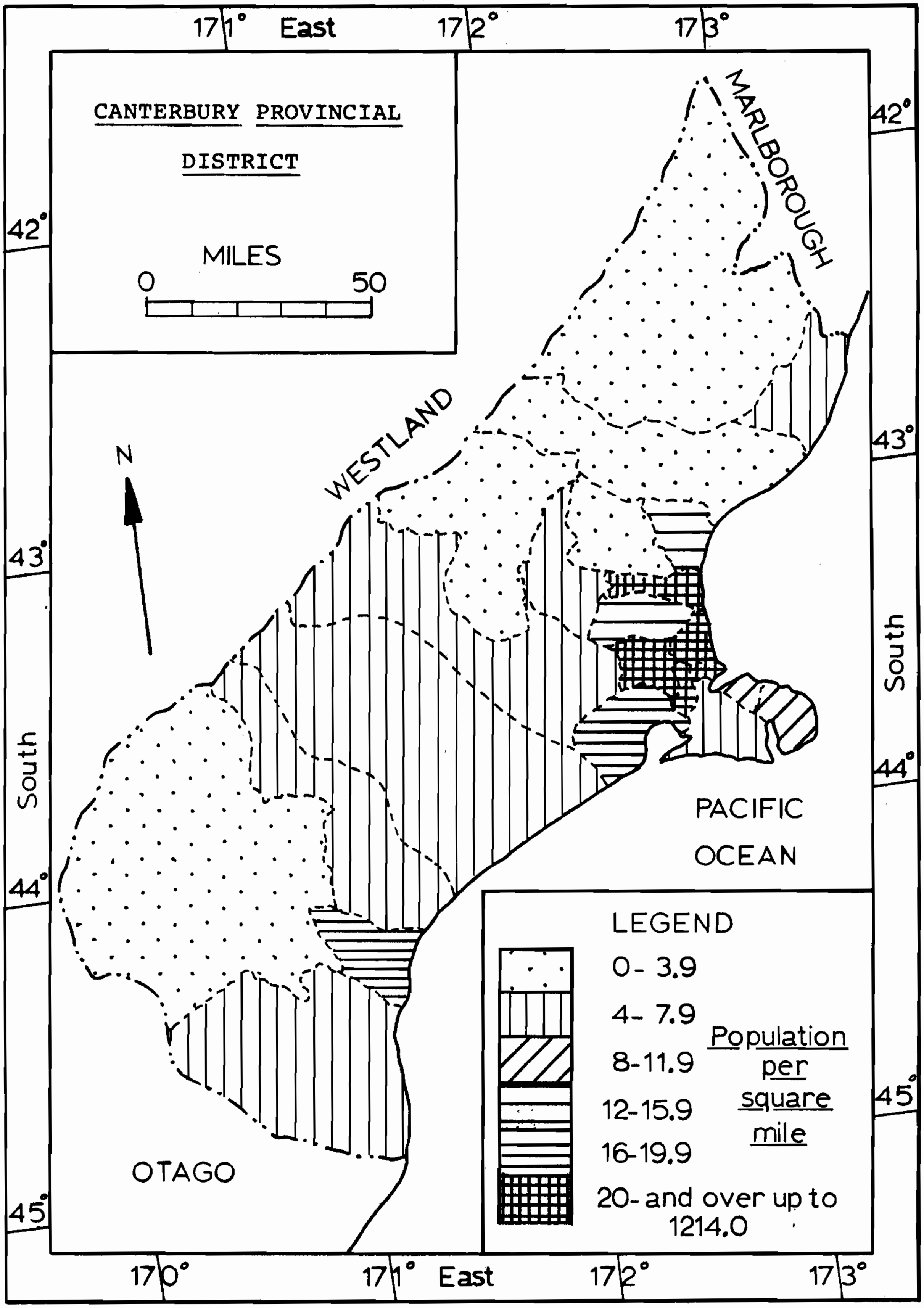

CANTERBURY PROVINCIAL DISTRICT
MILES
0
50
171° East
172°
173°
170°
42°
43°
44°
45°
South
N
WESTLAND
MARLBOROUGH
PACIFIC OCEAN
OTAGO
LEGEND
0- 3.9
4- 7.9
8-11.9
12-15.9
16-19.9
20- and over up to 1214.0
Population per square mile

fig. 5.15.

Student assignment sheet

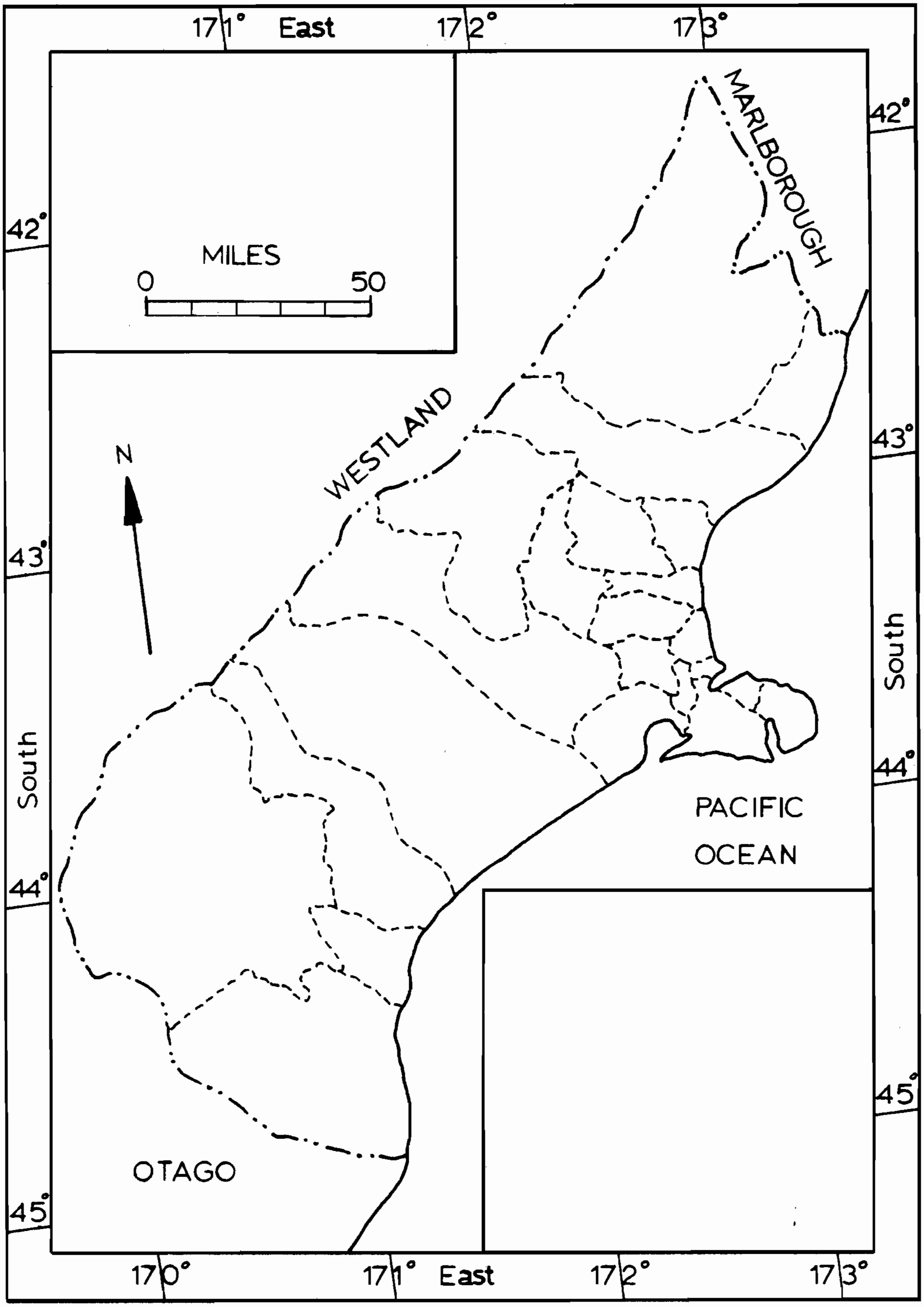


fig. 5.16.

APPENDIX I

DRAFTING EQUIPMENT

Facilities available to teachers and students will vary tremendously. The following are just general suggestions on equipment. They will give the teacher an idea of what to obtain, to work on the exercises in this handbook. There are many different qualities in the same instrument. Accuracy coupled with robustness should be sought after. The quality and the model must be decided by the individual to compliment their special circumstance.

The Drafting Surface

A flat, even surface is required for good work. The larger the area, the easier it is to draw large maps. Commercial drafting tables are the ultimate, but large 'formica' or 'arborite' covered tables will do excellently. If small desks are the only working areas available, drawing boards should be purchased or made. Drawings are supplied in appendix II for a simple drafting table. Drawing boards may be cut out of 3/4 inch thick birch plywood, lumber core, or birch veneered particle board. Boards may be cut out of a 4 feet by 8 feet sheet to give a selection of sizes. The edges should be planed straight and square. Vinyl drawing board surfacing may be purchased in rolls and sheets. Teachers should refer to a drafting supplies catalogue for details, (Hughes-Owens p.a-14). For a cheaper surface contact paper may be used. This is easily replaced when it is scratched.

<u>Drafting Instruments</u>

Tee Square.

This is used for drawing horizontal lines. The head should be held firmly to the edge of the drawing board. It is used from <u>one</u> side only. The blade should be long enough to cover the working area on the drawing board. The type with transparent acrylic edges is preferred, (Hughes-Owens #324 4724 24 inches, at $3.50 each, and #324 4730 30 inches, at $4.00 each). Ensure that the fastening between the blade and the head is secure. A loose fastening makes the instrument useless.

Set Square.

Two will be required for each drafting board; one $30^{\circ} \times 60^{\circ}$ set square, (Hughes-Owens 10 inches #324 2010 at 65¢ each) and one 45° set square, (Hughes-Owens #324 2008 at 45¢ each). These are used in conjunction with the Tee Square to draw vertical and inclined lines.

Scale.

The function of this instrument is to measure distances. It should not be used as a straightedge when drawing lines. There are two kinds of scales. One is the architects' scale, which is subdivided into fractions of an inch to the foot (multiples of 12). The other is an engineers' with divisions of 10, 20, 30, 40, 50 and 60 parts to the inch. There is a use for both in cartography and it is suggested that a selection, to be shared by students, is made. White plastic scales are suggested as they are cheap and stand up to hard use better than the boxwood scales. Insist on the students taking the required radii for the circles and arcs from a line on the drawing. Do not let them take it straight from the scale as the compass needle will damage the scale and the measurement will be less accurate.

Compasses.

There is a place for a pair of compasses in a cartographers' set of instruments, but it should be realized that a 6 inch bow compass will have a limited use. The bow compass is the type used by draftsmen. A 6 inch bow compass will draw a circle with a maximum diameter of 10 inches. The lead section on some compasses is removable and an extension bar may be fitted so larger diameters are possible, (Keuffel and Esser Co. #55 1716 and #55 1728 at $4.00 each). Another alternative is to purchase a beam compass, (Hughes-Owens #322 1811 at $10.25 each). With a 13 inch beam, something like a 24 inch diameter is possible. Circle templates are also extremely useful, especially in unskilled hands. There are many makes of templates but circle diameters go from 1/16 inch to 2 1/4 inches in varying increments. These are invaluable when drawing symbols. Another point which may be advisable to consider at this time is the use of ink. By far the easiest way for students to ink drawings is to use a technical fountain pen. The different sized points will give guaranteed thickness of lines of the same consistency, which is required for reproduction. Adaptors are available to fit the pen point to the bow and beam compasses.

When buying the instruments for drawing circles and arcs, consider first what has to be drawn. Polar projections will need an instrument for large diameters; small circular symbols are best drawn with a template. Clearly define the requirements before purchasing expensive equipment.

Protractor.

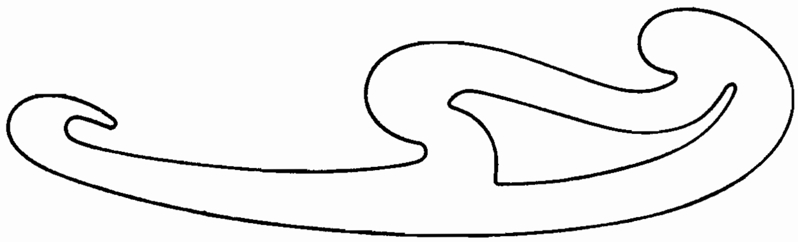
Only one type of protractor is now available. That is the one divided up into 360 degrees, (Keuffel and Esser Co. #57 0524 at $2.00 each). For making pie graphs a percentage protractor is very useful. A percentage protractor graph is on page 84. Multiple copies of this may be made on sensitive acetate, (3M #127), by passing this and the acetate through a photocopying machine, (Thermofax) which uses heat.

Irregular or French Curves.

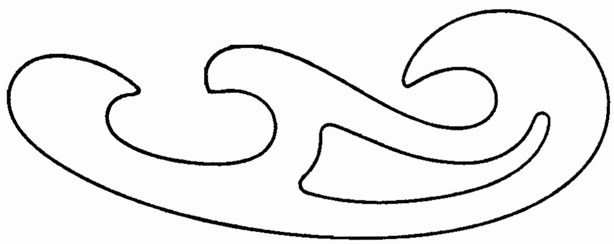
These are extremely useful for joining up several points to form a smooth curve. Map projections and graphs are two examples where they can be used. No less than 3 points must be taken. A curve must be found which will give a fair line through these points as well as ensuring uniformity with the continuation of the curved line through the other points. Sometimes a student will find it easier to sketch in faintly, a curved line through the points, and then find curves to suit his sketched line. A sketched line without using a curve would be too irregular.

Suggested shapes for a basic set of irregular curves.

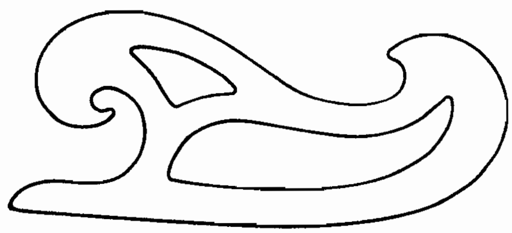
Approximate length



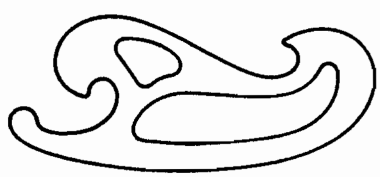
12 inches



8 inches



7 1/2 inches



5 1/2 inches

The choice of selecting irregular curves, is overwhelming, when a catalogue is studied. Each manufacturer has their own selection and numbering system. In the drawing on page 100, there are four basic curves with their approximate lengths. With this drawing, teachers may make selections from the manufacturer of their choice. These shapes have been found useful in cartography and will be a starting point for building up a useful set of curves.

Another instrument used by the professional for drawing curves is the Flexible Curve. These are not recommended for students' use as they are easily broken when bent carelessly.

Templates.

These are made in thin plastic and as mentioned earlier, when circles were discussed, they are very useful to the cartographer. A catalogue should be referred to for the complete range available, but the following have been found to be useful in the classroom.

a) Large circle template, (#140 Rapidesign at $3.45 each).

b) Square template, (#30 Rapidesign at $2.40 each).

c) Lettering set of 3 templates for upright letters and numbers, (#900 Rapidesign at $5.50 each). These templates may also be obtained individually, (#904 with letters 1/8 inch high at $2.10 each, #906 with letters 3/16 inch high at $2.10 each, and #908 with letters 1/4 inch high at $2.10 each).

d) A similar lettering set of 3 templates is useful with the letters and numerals inclined at 15^{o} to the vertical, (#930 Rapidesign at $5.50 each).

Good lettering takes a considerable amount of practice. Students do not have the time, therefore, lettering sets are very worthwhile. Poor lettering really spoils an otherwise well designed and drawn map or cartogram.

Technical Fountain Pen.

There are many makes of the technical fountain pen but they are all very similar. The pen point is interchangeable so that lines of different widths are possible. The point is a tube down which the ink flows. A needle moves up and down inside the tube when the pen is shaken. This keeps the ink flowing and stops the build-up of dried ink in the tube. The point must be kept clean and the top replaced when it is not in use. Manufacturers supply cleaner for the points but warm water may be substituted. Ink is supplied in cartridge form, or the pen's reservoir is filled with ink from a bottle. After use, the pen should be taken to pieces, and washed thoroughly. Make sure the needle moves up and down the tube easily. Shake the pen constantly when it is in use. You can hear the weight on the end of the needle clicking when it is shaken and the needle is doing its job.

A pen set of 4 or 5 different points would be adequate. A suggestion is #00, #0, #1, #2 and #3. Duplicates may be needed in some popular sizes and it is always advisable to have replacement points on hand. Adaptors are available to fit the pens to bow and beam compasses. Some manufacturers have a special compass to go along with the pen (Charvoz 31 Scarsdale Road, Don Mills, Ontario).

When using the pen, the straightedge should not be flat on the paper. The ink will flow between the paper and the straightedge. Use a straightedge with a reverse bevel. An ink riser, (#1015 Rapidesign at $2.00) may be used under templates and irregular curves. Dimes may be scotch-taped under set squares and flat straightedges. If there is a reverse bevel on the drawing edge there should not be any difficulty.

Pencil Sharpener.

This is normally standard equipment in all classrooms. If students elect to use mechanical pencils a special sharpener must be purchased, (Hughes-Owens #329 2411 at $5.50 each).

Tracing Table.

This is a necessity for copying drawings and maps. Sandblasted glass is placed over fluorescent lamps and the interior of the box is painted a light colour. These may be purchased or made in the school wood shop. A design for a portable tracing table is given in appendix III.

Erasing Shield.

This is a thin piece of plastic or metal with several punched holes of different shapes, (Hughes-Owens #339 1495 at 35¢ each). It is useful when erasing, as the lines which are to stay, are protected by the shield.

Pantograph.

This is used for reducing and enlarging drawings and maps and it is very useful to the cartographer, (Hughes-Owens #349 1608 at $11.50 each).

Consumables.

Pencils.

There are two kinds of pencils; the wooden cased, and the mechanical. A good quality of pencil should be purchased to ensure consistency of the line. The hardness of the pencil depends on the mixture of graphite with clay. The greater the percentage of clay the harder the pencil. A 3H or 4H pencil is used for preliminary work and an H pencil is used for the fair drawing. A pencil softer than H could be used for art work but it smudges quite easily. Grades of pencils for drafting:

10H, 9H, 8H, 7H, 5H, 4H	Hard Range for accurate layout work.
3H, 2H, H, F, HB, B	Medium Range of general drawing and sketching.
2B, 3B, 4B, 5B, 6B, 7B, 8B	Soft Range for art work.

Always sharpen the end opposite to the one that indicates the grade. A mechanical pencil is a lead holder, (Faber-Castell #9500 at $2.00 each). Leads may be changed quickly and new leads introduced when required. A special sharpener is required for sharpening the lead. One type of mechanical pencil does not require a sharpener as the leads are only 0.5 mm. thick. New leads are fed into the end and the top is replaced. The top is pressed to advance the lead. This pencil must be used upright as the lead breaks very easily, (Faber-Castell #9505 at $5.00 each).

Eraser.

A pink pearl eraser is desirable as it does not mar the paper's surface. A special eraser is required for ink.

Masking Tape.

Paper must be held down to the drawing board and masking tape does this very well. It is also used when tracing to hold the tracing paper to the original. Care must be taken when removing the tape so that the paper is not damaged. Tape with adhesive on both sides may be useful for displays and overlays.

Dry Cleaning Pad.

Small granules of art gum eraser are packed into an open mesh bag, (Hughes-Owens #339 1320 at 50¢ each). When this is sifted over the paper and instruments, it will prevent the build-up of dirt on the paper. A hand brush is necessary to dust this off on the completion of the drawing.

Sandpaper Block.

Pieces of #280 Garnet sandpaper should be stapled onto blocks of softwood. These may be replaced easily when the sandpaper is soiled. It is used for sharpening compass leads and touching up the point on the pencil. A special place should be found for the storage of these blocks as the graphite will soil the hands and paper.

Ink.

Black waterproof ink should be used in drawing, (Hughes-Owens #337 1917-50 at 90¢ an ounce). A good quality should be purchased so that the lines will be consistent and the instruments will not be damaged.

Coloured Drawing Pencils.

These are to be recommended for putting colour on the maps and drawings. A very wide colour selection is possible and there is no mess. Colour is easy to apply and some interesting designs are possible by placing an embossed surface under the paper before colouring. Aluminum sheets are manufactured with many embossed designs. The school metal shop may be able to supply pieces. Felt pens are not very good for this work. The density of colour is not consistent, the paper will wrinkle, and the colour will show through on the back.

Replacement Parts.

The instruments will need constant maintenance and it is wise to have replacement parts on hand for when the need arises. Compass leads and needles have a very high mortality rate. Leads may be purchased by the box. Pieces are broken off and put into the compass when required. The lead point is sharpened from the outside of the compass to a chisel point.

Technical fountain pen points are also easily damaged. An extra point of each size would save a lot of problems if an accident should occur.

Paper.

There is quite a range in the quality of paper. The very good paper will be too expensive for student use and the poorer quality will give unsatisfactory results. Professionals use plastics such as 'mylar' because they are less susceptible to temperature and humidity changes. In the classroom it is a good idea to tread the middle way. It does not do any harm to instil into the students the high cost of paper and get them to co-operate in keeping waste to the minimum. At the end of this appendix are some samples of paper with the prices as of January, 1973.

The teacher should first of all plan the programme so the needs of the students will be clear. The quality of drawing paper, tracing paper or bristol board will depend on the use of the finished work. If it is an intermediate stage drawing and the fair finished copy will be taken from this, it can be drawn on cheaper paper. The fair copy should always be on good paper.

If reproduction equipment is available in the school, (Blueprint machine for Oxalid prints), ink on tracing paper will give the best copies. Pencil will work well if the lines are dark and crisp on the tracing paper. Special pencils are obtainable for this kind of work.

For one copy of a map for display purposes bristol board, or a similar material is very good. The boards are bought in sheets. The other materials may be bought by the roll and by the sheet. Unless you have paper cutting machines the sheets will be easier to handle. Buy the size of sheet to conform to your established programme. Some sheet sizes are as follows; 11 x 15, 15 x 22, 18 x 24, 22 x 30, 24 x 36, and 27 x 40. Rolls of paper are found in 30, 36, 42 and 48 inch widths. The length of the rolls are 10, 50, and 100 yards. Some paper is bought by weight but this will not concern us here.

Hughes-Owens

"Royal Buff"

Drawing Paper

331 1000 series

Rolls

10-50-100 yards

Widths

30-36-42-48 inches

Sheets inches	Cost per sheet as of March 1973
11 x 15	.06¢
15 x 22	.08¢
18 x 24	.10¢
22 x 30	
24 x 36	
27 x 40	

Hughes-Owens

"Burma"

Drawing Paper

331 1500 series

Rolls

10-50-100 yards

Widths

30-36-42-48 inches

Sheets inches	Cost per sheet as of March 1973
11 x 15	.06¢
15 x 22	.08¢
18 x 24	.10¢
22 x 30	
24 x 36	
27 x 40	

Hughes-Owens

Ledger Paper

331 2100 series

Sheets only	Cost per sheet as of March 1973
11 x 17	.05¢
17 x 22	.08¢

Keuffel & Esser Co.

Swallow natural tracing paper

Thickness: .0016 inch approximately

Weight: Sub 13.

Rolls 20 yards 36, 42 inches wide

50 yards 36, 42 inches wide

Sheets cut to order

Cost as of March 1973

18 x 24 sheets per 100 @ $8.70

KEUFFEL & ESSER of CANADA, LTD.
REGISTERED USERS OF THE TRADE MARKS

The *permanently transparent* tracing paper. Transparentized with a solid, stable, synthetic resin. 100% long fiber, highest grade new white rag stock. Outstandingly high tearing strength for its weight. Specially surfaced for uniformly fine pencil and ink taking qualities. Made in three finished weights: 107154 Sub. 14½; 107155 Sub. 17; 107156 Sub. 20. Also available with non-reproducible cross section lines in rolls and pads.

100% MADE IN CANADA

107155 ALBANENE*

PREPARED TRACING PAPER

Thickness: .0025 in. approx.
Weight: Base, Sub. 14; Finished, Sub. 17

Rolls 20 yds., 30, 36, 42 in. wide
Rolls 50 yds., 30, 36, 42 in. wide
Sheets, sizes as ordered, plain or imprinted
105351 Sketch Pad, 50 sheets, 8½ x 11 in.
105353 Sketch Pad, 50 sheets, 11 x 17 in.

Also available as Standard Imprinted Forms in various sizes.

*Reg. T.M.

Cost as of March 1973

18 x 24 sheets per 100 @ $17.80

KEUFFEL & ESSER of CANADA, LTD.
REGISTERED USERS OF THE TRADE MARKS

The *permanently transparent* tracing paper. Transparentized with a solid, stable, synthetic resin. 100% long fiber, highest grade new white rag stock. Outstandingly high tearing strength for its weight. Specially surfaced for uniformly fine pencil and ink taking qualities. Made in three finished weights: 107154 Sub. 14½; 107155 Sub. 17; 107156 Sub. 20. Also available with non-reproducible cross section lines in rolls and pads.

100% MADE IN CANADA

107156 ALBANENE*

PREPARED TRACING PAPER

Thickness: .0028 in. approx.
Weight: Base, Sub. 17; Finished, Sub. 20

Rolls 20 yds., 30, 36, 42 in. wide
Rolls 50 yds., 30, 36, 42 in. wide
Sheets, sizes as ordered, plain or imprinted

Also available as Standard Imprinted Forms in various sizes.

*Reg. T.M.

Cost as of March 1973

18 x 24 sheets per 100 @ $21.30

KEUFFEL & ESSER CO.

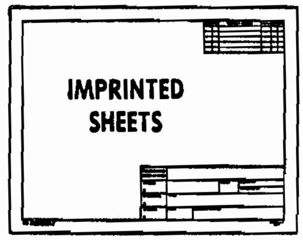
CRYSTALENE II Prepared Tracing Paper is a strong, 100% long-fiber, new white rag paper transparentized with a high-grade mobile synthetic for equally good tracing and reproduction quality. Tracing Papers, CRYSTALENE II may be used with pencil or ink. Its finely grained surface has excellent erasability and aging qualities. Made in two finished weights: 10 9155 Sub. 17; 10 9156 Sub. 20.

CRYSTALENE® II MEDIUM WEIGHT
PREPARED TRACING PAPER

Thickness: .0029 in. approx.
Weight: Base, Sub. 16; Finished, Sub. 17

10 9155	ROLLS	20 yds.	24, 30, 36, 42, 54 in. wide
		50 yds.	24, 30, 36, 42, 54 in. wide
	SHEETS	Sizes as ordered, plain or imprinted	

Also available:
SKETCH PADS in various sizes.
NON-REPRODUCIBLE cross section lines in sheets, rolls and pads.



Cost as of March 1973

18 x 24 sheets per 100 @ $17.30

APPENDIX II

DRAFTING TABLE.

Study the drawing carefully. One half of a sheet of plywood is required for this design. A cutting scheme for a 4 feet by 8 feet sheet of plywood is given on the drawing. The legs, braces, and drawing board cleats are to be made from good quality pine or maple.

The sizes given in the materials list on the drawing are finished sizes. Allowances must be made for waste. Use 1 1/4 inch 10 gauge flathead screws throughout. Always counter-sink the heads until they are flush with the wood surface. Drill 3/16 inch diameter holes all the way through the first piece of wood. The screw should be a push fit into this hole. Then drill a pilot hole into the second piece of wood 1/8 inch diameter to a depth of 1/4 inch.

Construction.

a) Cut out the pieces of plywood as shown in detail A. The numbers on the drawing are the part numbers. Choose the best surface for the drawing board, part number 1.

b) Shape the pieces of plywood for the stand (detail B). The inside piece is cut to allow the leg to slide up and down. Glue and screw the pieces together. Glue and screw the feet on to the bottom of the stand.

c) Assemble the legs and the leg braces. Glue and screw the joints. The inside measurement, between the legs, of 22 inches is critical. It has to match up with the tilt-hinge on the drawing board. The bottom braces should be 12 inches from the end of the legs. Check the frame for squareness by measuring the diagonals of the rectangle made by the legs and the braces.

d) Clamp the stands on to the legs and drill a hole for the bolt 3 inches down from the top of the stand and in the centre. Put in the bolt and tighten the nut firmly. Other holes may be drilled in the legs to allow the height to be adjustable but this can be done later to suit the individual.

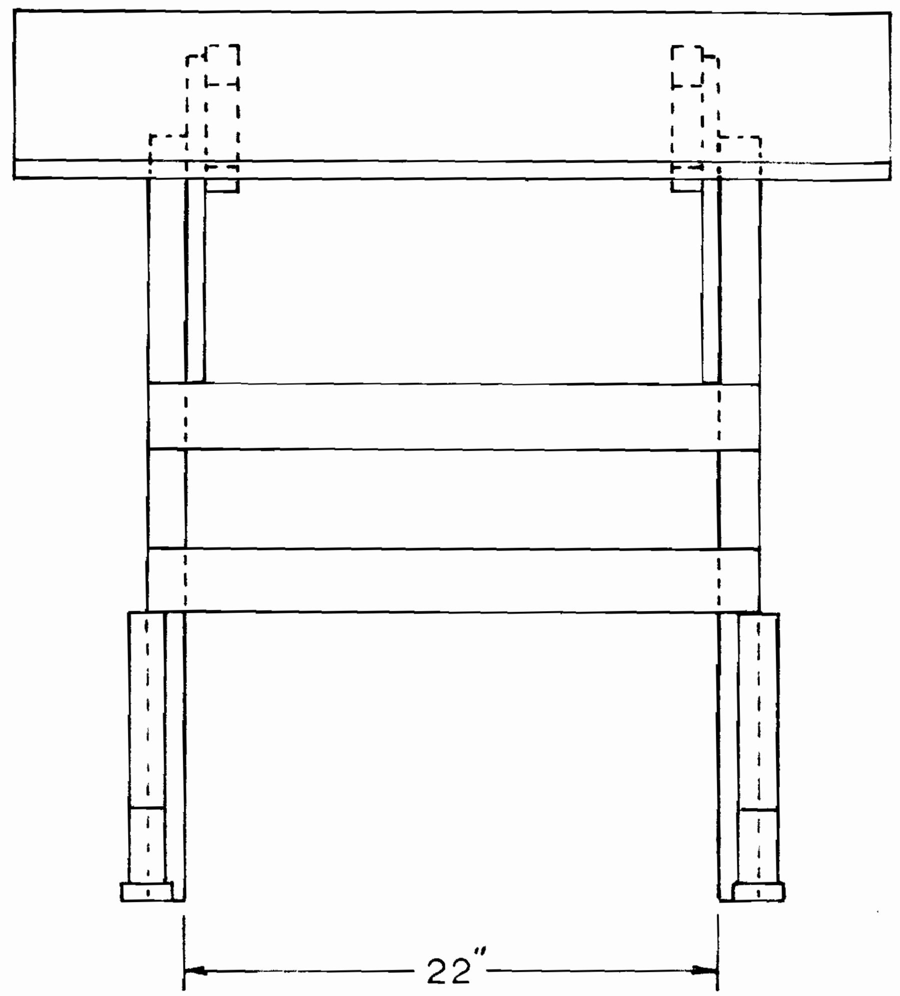
e) Cut out the piece of plywood for the tilt-hinge. Glue and screw it to the drawing board cleat as in detail C. Drill the bolt holes in the tilt-hinge as shown in the drawing.

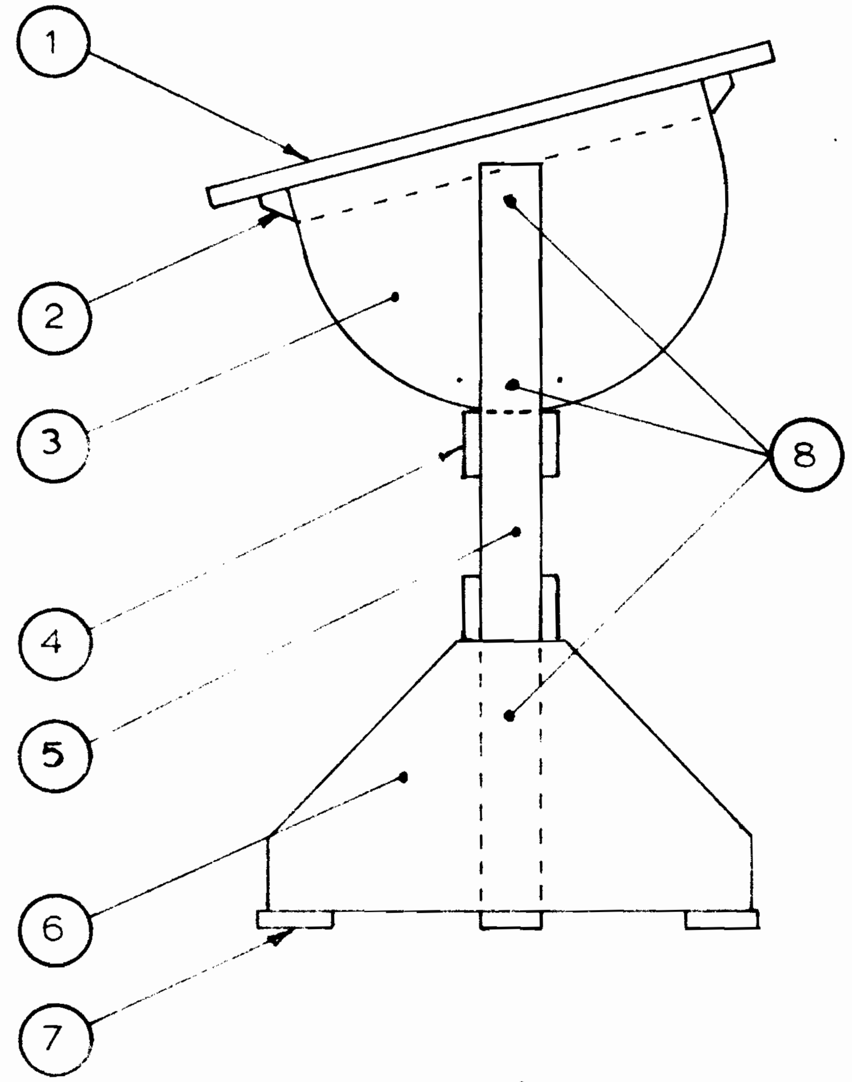
f) Screw the drawing board cleats on to the underside of the drawing board. A hole should be drilled for the head of the screw to a depth of 3/4 inch. The screw will project 1/2 inch. This requires care or the screw will project too far and go through the drawing board.

The drawing board cleats must be positioned carefully in order for the legs to fit snugly on the outside of the tilt-hinge.

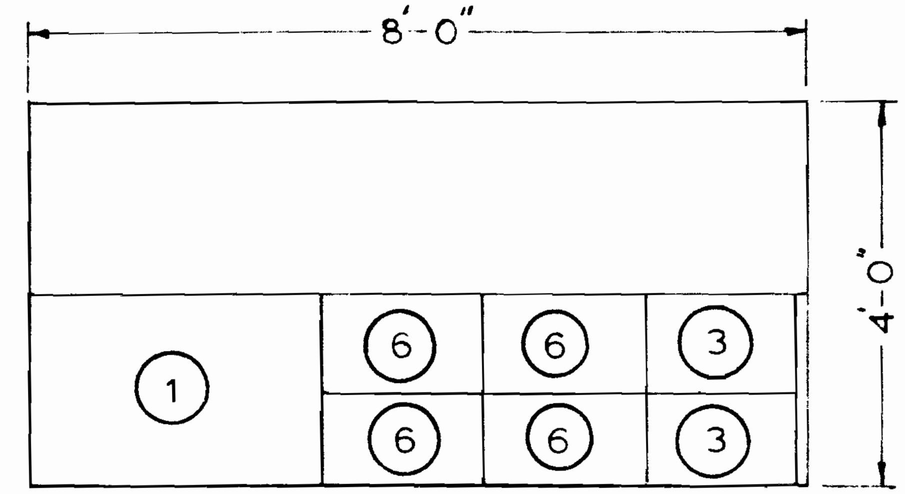
g) Drill a 3/8 inch hole at the top of the leg for the hinge bolt. Assemble the board section to the leg section. Tighten the bolts firmly. Put the drawing board horizontal and drill through the hole in the tilt-hinge into the leg. Check each location of the drawing board with the tilt locating bolt.

h) All edges should be planed straight and square, sand-papered and all the sharp corners taken off. The edges of the drawing board must be straight. Three coats of varnish should be applied to all surfaces with a light sanding between coats. The drawing surface may be covered with contact paper or green vinyl drawing board surfacing. The latter is obtainable in board size (Hughes-Owens catalogue number 314 3105, gauge .020 inch, 23 inches by 31 inches) or by linear foot (Hughes-Owens catalogue number 314 3142, gauge .020 inch, width 42 inches). Aluminum pencil tray is also available (Hughes-Owens catalogue number 312 9608, 31 inches long).





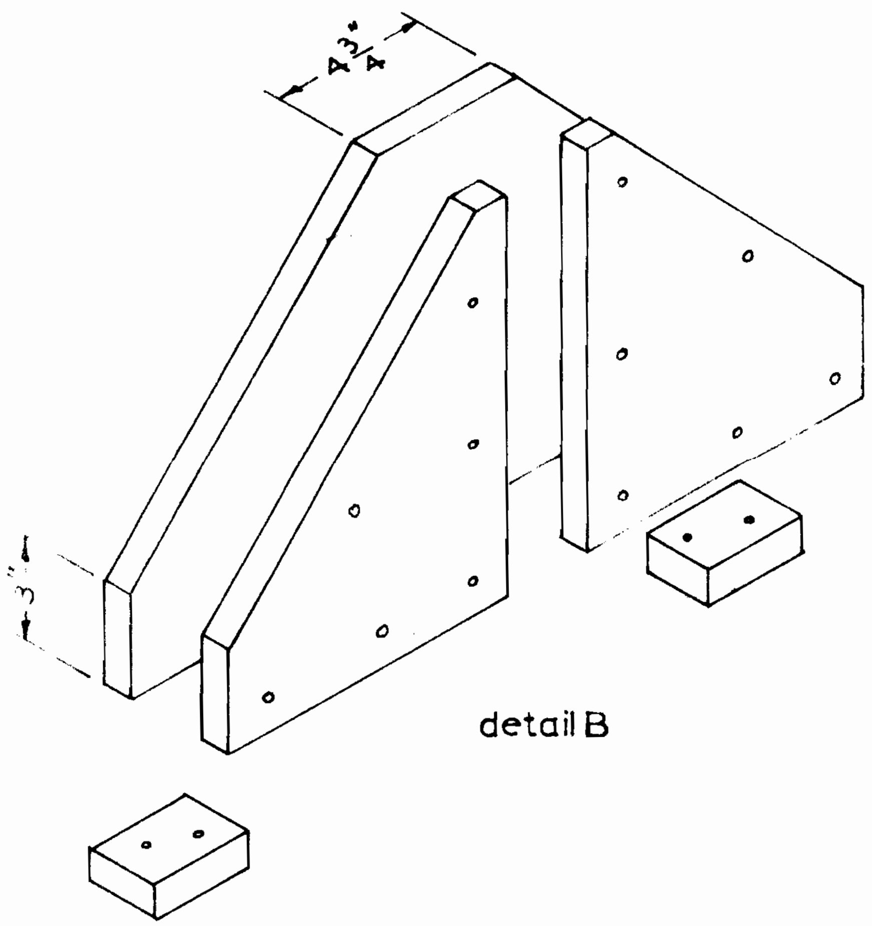
Cutting scheme for the plywood sheet



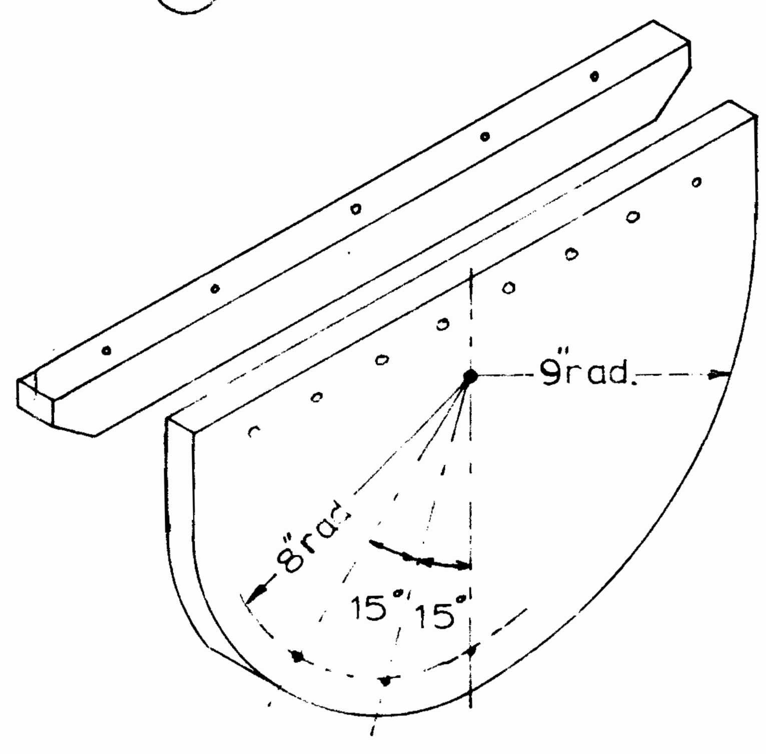
detail A

Working drawing scale $\frac{1}{8}'' = 1''$

Detail drawing scale $\frac{3}{16}'' = 1''$



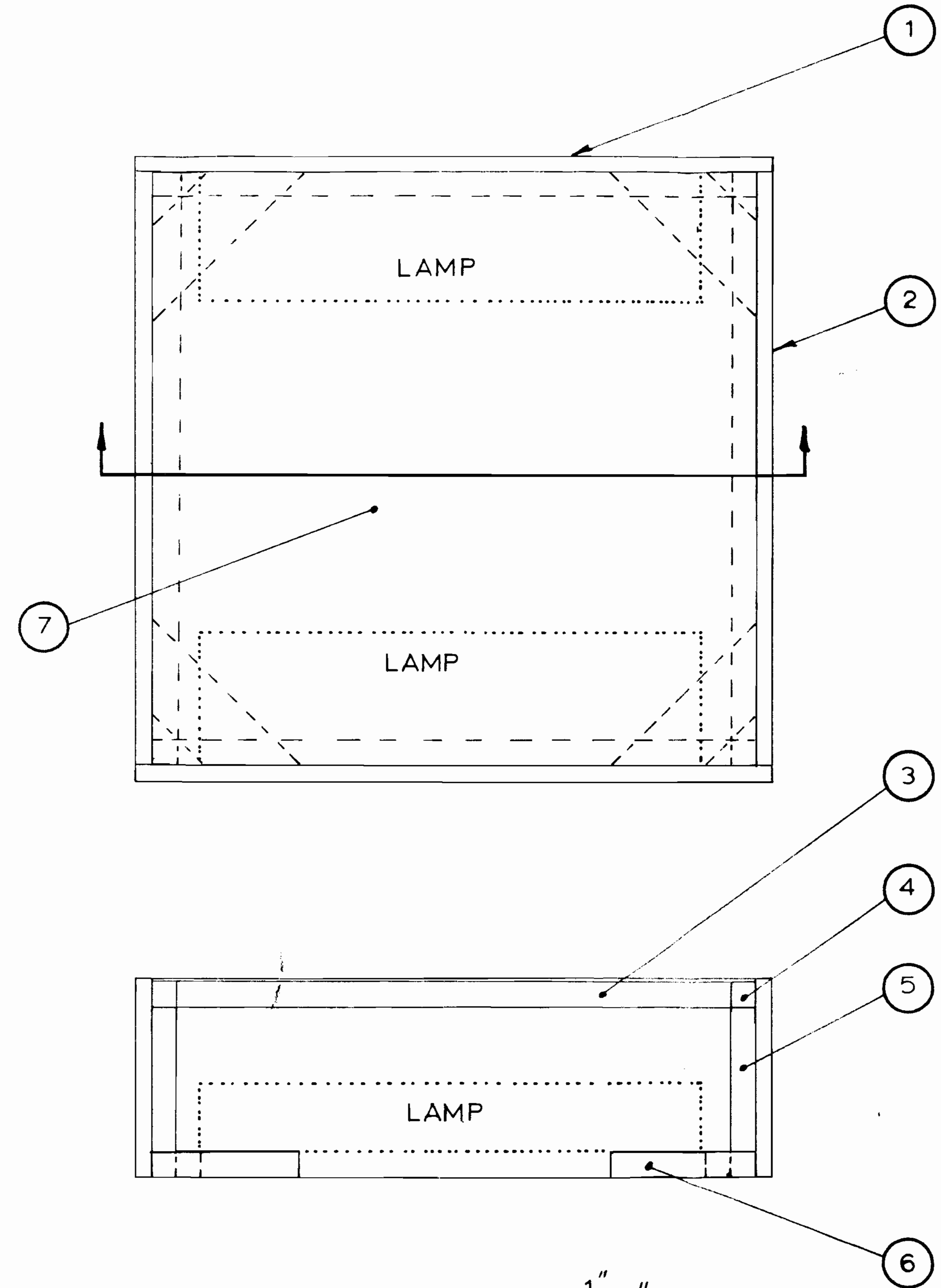
detail B



detail C

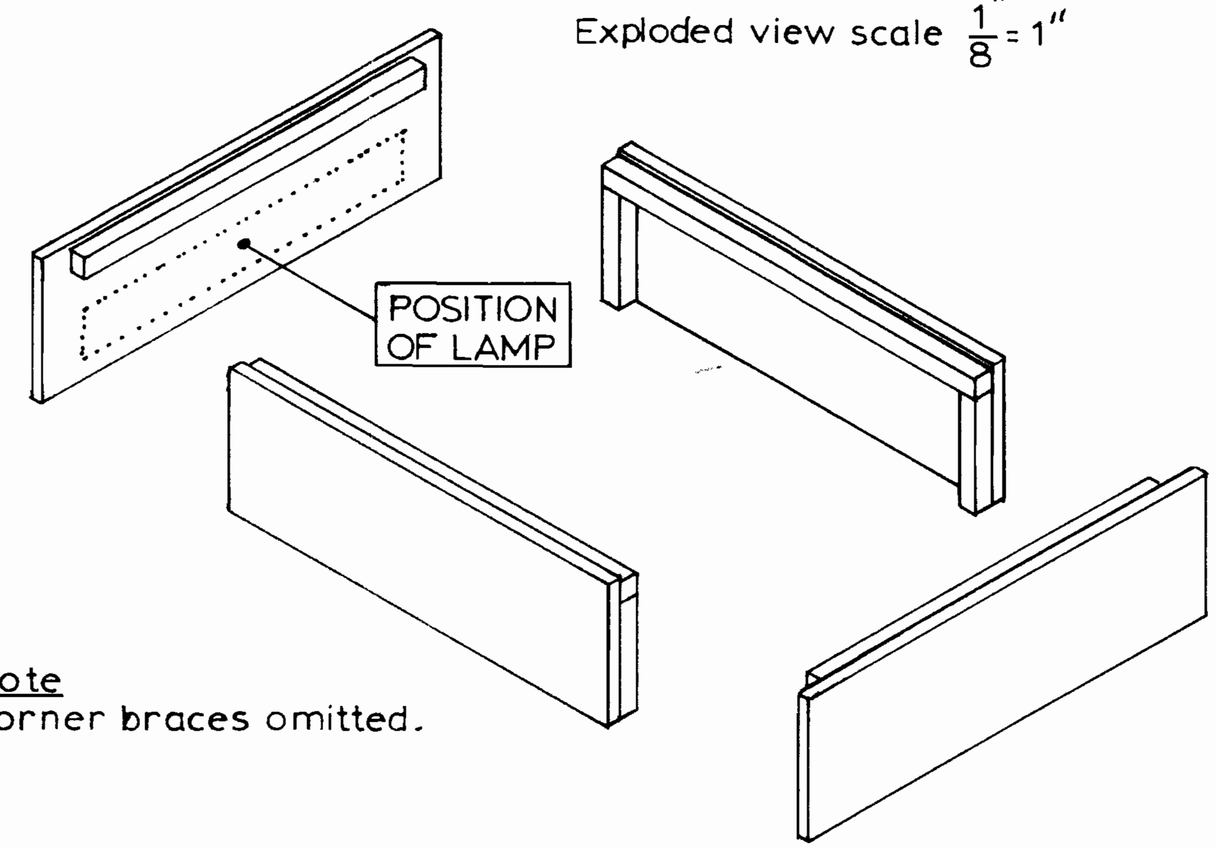
PART No.	NAME	QUAN.	MAT'L	WIDTH	TH'K	LENGTH
1	Drawing board	1	Plyw'd	24	$\frac{3}{4}$	36
2	Board cleat	1 for 2	Pine	$2\frac{3}{4}$	$\frac{1}{2}$	20
3	Tilt hinge	2	Plyw'd	$11\frac{3}{4}$	$\frac{3}{4}$	18
4	Leg braces	4	Pine	$2\frac{3}{4}$	$\frac{3}{4}$	25
5	Leg	2	Pine	$2\frac{3}{4}$	$1\frac{1}{2}$	32
6	Stand	4	Plyw'd	$11\frac{1}{4}$	$\frac{3}{4}$	20
7	Feet (use offcuts)	4	Plyw'd	2	$\frac{3}{4}$	3
8	Carriage bolts	6		$\frac{3}{8}$		3
	Flat head screws $1\frac{1}{4}''$.10	70	Steel			

DRAFTING TABLE	J. C. MARRIOTT	DEC 31st. 1972



Sectioned working drawing scale $\frac{1}{4}'' = 1''$

Exploded view scale $\frac{1}{8}'' = 1''$



note
corner braces omitted.

PART No	NAME	QUAN.	MAT'L	WIDTH	TH'K	LENGTH
1	End	2	Plyw'd	6	$\frac{1}{2}$	19
2	Side	2	Plyw'd	6	$\frac{1}{2}$	18
3	Glass support	2	Pine	$\frac{3}{4}$	$\frac{3}{4}$	$16\frac{1}{2}$
4	Glass support	2	Pine	$\frac{3}{4}$	$\frac{3}{4}$	18
5	Corner block	4	Pine	$\frac{3}{4}$	$\frac{3}{4}$	$5\frac{1}{8}$
6	Corner brace	4	Pine	$1\frac{3}{4}$	$\frac{3}{4}$	$6\frac{1}{4}$
7	Sandblasted glass	1		18	$\frac{1}{8}$	18
	Fluorescent lamp	2				15
	No 18 two strand wire					18ft.
	Plug cap	1				
	Switch	1				

LIGHT TABLE	J.C.MARRIOTT.	JANUARY 7th.1973

APPENDIX III

LIGHT TABLE.

Study the drawing carefully. The sizes of the separate parts are given in the materials list on the drawing. The sizes given are finished sizes. Allowances must be made for waste. The box can be made out of any kind of plywood or particle board. Pine can be used but it is not as stable as manufactured boards. All joints must be glued and nailed. Use finishing nails, set them in, and fill the holes with plastic wood. Give the woodwork three coats of varnish. Sand lightly between coats. The interior could be painted with a matt white or cream oil paint.

Construction

a) Cut out the pieces of plywood to the sizes shown in the drawing. Plane and sand the edges of the plywood. All the pieces must be square and exactly to size to make them easy to assemble.

b) Cut the 3/4 inch square pine to the lengths shown in the drawing. Glue and nail them on to the plywood. The strip supporting the glass must be down 1/8 inch from the top edge of the plywood side.

c) Glue and nail the two end pieces of plywood on to the side pieces of plywood. Put the glass into the box. This will square the box up before the glue sets.

d) When the glue has set, take out the glass and fit the pine corner braces into the four bottom corner. The brace ends

Are cut at 45 degrees and glued and nailed into place. These will keep the box rigid during transportation.

e) Fasten the lamps on to the ends. Do not put them too close to the glass. Fix the switch on to the outside of the box and wire up the lamps.

Costs.

The major outlay for this piece of equipment will be the glass and the two lamps. The following will act as a guide.

Sandblasted glass, 1/8 inch thick, approximately $2. per sq. ft.

Fluorescent lamp, 15 inches long, with a daylight bulb, approximately $6. each.

Teaching Cartography to Children

The beginnings of cartography are lost in the mists of antiquity along with the beginnings of other human endeavours. In those times it was impossible to differentiate between what we now know as cartography and other activities. In fact it is well into the 15th. and 16th. centuries before it is possible to separate the professional cartographer from the geographer. Even then there is never a clear cut line. It will be advantageous therefore to look back to the great times in cartography as they emerge from the vastness of geographic study and achievements.

Maps have come down to us on cave walls showing the routes to hunting grounds, salt-licks and the journey to the nether regions. The oldest surviving map, (3800 B.C.), formed in baked clay, shows land holdings in Babylon, now northern Mesopotamia (Robinson and Sale, 1969). In Turin, Italy, there is a map made in 1370 B.C. showing the Nubian gold mines in Wadi Alaika, Africa. The Islanders in the South Seas have made charts out of reeds and sticks to help them to navigate. These stick charts show the location of the islands and the type of current to expect. The Nile Valley must have been carefully surveyed and mapped to show the land holdings. These maps are called cadastral and were made by direct measurement on the ground.

The first reference to maps in the Hellenic world was by Herodotus (Thomson, 1966). The honour was given to Anaximander in the sixth century before Christ. Pythagoras in 500 B.C. had suggested that the world was spherical. Aristotle agreed entirely with Pythagoras. The spherical shape was inferred from the altitude of the stars at different places. They also pointed out that shorelines and ships came over the horizon when approached. To the great philosophers also the sphere was the most perfect form. Before this concept, Homer's view of the earth, as being a flat disk washed on all sides by oceans, had been accepted.

Eratosthenes of Cyrene, (276 B.C. - 196 B.C.), became head of the Library at Alexandria. He too was convinced that the earth was spherical and worked out the first sound method of measuring the earth's size. He computed that the earth's circumference was 25,000 miles and each degree would be equal to 68.5 miles (ibid, 1966, 4). Posidonius in 100 B.C. also estimated the size of the earth from angular measurements. Both men, unlike the Egyptians, were aided by astronomical observations. The remarkable thing is that although their assumptions and precision were not correct, the methods used were quite valid.

The next Greek of importance was Strabo. He was born in 63 B.C. and was attracted to Alexandria about 25 B.C. after receiving a good education in Rome. Like so many other Greeks he journeyed extensively over much of Europe and Africa. His massive work called Geography put all the known world of his day into a setting of the entire universe. He was well aware of the fact that to know where you are on this planet it is necessary to look into the heavens. The star-lore records of the Babylonion Priests he recognized as being of the utmost importance. The writings of Strabo included information about the stars and planets as well as the nature of the earth itself. His one disservice to cartography was the rejection of the Eratosthene's computation of the earth's size for a much smaller one of 18,000 miles. The degree size he took was only 50 miles.

No Greek maps have survived but from the writings of Claudius Ptolemy it is possible to get an idea of the level of cartography at this time. Ptolemy was a Greek born in Egypt in the second century A.D. Working in the Library at Alexandria, which was the intellectual centre of the western world, he collected all the known knowledge and wrote a treatise on cartography. He recognized the problems of showing a sphere on a flat surface. Although none of his maps have come down to us, he left instructions for the construction of twenty six maps and a general world map. His one major blunder was the acceptance of Strabo's erroneous calculation of the earth's circumference. Ptolemy's length of degree was 56 1/2 miles and one result was he put the equator 400 miles too far north. The errors show up in the maps of the Mediterranean up to 1700 A.D. Ptolemy's writings were lost for a thousand years to the western world but were preserved and expanded upon in the Arab world. They came to light in the 15th. century and had a great influence on European and cartographic thinking during the Renaissance. In the main, Ptolemy, like Strabo, was a compiler of information from a variety of secondary sources.

The western world moved into a period of time referred to as the Dark Ages (Robinson and Sale, 1969). It was a time when intellectual matters declined and the concern with the general theory of cartography died out. The objective thinking of faraway places was replaced by fancy and whimsy. This is shown graphically in the maps produced during those times. Maps were produced of the known world but they became a media for literal interpretations of Biblical passages. The earth was shown in some maps as a square. This was based on the reference to the 'four corners of the earth'. Even more common were the circular maps with Jerusalem at the centre. These are the T and O maps. The earth was divided up into three masses for the three sons of Noah, Shem, Ham and Japheth. The Mediterranean is the upright part of the T. The Don and the Nile rivers form the crosspiece with the whole earth inside a circular ocean. The farthest area away was the orient. Paradise was placed there as it was so difficult to reach. This was placed at the top of the map. From this we get our concept to orient a map. Mythical places, dangers, and beasts were placed in the empty spaces. The legendary kingdom of Gog and Magog, which were unbelieving menaces to the Christian world, is an example.

The Roman's cartographic activity was mainly directed towards surveying their empire (Crone, 1966). Only a copy of one of their maps has survived. This was drawn in twelve sheets around A.D. 1230 and was not discovered until three centuries later. Some of their surveying instruments did survive. Of interest to Canadians is the type of survey. It was not unlike the Dominion Land Survey found in Canada's continental interior.

A positive contribution at this time was the appearance of the Portolan sailing chart (Birch, 1964). These were produced by Italian and Catalan or east Spain seamen, and later by the Portuguese, on the skins of goats, sheep or calves to accompany the sailing directions (peripli). They were the products of experience in sailing the Mediterranean and surrounding waters. The charts were called portolani or harbour finding charts.

The charts are covered by a systematic series of unlabelled intersecting rhumb lines radiating from compass roses. These lines are not true compass sailing directions as they are not on a Mercator projection. The lines and shape of the coastline are remarkably accurate. The mariner's compass was used for local surveys and the astrolabe for determining the latitude. The charts that survived were made after A.D. 1300.

In 1512, Gerard Mercator was born. He combined the concept of latitude and longitude with the comparative accuracy of the local survey. The map projection which bears his name enabled compass directions to be drawn in a straight line. His initial map appeared in 1537, three years after Cartier sailed down the St. Lawrence. The map was published in 1569. He cleared away many of the errors left in maps from Ptolemy.

A widening of mental horizons came in the aftermath of the crusades (Wright, 1965). Merchant travellers moved freely and missions to faraway places were undertaken. The world of fancy and superstition began to recede. The 15th. century saw the discovery, translation and printing of Ptolemy's writings and maps. The end of the century heralded the age of discovery. Columbus, Vasco de Gama, Cabot, Magellan and Elcano sailed under great hardships to places that the Greek philosophers had only dreamed about. By the latter half of the 16th. century the cartographic profession had become well established. It had also become quite a lucrative trade. The products however were not first class examples of objective scientific thought.

A great boon to cartography came in 1450 with printing and engraving. All maps previously had been drawn by hand. This led to omissions and the introduction of new material in the copied maps. There are four maps in existence of Paris' map of England which were copied by the monks at St. Albans. They all differ, in one way or another, from each other. The new engraving and printing processes increased the number of copies, made identical copies, increased the chance of survival, widened the distribution, built-up the great publishing houses and put money back into the business which in turn improved the quality.

A fresh outlook came into cartography between 1600 to 1650. Accuracy and the scientific method became quite fashionable. The Dutchmen Hondius, Jansson and Blaeu produced great atlases as the Dutch republic's wealth grew from its empire.

In the second half of the 17th. century the French academy was founded and work was started on improving the charts and navigation. Precise navigation was a serious problem. It depended on the accurate determination of the size and shape of the earth and a practical method of determining longitude. On land also military action required accurate land maps. The French began to measure accurately the arc along a meridian. With the new triangulation method they began to position the outline of France. They found that the length of a degree differed along meridians. This brought into question the shape of the earth. In the first half of the 18th. century French expeditions in Lapland and Peru measured the arcs along other meridians. Their conclusion was the polar radius was shorter than the equatorial radius.

The problem of determining longitude was overcome in 1765 when Harrison, in England, perfected his chronometer (Brown, 1960). In Europe the governing bodies decided that the present maps were not accurate. They set up authorities such as the Ordnance survey in England in 1791. The next problem that presented itself, after each country was about its surveying, was that each country had its own system of measurement. The English measured in miles, the Russians in versts, and the French in toises. The relationship of one national unit to another was not known.

At the beginning of the 19th. century the metric system was established. A metre became one ten-millionth part of the arc distance from the equator to the pole as then calculated. An international measure became available and this was introduced on to the map along with the national measuring unit.

Turning now to the Canadian scene, maps of Canada began to appear around the 1500's. To put the scene in context with what has been written before, when Columbus was petitioning the Spanish Sovereign in 1491, in a small coastal town of St. Malo in Brittany, Jacques Cartier was born (Thomson, 1966). Jacques Cartier was to explore the Gulf of St. Lawrence without the aid of Mercator's map although they lived at the same time.

Surveying and mapping in Canada started in earnest with the arrival of Samuel de Champlain in 1603. Although he was primarily a surveyor and navigator it is interesting to note that his title at the royal court of Henry IV was that of geographer. Before Champlain's arrival the Royal Engineers and Royal Hydrographers had carried out some land surveys.

With Sieur de Monts, Champlain sailed around the Nova Scotia coast and into the Bay of Fundy. He noted the high tides and the reversing falls. Sailing through the Digby Gut he marvelled at the protected bay and named it Port Royal (Annapolis Basin). In 1605 they built there the first French habitation in North America.

In 1608 Champlain laid the foundation of Quebec City and was appointed lieutenant-governor of the colony. Champlain set about colonizing the new lands. He laid out the seignories of New France along the banks of the rivers. The linear arpent of 180 French feet (191.83 to 192.30 English feet) was used as the unit of measurement. A 1641 map shows that each lot had a river frontage of seven arpents and a depth of 84 arpents or more. These long lots were designed for each settler to have a frontage on a watercourse, which was the principal highway of communication, and the homesteads were close for defence and social purposes.

Champlain is the dean of Canadian land surveyors and from his descriptions he was the first geographer. It is impossible again to separate the two areas of study. His work in the new world changed topographical mapping from the speculative to maps based on first-hand surveys. He travelled extensively taking latitudinal readings which were remarkably accurate, Lachine $45^{o}18'$ (true reading $45^{o}23'$), Hull $45^{o}38'$ (true reading $45^{o}25'33''$). He was truly the pioneer in Canadian geography.

Jean Bourdon took over from Champlain after the latter's death. He served under eight different governors. The mapping done by Bourdon laid a solid foundation for cartography in Canada.

The middle of the 17th. century saw the colonization of New England. Land grants were not usually obtained when the colonists settled. This led to a great deal of confusion. Some townships were eight to ten miles square. It was found finally that an area of six square miles was all a township could manage initially. This became a standard in New England and was introduced into areas of Canada.

Canadian cartography continued to keep up the momentum with the work of Samuel Holland and Captain James Cook. Surveys were made and geographical descriptions were written up as the colonists poured in and the land was settled (Thomson, 1966). It was to be a long time before maps of Canada were produced in Canada.

By the 1900's great technical innovations had been made. The driving impetus which promoted this growth was the two world wars. A better educated general public began to demand good maps and atlases. Newspapers and magazines began to use maps to impress and inform the general reader. As the population grew it became necessary to prepare maps on resources and environmental factors. Photogrammetry, the use of photographs for the production of maps, became possible with the refinements in cameras and film. Air photographs were taken at first from kites, balloons, and on occasions carrier pidgeons provided a platform in the sky. By the 1930's, stereo-plotters were in use which brought together the photograph with the printing process.

The use of photographs was extremely limited until the airplane was used as a platform. This provided a vehicle which was highly mobile and navigable. The airplane, besides being itself a useful tool for cartography, began to make demands on the cartographer. Aeronautical charts were required, at a larger scale than the maps previously drawn, and for areas that had not been mapped.

Space age cartography has moved into remote sensing and moon mapping. Satellites are used as a platform for the cameras. They also provide precise measurements of the earth and its relative position to other planets. The electronic computer has taken over a great deal of the tediousness of plotting maps. The co-ordinates of a land survey are fed into an XY digitizer and the computer stores this in its memory bank. When instructed, it will feed these co-ordinates back to an XY plotter, which will draw the map. With the right programme it will draw a Gall's stereographic zenithal projection centred on Montreal, or any other location on the earth's surface.

Maps have become an indispensable tool in many professions (Greenhood, 1964). As the modern world increases in complexity a greater demand will be placed on mapping techniques. Nearly everyone uses a map at some point in their lifetime even if it is only the route maps given away by the oil companies.

The map extends man's normal horizons to take in the entire earth. Properly constructed the map will display wide spatial relationships which may then be analysed. Small scattered relationships may be brought together in one view so that problems can be solved and the resource potential as a whole may be better observed.

In the actual process of studying cartography, Monkhouse and Wilkinson (1963) have proposed this criteria for a course in cartography.

> The discipline necessary to attain this proficiency involves three things:
> (1) the handling of raw material and data;
> (2) a critical knowledge of cartographical principles and techniques; and
> (3) actual drawing practice to attain some degree of manual dexterity and skill in the execution of maps.

For a course in cartography at the college level or for vocational purposes these concepts are excellent. At the level of a grade nine student are they justifiable?

The course outlined in part one is not aimed for the top academic stream of students. There is something in there for every one. The material can be arranged into several programmes to suit the requirements of different levels of attainment. A great deal of emphasis is given towards the skills required in drafting. Bloom (1969) brushes off this aspect in his study of the _Taxonomy of Educational Objectives; Cognitive Domain_ (p.7). He recognized that there was so little being done in the high schools and colleges about the psycho-motor domain that he saw no reason why it should be covered in his programme. This emphasizes the feeling and modern trend in education that the manual skills are not important. Supposedly it is only the academic aspect of education that warrants study. It should be remembered that there are far more 'hewers of wood and drawers of water' on this planet than there are discussants of McLuhan's philosophy. Until this trend is corrected the average and below average student is not getting a good education in the high school.

Simple handwork was first introduced into education by Froebel (Boyd, 1964; Good, 1957). Manual skills he suggested should be introduced early and be used, ". . . to cultivate the mind and elevate the spirit". The handwork was designed to be an educational means to develop the inate capacities and interests of the children. The vocational aspect of manual skill was added later in the United States with the promotion of manual training in schools to provide workers for industry. Froebel did not accept the vocational aspect, as he maintained that a well-educated person, following a liberal programme should be able to turn his hand to anything. Man should not work just to provide adequate food, clothing and shelter.

The skills obtained in this course in cartography will not prepare the child for a vocation in cartography. It will help to develop manual dexterity and change the student from a passive role in education to an active role. The practical work entailed in producing the map will help recall of the information transmitted by the map (Walford, 1970).

A certain amount of knowledge must be assimilated, even in a practical course such as cartography. It is the kind of knowledge that is used in relation to other objectives rather than knowledge for its own sake (Bloom 1969, 33). The drawing of the maps require the manipulative and motor skills which assume knowledge of materials and tools such as pens, paper, ink, set squares and erasers. This knowledge lays a base for constructing the maps, the methods used, and for solving all the problems that will crop up as the map progresses from one stage to another (ibid, 41).

Through this knowledge it is possible to develop problem solving skills. In the 20th. century world it is impossible to predict what problems students will have to face. Our culture is not a closed system (ibid, 40). An individual must be prepared to act using his past experiences in new situations as they arise and by adapting make the necessary changes. It is not possible to equip an individual to meet every eventuality. He must be prepared to cope. This type of a course will help to promote and develop the intellectual abilities and skills to adapt to new situations.

The exercises on statistical mapping in part one can be classified as translation under the general heading of comprehension (ibid, 89). Raw data which is received by the student either on his own initiative or provided by the teacher is put into another language. During this change from one medium to another the meaning may change. This requires a great deal of selection and care by the student. The overall concept should not change although the emphasis may do so. The art of the cartographer during this translation period is to get the reader to respond in a favourable manner.

Producing the base map and the plotting of the statistical material requires the student to draw his material from many sources. He displays in his map what he considers to be relevant to the problem and discards anything that is superfluous. What he produces is quite unique and requires him to go through the mental process of synthesis (ibid, 163). The medium is the map and as McLuhan (1969) suggests the medium is the message. If the student really extends himself his creativity could be enormous in scope.

All students in geography will have to use the map as a tool. The remark by Peattie (1968) to teachers is excellent advice for students too. "To relieve the frustration of projections the only course open is to take a course in cartography and learn about projections". All maps have some faults. Not realizing what these faults are have led students into making erroneous conclusions from the maps that they are studying. As maps hold a certain fascination over people it is a good idea to capitalize on this and introduce cartography to them.

Many professional geographers and geography teachers have got into the business from daydreaming over maps. In the Heart of Darkness, Marlow speaks aloud that many have voiced only to themselves.

> Now when I was a little chap I had a passion for maps. I would look for hours at South America, or Africa, or Australia, and lose myself in all the glories of exploration.

> At that time there were many blank spaces on the earth, and when I saw one that looked particularly inviting on a map (but they all look that) I would put my finger on it and say 'When I grow up I will go there'. (Conrad, 1969, 10).

This daydreaming may be gently guided into reality and a stimulating experience will be the end result. No map in itself is complete. It requires an effort on the part of the viewer to fill in the blank spaces.

Children today are the products of the printed word (McLuhan, 1969). They have been brought up to believe that what is written is good and because of this it is the best means of cummunication. There is a great technological shift in process now which is creating a much greater public than the written word ever had. The written word has cleaved apart the visual faculty from the rest of man's senses. It is time to bring the senses together and humanize man again before the electric circuitry of technology makes passive depositories of all mankind.

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