LESSON

8

Where Are We?

Years 6 to 9

Maps, Bearings and Distances

This lesson introduces students to the cardinal point and the more precise 360 degree methods of specifying bearings on maps. The lesson includes problems and activities that involve measuring and calculating distances using map scales.

In this lesson students will:

- specify bearings using the compass rose and in degrees;
- calculate distances represented on a map, using the map scale;
- measure bearings with a protractor; and
- use bearings to find the perimeter of a block of land.

Materials Required

For each student:

- a MATHOMAT;
- unlined paper (scrap paper will do);
- a fine-point pen or pencil;
- a copy of Worksheets 8.2, 8.3 and 8.4 (photocopy masters are provided at the end of the lesson);
- felt-tipped and highlighter pens; and
- a drawing pin with their initials marked on it.

Additional materials:

- a piece of chalk for each group of four students;
- at least one magnetic compass, preferably one for each group of four students (orienteering style compasses similar to those manufactured by Silva or Suunto are ideal);
- a photocopy of Worksheet 8.1, Distances and Bearing of Students Homes from School;
- a street directory or other map of the local area—see the later section For The Teacher for details; and
- (optional) an aerial photograph of the school and its environs.

Lesson Summary

- Marking sites on a map and measuring distances and bearings;
- specifying bearings using the cardinal point and the 360° bearing methods; and
- using bearings and scale diagrams in a surveying exercise.

For the Teacher

The magnetic compass was invented in China about 3000 years ago and reached Europe about 1200 AD. It is a piece of technology still widely used and whose essential method of operation has not changed in all that time!

Modern maps (including road maps and street directories) and compasses simplify the task of finding our way between and within towns and cities, as well as in more remote areas. Any map is an interpretation or representation of part of the earth—just how much of the earth is represented depends on the scale of the map.

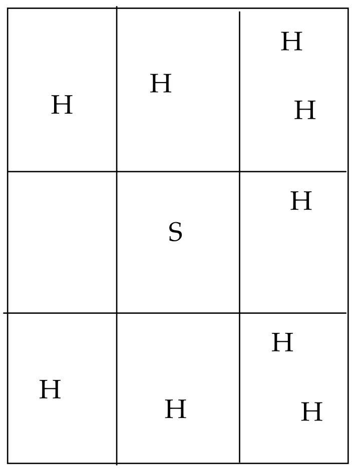
In this lesson students identify familiar locations on a map and measure distances and bearings associated with these locations. They use the cardinal point method for referring to bearings when precision is not required, and use the protractor on the MATHOMAT to measure bearings in degrees in situations requiring greater precision. As an example of an application of scales and bearings, students use scale diagrams to calculate perimeters of irregularly shaped blocks of land.

Ideally, the class should be divided into groups of four to six students for this lesson.

To use a map to find our direction of travel we need to know which direction is north on the map—most maps are printed with north at the top. You can use a compass to find the actual direction of north 'on the ground.' In most places there is a difference between magnetic north and true north but, at this introductory level, the difference does not affect the activities in the lesson.

In this lesson, students will need to refer to a map of the local area. Suitable maps can often be constructed from street directories. Select the page of the directory which contains the school, and the pages covering the surrounding areas which contain the homes (H) of most of the students. Join photocopies of these pages to form a map with the school (S) at the approximate centre—typically, nine to twelve pages form a convenient map.

Map constructed
from 9 directory pages



If your student's homes are widely dispersed then you may need to add further pages to the map, or use a topographical map covering a larger area. Avoid maps with scales less than 1: 50 000.

(In Victoria, a large range of maps and aerial photographs is available from Information Victoria, 356 Collins Street, Melbourne.)

Fasten the map to a notice board and pin a copy of Worksheet 8.1 next to it. If possible, display several copies of the map around the classroom and organise the class into groups of four to six pupils.

Activities in parts 3 and 4 of the lesson are best attempted in a paved area of the school grounds.

Although this is presented as a single lesson, several sessions will be required to complete all the activities.

Lesson Outline

1. Using maps, identifying features and measuring distances

This activity capitalises on the students' knowledge of the local area in order to extend their abilities to use a map, identify significant features on it and measure distances related to these features.

Begin the lesson with a class discussion based on the map of the local area (see For the Teacher). Focus initial discussion on the identification of major roads and significant local features such as parks, streams, sporting venues, etc—use felt-tipped pens of various colours to highlight the features.

Ask students to identify the streets in which they live and indicate the position of their homes with a drawing pin on which they have written their initials. Four or five students working at the map at any one time is sufficient.

If an aerial photograph of the area is available, it will enhance interest in the lesson as well as aid the identification of features.

Hold a class discussion about the information the students have marked on the map—identify clusters of students' homes, the students living closest/ furthest from school, the position of pupils' homes in relation to shops etc . Select some students to demonstrate their routes to school, using highlighter pens to mark the routes.

Ask all students to measure, in centimetres, the straight line length from home to school and the length of the actual route travelled to school. A centimetre scale is provided on the left-hand side of MATHOMAT—the fact that it is transparent is useful when measuring on a map.

Each student can then record their results on a displayed class copy of Worksheet 8.1, as shown below. These lengths should be recorded in the second and fourth columns of the worksheet—the remaining columns will be completed later in the lesson.

Name	Straight line distance to school		Straight line distance to school		Bearing from school to home
	cm	m	cm	m	
Bill	15		21		
Betty	6		9		

2. Calculating distances from map measurements

Begin this part of the lesson with a class discussion of 'scale'. At this stage there is no need to mention map scales as ratios. For example, many street directories have a scale of 1 : 20 000, but discussion should be based on the distance represented by 1 centimetre—in this example, 1 centimetre represents 200 metres.

Topographical maps often have scales with 1 cm representing 250 m or 1 cm representing 500 m.

Initially estimations of distances, rather than exact measurements, are appropriate. If you are using a street directory with a scale of 1 : 20 000, such as Melway, suitable questions for class discussion include:

- How far is it across one page of the street directory?
  (About 20 cm; 4000 m or 4 km.)

- What distance is represented by the length of the page?
  (About 25 cm; 5000 m or 5 km.)

- What is the distance on one side of the grid printed on the page?
  (2 cm; 400 m)

The answers to these questions help students to estimate distances on the class map.

Now ask students to estimate the distances between some of the features previously identified.

Guide discussion to the more accurate calculation of distances using the map scale.

Ask students to calculate the distances to their homes and enter them in the table as shown below. In this example the distances are given in metres. Depending on the age and background of your students you may elect to convert these to kilometres.

Map distances, using a '1 cm represents 200 m' scale, entered on Worksheet 8.1

Name	Straight line distance to school		Length of route to school		Bearing from school to home
	cm	m	cm	m	
Bill	15	3000	21	4200	
Betty	6	1200	9	1800	

(This information is ideal for entering into a spread-sheet. Sorting and graphing exercises can be based on it, and extra columns for the distance travelled each week and for a whole year can be added.)

3. Specifying bearings using a compass rose

Shape 15 on the MATHOMAT is a compass rose. The cardinal points, N, S, E, W, SE, SW, etc are used in situations where precise bearings are not required. For example, a knowledge of them is useful in discussion situations, such as, ‘I will meet you on the south west corner’, ‘Braeside is south east of Melbourne’ and ‘The south bank of the Yarra.’

To find the bearing (direction) of a feature from the school, place the MATHOMAT compass rose on the map, with the school at its centre and N on the rose aligned with north on the map—the bearing is the cardinal point on the rose closest to the feature. For example, in the diagram below, Bill's home is north east of the school.

The two activities in this part of the lesson clarify the concept of 'bearing' and provide an introduction to its more precise measurement.

Bill’s home is NE of the school; the school is SE of Bill's home

Begin with a class discussion of N, S, E and W and how these relate to the class map—mark them on the map. Demonstrate the compass rose and ask students to find the bearings (cardinal point) of several features on the map, including their homes, from school. The bearings to homes can be entered in the table.

Name	Straight line distance to school		Length of route to school		Bearing from school to home
	cm	m	cm	m	
Bill	15	3000	21	4200	NE
Betty	9	1200	9	1800	SW

In part 1 of this lesson significant features such as clusters of students' homes were identified. Use the now-completed worksheet to revisit the discussion of these features, incorporating information from the worksheet—for example, ‘there is a cluster of four homes about 4000 metres east of the school’.

4. Introducing the magnetic compass

Many students are unable to indicate north in their surroundings. They need the opportunity to relate 'north' as the top of the map, to 'north' as a direction.

Demonstrate a magnetic compass and explain how to use it to find north. If possible, allow each student an opportunity to play with the compass. The N of the compass rose on the MATHOMAT can be oriented so that it points north—the other cardinal points then begin to make sense.

Remind students who confuse east and west of the map of Australia and that Western Australia is 'on the left'.

Organise the class into groups of four and move into the school grounds, preferably onto a paved area. Ask each group to use chalk to mark a north-south line on the ground, using a compass as an aid. Use this to draw an enlarged (1 metre diameter) chalk version of the MATHOMAT compass rose. (This in itself is an interesting exercise. How can the cardinal points be marked reasonably accurately? Why not have a compass rose professionally painted in the school yard?)

Students can now use their large compass roses to find bearings. To find the bearing to an item, students stand in the compass rose and face the item—the bearing is the cardinal point in front of them.

Ask the students to note the bearings of several features visible from the school grounds. The compass roses can be used in part 5 of this lesson.

5. Measuring bearings with a protractor

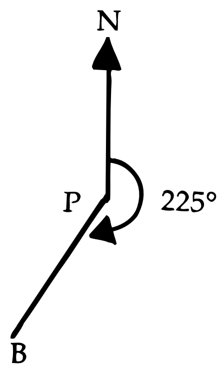
Bearings measured in degrees are used for surveying and precise navigation. Most modern compasses are marked in degrees from 0˚ to 360˚. By convention, bearings are measured clockwise from north.

Direction	Bearing
North	0˚
East	90˚
South	180˚
West	270˚

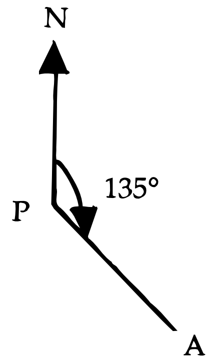
Ask students to extend the above table by calculating bearings, in degrees, corresponding to additional cardinal points: NNE, NE, ENE, ESE, SE, SSE, SSW, SW, WSW, WNW, NW and NNW. Depending on the space available, some of these can be written on the compass roses drawn in the school grounds.

Students need to be given the opportunity to measure angles on maps which represent bearings—examples given to them must encompass the full range of bearings from 0˚ to 360˚. Demonstrate the measuring of bearings with a protractor, stressing the significance of the N-S line.

The bearing from P to B is 225˚



The bearing from P to A is 135˚



To measure bearings, turn the MATHOMAT upside down and align 0° on the protractor with north on the map. Although now 'back to front' the protractor scale is still easy to use.

Ask students to complete Worksheets 8.2 and 8.3.

6. Using bearings to find the perimeter of a block of land

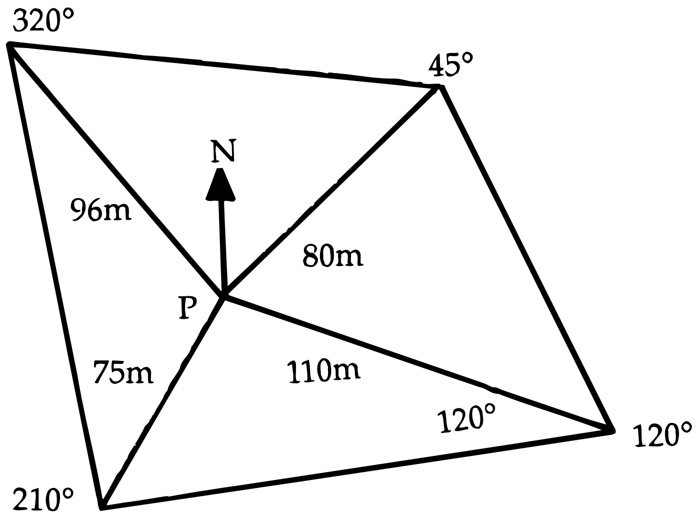
The 'radiation' method, which is explained below, may be used to find the perimeter of an irregularly shaped (polygonal) portion of land—it can be used even if the perimeter is not directly measurable because of obstructions etc.

Demonstrate and discuss this technique with the students and ask them to complete one or more of the exercises on Worksheet 8.4.

To use this method, choose an arbitrary point P near the centre of the land. For each corner of the land make two measurements:

- the bearing from point P to the corner; and
- the distance from point P to the corner.

These measurements are now incorporated into a scale diagram—a realistic scale for this example is to use 0.1 cm to represent 1 m.



A block of land with corners at A, B, C and D: Bearings and distances are displayed

To construct the diagram draw a N-S line through the central point P and use the protractor on the MATHOMAT to draw lines with the appropriate bearings. By measuring along these lines the corners can be marked and the boundary drawn and measured in centimetres. To calculate the perimeter, measure its length in centimetres and use the same scale to convert this length to metres.

7. Optional extension for older students

An interesting exercise is for students to use the radiation method to find the perimeter of an irregularly shaped section of the school ground.

Mark the corners of the chosen section with school bags or pieces of wood and ask students to measure the distances and bearings from a marked point within the area.

Students will find the measurement of bearings challenging and may require assistance. Two methods are available,

- either, measure the bearings directly with a compass;
- or, draw 'sighting lines' and north-south lines on the ground and measure bearings with a protractor (a 'sighting line' is a line drawn from the fixed point in the direction of the corner).

Compare the calculated perimeter with that found by direct measurement.

Distances and Bearings of Students' Homes from School

SCALE: 1 centimetre represents ☐ metres.

Name	Straight line distance to school		Length of route to school		Bearing from school to home
	cm	m	cm	m	

Measuring Bearings in Degrees

Here is a road map of an area south of Melbourne, it includes part of Albert Park Lake. Locate each site in the following list on the map and use the protractor on MATHOMAT to find its bearing, in degrees, from the southern tip of Gunn Island—the island near the north end of the lake.

1. The corner of Queens Rd. and Arthur Street (K5) ☐ degrees
2. The Town Hall in Bank Street (E2) ☐ degrees
3. Chinese Joss House in Raglan Street (E4) ☐ degrees
4. The water fountain in Albert Park Lake (G7) ☐ degrees
5. The southern end of Dodd Street (G1) ☐ degrees
6. Palmerston Place (H2) ☐ degrees

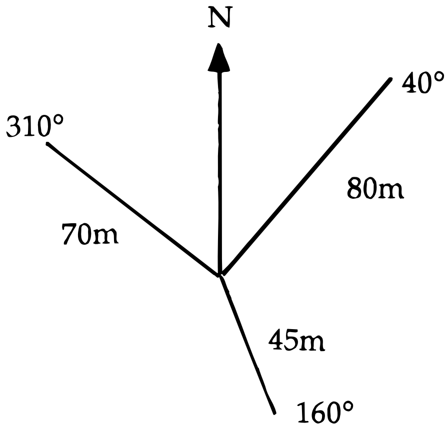
Find the Surf Beach

To challenge visiting friends one wet day during their holidays, Con and Sue planned complex instructions for a route from home to their favourite surfing beach. Their friends accepted the challenge and, armed with a MATHOMAT and a copy of the map (scale 1cm represents 200 m), successfully followed the directions—they located the correct place on the map. Can you find the surf beach?
The Directions.
Start at Con and Sue's home at the southern end of Woodlands Drive (D3). Follow a bearing of 98˚ for 400m. Travel due south for 300 m until you reach a road. Follow this road in a generally southern direction for 460 m and turn into the street which has a bearing of 234˚. Follow this street for 440 m. Turn into the road which has a bearing of 100˚ and follow it for just 70 m and turn south. Cross the park to the exit whose bearing is 196˚ from where you entered the park. Walk south for 40 m then turn onto the road which has a bearing of 93˚. Follow this road for 970 m. Travel on a bearing of 180˚ for 170 m to the meeting place on the beach.

Scale Diagrams and Perimeters

Each of the following is a rough 'field' sketch, made by a surveyor, of a plot of land. Make an accurate scale drawing of each region and find its perimeter.

1.



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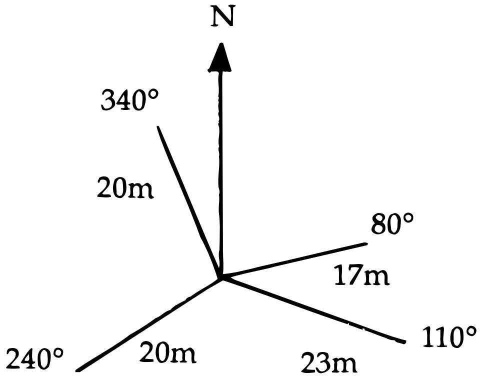

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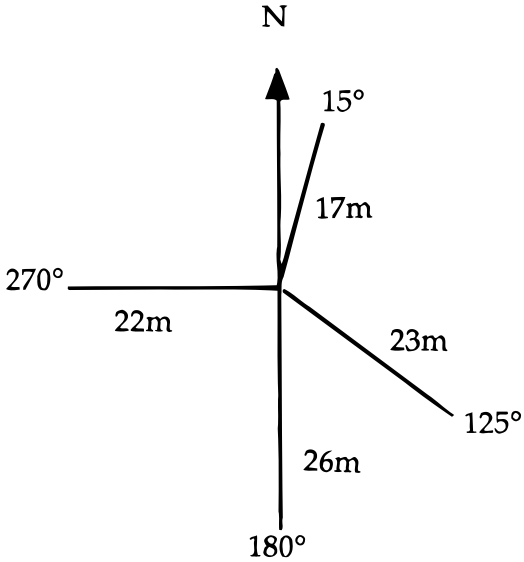

4.