6.2

Perspective and Orthographic Drawings

Suggested Timing
80 min

Tools
• grid paper
• isometric dot paper
• square dot paper
• linking cubes
• rulers
• coloured pencils
• computers
• *The Geometer's Sketchpad®*

Related Resources
BLM 6-7 Section 6.2 Perspective
    and Orthographic Drawings
BLM G-4 Square Dot Paper
BLM G-5 Isometric Dot Paper
BLM T-2 *The Geometer's Sketchpad® 3*
BLM T-3 *The Geometer's Sketchpad® 4*
BLM A-7 Thinking General
    Scoring Rubric

Link to Prerequisite Skills

Students should complete Prerequisite Skills questions 10 to 12 before proceeding with this section.

Warm-Up

1. a) Use isometric dot paper to draw a hexagon that contains the least number of dots. How many dots are there inside the hexagon?
   b) Measure the sides of the hexagon. What do you notice?
2. a) You can build a frame model of a cube using drinking straws. How many straws would you need? Assume you use whole straws.
   b) How many drinking straws would you need to build a frame model of a square-based pyramid?

Warm-Up Answers

1. a) 1 dot   **b)** The sides are all the same length. The hexagon is regular.
2. a) 12 straws   **b)** 8 straws

Teaching Suggestions

Warm-Up
• Write the Warm-Up questions on the board or on an overhead. Distribute copies of **BLM G-5 Isometric Dot Paper**. Have students complete the questions independently. Then, discuss the solutions as a class.

Section Opener
• Ask students to discuss some advantages and disadvantages of the kind of architecture shown in the photograph.
• The design of Habitat '67 was not a popular design for apartment buildings. Ask students to suggest reasons why this might be so.
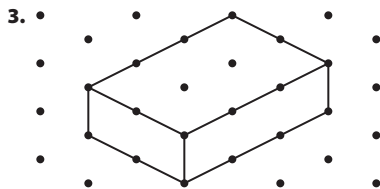
Investigate
• For Method 1, supply students with **BLM G-4 Square Dot Paper** and **BLM G-5 Isometric Dot Paper**.
• For Method 2, you may wish to copy the file **Dot Paper.gsp** into a more convenient directory for students to load from. The dots on the dot paper are generated using transformations. You cannot select most of them. You can adjust the dot spacing using the slider. It is suggested that you leave the spacing at the default setting, or it may cause problems later when dot paper is used to draw plans and make measurements.
• If you do not have a set of linking cubes available, you could use plastic blocks. Cardboard boxes could be used to build a large model that the whole class can see easily.

Investigate 1

Method 1

2. The spaces between the dots are 1 cm. The cube has a side length of 1 cm. The sides of the cubes on the drawing all have a length of 1 cm.
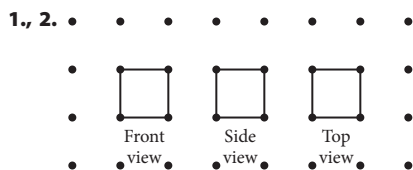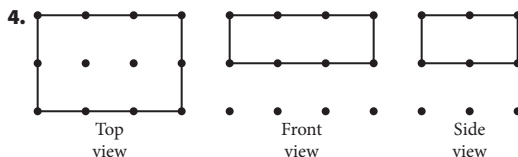
3.

Method 2

3. The spaces between the dots are 1 cm. The cube has side a length of 1 cm. The sides of the cubes on the drawing all have a length of 1 cm.

4. See the drawing in Method 1, question 3.

Investigate 2 (page 309)

Method 1

1., 2.

Front view   Side view   Top view

3. They are the same. The cube looks the same from the front, the side, and from the top.

**4.**

Top view   Front view   Side view

Method 2

2., 3. See drawing in Method 1, questions 1-2.

4. They are the same. The cube looks the same from the front, the side, and the top views.

5. See the drawing in Method 1, question 4.

Examples

- Have students work through the Examples as a class before proceeding to the Discuss the Concepts. Alternatively, have students complete the Examples independently or in small groups before reviewing them as a class.
- For Example 3, the isometric perspective drawing of a cylinder can be done using dot paper, a ruler, and a compass.

Centre   Radius
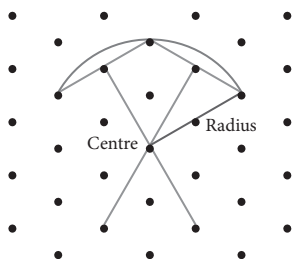
- Select three dots in a row. Join the dots with line segments.
- Use dots to help you draw the perpendicular bisector of each line segment.

- The dot where the perpendicular bisectors meet is the centre of the circle. Use a compass to draw an arc through the three dots.
- In a similar manner, draw the other three arcs needed for the cylinder.
- Draw the sides of the cylinder.
- Drinking straws, popsicle sticks, and coffee stir sticks are all useful materials for constructing scale models. Corners can be held in place with duct tape, plasticine, or modelling clay.
- Isometric perspective works reasonably well for straight-edged objects whose corners meet at right angles, such as cubes or rectangular prisms. It is not as satisfactory for objects with curved edges or sides that do not meet at right angles.

Key Concepts
- You can wrap up the Key Concepts by presenting a scale model that students have not seen before. Ask them to sketch the isometric perspective drawing and a set of orthographic drawings.

Discuss the Concepts
- Have the students work with a partner. Discuss the answers as a class.
- For **question D1**, it would be useful to have a three-dimensional model available for demonstration purposes after students have given their answers.
- For **question D2**, you may wish to have students try to build a model of this shape using linking cubes or other materials.

Discuss the Concepts Suggested Answers (page 313)

D1. Indira is correct. All three orthographic drawings of this object will look the same, an L-shape of three squares.

D2. It could not represent a real object. In the C-shaped portion of the diagram, the single layer of cubes changes height. At one end, it joins the stair-step portion of the diagram at the bottom. At the other end, it joins at the top.

Practise (A)
- Encourage students to refer to the Investigates and the Examples before asking for assistance.

Apply (B)
- **Question 5** is a Literacy Connect. You may wish to assign this question as a journal entry or to discuss the question as a class.
- When reviewing **question 7**, a model of a cone with the height equal to the diameter should be available. Cut out a circle of any convenient radius, r, from heavy construction paper or Bristol board. Cut out another circle of radius $\sqrt{5}r$ .Cut the second circle along a radius, and bend it into a cone such that it fits on top of the first circle.
- It may be useful to have a large image of Escher's *Convex and Concave* when discussing **question 8**. You can download the image from the Internet, then use a data projector to project it onto a screen. Go to the McGraw-Hill Ryerson Web-site at *www.mcgrawhill.ca/books/foundations11* and follow the links for more of Escher's "impossible" drawings.
- **Question 9** links to the Chapter Problem. Remind students to keep the solution to this question handy as the methods they used may help them with the Chapter Problem Wrap-Up.

- Some students find isometric drawings confusing and cannot decide in which direction a particular face is pointing.

R_x As the drawing is created, shade all faces pointing in the same direction using the same colour and shade, as in the diagram in question D2. This creates a better sense of the perspective.

- Some students may miss openings or cut-outs when drawing orthographic views.

R_x Have students make a model for each set of orthographic views. The original and the model should match if the views are drawn correctly.

Accommodations

Memory—have students put definitions of new terms on the word wall

Visual—provide concrete models of objects to be represented using orthographic projections and/or isometric perspective drawings

Perceptual—have students use technology to create orthographic drawings

Gifted and Enrichment—challenge students to produce sketches of interesting optical illusions, such as the Necker Cube

Extend (C)

- Assign the Extend questions to students who are not being challenged by the questions in Apply.
- For **questions 12** and **13**, you can likely find several art students who can present a quick perspective drawing using vanishing points, if you do not have the training yourself. Students might be willing to bring in some of their work, and show how they made use of perspective.

Literacy Connections

- Have students write a journal entry describing the different methods of representing objects, and the advantages and disadvantages of each method.

Mathematical Process Expectations

Process Expectation	Questions
Problem Solving	7, 11
Reasoning and Proving	1, 3, 7, 10
Reflecting	7
Selecting Tools and Computational Strategies	2
Connecting	6, 8, 12
Representing	6–9, 11–13
Communicating	4, 5, 7, 8, 10

Ongoing Assessment

- Use **BLM A-7 Thinking General Scoring Rubric** to assess students' responses to **question 7**.

Extra Practice

- You may wish to use **BLM 6-7 Section 6.2 Perspective and Orthographic Drawings** for remediation or extra practice.