CHAPTER 11
Visualizing and Constructing Polyhedrons

Goal
Visualize and build polyhedrons from 2-D nets.

At-Home Help
A polyhedron is a closed three-dimensional shape with polygons as faces. Pyramids and prisms are two kinds of polyhedrons.

For example:

1. Which are nets of pyramids? How can you tell?
   nets A and D
   Suggested answer: Pyramids have triangular faces, except for the base. Both these nets have triangles.

2. Which are nets of prisms? How can you tell?
   nets B and C
   Suggested answer: Prisms have rectangular faces, except for the top and base. Both these nets have rectangles.

3. What nets can you make from these shapes?
   Sketch each net and name the polyhedron it would make.

   square-based pyramid
   hexagonal prism
   cube
   hexagonal prism
   rectangular prism
   hexagonal pyramid
CHAPTER 11

Surface Area of Polyhedrons

Determine the surface area of triangular and rectangular prisms.

1. a) Sketch a net for the triangular prism. Label the dimensions.
   Suggested answer:
   \[\text{area of prism} = 2 \times \left(\frac{6 \text{ cm} \times 4 \text{ cm}}{2}\right) + (7 \text{ cm} \times 6 \text{ cm}) + 2 \times (7 \text{ cm} \times 5 \text{ cm})\]
   \[= 24 \text{ cm}^2 + 42 \text{ cm}^2 + 70 \text{ cm}^2\]
   \[= 136 \text{ cm}^2\]

   b) Determine the surface area of the triangular prism.

2. a) Sketch a net for the rectangular prism. Label the dimensions.

   b) Determine the surface area of the rectangular prism.
   \[\text{area of prism} = 2 \times (9 \text{ cm} \times 5 \text{ cm}) + 2 \times (9 \text{ cm} \times 8 \text{ cm}) + 2 \times (8 \text{ cm} \times 5 \text{ cm})\]
   \[= 2 \times 45 \text{ cm}^2 + 2 \times 72 \text{ cm}^2 + 2 \times 40 \text{ cm}^2\]
   \[= 90 \text{ cm}^2 + 144 \text{ cm}^2 + 80 \text{ cm}^2\]
   \[= 314 \text{ cm}^2\]

At–Home Help

The surface area of a polyhedron is the total area of all of the faces, or surfaces, of that polyhedron.

For example, the surface area of this cube is 24 cm\(^2\) because each face has an area of 4 cm\(^2\).
**CHAPTER 11**

**Volume of Rectangular and Triangular Prisms**

**Goal** Calculate the volume of rectangular and triangular prisms.

1. Determine the volume of each rectangular prism.

   a) [Diagram of a rectangular prism with dimensions 5 cm x 6 cm x 4 cm]

   **Suggested answer:**
   - **Area of base:** length x width = 5 cm x 6 cm = 30 cm²
   - **Volume of prism:** area of base x height = 30 cm² x 4 cm = 120 cm³

   b) [Diagram of a rectangular prism with dimensions 3 cm x 7 cm x 9 cm]

   **Suggested answer:**
   - **Volume of prism:** length x width x height = 7 cm x 3 cm x 9 cm = 189 cm³

2. Determine the volume of each triangular prism.

   a) [Diagram of a triangular prism with dimensions 4 cm x 5 cm x 8 cm]

   **Suggested answer:**
   - **Volume of prism:** area of base x height = (4 cm x 5 cm ÷ 2) x 8 cm = 80 cm³

   b) [Diagram of a triangular prism with dimensions 6 m x 3 m x 5 m]

   **Suggested answer:**
   - **Volume of prism:** area of base x height = (6 m x 3 m + 2) x 5 m = 45 m³

**At-Home Help**

**Volume** is the amount of space an object takes up.

You can calculate the volume of a prism using the rule:

\[
\text{Volume} = \text{area of base} \times \text{height}.
\]
Solve Problems by Making a Model

Make models to solve problems.

You will need centimetre cubes.

1. Jared is building rectangular prisms with 12 centimetre cubes.
   a) Which prism has the least surface area?
      Suggested answer:
      Understand the Problem
      I need to determine the dimensions of the rectangular prism with the least surface area.
      Make a Plan
      I’ll model the prism using 12 centimetre cubes.
      I’ll make rectangular prisms with the cubes and calculate the surface area of each one.
      I’ll record my results in a chart.
      Carry Out the Plan

      | Prism | Surface area |
      |-------|-------------|
      |       | surface area = 50 cm² |
      |       | surface area = 40 cm² |
      |       | surface area = 38 cm² |
      |       | surface area = 32 cm² |

      The prism that is 3 cm long, 2 cm wide, and 2 cm high has the least surface area.
      The surface area of this prism is 32 cm².

   b) What is the volume of the prism in part a)?
      Suggested answer: volume of prism = length \times width \times height
      = 3 \text{ cm} \times 2 \text{ cm} \times 2 \text{ cm}
      = 12 \text{ cm}³
CHAPTER 11

Creating Isometric Sketches

Goal
Sketch a polyhedron built from cubes.

You will need linking cubes.

1. Build the cube structures shown. Sketch each structure on isometric dot paper.

2. a) Build a structure using up to 10 linking cubes.
   b) Sketch your structure on isometric dot paper.

At-Home Help
An isometric drawing is a three-dimensional view of an object that can be drawn on isometric dot paper. All equal lengths on the cubes are equal on the grid.

For example, the vertices of this cube are placed on the dots.
Creating Cube Structures from Sketches

Goal

Create cube structures based on an isometric sketch.

You will need linking cubes.

1. a) Build a cube structure based on the isometric drawing. How many cubes did you use?
   
   7 cubes

   b) Sketch at least two views of your cube structure so someone else could build it exactly as you did.
   Suggested answer:

   

2. a) Build another cube structure using more cubes than you used in Question 1.
   How many cubes did you use? 8 cubes

   b) Sketch at least two views of your cube structure so someone else could build it exactly as you did.
   Suggested answer:

   

At-Home Help

It is possible to build cube structures based on isometric drawings.

For example, the isometric drawings below represent a cube structure.

Two cube structures that match the drawing would be

In order to know exactly how many cubes to use, you need more than one drawing to show what the cube structure looks like.
Different Views of a Cube Structure

**Goal**

Draw top, front, and side views of a cube structure.

1. Sketch the top, front, right, and left views of this cube structure.

   ![Cube Structure Diagram](image)

   top view  front view  right view  left view

   - **At-Home Help**
     - Cube structures can be represented accurately if their top, front, and side views are shown.
     - For example, the cube structure above can be represented by top, front, and side views.

2. **a)** Sketch the top, front, right, and left views of this cube structure.

   ![Cube Structure Diagram](image)

   top view  front view  right view  left view

   **Suggested answer:** The right view shows changes in depth, which means there are steps. If you don’t draw the left view, you might think that there are steps on that side too. The structure does not have any changes in depth on the left view. So the left view looks different from the right view.

   **b)** Why is it important to include both side views?

   - **Suggested answer:** The right view shows changes in depth, which means there are steps. If you don’t draw the left view, you might think that there are steps on that side too. The structure does not have any changes in depth on the left view. So the left view looks different from the right view.
Creating Cube Structures from Different Views

**Goal**

Make cube structures when given their top, front, and side views.

You will need linking cubes.

1. a) Make three different cube structures that match the top view. *Suggested answer:*

   ![Top View Diagram]

   ![Front View Diagram]

   ![Right View Diagram]

   ![Left View Diagram]

   b) Make three different cube structures that match the right view. Do any of your cube structures match both the top and right views? *Suggested answer:*

   ![Top View Diagram]

   ![Front View Diagram]

   ![Right View Diagram]

   ![Left View Diagram]

   *None of my cube structures for part b) has a top view that matches.*

   c) Make several different cube structures that match the front view. Do any of your cube structures match all four views? *Suggested answer:*

   ![Top View Diagram]

   ![Front View Diagram]

   ![Right View Diagram]

   ![Left View Diagram]

   *Yes, my first structure in part c) matches all four views.*
Circle the correct answer.
Use the polygons below to answer Questions 1 and 2.

1. Which combination of shapes would make a pyramid?
   A. 3 triangles, 1 square
   B. 4 triangles, 1 rectangle
   C. 5 triangles, 1 hexagon
   D. 6 triangles, 1 hexagon

2. Which combination of shapes would not make a prism?
   A. 2 hexagons, 3 rectangles, 3 squares
   B. 2 hexagons, 6 rectangles
   C. 2 triangles, 3 rectangles
   D. 2 triangles, 3 squares

Use the prism below to answer Questions 3 and 4.

3. What is the surface area of the rectangular prism?
   A. 74 cm$^2$
   B. 120 cm$^2$
   C. 148 cm$^2$
   D. 240 cm$^2$

4. What is the volume of the rectangular prism?
   A. 74 cm$^3$
   B. 120 cm$^3$
   C. 148 cm$^3$
   D. 240 cm$^3$
Use the prism below to answer Questions 5 and 6.

![Prism diagram]

5. What is the surface area of the triangular prism?
   A. $624 \text{ cm}^2$  
   B. $424 \text{ cm}^2$  
   C. $570 \text{ cm}^2$  
   D. $1040 \text{ cm}^2$

6. What is the volume of the triangular prism?
   A. $960 \text{ cm}^3$  
   B. $2800 \text{ cm}^3$  
   C. $864 \text{ cm}^3$  
   D. $2240 \text{ cm}^3$

7. All of the cube structures below are made with seven cubes. Which ones are the same?

   ![Cube structures]

   A. a, d  
   B. b, c  
   C. b, e  
   D. a, f

8. Which top, front, and side views match cube structure c in Question 7?

   ![Cube views]

   A.  
   B.  
   C.  
   D.  

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