1.3

Surface Area

Student Text Pages
26–35

Suggested Timing
80–160 min

Tools
- variety of boxes and cans (with labels)
- scissors
- rulers
- scientific calculators
- computers with *The Geometer's Sketchpad®*

Optional
- grid paper
- Polydron® pieces, colour tiles, or linking cubes

Related Resources
BLM 1-10 Section 1.3 Example 2 Net
BLM 1-11 Section 1.3 Surface Area
BLM 1-12 Section 1.3 Achievement Check Rubric

Link to Prerequisite Skills

Students should complete all the Prerequisite Skills questions before proceeding with this section.

Warm-Up

1. What does the volume of a box measure?
2. What does the surface area of a box measure?
3. What units are used for volume and surface area?

Warm-Up Answers

1. Volume is a measure of how much space the box occupies.
2. Surface area is the total area of all the faces of the box.
3. Volume is measured in cubic units. Surface area is measured in square units.

Teaching Suggestions

- You may wish to complete this section over two periods. Monitor students' progress while they work through Example 1, the Discuss the Concepts questions, and the Practise questions. If necessary, complete Example 2 and the Apply and Extend questions another day.

Warm-Up

- Display the Warm-Up questions. Have students complete the questions independently. Then, discuss the solutions as a class.

Section Opener

- Bring in packages like the ones in the opener photograph for students to see and manipulate.

Investigate

- The purpose of the Investigate is to help students see the relationship between the surface area of a three-dimensional figure and the areas of its faces.
- Consider using a jigsaw approach in which small groups of students use different tools or technology, such as linking cubes, TABS+, or graph paper. Then have students return to their home groups to describe their methods and verify their results.

Investigate Answers (pages 26–27)

Part A

1. Answers may vary. For example: cereal box: $l = 19.4$ cm, $w = 25.6$ cm, and $h = 5.2$ cm
2. b) The net has six faces; there are three pairs of congruent rectangular faces.
3. Answers may vary. For example:
a) Two faces with area 496.64 cm^2, two faces with area 100.88 cm^2, and two faces with area 133.12 cm^2.
b) 1461.28 cm^2
4. Since there are three pairs of congruent faces, the surface area is double the sum of the areas of each type of face.

Part B

1. Answers may vary. For example:
a) soup can: $d = 7.3$ cm and $h = 11.1$ cm **b)** 3.65 cm

2. b) It is a rectangle.

c) The width of the label is the height of the can. The length of the label is the circumference of the can.

3. Answers may vary. For example:

a) 41.9 cm^2 **b)** 254.6 cm^2 **c)** 338.4 cm^2

4. The formula for the surface area of a cylinder is composed of the area of the faces of the cylinder: the area of two circles plus the area of a rectangle. The length of the rectangle is the circumference of the base of the cylinder.

Examples

- For Example 1, students must use the given diameter to determine the radius before applying the surface area formula. Have a model available. When converting the answer, students must divide by the conversion factor, 10, twice.
- Example 2 requires several steps to complete. First identify the shapes of the various faces of the figure and then decide how to calculate the area of each face. Students must apply the Pythagorean theorem to determine one of the required dimensions.
- Students can use **BLM 1-10 Section 1.3 Example 2 Net** to build the figure.

Key Concepts

- Ensure students understand the Key Concepts.

Discuss the Concepts

- Concrete materials, such as Polydron® pieces, are helpful in constructing models for these questions.

Discuss the Concepts Suggested Answers (page 31)

D1. a) The surface area of an open box is wh less than the surface area of a congruent closed box.

b) The surface area of the closed box is S.A. $= 2(lw + hl + wh)$, while the surface area of the open box is S.A. $= 2(lw + hl) + wh$.

D2. a) The surface area of the open cylinder is πr^2 less than the surface area of the closed cylinder.

b) The surface area of the closed cylinder is S.A. $= 2\pi r^2 + 2\pi rh$, while the surface area of the open cylinder is S.A. $= \pi r^2 + 2\pi rh$.

D3. a) five faces

b) two triangular faces; three rectangular faces

c) one pair of congruent triangular faces; one pair of congruent rectangular faces

d) Calculate the area of each face and then add the areas.

Practise (A)

- Students may benefit from using concrete materials, such as Polydron® pieces to construct models. Have students work in pairs for the Practise questions.
- For **question 1**, students can assume the slope and indentation in the box lid are negligible and base their calculations on a flat lid.

Apply (B)

- **Question 6** lays a foundation for the optimization work in sections 1.4 to 1.6. Colour tiles or grid paper may be helpful problem solving tools.
- For **question 7**, you may need to remind students to convert units.
- For **question 8**, students need to relate the diameter of a golf ball to both the base side length and height of the rectangle-based prism box. A model might help students visualize the problem.
- **Question 9** provides an opportunity to discuss why it is often cheaper, per unit, to purchase items such as milk in larger quantities.
- **Question 11** is an Achievement Check question. It can be used for diagnostic or formative assessment, or assigned as a small summative

Common Errors

- Some students may miss faces or include too many faces when calculating surface area.

R_x Have students construct a net for each figure, and consider all the faces that must be included. In the case of an open box or cylinder, students should consider which faces to omit.

- Some students may use a volume formula to solve a surface area problem.

R_x Have students construct an organizer to help them clarify and distinguish the two concepts. When solving a problem involving a three-dimensional figure, encourage students to clearly identify which measure they must determine before choosing a formula or tool.

Accommodations

ESL—allow students to use point form in their Investigate responses

Motor—for the Investigate, provide a partner to assist with cutting and measuring

Visual—encourage students to use technology to construct nets whenever possible

Perceptual—cover a variety of three-dimensional figures with construction paper. Use Velcro tape to attach the paper to the object. Have students unwrap the shapes to see the net created in each case.

Spatial—provide grid paper for drawing nets and a three-dimensional model for each figure

Language—use a model to demonstrate the definitions of the terms *net area* and *lateral area*

Memory—post the formulas for the surface area of rectangular prisms, triangular prisms, and cylinders

Gifted and Enrichment—have students construct a net for a spherical object. Use clear plastic wrap to cover a ball. Cut out any overlap. Unwrap the ball and trace the net onto grid paper. Hypothesize a strategy for determining the surface area of the ball.

assessment piece. You may wish to use **BLM 1-12 Section 1.3 Achievement Check Rubric** to assist you in assessing your students.

- For **questions 11** and **12**, the Extrusion tool in TABS+ can be used to create a prism with a base of any shape.
- **Question 13** links to the Chapter Problem. Remind students to keep the solution to this question handy as it may help them with the Chapter Problem Wrap-Up.

Extend (C)

- For **question 15**, some students will use proportional reasoning to determine the area of the curved edge for one of the six wedges, then find the surface area of one wedge and multiply by six. Other students will determine the outer surface area of the complete wheel, then determine the area of the 12 interior faces. Some students will use different strategies.
- **Question 16** provides a good foundation for the optimization work in sections 1.4 to 1.6. Some students may benefit from using linking cubes.

Achievement Check Answers (page 34)

11. a) Use the Pythagorean theorem to calculate the length of the sloped section of the pool.

$$l = \sqrt{(36 - 20)^2 + (4 - 1.5)^2}$$
$$= 16.2$$

The pool liner is composed of four different rectangles and two pentagons, which can be broken into a rectangle and a trapezoid.

$$\text{Area of liner} = 18 \times 1.5 + 18 \times 16.2 + 18 \times 20 + 18 \times 4 + 2\,((20 \times 4) + 0.5\,(1.5 + 4) \times 16)$$
$$= 998.6$$

The area of the pool liner is 999 m^2.

b) $$\text{Material cost} = 999 \times 5$$
$$= 4995$$

The cost of the liner material is $4995.

No. The actual cost would be higher. It would include an installation charge and taxes. Also, the liner material probably is sold in rolls and there would be some waste. At places where two pieces of liner material join, there will be overlap to make the seam.

Literacy Connect

- Allow students to work in pairs or small groups when completing the Investigate.
- Encourage students to draw the shapes and label the dimensions when completing the Practise questions.

Mathematical Process Expectations

Process Expectation	Questions
Problem Solving	6, 9, 11, 13–16
Reasoning and Proving	6, 9, 11, 14
Reflecting	9–11
Selecting Tools and Computational Strategies	14
Connecting	6, 9–16
Representing	1–4, 10, 14–16
Communicating	9, 11

Extra Practice

- Use **BLM 1-11 Section 1.3 Surface Area** for remediation or extra practice.