Name: _____ Date: _____

UNIT 4

2.4.6 — Surface Area of Prisms

Faces • Nets • Rectangular Prisms • Cubes • Square Units • Surface Area vs Volume

A. SURFACE AREA FOUNDATIONS

Use precise mathematical language and include units where appropriate.

1. **Surface area** is the total area of _____ .
2. Surface area is measured in _____ units, while volume is measured in _____ units.
3. A rectangular prism has three pairs of congruent faces: _____ , _____ , and _____ .
4. Complete the formula shown: $SA = 2(lw + lh + wh)$. Explain what each product represents.

   _____
5. Why is multiplying **length × width × height** not a surface-area method?

   _____

B. CALCULATE SURFACE AREA

Show the three face-pair areas or an equivalent correct method.

1. Find the total surface area of a **10 cm × 4 cm × 3 cm** rectangular prism.

   _____
2. Find the total surface area of a **6 cm × 4 cm × 2 cm** rectangular prism.

   _____
3. Find the total surface area of a **9 cm × 5 cm × 2 cm** rectangular prism.

   _____
4. Find the total surface area of a **2.5 m × 1 m × 0.5 m** rectangular prism.

   _____
5. A cube has side length **7 cm**. Use $SA = 6s^2$ to find its surface area. _____

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2.4.6 — Surface Area of Prisms

Nets • Missing Faces • Open Prisms • Error Analysis • Comparing Surface Areas

C. NETS AND MISSING FACES

A net helps you account for every outside face exactly once.

1. A rectangular prism has dimensions **8 cm × 5 cm × 3 cm**. List the six face areas represented in its net.

   _____

2. An open-top rectangular box is **12 cm × 8 cm × 5 cm**. Use $SA_{open} = lw + 2lh + 2wh$ to find the material needed. _____

3. A shed is **9 m × 4 m × 2 m**. The exterior is painted, including the roof but not the floor. Find the painted area.

   _____

4. A parcel is **30 cm × 20 cm × 10 cm**. How much cardboard is needed to cover it completely?

   _____

D. REASONING AND ERROR ANALYSIS

1. A student writes: "For a 6 cm × 4 cm × 2 cm prism, surface area = 6 × 4 × 2 = 48 cm²." Identify the error and give the correct surface area.

   _____

   _____

2. For an **8 cm × 5 cm × 3 cm** prism, calculate each pair of face areas and verify that the total is 158 cm².

   _____

3. Two prisms both have volume **36 cm³**: **1 × 6 × 6** and **2 × 3 × 6**. Calculate both surface areas. What does this show about equal volume and surface area?

   _____

   _____

4. If every dimension of a prism is multiplied by a scale factor **k**, its new surface area follows $SA_{new} = k^2 SA_{old}$. If the dimensions are doubled, by what factor does surface area change?

   _____

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Applications • Units • Reverse Problems • Measurement • Communicating a Method

E. SURFACE AREA IN CONTEXT

Decide which faces are actually covered before calculating.

1. A studio is **6 m × 4 m × 3 m**. The four walls and roof are clad, but the floor is not. Find the cladded area. _____
2. A closed shipping box is **40 cm × 25 cm × 15 cm**. Packaging requires **8%** extra cardboard for tabs and waste. How many square centimetres of cardboard should be allowed?

   _____
3. An open-top aquarium measures **80 cm × 35 cm × 45 cm**. Find the total glass area in (a) cm^2 and (b) m^2.

   _____
4. A rectangular prism measures **0.6 m × 40 cm × 25 cm**. Convert to one unit, then find the total surface area in m^2.

   _____

F. REVERSE AND INQUIRY PROBLEMS

1. A rectangular prism has length **8 cm**, width **5 cm**, and total surface area **158 cm^2**. Find its height.

   _____
2. A rectangular prism has length **5 m**, width **4 m**, and total surface area **94 m^2**. Find its height.

   _____
3. Explain how a net can help prevent both **missing a face** and **counting a face twice** when calculating surface area.

   _____

   _____
4. Write one sentence explaining why a surface-area answer must use square units rather than cubic units.

   _____

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2.4.6 — Surface Area of Prisms

Extended Problems • Optimization • Scale Factors • Packaging • Multi-Step Reasoning

G. EXTENDED PROBLEMS — MULTI-STEP REASONING

Show labelled working and justify any rounding.

1. **Same volume, different design.** Three closed boxes all have volume **72 cm³**:
   A: 1 cm × 8 cm × 9 cm B: 2 cm × 6 cm × 6 cm C: 3 cm × 4 cm × 6 cm.
   Find each surface area and identify which design uses the least material.

2. **Packaging allowance.** A parcel is **32 cm × 18 cm × 10 cm**. Wrapping requires **12%** extra material for overlap. Find the minimum whole number of cm² of wrapping to prepare.

3. **Reverse cube problem.** A cube has total surface area **486 cm²**. Find its side length and volume.

4. **Square-based prism.** A closed prism has a square base of side **x cm** and height **10 cm**. Its surface area is **448 cm²**. Find **x**, then find the volume.

H. EXTENDED PROBLEMS — ANALYSIS AND TRANSFER

5. **Scale model.** Every dimension of a prism is enlarged by a factor of **1.5**. The original surface area is **160 cm²**. Find the new surface area and explain the scale-factor rule used.

6. **Painting estimate.** A room is **5 m × 4 m × 3 m**. Only the four walls are painted. Two coats are required, and one tin covers **12 m²**. How many tins are needed?

7. **Generalization.** The prisms 1 × 6 × 6 and 2 × 3 × 6 have the same volume but different surface areas. Write a short conclusion about how changing dimensions while keeping volume fixed can affect surface area.

ANSWER KEY

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ANSWER KEY — 2.4.6 Surface Area of Prisms

Teachers: accept equivalent correct methods with clearly labelled square units.

A. SURFACE AREA FOUNDATIONS

1. **all outside faces of a 3D object**.
2. **square** units; **cubic** units.
3. **lw, lh, wh**, each occurring twice.
4. **lw, lh and wh are the areas of the three different rectangular face types; the factor 2 counts the congruent opposite face.**
5. **lwh calculates volume, the space inside the prism, not the total outside covering.**

B. CALCULATE SURFACE AREA

1. $2(10\times4 + 10\times3 + 4\times3) = 2(40+30+12) =$ **164 cm²**.
2. $2(24+12+8) =$ **88 cm²**.
3. $2(45+18+10) =$ **146 cm²**.
4. $2(2.5+1.25+0.5) =$ **8.5 m²**.
5. $6(7^2) =$ **294 cm²**.

C. NETS AND MISSING FACES

1. **40, 40, 24, 24, 15, 15 cm²**; total 158 cm².
2. 96 + 120 + 80 = **296 cm²**.
3. Total closed SA = 124 m²; subtract the 36 m² floor: **88 m²**.
4. $2(600+300+200) =$ **2200 cm²**.

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ANSWER KEY — 2.4.6 Surface Area of Prisms

Teachers: accept equivalent correct methods with clearly labelled square units.

D. REASONING AND ERROR ANALYSIS

1. 6×4×2 = 48 gives the **volume, 48 cm³**. Surface area = 2(24+12+8) = **88 cm²**.
2. Top/base: 2(8×5)=80; long sides: 2(8×3)=48; ends: 2(5×3)=30. Total = **158 cm²**.
3. 1×6×6: 2(6+6+36)=**96 cm²**. 2×3×6: 2(6+12+18)=**72 cm²**. **Equal volume does not force equal surface area.**
4. Doubling gives k=2, so surface area changes by 2^2 = **4**.

E. SURFACE AREA IN CONTEXT

1. Walls = 2(6×3)+2(4×3)=60; roof = 24. Total = **84 m²**.
2. Box SA = 2(1000+600+375)=3950 cm². Add 8%: 3950(1.08) = **4266 cm²**.
3. Open top: 80×35 + 2(80×45) + 2(35×45) = **13,150 cm² = 1.315 m²**.
4. 0.6 m = 60 cm. SA = 2(60×40 + 60×25 + 40×25)=9800 cm² = **0.98 m²**.

F. REVERSE AND INQUIRY PROBLEMS

1. 158 = 2(40+8h+5h) = 80+26h, so h = **3 cm**.
2. 94 = 2(20+5h+4h) = 40+18h, so h = **3 m**.
3. **A net lays all faces out in 2D, so each face can be labelled and counted once before the areas are added.**
4. **Area measures two-dimensional covering, so its units are length × length, such as cm².**

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ANSWER KEY — 2.4.6 Surface Area of Prisms

Extended problems emphasize reasoning, representation and efficient use of formulas.

G. MULTI-STEP REASONING — WORKED ANSWERS

1. A: $2(8+9+72)=$**178 cm²**. B: $2(12+12+36)=$**120 cm²**. C: $2(12+18+24)=$**108 cm²**. **Design C uses the least material.**
2. SA = $2(576+320+180)=2152$ cm². With 12% extra: $2152(1.12)=2410.24$, so prepare **2411 cm²** to have at least enough whole square centimetres.
3. $6s^2=486 \rightarrow s^2=81 \rightarrow$ **s=9 cm**. Volume = $9^3 =$ **729 cm³**.
4. $2x^2+4(10x)=448 \rightarrow x^2+20x-224=0 \rightarrow (x-8)(x+28)=0$. **x=8 cm**. Volume = $8^2 \times 10 =$ **640 cm³**.

H. ANALYSIS AND TRANSFER — WORKED ANSWERS

5. Surface area factor = $1.5^2 = 2.25$. New SA = $160(2.25) =$ **360 cm²**.
6. Wall area = $2(5\times3)+2(4\times3)=54$ m². Two coats require 108 m² of coverage. $108 \div 12 =$ **9 tins**.
7. **Keeping volume fixed does not keep surface area fixed; changing the proportions changes the amount of outside covering. In the example, the more compact 2×3×6 prism has less surface area than 1×6×6.**

EXTENSION NOTE

The extended set moves beyond direct substitution into open surfaces, scale factors, reverse dimensions, material allowances, fixed-volume comparison and practical estimation. Accept clearly communicated alternative methods that are mathematically equivalent.