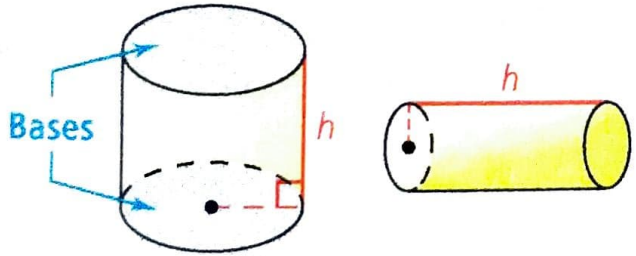
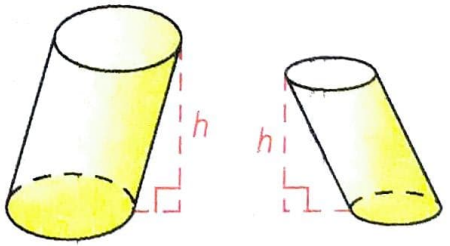
A **cylinder** is a solid that has two congruent parallel **bases** that are circles. An **altitude** of a cylinder is a perpendicular segment that joins the planes of the bases. The **height** h of a cylinder is the length of an altitude.



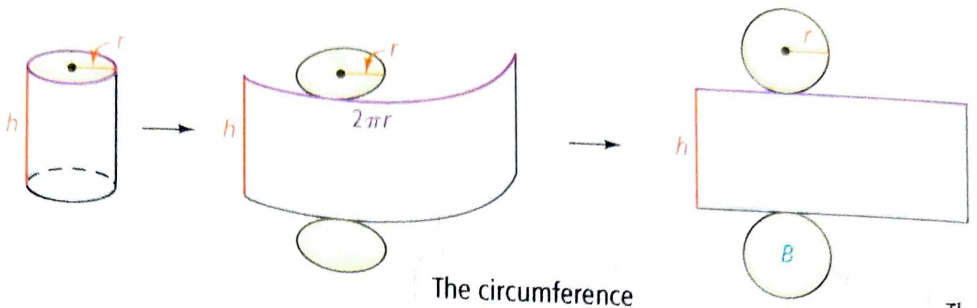
Right cylinders



Oblique cylinders

In a **right cylinder,** the segment joining the centers of the bases is an altitude. In an **oblique cylinder,** the segment joining the centers is not perpendicular to the planes containing the bases. In this book, you may assume that a cylinder is a right cylinder unless stated or pictured otherwise.

To find the area of the curved surface of a cylinder, visualize "unrolling" it. The area of the resulting rectangle is the **lateral area** of the cylinder. The **surface area** of a cylinder is the sum of the lateral area and the areas of the two circular bases. You can find formulas for these areas by looking at a net for a cylinder.



The circumference of a base is $2\pi r$.

The area B of a base is πr^2.

Lateral Area $= 2\pi rh$

Surface Area $=$ L.A. $+ 2\pi r^2$

take note

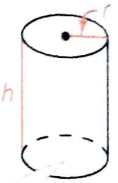
Theorem 11-2 Lateral and Surface Areas of a Cylinder

The lateral area of a right cylinder is the product of the circumference of the base and the height of the cylinder.

L.A. $= 2\pi r \cdot h$, or L.A. $= \pi dh$

The surface area of a right cylinder is the sum of the lateral area and the areas of the two bases.

S.A. $=$ L.A. $+ 2B$, or S.A. $= 2\pi rh + 2\pi r^2$



B is the area of a base.

Problem 3 Finding Surface Area of a Cylinder

Multiple Choice **The radius of the base of a cylinder is 4 in. and its height is 6 in. What is the surface area of the cylinder in terms of π?**

(A) 32π in.^{2} (B) 42π in.^{2} (C) 80π in.^{2} (D) 120π in.^{2}

How is finding the surface area of a cylinder like finding the surface area of a prism?
For both, you need to find the L.A. and add it to twice the area of a base.

S.A. $=$ L.A. $+ 2B$	Use the formula for surface area of a cylinder.
$= 2\pi rh + 2(\pi r^2)$	Substitute the formulas for lateral area and area of a circle.
$= 2\pi(4)(6) + 2(\pi 4^2)$	Substitute 4 for r and 6 for h.
$= 48\pi + 32\pi$	Simplify.
$= 80\pi$	

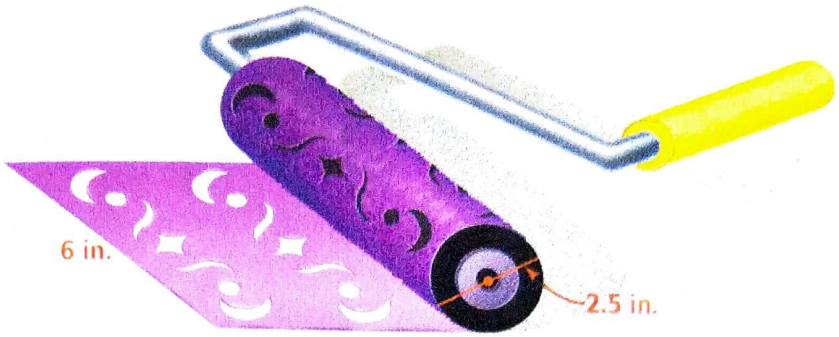
The surface area of the cylinder is 80π in.^{2}. The correct choice is C.

Got It? **3.** A cylinder has a height of 9 cm and a radius of 10 cm. What is the surface area of the cylinder in terms of π?

Problem 4 Finding Lateral Area of a Cylinder

What is the problem asking you to find? The area covered by one full turn of the roller is the rectangular part of the net of a cylinder. This is the lateral area.

Interior Design You are using the cylindrical stencil roller below to paint patterns on your floor. What area does the roller cover in one full turn?



The area covered is the lateral area of a cylinder with height 6 in. and diameter 2.5 in.

L.A. $= \pi dh$ Use the formula for lateral area of a cylinder.

$= \pi(2.5)(6)$ Substitute 2.5 for d and 6 for h.

$= 15\pi \approx 47.1$ Simplify.

In one full turn, the stencil roller covers about 47.1 in.^{2}.

Got It? **4. a.** A smaller stencil roller has a height of 1.5 in. and the same diameter as the roller in Problem 4. What area does the smaller roller cover in one turn? Round your answer to the nearest tenth.

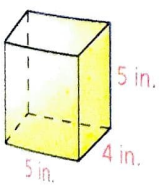
b. Reasoning What is the ratio of the smaller roller's height to the larger roller's height? What is the ratio of the areas the rollers can cover in one turn (smaller to larger)?

Lesson Check

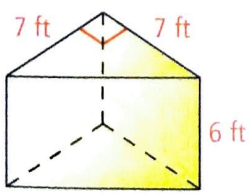
Do you know HOW?

What is the surface area of each prism?

1.

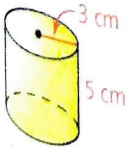


2.

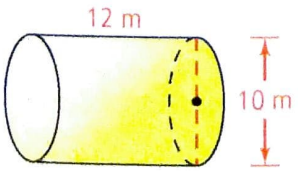


What is the surface area of each cylinder?

3.

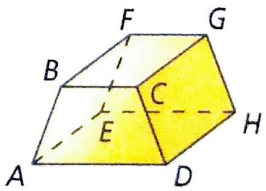


4.

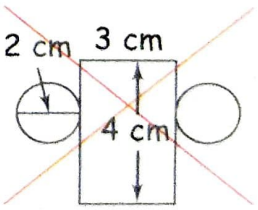


Do you UNDERSTAND? MATHEMATICAL PRACTICES

5. Vocabulary Name the lateral faces and the bases of the prism at the right.



6. Error Analysis Your friend drew a net of a cylinder. What is your friend's error? Explain.

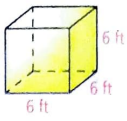


Practice

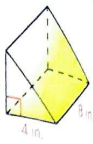
Use a net to find the surface area of each prism.

7.

8.



9. See Problem 1

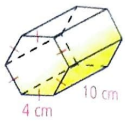


10. a. Classify the prism at the right.

b. Find the lateral area of the prism.

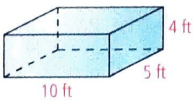
c. The bases are regular hexagons. Find the sum of their areas.

d. Find the surface area of the prism.

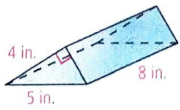


Use formulas to find the surface area of each prism. Round your answer to the nearest whole number. See Problem 2

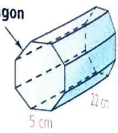
11.



12.

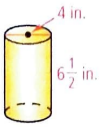


13. Regular octagon

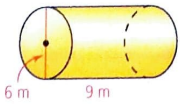


Find the lateral area of each cylinder to the nearest whole number. See Problems 3 and 4

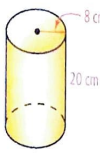
14.



15.

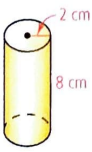


16.

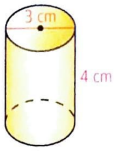


Find the surface area of each cylinder in terms of π.

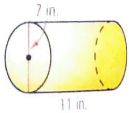
17.



18.

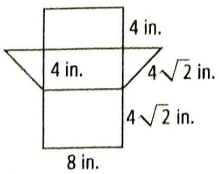


19.



STEM **20. Packaging** A cylindrical carton of oatmeal with radius 3.5 in. is 9 in. tall. If all surfaces except the top are made of cardboard, how much cardboard is used to make the oatmeal carton? Assume no surfaces overlap. Round your answer to the nearest square inch.

9. $(80 + 32\sqrt{2})$ in.^{2}, or about 125.3 in.^{2}



10a. right hexagonal prism

b. 240 cm^2

c. $48\sqrt{3}$ cm^2 or about 83.1 cm^2

d. $(240 + 48\sqrt{3})$ cm^2 or about 323.1 cm^2

11. 220 ft^2

12. 108 in.^{2}

13. 1121 cm^2

14. 82 in.^{2}

15. 170 m^2

16. 1005 cm^2

17. 40π cm^2

18. 16.5π cm^2

19. 101.5π in.^{2}

20. 236 in.^{2}