Practice Activities

Cross-Sections of Three-Dimensional Figures

1. A plane cuts through a rectangular prism parallel to its base. Which two-dimensional shape is always produced?

a) Triangle
b) Circle
c) Rectangle
d) Trapezoid

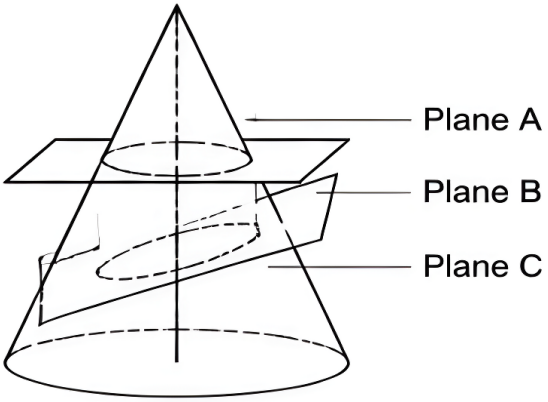
2. A chef slices a block of butter shaped like a rectangular prism straight down, perpendicular to the base. What shape does the exposed cut surface form?

a) Circle
b) Triangle
c) Rectangle
d) Pentagon

3. A plane cuts through a square pyramid parallel to its base, halfway between the base and the apex. What shape is the cross-section, and how does its size compare to the base?

4. The cross-section of a cylinder cut parallel to its base is always a circle congruent to the base. True or False?

5. Use the diagram below to answer the question.



Match each cutting plane with the cross-section it produces:

Plane A —

Plane B —

Plane C —

a) Triangle
b) Circle
d) Ellipse

6. A triangular prism has equilateral triangular bases and a length of 8 inches. A plane cuts through the prism parallel to its triangular base. Describe the cross-section completely, including its shape and how it compares to the base.

7. Jordan is building a model for science class using a cylinder with a circular base of radius 3 inches and a height of 10 inches. He makes three cuts:

- Cut 1: parallel to the base
- Cut 2: perpendicular to the base, passing through the central axis
- Cut 3: at a 45° diagonal angle through the full height

a) Name the shape produced by each cut.
b) For Cut 2, what are the dimensions of the cross-section?
c) Which cut produces a curved cross-section that is NOT a circle?

8. A plane cuts through a square pyramid and passes directly through the apex, perpendicular to the base. What shape is the cross-section?

a) Square
b) Rectangle
c) Isosceles triangle
d) Trapezoid

9. The cross-section of any prism cut perpendicular to its base is always a rectangle, regardless of the shape of the prism's base.
True or False?

10. Maya is analyzing a wooden triangular prism for an art project. The prism has a right triangle as its base, with legs of 3 inches and 4 inches, and the prism is 6 inches long. A plane cuts through the prism perpendicular to the triangular base, slicing straight through all three rectangular faces.

a) What shape is the cross-section?
b) What are the dimensions of the cross-section?

11. Look at the table below and fill in the missing cross-section shapes.

Solid	Cut Orientation	Cross-Section Shape
Rectangular Prism	Parallel to base	Rectangle
Square Pyramid	Parallel to base (near apex)	???
Cylinder	Perpendicular to base (through axis)	???
Cone	Parallel to base	???
Triangular Prism	Parallel to base	???

12. Alex slices an orange in half by cutting straight through it with a flat plane parallel to the top. What two-dimensional shape does the exposed cut surface most closely resemble? What would happen to that shape if Alex instead cut the orange at a diagonal angle?

13. A square pyramid has a base with side length 10 inches and a vertical height of 15 inches. A plane cuts through the pyramid parallel to the base, at a point that is 5 inches from the apex.

a) What shape is the cross-section?

b) What fraction of the height is the cut located at, measuring from the base?

c) What is the side length of the cross-section? (Hint: Use proportional reasoning based on how far the cut is from the apex.)

14. Tyler claims that a diagonal cut through a cylinder always produces an ellipse, no matter the angle or position of the cut. Is Tyler correct? Explain your reasoning, and describe at least one case where a cut through a cylinder produces a shape that is NOT an ellipse and NOT a rectangle.

15. Describe a real-world situation in the United States where understanding cross-sections of three-dimensional objects is important. Name the solid involved, describe the type of cut used, and explain what two-dimensional shape is revealed and why that information is useful.

Answer Key

1. **c) Rectangle**

   A plane parallel to the base of a rectangular prism always intersects all four vertical edges at the same height, producing a rectangle congruent to the base. This is true at any height along the prism.

2. **c) Rectangle**

   A perpendicular cut (straight down) through a rectangular prism slices across the width and height of the solid, exposing a rectangular face. The dimensions of the rectangle match the width and height of the prism.

3. The cross-section is a **square.** Because the cut is parallel to the base of a square pyramid, it always produces a shape similar to (and the same shape as) the base — a square. At the halfway point, the cross-section is smaller than the base. Since the cut is at half the height, the side length of the cross-section is half the side length of the base. For example, if the base is 6 cm, the cross-section **square** has side length 3 cm.

4. **True.**

   A cylinder has congruent circular bases. Any plane parallel to the base intersects the curved surface in a perfect loop, producing a circle with the same radius as the base — at every height along the cylinder.

5. **Plane A → b) Circle**

   A horizontal cut parallel to the base intersects the curved surface of the cone in a complete circular loop.

   Plane B → a) Triangle

   A vertical cut through the apex and the central axis intersects both slanted sides and produces a triangular cross-section (isosceles triangle).

   Plane C → c) Ellipse

   A diagonal cut that does not pass through the apex cuts through the curved surface at an angle, stretching the circular shape into an oval — an ellipse.

6. The cross-section is an equilateral triangle. Because the cut is parallel to the triangular base, it intersects all three rectangular lateral faces at the same position along the length of the prism. The resulting cross-section is congruent to the base — an equilateral triangle with side length 4 cm (matching the base). Every parallel cut through a prism, at any position along its length, produces a shape congruent to the base.

7. **a)** Cut 1 (parallel): Circle with radius 3 inches
Cut 2 (perpendicular through axis): Rectangle
Cut 3 (45° diagonal): Ellipse

b) Cut 2 produces a rectangle with width equal to the diameter of the base ($3 \times 2 = 6$ inches) and height equal to the full height of the cylinder (10 inches). The rectangle is 6 in × 10 in.

c) Cut 3 — the 45° diagonal cut — produces an ellipse, which is a curved, oval shape. It is the cut through a cylinder that creates a curved cross-section that is not a perfect circle.

8. **c)** Isosceles triangle

When a plane cuts through the apex of a square pyramid perpendicular to the base, it slices through two opposite triangular faces. The resulting cross-section is a triangle. Because a square pyramid is symmetric, this triangle is isosceles. The base of the triangle matches a dimension of the pyramid's base, and the two equal sides follow the slant height of the pyramid.

9. True.
For any prism — triangular, rectangular, pentagonal, or any other — a cut perpendicular to the base slices straight through the length of the prism, intersecting the rectangular lateral faces. This always produces a rectangle, regardless of the shape of the prism's base.

10. a) The cross-section is a rectangle.
A cut perpendicular to the triangular base, slicing straight through all three rectangular lateral faces, produces a rectangular cross-section. This is consistent with the rule: perpendicular cuts through prisms always produce rectangles.

b) The dimensions of the rectangle are 4 inches × 6 inches.
The width comes from one edge of the triangular base (4 inches — the longer leg), and the length comes from the full length of the prism (6 inches).
(Note: The width of the rectangle depends on which rectangular face the cut crosses. If the cut crosses the face opposite the 3-inch leg, the dimensions would be 3 in × 6 in. Accept either answer with correct reasoning.)

11. Completed table:

Shape	Type of cut	Shape of cross-section
2. Square Pyramid	Parallel to base (near apex)	Small square (similar to the base, but smaller)
3. Cylinder	Perpendicular to base (through axis)	Rectangle
4. Cone	Parallel to base	Circle (smaller than the base)
5. Triangular Prism	Parallel to base	Triangle (congruent to the base)

12. The cross-section is a circle. A flat cut parallel to the top of a spherical orange produces a circular cross-section, because the orange is roughly spherical and a parallel cut reveals a circular interior shape.

If Alex cuts the orange at a diagonal angle, the cross-section would become an ellipse — an oval shape. The diagonal cut stretches the circular cross-section, producing a wider and longer shape than the perfect circle of a parallel cut. This is the same principle as cutting a cylinder or a sphere at an oblique angle.

13.

a) The cross-section is a square.
Parallel cuts through a square pyramid always produce squares — the same shape as the base.

b) The cut is at 5 inches from the apex, out of a total height of 15 inches. Measuring from the base, the cut is at:
15 − 5 = 10 inches from the base, which is 10/15 = 2/3 of the total height.

c) Because the cut is 5 inches from the apex, and the full height is 15 inches, the cut is at 1/3 of the height measured from the apex (5 out of 15). Using proportional reasoning: the side length of the cross-section scales proportionally with the distance from the apex.
Side length = (5/15) × 10 inches = (1/3) × 10 = 10/3 ≈ 3.33 inches
The cross-section is a square with side length approximately 3⅓ inches

14. Tyler is not entirely correct. While it is true that most diagonal (oblique) cuts through a cylinder produce an ellipse, there is one important exception: a cut parallel to the base produces a circle — not an ellipse. A circle is the result whenever the cutting plane is perfectly horizontal (parallel to the circular base).
Additionally, a cut perpendicular to the base through the central axis produces a rectangle, which is also neither an ellipse nor related to an oblique cut.
Tyler's claim is only valid specifically for oblique cuts. Not every cut through a cylinder produces an ellipse — the angle of the plane determines the shape of the cross-section.

15. Sample answer: Medical imaging (MRI or CT scan)
In hospitals across the United States, doctors use MRI and CT scanning machines to take cross-sectional images of a patient's body. The human body (or an organ such as the brain) can be modeled as a three-dimensional solid. The scanning machine takes a series of cuts — parallel cross-sections — through the body at regular intervals. Each image shows a two-dimensional circle or oval shape that reveals the internal structure of organs, bones, and tissue at that location. This allows doctors to detect tumors, injuries, or disease without performing surgery. Understanding that a parallel cut through a roughly cylindrical organ produces a circular cross-section helps medical professionals interpret what they see on the scan.