Grade 10 Mathematics Lesson Plan

Volume of Pyramids

Strand:	**Measurement and Geometry**
Sub-Strand:	Volume: Volume of a Pyramid
Specific Learning Outcome:	Calculate the volume of prisms, pyramids, cones, frustums and spheres. Explore the use of the surface area and volume of solids in real-life situations.
Duration:	40 minutes
Key Inquiry Question:	How do we determine the surface area and volume of solids? Why do we determine the surface area and volume of solids?
Learning Resources:	CBC Grade 10 textbooks, pictures of famous pyramids (Egyptian, Mayan), measuring tape or rulers, small model or LEGO pyramid, calculators

Lesson Structure Overview

Phase	Duration	Focus
Problem-Solving and Discovery	15 minutes	Anchor activity: Pyramid City exploration and volume discovery
Structured Instruction	10 minutes	Formalizing the pyramid volume formula and addressing misconceptions
Practice and Application	10 minutes	Worked examples and varied problems
Assessment	5 minutes	Exit ticket to check understanding

Phase 1: Problem-Solving and Discovery (15 minutes)

Anchor Activity: Pyramid City

Objective: Students will discover the formula for finding the volume of a pyramid by exploring famous pyramids, estimating dimensions, and discovering the relationship between the volume of a pyramid and a prism with the same base and height.

Materials Needed:

- Pictures of famous pyramids (Egyptian Pyramids, Mayan Pyramids)
- Measuring tape or rulers
- Small model or LEGO pyramid
- Calculators
- Worksheets for recording estimates and calculations

Steps for the Activity:

1. Step 1: Explore Famous Pyramids. Display pictures of famous pyramids (Egyptian Pyramids, Mayan Pyramids). Discuss: What do you notice about these structures? What shape is the base? What shape are the faces?
2. Step 2: Understand Pyramid Structure. A pyramid has a polygonal base and triangular faces that meet at the apex (top point).
3. Step 3: Estimate Dimensions. Using a small model or LEGO pyramid, measure the base dimensions and height. Record your measurements.
4. Step 4: Discover the Volume Formula. If you had a prism with the same base and height, how many pyramids would fit inside? (Answer: 3 pyramids fit inside a prism with the same base and height). Therefore, Volume of pyramid = (1 / 3) times Volume of prism = (1 / 3) times Base Area times height.
5. Step 5: Calculate Volume. Using your measurements, calculate the volume of your pyramid model.

Discussion Questions:

6. What is a pyramid?
7. What shapes can the base of a pyramid be?
8. How is a pyramid different from a prism?
9. Why is the volume of a pyramid one-third the volume of a prism with the same base and height?
10. Can you think of real-world examples of pyramids?

Teacher Role During Discovery:

- Circulate among groups, ensuring students understand pyramid structure.
- Ask probing questions: What is the base shape? How do we find the base area?
- For struggling groups: Let us start by finding the base area. Then multiply by the height and divide by 3.
- For early finishers: How would the volume change if the height doubled? If the base dimensions doubled?

- Guide students to articulate: The volume of a pyramid is one-third the base area times the height.
- Identify 2-3 groups with clear findings to share with the class.

Phase 2: Structured Instruction (10 minutes)

Formalizing the Pyramid Volume Formula and Addressing Misconceptions

After students have completed the anchor activity and shared their findings, the teacher formalizes the formula for finding the volume of a pyramid.

Key Takeaway: What is a Pyramid?

A pyramid is a three-dimensional solid with a polygonal base and triangular faces that meet at a single point called the apex.

Formula:

Volume of a Pyramid = (1 / 3) times Base Area times h

Where:

- Base Area is the area of the polygonal base
- h is the height of the pyramid (perpendicular distance from base to apex)

Why (1 / 3)?

Three pyramids with the same base and height fit exactly inside a prism with the same base and height. Therefore, the volume of a pyramid is one-third the volume of a prism.

Types of Pyramids Based on Base Shape:

- Square pyramid: Base is a square
- Rectangular pyramid: Base is a rectangle
- Triangular pyramid: Base is a triangle
- Pentagonal pyramid: Base is a pentagon

Scaffolding Strategies to Address Misconceptions:

- Misconception: A pyramid is the same as a prism. Clarification: No, a pyramid has triangular faces that meet at an apex, while a prism has two parallel bases.
- Misconception: The volume formula is Base Area times height. Clarification: No, you must multiply by (1 / 3). The formula is (1 / 3) times Base Area times height.
- Misconception: The height is the slant height. Clarification: No, the height is the perpendicular distance from the base to the apex, not the slant height along the face.
- Misconception: All pyramids have square bases. Clarification: No, pyramids can have any polygonal base (triangle, rectangle, pentagon, etc.).

Phase 3: Practice and Application (10 minutes)

Worked Example 1: Square Pyramid

Find the volume of a square pyramid with a height of 6 cm and a side length of 10 cm.

Solution:

V = (1 / 3) times Base Area times h

Base Area = (10 cm times 10 cm) = 100 cm squared

V = (1 / 3) times 100 cm squared times 6 cm

V = (1 / 3) times 600 cm cubed

V = 200 cm cubed

Worked Example 2: Triangular Pyramid

A triangular pyramid has a base of 5 cm times 8 cm and a height of 10 cm.

Solution:

V = (1 / 3) times Base Area times h

Base Area = (1 / 2 times 5 cm times 8 cm) = 20 cm squared

V = (1 / 3) times 20 cm squared times 10 cm

V = (1 / 3) times 200 cm cubed

V = 66.67 cm cubed

Worked Example 3: Rectangular Pyramid

A pyramid has a rectangular base of 4 m by 6 m and a height of 12 m.

Solution:

V = (1 / 3) times Base Area times h

Base Area = (4 m times 6 m) = 24 m squared

V = (1 / 3) times 24 m squared times 12 m

V = (1 / 3) times 288 m cubed

V = 96 m cubed

Phase 4: Assessment (5 minutes)

Exit Ticket:

Students complete the following questions individually.

1. A pyramid has a square base with a side length of 6 cm. The height of the pyramid is 9 cm. Find the volume.

2. A pyramid-shaped tent has a rectangular base of 8 m by 6 m and a height of 5 m. Find the volume of air inside the tent.

3. A pyramid has a square base with each side measuring 10 cm. The height of the pyramid is 15 cm. Find the volume.

Answer Key:

1. V = (1 / 3) times 6 squared times 9 = (1 / 3) times 36 times 9 = 108 cm cubed.

2. V = (1 / 3) times (8 times 6) times 5 = (1 / 3) times 48 times 5 = 80 m cubed.

3. V = (1 / 3) times 10 squared times 15 = (1 / 3) times 100 times 15 = 500 cm cubed.

Differentiation Strategies

For Struggling Learners:

- Provide pre-made pyramid models with labeled dimensions.
- Use pyramids with simple dimensions for initial practice.
- Pair struggling students with confident problem solvers.
- Provide step-by-step calculation templates.
- Allow use of calculators for calculations.
- Break down the formula into steps: Find base area, multiply by height, divide by 3.

For On-Level Learners:

- Encourage students to verify their formula with different pyramid types.
- Ask students to explain the difference between a pyramid and a prism.
- Provide mixed practice with different base shapes.
- Challenge students to find the volume when only the base dimensions and slant height are given.

For Advanced Learners:

- Challenge students to derive the formula using the relationship with prisms.
- Explore real-world applications: Egyptian pyramids, Mayan pyramids, modern architecture.
- Investigate the relationship between base dimensions, height, and volume.
- Apply the concept to composite solids involving pyramids.
- Solve optimization problems: Given a fixed volume, what dimensions minimize the surface area?

Extension Activity

Real-World Application: Egyptian Pyramid Investigation

Work in groups

Situation: Research the Great Pyramid of Giza and calculate its volume.

Tasks:

11. Research the dimensions of the Great Pyramid of Giza (base side length approximately 230 m, original height approximately 146.5 m).
12. Calculate the volume of the Great Pyramid using the pyramid formula.
13. If each stone block has a volume of 1 cubic meter, estimate how many stone blocks were used.
14. Research how long it took to build the pyramid and estimate how many blocks were placed per day.
15. Compare the volume of the Great Pyramid with modern buildings or structures.
16. Present your findings with diagrams, measurements, and calculations.

Key Takeaway:

Students should understand how the volume of pyramids is used in real-world contexts such as ancient architecture (Egyptian pyramids, Mayan pyramids), modern architecture (pyramid-shaped buildings), engineering (tent structures), and design (decorative pyramids).

Teacher Reflection Prompts

- Did students successfully explore pyramids and discover the volume formula?
- Were students able to calculate volumes for different base shapes?
- What misconceptions emerged during the lesson, and how were they addressed?
- Did students understand the relationship between pyramids and prisms?
- What adjustments would improve this lesson for future classes?