Grade 10 Mathematics Lesson Plan

Volume of Composite Solids

Strand:	Measurement and Geometry
Sub-Strand:	Volume: Volume of Composite Solids
Specific Learning Outcome:	Determine the volume of composite solids. 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, building blocks or 3D shape cut-outs (foam, paper nets, toy blocks), rulers or measuring tapes, worksheets, volume formula sheet

Lesson Structure Overview

Phase	Duration	Focus
Problem-Solving and Discovery	15 minutes	Anchor activity: Building composite solids
Structured Instruction	10 minutes	Formalizing the composite solid volume formula
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: Constructing Real-World Objects

Objective: Students will construct real-world objects using basic solids (cylinder, cube, cone, hemisphere, etc.) and calculate the total volume by adding or subtracting individual volumes.

Materials Needed:

- Building blocks or 3D shape cut-outs (foam, paper nets, or toy blocks)
- Rulers or measuring tapes

- Worksheets for drawings and calculations
- Volume formula sheet

Activity Steps:

1. Step 1: Review volume formulas for Cube/cuboid, cylinder, cone, sphere, Hemisphere, triangular prisms and pyramids.
2. Step 2: Work in groups of at least four members.
3. Step 3: Build UP a structure using 2 to 3 shapes. For example: A lighthouse (cylinder + cone), An ice cream cone (cone + hemisphere), A mailbox (cuboid + half-cylinder), A robot body (cuboid + cylinder arms + sphere head).
4. Step 4: After building up, draw the structure, label the parts and measure dimensions.
5. Step 5: Calculate the volume of each solid part using the correct formulas.
6. Step 6: Add all volumes to get the total.

Discussion Questions:

7. What is a composite solid?
8. How do we find the volume of a composite solid?
9. When do we add volumes? When do we subtract?
10. What real-world objects are composite solids?
11. How can we break down complex shapes into simpler solids?

Teacher Role During Discovery:

- Circulate among groups, ensuring students build structures correctly.
- Ask probing questions: What shapes did you use? How will you find the total volume?
- For struggling groups: Let us identify the shapes together. What is this shape? What is the formula?
- For early finishers: Can you build a structure with a hole or removed part?
- Guide students to articulate: A composite solid is made up of two or more simple solids. We add or subtract their volumes.
- Identify 2-3 groups with clear findings to share with the class.

Phase 2: Structured Instruction (10 minutes)

Formalizing the Composite Solid Volume Formula

After students have completed the anchor activity and shared their findings, the teacher formalizes the process for finding the volume of composite solids.

Key Takeaway: What is a Composite Solid?

A composite solid is a three-dimensional shape made up of two or more simple solids (such as cubes, cylinders, cones, spheres, prisms, and pyramids). To find the volume of a composite solid, the volumes of the individual solids are calculated and then either added or subtracted, depending on the situation.

Steps to Find Volume of Composite Solids:

12. Step 1: Identify the simple solids that make up the composite solid
13. Step 2: Calculate the volume of each individual solid using the appropriate formula
14. Step 3: Add or subtract the volumes. If the solids are joined together, add their volumes. If a part of one solid is removed (e.g., a hole), subtract its volume from the total.

Examples of Composite Solids:

- Cylinder with a Hemisphere on Top
- Rectangular Prism with a Cylindrical Hole
- Ice cream cone (cone + hemisphere)
- Lighthouse (cylinder + cone)

Scaffolding Strategies to Address Misconceptions:

- Misconception: All composite solids require adding volumes. Clarification: No, if a part is removed (like a hole), you subtract its volume.
- Misconception: I can use any formula. Clarification: No, you must use the correct formula for each individual solid.
- Misconception: I only calculate one volume. Clarification: No, you must calculate the volume of each solid part separately, then add or subtract.
- Misconception: Composite solids are too complex. Clarification: No, break them down into simpler solids you already know.

Phase 3: Practice and Application (10 minutes)

Worked Example:

A rectangular prism has dimensions length = 10 cm, width = 6 cm, and height = 15 cm. A cylindrical hole of radius 2 cm passes vertically through the entire height of the prism. Find the volume of the remaining solid after the hole is removed.

Solution:

Step 1: Find the Volume of the Rectangular Prism

V prism = length times width times height

= 10 cm times 6 cm times 15 cm

= 900 cm cubed

Step 2: Find the Volume of the Cylindrical Hole

V cylinder = π r squared h

= 3.14 times (2 cm) squared times 15 cm

= 188.4 cm cubed

Step 3: Find the Volume of the Remaining Solid

V Total volume remaining = V prism minus V cylinder

= (900 minus 188.4) cm cubed

= 711.6 cm cubed

The volume of the remaining solid after the hole is removed is 711.6 cm cubed.

Phase 4: Assessment (5 minutes)

Exit Ticket:

Students complete the following questions individually.

1. A solid sphere with a radius of 6 cm is completely enclosed in a cube. Find the volume of the space inside the cube but outside the sphere.

2. A rectangular prism has a base of 10 cm by 6 cm and a height of 15 cm. A square pyramid with a base of 10 cm by 10 cm and a height of 8 cm is placed on top of the prism. Find the total volume of the solid.

Answer Key:

1. Cube side = 12 cm (diameter of sphere). V cube = 12 cubed = 1728 cm cubed. V sphere = (4 / 3) times π times 6 cubed = 904.32 cm cubed. V space = 1728 minus 904.32 = 823.68 cm cubed.

2. V prism = 10 times 6 times 15 = 900 cm cubed. V pyramid = (1 / 3) times 10 times 10 times 8 = 266.67 cm cubed. V total = 900 plus 266.67 = 1166.67 cm cubed.

Differentiation Strategies

For Struggling Learners:

- Provide pre-built composite solid models with labeled dimensions.
- Use simple shapes for initial practice (cylinder + cone).
- Pair struggling students with confident problem solvers.
- Provide step-by-step calculation templates.
- Allow use of calculators for calculations.
- Break down the process: Identify shapes, calculate each volume, add or subtract.

For On-Level Learners:

- Encourage students to build their own composite solids.
- Ask students to explain when to add vs. subtract volumes.
- Provide mixed practice with different composite solids.
- Challenge students to find the volume of more complex structures.

For Advanced Learners:

- Challenge students to design composite solids with specific volumes.
- Explore real-world applications: buildings, monuments, containers.
- Investigate optimization: Given a fixed volume, what shape minimizes surface area?

- Apply the concept to more complex composite solids with 4+ shapes.
- Solve problems involving multiple holes or removed parts.

Extension Activity

Real-World Application: Designing a Water Tank

Work in groups

Situation: Design a water tank for a rural community. The tank should consist of a cylindrical body with a hemispherical top for efficient water storage.

Tasks:

15. Choose dimensions for the cylinder (radius and height).
16. The hemisphere has the same radius as the cylinder.
17. Calculate the volume of the cylindrical part.
18. Calculate the volume of the hemispherical top.
19. Find the total volume of the water tank.
20. If the community needs 5000 liters of water, what dimensions would work? (1 liter equals 1000 cubic cm)
21. Present your findings with diagrams, measurements, and calculations.

Key Takeaway:

Students should understand how the volume of composite solids is used in real-world contexts such as architecture (buildings, monuments), engineering (water tanks, containers), packaging (boxes, bottles), and design (furniture, toys).

Teacher Reflection Prompts

- Did students successfully build composite solids?
- Were students able to identify when to add vs. subtract volumes?
- What misconceptions emerged during the lesson, and how were they addressed?
- Did students understand how to break down complex shapes into simpler solids?
- What adjustments would improve this lesson for future classes?