Grade 10 Mathematics Lesson Plan

Surface Area of Spheres

Strand:	**Measurement and Geometry**
Sub-Strand:	Surface Area of a Sphere
Specific Learning Outcome:	Determine the surface area of prisms, pyramids, cones, frustums and spheres.
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, oranges or balls, small square sticky notes, rulers, calculators

Lesson Structure Overview

Phase	Duration	Focus
Problem-Solving and Discovery	15 minutes	Anchor activity: Covering spheres with sticky notes and estimating surface area
Structured Instruction	10 minutes	Formalizing the sphere surface area 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: Covering Spheres with Sticky Notes

Objective: Students will discover the formula for finding the surface area of a sphere by covering a ball or orange with small square sticky notes and estimating how many squares fit over the surface.

Materials Needed:

- Oranges or balls (one per group)
- Small square sticky notes

- Rulers
- Calculators
- Worksheets for recording estimates and calculations

Steps for the Activity:

1. Step 1: Use an Orange or Ball. Each group receives an orange or ball.
2. Step 2: Cover with Sticky Notes. Cover the sphere with small square sticky notes. Try to fit as many squares as possible without overlapping.
3. Step 3: Estimate Surface Area. Count how many sticky notes fit on the surface. Measure the side length of one sticky note. Calculate the total surface area by multiplying the number of sticky notes by the area of one sticky note.
4. Step 4: Measure the Radius. Measure the radius of the sphere using a ruler.
5. Step 5: Compare with Formula. Compare your estimate with the actual formula: Surface Area = 4 π r squared.
6. Step 6: Discuss Results. Compare your results with other group members and discuss any differences.

Discussion Questions:

7. What is a sphere?
8. How many sticky notes did you use to cover the sphere?
9. How does your estimate compare with the formula?
10. Why do you think the formula is 4 π r squared?
11. What happens to the surface area if the radius doubles?

Teacher Role During Discovery:

- Circulate among groups, ensuring students understand how to cover the sphere with sticky notes.
- Ask probing questions: How many sticky notes did you use? What is the area of one sticky note?
- For struggling groups: Let us measure the radius first. Then use the formula to calculate the surface area.
- For early finishers: What happens to the surface area if the radius doubles? Can you verify this with the formula?
- Guide students to articulate: The surface area of a sphere is 4 π r squared.
- Identify 2-3 groups with clear findings to share with the class.

Phase 2: Structured Instruction (10 minutes)

Formalizing the Sphere Surface Area Formula and Addressing Misconceptions

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

Key Takeaway: What is a Sphere?

A sphere is a perfectly round three-dimensional object where every point on the surface is equidistant from the center. The surface area of a sphere is the total area covering its curved outer surface.

Formula:

Surface Area of a Sphere = 4 π r squared

Where:

- r is the radius of the sphere
- π is approximately 3.14 or 22 / 7

Why 4 π r squared?

The formula 4 π r squared comes from integrating small patches over the sphere's curved surface. We can compare the sphere to how a sphere fits inside a cylinder of the same radius and height.

Important Relationship:

If the radius doubles, the surface area increases by 4 times (since (2r) squared = 4 r squared).

Scaffolding Strategies to Address Misconceptions:

- Misconception: A sphere is the same as a circle. Clarification: No, a circle is two-dimensional, while a sphere is three-dimensional.

- Misconception: The formula is π r squared. Clarification: No, that is the area of a circle. The surface area of a sphere is 4 π r squared.
- Misconception: If the radius doubles, the surface area doubles. Clarification: No, if the radius doubles, the surface area increases by 4 times.
- Misconception: I can use the diameter directly in the formula. Clarification: No, you must use the radius. If you have the diameter, divide by 2 to get the radius.

Phase 3: Practice and Application (10 minutes)

Worked Example 1:

Find the surface area of a sphere with radius 7 cm (correct to 1 decimal place).

Solution:

Surface area of a sphere = 4 π r squared

= (22 / 7) times 4 times (7 cm) squared

= (22 / 7) times 196 cm squared

= 22 times 28 cm squared

= 616 cm squared

Worked Example 2:

A sphere has a radius of 14 cm.

a) Find its total surface area.

b) If the sphere were covered with paint, how much area would be painted?

c) If a second sphere has twice the radius, how does its surface area compare to the first sphere?

Solution:

a) Total Surface area = 4 times (22 / 7) times 14 cm times 14 cm

= 4 times 22 times 2 cm times 14 cm

= 4 times 22 times 28

= 4 times 616 cm squared

= 2464 cm squared

b) The area of the sphere painted would be the entire surface area = 2464 cm squared.

c) If the radius is doubled (r = 28 cm), the new surface area = 4 times (22 / 7) times 28 times 28 = 9856 cm squared.

The surface area is 4 times larger (9856 / 2464 = 4).

Phase 4: Assessment (5 minutes)

Exit Ticket:

Students complete the following questions individually.

1. The surface area of a spherical ornament is measured to be 452.16 cm squared. Using the formula for the surface area of a sphere, determine the radius of the ornament.

2. A planetarium is constructing a dome in the shape of a hemisphere with a radius of 20 m. Since the dome covers only half of a full sphere, determine its total surface area, including the flat circular base.

3. A spherical metal ball with a radius of 7 cm is to be coated with a layer of paint. Determine the total area that needs to be covered with paint.

Answer Key:

1. Surface area = 4 π r squared. 452.16 = 4 times 3.14 times r squared. 452.16 = 12.56 times r squared. r squared = 36. r = 6 cm.

2. Hemisphere surface area = (1 / 2) times 4 π r squared + π r squared (flat base) = 2 π r squared + π r squared = 3 π r squared = 3 times 3.14 times 20 squared = 3768 m squared.

3. Surface area = 4 π r squared = 4 times (22 / 7) times 7 squared = 616 cm squared.

Differentiation Strategies

For Struggling Learners:

- Provide pre-measured spheres with labeled radii.
- Use spheres 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: Square the radius, multiply by π, multiply by 4.

For On-Level Learners:

- Encourage students to verify their formula with different sphere sizes.
- Ask students to explain the difference between a sphere and a circle.
- Provide mixed practice with spheres and hemispheres.
- Challenge students to find the surface area when only the diameter is given.

For Advanced Learners:

- Challenge students to derive the formula using calculus or geometric reasoning.
- Explore real-world applications: sports balls, planets, bubbles, water tanks, domes.
- Investigate the relationship between radius and surface area (quadratic relationship).
- Apply the concept to composite solids involving spheres.
- Solve optimization problems: Given a fixed surface area, what radius maximizes the volume?

Extension Activity

Real-World Application: Spherical Objects Investigation

Work in groups

Situation: Identify sphere-shaped objects around school or home (e.g., sports balls, globes, water tanks, bubbles, planets, etc.).

Tasks:

12. Identify at least three sphere-shaped objects in your environment.
13. Measure the radius or diameter of each object (or use estimated values).
14. Calculate the surface area of each object using the sphere formula.
15. For hemispheres (like domes), calculate the surface area including the flat circular base.
16. Compare your results with classmates and discuss any differences.
17. Present your findings with diagrams, measurements, and calculations.

Key Takeaway:

Students should understand how the surface area of spheres is used in real-world contexts such as sports equipment (balls), astronomy (planets), architecture (domes), manufacturing (water tanks), and science (bubbles).

Teacher Reflection Prompts

- Did students successfully cover spheres with sticky notes and estimate surface area?
- Were students able to compare their estimates with the formula?
- What misconceptions emerged during the lesson, and how were they addressed?
- Did students understand the relationship between radius and surface area?
- What adjustments would improve this lesson for future classes?