### Grade 9 Mathematics
#### Unit 3: Shape and Space
##### Sub Unit #1: Surface Area

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Lesson #1 – Area, Perimeter and Circumference

The area of a shape is measured by determining how many square units fit within an area.

We can use the following formulas to determine the area of objects.

**Squares/Rectangles:** \( Area = \text{length} \times \text{width} \) \( (A = l \cdot w) \)

Ex/

\[
\begin{array}{c}
2 \text{ cm} \\
4 \text{ cm}
\end{array}
\]

**Triangles:** \( Area = \frac{1}{2} \times \text{base} \times \text{height} \) \( (A = \frac{1}{2}(b \cdot h) = \frac{bh}{2}) \)

- The height of a triangle is the length of a line that is perpendicular to the base and goes from the base to the opposite corner.

\[
\begin{array}{c}
3 \text{ cm} \\
5 \text{ cm}
\end{array}
\]

**Circles:** \( Area = \pi r^2 \) \( (A = \pi r^2) \)

- The radius of a circle is the distance from the center of the circle to any place on the edge of the circle.

\[
\begin{array}{c}
4 \text{ cm}
\end{array}
\]
The **perimeter** of a shape is the distance around the edge of the shape.

The **circumference** of a circle is the perimeter of a circle.

- We can use the formula $C = 2\pi r$ to determine the circumference of a circle.

  If the radius of a circle is 3 cm, what is the circumference?

Examples:

1. Work out the perimeter of the shape below.

![Shape with dimensions](image1)

2. If the perimeter of the shape below is 96 m, what is the length of the side shown to be dotted?

![Complex shape](image2)
3. Calculate the area of the shapes below:
   a. 
   b.

4. Calculate the shaded area in the diagram below.

Assignment:
1. Work out the perimeter of these shapes. If it is a circle, remember that perimeter is the same as circumference.
2. What is the length of the dotted line in each shape given the perimeter (indicated by P=n)?

3. Calculate the area of each of the following shapes. Round any answers to one decimal place as appropriate.
4. Calculate the amount of area that is shaded in the diagram(s) below.
Lesson #2 – Nets

The net is a two-dimensional pattern of a three-dimensional figure that can be folded to form the figure. In other words, a net is a flattened three-dimensional figure which can be turned into the solid by folding it.

Ex/ Which of the nets can be folded to form a cube?

Solution:
Step 1: A cube does not have a rectangular base or face. So, net (a) does not form a cube.
Step 2: A cube has only 6 squares in it. Nets (c) and (d) have 7 squares. So, they do not form a cube.
Step 3: If you fold net (b) with square 1 as the base, you get a cube. So, net (b) folds to give a cube.

Names of geometric shapes

Prism – a shape composed of two congruent bases and rectangular sides.

This is a rectangular prism. There are two rectangle bases and 4 rectangle sides. The names for prisms are given by the shape of the base.

Pyramid – a shape composed of a base and triangular sides that come together to a single point. Similar to prisms, the name of the pyramid is given by the shape of the base. Ex/ A pentagonal pyramid would have a pentagon base and 5 triangular sides.

Cylinder – a tube shaped object that has two circle bases and curved side joining them.

Cone – a shape that is composed of one circle base and a curved surface that converges to a point
Assignment:

**QUESTION 1** Match each net to the correct name of the solid.

- **a** Cube
- **b** Triangular prism
- **c** Square pyramid


**QUESTION 2** Draw the net of each solid.

- **a** Rectangular prism
- **b** Triangular pyramid (Tetrahedron)
- **c** Cylinder
- **d** Cone

**QUESTION 3** Which solids will be formed from the following net?

- **a**
- **b**
- **c**
- **d**
Lesson #3 – Surface Area

The surface area of an object is the area exposed on the outside of a three dimensional shape. In order to determine the surface area of a shape we must use the information from the two previous lessons. We must know how to calculate the area of basic geometric shapes such as, triangles, squares and circles, and how to determine the net of a three dimensional geometric shape.

Ex/ Determine the surface area of a 4 cm cube.

Since all 6 squares in a cube are equal, we do not need to calculate the area of each of the squares. The area of one of the squares is: \( \text{Area} = \text{length} \times \text{width} \)

Therefore,

\[ A = 4\text{cm} \times 4\text{cm} = 16 \text{ cm}^2 \]

Since there are 6 equal squares and we need the total surface area of the cube, we can add together the area of all six squares. \( 16\text{cm}^2 + 16\text{cm}^2 + 16\text{cm}^2 + 16\text{cm}^2 + 16\text{cm}^2 + 16\text{cm}^2 = 90 \text{ cm}^2 \)

OR we can multiply the area of one square by 6. \( 16\text{cm}^2 \times 6 = 90\text{cm}^2 \)

Determine the surface area of the following shapes:

a) 

\[ 8\text{cm} \]

\[ 3\text{cm} \]
In a triangular prism, there are two equal triangles, but unless there are two equal sides on the triangle, all of the rectangles are not equal.

In a cylinder, there are two equal circles, and a rectangle. In order to find the area of the rectangle, we must find the circumference of the circle, since this is the length of the rectangle.
Assignment

4. Find the surface area of each cylinder.

\[ \text{r} = 3\text{cm} \quad \text{r} = 8\text{cm} \]
\[ \text{h} = 12\text{cm} \quad \text{h} = 3\text{cm} \]
Lesson #5 – Composite Shapes #1

An object is called a composite object because it is composed of more than one three-dimensional geometric shape.

To find the surface area of a composite object, find the sum of the surface area of each geometric shape and subtract the surface area of the overlapping faces.

Ex/ Determine the surface area of the shape below. Given the following dimensions:

Top Rectangular Prism: Height = 1cm, Length = 4cm, Depth = 6cm

Bottom Rectangular Prism: Height = 2cm, Length = 15cm, Depth = 10cm
When the two objects are put together, the bottom of the top rectangular prism is no longer exposed. Therefore, that area must be subtracted from the total. Also, an area the same size is covered on the top of the bottom rectangular prism, so we must subtract double the area of the bottom of the top rectangular prism.

Total Surface Area = Top Surface Area + Bottom Surface Area – 2 x Overlap Area

Ex2) A warehouse measures 60 m by 30 m by 20 m (as pictured) and has an office attached to one wall of the warehouse with the measurements 20 m by 20 m by 10 m.

a) Determine the surface area of the building. **Be aware of any and all unexposed areas!**

b) A contractor quotes to paint the exterior of the building at a rate of $2.50/m^2$. How much will it cost to paint?

Assignment: Page 30 #8, 10, 13
Lesson #6 – Composite Shapes #2

Some objects are composites of two or more shapes where the two shapes are “blended” together to appear as one. Part of the challenge of determining their surface area is to “break down” these objects into smaller, easier to calculate objects.

Ex1)

a) Determine which two 3-D shapes we have already studied make up the object to the right.

b) Sketch each of the objects below, including the appropriate measurements.

c) Calculate the surface area of the object as a whole.

Assignment: Page 40 #3de, 7, 8
Lesson #7 – Composite Shapes #3

Ex1) Determine the surface area of the cake to be frosted if two round cakes are stacked, the bottom having a diameter of 26cm and the top having a diameter of 14 cm. Both cakes height is shown in the picture.
Ex) Calculate the surface area of the object below.