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3D Surface Area and Volume

IGCSE Mathematics

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1 Introduction

Note

Surface area and volume are essential topics at IGCSE level and build directly on the 2D perimeter and area skills you have already developed. They appear in both pure geometry questions and real-world contexts such as packaging design, liquid capacity, construction materials, and storage.
In this chapter, we will explore:

- The difference between surface area and volume
- Units of measurement and unit conversions for 3D
- Cuboids and cubes
- Prisms (including triangular prisms)
- Cylinders
- Pyramids
- Cones
- Spheres and hemispheres
- Composite solids (combining multiple 3D shapes)
- Real-world applications and problem-solving

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2 Key Definitions

Definition

The **surface area** of a 3D solid is the **total area of all its outer faces** — the amount of material you would need to completely wrap or cover the outside of the solid.
Surface area is measured in **square units**: mm^2, cm^2, m^2, etc.

Definition

The **volume** of a 3D solid is the **amount of space it occupies** (or encloses) in three dimensions.
Volume is measured in **cubic units**: mm^3, cm^3, m^3, etc.

Note

A helpful way to remember the difference:

- **Surface area** = the wrapping paper needed to cover a gift box (it covers the outside)
- **Volume** = how much the gift box can hold inside (it fills the space)

These are entirely different quantities and must **never be confused**. Always check which one the question is asking for.

Definition

A **net** of a 3D solid is the flat (2D) shape that can be folded up to form the solid. Nets are very useful for understanding and calculating surface area, since the surface area of a solid equals the total area of its net.

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3 Units of Measurement and Conversions

Unit Conversions for Volume

Since volume involves **three** dimensions, conversions are cubed:

$$1\ cm^3 = 1000\ mm^3 \quad \text{(because } 10 \times 10 \times 10 = 1000\text{)}$$
$$1\ m^3 = 1{,}000{,}000\ cm^3 \quad \text{(because } 100 \times 100 \times 100 = 1{,}000{,}000\text{)}$$
$$1\ km^3 = 1{,}000{,}000{,}000\ m^3 \quad \text{(because } 1000^3\text{)}$$

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