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| **UNIT 7: Perimeter, area and volume, plane shapes and prisms, circles, cylinders, spheres, cones; Accuracy and bounds** |

[Return to Overview](#HOverview)

**SPECIFICATION REFERENCES**

N8 calculate exactly with … multiples of *π*; …

N14 estimate answers; check calculations using approximation and estimation, including answers obtained using technology

N15 round numbers and measures to an appropriate degree of accuracy (e.g. to a specified number of decimal places or significant figures); use inequality notation to specify simple error intervals due to truncation or rounding

N16 apply and interpret limits of accuracy, **including upper and lower bounds**

A5 understand and use standard mathematical formulae; rearrange formulae to change the subject

A21 translate simple situations or procedures into algebraic expressions or formulae; derive an equation (or two simultaneous equations), solve the equation(s) and interpret the solution

R1 change freely between related standard units (e.g. time, length, area, volume/capacity, mass) … in numerical and algebraic contexts

G1 use conventional terms and notations: points, lines, vertices, edges, planes, parallel lines, perpendicular lines, right angles, polygons, regular polygons and polygons with reflection and/or rotation symmetries; …

G9 identify and apply circle definitions and properties, including: centre, radius, chord, diameter, circumference, tangent, arc, sector and segment

G12 identify properties of the faces, surfaces, edges and vertices of: cubes, cuboids, prisms, cylinders, pyramids, cones and spheres

G13 construct and interpret plans and elevations of 3D shapes.

G14 use standard units of measure and related concepts (length, area, volume/capacity, mass, time, money, etc)

G16 know and apply formulae to calculate: area of triangles, parallelograms, trapezia; volume of cuboids and other right prisms (including cylinders)

G17 know the formulae: circumference of a circle = 2*πr* = *πd*, area of a circle = *πr*2; calculate: perimeters of 2D shapes, including circles; areas of circles and composite shapes; surface area and volume of spheres, pyramids, cones and composite solids

G18 calculate arc lengths, angles and areas of sectors of circles

**PRIOR KNOWLEDGE**

Students should know the names and properties of 3D forms.

The concept of perimeter and area by measuring lengths of sides will be familiar to students.

Students should be able to substitute numbers into an equation and give answers to an appropriate degree of accuracy.

Students should know the various metric units.

**KEYWORDS**

Triangle, rectangle, parallelogram, trapezium, area, perimeter, formula, length, width, prism, compound, measurement, polygon, cuboid, volume, nets, isometric, symmetry, vertices, edge, face, circle, segment, arc, sector, cylinder, circumference, radius, diameter, pi, composite, sphere, cone, capacity, hemisphere, segment, frustum, bounds, accuracy, surface area

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| **7b. 3D forms and volume, cylinders, cones and spheres**  (N8, N14, N15, A5, A21, G1, G12, G13, G14, G16, G17) | **Teaching time**  6-8 hours |

**OBJECTIVES**

By the end of the sub-unit, students should be able to:

* Find the surface area of prisms using the formulae for triangles and rectangles, and other (simple) shapes with and without a diagram;
* Draw sketches of 3D solids and identify planes of symmetry of 3D solids, and sketch planes of symmetry;
* Recall and use the formula for the volume of a cuboid or prism made from composite 3D solids using a variety of metric measures;
* Convert between metric measures of volume and capacity, e.g. 1 ml = 1 cm3;
* Use volume to solve problems;
* Estimating surface area, perimeter and volume by rounding measurements to 1 significant figure to check reasonableness of answers;
* Use *π* ≈ 3.142 or use the *π* button on a calculator;
* Find the volume and surface area of a cylinder;
* Recall and use the formula for volume of pyramid;
* Find the surface area of a pyramid;
* Use the formulae for volume and surface area of spheres and cones;
* Solve problems involving more complex shapes and solids, including segments of circles and frustums of cones;
* Find the surface area and volumes of compound solids constructed from cubes, cuboids, cones, pyramids, spheres, hemispheres, cylinders;
* Give answers to an appropriate degree of accuracy or in terms of *π*;
* Form equations involving more complex shapes and solve these equations.

**POSSIBLE SUCCESS CRITERIA**

Given dimensions of a rectangle and a pictorial representation of it when folded, work out the dimensions of the new shape.

Work out the length given the area of the cross-section and volume of a cuboid.

Understand that answers in terms of *π* are more accurate.

Given two solids with the same volume and the dimensions of one, write and solve an equation in terms of *π* to find the dimensions of the other, e.g. a sphere is melted down to make ball bearings of a given radius, how many will it make?

**OPPORTUNITIES FOR REASONING/PROBLEM SOLVING**

Combinations of 3D forms such as a cone and a sphere where the radius has to be calculated given the total height.

**COMMON MISCONCEPTIONS**

Students often get the concepts of surface area and volume confused.

**NOTES**

Encourage students to draw a sketch where one isn’t provided.

Use lots of practical examples to ensure that students can distinguish between surface area and volume. Making solids using multi-link cubes can be useful.

Solve problems including examples of solids in everyday use.

Drawing 3D shapes in 2D using isometric grids isn’t an explicit objective but provides an ideal introduction to the topic and for some students provides the scaffolding needed when drawing 3D solids.

Scaffold drawing 3D shapes by initially using isometric paper.

Whilst not an explicit objective, it is useful for students to draw and construct nets and show how they fold to make 3D solids, allowing students to make the link between 3D shapes and their nets. This will enable students to understand that there is often more than one net that can form a 3D shape.

Formulae for curved surface area and volume of a sphere, and surface area and volume of a cone will be given on the formulae page of the examinations.

Ensure that students know it is more accurate to leave answers in terms of *π* but only when asked to do so.