Name	Date started	Target end date

WJEC GCSE Mathematics and Numeracy (Double Award) — Question Pack

Using π in exact calculations — leaving answers in terms of π for circles, sectors, spheres, cones and cylinders rather than evaluating nu

REVISE
.wales

3.28 — Exact calculations with π

Spec 1.9.6 — Unit 3 (calculator allowed)

Using π in exact calculations — leaving answers in terms of π for circles, sectors, spheres, cones and cylinders rather than evaluating numerically. Sourced from legacy WJEC GCSE Mathematics Higher calculator-allowed papers, organised for revision under the 2025 spec.

2025 SPECIFICATION

Estimated time for entire question pack: ~1 hours 15 minutes

*Derived from the GCSE Higher pace of **~1.5 min/mark** (50 marks across 8 questions).*

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **focused single-topic practice pack**, not a single mock paper. Questions are organised against the 2025 specification. Questions are ordered chronologically by sitting, with custom-written and SAM questions at the end.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working — method marks are awarded for clear setup.

A calculator is allowed on every question in this pack (Unit 3 is the calculator-allowed paper).

Exact calculations with π — what the new spec asks

WJEC GCSE Mathematics (first teaching 2025) · Unit 3: calculator-allowed.

π in exact calculations 1.9.6

- Leave answers in terms of π when an exact answer is asked.
- Multiply the numerical coefficients; keep π as a symbol.
- Don't evaluate $\pi \approx 3.14$ unless the question gives a numerical instruction.

Circle, sector 1.9.6

- $C = 2\pi r$, $A = \pi r^2$.
- Arc length $= \frac{\theta}{360} \cdot 2\pi r$.
- Sector area $= \frac{\theta}{360} \cdot \pi r^2$.

Sphere, cone, cylinder 1.9.6

- Sphere: $V = \frac{4}{3}\pi r^3$, $SA = 4\pi r^2$.
- Cone: $V = \frac{1}{3}\pi r^2 h$, curved SA $= \pi r l$.
- Cylinder: $V = \pi r^2 h$, curved SA $= 2\pi r h$.

Composite solids 1.9.6

- Add or subtract exact-form components; don't convert to decimals partway.
- Factor out π at the end to tidy the answer.
- Sanity-check dimensions — lengths in cm vs m matter.

Exact calculations with π in one page

Quick-reference notes — revisit before each question. Don't use during the questions.

When 'exact' means π

If the question says 'leave your answer in terms of π', do *not* evaluate π on the calculator.

Multiply numbers around the π symbol and leave it in the final answer.

Circle facts

$$C = 2\pi r,\ A = \pi r^2$$

Radius 5: $C = 10\pi$, $A = 25\pi$.

Diameter $d = 2r$, so $C = \pi d$ is the same as $2\pi r$.

Sectors of a circle

$$\text{arc} = \frac{\theta}{360} \cdot 2\pi r,\ \text{area} = \frac{\theta}{360} \cdot \pi r^2$$

For a 60° sector of radius 9: area $= \frac{1}{6} \cdot 81\pi = 13.5\pi$.

Sphere & hemisphere

$$V = \tfrac{4}{3}\pi r^3,\ SA = 4\pi r^2$$

Radius 3: $V = 36\pi$, $SA = 36\pi$.

Hemisphere SA $= 2\pi r^2 + \pi r^2 = 3\pi r^2$ (curved + flat).

Cone

$$V = \tfrac{1}{3}\pi r^2 h,\ \text{curved SA} = \pi r l$$

l is the slant height — use Pythagoras: $l = \sqrt{r^2 + h^2}$.

Radius 6, height 8: $l = 10$, curved SA $= 60\pi$.

Cylinder

$$V = \pi r^2 h,\ \text{curved SA} = 2\pi r h,\ \text{total SA} = 2\pi r h + 2\pi r^2$$

Radius 4, height 10: $V = 160\pi$, curved SA $= 80\pi$.

Combining shapes

Composite solids: keep each component in exact form, then add.

E.g. cylinder + hemisphere: $V = \pi r^2 h + \frac{2}{3}\pi r^3$.

Factor out π at the end where helpful.

Common traps

- Evaluating $\pi \approx 3.14$ when an exact answer is asked for.
- Forgetting the $\frac{1}{3}$ in a cone or $\frac{4}{3}$ in a sphere.
- Using the slant height where the perpendicular height is needed (or vice versa).
- Mixing up πr^2 (area) and $2\pi r$ (circumference).

Examiner only

11. The diagram below shows a wooden end-piece for a curtain pole.
It is in the shape of a cone with measurements as shown in the diagram.

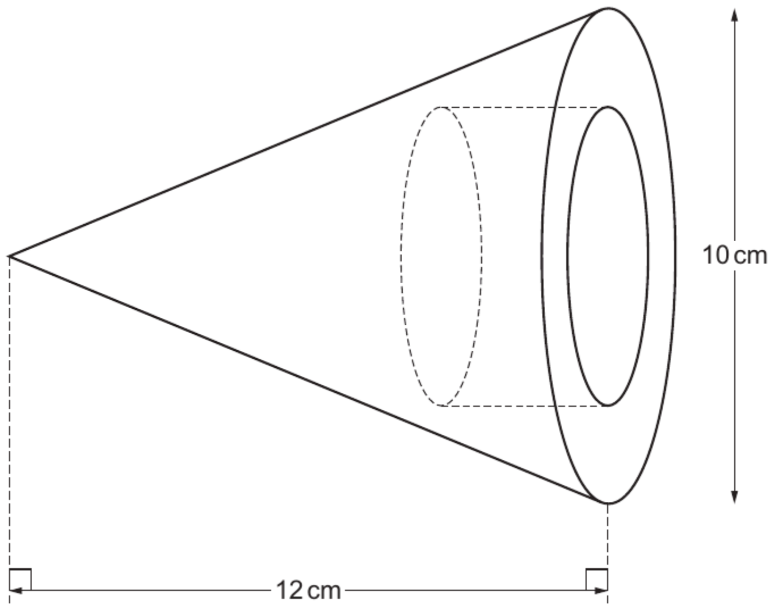


Diagram not drawn to scale

The curtain pole sits in a cylindrical hole that has been drilled into the end-piece.
The hole is of radius 3 cm and depth 4 cm.

(a) Show that the volume of wood that remains is $64\pi\,cm^3$. [4]

....

....

....

....

....

....

....

....

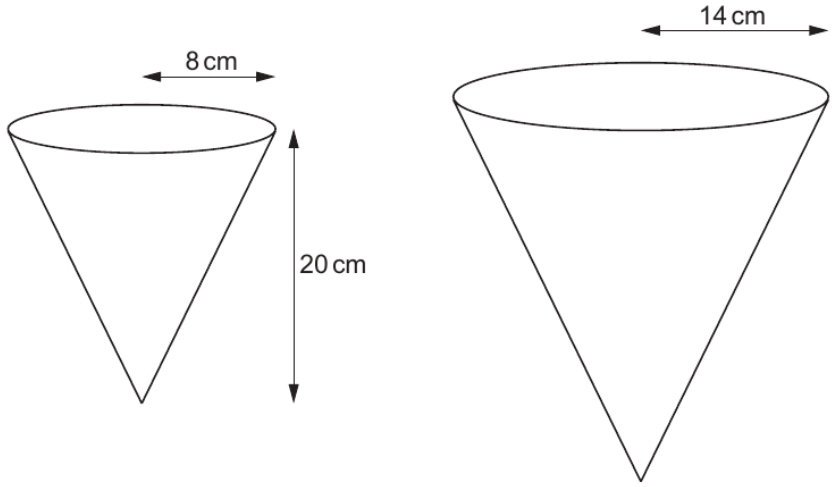
Examiner only

(b) The surface area of the end-piece is to be painted, except for the area inside the hole.
Calculate the surface area that is to be painted.
Give your answer in terms of π. [6]

END OF PAPER

Examiner only

10. The diagram below shows two **similar** flasks for measuring liquid.



Diagrams not drawn to scale

The flasks are in the shape of cones.
The smaller flask has a base radius of 8 cm and a vertical height of 20 cm.
The larger flask has a base radius of 14 cm.

(a) Calculate the vertical height of the larger flask. [2]

....

....

....

....

....

....

....

Examiner only

(b) The larger flask is now partly filled with liquid up to a vertical height of 15 cm.

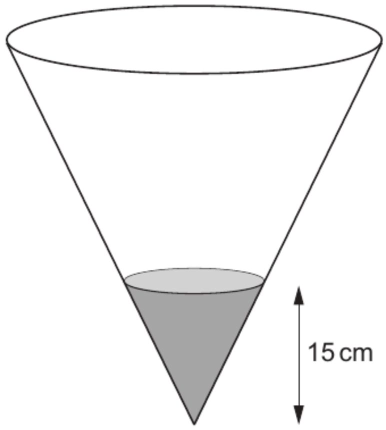


Diagram not drawn to scale

Calculate the volume of liquid in the flask.
Give your answer in terms of π. [4]

....

....

....

....

....

....

....

....

....

....

Examiner only

14. The diagram shows the simplified model of part of an engine.
It shows a belt which runs around three circular cogs.
The engine rotates Cog 1.
Cog 1 rotates the belt, which then makes Cogs 2 and 3 rotate.

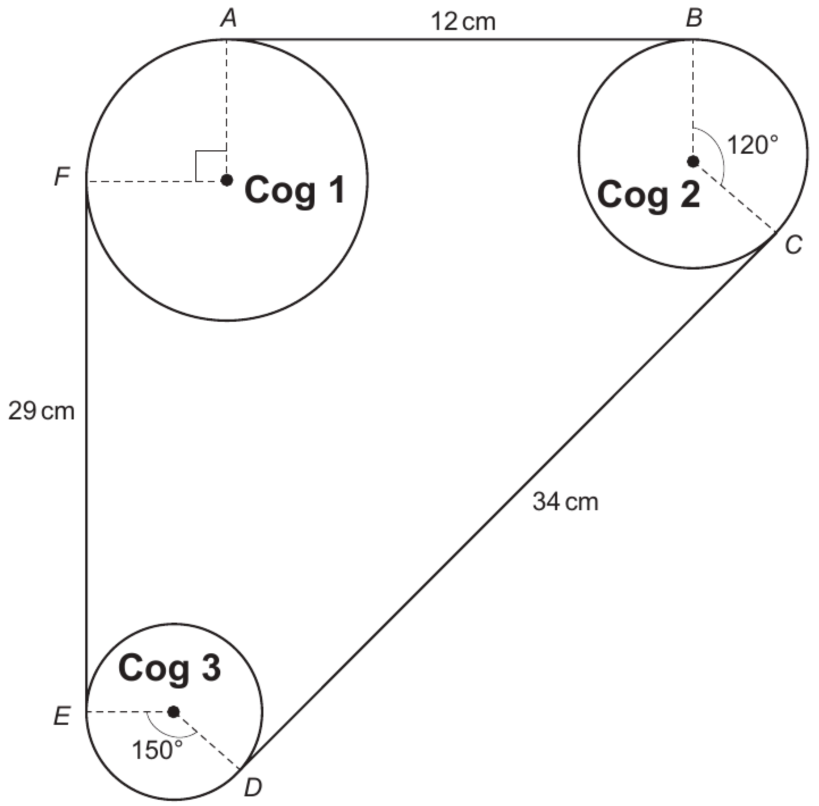


Diagram not drawn to scale

AB, *CD* and *EF* are straight sections of the belt.
AB = 12 cm, *CD* = 34 cm and *EF* = 29 cm.
The belt bends around the outer edges of the circular cogs, represented by the arcs *BC*, *DE* and *AF*.
The dimensions of the cogs are:

- radius of Cog 1 = 6 cm
- radius of Cog 2 = 4·5 cm
- radius of Cog 3 = 3 cm

(a) What is the length of arc *AF* in terms of π?
Circle your answer. [1]

2π $\quad$ 3π $\quad$ 6π $\quad$ 4π $\quad$ $\frac{3\pi}{2}$

....

....

....

Examiner only

(b) Calculate the total length of the belt.
Give your answer in terms of π in its simplest form. [4]

Total length of the belt = ... cm

(c) Elen notices that when Cog 3 makes two revolutions, Cog 1 makes only one revolution, because the radius of Cog 3 is half the radius of Cog 1.

In one minute, Cog 3 makes 2400 revolutions.
Calculate the number of revolutions **Cog 2** will make in one minute. [3]

END OF PAPER

Examiner only

13. Taryn made a birthday cake for her brother Carwyn, and placed it on a cake stand.
She made a cylindrical cake of radius 12 cm and height 10 cm.
To make the birthday cake look like the letter 'C' for Carwyn, she cut out a large slice.

The cake she has left has a uniform cross-section in the shape of a sector of a circle with sector angle 300°.

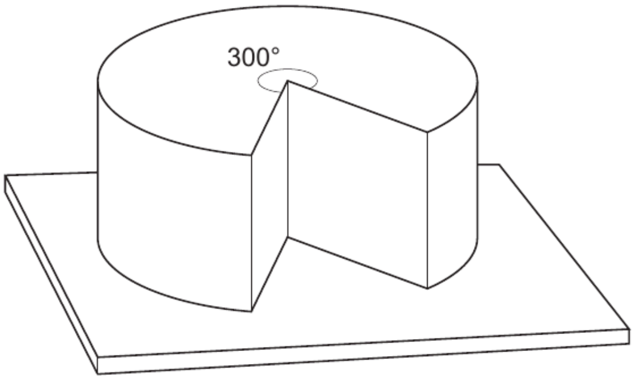


Diagram not drawn to scale

Taryn wants to put icing on all the visible surfaces of the cake.
Calculate the surface area that needs to be covered with icing.
Give your answer, **in its simplest form**, in terms of π. [5]

Examiner only

12. A new athletics stadium is to be built in Alltycapel.

(a) A throwing circle is to be built for the shot put and discus events.
There are lines drawn from the centre of the circle. They show the athletes where the boundaries are for their throws.
The lines form a sector of the circle.
This sector is to be painted, as shown in the diagram.

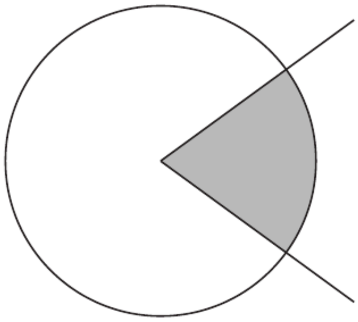


Diagram not drawn to scale

The radius of the throwing circle is 120 cm.

The area of the sector is $0{\cdot}08\dot{3}$ of the area of the circle.

(i) Write $0{\cdot}08\dot{3}$ as a fraction in its simplest form. [3]

....

....

....

....

....

....

....

....

....

....

....

Examiner only

(ii) Use your answer to (i) to calculate the area to be painted.
Give your answer in terms of π in its simplest form. [2]

Examiner only

(b) A new running track is to be built at the stadium.

Athletes in a 200-metre race run in lanes.
The inside line of one of the lanes is shown below.

The inside line consists of:

- a straight section of length 90 m,
- an arc of a circle with radius 36 m.

The length of this inside line is 200 m.

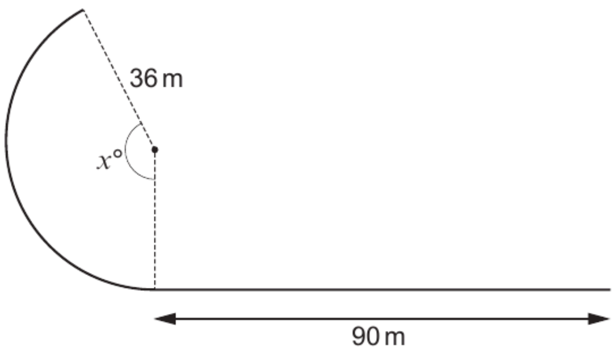


Diagram not drawn to scale

Show that the value of x is $\frac{550}{\pi}$. [5]

....

....

....

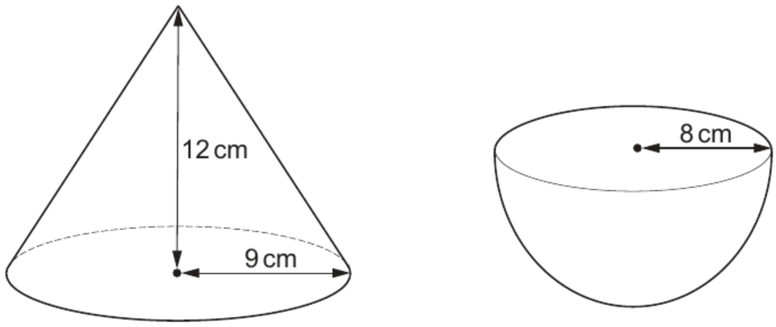
....

....

Examiner only

10. *In this question, you will be assessed on the quality of your organisation, communication and accuracy in writing.*

The diagrams below show a solid cone and a solid hemisphere.



Diagrams not drawn to scale

The cone has a base radius of 9 cm and a vertical height of 12 cm.
The hemisphere has a radius of 8 cm.

Which of the two solids has the greater **curved** surface area?
You should express any areas in terms of π.
You must show all your working. [7 + 2 OCW]

Examiner only

6. Most aircraft are held together with metal rivets.

(a) The rivet used on one type of aircraft is shown below. It can be thought of as a cylinder connected to a hemisphere.

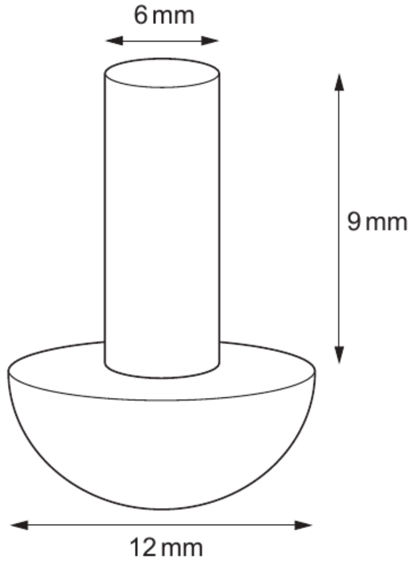


Diagram not drawn to scale

The cylinder has a diameter of 6 mm and a length of 9 mm.
The hemisphere has a diameter of 12 mm.

(i) Calculate the volume of the rivet.
Give your answer in terms of π in its simplest form. [4]

....

....

....

....

....

....

....

Examiner only

(ii) The manufacturer plans to reduce the length of the cylindrical part of the rivet from 9 mm to 8 mm.
Calculate the fractional reduction in the volume of a rivet this would produce. [2]

....

....

....

....

....

....

Fractional reduction in the volume of a rivet = ...

(b) For another type of rivet, the manufacturer plans to reduce the volume by $0\cdot16\dot{1}$ of its original volume.
Write $0\cdot16\dot{1}$ as a fraction.
Give your answer in its simplest form. [3]

....

....

....

....

....

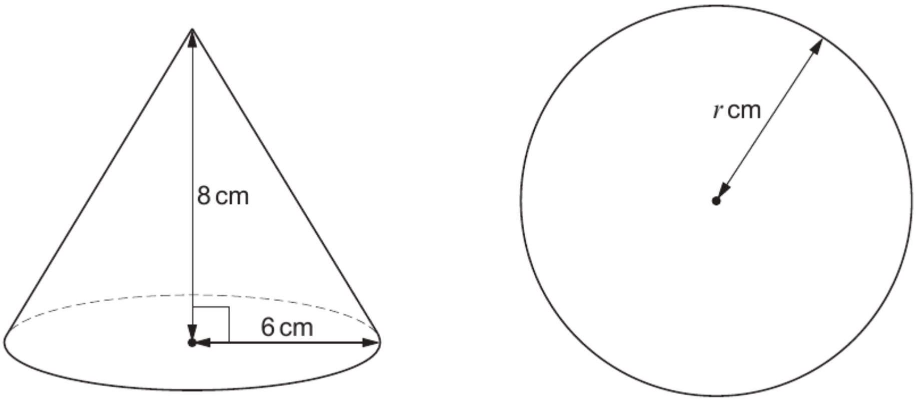
....

....

....

Examiner only

12. The diagrams below show a solid cone and a circle.



Diagrams not drawn to scale

The cone has a base radius of 6 cm and a vertical height of 8 cm.
The circle has a radius of r cm.

The **curved** surface area of the cone equals the area of the circle.

By expressing any areas in terms of π, find the value of r.
Give your answer in the form $a\sqrt{b}$, where a and b are integers, and b is as small as possible.
[6]