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CAMBRIDGE INTERNATIONAL MATHEMATICS

0607/63

Paper 6 Investigation and Modelling (Extended)

October/November 2020

1 hour 40 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer both part **A** (Questions 1 to 4) and part **B** (Questions 5 to 8).
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You should use a graphic display calculator where appropriate.
- You may use tracing paper.
- You must show all necessary working clearly, including sketches, to gain full marks for correct methods.
- In this paper you will be awarded marks for providing full reasons, examples and steps in your working to communicate your mathematics clearly and precisely.

INFORMATION

- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages. Blank pages are indicated.

Answer **both** parts **A** and **B**.

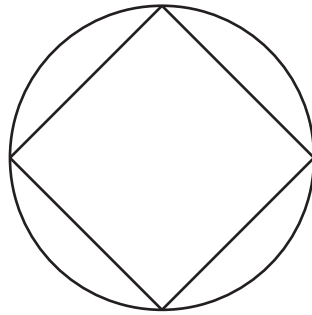
A INVESTIGATION (QUESTIONS 1 TO 4)

AREAS OF POLYGONS INSIDE AND OUTSIDE A CIRCLE (30 marks)

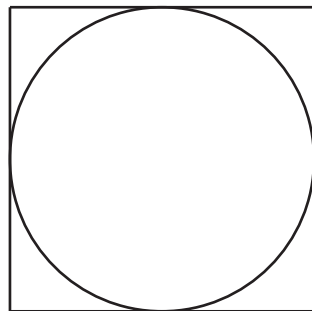
You are advised to spend no more than 50 minutes on this part.

This investigation looks at the areas of polygons drawn inside and outside a circle of radius 10 cm.

An inscribed polygon is a polygon in which all the vertices lie on a circle.
This is an inscribed square.



A circumscribed polygon is a polygon in which each side is a tangent to a circle.
This is a circumscribed square.



You may find some of these formulas useful.

$$\text{Area, } A, \text{ of circle, radius } r \qquad A = \pi r^2$$

$$\text{Area, } A, \text{ of triangle, base } b, \text{ height } h \qquad A = \frac{1}{2}bh$$

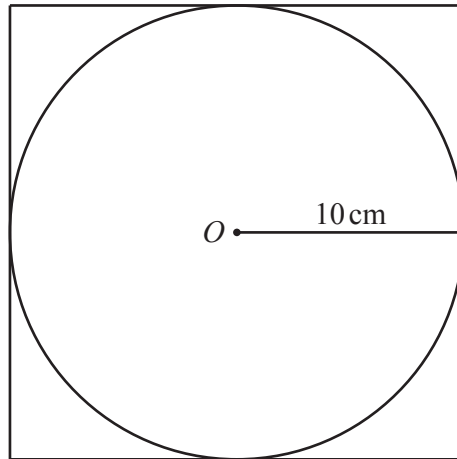
In a right-angled triangle,

$$\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}},$$

$$\cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}},$$

$$\tan \theta = \frac{\text{opposite}}{\text{adjacent}}.$$

1 (a)

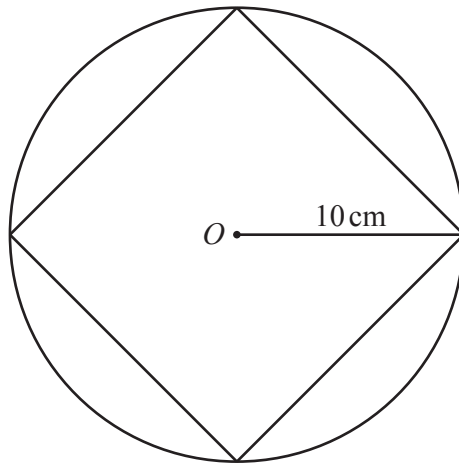
NOT TO
SCALE

A square circumscribes a circle, centre O , radius 10 cm.

Work out the area of the square.

..... [1]

(b)

NOT TO
SCALE

A square is inscribed in a circle, centre O , radius 10 cm.

Work out the area of the square.

..... [2]

(c) Show that the area of a circle, radius 10 cm, is $100\pi \text{ cm}^2$.

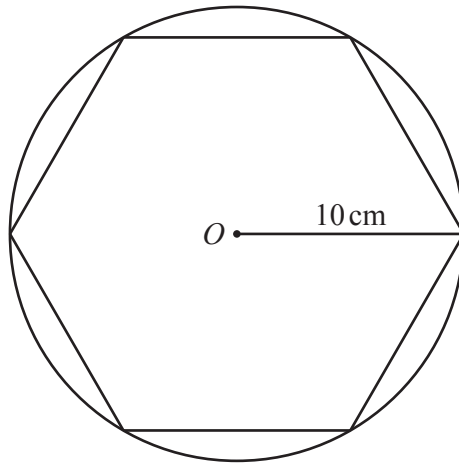
[1]

(d) Area of inscribed square $<$ Area of circle $<$ Area of circumscribed square

Use this statement to complete the inequality below.

..... $< \pi <$ [1]

2 (a)

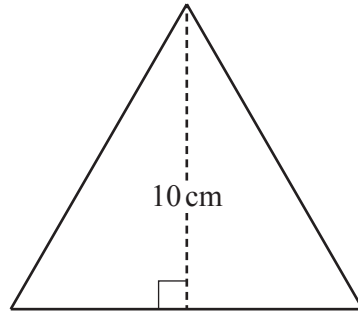
NOT TO
SCALE

A regular hexagon is inscribed in a circle, centre O , radius 10 cm.

Find the area of the hexagon.

..... [3]

(b) (i)

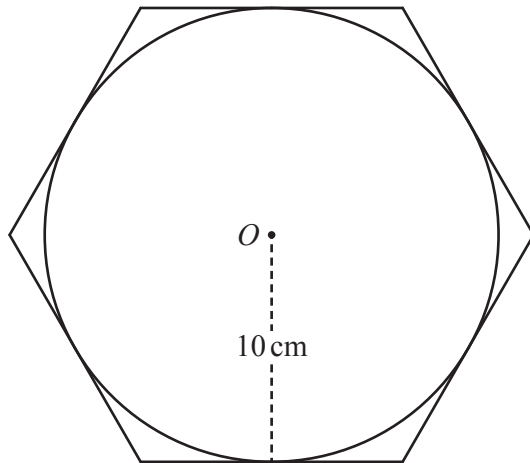
NOT TO
SCALE

An equilateral triangle has height 10 cm.

Find the area of the triangle.

..... [3]

(ii)

NOT TO
SCALE

A regular hexagon circumscribes a circle, centre O , radius 10 cm.

Using your answer to **part (i)**, find the area of the hexagon.

..... [2]

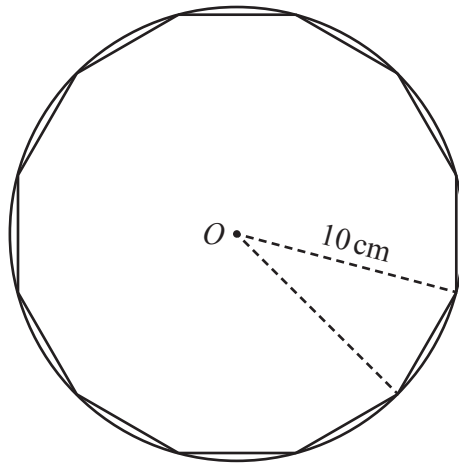
- (c) (i) Use **Question 1(c)**, **Question 2(a)** and **Question 2(b)(ii)** to complete the inequality.

$$\dots\dots\dots < \pi < \dots\dots\dots \quad [1]$$

- (ii) Give a geometric reason why the range in the inequality in **Question 2(c)(i)** is smaller than the range in the inequality in **Question 1(d)**.

.....
..... [1]

3 (a)

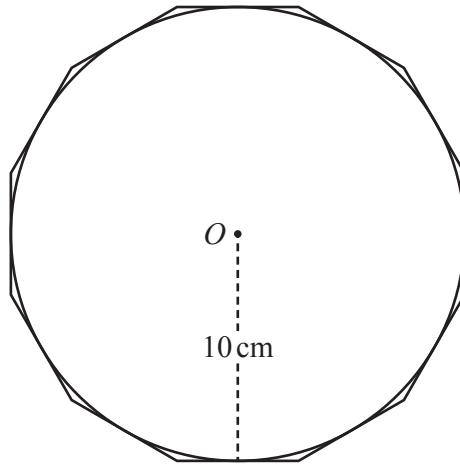
NOT TO
SCALE

A regular 12-sided polygon is inscribed in a circle, centre O , radius 10 cm.

Find the area of this polygon.

..... [2]

(b)

NOT TO
SCALE

A regular 12-sided polygon circumscribes a circle, centre O , radius 10 cm.

Find the area of this polygon.

..... [3]

(c) Use the answers to **part (a)** and **part (b)** to complete the inequality.

..... $< \pi <$ [1]

- 4 (a) (i) Show that a formula for the area, $A \text{ cm}^2$, of a regular polygon with n sides **inscribed** in a circle, radius 10 cm, is

$$A = 50n \sin\left(\frac{360}{n}\right)^\circ.$$

[2]

- (ii) Show that a formula for the area, $B \text{ cm}^2$, of a regular polygon with n sides that **circumscribes** a circle, radius 10 cm, is

$$B = 100n \tan\left(\frac{180}{n}\right)^\circ.$$

[2]

(b) (i) Work out the area of a regular polygon with 100 sides that is **inscribed** in a circle, radius 10 cm. Give your answer correct to 4 significant figures.

..... [2]

(ii) Work out the area of a regular polygon with 100 sides that **circumscribes** a circle, radius 10 cm. Give your answer correct to 4 significant figures.

..... [2]

(c) Use your answers to **part (b)** to explain how you can find the value of π correct to 3 significant figures.

.....
..... [1]

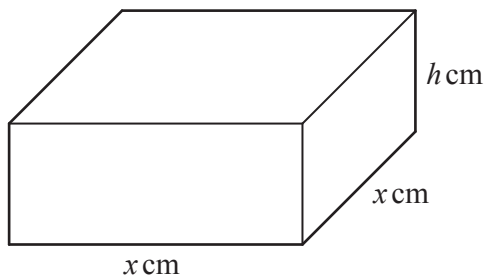
B MODELLING (QUESTIONS 5 TO 8)

MODELLING CONTAINERS (30 marks)

You are advised to spend no more than 50 minutes on this part.

Olivia wants to design a closed container with a volume of 1000 cm^3 and minimum surface area.

5 Olivia uses a square-based cuboid to model the container.



NOT TO SCALE

(a) (i) Write down a formula for the volume of the cuboid, $V \text{ cm}^3$, in terms of x and h .

..... [1]

(ii) Find a formula for the surface area, $S \text{ cm}^2$, of the cuboid, in terms of x and h .
Give your answer in its simplest form.

..... [2]

(b) (i) $V = 1000$.

Write h in terms of x .

..... [1]

(ii) Show that $S = 2x^2 + \frac{4000}{x}$.

[1]

(iii) Work out the value of S when $x = 25$.

..... [1]

(c) Sketch the graph of $S = 2x^2 + \frac{4000}{x}$ for $0 < x \leq 25$.



[3]

(d) (i) Find the minimum surface area of the cuboid.

..... [1]

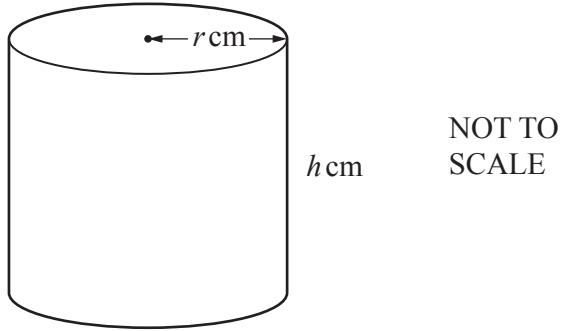
(ii) Describe the container that gives the minimum surface area for Olivia's model.

.....
 [2]

6

Volume, V , of a cylinder of radius r , height h $V = \pi r^2 h$
 Curved surface area, A , of a cylinder of radius r , height h $A = 2\pi r h$

Olivia now uses a cylinder to model the container.



The total surface area of this model is $T \text{ cm}^2$.

(a) $V = 1000$.

Show that $T = 2\pi r^2 + \frac{2000}{r}$.

[3]

(b) (i) Find the minimum surface area of the cylinder.

..... [2]

- (ii) Find the dimensions of the cylinder with the minimum surface area.

$$r = \dots\dots\dots$$

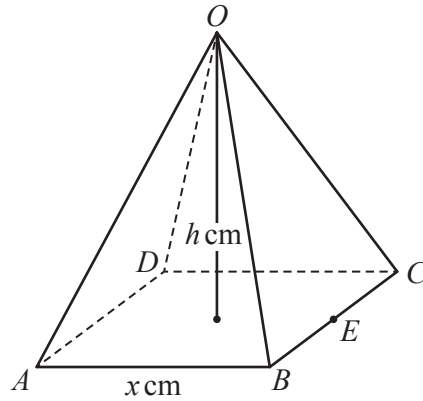
$$h = \dots\dots\dots [2]$$

7

Volume, V , of a pyramid, base area A , height h

$$V = \frac{1}{3}Ah$$

Olivia now uses a square-based pyramid to model the container.



NOT TO
SCALE

The pyramid, $OABCD$, has a square base of side x cm and height h cm.
The vertex of the pyramid, O , is directly above the centre of the square base.
 E is the mid-point of BC .

(a) Find an expression for OE in terms of h and x .

..... [2]

(b) The total surface area of this model is $P \text{ cm}^2$.

$$V = 1000.$$

Show that $P = x^2 + \frac{\sqrt{x^6 + 36000000}}{x}$.

[4]

(c) (i) Find the minimum surface area of the pyramid.

..... [2]

(ii) Find the dimensions of the pyramid with the minimum surface area.

$x =$

$h =$ [2]

8 Olivia recommends the container with the smallest surface area to a company.

Give a geometric reason why the company might not accept Olivia's recommendation.

Olivia recommends the

Geometric reason

..... [1]

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