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OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Monday 16 May 2022 – Afternoon

Level 3 Cambridge Technical in Engineering

05822/05823/05824/05825/05873

Unit 1: Mathematics for engineering

Time allowed: 1 hour 30 minutes plus your additional time allowance

You must have:

the Formula Booklet for Level 3 Cambridge Technical in Engineering (with this document)

a ruler (cm/mm)

a scientific calculator

Please write clearly in black ink.

Centre number								
Candidate number								
First name(s)								
Last name								
Date of birth	D	D	M	M	Y	Y	Y	Y

READ INSTRUCTIONS OVERLEAF

INSTRUCTIONS

Use black ink. You can use an HB pencil, but only for graphs and diagrams.

Write your answer to each question in the space provided. You can use extra paper if you need to, but you must clearly show your candidate number, the centre number and the question numbers.

Answer ALL the questions.

Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

Give your final answers to a degree of accuracy that is appropriate to the context.

INFORMATION

The total mark for this paper is 60.

The marks for each question are shown in brackets [ ].

ADVICE

Read each question carefully before you start your answer.

Answer ALL the questions.

1 (a) Multiply out $2(3x - 4y)$.

_____

_____ **[2]**

(b) Factorise $x^2 - 7x + 12$.

_____

_____ **[2]**

(c) Write as a single fraction $\frac{x+2}{4} + \frac{3-x}{3}$.

_____

_____

_____

_____

_____

_____ **[3]**

(d) Rearrange the following formula so that k is the subject.

$$T = 2\pi\sqrt{\frac{m}{k}}$$

_____

_____

_____

_____

_____

_____ **[2]**

2 You are given the cubic function

$f(x) = x^3 - 6x^2 + 11x - 6$.

(i) Show that $f(2) = 0$.

_____

_____

_____ **[2]**

(ii) Hence factorise $f(x)$.

_____

_____

_____

_____

_____

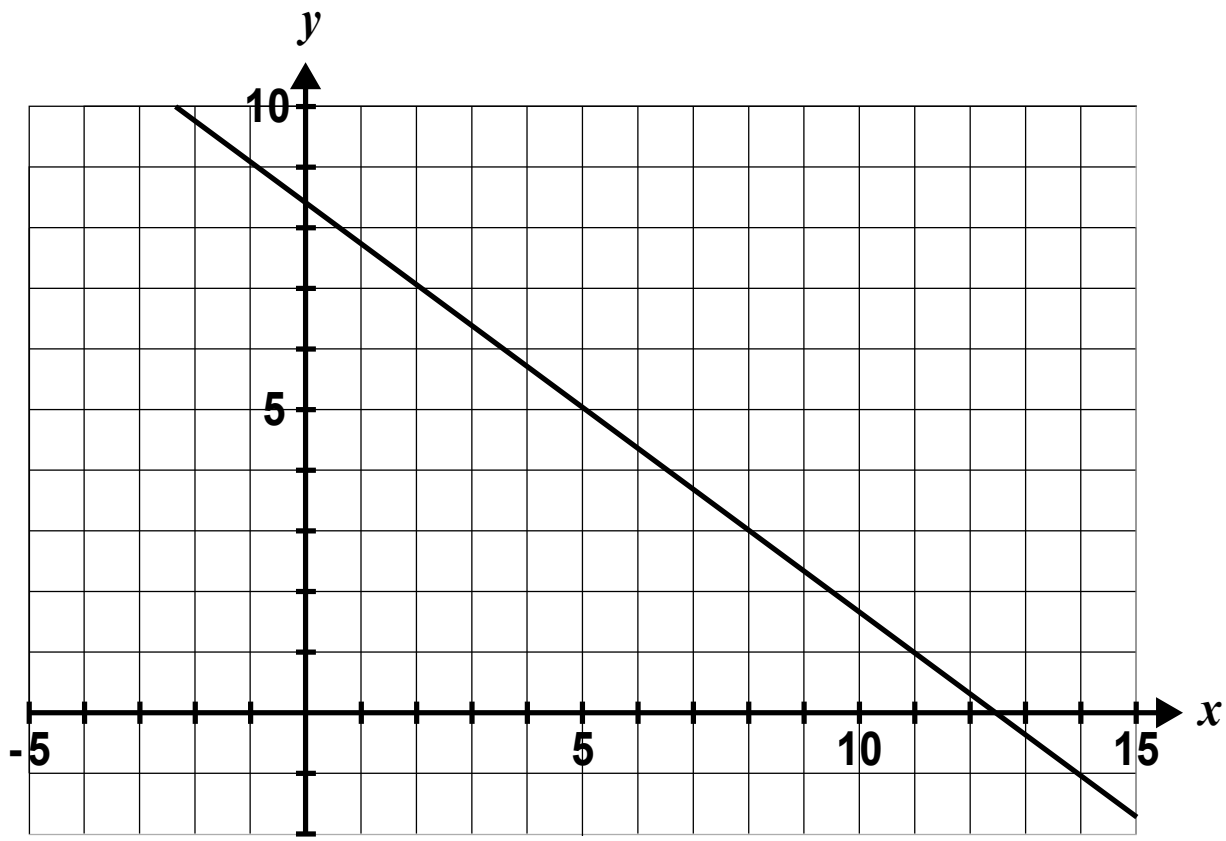
_____ **[3]**

(iii) Solve the equation $f(x) = 0$.

_____

_____ **[1]**

3 (a) The graph of the line $2x + 3y = 25$ is shown on the grid below.



(i) On the same grid plot the line with equation $y = 3x + 1$. [2]

(ii) Hence write down the solution to the simultaneous equations $y = 3x + 1$ and $2x + 3y = 25$.

_____ **[1]**

(b) A cylinder has a radius r cm and height h cm.

The surface area is given by the formula

$A = 2\pi r^2 + 2\pi rh$.

A particular cylinder has height 12 cm and a surface area 300 cm².

(i) Show that the radius satisfies the equation $3.14r^2 + 37.7r - 150 = 0$ where the coefficients are given to 3 significant figures.

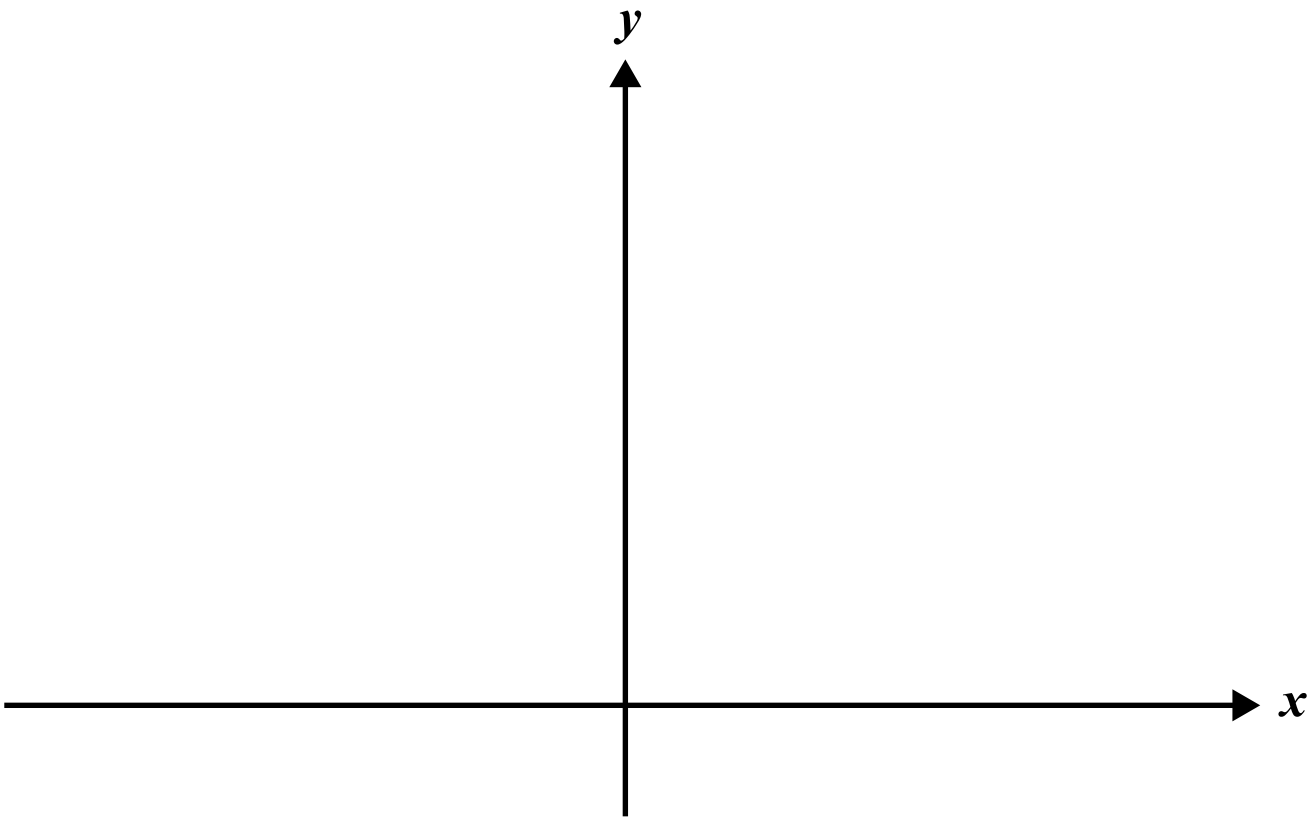
[2]

(ii) Use the quadratic formula to solve this equation to find the radius of the cylinder.

[3]

4 (a) On the grid below, sketch the graph of

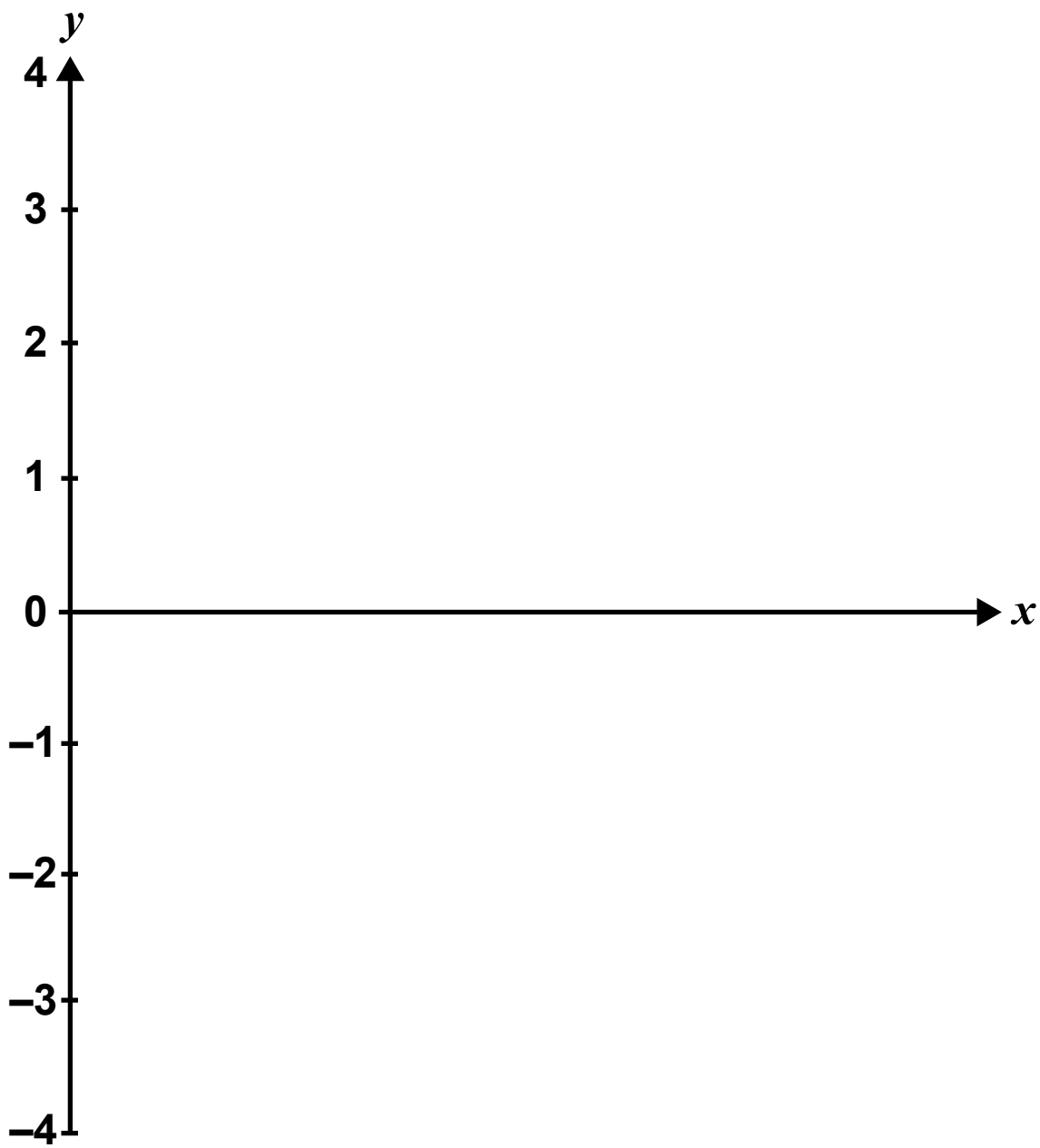
$y = (x - 2)^2 + 3$. **[2]**



(b) On the grid below, sketch

(i) the graph of $y = 2\cos x$ for $0° \leqslant x \leqslant 360°$, [2]

(ii) the graph of $y = 2 + 2\cos x$ for $0° \leqslant x \leqslant 360°$. [1]



(c) You are given that $\sin x = p$ where $-1 \leqslant p \leqslant 1$.

Find expressions for

(i) $\sin(-x)$,

_____

_____ [1]

(ii) $\cos x$.

_____

_____

_____ [2]

5 (a) Use calculus to determine the coordinates of the stationary point on the curve $y = x^2 - 4x + 7$.

_____

_____

_____

_____

_____

_____ [4]

(b) The voltage growth in a capacitor can be modelled by the formula

$$V = 12\,(1 - e^{-\frac{t}{4}})$$

where V is the voltage t seconds after the application of current through the circuit.

(i) Calculate the voltage in the capacitor after 5 seconds.

_____

_____ **[2]**

(ii) Calculate the time taken for the voltage to reach 7 V.

_____

_____

_____

_____ **[3]**

(c) A metal plate, $OABC$, has three straight edges and one curved edge.

On a coordinate system, O is the origin and the coordinates of A and C are (0,20) and (20,0) respectively.

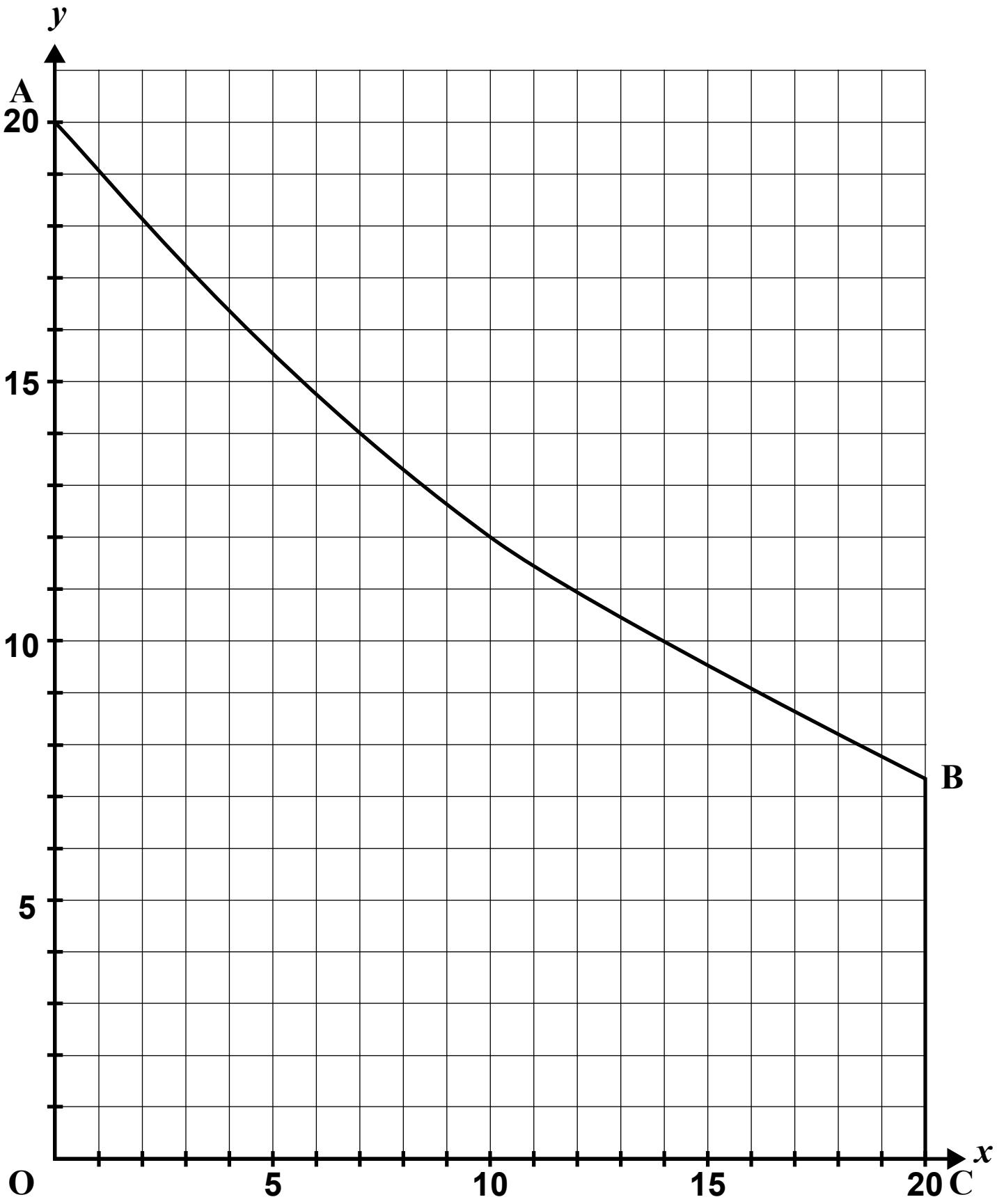
The curved edge, AB, has equation $y = 20e^{-\frac{x}{20}}$ as shown in the diagram opposite.

Units are millimetres.

Using calculus, calculate the area of the metal plate.

Give the units of your answer.

[4]


y
A
20
15
10
5
B
O
5
10
15
20
C
x

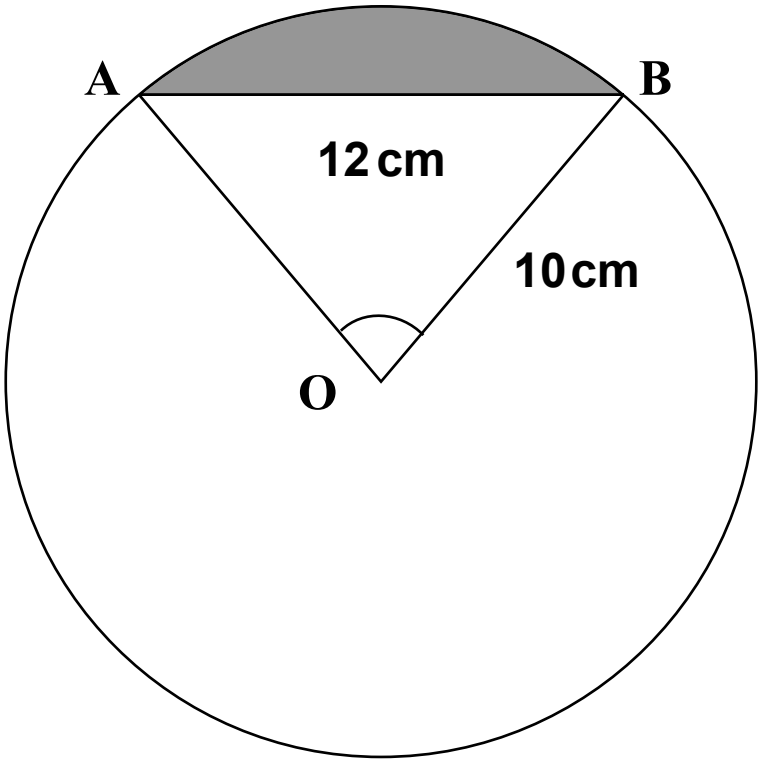
6 **A component of a machine is part of a circle which has radius 10 cm.**

Two points, A and B, on the circumference of the circle are 12 cm apart, as shown in FIG. 1.

The centre of the circle is O.

The component has a section of the circle above the line AB removed. This section is shown shaded in FIG. 1.

FIG. 1



Not to scale

(i) Find the angle AOB, giving your answer in degrees.

[3]

(ii) Hence find the area of the shaded section removed from the circle in FIG. 1.

Give the units of your answer.

[6]

7 (a) It is known that a particular component in a machine has a probability of failing in the first day of use of 0.2.

If the component fails then the machine fails.

What is the expected number of machines that will fail on the first day in a batch of 50 machines?

_____

_____ [2]

(b) In a bag there are 20 blue balls and 20 red balls, all identical except for their colour.

Two balls are drawn at random from the bag and their colour noted.

Find the probability that both balls will be red if

(i) the first ball is replaced before the second ball is drawn,

_____

_____

_____

_____ [2]

(ii) the first ball is not replaced before the second ball is drawn.

_____

_____

_____

_____ **[3]**

END OF QUESTION PAPER

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