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I declare this is my own work.

A-level

MATHEMATICS

Paper 3

7357/3

Thursday 20 June 2024 Afternoon

Time allowed: 2 hours

At the top of the page, write your surname and forename(s), your centre number, your candidate number and add your signature.

[Turn over]



J U N 2 4 7 3 5 7 3 0 1

MATERIALS

- **You must have the AQA Formulae for A-level Mathematics booklet.**
- **You should have a graphical or scientific calculator that meets the requirements of the specification.**

INSTRUCTIONS

- **Use black ink or black ball-point pen. Pencil should only be used for drawing.**
- **Answer ALL questions.**
- **You must answer each question in the space provided for that question.**
- **If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).**
- **Do not write on blank pages.**



- **Show all necessary working; otherwise, marks for method may be lost.**
- **Do all rough work in this book. Cross through any work you do not want to be marked.**

INFORMATION

- **The marks for questions are shown in brackets.**
- **The maximum mark for this paper is 100.**

ADVICE

- **Unless stated otherwise, you may quote formulae, without proof, from the booklet.**
- **You do not necessarily need to use all the space provided.**

DO NOT TURN OVER UNTIL TOLD TO DO SO



SECTION A

Answer ALL questions in the spaces provided.

- 1 Each of the series below shows the first four terms of a geometric series.**

Identify the only one of these geometric series that is convergent. [1 mark]

Tick (✓) ONE box.

$0.1 + 0.2 + 0.4 + 0.8 + \dots$

$1 - 1 + 1 - 1 + \dots$

$128 - 64 + 32 - 16 + \dots$

$1 + 2 + 4 + 8 + \dots$



2 The quadratic equation

$$4x^2 + bx + 9 = 0$$

has one repeated real root.

Find b

Circle your answer. [1 mark]

$$b = 0$$

$$b = \pm 12$$

$$b = \pm 13$$

$$b = \pm 36$$

[Turn over]

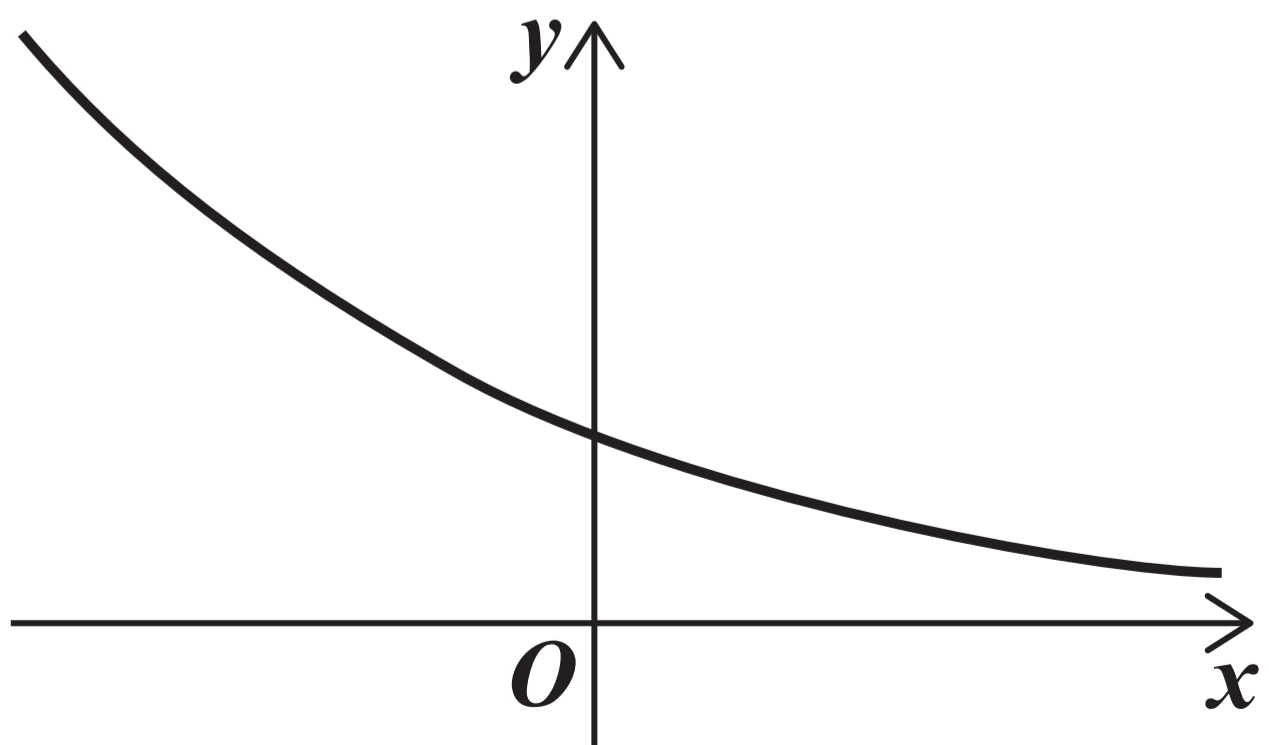
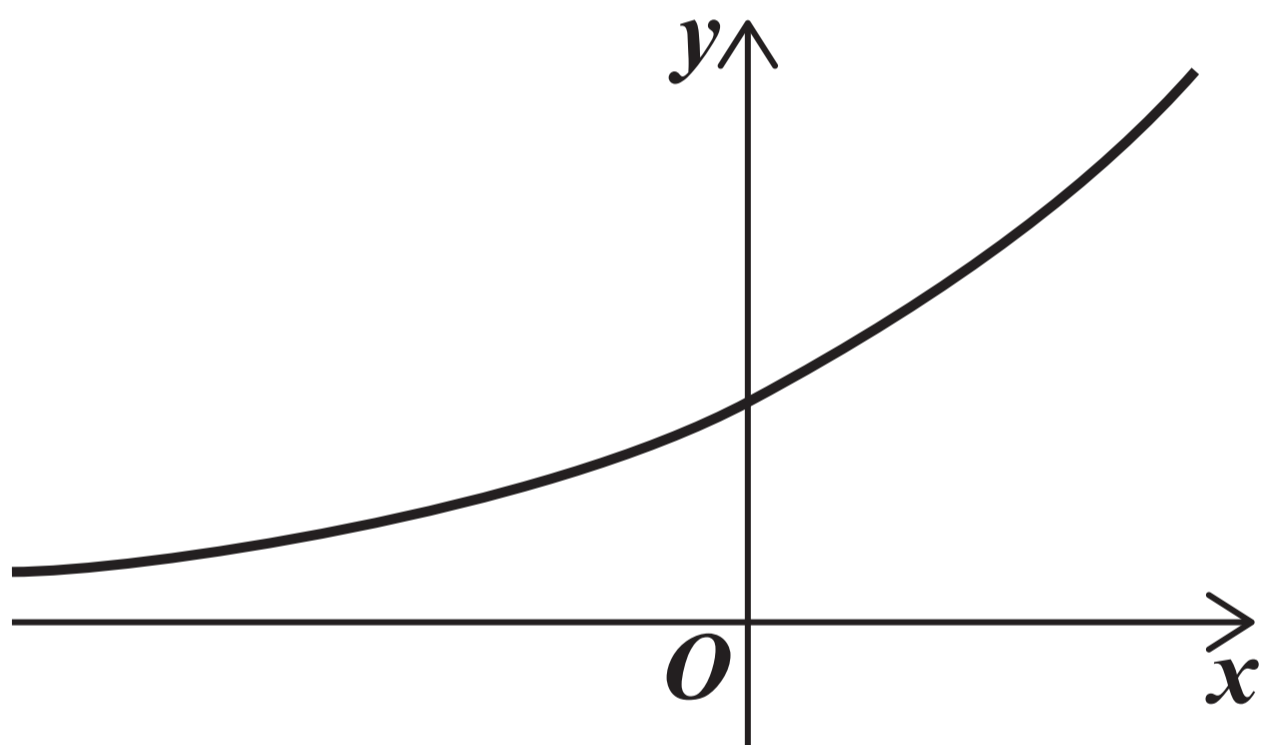


- 3 One of the graphs shown below and on the opposite page **CANNOT** have an equation of the form

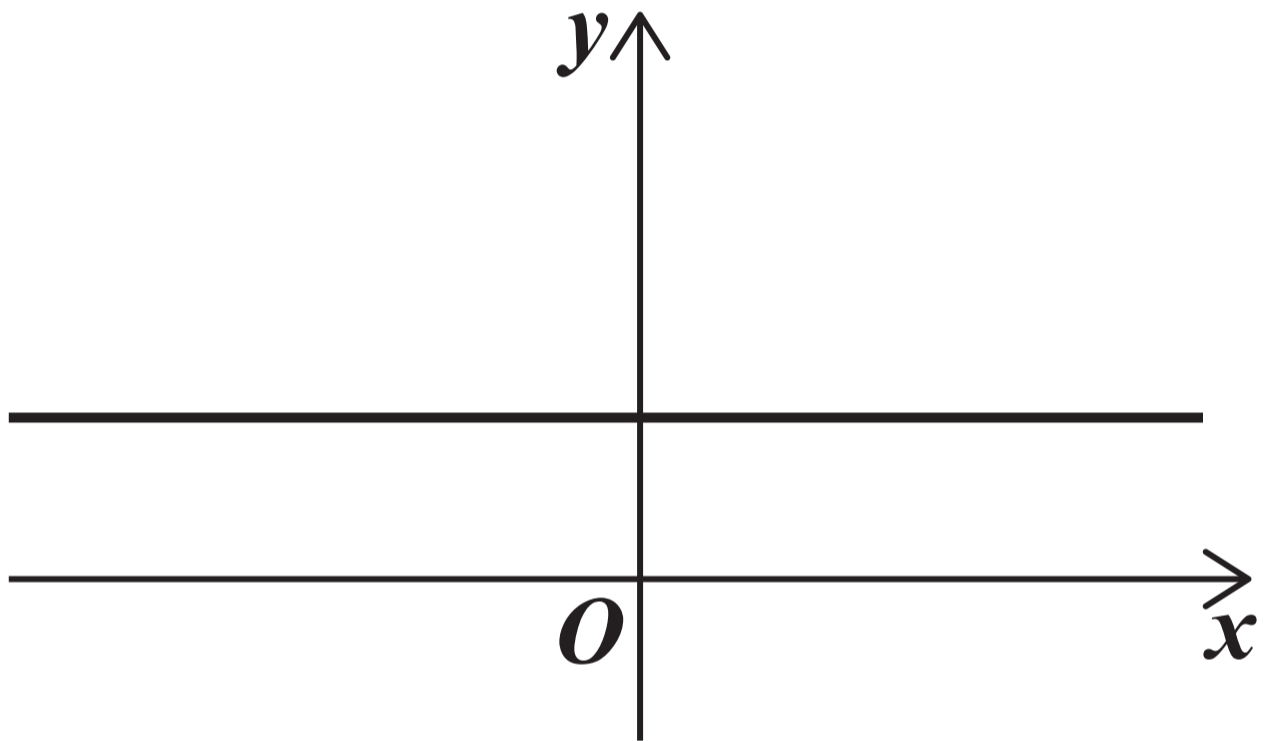
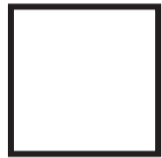
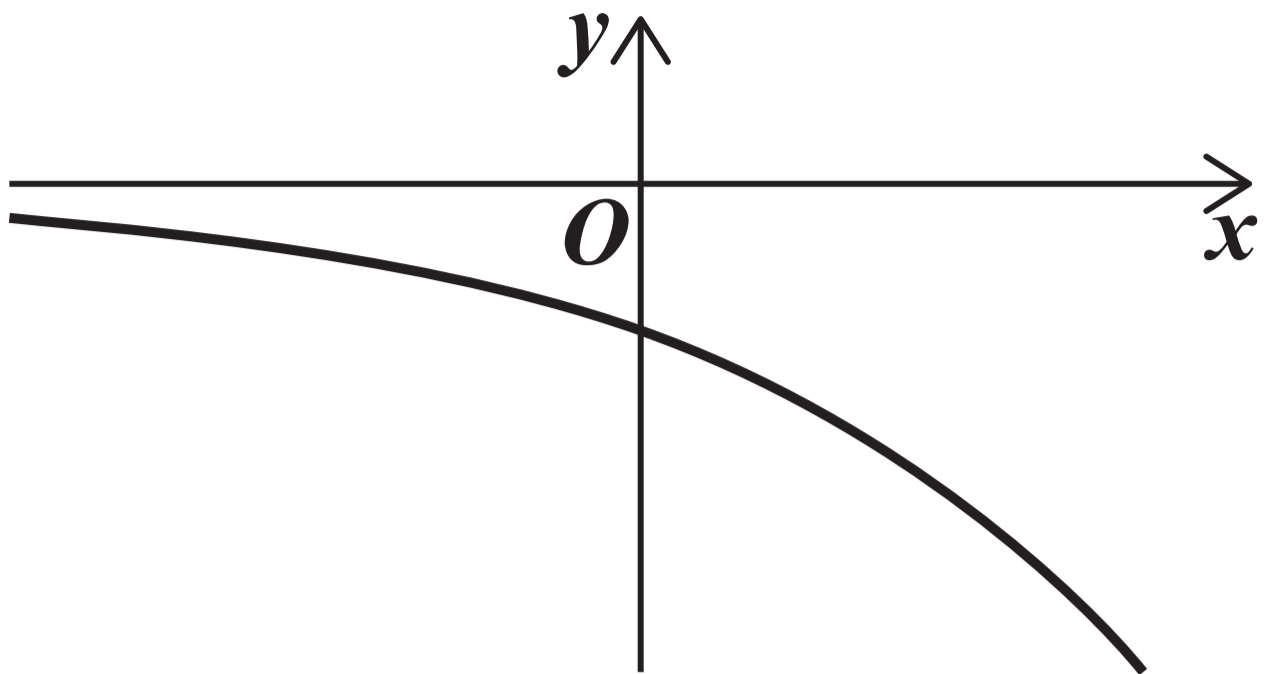
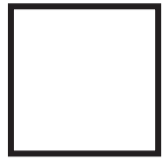
$$y = a^x \quad \text{where } a > 0$$

Identify this graph.

Tick (✓) **ONE** box. [1 mark]



7



[Turn over]



4 A curve has equation $y = x^4 + 2^x$

Find an expression for $\frac{dy}{dx}$

[2 marks]



[Turn over]

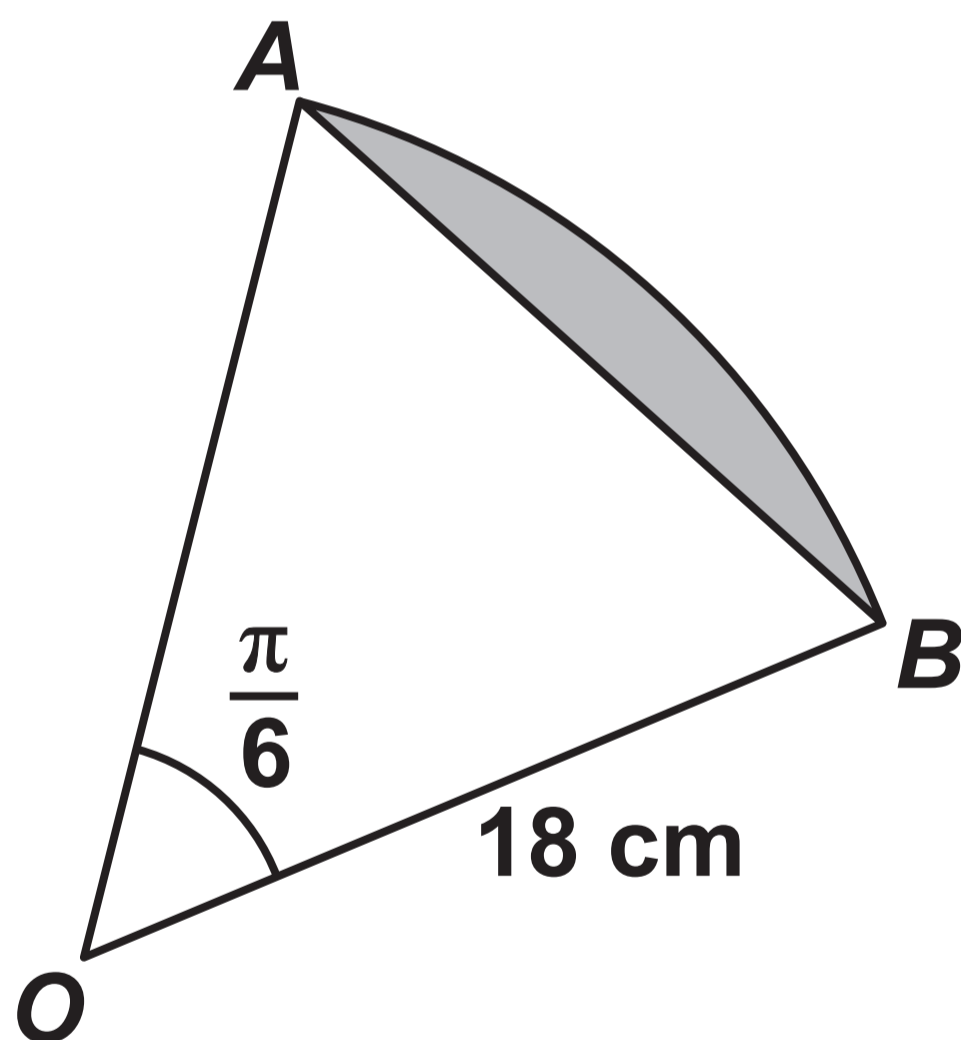


5 The diagram below shows a sector of a circle OAB .

The chord AB divides the sector into a triangle and a shaded segment.

Angle AOB is $\frac{\pi}{6}$ radians.

The radius of the sector is 18 cm.



Show that the area of the shaded segment is

$$k(\pi - 3) \text{ cm}^2$$

where k is an integer to be found. [3 marks]

[Turn over]





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[Turn over]



6 (a) Find $\int \left(6x^2 - \frac{5}{\sqrt{x}} \right) dx$ [3 marks]



[Turn over]



6 (b) The gradient of a curve is given by

$$\frac{dy}{dx} = 6x^2 - \frac{5}{\sqrt{x}}$$

The curve passes through the point (4, 90).

Find the equation of the curve.
[2 marks]



[Turn over]

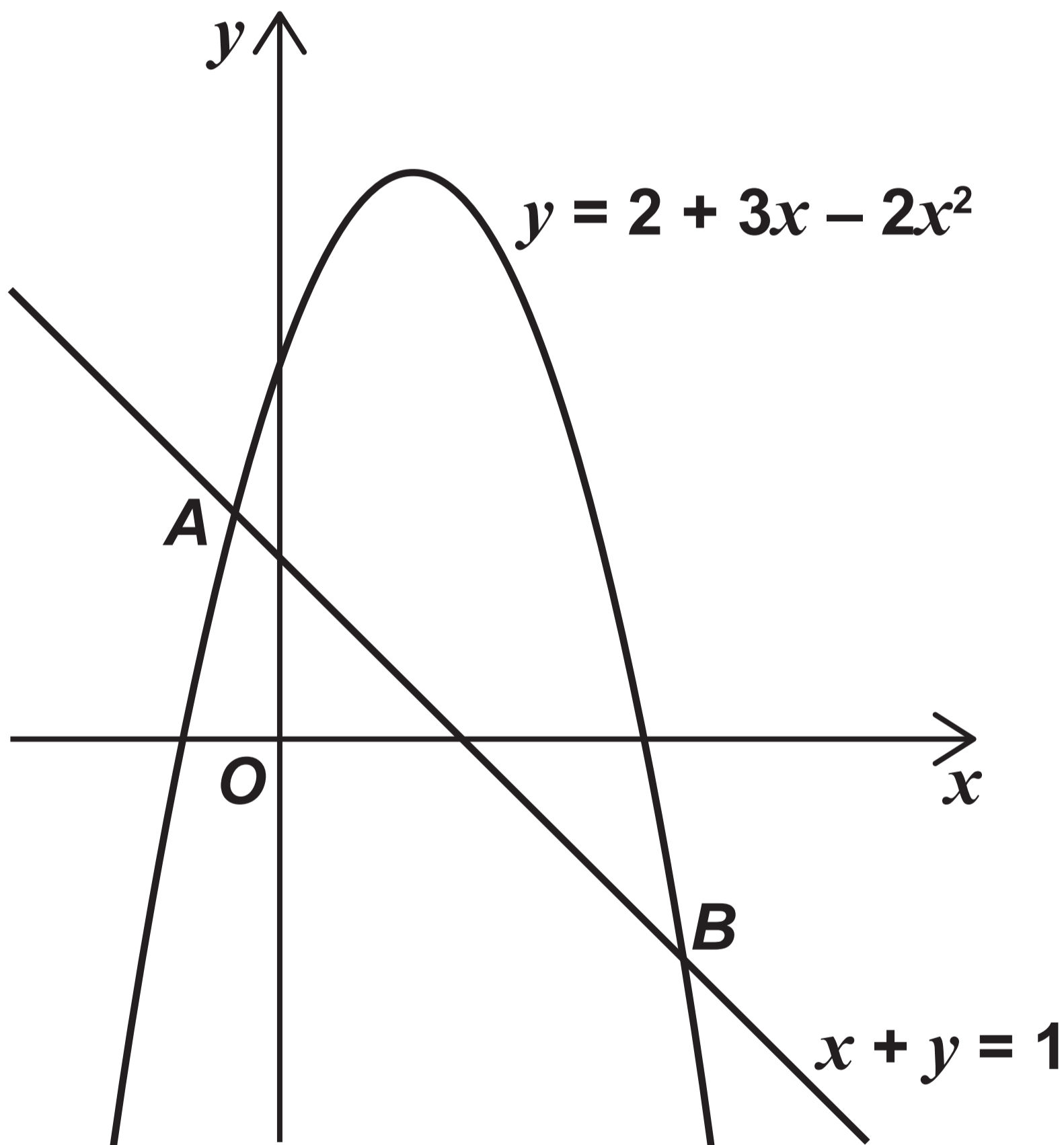


7

The graphs with equations

$$y = 2 + 3x - 2x^2 \text{ and } x + y = 1$$

are shown in the diagram below.



The graphs intersect at the points A and B



7 (a) On the diagram, on the opposite page, shade and label the region, R , that is satisfied by the inequalities

$$0 \leq y \leq 2 + 3x - 2x^2$$

and

$$x + y \geq 1 \quad [2 \text{ marks}]$$

[Turn over]



7 (b) Find the exact coordinates of A
[3 marks]

[Turn over]





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[Turn over]



8 The temperature θ °C of an oven t minutes after it is switched on can be modelled by the equation

$$\theta = 20(11 - 10e^{-kt})$$

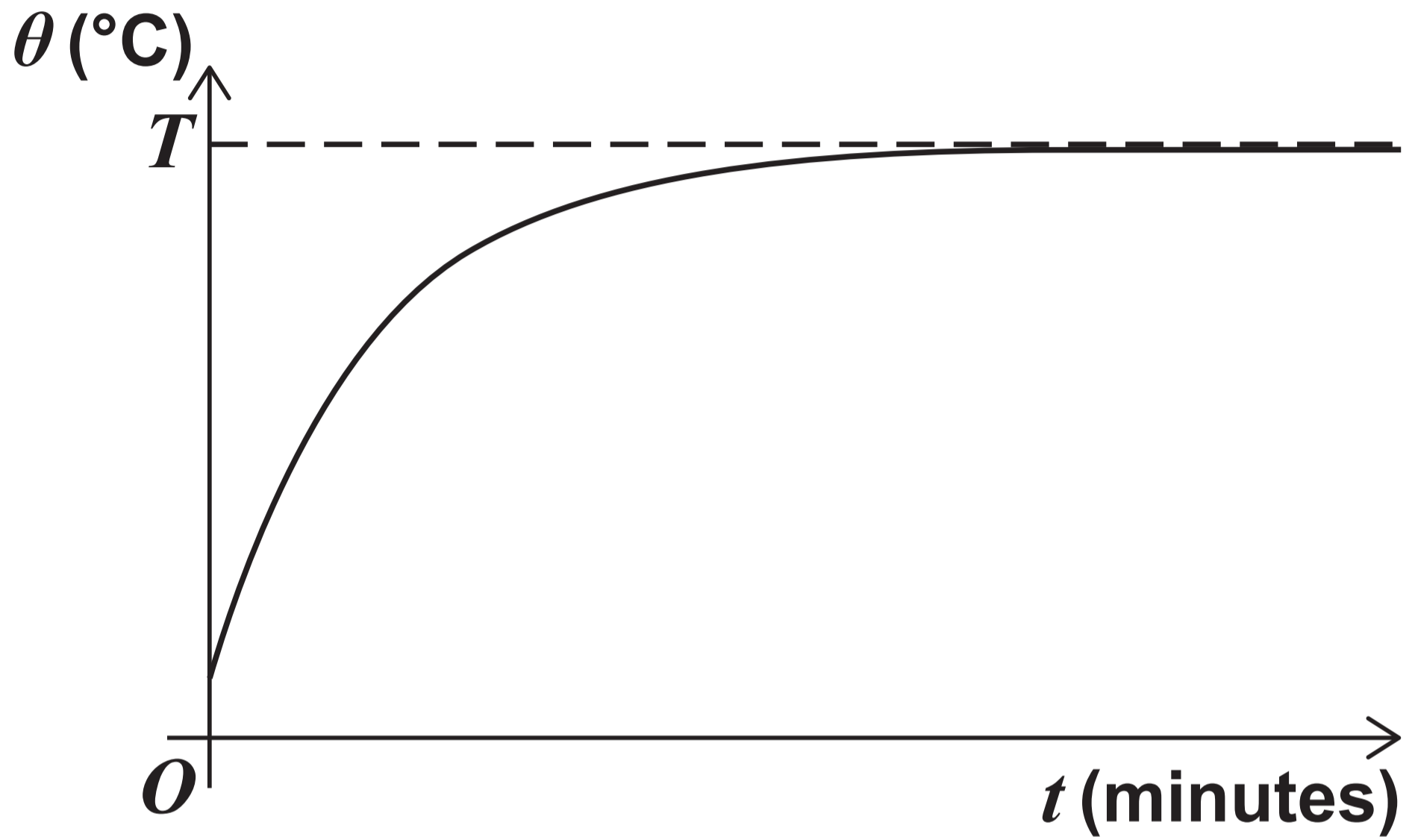
where k is a positive constant.

Initially the oven is at room temperature.

The maximum temperature of the oven is T °C



The temperature predicted by the model is shown in the graph below.



[Turn over]



[Turn over]



8 (b) Find the value of T [2 marks]

[Turn over]



8 (c) The oven reaches a temperature of 86 °C one minute after it is switched on.

8 (c) (i) Find the value of k . [2 marks]

[Turn over]



8 (c) (ii) Find the time it takes for the temperature of the oven to be within 1°C of its maximum. [2 marks]

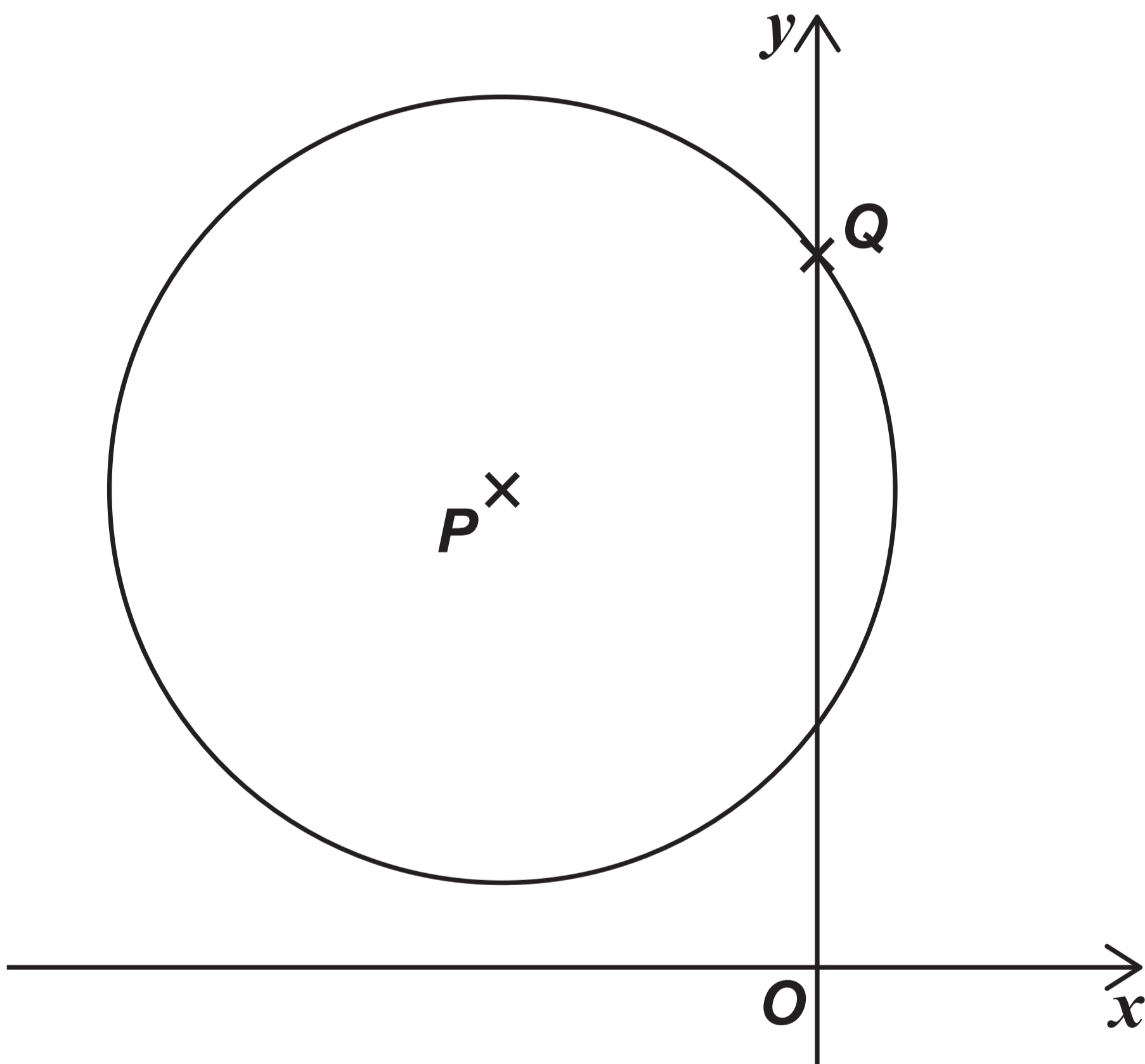
[Turn over]



9

FIGURE 1 below shows a circle.

FIGURE 1



The centre of the circle is P and the circle intersects the y -axis at Q as shown in FIGURE 1, on the opposite page.

The equation of the circle is

$$x^2 + y^2 = 12y - 8x - 27$$

[Turn over]



9 (a) Express the equation of the circle in the form

$$(x - a)^2 + (y - b)^2 = k$$

where a , b and k are constants to be found. [3 marks]

[Turn over]



**9 (b) State the coordinates of P
[1 mark]**

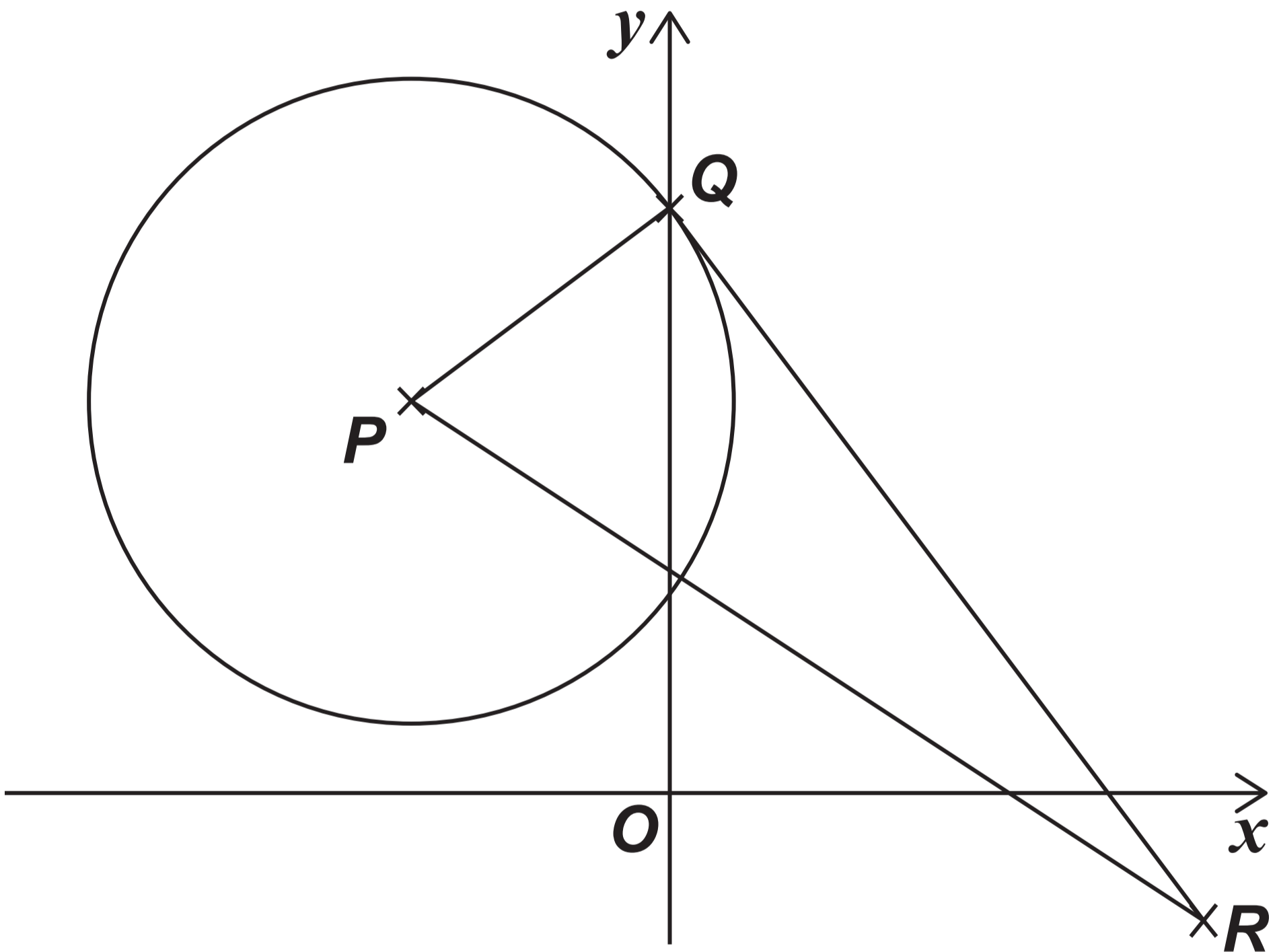
**9 (c) Find the y -coordinate of Q
[2 marks]**

[Turn over]



- 9 (d) The line segment QR is a tangent to the circle as shown in FIGURE 2 below.

FIGURE 2



41

The point R has coordinates $(9, -3)$.

Find the angle QPR

Give your answer in radians to three significant figures.

[3 marks]

[Turn over]





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[Turn over]



10

It is given that

$$f(x) = 5x^3 + x$$

Use differentiation from first principles to prove that

$$f'(x) = 15x^2 + 1 \quad [5 \text{ marks}]$$

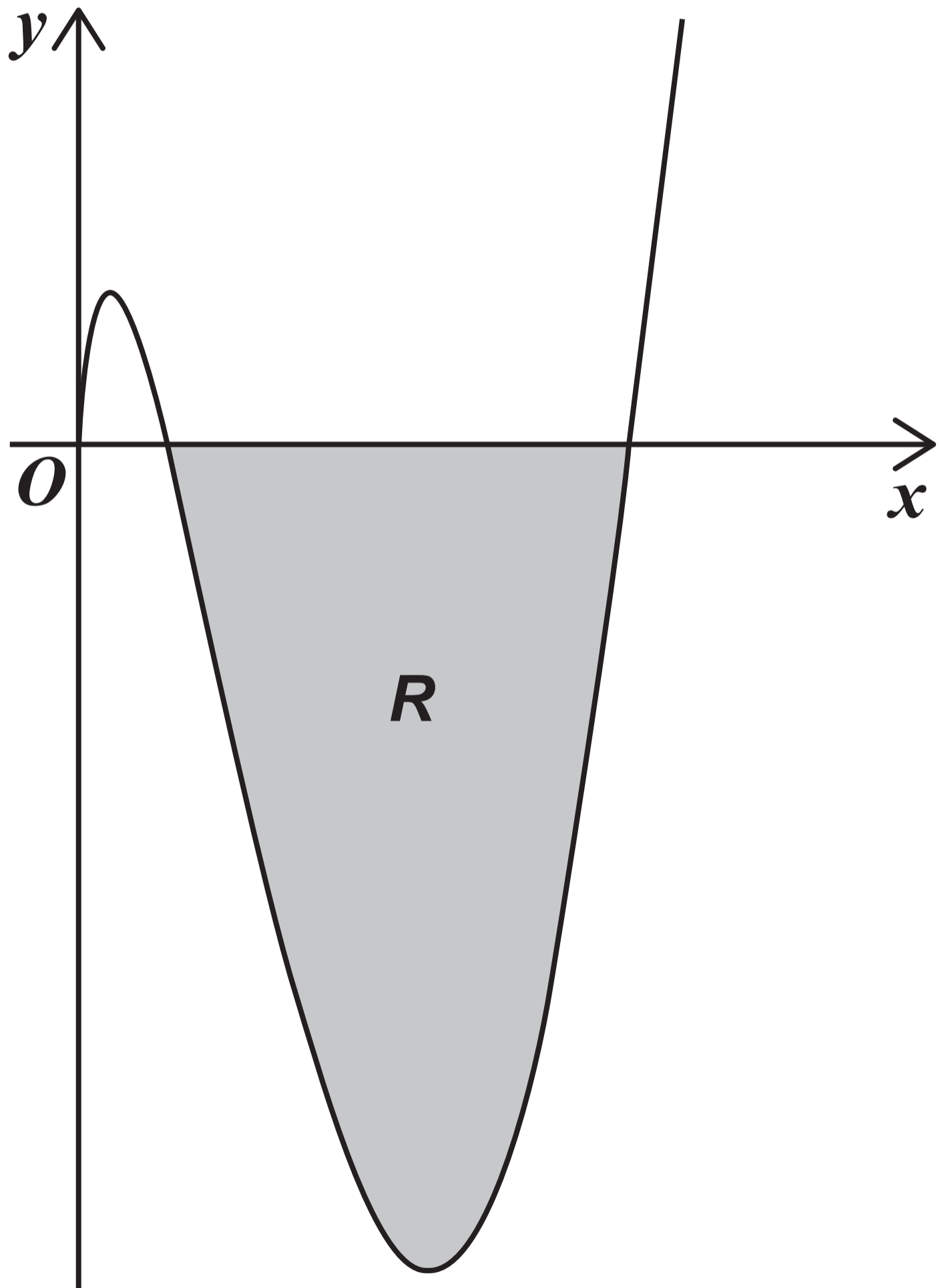


11

The curve C with equation

$$y = (x^2 - 8x) \ln x$$

is defined for $x > 0$ and is shown in the diagram below.



The shaded region, R , lies below the x -axis and is bounded by C and the x -axis.

Show that the area of R can be written as

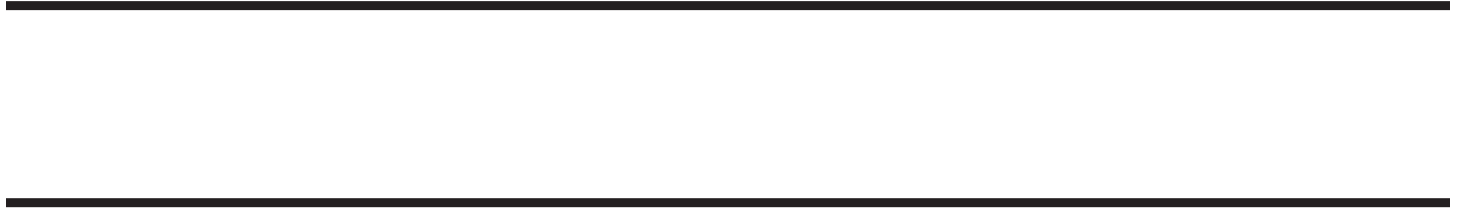
$$p + q \ln 2$$

where p and q are rational numbers to be found.

[10 marks]

[Turn over]





END OF SECTION A

[Turn over for Section B]



SECTION B

Answer ALL questions in the spaces provided.

12 **A random sample of 84 students was asked how many revision websites they had visited in the past month.**

The data is summarised in the table below.

NUMBER OF WEBSITES	FREQUENCY
0	1
1	4
2	18
3	16
4	5
5	37
6	2
7	1



53

Find the interquartile range of the number of websites visited by these 84 students.

Circle your answer. [1 mark]

3

4

19

42

[Turn over]

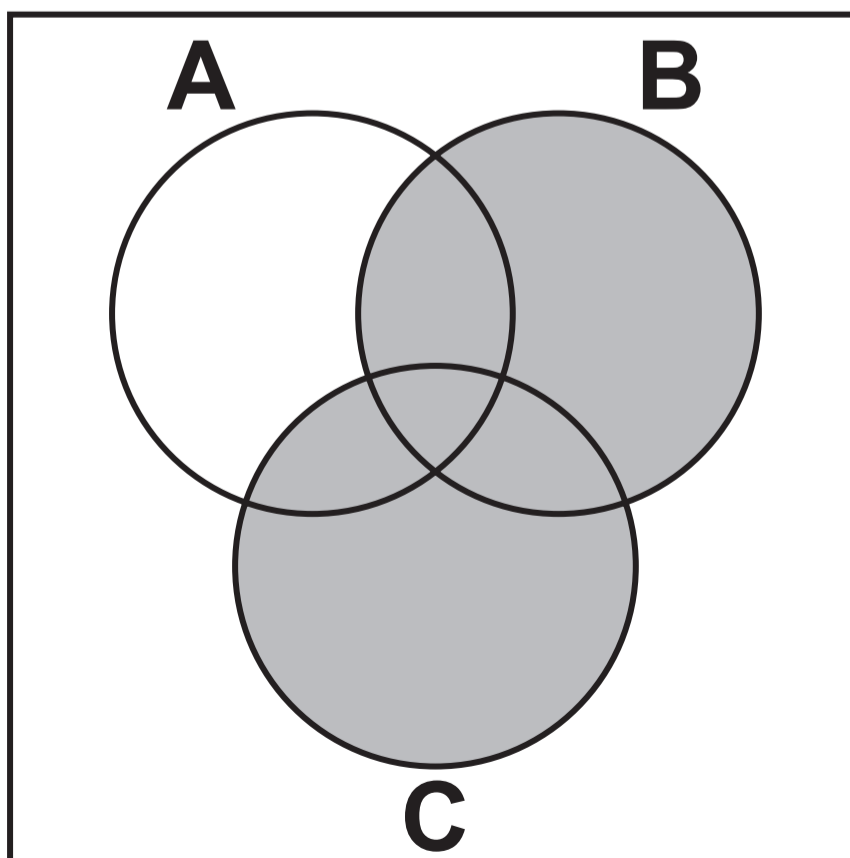
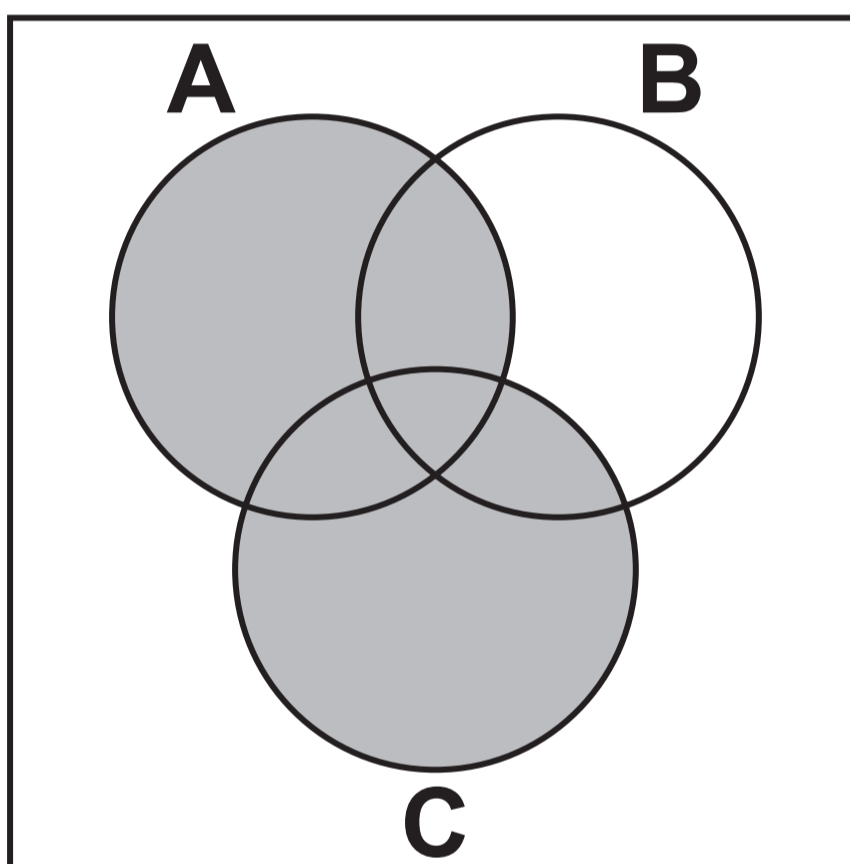


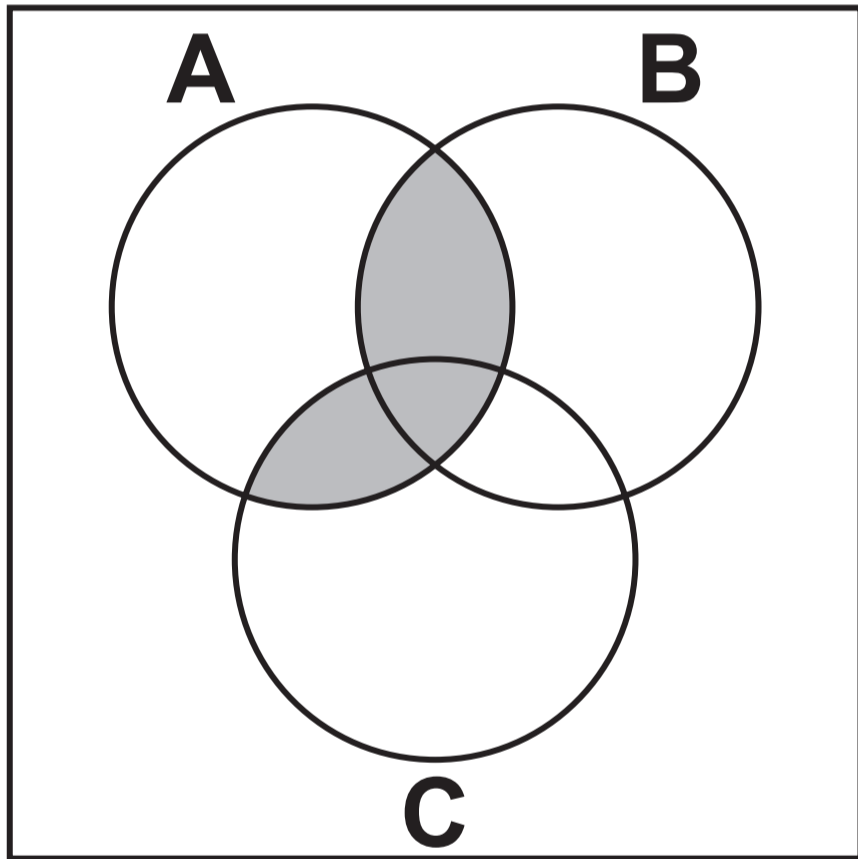
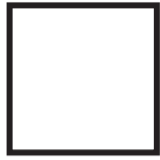
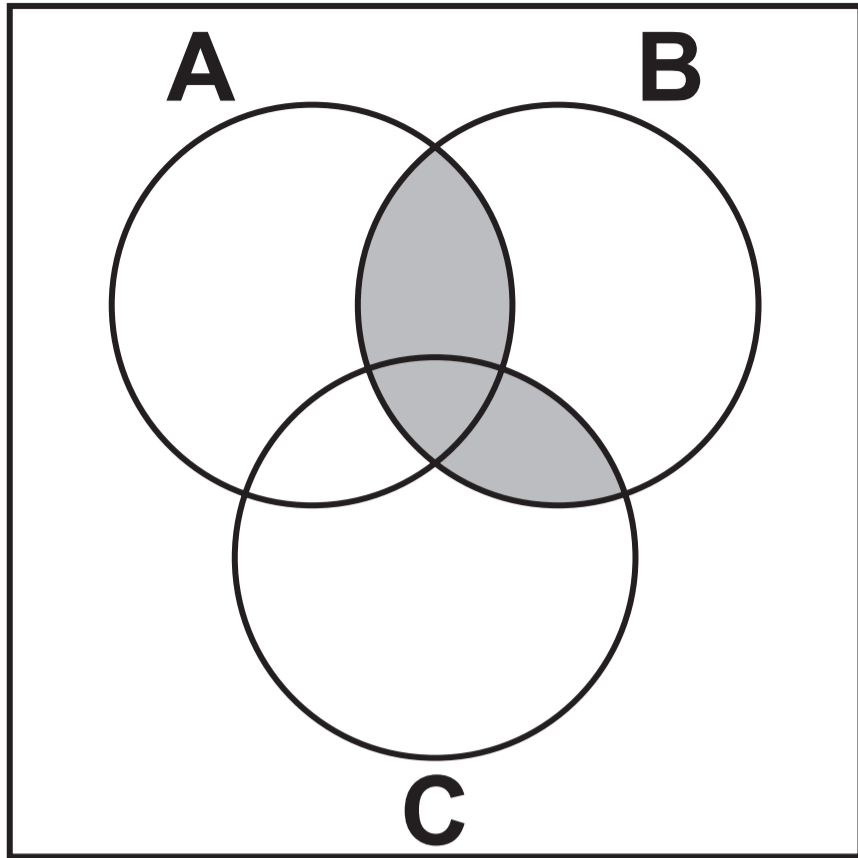
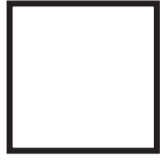
13

The shaded region on one of the Venn diagrams below represents $(A \cup C) \cap B$

Identify this Venn diagram.

Tick (✓) ONE box. [1 mark]





[Turn over]



- 14** The annual cost of energy in 2021 for each of the 350 households in Village A can be modelled by a random variable $\pounds X$

It is given that

$$\sum x = 945\,000$$

$$\sum x^2 = 2\,607\,500\,000$$

- 14 (a)** Calculate the mean of X .
[1 mark]



14 (b) **Calculate the standard deviation of X . [2 marks]**

[Turn over]



14 (c) For households in Village B the annual cost of energy in 2021 has mean £3100 and standard deviation £325

Compare the annual cost of energy in 2021 for households in Village A and Village B, on page 56. [2 marks]

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[Turn over]



15 It is given that

$$X \sim B(48, 0.175)$$

15 (a) Find the mean of X [1 mark]

15 (b) Show that the variance of X is 6.93 [1 mark]



15 (c) Find $P(X < 10)$ [1 mark]

15 (d) Find $P(X \geq 6)$ [2 marks]

[Turn over]



15 (e) Find $P(9 \leq X \leq 15)$ [2 marks]

[Turn over]



15 (f)

The aeroplanes used on a particular route have 48 seats.

The proportion of passengers who use this route to travel for business is known to be 17.5%

Make TWO comments on whether it would be appropriate to use X to model the number of passengers on an aeroplane who are travelling for business using this route. [2 marks]



16

A medical student believes that, in adults, there is a **NEGATIVE CORRELATION** between the amount of nicotine in their blood stream and their energy level.

The student collected data from a random sample of 50 adults.

The correlation coefficient between the amount of nicotine in their blood stream and their energy level was -0.45

Carry out a hypothesis test at the 2.5% significance level to determine if this sample provides evidence to support the student's belief.

For $n = 50$, the critical value for a one-tailed test at the 2.5% level for the population correlation coefficient is 0.2787
[4 marks]



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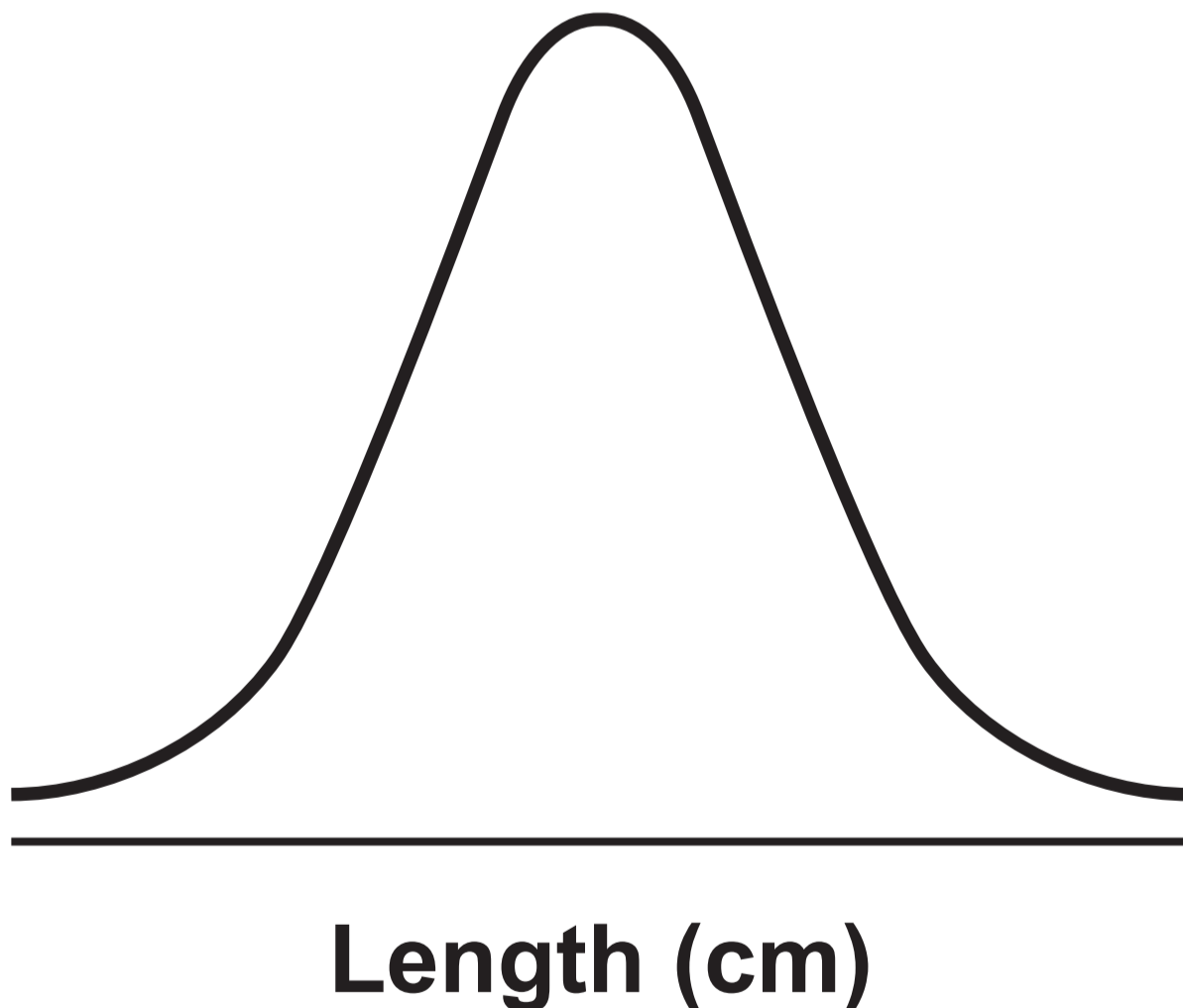
[Turn over]



17 In 2019, the lengths of new-born babies at a clinic can be modelled by a normal distribution with mean 50 cm and standard deviation 4 cm.

17 (a) This normal distribution is represented in the diagram below.

Label the values 50 and 54 on the horizontal axis. [2 marks]



17 (b) State the probability that the length of a new-born baby is less than 50 cm. [1 mark]

17 (c) Find the probability that the length of a new-born baby is more than 56 cm. [1 mark]

[Turn over]



- 17 (d)** Find the probability that the length of a new-born baby is more than 40 cm but less than 60 cm. [1 mark]

- 17 (e)** Determine the length exceeded by 95% of all new-born babies at the clinic. [2 marks]



[Turn over]



17 (f)

In 2020, the lengths of 40 new-born babies at the clinic were selected at random.

The total length of the 40 new-born babies was 2060 cm.

Carry out a hypothesis test at the 10% significance level to investigate whether the mean length of a new-born baby at the clinic in 2020 has **INCREASED compared to 2019.**

You may assume that the length of a new-born baby is still normally distributed with standard deviation 4 cm.

[7 marks]



[Turn over]



[Turn over]



18

The Human Resources director in a company is investigating the graduate status and salaries of its employees.

Event G is defined as the employee is a graduate.

Event H is defined as the employee earns at least £40 000 a year.

The director summarised the findings in the table of probabilities below.

	H	H'
G	0.21	0.18
G'	0.07	0.54



18 (a) An employee is selected at random.

18 (a) (i) Find $P(G)$
[1 mark]

18 (a) (ii) Find $P[(G \cap H)']$
[2 marks]

[Turn over]



**18 (a) (iii) Find $P(H | G')$
[2 marks]**



18 (b) Determine whether the events G and H are independent.

**Fully justify your answer.
[2 marks]**

[Turn over]





19 It is known that 80% of all diesel cars registered in 2017 had carbon monoxide (CO) emissions less than 0.3 g/km.

Talat decides to investigate whether the proportion of diesel cars registered in 2022 with CO emissions less than 0.3 g/km has CHANGED.

Talat will carry out a hypothesis test at the 10% significance level on a random sample of 25 diesel cars registered in 2022.

19 (a) (i) State suitable null and alternative hypotheses for Talat's test. [1 mark]



[Turn over]

19 (a) (ii) Using a 10% level of significance, find the critical region for Talat's test. [5 marks]

19 (a) (iii) In his random sample, Talat finds 18 cars with CO emissions less than 0.3 g/km.

State Talat's conclusion in context. [1 mark]

19 (b) Talat now wants to use his random sample of 25 diesel cars, registered in 2022, to investigate whether the proportion of diesel cars in England with CO emissions more than 0.5 g/km has changed from the proportion given by the Large Data Set.



Using your knowledge of the Large Data Set, give TWO reasons why it is not possible for Talat to do this. [2 marks]

END OF QUESTIONS

Additional page, if required. Write the question numbers in the left-hand margin.

Additional page, if required. Write the question numbers in the left-hand margin.



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