

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

1. Question | 9709 Feb-March 2016 P3 V2 Q6

6 A curve has equation

$$\sin y \ln x = x - 2 \sin y,$$

for $-\frac{1}{2}\pi \leq y \leq \frac{1}{2}\pi$.

(i) Find $\frac{dy}{dx}$ in terms of x and y . [5]

(ii) Hence find the exact x -coordinate of the point on the curve at which the tangent is parallel to the x -axis. [3]

2. Question | 9709 May-June 2016 P3 V1 Q5

5 The curve with equation $y = \sin x \cos 2x$ has one stationary point in the interval $0 < x < \frac{1}{2}\pi$. Find the x -coordinate of this point, giving your answer correct to 3 significant figures. [6]

3. Question | 9709 May-June 2016 P3 V1 Q7

7 The equation of a curve is $x^3 - 3x^2y + y^3 = 3$.

(i) Show that $\frac{dy}{dx} = \frac{x^2 - 2xy}{x^2 - y^2}$. [4]

(ii) Find the coordinates of the points on the curve where the tangent is parallel to the x -axis. [5]

4. Question | 9709 May-June 2016 P3 V2 Q4

4 The curve with equation $y = \frac{(\ln x)^4}{x}$ has two stationary points. Find the exact values of the coordinates of these points. [6]

5. Question | 9709 May-June 2016 P3 V3 Q4

- 4 The parametric equations of a curve are

$$x = t + \cos t, \quad y = \ln(1 + \sin t),$$

where $-\frac{1}{2}\pi < t < \frac{1}{2}\pi$.

- (i) Show that $\frac{dy}{dx} = \sec t$. [5]

- (ii) Hence find the x -coordinates of the points on the curve at which the gradient is equal to 3. Give your answers correct to 3 significant figures. [3]

6. Question | 9709 Oct-Nov 2016 P3 V1 Q4

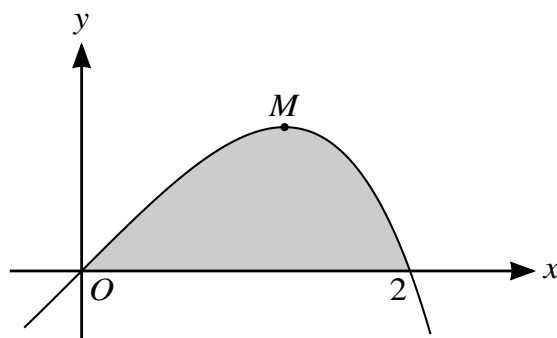
- 4 The equation of a curve is $xy(x - 6y) = 9a^3$, where a is a non-zero constant. Show that there is only one point on the curve at which the tangent is parallel to the x -axis, and find the coordinates of this point. [7]

7. Question | 9709 Oct-Nov 2016 P3 V2 Q4

- 4 The equation of a curve is $xy(x - 6y) = 9a^3$, where a is a non-zero constant. Show that there is only one point on the curve at which the tangent is parallel to the x -axis, and find the coordinates of this point. [7]

8. Question | 9709 Oct-Nov 2016 P3 V2 Q7

7



The diagram shows part of the curve $y = (2x - x^2)e^{\frac{1}{2}x}$ and its maximum point M .

- (i) Find the exact x -coordinate of M . [4]
- (ii) Find the exact value of the area of the shaded region bounded by the curve and the positive x -axis. [5]

9. Question | 9709 Oct-Nov 2016 P3 V3 Q2

- 2 The equation of a curve is $y = \frac{\sin x}{1 + \cos x}$, for $-\pi < x < \pi$. Show that the gradient of the curve is positive for all x in the given interval. [4]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

10. Question part 1/2 | 9709 Feb-March 2017 P3 V2 Q5

- 5 The curve with equation $y = e^{-ax} \tan x$, where a is a positive constant, has only one point in the interval $0 < x < \frac{1}{2}\pi$ at which the tangent is parallel to the x -axis. Find the value of a and state the exact value of the x -coordinate of this point. [7]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

10. Question part 2/2 | 9709 Feb-March 2017 P3 V2 Q5

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

11. Question part 1/2 | 9709 May-June 2017 P3 V1 Q4

4 The parametric equations of a curve are

$$x = \ln \cos \theta, \quad y = 3\theta - \tan \theta,$$

where $0 \leq \theta < \frac{1}{2}\pi$.

(i) Express $\frac{dy}{dx}$ in terms of $\tan \theta$.

[5]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

11. Question part 2/2 | 9709 May-June 2017 P3 V1 Q4

- (ii)** Find the exact y-coordinate of the point on the curve at which the gradient of the normal is equal to 1. [3]

[illegible]

(i) Express $\frac{dy}{dx}$ in terms of t . [3]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

12. Question part 2/2 | 9709 May-June 2017 P3 V2 Q4

- (ii) Find the equation of the normal to the curve at the point where $t = 1$. Give your answer in the form $ax + by + c = 0$. [3]

This image shows a full page of a handwriting practice worksheet. It consists of approximately 20 horizontal rows. Each row is defined by two parallel dotted lines, creating a series of uniform gaps for writing. The lines are evenly spaced across the entire page, providing a guide for letter height and placement. There is no text or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

13. Question part 1/2 | 9709 May-June 2017 P3 V3 Q5

5 A curve has equation $y = \frac{2}{3} \ln(1 + 3 \cos^2 x)$ for $0 \leq x \leq \frac{1}{2}\pi$.

(i) Express $\frac{dy}{dx}$ in terms of $\tan x$. [4]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

13. Question part 2/2 | 9709 May-June 2017 P3 V3 Q5

- (ii) Hence find the x -coordinate of the point on the curve where the gradient is -1 . Give your answer correct to 3 significant figures. [2]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

14. Question part 1/2 | 9709 Oct-Nov 2017 P3 V1 Q5

5 The equation of a curve is $2x^4 + xy^3 + y^4 = 10$.

(i) Show that $\frac{dy}{dx} = -\frac{8x^3 + y^3}{3xy^2 + 4y^3}$. [4]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting or typing. There are no margins, text, or other markings on the page.

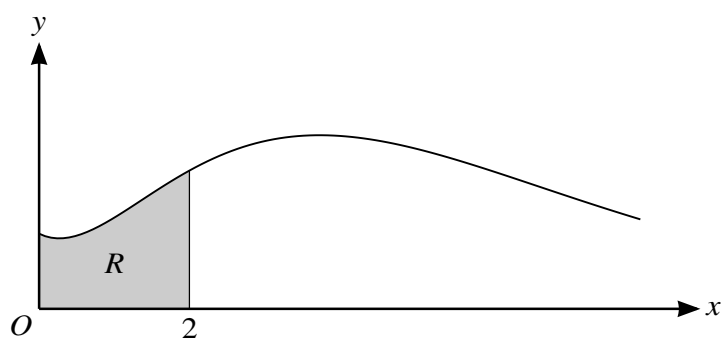
9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

14. Question part 2/2 | 9709 Oct-Nov 2017 P3 V1 Q5

- (ii) Hence show that there are two points on the curve at which the tangent is parallel to the x -axis and find the coordinates of these points. [4]

[illegible]



(i) Find the exact values of the x -coordinates of the stationary points of the curve. [4]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

15. Question part 2/2 | 9709 Oct-Nov 2017 P3 V1 Q9

(ii) Show that the exact value of the area of R is $18 - \frac{42}{e}$. [5]

This image shows a full page of a worksheet designed for handwriting practice. It consists of approximately 20 horizontal rows. Each row is defined by two parallel dotted lines, creating a series of uniform gaps for writing. The entire page is otherwise blank, with no margins, text, or other markings.

Topical questions | 106 questions

4 The curve with equation $y = \frac{2 - \sin x}{\cos x}$ has one stationary point in the interval $-\frac{1}{2}\pi < x < \frac{1}{2}\pi$.

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

16. Question part 2/2 | 9709 Oct-Nov 2017 P3 V2 Q4

(ii) Determine whether this point is a maximum or a minimum point.

[2]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

Topical questions | 106 questions

6 The equation of a curve is $x^3y - 3xy^3 = 2a^4$, where a is a non-zero constant.

(i) Show that $\frac{dy}{dx} = \frac{3x^2y - 3y^3}{9xy^2 - x^3}$. [4]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

17. Question part 2/2 | 9709 Oct-Nov 2017 P3 V2 Q6

(ii) Hence show that there are only two points on the curve at which the tangent is parallel to the x -axis and find the coordinates of these points. [4]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

Topical questions | 106 questions

5 The equation of a curve is $2x^4 + xy^3 + y^4 = 10$.

(i) Show that $\frac{dy}{dx} = -\frac{8x^3 + y^3}{3xy^2 + 4y^3}$. [4]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

18. Question part 2/2 | 9709 Oct-Nov 2017 P3 V3 Q5

- (ii) Hence show that there are two points on the curve at which the tangent is parallel to the x -axis and find the coordinates of these points. [4]

[illegible]

Topical questions | 106 questions

5 The parametric equations of a curve are

for $-\frac{1}{2}\pi < t < \frac{1}{2}\pi$.

(i) Show that $\frac{dy}{dx} = 2 \tan t$. [5]

This image shows a full page of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page, typical of notebook or legal stationery. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

19. Question part 2/2 | 9709 Feb-March 2018 P3 V2 Q5

- (ii) Hence find the x -coordinate of the point on the curve at which the gradient of the normal is 2. Give your answer correct to 3 significant figures. [2]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

20. Question | 9709 May-June 2018 P3 V1 Q3

- 3** A curve has equation $y = \frac{e^{3x}}{\tan \frac{1}{2}x}$. Find the x -coordinates of the stationary points of the curve in the interval $0 < x < \pi$. Give your answers correct to 3 decimal places. [6]

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

21. Question part 1/2 | 9709 May-June 2018 P3 V2 Q5

5 The equation of a curve is $x^2(x + 3y) - y^3 = 3$.

(ii) Show that $\frac{dy}{dx} = \frac{x^2 + 2xy}{y^2 - x^2}$. [4]

[illegible]

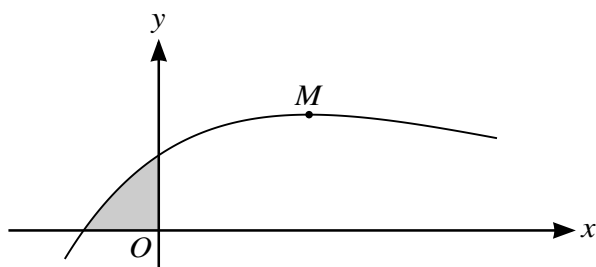
9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

21. Question part 2/2 | 9709 May-June 2018 P3 V2 Q5

- (ii) Hence find the exact coordinates of the two points on the curve at which the gradient of the normal is 1. [4]

[illegible]



(i) Find the x -coordinate of M .

[4]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

22. Question part 2/2 | 9709 May-June 2018 P3 V2 Q8

- (ii) Find the area of the shaded region enclosed by the curve and the axes, giving your answer in terms of e . [5]

[illegible]

Topical questions | 106 questions

4 The curve with equation $y = \frac{\ln x}{3+x}$ has a stationary point at $x = p$.

(ii) Show that p satisfies the equation $\ln x = 1 + \frac{3}{x}$. [3]

This image shows a full page of a worksheet designed for handwriting practice. It consists of multiple horizontal rows, each defined by two parallel dashed lines. The lines are evenly spaced and extend across the entire width of the page, providing a guide for letter height and placement. There is no text or other markings on the page.

Topical questions | 106 questions

(ii) By sketching suitable graphs, show that the equation in part (i) has only one root. [2]

(iii) It is given that the equation in part (i) can be written in the form $x = \frac{3+x}{\ln x}$. Use an iterative formula based on this rearrangement to determine the value of p correct to 2 decimal places. Give the result of each iteration to 4 decimal places. [3]

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings present.

Topical questions | 106 questions

8 The equation of a curve is $2x^3 - y^3 - 3xy^2 = 2a^3$, where a is a non-zero constant.

(i) Show that $\frac{dy}{dx} = \frac{2x^2 - y^2}{y^2 + 2xy}$. [4]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

24. Question part 2/2 | 9709 May-June 2018 P3 V3 Q8

(ii) Find the coordinates of the two points on the curve at which the tangent is parallel to the y-axis. [5]

[illegible]

Topical questions | 106 questions

4 The parametric equations of a curve are

where $0 < \theta < \pi$.

(i) Obtain an expression for $\frac{dy}{dx}$ in terms of θ . [3]

This image shows a full page of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page, typical of notebook or legal stationery. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

25. Question part 2/2 | 9709 Oct-Nov 2018 P3 V1 Q4

- (ii) Hence find the exact coordinates of the point on the curve at which the tangent is parallel to the y-axis. [4]

[illegible]

Topical questions | 106 questions

5 The equation of a curve is $y = x \ln(8 - x)$. The gradient of the curve is equal to 1 at only one point, when $x = a$.

(i) Show that a satisfies the equation $x = 8 - \frac{8}{\ln(8-x)}$. [3]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

[2]

[illegible]

- (iii) Use an iterative formula based on the equation in part (i) to determine a correct to 2 decimal places. Give the result of each iteration to 4 decimal places. [3]

[3]

This image shows a full page of white paper with ten horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and extend across the entire width of the page. There is no handwriting or other markings on the paper.

Topical questions | 106 questions

7 A curve has equation $y = \frac{3 \cos x}{2 + \sin x}$, for $-\frac{1}{2}\pi \leq x \leq \frac{1}{2}\pi$.

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

27. Question part 2/2 | 9709 Oct-Nov 2018 P3 V2 Q7

(ii) The constant a is such that $\int_0^a \frac{3 \cos x}{2 + \sin x} \, dx = 1$. Find the value of a , giving your answer correct to 3 significant figures. [4]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

Topical questions | 106 questions

4 The parametric equations of a curve are

where $0 < \theta < \pi$.

(i) Obtain an expression for $\frac{dy}{dx}$ in terms of θ . [3]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

28. Question part 2/2 | 9709 Oct-Nov 2018 P3 V3 Q4

- (ii) Hence find the exact coordinates of the point on the curve at which the tangent is parallel to the y-axis. [4]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

29. Question | 9709 Feb-March 2019 P3 V2 Q5

- 5** The variables x and y satisfy the relation $\sin y = \tan x$, where $-\frac{1}{2}\pi < y < \frac{1}{2}\pi$. Show that

$$\frac{dy}{dx} = \frac{1}{\cos x \sqrt{(\cos 2x)}}. \quad [5]$$

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

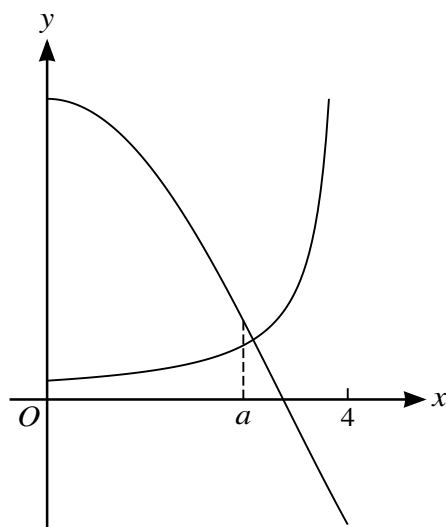
9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

30. Question | 9709 May-June 2019 P3 V1 Q3

3 Find the gradient of the curve $x^3 + 3xy^2 - y^3 = 1$ at the point with coordinates $(1, 3)$. [4]

[illegible]



(i) Show that $a = 4 - \sqrt{2 \sin \frac{1}{2}a}$. [4]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

[2]

[illegible]

[3]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

32. Question | 9709 May-June 2019 P3 V2 Q4

- 4** Find the exact coordinates of the point on the curve $y = \frac{x}{1 + \ln x}$ at which the gradient of the tangent is equal to $\frac{1}{4}$. [7]

This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal lines each: a solid top line, a dashed middle line, and a solid bottom line. These lines are evenly spaced across the entire page to guide letter formation and size. There is no text or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

33. Question part 1/2 | 9709 May-June 2019 P3 V3 Q4

4 The equation of a curve is $y = \frac{1 + e^{-x}}{1 - e^{-x}}$, for $x > 0$.

(i) Show that $\frac{dy}{dx}$ is always negative. [3]

[illegible]

Topical questions | 106 questions

(ii) The gradient of the curve is equal to -1 when $x = a$. Show that a satisfies the equation $e^{2a} - 4e^a + 1 = 0$. Hence find the exact value of a . [4]

This image shows a full page of a worksheet designed for handwriting practice. It features approximately 20 horizontal dashed lines spaced evenly across the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

(i) Find $\frac{dy}{dx}$. [2]

[illegible]

(ii) By considering the formula for $\cos(A + B)$, show that, at the stationary points on the curve, $\cos(2x + \frac{1}{3}\pi) = 0$. [2]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

34. Question part 2/2 | 9709 May-June 2019 P3 V3 Q7

(iii) Hence find the exact x -coordinates of the stationary points.

[3]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

35. Question | 9709 Oct-Nov 2019 P3 V1 Q3

3 The parametric equations of a curve are

$$x = 2t + \sin 2t, \quad y = \ln(1 - \cos 2t).$$

Show that $\frac{dy}{dx} = \operatorname{cosec} 2t$. [5]

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(i) Show that p satisfies the equation $x = 1 + \exp\left(\frac{1}{2(x-1)}\right)$, where $\exp(x)$ denotes e^x . [3]

This image shows a full page of a worksheet designed for handwriting practice. It consists of multiple rows of horizontal dotted lines spaced evenly across the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

[2]

This image shows a full page of white paper with horizontal dotted lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- (iii) Use an iterative formula based on the equation in part (i) to determine p correct to 2 decimal places. Give the result of each iteration to 4 decimal places. [3]

[3]

[illegible]

Topical questions | 106 questions

2 The curve with equation $y = \frac{e^{-4x}}{1-x^2}$ has a stationary point in the interval $-1 < x < 1$. Find $\frac{dy}{dx}$ and hence find the x -coordinate of this stationary point, giving the answer correct to 3 decimal places. [5]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting or typing. There are no margins, text, or other markings on the page.

Topical questions | 106 questions

5 The equation of a curve is $2x^2y - xy^2 = a^3$, where a is a positive constant. Show that there is only one point on the curve at which the tangent is parallel to the x -axis and find the y -coordinate of this point. [7]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

38. Question part 2/2 | 9709 Oct-Nov 2019 P3 V2 Q5

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

39. Question part 1/2 | 9709 Feb-March 2020 P3 V2 Q7

7 The equation of a curve is $x^3 + 3xy^2 - y^3 = 5$.

(a) Show that $\frac{dy}{dx} = \frac{x^2 + y^2}{y^2 - 2xy}$. [4]

[illegible]

Topical questions | 106 questions

(b) Find the coordinates of the points on the curve where the tangent is parallel to the y-axis. [5]

[illegible]

(a) Find the x -coordinate of this point, giving your answer correct to 2 decimal places. [4]

[illegible]

(b) Determine whether the stationary point is a maximum or a minimum. [2]

This image shows a blank sheet of white paper with ten horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and extend across the width of the page. There is no handwriting or other markings on the paper.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

41. Question part 1/2 | 9709 May-June 2020 P3 V1 Q7

7 Let $f(x) = \frac{\cos x}{1 + \sin x}$.

(a) Show that $f'(x) < 0$ for all x in the interval $-\frac{1}{2}\pi < x < \frac{3}{2}\pi$. [4]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

41. Question part 2/2 | 9709 May-June 2020 P3 V1 Q7

(b) Find $\int_{\frac{1}{6}\pi}^{\frac{1}{2}\pi} f(x) \, dx$. Give your answer in a simplified exact form. [4]

[illegible]

Topical questions | 106 questions

4 A curve has equation $y = \cos x \sin 2x$.

[illegible]

(a) Find $\frac{dy}{dx}$. [3]

[illegible]

(b) The tangent to the curve at the point where $x = 2$ meets the y -axis at the point with coordinates $(0, p)$.

Find p . [3]

[illegible]

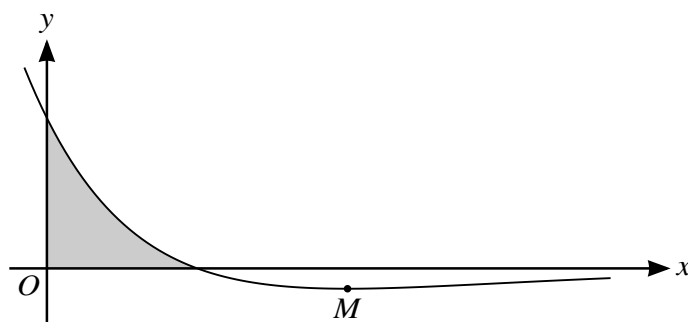
Topical questions | 106 questions

3 The parametric equations of a curve are

for $0 < \theta < \frac{1}{2}\pi$.

Show that $\frac{dy}{dx} = \cot \theta$. [5]

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.



(a) Find the exact coordinates of M .

[5]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

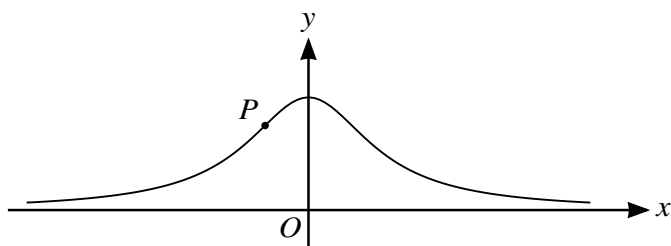
9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

45. Question part 2/2 | 9709 Oct-Nov 2020 P3 V1 Q10

- (b) Find the area of the shaded region bounded by the curve and the axes. Give your answer in terms of e. [5]

[illegible]


$$x = \tan \theta, \quad y = \cos^2 \theta,$$

for $-\frac{1}{2}\pi < \theta < \frac{1}{2}\pi$.

- (a) Show that the gradient of the curve at the point with parameter θ is $-2 \sin \theta \cos^3 \theta$. [3]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

46. Question part 2/2 | 9709 Oct-Nov 2020 P3 V2 Q5

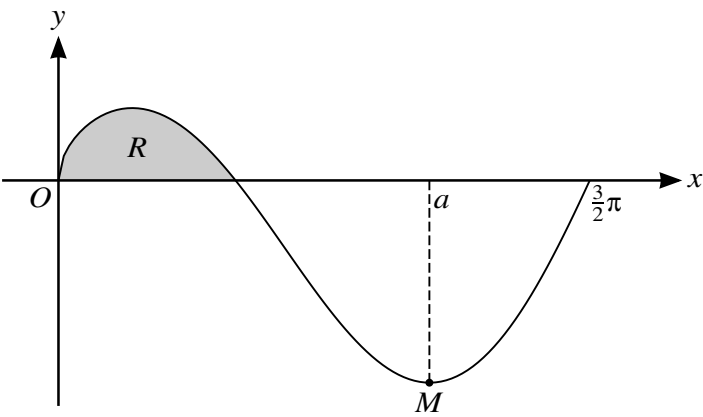
The gradient of the curve has its maximum value at the point P .

(b) Find the exact value of the x -coordinate of P .

[4]

This image shows a full page of a worksheet designed for handwriting practice. It features 20 evenly spaced, horizontal dashed lines across the entire width of the page. The background is plain white, and there are no margins, text, or other markings present.

10



The diagram shows the curve $y = \sqrt{x} \cos x$, for $0 \leq x \leq \frac{3}{2}\pi$, and its minimum point M , where $x = a$. The shaded region between the curve and the x -axis is denoted by R .

- (a) Show that a satisfies the equation $\tan a = \frac{1}{2a}$. [3]

.....

.....

.....

.....

.....

.....

- (b) The sequence of values given by the iterative formula $a_{n+1} = \pi + \tan^{-1}\left(\frac{1}{2a_n}\right)$, with initial value $x_1 = 3$, converges to a .

Use this formula to determine a correct to 2 decimal places. Give the result of each iteration to 4 decimal places. [3]

.....

.....

.....

.....

.....

.....

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

47. Question part 2/3 | 9709 Oct-Nov 2020 P3 V2 Q10

- (c) Find the volume of the solid obtained when the region R is rotated completely about the x -axis. Give your answer in terms of π . [6]

This image shows a full page of white paper with horizontal dotted lines, typical of primary school handwriting practice paper. The lines are evenly spaced and run across the entire width of the page. There are no margins, text, or other markings present.

If you use the following lined page to complete the answer(s) to any question(s), the question number(s) must be clearly shown.

[illegible]

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

48. Question | 9709 Oct-Nov 2020 P3 V3 Q3

3 The parametric equations of a curve are

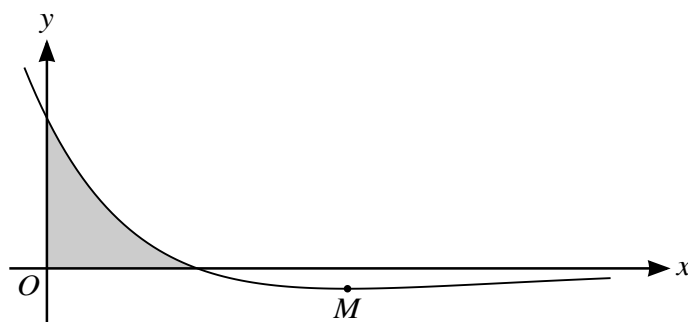
$$x = 3 - \cos 2\theta, \quad y = 2\theta + \sin 2\theta,$$

for $0 < \theta < \frac{1}{2}\pi$.

Show that $\frac{dy}{dx} = \cot \theta$.

[5]

[illegible]



(a) Find the exact coordinates of M .

[5]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

49. Question part 2/2 | 9709 Oct-Nov 2020 P3 V3 Q10

- (b) Find the area of the shaded region bounded by the curve and the axes. Give your answer in terms of e . [5]

[illegible]

$$x = \ln(2 + 3t), \quad y = \frac{t}{2 + 3t}.$$

(a) Show that the gradient of the curve is always positive. [5]

[illegible]

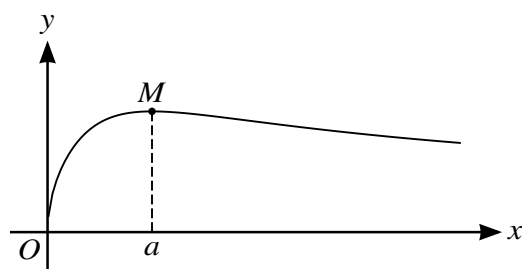
9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

50. Question part 2/2 | 9709 May-June 2021 P3 V1 Q6

- (b)** Find the equation of the tangent to the curve at the point where it intersects the y-axis. [3]

[illegible]



(a) Show that a satisfies the equation

$$a = \tan\left(\frac{2a}{1+a^2}\right). \quad [4]$$

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

51. Question part 2/3 | 9709 May-June 2021 P3 V1 Q7

(b) Verify by calculation that a lies between 1.3 and 1.5.

[2]

This image shows a blank sheet of white paper with ten horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

(c) Use an iterative formula based on the equation in part (a) to determine a correct to 2 decimal places. Give the result of each iteration to 4 decimal places. [3]

[3]

This image shows a full page of white paper with horizontal dotted lines, typical of primary school writing paper. The lines are evenly spaced and run across the entire width of the page. There are no margins, text, or other markings present.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

51. Question part 3/3 | 9709 May-June 2021 P3 V1 Q7

--

Topical questions | 106 questions

9 The equation of a curve is $y = x^{-\frac{2}{3}} \ln x$ for $x > 0$. The curve has one stationary point.

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

52. Question part 2/2 | 9709 May-June 2021 P3 V1 Q9

(b) Show that $\int_1^8 y \, dx = 18 \ln 2 - 9$.

[5]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

53. Question part 1/2 | 9709 May-June 2021 P3 V2 Q8

8 The equation of a curve is $y = e^{-5x} \tan^2 x$ for $-\frac{1}{2}\pi < x < \frac{1}{2}\pi$.

Find the x -coordinates of the stationary points of the curve. Give your answers correct to 3 decimal places where appropriate. [8]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

53. Question part 2/2 | 9709 May-June 2021 P3 V2 Q8

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

3 The parametric equations of a curve are

$$x = t + \ln(t + 2), \qquad y = (t - 1)e^{-2t},$$

where $t > -2$.

(a) Express $\frac{dy}{dx}$ in terms of t , simplifying your answer. [5]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Find the exact y-coordinate of the stationary point of the curve. [2]

.....

.....

.....

.....

.....

.....

.....

(a) Find the coordinates of this point. [4]

This image shows a full page of handwriting practice paper. It features ten sets of horizontal dashed lines spaced evenly down the page. Each set consists of three lines: a top solid line, a middle dashed line, and a bottom solid line, providing a guide for letter height and placement. The background is plain white, and there are no margins or additional markings.

(b) Determine whether the stationary point is a maximum or a minimum. [2]

This image shows a full page of white paper with ten horizontal dashed lines, typical of primary school handwriting practice paper. The lines are evenly spaced and extend across the entire width of the page. There is no text or other markings on the paper.

Topical questions | 106 questions

9 The equation of a curve is $ye^{2x} - y^2e^x = 2$.

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

56. Question part 2/3 | 9709 Oct-Nov 2021 P3 V2 Q9

(b) Find the exact coordinates of the point on the curve where the tangent is parallel to the y -axis.

[4]

This image shows a full page of a worksheet designed for handwriting practice. It consists of approximately 20 horizontal rows. Each row is defined by two parallel dotted lines, creating a series of uniform gaps for writing. The entire page is otherwise blank, with no text or other markings.

57. Question part 1/3 | 9709 Oct-Nov 2021 P3 V2 Q11

- 11** The equation of a curve is $y = \sqrt{\tan x}$, for $0 \leq x < \frac{1}{2}\pi$.
- (a)** Express $\frac{dy}{dx}$ in terms of $\tan x$, and verify that $\frac{dy}{dx} = 1$ when $x = \frac{1}{4}\pi$. [4]

.....

.....

.....

.....

.....

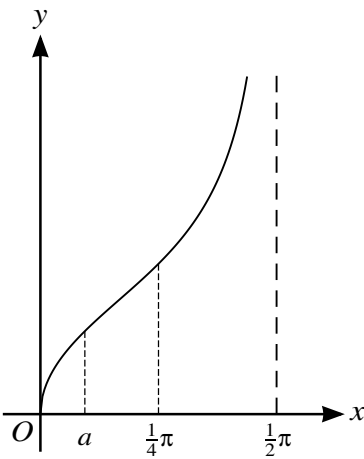
.....

.....

.....

.....

The value of $\frac{dy}{dx}$ is also 1 at another point on the curve where $x = a$, as shown in the diagram.



- (b)** Show that $t^3 + t^2 + 3t - 1 = 0$, where $t = \tan a$. [4]

.....

.....

.....

.....

.....

Topical questions | 106 questions

[illegible]
$$a_{n+1} = \tan^{-1} \left(\frac{1}{3}(1 - \tan^2 a_n - \tan^3 a_n) \right)$$
[illegible]

If you use the following lined page to complete the answer(s) to any question(s), the question number(s) must be clearly shown.

[illegible]

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

58. Question part 1/2 | 9709 Oct-Nov 2021 P3 V3 Q7

7 The equation of a curve is $\ln(x + y) = x - 2y$.

(a) Show that $\frac{dy}{dx} = \frac{x+y-1}{2(x+y)+1}$. [4]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

58. Question part 2/2 | 9709 Oct-Nov 2021 P3 V3 Q7

- (b) Find the coordinates of the point on the curve where the tangent is parallel to the x -axis. [3]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

59. Question part 1/2 | 9709 Oct-Nov 2021 P3 V3 Q9

9 Let $f(x) = \frac{1}{(9-x)\sqrt{x}}$.

(a) Find the x -coordinate of the stationary point of the curve with equation $y = f(x)$. [4]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

59. Question part 2/2 | 9709 Oct-Nov 2021 P3 V3 Q9

(b) Using the substitution $u = \sqrt{x}$, show that $\int_0^4 f(x) \, dx = \frac{1}{3} \ln 5$.

[6]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

60. Question | 9709 Feb-March 2022 P3 V2 Q4

4 The parametric equations of a curve are

$$x = 1 - \cos \theta, \quad y = \cos \theta - \frac{1}{4} \cos 2\theta.$$

Show that $\frac{dy}{dx} = -2 \sin^2(\frac{1}{2}\theta)$. [5]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

61. Question part 1/2 | 9709 May-June 2022 P3 V1 Q8

8 The equation of a curve is $x^3 + y^3 + 2xy + 8 = 0$.

(a) Express $\frac{dy}{dx}$ in terms of x and y . [4]

[illegible]

9709 Mathematics Paper 3 - Differentiation

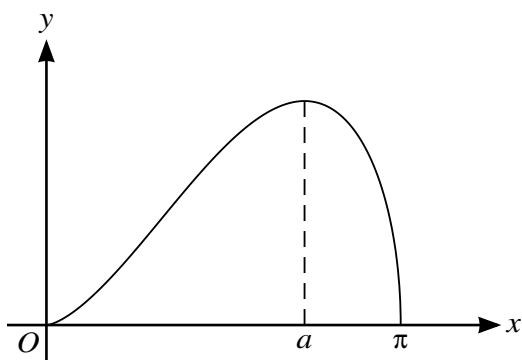
Topical questions | 106 questions

61. Question part 2/2 | 9709 May-June 2022 P3 V1 Q8

The tangent to the curve at the point where $x = 0$ and the tangent at the point where $y = 0$ intersect at the acute angle α .

(b) Find the exact value of $\tan \alpha$. [5]

[illegible]



(a) Show that $\tan a = -\frac{1}{2}a$. [4]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

(b) Verify by calculation that a lies between 2 and 2.5. [2]

.....

.....

.....

.....

.....

.....

.....

(c) Show that if a sequence of values in the interval $0 < x < \pi$ given by the iterative formula $x_{n+1} = \pi - \tan^{-1}(\frac{1}{2}x_n)$ converges, then it converges to a , the root of the equation in part (a). [2]

.....

.....

.....

.....

.....

.....

.....

(d) Use the iterative formula given in part (c) to determine a correct to 2 decimal places. Give the result of each iteration to 4 decimal places. [3]

.....

.....

.....

.....

.....

.....

.....

If you use the following lined page to complete the answer(s) to any question(s), the question number(s) must be clearly shown.

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

63. Question | 9709 May-June 2022 P3 V2 Q4

- 4** The equation of a curve is $y = \cos^3 x \sqrt{\sin x}$. It is given that the curve has one stationary point in the interval $0 < x < \frac{1}{2}\pi$.

Find the x -coordinate of this stationary point, giving your answer correct to 3 significant figures. [6]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

64. Question part 1/2 | 9709 May-June 2022 P3 V2 Q7

7 The equation of a curve is $x^3 + 3x^2y - y^3 = 3$.

(a) Show that $\frac{dy}{dx} = \frac{x^2 + 2xy}{y^2 - x^2}$. [4]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

64. Question part 2/2 | 9709 May-June 2022 P3 V2 Q7

(b) Find the coordinates of the points on the curve where the tangent is parallel to the x -axis. [5]

[illegible]

- (a) Obtain an expression for $\frac{dy}{dx}$ and show it can be written in the form $\sec^2 x(a + b \sin 2x)e^{-4x}$, where a and b are constants. [4]

This image shows a full page of a handwriting practice worksheet. It consists of multiple rows of horizontal dashed lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

65. Question part 2/2 | 9709 May-June 2022 P3 V3 Q4

(b) Hence find the exact x -coordinates of the two stationary points.

[3]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

66. Question part 1/2 | 9709 May-June 2022 P3 V3 Q6

6 The parametric equations of a curve are $x = \frac{1}{\cos t}$, $y = \ln \tan t$, where $0 < t < \frac{1}{2}\pi$.

(a) Show that $\frac{dy}{dx} = \frac{\cos t}{\sin^2 t}$. [5]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

66. Question part 2/2 | 9709 May-June 2022 P3 V3 Q6

(b) Find the equation of the tangent to the curve at the point where $y = 0$.

[3]

[illegible]

Topical questions | 106 questions

7 The equation of a curve is $y = \frac{x}{\cos^2 x}$, for $0 \leq x < \frac{1}{2}\pi$. At the point where $x = a$, the tangent to the curve has gradient equal to 12.

(a) Show that $a = \cos^{-1} \left(\sqrt[3]{\frac{\cos a + 2a \sin a}{12}} \right)$. [3]

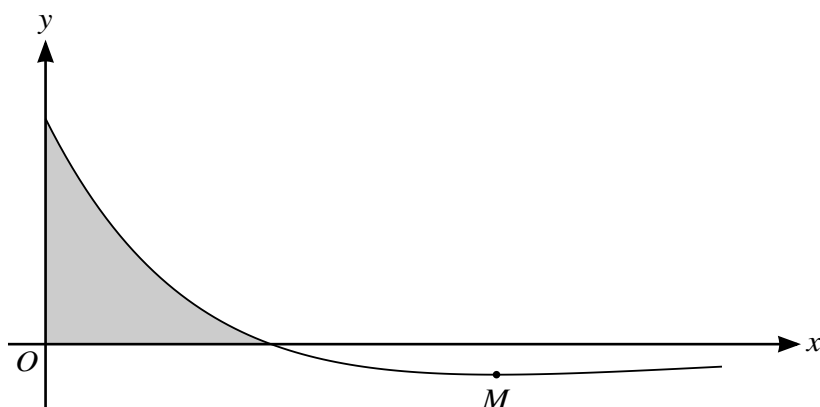
[illegible]

- [2]

[illegible]

- [3]

This image shows a full page of white paper with ten horizontal dashed lines, typical of primary school handwriting practice paper. The lines are evenly spaced and extend across the entire width of the page. There is no text or other markings on the paper.



(a) Find the exact coordinates of M .

[5]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

68. Question part 2/2 | 9709 Oct-Nov 2022 P3 V1 Q9

(b) Find the area of the shaded region bounded by the curve and the axes, giving your answer in terms of e . [5]

This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal dotted lines, providing a guide for letter height and placement. The lines are evenly spaced across the entire page, leaving ample room for writing practice. There is no text or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

69. Question | 9709 Oct-Nov 2022 P3 V2 Q3

- 3** The equation of a curve is $y = \sin x \sin 2x$. The curve has a stationary point in the interval $0 < x < \frac{1}{2}\pi$.

Find the x -coordinate of this point, giving your answer correct to 3 significant figures. [6]

This image shows a full page of a handwriting practice worksheet. It consists of multiple rows of horizontal dashed lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no margins or additional markings.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

70. Question | 9709 Oct-Nov 2022 P3 V3 Q4

4 The parametric equations of a curve are

$$x = 2t - \tan t, \quad y = \ln(\sin 2t),$$

for $0 < t < \frac{1}{2}\pi$.

Show that $\frac{dy}{dx} = \cot t$.

[5]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

71. Question part 1/2 | 9709 Feb-March 2023 P3 V2 Q5

5 The parametric equations of a curve are

$$x = te^{2t}, \quad y = t^2 + t + 3.$$

(a) Show that $\frac{dy}{dx} = e^{-2t}$. [3]

[illegible]

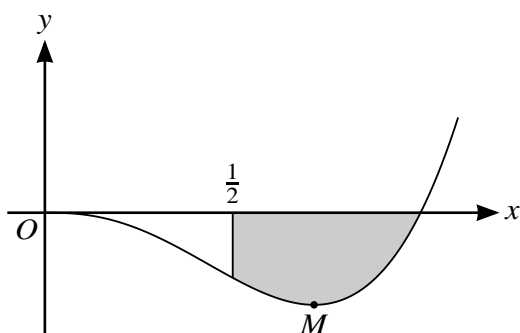
9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

71. Question part 2/2 | 9709 Feb-March 2023 P3 V2 Q5

(b) Hence show that the normal to the curve, where $t = -1$, passes through the point $\left(0, 3 - \frac{1}{e^4}\right)$. [3]

[illegible]



(a) Find the exact coordinates of M .

[4]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

72. Question part 2/2 | 9709 Feb-March 2023 P3 V2 Q8

(b) Find the exact area of the shaded region bounded by the curve, the x -axis and the line $x = \frac{1}{2}$. [5]

[illegible]

Topical questions | 106 questions

5 The equation of a curve is $x^2y - ay^2 = 4a^3$, where a is a non-zero constant.

(a) Show that $\frac{dy}{dx} = \frac{2xy}{2ay - x^2}$. [4]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

73. Question part 2/2 | 9709 May-June 2023 P3 V1 Q5

- (b)** Hence find the coordinates of the points where the tangent to the curve is parallel to the y-axis. [4]

[illegible]

Topical questions | 106 questions

7 The equation of a curve is $3x^2 + 4xy + 3y^2 = 5$.

This image shows a full page of a worksheet designed for handwriting practice. It features approximately 20 horizontal dashed lines spaced evenly across the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

74. Question part 2/2 | 9709 May-June 2023 P3 V2 Q7

(b) Hence find the exact coordinates of the two points on the curve at which the tangent is parallel to $y + 2x = 0$. [5]

[illegible]

Topical questions | 106 questions

4 The parametric equations of a curve are

Show that $\frac{dy}{dx} = (2 - \sin \theta)^2$. [5]

This image shows a full page of white paper with horizontal dashed lines, typical of primary-ruled notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

76. Question | 9709 Oct-Nov 2023 P3 V1 Q1

- 1** Find the exact coordinates of the points on the curve $y = \frac{x^2}{1-3x}$ at which the gradient of the tangent is equal to 8. [5]

This image shows a full page of a handwriting practice worksheet. It consists of multiple rows of horizontal dashed lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

77. Question | 9709 Oct-Nov 2023 P3 V1 Q6

6 The parametric equations of a curve are

$$x = \sqrt{t} + 3, \quad y = \ln t,$$

for $t > 0$.

(a) Obtain a simplified expression for $\frac{dy}{dx}$ in terms of t . [3]

[illegible]

(b) Hence find the exact coordinates of the point on the curve at which the gradient of the normal is -2 . [3]

[illegible]

for $t > 0$.

Find the gradient of the curve at the point where $t = e$, simplifying your answer. [4]

This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal dashed lines, providing a guide for letter height and placement. The lines are evenly spaced across the entire page, which is otherwise blank.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

79. Question | 9709 Oct-Nov 2023 P3 V3 Q5

5 Find the exact coordinates of the stationary points of the curve $y = \frac{e^{3x-1}}{1-x^2}$. [6]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

80. Question part 1/2 | 9709 Oct-Nov 2023 P3 V3 Q7

7 The equation of a curve is $x^3 + y^2 + 3x^2 + 3y = 4$.

(a) Show that $\frac{dy}{dx} = -\frac{3x^2 + 6x}{2y + 3}$. [3]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

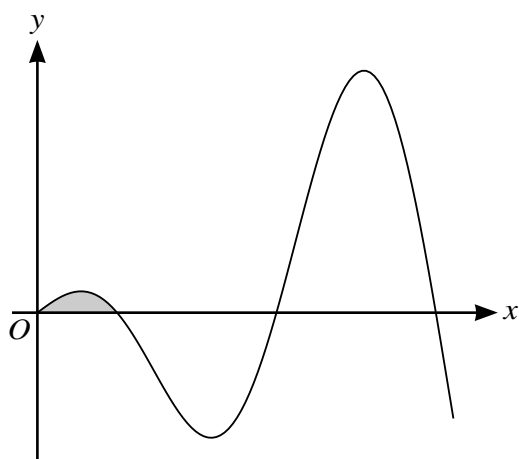
9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

80. Question part 2/2 | 9709 Oct-Nov 2023 P3 V3 Q7

(b) Hence find the coordinates of the points on the curve at which the tangent is parallel to the x -axis. [5]

[illegible]



(a) Find the equation of the tangent to the curve at the point where $x = \frac{1}{2}\pi$. [4]

This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal dashed lines, providing a guide for letter height and placement. The lines are evenly spaced across the entire page, which is otherwise blank white space.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

81. Question part 2/2 | 9709 Oct-Nov 2023 P3 V3 Q10

- (b) Find the exact area of the shaded region shown in the diagram, bounded by the curve and the x -axis. [5]

This image shows a full page of white paper with horizontal dashed lines, typical of primary school handwriting practice paper. The lines are evenly spaced and run across the entire width of the page. There are no margins, text, or other markings present.

Topical questions | 106 questions

6 The equation of a curve is $2y^2 + 3xy + x = x^2$.

(a) Show that $\frac{dy}{dx} = \frac{2x-3y-1}{4y+3x}$. [4]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

82. Question part 2/2 | 9709 Feb-March 2024 P3 V2 Q6

(b) Hence show that the curve does **not** have a tangent that is parallel to the x -axis.

[3]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

83. Question part 1/2 | 9709 May-June 2024 P3 V1 Q5

5 The equation of a curve is $y = \frac{e^{\sin x}}{\cos^2 x}$ for $0 \leq x \leq 2\pi$.

Find $\frac{dy}{dx}$ and hence find the x -coordinates of the stationary points of the curve. [7]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

83. Question part 2/2 | 9709 May-June 2024 P3 V1 Q5

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting or typing. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

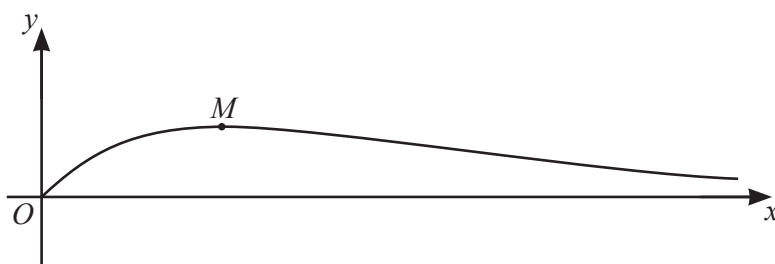
84. Question | 9709 May-June 2024 P3 V2 Q4

- 4** The equation of a curve is $ye^{2x} + y^2e^x = 6$.

Find the gradient of the curve at the point where $y = 1$.

[6]

[illegible]



(a) Find the exact coordinates of M . [4]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

85. Question part 2/2 | 9709 May-June 2024 P3 V2 Q6

(b) Find the exact value of $\int_0^{\frac{2}{a}} x e^{-ax} dx$.

[5]

This image shows a full page of white paper designed for handwriting practice. It features approximately 20 evenly spaced horizontal dotted lines running from left to right across the entire width of the page. There are no margins, text, or other markings present.

Topical questions | 106 questions

2 Find the exact coordinates of the stationary point of the curve $y = e^{2x} \sin 2x$ for $0 \leq x \leq \frac{1}{2}\pi$. [5]

This image shows a full page of a worksheet designed for handwriting practice. It features approximately 20 evenly spaced horizontal dotted lines across the entire width of the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.



9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

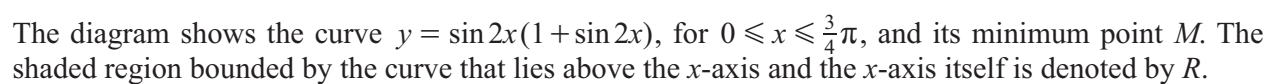
87. Question | 9709 Oct-Nov 2024 P3 V1 Q3

3 The equation of a curve is $\ln(x+y) = 3x^2y$.

Find the gradient of the curve at the point $(1, 0)$.

[4]

[illegible]



- (a) Given that the x -coordinate of M lies in the interval $\frac{1}{2}\pi < x < \frac{3}{4}\pi$, find the exact coordinates of M . [4]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

88. Question part 2/2 | 9709 Oct-Nov 2024 P3 V1 Q6



(b) Find the exact area of the region R .

[4]

[illegible]

Topical questions | 106 questions

89. Question part 1/2 | 9709 Oct-Nov 2024 P3 V2 Q8

$$x = \tan^2 2t, \quad y = \cos 2t,$$

(a) Show that $\frac{dy}{dx} = -\frac{1}{2} \cos^3 2t$. [4]

This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal dashed lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

89. Question part 2/2 | 9709 Oct-Nov 2024 P3 V2 Q8



- (b)** Hence find the equation of the normal to the curve at the point where $t = \frac{1}{8}\pi$. Give your answer in the form $y = mx + c$. [4]

[illegible]

Topical questions | 106 questions

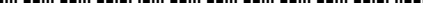
11 Let $f(x) = \frac{2e^{2x}}{e^{2x} - 3e^x + 2}$.

-
- This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

Give your answer in the form $\ln a$, where a is a rational number in its simplest form. [9]

[illegible]

Topical questions | 106 questions



If you use the following page to complete the answer to any question, the question number must be clearly shown.

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

91. Question part 1/2 | 9709 Oct-Nov 2024 P3 V3 Q7

7 The parametric equations of a curve are

$$x = 3 \sin 2t, \quad y = \tan t + \cot t,$$

for $0 < t < \frac{1}{2}\pi$.

(a) Show that $\frac{dy}{dx} = \frac{-2}{3 \sin^2 2t}$. [5]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

91. Question part 2/2 | 9709 Oct-Nov 2024 P3 V3 Q7



- (b)** Find the equation of the normal to the curve at the point where $t = \frac{1}{4}\pi$. Give your answer in the form $py + qx + r = 0$, where p , q and r are integers. [3]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

92. Question part 1/2 | 9709 Feb-March 2025 P3 V2 Q2

2 The equation of a curve is $xy^2 + \ln(x + 2y) = 1$.

Find the gradient of the curve at the point where $x = 0$.

[5]

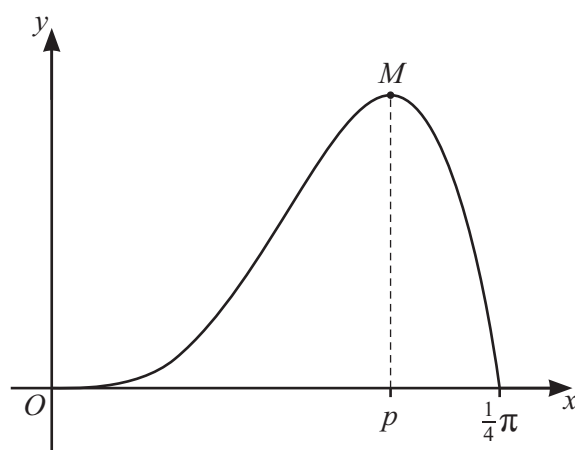
This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

92. Question part 2/2 | 9709 Feb-March 2025 P3 V2 Q2

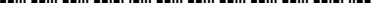
This image shows a full page of a worksheet designed for handwriting practice. It consists of approximately 20 evenly spaced horizontal dotted lines across the entire width of the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.



(a) Show that p satisfies the equation $p = \frac{1}{2} \tan^{-1} \left(\frac{3}{2p} \right)$. [3]

[illegible]

Topical questions | 106 questions



[2]

[illegible]

[3]

[illegible]

93. Question part 3/3 | 9709 Feb-March 2025 P3 V2 Q7



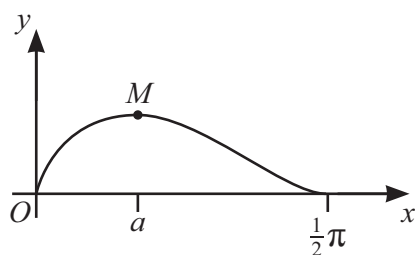
$$\frac{1}{-1} \quad \frac{1}{2} \quad \frac{1}{2} \quad \frac{1}{-1}$$

Topical questions | 106 questions

4 The parametric equations of a curve are

Find the equation of the tangent to the curve at the point $(e, 3)$. Give your answer in the form $y = mx + c$, where m and c are exact. [6]

This image shows a full page of a handwriting practice worksheet. It consists of approximately 20 horizontal rows. Each row is defined by two parallel dotted lines, creating a series of uniform gaps for writing. The lines are evenly spaced across the entire page, providing a guide for letter height and placement. There is no text or other markings on the page.

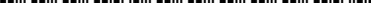


(a) Find the exact value of a .

[6]

This image shows a full page of a handwriting practice worksheet. It consists of multiple rows of horizontal dashed lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

Topical questions | 106 questions



- Find the exact volume of the solid generated. [5]

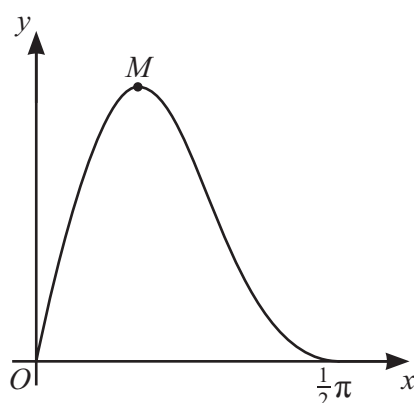
[illegible]



If you use the following page to complete the answer to any question, the question number must be clearly shown.

This image shows a full page of a worksheet designed for handwriting practice. It features 20 evenly spaced, horizontal dashed lines across the entire width of the page. The background is plain white, providing a clear guide for letter formation and alignment. There are no margins, text, or other markings present.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.



(a) Find the exact x -coordinate of M .

[6]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

96. Question part 2/3 | 9709 May-June 2025 P3 V2 Q11



- (b)** By using the substitution $u = \cos x$, find the area of the region bounded by the curve, the x -axis between $x = 0$ and $x = \frac{1}{4}\pi$, and the line $x = \frac{1}{4}\pi$. [5]

[illegible]

If you use the following page to complete the answer to any question, the question number must be clearly shown.

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.

Topical questions | 106 questions

5 The equation of a curve is $xy + y^2 e^{-x} = 4$.

(a) Show that $\frac{dy}{dx} = \frac{y^2 - ye^x}{xe^x + 2y}$. [4]

[illegible]

(b) Find the gradients of the tangents to the curve when $x = 0$. [2]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

98. Question | 9709 May-June 2025 P3 V5 Q4

- 4 Find the exact coordinates of the stationary point of the curve with equation $y = 3x^3 \ln x^4$, for $x > 0$. [5]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

Topical questions | 106 questions

$$x = \frac{2}{\cos 3t} \quad \text{and} \quad y = \tan 3t,$$

(a) Show that $\frac{dy}{dx}$ can be written as $A \operatorname{cosec} 3t$, where A is a constant to be found. [5]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

99. Question part 2/2 | 9709 May-June 2025 P3 V5 Q6



- (b)** Find an equation of the normal to the curve at the point where $t = \frac{1}{12}\pi$. Give your answer in the form $y = mx + c$, where the constants m and c are exact. [4]

[illegible]

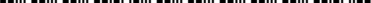
Topical questions | 106 questions

7 The equation of a curve is $y = \tan^{-1}(4x)$.

(a) Find the exact values of x when the gradient of the curve is $\frac{1}{4}$. [3]

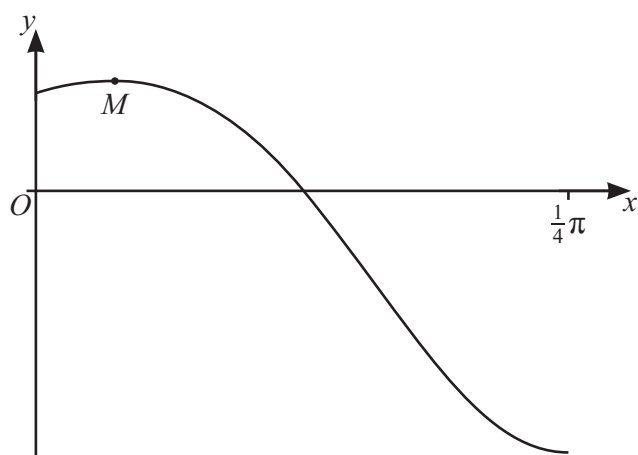
[illegible]

Topical questions | 106 questions



This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

4



Find the x -coordinate of M .

[5]

This image shows a full page of handwriting practice paper. It features 18 horizontal rows, each defined by two parallel dashed lines. The lines are evenly spaced and extend across the entire width of the page, providing a guide for letter height and placement. There is no text or other markings on the page.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

101. Question part 2/3 | 9709 Oct-Nov 2025 P3 V1 Q4

[illegible]

101. Question part 3/3 | 9709 Oct-Nov 2025 P3 V1 Q4



BLANK PAGE

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

102. Question | 9709 Oct-Nov 2025 P3 V1 Q7

7 The parametric equations of a curve are

$$x = t^2 - \ln(2t + 1), \quad y = \frac{t}{2t + 1}.$$

Obtain a simplified expression for $\frac{dy}{dx}$ in terms of t . [5]

[illegible]

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

103. Question part 1/2 | 9709 Oct-Nov 2025 P3 V2 Q7

7 The equation of a curve is $2y^3 - 3x^2y - x^3 = 16$.

(a) Show that $\frac{dy}{dx} = \frac{x^2 + 2xy}{2y^2 - x^2}$. [4]

[illegible]

9709 Mathematics Paper 3 - Differentiation

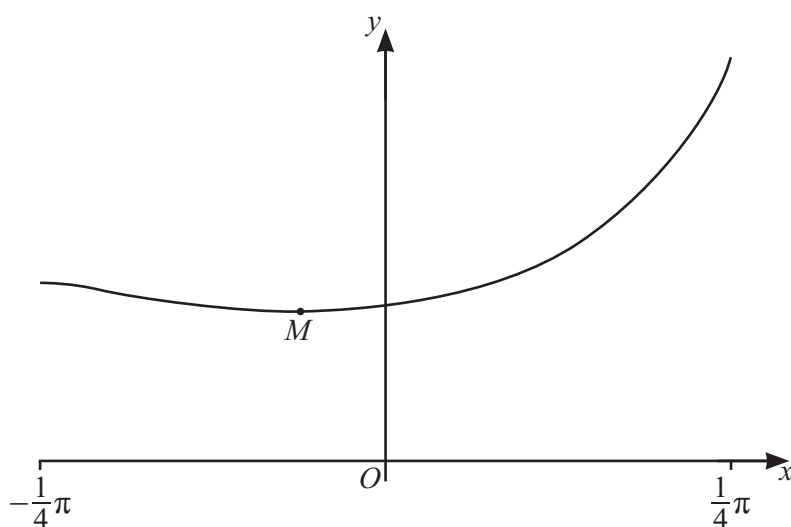
Topical questions | 106 questions

103. Question part 2/2 | 9709 Oct-Nov 2025 P3 V2 Q7



- (b)** Hence find the coordinates of the points on the curve at which the normal is parallel to the y -axis. [4]

[illegible]



(a) Find the x -coordinate of M . [6]

[illegible]

Topical questions | 106 questions

This image shows a full page of white paper with ten horizontal dashed lines, typical of primary school handwriting practice paper. The lines are evenly spaced and extend across the entire width of the page. There is no text or other markings on the paper.

- [illegible]

If you use the following page to complete the answer to any question, the question number must be clearly shown.

[illegible]

Cambridge Assessment International Education is part of Cambridge Assessment. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which is a department of the University of Cambridge.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

105. Question | 9709 Oct-Nov 2025 P3 V5 Q4

- 4** The equation of a curve is $x^2 \ln 2y - y \ln(2 + x^2) = \ln 6$.

Find the exact value of the gradient of the curve at the point $(2, 3)$. Give your answer in simplified form. [5]

This image shows a full page of a document template. It consists of approximately 28 evenly spaced horizontal dotted lines across the entire width of the page, providing a guide for handwriting or typing. There are no margins, text, or other markings present.

9709 Mathematics Paper 3 - Differentiation

Topical questions | 106 questions

106. Question | 9709 Oct-Nov 2025 P3 V5 Q6

6 A curve has equation $y = \frac{\tan x}{5 + 2 \sin x}$.

(a) Express $\frac{dy}{dx}$ as a simplified fraction in terms of $\sin x$. [4]

[illegible]

(b) Show that the curve has no stationary points. [2]

[illegible]