0606 Additional Mathematics Paper 2 - Calculus

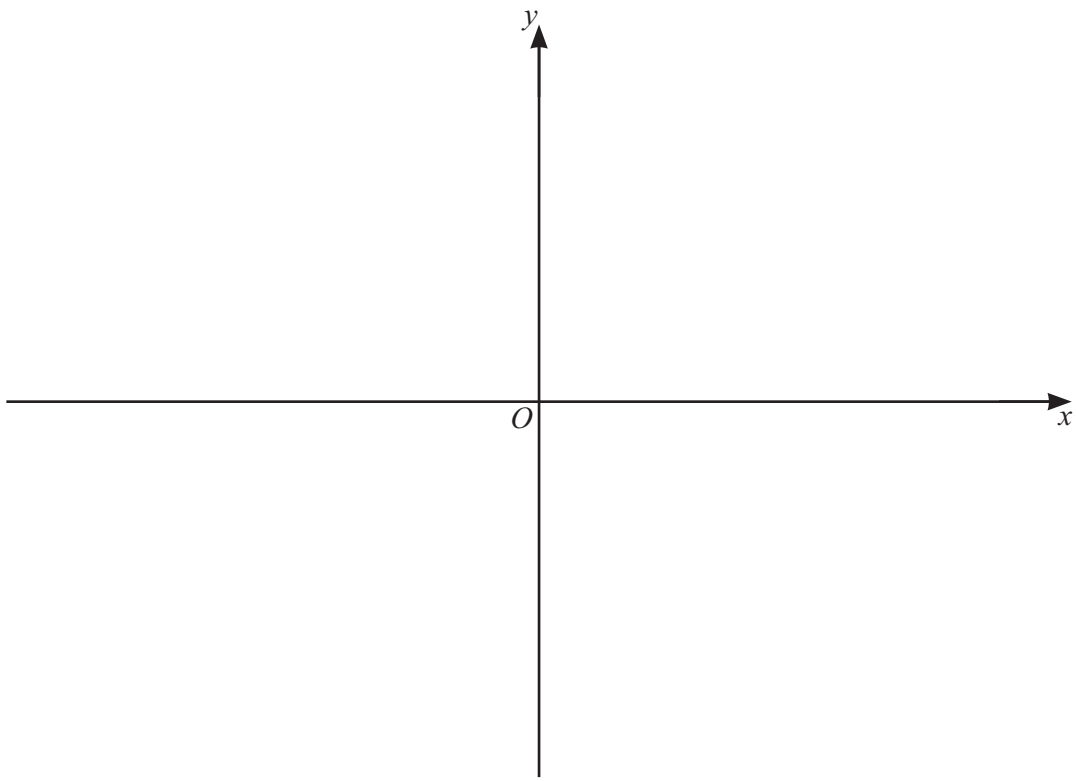
Topical questions | 31 questions

1. Question part 1/2 | 0606 Feb-March 2025 P2 V2 Q2

2 **(a)** Find the x-coordinates of the stationary points on the curve $y = \frac{1}{2}(3-2x)(x+2)^2$. [4]

1. Question part 2/2 | 0606 Feb-March 2025 P2 V2 Q2

(b) On the axes, sketch the graph of $y = \frac{1}{2}(3-2x)(x+2)^2$ stating the intercepts with the coordinate axes. [3]



(c) Find the values of k for which the equation $\frac{1}{2}(3-2x)(x+2)^2 = k$ has three real and distinct roots. [2]

2. Question | 0606 Feb-March 2025 P2 V2 Q6

6 It is given that $y = \dfrac{\ln\left(2x^2+1\right)}{x+2}$.

(a) Find $\dfrac{\mathrm{d}y}{\mathrm{d}x}$. [3]

(b) Given that x increases from 2 to $2+h$, where h is small, find the approximate change in y. [2]

(c) Given that y is decreasing by 0.4 units per second, find the corresponding rate of change in x when $x = 2$. [3]

3. Question part 1/2 | 0606 Feb-March 2025 P2 V2 Q9

9 In this question, all lengths are in metres and time is in seconds.

A particle, P, moves in a straight line such that t seconds after passing through a fixed point O its displacement, s, is given by $s = 5\ln(2t+1) - 5t$.

(a) Find the value of t for which P is instantaneously at rest. [4]

(b) Find the distance P travels between $t = 0$ and $t = 2$. [4]

3. Question part 2/2 | 0606 Feb-March 2025 P2 V2 Q9

(c) Find an expression for the acceleration of P in terms of t. [2]

(d) Find the acceleration when $t = 4.5$. [1]

4. Question | 0606 May-June 2025 P2 V1 Q5

5 Given that $y = x^2 \tan\frac{x}{2}$, use calculus to find the approximate change in y as x increases from $\frac{\pi}{3}$ to $\frac{\pi}{3} + h$, where h is small. [4]

5. Question part 1/2 | 0606 May-June 2025 P2 V1 Q10

10 A particle P moves in a straight line.
t seconds after passing a fixed point, O, the acceleration of P, $a\,\text{ms}^{-2}$, is given by

$$\begin{aligned} a &= t^2 - 2 && \text{for } 0 \leqslant t \leqslant 4 \\ a &= 19 - 5\text{e}^{8-2t} && \text{for } 4 \leqslant t \leqslant 10. \end{aligned}$$

When $t = 3$, the velocity of P is $-\frac{1}{3}\text{ms}^{-1}$ and its displacement from O is $-\frac{1}{4}\text{m}$.

(a) (i) Find the velocity of P when $t = 4$. [3]

(ii) Find the displacement of P from O when $t = 4$. [3]

5. Question part 2/2 | 0606 May-June 2025 P2 V1 Q10

(b) Find the displacement of P from O when $t = 10$. [5]

Question 11 is printed on the next page.

6. Question part 1/2 | 0606 May-June 2025 P2 V2 Q2

2 In this question, all lengths are in metres and time is in seconds.

A particle P moves in a straight line such that its displacement s from a fixed point O at time t is given by $s = (t-4)^2(t-1)$ for $t \geqslant 0$.

(a) On the axes, sketch the displacement–time graph of P, stating the intercepts with the axes. [2]



(b) Find an expression for the velocity, v, of P.
Give your answer in a factorised form. [2]

6. Question part 2/2 | 0606 May-June 2025 P2 V2 Q2

(c) On the axes, sketch the velocity–time graph of P, stating the intercepts with the axes. [2]



(d) Find an expression for the acceleration, a, of P. [1]

(e) On the axes, sketch the acceleration–time graph of P, stating the intercepts with the axes. [3]



7. Question | 0606 May-June 2025 P2 V2 Q4

4 **(a)** Given that $y = 4\sin 2x \cos 2x$, find the value of $\frac{\mathrm{d}y}{\mathrm{d}x}$ when $x = \frac{\pi}{6}$. [4]

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

The normal to the curve at the point where $x = \frac{\pi}{6}$ meets the x-axis at the point P.

Find the exact coordinates of P. [5]

8. Question | 0606 May-June 2025 P2 V2 Q6

6 The volume, V, of a sphere is increasing at the constant rate of $2\pi\,\text{cm}^3\,\text{s}^{-1}$.
Find the rate of change of the surface area, S, of this sphere when the volume of the sphere is $36\pi\,\text{cm}^3$.
[6]

9. Question part 1/2 | 0606 May-June 2025 P2 V2 Q8

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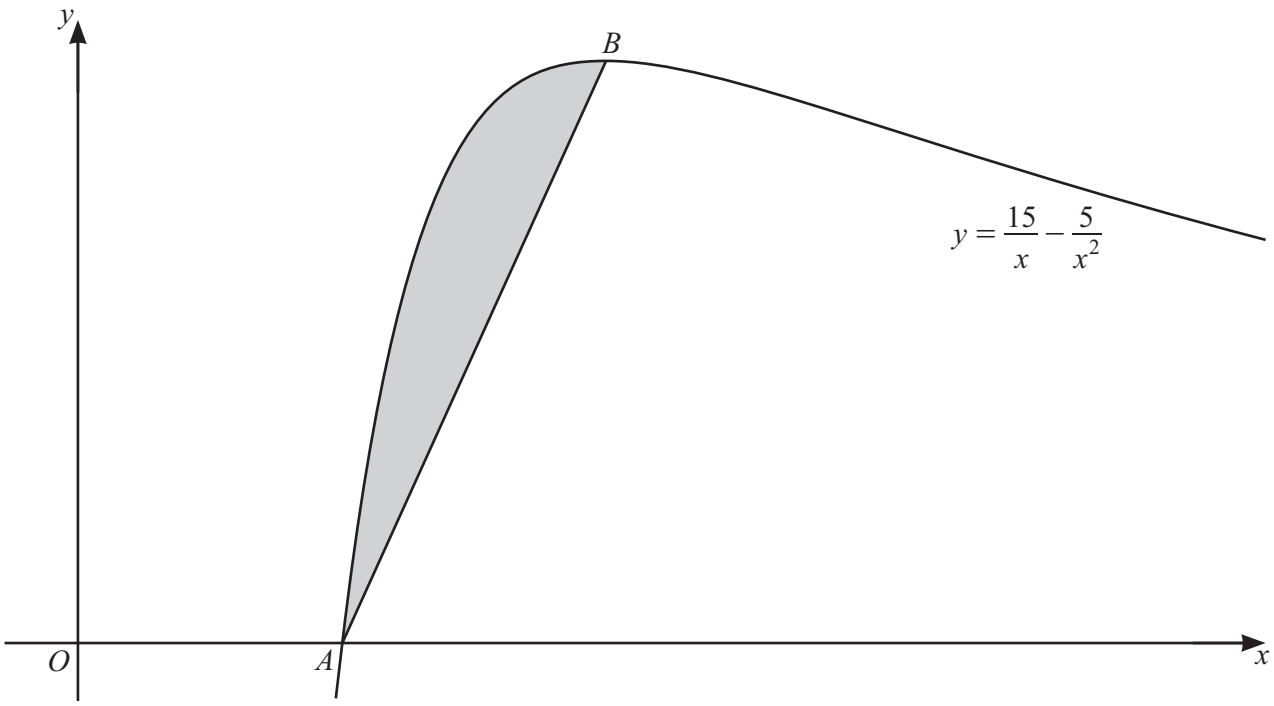

The diagram shows part of the curve $y = \frac{15}{x} - \frac{5}{x^2}$.

The curve meets the x-axis at the point A.
The curve has a maximum at the point B.

Find the area of the shaded region enclosed by the line AB and the curve.

Give your answer in exact form. [11]

9. Question part 2/2 | 0606 May-June 2025 P2 V2 Q8

Continuation of working space for Question 8.

10. Question | 0606 May-June 2025 P2 V3 Q2

2 Given that $y = \frac{4x^3 - 5}{x^2}$, show that $\frac{\mathrm{d}y}{\mathrm{d}x}$ can be written as $\frac{2(2x^3 + 5)}{x^3}$. [3]

11. Question part 1/2 | 0606 May-June 2025 P2 V3 Q8

8 **(a)** It is given that $y = e^{3x+2}\tan x$.

Use calculus to find the approximate change in y as x increases from 0.1 to $0.1 + h$, where h is small. [5]

11. Question part 2/2 | 0606 May-June 2025 P2 V3 Q8

(b) A curve is such that $\frac{\mathrm{d}y}{\mathrm{d}x} = \sin(3x + \pi)$.

The curve passes through the point $\left(\frac{\pi}{9}, \frac{4}{3}\right)$.

Find the exact y-coordinate of the point on the curve where $x = \frac{5\pi}{12}$. [4]

12. Question part 1/2 | 0606 May-June 2025 P2 V3 Q12

12 The function f is defined by $\mathrm{f}(x) = 15\cos^2(3x+1.5) + 7\sin(3x+1.5) - 13$ for $-0.3 \leqslant x \leqslant 0.5$, where x is in radians.

(a) Solve the equation $\mathrm{f}(x) = 0$. [5]

12. Question part 2/2 | 0606 May-June 2025 P2 V3 Q12

(b) Find the x-coordinates of the two stationary points on the curve $y = \mathrm{f}(x)$. [5]

Question 13 is printed on the next page.

13. Question | 0606 Oct-Nov 2025 P2 V1 Q7

7 Show that the curve $y = x - \ln(x^2 + 2x)$ has exactly one stationary point.

Find the x-coordinate of this point. [6]

14. Question part 1/2 | 0606 Oct-Nov 2025 P2 V1 Q8

8 In this question, the units are metres and seconds.

A particle P is travelling in a straight line through a fixed point O.
At time t its acceleration, a, is given by $a = (2t-3)^2$, where $t \geqslant 0$.

When $t = 3$, P has a velocity of 6.

(a) (i) Find an expression for the velocity, v, of P at time t. [3]

(ii) Find the time when P is at rest. [3]

When $t = \frac{5}{2}$, the displacement of P from O is 4.

(iii) Find the displacement of P from O when $t = 3$. [4]

(b) Use calculus to find the approximate change in v when t increases from $\frac{5}{2}$ by the small amount 0.02. [3]

15. Question | 0606 Oct-Nov 2025 P2 V1 Q11

11 A cylinder has radius r cm and height h cm.
The total surface area, including the two ends, is $A\,\text{cm}^2$.
The volume of the cylinder is $330\,\text{cm}^3$.

(a) Show that $A = 2\pi r^2 + \frac{660}{r}$. [3]

(b) Given that r can vary, find the value of r that gives a stationary value for A and show that this value is a minimum. [5]

16. Question | 0606 Oct-Nov 2025 P2 V2 Q7

7 **(a)** Given that $y = x\cos 2x$, find $\frac{\mathrm{d}y}{\mathrm{d}x}$. [2]

(b) Hence find $\int x\sin 2x \, \mathrm{d}x$. [4]

17. Question part 1/2 | 0606 Oct-Nov 2025 P2 V2 Q10

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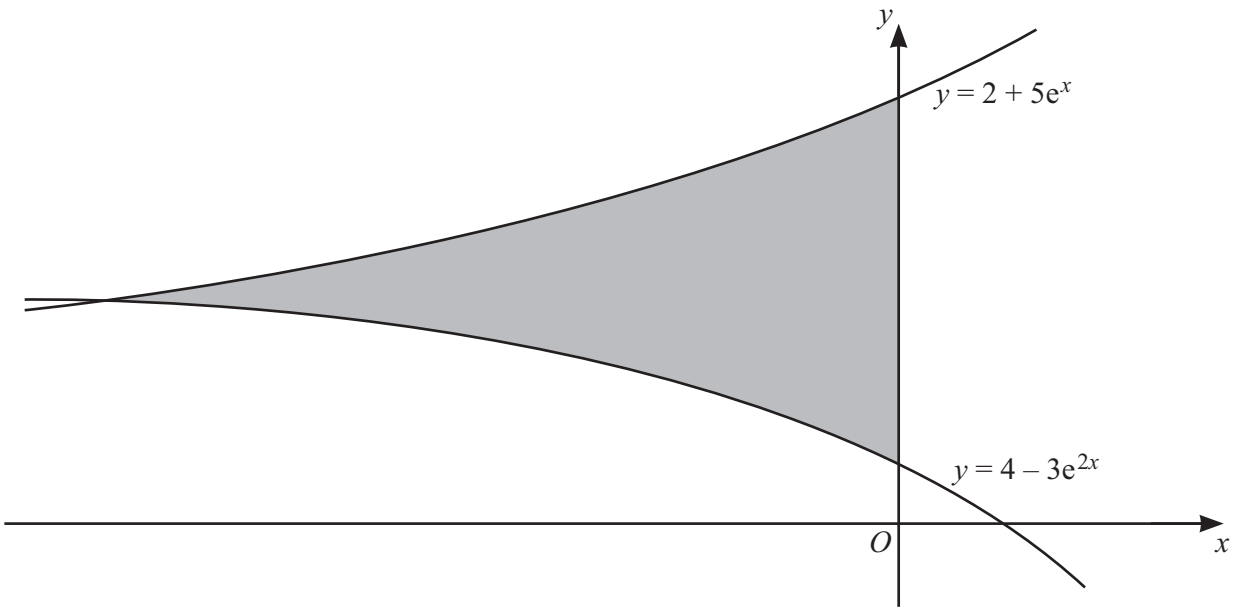


The diagram shows parts of the graphs of $y = 2 + 5e^x$ and $y = 4 - 3e^{2x}$.

Find the area of the shaded region.
Give your answer in the form $a + b \ln 3$, where a and b are exact constants. [10]

17. Question part 2/2 | 0606 Oct-Nov 2025 P2 V2 Q10

Additional working space for Question 10.

18. Question | 0606 Oct-Nov 2025 P2 V3 Q4

4 **(a)** Integrate the following with respect to x.

(i) e^{5x-2} [2]

(ii) $\frac{1}{4-3x}$ where $x < \frac{4}{3}$ [2]

(b) Show that $\int_{\frac{\pi}{3}}^{\frac{\pi}{2}} \sec^2\left(\frac{1}{2}x\right) dx = 2\left(1 - \frac{\sqrt{3}}{3}\right)$. [3]

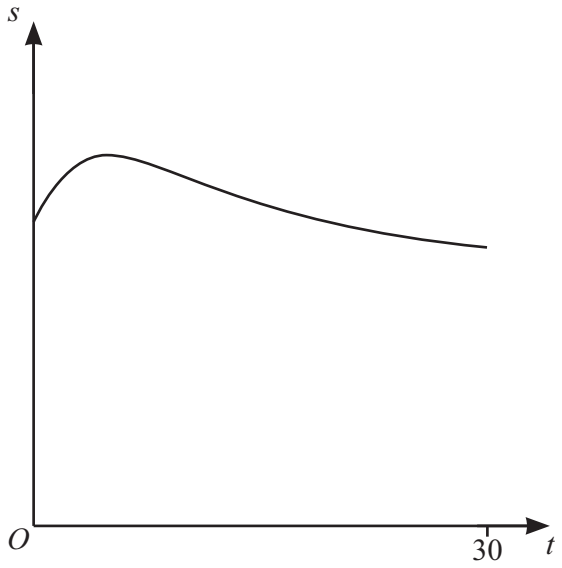
19. Question part 1/2 | 0606 Oct-Nov 2025 P2 V3 Q10

10 In this question the units are metres and seconds.

A particle moves along a straight line through a point A.

Its displacement, s, from A at time t is given by $s = \dfrac{10t + 100}{\sqrt{2t^2 + 100}}$.

The diagram shows the displacement–time graph for the first 30 seconds of the motion.



(a) Find the value of t when s is a maximum. [6]

19. Question part 2/2 | 0606 Oct-Nov 2025 P2 V3 Q10

(b) The particle passes through its starting point again at time $t = T$.

(i) Find the total distance travelled by the particle during the first T seconds of its motion. [2]

(ii) Use algebra to find T. [3]

Question 11 is printed on the next page.

20. Question | 0606 Specimen 2025 P2 Q5

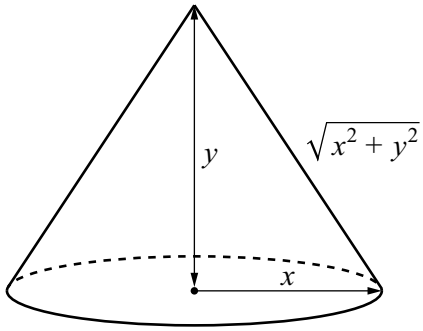
5 Given that $y = \tan x$, use calculus to find the approximate change in y as x increases from $-\frac{\pi}{4}$ to $h - \frac{\pi}{4}$, where h is small. [3]

21. Question | 0606 Specimen 2025 P2 Q6

6 A curve has equation $y = \ln(5 - 3x)$ where $x < \frac{5}{3}$. The normal to the curve at the point where $x = -5$, cuts the x-axis, at the point P.

Find the equation of the normal and the x-coordinate of P. [7]

11 In this question, all lengths are in centimetres.



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The diagram shows a cone of base radius x, height y and sloping edge $\sqrt{x^2 + y^2}$. The volume of the cone is $10\pi\,\text{cm}^3$.

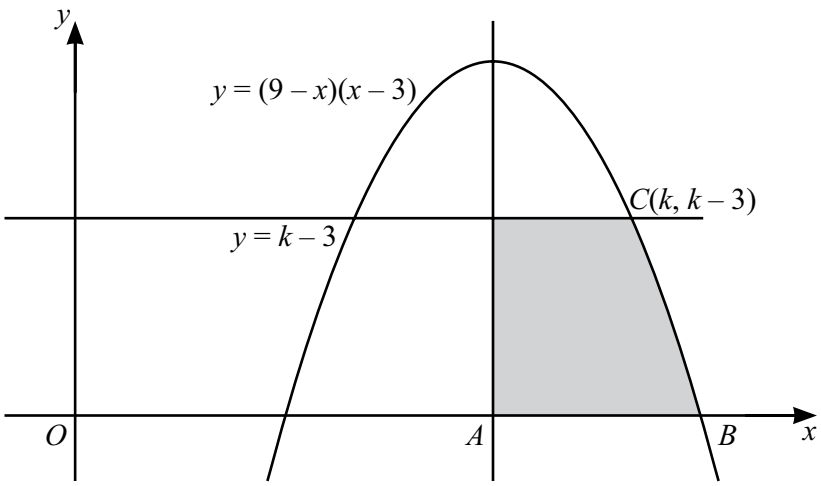
(a) Show that the curved surface area, S, of the cone is given by $S = \dfrac{\pi\sqrt{x^6 + 900}}{x}$. [3]

(b) Given that x can vary and that S has a minimum value, find the value of x for which S is a minimum.

[5]

23. Question part 1/2 | 0606 Specimen 2025 P2 Q12

12



The diagram shows part of the curve $y = (9 - x)(x - 3)$ and the line $y = k - 3$, where $k > 3$.
The line through the maximum point of the curve, parallel to the y-axis, meets the x-axis at A.
The curve meets the x-axis at B, and the line $y = k - 3$ meets the curve at the point $C(k, k - 3)$.

Find the area of the shaded region. [9]

23. Question part 2/2 | 0606 Specimen 2025 P2 Q12

Continuation of working space for Question 12.

24. Question | 0606 Feb-March 2026 P2 V2 Q7

7 A ship is sailing with speed $v\,\text{kmh}^{-1}$.
The sailing cost per hour, $\$C$, is given by $C = v^2 + \frac{3000}{v} + 100$.

(a) Find the speed that makes C a minimum.
Justify that this value of C is a minimum. [5]

(b) Hence find the minimum sailing cost for a journey of 150 km. [3]

25. Question part 1/2 | 0606 Feb-March 2026 P2 V2 Q10

10 In this question time t is in seconds and displacement s is in metres.

For $t \geqslant 0$, a particle moves on the positive x-axis.
At time t the acceleration of the particle is $2t - 9$.
At time $t = 7$ the velocity of the particle is 4.

(a) Find the times when the velocity of the particle is 0. [4]

(b) At time $t = 12$, the displacement of the particle from the origin O is 150.

(i) Find an expression for the displacement of the particle at time t. [3]

(ii) Find the distance travelled by the particle in the first 6 seconds. [3]

Question 11 is on the back page.

26. Question | 0606 May-June 2026 P2 V1 Q5

5 It is given that $y = \tan^3 5x$.

(a) Find $\frac{\mathrm{d}y}{\mathrm{d}x}$ in terms of $\tan 5x$. [4]

(b) Hence solve the equation $\frac{\mathrm{d}y}{\mathrm{d}x} = 0$ for $0 \leqslant x < \frac{4\pi}{5}$. [5]

27. Question | 0606 May-June 2026 P2 V1 Q10

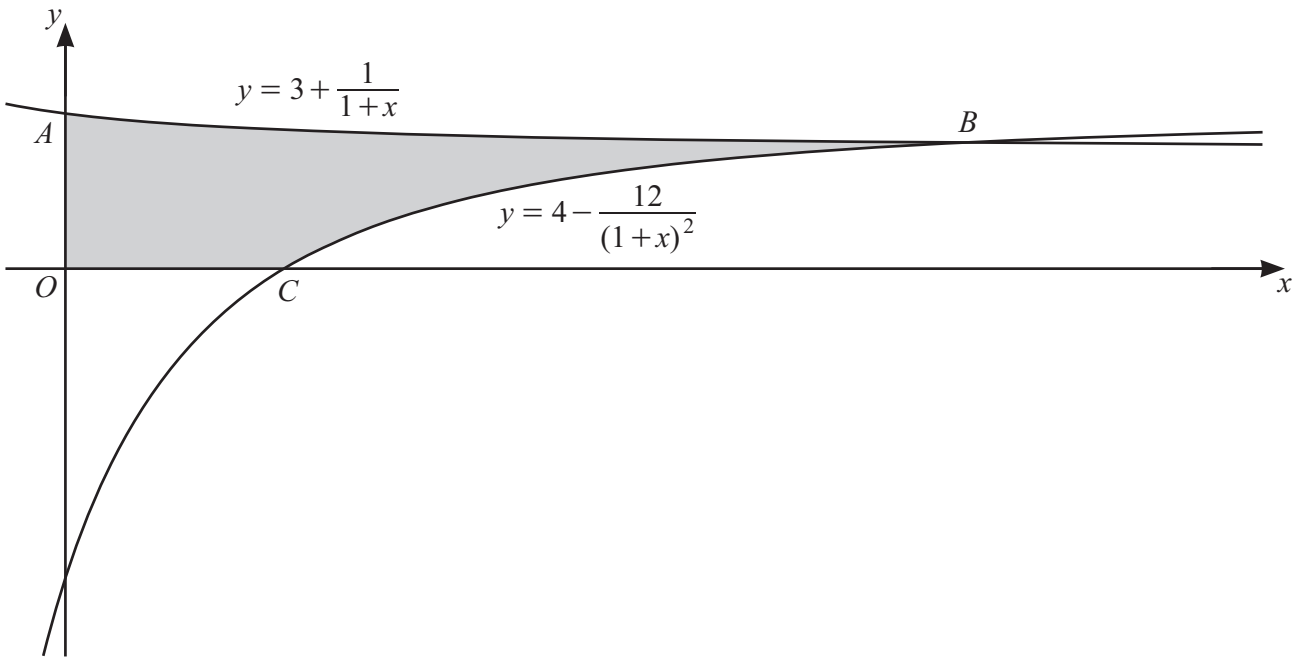
10 A curve has equation $y = x^2 \ln(3x^2 + 5)$.

The normal to the curve at the point where $x = -1$ meets the x-axis at the point P and the y-axis at the point Q.

Find the area of the triangle OPQ, where O is the origin.
Give your answer correct to 3 significant figures. [10]

28. Question part 1/2 | 0606 May-June 2026 P2 V1 Q11

11



The diagram shows part of the curve $y = 3 + \frac{1}{1+x}$ and part of the curve $y = 4 - \frac{12}{(1+x)^2}$.

The curve $y = 3 + \frac{1}{1+x}$ meets the y-axis at the point A.

The curve $y = 4 - \frac{12}{(1+x)^2}$ meets the x-axis at the point C.

The curves intersect at the point B.

Find the area of the shaded region $OABC$.
Give your answer in exact form. [10]

28. Question part 2/2 | 0606 May-June 2026 P2 V1 Q11

Continuation of working space for question 11.

29. Question | 0606 May-June 2026 P2 V2 Q3

3 **(a)** Differentiate $y = \sqrt{x+1} + \cos(5x+3)$ with respect to x. [3]

(b) Find $\int \sec^2 \frac{x}{3} \mathrm{d}x$. [3]

30. Question | 0606 May-June 2026 P2 V2 Q9

9 A particle P moves in a straight line such that t seconds after passing through a fixed point O, its displacement from O, s metres, is given by $s = e^{4t} - 10e^{2t} + 9$.

(a) The velocity of P is $v\,\text{ms}^{-1}$.

Find the value of t for which v has a stationary value. [5]

(b) Find the acceleration of P when $t = \ln 2$. [2]

31. Question | 0606 May-June 2026 P2 V2 Q12

12 A sphere has volume $V\,\text{cm}^3$ and radius r cm.

Given that r varies with time t, find V at the instant when $\frac{\mathrm{d}V}{\mathrm{d}t} = 9\frac{\mathrm{d}r}{\mathrm{d}t}$. [4]