

Cambridge International AS & A Level

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MATHEMATICS

9709/11

Paper 1 Pure Mathematics 1

May/June 2022

1 hour 50 minutes

You must answer on the question paper.

You will need: List of formulae (MF19)

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
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- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages.

- 1 (a) Express $x^2 - 8x + 11$ in the form $(x + p)^2 + q$ where p and q are constants. [2]

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- (b) Hence find the exact solutions of the equation $x^2 - 8x + 11 = 1$. [2]

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- 2** The thirteenth term of an arithmetic progression is 12 and the sum of the first 30 terms is -15 .

Find the sum of the first 50 terms of the progression.

[5]

[illegible]

- 3** The coefficient of x^4 in the expansion of $\left(2x^2 + \frac{k^2}{x}\right)^5$ is a . The coefficient of x^2 in the expansion of $(2kx - 1)^4$ is b .

(a) Find a and b in terms of the constant k .

[3]

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.

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4 (a) Prove the identity $\frac{\sin^3 \theta}{\sin \theta - 1} - \frac{\sin^2 \theta}{1 + \sin \theta} \equiv -\tan^2 \theta (1 + \sin^2 \theta)$. [4]

[illegible]

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(b) Hence solve the equation

$$\frac{\sin^3 \theta}{\sin \theta - 1} - \frac{\sin^2 \theta}{1 + \sin \theta} = \tan^2 \theta (1 - \sin^2 \theta)$$

for $0 < \theta < 2\pi$.

[2]

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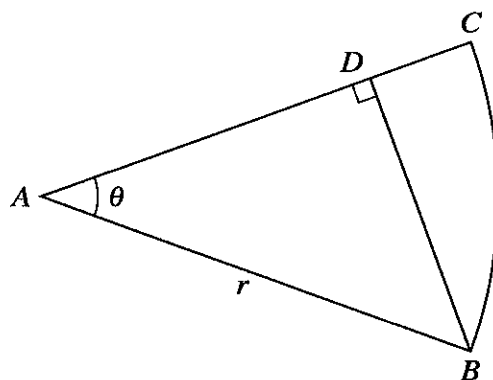
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(a) Given that $\theta = \frac{1}{6}\pi$, find the exact area of BCD in terms of r . [3]

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.

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(a) Find an expression for $f^{-1}(x)$. [3]

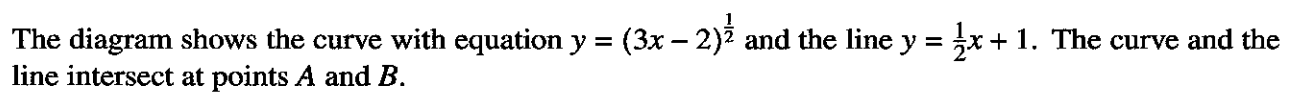
[illegible]

- (b)** Show that $1 - \frac{8}{x^2 + 4}$ can be expressed as $\frac{x^2 - 4}{x^2 + 4}$ and hence state the range of f . [4]

[illegible]

- (c) Explain why the composite function ff cannot be formed. [1]

[illegible]



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- This image shows a full page of white paper with horizontal dashed 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.

* (b) Hence find the area of the region enclosed between the curve and the line. [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 width of the page. There are no margins, text, or other markings on the paper.

- 8 (a)** The curve $y = \sin x$ is transformed to the curve $y = 4 \sin(\frac{1}{2}x - 30^\circ)$.

Describe fully a sequence of transformations that have been combined, making clear the order in which the transformations are applied. [5]

[illegible]

- (b)** Find the exact solutions of the equation $4 \sin(\frac{1}{2}x - 30^\circ) = 2\sqrt{2}$ for $0^\circ \leq x \leq 360^\circ$. [3]

[illegible]

- 9** The equation of a circle is $x^2 + y^2 + 6x - 2y - 26 = 0$.

- (a) Find the coordinates of the centre of the circle and the radius. Hence find the coordinates of the lowest point on the circle. [4]

[illegible]

- (b) Find the set of values of the constant k for which the line with equation $y = kx - 5$ intersects the circle at two distinct points. [6]

[illegible]

10 The equation of a curve is such that $\frac{d^2y}{dx^2} = 6x^2 - \frac{4}{x^3}$. The curve has a stationary point at $(-1, \frac{9}{2})$.

(a) Determine the nature of the stationary point at $(-1, \frac{9}{2})$. [1]

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* (b) Find the equation of the curve. [5]

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.

- * (c) Show that the curve has no other stationary points. [3]

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- * (d) A point A is moving along the curve and the y -coordinate of A is increasing at a rate of 5 units per second.

Find the rate of increase of the x -coordinate of A at the point where $x = 1$. [3]

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[illegible]

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MATHEMATICS

9709/11

Paper 1 Pure Mathematics 1

May/June 2023

1 hour 50 minutes

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- 1** Solve the equation $4 \sin \theta + \tan \theta = 0$ for $0^\circ < \theta < 180^\circ$. [3]

[illegible]

- 2 (a) Find the first three terms in the expansion, in ascending powers of x , of $(2 + 3x)^4$. [2]

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- (b) Find the first three terms in the expansion, in ascending powers of x , of $(1 - 2x)^5$. [2]

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- (c) Hence find the coefficient of x^2 in the expansion of $(2 + 3x)^4(1 - 2x)^5$. [2]

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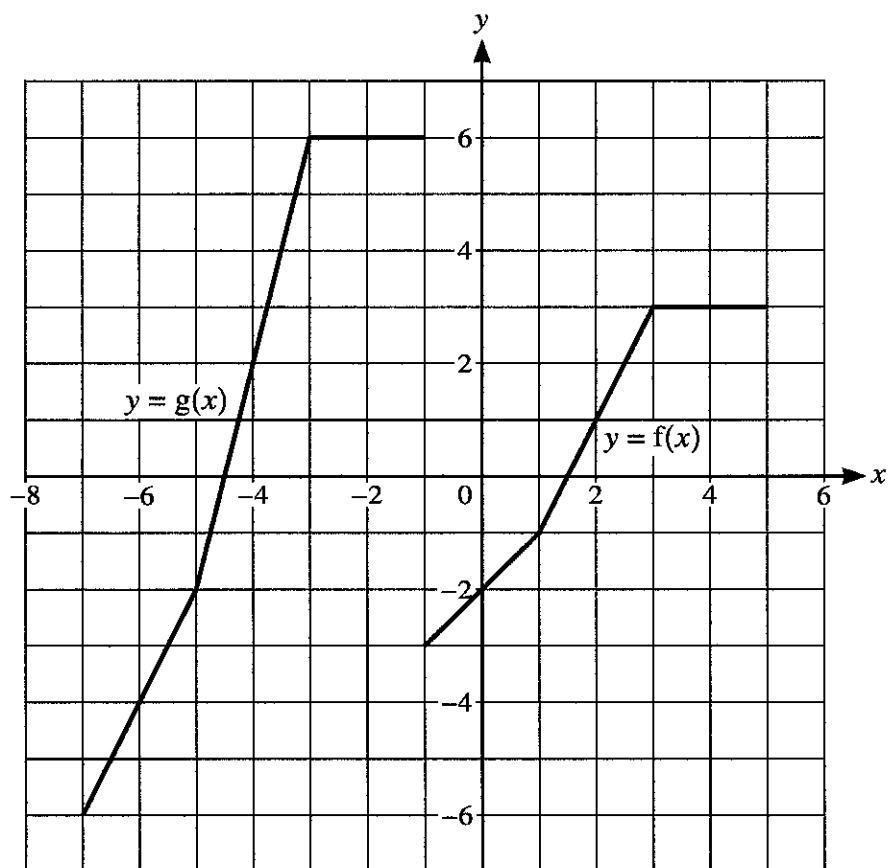
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The diagram shows graphs with equations $y = f(x)$ and $y = g(x)$.

Describe fully a sequence of two transformations which transforms the graph of $y = f(x)$ to $y = g(x)$. [4]

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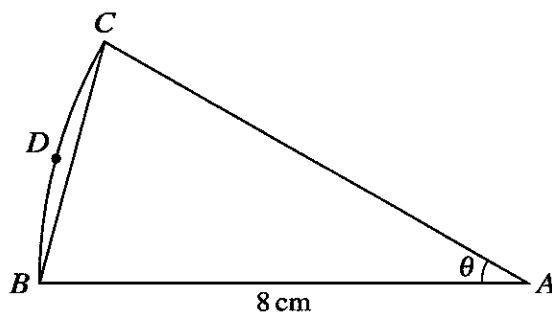
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The diagram shows a sector ABC of a circle with centre A and radius 8 cm. The area of the sector is $\frac{16}{3}\pi\text{ cm}^2$. The point D lies on the arc BC .

Find the perimeter of the segment BCD .

[4]

[illegible]

- 5** The line with equation $y = kx - k$, where k is a positive constant, is a tangent to the curve with equation $y = -\frac{1}{2x}$.

Find, in either order, the value of k and the coordinates of the point where the tangent meets the curve. [5]

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

6 The first three terms of an arithmetic progression are $\frac{p^2}{6}$, $2p - 6$ and p .

(a) Given that the common difference of the progression is not zero, find the value of p . [3]

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(b) Using this value, find the sum to infinity of the geometric progression with first two terms $\frac{p^2}{6}$ and $2p - 6$. [2]

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7 A curve has equation $y = 2 + 3 \sin \frac{1}{2}x$ for $0 \leq x \leq 4\pi$.

(a) State greatest and least values of y .

[2]

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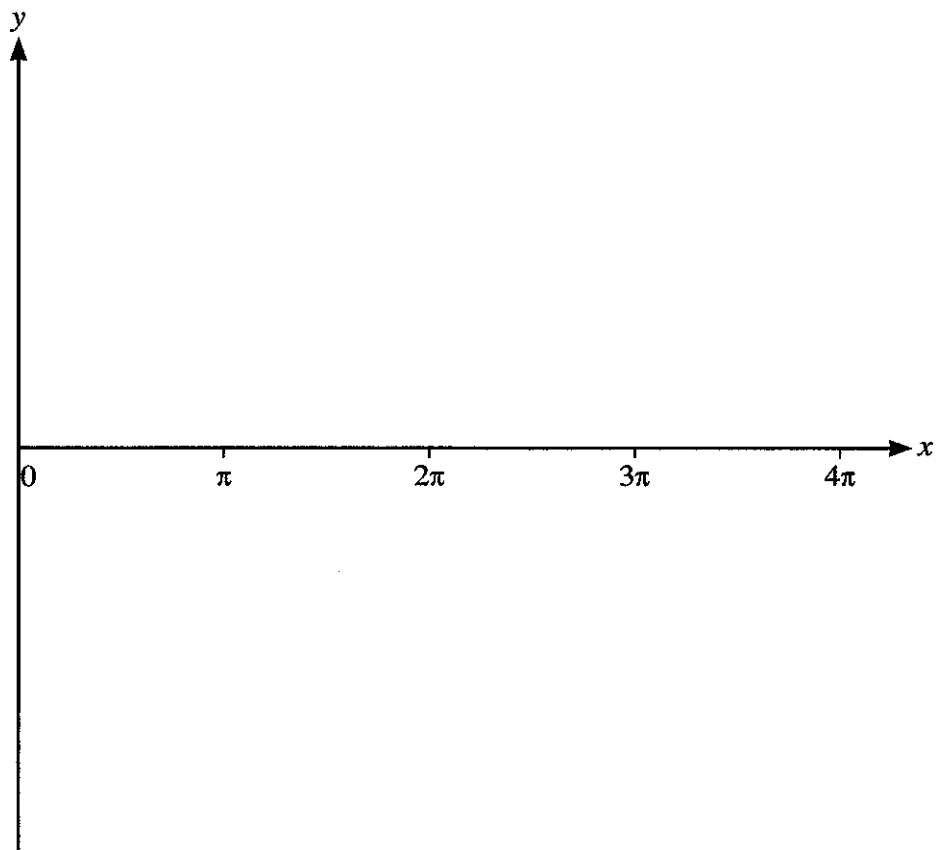
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(b) Sketch the curve.

[2]



(c) State the number of solutions of the equation

$$2 + 3 \sin \frac{1}{2}x = 5 - 2x$$

for $0 \leq x \leq 4\pi$.

[1]

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- 8** The functions f and g are defined as follows, where a and b are constants.

$$f(x) = 1 + \frac{2a}{x-a} \text{ for } x > a$$

$$g(x) = bx - 2 \text{ for } x \in \mathbb{R}$$

- (a) Given that $f(7) = \frac{5}{2}$ and $gf(5) = 4$, find the values of a and b . [4]

[illegible]

For the rest of this question, you should use the value of a which you found in (a).

(b) Find the domain of f^{-1} .

[1]

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(c) Find an expression for $f^{-1}(x)$.

[3]

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- * 9 Water is poured into a tank at a constant rate of 500 cm^3 per second. The depth of water in the tank, t seconds after filling starts, is h cm. When the depth of water in the tank is h cm, the volume, $V \text{ cm}^3$, of water in the tank is given by the formula $V = \frac{4}{3}(25 + h)^3 - \frac{62500}{3}$.

(a) Find the rate at which h is increasing at the instant when $h = 10$ cm. [3]

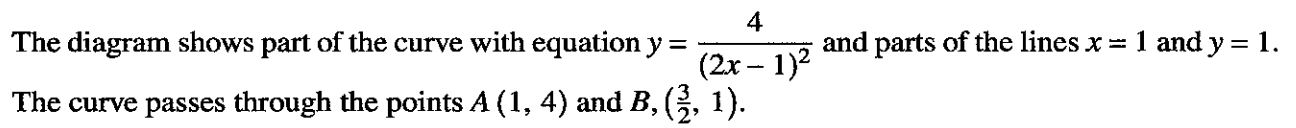
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- * (b) At another instant, the rate at which h is increasing is 0.075 cm per second.

Find the value of V at this instant.

[3]

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.



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- (b) A triangle is formed from the tangent to the curve at B , the normal to the curve at B and the x -axis.

Find the area of this triangle.

[6]

[illegible]

- 11** The equation of a curve is such that $\frac{dy}{dx} = 6x^2 - 30x + 6a$, where a is a positive constant. The curve has a stationary point at $(a, -15)$.

(a) Find the value of a . [2]

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(b) Determine the nature of this stationary point. [2]

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* (c) Find the equation of the curve.

[3]

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* (d) Find the coordinates of any other stationary points on the curve.

[2]

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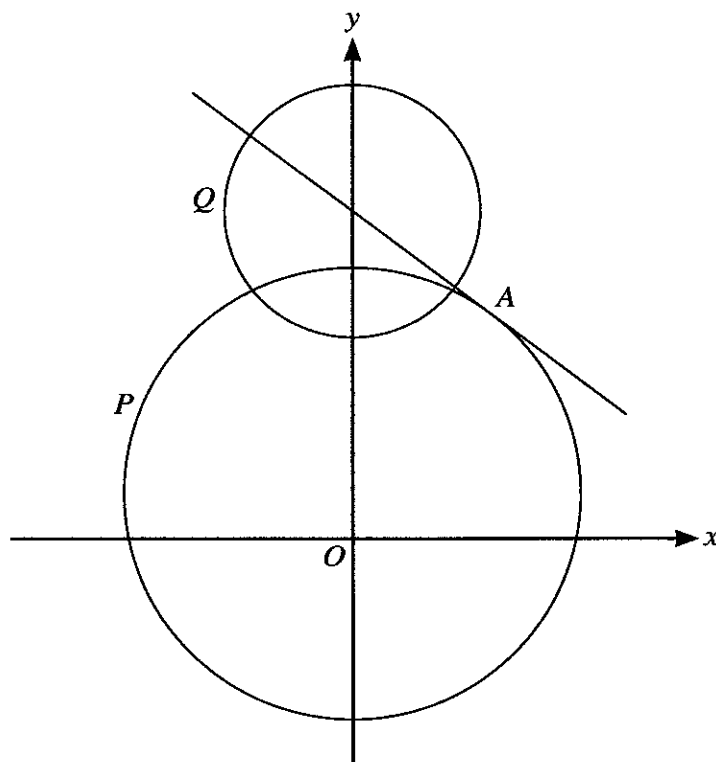
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The diagram shows a circle P with centre $(0, 2)$ and radius 10 and the tangent to the circle at the point A with coordinates $(6, 10)$. It also shows a second circle Q with centre at the point where this tangent meets the y -axis and with radius $\frac{5}{2}\sqrt{5}$.

- (a) Write down the equation of circle P . [1]

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- (b) Find the equation of the tangent to the circle P at A . [2]

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- (c) Find the equation of circle Q and hence verify that the y -coordinates of both of the points of intersection of the two circles are 11. [3]

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- (d) Find the coordinates of the points of intersection of the tangent and circle Q , giving the answers in surd form. [3]

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[illegible]

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- 1 (a) Express $3y^2 - 12y - 15$ in the form $3(y + a)^2 + b$, where a and b are constants. [2]

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- (b) Hence find the exact solutions of the equation $3x^4 - 12x^2 - 15 = 0$. [3]

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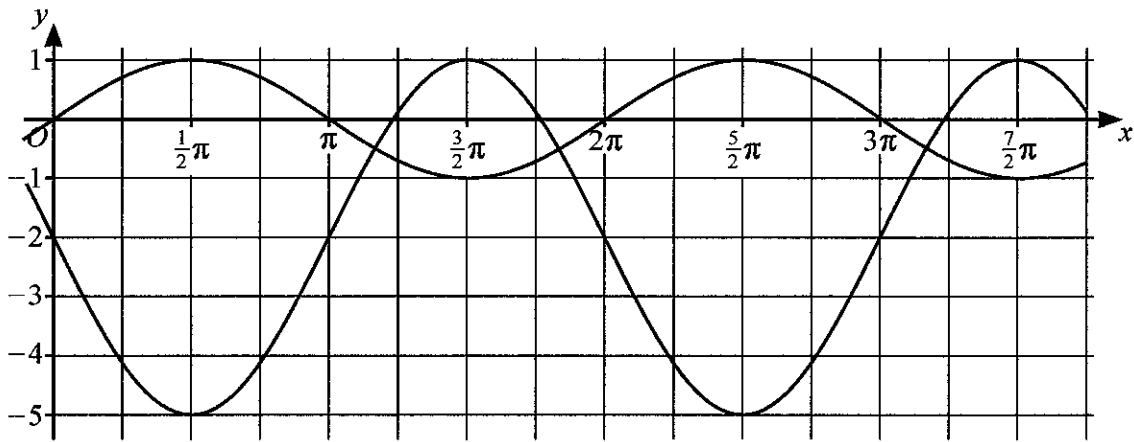
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The diagram shows two curves. One curve has equation $y = \sin x$ and the other curve has equation $y = f(x)$.

- (a) In order to transform the curve $y = \sin x$ to the curve $y = f(x)$, the curve $y = \sin x$ is first reflected in the x -axis.

Describe fully a sequence of two further transformations which are required.

[4]

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- (b) Find $f(x)$ in terms of $\sin x$.

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3 The coefficient of x^3 in the expansion of $(3+ax)^6$ is 160.

(a) Find the value of the constant a .

[2]

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(b) Hence find the coefficient of x^3 in the expansion of $(3+ax)^6(1-2x)$.

[3]

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- 4 The equation of a curve is $y = f(x)$, where $f(x) = (2x - 1)\sqrt{3x - 2} - 2$. The following points lie on the curve. Non-exact values have been given correct to 5 decimal places.

$A(2, 4)$, $B(2.0001, k)$, $C(2.001, 4.00625)$, $D(2.01, 4.06261)$, $E(2.1, 4.63566)$, $F(3, 11.22876)$

- (a) Find the value of k . Give your answer correct to 5 decimal places. [1]

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The table shows the gradients of the chords AB , AC , AD and AF .

Chord	AB	AC	AD	AE	AF
Gradient of chord	6.2501	6.2511	6.2608		7.2288

- (b) Find the gradient of the chord AE . Give your answer correct to 4 decimal places. [1]

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- (c) Deduce the value of $f'(2)$ using the values in the table. [1]

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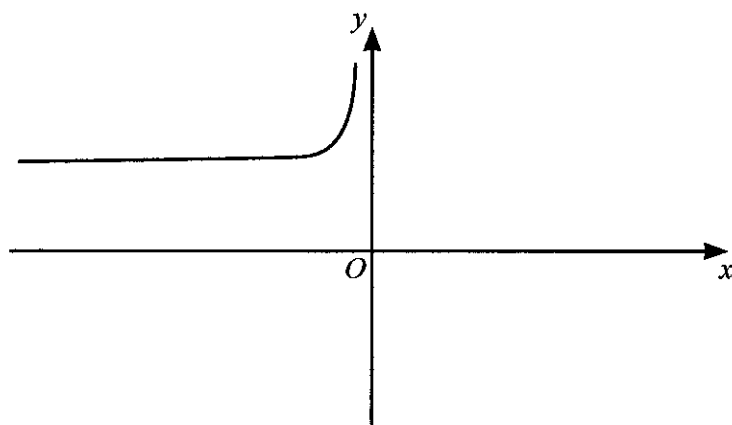
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(b) Hence solve the equation $\frac{\sin^2 x - \cos x - 1}{2 + 2 \cos x} = \frac{1}{4}$ for $0^\circ \leq x \leq 360^\circ$. [3]

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The function f is defined by $f(x) = \frac{2}{x^2} + 4$ for $x < 0$. The diagram shows the graph of $y = f(x)$.

(a) On this diagram, sketch the graph of $y = f^{-1}(x)$. Show any relevant mirror line. [2]

(b) Find an expression for $f^{-1}(x)$. [3]

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(c) Solve the equation $f(x) = 4.5$. [1]

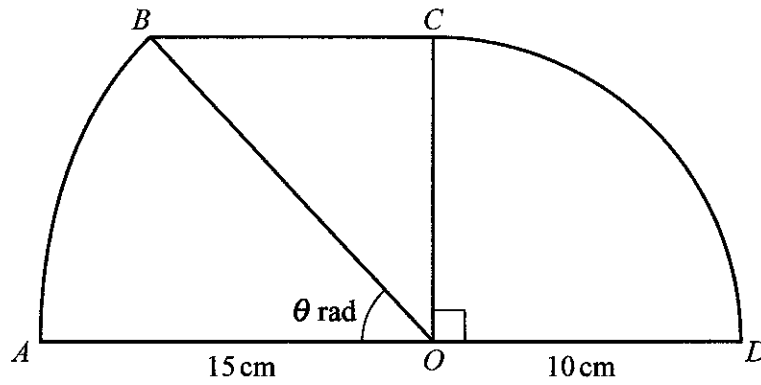
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(d) Explain why the equation $f^{-1}(x) = f(x)$ has no solution. [1]

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In the diagram, AOD and BC are two parallel straight lines. Arc AB is part of a circle with centre O and radius 15 cm . Angle $BOA = \theta$ radians. Arc CD is part of a circle with centre O and radius 10 cm . Angle $COD = \frac{1}{2}\pi$ radians.

- (a) Show that $\theta = 0.7297$, correct to 4 decimal places.

[1]

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- (b) Find the perimeter and the area of the shape $ABCD$. Give your answers correct to 3 significant figures.

[7]

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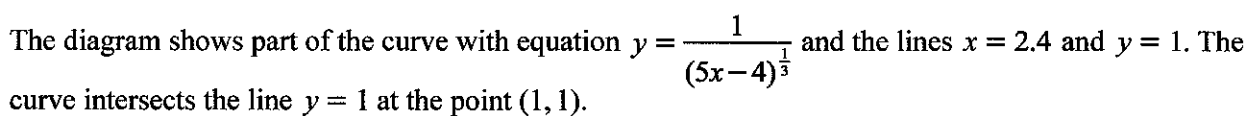
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- 8 (a) The first three terms of an arithmetic progression are 25 , $4p-1$ and $13-p$, where p is a constant.

Find the value of the tenth term of the progression.

[4]

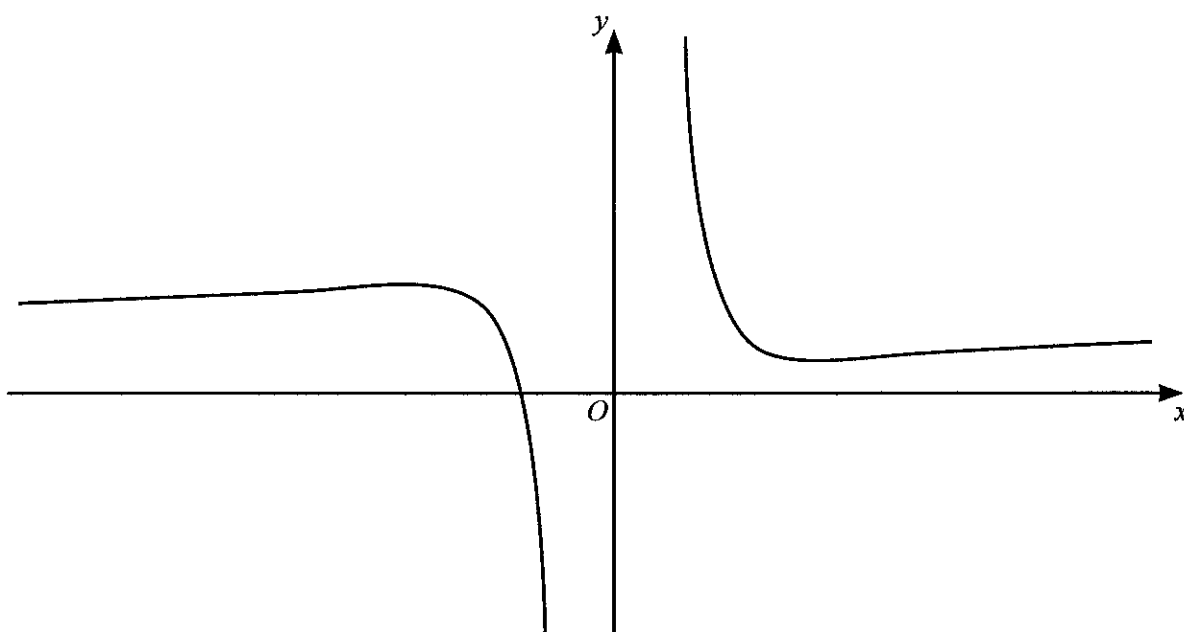
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[illegible]

- 10** The equation of a circle is $(x-3)^2 + y^2 = 18$. The line with equation $y = mx + c$ passes through the point $(0, -9)$ and is a tangent to the circle.

Find the two possible values of m and, for each value of m , find the coordinates of the point at which the tangent touches the circle. [8]

[illegible]



(a) Find the set of values of x for which $f(x)$ is decreasing.

[5]

[illegible]

- (b) A triangle is bounded by the y -axis, the normal to the curve at the point where $x = 1$ and the tangent to the curve at the point where $x = -1$.

Find the area of the triangle. Give your answer correct to 3 significant figures.

[8]

[illegible]

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