1. Nov 2025 paper 11 question 11

A curve passes through the point $P(4, 3)$ and is such that

$$\frac{dy}{dx} = \frac{8}{x^2} - \frac{10}{(2x-3)^2}.$$

(b) Find the rate of change of the gradient of the curve when $x = 4$. [3]

(c) Given that the curve also passes through the point $(-1, q)$, find the value of q. [5]

.....

.....

.....

.....

.....

.....

.....

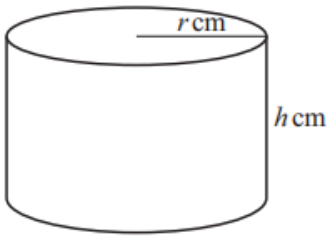
.....

.....

.....

.....

2. Nov 2025 paper 15 question 7



A manufacturer wishes to design an open cylindrical tank, as shown in the diagram. The tank will have a base but no top. The outside of the tank will have a fixed surface area of $600\pi\,\text{cm}^2$. The radius r cm and height h cm of the tank can vary.

(a) Show that the volume, $V\,\text{cm}^3$, of the tank is given by

$$V = \frac{\pi r(600 - r^2)}{2}.$$

[3]

(b) Find the exact value of r which corresponds to the maximum value of V. [3]

(c) Hence, find the maximum value of V. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

3. May 2025 paper 11 question 7

The equation of a curve is $y = 4x^2 + \frac{9}{x^2} - 8$.

(a) A point P is moving along the curve in such a way that its y-coordinate is decreasing at 5 units per second.

Find the rate at which the x-coordinate of point P is changing when $x = 2$. [4]

.....

.....

.....

.....

.....

.....

.....

.....

(b) Find the coordinates of the stationary points of the curve and determine their nature. [5]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

4. May 2025 paper 12 question 4

A point P is moving along the curve with equation $y = ax^{\frac{3}{2}} - 12x$ in such a way that the x-coordinate of P is increasing at a constant rate of 5 units per second.

(a) Find the rate at which the y-coordinate of P is changing when $x = 9$. Give your answer in terms of the constant a. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Given that the curve has a minimum point when $x = \frac{1}{4}$, find the value of a. [2]

.....

.....

.....

.....

.....

.....

.....

.....

5. May 2025 paper 13 question 7

A curve is such that $\frac{dy}{dx} = 3x^2 + 10x - 8$.

(a) Find the set of values of x for which y decreases as x increases. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) It is given that the maximum point of the curve has y-coordinate 27.

Find the equation of the curve. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

6. May 2025 paper 15 question 8

The equation of a curve is $y = x^3 + ax^2 + bx + 5$. The curve has a stationary point at (1, 9).

(a) Find the values of the constants a and b. [5]

(b) Find the coordinates of the other stationary point. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) A point P is moving along part of the curve in such a way that the y-coordinate of P is increasing at a constant rate of 6 units per second.

Find the rate at which the x-coordinate of P is increasing when $x = 5$. [3]

.....

.....

.....

.....

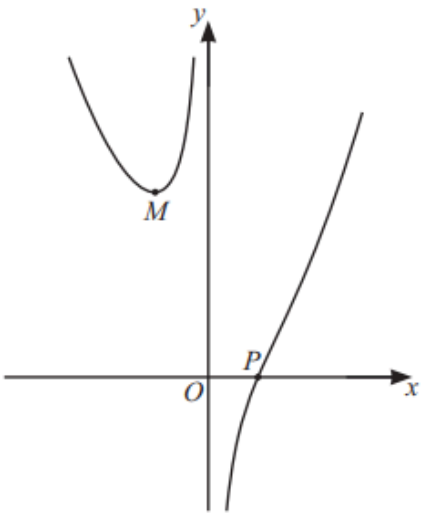
.....

.....

.....

.....

7. March 2025 paper 12 question 2



The diagram shows the curve with equation $y = 2x^2 - \frac{5}{x} + 3$. The curve crosses the x-axis at the point $P(1,0)$ and M is a minimum point.

(a) Find the gradient of the curve at P. [2]

.....

.....

.....

8. March 2025 paper 12 question 9

A curve is such that $\frac{d^2y}{dx^2} = \frac{6}{x^4} - \frac{5}{x^3}$. It is given that the curve has a stationary point at $\left(\frac{1}{2}, 9\right)$.

(a) Use the expression for $\frac{d^2y}{dx^2}$ to determine whether the stationary point is a maximum or a minimum point. [2]

.....

.....

.....

.....

(b) Find the equation of the curve. [7]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

9. Nov 2024 paper 11 question 2

The curve $y = x^2 - \frac{a}{x}$ has a stationary point at $(-3, b)$.

Find the values of the constants a and b. [4]

10. Nov 2024 paper 11 question 9

The equation of a curve is $y = 4 + 5x + 6x^2 - 3x^3$.

(a) Find the set of values of x for which y decreases as x increases. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) It is given that $y = 9x + k$ is a tangent to the curve.

Find the value of the constant k. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

11. Nov 2024 paper 13 question 10

The equation of a curve is $y = kx^{\frac{1}{2}} - 4x^2 + 2$, where k is a constant.

(a) Find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$ in terms of k. [2]

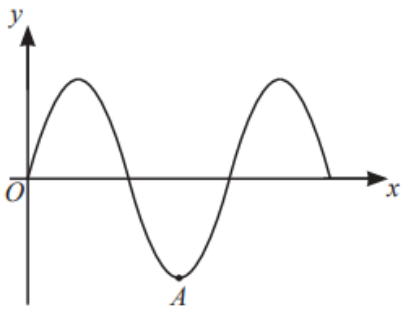
(b) It is given that $k = 2$.

Find the coordinates of the stationary point and determine its nature. [4]

(c) Points A and B on the curve have x-coordinates 0.25 and 1 respectively. For a different value of k, the tangents to the curve at the points A and B meet at a point with x-coordinate 0.6.

Find this value of k. [6]

12. March 2024 paper 12 question 2



The diagram shows part of the curve with equation $y = k \sin \frac{1}{2}x$, where k is a positive constant and x is measured in radians. The curve has a minimum point A.

(a) State the coordinates of A. [1]

.....

.....

.....

.....

.....

(b) A sequence of transformations is applied to the curve in the following order.

Translation of 2 units in the negative y-direction

Reflection in the x-axis

Find the equation of the new curve and determine the coordinates of the point on the new curve corresponding to A. [3]

.....

.....

.....

.....

.....

.....

.....

.....

13. May 2024 paper 12 question 6

The curve with equation $y = 2x - 8x^{\frac{1}{2}}$ has a minimum point at A and intersects the positive x-axis at B.

(a) Find the coordinates of A and B. [4]

14. May 2024 paper 12 question 9

A function f is such that $f'(x) = 6(2x-3)^2 - 6x$ for $x \in \mathbb{R}$.

(a) Determine the set of values of x for which $f(x)$ is decreasing. [4]

(b) Given that $f(1) = -1$, find $f(x)$. [4]

15. May 2024 paper 12 question 10

The equation of a curve is $y = (5-2x)^{\frac{3}{2}} + 5$ for $x < \frac{5}{2}$.

(a) A point P is moving along the curve in such a way that the y-coordinate of point P is decreasing at 5 units per second.

Find the rate at which the x-coordinate of point P is increasing when $y = 32$. [4]

(b) Point A on the curve has y-coordinate 32. Point B on the curve is such that the gradient of the curve at B is -3.

Find the equation of the perpendicular bisector of AB. Give your answer in the form $ax+by+c=0$, where a, b and c are integers. [6]

16. May 2024 paper 13 question 5

The equation of a curve is $y = 2x^2 - \frac{1}{2x} + 3$.

(a) Find the coordinates of the stationary point. [3]

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

(c) For positive values of x, determine whether the curve shows a function that is increasing, decreasing or neither. Give a reason for your answer. [2]

.....

.....

.....

.....

.....

.....

.....

17. Nov 2023 paper 12 question 6

The equation of a curve is $y = x^2 - 8x + 5$.

(a) Find the coordinates of the minimum point of the curve. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

The curve is stretched by a factor of 2 parallel to the y-axis and then translated by $\begin{pmatrix} 4 \\ 1 \end{pmatrix}$.

(b) Find the coordinates of the minimum point of the transformed curve. [2]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Find the equation of the transformed curve. Give the answer in the form $y = ax^2 + bx + c$, where a, b and c are integers to be found. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

18. Nov 2023 paper 12 question 10

The equation of a curve is $y = f(x)$, where $f(x) = (4x - 3)^{\frac{5}{3}} - \frac{20}{3}x$.

(a) Find the x-coordinates of the stationary points of the curve and determine their nature. [6]

(b) State the set of values for which the function f is increasing. [1]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

19. Nov 2023 paper 13 question 9

A curve has equation $y = 2x^{\frac{1}{2}} - 1$.

(a) Find the equation of the normal to the curve at the point $A\,(4,\ 3)$, giving your answer in the form $y = mx + c$. [3]

.....

.....

.....

.....

.....

.....

.....

A point is moving along the curve $y = 2x^{\frac{1}{2}} - 1$ in such a way that at A the rate of increase of the x-coordinate is $3\,\text{cm}\,\text{s}^{-1}$.

(b) Find the rate of increase of the y-coordinate at A. [2]

.....

.....

.....

.....

At A the moving point suddenly changes direction and speed, and moves down the normal in such a way that the rate of decrease of the y-coordinate is constant at $5\,\text{cm}\,\text{s}^{-1}$.

(c) As the point moves down the normal, find the rate of change of its x-coordinate. [3]

.....

.....

.....

.....

.....

.....

.....

20. March 2023 paper 12 question 3

A curve has equation $y = \frac{1}{60}(3x + 1)^2$ and a point is moving along the curve.

Find the x-coordinate of the point on the curve at which the x- and y-coordinates are increasing at the same rate. [4]

21. May 2023 paper 11 question 9

Water is poured into a tank at a constant rate of $500\,\text{cm}^3$ 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]

(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]

22. May 2023 paper 12 question 11

The equation of a curve is

$$y = k\sqrt{4x+1} - x + 5,$$

where k is a positive constant.

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

(b) Find the x-coordinate of the stationary point in terms of k. [2]

(c) Given that $k = 10.5$, find the equation of the normal to the curve at the point where the tangent to the curve makes an angle of $\tan^{-1}(2)$ with the positive x-axis. [4]

23. Nov 2022 paper 11 question 3

A curve has equation $y = ax^{\frac{1}{2}} - 2x$, where $x > 0$ and a is a constant. The curve has a stationary point at the point P, which has x-coordinate 9.

Find the y-coordinate of P. [5]

24. Nov 2022 paper 11 question 8

The function f is defined by $f(x) = 2 - \frac{3}{4x-p}$ for $x > \frac{p}{4}$, where p is a constant.

(a) Find $f'(x)$ and hence determine whether f is an increasing function, a decreasing function or neither. [3]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(b) Express $f^{-1}(x)$ in the form $\frac{p}{a} - \frac{b}{cx-d}$, where a, b, c and d are integers. [4]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(c) Hence state the value of p for which $f^{-1}(x) \equiv f(x)$. [1]

.....

.....

.....