# Differentiation 1

Q1.

The equation of a curve is $y = \frac{1}{6}(2x-3)^3 - 4x$.

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

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

**(iii)** Find the set of values of $x$ for which $\frac{1}{6}(2x-3)^3 - 4x$ is an increasing function of $x$. [3]

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Q2.

The equation of a curve is such that $\frac{dy}{dx} = \frac{6}{\sqrt{(3x-2)}}$. Given that the curve passes through the point $P\,(2, 11)$, find

**(i)** the equation of the normal to the curve at $P$, [3]

**(ii)** the equation of the curve. [4]

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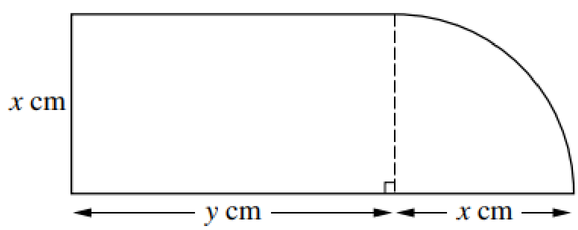
Q3.




The diagram shows a metal plate consisting of a rectangle with sides $x$ cm and $y$ cm and a quarter-circle of radius $x$ cm. The perimeter of the plate is 60 cm.

**(i)** Express $y$ in terms of $x$. [2]

**(ii)** Show that the area of the plate, $A\ \text{cm}^2$, is given by $A = 30x - x^2$. [2]

Given that $x$ can vary,

**(iii)** find the value of $x$ at which $A$ is stationary, [2]

**(iv)** find this stationary value of $A$, and determine whether it is a maximum or a minimum value. [2]

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Q4.

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

**(i)** Show that the equation of the normal to the curve at the point (3, 6) is $2y = x + 9$. [4]

**(ii)** Given that the normal meets the coordinate axes at points $A$ and $B$, find the coordinates of the mid-point of $AB$. [2]

**(iii)** Find the coordinates of the point at which the normal meets the curve again. [4]

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Q5.

The equation of a curve is $y = \dfrac{9}{2 - x}$.

**(i)** Find an expression for $\dfrac{dy}{dx}$ and determine, with a reason, whether the curve has any stationary points. [3]

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Q6.

The length, $x$ metres, of a Green Anaconda snake which is $t$ years old is given approximately by the formula

$$x = 0.7\sqrt{(2t - 1)},$$

where $1 \leqslant t \leqslant 10$. Using this formula, find

**(i)** $\dfrac{dx}{dt}$, [2]

**(ii)** the rate of growth of a Green Anaconda snake which is 5 years old. [2]

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Q7.

A curve has equation $y = \dfrac{1}{x - 3} + x$.

**(i)** Find $\dfrac{dy}{dx}$ and $\dfrac{d^2y}{dx^2}$. [2]

**(ii)** Find the coordinates of the maximum point $A$ and the minimum point $B$ on the curve. [5]

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Q8.

A curve has equation $y = \mathrm{f}(x)$. It is given that $\mathrm{f}'(x) = 3x^2 + 2x - 5$.

**(i)** Find the set of values of $x$ for which f is an increasing function. [3]

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Q9.

The volume of a spherical balloon is increasing at a constant rate of $50\,\text{cm}^3$ per second. Find the rate of increase of the radius when the radius is 10 cm. [Volume of a sphere = $\frac{4}{3}\pi r^3$.] [4]

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Q10.

A curve has equation $y = \dfrac{4}{3x - 4}$ and $P\,(2, 2)$ is a point on the curve.

**(i)** Find the equation of the tangent to the curve at $P$. [4]

**(ii)** Find the angle that this tangent makes with the $x$-axis. [2]

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Q11.

A curve is such that $\dfrac{\mathrm{d}y}{\mathrm{d}x} = \dfrac{2}{\sqrt{x}} - 1$ and $P\,(9, 5)$ is a point on the curve.

**(ii)** Find the coordinates of the stationary point on the curve. [3]

**(iii)** Find an expression for $\dfrac{\mathrm{d}^2y}{\mathrm{d}x^2}$ and determine the nature of the stationary point. [2]

**(iv)** The normal to the curve at $P$ makes an angle of $\tan^{-1} k$ with the positive $x$-axis. Find the value of $k$. [2]

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Q12.

A curve has equation $y = 3x^3 - 6x^2 + 4x + 2$. Show that the gradient of the curve is never negative. [3]

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