**1.**

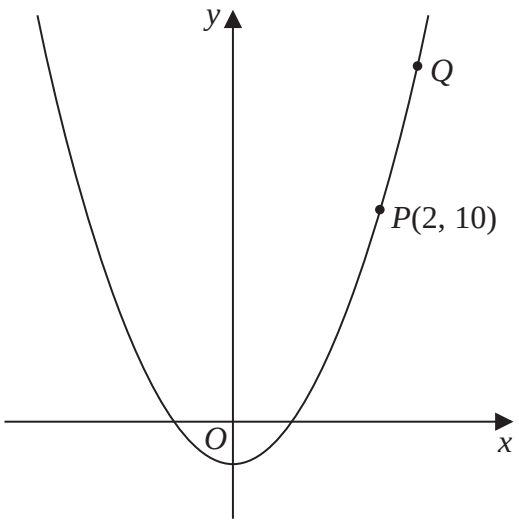


**Figure 1**

Figure 1 shows part of the curve with equation $y = 3x^2 - 2$

The point $P(2, 10)$ lies on the curve.

(a) Find the gradient of the tangent to the curve at $P$.

**(2)**

The point $Q$ with $x$ coordinate $2 + h$ also lies on the curve.

(b) Find the gradient of the line $PQ$, giving your answer in terms of $h$ in simplest form.

**(3)**

(c) Explain briefly the relationship between part (b) and the answer to part (a).

**(1)**

**2.**

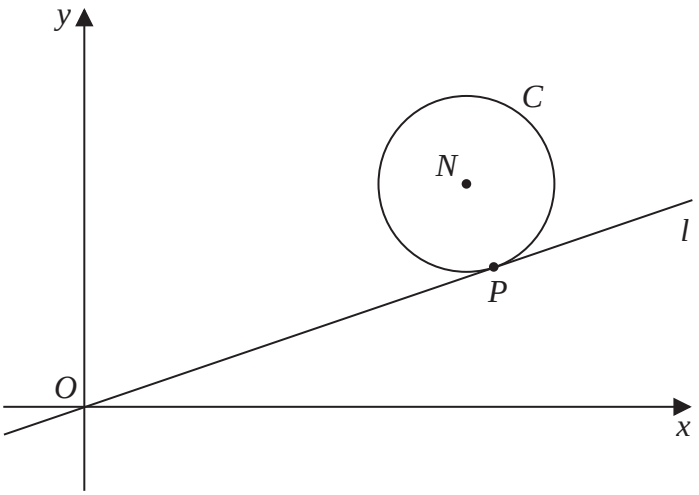


**Figure 4**

Figure 4 shows a sketch of a circle $C$ with centre $N(7, 4)$

The line $l$ with equation $y = \frac{1}{3}x$ is a tangent to $C$ at the point $P$.

Find

(a) the equation of line $PN$ in the form $y = mx + c$, where $m$ and $c$ are constants,

**(2)**

(b) an equation for $C$.

**(4)**

The line with equation $y = \frac{1}{3}x + k$, where $k$ is a non-zero constant, is also a tangent to $C$.

(c) Find the value of $k$.

**(3)**

**3.** **In this question you should show all stages of your working.**

**Solutions relying entirely on calculator technology are not acceptable.**

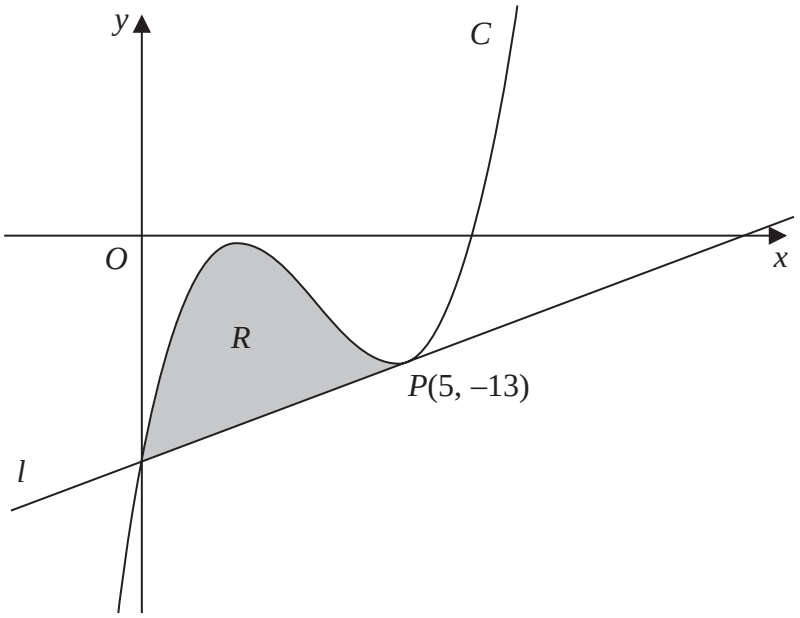


**Figure 2**

Figure 2 shows a sketch of part of the curve $C$ with equation

$$y = x^3 - 10x^2 + 27x - 23$$

The point $P(5, -13)$ lies on $C$

The line $l$ is the tangent to $C$ at $P$

(a) Use differentiation to find the equation of $l$, giving your answer in the form $y = mx + c$ where $m$ and $c$ are integers to be found.

**(4)**

(b) Hence verify that $l$ meets $C$ again on the $y$-axis.

**(1)**

The finite region $R$, shown shaded in Figure 2, is bounded by the curve $C$ and the line $l$.

(c) Use algebraic integration to find the exact area of $R$.

**(4)**

**4.** The curve $C$ has equation

$$px^3 + qxy + 3y^2 = 26$$

where $p$ and $q$ are constants.

(a) Show that

$$\frac{dy}{dx} = \frac{apx^2 + bqy}{qx + cy}$$

where $a$, $b$ and $c$ are integers to be found.

**(4)**

Given that

- the point $P(-1, -4)$ lies on $C$
- the normal to $C$ at $P$ has equation $19x + 26y + 123 = 0$

(b) find the value of $p$ and the value of $q$.

**(5)**

**5.** The curve $C$ has parametric equations

$$x = \sin 2\theta \qquad y = \text{cosec}^3 \theta \qquad 0 < \theta < \frac{\pi}{2}$$

(a) Find an expression for $\frac{dy}{dx}$ in terms of $\theta$

**(3)**

(b) Hence find the exact value of the gradient of the tangent to $C$ at the point where $y = 8$

**(3)**

**6.** **In this question you must show all stages of your working.**

**Solutions relying entirely on calculator technology are not acceptable.**

The curve $C$ has equation $y = f(x)$ where $x \in \mathbb{R}$

Given that

- $f'(x) = 2x + \frac{1}{2}\cos x$
- the curve has a stationary point with $x$ coordinate $\alpha$
- $\alpha$ is small

(a) use the small angle approximation for $\cos x$ to estimate the value of $\alpha$ to 3 decimal places.

**(3)**

The point $P(0, 3)$ lies on $C$

(b) Find the equation of the tangent to the curve at $P$, giving your answer in the form $y = mx + c$, where $m$ and $c$ are constants to be found.

**(2)**

**7.** **In this question you must show all stages of your working.**

**Solutions relying on calculator technology are not acceptable.**

A curve has equation

$$x^3 + 2xy + 3y^2 = 47$$

(a) Find $\frac{dy}{dx}$ in terms of $x$ and $y$

**(4)**

The point $P(-2, 5)$ lies on the curve.

(b) Find the equation of the normal to the curve at $P$, giving your answer in the form $ax + by + c = 0$, where $a$, $b$ and $c$ are integers to be found.

**(3)**