Please check the examination details below before entering your candidate information

Candidate surname: Solved by Mr. Pabitra | Other names:

Centre Number | Candidate Number

# Pearson Edexcel International Advanced Level

## Friday 8 May 2026

Morning (Time: 1 hour 30 minutes)

Paper reference **WMA11/01**

# Mathematics

## International Advanced Subsidiary/Advanced Level
## Pure Mathematics P1

**You must have:**
Mathematical Formulae and Statistical Tables (Yellow), calculator

Total Marks

**Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for symbolic algebra manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.**

### Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Inexact answers should be given to three significant figures unless otherwise stated.

### Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 10 questions in this question paper. The total mark for this paper is 75.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

### Advice

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- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

*Turn over* ▶



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**1.** Find

$$\int \left(3x + \frac{2}{x}\right)^2 \mathrm{d}x$$

giving the answer in simplest form.

**(5)**

Expand first: $(3x + \frac{2}{x})^2 = 9x^2 + 2 \times 3x \times \frac{2}{x} + \frac{4}{x^2} = 9x^2 + 12 + 4x^{-2}$

$\int (9x^2 + 12 + 4x^{-2})\, dx = \frac{9x^3}{3} + 12x + \frac{4x^{-1}}{-1} + c$

$$= 3x^3 + 12x - \frac{4}{x} + c$$

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**Question 1 continued**

**(Total for Question 1 is 5 marks)**

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**2.** The line $l_1$ has equation $y = 10 - 3x$

The line $l_2$

- is perpendicular to $l_1$
- intersects $l_1$ at the point $P$ with $x$ coordinate 4

(a) Find an equation for $l_2$ writing the answer in the form $ax + by + c = 0$, where $a$, $b$ and $c$ are integers.

**(3)**

Given that

- line $l_1$ cuts the $y$-axis at the point $M$
- line $l_2$ cuts the $y$-axis at the point $N$

(b) find the area of triangle $MPN$, making your method clear.

**(3)**

(a) Gradient of $l_1 = -3$, so gradient of $l_2 = \frac{1}{3}$ (perpendicular: $m_1 m_2 = -1$)

At $x = 4$: $y = 10 - 3 \times 4 = -2$, $P = (4, -2)$

$l_2$: $y + 2 = \frac{1}{3}(x - 4)$

$3y + 6 = x - 4$

$\boxed{x - 3y - 10 = 0}$

(b) M: $x = 0$ in $l_1$: $y = 10$, $M = (0, 10)$

N: $x = 0$ in $l_2$: $-3y - 10 = 0$, $y = -\frac{10}{3}$, $N = (0, -\frac{10}{3})$

MN lies on the y-axis: $MN = 10 + \frac{10}{3} = \frac{40}{3}$ (base)

Height = perpendicular distance from P to the y-axis = 4

Area $= \frac{1}{2} \times \frac{40}{3} \times 4$

$\boxed{\text{Area of } MPN = \frac{80}{3}}$

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**Question 2 continued**

**(Total for Question 2 is 6 marks)**

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**3.** A triangular plot of land, $ABC$, has area $60\ \text{m}^2$

Given

- $AB = 15\ \text{m}$
- $AC = 10\ \text{m}$
- angle $BAC = \theta°$

(a) show that $\sin\theta° = \frac{4}{5}$

**(1)**

Given also that $\theta°$ is the **largest** angle in the triangle,

(b) find the length of the side $BC$, in metres, to 3 significant figures,

**(3)**

(c) find the size of the **smallest** angle in the triangle, in degrees, to one decimal place.

**(2)**

(a) Area $= \frac{1}{2} \times AB \times AC \times \sin\theta°$

$60 = \frac{1}{2} \times 15 \times 10 \times \sin\theta° = 75 \sin\theta°$

$\sin\theta° = \frac{60}{75} = \frac{4}{5}$ as required

(b) $\theta$ is the largest angle, so it is obtuse: $\theta = 180 - 53.13... = 126.87...°$

$\cos\theta° = -\frac{3}{5}$

$BC^2 = 15^2 + 10^2 - 2 \times 15 \times 10 \times \cos\theta° = 225 + 100 + 180 = 505$

$BC = \sqrt{505} = 22.47...$

$BC = 22.5\ \text{m}$ (3 s.f.)

(c) Smallest angle is opposite the shortest side $AC = 10$, i.e. angle $ABC$

$\frac{\sin B}{10} = \frac{\sin\theta°}{\sqrt{505}}$ $\sin B = \frac{10 \times 0.8}{22.47...} = 0.35599...$

$B = 20.854...°$

Smallest angle $= 20.9°$

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**Question 3 continued**

**(Total for Question 3 is 6 marks)**

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**4.** **In this question you must show all stages of your working.**
**Solutions relying on calculator technology are not acceptable.**

$$f(x) = x^3 - 2x^2\sqrt{x} + 14 \qquad x > 0$$

(a) Solve the equation

$$f'(x) = 0$$

**(5)**

(b) (i) Show that the equation

$$f''(x) = 66$$

can be written as

$$4x - 5x^{\frac{1}{2}} - 44 = 0$$

(ii) Hence, using algebra, show that $x = 16$ is the only solution of the equation

$$f''(x) = 66$$

**(5)**

(a) $f(x) = x^3 - 2x^2\sqrt{x} + 14 = x^3 - 2x^{5/2} + 14$

$f'(x) = 3x^2 - 2 \times \frac{5}{2}x^{3/2} = 3x^2 - 5x^{3/2}$

$f'(x) = 0$: $3x^2 - 5x^{3/2} = 0$

$x^{3/2}(3x^{1/2} - 5) = 0$

$x > 0$, so $x^{3/2} \neq 0$: $3\sqrt{x} = 5$, $\sqrt{x} = \frac{5}{3}$

$\boxed{x = \frac{25}{9}}$

(b)(i) $f''(x) = 6x - 5 \times \frac{3}{2}x^{1/2} = 6x - \frac{15}{2}x^{1/2}$

$f''(x) = 66$: $6x - \frac{15}{2}x^{1/2} = 66$

Multiply by $\frac{2}{3}$: $4x - 5x^{1/2} = 44$

$4x - 5x^{1/2} - 44 = 0$ as required

(b)(ii) Let $u = x^{1/2}$: $4u^2 - 5u - 44 = 0$

$(4u + 11)(u - 4) = 0$

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**Question 4 continued**

$u = 4$ or $u = -\frac{11}{4}$

$u = x^{1/2} = \sqrt{x}$ cannot be negative, so $u = -\frac{11}{4}$ is rejected

$\sqrt{x} = 4$, $x = 16$, so $x = 16$ is the only solution.

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**Question 4 continued**

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**Question 4 continued**

**(Total for Question 4 is 10 marks)**

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

$$y = -2x^2 + 12x + 7$$

(a) Write $-2x^2 + 12x + 7$ in the form $a(x + b)^2 + c$, where $a$, $b$ and $c$ are constants.

**(3)**

The point $P$ is the maximum point on $C$.

(b) Find the coordinates of $P$.

**(2)**

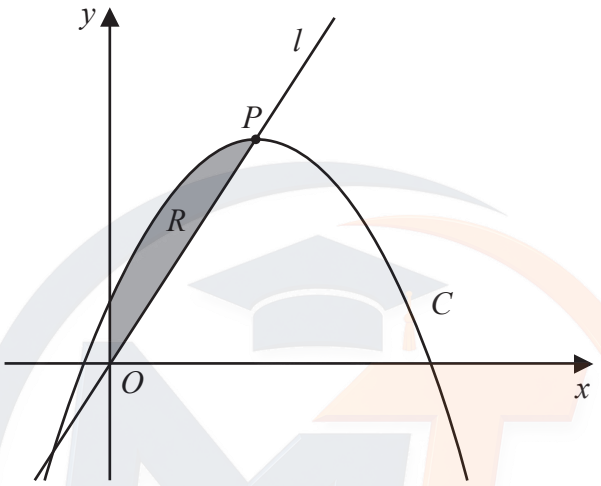



**Figure 1**

Figure 1 shows a sketch of the curve $C$ and a line $l$.

The line $l$ passes through the point $P$ and the origin $O$.

The region $R$, shown shaded in Figure 1, is bounded by $C$, $l$ and the $y$-axis.

(c) Use inequalities to define $R$.

**(2)**

(a) $-2x^2 + 12x + 7 = -2(x^2 - 6x) + 7$

$= -2[(x - 3)^2 - 9] + 7 = -2(x - 3)^2 + 18 + 7$

$= -2(x - 3)^2 + 25$ $\quad (a = -2, b = -3, c = 25)$

(b) Maximum when $(x - 3)^2 = 0$: $x = 3$, $y = 25$

$P = (3, 25)$

(c) $l$ through $O(0, 0)$ and $P(3, 25)$: $y = \frac{25}{3}x$

$R$ is right of the $y$-axis, above $l$ and below $C$:

$x \geq 0, \quad y \geq \frac{25}{3}x, \quad y \leq -2x^2 + 12x + 7$

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**Question 5 continued**

**(Total for Question 5 is 7 marks)**

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**6.**

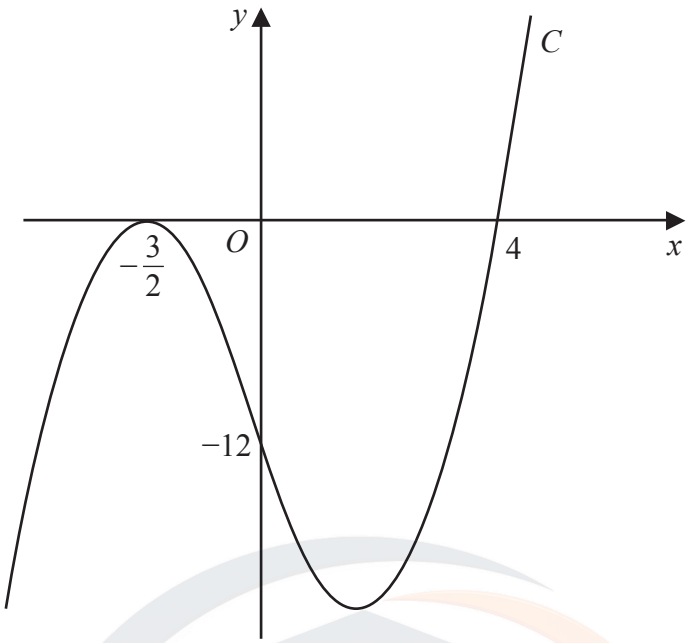



**Figure 2**

Figure 2 shows a sketch of the curve $C$ with equation $y = f(x)$.

The curve $C$

- touches the $x$-axis at $-\frac{3}{2}$
- cuts the $x$-axis at 4
- cuts the $y$-axis at $-12$

Given that $f(x)$ is a cubic function,

(a) find $f(x)$. You may leave the answer in a factorised form.

**(3)**

The line with equation $y = 2x - 12$ cuts $C$ at $(0, -12)$ and at two further points, $P$ and $Q$.

(b) Use algebra to find the exact $x$ coordinates of $P$ and $Q$.
Give each answer in simplest form.

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

**(4)**

(a) Touches the x-axis at $-\frac{3}{2}$ (repeated root), cuts at 4:

$f(x) = k(2x + 3)^2(x - 4)$

$f(0) = -12$: $k \times 9 \times (-4) = -12$, $-36k = -12$, $k = \frac{1}{3}$

$f(x) = \frac{1}{3}(2x + 3)^2(x - 4)$

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**Question 6 continued**

(b) $\frac{1}{3}(2x + 3)^2(x - 4) = 2x - 12$

$(4x^2 + 12x + 9)(x - 4) = 6x - 36$

$4x^3 - 16x^2 + 12x^2 - 48x + 9x - 36 = 6x - 36$

$4x^3 - 4x^2 - 39x - 36 = 6x - 36$

$4x^3 - 4x^2 - 45x = 0$

$x(4x^2 - 4x - 45) = 0$ $\quad$ $x = 0$ is the point $(0, -12)$

$$x = \frac{4 \pm \sqrt{16 + 4 \times 4 \times 45}}{8} = \frac{4 \pm \sqrt{736}}{8} = \frac{4 \pm 4\sqrt{46}}{8}$$

$$\boxed{x = \frac{1 + \sqrt{46}}{2} \quad \text{and} \quad x = \frac{1 - \sqrt{46}}{2}}$$

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**Question 6 continued**

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**Question 6 continued**

**(Total for Question 6 is 7 marks)**

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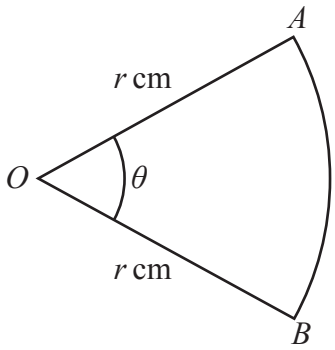



Diagram **NOT** accurately drawn

**Figure 3**

Figure 3 shows a sector $AOB$ of a circle, centre $O$.

The radius $OA$ of the sector is $r$ cm and angle $AOB$ is $\theta$ radians.

Given that

- the **area** of sector $AOB$ is $1\,\text{cm}^2$
- the **perimeter** of sector $AOB$ is $8\,\text{cm}$

(a) write down two different equations involving $r$ and $\theta$.

**(2)**

Given that $r > 2$

(b) solve the two simultaneous equations in part (a) to find the exact value of $r$ and the exact value of $\theta$.
Write each answer in the form $a + b\sqrt{c}$ where $a$, $b$ and $c$ are integers.

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

**(5)**

(a) Area: $\frac{1}{2}r^2\theta = 1$ Perimeter: $2r + r\theta = 8$

(b) From the perimeter: $r\theta = 8 - 2r$, $\theta = \frac{8-2r}{r}$

Substitute: $\frac{1}{2}r^2 \times \frac{8-2r}{r} = 1$

$\frac{1}{2}r(8-2r) = 1$, $8r - 2r^2 = 2$

$r^2 - 4r + 1 = 0$

$r = \frac{4 \pm \sqrt{16-4}}{2} = \frac{4 \pm 2\sqrt{3}}{2} = 2 \pm \sqrt{3}$

$r > 2$, so $r = 2 + \sqrt{3}$

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**Question 7 continued**

$$\theta = \frac{2}{r^2} = \frac{2}{(2+\sqrt{3})^2} = \frac{2}{7+4\sqrt{3}} \times \frac{7-4\sqrt{3}}{7-4\sqrt{3}} = \frac{14-8\sqrt{3}}{49-48}$$

$$\boxed{r = 2+\sqrt{3}, \qquad \theta = 14-8\sqrt{3}}$$

**(Total for Question 7 is 7 marks)**

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**8.** A curve $C$ has equation $y = f(x),\ x > 0$

The point $P$ with $x$ coordinate $\frac{1}{4}$ lies on $C$.

Given that

- $f'(x) = 10 + \dfrac{5\sqrt{x} - 4}{2x^2}$
- the tangent to $C$ at $P$ has equation $y = kx + 2$, where $k$ is a constant

(a) (i) find the value of $k$

(ii) find the equation of the normal to $C$ at $P$.
Give the answer in the form $y = mx + c$, where $m$ and $c$ are constants.

**(6)**

(b) Find $f(x)$.

**(5)**

(a)(i) At $x = \frac{1}{4}$: $\sqrt{x} = \frac{1}{2}$, $2x^2 = \frac{1}{8}$

$f'(\frac{1}{4}) = 10 + \dfrac{5 \times \frac{1}{4} - 4}{\frac{1}{8}} = 10 + (-\frac{3}{2}) \times 8 = 10 - 12 = -2$

The gradient of the tangent is k:

$\boxed{k = -2}$

(a)(ii) P is on the tangent: $y = -2 \times \frac{1}{4} + 2 = \frac{3}{2}$, $P = (\frac{1}{4}, \frac{3}{2})$

Gradient of normal $= -1 \div (-2) = \frac{1}{2}$

$y - \frac{3}{2} = \frac{1}{2}(x - \frac{1}{4})$ $\quad y = \frac{1}{2}x - \frac{1}{8} + \frac{3}{2}$

$\boxed{y = \frac{1}{2}x + \frac{11}{8}}$

(b) $f'(x) = 10 + \dfrac{5x^{1/2}}{2x^2} - \dfrac{4}{2x^2} = 10 + \frac{5}{2}x^{-3/2} - 2x^{-2}$

$f(x) = 10x + \frac{5}{2} \times \dfrac{x^{-1/2}}{-\frac{1}{2}} - 2 \times \dfrac{x^{-1}}{-1} + c = 10x - 5x^{-1/2} + 2x^{-1} + c$

$f(\frac{1}{4}) = \frac{3}{2}$: $\quad 10 \times \frac{1}{4} - 5 \times 2 + 2 \times 4 + c = \frac{3}{2}$

$2.5 - 10 + 8 + c = 1.5, \quad c = 1$

$\boxed{f(x) = 10x - \dfrac{5}{\sqrt{x}} + \dfrac{2}{x} + 1}$

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**Question 8 continued**

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**Question 8 continued**

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**Question 8 continued**

**(Total for Question 8 is 11 marks)**

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**9.**

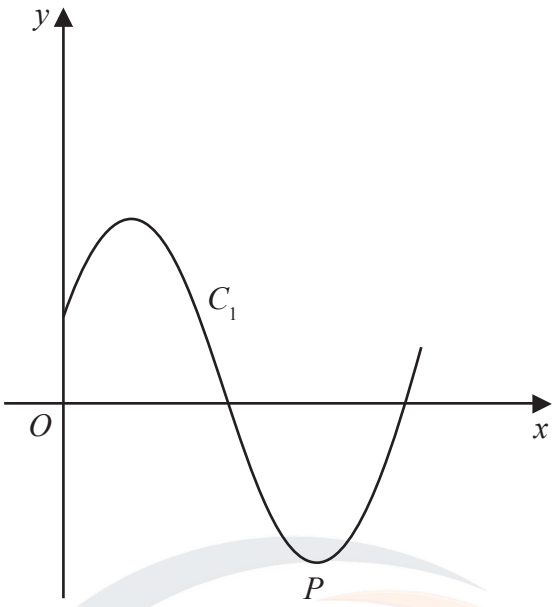



**Figure 4**

The curve $C_1$ has equation $y = \sin\left(x + \frac{\pi}{8}\right)$

Figure 4 shows a sketch of $C_1$ in the interval $0 \leqslant x < 2\pi$

The point $P$ is a minimum turning point on $C_1$ and is shown in Figure 4.

(a) State the $x$ coordinate of $P$.

**(1)**

(b) State the number of roots of the equation

$$\sin\left(x + \frac{\pi}{8}\right) = \sin\left(\frac{\pi}{8}\right)$$

in the interval $0 \leqslant x < 101\pi$, giving a reason for your answer.

**(2)**

The curve $C_2$ has equation $y = -5\sin\left(x + \frac{\pi}{8}\right)$

The point $Q$ is the minimum turning point on $C_2$ in the interval $0 \leqslant x < 2\pi$

(c) State the coordinates of $Q$.

**(2)**

(a) Minimum of sin when $x + \frac{\pi}{8} = \frac{3\pi}{2}$: $x = \frac{3\pi}{2} - \frac{\pi}{8}$

$$\boxed{x = \frac{11\pi}{8}}$$

(b) In each interval of length $2\pi$ there are 2 solutions ($x = 0$ and $x = \frac{3\pi}{4} + 2n\pi$)

$0 \leq x < 100\pi$ contains 50 full periods: $50 \times 2 = 100$ roots

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**Question 9 continued**

$100\pi \leq x < 101\pi$: $x = 100\pi$ and $x = 100\pi + \frac{3\pi}{4}$ are 2 more roots

102 roots $(50 \times 2 + 2)$

(c) $y = -5\sin(x + \frac{\pi}{8})$ is a minimum $(-5)$ when $\sin(x + \frac{\pi}{8}) = 1$

$x + \frac{\pi}{8} = \frac{\pi}{2}$, $x = \frac{3\pi}{8}$

$Q = (\frac{3\pi}{8}, -5)$

**(Total for Question 9 is 5 marks)**

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

$$y = \frac{3k}{x - 2k} \qquad x \neq 2k$$

where $k$ is a positive constant.

(a) Sketch a graph of $C$.
Show on your sketch the coordinates of the point where $C$ crosses a coordinate axis.

**(3)**

The line $l$ has equation $x + y = 12$

Given that $l$ is a tangent to $C$,

(b) show that

$$k^2 - 15k + 36 = 0$$

**(4)**

The line $l$ meets $C$ at a point $P$.

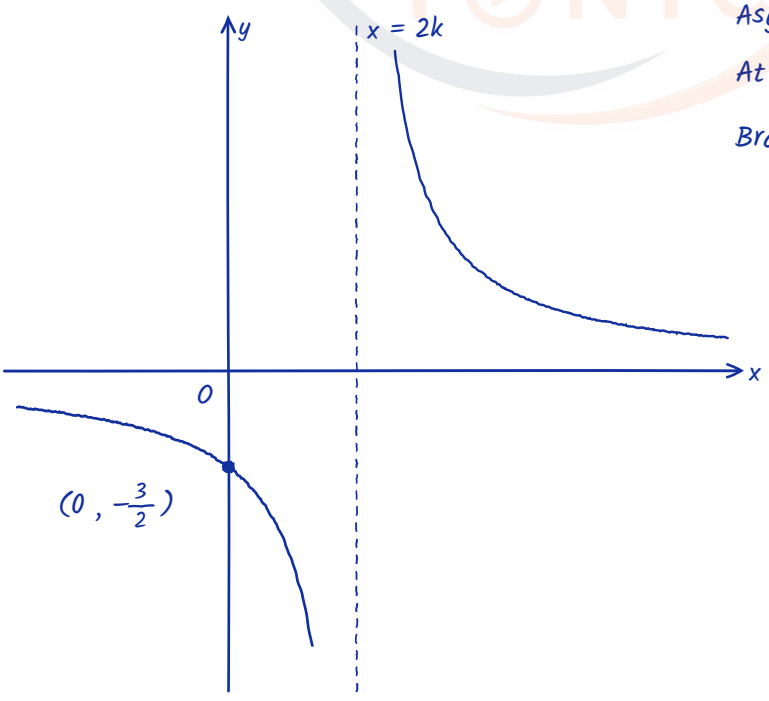
Given that $P$ lies below the $x$-axis,

(c) find the coordinates of $P$.

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

**(4)**

(a) Sketch of $y = \frac{3k}{x - 2k}$




Asymptotes: $x = 2k$ and $y = 0$

At $x = 0$: $y = \frac{3k}{-2k} = -\frac{3}{2}$

Branches in quadrants 1, 3 and 4

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**Question 10 continued**

(b) $x + y = 12$: $y = 12 - x$. Substitute into $y = \frac{3k}{x - 2k}$:

$(12 - x)(x - 2k) = 3k$

$12x - 24k - x^2 + 2kx = 3k$

$x^2 - (12 + 2k)x + 27k = 0$

$l$ is a tangent, so equal roots: $b^2 - 4ac = 0$

$(12 + 2k)^2 - 4 \times 27k = 0$

$144 + 48k + 4k^2 - 108k = 0$

$4k^2 - 60k + 144 = 0$ $(\div 4)$

$k^2 - 15k + 36 = 0$ as required

(c) $(k - 3)(k - 12) = 0$, $k = 3$ or $k = 12$

Repeated root: $x = \frac{12 + 2k}{2} = 6 + k$

$k = 3$: $x = 9$, $y = 12 - 9 = 3$ (above the x-axis, reject)

$k = 12$: $x = 18$, $y = 12 - 18 = -6$ (below the x-axis)

$\boxed{P = (18, -6)}$

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**Question 10 continued**

**(Total for Question 10 is 11 marks)**

**TOTAL FOR PAPER IS 75 MARKS**

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