Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

0689080313

ADDITIONAL MATHEMATICS — 0606/11

Paper 1 — **May/June 2023**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You should use a calculator where appropriate.
- 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 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages.

DC (CJ/FC) 312487/2

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Mathematical Formulae

1. ALGEBRA

Quadratic Equation

For the equation $ax^2 + bx + c = 0$,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Binomial Theorem

$$(a + b)^n = a^n + \binom{n}{1}a^{n-1}b + \binom{n}{2}a^{n-2}b^2 + \ldots + \binom{n}{r}a^{n-r}b^r + \ldots + b^n$$

where n is a positive integer and $\binom{n}{r} = \frac{n!}{(n-r)!\,r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a + l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1 - r^n)}{1 - r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1 - r} \quad (|r| < 1)$$

2. TRIGONOMETRY

Identities

$$\sin^2 A + \cos^2 A = 1$$
$$\sec^2 A = 1 + \tan^2 A$$
$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

Formulae for ΔABC

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc\cos A$$

$$\Delta = \frac{1}{2}bc\sin A$$

1 **(a)** Write $5x^2 - 14x + 8$ in the form $a(x+b)^2 + c$, where a, b and c are constants to be found. [3]

$5x^2 - 14x + 8 = 5\left(x^2 - \frac{14}{5}x\right) + 8 = 5\left[x^2 - \frac{14}{5}x + \frac{14^2}{10^2} - \frac{14^2}{10^2}\right] + 8$

$= 5\left[\left(x - \frac{14}{10}\right)^2 - \frac{196}{100}\right] + 8 = 5\left(x - \frac{7}{5}\right)^2 - \frac{196}{20} + 8 = 5\left(x - \frac{7}{5}\right)^2 - \frac{9}{5}$

$\therefore \quad a = 5, \quad b = -\frac{7}{5}, \quad c = -\frac{9}{5}$ #

(b) Hence write down the coordinates of the stationary point on the curve $y = 5x^2 - 14x + 8$. [2]

$y = 5\left(x - \frac{7}{5}\right)^2 - \frac{9}{5} \rightarrow$ min Point $\left(x = \frac{7}{5}, \; y = -\frac{9}{5}\right)$

$+ \cup$

(c) On the axes below, sketch the graph of $y = |5x^2 - 14x + 8|$, stating the coordinates of the points where the graph meets the coordinate axes. [3]

min $\left(\frac{7}{5}, -\frac{9}{5}\right)$

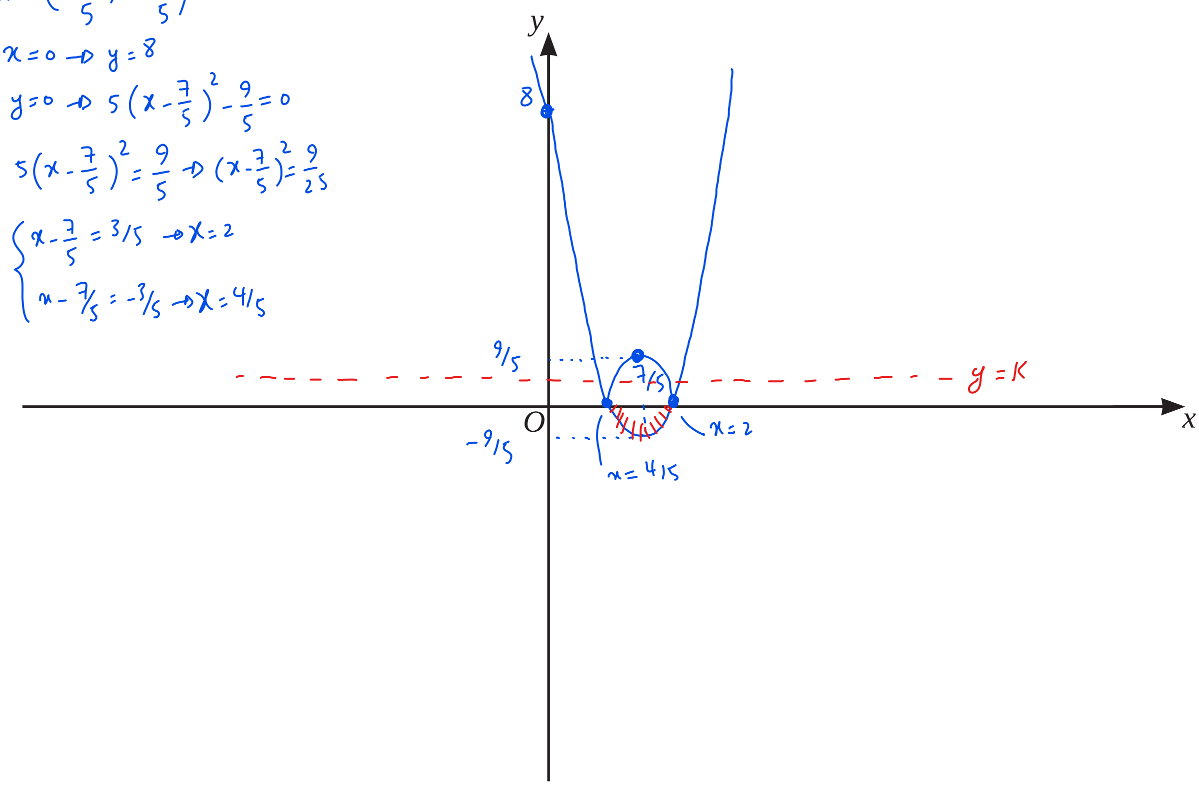
$x = 0 \rightarrow y = 8$

$y = 0 \rightarrow 5\left(x - \frac{7}{5}\right)^2 - \frac{9}{5} = 0$

$5\left(x - \frac{7}{5}\right)^2 = \frac{9}{5} \rightarrow \left(x - \frac{7}{5}\right)^2 = \frac{9}{25}$

$x - \frac{7}{5} = 3/5 \rightarrow x = 2$

$x - 7/5 = -3/5 \rightarrow x = 4/5$



(d) Write down the range of values of k for which the equation $|5x^2 - 14x + 8| = k$ has 4 distinct roots. [2]

y = K is a horizontal line and if wants Cut the graph at 4 distinct Point, must be $0 < K < 9/5$ #

2 The polynomial p is such that $p(x) = ax^3 + 7x^2 + bx + c$, where a, b and c are integers.

(a) Given that $p''\left(\frac{1}{2}\right) = 32$, show that $a = 6$. [2]

$P(x) = ax^3 + 7x^2 + bx + C \rightarrow P'(x) = 3ax^2 + 14x + b$

$\rightarrow P''(x) = 6ax + 14$

$P''\left(\frac{1}{2}\right) = 6\left(\frac{1}{2}\right)a + 14 = 32$

$3a + 14 = 32$

$3a = 18$

$a = 6$ #

$P(x) = 6x^3 + 7x^2 + bx + C$

(b) Given that $p(x)$ has a factor of $3x - 4$ and a remainder of 7 when divided by $x + 1$, find the values of b and c. [4]

$x + 1 = 0$

$x = -1$

$3x - 4 = 0 \rightarrow x = 4/3$

$P(4/3) = 0$

$P(-1) = 7$

$\rightarrow \begin{cases} 6\left(\frac{4}{3}\right)^3 + 7\left(\frac{4}{3}\right)^2 + b\left(\frac{4}{3}\right) + C = 0 \\ 6(-1)^3 + 7(-1)^2 + b(-1) + C = 7 \end{cases}$

$\rightarrow \begin{cases} 6\left(\frac{64}{27}\right) + 7\left(\frac{16}{9}\right) + b\left(\frac{4}{3}\right) + C = 0 \\ -6 + 7 - b + C = 7 \rightarrow -b + C = 6 \end{cases} \rightarrow \begin{cases} \frac{128}{9} + \frac{112}{9} + \frac{4}{3}b + C = 0 \\ -b + C = 6 \end{cases}$

$\rightarrow \begin{cases} \frac{240}{9} + \frac{4}{3}b + C = 0 \\ -b + C = 6 \end{cases} \xrightarrow{\times 3} \begin{cases} 80 + 4b + 3C = 0 \\ -b + C = 6 \end{cases} \rightarrow$ $b = -14$, $C = -8$

(c) Write $p(x)$ in the form $(3x - 4)q(x)$, where $q(x)$ is a quadratic factor. [2]

$$p(x) = 6x^3 + 7x^2 - 14x - 8 = (3x - 4)\underbrace{(ax^2 + bx + c)}_{q(x)}$$

$$= (3x - 4)(2x^2 + 5x + 2)$$

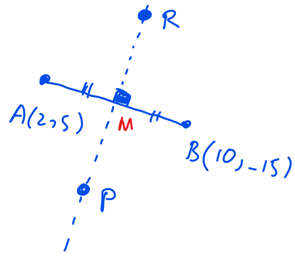
$$
\begin{array}{r|l}
 & 2x^2 + 5x + 2 \\
\hline
3x - 4 & 6x^3 + 7x^2 - 14x - 8 \\
 & 6x^3 - 8x^2 \\
\hline
 & 15x^2 - 14x - 8 \\
 & 15x^2 - 20x \\
\hline
 & 6x - 8 \\
 & 6x - 8 \\
\hline
 & 0
\end{array}
$$

(d) Hence write $p(x)$ as a product of linear factors with integer coefficients. [1]

$$p(x) = (3x - 4)(2x^2 + 5x + 2) = (3x - 4)(2x + 1)(x + 2)$$

3 The points A and B have coordinates $(2, 5)$ and $(10, -15)$ respectively. The point P lies on the perpendicular bisector of the line AB. The y-coordinate of P is -9.

(a) Find the x-coordinate of P. [5]



$$M = \left(\frac{2+10}{2}, \frac{5+-15}{2}\right) = (6, -5)$$

midPoint of AB

$$m_{AB} = \frac{y_B - y_A}{x_B - x_A} = \frac{-15-5}{10-2} = \frac{-20}{8} = \frac{-5}{2} \rightarrow m_h = \frac{2}{5}$$

line Perpendicular bisector of AB : $Y - y_M = \frac{2}{5}(X - x_M)$

$$Y - -5 = \frac{2}{5}(X - 6)$$

P lies on this line $\xrightarrow{y_p = -9}$ $-9 - -5 = \frac{2}{5}(X - 6)$

$$-4 = \frac{2}{5}(X - 6) \rightarrow -20 = 2X - 12$$

$$-8 = 2X \rightarrow \boxed{X_P = -4}$$

(b) The point R is the reflection of P in the line AB. Find the coordinates of R. [2]

means Point M is midPoint of Points R and P.

$M(6, -5)$

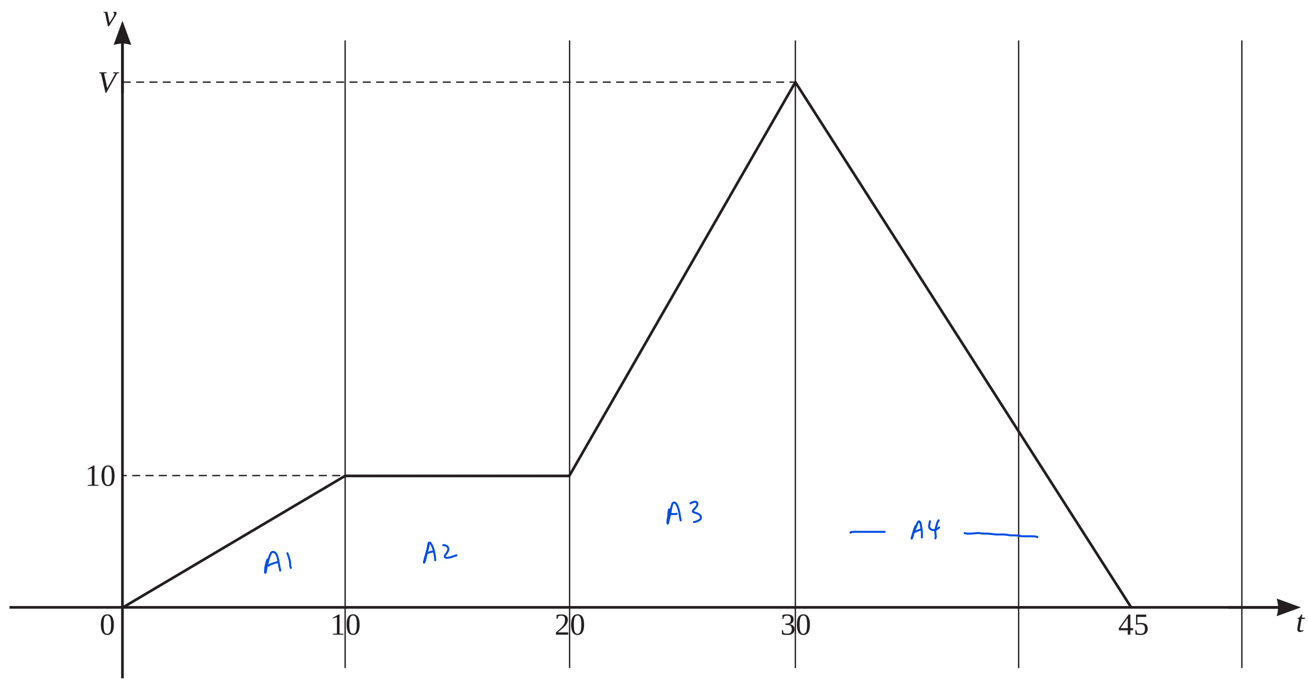
$P(-4, -9)$

$$x_M = \frac{x_P + x_R}{2} \rightarrow 6 = \frac{-4 + x_R}{2} \rightarrow x_R = 16$$

$$y_M = \frac{y_P + y_R}{2} \rightarrow -5 = \frac{-9 + y_R}{2} \rightarrow y_R = -1$$

$$\boxed{R = (16, -1)}$$

4



The diagram shows the velocity–time graph for a particle travelling in a straight line with velocity, $v\,\mathrm{ms}^{-1}$, at time t seconds. When $t = 30$ the velocity of the particle is $V\,\mathrm{ms}^{-1}$. The particle travels 800 metres in 45 seconds.

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

area Under the graph = Total distance

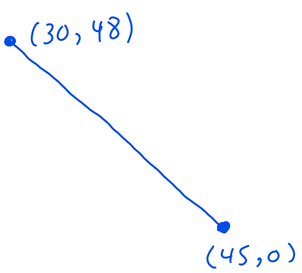
$A1 = \frac{10 \times 10}{2} = 50$ $\qquad A3 = \frac{1}{2}(10 + V) \times 10 = 50 + 5V$

$A2 = 10 \times 10 = 100$ $\qquad A4 = \frac{1}{2} \times V \times 15 = \frac{15}{2} V$

$\underbrace{50 + 100 + 50}_{200} + 5V + \frac{15}{2} V = 800$

$\frac{25V}{2} = 600 \rightarrow V = \frac{1200}{25} = 48$ #

(b) Find the acceleration of the particle when $t = 35$. [2]



$m = \frac{0 - 48}{45 - 30} = \frac{-48}{15} = \frac{-16}{5}\ \mathrm{ms}^{-2}$ #

acceleration = gradient of the line