Please check the examination details below before entering your candidate information

Candidate surname StemUp Model Solution | Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Wednesday 15 October 2025

Morning (Time: 1 hour 30 minutes)

Paper reference **WMA12/01**

Mathematics

International Advanced Subsidiary/Advanced Level
Pure Mathematics P2

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 9 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

- 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 ▶

P81269A

©2025 Pearson Education Ltd.
M:1/1/1/1/

P 8 1 2 6 9 A 0 1 3 2

Pearson

1. An arithmetic series starts

$$78 + 75 + 72 + ...$$

Find

(a) the 18th term in the series,

(2)

(b) the sum of the first 100 terms of the series.

(2)

(a) $a = 78, \quad d = -3$

$u_{18} = a + 17d = 78 + 17 \times (-3) = 78 - 51 = 27$

(b) $S_{100} = \frac{100}{2}(2 \times 78 + 99 \times (-3))$

$= 50 \times (156 - 297) = 50 \times (-141)$

$= -7050$

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 1 continued

(Total for Question 1 is 4 marks)

2. The first 4 terms, in ascending powers of x, in the binomial expansion of

$$(1 + px)^{10}$$

are

$$1 + 15x + qx^2 + rx^3$$

where p, q and r are constants.

Find the value of p, the value of q and the value of r.

(6)

$(1 + px)^{10} = 1 + 10px + \frac{10 \times 9}{2}(px)^2 + \frac{10 \times 9 \times 8}{3 \times 2 \times 1}(px)^3 + \ldots$

$= 1 + 10px + 45p^2x^2 + 120p^3x^3 + \ldots$

x terms: $10p = 15 \Rightarrow p = 1.5$

$q = 45p^2 = 45 \times 1.5^2 = 45 \times 2.25 = 101.25$

$r = 120p^3 = 120 \times 1.5^3 = 120 \times 3.375 = 405$

$p = 1.5, \quad q = 101.25, \quad r = 405$

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 2 continued

(Total for Question 2 is 6 marks)

3.

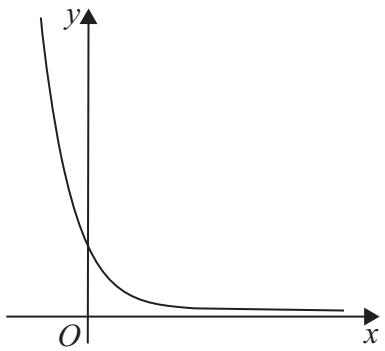


Figure 1

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

Figure 1 shows a sketch of the curve with equation $y = 3 \times 2^{-x}$

The point $P(k, 300\,000)$ lies on the curve.

(a) Use logarithms to find the value of k to 2 decimal places.

(2)

x	–0.5	1	2.5	4.0	5.5	7
y	4.243	1.5	0.530	0.188	0.066	0.023

The table shows corresponding values of x and y for $y = 3 \times 2^{-x}$

The values of y are given to 3 decimal places where appropriate.

(b) (i) Use the trapezium rule, with all the values of y from the table, to find an approximate value, to 2 decimal places, for

$$\int_{-0.5}^{7} 3 \times 2^{-x} \, dx$$

(3)

(ii) Use your answer to part (b)(i) to estimate

$$\int_{-0.5}^{7} 2^{-x} \, dx + \int_{-7}^{0.5} 2^{x} \, dx$$

(2)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 3 continued

(a) $300000 = 3 \times 2^{-k} \Rightarrow 2^{-k} = 100000$

$-k \log 2 = \log 100000 \Rightarrow k = -\frac{\log 100000}{\log 2} = -\frac{5}{\log 2}$

$k = -16.6096... = -16.61$ (2 d.p.)

(b)(i) $h = \frac{7 - (-0.5)}{5} = 1.5$

$\int_{-0.5}^{7} 3 \times 2^{-x}\, dx \approx \frac{1.5}{2}\{4.243 + 0.023 + 2(1.5 + 0.530 + 0.188 + 0.066)\}$

$= 0.75 \times \{4.266 + 2(2.284)\} = 0.75 \times 8.834$

$= 6.6255 = 6.63$ (2 d.p.)

(ii) $\int_{-0.5}^{7} 2^{-x}\, dx = \frac{1}{3}\int_{-0.5}^{7} 3 \times 2^{-x}\, dx \approx \frac{1}{3} \times 6.63 = 2.21$

$\int_{-7}^{0.5} 2^{x}\, dx$: $y = 2^x$ is the reflection of $y = 2^{-x}$ in the y-axis,

so $\int_{-7}^{0.5} 2^{x}\, dx = \int_{-0.5}^{7} 2^{-x}\, dx \approx 2.21$

$\int_{-0.5}^{7} 2^{-x}\, dx + \int_{-7}^{0.5} 2^{x}\, dx \approx \frac{1}{3} \times 6.63 + \frac{1}{3} \times 6.63 = 4.42$

Question 3 continued

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 3 continued

(Total for Question 3 is 7 marks)

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

$$f(x) = 4x^3 + 13x^2 - 10x + 8$$

(a) When $f(x)$ is divided by $(x - 2)$ the remainder is R and the quotient is $Q(x)$.

(i) Find $Q(x)$.

(ii) Find R.

(4)

(b) (i) Use the factor theorem to show that $(x + 4)$ is a factor of $f(x)$.

(ii) Hence prove, using algebra, that the equation $f(x) = 0$ has only one real solution.

(5)

(c) Find the range of values of x for which $f(x)$ is decreasing.

(3)

(a) Long division of $4x^3 + 13x^2 - 10x + 8$ by $(x - 2)$:

$4x^2(x - 2) = 4x^3 - 8x^2$, leaves $21x^2 - 10x + 8$

$21x(x - 2) = 21x^2 - 42x$, leaves $32x + 8$

$32(x - 2) = 32x - 64$, leaves 72

So $f(x) = (x - 2)(4x^2 + 21x + 32) + 72$

(i) $Q(x) = 4x^2 + 21x + 32$

(ii) $R = 72$ (check: $f(2) = 32 + 52 - 20 + 8 = 72$)

(b) (i) $f(-4) = 4(-4)^3 + 13(-4)^2 - 10(-4) + 8$

$= -256 + 208 + 40 + 8 = 0$

$f(-4) = 0$, so by the factor theorem $(x + 4)$ is a factor of $f(x)$

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

For $4x^2 - 3x + 2$: $b^2 - 4ac = (-3)^2 - 4 \times 4 \times 2 = 9 - 32 = -23$

$b^2 - 4ac < 0$, so $4x^2 - 3x + 2 = 0$ has no real roots

$\therefore$ the only real solution of $f(x) = 0$ is $x = -4$,

so $f(x) = 0$ has only one real solution

(c) $f'(x) = 12x^2 + 26x - 10$

f decreasing when $f'(x) < 0$: $12x^2 + 26x - 10 < 0$

$2(6x^2 + 13x - 5) < 0 \Rightarrow 2(3x - 1)(2x + 5) < 0$

Critical values $x = \frac{1}{3}$, $x = -\frac{5}{2}$

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 4 continued

$-\frac{5}{2} < x < \frac{1}{3}$

Question 4 continued

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 4 continued

(Total for Question 4 is 12 marks)

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

(i) Solve, for $0 < \theta \leqslant 360°$, the equation

$$4\tan\theta + 5\sin\theta = 0$$

giving any non-exact answers to one decimal place.

(5)

(ii) Solve, for $0 < x < \pi$, the equation

$$\frac{\sin x}{\cos x} + \frac{\cos x}{\sin x} = \frac{5}{\cos x}$$

giving the answers, in radians, to 3 significant figures.

(4)

(i) $4\tan\theta + 5\sin\theta = 0 \Rightarrow \frac{4\sin\theta}{\cos\theta} + 5\sin\theta = 0$

$4\sin\theta + 5\sin\theta\cos\theta = 0 \Rightarrow \sin\theta(4 + 5\cos\theta) = 0$

$\sin\theta = 0$ or $\cos\theta = -\frac{4}{5}$

$\sin\theta = 0 \Rightarrow \theta = 180°, 360°$

$\cos\theta = -\frac{4}{5} \Rightarrow \theta = 143.130...°$ or $\theta = 360° - 143.130...° = 216.869...°$

$\theta = 143.1°,\ 180°,\ 216.9°,\ 360°$

(ii) $\frac{\sin x}{\cos x} + \frac{\cos x}{\sin x} = \frac{5}{\cos x}$ (multiply by $\sin x \cos x$)

$\sin^2 x + \cos^2 x = 5\sin x$

$1 = 5\sin x \Rightarrow \sin x = \frac{1}{5}$

$x = 0.20135...$ or $x = \pi - 0.20135... = 2.94023...$

$x = 0.201,\ 2.94$

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 5 continued

Question 5 continued

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 5 continued

(Total for Question 5 is 9 marks)

6.

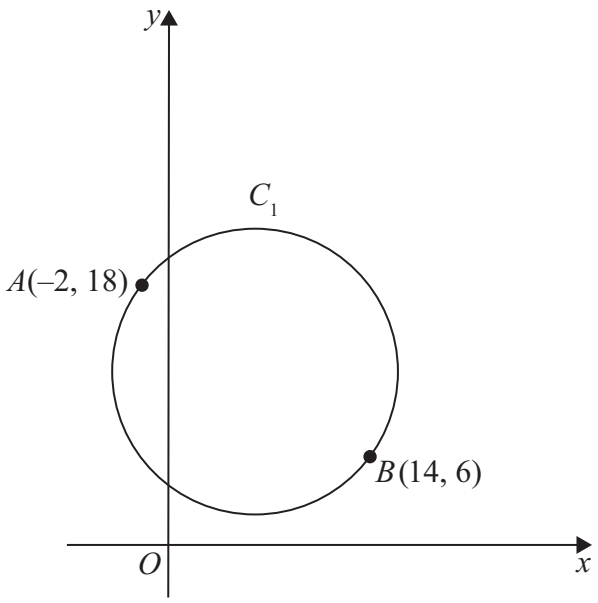


Figure 2

The points $A(-2, 18)$ and $B(14, 6)$ lie on a circle C_1 as shown in Figure 2.

Given that AB is a diameter of the circle C_1

(a) find an equation for C_1 making your method clear.

(5)

A circle C_2 has its centre at the origin.

Given that circles C_1 and C_2 touch,

(b) find possible equations for C_2

(4)

(a) Centre = midpoint of AB = $\left(\frac{-2+14}{2}, \frac{18+6}{2}\right)$ = (6, 12)

$AB^2 = (14 - (-2))^2 + (6 - 18)^2 = 16^2 + 12^2 = 400$

diameter = 20, so radius = 10, $r^2 = 100$

C_1: $(x - 6)^2 + (y - 12)^2 = 100$

(b) C_2: $x^2 + y^2 = k^2$, centre O(0, 0), radius k

Distance from O to centre of $C_1 = \sqrt{(6^2 + 12^2)} = \sqrt{180} = 6\sqrt{5}$

C_2 touches C_1 on the line through O and (6, 12), so

$k = 6\sqrt{5} + 10$ (C_1 inside C_2) or $k = 6\sqrt{5} - 10$ (outside, $6\sqrt{5} > 10$)

$x^2 + y^2 = (6\sqrt{5} + 10)^2$ i.e. $x^2 + y^2 = 280 + 120\sqrt{5}$

$x^2 + y^2 = (6\sqrt{5} - 10)^2$ i.e. $x^2 + y^2 = 280 - 120\sqrt{5}$

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 6 continued

Question 6 continued

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 6 continued

(Total for Question 6 is 9 marks)

7.

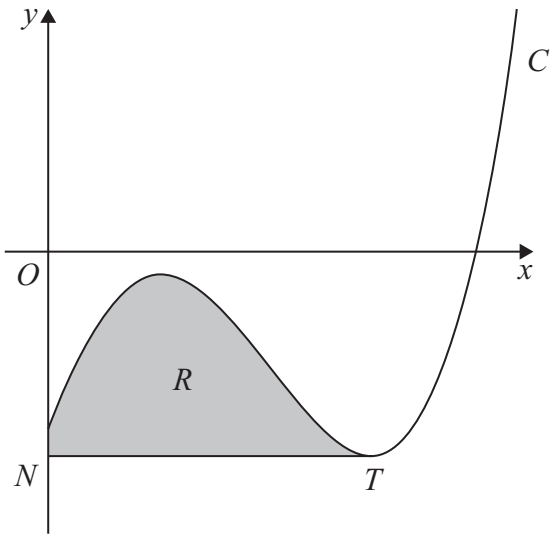


Figure 3

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

Figure 3 shows a sketch of part of the curve C with equation

$$y = x^3 - 4x^{\frac{5}{2}} - kx^{\frac{1}{2}} + 28x - 44 \qquad x \geqslant 0$$

where k is a positive constant.

(a) Find $\dfrac{dy}{dx}$ in simplest form.

(2)

The point T, shown in Figure 3, is a minimum stationary point on C.

Given that the x coordinate of T is 9

(b) show that $k = 6$

(2)

The line through T parallel to the x-axis meets the y-axis at the point N.

The finite region R, shown shaded in Figure 3, is bounded by C, the y-axis and the line segment NT.

(c) Use algebraic integration to find the area of R, giving the answer to 3 significant figures.

(6)

(a) $\dfrac{dy}{dx} = 3x^2 - 10x^{3/2} - \dfrac{k}{2}x^{-1/2} + 28$

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 7 continued

(b) At T, $x = 9$ and $\frac{dy}{dx} = 0$:

$3 \times 9^2 - 10 \times 9^{3/2} - \frac{k}{2} \times 9^{-1/2} + 28 = 0$

$243 - 270 - \frac{k}{6} + 28 = 0 \Rightarrow \frac{k}{6} = 1 \Rightarrow k = 6$

(c) At T: $y = 9^3 - 4 \times 9^{5/2} - 6 \times 9^{1/2} + 28 \times 9 - 44$

$= 729 - 972 - 18 + 252 - 44 = -53$, so N is $(0, -53)$

$\int (x^3 - 4x^{5/2} - 6x^{1/2} + 28x - 44)\, dx$

$= \frac{x^4}{4} - \frac{8}{7} x^{7/2} - 4x^{3/2} + 14x^2 - 44x$

$\int_0^9 y\, dx = \left[\frac{x^4}{4} - \frac{8}{7} x^{7/2} - 4x^{3/2} + 14x^2 - 44x \right]_0^9$

$= \frac{6561}{4} - \frac{8}{7} \times 2187 - 4 \times 27 + 14 \times 81 - 44 \times 9 - 0$

$= 1640.25 - 2499.428... - 108 + 1134 - 396 = -229.178...$

Area of R = area between C and line $y = -53$ from $x = 0$ to $x = 9$

$= \int_0^9 (y + 53)\, dx = -229.178... + 53 \times 9$

$= -229.178... + 477 = 247.821...$

Area of R = 248 (3 s.f.)

Question 7 continued

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Question 7 continued

(Total for Question 7 is 10 marks)

8. (i) A geometric series has first term a and common ratio r.

Prove that the sum of the first n terms of this series S_n is given by

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

(3)

(ii) A liquid is to be stored in a barrel.

Due to evaporation, the volume of the liquid in the barrel at the end of each year is 8% less than the volume of the liquid in the barrel at the start of the year.

At the start of the first year, the barrel is filled with 150 litres of the liquid.

(a) Show that the amount of the liquid in the barrel at the end of 6 years is approximately 91 litres.

(2)

At the start of each year a new barrel is filled with 150 litres of the liquid so that, at the end of 40 years, there are 40 barrels containing the liquid.

(b) Calculate the total amount of the liquid, to the nearest litre, in the 40 barrels at the end of 40 years.

(3)

(i) $S_n = a + ar + ar^2 + \ldots + ar^{n-2} + ar^{n-1}$

$rS_n = ar + ar^2 + ar^3 + \ldots + ar^{n-1} + ar^n$

Subtracting: $S_n - rS_n = a - ar^n$

$S_n(1-r) = a(1-r^n)$

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

(ii)(a) Each year the volume is multiplied by 0.92

Volume at end of 6 years $= 150 \times 0.92^6$

$= 90.953\ldots \approx 91$ litres as required

(b) Barrel filled at the start of year 40 has 150×0.92 litres,

... barrel filled at the start of year 1 has 150×0.92^{40} litres

Total $= 150 \times 0.92 + 150 \times 0.92^2 + \ldots + 150 \times 0.92^{40}$

Geometric series with $a = 138$, $r = 0.92$, $n = 40$

$\text{Total} = \frac{138(1-0.92^{40})}{1-0.92} = \frac{138 \times (1-0.035605\ldots)}{0.08}$

$= 1663.58\ldots$

$= 1664$ litres (to the nearest litre)

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Question 8 continued

Question 8 continued

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

Question 8 continued

(Total for Question 8 is 8 marks)

9. **In this question you must show detailed reasoning.**
Solutions relying on calculator technology are not acceptable.

(i) Solve

$$2\log_3(4x + 5) - \log_3(x + 3) = 2$$

(5)

(ii) Given that $a > 0$, $b > 0$ and

$$\log_{10} a + \log_{10} b = \log_{10}(a + b)$$

(a) prove that $a = \dfrac{b}{b-1}$

(3)

(b) Hence write down the full restriction on the value of b, giving a reason for your answer.

(2)

(i) $2\log_3(4x + 5) - \log_3(x + 3) = 2$

$\log_3(4x + 5)^2 - \log_3(x + 3) = 2 \Rightarrow \log_3 \dfrac{(4x + 5)^2}{x + 3} = 2$

$\dfrac{(4x + 5)^2}{x + 3} = 3^2 = 9 \Rightarrow (4x + 5)^2 = 9(x + 3)$

$16x^2 + 40x + 25 = 9x + 27$

$16x^2 + 31x - 2 = 0$

$(16x - 1)(x + 2) = 0 \Rightarrow x = \dfrac{1}{16}$ or $x = -2$

$x = -2$ gives $4x + 5 = -3 < 0$, and $\log_3(-3)$ is undefined: reject

$x = \dfrac{1}{16}$ only

(ii)(a) $\log_{10}a + \log_{10}b = \log_{10}(ab)$

so $\log_{10}(ab) = \log_{10}(a + b) \Rightarrow ab = a + b$

$ab - a = b \Rightarrow a(b - 1) = b$

$a = \dfrac{b}{b - 1}$ as required

(b) $b > 1$

Reason: $a > 0$ (logs only exist for positive numbers) and $b > 0$, so $\dfrac{b}{b - 1} > 0$

requires $b - 1 > 0$, i.e. $b > 1$

DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Question 9 continued

Question 9 continued

(Total for Question 9 is 10 marks)

TOTAL FOR PAPER IS 75 MARKS

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA