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

Tuesday 13 May 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 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:

- 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 ▶

P76194A

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

P 7 6 1 9 4 A 0 1 3 2

Pearson

stemup.co.uk

1: (a) Find the first 4 terms, in ascending powers of x, of the binomial expansion of

$$(1 - 4x)^7$$

giving each term in simplest form.

(4)

In the series expansion of

$$(5 + kx)(1 - 4x)^7 \qquad \text{where } k \text{ is a constant}$$

the coefficient of the term in x^2 is 1316

(b) Use the answer to part (a) to find the value of k.

(2)

(a) $(1 - 4x)^7 = 1 + 7(-4x) + {}^7C_2(-4x)^2 + {}^7C_3(-4x)^3 + \ldots$

$= 1 - 28x + \frac{7 \times 6}{2}(16x^2) + \frac{7 \times 6 \times 5}{6}(-64x^3) + \ldots$

$= 1 - 28x + 21 \times 16x^2 + 35 \times (-64)x^3 + \ldots$

$= 1 - 28x + 336x^2 - 2240x^3 + \ldots$

(b) $(5 + kx)(1 - 28x + 336x^2 - \ldots)$

x^2 term: $5 \times 336x^2 + kx \times (-28x)$

$5 \times 336 - 28k = 1316$

$1680 - 28k = 1316 \Rightarrow 28k = 364$

$k = 13$

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

stemup.co.uk

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 6 marks)

2: The line joining the points (–2, 5) and (4, 15) is the diameter of a circle C.

(a) Find an equation for C.

(5)

(b) Hence find the exact coordinates of the point on C that is nearest the x-axis.

(2)

(a) Centre = midpoint = $\left(\frac{-2+4}{2}, \frac{5+15}{2}\right) = (1, 10)$

Diameter$^2 = (4-(-2))^2 + (15-5)^2 = 36 + 100 = 136$

$r^2 = \left(\frac{d}{2}\right)^2 = \frac{136}{4} = 34$

C: $(x-1)^2 + (y-10)^2 = 34$

(b) $r = \sqrt{34} \approx 5.83 < 10$, so the circle lies above the x-axis.

Nearest point is directly below the centre: $x = 1$, $y = 10 - \sqrt{34}$

$(1, 10 - \sqrt{34})$

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

stemup.co.uk

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 7 marks)

3:

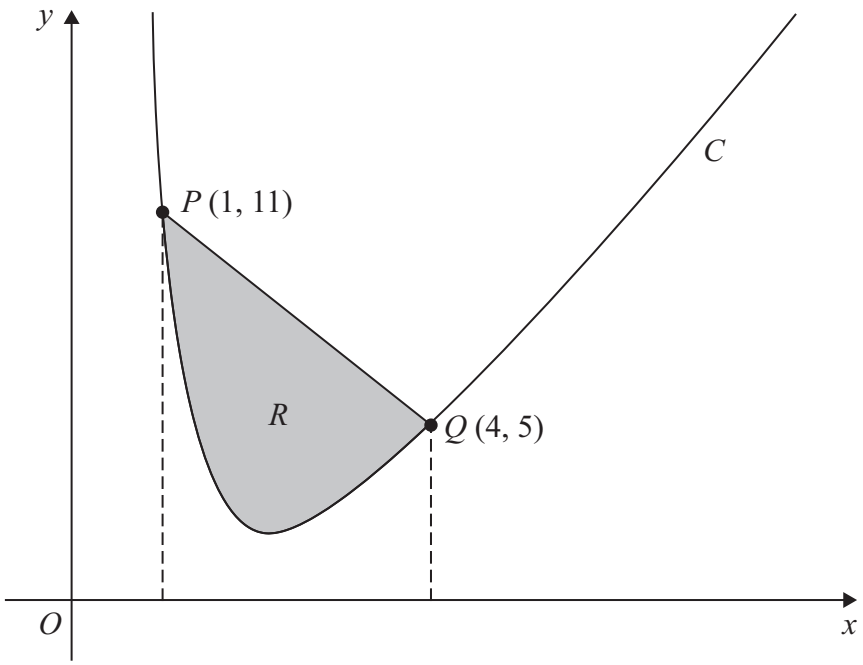


Figure 1

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 C with equation

$$y = 3x + \frac{16}{x^2} - 8 \qquad x > 0$$

The points $P(1, 11)$ and $Q(4, 5)$ lie on C and are shown in Figure 1.

The region R, shown shaded in Figure 1, is bounded by C and line segment PQ.

Use algebraic integration to find the area of R.

(5)

$\int_1^4 \left(3x + \frac{16}{x^2} - 8\right) dx = \int_1^4 (3x + 16x^{-2} - 8)\, dx$

$= \left[\frac{3}{2}x^2 - \frac{16}{x} - 8x\right]_1^4$

$= \left(\frac{3}{2}(16) - \frac{16}{4} - 32\right) - \left(\frac{3}{2} - 16 - 8\right)$

$= (-12) - (-22.5) = 10.5 = \frac{21}{2}$

Area of trapezium under PQ $= \frac{1}{2}(11 + 5) \times (4 - 1) = 24$

Area of R $= 24 - 10.5 = 13.5 = \frac{27}{2}$

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

stemup.co.uk

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 5 marks)

stemup.co.uk

4: The function f(x) is defined by

$$f(x) = ax^3 + bx^2 + 5x - 3$$

where a and b are constants.

Given that $(x + 3)$ is a factor of f(x),

(a) show that

$$b = 3a + 2$$

(2)

Given further that when f(x) is divided by $(2x - 1)$ the remainder is $\frac{7}{4}$

(b) find the value of a and the value of b.

(4)

(c) Using algebra, find the quotient and the remainder when f(x) is divided by $(x - 2)$

(3)

(a) $(x + 3)$ is a factor $\Rightarrow$ $f(-3) = 0$

$a(-3)^3 + b(-3)^2 + 5(-3) - 3 = 0$

$-27a + 9b - 15 - 3 = 0$

$-27a + 9b = 18 \quad (\div 9)$

$-3a + b = 2 \Rightarrow b = 3a + 2$

(b) $f\left(\frac{1}{2}\right) = \frac{7}{4}$: $a\left(\frac{1}{2}\right)^3 + b\left(\frac{1}{2}\right)^2 + 5\left(\frac{1}{2}\right) - 3 = \frac{7}{4}$

$\frac{a}{8} + \frac{b}{4} + \frac{5}{2} - 3 = \frac{7}{4} \quad (\times 8)$

$a + 2b + 20 - 24 = 14 \Rightarrow a + 2b = 18$

$a + 2(3a + 2) = 18 \Rightarrow 7a + 4 = 18 \Rightarrow 7a = 14$

$a = 2, \quad b = 3(2) + 2 = 8$

(c) $f(x) = 2x^3 + 8x^2 + 5x - 3$

$2x^3 + 8x^2 + 5x - 3 \equiv (x - 2)(Ax^2 + Bx + C) + R$

x^3: $A = 2$

x^2: $B - 2A = 8 \Rightarrow B = 12$

x: $C - 2B = 5 \Rightarrow C = 29$

constant: $R - 2C = -3 \Rightarrow R = -3 + 58 = 55$

Quotient = $2x^2 + 12x + 29$, Remainder = 55

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

P 7 6 1 9 4 A 0 8 3 2

stemup.co.uk

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

Question 4 continued

Question 4 continued

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

stemup.co.uk

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 9 marks)



5:

x	–2	–0.5	1	2.5	4	5.5	**7**
y	12	4.243	1.5	0.530	0.188	0.066	0.023

The table above shows corresponding values of x and y for

$$y = 3\left(\frac{1}{2}\right)^x$$

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

(a) Using the trapezium rule with all the values of y in the given table, obtain an estimate for

$$\int_{-2}^{7} 3\left(\frac{1}{2}\right)^x \, dx$$

giving the answer to one decimal place.

(3)

Using the answer to part (a) and making your method clear, estimate

(b) (i) $\displaystyle\int_{-2}^{7} 3\left(\frac{1}{2}\right)^{x+2} \, dx$

(ii) $\displaystyle\int_{-2}^{7} \left(2^{-x} + 2x\right) dx$

(3)

(a) $h = 1.5$

$\int_{-2}^{7} 3\left(\frac{1}{2}\right)^x dx \approx \frac{1.5}{2}\{12 + 0.023 + 2(4.243 + 1.5 + 0.530 + 0.188 + 0.066)\}$

$= 0.75 \times \{12.023 + 13.054\} = 0.75 \times 25.077 = 18.80775$

≈ 18.8

(b) (i) $\int_{-2}^{7} 3\left(\frac{1}{2}\right)^{x+2} dx = \int_{-2}^{7} 3\left(\frac{1}{2}\right)^x \times \frac{1}{4} \, dx = \frac{1}{4} \times 18.8 = 4.7$

(ii) $2^{-x} = \left(\frac{1}{2}\right)^x = \frac{1}{3} \times 3\left(\frac{1}{2}\right)^x$

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

P 7 6 1 9 4 A 0 1 2 3 2
stemup.co.uk

Question 5 continued

$$\int_{-2}^{7} (2^{-x} + 2x)\,dx = \frac{1}{3}\int_{-2}^{7} 3\left(\frac{1}{2}\right)^{x} dx + \left[x^2\right]_{-2}^{7}$$

$$= \frac{1}{3} \times 18.8 + (49 - 4) = 6.2666\ldots + 45 = 51.266\ldots$$

$$\approx 51.3$$

(Total for Question 5 is 6 marks)

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

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

(i) Solve

$$2\log_2(4-x) = 3 + \log_2\left(\frac{x+11}{2}\right)$$

(5)

(ii) The curves C_1 and C_2 with equations

$$y = 3^{2x+1} \qquad \text{and} \qquad y = 6 \times 3^x$$

meet at the point P.

Find the exact coordinates of P, writing your answer in the form $(\log_3 a, b)$ where a and b are integers.

(5)

(i) $2\log_2(4-x) = 3 + \log_2\left(\frac{x+11}{2}\right)$

$\log_2(4-x)^2 - \log_2\left(\frac{x+11}{2}\right) = 3$

$\log_2\left[\frac{2(4-x)^2}{x+11}\right] = 3 \quad (3 = \log_2 8)$

$\frac{2(4-x)^2}{x+11} = 2^3 = 8$

$2(4-x)^2 = 8(x+11) \Rightarrow (4-x)^2 = 4x + 44$

$16 - 8x + x^2 = 4x + 44 \Rightarrow x^2 - 12x - 28 = 0$

$(x-14)(x+2) = 0 \Rightarrow x = 14$ or $x = -2$

$x = 14$ gives $4 - x = -10 < 0$, so $\log_2(4-x)$ undefined: reject

$x = -2$

(ii) $3^{2x+1} = 6 \times 3^x$

$3 \times (3^x)^2 = 6 \times 3^x$

$3^x \neq 0 \Rightarrow 3 \times 3^x = 6 \Rightarrow 3^x = 2$

$x = \log_3 2$

$y = 6 \times 3^{\log_3 2} = 6 \times 2 = 12$

$P(\log_3 2, 12)$

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

stemup.co.uk

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

stemup.co.uk

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 10 marks)

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

(i) A **geometric** series begins

$$10 + 8 + 6.4 + \ldots$$

(a) Find the sum to infinity of this series.

(2)

Given that the kth term of this series is less than 0.0005

(b) use algebra to find the smallest possible value of k.

(3)

(ii) An **arithmetic** series begins

$$850 + 843 + 836 + \ldots$$

Given that the sum of the first n terms of this series is S_n
find the greatest possible value of S_n

(4)

(i) (a) $a = 10, \quad r = \frac{8}{10} = 0.8$

$S_\infty = \frac{a}{1-r} = \frac{10}{1-0.8} = \frac{10}{0.2} = 50$

(b) $u_k = 10 \times 0.8^{k-1} < 0.0005$

$0.8^{k-1} < 0.00005$

$(k-1)\log 0.8 < \log 0.00005$

$k - 1 > \frac{\log 0.00005}{\log 0.8}$ (log 0.8 < 0, so the inequality reverses)

$k - 1 > 44.38\ldots \Rightarrow k > 45.38\ldots$

Smallest $k = 46$

(ii) $a = 850, \quad d = -7$

S_n is greatest when the terms stop being positive:

$u_n = 850 + (n-1)(-7) = 0 \Rightarrow n - 1 = 121.43\ldots \Rightarrow n = 122.43\ldots$

So $n = 122$ ($u_{122} = 3 > 0$, $u_{123} = -4 < 0$)

$S_{122} = \frac{122}{2}\{2 \times 850 + 121 \times (-7)\} = 61 \times (1700 - 847) = 61 \times 853$

Greatest $S_n = 52033$

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

stemup.co.uk

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

Question 7 continued

Question 7 continued

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

stemup.co.uk

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 9 marks)

stemup.co.uk

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

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

$$3\tan\left(2x + \frac{\pi}{5}\right) = \sqrt{3}$$

giving the answers in radians in the form $k\pi$, where k is a rational constant to be found.

(3)

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

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

giving your answers, in degrees, to one decimal place.

(5)

(i) $3\tan\left(2x + \frac{\pi}{5}\right) = \sqrt{3} \Rightarrow \tan\left(2x + \frac{\pi}{5}\right) = \frac{\sqrt{3}}{3}$

$\frac{\pi}{5} \leqslant 2x + \frac{\pi}{5} < \frac{11\pi}{5}$: $2x + \frac{\pi}{5} = \frac{\pi}{6}$ (too small), $\frac{7\pi}{6}$, $\frac{13\pi}{6}$

$2x = \frac{7\pi}{6} - \frac{\pi}{5} = \frac{29\pi}{30}$, $2x = \frac{13\pi}{6} - \frac{\pi}{5} = \frac{59\pi}{30}$

$x = \frac{29}{60}\pi$, $\frac{59}{60}\pi$

(ii) $5\sin\theta \times \frac{\sin\theta}{\cos\theta} = \cos\theta + 4$

$5\sin^2\theta = \cos^2\theta + 4\cos\theta$

$5(1 - \cos^2\theta) = \cos^2\theta + 4\cos\theta$

$6\cos^2\theta + 4\cos\theta - 5 = 0$

$\cos\theta = \frac{-4 \pm \sqrt{(16 + 120)}}{12} = \frac{-4 \pm \sqrt{136}}{12}$

$\cos\theta = 0.63849...$ ($\cos\theta = -1.3051... < -1$, no solutions)

$\theta = \cos^{-1}(0.63849...) = 50.320...°$, $\theta = 360° - 50.320...° = 309.679...°$

$\theta = 50.3°$, $309.7°$

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

stemup.co.uk

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

stemup.co.uk

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:

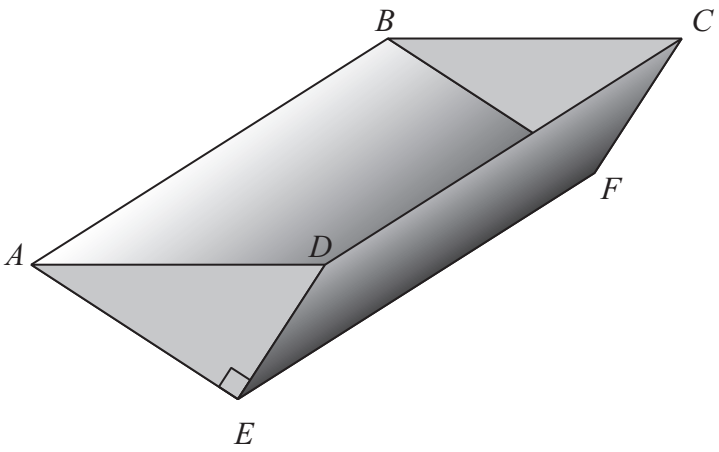


Figure 2

Figure 2 shows a sketch of an open container.

The sides $CDEF$ and $ABFE$ are rectangles.

The ends ADE and BCF are congruent (identical) right-angled triangles.

The container is made from metal of negligible thickness.

Given that

- $AE = BF = 3x$ metres
- $DE = CF = 2x$ metres
- $AB = DC = EF = L$ metres

and the capacity of the container is $12\,\text{m}^3$

(a) show that the area of metal used to make the container, $S\,\text{m}^2$, is given by

$$S = Px^2 + \frac{Q}{x}$$

where P and Q are positive integers to be found.

(4)

Given that x can vary,

(b) use algebraic calculus to find the minimum value of S, giving your answer to one decimal place.

(5)

(c) Justify that the value of S found in part (b) is a minimum.

(2)

(a) Volume $= \frac{1}{2} \times 3x \times 2x \times L = 3x^2L = 12$

$\Rightarrow L = \frac{4}{x^2}$

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 9 continued

$S = 2 \times \frac{1}{2}(3x)(2x) + 2xL + 3xL = 6x^2 + 5xL$

$S = 6x^2 + 5x \times \frac{4}{x^2} \Rightarrow S = 6x^2 + \frac{20}{x}$ $(P = 6,\ Q = 20)$

(b) $\frac{dS}{dx} = 12x - 20x^{-2} = 12x - \frac{20}{x^2}$

$\frac{dS}{dx} = 0 \Rightarrow 12x = \frac{20}{x^2} \Rightarrow x^3 = \frac{20}{12} = \frac{5}{3}$

$x = 1.18563...$

$S = 6(1.18563...)^2 + \frac{20}{1.18563...} = 8.4343... + 16.8686... = 25.3029...$

Minimum $S = 25.3\ (m^2)$

(c) $\frac{d^2S}{dx^2} = 12 + 40x^{-3} = 12 + \frac{40}{x^3}$

At $x^3 = \frac{5}{3}$: $\frac{d^2S}{dx^2} = 12 + 40 \times \frac{3}{5} = 36 > 0$

so $S = 25.3$ is a minimum



Question 9 continued

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

stemup.co.uk

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

Question 9 continued

(Total for Question 9 is 11 marks)

stemup.co.uk

10: **In this question you must show detailed reasoning.**

Use algebra to prove by exhaustion that,

for all positive integers m that are **not** multiples of 3, the value of

$$m^2 + 3m + 2$$

is always a multiple of 3

(4)

If m is not a multiple of 3, then $m = 3p + 1$ or $m = 3p + 2$ (p an integer, $p \geq 0$)

Case 1: $m = 3p + 1$

$m^2 + 3m + 2 = (3p + 1)^2 + 3(3p + 1) + 2$

$= 9p^2 + 6p + 1 + 9p + 3 + 2$

$= 9p^2 + 15p + 6 = 3(3p^2 + 5p + 2)$, which is a multiple of 3

Case 2: $m = 3p + 2$

$m^2 + 3m + 2 = (3p + 2)^2 + 3(3p + 2) + 2$

$= 9p^2 + 12p + 4 + 9p + 6 + 2$

$= 9p^2 + 21p + 12 = 3(3p^2 + 7p + 4)$, which is a multiple of 3

In both cases $m^2 + 3m + 2$ is a multiple of 3, so for all positive integers m that are not multiples of 3, $m^2 + 3m + 2$ is always a multiple of 3.

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 10 continued

Question 10 continued

(Total for Question 10 is 4 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

stemup.co.uk