



General Certificate of Education

Mathematics 6360

MPC4 Pure Core 4

Mark Scheme

2008 examination - January series

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Key to mark scheme and abbreviations used in marking

| | | | |
|--------------|--|-----|----------------------------|
| M | mark is for method | | |
| m or dM | mark is dependent on one or more M marks and is for method | | |
| A | mark is dependent on M or m marks and is for accuracy | | |
| B | mark is independent of M or m marks and is for method and accuracy | | |
| E | mark is for explanation | | |
| √ or ft or F | follow through from previous incorrect result | MC | mis-copy |
| CAO | correct answer only | MR | mis-read |
| CSO | correct solution only | RA | required accuracy |
| AWFW | anything which falls within | FW | further work |
| AWRT | anything which rounds to | ISW | ignore subsequent work |
| ACF | any correct form | FIW | from incorrect work |
| AG | answer given | BOD | given benefit of doubt |
| SC | special case | WR | work replaced by candidate |
| OE | or equivalent | FB | formulae book |
| A2,1 | 2 or 1 (or 0) accuracy marks | NOS | not on scheme |
| -x EE | deduct x marks for each error | G | graph |
| NMS | no method shown | C | candidate |
| PI | possibly implied | Sf | significant figure(s) |
| SCA | substantially correct approach | Dp | decimal place(s) |

No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded. However, there are situations in some units where part marks would be appropriate, particularly when similar techniques are involved. Your Principal Examiner will alert you to these and details will be provided on the mark scheme.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

Otherwise we require evidence of a correct method for any marks to be awarded.

MPC4

| Q | Solution | Marks | Total | Comments |
|--------------|--|-----------|----------|--|
| 1(a) | $3 = k(3 + x + 3 - x)$ | M1 | 2 | OE $\frac{A}{3-x} + \frac{B}{3+x} \Rightarrow 6A = 3 \quad 6B = 3$ |
| | $k = \frac{1}{2}$ | A1 | | or eg put $x = 0, \frac{3}{9} = k\left(\frac{1}{3} + \frac{1}{3}\right) \Rightarrow k = \frac{1}{2}$ |
| 1(b) | $\int_1^2 \frac{3}{9-x^2} dx = -\frac{1}{2} \ln(3-x) + \frac{1}{2} \ln(3+x)$ | M1 A1F | 3 | $a \ln(3 \pm x)$ ft on k |
| | $= \frac{1}{2}((\ln 5 - \ln 1) - (\ln 4 - \ln 2)) = \frac{1}{2} \ln\left(\frac{5}{2}\right)$ | A1F | | accept $\ln\left(\frac{10}{4}\right)$ ft only for sign error in integral: $\frac{1}{2} \ln\left(\frac{5}{8}\right)$ |
| Total | | | 5 | |

| Q | Solution | Marks | Total | Comments |
|---------|--|-------|-----------|---|
| 2(a)(i) | $f\left(\frac{1}{2}\right) = 2 \times \left(\frac{1}{2}\right)^3 + 3 \times \left(\frac{1}{2}\right)^2 - 18\left(\frac{1}{2}\right) + 8$ | M1 | | use of $\pm \frac{1}{2}$ substituted in $f(x)$ |
| | $= \frac{1}{4} + \frac{3}{4} - 9 + 8 = 0 \Rightarrow \text{factor}$ | A1 | 2 | arithmetic seen and conclusion – minimum seen: $2 \times \frac{1}{8} + 3 \times \frac{1}{4} - 18 \times \frac{1}{2} + 8 = 0$ |
| (ii) | $f(x) = (2x-1)(x^2 + 2x - 8)$ | B1B1 | 2 | or $p = 2, q = -8$ |
| (iii) | $\frac{4x(x+4)}{(2x-1)(x+4)(x-2)}$ | M1 | | numerator correct; attempt to factorise denominator (algebraic fraction not required) |
| | $= \frac{4x}{(2x-1)(x-2)}$ | A1 | 2 | CAO |
| (b) | $2x^2 = A(x+5)(x-3) + B + Cx$ | M1 | | any equivalent method |
| | $A = 2$ | B1 | | using PFs (see alternative method) |
| | $2A + C = 0 \quad -15A + B = 0$ | M1 | | equate coefficients or use 2 values of x to find B and C |
| | $C = -4 \quad B = 30$ | A1 | 4 | both B and C correct |
| | ALTERNATIVE METHOD 1 | | | |
| | $\begin{array}{r} x^2 + 2x - 15 \overline{) 2x^2} \\ \underline{2x^2 + 4x - 30} \\ -4x + 30 \end{array}$ | (M1) | | complete division |
| | $A = 2$ | (B1) | | |
| | $B = 30$ | (A1) | | |
| | $C = -4$ | (A1) | | |
| | ALTERNATIVE METHOD 2 | | | |
| | $\frac{2x^2}{(x+5)(x-3)} = A + \frac{D}{x+5} + \frac{E}{x-3}$ | | | |
| | $2x^2 = A(x+5)(x-3) + D(x-3) + E(x+5)$ | | | |
| | $x = 3 \quad 18 = 8E \quad E = \frac{9}{4}$ | (M1) | | find D and E |
| | $x = -5 \quad 50 = -8D \quad D = -\frac{25}{4}$ | | | |
| | $x = 0, 0 = -15A + \left(-\frac{25}{4}\right)(-3) + \left(\frac{9}{4}\right)(5)$ | | | |
| | $A = 2$ | (B1) | | |
| | $\frac{D}{x+5} + \frac{E}{x-3} = \frac{-25}{4(x+5)} + \frac{9}{4(x-3)}$ | | | |
| | $= \frac{-25(x-3) + 9(x+5)}{4(x+5)(x-3)}$ | | | |
| | $= \frac{120 - 16x}{4(x+5)(x-3)}$ | (M1) | | recombine to required form |
| | $= \frac{30 - 4x}{(x+5)(x-3)}$ | (A1) | | CAO |
| | Total | | 10 | |

MPC4 (cont)

| Q | Solution | Marks | Total | Comments |
|--------------|---|-------|----------|--|
| 3(a) | $(1+x)^{\frac{1}{2}} = 1 + \frac{1}{2}x + kx^2$ $= 1 + \frac{1}{2}x - \frac{1}{8}x^2$ | M1 | 2 | |
| | | A1 | | |
| (b) | $\left(1 + \frac{3}{2}x\right)^{\frac{1}{2}} = 1 + \frac{1}{2}\left(\frac{3}{2}x\right) - \frac{1}{8}\left(\frac{3}{2}x\right)^2$ $= 1 + \frac{3}{4}x - \frac{9}{32}x^2$ | M1 | 2 | <p>x replaced by $\frac{3}{2}x$ – condone missing brackets, but not incorrectly placed brackets eg $\left(\frac{3}{2}\right)x^2$</p> <p>alternatively, start again and find correct expression</p> |
| | | A1 | | |
| (c) | $\sqrt{\frac{2+3x}{8}} = \sqrt{\frac{2+3x}{4 \times 2}} = k\left(1 + \frac{3}{2}x\right)^{\frac{1}{2}}$ $= \frac{1}{2} + \frac{3}{8}x - \frac{9}{64}x^2$ | M1 | 2 | <p>manipulation to $k \times$ (answer to (b)) and evaluated $\Rightarrow a+bx+cx^2$</p> <p>a, b, c fractions or decimals only</p> <p>Or use $(a+x)^n$ formula (condone one error for M1)</p> |
| | | A1 | | |
| Total | | | 6 | |
| 4(a)(i) | $A = 20$ | B1 | 1 | |
| (ii) | $\frac{2000}{A} = k^{60}$ $k = (100)^{\frac{1}{60}} = 1.079775$ | M1 | 2 | <p>AG; or $k = 10^{\frac{\log 100}{60}} = 10^{0.0333}$ or $\sqrt[60]{100}$ or $\sqrt[30]{10}$ or $e^{\frac{\ln 100}{60}} = e^{0.076}$ or $e^{0.077}$ or 1.0797751(6) seen</p> |
| | | A1 | | |
| (iii) | $P = 20 \times k^{2008-1885}$ $= 251780 \approx 252000$ | M1 | 2 | CAO nearest 1000 |
| | | A1 | | |
| (b) | $15 \times 1.082709^t = 20 \times 1.079775^t$ $\frac{15}{20} = \left(\frac{1.079775}{1.082709}\right)^t$ $t = \frac{\log 0.75}{\log 0.997290}$ $t = 106.017 \Rightarrow 1991$ | M1 | 4 | <p>equate prices</p> <p>t as a single index, or correct log expression at this stage</p> <p>expression for t</p> <p>SC Answer only/Trial and error 106 seen (2 out of 4) 1991 (4 out of 4)</p> |
| | | M1 | | |
| | | m1 | | |
| | | A1 | | |
| Total | | | 9 | |

| Q | Solution | Marks | Total | Comments | |
|--------------------------------|---|----------------|-----------|--|--|
| 5(a)(i) | $t = \frac{1}{2} \quad x = 2 \times \frac{1}{2} + \frac{1}{\left(\frac{1}{2}\right)^2} \quad y = 2 \times \frac{1}{2} - \frac{1}{\left(\frac{1}{2}\right)^2}$ | M1 | 2 | | |
| | $x = 5 \quad y = -3$ | A1 | | | |
| (ii) | $\frac{dy}{dt} = 2 + 2t^{-3} \quad \frac{dx}{dt} = 2 - 2t^{-3}$ | M1A1 | 5 | 2 and $\frac{d}{dt}\left(\frac{1}{t^2}\right)$ attempted in both derivatives use chain rule; expressions can be in terms of t or evaluated CAO or any equivalent fraction (not decimals) | |
| | $t = \frac{1}{2} \quad \frac{dy}{dx} = \frac{2 + \frac{2}{\frac{1}{8}}}{2 - \frac{2}{\frac{1}{8}}} = -\frac{9}{7}$ | M1 A1 | | | |
| | $y + 3 = -\frac{9}{7}(x - 5)$ | B1F | | | |
| (b) | $x - y = \frac{2}{t^2} \quad x + y = 4t$ | M1 | 3 | ft on x, y and gradient if $y = mx + c$ used, c must be found correctly and the equation must be re-written either correct expression or both of $x - y = 4t$ and $x + y = \frac{2}{t^2}$ | |
| | $\frac{2}{(x - y)} = \left(\frac{x + y}{4}\right)^2$ | M1 | | | eliminate t |
| | $32 = (x - y)(x + y)^2$ | A1 | | | or $(x - y)(x + y)^2 = \frac{2}{t^2} \times (4t)^2 = 32$ $k = 32$ alone, no marks |
| Total | | | 10 | | |
| 6 | $3x \frac{dy}{dx} + 3y - 4y \frac{dy}{dx} = 0$ | M1 | 5 | attempt implicit differentiation product chain constant CSO solve for $x =$ expression in y and differentiate with respect to y substitute $y = 1$ CSO | |
| | $\frac{dy}{dx} = -\frac{3}{2}$ | A1 A1 B1 | | | |
| | ALTERNATIVE METHOD $x = \frac{2}{3}y + \frac{4}{3y}$ | (M1) | | | |
| | $\frac{dx}{dy} = \frac{2}{3} - \frac{4}{3y^2}$ | (A1A1) | | | |
| | $y = 1, \frac{dx}{dy} = \frac{2}{3} - \frac{4}{3}$ | (M1) | | | |
| $\frac{dx}{dy} = -\frac{3}{2}$ | (A1) | | | | |
| Total | | | 5 | | |

MPC4 (cont)

| Q | Solution | Marks | Total | Comments |
|--------------|---|-----------------------|-----------|--|
| 7(a)(i) | $R = 10$ $\tan \alpha = \frac{8}{6}, \alpha = 53.1$ | B1 B1F | 2 | $R = 10$ For α , ft incorrect R |
| (ii) | $\sin(2x + 53.1) = 0.7$ $2x + 53.1 = 44.4$ 135.6 or 135.7, 404.4, 495.6 or 495.7 $x = 41.2$ or $41.3, 175.6$ or $175.7,$ 221.2 or $221.3, 355.6$ or 355.7 | M1 A1F A1 A1 | 4 | one correct answer ; ft α and R 3 other correct answers – ignore extras four solutions CAO (with decimal place discrepancies) Answers only: 0/4 |
| (b)(i) | $\sin 2x = 2 \sin x \cos x$ $\cos 2x = \cos^2 x - \sin^2 x$ $\frac{\sin 2x}{1 - \cos 2x} = \frac{2 \sin x \cos x}{1 - (1 - 2 \sin^2 x)} =$ $\frac{2 \sin x \cos x}{2 \sin^2 x} = \frac{\cos x}{\sin x} = \frac{1}{\tan x}$ | B1 B1 M1 A1 | 4 | identities for $\sin 2x$ and $\cos 2x$ in any correct form use of candidate's double angle formulae AG, CSO |
| (ii) | $\frac{1}{\tan x} = \tan x \quad \tan x = \pm 1$ $x = 45,$ 135, 225, 315 | M1A1 B1 A1 | 4 | (see * below) $x=45$ if answers given without working, B1 max if $\frac{1}{\tan x} = \tan x$ seen and followed by correct answers without working 4 out of 4 |
| Total | | | 14 | |

* Comments for 7(b)(ii)

If hence ignored, so working in sines and cosines, must simplify as far as:

| | | | | | |
|-----------------------|----|-----------------------------------|----|-----------------------------------|--------|
| $\cos^2 x = \sin^2 x$ | or | $\cos^2 x = \frac{1}{2}$ | or | $\sin^2 x = \frac{1}{2}$ | for M1 |
| $\cos 2x = 0$ | or | $\cos x = \pm \frac{1}{\sqrt{2}}$ | or | $\sin x = \pm \frac{1}{\sqrt{2}}$ | for A1 |

MPC4 (cont)

| Q | Solution | Marks | Total | Comments |
|--------------|--|-----------------------------------|-----------|---|
| 8 | $\int y dy = \int 3 \cos 3x dx$ $\frac{1}{2}y^2 = \sin 3x (+C)$ $\left(\frac{\pi}{2}, 2\right) \frac{1}{2} \times 4 = \sin \frac{3\pi}{2} + C$ $C = 3$ $y^2 = 2 \sin 3x + 6$ | M1 A1A1 M1 A1 | 5 | attempt to separate and integrate $py^2 = q \sin 3x$ seen \Rightarrow implies separation integrals – accept $\frac{1}{3} \times 3 \sin 3x$ use $\left(\frac{\pi}{2}, 2\right)$ to find constant CSO (in any correct form) |
| Total | | | 5 | |
| 9(a)(i) | $\overline{AB} = \begin{bmatrix} 4 \\ 1 \\ -2 \end{bmatrix} - \begin{bmatrix} 2 \\ 5 \\ 1 \end{bmatrix} = \begin{bmatrix} 2 \\ -4 \\ -3 \end{bmatrix}$ | M1A1 | 2 | M1 for $\pm(\overline{OA} - \overline{OB})$ |
| (ii) | $(\mathbf{r} =) \begin{bmatrix} 2 \\ 5 \\ 1 \end{bmatrix} + \lambda \begin{bmatrix} 2 \\ -4 \\ -3 \end{bmatrix}$ | B1F | 1 | ft on \overline{AB} ; OE |
| (b)(i) | $\begin{bmatrix} 1 \\ -3 \\ -1 \end{bmatrix} + \mu \begin{bmatrix} 1 \\ 0 \\ -2 \end{bmatrix} = \begin{bmatrix} -2 \\ -3 \\ 5 \end{bmatrix}$ $1 + \mu = -2 \quad \mu = -3$ $-1 - 2\mu = 5 \quad \mu = -3$ ALTERNATIVE METHOD $\mu \begin{bmatrix} 1 \\ 0 \\ -2 \end{bmatrix} = \begin{bmatrix} -3 \\ 0 \\ 6 \end{bmatrix}$, which is satisfied by $\mu = -3$ | M1 A1 | 2 | μ found and verified or statement $\mu = -3$ satisfies all components $\mu = -3$ alone B1 |
| (ii) | $\overline{PQ} = \left(\begin{bmatrix} 2 \\ 5 \\ 1 \end{bmatrix} + \lambda \begin{bmatrix} 2 \\ -4 \\ -3 \end{bmatrix} \right) - \begin{bmatrix} -2 \\ -3 \\ 5 \end{bmatrix} = \begin{bmatrix} 4 + 2\lambda \\ 8 - 4\lambda \\ -4 - 3\lambda \end{bmatrix}$ $\begin{bmatrix} 4 + 2\lambda \\ 8 - 4\lambda \\ -4 - 3\lambda \end{bmatrix} \cdot \begin{bmatrix} 1 \\ 0 \\ -2 \end{bmatrix}$ $(4 + 2\lambda) + (-2)(-4 - 3\lambda) = 0$ $\lambda = -1.5$ Q is $(-1, 11, 5.5)$ | M1 A1 M1 m1 A1F A1 | 6 | $\overline{PQ} = \overline{OQ} - \overline{OP}$ with \overline{OQ} in parametric form in terms of λ (can be inferred later) or $\begin{bmatrix} 6 + 2\lambda \\ 4 - 4\lambda \\ -7 - 3\lambda \end{bmatrix}$ $\overline{PQ} \cdot \begin{bmatrix} 1 \\ 0 \\ -2 \end{bmatrix}$ with \overline{PQ} in terms of λ (can be inferred later) linear expression in λ equated to 0 ft on sign/arithmetic error in \overline{PQ} or equation CAO |
| Total | | | 11 | |
| TOTAL | | | 75 | |