Version 1.0: 0110

## General Certificate of Education

# Mathematics 6360

## MPC4 Pure Core 4

# Mark Scheme

*2010 examination - January series*

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.



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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.**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **1(a)(i)** | $f(-1) = -15 + 19 - 4 = 0$ | B1 | 1 | |
| **(ii)** | $f\left(\frac{2}{5}\right)$ | M1 | | evaluate **or** complete division leading to a numerical remainder |
| | $\left(15\times\frac{8}{125} + 19\times\frac{4}{25} - 4\right) = 0 \Rightarrow$ factor | A1 | 2 | Or decimal equivalent $(0.96 + 3.04 - 4)$ **or** zero remainder $\Rightarrow$ factor |
| **(b)** | $(x+1)$ is a factor | B1 | | Stated or implied. |
| | Third factor is $(3x+2)$ | M1<br>A1 | | Any appropriate method to find third factor |
| | $\frac{15x^2 - 6x}{f(x)} = \frac{3x(5x-2)}{(x+1)(5x-2)(3x+2)}$ | M1 | | $(5x-2)(3x^2 \pm 5x \pm 2)$ + attempt to factorise<br>Factorise numerator correctly and attempt to simplify |
| | $= \frac{3x}{(x+1)(3x+2)}$ | A1 | 5 | CSO no ISW |
| | **Total** | | **8** | |
| **2(a)** | $R = \sqrt{10}$ | B1 | | Accept $R = 3.16$ or better |
| | $\tan\alpha = 3$ | M1 | | OE |
| | $\alpha = 1.249$ ignore extra out of range | A1 | 3 | AWRT 1.25 SC $\alpha = 0.322$ B1 radians only |
| **(b)(i)** | minimum value $= -\sqrt{10}$ | B1F | 1 | F on $R$ |
| **(ii)** | $\cos(x - \alpha) = -1$ | M1 | | |
| | $x = 4.391$ | A1F | 2 | AWRT 4.39<br>$51.56^\circ$ or .. $.57^\circ$ or better |
| **(c)** | $\cos(x-\alpha) = \frac{2}{\sqrt{10}}$ | M1 | | |
| | $x - \alpha = \pm\ 0.886$ 5.397<br>ignore extra out of range | A1 | | Two values, accept 2dp and condone 5.4<br>condone use of degrees |
| | $x = 0.36296..$ 2.13512.. | A1F | | F on $x - \alpha$, either value. AWRT |
| | $x = 0.363$ 2.135 | A1 | 4 | CSO 3dp or better |
| | **Total** | | **10** | |
| **(c)** | **Alternative**<br>$10\sin^2 x - 12\sin x + 3 = 0$ | M1 | | Or equivalent quadratic using cos $x$ (ie $\sin^2 x + \cos^2 x = 1$ used) |
| | $\sin x$ = two numerical answers<br>$-1 \le$ ans $\le 1$ | A1F | | Or equivalent using cos $x$ |
| | $x$ = one correct answer | A1F | | |
| | $x = 0.363$ 2.135 | A1 | | CSO 3 dp or better |

**MPC4 (cont)**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **3(a)(i)** | $(1+x)^{\frac{1}{3}} = 1 \pm \frac{1}{3}x + kx^2$ | M1 | | $1 \pm \frac{1}{3}x + kx^2$ |
| | $= 1 - \frac{1}{3}x + \frac{2}{9}x^2$ | A1 | 2 | |
| **(ii)** | $\left(1+\frac{3}{4}x\right)^{-\frac{1}{3}} = 1 - \frac{1}{3} \times \frac{3}{4}x + \frac{2}{9}\left(\frac{3}{4}x\right)^2$ | M1 | | $x$ replaced by $\frac{3}{4}x$<br>or start binomial again;<br>condone missing brackets |
| | $= 1 - \frac{1}{4}x + \frac{1}{8}x^2$ | A1 | 2 | |
| **(b)** | $\sqrt[3]{\frac{256}{4+3x}} = k\left(1+\frac{3}{4}x\right)^{-\frac{1}{3}}$ | M1 | | $k \neq 1$ |
| | $= 4\left(1 - \frac{1}{4}x + \frac{1}{8}x^2\right)$ | A1F | | F on (a)(ii) $k$ = 4, accept $\sqrt[3]{64}$ or $64^{\frac{1}{3}}$ |
| | $= 4 - x + \frac{1}{2}x^2$ or<br>$a = 4 \quad b = -1 \quad c = \frac{1}{2}$ | A1 | 3 | CSO fully simplified<br>Be convinced |
| | **Total** | | **7** | |
| **4(a)** | $10x^2 + 8 = 2(x+1)(5x-1) +$ | M1 | | $A$ and $B$ terms correct |
| | $A(5x-1) + B(x+1)$ | A1 | | |
| | $x = -1 \quad x = \frac{1}{5}$ | m1 | | Use two values of $x$ to find $A$ and $B$, or set up and solve |
| | $A = -3 \quad B = 7$ | A1 | 4 | $8 + 5A + B = 0$<br>$-2 - A + B = 8$<br>SC1 NWS $A$ & $B$ correct $4/4$<br>SC2 NWS $A$ or $B$ correct $1/4$ |
| **(b)** | $\int \frac{10x^2+8}{(x+1)(5x-1)}\,dx = \int 2 - \frac{3}{x+1} + \frac{7}{5x-1}\,dx$ | M1 | | Use the partial fractions |
| | $= 2x + C$ | B1 | | |
| | | M1 | | $a\ln(x+1) + b\ln(5x-1)$<br>condone missing brackets |
| | $-3\ln(x+1) + \frac{7}{5}\ln(5x-1)$ | A1F | 4 | F on $A$ and $B$ |
| | **Total** | | **8** | |
| **5** | $x^2 + xy = e^y$ | | | |
| | $2x + y + x\frac{dy}{dx} = e^y \frac{dy}{dx}$ | B1<br>M1<br>A1<br>B1 | | $2x$<br>Use product rule<br><br>RHS |
| | $(-1, 0) \quad \frac{dy}{dx} = -1$ | A1 | 5 | CSO |
| | **Total** | | **5** | |

**MPC4 (cont)**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **6(a)(i)** | $\sin 2\theta = 2\sin\theta\cos\theta$<br>$\cos 2\theta = \cos^2\theta - \sin^2\theta$ | B1<br>B1 | 2 | <br>OE condone use of $x$ etc, but variable must be consistent |
| **(ii)** | $\sin\theta = \frac{4}{5} \Rightarrow \sin 2\theta = 2\times\frac{4}{5}\times\frac{3}{5} = \frac{24}{25}$<br>**or**<br>$2\times\sin\left(\cos^{-1}\frac{3}{5}\right)\times\frac{3}{5}$ | B1 | | AG<br>Use of 106.26° …. B0 |
| | $\cos 2\theta = \frac{9}{25} - \frac{16}{25} = -\frac{7}{25}$ | B1 | 2 | - 0.28 |
| **(b)(i)** | $\frac{dx}{d\theta} = 6\cos 2\theta$ , $\frac{dy}{d\theta} = -8\sin 2\theta$<br>$\frac{dy}{dx} = -\frac{4}{3}\frac{\sin 2\theta}{\cos 2\theta}$ ISW | M1<br>A1<br>A1 | <br><br>3 | Attempt both derivatives. ie $p\cos 2\theta$, $q\sin 2\theta$<br>Both correct.<br>CSO OE |
| **(ii)** | $P\left(\frac{72}{25}, -\frac{28}{25}\right)$ | B1F | | (2.88,- 1.12) |
| | Gradient = $= -\frac{4}{3}\times -\frac{24}{7}$ | M1 | | Their $\frac{q\sin 2\theta}{p\cos 2\theta}$ **or** $\frac{p\cos 2\theta}{q\sin 2\theta}$<br>must be working with rational numbers |
| | Tangent $y + \frac{28}{25} = \frac{32}{7}\left(x - \frac{72}{25}\right)$ ISW | A1 | 3 | Any correct form.<br>$7y = 32x - 100$<br>Fractions in simplest form<br>Equation required |
| | **Total** | | **10** | |

**MPC4 (cont)**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **7** | $\int y\ \mathrm{d}y = \int \cos\left(\frac{x}{3}\right)\mathrm{d}x$ | B1 | | Separate; condone missing integral signs. |
| | $\frac{1}{2}y^2 = 3\sin\left(\frac{x}{3}\right) + (C)$ | B1<br>B1 | | Accept $\dfrac{\sin\left(\frac{x}{3}\right)}{\frac{1}{3}}$ |
| | $\left(\frac{\pi}{2}, 1\right) \quad \frac{1}{2} = 3\sin\frac{\pi}{6} + C$ | M1 | | Use $\left(\frac{\pi}{2}, 1\right)$ to find $C$<br>must be in form $py^2 = q\sin\left(\frac{x}{3}\right) + C$ |
| | $C = -1$ | A1F | | |
| | $y^2 = 6\sin\left(\frac{x}{3}\right) - 2$ | A1 | 6 | CSO |
| | **Total** | | **6** | |
| **8(a)** | $0 = 2 + \lambda \Rightarrow \lambda = -2$ | M1 | | |
| | **Check** $\quad -1 + -2\times -3 = -1 + 6 = 5$ | | | |
| | $-5 - 2\times 2 = -5 \times -4 = -9$ | A1 | 2 | OE |
| **(b)** | $\overrightarrow{BC} = \begin{bmatrix} 9 \\ 2 \\ 3 \end{bmatrix} - \begin{bmatrix} 0 \\ 5 \\ -9 \end{bmatrix} = \begin{bmatrix} 9 \\ -3 \\ 12 \end{bmatrix}$ | M1<br>A1 | 2 | $\pm\left(\overrightarrow{OC} - \overrightarrow{OB}\right)$ |
| **(c)(i)** | $\overrightarrow{OD} = \overrightarrow{OA} + \overrightarrow{AD} = \overrightarrow{OA} + 2\overrightarrow{BC}$ | M1 | | |
| | $\overrightarrow{OD} = \begin{bmatrix} 2 \\ -1 \\ -5 \end{bmatrix} + \begin{bmatrix} 18 \\ -6 \\ 24 \end{bmatrix} = \begin{bmatrix} 20 \\ -7 \\ 19 \end{bmatrix}$ | | | |
| | $D$ is $(20, -7, 19)$ | A1 | 2 | AG |
| **(ii)** | $\overrightarrow{PD} = \overrightarrow{OD} - \overrightarrow{OP} =$ | | | |
| | $\begin{bmatrix} 20 \\ -7 \\ 19 \end{bmatrix} - \begin{bmatrix} 2+p \\ -1-3p \\ -5+2p \end{bmatrix} = \begin{bmatrix} 18-p \\ -6+3p \\ 24-2p \end{bmatrix}$ | M1<br>A1 | | Find $\overrightarrow{PD}$ in terms of $p$<br>condone $\overrightarrow{PD} = \overrightarrow{OP} - \overrightarrow{OD}$ here |
| | $\overrightarrow{PD} \bullet \begin{bmatrix} 1 \\ -3 \\ 2 \end{bmatrix} = 0$ | B1 | | |
| | $(18-p)\times 1 + (-6+3p)\times -3 + (24-2p)\times 2 = 0$ | m1 | | |
| | $p = 6$ | A1 | 5 | CSO OE working with $\overrightarrow{DP}$ |
| | Total | | **11** | |

**MPC4 (cont)**

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **9(a)(i)** | $t=0 \quad h=A(1-1)=0$ | B1 | 1 | |
| **(ii)** | $57=A\left(1-\mathrm{e}^{-\frac{12}{4}}\right)$ | M1 | | |
| | $A=\dfrac{57}{\left(1-\mathrm{e}^{-3}\right)}\approx 60$ | A1 | 2 | Or 59.9… seen.<br>$A$ = correct expression $\approx$ 60 2 sf |
| **(b)(i)** | $h=48 \quad \dfrac{48}{60}=1-\mathrm{e}^{-\frac{1}{4}t}$ | M1 | | |
| | $\ln\left(\mathrm{e}^{-\frac{1}{4}t}\right)=\ln\left(\dfrac{1}{5}\right)$ | m1 | | |
| | $-\dfrac{1}{4}t=-\ln 5 \Rightarrow t=4\ln 5$ | A1 | 3 | |
| **(ii)** | $\dfrac{\mathrm{d}h}{\mathrm{d}t}=-\dfrac{1}{4}\times -60\times \mathrm{e}^{-\frac{1}{4}t}$ | M1 | | Differentiate, condone sign errors |
| | $60e^{-\frac{1}{4}t}=60-h \Rightarrow \dfrac{\mathrm{d}h}{\mathrm{d}t}=\dfrac{1}{4}(60-h)$ | m1 | | Eliminate $\mathrm{e}^{-\frac{1}{4}t}$ |
| | $\dfrac{\mathrm{d}h}{\mathrm{d}t}=15-\dfrac{h}{4}$ | A1 | 3 | CSO, AG |
| **(iii)** | $h=8$ | B1 | 1 | |
| | **Total** | | **10** | |
| | **TOTAL** | | **75** | |