Version 1.0

**General Certificate of Education (A-level)**
**June 2013**

# Mathematics MPC1

# (Specification 6360)

# Pure Core 1

# Final

# *Mark Scheme*

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 events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised 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 students' 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 abbreviations

| | |
|---|---|
| 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 |
| CAO | correct answer only |
| CSO | correct solution only |
| AWFW | anything which falls within |
| AWRT | anything which rounds to |
| ACF | any correct form |
| AG | answer given |
| SC | special case |
| OE | or equivalent |
| A2,1 | 2 or 1 (or 0) accuracy marks |
| –*x* EE | deduct *x* marks for each error |
| NMS | no method shown |
| PI | possibly implied |
| SCA | substantially correct approach |
| c | candidate |
| sf | significant figure(s) |
| 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.

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**.

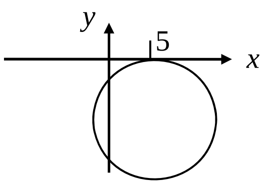
Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

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.**

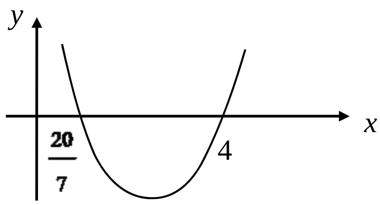
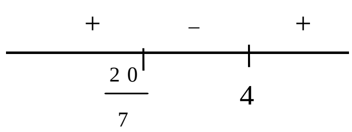
| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **1(a)** | $3p-4(p+2)+5=0$ | M1 | | condone omission of brackets or one sign error |
| | $(\Rightarrow p=)\ -3$ | A1 | 2 | |
| **(b)** | $y=\frac{3}{4}x+\frac{5}{4}$ | M1 | | rearranging into form $y=\pm\frac{3}{4}x+c$ |
| | (gradient $AB$ =) $\frac{3}{4}$ | A1 | 2 | condone slips in rearranging if gradient is correct . |
| **(c)** | (gradient $AC$ =) $\frac{k-2}{-5-1}$ | M1 | | *or* $\frac{2-k}{1--5}$ (condone one sign error) |
| | "their" $\frac{(k-2)}{-6}\times\frac{3}{4}=-1$ *OE* | m1 | | product of grads = –1 in terms of $k$ |
| | $(\Rightarrow k=)\ 10$ | A1 | 3 | |
| **(d)** | $3x-4y+5=0$ and $2x-5y=6$<br>$\Rightarrow Px=Q$ or $Ry=S$ | M1 | | must use "correct" pair of equations **and** attempt to eliminate $y$ (or $x$) (generous) |
| | $x=-7$ | A1 | | |
| | $y=-4$ | A1 | 3 | $(-7,-4)$ |
| | **Total** | | **10** | |

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **2(a)(i)** | $\left(\sqrt{48}\ =\right)4\sqrt{3}$ | B1 | 1 | condone $n=4$. No ISW. |
| **(ii)** | $\sqrt{12}=2\sqrt{3}$ and $\sqrt{48}=4\sqrt{3}$ | M1 | | (FT 'their' $n$) $2x\sqrt{3}=7\sqrt{3}-4\sqrt{3}$ |
| | $(x=)\dfrac{7\sqrt{3}-4\sqrt{3}}{2\sqrt{3}}$ | A1 | | correct quotient unsimplified<br>or correct equation in integers<br>eg $6x=21-12$ |
| | $=\dfrac{3}{2}$ | A1cso | 3 | accept 1.5 but not $\dfrac{9}{6}$ etc<br>**alternative 1**<br>$x=\dfrac{7\sqrt{3}-\sqrt{48}}{\sqrt{12}}\times\dfrac{\sqrt{12}}{\sqrt{12}}$ M1<br>integer terms $=\dfrac{42-24}{12}$ A1<br>$=\dfrac{3}{2}$ A1 |
| **(b)** | $\dfrac{11\sqrt{3}+2\sqrt{5}}{2\sqrt{3}+\sqrt{5}}\times\dfrac{2\sqrt{3}-\sqrt{5}}{2\sqrt{3}-\sqrt{5}}$ | M1 | | |
| | (numerator =)<br>$22\times3+4\sqrt{15}-11\sqrt{15}-2\times5$ | A1 | | correct unsimplified but must simplify $\left(\sqrt{3}\right)^2$, $\left(\sqrt{5}\right)^2$ and $\sqrt{3}\times\sqrt{5}$ correctly |
| | (denominator = 12 – 5 =) 7 | B1 | | must be seen or identified as denominator<br>giving $\dfrac{56-7\sqrt{15}}{7}$ |
| | (Answer =) $8-\sqrt{15}$ | A1cso | 4 | $m=8$ |
| | **Total** | | **8** | |

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **3(a)** | $(x-5)^2+(y+7)^2$ | M1 | | one term correct |
| | | A1 | | both terms correct and added |
| | $(x-5)^2+(y+7)^2=49$ | A1cao | 3 | must see 49 not just $7^2$ |
| | | | | condone $(x-5)^2+(y--7)^2=49$ |
| **(b)(i)** | (Centre is ) $(5, -7)$ | B1√ | 1 | correct or FT their $a$ and $b$ |
| **(ii)** | Radius = 7 | B1√ | 1 | condone $\sqrt{49}$ but **not** $\pm 7$ or $\pm\sqrt{49}$ |
| | | | | correct or FT their $\sqrt{k}$ provided $k > 0$ |
| **(c)(i)** |  | M1 | | freehand circle with centre in correct quadrant or FT from their **(b)(i)**<br>must have both axes shown clearly |
| | | A1 | 2 | correct position cutting negative $y$-axis twice and touching $x$-axis at $x = 5$<br>5 must be marked on $x$-axis or centre clearly marked as $(5, -7)$<br>must have correct centre and radius in **(b)** |
| **(ii)** | $x=5$ | B1 | | |
| | $y=-14$ | B1 | 2 | $(5, -14)$ |
| **(d)** | Translation | E1 | | and no other transformation |
| | through $\begin{bmatrix} 6 \\ * \end{bmatrix}$ | M1 | | |
| | $\begin{bmatrix} 6 \\ -7 \end{bmatrix}$ | A1cso | 3 | both components correct for A1; may describe in words or use a column vector |
| | **Total** | | **12** | |

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **4(a)** | $\mathrm{f}(-3)=(-3)^3-4\times(-3)+15$<br>$\mathrm{f}(-3)=-27+12+15$<br>$=0 \Rightarrow x+3$ is a factor | M1<br><br>A1 | <br><br>2 | f(–3) attempted **not** long division<br><br>shown = 0 plus statement |
| **(ii)** | Quadratic factor $(x^2-3x+5)$<br><br>$(\mathrm{f}(x)=)\quad (x+3)(x^2-3x+5)$ | M1<br><br>A1 | <br><br>2 | $-3x$ or $+5$ term by inspection<br>*or* full long division attempt<br>must see correct product |
| **(b) (i)** | $\left(\dfrac{\mathrm{d}y}{\mathrm{d}x}=\right)4x^3-16x+60$ | M1<br>A1<br>A1 | <br><br>3 | one of these terms correct<br>another term correct<br>all correct ( no $+c$ etc) |
| **(ii)** | $4x^3-16x+60=0$<br>$\Rightarrow x^3-4x+15=0$ | <br>B1 | <br>1 | must see this line OE<br>**AG** |
| **(iii)** | Discriminant of quadratic = $(-3)^2-4\times5$ | M1 | | discriminant of “ their” quadratic or correct use of quad eqn “formula” |
| | $b^2-4ac=-11$ (*or* $b^2-4ac<0$)<br>therefore quadratic has no (real )roots<br>Hence only stationary point is when $x=-3$ | A1 | 2 | **correct discriminant** evaluated correctly (or shown to be $<0$) with appropriate conclusion<br>**plus** final statement |
| **(iv)** | $\left(\dfrac{\mathrm{d}^2y}{\mathrm{d}x^2}=\right)12x^2-16$ | B1√ | | |
| | $=12(-3)^2-16$ (*or* $12\times9-16$ etc)<br>$=92$ | M1<br>A1 | <br>3 | sub $x=-3$ into “their” $\dfrac{\mathrm{d}^2y}{\mathrm{d}x^2}$ |
| **(v)** | Minimum **since** $\dfrac{\mathrm{d}^2y}{\mathrm{d}x^2}>0$ (*or* 92 $>0$ etc) | E1√ | 1 | FT appropriate conclusion from their value from **(iv)** **plus** reason<br>treat parts **(iv)** & **(v)** holistically |
| | **Total** | | **14** | |

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **5(a)(i)** | $2(x+1.5)^2$ | M1 | | OE |
| | $2(x+1.5)^2+0.5$ | A1 | 2 | $2\left(x+\frac{3}{2}\right)^2+\frac{1}{2}$ OE |
| **(ii)** | (Minimum value is) 0.5 | B1√ | 1 | ft their $q$ |
| **(b)(i)** | $(AB^2=)\quad (x+3)^2+(3x+9-5)^2$ | M1 | | condone one sign error inside one bracket |
| | $(3x+4)^2=9x^2+24x+16$ | B1 | | OE |
| | $AB^2=x^2+6x+9+9x^2+24x+16=10x^2+30x+25$<br>$\Rightarrow AB^2=5(2x^2+6x+5)$ | A1cso | 3 | **AG** |
| **(ii)** | *Either* $\sqrt{5\times\text{'their'}\,\textbf{(a)(ii)}}$ *or* $5\times\text{'their'}$ **(a)(ii)** | M1 | | using their minimum value from **(a)(ii)** and 5<br><br>provided "their" **(a)(ii)** > 0 |
| | ( Minimum length of $AB$ = ) $\frac{1}{2}\sqrt{10}$ | A1cso | 2 | |
| | **Total** | | **8** | |
| **6(a)** | $\frac{dy}{dx}=5x^4-4x$ | M1<br>A1 | | one of these terms correct<br>all correct ( no +c etc) |
| | $\left(=5(-1)^4-4(-1)\right)\quad =9$ | A1 | | |
| | Tangent has equation $y=\text{'their }9\text{'}\,x+c$<br>**and** $6=\text{'their }9\text{'}(-1)+c \quad \Rightarrow c=\ldots$ | m1 | | tangent using 'their' gradient, and attempt to find $c$ using $x=-1$ and $y=6$ |
| | $\Rightarrow y=9x+15$ | A1 | 5 | equation must be seen in this form |
| **(b)(i)** | When $x=2$, $y=2^5-2\times2^2+9=32-8+9=33$ | | | be convinced that they are using **curve** equation |
| | $(k=)\ 33$ | B1 | 1 | **NMS** $k=33$ scores B0 |
| **(ii)** | When $x=2$, $y=9\times2+15=33$ so lies on tangent | B1 | 1 | be convinced that they are using **tangent** equation **and** have statement |

| Q | Solution | Marks | Total | Comments |
|---|---|---|---|---|
| **6(c)(i)** | $\frac{x^6}{6}-\frac{2x^3}{3}+9x$ | M1<br>A1<br>A1 | | one of these terms correct<br>another term correct<br>all correct (may have +c) |
| | $\left[\frac{2^6}{6}-\frac{2\times 2^3}{3}+9\times 2\right]-\left[\frac{(-1)^6}{6}-\frac{2\times(-1)^3}{3}+9\times(-1)\right]$ | m1 | | F(2) – F(–1) unsimplified FT<br>"their terms" from integration |
| | $\left[\frac{64}{6}-\frac{16}{3}+18\right]-\left[\frac{1}{6}+\frac{2}{3}-9\right]$ | | | $=\frac{70}{3}-\left(-\frac{49}{6}\right)$ |
| | = 31.5<br>$\left(or\ \frac{189}{6}\ etc\right)$ | A1 | 5 | condone single fraction |
| **(ii)** | Area of trapezium = $\frac{1}{2}\times 3\times(6+'their'k)$ | B1√ | | = 58.5 when $k$ = 33 |
| | Shaded area = **Trapezium** – 'their' **(c)(i)** value | M1 | | |
| | = 27 | A1 | 3 | OE $eg\ \frac{162}{6}$ |
| | **Total** | | **15** | |
| **7(a)** | $(k-2)^2-4\times(2k-7)(k-3)$ | M1 | | discriminant – condone one slip<br>–condone omission of brackets |
| | $k^2-4k+4-4(2k^2-6k-7k+21)$ | A1 | | |
| | "their" $-7k^2+48k-80\geqslant 0$ | B1 | | real roots condition ; f($k$) $\geqslant$ 0<br>must appear before final line |
| | $7k^2-48k+80\leqslant 0$ | A1cso | 4 | **AG** (all working correct with no missing brackets etc) |
| **(b)** | $7k^2-48k+80=(7k-20)(k-4)$ | M1 | | correct factors<br>(or roots unsimplified) $\frac{48\pm\sqrt{64}}{14}$ |
| | critical values are 4 and $\frac{20}{7}$ | A1 | | accept $\frac{56}{14}$, $\frac{40}{14}$ etc here |
| |  | M1 | | sketch or sign diagram including values<br> |
| | $\frac{20}{7}\leqslant k \leqslant 4$<br>***Take their final line as their answer*** | A1cao | 4 | fractions must be simplified here |
| | **Total** | | **8** | |
| | **TOTAL** | | **75** | |