1   The point A has coordinates (7, 4). The straight lines with equations $x + 3y + 1 = 0$ and

$2x + 5y = 0$ intersect at B.

(a)   Find the gradient of AB.   **3**

(b)   Hence show that AB is perpendicular to only one of these two lines.   **5**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
1	a	3	C	1.1.1	CN	04/15
	b	5	C	1.1.9, 1.1.10		

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$\bullet^1$ ss : strategy for solving sim. equations

$\bullet^2$ pd : process

$\bullet^3$ pd : calculate gradient

$\bullet^4$ ss : use $m_1.m_2 = -1$

$\bullet^5$ ss : arrange in standard form

$\bullet^6$ ic : state gradient

$\bullet^7$ ic : state gradient

$\bullet^8$ ic : complete proof

Notes

1   For $\bullet^1$

Elimination may be used instead of substitution

Evidence of a start to elimination would be the appearance of equal coefficients of x or y.

2   For (a) equating the zeros, neither of the first two marks are available.

3   (5,–2) may be obtained by inspection or trial and improvement. If it is justified by checking in both equations, $\bullet^1$ and $\bullet^2$ may be awarded. If is not justified in both equations, award neither of the first two marks.

4   A general statement about perpendicular lines must have $m_1.m_2 = -1$ earns no marks

5   Candidates who make a mistake in (a) may have to show in (b) that neither line is perpendicular to AB. All five marks are available.

Primary Method : Give 1 mark for each •

$\bullet^1$ $x = -3y - 1$ and $attempt$ to $substitute$

$e.g.$ $2(-3y - 1) + ... = 0$

$\bullet^2$ $B(5, -2)$

$\bullet^3$ $m_{AB} = 3$

3 $marks$

$\bullet^4$ $m_{AB} = 3 \Rightarrow m_{perp} = -\frac{1}{3}$

$\bullet^5$ $y = -\frac{1}{3}x.....$ $stated$ / $implied$ by $\bullet^6$

$\bullet^6$ $m_{l_1} = -\frac{1}{3}$

$\bullet^7$ $m_{l_2} = -\frac{2}{5}$

$\bullet^8$ so only the 1st line is perpendicular to AB

5 $marks$

---

1 Alternative Method for •4 to •8

$\bullet^4$ $y = -\frac{1}{3}x...$ may be $implied$ by $\bullet^5$

$\bullet^5$ $m_{l_1} = -\frac{1}{3}$

$\bullet^6$ $m_{l_2} = -\frac{2}{5}$

$\bullet^7$ $l_1 : 3 \times -\frac{1}{3} = -1$ so $AB \perp l_1$

$\bullet^8$ and AB is not $\perp l_2$

5 $marks$

---

2 Alternative Method for •4 to •8

$\bullet^4$ $m_{AB} = 3 \Rightarrow m_{perp} = -\frac{1}{3}$

$\bullet^5$ $y = -\frac{2}{5}x$ $stated$ / $implied$ by $\bullet^6$

$\bullet^6$ $m_{l_1} = -\frac{2}{5}$

$\bullet^7$ $m_{l_2} = -\frac{1}{3}$

$\bullet^8$ so only the 2nd line is perpendicular to AB

5 $marks$

1   The point A has coordinates $(7, 4)$. The straight lines with equations $x + 3y + 1 = 0$ and

$2x + 5y = 0$ intersect at B.

    (a) Find the gradient of AB.   **3**

    (b) Hence show that AB is perpendicular to only one of these two lines.   **5**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
1	a	3	C	1.1.1	CN	04/15
	b	5	C	1.1.9, 1.1.10		

continued from page 5

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3 Alternative Method for •4 to •8

- •⁴ $m_{perp} = -\frac{1}{3}$
- •⁵   strat: find equ. thr' B with gradient $-\frac{1}{3}$
- •⁶ $y - (-2) = -\frac{1}{3}(x - 5)$
- •⁷   *leading to* $3y + x + 1 = 0$
- •⁸   the first line is the ONLY line perp. to AB

         5 marks

---

4 Alternative Method for •4 to •8

- •⁴ $y = -\frac{1}{3}x...$ may be implied by   •⁵
- •⁵ $m_{l_1} = -\frac{1}{3}$
- •⁶ $m_{l_2} = -\frac{2}{5}$
- •⁷ $l_1 : 3 \times -\frac{1}{3} = -1$ *so AB is the* **ONLY** *line* $\perp l_1$
- •⁸   *implied by the* "**ONLY**" *at* •⁷.

         5 marks

---

5 A "Poor" illustration

$\left. \begin{matrix} y = -\frac{1}{3}x... \\ y = -\frac{2}{5}x \end{matrix} \right]$ 1 *mark*

$\left. \begin{matrix} \text{1st equ is perp. to AB} \\ \text{2nd equ is not perp to AB} \end{matrix} \right]$ 1 *mark*

---

6 Further illustrations

AB is perp. to $x + 3y + 1 = 0$
because $3 \times -\frac{1}{3} = -1$ •⁴ *only*
$[end!]$

AB is perp. to $x + 3y + 1 = 0$
as its gradient is $-\frac{1}{3}$ •⁴ (& •⁵)
and AB is $3 \Leftrightarrow 3 \times -\frac{1}{3} = -1$
     all of the above writing   •⁷

AB is perp. to the line $y = -\frac{1}{3}...$ •⁵
because $3 \times -\frac{1}{3} = -1$ •⁴
     all of the above writing   •⁷

2        $f(x) = x^3 - x^2 - 5x - 3$.

    (*a*)   (i)   Show that $(x + 1)$ is a factor of $f(x)$.

          (ii)   Hence or otherwise factorise $f(x)$ fully.

    (*b*)   One of the turning points of the graph of $y = f(x)$ lies on the x-axis.

        Write down the coordinates of this turning point .

5

1

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
2	a	5	C	2.1.3	NC	04/58
	b	1	C	2.1.3		

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$\bullet^1$ ss : know to find $f(-1)$

$\bullet^2$ ss : start eg synthetic division

$\bullet^3$ pd : complete to zero remainder

$\bullet^4$ ic : extract quadratic

$\bullet^5$ ic : fully factorise

$\bullet^6$ ic : state coordinates

Primary Method : Give 1 mark for each •

$\bullet^1$ *know to find* $f(-1)$

$\bullet^2$ -1 | 1 -1 -5 -3 |
            | -1 |

. 1

$\bullet^3$ -1 | 1 -1 -5 -3 |
          | -1 2 3 |

. 1 -2 -3 0

$\bullet^4$ $x^2 - 2x - 3$

$\bullet^5$ $(x+1)(x+1)(x-3)$

                     5 marks

$\bullet^6 (-1,0)$

                     1 mark

---

1 Alternative Method 1 for •1 , •2 and •3

$\bullet^1$ *know to find* $f(-1)$

$\bullet^2$ $f(-1) = (-1)^3 - (-1)^2 - 5(-1) - 3 = 0$

$\bullet^3$ *a strategy for finding the quadratic factor*
      eg inspection, long division, synthetic division

Notes

1 Treat $f(x) = (x+1),(x+1),(x-3)$ as bad form

2 $\bullet^6$ is not available for

       "(–1,0) or (3, 0)"

       "$x = -1$"

       an unsupported "(0,–1)"

3 Treat | $x = -1$ |
         | $y = ... = 0$ | as bad form
         | so point $= (0,-1)$ |

3　　　Find all the values of x in the interval $0 \leq x \leq 2\pi$ for which $\tan^2\left(x\right) = 3$.　　　**4**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
3		4	C	1.2.9, 1.2.11	NC	04/85

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$\bullet^1$ ss :　know to get the square root

$\bullet^2$ pd :　solve trig equation

$\bullet^3$ pd :　solve trig equation

$\bullet^4$ ic :　know there is $+\sqrt{}$ and $-\sqrt{}$

Primary Method : Give 1 mark for each •

$\bullet^1$　$\tan x = \sqrt{3}$

$\bullet^2$　$x = \dfrac{\pi}{3}$

$\bullet^3$　$x = \dfrac{4\pi}{3}$

$\bullet^4$　$\tan x = -\sqrt{3}$　　　stated explicitly

　　and $x = \dfrac{2\pi}{3}, \dfrac{5\pi}{3}$

　　　　　　　　　　　　　　4 *marks*

---

1 Alternative Method for •1 and •2

$\bullet^1$　$\tan x = \sqrt{3}$

$\bullet^2$　$x = \dfrac{\pi}{3}$

$\bullet^3$　$\tan x = -\sqrt{3}$ **and** $x = \dfrac{2\pi}{3}$

$\bullet^4$　$\dfrac{4\pi}{3}$　**and** $\dfrac{5\pi}{3}$

　　　　　　　　　　　　　　4 *marks*

Notes

1　Candidates must produce final answers in radians. If their final answer(s) are in degrees then deduct one mark.

2　**Cave**

Candidates who produce the four correct answers from $\tan(x) = \sqrt{3}$ can only be awarded $\bullet^1$ and $\bullet^2$.

3　Do not penalise "correct" answers outside the range $0 \leq x \leq 2\pi$

4　Do **NOT** accept $\pi + \dfrac{\pi}{3}$ for $\dfrac{4\pi}{3}$.

4   The diagram shows the graph of $y = g(x)$.

    (a)   Sketch the graph of $y = -g(x)$.   **2**

    (b)   On the same diagram sketch the graph of $y = 3 - g(x)$.   **2**
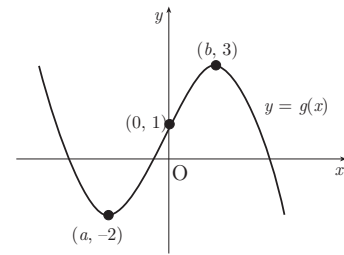
| Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
4	a	2	C	1.2.4	CN	04/6
	b	2	C	1.2.4		

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$\bullet^1$ ic :   sketch transformed graph

$\bullet^2$ ic :   show new coordinates

$\bullet^3$ ic :   sketch transformed graph

$\bullet^4$ ic :   show new coordinates

Primary Method : Give 1 mark for each $\bullet$

$\bullet^1$ reflection in x-axis and any one from
   $(0,-1),(a,2),(b,-3)$ clearly annotated

$\bullet^2$ the remaining two from the above list

                                           2 marks

$\bullet^3$ translation and any one from
   $(0,2),(a,5),(b,0)$ clearly annotated

$\bullet^4$ the remaining two from the above list

                                           2 marks

solution
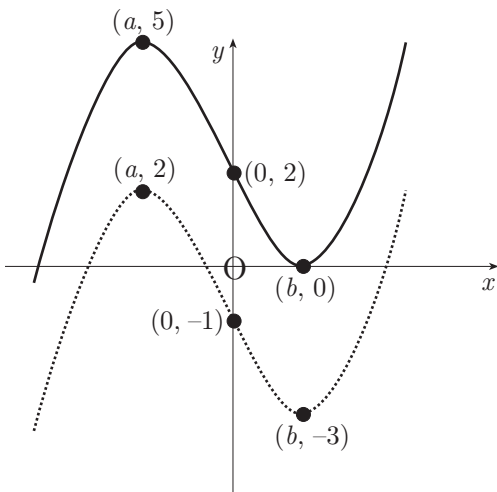
Notes

1   For (a), reflection in the y-axis earns a maximum of 1 out of 2 with all 3 points clearly annotated

2   For (b), a translation of $\begin{pmatrix} 0 \\ -3 \end{pmatrix}$ earns a maximum of 1 out of 2 with all 3 points clearly annotated

3   For (b), a translation of $\begin{pmatrix} \pm 3 \\ 0 \end{pmatrix}$ earns no marks.

4   For the annotated points in (a) and (b), accept a superimposed grid.

5    $g(x)$ needs to retain its cubic shape for $\bullet^1$ and $\bullet^2$

6   In (b) $\bullet^3$ and $\bullet^4$ are only available for applying the translation to the resulting graph from (a).

5   A,B, and C have coordinates $(-3, 4, 7)$, $(-1, 8, 3)$, and $(0, 10, 1)$ respectively.

   (a)   Show that A, B, and C are collinear.   **3**

   (b)   Find the coordinates of D such that $\overrightarrow{AD} = 4\overrightarrow{AB}$.   **2**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
5	a	3	C	3.1.7	CN	04/n
	b	2	B	3.1.6		

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$\bullet^1$ ss :   use vector approach eg for $\overrightarrow{AB}$

$\bullet^2$ ic :   compare two vectors

$\bullet^3$ ic :   complete proof

$\bullet^4$ pd :   find multiple of vector

$\bullet^5$ ic :   interpret vector

Primary Method : Give 1 mark for each •

$\bullet^1 \quad \overrightarrow{AB} = \begin{pmatrix} 2 \\ 4 \\ -4 \end{pmatrix}$

$\bullet^2 \quad \overrightarrow{AC} = \begin{pmatrix} 3 \\ 6 \\ -6 \end{pmatrix} = \frac{3}{2} \times \overrightarrow{AB}$

$\bullet^3 \quad \overrightarrow{AB}$ & $\overrightarrow{AC}$ have <u>common</u>
<u>direction</u> and <u>common point</u>
Hence A,B and C collinear

                                            3 *marks*

$\bullet^4 \quad \overrightarrow{AD} = \begin{pmatrix} 8 \\ 16 \\ -16 \end{pmatrix}$

$\bullet^5 \quad D = (5, 20, -9)$

                                            2 *marks*

2 Alternative Method for •1 and •2

eg

$\bullet^1 \quad \overrightarrow{AB} = \begin{pmatrix} 2 \\ 4 \\ -4 \end{pmatrix} = 2\begin{pmatrix} 1 \\ 2 \\ -2 \end{pmatrix}$

$\bullet^2 \quad \overrightarrow{AC} = \begin{pmatrix} 3 \\ 6 \\ -6 \end{pmatrix} = 3\begin{pmatrix} 1 \\ 2 \\ -2 \end{pmatrix}$

3 Alternative Method for •4

$\bullet^4 \quad \boldsymbol{d} - \boldsymbol{a} = 4(\boldsymbol{b} - \boldsymbol{a}) \Rightarrow \boldsymbol{d} = 4\boldsymbol{b} - 3\boldsymbol{a}$
or

$\bullet^4 \quad \boldsymbol{d} - \boldsymbol{a} = 4(\boldsymbol{b} - \boldsymbol{a}) \Rightarrow \boldsymbol{d} - \boldsymbol{a} = \begin{pmatrix} 8 \\ 16 \\ -16 \end{pmatrix}$

1 Alternatives Method for •1 and •2

$\bullet^1 \quad \overrightarrow{BC} = \begin{pmatrix} 1 \\ 2 \\ -2 \end{pmatrix}$ $\bullet^1 \quad \overrightarrow{AB} = \begin{pmatrix} 2 \\ 4 \\ -4 \end{pmatrix}$

$\bullet^2 \quad \overrightarrow{AC} = \begin{pmatrix} 3 \\ 6 \\ -6 \end{pmatrix} = 3 \times \overrightarrow{BC}$ $\bullet^2 \quad \overrightarrow{BC} = \begin{pmatrix} 1 \\ 2 \\ -2 \end{pmatrix} = \frac{1}{2} \times \overrightarrow{AB}$

Notes

1   Treat D= $\begin{pmatrix} 5 \\ 20 \\ -9 \end{pmatrix}$ as bad form.

2   For $\bullet^3$ accept **ONLY** "parallel" in lieu of "common direction"

6   Given that $y = 3\sin(x) + \cos(2x)$, find $\dfrac{dy}{dx}$.   **3**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
6		3	B	3.2.1	CN	04/n

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$\bullet^1$ pd : process simple derivative

$\bullet^2$ pd : start to process compound derivative

$\bullet^3$ ic :   complete compound derivative

Primary Method : Give 1 mark for each •

$\bullet^1$ $3\cos(x)$

$\bullet^2$ $-\sin(2x)$

$\bullet^3$ $\times 2$

3 marks

1 Alternative Methods

e.g.

$y = 3\sin(x) + 2\cos^2(x) - 1$

$\bullet^1$ $3\cos(x)$

$\bullet^2$ $4\cos(x)$

$\bullet^3$ $\times -\sin(x)$ and no further terms

3 marks

Notes

1   For differentiating incorrectly:

For $y' = -3\cos(x) + 2\sin(2x)$, only $\bullet^3$ may be awarded.

2   For $y' = 3\cos(x) - 2\sin(2x) + c$, treat the "+c" as bad form.

3   For clearly integrating correctly or otherwise: Award no marks.

4   If you cannot decide whether a candidate has attempted to differentiate or integrate, assume they have attempted to differentiate.

7   Find $\displaystyle\int_0^2 \sqrt{4x+1}\ dx$.   **5**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
7		5	AB	3.2.3	CN	04/52

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$\bullet^1$ ic :   express in integrable form

$\bullet^2$ pd : integrate a composite fractional power

$\bullet^3$ ic :   interpret the '4'

$\bullet^4$ ic :   substitute limts

$\bullet^5$ pd : evaluate

Primary Method : Give 1 mark for each •

$\bullet^1$ $\left(4x+1\right)^{\frac{1}{2}}$

$\bullet^2$ $\dfrac{1}{\frac{3}{2}}\left(4x+1\right)^{\frac{3}{2}}$

$\bullet^3$ $\div 4$

$\bullet^4$ $\dfrac{1}{6}\left(4\times2+1\right)^{\frac{3}{2}}-\dfrac{1}{6}\left(4\times0+1\right)^{\frac{3}{2}}$

$\bullet^5$ $\dfrac{13}{3}$ *or equivalent fraction or mixed number*

5 marks

1 Common wrong solution

$\bullet^1$ $\checkmark$ $\displaystyle\int \left(4x+1\right)^{\frac{1}{2}} dx$

$\bullet^2$ $\times$ $\displaystyle\int \left(4x^{\frac{1}{2}}+1^{\frac{1}{2}}\right) dx$

$\bullet^3$ $\times$ $\dfrac{4x^{\frac{3}{2}}}{\frac{3}{2}}+x$

$\bullet^4$ $\checkmark$ $\left(\dfrac{4.2^{\frac{3}{2}}}{\frac{3}{2}}+2\right)-\left(\dfrac{4.0^{\frac{3}{2}}}{\frac{3}{2}}+0\right)$

$\bullet^5$ $\checkmark$ $\dfrac{16\sqrt{2}}{3}+2$

3 marks awarded

Notes

1 $\bullet^4$ is available for substituting the limits correctly into any function except the original one.

eg $\displaystyle\int_0^2\left(4x+1\right)^{\frac{1}{2}}dx$

$=\left[\left(4x+1\right)^{\frac{1}{2}}\right]_0^2$

$=\left(4\times2+1\right)^{\frac{1}{2}}-\left(4\times0+1\right)^{\frac{1}{2}}$

$=3-1$

$=2$

may be awarded $\bullet^1$, not $\bullet^2$ (no integration)

not $\bullet^3$ (not dealing with $f(g(x))$)

not $\bullet^4$ (original function)

not $\bullet^5$ (working eased)

2 For $\bullet^5$, **DO NOT accept** answers like $\dfrac{\sqrt{729}}{6}-\dfrac{1}{6}$.

8   (a)   Write $x^2 - 10x + 27$ in the form $\left(x+b\right)^2 + c$.   **2**

       (b)   Hence show that the function $g(x) = \frac{1}{3}x^3 - 5x^2 + 27x - 2$ is always increasing.   **4**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
8	a	2	C	1.2.8	NC	04/37
	b	4	B	1.3.11		

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- $\bullet^1$ pd : deal with the 'b'
- $\bullet^2$ pd : deal with the 'c'
- $\bullet^3$ ss : use differentiation
- $\bullet^4$ pd : differentiate
- $\bullet^5$ ss : use previous working
- $\bullet^6$ ic : complete proof

Primary Method : Give 1 mark for each •

- $\bullet^1$ $\left(x-5\right)^2 \ldots$
- $\bullet^2$ $\left(x-5\right)^2 + 2$

  2 marks

- $\bullet^3$ $g'(x) =$ *STATED EXPLICITLY*
- $\bullet^4$ $x^2 - 10x + 27$
- $\bullet^5$ $\left(x-5\right)^2 + 2$
- $\bullet^6$ $g'(x) > 0$ for all x
  and so $g(x)$ increasing

  4 marks

---

1 Alternative Method for •3 to •6

- $\bullet^3$ $g'(x) =$ *STATED EXPLICITLY*
- $\bullet^4$ $x^2 - 10x + 27$
- $\bullet^5$ $b^2 - 4ac = 100 - 108 = -8$
- $\bullet^6$ no roots, concave up, $g'(x) > 0$
  and thus $g(x)$ increasing

  4 marks

Notes

1   For $\bullet^6$, accept $g'(x) > 2$ in lieu of $g'(x) > 0$

2   Evaluating $g(1), \ g(2) \ etc \ or \ g'(1), g'(2) \ etc$ gains no
       credit.

9   Solve the equation $\log_2(x+1) - 2\log_2(3) = 3$.   **4**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
9		4	AB	3.3.4	NC	04/57

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- $\bullet^1$ ic :   use log laws

- $\bullet^2$ ic :   use log laws

- $\bullet^3$ ic :   express in exponential form

- $\bullet^4$ pd : process

Primary Method : Give 1 mark for each •

- $\bullet^1$ $-\log_2 3^2$
- $\bullet^2$ $\log_2\left(\dfrac{x+1}{3^2}\right) = 3$
- $\bullet^3$ $\dfrac{x+1}{3^2} = 2^3$
- $\bullet^4$ $x = 71$

4 marks

---

1 Alternative Method

- $\bullet^1$ $\log_2(x+1) - 2\log_2 3 = 3\log_2 2$
- $\bullet^2$ $\log_2(x+1) = \log_2 2^3 + \log_2 3^2$
- $\bullet^3$ $\log_2(x+1) = \log_2\left(2^3 \times 3^2\right)$
- $\bullet^4$ $x = 71$

4 marks

10   In the diagram,

angle DEC = angle CEB = $x°$ and

angle CDE = angle BEA = 90°. CD = 1 unit; DE = 3 units.

By writing angle DEA in terms of $x°$, find the exact value of $\cos\left(D\hat{E}A\right)$.   **7**
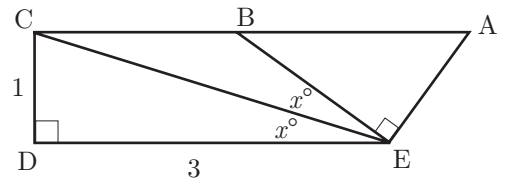
Qu. 10	part	marks 7	Grade B	Syllabus Code 2.3.2, 2.3.3	Calculator class CN	Source 04/33

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$\bullet^1$ ic :   interpret diagram

$\bullet^2$ pd : expand trig expression

$\bullet^3$ pd : simplify

$\bullet^4$ ss :   use appropriate formula

$\bullet^5$ pd : process

$\bullet^6$ ic :   interpret

$\bullet^7$ pd : simplify

Primary Method : Give 1 mark for each •

- $\bullet^1$ $D\hat{E}A = (2x° + 90°)$
- $\bullet^2$ $\cos(2x°)\cos(90°) - \sin(2x°)\sin(90°)$
- $\bullet^3$ $-\sin(2x°)$
- $\bullet^4$ $-2\sin(x°)\cos(x°)$
- $\bullet^5$ $CE = \sqrt{1^2 + 3^2} = \sqrt{10}$ *stated / implied by $\bullet$6*
- $\bullet^6$ $\sin(x°) = \left(\frac{1}{\sqrt{10}}\right)$

  and $\cos(x°) = \frac{3}{\sqrt{10}}$
- $\bullet^7$ $\cos D\hat{E}A = -2\left(\frac{1}{\sqrt{10}}\right)\left(\frac{3}{\sqrt{10}}\right) = -\frac{6}{10}$

          7 marks

Note

1   Although unusual, it would be perfectly acceptable for a candidate to go from $\bullet^1$ to $\bullet^3$ without expanding (via knowledge of transformations). In this case $\bullet^2$ would awarded by default.

---

2 another common wrong solution

- $\bullet^1 \checkmark$ $D\hat{E}A = (2x° + 90°)$

  $\cos(2x° + 90°)$
- $\bullet^2 \times$ $\cos(2x°) + \cos(90°)$
- $\bullet^3 \times$ $\cos(2x°)$ *[working eased]*
- $\bullet^4 \checkmark$ *eg* $2\cos^2 x - 1$
- $\bullet^5 \checkmark$ $CE = \sqrt{1^2 + 3^2} = \sqrt{10}$ *stated / implied by $\bullet$6*
- $\bullet^6 \checkmark$ $\cos(x°) = \frac{3}{\sqrt{10}}$
- $\bullet^7 \checkmark$ $\cos D\hat{E}A = 2\left(\frac{3}{\sqrt{10}}\right)\left(\frac{3}{\sqrt{10}}\right) - 1 = \frac{8}{10}$

          5 marks awarded

---

1 common wrong solution

- $\bullet^1 \checkmark$ $D\hat{E}A = (2x° + 90°)$
- $\bullet^2 \checkmark$ $\cos(2x°)\cos(90°) - \sin(2x°)\sin(90°)$

  $\cos(2x°) \times 1 - \sin(2x°) \times 0$
- $\bullet^3 \times$ $\cos(2x°)$
- $\bullet^4 \checkmark$ *eg* $2\cos^2 x - 1$
- $\bullet^5 \checkmark$ $CE = \sqrt{1^2 + 3^2} = \sqrt{10}$ *stated / implied by $\bullet$6*
- $\bullet^6 \checkmark$ $\cos(x°) = \frac{3}{\sqrt{10}}$
- $\bullet^7 \checkmark$ $\cos D\hat{E}A = 2\left(\frac{3}{\sqrt{10}}\right)\left(\frac{3}{\sqrt{10}}\right) - 1 = \frac{8}{10}$
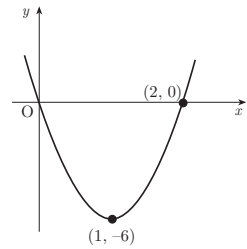
          6 marks awarded

11   **T**he diagram shows a parabola passing through the points $(0, 0)$, $(1, -6)$ and $(2, 0)$.

(a)   The equation of the parabola is of the form $y = ax(x - b)$.

Find the values of a and b.

(b)   This parabola is the graph of $y = f'(x)$.

Given that $f(1) = 4$, find the formula for $f(x)$.

3

5

(2, 0)

(1, –6)

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
11	a	3	B	2.1.10	CN	04/57
	b	5	A	2.2.8		

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$\bullet^1$ ss :   use parabolic form

$\bullet^2$ pd : substitute

$\bullet^3$ pd : process

$\bullet^4$ ss :   know to integrate

$\bullet^5$ pd : express in integrable form

$\bullet^6$ pd : integrate

$\bullet^7$ ss :   introduce constant and substitute

$\bullet^8$ pd : process

Primary Method : Give 1 mark for each •

$\bullet^1$ $b = 2$ or $y = ax(x - 2)$

$\bullet^2$ substitute $(1, -6)$

$\bullet^3$ $a = 6$

3 marks

$\bullet^4$ $f(x) = \int \left(6x(x - 2)\right)dx$

$\bullet^5$ $\int \left(6x^2 - 12x\right)dx$

$\bullet^6$ $2x^3 - 6x^2$

$\bullet^7$ $4 = 2 \times 1^3 - 6 \times 1^2 + c$

$\bullet^8$ $c = 8$

5 marks

Notes

1   In the primary method, •3 must be justified.
A "guess and check" would be acceptable ie guess $a = 6$ then check that $(1, –6)$ fits the equation.

2   In the primary method, •5 is only available if an intention to integrate has been indicated.

3   For candidates who fail to complete (a) but produce values for a and b ex nihilo, 5 marks are available in (b). A deduction of 1 mark may be made if their choice eases the working.

4   For candidates who retain "a" and "b" in part (b), marks $\bullet^4$ to $\bullet^7$ are available.

5   **CAVE**

$\int_{0}^{2} 6x(x - 2)dx = \left[2x^3 - 6x^2\right]_{0}^{2} = -8$ may be

awarded $\bullet^4$, $\bullet^5$ and $\bullet^6$.

1 Alternative Method for •1 to •3

$\bullet^1$ two simultaneous equations
$2a(2 - b) = 0$ *and* $a(1 - b) = -6$

$\bullet^2$ $b = 2$

$\bullet^3$ $a = 6$

3 marks

2 Alternative Method for •1 to •3

$\bullet^1$ $y = k(x - 1)^2 - 6$

$\bullet^2$ $0 = k(2 - 1)^2 - 6 \Rightarrow k = 6$

$\bullet^3$ $y = 6(x - 1)^2 - 6 \Rightarrow y = 6x(x - 2)$

3 marks

		IQs of a group of students

S1   The IQs of a group of students were measured and the scores recorded in the stem-and-leaf diagram as shown. Identify any outliers.

replacing qu.5 (in position 1)

10	2 3 5 5 6 8 8	
	9	
11	0 0 2 3 5 6 7	**4**
	9	
12	1 3	
13	2 6	

$n=20$ 10 $\mid$ 2   means 102

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
S1		4	C	4.1.2, 4.1.3	CN	04/61

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- $\bullet^1$ pd : calculate quartiles
- $\bullet^2$ ss : know how to calculate fences
- $\bullet^3$ pd : calculate fence/interpret outlier
- $\bullet^4$ pd : calculate fence/interpret outlier

Primary Method : Give 1 mark for each •

- $\bullet^1$ $Q_1 = 107, Q_3 = 118$
- $\bullet^2$ *eg lower fence* $= Q_1 - 1 \cdot 5(Q_3 - Q_1)$
- $\bullet^3$ *fence* $= 90.5$
- $\bullet^4$ *fence* $= 134.5 \,\&\, 136$ *is outlier*

4 marks

S2   Calculate the mean and variance of the discrete random variable X whose probability distribution is as follows:

x	0	1	2	3
$P(X = x)$	0.4	0.3	0.2	0.1

6

replacing qu.6

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
S2		6	C	4.2.12	NC	04/66

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- $\bullet^1$ ss : know and state rule for mean
- $\bullet^2$ pd : calculate mean
- $\bullet^3$ ss : know/state rule for variance
- $\bullet^4$ ss : know how to find $E(X^2)$
- $\bullet^5$ pd : calculate $E(X^2)$
- $\bullet^6$ pd : calculate variance

Primary Method : Give 1 mark for each •

- $\bullet^1$ $E(X) = \Sigma x p(x)$
- $\bullet^2$ $\Sigma x p(x) = 1$
- $\bullet^3$ $V(X) = E(X^2) - \left(E(X)\right)^2$
- $\bullet^4$ $E(X^2) = \Sigma x^2 p(x)$
- $\bullet^5$ $\Sigma x^2 p(x) = 2$
- $\bullet^6$ $V(X) = 1$

6 marks

S3   The committee of New Tron Golf Club consists of 15 men and 10 women which reflects the

proportions of men and women who are members of the club.

It is agreed to send a delegation of 10 committee members to a local planning meeting. The

members of the delegation are to be chosen at random and will consist of 6 men and 4 women.

What is the probability that both committee members Mr Hook and Miss Green will be selected?   **4**

replacing qu.7

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
S3		4	C	4.2.3, 4.2.7	NC	04/67

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- $\bullet^1$ ic :   interpret probability

- $\bullet^2$ ic :   interpret probability

- $\bullet^3$ ss :   know to multiply for independent events

- $\bullet^4$ pd : process

Primary Method : Give 1 mark for each •

- $\bullet^1$ $P(man) = \frac{6}{15}$
- $\bullet^2$ $P(lady) = \frac{4}{10}$
- $\bullet^3$ $multiply$
- $\bullet^4$ $\frac{6}{15} \times \frac{4}{10} = \frac{4}{25}$

4 marks

1   Alternative Method

- $\bullet^1$ $eg \; ^{15}C_6$
- $\bullet^2$ $^{15}C_6 \times ^{10}C_4$
- $\bullet^3$ $^{14}C_5 \times ^9 C_3$
- $\bullet^4$ $\frac{\frac{14!}{5!9!} \cdot \frac{9!}{3!6!}}{\frac{15!}{6!9!} \cdot \frac{10!}{4!6!}} = \frac{4}{25}$

4 marks

S4   The cumulative distribution function for a random variable X is given by

$$F(x) = \begin{cases} \frac{1}{32}x^2\left(6-x\right) & 0 \le x \le 4 \\ \\ 0 & \text{otherwise} \end{cases}$$

Show that the median is 2.   **3**

replacing qu.9

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
S4		3	AB	4.3.3, 4.3.5, 2.1.3	NC	04/70

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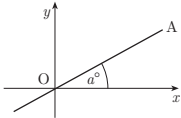METHOD OR ANY ALTERNATIVE METHOD SHOWN IN DETAIL IN
THE MARKING SCHEME.

•¹ ss :   know where median is

•² pd :   substitute

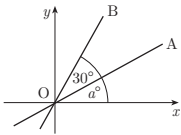•³ ic :   interpret result

Primary Method : Give 1 mark for each •

•¹ $F(median) = \frac{1}{2}$

•² $F(2) = \frac{1}{32} \times 2^2 \times \left(6-2\right)$

•³ $F(2) = \frac{1}{2}$, *hence median* $= 2$

3 marks

1   (*a*) The diagram shows line OA with equation $x - 2y = 0$.

The angle between OA and the *x*-axis is $a°$.

Find the value of *a*.   **3**

(*b*) The second diagram shows lines OA and OB. The angle between these

two lines is $30°$.

Calculate the gradient of line OB correct to 1 decimal place.   **1**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
1	a	3	C	1.1.3	CR	04/81
	b	1	C	1.1.3		

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$\bullet^1$ ic : find gradient of a line

$\bullet^2$ ss : know gradient =tan(angle) and apply

$\bullet^3$ pd : process

$\bullet^4$ pd : process angle=$\tan^{-1}$(angle)

Primary Method : Give 1 mark for each •

$\bullet^1$ gradient $= \frac{1}{2}$

$\bullet^2$ $\tan a° =$ gradient   stated or implied by $\bullet^3$

$\bullet^3$ $\tan^{-1}\left(\frac{1}{2}\right) = 26.6°$

                                                            3 *marks*

$\bullet^4$ $m_{l_2} = \tan\left(30 + 26.6\right)° = 1\cdot 5$

                                                            1 *mark*

1	Common Error no.1

$m = -2$ $\times \ \bullet 1$

$\tan a° = m$ $\sqrt{} \ \bullet 2$

$a = \tan^{-1}(-2) = 116.6$ $\sqrt{} \ \bullet 3$

2	Common Error no.2

$m = 1$ $\times \ \bullet 1$

$\tan a° = m$ $\sqrt{} \ \bullet 2$

$a = \tan^{-1}(1) = 45$ $\sqrt{} \ \bullet 3$

3	Common Error no.3

$m = -2$ $\times \ \bullet 1$

$\tan a° = m$ $\sqrt{} \ \bullet 2$

$a = \tan^{-1}(-2) = -63.4 \ or \ 63.4$ $\times \ \bullet 3$

Notes

1   Accept any answer in (a) rounded correctly, so that

e.g.   if $a = 27°$ (OK)

$m_{OB} = \tan(30+27)° = 1.5$

2   A candiate who states $m = \tan\theta$, and does not go

on to use it, cannot be awarded •2.

3   Treat $\tan\left(\frac{1}{2}\right) = 26\cdot 6°$ as very bad form.

4   In (b) do not penalise "not rounding to 1 d.p." but

accept any correct answer which rounds to 1.5

2   P,Q and R have coordinates (1, 3, –1), (2, 0, 1) and (–3, 1, 2) respectively.

    (*a*) Express the vectors $\overrightarrow{QP}$ and $\overrightarrow{QR}$ in component form.   **2**

    (*b*) Hence or otherwise find the size of angle PQR.   **5**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
2	a	2	C	3.1.8	CR	04/117
	b	5	C	3.1.9, 3.1.11		

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$\bullet^1$ ic : interpret coordinates to vectors

$\bullet^2$ ic : interpret coordinates to vectors

$\bullet^3$ ss : know to use eg scalar product

$\bullet^4$ pd : process scalar product

$\bullet^5$ pd : process length

$\bullet^6$ pd : process length

$\bullet^7$ pd : process angle

Note

1 in (a)

  For calculating $\overrightarrow{PQ}$ and $\overrightarrow{RQ}$, award

  1 mark (out of 2)

2 in (a)

  Treat e.g. (–1, 3, –2) as bad form

3 For candidates who do not attempt $\bullet 7$:

  the formula quoted at $\bullet 3$ in both methods

  must relate to the labelling in the

  question to earn $\bullet 3$

Primary Method : Give 1 mark for each •

$\bullet^1$ $\overrightarrow{QP} = \begin{pmatrix} -1 \\ 3 \\ -2 \end{pmatrix}$

$\bullet^2$ $\overrightarrow{QR} = \begin{pmatrix} -5 \\ 1 \\ 1 \end{pmatrix}$

            2 marks

$\bullet^3$ $\cos PQR = \dfrac{\overrightarrow{QP}.\overrightarrow{QR}}{\left|\overrightarrow{QP}\right| \times \left|\overrightarrow{QR}\right|}$ stated or implied by •7

$\bullet^4$ $\overrightarrow{QP}.\overrightarrow{QR} = 6$

$\bullet^5$ $\left|\overrightarrow{QP}\right| = \sqrt{14}$

$\bullet^6$ $\left|\overrightarrow{QR}\right| = \sqrt{27}$

$\bullet^7$ $P\hat{Q}R = 72.0°$

            5 marks

Alternative Method 1 for •3 and •7

$\bullet^3$ $\cos P\hat{Q}R = \dfrac{p^2 + r^2 - q^2}{2pr}$ stated or implied by •7

$\bullet^4$ $q = \sqrt{29}$

$\bullet^5$ $r = \sqrt{14}$

$\bullet^6$ $p = \sqrt{27}$

$\bullet^7$ $P\hat{Q}R = 72.0°$

           5 marks

CONTINUED

2   P,Q and R have coordinates $(1, 3, -1)$, $(2, 0, 1)$ and $(-3, 1, 2)$ respectively.

    (a) Express the vectors $\overrightarrow{QP}$ and $\overrightarrow{QR}$ in component form.   **2**

    (b) Hence or otherwise find the size of angle PQR.   **5**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
2	a	2	C	3.1.8	CR	04/117
	b	5	C	3.1.9, 3.1.11		

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3 Common errors no.1

$\bullet^3$ $\cos POR = \dfrac{\overrightarrow{OP}.\overrightarrow{OR}}{\left|\overrightarrow{OP}\right| \times \left|\overrightarrow{OR}\right|}$ stated or implied by $\bullet 7$

$\bullet^4$ $\overrightarrow{OP}.\overrightarrow{OR} = -2$

$\bullet^5$ $\left|\overrightarrow{OP}\right| = \sqrt{11}$

$\bullet^6$ $\left|\overrightarrow{OR}\right| = \sqrt{14}$

$\bullet^7$ $P\hat{O}R = 99.3° \ or \ 1.733^c$

       4 marks awarded : deduct 1 per error

---

4 Common errors no.2

$\bullet^3$ $\cos QOR = \dfrac{\overrightarrow{OQ}.\overrightarrow{OR}}{\left|\overrightarrow{OQ}\right| \times \left|\overrightarrow{OR}\right|}$ stated or implied by $\bullet 7$

$\bullet^4$ $\overrightarrow{OQ}.\overrightarrow{OR} = -4$

$\bullet^5$ $\left|\overrightarrow{OQ}\right| = \sqrt{5}$

$\bullet^6$ $\left|\overrightarrow{OR}\right| = \sqrt{14}$

$\bullet^7$ $Q\hat{O}R = 118.6° \ or \ 2.069^c$

       3 marks awarded : deduct 1 per error

---

5 Common errors no.3

$\bullet^3$ $\cos QOP = \dfrac{\overrightarrow{OQ}.\overrightarrow{OP}}{\left|\overrightarrow{OQ}\right| \times \left|\overrightarrow{OP}\right|}$ stated or implied by $\bullet 7$

$\bullet^4$ $\overrightarrow{OQ}.\overrightarrow{OP} = 1$

$\bullet^5$ $\left|\overrightarrow{OQ}\right| = \sqrt{11}$

$\bullet^6$ $\left|\overrightarrow{OP}\right| = \sqrt{5}$

$\bullet^7$ $Q\hat{O}R = 82.3° \ or \ 1.436^c$

       3 marks awarded : deduct 1 per error

---

6 Common errors no.4

$\bullet^3$ $\cos P\hat{R}Q = \dfrac{\overrightarrow{RP}.\overrightarrow{RQ}}{\left|\overrightarrow{RP}\right| \times \left|\overrightarrow{RQ}\right|}$ stated or implied by $\bullet 7$

$\bullet^4$ $\overrightarrow{RP}.\overrightarrow{RQ} = 21$

$\bullet^5$ $\left|\overrightarrow{RP}\right| = \sqrt{29}$

$\bullet^6$ $\left|\overrightarrow{RQ}\right| = \sqrt{27}$

$\bullet^7$ $P\hat{R}Q = 41.4° \ or \ \ 0.722^c$

       3 marks awarded : deduct 1 per error

---

7 Common errors no.5

$\bullet^3$ $\cos R\hat{P}Q = \dfrac{\overrightarrow{PR}.\overrightarrow{PQ}}{\left|\overrightarrow{PR}\right| \times \left|\overrightarrow{PQ}\right|}$ stated or implied by $\bullet 7$

$\bullet^4$ $\overrightarrow{PR}.\overrightarrow{PQ} = 8$

$\bullet^5$ $\left|\overrightarrow{PR}\right| = \sqrt{14}$

$\bullet^6$ $\left|\overrightarrow{PQ}\right| = \sqrt{29}$

$\bullet^7$ $R\hat{P}Q = 66.6° \ or \ \ 1.163^c$

       3 marks awarded : deduct 1 per error

3   Prove that the roots of the equation $2x^2 + px - 3 = 0$ are real for all values of p.   **4**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
3		4	C,B	1.3.4, 1.1.6	CN	03/85

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- $\bullet^1$ ss :   know/use discriminant
- $\bullet^2$ ic :   identify discriminant
- $\bullet^3$ pd :   simplify
- $\bullet^4$ ic :   complete proof

Primary Method : Give 1 mark for each •

- $\bullet^1$ *know to show* $b^2 - 4ac \geq 0$
- $\bullet^2$ $p^2 - 4 \times 2 \times (-3)$
- $\bullet^3$ $p^2 + 24$
- $\bullet^4$ p^2 *is positive*
  so $\Delta \geq 0$ *and roots real*

                               4 marks

Note

1   Evidence for $\bullet^1$ will more than likely appear at the $\bullet^4$ stage.

2   Treat $b^2 - 4ac > 0$ as bad form

1   Alternative Method 1

- $\bullet^1$ $x = \dfrac{-p \pm \sqrt{(-p)^2 - 4 \times 2 \times (-3)}}{4}$
- $\bullet^2$ $x = \dfrac{-p \pm \sqrt{p^2 + 24}}{4}$
- $\bullet^3$ *we need* $p^2 + 24 \geq 0$
- $\bullet^4$ p^2 *is positive and so roots real*

                               4 marks

4   A sequence is defined by the recurrence relation $u_{n+1} = ku_n + 3$.

    (a) Write down the condition on k for this sequence to have a limit.   **1**

    (b) The sequence tends to a limit of 5 as $n \to \infty$. Determine the value of k.   **3**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
4	a	1	C	1.4.3	CN	04/16
	b	3	B	1.4.3		

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$\bullet^1$ ic :   state condition for limit

$\bullet^2$ ss :   know how to find limit

$\bullet^3$ ic :   substitute

$\bullet^4$ pd :   process

Primary Method : Give 1 mark for each •

$\bullet^1$ $-1 < k < 1$

                                        1 mark

$\bullet^2$ $l = "\dfrac{b}{1-a}"$ *stated or implied by* $\bullet^3$

$\bullet^3$ $5 = \dfrac{3}{1-k}$

$\bullet^4$ $k = \dfrac{2}{5}$

                                        3 marks

---

1   Alternative Method : no.1

$\bullet^1$ $-1 < k < 1$

                                        1 mark

$\bullet^2$ $L = kL + 3$ *stated or implied by* $\bullet^3$

$\bullet^3$ $5 = 5k + 3$

$\bullet^4$ $k = \dfrac{2}{5}$

                                        3 marks

Notes

1    $-1 \le k \le 1$ does not gain $\bullet^1$
    but
    accept "between –1 and 1"   for $\bullet^1$
    accept $|k| < 1$ for $\bullet^1$

    $-1 < a < 1$ does not gain •1 unless it has
    been replaced by k in subsequent working in
    (b)

2   Guess and check :
    Guessing $k = 0.4$ and checking algebraically
    that this does yield a limit of 5 may be
    awarded 2 marks

3   Guess and check :
    Guessing $k = 0.4$ and checking iteratively
    that this does yield a limit of 5 may be
    awarded 1 mark

4   No working :
    Simply stating that $k = 0.4$ earns no marks

5   Wrong formula :
    Work using an incorrect "formula" leading to
    a valid value of k may be awarded 1 mark.

5.   The point P(x, y) lies on the curve with equation $y = 6x^2 - x^3$.

    (a) Find the value of x for which the gradient of the tangent at P is 12.   **5**

    (b) Hence find the equation of the tangent at P.   **2**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
5	a	5	C	1.3.2, 1.3.9	CN	04/96
	b	2	C	1.1.6		

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$\bullet^1$ ss :   know to differentiate

$\bullet^2$ pd :   differentiate

$\bullet^3$ ss :   set derivative = gradient

$\bullet^4$ pd :   start to solve

$\bullet^5$ pd :   process

$\bullet^6$ pd :   process

$\bullet^7$ ic :   state equation of tangent

Primary Method : Give 1 mark for each •

$\bullet^1$ $\dfrac{dy}{dx} =$ *stated or implied by* $\bullet 2$

$\bullet^2$ $12x - 3x^2$

$\bullet^3$ $12x - 3x^2 = 12$

$\bullet^4$ $3(x - 2)^2 = 0$

$\bullet^5$ $x = 2$

                 5 marks

$\bullet^6$ $y = 16$

$\bullet^7$ $y - 16 = 12(x - 2)$

                 2 marks

---

1   Common error no.1

$\bullet^1$ √ $\dfrac{dy}{dx} =$ *stated or implied by* $\bullet 2$

$\bullet^2$ √ $12x - 3x^2$

$\bullet^3$ × $12x - 3x^2 = 0$

$\bullet^4$ × $3x(4 - x)$

$\bullet^5$ × $x = 0$ *and* $x = 4$

              2 marks awarded

$\bullet^6$ √ $x = 4 \Rightarrow y = 32$

$\bullet^7$ √ $y - 32 = 12(x - 4)$

              2 marks awarded

Notes

1   For $\frac{dy}{dx} = 12x - 3x^2$

        $12x - 3x^2 = 12$

       followed by a guess of $x = 2$ and no check, only

       $\bullet 1, \bullet 2$ and $\bullet 3$ can be awarded.

2   For $\frac{dy}{dx} = 12x - 3x^2$

        $12x - 3x^2 = 12$

       followed by a guess of $x = 2$ and a check that does

       in fact yield 12, $\bullet 1, \bullet 2, \bullet 3$ and $\bullet 4$ can be awarded.

6   (*a*)   Express $3\cos\left(x^\circ\right) + 5\sin\left(x^\circ\right)$ in the form $k\cos\left(x^\circ - a^\circ\right)$ where $k > 0$ and $0 \le a \le 90$.   **4**

         (*b*)   Hence solve the equation $3\cos\left(x^\circ\right) + 5\sin\left(x^\circ\right) = 4$ for $0 \le x \le 90$.   **3**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
6	a	4	C	3.4.2	CR	04/122
6	b	3	B	3.4.2	CR	

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- $\bullet^1$ ss :   expand
- $\bullet^2$ ic :   equate coefficients
- $\bullet^3$ pd : solve for k
- $\bullet^4$ pd : solve for a
- $\bullet^5$ ss :   use transformed function
- $\bullet^6$ pd : solve trig equation for "$x - a$"
- $\bullet^7$pd :   solve for x

Primary Method : Give 1 mark for each •

- $\bullet^1$ $k\cos x \cos a + k\sin x \sin a$ *STATED EXPLICITLY*
- $\bullet^2$ $k\cos a = 3, k\sin a = 5$ *STATED EXPLICITLY*
- $\bullet^3$ $k = \sqrt{34}$
- $\bullet^4$ $a = 59$

         4 marks

- $\bullet^5$ $\sqrt{34}\cos(x - 59)^\circ = 4$
- $\bullet^6$ $x - 59 =$ any one of $-46 \cdot 7,\, 46 \cdot 7,\, 313.3$
- $\bullet^7$ $x = 12 \cdot 3$

         3 marks

Note

1   Using $k\cos(x^\circ + a^\circ)$ etc:
candidates may use any form of wave equation to start with, as long as their answer is in the form $k\cos(x - a)$.
If it is not, then $\bullet^4$ is not available.

2   $k\left(\cos x \cos a + \sin x \sin a\right)$ is OK for $\bullet^1$

3   $\sqrt{34}\cos x \cos a + \sqrt{34}\sin x \sin a$ is OK for $\bullet^1$

4   Treat $k\cos x \cos a + \sin x \sin a$ as bad form provided $\bullet^2$ is gained

5   Accept answers which round to 5.8 for k at $\bullet^3$

6   For $\bullet^4$, accept any answer which rounds to 59

7   Using $k\cos a = 5, k\sin a = 3$, leads to $a = 31$.
Only marks $\bullet^1$, $\bullet^3$ and $\bullet^4$ are available

---

1   Alternative Method 1

- $\bullet^1$ *strategy : r / a triangle* $3, 5, \sqrt{34}$
- $\bullet^2$ $\sqrt{34}\left(\cos x . \dfrac{3}{\sqrt{34}} + \sin x . \dfrac{5}{\sqrt{34}}\right)$
- $\bullet^3$ $\sqrt{34}\left(\cos x . \cos a + \sin x . \sin a\right)$ ***and*** $\tan a = \frac{5}{3}$
- $\bullet^4$ $a = 59^\circ$

         4 marks

CONTINUED

6   (a)   Express $3\cos\left(x^\circ\right) + 5\sin\left(x^\circ\right)$ in the form $k\cos\left(x^\circ - a^\circ\right)$ where $k > 0$ and $0 \le a \le 90$.   **4**

       (b)   Hence solve the equation $3\cos\left(x^\circ\right) + 5\sin\left(x^\circ\right) = 4$ for $0 \le x \le 90$.   **3**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
6	a	4	C	3.4.2	CR	04/122
6	b	3	B	3.4.2	CR	

2	Common wrong solution

- $\bullet^1$ $\checkmark$ $k\cos x \cos a + k \sin x \sin a$ *STATED EXPLICITLY*
- $\bullet^2$ $\times$ $k\cos a = 5, k\sin a = 3$ *STATED EXPLICITLY*
- $\bullet^3$ $\checkmark$ $k = \sqrt{34}$
- $\bullet^4$ $\checkmark$ $a = 31$

- $\bullet^5$ $\checkmark$ $\sqrt{34}\cos(x-31)^\circ = 4$
- $\bullet^6$ $\checkmark$ $x - 31 = any\ one\ of$ $46\cdot 7, 313.3$
- $\bullet^7$ $\times$ $x = 77.7^\circ$ *(this mark not awarded as working eased)*

       so award 5 *marks*((5 *ticks*)

3	Early rounding

- $\bullet^1$ $\checkmark$ $k\cos x \cos a + k \sin x \sin a$ *STATED EX.*
- $\bullet^2$ $\checkmark$ $k\cos a = \mathbf{3}, k\sin a = \mathbf{5}$ *STATED EX.*
- $\bullet^3$ $\checkmark$ $k = 5.8$
- $\bullet^4$ $\checkmark$ $a = 59$

- $\bullet^5$ $\checkmark$ $6\cos(x-59)^\circ = 4$
- $\bullet^6$ $\checkmark$ $x - 59 = any\ one\ of$ $-48.2, 48\cdot 2, 311.8$
- $\bullet^7$ $\checkmark$ $x = 10.8^\circ$

       so award 7 *marks*((7 *ticks*)
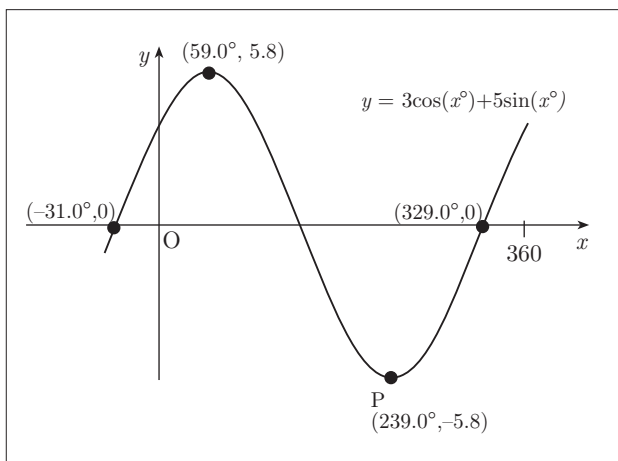
Alternative Method 2	via a Graphics Calculator

- $\bullet^1$ *annotated on diagram*
  max at $\left(59.0, 5.8\right)$ ***and*** min at $\left(239.0, -5.8\right)$
- $\bullet^2$ *annotated on diagram*
  $\left(-31.0, 0\right)$ ***or*** $(149.0, 0)$ ***or*** $(329.0, 0)$
- $\bullet^3$ "from the amplitude $k = 5.8$"
- $\bullet^4$ "from the shift $a = 59.0$"

       4 *marks*

- $\bullet^5$ *communication* : eg solution will be
  where $y = 4$ meets the graph
- $\bullet^6$ *annotated on diagram*
  the line with equation $y = 4$
- $\bullet^7$ intersection gives $x = 12.3$

       3 *marks*

7   The graph of the cubic function $y = f(x)$ is shown in the diagram. There are turning points at $(1, 1)$ and $(3, 5)$. Sketch the graph of $y = f'(x)$.

3

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
7		3	B	1.3.13	CN	04/87

The Primary Method m/s is based on the following generic m/s.
THIS GENERIC M/S MAY BE USED AS AN EQUIVALENCE GUIDE BUT ONLY WHERE A CANDIDATE DOES NOT USE THE PRIMARY METHOD OR ANY ALTERNATIVE METHOD SHOWN IN DETAIL IN THE MARKING SCHEME.

$\bullet^1$ ic :   interpret stationary points

$\bullet^2$ ic :   interpret between roots

$\bullet^3$ ic :   know $f'(cubic) = parabola$

Primary Method : Give 1 mark for each •

a sketch with the following details
- $\bullet^1$ *only two intercepts on the x - axis at 1 and 3*
- $\bullet^2$ *function is + ve between the roots and – ve outwith*
- $\bullet^3$ *a parabola (symmetrical about midpoint of x - intercepts), stated or implied by the accuracy of the diagram*

3 marks
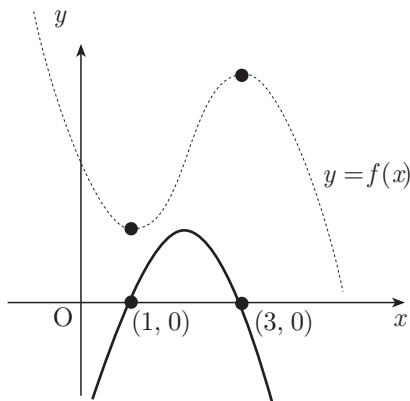
Note

1   The evidence for $\bullet^1$ may be on a diagram or in a table or in words

2   For $\bullet^3$, with the intercepts unknown, they must lie on the positive branch of the x-axis

3   For a parabola passing through $(1, 1)$ and $(3, 5)$ award **ONLY 1 MARK.**
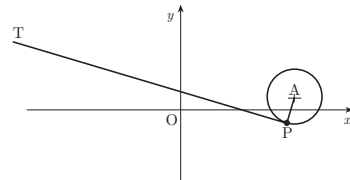
8   The circle with centre A has equation

$x^2 + y^2 - 12x - 2y + 32 = 0$ .The line PT is a tangent to

this circle at the point P(5, –1).

(a) Show that the equation of this tangent is $x + 2y = 3$.   **4**

The circle with centre B has equation $x^2 + y^2 + 10x + 2y + 6 = 0$.

(b) Show that PT is also a tangent to this circle.   **5**

(c) Q is the point of contact. Find the length of PQ.   **2**
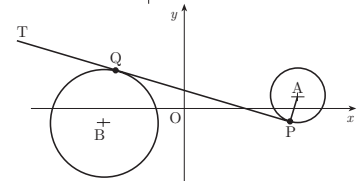
Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
8	a	4	C	2.4.2, 2.4.4	CN	04/113
	b	5	C	2.1.8		
	c	2	C	1.1.1		

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METHOD OR ANY ALTERNATIVE METHOD SHOWN IN DETAIL IN
THE MARKING SCHEME.

•^{1} ic : interpret circle equation

•^{2} ic : find gradient

•^{3} ss : know/find perpendicular gradient

•^{4} pd : complete proof

•^{5} pd : start solving process

•^{6} ss : know/substitute

•^{7} pd : arrange in standard form

•^{8} ss : know how to justify tangency

•^{9} ic : complete proof

•^{10} ic : interpret solution from (b)

•^{11} pd : process distance formula

Primary Method : Give 1 mark for each •

•^{1} $A(6,1)$

•^{2} $m_{AP} = 2$ *STATED EXPLICITLY*

•^{3} $m_{PQ} = -\frac{1}{2}$

•^{4} $y + 1 = -\frac{1}{2}(x - 5)$ *and complete*

                  4 marks

•^{5} $x = 3 - 2y$

•^{6} $(3 - 2y)^2 + y^2 + 10(3 - 2y) + 2y + 6 = 0$

•^{7} $5y^2 - 30y + 45 = 0$

•^{8} *solve and get double root ⇒ tangent*

•^{9} $5(y - 3)^2 = 0$

                  5 marks

•^{10} $Q = (-3, 3)$

•^{11} $PQ = \sqrt{80}$

                  2 marks

---

1   Alternative method for •1 to •4

•^{1} $(3 - 2y)^2 + y^2 - 12(3 - 2y) - 2y + 32 = 0$

•^{2} $5(y + 1)^2 = 0$

•^{3} *double root ⇒ tangent*

•^{4} $x = 3 - 2y = 3 - 2 \times (-1) = 5$

                  4 marks

Notes

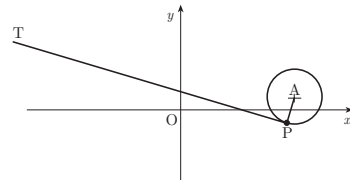1   •^{3} is **ONLY AVAILABLE** if •^{2} has been

    awarded.

2   •^{4} is only available if an attempt has been

    made to find a perpendicular gradient

3   completion at •^{4} :

    the minimum acceptable would be

$$y + 1 = -\tfrac{1}{2}(x - 5)$$
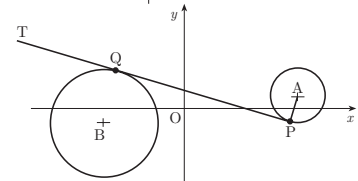$$2y + 2 = -x + 5$$
$$2y + x = 3$$

8   The circle with centre A has equation

$x^2 + y^2 - 12x - 2y + 32 = 0$ .The line PT is a tangent to

this circle at the point P(5, –1).

(*a*)   Show that the equation of this tangent is $x + 2y = 3$.   **4**

The circle with centre B has equation $x^2 + y^2 + 10x + 2y + 6 = 0$.

(*b*)   Show that PT is also a tangent to this circle.   **5**

(*c*)   Q is the point of contact. Find the length of PQ.   **2**

Notes cont

4   An "= 0" must appear at either the $\bullet^6$

or $\bullet^7$ stage. Failure to appear will forfeit

one of these marks.

5   Evidence for (b) may appear in the

working for (c)

1	Alternative for •8 and •9

$\bullet^8$ *use discriminant, and get zero $\Rightarrow$ tangent*

$\bullet^9$ $b^2 - 4ac = \left(-30\right)^2 - 4.5.45 = 0$

2	Alternative for (c) (•10 and •11)

$\bullet^8$ $BP = 10$ *units, $BQ = radius = \sqrt{20}$ units*

$\bullet^9$ *by Pythagoras $PQ = \sqrt{80}$*

3	Alternative Method for (b) (•5 to •9)

$\bullet^5$ $y = \frac{1}{2}\left(3 - x\right)$

$\bullet^6$ $\left(x\right)^2 + \left(\frac{1}{2}\left(3 - x\right)\right)^2 + 10\left(x\right) + 2\left(\frac{1}{2}\left(3 - x\right)\right) + 6 = 0$

$\bullet^7$ $5x^2 + 30x + 45 = 0$

$\bullet^8$ $5(x + 3)^2 = 0$

$\bullet^9$ *double root $\Rightarrow$ tangency*

   or b^2 - $4ac = 900$ - $4.5.45 \Rightarrow$ *tangency*

   5 marks

4	Alternative Method for (b) (•5 to •9)

$\bullet^5$ *centre $B = (-5, -1)$*

$\bullet^6$ *diam* : $y + 1 = 2(x + 5)$

$\bullet^7$ $2x + 9 = \dfrac{3 - x}{2}$

$\bullet^8$ $Q = (-3, 3)$

$\bullet^9$ *check* : $9 + 9 - 30 + 6 + 6 = 0$

   5 marks

5	Common error for (b)

$\bullet^5$ ✗ $x = 2y - 3$

$\bullet^6$ ✓ $\left(2y - 3\right)^2 + y^2 + 10\left(2y - 3\right) + 2y + 6 = 0$

$\bullet^7$ ✓ $5y^2 + 10y - 15 = 0$

$\bullet^8$ ✓ $5(y + 3)(y - 1) = 0$

$\bullet^9$ ✓   *intersects in two pts (y=1 and y=-3) $\Rightarrow$ not a tgt*

   4 marks awarded

9   An open cuboid measures internally x units by $2x$ uits by h units and has an inner surface area of 12 units^2.
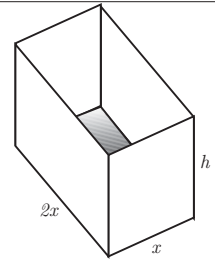
(a) Show that the volume, V units^3, of the cuboid is given by

$$V(x) = \tfrac{2}{3}x\left(6 - x^2\right).$$

3

(b) Find the exact value of x for which this volume is a maximum.

5

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
9	a	3	AB	1.3.15	CN	04/n
	b	5	C	1.3.15		

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- $\bullet^1$ ss : use area facts
- $\bullet^2$ ss : use volume facts
- $\bullet^3$ ic : complete proof
- $\bullet^4$ pd : arrange in standard form
- $\bullet^5$ pd : differentiate
- $\bullet^6$ ss : set derivative to zero
- $\bullet^7$ pd : process
- $\bullet^8$ ic : justification

Primary Method : Give 1 mark for each •

- $\bullet^1$ $A = 2x^2 + 2xh + 4xh = 12$
- $\bullet^2$ $V = 2x \times x \times h$
- $\bullet^3$ $V = 2x \times \frac{12 - 2x^2}{6} = \&\ complete$

                                       3 marks

- $\bullet^4$ $V = 4x - \tfrac{2}{3}x^3$
- $\bullet^5$ $\frac{dV}{dx} = 4 - 2x^2$
- $\bullet^6$ $\frac{dV}{dx} = 0$ *STATED EXPLICITLY*
- $\bullet^7$ $x = \sqrt{2}$
- $\bullet^8$

x	$< \sqrt{2}$	$\sqrt{2}$	$> \sqrt{2}$
$\frac{dV}{dx}$	$+ve$	0	$-ve$
tgt	$/$	$-$	$\backslash$

                  max

                                        5 marks

Alternative for •1, •2 and •3

- $\bullet^1$ $2x^2 + 2xh + 4xh = 12$
- $\bullet^2$ $h = \frac{12 - 2x^2}{6x}$
- $\bullet^3$ $V = 2x \times x \times \frac{12 - 2x^2}{6x} = \&\ complete$

                                       3 marks

Notes

1   Do not penalise the non-appearance of $-\sqrt{2}$ at the $\bullet^7$ stage.

2    $\frac{d^2x}{dx^2} = -4x < 0 \Rightarrow$ maximum may be accepted for $\bullet^8$.

10   **T**he amount A_t micrograms of a certain radioactive substance remaining after t years decreases according to the formula $A_t = A_0 e^{-0.002t}$, where A_0 is the amount present initially.

(a) If 600 micrograms are left after 1000 years, how many micrograms were present initially?   **3**

(b) The half-life of a substance is the time taken for the amount to decrease to half of its initial amount. What is the half-life of this substance?   **4**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
10	a	3	C	3.3.4	CR	04/121
	b	4	AB	3.3.4		

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$\bullet^1$ ss : substitute

$\bullet^2$ pd : change the subject

$\bullet^3$ pd : process exponential power

$\bullet^4$ ic : interpret half life

$\bullet^5$ pd : process

$\bullet^6$ ss : switch to logarithmic form

$\bullet^7$ pd : solve logarithmic equation

Primary Method : Give 1 mark for each •

$\bullet^1$ $600 = A_0 e^{-0.002 \times 1000}$

$\bullet^2$ $A_0 = \dfrac{600}{e^{-0.002 \times 1000}}$

$\bullet^3$ 4433

                         3 marks

$\bullet^4$ $\frac{1}{2}A_0 = A_0 e^{-0.002t}$

$\bullet^5$ $0.5 = e^{-0.002t}$

$\bullet^6$ $-0.002t = \ln 0.5$

$\bullet^7$ $t = 347$ years

                         4 marks

---

1   Alternative method for (a)

$\bullet^1$ $600 = A_0 e^{-0.002 \times 1000}$

$\bullet^2$ $\ln A_0 = \ln 600 - \ln e^{-0.002 \times 1000}$
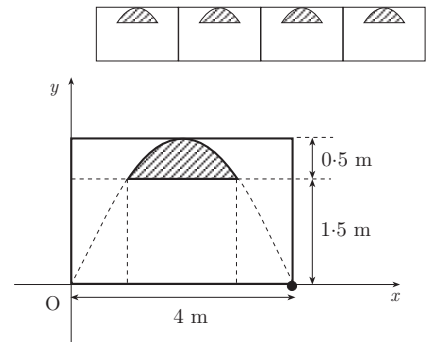
$\bullet^3$ $A_0 = 4433$

                         3 marks

Notes

1   Accept any correct answer which rounds to 4430.

     For any other answer, rounding must be indicated.

2   A trial and improvement approach :

     For $600 = A_0 e^{-2}$ award $\bullet^1$

     For eg $4000 e^{-2} = 541$

               $4500 e^{-2} = 609$

     leading to an answer which rounds to 4430, award $\bullet^3$

3   At $\bullet^4$, A_0 may be replaced by any real number

4   For (b) an answer obtained by trial and improvement which rounds to 346 or 347 may be awarded 1 mark.

11   An architectural feature of a building is a wall with arched

windows. The curved edge of each window is parabolic.

The second diagram shows one such window. The shaded part

represents the glass.

The top edge of the window is part of the parabola with

equation $y = 2x - \frac{1}{2}x^2$.

Find the area in square metres of the glass in one window.   **8**

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
11		8	A	2.1.0, 2.1.9	CN	04/110

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THE MARKING SCHEME.

- $\bullet^1$ ss :   find intersections

- $\bullet^2$ pd : process quadratic to solution

- $\bullet^3$ ss : decide on appropriate areas

- $\bullet^4$ ss : know to integrate

- $\bullet^5$ ic :   state limits

- $\bullet^6$ pd : integrate

- $\bullet^7$ pd : evaluate using limits

- $\bullet^8$ pd : evaluate area

Primary Method : Give 1 mark for each •

- $\bullet^1$ $2x - \frac{1}{2}x^2 = 1\cdot 5$
- $\bullet^2$ $x = 1, x = 3$
- $\bullet^3$ $"split\ area\ up"$ $stated\ or\ implied\ by\ \bullet^4$
- $\bullet^4$ $\int\left(2x - \frac{1}{2}x^2 - \frac{3}{2}\right)dx$
- $\bullet^5$ $\int_1^3 .. dx$
- $\bullet^6$ $\left[x^2 - \frac{1}{6}x^3 - \frac{3}{2}x\right]_1^3$
- $\bullet^7$ $\left(3^2 - \frac{1}{6}.3^3 - \frac{3}{2}.3\right) - \left(1^2 - \frac{1}{6}.1^3 - \frac{3}{2}.1\right)$
- $\bullet^8$ $\frac{2}{3}$

8 marks

Notes

1   The first two marks may be obtained as

follows:

Guess $x = 1$ and check that $y = 1.5$, award $\bullet^1$

Guess $x = 3$ and check that $y = 1.5$, award $\bullet^2$

2   In the Primary method, $\bullet^3$ is clearly not

available for subtracting the wrong way

round.

$\bullet^8$ will also be lost for statements such as

$-\frac{2}{3} = \frac{2}{3}$

$-\frac{2}{3}$ so ignore the negative

$-\frac{2}{3} = \frac{2}{3}$ squ units

$\bullet^8$ can still be gained for statements such as

$... - \frac{2}{3}$ and so the area $= \frac{2}{3}$

---

1   Alternative Method

- $\bullet^1$ $2x - \frac{1}{2}x^2 = 1\cdot 5$
- $\bullet^2$ $x = 1, x = 3$
- $\bullet^3$ $\int\left(2x - \frac{1}{2}x^2\right)dx$
- $\bullet^4$ choose limits, a and b: $0 \le a \le b \le 4$
- $\bullet^5$ $\left[x^2 - \frac{1}{6}x^3\right]$
- $\bullet^6$ evaluate $\left[x^2 - \frac{1}{6}x^3\right]_a^b$ for chosen values of a and b
- $\bullet^7$ state areas to be added/subtracted $st\,/\,imp\ by\ \bullet^8$
- $\bullet^8$ $\frac{2}{3}$

8 marks

S1   A die has three red faces, two blue faces and one yellow face. An experiment consists of noting the uppermost colour after a roll of the die.

Random Numbers

       2 7 9 8 9   6 4 7 2 8   1 0 7 4 4   0 8 3 9 6   5 6 2 4 2

       9 0 9 8 5   2 8 8 6 8   9 9 4 3 1   5 0 9 9 5   2 0 5 0 7

(*a*)   Use the given random numbers to simulate 18 trials of the experiment. Explain your strategy.   **2**

(*b*)   How closely do the results of your simulation agree with the theoretical probability of obtaining blue?   **2**

replacing qu.2

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
S1	a	2	C	4.2	CR	04/124
	b	2	C	4.2		

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$\bullet^1$ ic :   define simulation

$\bullet^2$ pd :   process simulation

$\bullet^3$ pd :   find probability

$\bullet^4$ ic :   comment

Primary Method : Give 1 mark for each •

$\bullet^1$ define simulation

$\bullet^2$ results of simulation

$\bullet^3$ $P(blue_{theoretical}) = \frac{1}{3}$

$\bullet^3$ cf simulation $P(blue_{experimental})$ with $\frac{1}{3}$

         4 marks

S2   As part of a study on intensive exercise, a sports scientist recorded the peak heart rates of a random selection of sixteen volunteers of different ages who took regular exercise. The linear regression equation was calculated for the data shown in the scatter diagram and found to be $y = 209 - 0 \cdot 727x$.
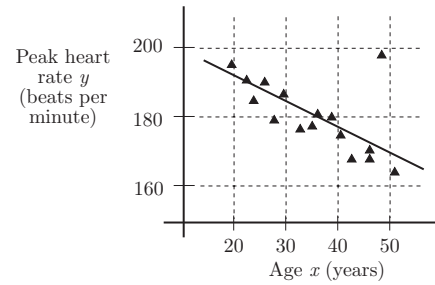
However after considering the scatter diagram for the data, it was realised that one piece of data had been misrecorded and this volunteer's data was ignored.

(a) State the approximate age of the volunteer whose data was ignored.   **1**

(b) Calculate the new regression equation using the values

$\Sigma x = 509, \Sigma x^2 = 18\ 477, \Sigma y = 2738, \Sigma y^2 = 501\ 192, \Sigma xy = 91\ 694$.   **6**

(c) Comment on the difference this makes to the prediction for the average peak heart rate of a 45 year old volunteer.   **2**

replacing qu.6

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
S2	a	1	B	4.4.2	CR	04/131
	b	6	B	4.4.2		
	c	2	A	4.4.2		

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•^{1} ic :   estimate from graph

•^{2} ic :   state n

•^{3} pd : process

•^{4} pd : process

•^{5} pd : determine regression coefficients

•^{6} pd : determine regression coefficients

•^{7} ic: state regression equation

•^{8} pd : use regression equation

•^{9} ic :   interpret results

Primary Method : Give 1 mark for each •

•^{1} 48

1 *mark*

•^{2} $n = 15$

•^{3} $S_{xx} = 1204 \cdot 93$

•^{4} $S_{xy} = -1215 \cdot 47$

•^{5} $a = 217$

•^{6} $b = -1 \cdot 01$

•^{7} $y = 217 - 1 \cdot 01x$

6 *marks*

•^{8} $est_{old} = 176, est_{new} = 172$

•^{9} removing outlier improves estimate

2 *marks*

S3   The selection procedure for a Police force consists of 3 independent tests, Intelligence(I),

Fitness (F) and Communication(C). The outcome of each test is an independent event and

is either pass or fail. A candidate must pass all three tests to enter training.

It has been established that the probability of failing each test is as follows:

Test	I	F	C
P(failing)	0·2	0·6	0·3

(a) Calculate the probability that a candidate will be selected for training.   **2**

(b) Five candidates are being tested for selection. Find the probability that

    (i)   all five candidates will be accepted

    (ii)   all five candidates will be rejected.   **3**

replacing qu.10

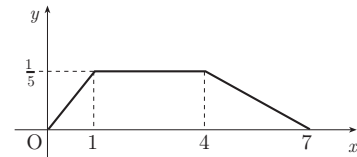| Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
S3	a	2	B	4.2.7	CN	04/126
	b	32	B	4.2.10		

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THIS GENERIC M/S MAY BE USED AS AN EQUIVALENCE GUIDE BUT ONLY WHERE A CANDIDATE DOES NOT USE THE PRIMARY METHOD OR ANY ALTERNATIVE METHOD SHOWN IN DETAIL IN THE MARKING SCHEME.

- $\bullet^1$ ss : use approp. strategy P(Pass) or $1 - $ P(fail)

- $\bullet^2$ pd : process

- $\bullet^3$ pd : process all pass

- $\bullet^4$ pd : process one fail

- $\bullet^5$ pd : process all fail

Primary Method : Give 1 mark for each •

- $\bullet^1$ P(selected) $= 0 \cdot 8 \times 0 \cdot 4 \times 0 \cdot 7$
- $\bullet^2$ $0 \cdot 224 \; or \; \frac{28}{125}$

                                                     2 marks

- $\bullet^3$ $0 \cdot 224^5 = 0 \cdot 000564$
- $\bullet^4$ P(1 *not selected*) $= 0.776$
- $\bullet^5$ $0.776^5 = 0 \cdot 281$

                                                     3 marks

S4   Show that the diagram represents a probabilty density function for a continuous random variable X.

replacing qu.10

3

Qu.	part	marks	Grade	Syllabus Code	Calculator class	Source
S4		3	A	4.3.4	CN	04/129

The Primary Method m/s is based on the following generic m/s.
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$\bullet^1$ ic :   state requirement for pdf

$\bullet^2$ ic :   state requirement for pdf

$\bullet^3$ pd : complete proof

Primary Method : Give 1 mark for each •

$\bullet^1$ function above $x-$ axis

$\bullet^2$ total area must be 1

$\bullet^3$ $\frac{1}{2}\times 1\times\frac{1}{5}+3\times\frac{1}{5}+\frac{1}{2}\times 3\times\frac{1}{5}$

     $=\frac{1}{10}+\frac{6}{10}+\frac{3}{10}=1$

3 marks