



**Coimisiún na Scrúduithe Stáit**  
**State Examinations Commission**

**Leaving Certificate 2016**

**Marking Scheme**

**Mathematics**

**Ordinary Level**

### **Note to teachers and students on the use of published marking schemes**

Marking schemes published by the State Examinations Commission are not intended to be standalone documents. They are an essential resource for examiners who receive training in the correct interpretation and application of the scheme. This training involves, among other things, marking samples of student work and discussing the marks awarded, so as to clarify the correct application of the scheme. The work of examiners is subsequently monitored by Advising Examiners to ensure consistent and accurate application of the marking scheme. This process is overseen by the Chief Examiner, usually assisted by a Chief Advising Examiner. The Chief Examiner is the final authority regarding whether or not the marking scheme has been correctly applied to any piece of candidate work.

Marking schemes are working documents. While a draft marking scheme is prepared in advance of the examination, the scheme is not finalised until examiners have applied it to candidates' work and the feedback from all examiners has been collated and considered in light of the full range of responses of candidates, the overall level of difficulty of the examination and the need to maintain consistency in standards from year to year. This published document contains the finalised scheme, as it was applied to all candidates' work.

In the case of marking schemes that include model solutions or answers, it should be noted that these are not intended to be exhaustive. Variations and alternatives may also be acceptable. Examiners must consider all answers on their merits, and will have consulted with their Advising Examiners when in doubt.

### **Future Marking Schemes**

Assumptions about future marking schemes on the basis of past schemes should be avoided. While the underlying assessment principles remain the same, the details of the marking of a particular type of question may change in the context of the contribution of that question to the overall examination in a given year. The Chief Examiner in any given year has the responsibility to determine how best to ensure the fair and accurate assessment of candidates' work and to ensure consistency in the standard of the assessment from year to year. Accordingly, aspects of the structure, detail and application of the marking scheme for a particular examination are subject to change from one year to the next without notice.

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**Coimisiún na Scrúduithe Stáit**  
State Examinations Commission

**Leaving Certificate 2016**

**Model Solutions and Marking Scheme**

**Mathematics**

**Ordinary Level**

**Paper 1**

## Marking Scheme – Paper 1, Section A and Section B

### Structure of the marking scheme

Candidate responses are marked according to different scales, depending on the types of response anticipated. Scales labelled A divide candidate responses into two categories (correct and incorrect). Scales labelled B divide responses into three categories (correct, partially correct, and incorrect), and so on. The scales and the marks that they generate are summarised in this table:

Scale label	A	B	C	D	E
No of categories	2	3	4	5	6
5 mark scales	0, 5	0, 2, 5	0, 2, 4, 5	0, 2, 3, 4, 5	
10 mark scales	0, 10	0, 3, 10	0, 2, 5, 10	0, 2, 4, 6, 10	
15 mark scales	0, 15	0, 7, 15	0, 3, 7, 15	0, 4, 7, 11, 15	
20 mark scales	0, 20	0, 10, 20	0, 7, 13, 20	0, 5, 10, 15, 20	
25 mark scales	0, 25	0, 12, 25	0, 8, 17, 25	0, 6, 12, 19, 25	0, 5, 10, 15, 20, 25

A general descriptor of each point on each scale is given below. More specific directions in relation to interpreting the scales in the context of each question are given in the scheme, where necessary.

### Marking scales – level descriptors

#### A-scales (two categories)

- incorrect response
- correct response

#### B-scales (three categories)

- response of no substantial merit
- partially correct response
- correct response

#### C-scales (four categories)

- response of no substantial merit
- response with some merit
- almost correct response
- correct response

#### D-scales (five categories)

- response of no substantial merit
- response with some merit
- response about half-right
- almost correct response
- correct response

#### E-scales (six categories)

- response of no substantial merit
- response with some merit
- response almost half-right
- response more than half-right
- almost correct response
- correct response

In certain cases, typically involving incorrect rounding, omission of units, a misreading that does not oversimplify the work or an arithmetical error that does not oversimplify the work, a mark that is one mark below the full-credit mark may also be awarded. Thus, for example, in *scale 10C*, 9 marks may be awarded. Throughout the scheme indicate by use of \* where an arithmetic error occurs.

## Summary of mark allocations and scales to be applied

### **Section A**

Question 1	
(a)	10C
(b)	5A
(c)	10C
Question 2	
(a)	5C
(b)	5C
(c)	5A
(d)	10D
Question 3	
(a)	5C
(b)	10B
(c)	10C
Question 4	
(a)	5B
(b)	5B
(c)(i)	10D
(ii)	5B
Question 5	
(a)	5C
(b)	15C
(c)	5C
Question 6	
(a)	5C
(b)	10C
(c)	10C

### **Section B**

Question 7	
(a)	10D
(b)	10D
(c)	5A
(d)	10C
(e)(i)	10C
(ii)	10C
Question 8	
(a)	5B
(b)(i)	5D
(ii)	5D
(c)	5C
(d)(i)	15C
(ii)	5B
(iii)	5C
(iv)	5B
Question 9	
(a)(i)	10D
(ii)	15D
(b)	5B
(c)	5B
(d)	10D

## Model Solutions & Marking Detailed Notes

**Note:** The model solutions for each question are not intended to be exhaustive – there may be other correct solutions. Any Examiner unsure of the validity of the approach adopted by a particular candidate to a particular question should contact his / her Advising Examiner

Q1	Model Solution – 25 Marks	Marking Notes
(a)	$5 \times 2 = 10$ $28 - 10 = 18$ $18 \div 2 = 9$ €9 per hour	Scale 10C (0, 2, 5, 10) <i>Low Partial Credit</i> <ul style="list-style-type: none"> <li>• Any use of 2, 5 or 28</li> </ul> <i>High Partial Credit</i> <ul style="list-style-type: none"> <li>• 18 calculated</li> </ul>
(b)	$w = 9h + 2d$	Scale 5A (0, 5)
(c)	$9(6) + 12(2) + 5(13.5) + 2d = 161.50$ $145.5 + 2d = 161.50$ $2d = 16$ $d = 8$	Scale 10C (0, 2, 5, 10) <i>Low Partial Credit</i> <ul style="list-style-type: none"> <li>• 9(6) or 12(2) or 78 formulated calculated or used</li> <li>• 13.5 written</li> </ul> <i>High Partial Credit</i> <ul style="list-style-type: none"> <li>• 83.5 and/or 67.5</li> </ul>

Q2	Model Solution – 25 Marks	Marking Notes
(a)	$z_3 = 1 + 3i + 2(2 - i)$ $z_3 = 5 + i$	<p>Scale 5C (0, 2, 4, 5)  <i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>Any correct substitution</li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>Correct multiplication</li> </ul>
(b)		<p>Scale 5C (0, 2, 4, 5)  <i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>One Point correctly plotted</li> <li>2 points correctly plotted but without labels</li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>2 points correctly plotted and labelled</li> <li>3 points correctly plotted without labels</li> <li>Mixes up real and imaginary axes with label of 3 correct points</li> </ul>
(c)	$ -3 - 2i  = \sqrt{13}$ $ 3 + 2i  = \sqrt{13}$	<p>Scale 5A (0, 5)</p>
(d)	$w = \frac{(1 + 3i)(2 + i)}{(2 - i)(2 + i)}$ $\frac{2 + i + 6i + 3i^2}{4 + 2i - 2i - i^2}$ $w = \frac{-1 + 7i}{5}$ $w = -\frac{1}{5} + \frac{7}{5}i$	<p>Scale 10D (0, 2, 4, 6, 10)  <i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>Any correct substitution</li> </ul> <p><i>Mid Partial Credit</i></p> <ul style="list-style-type: none"> <li>Conjugate identified</li> <li>Some multiplication above and below, even if by wrong conjugate</li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>multiply out correctly</li> </ul>



Q3	Model Solution – 25 Marks	Marking Notes
(a)	$3x - 21 + 5x - 20 = 15$ $8x = 56$ $x = 7$	<p>Scale 5C (0, 2, 4, 5)  <i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>• Any correct multiplication</li> <li>• Correct answer no work</li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>• Both multiplications done correctly and fails to finish</li> <li>• Error in expanding brackets and finishes correctly</li> </ul>
(b)	$4a + 3b = -3$ $5a - 2b = 25$ $8a + 6b = -6$ $\underline{15a - 6b = 75}$ $23a = 69$ $a = 3$ $b = -5$	<p>Scale 10B (0, 3, 10)</p> <p><i>Partial Credit</i></p> <ul style="list-style-type: none"> <li>• Some correct work in solving</li> </ul>
(c)	$4x - 6 + 6x < 25$ $10x < 31$ $x < 3.1$ $\{1, 2, 3\}$ <p><b>Note:</b> accept {0, 1, 2, 3}</p>	<p>Scale 10C (0, 2, 5, 10)  <i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>• Any correct step</li> <li>• Correct answer without work</li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>• Solves for <math>x</math></li> <li>• Error in multiplication but finishes correctly</li> </ul>

Q4	Model Solution – 25 Marks	Marking Notes
(a)	$x = 0$ $y = 7$	Scale 5B (0, 2, 5) <i>Partial Credit</i> <ul style="list-style-type: none"> <li>• <math>x = 0</math>, written</li> <li>• Zero correctly substituted into equation</li> </ul>
(b)	$1 + 1 - 2 + 7 = 7$ $7 = 7$	Scale 5B (0, 2, 5) <i>Partial Credit</i> <ul style="list-style-type: none"> <li>• Any correct substitution</li> </ul>
(c) (i)	$f'(x) = 3x^2 + 2x - 2$ <p style="text-align: center;">at <math>x = 1</math></p> $f'(x) = 3(1)^2 + 2(1) - 2$ $m = 3$	Scale 10D (0, 2, 4, 6, 10) <i>Low Partial Credit</i> <ul style="list-style-type: none"> <li>• Any correct differentiation</li> </ul> <i>Mid Partial Credit</i> <ul style="list-style-type: none"> <li>• Fully correct differentiation</li> </ul> <i>High Partial Credit</i> <ul style="list-style-type: none"> <li>• Correct substitution for slope</li> </ul>
(c) (ii)	$y - 7 = 3(x - 1)$ <p style="text-align: center;"><b>or</b></p> $y = 3x + 4$ <p style="text-align: center;"><b>or</b></p> $3x - y + 4 = 0$	Scale 5B (0, 2, 5) <i>Partial Credit</i> <ul style="list-style-type: none"> <li>• Shows <math>m = 3</math></li> <li>• Correct equation of a line formula</li> <li>• Any correct substitution</li> </ul>

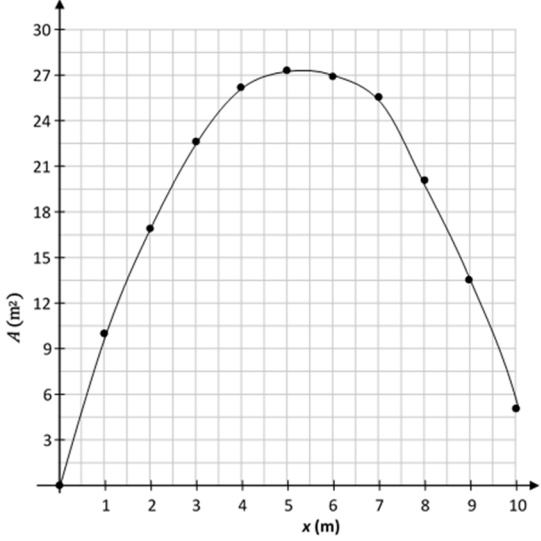
Q5	Model Solution – 25 Marks	Marking Notes																		
(a) (i)	<table border="1" data-bbox="240 264 595 815"> <thead> <tr> <th>Term Number</th> <th>Sequence</th> </tr> </thead> <tbody> <tr><td><math>U_1</math></td><td></td></tr> <tr><td><math>U_2</math></td><td></td></tr> <tr><td><math>U_3</math></td><td></td></tr> <tr><td><math>U_4</math></td><td></td></tr> <tr><td><math>U_5</math></td><td></td></tr> <tr><td><math>U_6</math></td><td>43</td></tr> <tr><td><math>U_7</math></td><td>55</td></tr> <tr><td><math>U_8</math></td><td>69</td></tr> </tbody> </table>	Term Number	Sequence	$U_1$		$U_2$		$U_3$		$U_4$		$U_5$		$U_6$	43	$U_7$	55	$U_8$	69	
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(a) (ii)	<table border="1" data-bbox="304 880 617 1361"> <thead> <tr> <th>1<sup>st</sup> Difference</th> <th>2<sup>nd</sup> Difference</th> </tr> </thead> <tbody> <tr><td>2</td><td>2</td></tr> <tr><td>4</td><td>2</td></tr> <tr><td>6</td><td>2</td></tr> <tr><td>8</td><td>2</td></tr> <tr><td>10</td><td>2</td></tr> <tr><td>12</td><td>2</td></tr> <tr><td>14</td><td>2</td></tr> </tbody> </table> <p data-bbox="240 1417 758 1451">2<sup>nd</sup> difference is constant implies quadratic</p>	1 <sup>st</sup> Difference	2 <sup>nd</sup> Difference	2	2	4	2	6	2	8	2	10	2	12	2	14	2	<p data-bbox="842 786 1070 819">Scale 5C (0, 2, 4, 5)</p> <p data-bbox="842 819 1058 853"><i>Low Partial Credit</i></p> <ul data-bbox="850 860 1187 893" style="list-style-type: none"> <li>• One or two correct terms</li> </ul> <p data-bbox="842 929 1062 963"><i>High Partial credit</i></p> <ul data-bbox="850 969 1394 1003" style="list-style-type: none"> <li>• 3 terms correct but fails to show quadratic</li> </ul>		
1 <sup>st</sup> Difference	2 <sup>nd</sup> Difference																			
2	2																			
4	2																			
6	2																			
8	2																			
10	2																			
12	2																			
14	2																			
(b)	$U_1: 1 + b + c = 13$ $U_2: 4 + 2b + c = 15$ $b + c = 12$ $2b + c = 11$ $b = -1$ $c = 13$	<p data-bbox="842 1576 1107 1610">Scale 15C (0, 3, 7, 15))</p> <p data-bbox="842 1610 1058 1644"><i>Low Partial Credit</i></p> <ul data-bbox="850 1650 1299 1720" style="list-style-type: none"> <li>• Some relevant substitution into <math>U_n</math></li> <li>• Derives one correct equation</li> </ul> <p data-bbox="842 1756 1062 1789"><i>High Partial Credit</i></p> <ul data-bbox="850 1796 1243 1830" style="list-style-type: none"> <li>• Derives two correct equations</li> </ul>																		

(c)	$a = 12$ $d = 2$ $T_n = 12 + 2(n - 1)$ <p style="text-align: center;"><b>or</b></p> $T_n = 10 + 2n$ $T_{30} = 10 + 2(30) = 70$	<p>Scale 5C (0, 2, 4, 5)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>• <math>a</math> or <math>d</math> identified</li> <li>• Writes <math>T_n = a + (n - 1)d</math></li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>• <math>T_n</math> correct and stops</li> <li>• Finds <math>T_{30}</math> correctly using list method, without finding <math>T_n</math></li> </ul>
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Q6	Model Solution – 25 Marks	Marking Notes
(a)	$1300 \times 0.2 = 260$ $250 \times 0.4 = 100$ $260 + 100 = 360$ $360 - 126 = 234$	<p>Scale 5C (0, 2, 4, 5)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>• Sets up 20% of 1300</li> <li>• calculates €250</li> <li>• Finds €260 or €100</li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>• Finds €260 and €100, or finds €360</li> </ul>
(b)	$462 \times 0.01 + 214 \times 0.03 + 874 \times 0.055$ $4.62 + 6.42 + 48.07$ $= 59.11$	<p>Scale 10C (0, 2, 5, 10)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>• Finds one correct amount</li> <li>• Formulates a % correctly</li> <li>• Finds €874 or €676</li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>• Finds two correct amounts</li> </ul>
(c) (i) and (c) (ii)	$18 + 234 + 59.11 = 311.11$ $\frac{311.11}{1550} \times \frac{100}{1} = 20.1\%$	<p>Scale 10C (0, 2, 5, 10)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>• €234 or €59.11 written in this section</li> <li>• Some correct addition for <b>(c)(i)</b></li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>• Correct deductions found, €311.11</li> <li>• Formulates % correctly for <b>(c)(ii)</b></li> </ul>

Q7	Model Solution – 55 Marks	Marking Notes
(a)	$8000(1.02)(1.03)(1.05) = 8825.04$ <p style="text-align: center;"><b>Or</b></p> $8000(1.02) = 8160$ $8160(1.03) = 8404.8$ $8404.8(1.05) = 8825.04$	<p>Scale 10D (0, 2, 4, 6, 10)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>Any effort at calculation of interest on €8000 at 2% or 3% or 5%</li> </ul> <p><i>Mid partial credit</i></p> <ul style="list-style-type: none"> <li>One correct calculation, €160 or €8160</li> <li>Uses simple interest leading to €8800 or €800</li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>Two correct calculations, €244.80 or €8404.80</li> <li>Finds correct interest for each year but fails to finish</li> <li>Fully correct formulation of amount</li> </ul>
(b)	$8000(1.037)^3 = 8921.26$ <p style="text-align: center;"><b>Or</b></p> $8000(1.037) = 8296$ $8296(1.037) = 8602.95$ $8602.95(1.037) = 8921.26$	<p>Scale 10D (0, 2, 4, 6, 10)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>Relevant use of 3.7%</li> </ul> <p><i>Mid partial credit</i></p> <ul style="list-style-type: none"> <li>One correct calculation, €296 or €8296</li> <li>Use of simple interest leading to €8888, or €888</li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>Two correct calculations, €306.95 or €8602.95</li> <li>Finds correct interest for each year but fails to finish</li> <li>Fully correct formulation of amount</li> </ul>
(c)	<p>Might want the flexibility of taking money out before the end.</p> <p style="text-align: center;"><b>Or</b></p> <p>Choose the one that gives the most money</p>	<p>Scale 5A (0, 5)</p>
(d)	$8000\left(1 + \frac{x}{100}\right)^3 = 9000$ $1 + \frac{x}{100} = \sqrt[3]{\frac{9}{8}}$ $x = 4\%$	<p>Scale 10C (0, 2, 5, 10)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>At least one correct substitution</li> <li>Correct formula</li> <li>Correct answer no work</li> <li><math>9000 - 8000 = 1000</math></li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>Fully correct substitution into formula but fails to finish</li> </ul>

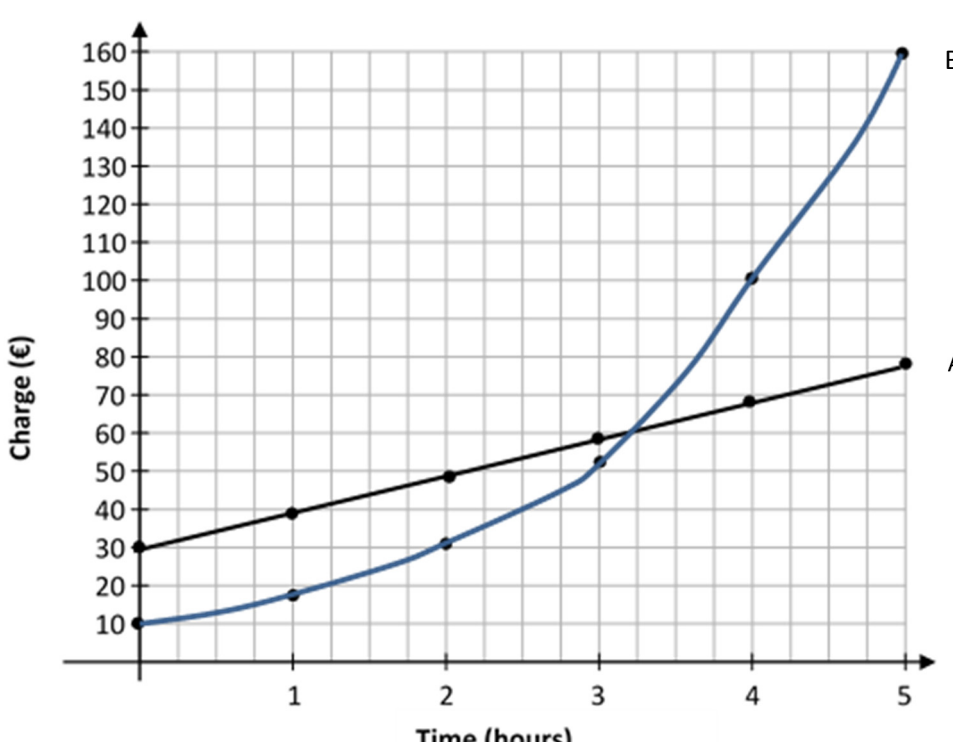
<p><b>(e)</b> <b>(i)</b></p>	$v = 8000 + 36(12) - 1 \cdot 2(12)^2$ $v = 8259 \cdot 20$	<p>Scale 10C (0, 2, 5, 10) <i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>• Any correct substitution into formula</li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>• Fully correct substitution into formula but fails to finish</li> <li>• Subs <math>t = 1</math> giving answer of 8034·80</li> </ul>
<p><b>(e)</b> <b>(ii)</b></p>	$\frac{259 \cdot 20}{8000} \times 100 = 3 \cdot 24$ <p>Rate = 3·24</p> <p style="text-align: center;"><b>Or</b></p> $\frac{8259 \cdot 20}{8000} = 1 \cdot 0324$ <p>Rate = 3·24</p>	<p>Scale 10C (0, 2, 5, 10) <i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>• Brings down interest or amount from <b>e(i)</b></li> <li>• Relevant work</li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>• Formulates correctly</li> </ul>

Q8	Model Solution – 50 Marks	Marking Notes																																				
(a)	$2x + 2y = 21$ $x + y = 10.5$ $y = 10.5 - x$	Scale 5B (0, 2, 5) <i>Partial Credit</i> <ul style="list-style-type: none"> <li>• Some correct work on perimeter</li> <li>• Relevant work on diagram</li> </ul>																																				
b (i)	<table border="1" data-bbox="360 510 1310 696"> <thead> <tr> <th><math>x</math></th> <th>0</th> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> <th>6</th> <th>7</th> <th>8</th> <th>9</th> <th>10</th> </tr> </thead> <tbody> <tr> <th><math>y</math></th> <td>10.5</td> <td>9.5</td> <td>8.5</td> <td>7.5</td> <td>6.5</td> <td>5.5</td> <td>4.5</td> <td>3.5</td> <td>2.5</td> <td>1.5</td> <td>0.5</td> </tr> <tr> <th><math>A</math> (m<sup>2</sup>)</th> <td>0</td> <td>9.5</td> <td>17</td> <td>22.5</td> <td>26</td> <td>27.5</td> <td>27</td> <td>24.5</td> <td>20</td> <td>13.5</td> <td>5</td> </tr> </tbody> </table>	$x$	0	1	2	3	4	5	6	7	8	9	10	$y$	10.5	9.5	8.5	7.5	6.5	5.5	4.5	3.5	2.5	1.5	0.5	$A$ (m <sup>2</sup> )	0	9.5	17	22.5	26	27.5	27	24.5	20	13.5	5	
$x$	0	1	2	3	4	5	6	7	8	9	10																											
$y$	10.5	9.5	8.5	7.5	6.5	5.5	4.5	3.5	2.5	1.5	0.5																											
$A$ (m <sup>2</sup> )	0	9.5	17	22.5	26	27.5	27	24.5	20	13.5	5																											
b (i)		Scale 5D (0, 2, 3, 4, 5) <i>Low Partial Credit</i> <ul style="list-style-type: none"> <li>• relevant calculations without any correct entry</li> <li>• 1, 2, 3 or 4 correct entries to table (<math>y</math> or <math>A</math>)</li> </ul> <i>Mid Partial Credit</i> <ul style="list-style-type: none"> <li>• 5 or 6 correct pairs of entries (<math>y</math> and <math>A</math>) or full <math>y</math> line correct</li> </ul> <i>High Partial Credit</i> <ul style="list-style-type: none"> <li>• 7, 8 or 9 correct pairs of entries (<math>y</math> and <math>A</math>)</li> </ul>																																				
b (ii)		Scale 5D (0, 2, 3, 4, 5) <i>Low Partial Credit</i> <ul style="list-style-type: none"> <li>• 1, 2, 3 or 4 correct plots</li> <li>• Graphs <math>y</math> only</li> </ul> <i>Mid Partial Credit</i> <ul style="list-style-type: none"> <li>• 5, 6, 7 or 8 correct plots</li> </ul> <i>High Partial Credit</i> <ul style="list-style-type: none"> <li>• 9, 10 or 11 correct plots but no joining or incorrect joining</li> </ul>																																				



(c)	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%; padding: 5px;">Maximum area</td> <td style="padding: 5px;"><math>27.5 \leq A \leq 28</math></td> </tr> <tr> <td style="padding: 5px;"><math>x</math> value</td> <td style="padding: 5px;"><math>5 \leq X \leq 5.5</math></td> </tr> <tr> <td style="padding: 5px;"><math>y</math> value</td> <td style="padding: 5px;"><math>5.5 \geq Y \geq 5</math></td> </tr> </table>	Maximum area	$27.5 \leq A \leq 28$	$x$ value	$5 \leq X \leq 5.5$	$y$ value	$5.5 \geq Y \geq 5$	<p>Scale 5C (0, 2, 4, 5)  <i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>Maximum area identified from graph</li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>Area and one corresponding value</li> </ul>
Maximum area	$27.5 \leq A \leq 28$							
$x$ value	$5 \leq X \leq 5.5$							
$y$ value	$5.5 \geq Y \geq 5$							
(d) (i)	$A = xy$ $A = x(10.5 - x)$ $A = 10.5x - x^2$	<p>Scale 15C (0, 3, 7, 15)  <i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>Relevant area formula</li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>Correct substitution into area formula</li> </ul>						
(d) (ii)	$\frac{dA}{dx} = 10.5 - 2x$	<p>Scale 5B(0, 2, 5)  <i>Partial Credit</i></p> <ul style="list-style-type: none"> <li>Any correct differentiation</li> </ul>						
(d) (iii)	$10.5 - 2x = 0$ $x = 5.25$	<p>Scale 5C (0, 2, 4, 5)  <b>Note:</b> Must have calculus in (d)(ii) to get any marks in this section</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>Any use of answer to (d)(ii)</li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>Lets their derivative = 0</li> </ul>						
(d) (iv)	$A = xy$ $A = 5.25 \times 5.25$ $A = 27.56$ <p style="text-align: center;"><b>Or</b></p> $A = 10.5(5.25) - (5.25)^2$ $55.125 - 27.5625$ $A = 27.56$	<p>Scale 5B (0, 2, 5)  <i>Partial Credit</i></p> <ul style="list-style-type: none"> <li>Any substitution into area formula or equation given in (d)(i)</li> <li>Writes area formula</li> </ul>						

Q9	Model Solution – 45 Marks	Marking Notes																										
(a) (i)	<table border="1" data-bbox="242 264 1359 497"> <thead> <tr> <th data-bbox="242 264 625 340">Time (hours)</th> <th data-bbox="625 264 737 340">0</th> <th data-bbox="737 264 871 340">1</th> <th data-bbox="871 264 1002 340">2</th> <th data-bbox="1002 264 1110 340">3</th> <th data-bbox="1110 264 1244 340">4</th> <th data-bbox="1244 264 1359 340">5</th> </tr> </thead> <tbody> <tr> <td data-bbox="242 340 625 416">Company A charge <math>A(h)</math> (€)</td> <td data-bbox="625 340 737 416">30</td> <td data-bbox="737 340 871 416">39.5</td> <td data-bbox="871 340 1002 416">49</td> <td data-bbox="1002 340 1110 416">58.5</td> <td data-bbox="1110 340 1244 416">68</td> <td data-bbox="1244 340 1359 416">77.5</td> </tr> <tr> <td data-bbox="242 416 625 497">Company B charge <math>B(h)</math> (€)</td> <td data-bbox="625 416 737 497">10</td> <td data-bbox="737 416 871 497">17.4</td> <td data-bbox="871 416 1002 497">30.28</td> <td data-bbox="1002 416 1110 497">52.68</td> <td data-bbox="1110 416 1244 497">91.66</td> <td data-bbox="1244 416 1359 497">159.49</td> </tr> </tbody> </table>							Time (hours)	0	1	2	3	4	5	Company A charge $A(h)$ (€)	30	39.5	49	58.5	68	77.5	Company B charge $B(h)$ (€)	10	17.4	30.28	52.68	91.66	159.49
	Time (hours)	0	1	2	3	4	5																					
	Company A charge $A(h)$ (€)	30	39.5	49	58.5	68	77.5																					
	Company B charge $B(h)$ (€)	10	17.4	30.28	52.68	91.66	159.49																					
(a) (i)							<p data-bbox="842 609 1134 642">Scale 10D (0, 2, 4, 6, 10)</p> <p data-bbox="842 645 1059 678"><i>Low Partial Credit</i></p> <ul data-bbox="853 683 1318 752" style="list-style-type: none"> <li>• relevant calculations</li> <li>• 1, 2, 3 or 4 correct entries into table</li> </ul> <p data-bbox="842 790 1059 824"><i>Mid Partial Credit</i></p> <ul data-bbox="853 828 1134 862" style="list-style-type: none"> <li>• 5 or 6 correct entries</li> </ul> <p data-bbox="842 900 1066 934"><i>High Partial Credit</i></p> <ul data-bbox="853 938 1166 972" style="list-style-type: none"> <li>• 7, 8 or 9 correct entries</li> </ul>																					

<p>(a) (ii)</p>	 <table border="1" data-bbox="319 224 1276 963"> <caption>Data points for Line A and Line B</caption> <thead> <tr> <th>Time (hours)</th> <th>Charge (€) - Line A</th> <th>Charge (€) - Line B</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>30</td> <td>10</td> </tr> <tr> <td>1</td> <td>40</td> <td>18</td> </tr> <tr> <td>2</td> <td>50</td> <td>32</td> </tr> <tr> <td>3</td> <td>60</td> <td>52</td> </tr> <tr> <td>4</td> <td>70</td> <td>100</td> </tr> <tr> <td>5</td> <td>80</td> <td>160</td> </tr> </tbody> </table>	Time (hours)	Charge (€) - Line A	Charge (€) - Line B	0	30	10	1	40	18	2	50	32	3	60	52	4	70	100	5	80	160
Time (hours)	Charge (€) - Line A	Charge (€) - Line B																				
0	30	10																				
1	40	18																				
2	50	32																				
3	60	52																				
4	70	100																				
5	80	160																				
<p>(a) (ii)</p>	<p>Scale 15D (0, 4, 7, 11, 15)  <i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>• 1, 2, 3 or 4 correct plots</li> </ul> <p><i>Mid Partial Credit</i></p> <ul style="list-style-type: none"> <li>• 5 to 11 correct plots</li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>• All plots correct but no joining or incorrect joining</li> <li>• 9, 10 or 11 points plotted correct and joined correctly</li> </ul>																					

<b>(b)</b>	$B = \text{€}40$ $A = \text{€}52$ <p>B is cheaper (from graph)</p>	<p>Scale 5B (0, 2, 5)</p> <p><i>Partial Credit</i></p> <ul style="list-style-type: none"> <li>• A or B clearly identified on graph</li> <li>• B given as answer but no reason</li> </ul>
<b>(c)</b>	$h \approx 3.2$	<p>Scale 5B (0, 2, 5)</p> <p><i>Partial Credit</i></p> <ul style="list-style-type: none"> <li>• Point clearly indicated on graph</li> </ul>
<b>(d)</b>	$A(6) = 30 + 9 \cdot 5(6) = 87$ $B(6) = 10(1.74)^6 = 277.52$ <p>Difference = 190.52</p>	<p>Scale 10D (0, 2, 4, 6, 10)</p> <p><i>Low Partial Credit</i></p> <ul style="list-style-type: none"> <li>• A(6) or B(6) substituted correctly</li> </ul> <p><i>Mid Partial credit</i></p> <ul style="list-style-type: none"> <li>• A(6) or B(6) evaluated correctly</li> </ul> <p><i>High Partial Credit</i></p> <ul style="list-style-type: none"> <li>• A(6) and B(6) evaluated correctly</li> </ul>

**Coimisiún na Scrúduithe Stáit**  
State Examinations Commission

**Leaving Certificate 2016**

**Model Solutions and Marking Scheme**

**Mathematics**

**Ordinary Level**

**Paper 2**

## Marking Scheme – Paper 1, Section A and Section B

### Structure of the marking scheme

Candidate responses are marked according to different scales, depending on the types of response anticipated. Scales labelled A divide candidate responses into two categories (correct and incorrect). Scales labelled B divide responses into three categories (correct, partially correct, and incorrect), and so on. The scales and the marks that they generate are summarised in this table:

Scale label	A	B	C	D	E
No of categories	2	3	4	5	6
5 mark scales	0, 5	0, 1, 5	0, 1, 2, 5	0, 2, 3, 4, 5	
10 mark scales			0, 2, 4, 10		
15 mark scales		0, 4, 15	0, 3, 5, 15	0, 2, 4, 8, 15	
20 mark scales			0, 5, 10, 20	0, 5, 10, 15, 20	
25 mark scales					

A general descriptor of each point on each scale is given below. More specific directions in relation to interpreting the scales in the context of each question are given in the scheme, where necessary.

### Marking scales – level descriptors

#### A-scales (two categories)

- incorrect response
- correct response

#### B-scales (three categories)

- response of no substantial merit
- partially correct response
- correct response

#### C-scales (four categories)

- response of no substantial merit
- response with some merit
- almost correct response
- correct response

#### D-scales (five categories)

- response of no substantial merit
- response with some merit
- response about half-right
- almost correct response
- correct response

#### E-scales (six categories)

- response of no substantial merit
- response with some merit
- response almost half-right
- response more than half-right
- almost correct response
- correct response

In certain cases, typically involving incorrect rounding, omission of units, a misreading that does not oversimplify the work or an arithmetical error that does not oversimplify the work, a mark that is one mark below the full-credit mark may also be awarded. Thus, for example, in *Scale 10C*, 9 marks may be awarded. Throughout the scheme indicate by use of \* where an arithmetic error occurs.

## Summary of mark allocations and scales to be applied

### Section A

#### Question 1

- (a)(i) 5C
- (a)(ii) 5C
- (a)(iii) 5C
- (b) 10C

#### Question 2

- (a) 5D
- (b) 20D

#### Question 3

- (a) 5C
- (b) 5C
- (c) 10C
- (d) 5C

#### Question 4

- (a) 15D
- (b) 5C
- (c) 5C

#### Question 5

- (a) 15C
- (b) 5C
- (c) 5C

#### Question 6

- (a)(i)(ii) 5D
- (b) 5B
- (c) 15C

### Section B

#### Question 7 (55)

- (a) 15B
- (b)(i) 5B
- (b)(ii) 5C
- (c) 5C
- (d)(i) 5C
- (d)(ii) 15C
- (d)(iii) 5A

#### Question 8 (50)

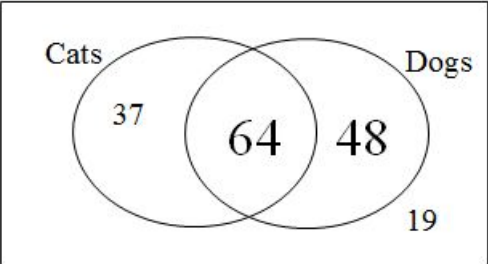
- (a) 5B
- (b)(i) 5C
- (b)(ii) 5C
- (c)(i) 5C
- (c)(ii) 5C
- (c)(iii) 5A
- (d) 20C

#### Question 9 (45)

- (a)(i) 5B
- (a)(ii) 5B
- (b) 5C
- (c) 5B
- (d) 5D
- (e) 20C

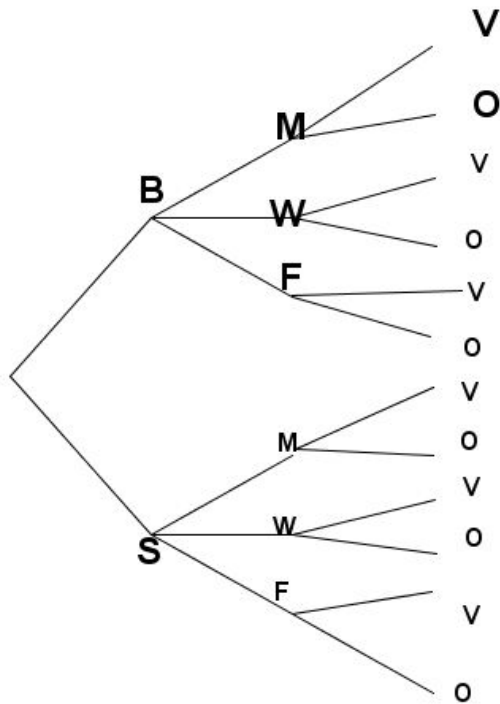
## Model Solutions & Detailed Marking Notes

**Note:** The model solutions for each question are not intended to be exhaustive – there may be other correct solutions. Any Examiner unsure of the validity of the approach adopted by a particular candidate to a particular question should contact his / her Advising Examiner.

Q1	Model Solution – 25 Marks	Marking Notes
(a) (i)	<p style="text-align: center;">U</p> 	<p>Scale 5C(0, 1, 2, 5) <i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Any work of merit.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>One correct/consistent entry calculated or inserted in diagram.</li> </ul> <p><i>Full Credit:</i></p> <ul style="list-style-type: none"> <li>Correctly filled in diagram without work.</li> </ul>
(a) (ii)	$\frac{64}{168} \text{ or } \frac{8}{21}$	<p>Scale 5C(0, 1, 2, 5) <i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Works with <math>64</math> or <math>168 \neq \#(E), \#(S)</math>.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li><math>\frac{x}{168}, (x \neq 64, x &lt; 168)</math></li> <li><math>\frac{64}{x} (x \neq 168, x &gt; 64)</math></li> </ul>
(a) (iii)	$\frac{37 + 48}{168} = 50.59 = 50.6\%$	<p>Scale 5C(0, 1, 2, 5) <i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Works with 37, 48, 168 (or consistent).</li> <li><math>\frac{*}{\#} \times 100</math>.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Works to 85. (or consistent)</li> <li>Correct answer without work.</li> </ul>



(b)



$$BWV = \frac{1}{2} \times \frac{1}{3} \times \frac{1}{2} = \frac{1}{12}$$

$$SWV = \frac{1}{2} \times \frac{1}{3} \times \frac{1}{2} = \frac{1}{12}$$

$$= \frac{2}{12} \text{ or } \frac{1}{6}$$

Scale 10C(0, 2, 4, 10)

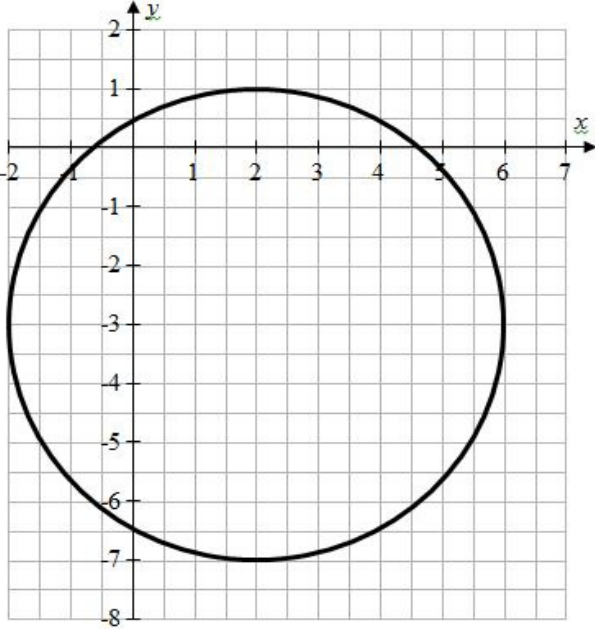
*Low Partial Credit:*

- Any relevant continuation of the tree diagram.
- One probability formulated correctly.  
e.g.  $\frac{1}{2}$

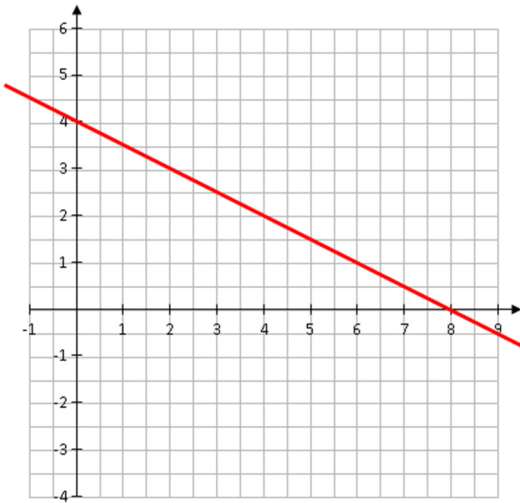
*High Partial Credit:*

- Tree diagram fully correct.
- Probability worked to  $\frac{2}{12}$  correct but tree diagram incomplete.

Q2	Model Solution – 25 Marks	Marking Notes
(a)	$\frac{1}{2}(8)(12) \sin 30^\circ = 24 \text{ cm}^2$	<p>Scale 5D(0, 2, 3, 4, 5)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Writes correct relevant formula for area of triangle. <i>e.g.</i> <math>(\frac{1}{2}ab \sin C)</math></li> </ul> <p><i>Mid Partial Credit:</i></p> <ul style="list-style-type: none"> <li>One/Two variables correctly substituted into sine formula.</li> <li><math>h_{\perp}</math> calculated.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Full correct substitution without calculation.</li> <li>One incorrect or omitted length substitution with area calculated.</li> <li>Incorrect calculator mode but otherwise correct. (once only)</li> <li>Radian = <math>-47.42</math>, Gradian = <math>21.79</math>.</li> <li>Correct answer without work.</li> </ul> <p><i>No Credit:</i></p> <ul style="list-style-type: none"> <li>Answer as <math>\frac{1}{2}(8)(12)</math> or <math>\frac{1}{2} \sin(30^\circ)</math> without formula.</li> </ul>
(b)	$7^2 = 5^2 + 3^2 - 2(3)(5) \cos A$ $49 - 9 - 25 = -30 \cos A$ $\cos A = -\frac{1}{2}$ $A = 120^\circ$	<p>Scale 20D(0, 5, 10, 15, 20)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Any work of merit to identify the correct angle required. (Pilot Diagram)</li> <li>Writes Cosine Rule correctly.</li> </ul> <p><i>Mid Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Two variables correctly substituted into correct relevant formula.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Fully correct substitution.</li> <li>One incorrect substitution followed by correct calculation.</li> <li>Calculates a different angle correctly.</li> <li><math>(21.79^\circ, 38.21^\circ)</math></li> <li>A correct or consistent answer without work.</li> <li>Incorrect calculator mode but otherwise correct. (only once)</li> </ul> <p>Radian = <math>2.09</math>, Gradian = <math>133.33</math></p> <ul style="list-style-type: none"> <li>Correct answer without work.</li> </ul> <p><i>No Credit:</i></p> <ul style="list-style-type: none"> <li>Treats triangle as right angled.</li> </ul>

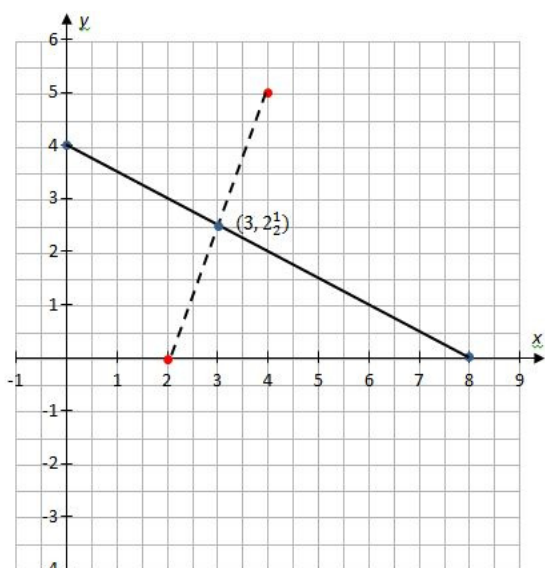
Q3	Model Solution – 25 Marks	Marking Notes
(a)	$(x - 2)^2 + (y + 3)^2 = 4^2$	<p>Scale 5C(0, 1, 2, 5)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Identifies correct formula.</li> <li>• Labels any one of (2, -3) or 4 correctly.</li> <li>• Works to <math>r^2 = 4^2</math>.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Answer as <math>(x - 2)^2 + (y - 3)^2 = 4^2</math>.</li> <li>• Substitutes centre or radius correctly into formula.</li> </ul>
(b)		<p>Scale 5C(0, 1, 2, 5)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Any work of merit e.g. Marks centre on grid.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Any TWO of the three components, centre, radius or drawing correct.</li> </ul>
(c)	$(x - 2)^2 + (y + 3)^2 = 4^2$ $(3 - 2)^2 + (1 + 3)^2$ $1 + 16 > 16$ <p style="text-align: center;">or</p> $\sqrt{(3 - 2)^2 + (1 + 3)^2}$ $\sqrt{17} > 4$	<p>Scale 10C(0, 2, 4, 10)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Plots (3,1).</li> <li>• Identifies correct relevant formula.</li> <li>• Substitutes (3, 1) into correct/consistent formula .</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• (1 + 16) or 17 but no conclusion. (&gt;16)</li> <li>• <math>\sqrt{17}</math> but no conclusion. (&gt;4)</li> </ul>

<b>(d)</b>	$8 \times 8 = 64 \text{ cm}^2$	Scale 5C(0, 1, 2, 5) <i>Low Partial Credit:</i> <ul style="list-style-type: none"><li>• Drawing on grid. (Any one dimension)</li></ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"><li>• Identifies correct/consistent square.</li><li>• Scale error in dimensions calculated correctly.</li></ul>
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Q4	Model Solution – 25 Marks	Marking Notes
(a)	$m = \frac{0 - 5}{2 - 4} = \frac{5}{2}$ $y - 5 = \frac{5}{2}(x - 4)$ $2y - 10 = 5x - 20$ $5x - 2y - 10 = 0$	<p>Scale 15D(0, 2, 4, 8, 15)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Identifies a correct relevant formula.</li> </ul> <p><i>Mid Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Slope formula with some substitution.</li> <li>Equation of line formula with some substitution.</li> <li>Slope correct and stops.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Equation of line formula fully substituted correctly (consistently).</li> </ul> <p><b>Note:</b> Accept <math>(-5x + 2y + 10 = 0, \text{ in any order})</math>.</p>
(b)	 <p style="text-align: center;"> <math>x = 0, y = 4 \Rightarrow (0, 4)</math>  <math>y = 0, x = 8 \Rightarrow (8, 0)</math> </p>	<p>Scale 5C(0, 1, 2, 5)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li><math>x = 0</math> or <math>y = 0</math> written.</li> <li>Any work of merit working with line <math>k</math>.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Finds two correct points but no plots or line on graph.</li> </ul>

(c)

**Graphical:**



**Numerical:**

$$\begin{aligned}5x - 2y - 10 &= 0 \\5(3) - 2y - 10 &= 0 \\15 - 2y - 10 &= 0 \\2y &= 5 \\y &= 2\frac{1}{2} \\x + 2y &= 8 \\3 + 2y &= 8 \\2y &= 5 \\y &= 2\frac{1}{2} \\l \cap k &= (3, 2\frac{1}{2})\end{aligned}$$

**Algebraic:**

$$\begin{aligned}x + 2y &= 8 \\5x - 2y &= 10 \\6x &= 18 \\x &= 3 \\y &= \frac{5}{2} \\(3, 2\frac{1}{2})\end{aligned}$$

Scale 5C(0, 1, 2, 5)

*Low Partial Credit:*

- Effort to draw line  $l$ .

*High Partial Credit:*

- $l$  drawn correctly on grid (in this part) and point of intersection marked but not written.

*Full Credit:*

- $l \cap k = (3, 2\frac{1}{2})$ .

*Low Partial Credit:*

- Effort at substituting a value of  $x$  into equations of one or both lines.

*High Partial Credit:*

- Uses  $x = 3$  to find  $y = 2\frac{1}{2}$  in both equations.

*Full Credit:*

- $l \cap k = (3, 2\frac{1}{2})$ .

*Low Partial Credit:*

- Effort to solve using simultaneous equations.

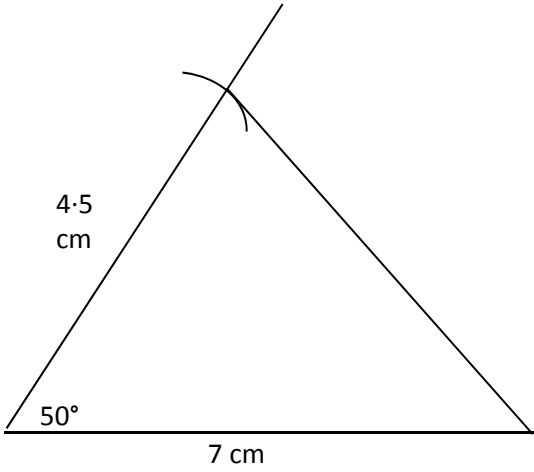
*High Partial Credit:*

- $x$  and/or  $y$  calculated correctly.
- Writes  $l \cap k$  as  $(y, x)$ .

*Full Credit:*

- $l \cap k = (3, 2\frac{1}{2})$ .

Q5	Model Solution – 25 Marks	Marking Notes																																				
(a)	<table border="1" data-bbox="252 248 699 405"> <tr> <td data-bbox="258 257 440 322">Mode =</td> <td data-bbox="446 257 692 322">12</td> </tr> <tr> <td data-bbox="258 331 440 396">Median =</td> <td data-bbox="446 331 692 396"><math>(24+25)\div 2=24.5</math></td> </tr> </table>	Mode =	12	Median =	$(24+25)\div 2=24.5$	<p>Scale 15C(0, 3, 5, 15)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Any work of merit in finding Mode or Median.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Mode or Median correct.</li> </ul> <p><i>Full Credit:</i></p> <ul style="list-style-type: none"> <li>Both answers correct without work.</li> </ul>																																
Mode =	12																																					
Median =	$(24+25)\div 2=24.5$																																					
(b)	$\frac{\text{sum}}{16} = \frac{363}{16}$ $=22.6875$ $=22.7$	<p>Scale 5C(0, 1, 2, 5)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Indicates addition of values.(5 + 8 ...</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Sum correct (53) or (63) or <math>\frac{x}{16}</math>, <math>\frac{x}{21}</math>.</li> <li>Count correct (16), (21).</li> </ul> <p><i>Full Credit:</i></p> <ul style="list-style-type: none"> <li>Correct answer without work.</li> </ul>																																				
(c)	<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;"></th> <th style="text-align: center; width: 10%;">Week 2</th> <th style="width: 10%;"></th> <th style="text-align: center; width: 10%;">Week 1</th> <th style="width: 10%;"></th> <th style="width: 10%;"></th> </tr> </thead> <tbody> <tr> <td></td> <td style="text-align: right;">9 6</td> <td style="border-left: 1px solid black; text-align: center;">0</td> <td style="text-align: left;">5 8</td> <td></td> <td></td> </tr> <tr> <td style="text-align: right;">8 8 7 6</td> <td style="text-align: right;">6 5 5 2</td> <td style="border-left: 1px solid black; text-align: center;">1</td> <td style="text-align: left;">2 2 2 3</td> <td></td> <td></td> </tr> <tr> <td></td> <td style="text-align: right;">9 8 7 3</td> <td style="border-left: 1px solid black; text-align: center;">2</td> <td style="text-align: left;">0 4 5 7</td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td style="border-left: 1px solid black; text-align: center;">2 3</td> <td style="text-align: left;">0 1 2 4 4</td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td style="border-left: 1px solid black; text-align: center;">0 4</td> <td style="text-align: left;">4</td> <td></td> <td></td> </tr> </tbody> </table> <p style="text-align: right; margin-top: 10px;">Key: 1 3 = 13 minutes</p>			Week 2		Week 1				9 6	0	5 8			8 8 7 6	6 5 5 2	1	2 2 2 3				9 8 7 3	2	0 4 5 7					2 3	0 1 2 4 4					0 4	4		
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(c)		<p>Scale 5C(0, 1, 2, 5)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Any effort at ordering results.</li> <li>Any correct entry.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Nine correct entries.</li> </ul>																																				

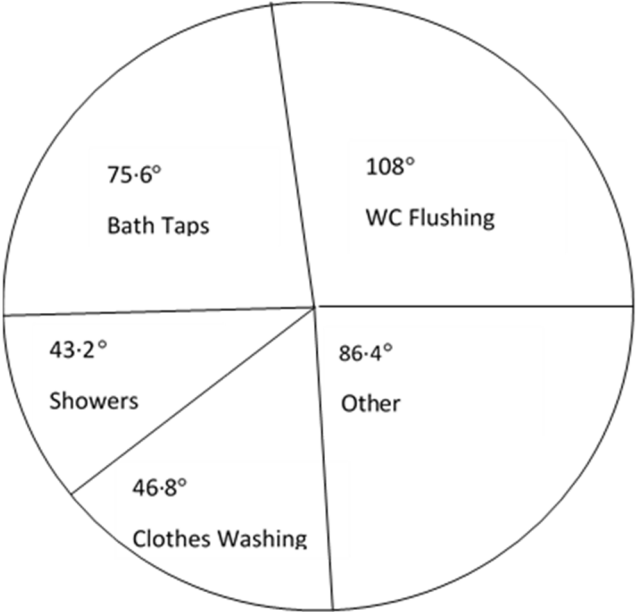
Q6	Model Solution – 25 Marks	Marking Notes
(a) (i)(ii)	 <p> <math> AC  = 4.5</math>  <math> BC  = 5.4</math>  Sum = 9.9 cm </p>	<p>Scale 5D(0, 2, 3, 4, 5)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• One correct line or angle drawn.</li> <li>• Any triangle drawn.(Pilot Diagram)</li> </ul> <p><i>Mid Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Two correct elements drawn &amp; stops.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Construction correct.</li> <li>• Two correct elements and finished correctly/consistently.</li> </ul> <ul style="list-style-type: none"> <li>• Tolerance : <math>\pm 0.25</math> cm , <math>\pm 2.5^\circ</math></li> </ul>
(b)	<p>Answer: Triangle 2</p> <p>Reason: The sides 6 and 7 are not long enough to reach the side of length 15.</p>	<p>Scale 5B (0, 1, 5)</p> <p><i>No Credit:</i></p> <ul style="list-style-type: none"> <li>• Nominates Triangle 1.</li> </ul> <p><i>Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Triangle correct but no reason.</li> <li>• Reason correct but no Triangle.</li> <li>• Any work of merit leading towards correct triangle or reason.</li> </ul>
(c)	$(x + 1)^2 = 5^2 + x^2$ $x^2 + 2x + 1 = 25 + x^2$ $2x = 24$ $x = 12$	<p>Scale 15C(0, 3, 5, 15)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Pythagoras with some substitution.</li> <li>• Trial and error to try and find <math>x = 12</math>.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Pythagoras fully substituted correctly.</li> </ul> <p><i>Full Credit:</i></p> <ul style="list-style-type: none"> <li>• <math>13^2 = 12^2 + 5^2</math>.</li> <li>• (5, 12, 13) identified.</li> </ul>



Q7	Model Solution – 55 Marks	Marking Notes
(a)	$165 \times 10^3 \times 10^6$ $= 165 \times 10^9$ $= 1.65 \times 10^{11}$	Scale 15B(0, 4, 15) <i>Partial Credit:</i> Accept any one of the following: <ul style="list-style-type: none"> <li>• <math>16.5 \times 10^{10}</math></li> <li>• <math>165 \times 10^9</math></li> <li>• <math>10^9</math></li> <li>• <math>10^6</math></li> <li>• <math>10^3</math></li> <li>• 165 000 000 000</li> <li>• 1.65</li> </ul>
(b) (i)	$r = 9 \text{ m}$	Scale 5B(0, 1, 5) <i>Partial Credit:</i> <ul style="list-style-type: none"> <li>• Writes answer as <math>\frac{18}{2}</math> or similar.</li> </ul>
(b) (ii)	$V = \frac{4}{3}\pi r^3$ $= \frac{4}{3}\pi(9)^3$ $= 972\pi$ $= 3053.63 \text{ m}^3$	Scale 5C(0, 1, 2, 5) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>• Identifies correct volume formula.</li> <li>• Writes answer from part (b)(i) in this section.</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>• Formula fully substituted correctly (consistently).</li> <li>• One error in substitution followed by correct calculation.</li> <li>• Answer as <math>972\pi</math>.</li> </ul> <p><b>Note:</b> <math>\pi = 3.14</math>, (3052.08 m<sup>3</sup>)  <math>\pi = \frac{22}{7}</math>, (3054.86 m<sup>3</sup>)</p>
(c)	$A = 9 \times 4\pi r^2$ $= 9 \times 4 \times \pi \times (9)^2$ $= 2916\pi$ $= 9160.88$ $= 9161 \text{ m}^2$	Scale 5C(0, 1, 2, 5) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>• Identifies correct formula.</li> <li>• Identifies <i>radius</i> correctly or consistently (in this part).</li> <li>• Indicates multiplication by 9.</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>• Expression fully substituted.</li> <li>• S.A. of one sphere correctly calculated.(1018 m<sup>2</sup>)</li> </ul> <p><b>Note:</b> <math>\pi = 3.14</math>, (9156 m<sup>2</sup>)  <math>\pi = \frac{22}{7}</math>, (9165 m<sup>2</sup>)</p>

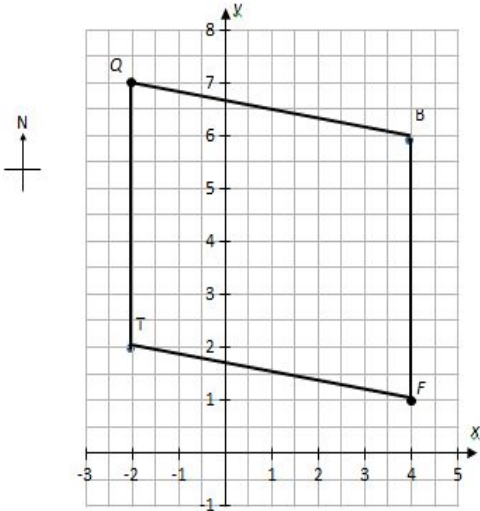
<p>(d) (i)</p>	$CSA = 8 \times 2 \times \pi \times r \times h$ $= 8 \times 2 \times \pi \times 1.65 \times 23$ $= 8(75.9\pi)$ $= 607.2\pi$ $= 1907.57$ $= 1908 \text{ m}^2$	<p>Scale 5C(0, 1, 2, 5)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Identifies correct formula.</li> <li>• Identifies <math>r = 1.65</math>, or <math>h = 23</math>.</li> <li>• Indicates multiplication by 8.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Expression fully substituted.</li> <li>• Area of one pipe correct.</li> </ul> <p><b>Note:</b> <math>\pi = 3.14</math>, (1907 m<sup>2</sup>)  <math>\pi = \frac{22}{7}</math>, (1908 m<sup>2</sup>)</p>
<p>(d) (ii)</p>	$\frac{3170}{12} = 264.17$ $2 \times \pi \times (1.45) \times h = 264.17$ $h = 28.997$ $h = 29$	<p>Scale 15C(0, 3, 5, 15)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• <math>\div 12</math> indicated.</li> <li>• Identifies correct formula.</li> <li>• Indicates <math>r = 1.45</math>.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Equation fully substituted.</li> </ul>
<p>(d) (iii)</p>	$1908 + 3170 + 9161 = 14\,239$ $14\,239 \times 70 =$ $\text{€}996\,730$	<p>Scale 5A(0, 5)</p>

Q8	Model Solution – 50 Marks	Marking Notes																		
(a)	$100 - 76 = 24\%$	Scale 5B(0, 1, 5) <i>Partial Credit:</i> <ul style="list-style-type: none"> <li>• 100% – (any relevant percentage).</li> <li>• Indicates addition of given percentages.</li> </ul>																		
(b) (i)	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="background-color: #cccccc;">Activity</th> <th style="background-color: #cccccc;">Percentage used</th> <th style="background-color: #cccccc;">Angle (Degrees)</th> </tr> </thead> <tbody> <tr> <td>WC flushing</td> <td style="text-align: center;">30%</td> <td style="text-align: center;">108°</td> </tr> <tr> <td>Personal Washing – Baths and Taps</td> <td style="text-align: center;">21%</td> <td style="text-align: center;">75·6°</td> </tr> <tr> <td>Personal Washing – Showers</td> <td style="text-align: center;">12%</td> <td style="text-align: center;">43·2°</td> </tr> <tr> <td>Clothes Washing</td> <td style="text-align: center;">13%</td> <td style="text-align: center;">46·8°</td> </tr> <tr> <td>Other</td> <td style="text-align: center;">24%</td> <td style="text-align: center;">86·4°</td> </tr> </tbody> </table>	Activity	Percentage used	Angle (Degrees)	WC flushing	30%	108°	Personal Washing – Baths and Taps	21%	75·6°	Personal Washing – Showers	12%	43·2°	Clothes Washing	13%	46·8°	Other	24%	86·4°	
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(b) (i)	$1\% = \frac{46\cdot8}{13} = 3\cdot6^\circ$ <p style="text-align: center;"><b>or</b></p> $\frac{360^\circ}{100} = 3\cdot6^\circ$ <p> <math>30\% = 30 \times 3\cdot6 = 108^\circ</math>  <math>21\% = 21 \times 3\cdot6 = 75\cdot6^\circ</math>  <math>12\% = 12 \times 3\cdot6 = 43\cdot2^\circ</math>  <math>24\% = 24 \times 3\cdot6 = 86\cdot4^\circ</math> </p>	Scale 5C(0, 1, 2, 5) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>• Works with 3·6 or similar.</li> <li>• One correct angle.</li> <li>• Three incorrect but consistent angles.</li> <li>• Any use of 360°</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>• Three correct angles.</li> <li>• All incorrect consistent angles.</li> <li>• Correct answer without work.</li> </ul>																		

<p>(b) (ii)</p>	 <table border="1" data-bbox="549 188 1187 797"> <caption>Pie Chart Data</caption> <thead> <tr> <th>Category</th> <th>Angle (degrees)</th> </tr> </thead> <tbody> <tr> <td>WC Flushing</td> <td>108</td> </tr> <tr> <td>Other</td> <td>86.4</td> </tr> <tr> <td>Clothes Washing</td> <td>46.8</td> </tr> <tr> <td>Showers</td> <td>43.2</td> </tr> <tr> <td>Bath Taps</td> <td>75.6</td> </tr> </tbody> </table>		Category	Angle (degrees)	WC Flushing	108	Other	86.4	Clothes Washing	46.8	Showers	43.2	Bath Taps	75.6
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<p>(b) (ii)</p>		<p>Scale 5C(0, 1, 2, 5)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Circle with a sector(s) drawn.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Any 3 sectors drawn correctly. i.e. (with angle and label indicated).</li> <li>• All sectors drawn correctly but either angle or label omitted.</li> </ul>												

(c) (i)	John's weekly household water usage			
	Activity	Water Required	Activities	Number of litres used
	One Bath	80 litres	3 Baths	240
	One Shower	125 litres	20 Showers	2500
	Brushing Teeth with Tap Running	6 litres per minute	32 Minutes	192
	One WC Flush	6 litres	60 Flushes	360
	One Use of Washing Machine	45 litres	8 Uses	360
	One Use of Dishwasher	20 litres	7 Uses	140
	Washing One Car with a Bucket	10 litres	1 Wash	10
	Hosepipe	9 litres per minute	15 Minutes	135
Total Number of litres used			<b>3937</b>	
(c) (i)	$125 \times 20 = 2500$ $6 \times 32 = 192$ $6 \times 60 = 360$ $45 \times 8 = 360$ $20 \times 7 = 140$ $10 \times 1 = 10$ $9 \times 15 = 135$ Total = 3937			Scale 5C(0, 1, 2, 5) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>Indicates one correct water calculation.</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>Four correct water calculations.</li> </ul>
(c) (ii)	$3937 \times 52 = 204\,724$ $\frac{204724}{1000} = 204.724$ $204.724 \times 1.85 = 378.7394$ Cost = €378.74			Scale 5C(0, 1, 2, 5) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>Any use of answer to (c)(i).</li> <li>Any ONE of tasks:               <ul style="list-style-type: none"> <li><math>\times</math> by 52,</li> <li><math>\times</math> 1.85</li> <li><math>\div</math> 1000 correct.</li> </ul> </li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>Any TWO of tasks:               <ul style="list-style-type: none"> <li><math>\times</math> by 52,</li> <li><math>\times</math> 1.85</li> <li><math>\div</math> 1000 correct.</li> </ul> </li> </ul>

(c) (iii)	$378.74 \times 1.135 = \text{€}429.87$	Scale 5A(0, 5)
(d)	$\frac{260}{(1.85)(1.135)} = 123.8242648$ $= 123\,824.3$ <p style="text-align: center;">or = 123 825</p>	<p>Scale 20C(0, 5, 10, 20)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Any ONE of tasks: <ul style="list-style-type: none"> <li>÷ 1.85</li> <li>÷ 1.135</li> <li>× 1000 correct.</li> </ul> </li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Any TWO of tasks: <ul style="list-style-type: none"> <li>÷ 1.85</li> <li>÷ 1.135</li> <li>× 1000 correct</li> </ul> </li> <li>• Formulates correctly with both divisions. (may be done separately)</li> <li>• 123.824 or equivalent and stops.</li> </ul>

Q9	Model Solution – 45 Marks	Marking Notes
(a) (i)	$F = (4, 1)$	Scale 5B(0, 1, 5) <i>Partial Credit:</i> <ul style="list-style-type: none"> <li>• One ordinate correct.</li> <li>• Answer as (1, 4).</li> </ul>
(a) (ii)		Scale 5B(0, 1, 5) <i>Partial Credit:</i> <ul style="list-style-type: none"> <li>• Point correct. (No label)</li> <li>• Point plotted as (B), but not in the correct position.</li> <li>• Plot and label as (4, 6).</li> <li>• Any plot North of F.</li> </ul> <i>No Credit:</i> <ul style="list-style-type: none"> <li>• All other incorrect points with no labels.</li> </ul>
(b)	$d = \sqrt{(-2 - 4)^2 + (7 - 6)^2}$ $= \sqrt{37}$ $= 6.08$	Scale 5C(0, 1, 2, 5) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>• Writes co-ordinates of B and/or Q.</li> <li>• Any work of merit.</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>• Fully correct/consistent substitution without calculation.</li> <li>• One incorrect substitution with correct calculation.</li> <li>• One consistent error throughout.</li> </ul>
(c)	$T = (-2, 2)$	Scale 5B(0, 1, 5) <i>Partial Credit:</i> <ul style="list-style-type: none"> <li>• Any work of merit. (Join F to B)</li> <li>• One ordinate correct.</li> <li>• Answer as (2, -2).</li> </ul>

<p><b>(d)</b></p>	$\begin{array}{ccc} (-2, 2), & (4, 6), & (4, 1) \\ & \downarrow & \\ (0, 0), & (6, 4), & (6, -1) \end{array}$ <p>Area = 2 × Area <math>\Delta TBF</math></p> $2 \times \left(\frac{1}{2}\right)  x_1y_2 - x_2y_1 $ $ (6)(-1) - (4)(6) $ $= 30$ <p style="text-align: center;"><b>or</b></p> $\text{Area} = a \times h_{\perp} = 5 \times 6 = 30$	<p>Scale 5D( 0, 2, 3, 4, 5)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Correct relevant formula identified.</li> <li>• Triangle co-ordinates identified correctly.</li> <li>• Triangle translated correctly.</li> <li>• Works with 5, 6, or 6.08.</li> </ul> <p><i>Mid Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Triangle formula fully substituted.</li> <li>• One error in substitution followed by correct calculation of triangle.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Area of triangle calculated correctly.</li> <li>• One error in substitution followed by correct calculation of parallelogram.</li> <li>• Parallelogram formula fully substituted.</li> <li>• A correct answer without work.</li> </ul>
<p><b>(e)</b></p>	$\frac{\sin \angle FQB}{ FB } = \frac{\sin 45^\circ}{ QB }$ $\sin \angle FQB = \frac{5 \times \sin 45^\circ}{6.08}$ $\sin \angle FQB = 0.5815$ $ \angle FQB  = 35.6^\circ$	<p>Scale 20C(0, 5, 10, 20)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Correct relevant formula.</li> <li>• Work of merit on diagram.</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Sine rule fully substituted.</li> <li>• <math> \angle BQF </math> calculated with one incorrect substitution.</li> <li>• <math> \angle QBF  = 99.47^\circ</math>.</li> <li>• Incorrect calculator mode. (once only) Radian = 0.8      Gradian = 35.9</li> <li>• Correct answer without work.</li> </ul> <p><i>No Credit:</i></p> <ul style="list-style-type: none"> <li>• Treats as right-angled or isosceles Triangle.</li> </ul>



## Marcanna breise as ucht freagairt trí Ghaeilge

### (Bonus marks for answering through Irish)

Ba chóir marcanna de réir an ghnáthráta a bhronnadh ar iarrthóirí nach ngnóthaíonn níos mó ná 75% d'iomlán na marcanna don pháipéar. Ba chóir freisin an marc bónais sin a shlánú **síos**.

Déantar an cinneadh agus an ríomhaireacht faoin marc bónais i gcás gach páipéir ar leithligh.

Is é 5% an gnáthráta agus is é 300 iomlán na marcanna don pháipéar. Mar sin, bain úsáid as an ngnáthráta 5% i gcás iarrthóirí a ghnóthaíonn 225 marc nó níos lú, e.g.  $198 \text{ marc} \times 5\% = 9.9 \Rightarrow$  bónas = 9 marc.

Má ghnóthaíonn an t-iarrthóir níos mó ná 225 marc, ríomhtar an bónas de réir na foirmle  $[300 - \text{bunmharc}] \times 15\%$ , agus an marc bónais sin a shlánú **síos**. In ionad an ríomhaireacht sin a dhéanamh, is féidir úsáid a bhaint as an tábla thíos.

Bunmharc	Marc Bónais
226	11
227 – 233	10
234 – 240	9
241 – 246	8
247 – 253	7
254 – 260	6
261 – 266	5
267 – 273	4
274 – 280	3
281 – 286	2
287 – 293	1
294 – 300	0

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