



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

**Leaving Certificate 2016**

**Marking Scheme**

**Mathematics**

**Foundation 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 Examination 2016

**Mathematics**

Foundation Level

Solutions and Marking scheme

300 marks

## Marking Scheme –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, 3, 5	0, 2, 3, 4, 5	
10 mark scales	0, 10	0, 5, 10	0, 4, 7, 10	0, 2, 5, 8, 10	
15 mark scales	0, 15	0, 7, 15	0, 5, 10, 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.

## Summary of mark allocations and scales to be applied

### *Section A*

#### **Question 1**

- (a) (i)+(ii)+(iii) 15D
- (b) (i)+(ii)+(iii) 10D

#### **Question 2**

- (a) (i)+(ii) 10C
- (b) (i)+(ii)+(iii) 15D

#### **Question 3**

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

#### **Question 4**

- (a)(i) 5B
- (a)(ii) 5B
- (b)(i) 5C
- (b) (ii)+(iii)+(iv) 10D

#### **Question 5**

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

#### **Question 6**

- (a) 15D
- (b) 5A
- (c) 5B

#### **Question 7**

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

#### **Question 8**

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

### *Section B*

#### **Question 9**

- (a)(i) 5B
- (a)(ii) 5B
- (a)(iii) 5B
- (a) (iv) 5B
- (b) (i) 10C
- (b) (ii) 10D
- (b) (iii) 5B
- (b) (iv) 5B

#### **Question 10**

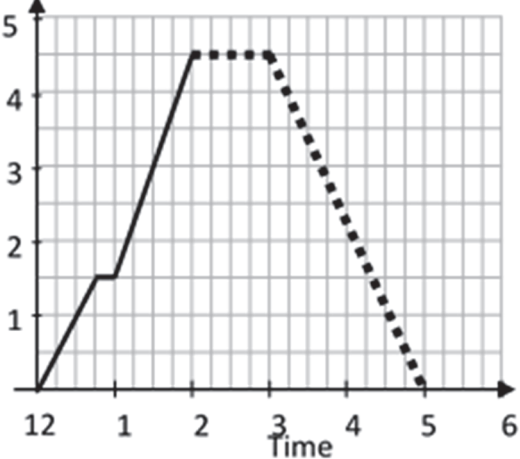
- (a)(i) 5D
- (a)(ii) 10D
- (a)(iii) 15C
- (b)(i)(ii) 15C
- (c) 5C

**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 Solutions 25 marks	Marking Notes
<b>a</b> <b>(i)</b>  <b>a</b> <b>(ii)</b>  <b>a</b> <b>(iii)</b>	$6 + 7 + 14 = 27$  $\frac{14}{27}$  $\frac{13}{27}$	Scale 15D (0, 4, 7, 11, 15) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>Any work of relevance in any of the three parts</li> </ul> <i>Mid Partial Credit:</i> <ul style="list-style-type: none"> <li>One part correct</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>Two parts correct</li> </ul>
<b>b</b> <b>(i)</b>  <b>b</b> <b>(ii)</b>  <b>b</b> <b>(iii)</b>	$\frac{9}{16}$  $\frac{8}{12}$  $28 - (9 + 8) = 11$  $\frac{11}{28}$	Scale 10D (0, 2, 5, 8, 10) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>Any work of relevance in any of the three parts</li> </ul> <i>Mid Partial Credit:</i> <ul style="list-style-type: none"> <li>One part correct</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>Two parts correct</li> </ul>

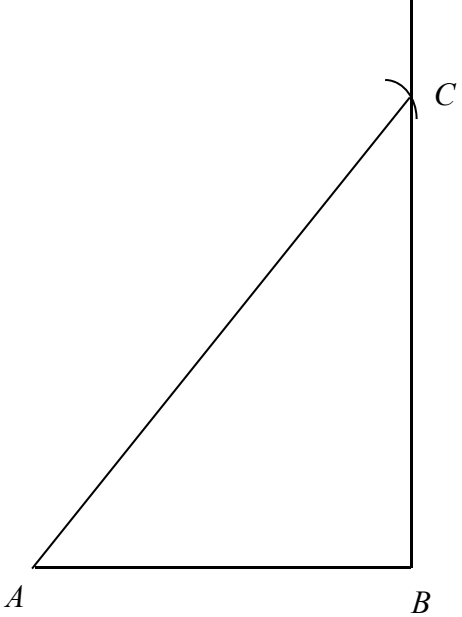


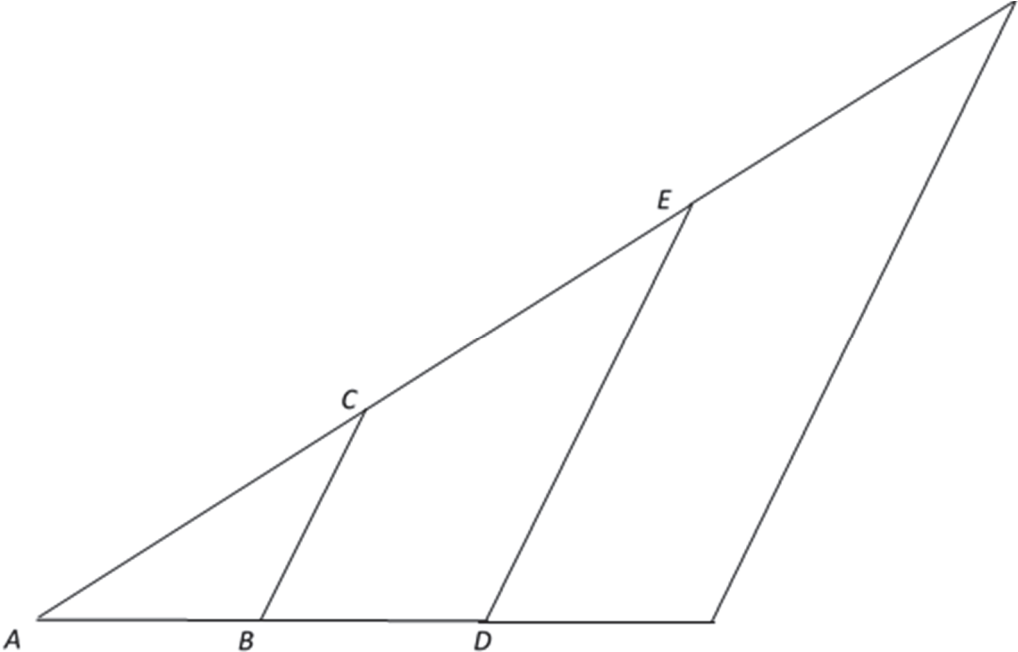
Q2	Model Solutions 25 marks	Marking Notes
<b>a</b> <b>(i)</b>  <b>a</b> <b>(ii)</b>	$8 \times 10 = 80 \text{ cm}$  $8 \times 14 = 112 \text{ cm}$	Scale 10C (0, 4, 7, 10) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>Any work of relevance in any of the two parts</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>One part correct</li> </ul>
<b>b</b> <b>(i)</b>  <b>b</b> <b>(ii)</b>  <b>b</b> <b>(iii)</b>	$A = 4 \times 3 \times 2^2 = 48 \text{ cm}^2$  $4 \times 3 \cdot 142 \times (1 \cdot 9)^2$ $= 45 \cdot 37 = 45 \cdot 4 \text{ cm}^2$  $48 - 45 \cdot 4 = 2 \cdot 6 \text{ cm}^2$	Scale 15D (0, 4, 7, 11, 15) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>Any work of relevance in any of the three parts</li> </ul> <i>Mid Partial Credit:</i> <ul style="list-style-type: none"> <li>One part correct</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>Two parts correct</li> </ul>

Q3	Model Solutions 25 marks	Marking Notes
<p>(a) (i)</p> <p>(a) (ii)</p>	<p>15 min</p> <p>30 km</p>	<p>Scale 5C (0, 2, 3, 5)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Any work of relevance in any of the two parts</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>One part correct</li> </ul>
<p>(a) (iii)</p>		<p>Scale 10C (0, 4, 7, 10)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Any work of relevance on the graph</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>One correct interval marked on graph</li> </ul>
<p>b (i)</p> <p>b (ii)</p>	<p><math>42 \times 2 \times 4 = 336 \text{ km}</math></p> <p><math>336 + 14 = 350</math></p> <p>B to C: <math>350 \div (2 \times 5) = 35 \text{ km}</math></p> <p>A to B: <math>42 - 35 = 7 \text{ km}</math></p>	<p>Scale 10C (0, 4, 7, 10)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Any work of relevance in any of the two parts</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>One part correct</li> </ul>

Q4	Model Solutions	25 marks	Marking Notes			
(a) (i)	26		Scale 5B (0, 2, 5) <i>Partial Credit:</i> <ul style="list-style-type: none"> <li>Shows knowledge of relevance of middle term</li> </ul>			
(a) (ii)	$34 - 18 = 16$		Scale 5B (0, 2, 5) <i>Partial Credit:</i> <ul style="list-style-type: none"> <li>Shows knowledge of relevance of either or both end terms</li> </ul>			
<b>(b)(i)</b>						
Time (minutes)		0 – 10	10 – 20	20 – 30	30 – 40	40 – 50
Number of people		<b>30</b>	60	45	20	15
(b) (i)			Scale 5C (0, 2, 3, 5) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>One correct new entry</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>Two or three correct new entries</li> </ul>			
(b) (ii)	$30 + 60 + 45 + 20 + 15 = 170$		Scale 10D (0, 2, 5, 8, 10) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>Any work of relevance in any of the three parts</li> </ul> <i>Mid Partial Credit</i> <ul style="list-style-type: none"> <li>One part correct</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>Two parts correct</li> </ul>			
(b) (iii)	$20 + 15 = 35$ $35 \times 100 \div 170 = 20.58\dots$ $= 21\%$					
(b) (iv)	$30 + 60 + 45 = 135$					

Q5	Model Solutions 25 marks	Marking Notes
(a)	$20\,100 \times \frac{1}{3} = 6700$ $20\,100 - 6700 = \text{€}13400$	Scale 5C (0, 2, 3, 5) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>• Any work of relevance</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>• 6700 calculated</li> </ul>
(b)	$21\,500 \times \frac{40}{100} = 8600$ $21\,500 - 8600 = \text{€}12900$	Scale 5C (0, 2, 3, 5) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>• Any work of relevance</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>• 8600 calculated</li> </ul>
(c)	$272.50 \times 12 \times 4 = \text{€}13080$	Scale 10C (0, 4, 7, 10) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>• Any work of relevance</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>• <math>272.50 \times 12</math> or <math>272.50 \times 4</math> calculated correctly i.e. €3270, €1090</li> </ul>
(d)	Option B	Scale 5A (0, 5) <b>Note:</b> Answer should be correct based on candidate's previous work.

Q6	Model Solutions 25 marks	Marking Notes
(a)		<p>Scale 15D (0, 4, 7, 11, 15)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• One line or angle correct</li> </ul> <p><i>Mid Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• One line and angle correct</li> <li>• Two lines correct but wrong angle</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Triangle transposed but correct otherwise i. e. , <math> \angle BAC  = 90^\circ</math></li> </ul> <p><b>Note:</b> Tolerance <math>\pm 0.2</math> cm <b>Note:</b> Tolerance <math>\pm 5^\circ</math></p>
(b)	<p><math>51^\circ</math></p>	<p>Scale 5A (0, 5)</p> <p><b>Note:</b> Tolerance <math>\pm 5^\circ</math> <b>Note:</b> May have correct answer based on candidate's diagram</p>
(c)	$ BC  = \sqrt{8^2 - 5^2} = \sqrt{39}$ $= 6.24\dots = 6.2 \text{ cm}$	<p>Scale 5B (0, 2, 5)</p> <p><i>Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Some relevant use of Pythagoras</li> </ul>

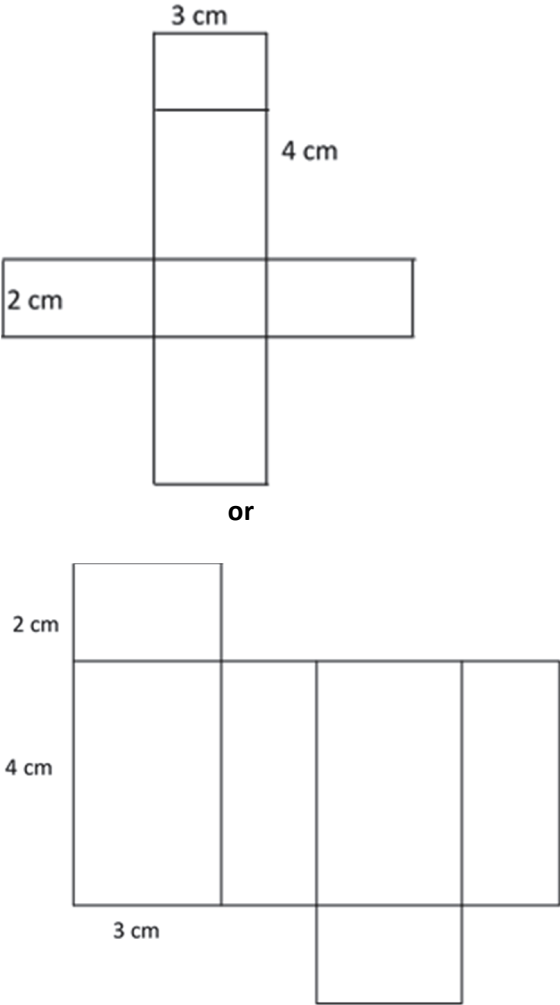
Q7	Model Solutions 25 marks	Marking Notes
(a)	$ AB  = 3.3 \text{ cm}$ $ AD  = 6.6 \text{ cm}$	Scale 10C (0, 4, 7, 10) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>Some indication of measurement</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>One relevant measurement correct</li> </ul> <b>Note:</b> Tolerance $\pm 0.2 \text{ cm}$
(b)	$\frac{6.6}{3.3} = 2$	Scale 5B (0, 2, 5) <i>Partial Credit:</i> <ul style="list-style-type: none"> <li>Any work of relevance</li> </ul>
(c)	$3 \times 2^2 = 12 \text{ sq units}$	Scale 5C (0, 2, 3, 5) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>Some effort at finding area of triangle</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li><math>3 \times 2</math></li> </ul>
(d)		
		Scale 5B (0, 2, 5) <i>Partial Credit:</i> <ul style="list-style-type: none"> <li>Some relevant construction</li> </ul>

Q8	Model Solutions 25 marks	Marking Notes
(a) (i)	40	Scale 5B (0, 2, 5) <i>Partial Credit:</i> • Any work of relevance
(a) (ii)	7	Scale 5B (0, 2, 5) <i>Partial Credit:</i> • Any work of relevance
(a) (iii)	$12 - 2 \times (3 + 1) = 4$	Scale 5A (0, 5)
(b) (i) & (ii)	$55 - 12 = \text{€}43$  $43 - 7 = 36$  $36 \div 2 = \text{€}18$	Scale 10C (0, 4, 7, 10) <i>Low Partial Credit:</i> • Any work of relevance in any part  <i>High Partial Credit:</i> • One part correct

Q9	Model Solutions 50 marks	Marking Notes																
(a) (i)	€40	Scale 5B (0, 2, 5) <i>Partial Credit:</i> <ul style="list-style-type: none"> <li>• Indication of correct point on graph</li> </ul>																
(a) (ii)	€280	Scale 5B (0, 2, 5) <i>Partial Credit:</i> <ul style="list-style-type: none"> <li>• Indication of correct point on graph</li> </ul>																
(a) (iii)	3 valves	Scale 5B (0, 2, 5) <i>Partial Credit:</i> <ul style="list-style-type: none"> <li>• Incorrect use of candidates standing charge or single valve cost</li> <li>• Clear indication on graph but no answer given</li> </ul>																
(a) (iv)	€360	Scale 5B (0, 2, 5) <i>Partial Credit:</i> <ul style="list-style-type: none"> <li>• Incorrect use of candidates standing charge or single valve cost</li> <li>• Graph continued but no answer given</li> </ul>																
(b) (i)	<table border="1"> <thead> <tr> <th>Number. of radiators</th> <th>Charge(€)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> </tr> <tr> <td>1</td> <td><b>60</b></td> </tr> <tr> <td>2</td> <td>120</td> </tr> <tr> <td>3</td> <td>180</td> </tr> <tr> <td>4</td> <td>240</td> </tr> <tr> <td>5</td> <td>300</td> </tr> <tr> <td>6</td> <td>360</td> </tr> </tbody> </table>	Number. of radiators	Charge(€)	0	0	1	<b>60</b>	2	120	3	180	4	240	5	300	6	360	Scale 10C (0, 4, 7, 10) <i>Low Partial Credit:</i> <ul style="list-style-type: none"> <li>• one correct entry</li> </ul> <i>High Partial Credit:</i> <ul style="list-style-type: none"> <li>• three correct entries</li> </ul>
Number. of radiators	Charge(€)																	
0	0																	
1	<b>60</b>																	
2	120																	
3	180																	
4	240																	
5	300																	
6	360																	



<p><b>(b)</b> <b>(ii)</b></p>	<p>The graph shows two linear relationships between the number of radiators and the charge. The solid line starts at a charge of 40 for 0 radiators and reaches 360 at 6 radiators. The dotted line starts at 0 for 0 radiators and reaches 360 at 8 radiators.</p>	<p>Scale 10D (0, 2, 5, 8, 10) <i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• One point plotted correctly</li> </ul> <p><i>Mid Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Two points plotted correctly</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Five points plotted correctly</li> </ul>
<p><b>(b)</b> <b>(iii)</b></p>	<p>( 2, 120 )</p>	<p>Scale 5B (0, 2, 5) <i>Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• Point clearly indicated on graph</li> <li>• 2 or 120 written</li> </ul>
<p><b>(b)</b> <b>(iv)</b></p>	<p>Company: Thermolok</p> <p>Amount saved: <math>300 - 240 = \text{€}60</math></p>	<p>Scale 5B (0, 2, 5) <i>Partial Credit:</i></p> <ul style="list-style-type: none"> <li>• One answer correct</li> </ul>

Q10	Model Solutions 50 marks	Marking Notes
(a) (i)		<p>Scale 5D (0, 2, 3, 4, 5)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Any line of correct length drawn</li> </ul> <p><i>Mid Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Any side correctly drawn</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>6 correct sides drawn but not net of the given block</li> </ul>
(a) (ii)	$2(3 \times 4) = 24$ $2(3 \times 2) = 12$ $2(4 \times 2) = 16$ $24 + 12 + 16 = 52 \text{ cm}^2$	<p>Scale 10D (0, 2, 5, 8, 10)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Relevant work to find an area of a side</li> </ul> <p><i>Mid Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Area of 1 side correct</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Areas of 3 different sides (non congruent) correct but not added <b>or</b> incorrectly added</li> </ul>
(iii)	$2 \times 4 \times 3 = 24 \text{ cm}^3$	<p>Scale 15C (0, 5, 10, 15)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Correct relevant formula with some substitution</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Correct substitution into formula but no answer or incorrect answer</li> </ul>

<p>(b) (i)</p> <p>(b) (ii)</p>	$V = \pi r^2 h$ $= \pi \times (1.6)^2 \times 12$ $= 96.50\dots = 96.5 \text{ cm}^3$ $96.5 \div 0.5 =$ $193$	<p>Scale 15C (0, 5, 10, 15)</p> <p><i>Low Partial Credit:</i></p> <ul style="list-style-type: none"> <li>Any work of relevance in any part</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li>One part correct</li> </ul>
<p>(c)</p>	<p>Yes</p> $\cos A = \frac{1}{4}$ $A = 75.5^\circ$	<p>Scale 5C (0, 2, 3, 5)</p> <p><i>Low Partial credit:</i></p> <ul style="list-style-type: none"> <li>"Yes" written without trig</li> <li>cos</li> </ul> <p><i>High Partial Credit:</i></p> <ul style="list-style-type: none"> <li><math>\frac{1}{4}</math></li> <li><math>75.5^\circ</math> but without "Yes"</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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