Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2017

Marking Scheme

Mathematics

Higher 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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State Examinations Commission

Leaving Certificate Examination 2017

Mathematics

Higher Level

Paper 1

Solutions and Marking scheme

300 marks

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, 3, 5	0, 3, 4, 5	0, 2 ,3, 4, 5	
10 mark scales	0, 10	0, 4, 10	0, 5, 8, 10	0, 4, 7, 8, 10	
15 mark scales	0, 15	0, 7, 15	0, 5, 10, 15	0, 5, 8, 12, 15	
20 mark scales	0, 20	0, 10, 20	0, 10, 18, 20	0, 5, 14, 17, 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

Summary of mark allocations and scales to be applied

Section A

Question 1

(a)	5D
(b)	10B
(c)(i)	5B
(ii)	5C

Question 2

(a)	15D
(b)	10D

Question 3

(a)	20D
(b)	5C

Question 4

(a)	15D
(b)	10C

Question 5

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

Question 6

(a)	15C
(b)	10C

Section B

Question 7

(a)	10B
(b)	10B
(c)	5C
(d)	15C
(e)	5C
(f)	5C
(g)	5C

Question 8

(a)	5C
(b)(i)	10B
(b)(ii)	10B
(b)(iii)	10C
(b)(iv)	5C
(b)(v)	10C
(b)(vi)	5B

Question 9

(a)	20C
(b)(i)	10C
(b)(ii)	5C
(c)	5C

NOTE: 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.
Rounding and units penalty to be applied only once in each section (a), (b), (c) etc.
Throughout the scheme indicate by use of * where an arithmetic error occurs.

Detailed marking notes

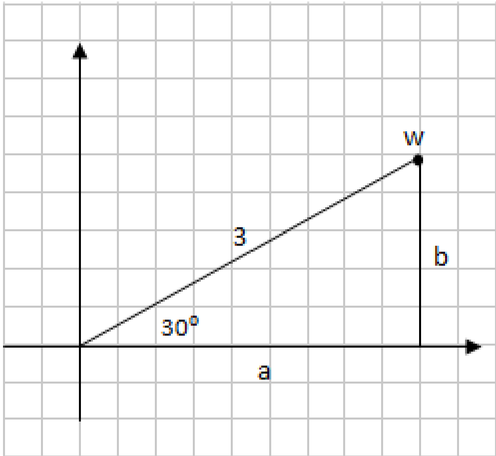
Model Solutions & Marking Notes

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)	$2\left(x^2 - \frac{7}{2}x - 5\right)$ $= 2\left(\left(x - \frac{7}{4}\right)^2 - \frac{129}{16}\right)$ $= 2\left(\left(x - \frac{7}{4}\right)^2\right) - \frac{129}{8}$	**Scale 5D (0, 2, 3, 4, 5)** *Low Partial Credit:* • $a = 2$ identified explicitly or as factor *Mid partial Credit:* • Completed square *High partial Credit:* • h or k identified from work
(b)	$\left(\frac{7}{4}, \quad \frac{-129}{8}\right)$	**Scale 10B (0, 4, 10)** *Partial Credit:* • One relevant co-ordinate identified

(c) (i)	$f(x)$ has min point as $a > 0$ y co-ordinate of min < 0 $\Rightarrow$graph must cut x-axis twice hence two real roots. **or** $b^2 - 4ac = 49 + 80 > 0$ Therefore real roots	**Scale 5B (0, 3, 5)** *Partial Credit:* • Mention of $a > 0$ • $b^2 - 4ac$ • Identifies location of one or two roots, e.g. between 4 and 5.
c (ii)	$2x^2 - 7x - 10 = 0$ $2\left(\left(x - \frac{7}{4}\right)^2\right) - \frac{129}{8} = 0$ $\left(x - \frac{7}{4}\right)^2 = \frac{129}{16}$ $x - \frac{7}{4} = \pm\frac{\sqrt{129}}{4}$ $x = \frac{7}{4} \pm \sqrt{\frac{129}{16}}$ **OR** $2x^2 - 7x - 10 = 0$ $x = \frac{7 \pm \sqrt{49 + 80}}{4}$ $= \frac{7 \pm \sqrt{129}}{4}$ $x = \frac{7}{4} \pm \sqrt{\frac{129}{16}}$	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • Formula with some substitution • Equation rewritten with some transpose *High Partial Credit:* • $x - \frac{7}{4} = \pm\frac{\sqrt{129}}{4}$ or equivalent

Q2	Model Solution – 25 Marks	Marking Notes
(a)	$z = 2\left(\cos\frac{5\pi}{6} + i\sin\frac{5\pi}{6}\right)$ $z^4 = \left(2\left(\cos\frac{5\pi}{6} + i\sin\frac{5\pi}{6}\right)\right)^4$ $z^4 = 16\left(\cos\frac{10\pi}{3} + i\sin\frac{10\pi}{3}\right)$ $= -8 - 8\sqrt{3}i$	**Scale 15D (0, 5, 8, 12, 15)** *Low Partial Credit:* • θ or $\|z\|$ found *Mid Partial Credit:* • z written in polar form *High Partial Credit:* • De Moivre's Theorem applied correctly **Note**: Not using De Moivre: Low partial credit for fully correct work
(b)	$w = 3(\cos 30 + i\sin 30)$ $zw = 2\left(\cos\frac{5\pi}{6} + i\sin\frac{5\pi}{6}\right) \times 3\left(\cos\frac{\pi}{6} + i\sin\frac{\pi}{6}\right)$ $zw = 6(\cos\pi + i\sin\pi)$ $= 6(-1 + 0i)$ $= -6$ **OR (contd)**	**Scale 10D (0, 4, 7, 8, 10)** *Low Partial Credit:* • Work towards w in Cartesian or polar form *Mid Partial Credit* • zw expressed as a product *High Partial Credit:* • zw in Cartesian or polar form



$$w = a + bi$$

$$a^2 + b^2 = 9$$

$$\frac{b}{3} = \sin 30° = \frac{1}{2}$$

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

$$a^2 + \left(\frac{3}{2}\right)^2 = 9$$

$$a^2 = \frac{27}{4}$$

$$a = \sqrt{\frac{27}{4}} = \frac{3\sqrt{3}}{2}$$

$$w = a + bi = \frac{3\sqrt{3}}{2} + \frac{3}{2}i$$

$$z = -\sqrt{3} + i$$

$$zw = \left(-\sqrt{3} + i\right)\left(\frac{3\sqrt{3}}{2} + \frac{3}{2}i\right)$$

$$= -\frac{9}{2} - \frac{3\sqrt{3}i}{2} + \frac{3\sqrt{3}i}{2} - \frac{3}{2}$$

$$= -6$$

<table>
<tr><th>Q3</th><th>Model Solution – 25 Marks</th><th>Marking Notes</th></tr>
<tr><td>(a)</td><td>

$$f(x+h) = \frac{1}{3}(x+h)^2 - (x+h) + 3$$

$$f(x) = \frac{1}{3}x^2 - x + 3$$

$$f(x+h) - f(x) = \frac{2xh}{3} + \frac{h^2}{3} - h$$

$$\frac{f(x+h) - f(x)}{h} = \frac{2x}{3} + \frac{h}{3} - 1$$

$$\lim_{h\to 0}\frac{f(x+h) - f(x)}{h} = \frac{2x}{3} - 1$$

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Scale 20D (0, 5, 14, 17, 20)
Low Partial Credit
any $f(x+h)$
Mid Partial Credit
$f(x+h) - f(x)$ with some correct work
High Partial Credit
$\frac{\frac{1}{3}(x+h)^2 - (x+h) + 3 - \left(\frac{x^2}{3} - x + 3\right)}{h}$ simplified
Notes:
omission of limit sign penalised once only
answer not from 1st Principles merits 0 marks

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<tr><td>(b)</td><td>

$$\frac{d(fg(x))}{dx} =$$

$$\frac{1}{(3(x+5)^2 + 2)}(6(x+5))$$

$$\frac{d(fg\left(\frac{1}{4}\right))}{dx} = \frac{6(\frac{21}{4})}{3(\frac{21}{4})^2 + 2} = \frac{504}{1355}$$

$$= 0{\cdot}372$$

OR

$$f(x) = \ln(3x^2 + 2)$$

$$g(x) = (x+5)$$

$$f[g(x)] = \ln[3(x+5)^2 + 2]$$

$$= \ln(3x^2 + 30x + 77)$$

$$f'(x) = \frac{6x + 30}{3x^2 + 30x + 77}$$

$$x = \frac{1}{4}: \quad f'(x) = \frac{31{\cdot}5}{84{\cdot}6875} = 0{\cdot}3719$$

$$= 0{\cdot}372$$

</td><td>

Scale 5C (0, 3, 4, 5)
Low Partial Credit:
Any correct differentiation
$fg(x)$ formulated
High Partial Credit:
$\frac{d(fg(x)}{dx}$ found
Note:
Work with $f(x) \times g(x)$ merits low partial credit at most

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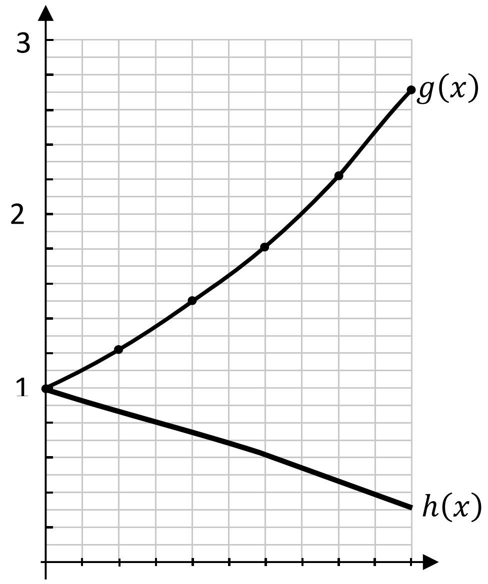
Q4	Model Solution – 25 Marks	Marking Notes
(a)	$r = \frac{42·75}{95} = \frac{9}{20}$ $\quad T_n = ar^{n-1} < 0·01$ $95\left(\frac{9}{20}\right)^{n-1} < 0·01$ $\left(\frac{9}{20}\right)^{n-1} < \frac{0·01}{95}$ $(n-1)\log\left(\frac{9}{20}\right) < \log\left(\frac{0.01}{95}\right)$ $(n-1) > \frac{\log\left(\frac{0.01}{95}\right)}{\log\left(\frac{9}{20}\right)}$ (since $\log\left(\frac{9}{20}\right)$ is negative) $n - 1 > 11·47$ $n > 12·47$ 12th day	**Scale 15D (0, 5, 8, 12, 15)** *Low Partial Credit:* • r found • T_n of a GP with some substitution *Mid Partial Credit:* • Inequality in n written *High Partial Credit:* • Inequality in n simplified (log handled) *Full Credit:* • Accept $n = 12·47$
(b)	$4(2) + 4\sqrt{2} + 4 + \cdots\cdots$ $a = 8 \quad r = \frac{1}{\sqrt{2}}$ $S_\infty = \frac{a}{1-r}$ $S_\infty = \frac{8}{1-\frac{1}{\sqrt{2}}}$ $S_\infty = \frac{8}{1-\frac{1}{\sqrt{2}}} \cdot \frac{1+\frac{1}{\sqrt{2}}}{1+\frac{1}{\sqrt{2}}}$ $S_\infty = \frac{8\left(1+\frac{1}{\sqrt{2}}\right)}{\frac{1}{2}}$ $S_\infty = 16 + 8\sqrt{2}$	**Scale 10C (0, 5, 8, 10)** *Low Partial Credit:* • length of one side of new square *High Partial Credit:* • S_∞ fully substituted • Correct work with one side only

Q5	Model Solution – 25 Marks	Marking Notes
(a)	$f(x) = 2x^3 + 5x^2 - 4x - 3$ $f(-3) = 2(-3)^3 + 5(-3)^2 - 4(-3) - 3$ $= -54 + 45 + 12 - 3$ $f(-3) = 0$ $\Rightarrow (x+3)$ is a factor $x+3 \overline{)\,2x^3 + 5x^2 - 4x - 3}$ quotient $2x^2 - x - 1$ $\underline{2x^3 + 6x^2}$ $-x^2 - 4x$ $\underline{-x^2 - 3x}$ $-x - 3$ $\underline{-x - 3}$ $f(x) = (x+3)(2x^2 - x - 1)$ $f(x) = (x+3)(2x+1)(x-1)$ $x = -3 \quad x = -\frac{1}{2} \quad x = 1$	**Scale 15C (0, 5, 10, 15)** *Low Partial Credit:* • Shows $f(-3) = 0$ *High Partial Credit:* • quadratic factor of $f(x)$ found Note: No remainder in division may be stated as reason for $x = -3$ as root

(b)	$$y = 2x^3 + 5x^2 - 4x - 3$$ $$\frac{dy}{dx} = 6x^2 + 10x - 4 = 0$$ $$3x^2 + 5x - 2 = 0$$ $$(x+2)(3x-1) = 0$$ $$3x - 1 = 0 \quad x + 2 = 0$$ $$x = \frac{1}{3} \quad x = -2$$ $$f\left(\frac{1}{3}\right) = \frac{-100}{27} \quad f(-2) = 9$$ $$Max = (-2, 9) \quad Min = \left(\frac{1}{3}, \frac{-100}{27}\right)$$	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • $\frac{dy}{dx}$ found (Some correct differentiation) *High Partial Credit* • roots and one y value found **Note**: One of Max/Min must be identified for full credit
(c)	$a > \frac{100}{27}$ **or** $a < -9$	**Scale 5B (0, 3, 5)** *Partial Credit:* • one value identified • no range identified (from 2 values)

Q6	Model Solution – 25 Marks	Marking Notes

(a)



$$g(x) = e^x \quad h(x) = e^{-x} = \frac{1}{e^x}$$

$g(x) = e^x$:

x	0	0·2	0·4	0·6	0·8	1·0
y	1	1·22	1·49	1·82	2·23	2·72

$h(x) = \frac{1}{e^x}$:

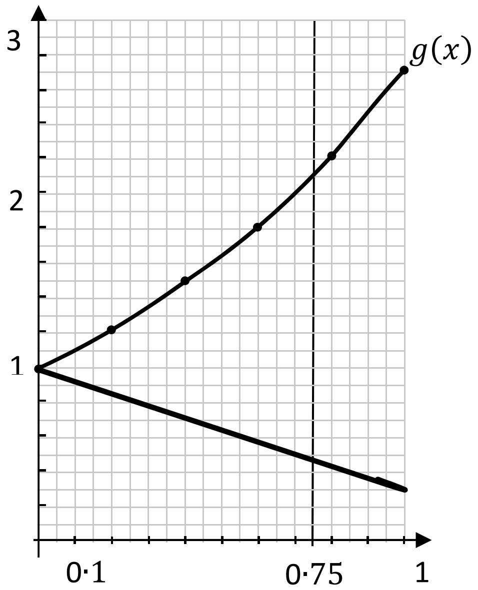
x	0	0·2	0·4	0·6	0·8	1·0
y	1	0·82	0·67	0·55	0·45	0·37

Marking Notes

Scale 15C (0, 5, 10, 15)

Low Partial Credit:
- one point correct

High Partial Credit
- Graph not in required domain

(b)	 $A = \int_0^{0 \cdot 75} e^x dx - \int_0^{0 \cdot 75} e^{-x} dx$ $= \int_0^{0 \cdot 75} (e^x - e^{-x}) dx$ $= e^x + e^{-x}$ $e^{0 \cdot 75} + e^{-0 \cdot 75} - [e^0 + e^0]$ $= 0 \cdot 5894$	**Scale 10C (0, 5, 8, 10)** *Low Partial Credit:* • Formulates integration for area under one curve with limits *High Partial Credit* • integrates twice for correct area under both curves **Note**: Trapezoidal rule must have at least 5 divisions AND fully correct work gets Low Partial Credit

Q7	Model Solution – 55 Marks	Marking Notes
(a)	$Se^{\cdot 1(0)} \times 10^6 = 1100000$ $S = 1{\cdot}1$	**Scale 10B (0, 4, 10)** *Partial Credit* • equation in S with substitution
(b)	$p(5) = 1{\cdot}1e^{0\cdot 1(5)} \times 10^6$ $= 1{\cdot}813593 \times 10^6$ $= 1813593$	**Scale 10B (0, 4, 10)** *Partial Credit* • substitution into formula for $p(5)$
(c)	$p(6) = 1{\cdot}1e^{0\cdot 6} \times 10^6$ $p(5) = 1{\cdot}1e^{0\cdot 5} \times 10^6$ $p(6) - p(5) = (1{\cdot}1e^{0\cdot 6} - 1{\cdot}1e^{0\cdot 5}) \times 10^6$ $= 0{\cdot}1907372 \times 10^6$ $= 190737$	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • substitution into formula for $p(6)$ • use of $p(5)$ from previous part • $p(6) - p(5)$ written or implied *High partial Credit* • Formulates $p(6) - p(5)$ with some substitution

(d)	$$q(t) = 3{\cdot}9e^{kt} \times 10^6$$ $$3709795 = 3{\cdot}9e^{k} \times 10^6$$ $$\frac{3{\cdot}709795}{3{\cdot}9} = e^k$$ $$\log_e \frac{3{\cdot}709795}{3{\cdot}9} = k$$ $$k = -0{\cdot}0499 = -0{\cdot}05$$	**Scale 15C (0, 5, 10, 15)** *Low Partial Credit* • Either substitution into formula for k • Verifies k value only. *High Partial Credit* • relevant equation in k
(e)	$$p(t) = q(t)$$ $$1{\cdot}1e^{0{\cdot}1t} \times 10^6 = 3{\cdot}9e^{-0{\cdot}05t} \times 10^6$$ $$1{\cdot}1e^{0{\cdot}1t} = 3{\cdot}9e^{-0{\cdot}05t}$$ $$\frac{e^{0{\cdot}1t}}{e^{-0{\cdot}05t}} = \frac{3{\cdot}9}{1{\cdot}1}$$ $$e^{0{\cdot}15t} = \frac{39}{11}$$ $$\ln\frac{39}{11} = 0{\cdot}15t$$ $t = 8{\cdot}44$ years In 2018 both populations equal	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit* • $p(t) = q(t)$ written or implied *High Partial Credit* • relevant equation in t
(f)	$$\frac{1}{15}\int_0^{15} 3{\cdot}9e^{-0{\cdot}05t} \times 10^6 dt$$ $$\frac{1}{15}\left[\frac{3{\cdot}9}{-0{\cdot}05}e^{-0{\cdot}05(15)} - \frac{3{\cdot}9}{-0{\cdot}05}e^{-0{\cdot}05(0)}\right]$$ $$\times 10^6$$ $$2{\cdot}743694 \times 10^6$$ $$2743694$$	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • integral formulated (with limits) *High Partial Credit:* • integration with full substitution
(g)	$$q(t) = 3.9e^{-0.05t} \times 10^6$$ $$q'(t) = -0{\cdot}05(3{\cdot}9e^{-0{\cdot}05t} \times 10^6)$$ $$q'(8) = -0{\cdot}05\left(3{\cdot}9e^{-0{\cdot}05(8)} \times 10^6\right)$$ $$= -130712$$	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit* • $q'(t)$ *High Partial Credit* • $q'(t)$ fully substituted

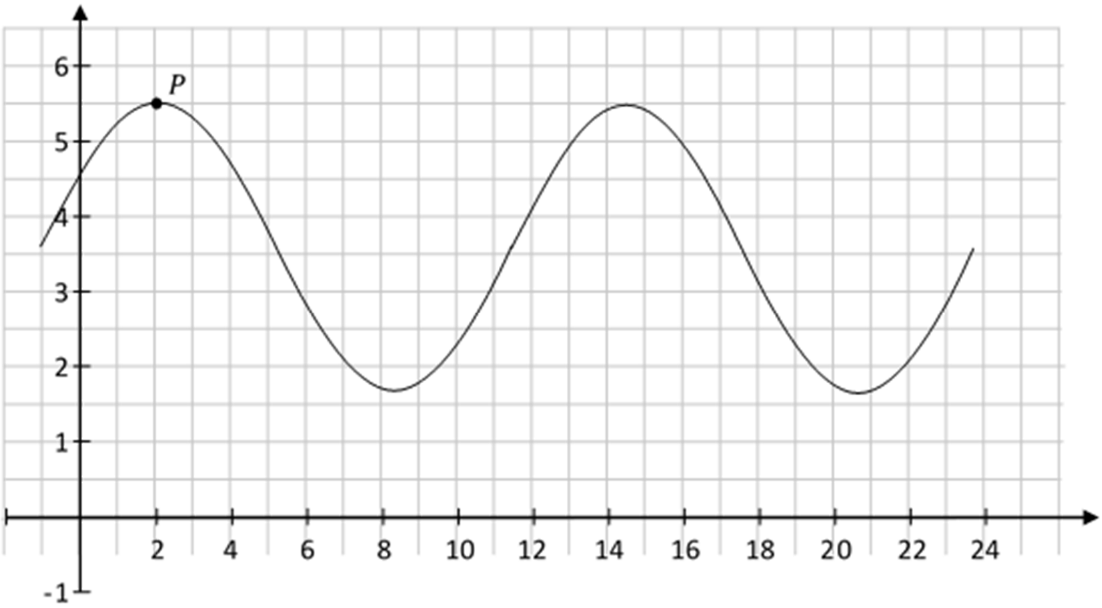
Q8	Model Solution – 55 Marks	Marking Notes
(a)	$P=\frac{A}{1+i}+\frac{A}{(1+i)^2}+\cdots\cdots+\frac{A}{(1+i)^t}$ $P=\frac{\left(\frac{A}{1+i}\right)\left(1-\left(\frac{1}{1+i}\right)^t\right)}{1-\frac{1}{1+i}}$ $=\frac{A\left(1-\frac{1}{(1+i)^t}\right)}{1+i-1}$ $=\frac{A((1+i)^t-1)}{i(1+i)^t}$ $A=\frac{P(i)(1+i)^t}{(1+i)^t-1}$	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • $P=\frac{A}{1+i}$ • $A=P(1+i)$ • S_n formula with some substitution *High Partial Credit:* • full substitution for P (or A) into S_n formula.
(b) (i)	$2{\cdot}5\% \times 5000 = 125$	**Scale 10B (0, 4, 10)** *Partial Credit* • Any one unknown
(b) (ii)	$(1+i)^{\frac{1}{12}}=(1{\cdot}2175)^{\frac{1}{12}}=1{\cdot}016535$ $Rate=1{\cdot}65\%$	**Scale 10B (0, 4, 10)** *Partial Credit* • Formula with some substitution
(b) (iii)	(see table below)	

Payment number	Fixed monthly payment, €A	€A: Interest	€A: Previous balance reduced by (€)	New balance of debt (€)
0				5000
1	125	82·50	42·50	4957·50
2	125	81·80	43·20	4914·30
3	125	81·09	43·91	4870·39

(b) (iii)		Marking Notes
		Scale 10C (0, 5, 8, 10) *Low Partial Credit:* • One correct additional entry *High Partial Credit:* • 6 correct additional entries **Note:** Where interest rate in b(ii) is not 1·65%, then check the validity of all values given.

(iv)	$$A = p\left[\frac{i(1+i)^t}{(1+i)^t - 1}\right]$$ $$A[(1+i)^t - 1] = pi(1+i)^t$$ $$A(1+i)^t - A = pi(1+i)^t$$ $$A = (1+i)^t[A - pi]$$ $$\frac{A}{A - pi} = (1+i)^t$$ $$\frac{125}{125 - 5000\left(\frac{1{\cdot}65}{100}\right)} = \left(1 + \frac{1{\cdot}65}{100}\right)^t$$ $$\frac{125}{42{\cdot}5} = (1{\cdot}0165)^t$$ $$\log\left(\frac{125}{42{\cdot}5}\right) = t\log(1{\cdot}0165)$$ $$t = \frac{\log\left(\frac{125}{42{\cdot}5}\right)}{\log(1{\cdot}0165)}$$ $$t = 65{\cdot}920$$ $$t = 66 \text{ months}$$ **OR** $$A = p\left[\frac{i(1+i)^t}{(1+i)^t - 1}\right]$$ $$125 = \frac{5000(0{\cdot}0165)(1{\cdot}0165)^t}{(1{\cdot}0165)^t - 1}$$ $$125 = \frac{82{\cdot}5(1{\cdot}0165)^t}{(1{\cdot}0165)^t - 1}$$ $$\frac{125}{82{\cdot}5} = \frac{1{\cdot}0165^t}{1{\cdot}0165^t - 1}$$ $$\frac{50}{33} = \frac{1{\cdot}0165^t}{1{\cdot}0165^t - 1}$$ $$50(1 \cdot 0165^t - 1) = 33(1{\cdot}0165^t)$$ $$50(1{\cdot}0165^t) - 50 = 33(1{\cdot}0165^t)$$ $$50(1{\cdot}0165^t) - 33(1{\cdot}0165^t) = 50$$ $$1{\cdot}0165^t(50 - 33) = 50$$ $$1{\cdot}0165^t(17) = 50$$ $$1{\cdot}0165^t = \frac{50}{17}$$ $$t\log 1{\cdot}0165 = \log\frac{50}{17}$$ $$t = \frac{\log\left(\frac{50}{17}\right)}{\log 1{\cdot}0165} = 65{\cdot}92$$ $$t = 66 \text{ months}$$	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • Formula with some substitution • Some relevant manipulation of formula. *High Partial Credit:* • Equation in t (t no longer an index)

(v)	$$A = \frac{pi(1+i)^t}{(1+i)^t - 1}$$ $$= \frac{5000\left(1{\cdot}085^{\frac{1}{52}} - 1\right)(1{\cdot}085)^3}{(1{\cdot}085)^3 - 1}$$ $$= €36{\cdot}16$$ **OR** Weekly interest rate $(1+i)^{52} = 1{\cdot}085$ $$1 + i = 1{\cdot}085^{\frac{1}{52}}$$ $$1 + i = 1{\cdot}00157$$ $$i = 0{\cdot}00157$$ $$A = \frac{pi(1+i)^t}{(1+i)^t - 1}$$ $$A = \frac{5000(0{\cdot}00157)(1{\cdot}00157)^{156}}{(1{\cdot}00157)^{156} - 1}$$ $$= €36{\cdot}16$$	**Scale 10C (0, 5, 8, 10)** *Low Partial Credit:* • r (weekly) found *High Partial Credit:* • Fully substituted equation
(vi)	$$125 \times 66 - (36{\cdot}16)(156)$$ =€2609·04	**Scale 5B (0, 3, 5)** *Partial Credit:* • Total repayment by either method found

Q9	Model Solution – 40 Marks	Marking Notes
(a)		
(a)		**Scale 20C (0, 10, 18, 20)** *Low Partial Credit:* • Vertical axis drawn • Horizontal axis drawn. *High Partial Credit:* • Horizontal axis fully scaled and positioned OR • Vertical axis fully scaled Use relevant portions of axes **Note:** P can be on vertical axis

Q9		Marking Notes
(b) (i)	$f(t) = a + b\cos ct$ $Range$: $[(a+b),(a-b)]$ $a + b = 5{\cdot}5 \quad a - b = 1{\cdot}7$ $a = 3{\cdot}6 \quad b = 1{\cdot}9$	**Scale 10C (0, 5, 8, 10)** *Low Partial Credit:* • one equation in a and b • Range in terms of a and b *High Partial Credit:* • a or b found Note: Accept correct answer without work
(b) (ii)	Time between two successive high tides is: $12\frac{34}{60}$ hours period $= 12\dfrac{34}{60}$ period $= \dfrac{2\pi}{c}$ $c = \dfrac{2\pi}{12\frac{34}{60}} = 0{\cdot}4999 = 0{\cdot}5$	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • Period identified **or** $\frac{2\pi}{c}$ **or** $12{\cdot}34$ *High Partial Credit:* • equation in c with some substitution
(c)	$5{\cdot}2 = a + b\cos ct$ $5{\cdot}2 = 3{\cdot}6 + 1{\cdot}9\cos 0{\cdot}5t$ $0{\cdot}5t = \cos^{-1}\dfrac{1{\cdot}6}{1{\cdot}9} = 0{\cdot}569621319$ $0{\cdot}5t = 0{\cdot}5696$ $t = 1{\cdot}139$ hours (before and after high tide at 14:34) Time = 1 hour 8 minutes Times: (14:34) ± 1 hour 8 min ⇒ 13:26 and 15:42	**Scale 5C (0, 3, 4, 5)** *Low Partial Credit:* • equation with some substitution *High Partial Credit:* • solution for t **Note**: Low partial at most if formula not used