Paper 2

Question		Generic Scheme		Illustrative Scheme		Max Mark
1	The first three terms of a sequence are 4, 7 and 16. The sequence is generated by the recurrence relation $u_{n+1} = mu_n + c$, with $u_1 = 4$. Find the values of m and c.					**4**
	•1	ic	interpret recurrence relation	•1	$7 = 4m + c$	
	•2	ic	interpret recurrence relation	•2	$16 = 7m + c$	
	•3	ss	know to use simultaneous equation	•3	$7m + c = 16$ $4m + c = 7$ leading to	
	•4	pd	find m and c	•4	$m = 3$, $c = -5$	

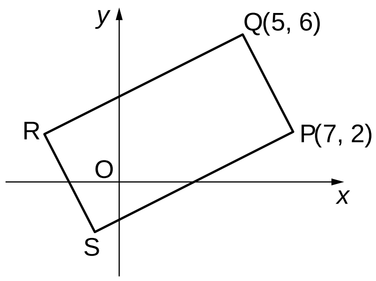
Notes:

1. Treat equations like $7 = m4 + c$ or $7 = m(4) + c$ as bad form.

Regularly Occurring Responses:

Candidate A	Candidate B	Candidate C
No working $m = 3$ and $c = -5$ or $u_{n+1} = 3u_n - 5$ 1 mark out of 4	Only one equation $7 = 4m + c$ $m = 3$ and $c = -5$ 2 marks out of 4	Partial verification $m = 3$ and $c = -5$ $3 \times 4 - 5 = 7$ 2 marks out of 4
Candidate D	**Candidate E**	
by verification $m = 3$ and $c = -5$ $3 \times 4 - 5 = 7$ **and** $3 \times 7 - 5 = 16$ 3 marks out of 4	$7 = 4m + c$ $16 = 7m + c$ $m = 3$ and $c = -5$ 4 marks out of 4	

Question		Generic Scheme	Illustrative Scheme	Max Mark
2	a	The diagram shows rectangle PQRS with P(7, 2) and Q(5, 6). Find the equation of QR.		

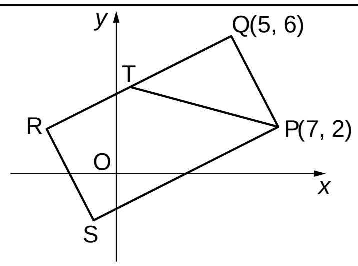


	Generic Scheme		Illustrative Scheme	Max Mark
$\bullet^1$	ss	know to find gradient	$\bullet^1$ $m_{PQ} = -2$	3
$\bullet^2$	ic	use perpendicular gradient	$\bullet^2$ $m_{QR} = \frac{1}{2}$	
$\bullet^3$	ic	state equation of line	$\bullet^3$ $y - 6 = \frac{1}{2}(x - 5)$	

Notes:

1. $\bullet^3$ is only available as a consequence of using a perpendicular gradient and the point Q.
2. $m = \frac{1}{2}$ appearing ex nihilo leading to the correct equation for QR gains 0 marks.

Question				Max Mark
2	b	The line from P with the equation $x + 3y = 13$ intersects QR at T. Find the coordinates of T.		



	Generic Scheme		Illustrative Scheme	Max Mark
$\bullet^4$	ss	prepare to solve	$\bullet^4$ $x + 3y = 13$ **and** $x - 2y = -7$	3
$\bullet^5$	pd	solve for one variable	$\bullet^5$ $x = 1$ **or** $y = 4$	
$\bullet^6$	pd	solve for second variable	$\bullet^6$ $y = 4$ **or** $x = 1$	

Notes:

3. Subsequent to making an error in rearranging the equation of QR, $\bullet^4$ can still be awarded but $\bullet^5$ is lost.
4. Stepping out from P to Q and then the reverse from Q is not a valid strategy for obtaining T.
5. $\bullet^4$, $\bullet^5$ and $\bullet^6$ are not available to candidates who: (i) equate zeroes , (ii) give answers only without working.

Regularly Occurring Responses:

Candidate A

$y - 6 = \frac{1}{2}(x - 5)$ leading to

$2y - x = -17$

$x + 3y = 13$ $\bullet^4$ ✓

$5y = -4$ $\bullet^5$ ✗

$y = -\frac{4}{5}$

$x = 15\frac{2}{5}$ $\bullet^6$ ✓

Question		Generic Scheme		Illustrative Scheme		Max Mark
2	c	Given that T is the midpoint of QR, find the coordinates of R and S.				
		•7 ss	valid method eg vectors or stepping out or mid-point formula	•7	eg $\overrightarrow{QT} = \begin{pmatrix}-4\\-2\end{pmatrix}$	3
		•8 ss	know how to find R	•8	R(–3, 2)	
		•9 ss	know how to find S using $\overrightarrow{RS} = \overrightarrow{QP} = \begin{pmatrix}2\\-4\end{pmatrix}$	•9	S (–1, –2)	

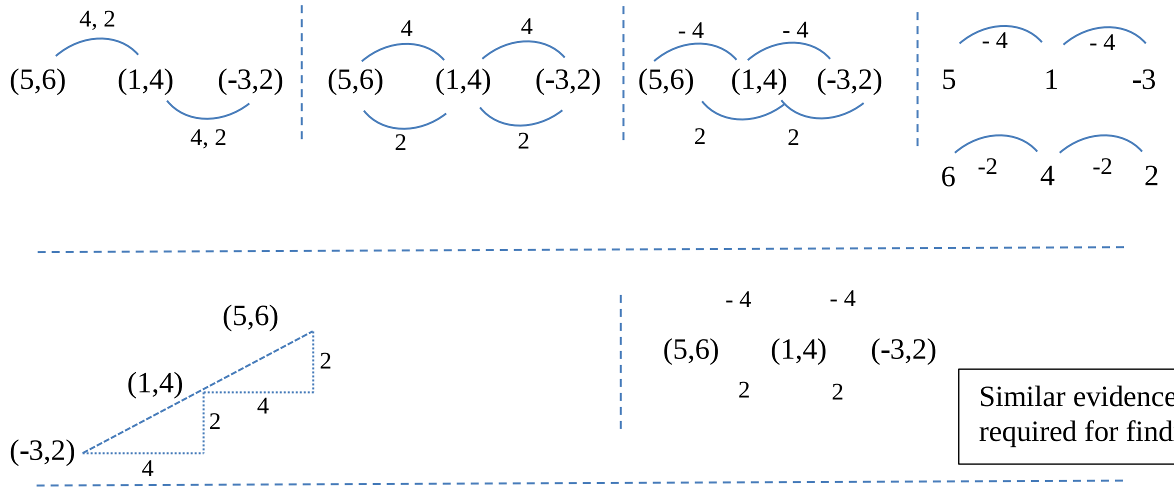
Notes:

6. Any strategy that relies upon the rectangle being composed of two congruent squares can only be given credit if this fact has been justified. Candidates who have already been penalised in 2(b) for making this assumption can gain full credit in (c).

7. If $R(-3,2)$ and $S(-1,-2)$ appear without working then •7, •8 and •9 are not available.

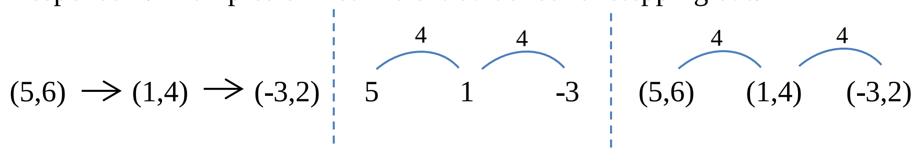
Regularly Occurring Responses:

Response 1: Examples of evidence for stepping out.

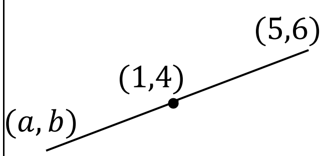


Similar evidence is required for finding S.

Response 2: Examples of insufficient evidence for stepping out.



Candidate B



•7	•8	
$\dfrac{a+5}{2} = 1$	$\dfrac{b+6}{2} = 4$	•7
$a = -3$	$b = 2$	•8

Question		Generic Scheme			Illustrative Scheme	Max Mark
3	a	Given that $(x-1)$ is a factor of x^3+3x^2+x-5, factorise this cubic fully.				4
		•1	ss	know to use $x=1$ in synthetic division	•1 $\begin{array}{c\|cccc} 1 & 1 & 3 & 1 & -5 \\ & & 1 & 4 & 5 \\ \hline \end{array}$	
		•2	pd	complete evaluation	•2 $\begin{array}{cccc} 1 & 4 & 5 & 0 \end{array}$	
		•3	ic	state quadratic factor	•3 x^2+4x+5	
		•4	ic	valid reason for irreducible quadratic	•4 $(x-1)(x^2+4x+5)$ with valid reason	

Notes:

1. Accept any of the following for •4
   a) $b^2-4ac=16-20<0$, so does not factorise.
   b) $b^2-4ac=16-4\times5<0$, so does not factorise.
   c) $16-4\times5<0$, so does not factorise.

2. Do **not** accept any of the following for •4
   a) $b^2-4ac<0$, so does not factorise.
   b) $(x-1)(x^2+4x+5)$ does not factorise.
   c) $(x-1)(x\ldots\ldots)(x\ldots\ldots)$ cannot factorise further.

3. Candidates who use algebraic long division to arrive at $(x-1)(x^2+4x+5)$ gain marks •1, •2 and •3.

4. Candidates who complete the square and make a relative comment regarding no real roots gain •4.

5. Treat $(x-1)x^2+4x+5$, with a valid reason, as bad form for •4.

Regularly Occurring Responses:

Candidate A	Candidate B
x^2+4x+5 •3 ✓ $(x-1)(x+5)(x-1)$ •4 ✗	$x^3+3x^2+x-5=(x-1)(..x^2+..x+..)$ •1 ✓ •2 ✓ $=(x-1)(x^2+4x+5)$ •3 ✓ •4 ✓ With a valid reason.
Candidate C x^2+4x+5 •3 ✓ $(x-1)x^2+4x+5$ $b^2-4ac=16-20<0$ so does not factorise. •4 ✓	

Question		Generic Scheme			Illustrative Scheme		Max Mark
3	b	Show that the curve with equation $y = x^4 + 4x^3 + 2x^2 - 20x + 3$ has only one stationary point. Find the x-coordinate and determine the nature of this point.					
		•5	ss	start to differentiate	•5	two non-zero terms correct	
		•6	pd	complete derivative and equate to 0	•6	$4x^3 + 12x^2 + 4x - 20 = 0$	
		•7	ic	factorise	•7	$4(x-1)(x^2 + 4x + 5)$	5
		•8	pd	process for x	•8	$x = 1$	
		•9	ic	justify nature and state conclusion	•9	nature table **and** minimum	

Notes:

6. $= 0$ must appear at •6 or •7 for mark •6 to be gained.
7. •9 can be gained using the second derivative to determine the nature.
8. Candidates who incorrectly obtain more than one linear factor in (a) and use this result in (b) **must** solve to get more than one solution in order to gain •8. Mark •9 is not available.
9. If the equation solved at •8 is not a cubic then •8 and •9 are not available.

Regularly Occurring Responses:

Candidate D

$(x-1)(x+5)(x-1)$ from (a)

leading to

$4x^3 + 12x^2 + 4x - 20 = 0$ •5 ✓ •6 ✓

$4(x^3 + 3x^2 + x - 5) = 0$

$4(x-1)(x+5)(x-1) = 0$ •7 ✗

$x = 1$ or $x = -5$ •8 ✗ •9 ✗

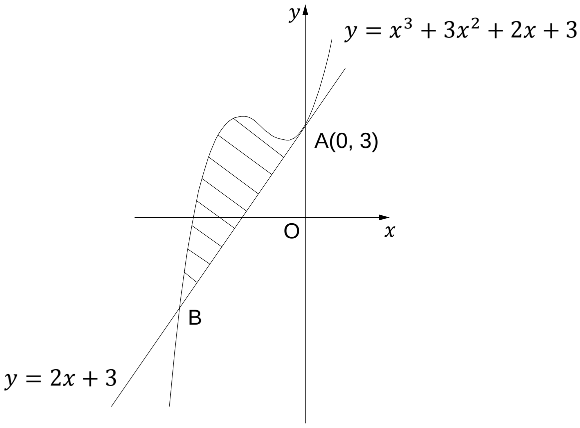
Candidate E

x	…..	1	…….
$\frac{dy}{dx}$	$-$	0	$+$
		Min	

•9 ✓

Minimum acceptable response.

Question	Generic Scheme	Illustrative Scheme	Max Mark
4	The line with equation $y = 2x + 3$ is a tangent to the curve with equation $y = x^3 + 3x^2 + 2x + 3$ at A(0, 3), as shown in the diagram. The line meets the curve again at B. Show that B is the point $(-3, -3)$ and find the area enclosed by the line and the curve.		



	Generic Scheme			Illustrative Scheme	Max Mark
	•[1]	ss	know how to show that B is the point of intersection of the line and curve.	•[1] $(-3)^3 + 3(-3)^2 + 2(-3) + 3 = -3$ **and** $2(-3) + 3 = -3$ **or** solving simultaneous equations	6
	•[2]	ss	know to integrate and interpret limits.	•[2] $\int_{-3}^{0} \dots\dots\dots$	
	•[3]	ic	use " upper – lower"	•[3] $\int_{-3}^{0}(x^3 + 3x^2 + 2x + 3) - (2x + 3)dx$	
	•[4]	pd	integrate	•[4] $\frac{1}{4}x^4 + x^3$	
	•[5]	pd	substitute limits	•[5] $0 - \left(\frac{1}{4}(-3)^4 + (-3)^3\right)$	
	•[6]	pd	evaluate area	•[6] $\frac{27}{4}$ units^2	

Notes:

1. Where a candidate differentiates one or more terms at •[4] then •[5] and •[6] are not available.
2. Candidates who substitute without integrating at •[3] do not gain •[4], •[5] and •[6].
3. Candidates must show evidence that they have considered the upper limit 0 at •[5].
4. Where candidates show no evidence for both •[4] and •[5], but arrive at the correct area, then •[4], •[5] and •[6] are not available.
5. The omission of dx at •[3] should not be penalised.

Regularly Occurring Responses:

Candidate A

$\int_0^{-3}(lower - upper\,)dx$ •[3] ✓

$= \frac{27}{4}$ •[6] ✓

Candidate B

$\int_{-3}^{0} x^3 + 3x^2 + 2x + 3 - 2x + 3$ $\bullet^3$ ✓

$= \frac{x^4}{4} + x^3$ $\bullet^4$ ✓

Candidate C

$\int_{-3}^{0}(x^3 + 3x^2 + 2x + 3) - (2x + 3)dx$

$= -\frac{27}{4}$ cannot be negative so $= \frac{27}{4}$ $\bullet^6$ ✗

However …. $= -\frac{27}{4}$ so Area $= \frac{27}{4}$ $\bullet^6$ ✓

Reference to ‘Area’ **must** be made.

Candidate D

$\int_{-3}^{0}(x^3 + 3x^2 + 2x + 3) - (2x + 3)dx$ $\bullet^2$ ✓ $\bullet^3$ ✓

$= \left[\frac{1}{4}x^4 + x^3 + x^2 + 3x - x^2 + 3x\right]_{-3}^{0}$ $\bullet^4$ ✗

$=[0] - \left[\frac{1}{4}(-3)^4 + (-3)^3 + (-3)^2 + 3(-3) - (-3)^2 + 3(-3)\right]$ $\bullet^5$ ✓

$= \frac{-45}{4}$ $\bullet^6$ ✗

See Candidate C

Candidate E

$\int_{-3}^{3}(x^3 + 3x^2 + 2x + 3) - (2x + 3)dx$ $\bullet^2$ ✗ $\bullet^3$ ✓

$= \left[\frac{1}{4}\ x^4\ +\ x^3\right]_{-3}^{3}$ $\bullet^4$ ✓

$= \left[\frac{1}{4}(3)^4 + (3)^3\right] - \left[\frac{1}{4}(-3)^4 + (-3)^3\right]$ $\bullet^5$ ✓

$= 54$ units ^{2} $\bullet^6$ ✓

Candidate F

$\int_{-3}^{3}(x^3 + 3x^2 + 2x + 3) - (2x + 3)dx$ $\bullet^2$ ✗ $\bullet^3$ ✓

$= \left[\frac{1}{4}x^4 + x^3 + x^2 + 3x - x^2 + 3x\right]_{-3}^{3}$ $\bullet^4$ ✗

$= \left[\frac{1}{4}(3)^4 + (3)^3 + (3)^2 + 3(3) - (3)^2 + 3(3)\right] - \left[\frac{1}{4}(-3)^4 + (-3)^3 + (-3)^2 + 3(-3) - (-3)^2 + 3(-3)\right]$ $\bullet^5$ ✓

$= 54 + 18 + 18$

$= 90$ units^2 $\bullet^6$ ✓

Candidate G

$\int_{-3}^{0} x^3 + 3x^2 + 2x + 3 - 2x + 3\ dx$ $\bullet^2$ ✓ $\bullet^3$ ✓

$= \int_{-3}^{0} x^3 + 3x^2 + 6\ dx$

$= \left[\frac{1}{4}\ x^4\ +\ x^3 + 6x\right]_{-3}^{0}$ $\bullet^4$ ✓

$= [0] - \left[\frac{1}{4}(-3)^4 + (-3)^3 + 6(-3)\right]$ $\bullet^5$ ✓

$= \frac{99}{4}$ units^2 $\bullet^6$ ✓

Question	Generic Scheme			Illustrative Scheme	Max Mark
5	Solve the equation $\log_5(3-2x)+\log_5(2+x)=1$, where x is a real number.				
	•¹	ss	use correct law of logs	•¹ $\log_5[(3-2x)(2+x)]=1$ stated or implied by •²	**4**
	•²	ic	know to and convert to exponential form	•² $(3-2x)(2+x)=5^1$	
	•³	pd	express as an equation in standard quadratic form	•³ $2x^2+x-1=0$	
	•⁴	ic	solve quadratic	•⁴ $x=\frac{1}{2}$, $x=-1$	

Notes:

1. For •² accept ……. = $\log_5 5$.
2. Where candidates discard an acceptable solution either by crossing out or by explicit statement, then •⁴ is not available.

Regularly Occurring Responses:

Candidate A $x=\frac{1}{2}$, $\cancel{x=-1}$ •⁴ ✗	**Candidate B** $2x^2+x-1=0$ •³ ✓ $(2x+1)(x-1)=0$ $\cancel{x=-\frac{1}{2}}$, $x=1$ •⁴ ✗
Candidate C incorrect working leading to $\cancel{x=-2}$, $x=1$ •⁴ ✓ Here the discard of $x=-2$ is valid in the context of the original question.	**Candidate D** $\log_5\frac{(3-2x)}{(2+x)}=1$ •¹ ✗ $\frac{(3-2x)}{(2+x)}=5^1$ •² ✓ •³ ✗ •⁴ ✗
Candidate E $\log_5[(3-2x)(2+x)]=1$ •¹ ✓ $(3-2x)(2+x)=1$ •² ✗ $2x^2-x-6=0$ •³ ✗ $x=2,\ x=\frac{-3}{2}$ •⁴ ✗ •⁴ is not awarded since $x=2$ is not a valid solution.	**Candidate F** •¹ ✗ $(3-2x)(2+x)=1$ •² ✗ •³ •⁴ not available

Question	Generic Scheme		Illustrative Scheme		Max Mark
6	Given that $\int_0^a 5\sin 3x\, dx = \frac{10}{3}$, $0 \le a < \pi$, calculate the value of a.				
	•[1] ss	integrate correctly	•[1]	$\left[\frac{-5}{3}\cos 3x\right]$	5
	•[2] pd	process limits	•[2]	$\frac{-5}{3}\cos 3a + \frac{5}{3}\cos 0$	
	•[3] pd	evaluate and form a correct equation	•[3]	$\frac{-5}{3}\cos 3a + \frac{5}{3} = \frac{10}{3}$	
	•[4] pd	start to solve equation	•[4]	$\cos 3a = -1$	
	•[5] pd	solve for a	•[5]	$a = \frac{\pi}{3}$	

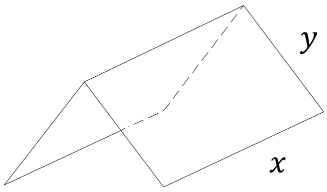
Notes:

1. Candidates who include solutions outwith the range cannot gain •[5].
2. The inclusion of $+c$ at •[1] should be treated as bad form.
3. •[5] is only available for a valid numerical answer.
4. Where the candidate differentiates •[1] and •[2] are not available. See Candidate A.
5. Where candidate integrate incorrectly •[2], •[3], •[4] and •[5] are still available.
6. The value of a **must** be given in radians.

Regularly Occurring Responses:

Candidate A		Candidate B	
$[15\cos 3x]_0^a$	•[1] ✗	$[-5\cos 3x]_0^a$	•[1] ✗
$15\cos 3a - 15\cos 0$	•[2] ✗	$-5\cos 3a + 5\cos 0$	•[2] ✓
$15\cos 3a - 15 = \frac{10}{3}$	•[3] ✓	$-5\cos 3a + 5 = \frac{10}{3}$	•[3] ✓
$\cos 3a = \frac{55}{45}$	•[4] ✓	$\cos 3a = \frac{1}{3}$	•[4] ✓
no solutions	•[5] ✓̶	$a = 0\cdot 41$ Ignore other solutions in given interval	•[5] ✓

Candidate C		Candidate D	
$\frac{5}{3}\cos 3x$	•[1] ✗	$-15\cos 3x$	•[1] ✗
$\frac{5}{3}\cos 3a - \frac{5}{3}\cos 0$	•[2] ✓	$-15\cos 3a + 15\cos 0$	•[2] ✓
$\frac{5}{3}\cos 3a - \frac{5}{3} = \frac{10}{3}$	•[3] ✓	$-15\cos 3a + 15 = \frac{10}{3}$ $-15\cos 3a = \frac{-35}{3}$	•[3] ✓
$\cos 3a = 3$	•[4] ✓	$\cos 3a = \frac{7}{9}$	•[4] ✓
no solutions	•[5] ✓̶	$a = 0\cdot 23$ Ignore other solutions in given interval	•[5] ✓

Question		Generic Scheme	Illustrative Scheme	Max Mark
7		A manufacturer is asked to design an open-ended shelter, as shown, subject to the following conditions. Condition 1 The frame of a shelter is to be made of rods of two different lengths: • x metres for top and bottom edges; • y metres for each sloping edge. Condition 2 The frame is to be covered by a rectangular sheet of material. The total area of the sheet is 24 m².	 	
	a	Show that the total length, L metres, of the rods used in a shelter is given by $L = 3x + \frac{48}{x}$.		
		●¹ ss identify expression for L in x and y ●² ic identify expression for y in terms of x ●³ pd complete proof	●¹ $L = 3x + 4y$ ●² $y = \frac{24}{2x}$ ●³ $L = 3x + 4 \times \frac{24}{2x}$ and complete	3

Notes:

1. The substitution for y at ●³ must be clearly shown.

Question		Generic Scheme			Illustrative Scheme		Max Mark
7	b	These rods cost £8·25 per metre. To minimise production costs, the total length of rods used for a frame should be as small as possible.					
	i	Find the value of x for which L is a minimum.					
	ii	Calculate the minimum cost of a frame.					
		•4	pd	prepare to differentiate	•4	$\ldots 48x^{-1}$	7
		•5	pd	differentiate	•5	$3 - 48x^{-2}$	
		•6	pd	equate derivative to 0	•6	$3 - 48x^{-2} = 0$	
		•7	pd	process for x	•7	$x = 4$	
		•8	ic	verify nature	•8	nature table or 2nd derivative	
		•9	ic	evaluate L	•9	$L = 24$	
		•10	pd	evaluate cost	•10	cost $24 \times £8{\cdot}25 = £198$	

Notes:

2. Do not penalise the non-appearance of -4 at •7. However candidates who process $x = -4$ to obtain $L = -24$ do not gain •9.
3. $y = 24$ is not awarded •9.

Regularly Occurring Responses:

Candidate A

$$L = 3x + \frac{48}{x}$$

$$\frac{dL}{dx} = 3 - \frac{48}{x^2} \qquad •4 ✓ \quad •5 ✓$$

Candidate B

$$\begin{array}{c|ccccc} x & \longrightarrow & 4 & \longrightarrow \\ \hline \frac{dL}{dx} & - & 0 & + \\ & & \text{Min} & \end{array}$$

Minimum acceptable response

Candidate C

$$\begin{array}{c|ccccc} x & \longrightarrow & -4 & \longrightarrow & 4 & \longrightarrow \\ \hline \frac{dL}{dx} & + & 0 & - & 0 & + \\ & & & & \text{Min} & \end{array}$$

Do not penalise the inclusion of $x = -4$

Question			Generic Scheme		Illustrative Scheme	Max Mark
8	Solve algebraically the equation $\sin 2x = 2\cos^2 x$ for $0 \le x < 2\pi$					
					Method 1	
	•1	ss	use correct double angle formulae	•1	$2\sin x\cos x$	
	•2	ss	form correct equation	•2	$2\sin x\cos x - 2\cos^2 x = 0$	
	•3	ss	take out common factor	•3	$2\cos x(\sin x - \cos x) = 0$	
	•4	ic	proceed to solve	•4	$\cos x = 0$ and $\sin x = \cos x$	
					•5 | •6	
	•5	pd	find solutions	•5	$\frac{\pi}{2}$ | $\frac{3\pi}{2}$	
	•6	pd	find remaining solutions	•6	$\frac{\pi}{4}$ | $\frac{5\pi}{4}$	6
					Method 2	
	•1	ss	use double angle formula	•1	$\cos 2x + 1$	
	•2	ss	form correct equation	•2	$\sin 2x - \cos 2x = 1$	
	•3	ss	express as a single trig function	•3	$\sqrt{2}\sin\left(2x - \frac{\pi}{4}\right) = 1$	
	•4	ic	proceed to solve	•4	$\sin\left(2x - \frac{\pi}{4}\right) = \frac{1}{\sqrt{2}}$	
					•5 | •6	
	•5	pd	find solutions	•5	$2x - \frac{\pi}{4} = \frac{\pi}{4}, \frac{3\pi}{4}$ | $\frac{9\pi}{4}, \frac{11\pi}{4}$	
	•6	pd	find solutions	•6	$x = \frac{\pi}{4}, \frac{\pi}{2}$ | $x = \frac{5\pi}{4}, \frac{3\pi}{2}$	

Notes:

1. In Method 1, = 0 must appear at stage •2 or •3 for •2 to be available.
2. Accept the use of the wave function to solve $\sin x - \cos x = 0$ at stage •4 in Method 1.
3. Accept $\sin 2x - 2\cos^2 x = 0$ as evidence for •2.
4. For candidates who obtain all **four** solutions in degrees •6 can be gained but •5 is not available.

Regularly Occurring Responses:

Candidate A	Candidate B
Correct working leading to $x = 45^0, 90^0, 225^0, 270^0$ •5 ✗ •6 ✓	Correct working leading to $x = 90^0,\ 270^0$ •5 ✗ •6 ^

Question		Generic Scheme			Illustrative Scheme		Max Mark
9	a	The concentration of the pesticide, *Xpesto*, in soil can be modelled by the equation $P_t = P_0e^{-kt}$ where: • P_0 is the initial concentration; • P_t is the concentration at time t; • t is the time, in days, after the application of the pesticide. Once in the soil, the half-life of a pesticide is the time taken for its concentration to be reduced to one half of its initial value. If the half-life of *Xpesto* is 25 days, find the value of k to 2 significant figures.					
		•¹	ic	interpret half-life	•¹	$\frac{1}{2}P_0 = P_0e^{-25k}$ **stated or implied by •²**	4
		•²	pd	process equation	•²	$e^{-25k} = \frac{1}{2}$	
		•³	ss	write in logarithmic form	•³	$\log_e \frac{1}{2} = -25k$	
		•⁴	pd	process for k	•⁴	$k \approx 0{\cdot}028$	

Notes:

1. Do not penalise candidates who substitute a numerical value for P_0 in part (a).

Regularly Occurring Responses:

Candidate A

$\frac{1}{2}P_0 = P_0e^{-25k}$	•¹ ✓
$\frac{1}{2} = e^{-25k}$	•² ✓
$\log_{10}\left(\frac{1}{2}\right) = -25k\log_{10}e$	•³ ✓
$k = 0\cdot028$	•⁴ ✓

Question		Generic Scheme	Illustrative Scheme	Max Mark
9	b	Eighty days after the initial application, what is the percentage decrease in concentration of *Xpesto*?		3
		•5 ic interpret equation	•5 $P_t = P_0 e^{-80 \times 0{\cdot}028}$	
		•6 pd process	•6 $P_t \approx 0{\cdot}1065 P_0$	
		•7 ic state percentage decrease	•7 89%	

Notes:

2. For candidates who use a value of k which does not round to $0 \cdot 028$, •5 is not available unless already penalised in part(a).
3. For a value of k ex-nihilo then •5, •6 and •7 are not available.
4. •6 is only available for candidates who express P_t as a multiple of P_0.
5. Beware of candidates using proportion. This is not a valid strategy.

Regularly Occurring Responses:

Candidate B		**Candidate C**	
$P_t = P_0 e^{-0{\cdot}03\times 80}$	•5 ✗	$P_t = P_o e^{-80\times 0{\cdot}0277......}$	•5 ✓
$= 0 \cdot 0907$	•6 ^	$P_t \approx 0 \cdot 1088 \ldots . P_o$	•6 ✓
leading to $90 \cdot 9\%$	•7 ✓	$89 \cdot 11\ldots\%$	•7 ✓

Candidate D		**Candidate E**	
•5 ✓ •6 ✓		$P_t = P_0 e^{-80 \times 0{\cdot}028}$	•5 ✓
$P_t = 89\% \, P_0$	•7 ✗	Let P_0 be 100 and $P_t = 100 \times 0{\cdot}1065$	•6 ✓
		$P_t = 10{\cdot}65$	
		⇒ Percentage decrease is 100 - 10·65 = 89·35%	•7 ✓

Candidate F	
$P_t = 100 e^{-80 \times 0{\cdot}028}$	•5 ^
$P_t = 10{\cdot}65$	•6 ✗
⇒89·35%	•7 ✓

Candidate G		**Candidate H**	
$P_t = P_0 e^{-80 \times 0{\cdot}028}$	•5 ✓	$P_t = P_0 e^{-80 \times 0{\cdot}028}$	•5 ✓
$P_t = 1 \times e^{-80 \times 0{\cdot}028}$		$P_t = \ldots . \, e^{-80 \times 0{\cdot}028}$	
$P_t = 10{\cdot}65$	•6 ✗	$P_t = 0.1065 \, P_0$	•6 ✓
⇒ 89·35% decrease	•7 ✓	⇒ 89·35% decrease	•7 ✓

[END OF MARKING INSTRUCTIONS]