Detailed Marking Instructions for each question

Question			Expected Response (Give one mark for each •)	Max mark	Additional Guidance (Illustration of evidence for awarding a mark at each •)
1	(a)		$u_1 = 8$ and $u_2 = -4$	1	
			•[1] find terms of sequence		•[1] $u_1 = 8$ and $u_2 = -4$
1	(b)		$p = 2$ or $q = -3$	3	
			•[2] interpret sequence		•[2] eg $4p + q = 5$ **and** $5p + q = 7$
			•[3] solve for one variable		•[3] $p = 2$ or $q = -3$
			•[4] state second variable		•[4] $q = -3$ or $p = 2$
Notes			1 Candidates may use $7p + q = 11$ as one of their equations at •[2]. 2 Treat equations like $p4 + q = 5$ or $p(4) + q = 5$ as bad form. 3 Candidates should not be penalised for using $u_{n+1} = pu_n + q$.		
1	(c)	(i)	$l = 0$, $-1 < p < 1$	3	
			•[5] know how to find a valid limit		•[5] $l = -\frac{1}{2}l$ or $l = \frac{0}{1-\left(-\frac{1}{2}\right)}$
			•[6] calculate a valid limit only		•[6] $l = 0$
		(ii)	•[7] state reason		•[7] outside interval $-1 < p < 1$
Notes			4 Just stating that $l = al + b$ or $l = \frac{b}{1-a}$ is not sufficient for •[5]. 5 Any calculations based on formulae masquerading as a limit rule cannot gain •[5] and •[6]. 6 For candidates who use "$b = 0$", •[6] is only available to those who simplify $\frac{0}{\ldots}$ to 0. 7 Accept $2 > 1$ or $p > 1$ for •[7]. This may be expressed in words. 8 Candidates who use a without reference to p or 2 cannot gain •[7].		

2	**(a)**	P $(-3, -1)$ Q $(1, 7)$	**6**	
		$\bullet^1$ rearrange linear equation $\bullet^2$ substitute into circle $\bullet^3$ express in standard form $\bullet^4$ start to solve $\bullet^5$ state roots $\bullet^6$ determine corresponding y coordinates		Substituting for y $\bullet^1$ $y = 2x + 5$ **stated or implied by** $\bullet^2$ $\bullet^2$ $\ldots(2x+5)^2 \ldots - 2(2x+5)\ldots$ $\bullet^3$ $5x^2 + 10x - 15 = 0$ $\bullet^4$ eg $5(x+3)(x-1)$ = 0 must appear at the $\bullet^3$ or $\bullet^4$ stage to gain $\bullet^3$ $\bullet^5$ $x = -3$ and $x = 1$ $\bullet^6$ $y = -1$ and $y = 7$ Substituting for x $\bullet^1$ $x = \frac{y-5}{2}$ **stated or implied by** $\bullet^2$ $\bullet^2$ $\left(\frac{y-5}{2}\right)^2 \ldots - 6\left(\frac{y-5}{2}\right)\ldots$ $\bullet^3$ $5y^2 - 30y - 35 = 0$ $\bullet^4$ eg $5(y+1)(y-7)$ = 0 must appear at the $\bullet^3$ or $\bullet^4$ stage to gain $\bullet^3$ $\bullet^5$ $y = -1$ and $y = 7$ $\bullet^6$ $x = -3$ and $x = 1$
Notes		1 At $\bullet^4$ the quadratic must lead to two real distinct roots for $\bullet^5$ and $\bullet^6$ to be available. 2 Cross marking is available here for $\bullet^5$ and $\bullet^6$. 3 Candidates do not need to distinguish between points P and Q.		

2	**(b)**	$(x+5)^2+(y-5)^2=40$	6	
		$\bullet^7$ centre of original circle		$\bullet^7$ (3, 1)
		$\bullet^8$ radius of original circle		$\bullet^8$ $\sqrt{40}$ accept $r^2=40$
		Method 1: Using midpoint		**Method 1: Using midpoint**
		$\bullet^9$ midpoint of chord		$\bullet^9$ (-1, 3)
		$\bullet^{10}$ evidence for finding new centre		$\bullet^{10}$ eg stepping out or midpoint formula
		$\bullet^{11}$ centre of new circle		$\bullet^{11}$ (-5, 5)
		$\bullet^{12}$ equation of new circle		$\bullet^{12}$ $(x+5)^2+(y-5)^2=40$
		Method 2: Stepping out using P and Q		**Method 2: Stepping out using P and Q**
		$\bullet^9$ evidence of C_1 to P **or** C_1 to Q		$\bullet^9$ eg stepping out or vector approach
		$\bullet^{10}$ evidence of Q to C_2 **or** P to C_2		$\bullet^{10}$ eg stepping out or vector approach
		$\bullet^{11}$ centre of new circle		$\bullet^{11}$ (-5, 5)
		$\bullet^{12}$ equation of new circle		$\bullet^{12}$ $(x+5)^2+(y-5)^2=40$
Notes		4 The evidence for $\bullet^7$ and $\bullet^8$ may appear in (a). 5 Centre (-5, 5) **without working** in method 1 may still gain $\bullet^{12}$ but not $\bullet^{10}$ or $\bullet^{11}$, in method 2 may still gain $\bullet^{12}$ but not $\bullet^9$, $\bullet^{10}$ or $\bullet^{11}$. Any other centre **without working** in method 1 does not gain $\bullet^{10}$, $\bullet^{11}$ or $\bullet^{12}$, in method 2 does not gain $\bullet^9$, $\bullet^{10}$, $\bullet^{11}$ or $\bullet^{12}$. 6 The centre must have been clearly indicated before it is used at the $\bullet^{12}$ stage. 7 Do not accept, eg $\sqrt{40}^2$ or $39{\cdot}69$, or any other approximations for $\bullet^{12}$. 8 The evidence for $\bullet^8$ may not appear until the candidate states the radius or equation of the second circle.		
3		$-7<p<5$	4	
		$\bullet^1$ substitute into discriminant		$\bullet^1$ $(p+1)^2-4\times1\times9$
		$\bullet^2$ know condition for no real roots		$\bullet^2$ $b^2-4ac<0$
		$\bullet^3$ factorise		$\bullet^3$ $(p-5)(p+7)<0$
		$\bullet^4$ solve for p		$\bullet^4$ $-7<p<5$

4		$\frac{27}{4}$	5	
		$\bullet^1$ know to integrate and interpret limits $\bullet^2$ use "upper − lower" $\bullet^3$ integrate $\bullet^4$ substitute limits $\bullet^5$ evaluate area		$\bullet^1$ $\int_{-3}^{0} \ldots\ldots\ldots$ $\bullet^2$ $\int_{-3}^{0}\left(x^3+3x^2+2x+3\right)-\left(2x+3\right)dx$ $\bullet^3$ $\frac{1}{4}x^4+x^3$ $\bullet^4$ $0-\left(\frac{1}{4}(-3)^4+(-3)^3\right)$ $\bullet^5$ $\frac{27}{4}$ units^2
Notes		1 Where a candidate differentiates one or more terms at $\bullet^3$ then $\bullet^4$ and $\bullet^5$ are not available. 2 Candidates who substitute without integrating at $\bullet^2$ do not gain $\bullet^3$, $\bullet^4$ and $\bullet^5$. 3 Candidates must show evidence that they have considered the upper limit 0 at $\bullet^4$. 4 Where candidates show no evidence for both $\bullet^3$ and $\bullet^4$, but arrive at the correct area, then $\bullet^3$, $\bullet^4$ and $\bullet^5$ are not available. 5 The omission of dx at $\bullet^2$ should not be penalised.		
5	**(a)**	$\overrightarrow{OB} = 4\mathbf{i} + 4\mathbf{j}$	1	
		$\bullet^1$ state $\overrightarrow{OB}$ in unit vector form		$\bullet^1$ $4\mathbf{i}+4\mathbf{j}$
5	**(b)**	$\overrightarrow{DB}=\begin{pmatrix}2\\2\\-6\end{pmatrix}$ $\overrightarrow{DM}=\begin{pmatrix}0\\-2\\-6\end{pmatrix}$	3	
		$\bullet^2$ state components of $\overrightarrow{DB}$ $\bullet^3$ state coordinates of M $\bullet^4$ state components of $\overrightarrow{DM}$		$\bullet^2$ $\begin{pmatrix}2\\2\\-6\end{pmatrix}$ $\bullet^3$ $(2,0,0)$ stated, or implied by $\bullet^4$ $\bullet^4$ $\begin{pmatrix}0\\-2\\-6\end{pmatrix}$

5	**(c)**	$40\cdot3°$ or $0\cdot703$ rads	5	
		$\bullet^5$ know to use scalar product		$\bullet^5\ \cos\hat{BDM}=\dfrac{\overrightarrow{DB}.\ \overrightarrow{DM}}{\left\|\overrightarrow{DB}\right\|.\left\|\overrightarrow{DM}\right\|}$ **stated or implied by** $\bullet^9$
		$\bullet^6$ find scalar product		$\bullet^6\ \overrightarrow{DB}.\overrightarrow{DM}=32$
		$\bullet^7$ find magnitude of a vector		$\bullet^7\ \left\|\overrightarrow{DB}\right\|=\sqrt{44}$
		$\bullet^8$ find magnitude of a vector		$\bullet^8\ \left\|\overrightarrow{DM}\right\|=\sqrt{40}$
		$\bullet^9$ evaluate angle BDM		$\bullet^9\ 40\cdot3°$ or $0\cdot703$ rads
Notes		1 $\bullet^5$ is not available to candidates who evaluate the wrong angle. 2 If candidates do not attempt $\bullet^9$, then $\bullet^5$ is only available if the formula quoted relates to the labelling in the question. 3 $\bullet^9$ should be awarded to any answer which rounds to $40°$ or $0\cdot7$ radians. 4 In the event that both magnitudes are equal **or** there is only one non-zero component, $\bullet^8$ is not available.		
6		$\dfrac{27}{2}$	4	
		$\bullet^1$ use distributive law		$\bullet^1\ \mathbf{p.p}+\mathbf{p.q}+\mathbf{p.r}$
		$\bullet^2$ calculate scalar product		$\bullet^2\ \mathbf{p.p}=9$
		$\bullet^3$ calculate scalar product		$\bullet^3\ \mathbf{p.q}=\dfrac{9}{2}$
		$\bullet^4$ process scalar product $=0$ and complete		$\bullet^4\ \mathbf{p.r}=0$ and $\dfrac{27}{2}$
7	**(a)**	$k\ \approx\ 0\cdot028$	4	
		$\bullet^1$ interpret half-life		$\bullet^1\ \dfrac{1}{2}P_0=P_0e^{-25k}$ **stated or implied by** $\bullet^2$
		$\bullet^2$ process equation		$\bullet^2\ e^{-25k}=\dfrac{1}{2}$
		$\bullet^3$ write in logarithmic form		$\bullet^3\ \log_e\dfrac{1}{2}=-25k$
		$\bullet^4$ process for k		$\bullet^4\ k\ \approx\ 0\cdot028$
Notes		1 Do not penalise candidates who substitute a numerical value for P_0 in part (a).		

7	**(b)**	No, with reason	4	
		•5 interpret equation •6 process •7 state percentage decrease •8 justify answer		•5 $P_t = P_0 e^{-80\times 0\cdot 028}$ •6 $P_t \approx 0\cdot 1065 P_0$ •7 89% •8 No, the concentration will not have decreased by over 90%. 89% decrease.
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.		
8		$\frac{3\pi}{8}$	6	
		•1 start to integrate •2 complete integration •3 process limits •4 simplify numeric term and equate to $\frac{10}{4}$ •5 start to solve equation •6 solve for a		•1 $-\frac{5}{4}\cos\ldots$ •2 $-\frac{5}{4}\cos\left(4x-\frac{\pi}{2}\right)$ •3 $-\frac{5}{4}\cos\left(4a-\frac{\pi}{2}\right)+\frac{5}{4}\cos\left(\frac{4\pi}{8}-\frac{\pi}{2}\right)$ •4 $-\frac{5}{4}\cos\left(4a-\frac{\pi}{2}\right)+\frac{5}{4}=\frac{10}{4}$ •5 $\cos\left(4a-\frac{\pi}{2}\right)=-1$ •6 $a=\frac{3\pi}{8}$
Notes		1 Candidates who include solutions outwith the range cannot gain •6. 2 The inclusion of $+\,c$ at •1 or •2 should be treated as bad form. 3 •6 is only available for a valid numerical answer. 4 Where the candidate differentiates, •1, •2 and •3 are not available. 5 Where the candidate integrates incorrectly, •3, •4, •5 and •6 are still available. 6 The value of a **must** be given in radians.		

9	**(a)**	4 cm	5	
		•[1] prepare to differentiate •[2] differentiate •[3] equate derivative to 0 •[4] process for x •[5] verify nature		•[1] … $48x^{-1}$ •[2] $3-48x^{-2}$ •[3] $3-48x^{-2}=0$ •[4] $x=4$ •[5] nature table or 2nd derivative
Notes		1 Do not penalise the non-appearance of -4 at •[4].		
9	**(b)**	No, (£198 > £195)	2	
		•[6] evaluate L •[7] calculate cost and justify answer		•[6] $L=24$ •[7] $24\times£8\cdot25$ = £198. No and reason (£198 > £195)
Notes		2 Candidates who process $x=-4$ to obtain $L=-24$ do not gain •[6]. 3 $y=24$ is not awarded •[6].		
10	**(a)**	$a(t)=-16\sin\left(2t-\frac{\pi}{2}\right)$	3	
		•[1] know to differentiate •[2] differentiate trig function •[3] applies chain rule		•[1] $a=v'(t)$ •[2] $-8\sin\left(2t-\frac{\pi}{2}\right)$..... •[3] .....$\times 2$ and complete $a(t)=-16\sin\left(2t-\frac{\pi}{2}\right)$
Notes		1 Alternatively, $8\cos\left(2t-\frac{\pi}{2}\right)=8\sin 2t$ •[1] $v'(t)$..... •[2] $=8\cos 2t$... •[3] $=...\times 2$		

10	**(b)**	$a(10) > 0$ therefore increasing	2	
		•[4] know to and evaluate $a(10)$ •[5] interpret result		•[4] $a(10) = 6 \cdot 53$ •[5] $a(10) > 0$ therefore increasing
Notes		1 •[5] is available only as a consequence of substituting into a derivative. 2 •[4] and •[5] are not available to candidates who work in degrees. 3 •[2] and •[3] may be awarded if they appear in the working for 10(b). However, •[1] requires a clear link between acceleration and $v'(t)$.		
10	**(c)**	$s(t) = 4\sin\left(2t - \frac{\pi}{2}\right) + 8$	3	
		•[6] know to integrate •[7] integrate correctly •[8] determine constant and complete		•[6] $s(t) = \int v(t)dt$ •[7] $s(t) = 4\sin\left(2t - \frac{\pi}{2}\right) + c$ •[8] $c = 8$ so $s(t) = 4\sin\left(2t - \frac{\pi}{2}\right) + 8$
Notes		4 •[7] and •8 are not available to candidates who work in degrees. However, accept $\int 8\cos(2t - 90)dt$ for •[6].		

[END OF EXEMPLAR MARKING INSTRUCTIONS]