Paper 2

Question		Generic Scheme			Illustrative Scheme		Max Mark
1	a						
		●1	ss	find gradient of AB	●1	$m_{AB}=1$	
		●2	pd	find perpendicular gradient	●2	$m_{perp}=-1$ stated or implied by ●4	
		●3	pd	find midpoint of AB	●3	$(4,1)$ stated or implied by ●4	
		●4	pd	obtain equation	●4	$y-1=-1(x-4)$	**4**

Notes:

1. ●4 is only available as a consequence of using a perpendicular gradient **and** a midpoint.
2. The gradient must appear in simplified form at ●4 stage for ●4 to be awarded.

Commonly Observed Responses:

Candidate A

$m_{\mathrm{AB}}=-1$ ●1 ✗

$m_{\mathrm{perp}}=1$ ●2 ✓

$(4,1)$ ●3 ✓

$y-1=1(x-4)\ \Rightarrow y=x-3$ ●4 ✓

Leading to part (b)

$y-x=-3$

$y+2x=6$ ●5 ✓

$(3,0)$ ●6 ✓

●7 and ●8 are not available as $\mathrm{A}=\mathrm{T}=(3,0)$

Question		Generic Scheme		Illustrative Scheme	Max Mark
1	b				
•5	ss	know to solve simultaneously	•5	$y+2x=6$ $y+x=5$	
•6	pd	solve correctly for x and y	•6	$x=1,\ y=4$	2

Commonly Observed Responses:

Candidate B

Part (a) $y-1=-1(x-4)$ •4 ✓

$y=-x+3$ error

Part (b) $y+2x=6$ and $y+x=3$ •5 ✓

$x=3,\ y=0$ •6 ✓ correct strategy used, pd mark not available

Question		Generic Scheme		Illustrative Scheme	Max Mark
1	c				
•7	ss	know and use $m=\tan\theta$	•7	$\tan\theta=-2$	
•8	pd	calculate angle	•8	$116\cdot6^{\circ}$ accept 117^{0} or $2\cdot03$ radians	2

Commonly Observed Responses:

Candidate C

$m_{AT}=-\dfrac{1}{2}$

base angle $=26\cdot6^{\circ}$ •7 x

$\Rightarrow$ angle $=90+26\cdot6=116\cdot6^{\circ}$ •8 x

Candidate D

$m_{AT}=2$ •7 x

angle $=\tan^{-1}(2)=63\cdot4^{\circ}$ •8 ✓

Candidate E:

Part (a)

$m_{AB}=\dfrac{2-0}{5-3}=\dfrac{2}{8}=\dfrac{1}{4}$ •1 x

$m_{perp}=-4$ •2 ✓

Midpoint of AB (4, 1) •3 ✓

$y-1=-4(x-1)$ •4 ✓

$y+4x-5$

Part (b)

$y+4x-5=0$
$y+2x+6=0$ •5 x $\Rightarrow$ $y+2x=-6$
$y+4x=-5$ •6 x

$\Rightarrow 2x=1,\ \ x=\dfrac{1}{2},\ y=-7$

•5 is a strategy mark. The correct strategy is to solve the **given equation** with the equation from part (a) simultaneously. •5 is not awarded as the given equation has not been used.

The equation obtained at stage •4, has been rearranged incorrectly in part (b). The next pd mark, •6, is therefore not awarded.

Question		Generic Scheme		Illustrative Scheme	Max Mark
2					
•[1]	ss	know to and differentiate	•[1]	$4x^3-6x^2$	
•[2]	ic	find gradient	•[2]	8	
•[3]	pd	find y-coordinate	•[3]	5	
•[4]	ic	state equation of tangent	•[4]	$y-5=8(x-2)$	**4**

Notes:

1. •[4] is only available if an attempt has been made to find the gradient from differentiation **and** calculating the *y*-coordinate by substitution into the original equation.

Commonly Observed Responses:

Candidate A

•[1] ✓ •[2] ✓ •[3] ✓

using $y=mx+c$

$x=2,\ y=5,\ m=8$

$\Rightarrow 5=8\times 2+c$

$\Rightarrow c=-11$ •[4] ✓

$y=8x-11$

Question		Generic Scheme	Illustrative Scheme	Max Mark
3	a			
		•[1] ic interpret notation •[2] pd a correct expression	•[1] $f\left(x+3\right)$ stated or implied by •[2] •[2] $=\left(x+3\right)\left(x+2\right)+q$ **OR** $=\left(x+3\right)^2-\left(x+3\right)+q$ or equivalent	2

Notes:

1. Special Case: •[1] is for substituting $(x+3)$ for x thus, treat $x+3(x+3-1)+q$ as bad form.

Commonly Observed Responses:

Candidate A		**Candidate B**	
$f(g(x))=x+3(x+3-1)+q$	•[1] ✓	$f(g(x))=x+3(x+3-1)+q$	•[1] ✓
$=x^2+5x+6+q$	•[2] ✓ •[3] ✓	$=4x+6+q$	•[2] X

Candidate C		**Candidate D**	
$f(g(x))=x+3(x+3-1)+q$	•[1] ✓	$f(g(x))=(x+3)(x+3-1)+q$	•[1] ✓ •[2] ✓
$=(x+3)^2-x+3+q$		$=(x+3)^2-x+3+q$	
$x^2+5x+6+q=0$	•[2] ✓ •[3] ✓	$x^2+5x+12+q=0$	•[3] X

Candidate E: using $g(f(x))$

part (a)		part (b)		
$g(f(x))=g(x(x-1)+q)$	•[1] X	$x^2-x+q+3=0$	•[3] ✓	(eased)
$=x(x-1)+q+3$	•[2] ✓	$b^2-4ac=\left(-1\right)^2-4\times1\times(q+3)$	•[4] ✓	
Leading to …..		$1-4q-12=0$	•[5] ✓	
		$q=-\dfrac{11}{4}$	•[6] ✓	

Question		Generic Scheme	Illustrative Scheme	Max Mark
3	b			
		Method 1	**Method 1**	
●3	pd	write in standard quadratic form	●3 $x^2+5x+6+q=0$	
●4	ic	use discriminant	●4 $b^2-4ac=5^2-4\times1\times(6+q)$	
●5	pd	simplify and equate to zero	●5 $\Rightarrow 25-24-4q=0$	
●6	pd	find value of q	●6 $q=\frac{1}{4}$	4
		Method 2	**Method 2**	
●3	pd	write in standard quadratic form	●3 $x^2+5x+6+q=0$	
●4	ic	complete the square	●4 $\left(x+\frac{5}{2}\right)^2-\frac{25}{4}+6+q=0$	
●5	pd	equate to zero	●5 $-\frac{25}{4}+6+q=0$	
●6	pd	find value of q	●6 $q=\frac{1}{4}$	
		Method 3	**Method 3**	
●3	pd	write in standard quadratic form	●3 $f(g(x))=x^2+5x+6+q=0$	
●4	ic	geometric interpretation	●4 equal roots so touches x-axis at SP	
●5	pd	differentiates to obtain x	●5 $\Rightarrow \frac{dy}{dx}=2x+5=0$ $x=-\frac{5}{2}$	
●6	pd	find value of q	●6 $\frac{25}{4}-\frac{25}{2}+6+q=0$ $q=\frac{1}{4}$	

Notes:

2. Do not penalise the omission of '$=0$' at ●3.
3. In Method 1 $a=1,\ b=5,\ c=6+q$ is sufficient for ●3.
4. Candidates who assume '$=0$' and follow through to a correct value of q, ●6 is still available. In Methods 1 and 2 '$=0$' must appear at ●4 or ●5 for ●5 to be awarded.
5. If the expression obtained at ●3 is not a quadratic then ●3, ●4, ●5 and ●6 are not available.

Question	Generic Scheme	Illustrative Scheme	Max Mark
Throughout this question treat coordinates written as components, and vice versa, as bad form.			
4 a			
$\bullet^1$	pd states coordinates of C	$\bullet^1$ C(11,12,6)	
$\bullet^2$	pd states coordinates of D	$\bullet^2$ $D(8,8,4)$	2

Notes:

1. Accept $x=11$, $y=12$ and $z=6$ for $\bullet^1$ and $x=8$, $y=8$ and $z=4$ for $\bullet^2$.
2. For candidates who write the coordinates as Cartesian triples and omit brackets in both cases, $\bullet^2$ is not available.

Question	Generic Scheme	Illustrative Scheme	Max Mark
4 b			
$\bullet^3$	pd finds $\overrightarrow{CB}$	$\bullet^3$ $\begin{pmatrix}0\\-8\\-4\end{pmatrix}$	
$\bullet^4$	pd finds $\overrightarrow{CD}$	$\bullet^4$ $\begin{pmatrix}-3\\-4\\-2\end{pmatrix}$	2

Notes:

3. For candidates who find both $\overrightarrow{BC}$ and $\overrightarrow{DC}$, only $\bullet^4$ is available (repeated error).

Question	Generic Scheme	Illustrative Scheme	Max Mark
4 c .			
$\bullet^5$	ss know to use scalar product applied to the correct angle	$\bullet^5$ $\cos B\hat{C}D = \dfrac{\overrightarrow{CB}.\overrightarrow{CD}}{\lvert\overrightarrow{CB}\rvert\lvert\overrightarrow{CD}\rvert}$ stated or implied by $\bullet^9$	
$\bullet^6$	pd find scalar product	$\bullet^6$ 40	
$\bullet^7$	pd find $\lvert\overrightarrow{CB}\rvert$	$\bullet^7$ $\sqrt{80}$	
$\bullet^8$	pd find $\lvert\overrightarrow{CD}\rvert$	$\bullet^8$ $\sqrt{29}$	
$\bullet^9$	pd find angle	$\bullet^9$ 33·9°	5

Notes:

4. $\bullet^5$ is not available for candidates who choose to evaluate an incorrect angle.
5. $\bullet^9$ accept 33·8 to 34 degrees or 0·59 to 0·6 radians.
6. If candidates do not attempt $\bullet^9$, then $\bullet^5$ is only available if the formula quoted relates to the labelling in the question.
7. $\bullet^9$ is only available as a result of using a valid strategy.
8. $\bullet^5$ is not available for candidates who write $\cos\theta = \dfrac{40}{\sqrt{80}\times\sqrt{29}}$. Some reference to the labelling of the diagram **must** be made within their solution to part (c), to indicate they are attempting to find the correct angle.

Commonly Observed Responses:	
Candidate A: Cosine Rule $\cos B\hat{C}D = \dfrac{CB^2 + CD^2 - BD^2}{2 \times CB \times CD}$ •5 ✓ $CB = \sqrt{80},\ CD = \sqrt{29},\ BD = \sqrt{29}$ •6 ✓ •7 ✓ •8 ✓ $33{\cdot}9^{\circ}$ or $0{\cdot}59$ radians •9 ✓	**Candidate B** $\cos B\hat{C}D = \dfrac{\overrightarrow{BC}.\overrightarrow{CD}}{\lvert\overrightarrow{BC}\rvert \times \lvert\overrightarrow{CD}\rvert}$ •5 ✗ $\overrightarrow{BC}.\overrightarrow{CD} = -40$ •6 ✓ $\lvert\overrightarrow{BC}\rvert = \sqrt{80}$, $\lvert\overrightarrow{CD}\rvert = \sqrt{29}$ •7 ✓ •8 ✓ $146{\cdot}1^{\circ}$ or $2{\cdot}55$ radians •9 ✓
Candidate C $\cos B\hat{O}D = \dfrac{\overrightarrow{OB}.\overrightarrow{OD}}{\lvert\overrightarrow{OB}\rvert \times \lvert\overrightarrow{OD}\rvert}$ •5 ✗ $\overrightarrow{OB}.\overrightarrow{OD} = 128$ •6 ✓ $\lvert\overrightarrow{OB}\rvert = \sqrt{141}$, $\lvert\overrightarrow{OD}\rvert = 12$ •7 ✓ •8 ✓ $26{\cdot}1^{\circ}$ or $0{\cdot}46$ radians •9 ✓	**Candidate D** $\cos C\hat{B}D = \dfrac{\overrightarrow{BC}.\overrightarrow{BD}}{\lvert\overrightarrow{BC}\rvert \times \lvert\overrightarrow{BD}\rvert}$ •5 ✗ $\overrightarrow{BC}.\overrightarrow{BD} = 40$ •6 ✓ $\lvert\overrightarrow{BC}\rvert = \sqrt{80}$, $\lvert\overrightarrow{BD}\rvert = \sqrt{29}$ •7 ✓ •8 ✓ $33{\cdot}9^{\circ}$ or $0{\cdot}59$ radians •9 ✓
Candidate E $\cos B\hat{O}C = \dfrac{\overrightarrow{OB}.\overrightarrow{OC}}{\lvert\overrightarrow{OB}\rvert \times \lvert\overrightarrow{OC}\rvert}$ •5 ✗ $\overrightarrow{OB}.\overrightarrow{OC} = 181$ •6 ✓ $\lvert\overrightarrow{OB}\rvert = \sqrt{141}$, $\lvert\overrightarrow{OC}\rvert = \sqrt{301}$ •7 ✓ •8 ✓ $28{\cdot}5^{\circ}$ or $0{\cdot}50$ radians •9 ✓	**Candidate F** $\cos B\hat{C}D = \dfrac{\overrightarrow{BC}.\overrightarrow{DC}}{\lvert\overrightarrow{BC}\rvert \times \lvert\overrightarrow{DC}\rvert}$ •5 ✓ this is an acceptable form for the scalar product.

Question		Generic Scheme		Illustrative Scheme	Max Mark
5					
$\bullet^1$	ss	start to integrate	$\bullet^1$	$\dfrac{1}{1/2}(\ldots\ldots)^{1/2}$	
$\bullet^2$	pd	complete integration	$\bullet^2$	$\ldots\times\dfrac{1}{3}$	
$\bullet^3$	pd	process limits	$\bullet^3$	$\dfrac{2}{3}(3t+4)^{\frac{1}{2}}-\dfrac{2}{3}(3(4)+4)^{\frac{1}{2}}$	
$\bullet^4$	pd	start to solve equation	$\bullet^4$	$(3t+4)^{\frac{1}{2}}=7$	
$\bullet^5$	pd	solve for t	$\bullet^5$	$t=15$	5

Notes:

1. $\bullet^3$ is awarded for correct substitution leading to $F(t)-F(4)$ where $F(x)$ is the candidates attempt
2. to integrate $(3x+4)^{-\frac{1}{2}}$. For substituting into the original function $\bullet^3$ is unavailable.
3. $\bullet^5$ is only available as a consequence of squaring both sides of an equation.
4. The integral obtained must contain a non integer power for $\bullet^4$ and $\bullet^5$ to be available.
5. Do not penalise the inclusion of '$+c$'.
6. Incorrect expansion of $(\ldots)^{-1/2}$ at stage $\bullet^1$, only $\bullet^3$ is available as follow through. Incorrect expansion of $(\ldots)^{1/2}$ at stage $\bullet^4$, $\bullet^4$ and $\bullet^5$ are not available.

Commonly Observed Responses:

Candidate A: Forgetting the $\frac{1}{3}$

$\left[2(3x+4)^{\frac{1}{2}}\right]_4^t=2$ $\bullet^1$ ✓ $\bullet^2$ ✗

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

$(3t+4)^{\frac{1}{2}}=5$ $\bullet^4$ ✓

$t=7$ $\bullet^5$ ✓

Candidate B

$\left[\frac{1}{6}(3x+4)^{\frac{1}{2}}\right]_4^t=2$ $\bullet^1$ ✗ $\bullet^2$ ✓

$\left(\frac{1}{6}(3t+4)^{\frac{1}{2}}\right)-\left(\frac{1}{6}(3(4)+4)^{\frac{1}{2}}\right)=2$ $\bullet^3$ ✓

$(3t+4)^{\frac{1}{2}}=16$ $\bullet^4$ ✓

$t=84$ $\bullet^5$ ✓

Candidate C

$\left[\dfrac{(3x+4)^{\frac{1}{2}}}{1/2}\times 3\right]_4^t=2$ $\bullet^1$ ✓ $\bullet^2$ ✗

$\left[\frac{2}{3}(3x+4)^{\frac{1}{2}}\right]_4^t=2$

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

$(3t+4)^{\frac{1}{2}}=7$ $\bullet^4$ ✓

$t=15$ $\bullet^5$ ✓

Candidate D

$\left[-\frac{3}{2}(3x+4)^{-3/2}\right]_4^t=2$ $\bullet^1$ ✗ $\bullet^2$ ✗

$-\frac{3}{2}(3t+4)^{-3/2}-\left(-\frac{3}{2}\times 16^{-3/2}\right)=2$ $\bullet^3$ ✓

$(3t+4)^{3/2}=-\dfrac{192}{253}$ $\bullet^4$ ✓

decimal equivalent not accepted

$t=-1\cdot 056$ $\bullet^5$ ✓

Question		Generic Scheme			Illustrative Scheme	Max Mark
6						
	$\bullet^1$	ss	use correct double angle formula		$\bullet^1$ $\sin x - 2(1-2\sin^2 x)$ stated or implied by $\bullet^2$	
	$\bullet^2$	ss	arrange in standard quadratic form		$\bullet^2$ $4\sin^2 x + \sin x - 3 = 0$	
	$\bullet^3$	ss	start to solve		$\bullet^3$ $(4\sin x - 3)(\sin x + 1) = 0$ **OR** $\dfrac{-1 \pm \sqrt{(1)^2 - 4\times 4\times(-3)}}{2\times 4}$	
	$\bullet^4$	ic	reduce to equations in $\sin x$ only		$\bullet^4$ $\sin x = \dfrac{3}{4}$ and $\sin x = -1$	
	$\bullet^5$	pd	process to find solutions in given domain		$\bullet^5$ $0\cdot848$, $2\cdot29$ and $\dfrac{3\pi}{2}$ **OR** $\bullet^4$ $\sin x = \dfrac{3}{4}$ and $x = 0\cdot848,\ 2\cdot29$ $\bullet^5$ $\sin x = -1$, and $x = \dfrac{3\pi}{2}$	5

Notes:

1. $\bullet^1$ is not available for simply stating $\cos 2A = 1 - 2\sin^2 A$ with no further working.
2. In the event of $\cos^2 x - \sin^2 x$ or $2\cos^2 x - 1$ being substituted for $\cos 2x$, $\bullet^1$ cannot be awarded until the equation reduces to a quadratic in $\sin x$.
3. Substituting $1 - 2\sin^2 A$ or $1 - 2\sin^2 \alpha$ for $\cos 2\alpha$ at $\bullet^1$ stage should be treated as bad form provided the equation is written in terms of x at stage $\bullet^2$. Otherwise, $\bullet^1$ is not available.
4. '$= 0$' must appear by $\bullet^3$ stage for $\bullet^2$ to be awarded. However, for candidates using the quadratic formula to solve the equation, '$= 0$' must appear at $\bullet^2$ stage for $\bullet^2$ to be awarded.
5. Candidates may express the equation obtained at $\bullet^2$ in the form $4s^2 + s - 3 = 0$ or $4x^2 + x - 3 = 0$. In these cases, award $\bullet^3$ for $(4s-3)(s+1) = 0$ or $(4x-3)(x+1) = 0$. However, $\bullet^4$ is only available if $\sin x$ appears explicitly at this stage.
6. $\bullet^4$ and $\bullet^5$ are only available as a consequence of solving a quadratic equation.
7. $\bullet^3$, $\bullet^4$ and $\bullet^5$ are not available for any attempt to solve a quadratic written in the form $ax^2 + bx = c$.
8. $\bullet^5$ is not available to candidates who work in degrees and do not convert their solutions into radian measure.
9. $\sin x + 4\sin^2 x - 3 = 0$ does not gain $\bullet^2$, unless $\bullet^3$ is awarded.

Commonly Observed Responses:

Candidate A

•1 ✓ •2 ✓

$(4s-3)(s+1)=0$ •3 ✓

$s=\frac{3}{4},\ s=-1$ •4 ✗

$x=0{\cdot}848,\ 2{\cdot}29$ and $\frac{3\pi}{2}$ •5 ✓

Candidate B

•1 ✓

$4\sin^2 x+\sin x-3=0$ •2 ✓

$5\sin x-3=0$ •3 ✗

$\sin x=\frac{3}{5}$ •4 ✗

$x=0{\cdot}644,\ 2{\cdot}50$ •5 $\cancel{\checkmark}$

Candidate C

•1 ✓

$\sin x-2(1-2\sin^2 x)=1$

$\sin x-2+4\sin^2 x=1$

$4\sin^2 x+\sin x=3$ •2 $\cancel{\checkmark}$

$\sin x(4\sin x+1)=3$ •3 $\cancel{\checkmark}$

$\sin x=3,\ \ 4\sin x+1=3$ •4 ✗

no solution, $\sin x=\frac{1}{2}$

$x=\frac{\pi}{6},\ \frac{5\pi}{6}$ •5 $\cancel{\checkmark}$

Candidate D

•1 ✓

$\sin x-2(1-2\sin^2 x)=1$

$4\sin^2 x+\sin x-3=0$ •2 ✓

$4\sin^2 x+\sin x=3$

$\sin x(4\sin x+1)=3$ •3 $\cancel{\checkmark}$

$\sin x=3,\ \ 4\sin x+1=3$ •4 ✗

no solution, $\sin x=\frac{1}{2}$

$x=\frac{\pi}{6},\ \frac{5\pi}{6}$ •5 $\cancel{\checkmark}$

Candidate E: Reading $\cos 2x$ as $\cos^2 x$

$\sin x-2\cos^2 x=1$ •1 ✗

$\sin x-2(1-\sin^2 x)=1$

$2\sin^2 x+\sin x-3=0$ •2 $\cancel{\checkmark}$

$(2\sin x+3)(\sin x-1)=0$ •3 $\cancel{\checkmark}$

$\sin x=-\frac{3}{2},\ \ \sin x=1$ •4 $\cancel{\checkmark}$

no solution, $x=\frac{\pi}{2}$ •5 $\cancel{\checkmark}$

Question		Generic Scheme		Illustrative Scheme	Max Mark
7	**a**				
$\bullet^1$		ss	know to and find intersection of line and curve	$\bullet^1$ $2x=6x-x^2 \Rightarrow x=0, x=4$	
$\bullet^2$		ic	use " upper – lower"	$\bullet^2$ $\int\left(\left(6x-x^2\right)-2x\right)dx$	
$\bullet^3$		pd	integrate	$\bullet^3$ $2x^2-\frac{1}{3}x^3$	
$\bullet^4$		pd	substitute limits and evaluate	$\bullet^4$ $10\frac{2}{3}$	
$\bullet^5$		pd	evaluate area developed	$\bullet^5$ $10\frac{2}{3}\times 300=3200\,\mathrm{m}^2$	**5**

Notes:

1. '0' appearing as the lower limit of the integral is sufficient evidence for $x=0$ at $\bullet^1$ stage.
2. $\bullet^5$ is only available as a consequence of multiplying an **exact** answer at $\bullet^4$ stage.
3. The omission of dx at $\bullet^2$ should not be penalised.
4. Where a candidate differentiates one or both terms $\bullet^3$, $\bullet^4$ and $\bullet^5$ are unavailable.
5. Do not penalise the inclusion of '$+c$'.
6. Accept $\int\left(4x-x^2\right)dx$ for $\bullet^2$.

Commonly Observed Responses:

Candidate A

$\int_0^4 \left(2x-\left(6x-x^2\right)\right)dx$ $\bullet^2$ ✗

$=\frac{1}{3}x^3-2x^2$ $\bullet^3$ ✓

$=-10\frac{2}{3}$ cannot be negative so $=10\frac{2}{3}$ $\bullet^4$ ✗ however $\ldots.=-10\frac{2}{3}$ so Area $=10\frac{2}{3}$ $\bullet^4$ ✓

Area = 3200m^2 $\bullet^5$ ✓

Candidate B

$2x=6x-x^2 \Rightarrow x=0,\ 4$ $\bullet^1$ ✓

Shaded area

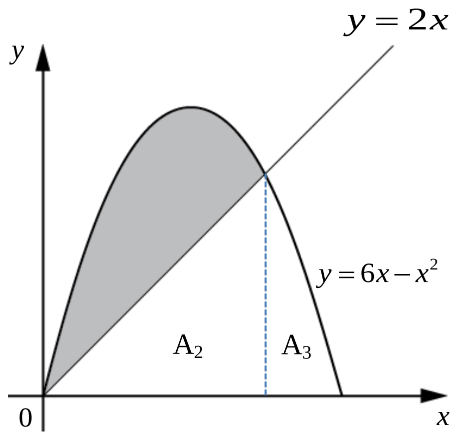
= area under parabola – ($A_2 + A_3$)

$=\int_0^6 \left(6x-x^2\right)dx-\left[A_2+\int_4^6 (6x-x^2)dx\right]$ $\bullet^2$ ✓

Stated or implied by $\bullet^4$

Area under parabola = 36, A_2 = 16 and A_3 = $\frac{28}{3}$ $\bullet^3$ ✓

Shaded area $=36-\left(16+\frac{28}{3}\right)=\frac{32}{3}$ $\bullet^4$ ✓



Candidate C

Part (a)

$x=0,\ x=6$ $\bullet^1$ ✗

$\int\left(\left(6x-x^2\right)-2x\right)dx$ $\bullet^2$ ✓

$\left[2x^2-\frac{1}{3}x^3\right]_0^6$ $\bullet^3$ ✓

$\left(2\times6^2-\frac{1}{3}\times6^3\right)-(0)=0$ $\bullet^4$ ✗

$\Rightarrow \text{Area}=0\times300=0\ \text{m}^2$ $\bullet^5$ ✓

Question		Generic Scheme		Illustrative Scheme	Max Mark
7	b				
●6	ss	set derivative to 2	●6	$6-2x=2$	
●7	pd	find point of contact	●7	$x=2,\ y=8$	
●8	pd	find equation of road	●8	$y=2x+4$	
●9	ss	find correct integral	●9	$\left[\left(x^2+4x\right)-\left(3x^2-\frac{1}{3}x^3\right)\right]_0^2$	
●10	ic	calculate area	●10	800m^2	5

Notes:

6. For candidates who omit 'm^2' at both ●5 and ●10 stages, ●10 is not available.
7. Candidates who arrive at an incorrect equation at ●8, or produce an equation ex nihilo, must use an equation of the form $y=2x+c$ with $c>0$, for ●9 and ●10 to be available.
8. $y=2x+4$ must appear explicitly or as part of the integrand for ●8 to be awarded.
9. ●10 is only available as a result of a valid strategy at the ●9 stage, ie $\int(\text{line})-(\text{quadratic})$ **and** lower limit = 0 and upper limit < 3.

Commonly Observed Responses:

Candidate D: Alternative Method

Line has equation of the form $y=2x+c$, $y=2x+c$ and $y=6x-x^2$

intersect where $x^2-4x+c=0$ ●6 ✓

tangency $\Rightarrow$ 1 point of intersection

$\Rightarrow b^2-4ac=0$ ●7 ✓

$16-4c=0$ ●8 ✓

$c=4$

Continue as above.

Question		Generic Scheme		Illustrative Scheme	Max Mark
8					
•1	pd	correct values	•1	$g=-p$, $f=-2p$, $c=3p+2$	
•2	ss	substitute and rearrange	•2	$5p^2-3p-2$	
•3	ic	knowing condition	•3	$g^2+f^2-c>0$	
•4	pd	factorise and solve	•4	$(5p+2)(p-1)=0 \Rightarrow p=-\frac{2}{5}, p=1$	
•5	ic	correct range	•5	$p<-\frac{2}{5},\ p>1$	5

Notes:

1. Candidates who state the coordinates of the centre, $(p,2p)$ and state the radius, $r=\sqrt{...-(3p+2)}$ gain •1.
2. Accept $(-p)^2+(-2p)^2-(3p+2)$ or $p^2+(2p)^2-(3p+2)$. If brackets are omitted •1 may only be awarded if subsequent working is correct.
3. Do not accept $(-p)^2+(2p)^2-(3p+2)$ or $(p)^2+(-2p)^2-(3p+2)$ for •1.
4. Do not accept $g^2+f^2-c\geq 0$ for •3.
5. For a candidate who uses $c = 2$ and follows through to get $p<-\sqrt{\frac{2}{5}},\ p>\sqrt{\frac{2}{5}}$, award •2, •3 and •5.
6. Evidence for •3 may appear at •5 stage.
7. •4 and •5 can only be awarded for solving a quadratic inequation.

Commonly Observed Responses:

Candidate A		Candidate B	
$g=-2p,\ f=-4p,\ c=3p+2$	•1 X	$(x-p)^2-p^2+(y-2p)^2-4p^2+3p+2=0$	
$20p^2-3p-2$	•2 ✓	$(x-p)^2+(y-2p)^2$	•1 ✓
$g^2+f^2-c>0$	•3 ✓	$=5p^2-3p-2$	•2 ✓
$(4p+1)(5p-2)=0 \Rightarrow p=-\frac{1}{4},\ p=\frac{2}{5}$	•4 ✓	$5p^2-3p-2>0$	•3 ✓
$p<-\frac{1}{4},\ p>\frac{2}{5}$	•5 ✓	$(5p+2)(p-1)>0$	•4 ✓
		$p<-\frac{2}{5},\ p>1$	•5 ✓

Question		Generic Scheme	Illustrative Scheme	Max Mark
9	a			
		•1 ss know to differentiate	•1 $a = v'(t)$	
		•2 pd differentiates trig. function	•2 $-8\sin\left(2t - \frac{\pi}{2}\right)\ldots\ldots$	
		•3 pd applies chain rule	•3 $\ldots\ldots \times 2$ and complete $a(t) = -16\sin\left(2t - \frac{\pi}{2}\right)$	3

Commonly Observed Responses:

Candidate A: Alternative Method

Part (a)

$v(t) = 8\cos\left(2t - \frac{\pi}{2}\right) = 8\sin 2t$

$v'(t) = \ldots.$ •1 ✓

$= 8\cos 2t\ldots$ •2 ✓

$= \ldots\ldots \times 2$ •3 ✓

Part (b)

$v'(10) = 16\cos 20 = 6\cdot 53$ •4 ✓

$> 0, \Rightarrow$ velocity is increasing •5 ✓

Part (c)

$s(t) = \int v(t)dt$ •6 ✓

$s(t) = -4\cos 2t + c$ •7 ✓

$4 = -4 + c \Rightarrow c = 8$

$\Rightarrow s(t) = -4\cos 2t + 8$ •8 ✓

or $\Rightarrow s(t) = 8 - 4\cos 2t$

Candidate B: Candidates who misinterpret the process for rate of change.

Part (a)

$a(t) = \int 8\cos\left(2t - \frac{\pi}{2}\right)dt$

$= 4\sin\left(2t - \frac{\pi}{2}\right) + c$

Wrong process award $0/3$

Part (b)

If $t = 10$, $a = 4\sin\left(20 - \frac{\pi}{2}\right) + c$

$= -1\cdot 63 + c$

Cannot evaluate award $0/2$

Part (c)

$s = v'(t)$

$s(t) = -16\sin\left(2t - \frac{\pi}{2}\right)$

Award $2/3$

Candidate C

Part (a)

$a = v'(t)$ or equivalent •1

$a = 4\sin\left(2t - \frac{\pi}{2}\right)$ •2 x •3 x

Part (b)

$a(10) = 4\sin\left(20 - \frac{\pi}{2}\right) = -1\cdot 63$ •4

<0, So decreasing •5 ✓

Only as a consequence of •1 in part (a)

Question		Generic Scheme			Illustrative Scheme	Max Mark
9	b					
		$\bullet^4$	ss	know to and evaluate $a(10)$	$\bullet^4$ $a(10)=6\cdot53$	
		$\bullet^5$	ic	interpret result	$\bullet^5$ $a(10)>0$ therefore increasing	2

Notes:

1. $\bullet^5$ is available only as a consequence of substituting into a derivative.
2. $\bullet^4$ and $\bullet^5$ are not available to candidates who work in degrees.
3. $\bullet^2$ and $\bullet^3$ may be awarded if they appear in the working for 9(b). However, $\bullet^1$ requires a clear link between acceleration and $v'(t)$.

Question		Generic Scheme			Illustrative Scheme	Max Mark
9	c					
		$\bullet^6$	ic	know to integrate	$\bullet^6$ $s(t)=\int v(t)\,dt$	
		$\bullet^7$	pd	integrate correctly	$\bullet^7$ $s(t)=4\sin\left(2t-\frac{\pi}{2}\right)+c$	
		$\bullet^8$	ic	determine constant and complete	$\bullet^8$ $c=8$ so $s(t)=4\sin\left(2t-\frac{\pi}{2}\right)+8$	3

Notes:

4. $\bullet^7$ and $\bullet^8$ are not available to candidates who work in degrees. However, accept $\int 8\cos(2t-90)\,dt$ for $\bullet^6$.

[END OF MARKING INSTRUCTIONS]