part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
a)	2	1.1.7, 1.1.6	NC	C	2002W q1
b)	2	1.1.3	NC	C	

(*a*)	Find the equation of the straight line through the points A(–1, 5) and B(3, 1).	2
(*b*)	Find the size of the angle which AB makes with the positive direction of the *x*-axis.	2

Give 1 mark for each •	Illustrations for awarding each •
a ans: $y + x = 4$ 2 marks	
•[1] ss : know how to and find gradient	•[1] $m = -1$
•[2] ic : state equation of st line	•[2] $y - 5 = -1(x+1)$ **or** $y - 1 = -1(x-3)$
b ans: 135° 2 marks	
•[3] ss : know that tan(angle) = gradient	•[3] $\tan(\text{angle}) = -1$
•[4] pd : calculate angle	•[4] $\text{angle} = 135°$

Notes

1. •[3] and •[4] are only available for candidates who use their gradient from part (a).
2. If part (a) yields a positive gradient, maximum award for (*b*) is 1.
3. For •[3] and •[4], accept a diagram correctly showing 45° and 135°.
4. For •[3] treat as bad form tan(–1) = angle

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
a)	2	3.1.2	CN	C	2002W q2
b)	2	3.1.10	CN	C	

(*a*) If $\boldsymbol{u} = \begin{pmatrix} 1 \\ 7 \\ -2 \end{pmatrix}$ and $\boldsymbol{v} = \begin{pmatrix} 1 \\ -2 \\ 1 \end{pmatrix}$, write down the components of $\boldsymbol{u} + 3\boldsymbol{v}$ and $\boldsymbol{u} - 3\boldsymbol{v}$. 2

(*b*) Hence, or otherwise, show that $\boldsymbol{u} + 3\boldsymbol{v}$ and $\boldsymbol{u} - 3\boldsymbol{v}$ are perpendicular. 2

Give 1 mark for each •	Illustrations for awarding each •
a ans: as shown 2 marks	
•[1] ic : interpret vector components	•[1] $u + 3v = \begin{pmatrix} 4 \\ 1 \\ 1 \end{pmatrix}$
•[2] ic : interpret vector components	•[2] $u - 3v = \begin{pmatrix} -2 \\ 13 \\ -5 \end{pmatrix}$
b ans: proof 2 marks	
•[3] ss : know to use scalar product	•[3] $\begin{pmatrix} 4 \\ 1 \\ 1 \end{pmatrix} . \begin{pmatrix} -2 \\ 13 \\ -5 \end{pmatrix}$
•[4] pd : process s.p. to get zero	•[4] $= -8 + 13 - 5 = 0$

Alternative

•[3] $(u + 3v).(u - 3v)$ $= |u|^2 - 9|v|^2$

•[4] $= 54 - 9 \times 6 = 0$

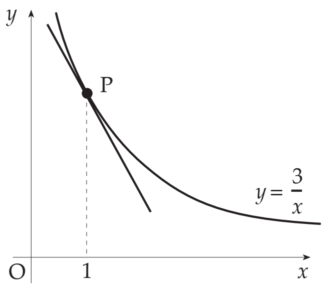
Notes

1 Treat $\begin{pmatrix} 4 \\ 1 \\ 1 \end{pmatrix} . \begin{pmatrix} -2 \\ 13 \\ -5 \end{pmatrix} = \begin{pmatrix} -8 \\ 13 \\ -5 \end{pmatrix} = -8 + 13 - 5 = 0$ as bad form.

2 Treat $\begin{pmatrix} 1 \\ 7 \\ 2 \end{pmatrix}$ as a casual error - max 3/4

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	5	1.3.4, 1.3.7, 1.1.6	CN	C	2002W q3

Find the equation of the tangent to the curve with equation $y = \frac{3}{x}$ at the point P where $x = 1$. 5



Give 1 mark for each • | Illustrations for awarding each •

ans: $y + 3x = 6$ 5 marks

•[1] ic : express in standard form	•[1] $y = 3x^{-1}$
•[2] pd : differentiate negative power	•[2] $\frac{dy}{dx} = -3x^{-2}$
•[3] ss : know how to and find gradient	•[3] $m_{x=1} = -3$
•[4] ss : know how to and find y-coord.	•[4] $y_{x=1} = 3$
•[5] ic : write down equ of tangent	•[5] $y - 3 = -3(x - 1)$

Notes

1 For •[5], gradient must be obtained froma derivative.

2 •[5] is not available to candidates who find and use the gradient perpendicular to –3.

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
a)	1	1.2.11	NC	C	2002W q4
b)	2	2.3.1	NC	C	

(*a*) Write down the exact values of $\sin\left(\frac{\pi}{3}\right)$ and $\cos\left(\frac{\pi}{3}\right)$. 1

(*b*) If $\tan x = 4\sin\left(\frac{\pi}{3}\right)\cos\left(\frac{\pi}{3}\right)$, find the exact values of x for $0 \le x \le 2\pi$. 2

Give 1 mark for each •	Illustrations for awarding each •
a ans: $\frac{\sqrt{3}}{2}, \frac{1}{2}$ 1 mark	
•1 ic : know exact values	•1 $\sin\frac{\pi}{3} = \frac{\sqrt{3}}{2}$ **and** $\cos\frac{\pi}{3} = \frac{1}{2}$
b ans : $\frac{\pi}{3}, \frac{4\pi}{3}$ 2 marks	
•2 pd : start to solve - simplify fractions	•2 $\tan x = \sqrt{3}$
•3 pd : complete solving process	•3 $x = \frac{\pi}{3}, \frac{4\pi}{3}$

Notes

1 •2 is only available for an expression for $\tan x$ involving at least 1 surd and tidied up.

2 •3 is only available for answers in radians.

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	5	2.1.1	CN	C	2002W q5

Given that $(x-2)$ and $(x+3)$ are factors of $f(x)$ where $f(x)=3x^3+2x^2+cx+d$, find the values of c and d. 5

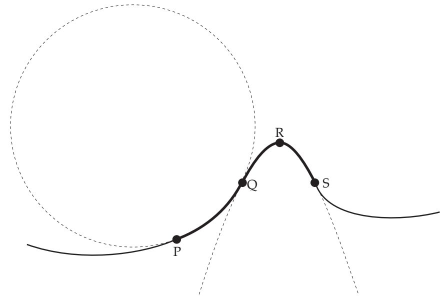
Give 1 mark for each •	Illustrations for awarding each •
ans: c = –19, d = 6 5 marks	
•1 ss : know to use f(a) or synth. division	•1 use $f(2)$ or $f(-3)$ or start appr.synth. division
•2 pd : determine an exp. in c & d	•2 $2c+d+32$
•3 pd : determine another equ. in c & d	•3 $-3c+d-63$
•4 ss : know to form and solve sim. equ.	•4 $2c+d=-32$ **and** $-3c+d=63$ or equiv
•5 pd : process solutions of sim. equations	•5 $(c,d)=(-19,6)$

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
a)	4	2.4.4	CN	C	2002W q6
b)	2	1.3.9	CN	B	

The side view of part of a roller coaster ride is shown by the path PQRS. The curve PQ is an arc of the circle with equation $x^2 + y^2 + 4x - 10y + 9 = 0$. The curve QRS is part of the parabola with equation $y = -x^2 + 6x - 5$. The point Q has coordinates (2, 3).

(*a*) Find the equation of the tangent to the circle at Q. 4

(*b*) Show that this tangent to the circle at Q is also the tangent to the parabola at Q. 2



Give 1 mark for each •	Illustrations for awarding each •

a ans: $y - 2x = -1$ 4 marks

- •1 ic : state coord of centre of circle — •1 centre $= (-2, 5)$
- •2 ss : know how to and find m_{radius} — •2 $m_{rad} = \frac{2}{-4}$
- •3 ss : know how to and find $m_{tangent}$ — •3 $m_{tgt} = 2$
- •4 ic : write down equ of tangent — •4 $y - 3 = 2(x - 2)$

Notes

1 •4 only available if perp. gradient used

2 Attempting to solve the circle and the parabola casnnot earn any credit.

b ans: proof 2 marks

- •5 ss : know to diff and differentiate — •5 $\frac{dy}{dx} = -2x + 6$
- •6 ic : complete proof — •6 $m = 2$ and complete

OR

- •5 ss : know to solve two curves — •5 $-x^2 + 6x - 5 = 2x - 1$, $(x - 2)^2 = 0$
- •6 ic : complete proof of equal roots — •6 $\Rightarrow$ equal roots so tgt at $x = 2$

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	4	2.2.4	CN	C	2002W q7

Find $\int\left(\sqrt[3]{x}-\frac{1}{\sqrt{x}}\right)dx$. 4

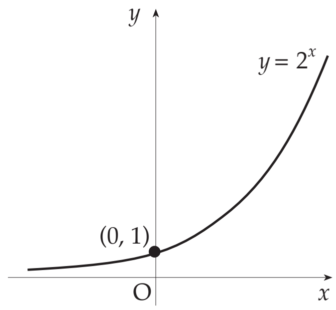
Give 1 mark for each •	Illustrations for awarding each •
ans: $\frac{3}{4}x^{\frac{4}{3}}-2x^{\frac{1}{2}}+c$ 4 marks	
•1 ic : express in standard form	•1 $x^{\frac{1}{3}}$
•2 ic : express in standard form	•2 $x^{-\frac{1}{2}}$
•3 pd : integrate fractional power	•3 $\frac{3}{4}x^{\frac{4}{3}}$ **or** $-2x^{\frac{1}{2}}$
•4 pd : integrate neg. fractional power plus constant of int.	•4 $\frac{3}{4}x^{\frac{4}{3}}-2x^{\frac{1}{2}}+c$

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
a)	2	1.2.4	NC	B	2002W q8
b)	2	1.2.5	NC	A	

The diagram shows part of the graph of $y = 2^x$.

(*a*) Sketch the graph of $y = 2^{-x} - 8$. 2

(*b*) Find the coordinates of the points where it crosses the x and y axes. 2



Give 1 mark for each • | Illustrations for awarding each •

a ans: sketch 2 marks

•[1] ic : interpret negative index

•[2] ic : interpret vertical displacement

•[1] sketch with y – axis reflection

•[2] sketch with translation | |el to y – axis

b ans: sketch 2 marks

•[3] ic : interpret new y-intercept

•[4] pd : calculate the new 'x'-intercept

•[3] $(0, -7)$

•[4] $(-3, 0)$

Notes

1 •[2] and •[3] are connected!. Stating they are "going down 8" will earn •[2]. Doing it to get (0, –7) will earn •[3]. A wrong translation downwards on its own will earn neither mark.

2 Horizontal translations earn no marks.

3 •[2] is still available after first reflecting in the line $y = x$.

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
a)	3	1.2.6	CN	C	2002W q9
b)	1	1.2.2	CN	B	

The function *f*, defined on a suitable domain, is given by $f(x)=\frac{3}{x+1}$.

(*a*) Find an expression for $h(x)$ where $h(x)=f(f(x))$, giving your answer as a fraction in its simplest form. 3

(*b*) Describe any restriction on the domain of *h*. 1

Give 1 mark for each •	Illustrations for awarding each •
a ans: $\frac{3(x+1)}{x+4}$ 3 marks	
•1 ic : interpret composite functions	•1 $f\left(\frac{3}{x+1}\right)$ **stated or implied by •2**
•2 ic : interpret composite functions	•2 $\dfrac{3}{\frac{3}{x+1}+1}$
•3 pd : simplify algebraic fractions	•3 $\frac{3x+3}{x+4}$
b ans: $x \neq -4$ 1 mark	
•4 ic : interpret alg. fraction	•4 $x \neq -4$

Notes

1 Do not penalise the inclusion of $x \neq -1$ at •4

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	5	3.2.2, 2.1.9, 1.3.11	CN	A	2002W q10

A function f is defined by $f(x) = 2x + 3 + \frac{18}{x-4}$, $x \neq 4$.

Find the values of x for which the function is strictly increasing. 5

Give 1 mark for each •	Illustrations for awarding each •
ans: proof 5 marks	
•[1] ss : know to diff and begin	•[1] $f'(x) = 2$ ……
•[2] pd : complete $f'(x)$	•[2] $\ldots\ldots -18(x-4)^2$
•[3] ss : know to solve $f'(x) = 0$ and begin	•[3] $(x-4)^2 - 9 = 0$
•[4] pd : complete solution of $f'(x) = 0$	•[4] $x = 1,\ x = 7$
•[5] ic : interpret solution to $f'(x) > 0$	•[5] $x < 1,\ x > 7$

More aesthetic solution

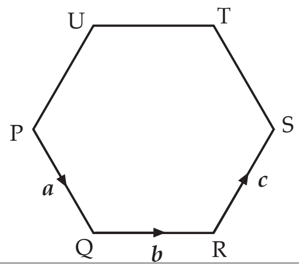
		Alternative for •[3], •[4], •[5]
•[1] ss : know that for incr. f, $f'(x) > 0$	•[1] $f'(x) > 0$	
•[2] pd : find $f'(x)$	•[2] $2 - \frac{18}{(x-4)^2}$	
•[3] pd : start to solve inequality	•[3] $(x-4)^2 - 9 > 0$	•[3] $(x-4)^2 > 9$
•[4] pd : continue to solve inequality	•[4] $(x-7)(x-1) > 0$	•[4] $(x-4) > 3$ **and** $(x-4) < -3$
•[5] ic : interpret factors	•[5] $x < 1,\ x > 7$	•[5] $x < 1,\ x > 7$

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	3	3.1.9	CN	A	2002W q11

PQRSTU is a regular hexagon of side 2 units.

$\overrightarrow{PQ}$, $\overrightarrow{QR}$ and $\overrightarrow{RS}$ represent vectors $\boldsymbol{a}$, $\boldsymbol{b}$ and $\boldsymbol{c}$ respectively.

Find the value of $\boldsymbol{a}.(\boldsymbol{b}+\boldsymbol{c})$. 3



Give 1 mark for each • | Illustrations for awarding each •

ans: 0 3 marks

- •[1] ss : know to use and use dist. law
- •[2] ic : interpret scalar product
- •[3] pd : evaluate scalar products

•[1] $a.b + a.c$

•[2] $|a||b|\cos 60° + |a||c|\cos 120°$

•[3] $2 \times 2 \times \frac{1}{2} + 2 \times 2 \times -\frac{1}{2} = 0$

Alternative sol^{u}:

•[1] $\overrightarrow{PQ}.\overrightarrow{QS}$

•[2] $Q\hat{R}S = 120° \Rightarrow R\hat{Q}S = 30° \Rightarrow P\hat{Q}S = 90°$

•[3] $\overrightarrow{PQ}.\overrightarrow{QS} = |PQ||QS|\cos 90° = 0$

Note

1 The use of a coordinate framework is acceptable.

2 •[2] may be awarded for $|a||b|\cos 60° = 2 \times 2 \times \frac{1}{2}$ or $|a||b|\cos 120° = 2 \times 2 \times -\frac{1}{2}$.

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	3	3.3.2, 3.3.1	CN	A	2002W q11

If $\log_a p = \cos^2 x$ and $\log_a r = \sin^2 x$, show that $pr=a$. 3

Give 1 mark for each •	Illustrations for awarding each •
ans: a 3 marks	
•[1] ss : choose a starting point	•[1] $\log_a p + \log_a r = \cos^2 x + \sin^2 x$
•[2] pd : know and use sum/product rule	•[2] $\log_a p + \log_a r = \log_a pr$
•[3] ic : interpret log statement and complete proof.	•[3] $\log_a pr = 1$ and so $pr = a$

Alternative sol[u]:

•[1] $p = a^{\cos^2 x}$ $r = a^{\sin^2 x}$

•[2] $pr = a^{\cos^2 x + \sin^2 x}$

•[3] $pr = a^1 = a$

Note

1 To gain all 3 marks there needs to be some indication that the candidate has noticed that $\cos^2 x + \sin^2 x = 1$.

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
a)	6	1.1.10	CN	C	2002W q1
b)	2	1.1.8	CN	C	

The diagram shows a rhombus PQRS with its diagonals PR and QS.

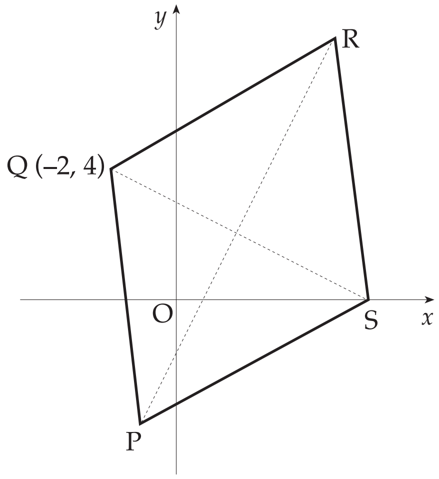
PR has equation $y = 2x - 2$.

Q has coordinates (–2, 4).

(*a*) (i) Find the equation of the diagonal QS.

(ii) Find the coordinates of T, the point of intersection of PR and QS. **6**

(*b*) R is the point (5, 8). Write down the coordinates of P. **2**



Give 1 mark for each • | Illustrations for awarding each •

a ans: $2y + x = 6$, $T(2, 2)$ 6 marks

- •1 ss : know to & find gradient thr' 2 pts — •1 $m_{PR} = 2$ **stated or implied by •2**
- •2 ss : know and use product of perp. grads — •2 use $m_1 m_2 = -1 \Rightarrow m_{QS} = -\frac{1}{2}$
- •3 ic : state equ. of st line — •3 $y - 4 = -\frac{1}{2}(x + 2)$
- •4 pd : simplify — •4 $2y + x = 6$ or equivalent
- •5 ss : know to solve sim equ. and start — •5 strategy for sim. equ eg substitute
- •6 pd : complete solving process — •6 $T(2,2)$

b ans: $P(-1, -4)$ 2 marks

- •7 ss : choose strategy eg use R and T — •7 *strategy eg* $\overrightarrow{TP} = \overrightarrow{RT}$ **OR** •7 $x_P = -1$
- •8 pd : complete chosen strategy — •8 $P(-1,-4)$ **OR** •8 $y_P = -4$

Notes

1 •3 is only available to candidates who have made an attempt to find the perp. gradient

2 alt for •7: $\overrightarrow{QP} = \overrightarrow{RS}$ **and** $\overrightarrow{TS} = \overrightarrow{QT}$

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	4	3.1.6. 3.1.7	CN	C	2002W q2

With reference to a suitable set of coordinate axes, A, B and C are the points (–8, 10, 20), (–2, 1, 8) and (0, –2, 4) respectively.
Show that A, B and C are collinear and find the ratio AB : BC. **4**

Give 1 mark for each •	Illustrations for awarding each •
ans: proof, 3:1 4 marks	
•1 ic : interpret information as vector	•1 $\vec{AB}=\begin{pmatrix}6\\-9\\-12\end{pmatrix}$ ***or*** $\vec{BC}=\begin{pmatrix}2\\-3\\-4\end{pmatrix}$ ***or*** $\vec{AC}=\begin{pmatrix}8\\-12\\-16\end{pmatrix}$
•2 ss : know to find $\underline{\boldsymbol{a}} = k\underline{\boldsymbol{b}}$	•2 2nd vector ***and*** *e.g.* $\vec{AB}=3\vec{BC}$ $\left(\textbf{or}\ \begin{pmatrix}6\\-9\\-12\end{pmatrix}=3\begin{pmatrix}2\\-3\\-4\end{pmatrix}\right)$
•3 ic : complete proof	•3 *e.g.* $\vec{AB}, \vec{BC}$ have common direction, B common pt., so A, B, C collinear
•4 ic : interpret results	•4 AB:BC = 3:1

Notes

1 Accept AB $\|^{el}$ to BC in lieu of common direction.

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
a)	3	1.4.5	CR	C	2002W q3
b)	2	1.4.3	CR	C	

(*a*) Calculate the limit as $n \to \infty$ of the sequence defined by $u_{n+1} = 0 \cdot 9u_n + 10, \quad u_0 = 1$. **3**

(*b*) Determine the least value of n for which u_n is greater than half of this limit and the corresponding value of u_n. **2**

Give 1 mark for each •	Illustrations for awarding each •

a ans: 100 3 marks

- •[1] ic : state conditions for limit to exist
- •[2] ss : know and use a limit rule
- •[3] pd : complete limit calculations

- •[1] $-1 < a < 1$ **stated explicitly**
- •[2] $l = 0.9l + 10$ *or equiv. strat*
- •[3] $l = 100$

b ans: 100 2 marks

- •[4] pd : calculate terms
- •[5] pd : complete processing

- •[4] 10.9, 19.8, 27.8
- •[5] $u_7 = 52.65$

Notes

1 10.9, 19.8, 27.8, 35.5, 41.54, 47.39, 52.65

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
a)	4	3.4.1	NC	C	2002W q4
b)	2	3.4..3	NC	B	

(*a*) Write $\sqrt{3}\sin x° + \cos x°$ in the form $k\sin(x+\alpha)°$ where $k > 0$ and $0 \le \alpha < 360$. **4**

(*b*) Hence find the maximum value of $5 + \sqrt{3}\sin x° + \cos x°$ and determine the corresponding value of x in the interval $0 \le x \le 360$. **2**

Give 1 mark for each •		Illustrations for awarding each •	
a ans: $2\sin(x + 30)°$	4 marks		
•1 ss : expand $k\sin(x + a)°$		•1 $k\sin x°\cos a° + k\cos x°\sin a°$	**stated explicitly**
•2 ic : compare coefficients		•2 $k\sin a° = 1$ *and* $k\cos a° = \sqrt{3}$	**stated explicitly**
•3 pd : process k		•3 $k = 2$	
•4 pd : process a		•4 $a = 30$	
b ans: max = 7 when $x = 60$	2 marks		
•5 ic : interpret maximum		•5 $\max = 5 + 2 = 7$	
•6 sp : know how to and find x_{max}		•6 $x = 60$	

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	4	2.3.5	CN	C	2002W q5

Solve the equation $\cos 2x - 2\sin^2 x = 0$ in the interval $0 \le x < 2\pi$. **4**

Give 1 mark for each •	Illustrations for awarding each •

ans: $\frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6}$ 4 marks

- •[1] ss : know to make angles same size
- •[2] pd : simplify
- •[3] pd : process solution
- •[4] pd : process solution

Method 1

- •[1] *use eg* $2\sin^2 x = 1 - \cos 2x$
- •[2] $\cos 2x = \frac{1}{2}$
- •[3] $2x = \frac{\pi}{3}, \frac{5\pi}{3}, \frac{7\pi}{3}, \frac{11\pi}{3}$
- •[4] $x = \frac{\pi}{6}, \frac{5\pi}{6}, \frac{7\pi}{6}, \frac{11\pi}{6}$

Alternative for •[3] and •[4]

- •[3] $2x = \frac{\pi}{3}, \frac{5\pi}{3}$ **and** $x = \frac{\pi}{6}, \frac{5\pi}{6}$
- •[4] $2x = \frac{7\pi}{3}, \frac{11\pi}{3}$ **and** $x = \frac{7\pi}{6}, \frac{11\pi}{6}$

Method 2

- •[1] *use eg* $\cos 2x = 1 - 2\sin^2 x$
- •[2] $\sin^2 x = \frac{1}{4}$
- •[3] $\sin x = \frac{1}{2} \ldots\ldots x = \frac{\pi}{6}, \frac{5\pi}{6}$
- •[4] $\sin x = -\frac{1}{2} \ldots\ldots x = \frac{7\pi}{6}, \frac{11\pi}{6}$

- •[3] $\sin x = \frac{1}{2} \ldots\ldots x = \frac{\pi}{6}$
  and $\sin x = -\frac{1}{2} \ldots\ldots x = \frac{7\pi}{6}$
- •[4] $\frac{5\pi}{6}, \frac{11\pi}{6}$

Method 3

- •[1] *use eg* $\cos 2x = \cos^2 x - \sin^2 x$
- •[2] $\tan^2 x = \frac{1}{3}$
- •[3] $\tan x = \frac{1}{\sqrt{3}} \ldots\ldots x = \frac{\pi}{6}, \frac{7\pi}{6}$
- •[4] $\tan x = -\frac{1}{\sqrt{3}} \ldots\ldots x = \frac{5\pi}{6}, \frac{11\pi}{6}$

Alternative for •[3] and •[4]
similar to method 2

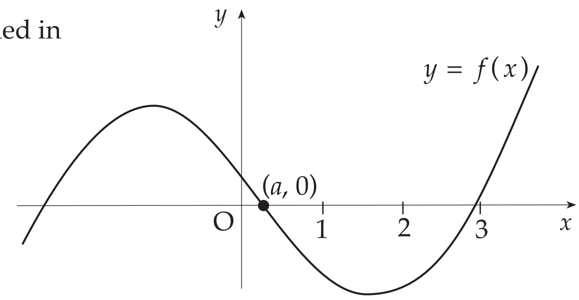
Notes

1. answers left in degrees lose 1 mark
   ie if a candidate gets to 30° and 150° and does no more then it only earns •[1] and •[2].

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	3	2.1.11	CR	C	2002W q6

The graph of $f(x) = 2x^3 - 5x^2 - 3x + 1$ has been sketched in the diagram shown.

Find the value of a correct to one decimal place. **3**



Give 1 mark for each •

Illustrations for awarding each •

ans: $a = 0.2$ 3 marks

•[1] ss : find a ±ve $f(b)$ for suitable b

•[2] ss : find a ±ve $f(c)$ for suitable c and another value of $f(x)$ for $c < x < b$.

•[3] pd : process minimum requirements

•[1] evaluating $f(b)$ for any b making $f(b) + ve$ or $-ve$, $0 \le b \le 0.5$

•[2] evaluating $f(c)$ for any c making $f(c) - ve$ or $+ve$, $0 \le c \le 0.5$ **and** evaluating $f(d)$ for any d lying between b and c.

•[3] $a = 0.2$

Notes

1 The minimum requirements to conclude that $a = 0.2$ is to show that $0.2 < a < 0.25$

x	f(x)
0	1
0.1	0.625
0.2	0.216
0.25	–0.03125
0.3	–0.296
0.4	–0.872
0.5	–1.5
1	–5

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	3	3.2.4	CR	B	2002W q7

Find $\int_0^1 \left(\cos(3x) - \sin\left(\frac{1}{3}x + 1\right)\right) \, dx$ correct to 3 decimal places. **3**

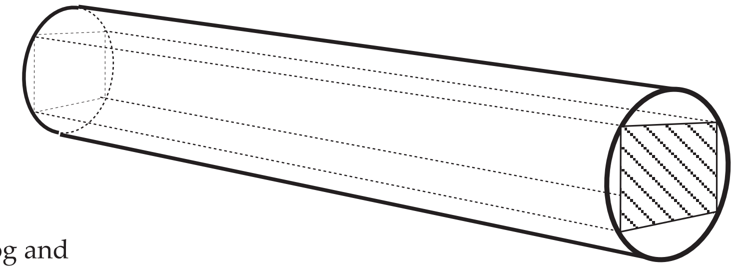
Give 1 mark for each •	Illustrations for awarding each •
ans: $a = -0.868$ 3 marks	
•1 ic : integrate cosax	•1 $\frac{1}{3}\sin 3x$
•2 ic : integrate sin(ax+b)	•2 $+\frac{1}{\frac{1}{3}}\cos\left(\frac{1}{3}x+1\right)$
•3 pd : evaulate limits	•3 $\left(\frac{1}{3}\sin 3 + 3\cos\frac{4}{3}\right) - 3\cos 1 = -0\cdot 868$

Note

1 0.047 + 0.706 - 1.62 = –0.868

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	5	1.3.15	CR	B	2002W q8

A rectangular beam is to be cut from a cylindrical log of diameter 20 cm.

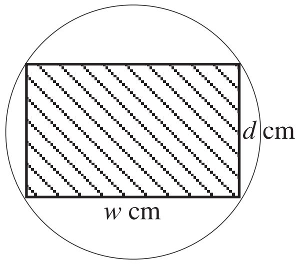


The diagram shows a cross-section of the log and beam where the beam has a breadth of w cm and a depth of d cm.

The strength S of the beam is given by

$S = 1.7w\left(400 - w^2\right)$.

Find the dimensions of the beam for maximum strength.



5

Give 1 mark for each • | Illustrations for awarding each •

ans: $d = 20\sqrt{\frac{2}{3}}$ 5 marks

Give 1 mark for each •	Illustrations for awarding each •	
•1 ss : know to set derivative to zero	•1 $\frac{dS}{dw} = \ldots = 0$	**stated explicitly**
•2 pd : differentiate	•2 $680 - 5.1w^2$	
•3 pd : solve	•3 $w = \frac{20}{\sqrt{3}}$ (11.5)	
•4 ic : justify maximum	•4 *e.g.* nature table	
•5 pd : substitute	•5 $d = 20\sqrt{\frac{2}{3}}$ (16.3)	

Note

1 "$680 - 5.1w^2 = 0$" would earn •1 ansd •2.

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
a)	1	3.3.4	CR	C	2002W q9
b)	4	3.3.4	CR	B	

A researcher modelled the size N of a colony of bacteria t hours after the beginning of her observations by $N(t) = 950 \times (2 \cdot 6)^{0 \cdot 2t}$.

(*a*) What was the size of the colony when observations began? **1**

(*b*) How long does it take for the size of the colony to be multiplied by 10? **4**

Give 1 mark for each •		Illustrations for awarding each •
a ans: 950	1 mark	
•[1] ic : interpret $N(0)$		•[1] 950
b ans: approx 12 hours	4 marks	
•[2] ic : substitute		•[2] $9500 = 950 \times 2.6^{0.2t}$ OR $10 = 2.6^{0.2t}$
•[3] ss : know how to isolate index		•[3] $\log_{10} 10 = \log_{10} 2.6^{0.2t}$
•[4] pd : process solution		•[4] $0.2t = \dfrac{\log_{10} 10}{\log_{10} 2.6}$
•[5] pd : process solution		•[5] $t \approx 12$ hours

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
a)	7	2.4.4, 2.1.8	CN	A	2002W q10
b)	2	2.4.4	CN	A	

The line $y + 2x = k, \quad k > 0$, is a tangent to the circle $x^2 + y^2 - 2x - 4 = 0$.

(*a*) Find the value of *k*. **7**

(*b*) Deduce the coordinates of the point of contact. **2**

Give 1 mark for each •	Illustrations for awarding each •	
a ans: $k = 7$ — 7 marks		
•1 ss : know to sub and start process	•1 $y = k - 2x$	**stated or implied by •2**
•2 ic : substitute	•2 $x^2 + (k - 2x)^2 - 2x - 4 = 0$	
•3 pd : simplify to quadratic	•3 $5x^2 - (2 + 4k)x + (k^2 - 4) = 0$	
•4 ss : know to make discriminant zero	•4 discriminant $= 0$	**stated or implied by •5**
•5 ic : identify discriminant	•5 $(2 + 4k)^2 - 4 \times 5 \times (k^2 - 4) = 0$	
•6 pd : simplify to quadratic	•6 $-4k^2 + 16k + 84 = 0$	
•7 pd : solve	•7 $k = 7$	
b ans: (3, 1) — 2 marks		
•8 ss : know to substitute	•8 $5x^2 - 30x + 45 = 0$	
•9 pd : solve	•9 $(3,1)$	

Notes

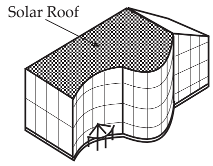
1 The zero at •2 / •3 stage must appear at least once.

2 The zero at •4 / •5 / •6 stage must appear at least once.

3 Sustitution at •1 can be for *x*

4 If a value for *k* is not found in (*a*), a plucked *k* may be used in (*b*) with no loss of available marks.

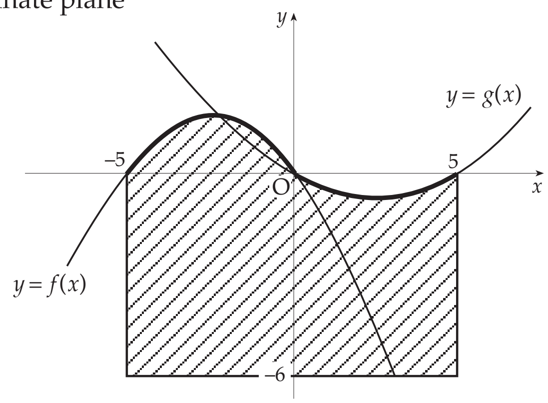
part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
a)	7	2.2.7	CN	A	2002W q11
b)	1	2.2.7	CN	A	



An energy efficient building is designed with solar cells covering the whole of its south facing roof. The energy generated by the solar cells is directly proportional to the area in square units.

The shape of the solar roof can be represented on the coordinate plane as the shaded area bounded by the functions

$f(x) = \frac{1}{4}\left(-x^2 - 5x\right)$, $g(x) = \frac{1}{12}\left(x^2 - 5x\right)$ and the lines $x = -5$, $x = 5$ and $y = -6$.



(*a*) Find the area of the solar roof. **7**

(*b*) Ten square units of solar cells generate a maximum of 1 kilowatt.
What is the maximum energy the solar roof can generate in kilowatts (to the nearest kilowatt)? **1**

Give 1 mark for each •	Illustrations for awarding each •
	Method 1
a ans: $63\frac{17}{36}$ — 7 marks	
•1 ss : split into calculatable parts	•1 *strategy* : f to x – axis + g to x – axis + rectangle
•2 ic : first integral with limits	•2 $\int_{-5}^{0} \frac{1}{4}\left(-x^2 - 5x\right)\,dx$
•3 pd : integrate	•3 $\left[-\frac{1}{12}x^3 - \frac{5}{8}x^2\right]_{-5}^{0}$
•4 pd : process limits	•4 $5\frac{5}{24}$ (5.2)
•5 ic : second integral with limits	•5 $\int_{0}^{5} \frac{1}{12}\left(x^2 - 5x\right)\,dx$
•6 pd : integrate	•6 $\left[\frac{1}{36}x^3 - \frac{5}{24}x^2\right]_{0}^{5}$
•7 ic : process limits & complete strategy	•7 $-1\frac{53}{72}$ (–1.7) *and* $63\frac{17}{36}$ (63.5)
	Note •2, •3, •4 apply to the first integral, whichever it is.
b ans: 6 kw — 1 mark	
•8 ic : interpret context	•8 6 kilowatts
Method 2	•1 *strategy* : $(y = f) - (y = -6)$ + $(y = g) - (y = -6)$
	•2 $\int_{-5}^{0} \frac{1}{4}\left(-x^2 - 5x\right) - (-6)\,dx$
	•3 $\left[-\frac{1}{12}x^3 - \frac{5}{8}x^2 + 6x\right]_{-5}^{0}$
	•4 $35\frac{5}{24}$ (35.2)
	•5 $\int_{0}^{5} \frac{1}{12}\left(x^2 - 5x\right) - (-6)\,dx$
	•6 $\left[\frac{1}{36}x^3 - \frac{5}{24}x^2 + 6x\right]_{0}^{5}$
	•7 $28\frac{19}{72}$ (28.3) *and* $63\frac{17}{36}$ (63.5)