part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	3	1.1.8, 1.1.7	CN	C	2001 q1

Find the equation of the straight line which is parallel to the line with equation $2x + 3y = 5$ and which passes through the point (2, –1). **3**

Give 1 mark for each •	Illustrations for awarding each •
ans: $2x + 3y = 1$ 3 marks	
•1 ss : express in standard form	•1 $y = -\frac{2}{3}x + \frac{5}{3}$ stated or implied by •2
•2 ic : interpret gradient	•2 $m_{line} = -\frac{2}{3}$ stated or implied by •3
•3 ic : state equation of st line	•3 $y - (-1) = -\frac{2}{3}(x - 2)$

Notes

1 •3 is only available for candidates who attempt to find or state the gradient.

2 •3 is still available even though •1 and •2 may not have been awarded.

example for note 2

$m = 2$

$y - (-1) = 2(x - 2)$ earns •3

example for note 1

$y - (-1) = 7(x - 2)$ earns no marks.

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	3	2.1.7	CN	C	2001 q2

For what value of k does the equation $x^2 - 5x + (k + 6) = 0$ have equal roots? **3**

Give 1 mark for each •	Illustrations for awarding each •
ans: $k = \frac{1}{4}$ 3 marks	
•1 ss : know to set disc. to zero	•1 $b^2 - 4ac = 0$ stated or implied by •2
•2 ic : substitute a, b and c into discriminant	•2 $(-5)^2 - 4 \times (k + 6)$
•3 pd : process equation in k	•3 $k = \frac{1}{4}$

Notes

1. "= 0" must occur on one of the lines in the solution to this question.
2. If the expression for the discriminant involves x, no marks are available.
3. If the phrase "discriminant = 0" appears at the start, then •1 can only be awarded if •2 is awarded.

   ie $disc = 0$
   $25 - 4(k + 6) = 0$
   $k = \frac{1}{4}$

   can be awarded 3 marks.

Alternative sol

•1 $x^2 - 5x + k + 6 = 0$

•2 $x^2 - 5x + \left(\frac{5}{2}\right)^2 = 0$ has equal roots

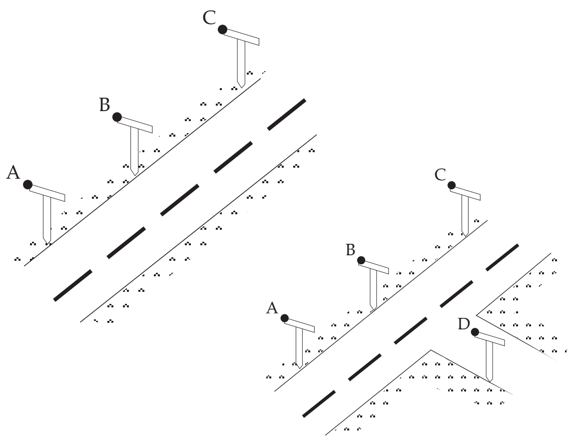
$k + 6 = \frac{25}{4}$

•3 $k = \frac{1}{4}$

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
a)	3	3.1.7	CN	C	2001 q3
b)	3	3.1.10	CN	C	

(*a*) Roadmakers look along the tops of a set of T-rods to ensure that straight sections of road are being created. Relative to suitable axes the top left corners of the T-rods are the points A(–8, –10, –2), B (–2, –1, 1) and C(6, 11, 5). Determine whether or not the section of road ABC has been built in a straight line. **3**

(*b*) A further T-rod is placed such that D has coordinates (1, –4, 4). Show that DB is perpendicular to AB. **3**



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

a ans: the road ABC is straight 3 marks

•[1] ic : interpret vector (eg $\vec{AB}$)
•[2] ic: interpret multiple of vector
•[3] ic : complete proof

•[1] *e.g.* $\vec{AB} = \begin{pmatrix} 6 \\ 9 \\ 3 \end{pmatrix}$

•[2] *e.g.* $\vec{BC} = \begin{pmatrix} 8 \\ 12 \\ 4 \end{pmatrix} = \frac{4}{3}\vec{AB}$

•[3] a) a common direction exists
and b) a common point exists
so A, B, C collinear

Notes
1 For •[3], accept references to "they" are parallel.
2 For (b) Converse of Pythagoras provides an alternative.[See below].
3 Other methods include using the cosine rule and the scalar product.

•[1] calculating $AB^2 = 126,\ BD^2 = 27,\ AD^2 = 153$	•[1] calculating $AB^2 = 126,\ BD^2 = 27,\ AD^2 = 153$
•[2] stating $\cos A\hat{B}D = \frac{126+27-153}{\sqrt{\ldots}\sqrt{\ldots}}$	•[2] stating $126 + 27 = 153$
•[3] $= 0$ *so* $\angle ABD = 90°$	•[3] by converse of Pythagoras $\angle ABD = 90°$

b ans: proof 3 marks

•[4] ic : interpret vector (ie $\vec{BD}$)
•[5] ss: state requirement for perpend.
•[6] ic : complete proof

•[4] $\vec{BD} = \begin{pmatrix} 3 \\ -3 \\ 3 \end{pmatrix}$

•[5] $\vec{AB}.\vec{BD} = 0$

•[6] $\vec{AB}.\vec{BD} = 18 - 27 + 9 = 0$

•[4] $\vec{BD} = \begin{pmatrix} 3 \\ -3 \\ 3 \end{pmatrix}$

•[5] $\vec{AB}.\vec{BD} = 18 - 27 + 9$

•[6] $= 0$ so AB is at right angles to BD

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	2	1.2.8	NC	C	2001 q4

Given $f(x) = x^2 + 2x - 8$, express $f(x)$ in the form $(x+a)^2 - b$. **2**

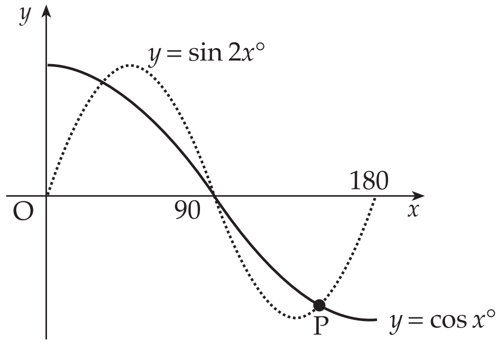
Give 1 mark for each •	Illustrations for awarding each •
ans: $(x+1)^2 - 9$ 2 marks	•1 $(x+1)^2 \ldots\ldots$
•1 ss : eg start to complete square	•2 $(x+1)^2 - 9$
•2 pd : complete process	***OR***
	•1 $a = 1$
	•2 $b = 9$
	OR
	•1 $x^2 + 2x - 8 \equiv x^2 + 2ax + a^2 - b$
	•2 $a = 1$ and $b = 9$

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	4,1	2.3.5	NC	C	2001 q5

b

5 (*a*) Solve the equation $\sin 2x° - \cos x° = 0$ in the interval $0 \leq x \leq 180$. **4**

(*b*) The diagram shows parts of two trigonometric graphs, $y = \sin 2x°$ and $y = \cos x°$.
Use your solutions in (*a*) to write down the coordinates of the point P. **1**



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

a ans: 30, 90, 150 — 4 marks

- •1 ss : use double angle formula — •1 $2\sin x° \cos x°$
- •2 pd : factorise — •2 $\cos x°(2\sin x° - 1)$
- •3 pd : process — •3 $\cos x° = 0,\ \sin x° = \frac{1}{2}$
- •4 pd : process — •4 $90, 30, 150$

- •3 $\sin x° = \frac{1}{2}$ and $x = 30, 150$
- •4 $\cos x° = 0$ and $x = 90$

Notes

1 The inclusion of wrong answer(s) means the mark is not awarded (•4 in method 1, •3 or •4 in method 2).

b ans: $\left(150, -\frac{\sqrt{3}}{2}\right)$ — 1 mark

- •5 ic : interpret graph — •5 $\left(150, -\frac{\sqrt{3}}{2}\right)$

Notes

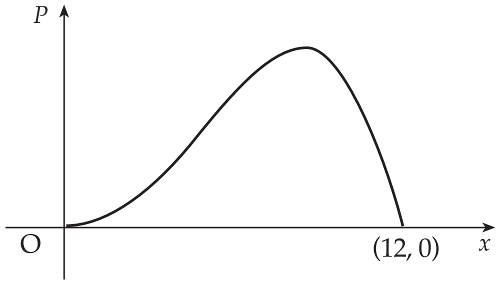
2 Accept $y = \cos 150° = -\frac{\sqrt{3}}{2}$ as poor form

3 Wrong formula:

- •1 ✗ $2\cos^2 x° - 1$
- •2 √ $(2\cos x° + 1)(\cos x° - 1) = 0$
- •3 √ $\cos x° = -\frac{1}{2},\ \cos x° = 1$
- •4 √ $0, 120, (~~240, 360~~)$

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	5	1.3.15	NC	C	2001 q6

A company spends x thousand pounds a year on advertising and this results in a profit of P thousand pounds. A mathematical model, illustrated in the diagram, suggests that P and x are related by $P = 12x^3 - x^4$ for $0 \le x \le 12$.
Find the value of x which gives the maximum profit.



5

Give 1 mark for each •	Illustrations for awarding each •

ans: x = 9 — 5 marks

- •1 ss : start diff. process
- •2 pd : process
- •3 ss : set derivative to zero
- •4 pc : process
- •5 ic : interpret solutions

- •1 $\frac{dP}{dx} = 36x^2 \ldots\ldots$ ***or*** $\frac{dP}{dx} = \ldots\ldots - 4x^3$
- •2 $\frac{dP}{dx} = 36x^2 - 4x^3$
- •3 $\frac{dP}{dx} = 0$
- •4 $x = 0$ ***and*** $x = 9$
- •5 nature table about $x = 9$ ***and*** $x = 9$

Notes

1 The "= 0" shown in •3 may appear anywhere in the working but must appear explicitly.

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
a)	2	1.2.6	NC	C	2001 q7
b)	5	2.3.5	NC	C	

Functions $f(x) = \sin x$, $g(x) = \cos x$ and $h(x) = x + \frac{\pi}{4}$ are defined on a suitable set of real numbers.

(*a*) Find expressions for

(i) $f(h(x))$

(ii) $g(h(x))$. **2**

(*b*) (i) Show that $f(h(x)) = \frac{1}{\sqrt{2}}\sin x + \frac{1}{\sqrt{2}}\cos x$.

(ii) Find a similar expression for $g(h(x))$ and hence solve the equation $f(h(x)) - g(h(x)) = 1$ for $0 \le x \le 2\pi$. **5**

Give 1 mark for each •	Illustrations for awarding each •
a ans: $\sin\left(x+\frac{\pi}{4}\right)$, $\cos\left(x+\frac{\pi}{4}\right)$ 2 marks	
•[1] ic : interpret composite functions	•[1] $\sin\left(x+\frac{\pi}{4}\right)$
•[2] ic : interpret composite functions	•[2] $\cos\left(x+\frac{\pi}{4}\right)$

Notes

1 One mark may be awarded for "$f\left(x+\frac{\pi}{4}\right)$ ***and*** $g\left(x+\frac{\pi}{4}\right)$"

2 For $\sin x + \frac{\pi}{4}$ *and* $\cos x + \frac{\pi}{4}$ award 1 mark only, unless there is evidence in part b that they have been expanded correctly, in which case treat as bad form and award 2 marks.

3 Do not penalise the appearance of 45°

Give 1 mark for each •	Illustrations for awarding each •
b ans: proof and $x = \frac{\pi}{4}, \frac{3\pi}{4}$ 5 marks	
•[3] ss : expand $\sin\left(x+\frac{\pi}{4}\right)$	•[3] $\sin x \cos\frac{\pi}{4} + \cos x \sin\frac{\pi}{4}$ ***and complete***
•[4] ic : interpret	•[4] $g(h(x)) = \frac{1}{\sqrt{2}}\cos x - \frac{1}{\sqrt{2}}\sin x$
•[5] ic : substitute	•[5] $\left(\frac{1}{\sqrt{2}}\sin x + \frac{1}{\sqrt{2}}\cos x\right) - \left(\frac{1}{\sqrt{2}}\cos x - \frac{1}{\sqrt{2}}\sin x\right)$
•[6] pd : start solving process	•[6] $\frac{2}{\sqrt{2}}\sin x$
•[7] pd : process	•[7] $x = \frac{\pi}{4}, \frac{3\pi}{4}$

Notes

4 If the evidence for •[5] has no brackets, •[5] can only be awarded if there is evidence further on that brackets has been implied.

5 •[7] is only available for answers in radians.

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	3	3.3.3, 3.3.4	NC	C	2001 q8

Find x if $4\log_x 6 - 2\log_x 4 = 1$. **3**

Give 1 mark for each •	Illustrations for awarding each •
ans: 81 3 marks	
•1 pd : use log-to-index rule	•1 $\log_x 6^4 - \log_x 4^2$
•2 pd : use log-to-division rule	•2 $\log_x \frac{6^4}{4^2}$
•3 ic : interpret base for $\log_x a = 1$ and simplify	•3 all processing leading to $x = 81$

Further illustrations

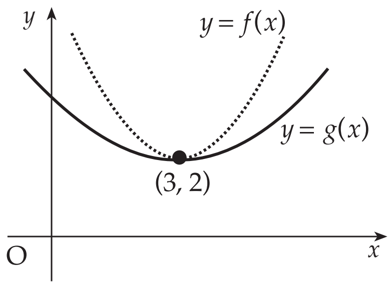
•1 $4\log_x 6 - 4\log_x 2 = 1$
$4(\log_x 6 - \log_x 2) = 1$
•2 $4\log_x \frac{6}{2} = 1$
$\log_x \frac{6}{2} = \frac{1}{4}$
$x^{\frac{1}{4}} = 3$
•3 $x = 81$

•1 $4\log_x 6 - 4\log_x 2 = 1$
$4(\log_x 6 - \log_x 2) = 1$
$4\log_x \frac{6}{2} = 1$
•2 $\log_x \left(\frac{6}{2}\right)^4 = 1$
•3 $x = 81$

$2\log_x 6 - \log_x 4 = \frac{1}{2}$
•1 $\log_x 6^2 - \log_x 4 = \frac{1}{2}$
•2 $\log_x \frac{6^2}{4} = \frac{1}{2}$
$x^{\frac{1}{2}} = 9$
•3 $x = 81$

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
	2	1.2.4, 1.3.8	CN	C	2001 q9

The diagram shows the graphs of two quadratic functions $y = f(x)$ and $y = g(x)$. Both graphs have a minimum turning point at (3, 2).
Sketch the graph of $y = f'(x)$ and on the same diagram sketch the graph of $y = g'(x)$. **2**



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

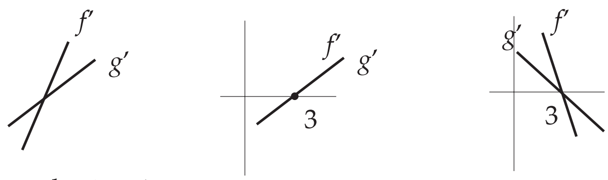
ans: for all k 2 marks

•[1] ss : use $\frac{d}{dx}$("quadratic") = "linear"
•[2] ic : iinterpret stationary point

•[1] st line for f' thr' $(3,0)$, $m_{f'} > 0$
•[2] st line for g' thr' $(3,0)$, $m_{f'} > m_{g'} > 0$

•[1] st lines for f' and g ', with $m_{f'} > m_{g'} > 0$
•[2] two lines intersecting at $(3,0)$

Notes
1 Award 0 marks for two curves through anywhere.
2 Further illustrations:



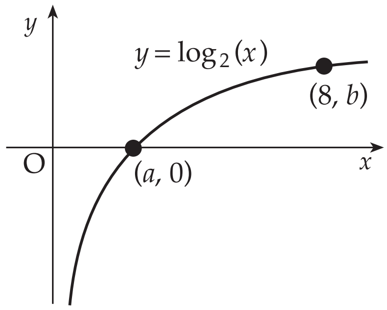
method 2 •[1] method 1 •[1] method 2 •[2]

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
a)	1	1.2.5	CN	B	2001 q10
b)	3	1.2.4, (3.0.0HG?)	CN	A	

10 The diagram shows a sketch of part of the graph of $y = \log_2(x)$.

(*a*) State the values of *a* and *b*. 1

(*b*) Sketch the graph of $y = \log_2(x+1) - 3$. 3



Give 1 mark for each •	Illustrations for awarding each •
a ans: $a = 1,\ b = 3$ 1 mark	
•[1] pd : use $\log_p q = 0 \Rightarrow q = 1$ and evaluate $\log_p p^k$.	•[1] $a = 1$ ***and*** $b = 3$
b ans: sketch 3 marks	
•[2] ss : use a translation	•[2] a "log – shaped" graph of the same orientation
•[3] ic : identify one point	•[3] sketch passes through $(0, -3)$ (labelled)
•[4] ic : identify a second point	•[4] sketch passes through $(7, 0)$ (labelled)

Notes

1 Do not penalise any errors made in relation to the asymptote, missing or otherwise.

2 $\begin{pmatrix}-1\\-3\end{pmatrix}$ is the correct translation!. You may also consider $\begin{pmatrix}-1\\3\end{pmatrix}, \begin{pmatrix}1\\3\end{pmatrix}$ *and* $\begin{pmatrix}1\\-3\end{pmatrix}$. •[2] is still available and in addition one mark (from •[3] an •[4]) may be awarded for both points consistent with the wrong translation.
Do not consider any other translation.

part	marks	Syllabus Code	Calc. Code (CN,CR,NC)	Grade (C, B, A)	Source
a)	4	2.4.5	CN	B	2000 q11
b)	3	2.4.4	CN	B	
c)	3	2.4.4	CN	A	

Circle P has equation $x^2 + y^2 - 8x - 10y + 9 = 0$. Circle Q has centre (–2, –1) and radius $2\sqrt{2}$.

(*a*) (i) Show that the radius of circle P is $4\sqrt{2}$. **4**

(ii) Hence show that circles P and Q touch. **3**

(*b*) Find the equation of the tangent to circle Q at the point (–4, 1).

(*c*) The tangent in (*b*) intersects circle P in two points. Find the *x*-coordinates of the points of intersection, expressing your answers in the form $a \pm b\sqrt{3}$. **3**

Give 1 mark for each •	Illustrations for awarding each •
a ans: proof 4 marks	
•[1] ic : interpret centre of circle (P)	•[1] $r_P = \sqrt{16+25-9} = \sqrt{32} = 4\sqrt{2}$
•[2] ss: find radius of circle (P)	•[2] $r_P + r_Q = 4\sqrt{2} + 2\sqrt{2} = 6\sqrt{2}$
•[3] ss : find sum of radii	•[3] $C_P = (4,5)$
•[4] pd : compare with distance between centres	•[4] $C_PC_Q = \sqrt{6^2+6^2} = 6\sqrt{2}$ ***and*** "so touch"
	• •
	•[1] $C_P = (4,5)$
	•[2] $C_PC_Q = \sqrt{6^2+6^2} = \sqrt{72}$
	•[1] $r_P = \sqrt{16+25-9} = \sqrt{32} = 4\sqrt{2}$
	•[2] $r_P + r_Q = 4\sqrt{2} + 2\sqrt{2} = 6\sqrt{2} = \sqrt{72}$ ***and*** "so touch"
b ans: $y = x + 5$ 3 marks	
•[5] ss : find gradient of radius	•[5] $m_r = -1$
•[6] ss : use $m_1m_2 = -1$	•[6] $m_{tgt} = +1$
•[7] ic : state equation of tangent	•[7] $y - 1 = 1(x+4)$
	Note 1 •[7] is only available if an attempt has been made to find a perpendicular gradient.
c ans: $x = 2 \pm 2\sqrt{3}$ 3 marks	
•[8] ss : substitute linear into circle	•[8] $x^2 + (x+5)^2 - 8x - 10(x+5) + 9 = 0$
•[9] pd : express in standard form	•[9] $2x^2 - 8x - 16 = 0$
•[10] pd : solve (quadratic) equation	•[10] $x = 2 \pm 2\sqrt{3}$
	Note 2 •[8], •[9] and •[10] are only available when the answer to part (b) is of the form $y = ax + b$ *where* $a, b \in R,\ a \neq 0$.