C2

1.

1·6	0·203915171		
1·7	0·244678248		
1·8	0·315656565		
1·9	0·467071461	(5 values correct)	B2
2	1	(3 or 4 values correct)	B1

Correct formula with $h = 0{\cdot}1$ M1

$I \approx \frac{0{\cdot}1}{2} \times \{0{\cdot}203915171 + 1 + 2(0{\cdot}244678248 + 0{\cdot}315656565 + 0{\cdot}467071461)\}$

$I \approx 3{\cdot}258727719 \div 20$

$I \approx 0{\cdot}162936386$

$I \approx 0{\cdot}163$ (f.t. one slip) A1

Special case for candidates who put $h = 0{\cdot}08$

1·6	0·203915171		
1·68	0·234831747		
1·76	0·281831135		
1·84	0·360946198		
1·92	0·520261046		
2	1	(all values correct)	B1

Correct formula with $h = 0{\cdot}08$ M1

$I \approx \frac{0{\cdot}08}{2} \times\{0{\cdot}203915171 + 1 + 2(0{\cdot}234831747 + 0{\cdot}281831135 + 0{\cdot}360946198 + 0{\cdot}520261046)\}$

$I \approx 3{\cdot}999655423 \div 25$

$I \approx 0{\cdot}159986216$

$I \approx 0{\cdot}160$ (f.t. one slip) A1

Note: Answer only with no working earns 0 marks

2. (*a*) $\sin\theta + 12(1 - \sin^2\theta) = 6$ (correct use of $\cos^2\theta = 1 - \sin^2\theta$) M1

An attempt to collect terms, form and solve quadratic equation in $\sin\theta$, either by using the quadratic formula or by getting the expression into the form $(a\sin\theta + b)(c\sin\theta + d)$, with $a \times c$ = coefficient of $\sin^2\theta$ and $b \times d$ = constant m1

$12\sin^2\theta - \sin\theta - 6 = 0 \Rightarrow (4\sin\theta - 3)(3\sin\theta + 2) = 0$

$\Rightarrow \sin\theta = \frac{3}{4}$, $\sin\theta = -\frac{2}{3}$ (c.a.o.) A1

$\theta = 48{\cdot}59°, 131{\cdot}41°$ B1

$\theta = 221{\cdot}81°, 318{\cdot}19°$ B1 B1

Note: Subtract 1 mark for each additional root in range for each branch, ignore roots outside range.
$\sin\theta = +, -$, f.t. for 3 marks, $\sin\theta = -, -$, f.t. for 2 marks
$\sin\theta = +, +$, f.t. for 1 mark

(*b*) $2x - 35° = -27°, 27°, 333°$ (one value) B1

$x = 4°, 31°$ B1, B1

Note: Subtract (from final two marks) 1 mark for each additional root in range, ignore roots outside range.

(*c*) Correct use of $\tan\phi = \frac{\sin\phi}{\cos\phi}$ (o.e.) M1

$\phi = 135°$ A1

$\phi = 315°$ A1

Note: Subtract (from final two marks) 1 mark for each additional root in range, ignore roots outside range.

3. (*a*) $\frac{y}{^3/_5} = \frac{x}{^5/_{13}}$ (o.e.) (correct use of sine rule) M1

$y = 1{\cdot}56x$ (convincing) A1

(*b*) $^1/_2 \times x \times y \times {}^{56}/_{65} = 4{\cdot}2$ (correct use of area formula) M1

Substituting $1{\cdot}56x$ for y in candidate's equation of form $axy = b$ M1

$1{\cdot}56x^2 = 9{\cdot}75$ (o.e.) A1

$x = 2{\cdot}5$ (f.t. candidate's quadratic equation provided both M's awarded) A1

$y = 3{\cdot}9$ (f.t. provided both M's awarded) A1

4. (*a*) $\frac{15}{2} \times [2a + 14d] = 780$ B1

Either $[a + d] + [a + 3d] + [a + 9d] = 100$

or $[a + 2d] + [a + 4d] + [a + 10d] = 100$ M1

$3a + 13d = 100$ (seen or implied by later work) A1

An attempt to solve candidate's derived linear equations simultaneously by eliminating one unknown M1

$a = 3$, $d = 7$ (both values) (c.a.o.) A1

(*b*) $d = 9$ B1

A correct method for finding $(p + 7)$ th term M1

$(p + 7)$ th term = 1086 (c.a.o.) A1

5. (*a*) $S_n = a + ar + \ldots + ar^{n-1}$ (at least 3 terms, one at each end) B1

$rS_n = \quad ar + \ldots + ar^{n-1} + ar^n$

$S_n - rS_n = a - ar^n$ (multiply first line by r and subtract) M1

$(1 - r)S_n = a(1 - r^n)$

$S_n = \frac{a(1 - r^n)}{1 - r}$ (convincing) A1

(*b*) (i) $\frac{a}{1 - r} = ka$, ($k = 4$ or ¼) M1

$r = 0{\cdot}75$ (c.a.o.) A1

(ii) $a + 0{\cdot}75a = 35$ (f.t. candidate's derived value for r, provided $r \neq 1$) M1

$a = 20$ (f.t. candidate's derived value for r, provided $r \neq 1$) A1

$S_9 = \frac{20(1 - 0{\cdot}75^9)}{1 - 0{\cdot}75}$

(f.t. candidate's derived values for r and a, provided $r \neq 1$) M1

$S_9 = 73{\cdot}99 = 74$ (c.a.o.) A1

6. (*a*) $\dfrac{x^{4/3}}{4/3} - 2 \times \dfrac{x^{1/4}}{1/4} + c$ B1, B1

(–1 if no constant term present)

(*b*) (i) $x^2 - 4x + 6 = -x + 10$ M1

An attempt to rewrite and solve quadratic equation in x, either by using the quadratic formula or by getting the expression into the form $(x + a)(x + b)$, with $a \times b$ = candidate's constant m1

$(x - 4)(x + 1) = 0 \Rightarrow x = 4, -1$ (both values, c.a.o.) A1

$y = 6, y = 11$ (both values, f.t. candidate's x-values) A1

Note: Answer only with no working earns 0 marks

(ii) **Either:**

Total area $= \displaystyle\int_{-1}^{4}(-x + 10)\,dx - \int_{-1}^{4}(x^2 - 4x + 6)\,dx$

(use of integration) M1

$\displaystyle\int x^2\,dx = \frac{x^3}{3}$ B1

Either: $\displaystyle\int x\,dx = \frac{x^2}{2}$ **and** $\displaystyle\int 4x\,dx = \frac{4x^2}{2}$ or: $\displaystyle\int 3x\,dx = \frac{3x^2}{2}$ B1

Either: $\displaystyle\int 10\,dx = 10x$ **and** $\displaystyle\int 6\,dx = 6x$ or: $\displaystyle\int 4\,dx = 4x$ B1

Total area $= [-(1/2)x^2 + 10x]_{-1}^{4} - [(1/3)x^3 - (4/2)x^2 + 6x]_{-1}^{4}$ (o.e.)

$= \{(-16/2 + 40) - (-1/2 - 10)\}$

$- \{(64/3 - 32 + 24) - (-1/3 - 2 - 6)\}$

(substitution of candidate's limits in at least one integral) m1

Subtraction of integrals with correct use of candidate's x_A, x_B as limits m1

Total area = 125/6 (c.a.o.) A1

Or:

Area of trapezium = 85/2 (f.t. candidate's x_A, x_B) B1

Area under curve $= \displaystyle\int_{-1}^{4}(x^2 - 4x + 6)\,dx$

(use of integration) M1

$= [(1/3)x^3 - (4/2)x^2 + 6x]_{-1}^{4}$

(correct integration) B2

$= (64/3 - 32 + 24) - (-1/3 - 2 - 6)$

(substitution of candidate's limits) m1

$= 65/3$

Use of candidate's, x_A, x_B as limits and trying to find total area by subtracting area under curve from area of trapezium m1

Total area = 85/2 – 65/3 = 125/6 (c.a.o.) A1

7. (*a*) Let $p = \log_a x$, $q = \log_a y$

Then $x = a^p$, $y = a^q$ (the relationship between log and power) B1

$\frac{x}{y} = \frac{a^p}{a^q} = a^{p-q}$ (the laws of indices) B1

$\log_a x/y = p - q$ (the relationship between log and power)

$\log_a x/y = p - q = \log_a x - \log_a y$ (convincing) B1

(*b*) $\frac{1}{2}\log_a x^8 = \log_a x^4$, $3\log_a 2/x = \log_a 2^3/x^3$

(one use of power law) B1

$\frac{1}{2}\log_a x^8 - \log_a 4x + 3\log_a 2/x = \log_a \frac{x^4 \times 2^3}{4x \times x^3}$ (addition law) B1

(subtraction law) B1

$\frac{1}{2}\log_a x^8 - \log_a 4x + 3\log_a 2/x = \log_a 2$ (c.a.o.) B1

8. (*a*) $A(2, -1)$ B1

A correct method for finding the radius M1

Radius = 5 A1

(*b*) (i) A correct method for finding the length of AB M1

$AB = 10$ (f.t. candidate's coordinates for A) A1

Difference in radii = distance between centres,

$\therefore$ circles touch A1

(ii) Gradient $BP(AP)(AB) = \frac{\text{inc in } y}{\text{inc in } x}$ M1

Gradient $BP = \frac{11 - 3}{-7 - (-1)} = \frac{8}{-6}$ (o.e)

(f.t. candidate's coordinates for A) A1

Use of $m_{\text{tan}} \times m_{\text{rad}} = -1$ M1

Equation of common tangent is:

$y - 3 = \frac{3}{4}[x - (-1)]$ (o.e)

(f.t. one slip provided both M's are awarded) A1

9. $r\theta = 7{\cdot}6$ B1

$\frac{r^2\theta}{2} = 36{\cdot}1$ B1

An attempt to eliminate θ M1

$\frac{r}{2} = \frac{36{\cdot}1}{7{\cdot}6} \Rightarrow r = 9{\cdot}5$ A1

$\theta = \frac{7{\cdot}6}{9{\cdot}5} \Rightarrow \theta = 0{\cdot}8$ (f.t. candidate's value for r) A1