1. (*a*)

1	0·301029995		
1·5	0·544068044		
2	0·698970004		
2·5	0·812913356		
3	0·903089987	(5 values correct)	B2

(**If B2 not awarded**, award B1 for either 3 or 4 values correct)

Correct formula with $h = 0·5$ M1

$$I \approx \frac{0·5}{2} \times \{0·301029995 + 0·903089987 + 2(0·544068044 + 0·698970004 + 0·812913356)\}$$

$I \approx 5·31602279 \times 0·5 \div 2$

$I \approx 1·329005698$

$I \approx 1·329$ (f.t. one slip) A1

Note: Answer only with no working earns 0 marks

Special case for candidates who put $h = 0·4$

1	0·301029995		
1·4	0·505149978		
1·8	0·643452676		
2·2	0·748188027		
2·6	0·832508912		
3	0·903089987	(all values correct)	B1

Correct formula with $h = 0·4$ M1

$$I \approx \frac{0·4}{2} \times \{0·301029995 + 0·903089987 + 2(0·505149978 + 0·643452676 + 0·748188027 + 0·832508912))$$

$I \approx 6·662719168 \times 0·4 \div 2$

$I \approx 1·332543834$

$I \approx 1·333$ (f.t. one slip) A1

Note: Answer only with no working earns 0 marks

(*b*) $\int_1^3 \log_{10}(3x-1)^2\,dx \approx 2·658$ (f.t. candidate's answer to (*a*)) B1

2. (*a*) $4\cos^2\theta + 1 = 4(1 - \cos^2\theta) - 2\cos\theta$

(correct use of $\sin^2\theta = 1 - \cos^2\theta$) M1

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

$8\cos^2\theta + 2\cos\theta - 3 = 0 \Rightarrow (2\cos\theta - 1)(4\cos\theta + 3) = 0$

$\Rightarrow \cos\theta = \frac{1}{2}$, $\cos\theta = -\frac{3}{4}$ (c.a.o.) A1

$\theta = 60°, 300°$ B1

$\theta = 138{\cdot}59°, 221{\cdot}41°$ B1 B1

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

(*b*) $\alpha + 40° = 45°, 135°, \Rightarrow \alpha = 5°, 95°$ (at least one value of α) B1

$\alpha - 35° = 60°, 120°, \Rightarrow \alpha = 95°, 155°$ (at least one value of α) B1

$\alpha = 95°$ (c.a.o.) B1

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

$\tan\phi = \frac{10}{7}$ A1

$\phi = 55°, 235°$ (f.t $\tan\phi = a$) B1

3. (*a*) $\frac{y}{^4/_5} = \frac{x}{^8/_{17}}$ (o.e.) (correct use of sine rule) M1

$y = 1{\cdot}7x$ (convincing) A1

(*b*) $10{\cdot}5^2 = x^2 + y^2 - 2 \times x \times y \times (^{-13}/_{85})$

(correct use of the cosine rule) M1

Substituting $1{\cdot}7x$ for y in candidate's equation of form

$10{\cdot}5^2 = x^2 + y^2 \pm 2 \times x \times y \times {^{13}/_{85}}$ M1

$10{\cdot}5^2 = x^2 + 2{\cdot}89x^2 + 0{\cdot}52x^2$ (o.e.) A1

$x = 5$

(f.t. candidate's equation for x^2 provided both M's awarded) A1

4. (*a*) $S_n = a + [a + d] + \ldots + [a + (n-1)d]$

(at least 3 terms, one at each end) B1

$S_n = [a + (n-1)d] + [a + (n-2)d] + \ldots + a$

In order to make further progress, the two expressions for S_n must contain at least three pairs of terms, including the first pair, the last pair and one other pair of terms

Either:

$2S_n = [a + a + (n-1)d] + [a + a + (n-1)d] + \ldots + [a + a + (n-1)d]$

Or:

$2S_n = [a + a + (n-1)d]$ n times M1

$2S_n = n[2a + (n-1)d]$

$S_n = \frac{n}{2}[2a + (n-1)d]$ (convincing) A1

(*b*) $\frac{n}{2}[2 \times 3 + (n-1) \times 2] = 360$ M1

Rewriting above equation in a form ready to be solved

$2n^2 + 4n - 720 = 0$ or $n^2 + 2n - 360 = 0$ or $n(n + 2) = 360$ A1

$n = 18$ (c.a.o.) A1

(*c*) $a + 9d = 7 \times (a + 2d)$ B1

$a + 7d + a + 8d = 80$ B1

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

$a = -5$, $d = 6$ (both values) (c.a.o.) A1

5. (*a*) $ar + ar^2 = -216$ B1

$ar^4 + ar^5 = 8$ B1

A correct method for solving the candidate's equations simultaneously

e,g multiplying the first equation by r^3 and subtracting

or eliminating a and $(1 + r)$ M1

$-216r^3 = 8$ (o.e.) A1

$r = -{}^1/_3$ (convincing) A1

(*b*) $a \times (-{}^1/_3) \times (1 - {}^1/_3) = -216 \Rightarrow a = 972$ B1

$S_\infty = \frac{972}{1 - (-{}^1/_3)}$ (correct use of formula for S_∞, f.t. candidate's derived value for a) M1

$S_\infty = 729$ (f.t. candidate's derived value for a) A1

6. (*a*) $5 \times \dfrac{x^{1/4}}{1/4} - 7 \times \dfrac{x^{3/2}}{3/2} + c$ B1, B1

(–1 if no constant term present)

(*b*) (i) $16 - x^2 = x + 10$ 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

$(x - 2)(x + 3) = 0 \Rightarrow x = 2, -3$ (both values, c.a.o.) A1

$y = 12, y = 7$ (both values, f.t. candidate's x-values) A1

(ii) Use of integration to find the area under the curve M1

$\int 16\,dx = 16x$, $\int x^2\,dx = (1/3)x^3$, (correct integration) B1

Correct method of substitution of candidate's limits m1

$[16x - (1/3)x^3]_{-3}^{2} = (32 - 8/3) - (-48 - (-9)) = 205/3$

Use of a correct method to find the area of the trapezium (f.t. candidate's coordinates for A, B) M1

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

Shaded area = 205/3 – 95/2 = 125/6 (c.a.o.) A1

7. (*a*) **Either:**

$(5x/4 - 2)\log_{10}3 = \log_{10}7$

(taking logs on both sides and using the power law) M1

$\dfrac{5x}{4} = \dfrac{(\log_{10}7 + 2\log_{10}3)}{\log_{10}3}$ A1

$x = 3{\cdot}017$ (f.t. one slip, see below) A1

Or:

$5x/4 - 2 = \log_3 7$ (rewriting as a log equation) M1

$5x/4 = \log_3 7 + 2$ A1

$x = 3{\cdot}017$ (f.t. one slip, see below) A1

Note: an answer of $x = -0{\cdot}183$ from $\dfrac{5x}{4} = \dfrac{(\log_{10}7 - 2\log_{10}3)}{\log_{10}3}$

earns M1 A0 A1

an answer of $x = 0{\cdot}183$ from $\dfrac{5x}{4} = \dfrac{(2\log_{10}3 - \log_{10}7)}{\log_{10}3}$

earns M1 A0 A1

Note: Answer only with no working earns 0 marks

(*b*) (i) $b = a^5$ (relationship between log and power) B1

(ii) $a = b^{1/5}$ (the laws of indices) B1

$\log_b a = 1/5$ (relationship between log and power) B1

8. (*a*) (i) A correct method for finding the length of *AB* M1

$AB = 20$ A1

Sum of radii = distance between centres,

$\therefore$ circles touch A1

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

Gradient $AP = \frac{9-5}{-2-1} = -\frac{4}{3}$ (o.e) A1

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

Equation of common tangent is:

$y - 5 = \frac{3}{4}(x - 1)$ (o.e)

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

(*b*) **Either:**

An attempt to rewrite the equation of *C* with l.h.s. in the form

$(x - a)^2 + (y - b)^2$ M1

$(x + 2)^2 + (y - 3)^2 = -7$ A1

Impossible, since r.h.s. must be positive ($= r^2$) A1

Or:

$g = 2$, $f = -3$, $c = 20$ and an attempt to use $r^2 = g^2 + f^2 - c$ M1

$r^2 = -7$ A1

Impossible, since r^2 must be positive A1

9. (*a*) (i) Area of sector $POQ = \frac{1}{2} \times r^2 \times 0{\cdot}9$ B1

(ii) Length of $PS = r \times \tan(0{\cdot}9)$ B1

(iii) Area of triangle $POS = \frac{1}{2} \times r \times r \times \tan(0{\cdot}9)$

(f.t. candidate's expression in *r* for the length of *PS*) B1

(*b*) $\frac{1}{2} \times r \times r \times \tan(0{\cdot}9) - \frac{1}{2} \times r^2 \times 0{\cdot}9 = 95{\cdot}22$

(f.t. candidate's expressions for area of sector and area of triangle, at least one correct) M1

$r^2 = \frac{2 \times 95{\cdot}22}{(1{\cdot}26 - 0{\cdot}9)}$ (o.e.) (c.a.o.) A1

$r = 23$ (f.t. one numerical slip) A1