1. $(2 + x)^6 = 64 \ldots$ B1

$(6 \times 2^5 \times x) + \left(\frac{6 \times 5}{2} \times 2^4 \times x^2\right)$, $+192x$, $+240x^2$ M1,A1,A1 4

The terms can be 'listed' rather than added.

M1: Requires correct structure: 'binomial coefficients' (perhaps from Pascal's triangle), increasing powers of one term, decreasing powers of the other term (this may be 1 if factor 2 has been taken out). Allow 'slips'.

$\binom{6}{1}$ *and* $\binom{6}{2}$ *or equivalent are acceptable,*

or even $\left(\frac{6}{1}\right)$ *and* $\left(\frac{6}{2}\right)$.

<u>Decreasing powers of x:</u>

Can score only the M mark.

64(1 +……), even if all terms in the bracket are correct, scores max. B1M1A0A0.

[4

2. $\int \left(3x^2 + 5 + 4x^{-2}\right) dx = \frac{3x^3}{3} + 5x + \frac{4x^{-1}}{-1}$ $(= x^3 + 5x - 4x^{-1})$ M1 A1 A1

$\left[x^3\ 5x - 4x^{-1}\right]_1^2 = (8 + 10 - 2) - (1 + 5 - 4), = 14$ M1, A1 5

<u>Integration:</u>

Accept any correct version, simplified or not.

All 3 terms correct: M1 A1 A1,
Two terms correct: M1 A1 A0,
One power correct: M1 A0 A0.

The <u>given</u> function must be integrated to score M1, and not e.g. $3x^4 + 5x^2 + 4$.

<u>Limits:</u>

M1: Substituting 2 and 1 into a 'changed function' and subtracting, either way round.

[5]

3. (i) 2 B1 1

(ii) $2\log 3 = \log 3^2$ (or $2\log p = \log p^2$) B1

$\log_a p + = \log_a 11 = \log_a 11p = \log_a 99$ (Allow e.g. $\log_a(3^2 \times 11)$) M1,A1 3

Ignore 'missing base' or wrong base.
The correct answer with no working scores full marks
$\log_a 9 \times \log_a 11 = \log_a 99$, or similar mistakes, score M0 A0.

[4]

4. (a) $f(-2) = 2(-2)^3 + 3(-2)^2 - 29(-2) - 60$ M: Attempt f(2) or f(–2) M1

$= -16 + 12 + 58 - 60 = -6$ A1 2

<u>Alternative (long division)</u>:

Divide by $(x + 2)$ to get $(2x^2 + ax + b)$, $a \neq 0$, $b \neq 0$. *[M1]*

$(2x^2 - x - 27)$, remainder $= -6$ *[A1]*

(b) $f(-3) = 2(-3)^3 + 3(-3)^2 - 29(-3) - 60$ M: Attempt f(3) or f(–3) M1

$(= -54 + 27 + 87 - 60) = 0 \therefore (x + 3)$ is a factor A1 2

A1 requires zero and a simple conclusion (even just a tick, or Q.E.D.).

(c) $(x + 3)(2x^2 - 3x - 20)$ M1 A1

$= (x + 3)(2x + 5)(x - 4)$ M1 A1 4

First M requires division by $(x + 3)$ to get $(2x^2 + ax + b)$, $a \neq 0$, $b \neq 0$.
Second M for the attempt to factorise their quadratic.
Usual rule: $(2x^2 + ax + b) = (2x + c)(x + d)$, where $|cd| = |b|$.

<u>Alternative (first 2 marks):</u>

$(x + 3)(2x^2 + ax + b) = 2x^3 + (6 + a)x^2 + (3a + b)x + 3b = 0$, then compare coefficients to find <u>values</u> of a and b. *[M1]*
$a = -3$, $b = -20$ *[A1]*

Alternative:

Factor theorem:

Finding that $f\left(-\frac{5}{2}\right)=0$

$\therefore$ *factor is, (2x + 5)* *[M1, A1]*

Finding that f (4) = 0

$\therefore$ *factor is, (x −4)* *[M1, A1]*

"Combining" all 3 factors is *not* *required.*

If just one of these is found, score the first 2 marks M1 A1 M0 A0.

Losing a factor of 2:

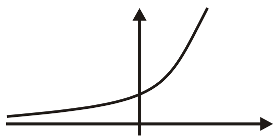
(x + 3) $\left(x+\frac{5}{2}\right)(x-4)$ *scores M1 A1 M1 A0.*

Answer only, one sign wrong:

e.g. (x + 3)(2x −5)(x −4) scores M1 A1 M1 A0.

[8]

5. (a)



Shape	B1	
(0, 1), or just 1 on the y-axis, or seen in table for (b)	B1	2

Beware the order of marks!

Must be a curve (not a straight line).

Curve must extend to the left of the y-axis, and must be increasing.

Curve can 'touch' the x-axis, but must not go below it.

Otherwise, be generous in cases of doubt.

The B1 for (0, 1) is independent of the sketch.

(b)	Missing values:	1.933, 2.408	(Accept awrt)	B1, B1	2

(c) $\frac{1}{2} \times 0.2, \{(1+3)+2(1.246+1.552+1.933+2.408)\}$ B1, M1 A1ft

= 1.8828 (awrt 1.83) A1 4

Beware the order of marks!

Bracketing mistake:

i.e. $\frac{1}{2} \times 0.2(1+3)+2(1.246+1.552+1.993+2.408)$

scores B1 M1 A0 A0 unless the final answer implies that the calculation has been done correctly (then full marks can be given).

[8]

6. (a) $\tan\theta = 5$ B1 1

Must be seen explicitly, e.g. $\tan\theta = \tan^{-1} 5 = 78.7$ *or equiv. is B0, unless* $\tan\theta = 5$ *is also seen.*

(b) $\tan\theta = k$ $(\theta = \tan^{-1} k)$ M1

$\theta = 78.7$, 258.7 (Accept awrt) A1, A1ft 3

The M mark may be implied by working in (a).

A1ft for $180 + \alpha$. $(a \neq k)$.

Answers in radians would lose both the A marks.

Extra answers between 0 and 360: Deduct the final mark.

Alternative:

Using $\cos^2\theta = 1 - \sin^2\theta$ *(or equiv.) and proceeding to* $\sin\theta = k$ *(or equiv.): M1 then A marks as in main scheme.*

[4]

7. (a) Gradient of PQ is $-\frac{1}{3}$ B1

$y - 2 = -\frac{1}{3}(x-2)$ $(3y + x = 8)$ M1 A1 3

M1: eqn. of a straight line through (2, 2) with any gradient except 3, 0 or ∞.

Alternative: Using (2, 2) in $y = mx + c$ *to find a value of c scores M1, but an equation (general or specific) must be seen.*

If the given value $x = 5$ *is used to find the gradient of PQ, maximum marks are (a) B0 M1 A1 (b) B0.*

(b) $y = 1$: $3 + x = 8$ $x = 5$ B1 1

(c) $(\text{“}5\text{”} - 2)^2 + (1-2)^2$ M: Attempt PQ^2 or PQ M1 A1

		$(x-5)^2 + (y-1)^2 = 10$	M: $(x \pm a)^2 + (y \pm b)^2 = k$	M1 A1	4

For the first M1, condone one slip, numerical or sign, inside a bracket.

The first M1 can be scored if their x-coord. is used instead of 5.

For the second M1, allow any equation in this form, with non-zero a, b and k.

[8]

8. (a) $r\theta = 2.12 \times 0.65$ 1.38 (m) M1 A1 2

M1: Use of $r\theta$ with r = 2.12 or 1.86, and θ = 0.65, or equiv. method for the angle changed to degrees (allow awrt 37°).

(b) $\frac{1}{2}r^2\theta = \frac{1}{2} \times 2.12^2 \times 0.65$ 1.46 (m^2) M1 A1 2

M1: Use of $\frac{1}{2}r^2\theta$ with r = 2.12 or 1.86,

and θ = 0.65, or equiv.

method for the angle changed to degrees (allow awrt 37°).

(c) $\frac{\pi}{2} - 0.65$ 0.92 (radians) (α) M1 A1 2

M1: Subtracting 0.65 from $\frac{\pi}{2}$, or subtracting awrt 37 from 90 (degrees), (perhaps implied by awrt 53).

Angle changed to degrees wrongly and used throughout (a), (b) and (c):

Penalise 'method' only once, so could score M0A0, M1 A0, M1 A0.

(d) ΔACD: $\frac{1}{2}(2.12)(1.86)\ \sin\alpha$ (With the value of α from part (c)) M1

Area = "1.46" + "1.57", 3.03 (m^2) M1 A1 3

First M1: Other area methods must be fully correct.

Second M1: Adding answer to (b) to their ΔACD.

Failure to round to 2 d.p:

Penalise only once, on the first occurrence, then accept awrt.

If 0.65 is taken as degrees throughout:

Only award marks in part (d).

[9]

9. (a) $ar = 4$, $\frac{a}{1-r} = 25$ (These can be seen elsewhere) B1, B1

$a = 25(1-r)$ $25r(1-r) = 4$ M: Eliminate a M1

$25r^2 - 25r + 4 = 0$ A1cso 4

The M mark is not dependent, but both expressions must contain both a and r.

(b) $(5r - 1)(5r - 4) = 0$ $r = \ldots,$ $\frac{1}{5}$ or $\frac{4}{5}$ M1,A1 2

Special case:

One correct r value given, with no method (or perhaps trial and error): B1 B0.

(c) $r = \ldots \Rightarrow a = \ldots,$ 20 or 5 M1,A1 2

M1: Substitute one r value back to find a value of a.

(d) $S_n = \frac{a(1-r^n)}{1-r}$, but $\frac{a}{1-r} = 25$, so $S_n = 25(1 - r^n)$ B1 1

Sufficient here to verify with just one pair of values of a and r.

(e) $25(1 - 0.8^n) > 24$ and proceed to $n = ..$ (or >, or <) with no unsound algebra. M1

$\left(n > \frac{\log 0.04}{\log 0.8} (=14.425)\right)$ $n = 15$ A1 2

Accept "=" rather than inequalities throughout, and also allow the wrong inequality to be used at any stage.

M1 requires use of their larger value of r.

A correct answer with no working scores both marks.

For "trial and error" methods, to score M1, a value of n between 12 and 18 (inclusive) must be tried.

[11]

10. (a) $\frac{dy}{dx} = 3x^2 - 16x + 20$ M1 A1

$3x^2 - 16x + 20 = 0$ $(3x - 10)(x - 2) = 0$ $x = \ldots,$ $\frac{10}{3}$ and 2 dM1 A1 4

The second M is dependent on the first, and requires an attempt to solve a 3 term quadratic.

(b) $\frac{d^2y}{dx^2} = 6x - 16$ At $x = 2$, $\frac{d^2y}{dx^2} = \ldots$ M1

-4 (or < 0, or both), therefore maximum A1ft 2

M1: Attempt second differentiation and substitution of one of the x values.

A1ft: Requires correct second derivative and negative value of the second derivative, but ft from their x value.

(c) $\int (x^3 - 8x^2 + 20x)\mathrm{d}x = \frac{x^4}{4} - \frac{8x^3}{3} + \frac{20x^2}{2} (+C)$ M1 A1 A1 3

All 3 terms correct: M1 A1 A1,

Two terms correct: M1 A1 A0,

One power correct: M1 A0 A0.

(d) $4 - \frac{64}{3} + 40$ $\left(= \frac{68}{3}\right)$ M1

A: $x = 2$: $y = 8 - 32 + 40 = 16$ (May be scored elsewhere) B1

Area of Δ = $\frac{1}{2}\left(\frac{10}{3} - 2\right) \times 16$ $\left(\frac{1}{2}(x_B - x_A) \times y_A\right)$ $\left(= \frac{32}{3}\right)$ M1

Shaded area = $\frac{68}{3} + \frac{32}{3} = \frac{100}{3}$ $\left(= 33\frac{1}{3}\right)$ M1 A1 5

Limits M1: Substituting their lower x value into a 'changed' expression.

Area of triangle M1: Fully correct method.

Alternative for the triangle (finding an equation for the straight line then integrating) requires a fully correct method to score the M mark.

Final M1: Fully correct method (beware valid alternatives!)

[14]