Question Number	Scheme	Marks
1. (a)	$p^{\frac{1}{2}} = \left(\frac{1}{16}x^4\right)^{\frac{1}{2}} = \frac{1}{4}x^2$	B1
		(1)
(b)	$(pq)^{-1} = \left(\frac{1}{16}x^4 \times \frac{40}{x^3}\right)^{-1} = \left(\frac{5}{2}x\right)^{-1} = \frac{2}{5}x^{-1}$	M1, A1
		(2)
(c)	$p\,q^2 = \frac{1}{16}x^4 \times \left(\frac{40}{x^3}\right)^2 = \frac{1600}{16} \times \frac{x^4}{x^6} = 100x^{-2}$	M1, A1
		(2)
		(5 marks)

(a)

B1: For $\frac{1}{4}x^2$. Allow $\frac{x^2}{4}$ or $0.25\,x^2$ Condone $\pm\frac{1}{4}x^2$

Note: **final** answer below for (b) and (c) does not include going on to give alternative correct forms for the same answer. If further incorrect work follows a correct answer then do not isw but take the final expression as their answer.

(b)

M1: A **final** answer with a correct simplified coefficient or index. E.g $\frac{2}{5}x^n$, $0.4x^n$, kx^{-1} or $\frac{k}{x^1}$ (or equivalent variations) Also allow $(kx)^{-1}$

A1: A **final** answer of $\frac{2}{5}x^{-1}$ or $0.4\,x^{-1}$ but isw $\frac{2}{5x}$ following this. Incorrect "simplifications" will be A0, though.

(c)

M1: A **final** answer with a correct simplified coefficient or index. E.g $100x^n$, kx^{-2} or $\frac{k}{x^2}$

A1: A **final** answer of $100x^{-2}$ but isw $\frac{100}{x^2}$ following this. Incorrect "simplifications" will be A0, though.

Question Number	Scheme	Marks
	$y = 2x^{\frac{5}{2}} - 4x + 3$	
2. (a)	$\left\{\frac{dy}{dx} =\right\} 5x^{\frac{3}{2}} - 4$	M1, A1
		(2)
(b)	$5x^{\frac{3}{2}} - 4 = 16 \Rightarrow x^{\frac{3}{2}} = 4$	M1, A1
	$\Rightarrow x = 4^{\frac{2}{3}} = 2^{\frac{4}{3}} \qquad \Rightarrow k = \frac{4}{3}$	A1
		(3)
		(5 marks)

Note: Allow benefit of doubt if some fractional indices look like they are inline but it is clear that powers are intended.

(a)

M1: For decreasing a correct power by one including $3 \to 0$

A1: For $5x^{\frac{3}{2}} - 4$

(b)

M1: Sets their $\frac{dy}{dx} = \alpha x^{\frac{3}{2}} + \beta = 16$ and proceeds to $x^{\frac{3}{2}} = \delta$ or $\frac{dy}{dx} = \alpha\left(2^k\right)^{\frac{3}{2}} + \beta = 16$ and proceeds with correct index work to $\left(2^k\right)^{\frac{3}{2}} = q$ or $2^{pk} = q$ (oe)

A1: Achieves $x^{\frac{3}{2}} = 4$ or $\left(2^k\right)^{\frac{3}{2}} = 4$ or $2^{3k} = 16$ (oe in form $2^{pk} = q$)

A1: $k = \frac{4}{3}$ (oe) but accept $x = 2^{\frac{4}{3}}$ as long as no incorrect statement for k follows. Note if a decimal is given it must be recurring, not rounded.

They may use logs to solve, do not be concerned about use of rounded values in working. If $x^{\frac{3}{2}} = 4$ is achieved and they reach $k = \frac{4}{3}$ from log work even with incorrect rounding shown, assume full calculator accuracy was kept in working and award the mark.

Question Number	Scheme	Marks
3.	$\int \frac{(x+3)^2}{3\sqrt{x}}\,dx$	
	$\frac{(x+3)^2}{3\sqrt{x}} = \frac{x^2+6x+9}{3\sqrt{x}} = \frac{1}{3}x^{\frac{3}{2}} + 2x^{\frac{1}{2}} + 3x^{-\frac{1}{2}}$	M1
	$\int \frac{(x+3)^2}{3\sqrt{x}}\,dx = \frac{1}{3}\times\frac{2}{5}x^{\frac{5}{2}} + 2\times\frac{2}{3}x^{\frac{3}{2}} + 3\times\frac{2}{1}x^{\frac{1}{2}} + c$	dM1
	$= \frac{2}{15}x^{\frac{5}{2}} + \frac{4}{3}x^{\frac{3}{2}} + 6x^{\frac{1}{2}} + c$	A1, A1, A1
		(5)
		(5 marks)

M1: For an attempt to multiply out the numerator and divide at least two terms by the denominator with at least one power correct. Allow if there are only two terms from squaring.

dM1: For correctly achieving two correct powers following integration (need not be simplified).

A1: Previous dM must have been gained (so two correct powers after integrating), at least **one** correct algebraic term, allow unsimplified. E,g, allow $\frac{\frac{1}{3}}{\frac{5}{2}}x^{\frac{5}{2}}$ Allow $\frac{1}{3}(...)$ with one correct term inside the bracket.

A1: Two correct **simplified** algebraic terms. May have the $\frac{1}{3}$ factored out.

A1: Fully correct and simplified including the + c, accepting equivalent simplified forms. Ignore spurious extra integral signs or dx's if they have the correct expression. May have the $\frac{1}{3}$ factored out. ISW if they multiply through their answer by a constant after the integration.

Note: If you see attempts at parts or substitution that look worthy of merit then send to review.

Question Number	Scheme	Marks
4. (a)	$(270°, 0)$	B1
		(1)
(b)	$(-180°, -4)$	B1, B1
		(2)
(c)(i)	100	B1
(ii)	4	B1
(iii)	7	B1
		(3)
		(6 marks)

Note: Watch for answers next to the question itself rather than in line. If different answers are given next to a question and in the answer space then score the response in the answer space.

(a)
B1: $(270°, 0)$ but allow $x = 270,\ y = 0$ (degrees symbol may be missing) Just 270 without reference to coordinates is B0. Condone missing brackets, but the order must be correct.
(b)
B1: Either $(-180°, y)$ or $(x, -4)$ and allow if coordinates are the wrong way round for this mark, but they must be giving a coordinate pair. E.g. just -4 on its own is B0, but $(-4, p)$ or $(q, -180°)$ can score B1.
SC: Allow $(-\pi, y)$ (if y is incorrect – they will score B1 regardless of if y is correct).
B1: $(-180°, -4)$ but allow $x = -180,\ y = -4$
(degrees symbol may be missing). Condone missing brackets, but the order must be correct.

(c)
B1: 100
B1: 4
B1: 7
Note : if there is no labelling for (i),(ii) and (iii) then score in the order listed.

Question Number	Scheme	Marks
	$x-2y+25=0$	
5. (a)	$y=\frac{1}{2}x+\frac{25}{2} \Rightarrow y=-2x+...$	M1
	$y=-2x$	A1
		(2)
(b)	Substitutes $y=-2x$ into $x-2y+25=0 \Rightarrow x+4x+25=0$	M1
	$\Rightarrow x=-5,\ y=10$	A1, A1
		(3)
(c)	Shortest distance = $\sqrt{5^2+10^2}=5\sqrt{5}$	M1, A1cso
		(2)
		(7 marks)

(a)

M1: Attempts the normal gradient. E.g. writes $x-2y+25=0$ in the form $y=px+q$ AND changes the gradient (need not be correctly changed). Alternatively, may switch the x and y coordinates and change a sign – e.g. perpendicular line is $2x+y+k=0$. Another approach is to find the gradient of l_1 by identifying two points on the line and attempting the gradient (must be change in y over change in x) between these two points.
May be implied by the correct answer.

A1: $y=-2x$ o.e. Score for the correct answer even if an incorrect "q" was seen.

(b)

M1: Attempts to solve their $y=-2x$ (must be of form kx) with $x-2y+25=0$ (or their rearrangement of this).
Score for setting up an equation in a single variable.

A1: $x=-5$ OR $y=10$ from correct work.

A1: Both $x=-5,\ y=10$ from correct work

(c)

M1: Attempts to use Pythagoras theorem to find the distance or distance squared between (0, 0) and their $(-5,10)$ or other full method to find the shortest distance.

A1cso: $5\sqrt{5}$ Must be simplified surd form. Must have come from correct coordinates in (b).

Question Number	Scheme	Marks
6 (a)	$\frac{\sin CAO}{17} = \frac{\sin 0.6}{15} \Rightarrow CAO = 0.6944...$	M1
	Angle $COA = \pi - 0.6 - "0.6944" = 1.847$ *	dM1, A1*
		(3)
(b)	Attempts $\frac{1}{2}r^2\theta = \frac{1}{2}\times 15^2 \times \theta$ where $\theta = \left(2\pi - 1.847\right)$ or just 1.847 OR attempts $\frac{1}{2}ab\sin C = \frac{1}{2}\times 15\times 17\sin\left(1.847\right)$	M1
	Attempts $\frac{1}{2}r^2\theta = \frac{1}{2}\times 15^2 \times\left(2\pi - 1.847\right)\left(\approx 499\right)$ AND $\frac{1}{2}ab\sin C = \frac{1}{2}\times 15\times 17\sin\left(1.847\right)\left(\approx 122.7\right)$ AND adds	dM1
	(awrt) 622 m^2	A1
		(3)
(c)	$r\theta = 15\times\theta$ where $\theta = \left(2\pi - 1.847\right)$ or just 1.847 OR $\left(AC^2 =\right)15^2 + 17^2 - 2\times 15\times 17\cos\left(1.847\right)\left(\approx 653\right)$	M1
	Attempts $r\theta = 15\times\left(2\pi - 1.847\right)\left(= 66.54\right)$ AND $\left\{AC =\right\}\sqrt{15^2 + 17^2 - 2\times 15\times 17\cos\left(1.847\right)}$	dM1
	92.1 + 2 = (awrt) 94.1 m	A1
		(3)
		(9 marks)

Note: Work must be completed in the appropriate parts to gain credit, but if no labelling is given, apply benefit of doubt that area work is for (b) and perimeter work is for (c).

(a)

M1: Writes down a correct sine rule and attempts to find angle *CAO*. Alternatively, writes down a correct cosine rule and attempts to find *AC* :

$$15^2 = 17^2 + AC^2 - 2\times 17\times AC\cos 0.6 \Rightarrow AC = \frac{34\cos 0.6 \pm \sqrt{(34\cos 0.6)^2 - 4\times 64}}{2} = ...$$

Allow if degrees mode is used. Here angle *CAO* = 0.680

Watch for cases where the inverse sine is not taken, which give 0.6399. These will score M0dM0A0.

dM1: Full method to find angle *COA*. As scheme or in the Alt they may proceed to use the sine rule with their *AC* (note they should get 1.293… from this method).

A1*: Complete and correct proof. In the Alt the selection of the positive root must be justified (from diagram angle *COA* is obtuse so…) and justification of the correct angle seen (ie $\pi - 1.293...$ before the 1.847…). Allow as long as all values are to at least 3dp throughout (if seen).

There may be attempts via verification. Allow

M1: For a correct attempt at the sine (or cosine) rule as a part of their check.

dM1: For a full process to check the angle, e.g.

$$\text{angle } CAO = \pi - 0.6 - 1.847 = 0.69459... \Rightarrow \angle ACO = \arcsin\left(\frac{15\sin 0.69459...}{17}\right) = 0.600 \ \checkmark$$

A1*: If all is correct with a minimal conclusion.

Note: for (b) and (c) if they use their 1.847 rather than the given value in the question, allow the M's for correct method with their value.

(b)

M1: Correct attempt at one relevant area, allowing the minor sector as relevant. See scheme.

dM1: Complete method to find both areas and adds.

A1: Awrt 622 m^2 including the units

(c)

M1: Attempts major or minor arc length *AB* OR length *AC* or its square, e.g. $r\theta = 15\times\theta$ where $\theta = (2\pi - 1.847)$ or just 1.847 OR attempts $15^2 + 17^2 - 2\times 15\times 17\cos(1.847)$ condoning if it is called *AC*.

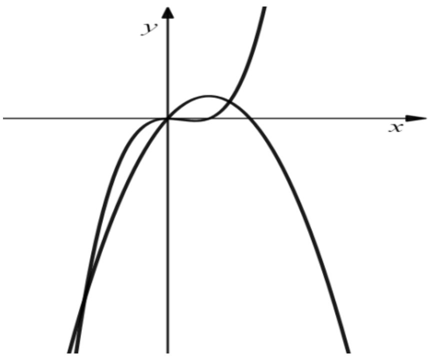
There may be alternative approaches to these (e.g. sine rule $AC = \frac{15\sin 1.847}{\sin 0.6}$).

For each approach allow if correct formula is quoted but they subsequently forget to apply the cosine or sine to the angle.

dM1: Attempts both major arc length and length *AC* ie $r\theta = 15\times(2\pi - 1.847)$ AND

$AC = \sqrt{15^2 + 17^2 - 2\times 15\times 17\cos(1.847)}$ or equivalent approaches. Must correctly apply the trig ratios for this mark.

A1: Awrt 94.1 m. Should include units unless the A mark in (b) was penalised only for lack of units (ie penalise only the first instance of incorrect or missing units).

Question Number	Scheme	Marks
7 (a)	States or implies that $f(x) = \lambda x^2(x-4)$	M1
	Attempts to find λ. E.g. $120 = \lambda 10^2(10-4) \Rightarrow \lambda = ...$	dM1
	$\{f(x) =\} 0.2x^2(x-4)$	A1
		(3)
(b)	 "Upside down" parabola	M1
	Passing through O and +ve x axis > 4	A1
		(2)
(c)	Sets $1.2x(8-x) =$ their $0.2x^2(x-4)$	B1ft
	$1.2x(8-x) = 0.2x^2(x-4) \Rightarrow x\left(x^2+2x-48\right) = 0$ or $\Rightarrow x^3+2x^2-48x = 0$	M1
	$\Rightarrow x = ...,...(,0)$	dM1
	For $x = -8, 0, 6$ OR one of $(-8,-153.6),(6,14.4)$	A1
	All of $(-8,-153.6),(6,14.4),(0,0)$ $\left\{\left(-8,-\frac{768}{5}\right),\left(6,\frac{72}{5}\right),(0,0)\right\}$	A1
		(5)
		(10 marks)

(a)

M1: States or implies that $f(x) = \lambda x^2(x-4)$. Allow with λ = 1 (or any other constant). Credited when first seen, but must use this expression to access the dM mark.

dM1: Attempts to find λ. E.g. $120 = \lambda 10^2(10-4) \Rightarrow \lambda = ...$

A1: $\{f(x) =\} 0.2x^2(x-4)$ o.e. Allow with $(x-0)^2$

Alt: May see attempts at using $f(x) = ax^3 + bx^2 + cx + d$

M1: States or implies $f(x) = ax^3 + bx^2 + cx + d$ AND uses (0,0) on curve to deduce $d = 0$

dM1: Full method to find the remaining constants, so $f'(0) = 0 \Rightarrow c = 0$ and

$f(4) = 0 \Rightarrow 64a + 16b = 0 \Rightarrow b = -4a$ then $f(10) = 120 \Rightarrow 1000a + 100b = 120 \Rightarrow 50a + 5b = 6 \Rightarrow a = ..., b = ...$

They must set up sufficient equations to be able to solve for all the constants.

A1: For $f(x) = 0.2x^3 - 0.8x^2$ o.e.

Note, do not be concerned if the f(x) = … is missing, mark the expression.

(b)

Note: If there are multiple attempts with no clearly designated answer, Diagram 1 takes precedence if not crossed out. If Diagram 1 is not used, or is crossed out and no clear statement of answer is given, then an answer in the answer space takes precedence over an answer on Figure 3.

M1: Correct shape, a $\cap$ shape parabola in any position. Be tolerant with the shape, must at least touch the *x*-axis.

A1: Correct shape and position, a $\cap$ shape parabola passing through *O* and the +ve *x* axis to the right hand side of $x = 4$. The graph must **clearly** extend into quadrants 3 and 4, not stop at the *x*-axis.
Ignore any coordinates on the graph, and don't be concerned if the intersection in quadrant 3 is not shown.

(c)

B1ft: Sets $1.2x(8-x) = \text{their } 0.2x^2(x-4)$. It is for a "correct" ft equation on their part (a) as long as their answer to part (a) is a cubic expression.

M1: Valid attempt to solve an equation of the form $1.2x(8-x) = \text{cubic}$ with their cubic (and their quadratic $1.2x(8-x)$ if they incorrectly try to simplify this) to reach at least a gathered cubic with no constant, or a quadratic in *x*. The *x* may be cancelled, e.g $1.2x(8-x) = 0.2x^2(x-4) \Rightarrow$ Quadratic equation in *x*. Do not allow solutions which reach a cubic with non-zero constant and simply state answers from a calculator. This is for progressing via algebra to a point at which a quadratic (possibly tacit in a cubic with no constant) can be identified.

dM1: Attempts to solve the resulting (possibly tacit) 3 term quadratic equation, usual rules. Allow solutions from calculator as long as a quadratic can be identified in their equation. You may need to check their values (both must be correct).

A1: Either all three *x* coordinates stated as answers (the 0 must be present but may have been given earlier), or one correct coordinate pair from $(-8, -153.6), (6, 14.4)$

A1: All three of $(-8, -153.6), (6, 14.4), (0, 0)$, accept as $x = \ldots, y = \ldots$ for each as long as they are paired correctly. The (0,0) may be stated earlier, so check the whole solution if it is not listed at the end.

Question Number	Scheme	Marks
8 (a) (i)	$x=4, \mathrm{f}'(x)=10,\ \mathrm{f}'(x)=3\sqrt{x}+kx^2 \Rightarrow 10=3\sqrt{4}+4^2k \Rightarrow k=...$	M1
	$10=3\times 2+k\times 16 \Rightarrow k=\frac{1}{4}$ *	A1*
(ii)	$x=4, y=12$ on $y=10x+c \Rightarrow 12=10\times 4+c$	M1
	$\Rightarrow c=-28$	A1
		(4)
(b)	$\mathrm{f}''(x)=\frac{3}{2}x^{-\frac{1}{2}}+\frac{1}{2}x$	M1 A1ft
	$\{\Rightarrow \mathrm{f}''(4)\}=\frac{11}{4}$	A1
		(3)
(c)	$\mathrm{f}(x)=2x^{\frac{3}{2}}+\frac{1}{12}x^3+d$	M1, A1ft
	Uses $P(4,12) \Rightarrow 12=2\times 8+\frac{1}{12}\times 4^3+d \Rightarrow d=...$	dM1
	$\{\mathrm{f}(x)=\}\,2x^{\frac{3}{2}}+\frac{1}{12}x^3-\frac{28}{3}$	A1
		(4) **(11 marks)**

Note: If work is done out of order (e.g. if an attempt to find f(x) is made in part (a) but no attempt is made at (c)) then allow the M1A1 marks for differentiation in (b) and integration in (c) for the work in part (a) as long is it is clear it is an attempt at the correct process. However, e.g. an attempt at integration with a decrease in power should not be awarded the marks for (b).

(a)(i)

M1: Attempts to solve $\mathrm{f}'(4)=10$ to find k. Alternatively, substitutes x =4 and $k=\frac{1}{4}$ into f'(x) and evaluates.

A1*: Shows that $k=\frac{1}{4}$ with a correct intermediate line where powers/roots have been evaluated, and with no incorrect steps. Alternatively, correctly reaches f'(4) = 10 and conclude $k=\frac{1}{4}$

(ii)

M1: Substitutes $x=4, y=12$ in $y=10x+c$

Alternatively, substitutes x = 4, y = 12 and m = 10 into $y-y_1=m(x-x_1)$

A1: Correct value for c which may be embedded in the equation, e.g. $y=10x-28$, as long as no incorrect value for c is subsequently given.

(b)

M1: Differentiates with attempt to decrease power by 1 in each term. This should be to a form $Ax^{-\frac{1}{2}}+Bx$ but allow if a slip in one power has occurred before differentiating.

A1ft: $\frac{3}{2}x^{-\frac{1}{2}}+\frac{1}{2}x$ Allow for $\frac{3}{2}x^{-\frac{1}{2}}+2kx$ without k replaced or follow through their k if they use a different value than the one given. Need not be simplified.

A1: $\{f''(4)=\}\frac{11}{4}$ o.e.

(c)

M1: Integrates with attempt to increase each power by 1. This should be to a form $px^{\frac{3}{2}}+qx^{3}$ but allow if a slip in one power has occurred before integrating. There is no requirement for + *d* for this mark. NB If they try starting from f''(*x*) then ignore any spurious constant term in f'(*x*) for this mark.

A1ft: $f(x)=2x^{\frac{3}{2}}+\frac{1}{12}x^{3}\left(+d\right)$ with no requirement for + *d* for this mark. Allow with *k* for this mark or follow through their value of *k* if they use a different value from the one given. Need not be simplified.

dM1: Substitutes $x=4, y=12$ into $y=f(x)$ to find "*d*". (Must have had a constant of integration but need not be called *d*.) They must be using a value for *k* at this stage.

A1: $\{f(x)=\}2x^{\frac{3}{2}}+\frac{1}{12}x^{3}-\frac{28}{3}$ Allow *y* = ... or just the expression with no f(*x*).

Question Number	Scheme	Marks
9 (a) (i)	Stretch parallel to the x-axis $\times\frac{1}{2}$ or stretch parallel to the y-axis $\times\sqrt{2}$	M1, A1
(ii)	Translate by the vector $\begin{pmatrix}0\\12\end{pmatrix}$ (or translate up by 12 (units))	M1, A1
		(4)
(b) (i)	$12-\sqrt{x}=\sqrt{2}\sqrt{x}$ $12=\left(\sqrt{2}+1\right)\sqrt{x}$	M1
	$\Rightarrow\sqrt{x}=\frac{12}{\sqrt{2}+1}\times\frac{\sqrt{2}-1}{\sqrt{2}-1}=12\left(\sqrt{2}-1\right)$ *	dM1, A1 *
Alt (i)	$12-\sqrt{x}=\sqrt{2x}\Rightarrow\left(12-\sqrt{x}\right)^2=2x\Rightarrow x+24\sqrt{x}-144=0$	M1
	$\Rightarrow\left(\sqrt{x}\right)=\frac{-24\pm\sqrt{24^2-4\times-144}}{2}=-12\pm\frac{12}{2}\sqrt{4+8}=-12\pm12\sqrt{2}$	dM1
	$\sqrt{x}>0\Rightarrow\sqrt{x}=-12+12\sqrt{2}=12\left(\sqrt{2}-1\right)$*	A1
(ii)	$\Rightarrow x=12^2\left(\sqrt{2}-1\right)^2=144\left(2+1-2\sqrt{2}\right)=144\left(3-2\sqrt{2}\right)$	M1, A1
	$y\left\{=12-\sqrt{x}=12-12\left(\sqrt{2}-1\right)\right\}=12\left(2-\sqrt{2}\right)$	B1
	Or common acceptable alt forms: $P\left(432-288\sqrt{2},\ \ 24-12\sqrt{2}\right)$	
		(6) **(10 marks)**

(a)(i)

M1: Correct type of transformation identified. Score for any of

- "Stretch", x/y-"scaling" or "compression"
- Condone "contraction", "enlargement", "magnify", "squish", "shrink" and "elongate". There may be other acceptable words, use discretion.

Do not accept such as "multiply each x value by 2"

A1: Completely correct using correct terminology. The direction (x or y or horizontal or vertical), type (must be scaling or stretch or compression) and the correct scale factor must be given. If there are any contradictory statements, then it is A0.

Accept e.g.

- Stretch or scaling or compression in the x direction with (scale) factor $\frac{1}{2}$
- Stretch or scaling in the y direction with (scale) factor $\sqrt{2}$

Note a compression in the x direction by factor 2 is A0.

(a)(ii)

M1: Correct type of transformation identified. Score for e.g.

- Translate, shift
- Move Up/down
- Allow translation vector given as indicating translation

Do not accept such as "add 12 to each y value".

A1: Completely correct using correct terminology. E.g. "move up by 12" is minimal acceptable answer. The type (translation or "move" or accept "shift") direction (up or translation vector or positive *y* direction), and the correct distance must be given, but accept the translation vector to represent the direction and distance. If there are any contradictory statements, then it is A0.

(b)(i)

M1: Sets up equation and attempts to take out a common factor of $\sqrt{x}$

dM1: Correct attempt to rationalise. Must see evidence that the numerator and denominator both multiplied by an appropriate term e.g. seeing the denominator as just $2-1$, ie $\frac{12}{\sqrt{2}+1}=\frac{12\left(\sqrt{2}-1\right)}{2-1}$ is fine.

A1*: Complete proof showing all necessary steps. Condone invisible brackets when rationalising.

There may be variations where they do things in a slightly different order, but the scheme can still apply.

E.g.

$\sqrt{2x}=12-\sqrt{x}\Rightarrow\sqrt{x}+\sqrt{2x}=12\Rightarrow\left(\sqrt{2}-1\right)\left(\sqrt{x}+\sqrt{2x}\right)=12\left(\sqrt{2}-1\right)$

$\Rightarrow\sqrt{x}\left(\sqrt{2}+2-1-\sqrt{2}\right)=12\left(\sqrt{2}-1\right)$ scores M1 when $\sqrt{x}$ factored out

$\Rightarrow\sqrt{x}=12\left(\sqrt{2}-1\right)$ scores dM1A1 when achieving $\sqrt{x}=\ldots$

Alt:

M1: Sets up equation and squares both sides, then rearranges to a quadratic in $\sqrt{x}$.

dM1: Solves the quadratic (allow if it is called x =..)

A1: Gives correct justification for the choice of roots and completes to the given answer.

(b)(ii)

M1: Attempts to square $12\left(\sqrt{2}-1\right)$ achieving a not necessarily simplified form $a\sqrt{2}+b$. Allow slips if a coefficient is miscopied. E.g. $x=\left(12\sqrt{2}-1\right)^2=144\times2-2\sqrt{2}+1$ can score M1.

A1: $x=144\left(3-2\sqrt{2}\right)$ or $432-288\sqrt{2}$

B1: $y=24-12\sqrt{2}$ or $12\left(2-\sqrt{2}\right)$

Note: It is possible some will find *y* before *x* and attempt a longer method to find *x*. Score the M at the point at which they attempt to square out the relevant bracket for their method.

Question Number	Scheme	Marks
10	$(k-1)x^6 + 4x^3 + (k-4) = 0$	
(a)	$3.5x^6 + 4x^3 + 0.5 = 0 \Rightarrow 7x^6 + 8x^3 + 1 = 0$	
	$\Rightarrow \left(x^3+1\right)\left(7x^3+1\right) = 0$	M1
	$\Rightarrow x^3 = -1, \quad x^3 = -\frac{1}{7}$	A1
	$\Rightarrow x = -1, \quad x = -\frac{1}{\sqrt[3]{7}}$	A1
		(3)
(b)	Attempts $b^2 - 4ac = 16 - 4(k-1)(k-4)$	M1
	$= 20k - 4k^2$	A1
	Solves $b^2 - 4ac < 0 \Rightarrow 4k(5-k) < 0 \Rightarrow k < 0, \ k > 5$	dM1 A1
		(4)
		(7 marks)

(a)

M1: Substitutes in $k = 4.5$ (allowing a minor slip) and attempts to solve a quadratic in x^3. Ignore reference to any complex roots. Allow solutions via calculator to find values for x^3 but directly to x is M0. Essentially this mark is for recognising the quadratic in x^3 and attempting to solve it.

A1: For **both** values for x^3 Allow for, e.g. $y = ...$ if they substituted $y = x^3$ but if they used $x = x^3$ then they need to return to x^3 before accessing the mark.

A1: $x = -1, \quad x = -\frac{1}{\sqrt[3]{7}}$ and no other real solutions. Condone alternative forms such as $\sqrt[3]{-\frac{1}{7}}$ or $\left(-\frac{1}{7}\right)^{\frac{1}{3}}$ for $-\frac{1}{\sqrt[3]{7}}$ and isw after a correct answer. Ignore complex roots.

(b)

M1: Attempts $b^2 - 4ac = 16 - 4(k-1)(k-4)$ condoning slips.

A1: Correct expanded and simplified expression for $b^2 - 4ac$ (may be implied if they divide through by 4 before simplifying). (Do not be concerned about the inequality or equality for this mark.)

dM1: Attempts to find the region for $b^2 - 4ac < 0$ following through on their roots to an expression with negative k^2 coefficient (allow if there were slips solving) - must be choosing the outside region. They must have obtained two values for k. Condone „ instead of < and condone poor notation such as $5 < k < 0$ for this mark only.

A1: $k < 0, k > 5$ Accept with "or" or "and" between. Accept set or interval notation $\left[\text{e.g } k \in (-\infty, 0) \cup (5, \infty)\right]$ (must use union). Do not allow x or another variable, though.