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: $P\left(432-288\sqrt{2},\quad 24-12\sqrt{2}\right)$	
		(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 $\sqrt{x}=...$

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.