Mark Scheme 4721
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1	$\frac{5}{2-\sqrt{3}}$ x $\frac{2+\sqrt{3}}{2+\sqrt{3}}$ $= \frac{5(2+\sqrt{3})}{4-3}$ $= 10+5\sqrt{3}$	M1 A1 A1 3 **3**	Multiply top and bottom by $\pm(2+\sqrt{3})$ $(2+\sqrt{3})(2-\sqrt{3})=1$ (may be implied) $10+5\sqrt{3}$
2(i) (ii)	1 $\frac{1}{2}\times 2^4$ = 8	B1 1 M1 M1 A1 3 **4**	 $2^{-1}=\frac{1}{2}$ **<u>or</u>** $32^{\frac{1}{5}}=2$ **<u>or</u>** $2^5=32$ soi $32^{\frac{4}{5}}=2^4$ or 16 seen or implied 8
3(i) (ii)	$3x-15\le 24$ $3x\le 39$ $x\le 13$ **or** $x-5\le 8$ M1 $x\le 13$ A1 $5x^2>80$ $x^2>16$ $x>4$ or $x<-4$	M1 A1 2 M1 B1 A1 3 **5**	Attempt to simplify expression by multiplying out brackets $x\le 13$ Attempt to simplify expression by dividing through by 3 Attempt to rearrange inequality or equation to combine the constant terms $x>4$ fully correct, not wrapped, not ‘and’ **SR** B1 for $x\ge 4$, $x\le -4$

4	Let $y = x^{\frac{1}{3}}$ $y^2 + 3y - 10 = 0$ $(y-2)(y+5) = 0$ $y = 2, y = -5$ $x = 2^3, x = (-5)^3$ $x = 8, x = -125$	*M1 DM1 A1 DM1 A1 ft 5 **5**	Attempt a substitution to obtain a quadratic or factorise with $\sqrt[3]{x}$ in each bracket Correct attempt to solve quadratic Both values correct Attempt cube Both answers correctly followed through **SR** B2 $x = 8$ from T & I
5 (i)		M1 A1 2	Reflection in either axis Correct reflection in x axis
(ii)	(1, 3)	B1 B1 2	Correct x coordinate Correct y coordinate **SR** B1 for (3, 1)
(iii)	Translation 2 units in negative x direction	B1 B1 2 **6**	
6 (i)	$2(x^2 - 12x + 40)$ $= 2\left[(x-6)^2 - 36 + 40\right]$ $= 2\left[(x-6)^2 + 4\right]$ $= 2(x-6)^2 + 8$	B1 B1 M1 A1 4	$a = 2$ $b = 6$ $80 - 2b^2$ or $40 - b^2$ or $80 - b^2$ or $40 - 2b^2$ (their b) $c = 8$
(ii)	$x = 6$	B1 ft 1	
(iii)	$y = 8$	B1 ft 1 **6**	

7(i)	$\frac{dy}{dx} = 5$	B1 1	
(ii)	$y = 2x^{-2}$	B1	x^{-2} soi
	$\frac{dy}{dx} = -4x^{-3}$	B1	$-4x^{c}$
		B1 3	kx^{-3}
(iii)	$y = 10x^2 - 14x + 5x - 7$	M1	Expand the brackets to give an expression of form $ax^2 + bx + c$ $(a \neq 0, b \neq 0, c \neq 0)$
	$y = 10x^2 - 9x - 7$	A1	Completely correct (allow 2 x-terms)
	$\frac{dy}{dx} = 20x - 9$	B1 ft B1 ft 4	1 term correctly differentiated Completely correct (2 terms)
		8	
8 (i)	$\frac{dy}{dx} = 9 - 6x - 3x^2$	*M1 A1	Attempt to differentiate y or $-y$ (at least one correct term) 3 correct terms
	At stationary points, $9 - 6x - 3x^2 = 0$	M1	Use of $\frac{dy}{dx} = 0$ (for y or $-y$)
	$3(3 + x)(1 - x) = 0$ $x = -3$ or $x = 1$	DM1 A1	Correct method to solve 3 term quadratic $x = -3,\ 1$
	$y = 0,\ 32$	A1ft 6	$y = 0,\ 32$ (1 correct pair www A1 A0)
(ii)	$\frac{d^2y}{dx^2} = -6x - 6$	M1	Looks at sign of $\frac{d^2y}{dx^2}$, derived correctly from $k\frac{dy}{dx}$, or other correct method
	When $x = -3, \frac{d^2y}{dx^2} > 0$	A1	$x = -3$ minimum
	When $x = 1, \frac{d^2y}{dx^2} < 0$	A1 3	$x = 1$ maximum
(iii)	$-3 < x < 1$	M1	Uses the x values of both turning points in inequality/inequalities
		A1 2	Correct inequality or inequalities. Allow $\leq$
		11	

9 (i)	Gradient = 4	B1	Gradient of 4 soi
	$y - 7 = 4(x - 2)$	M1	Attempts equation of straight line through (2, 7) with any gradient
	$y = 4x - 1$	A1 3	
(ii)	$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$ $= \sqrt{(2 - {}^{-}1)^2 + (7 - {}^{-}2)^2}$	M1	Use of correct formula for d or d^2 (3 values correctly substituted)
	$= \sqrt{3^2 + 9^2}$ $= \sqrt{90}$	A1	$\sqrt{3^2 + 9^2}$
	$= 3\sqrt{10}$	A1 3	Correct simplified surd
(iii)	Gradient of AB = 3	B1	
	Gradient of perpendicular line = $-\frac{1}{3}$	B1 ft	**SR** Allow B1 for $-\frac{1}{4}$
	Midpoint of AB = $\left(\frac{1}{2}, \frac{5}{2}\right)$	B1	
	$y - \frac{5}{2} = -\frac{1}{3}\left(x - \frac{1}{2}\right)$	M1	Attempts equation of straight line through their midpoint with any non-zero gradient
		A1	$y - \frac{5}{2} = \frac{-1}{3}(x - \frac{1}{2})$
	$x + 3y - 8 = 0$	A1 6	$x + 3y - 8 = 0$
		12	

10 (i)	Centre (-1, 2) $(x+1)^2 - 1 + (y-2)^2 - 4 - 8 = 0$ $(x+1)^2 + (y-2)^2 = 13$ Radius $\sqrt{13}$	B1 M1 A1 3	Correct centre Attempt at completing the square Correct radius Alternative method: Centre ($-g$, $-f$) is (-1, 2) B1 $g^2 + f^2 - c$ M1 Radius = $\sqrt{13}$ A1
(ii)	$(2)^2 + (k-2)^2 = 13$ $(k-2)^2 = 9$ $k - 2 = \pm 3$ $k = -1$	M1 M1 A1 3	Attempt to substitute x = -3 into circle equation Correct method to solve quadratic $k = -1$ (negative value chosen)
(iii)	EITHER $y = 6 - x$ $(x+1)^2 + (6 - x - 2)^2 = 13$ $(x+1)^2 + (4 - x)^2 = 13$ $x^2 + 2x + 1 + 16 - 8x + x^2 = 13$ $2x^2 - 6x + 4 = 0$ $2(x-1)(x-2) = 0$ $x = 1 , 2$ $\therefore y = 5 , 4$ OR $x = 6 - y$ $(6 - y + 1)^2 + (y-2)^2 = 13$ $(7 - y)^2 + (y-2)^2 = 13$ $49 - 14y + y^2 + y^2 - 4y + 4 = 13$ $2y^2 - 18y + 40 = 0$ $2(y-4)(y-5) = 0$ $y = 4 , 5$ $\therefore x = 2 , 1$	M1 M1 A1 M1 A1 A1 6 **12**	Attempt to solve equations simultaneously Substitute into their circle equation for x/y or attempt to get an equation in 1 variable only Obtain correct 3 term quadratic Correct method to solve quadratic of form $ax^2 + bx + c = 0$ $(b \neq 0)$ Both x values correct Both y values correct or one correct pair of values **www** B1 second correct pair of values B1 **SR** **T & I** M1 A1 One correct x (or y) value A1 Correct associated coordinate