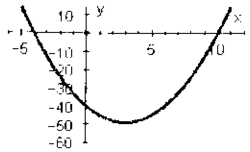
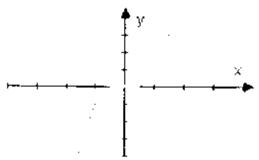
1	$x^2-6x-40\ge 0$ $(x+4)(x-10)\ge 0$	M1	Correct method to find roots
		A1	-4, 10
		M1	Correct method to solve quadratic inequality e.g. +ve quadratic graph
	$x\le -4,\quad x\ge 10$	A1 4 **4**	$x\le -4,\quad x\ge 10$ (not wrapped, not strict inequalities, no 'and')
2(i)	EITHER $3(x^2+4x)+7$ $3(x+2)^2-12+7$ $3(x+2)^2-5$ OR $3(x^2+2ax+a^2)+b$ $3x^2+6ax+3a^2+b$ $6a=12$	M1	$a=\frac{12}{6\text{ or }2}$
	$a=2$	A1	a = 2
	$3a^2+b=7$	M1	$7-a^2$ or $7-3a^2$ or $\frac{7}{3}-a^2$ (their a)
	$b=-5$	A1 4	b = −5
(ii)	$x=-2$	B1 ft 1 **5**	$x=-2$
3 (i)		B1 1	Correct sketch showing point of inflection at origin
(ii)	Reflection in *x*-axis or reflection in *y*-axis	B1 B1 2	Reflection In *x*-axis or *y*=0 or *y*-axis or *x*=0
(iii)	$y=(x-p)^3$	M1	$y=(x\pm p)^3$
		A1 2 **5**	$y=(x-p)^3$

4	$k=x^3$	*M1	Attempt a substitution to obtain a quadratic
	$k^2+26k-27=0$	A1	$k^2+26k-27=0$
	$k=-27, 1$	A1	−27, 1
		DM1	Attempt cube root
	$x=-3, 1$	A1 5	x = −3, 1 (no extras) (**SR:** x = 1 seen www **B1** x = -3 seen www **B1**)
		5	
5 (a)	$2x^{\frac{2}{3}}\times 3x^{-1}$	M1	Adds indices
	$=6x^{-\frac{1}{3}}$	A1 2	$6x^{-\frac{1}{3}}$
(b)	$2^{40}\times 4^{30}$ $=2^{40}\times 2^{60}$	M1	2^{60} or 4^{20}
	$=2^{100}$	A1 2	2^{100}
(c)	$\dfrac{26(4+\sqrt{3})}{(4-\sqrt{3})(4+\sqrt{3})}$	M1	Multiply top and bottom by $(4+\sqrt{3})$ or $(-4-\sqrt{3})$
	$=8+2\sqrt{3}$	A1	$(4-\sqrt{3})(4+\sqrt{3})=13$
		A1 3 **7**	$8+2\sqrt{3}$
6 (i)	$(x^2+2x+1)(3x-4)$ $=3x^3+2x^2-5x-4$	M1	Expand 2 brackets to give an expression of the form ax^2+bx+c ($a\ne 0$, $b\ne 0$, $c\ne 0$) and attempt to multiply by third bracket $3x^3+2x^2-5x-4$
		A1 A1 3	3 correct simplified terms Completely correct
(ii)	$9x^2+4x-5$		$9x^2+4x-5$
		B1 ft B1 ft 2	1 term correct Completely correct (3 terms)
(iii)	$18x+4$	M1 A1 ft 2	Attempt to differentiate their (ii) $18x+4$ (2 terms)
			(**SR** (ii) $3ax^2+2bx+c$ **B1** (iii) $6ax+2b$ **B1**)
		7	

7 (i)	$b^2 - 4ac$ (a) 36 – 9 x 4 = 0 (b) 100 – 48 = 52 (c) 4 – 20 = -16	M1 A1 A1 3	Uses $b^2 - 4ac$ 1 correct 3 correct **SR** All 3 values correct but $\sqrt{}$ used **B1**
(ii)	(a) Fig 3 (b) Fig 2 (c) Fig 5	B1 B1	1 correct matching 3 correct matchings
	(a) 1 root, touches *x*-axis once, line of symmetry *x*= -3 or root *x* =-3 (b) 2 roots, meets *x*-axis twice, line of symmetry *x*=5 (c) No real roots, does not meet *x*-axis	B1 B1 4 7	1 correct comment relating roots to touching/crossing *x*-axis or about line of symmetry or vertex o.e. for one graph 2 further correct comments about roots, line of symmetry o.e. for the other 2 graphs
8 (i)	Circle, centre (0, 0), radius 5	B1 B1 2	Circle centre (0, 0) Radius 5
(ii)	$y = 5 - 2x$ $x^2 + (5 - 2x)^2 = 25$ $5x^2 - 20x = 0$ OR $x = \frac{5-y}{2}$ $\frac{(5-y)^2}{4} + y^2 = 25$ $y^2 - 2y - 15 = 0$ $x = 0, 4$ $y = 5, -3$	M1 *M1 DM1 M1 A1 A1 6 8	Attempt to solve equations simultaneously Substitute for *x*/*y* or correct attempt at elimination of one variable (NOT for 2 linear equations) Obtain quadratic $ax^2 + bx + c = 0$ ($a \neq 0$, $b \neq 0$) Correct method to solve quadratic $x = 0, 4$ or $y = 5, -3$ $y = 5, -3$ or $x = 0, 4$ **SR** one correct pair **www** **B1** <u>SR</u> If solution by graphical methods Drawing circle, centre (0,0) radius 5 B1 Drawing line B1 Looking for intersection M1 (0,5) correct A1 (4, –3) correct A2

9 (i)	$y = \frac{4}{3}x + \frac{5}{3}$ gradient $= \frac{4}{3}$	B1 1	$\frac{4}{3}$ or 1.33 or better
(ii)	gradient of $\perp^r = -\frac{3}{4}$ $y - 2 = -\frac{3}{4}(x - 1)$ $4y + 3x = 11$	B1 ft M1 A1 A1 4	$-\frac{3}{4}$ seen or implied Attempts equation of straight line through (1, 2) with any gradient $y - 2 = -\frac{3}{4}(x - 1)$ $3x + 4y - 11 = 0$ (not aef)
(iii)	$P\left(-\frac{5}{4}, 0\right)$ $Q\left(0, \frac{11}{4}\right)$ $\left(-\frac{5}{8}, \frac{11}{8}\right)$	B1 B1 ft B1 ft 3	$\left(-\frac{5}{4}, 0\right)$ seen or implied $\left(0, \frac{11}{4}\right)$ seen or implied (from a straight line equation in (ii)) $\left(-\frac{5}{8}, \frac{11}{8}\right)$ aef
(iv)	$\sqrt{\left(\frac{5}{4}\right)^2 + \left(\frac{11}{4}\right)^2}$ $\frac{\sqrt{146}}{4}$	M1 A1 A1 3 11	Correct method to find line length using Pythagoras' theorem $\sqrt{\left(\frac{5}{4}\right)^2 + \left(\frac{11}{4}\right)^2}$ $\frac{\sqrt{146}}{4}$

10 (i)	$\frac{dy}{dx} = x^2 - 9$	B1 B1 2	$x^2 - 9$ 1 term correct Both terms correct
(ii)	$x^2 - 9 = 0$ $x = 3, -3$ $y = -18, 18$	*M1 A1 A1 3	uses $\frac{dy}{dx} = 0$ $x = 3, -3$ $y = -18, 18$ (1 correct pair A1 A0)
(iii)	$\frac{d^2y}{dx^2} = 2x$ $x = 3 \quad \frac{d^2y}{dx^2} = 6$ $x = -3 \quad \frac{d^2y}{dx^2} = -6$	DM1 A1 A1 3	Looks at sign of $\frac{d^2y}{dx^2}$ or other correct method $x = 3$ minimum $x = -3$ maximum (N.B. If no method shown but min and max correctly stated, award all 3 marks unless earlier incorrect working)
(iv)	gradient of $24x + 3y + 2 = 0$ is -8 $x^2 - 9 = -8$ $x = \pm 1$ For line $x = 1, y = -8\frac{2}{3}$ $x = -1, y = 7\frac{1}{3}$ For curve $x = 1, y = -8\frac{2}{3}$ $x = -1, y = 8\frac{2}{3}$ $\therefore p = 1, q = -8\frac{2}{3}$	B1 M1 M1 M1 A1 5	Gradient = -8 $x^2 - 9 = -8$ one of their x values substituted in both line <u>and</u> curve second x value substituted in both line and curve **<u>or</u>** justification that first point is the correct one $p = 1, q = -8\frac{2}{3}$ seen <u>Alternative methods:</u> <u>Either:</u> Solve equations for curve and line simultaneously to get one solution (either $x = 1$ or $x = -2$) M1 Gradient of line = -8 B1 Substitution of one x value into their gradient formula and check for -8 M1 Substitution of other x value into gradient formula and check for -8 or justification as above M1 Correct q value A1 <u>Or:</u> Solve equations for curve and line simultaneously to get one solution M1 Factorise to $(x-1)^2(x+2)$ B1 State that a double root implies a tangent at x = 1 M2 Correct value for y A1
		13	

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