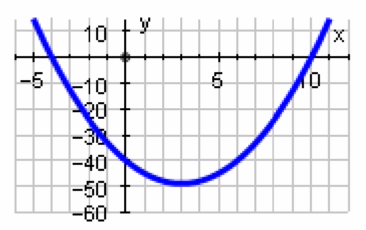
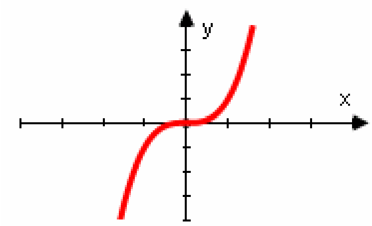
Mark Scheme 4721
June 2005

<table>
<tr><td>1</td><td>$x^2-6x-40\ge 0$
$(x+4)(x-10)\ge 0$</td><td>M1</td><td>Correct method to find roots</td></tr>
<tr><td></td><td></td><td>A1</td><td>-4, 10</td></tr>
<tr><td></td><td></td><td>M1</td><td>Correct method to solve quadratic inequality e.g. +ve quadratic graph</td></tr>
<tr><td></td><td>$x\le -4,\quad x\ge 10$</td><td>A1 4
4</td><td>$x\le -4,\quad x\ge 10$
(not wrapped, not strict inequalities, no ‘and’)</td></tr>
<tr><td>2(i)</td><td>EITHER
$3(x^2+4x)+7$
$3(x+2)^2-12+7$
$3(x+2)^2-5$

OR
$3(x^2+2ax+a^2)+b$
$3x^2+6ax+3a^2+b$</td><td></td><td></td></tr>
<tr><td></td><td>$6a=12$</td><td>M1</td><td>$a=\frac{12}{6 \text{ or } 2}$</td></tr>
<tr><td></td><td>$a=2$</td><td>A1</td><td>a = 2</td></tr>
<tr><td></td><td>$3a^2+b=7$</td><td>M1</td><td>$7-a^2$ or $7-3a^2$ or $\frac{7}{3}-a^2$ (their a)</td></tr>
<tr><td></td><td>$b=-5$</td><td>A1 4</td><td>b = –5</td></tr>
<tr><td>(ii)</td><td>$x=-2$</td><td>B1 ft 1
5</td><td>$x=-2$</td></tr>
<tr><td>3 (i)</td><td></td><td>B1 1</td><td>Correct sketch showing point of inflection at origin</td></tr>
<tr><td>(ii)</td><td>Reflection in *x*-axis or reflection in *y*-axis</td><td>B1
B1 2</td><td>Reflection
In *x*-axis or *y*=0 or *y*-axis or *x*=0</td></tr>
<tr><td>(iii)</td><td>$y=(x-p)^3$</td><td>M1</td><td>$y=(x\pm p)^3$</td></tr>
<tr><td></td><td></td><td>A1 2
5</td><td>$y=(x-p)^3$</td></tr>
</table>

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

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 √ used **B1**
(ii)	(a) Fig 3 (b) Fig 2 (c) Fig 5 (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 B1 B1 4 **7**	1 correct matching 3 correct matchings 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 ≠ 0, b ≠ 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		
	$\perp^r=-\frac{3}{4}$	B1 ft	$-\frac{3}{4}$ seen or implied
	$y-2=-\frac{3}{4}(x-1)$	M1	Attempts equation of straight line through (1, 2) with any gradient
	$4y+3x=11$	A1	$y-2=-\frac{3}{4}(x-1)$
		A1 4	$3x+4y-11=0$ (not aef)
(iii)	$P\left(-\frac{5}{4},0\right)$	B1	$\left(-\frac{5}{4},0\right)$ seen or implied
	$Q\left(0,\frac{11}{4}\right)$	B1 ft	$\left(0,\frac{11}{4}\right)$ seen or implied (from a straight line equation in (ii))
	$\left(-\frac{5}{8},\frac{11}{8}\right)$	B1 ft 3	$\left(-\frac{5}{8},\frac{11}{8}\right)$ aef
(iv)	$\sqrt{\left(\frac{5}{4}\right)^2+\left(\frac{11}{4}\right)^2}$	M1	Correct method to find line length using Pythagoras' theorem
	$\frac{\sqrt{146}}{4}$	A1	$\sqrt{\left(\frac{5}{4}\right)^2+\left(\frac{11}{4}\right)^2}$
		A1 3	$\frac{\sqrt{146}}{4}$
		11	

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 **13**	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