Practice examination questions for Quadratics

1.Jan2005

7 (a) Simplify $(k+5)^2 - 12k(k+2)$. *(2 marks)*

(b) The quadratic equation $3(k+2)x^2 + (k+5)x + k = 0$ has real roots.

(i) Show that $(k-1)(11k+25) \leqslant 0$. *(5 marks)*

(ii) Hence find the possible values of k. *(3 marks)*

2.June 2005

2 (a) Express $x^2 - 6x + 16$ in the form $(x-p)^2 + q$. *(2 marks)*

(b) A curve has equation $y = x^2 - 6x + 16$.

Using your answer from part (a), or otherwise:

(i) find the coordinates of the vertex (minimum point) of the curve; *(2 marks)*

(ii) sketch the curve, indicating the value where the curve crosses the y-axis; *(2 marks)*

(iii) state the equation of the line of symmetry of the curve. *(1 mark)*

(c) Describe geometrically the transformation that maps the graph of $y = x^2$ onto the graph of $y = x^2 - 6x + 16$. *(3 marks)*

3.June 2005

8 A line has equation $y = mx - 1$, where m is a constant.

A curve has equation $y = x^2 - 5x + 3$.

(a) Show that the x-coordinate of any point of intersection of the line and the curve satisfies the equation

$$x^2 - (5+m)x + 4 = 0$$ *(1 mark)*

(b) Find the values of m for which the equation $x^2 - (5+m)x + 4 = 0$ has equal roots. *(4 marks)*

(c) Describe geometrically the situation when m takes either of the values found in part (b). *(1 mark)*

4.Jan 2006

3 (a) (i) Express $x^2 - 4x + 9$ in the form $(x - p)^2 + q$, where p and q are integers. *(2 marks)*

(ii) Hence, or otherwise, state the coordinates of the minimum point of the curve with equation $y = x^2 - 4x + 9$. *(2 marks)*

(b) The line L has equation $y + 2x = 12$ and the curve C has equation $y = x^2 - 4x + 9$.

(i) Show that the x-coordinates of the points of intersection of L and C satisfy the equation

$$x^2 - 2x - 3 = 0$$ *(1 mark)*

(ii) Hence find the coordinates of the points of intersection of L and C. *(4 marks)*

5.June 2006

2 (a) Express $x^2 + 8x + 19$ in the form $(x + p)^2 + q$, where p and q are integers. *(2 marks)*

(b) Hence, or otherwise, show that the equation $x^2 + 8x + 19 = 0$ has no real solutions. *(2 marks)*

(c) Sketch the graph of $y = x^2 + 8x + 19$, stating the coordinates of the minimum point and the point where the graph crosses the y-axis. *(3 marks)*

(d) Describe geometrically the transformation that maps the graph of $y = x^2$ onto the graph of $y = x^2 + 8x + 19$. *(3 marks)*

6.Jan 2007

7 The quadratic equation $(k + 1)x^2 + 12x + (k - 4) = 0$ has real roots.

(a) Show that $k^2 - 3k - 40 \leqslant 0$. *(3 marks)*

(b) Hence find the possible values of k. *(4 marks)*

7.June 2007

3 (a) (i) Express $x^2 + 10x + 19$ in the form $(x + p)^2 + q$, where p and q are integers. *(2 marks)*

(ii) Write down the coordinates of the vertex (minimum point) of the curve with equation $y = x^2 + 10x + 19$. *(2 marks)*

(iii) Write down the equation of the line of symmetry of the curve $y = x^2 + 10x + 19$. *(1 mark)*

(iv) Describe geometrically the transformation that maps the graph of $y = x^2$ onto the graph of $y = x^2 + 10x + 19$. *(3 marks)*

(b) Determine the coordinates of the points of intersection of the line $y = x + 11$ and the curve $y = x^2 + 10x + 19$. *(4 marks)*

8.Jan 2008

5 (a) Factorise $9 - 8x - x^2$. *(2 marks)*

(b) Show that $25 - (x+4)^2$ can be written as $9 - 8x - x^2$. *(1 mark)*

(c) A curve has equation $y = 9 - 8x - x^2$.

(i) Write down the equation of its line of symmetry. *(1 mark)*

(ii) Find the coordinates of its vertex. *(2 marks)*

(iii) Sketch the curve, indicating the values of the intercepts on the x-axis and the y-axis. *(3 marks)*

9.Jan 2008

7 The curve C has equation $y = x^2 + 7$. The line L has equation $y = k(3x+1)$, where k is a constant.

(a) Show that the x-coordinates of any points of intersection of the line L with the curve C satisfy the equation

$$x^2 - 3kx + 7 - k = 0$$ *(1 mark)*

(b) The curve C and the line L intersect in two distinct points. Show that

$$9k^2 + 4k - 28 > 0$$ *(3 marks)*

(c) Solve the inequality $9k^2 + 4k - 28 > 0$. *(4 marks)*

10.June 2008

4 (a) Express $x^2 - 3x + 4$ in the form $(x-p)^2 + q$, where p and q are rational numbers. *(2 marks)*

(b) Hence write down the minimum value of the expression $x^2 - 3x + 4$. *(1 mark)*

(c) Describe the geometrical transformation that maps the graph of $y = x^2$ onto the graph of $y = x^2 - 3x + 4$. *(3 marks)*

11.June 2008

8 The quadratic equation $(k+1)x^2 + 4kx + 9 = 0$ has real roots.

(a) Show that $4k^2 - 9k - 9 \geqslant 0$. *(3 marks)*

(b) Hence find the possible values of k. *(4 marks)*

12.Jan 2009

4 (a) (i) Express $x^2 + 2x + 5$ in the form $(x + p)^2 + q$, where p and q are integers. *(2 marks)*

(ii) Hence show that $x^2 + 2x + 5$ is always positive. *(1 mark)*

(b) A curve has equation $y = x^2 + 2x + 5$.

(i) Write down the coordinates of the minimum point of the curve. *(2 marks)*

(ii) Sketch the curve, showing the value of the intercept on the y-axis. *(2 marks)*

(c) Describe the geometrical transformation that maps the graph of $y = x^2$ onto the graph of $y = x^2 + 2x + 5$. *(3 marks)*

13.June 2009

6 (a) (i) Express $x^2 - 8x + 17$ in the form $(x - p)^2 + q$, where p and q are integers. *(2 marks)*

(ii) Hence write down the minimum value of $x^2 - 8x + 17$. *(1 mark)*

(iii) State the value of x for which the minimum value of $x^2 - 8x + 17$ occurs. *(1 mark)*

(b) The point A has coordinates $(5, 4)$ and the point B has coordinates $(x, 7 - x)$.

(i) Expand $(x - 5)^2$. *(1 mark)*

(ii) Show that $AB^2 = 2(x^2 - 8x + 17)$. *(3 marks)*

(iii) Use your results from part (a) to find the minimum value of the distance AB as x varies. *(2 marks)*

14.Jan 2010

5 (a) Express $(x - 5)(x - 3) + 2$ in the form $(x - p)^2 + q$, where p and q are integers. *(3 marks)*

(b) (i) Sketch the graph of $y = (x - 5)(x - 3) + 2$, stating the coordinates of the minimum point and the point where the graph crosses the y-axis. *(3 marks)*

(ii) Write down an equation of the tangent to the graph of $y = (x - 5)(x - 3) + 2$ at its vertex. *(2 marks)*

(c) Describe the geometrical transformation that maps the graph of $y = x^2$ onto the graph of $y = (x - 5)(x - 3) + 2$. *(3 marks)*

15.June 2010

7 (a) (i) Express $2x^2 - 20x + 53$ in the form $2(x-p)^2 + q$, where p and q are integers. *(2 marks)*

(ii) Use your result from part **(a)(i)** to explain why the equation $2x^2 - 20x + 53 = 0$ has no real roots. *(2 marks)*

(b) The quadratic equation $(2k-1)x^2 + (k+1)x + k = 0$ has real roots.

(i) Show that $7k^2 - 6k - 1 \leqslant 0$. *(4 marks)*

(ii) Hence find the possible values of k. *(4 marks)*

16.Jan 2011

7 (a) (i) Express $4 - 10x - x^2$ in the form $p - (x+q)^2$. *(2 marks)*

(ii) Hence write down the equation of the line of symmetry of the curve with equation $y = 4 - 10x - x^2$. *(1 mark)*

(b) The curve C has equation $y = 4 - 10x - x^2$ and the line L has equation $y = k(4x - 13)$, where k is a constant.

(i) Show that the x-coordinates of any points of intersection of the curve C with the line L satisfy the equation

$$x^2 + 2(2k+5)x - (13k+4) = 0$$ *(1 mark)*

(ii) Given that the curve C and the line L intersect in two distinct points, show that

$$4k^2 + 33k + 29 > 0$$ *(3 marks)*

(iii) Solve the inequality $4k^2 + 33k + 29 > 0$. *(4 marks)*

17.June 2011

4 (a) Express $x^2 + 5x + 7$ in the form $(x+p)^2 + q$, where p and q are rational numbers. *(3 marks)*

(b) A curve has equation $y = x^2 + 5x + 7$.

(i) Find the coordinates of the vertex of the curve. *(2 marks)*

(ii) State the equation of the line of symmetry of the curve. *(1 mark)*

(iii) Sketch the curve, stating the value of the intercept on the y-axis. *(3 marks)*

(c) Describe the geometrical transformation that maps the graph of $y = x^2$ onto the graph of $y = x^2 + 5x + 7$. *(3 marks)*

18.Jan 2012

2 (a) Factorise $x^2 - 4x - 12$. *(1 mark)*

(b) Sketch the graph with equation $y = x^2 - 4x - 12$, stating the values where the curve crosses the coordinate axes. *(4 marks)*

(c) (i) Express $x^2 - 4x - 12$ in the form $(x - p)^2 - q$, where p and q are positive integers. *(2 marks)*

(ii) Hence find the minimum value of $x^2 - 4x - 12$. *(1 mark)*

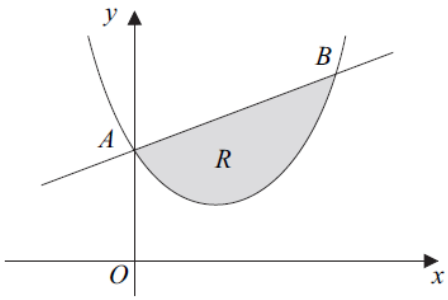
(d) The curve with equation $y = x^2 - 4x - 12$ is translated by the vector $\begin{bmatrix} -3 \\ 2 \end{bmatrix}$.
Find an equation of the new curve. You need not simplify your answer. *(2 marks)*

19.June 2012

5 (a) (i) Express $x^2 - 3x + 5$ in the form $(x - p)^2 + q$. *(2 marks)*

(ii) Hence write down the equation of the line of symmetry of the curve with equation $y = x^2 - 3x + 5$. *(1 mark)*

(b) The curve C with equation $y = x^2 - 3x + 5$ and the straight line $y = x + 5$ intersect at the point $A(0, 5)$ and at the point B, as shown in the diagram below.



(i) Find the coordinates of the point B. *(3 marks)*

(ii) Find $\int (x^2 - 3x + 5)\,dx$. *(3 marks)*

(iii) Find the area of the shaded region R bounded by the curve C and the line segment AB. *(4 marks)*

20.Jan 2013

4 (a) (i) Express $x^2 - 6x + 11$ in the form $(x - p)^2 + q$. *(2 marks)*

(ii) **Use the result from part (a)(i)** to show that the equation $x^2 - 6x + 11 = 0$ has no real solutions. *(2 marks)*

(b) A curve has equation $y = x^2 - 6x + 11$.

(i) Find the coordinates of the vertex of the curve. *(2 marks)*

(ii) Sketch the curve, indicating the value of y where the curve crosses the y-axis. *(3 marks)*

(iii) Describe the geometrical transformation that maps the curve with equation $y = x^2 - 6x + 11$ onto the curve with equation $y = x^2$. *(3 marks)*

21.Jan 2006

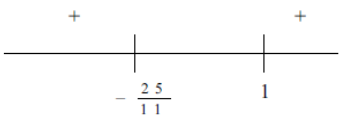
4 The quadratic equation $x^2 + (m + 4)x + (4m + 1) = 0$, where m is a constant, has equal roots.

(a) Show that $m^2 - 8m + 12 = 0$. *(3 marks)*

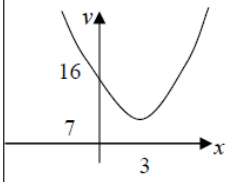
(b) Hence find the possible values of m. *(2 marks)*

Answers:

1.Jan 2005

7(a)	$k^2+10k+25-12k^2-24k$ $=-11k^2-14k+25$	M1 A1	 2	Condone one slip No ISW here
(b)(i)	Real roots when "b^2-4ac" $\geqslant 0$ $(k+5)^2-12k(k+2)$ $(k-1)(11k+25)$ attempted to be shown equal to $11k^2+14k-25$ $-11k^2-14k+25\geqslant 0$ $\Rightarrow (k-1)(11k+25)\leqslant 0$	B1 M1 m1 A1 A1	 5	Non-negative discriminant (stated / used) Finding b^2-4ac in terms of k Or factorisation attempt Real roots condition correct and ... AG (be convinced about inequality)
(ii)	(Critical values) 1 and $-\frac{25}{11}$ seen Sketch or sign diagram $\Rightarrow -\frac{25}{11}\leqslant k\leqslant 1$	B1 M1 A1	 3	
	Total		**10**	

2.June 2005

2(a)	$(x-3)^2$ $+\ 7$	B1 B1	 2	$p=3$ $q=7$
(b)(i)	Vertex (3, 7)	B1√ B1√	 2	ft their p ft their q
(ii)	 graph	M1 A1	 2	parabola (ft on vertex approx position) correct with $y=16$ marked or stated
(iii)	Line of symmetry $x=3$	B1	1	Must have correct equation
(c)	Translation (and no additional transf'n) through $\begin{bmatrix}3\\7\end{bmatrix}$	E1 M1 A1	 3	Not shift, move, transformation, etc one part correct eg 7 units up all correct – if not vector – must say 3 units in positive x- direction etc
	Total		**10**	

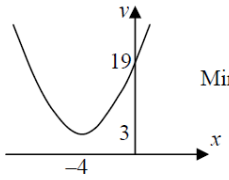
3.June 2005

8(a)	$mx-1=x^2-5x+3$ $\Rightarrow x^2-5x-mx+4=0$ $\Rightarrow x^2-(5+m)x+4=0$	 B1	 1	Strict mark here – no trailing equals signs **AG** (be convinced about algebra and = 0)
(b)	$(5+m)^2-16=0$ $5+m=(\pm)4$ or $(m+1)(m+9)=0$ $m=-1$ $m=-9$	M1 m1 A1 A1	 4	Equal roots when "b^2-4ac" = 0 used Square root or factor/formula attempt **SC** B1, B1 only for –1 , –9 (no working)
(c)	Line is a tangent to the curve	E1	1	Line touches curve, cuts at one point etc
	Total		**6**	

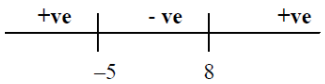
4.Jan 2006

3(a)(i)	$(x-2)^2$ $+5$	B1 B1	 2	$p=2$ $q=5$
(ii)	Minimum point (2, 5) or $x=2,\ y=5$	B2√	2	B1 for each coordinate correct or ft **Alt method** M1, A1 sketch, differentiation
(b)(i)	$12-2x=x^2-4x+9$ $\Rightarrow x^2-2x-3=0$	 B1	 1	Or $x^2-4x+9+2x=12$ **AG** (be convinced) (must have = 0)
(ii)	$(x-3)(x+1)=0$ $x=3,\ \ -1$ Substitute one value of x to find y Points are (3, 6) and (–1, 14)	M1 A1 M1 A1	 4	Attempt at factors or quadratic formula or one value spotted Both values correct & simplified May substitute into equation for L or C y-coordinates correct linked to x values
	Total		**9**	

5.June 2006

2(a)	$(x+4)^2$ $+3$	B1 B1	 2	$p=4$ $q=3$
(b)	$(x+4)^2=-3$ or "their" $(x+p)^2=-q$ No real square root of –3	M1 A1	 2	Or discriminant = 64 –76 Disc < 0 so no real roots (all correct figs)
(c)	 Minimum (– 4, 3) graph	 B1√ B1 B1	 3	 ft their $-p$ and q (or correct) Parabola (vertex roughly as shown) Crossing at $y=19$ marked or (0, 19) stated
(d)	Translation (and no additional transf'n) through $\begin{bmatrix}-4\\3\end{bmatrix}$	E1 M1 A1	 3	Not shift, move, transformation, etc One component correct eg 3 units up All correct – if not vector – must say 4 units in negative x- direction, to left etc
	Total		**10**	

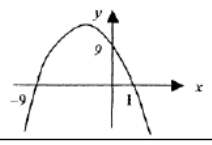
6.Jan 2007

7(a)	$b^2-4ac\ =\ 144-4(k+1)(k-4)$ Real roots when $b^2-4ac\geqslant 0$ $36-(k^2-3k-4)\geqslant 0$ $\Rightarrow k^2-3k-40\leqslant 0$	M1 B1 A1	 3	Clear attempt at b^2-4ac Condone slip in one term of expression Not just a statement, must involve k **AG** (watch signs carefully)
(b)	$(k-8)(k+5)$ Critical points 8 and –5 Sketch or sign diagram **correct,** must have 8 and –5 $-5\leqslant k\leqslant 8$ A0 for $-5<k<8$ or two separate inequalities unless word AND used	M1 A1 M1 A1	 4	Factors attempt or formula 

7.June 2007

3(a)(i)	$(x+5)^2$ -6	B1 B1	 2	$p=5$ $q=-6$
(ii)	$x_{\text{vertex}}=-5$ (or their $-p$) $y_{\text{vertex}}=-6$ (or their q)	B1√ B1√	 2	may differentiate but must have $x=-5$ and $y=-6$. Vertex $(-5,-6)$
(iii)	$x=-5$	B1	1	
(iv)	Translation (not shift, move etc) through $\begin{bmatrix}-5\\-6\end{bmatrix}$ (or 5 left, 6 down)	E1 M1 A1	 3	and NO other transformation stated either component correct M1, A1 independent of E mark
(b)	$x+11=x^2+10x+19$ $\Rightarrow x^2+9x+8=0$ or $y^2-13y+30=0$ $(x+8)(x+1)=0$ or $(y-3)(y-10)=0$ $\left.\begin{matrix}x=-1\\y=10\end{matrix}\right\}$ or $\left.\begin{matrix}x=-8\\y=3\end{matrix}\right\}$	 M1 m1 A1 A1	 4	quadratic with all terms on one side of equation attempt at formula (1 slip) or to factorise both x values correct both y values correct and linked **SC** $(-1,10)$ B2, $(-8,3)$ B2 no working
	Total		**12**	

8.Jan 2008

5(a)	$(9+x)(1-x)$	M1 A1	 2	$\pm(9\pm x)(1\pm x)$ Correct factors
(b)	$25-\left(x^2+8x+16\right)=9-8x-x^2$	B1	1	AG
(c)(i)	$x=-4$ is line of symmetry	B1	1	
(ii)	Vertex is (–4, 25)	B1,B1	2	
(iii)		M1 B1 A1	 3	General ⋂ shape –9 and 1 marked on x-axis or stated 9 marked on y-axis and maximum to the left of y-axis Must continue below x-axis at both ends
	Total		**9**	

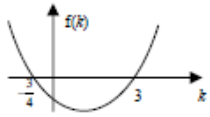
9.Jan 2008

7(a)	$x^2+7=k(3x+1)\Rightarrow x^2-3kx+7-k=0$	B1	1	AG
(b)	$b^2-4ac=(-3k)^2-4(7-k)$ (2 distinct roots when) $b^2-4ac>0$ $9k^2+4k-28>0$	M1 B1 A1	 3	Clear attempt at b^2-4ac Condone slip in one term of expression Must involve k CSO; AG
(c)	$(9k-14)(k+2)$ Critical points –2 and $\frac{14}{9}$ Sketch ∪ or sign diagram correct $k<-2,\ k>\frac{14}{9}$	M1 A1 M1 A1	 4	Factors or formula correct unsimplified +ve | –ve | +ve –2 | $\frac{14}{9}$
	Total		**8**	

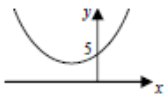
10.June 2008

4(a)	$\left(x-\frac{3}{2}\right)^2$	B1		Must have $(\ )^2$ $p=1.5$
	$+\frac{7}{4}$	B1	2	$q=1.75$
(b)	Minimum value is $\frac{7}{4}$	B1√	1	ft their q or correct value
(c)	**Translation** (and **no other** transformation stated)	E1		(**not** shift, move, transformation etc)
	through $\begin{bmatrix}\frac{3}{2}\\ \frac{7}{4}\end{bmatrix}$ (or equivalent in words)	M1		M1 for one component correct or ft their p or q values
		A1	3	CSO; condone 1.5 right and 1.75 up etc
	Total		6	

11.June 2008

8(a)	$b^2-4ac=16k^2-36(k+1)$	M1		Condone one slip
	Real roots: discriminant $\geqslant 0$	B1		
	$\Rightarrow 16k^2-36k-36\geqslant 0$			
	$\Rightarrow 4k^2-9k-9\geqslant 0$	A1	3	AG (watch signs)
(b)	$(4k+3)(k-3)$	M1		Or correct use of formula (unsimplified)
	critical points $(k=)\ -\frac{3}{4}$, 3	A1		Not in a form involving surds Values may be seen in inequalities etc
	 sketch	M1		Or sign diagram
	$k\geqslant 3,\quad k\leqslant -\frac{3}{4}$	A1	4	NMS full marks Condone use of word "and" but final answer in a form such as $3\leqslant k\leqslant -\frac{3}{4}$ scores A0
	Total		7	

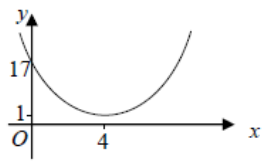
12.Jan 2009

Q	Solution	Marks	Total	Comments
4(a)(i)	$(x+1)^2$	B1		$p=1$
	$+\ 4$	B1	2	$q=4$
(ii)	$(x+1)^2\geqslant 0\Rightarrow (x+1)^2+4>0$	E1	1	Condone if they say $(x+1)^2$ *positive*
	$(\Rightarrow x^2+2x+5>0$ for all values of $x)$			and adding 4 so always positive
(b)(i)	$x=-1$ **or** $y=4$	M1		ft their $x=-p$ or $y=q$
	Minimum point is $(-1, 4)$	A1	2	
(ii)		B1		Sketch roughly as shown
		B1	2	y-intercept 5 or (0, 5) marked or stated
(c)	Translation (not shift, move etc)	E1		and NO other transformation stated
	through $\begin{bmatrix}-1\\ 4\end{bmatrix}$ (or 1 left, 4 up etc)	M1		either component correct or ft their $-p$, q
		A1	3	correct translation M1, A1 independent of E mark
	Total		10	

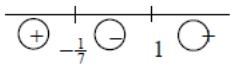
13.June 2009

Q	Solution	Marks	Total	Comments
6(a)(i)	$(x-4)^2$ *or* $p=4$	B1		ISW for $p=-4$ if $(x-4)^2$ seen
	$+1$ *or* $q=1$	B1	2	
(ii)	(Minimum value is) 1	B1√	1	Correct or FT "their q" (NOT coords)
(iii)	(Minimum occurs when $x=$)4	B1√	1	Correct or FT "their p" – may use calculus Condone (p, **) for this B1 mark
(b)(i)	$(x-5)^2 = x^2-10x+25$	B1	1	
(ii)	$(x-5)^2+(7-x-4)^2$ $=(x-5)^2+(3-x)^2$	M1		Condone one slip in one bracket May be seen under $\sqrt{\ }$ sign
	$=x^2-10x+25+9-6x+x^2$	A1		From a fully correct expression
	$AB^2 = 2x^2-16x+34$ $=2(x^2-8x+17)$	A1	3	AG CSO
(iii)	Minimum $AB^2 = 2\times$ "their (a)(ii)"	M1		Or use of their $x=4$ in expression Or use of their $B(4, 3)$ and $A(5, 4)$ in distance formula M0 if calculus used Answer only of $2\times$ "their (a)(ii)" scores M1, A0
	Minimum $AB=\sqrt{2}$	A1	2	
	Total		**10**	

14.Jan 2010

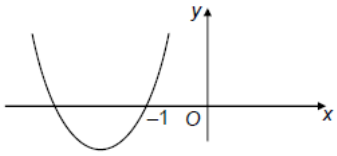
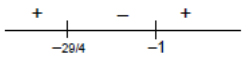
Q	Solution	Marks	Total	Comments
5(a)	$x^2-8x+15+2$	B1		Terms in x must be collected, PI
	their $(x-4)^2$ $(+k)$	M1		ft $(x-p)^2$ for their quadratic
	$=(x-4)^2+1$	A1	3	ISW for stating $p=-4$ if correct expression seen
(b)(i)		M1		∪ shape in any quadrant (generous)
		A1		correct with min at (4, 1) stated or 4 and 1 marked on axes condone within first quadrant only
		B1	3	crosses y-axis at (0, 17) stated or 17 marked on y-axis
(ii)	$y=k$	M1		$y=$ constant
	$y=1$	A1	2	Condone $y=0x+1$
(c)	Translation (*not shift, move etc*)	E1		and no other transformation
	with vector $\begin{bmatrix}4\\1\end{bmatrix}$	M1		One component correct or ft either their p or q
		A1	3	CSO; condone 4 across, 1 up; or two separate vectors etc
	Total		**11**	

15.June 2010

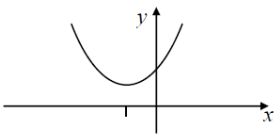
Q	Solution	Marks	Total	Comments
7(a)(i)	$2(x-5)^2$	B1		$p=5$
	$+3$	B1	2	$q=3$
(ii)	Stating both $(x-5)^2 \geqslant 0$ and $3>0$	M1		FT their p & q, but must have $q>0$
	$\Rightarrow 2x^2-20x+53>0$ *or* $2(x-5)^2+3>0$			
	$\Rightarrow 2x^2-20x+53=0$ has no real roots	A1cso	2	Must have statement and correct p & q.
(b)(i)	$b^2-4ac=(k+1)^2-4k(2k-1)$	M1		Condone one slip (including x is one slip)
	$=-7k^2+6k+1$	A1		Condone recovery from missing brackets
	real roots $\Rightarrow b^2-4ac \geqslant 0$			Their discriminant $\geqslant 0$ (in terms of k)
	$-7k^2+6k+1 \geqslant 0$	B1√		Need not be simplified & may earn earlier
	$\Rightarrow 7k^2-6k-1 \leqslant 0$	A1cso	4	AG (must see sign change)
(ii)	$(7k+1)(k-1)$	M1		**Correct** factors or **correct** use of formula
	Critical values $k=1, -\frac{1}{7}$	A1		May score M1, A1 for correct critical values seen as part of incorrect final answer with or without working.
	Use of sign diagram or sketch 	M1		If previous A1 earned, sign diagram or sketch must be correct for M1 Otherwise M1 may be earned for an attempt at the sketch or sign diagram using ***their*** critical values.
	$-\frac{1}{7} \leqslant k \leqslant 1$	A1	4	$\left(-\frac{1}{7}<k<1\right)$, $\left(k \geqslant -\frac{1}{7}\right.$ OR $\left.k \leqslant 1\right)$, $\left(k \geqslant -\frac{1}{7},\ k \leqslant 1\right)$ score M1A1M1A0
	Full marks for correct answer NMS			
	Condone $-\frac{2}{14}$ throughout			*Answer only of* $k<-\frac{1}{7}$, $k<1$ etc scores M1, A1, M0 since the critical values are evident.
	Condone $k \geqslant -\frac{1}{7}$ AND $k \leqslant 1$ for full marks			*Answer only of* $\frac{1}{7} \leqslant k \leqslant 1$ etc scores M0, M0 since the critical values are not both correct.
	Take their final line as their answer.			
	Total		**12**	

16.Jan 2011

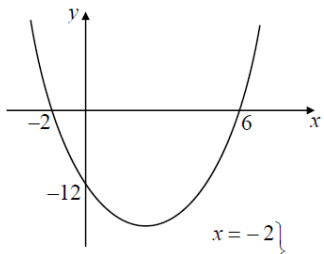
Q	Solution	Marks	Total	Comments
7(a)(i)	(−) $(x+5)^2$	M1		$q=5$; condone $(-x-5)^2$
	$29-(x+5)^2$	A1	2	$p=29$ and $q=5$
(ii)	$x=-5$ is line of symmetry	B1√	1	FT $x=-$ 'their q' or correct
(b)(i)	$4-10x-x^2=k(4x-13)$			
	$\Rightarrow x^2+4kx+10x-13k-4=0$			Must see both these lines OE
	$\Rightarrow x^2+2(2k+5)x-(13k+4)=0$	B1	1	AG all correct working and $=0$
(ii)	2 distinct roots $\Rightarrow b^2-4ac>0$	B1		stated or used (must be >0)
	Discriminant $=4(2k+5)^2+4(13k+4)$	M1		condone one slip (may be within formula)
	$4(4k^2+20k+25+13k+4)>0$			or $16k^2+132k+116>0$
	$\Rightarrow 4k^2+33k+29>0$	A1	3	AG >0 must appear before final line

(iii)	$(4k+29)(k+1)$	M1		correct factors or correct unsimplified quadratic equation formula $\frac{-33\pm\sqrt{33^2-4\times4\times29}}{8}$
	$k=-\frac{29}{4}$, $k=-1$	A1		condone $k=-\frac{58}{8}$, -7.25 etc but not left with square roots etc as above
$-\frac{29}{4}$		M1		sketch or sign diagram including values 
	$k<-\frac{29}{4}$, $k>-1$ ***Take their final line as their answer***	A1	4	condone use of **OR** but not **AND**
	Total		**11**	

17.June2011

Q	Solution	Marks	Total	Comments
4(a)	$(x+2.5)^2$	B1		$p=\frac{5}{2}$
	$q=7-\text{'their'}\,p^2$	M1		unsimplified attempt at $q=7-\text{'their'}\,p^2$ $q=7-\frac{25}{4}=\frac{3}{4}$
	$(x+2.5)^2+0.75$ ***mark their final line as their answer***	A1	3	
(b)(i)	$x=-$ 'their' p or $y=$ 'their' q	M1		or $x=-\frac{5}{2}$ cao found using calculus
	$\left(-\frac{5}{2},\ \frac{3}{4}\right)$	A1cao	2	condone correct coordinates stated $x=-2.5$, $y=0.75$
(ii)	$x=-\frac{5}{2}$	B1√	1	correct *or* ft "$x=-$ 'their' p"
(iii)		B1		y intercept = 7 stated or seen in table as $y=7$ when $x=0$ or 7 marked as intercept on y-axis (any graph)
		M1		∪ shape
		A1	3	vertex above x-axis in correct quadrant and parabola extending beyond y-axis into first quadrant
(c)	Translation	E1		and no other transformation
	through $\begin{bmatrix}-\frac{5}{2}\\ \frac{3}{4}\end{bmatrix}$	M1		ft either 'their' $-p$ or 'their' q or one component correct for M1
		A1cao	3	both components correct for A1; may describe in words or use a vector
	Total		**12**	

18.Jan 2012

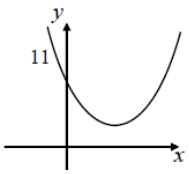
Q	Solution	Marks	Total	Comments
2(a)	$(x-6)(x+2)$	B1	1	ISW for $x=6$, $x=-2$ etc
(b)				
	$\left.\begin{array}{l} x=-2 \\ x=6 \end{array}\right\}$	B1√		correct x values *or* FT 'their' factors (x-intercepts stated ***or*** marked on sketch) may be seen in (a)
	$y=-12$	B1		(stated ***or*** −12 marked on sketch)
	∪ – shaped curve	M1		approximately
	"correct" shape in all 4 quadrants with minimum to right of y-axis	A1	4	
(c)(i)	$(x-2)^2$	M1		$p=2$
	$(x-2)^2-16$	A1	2	$p=2$ and $q=16$
(ii)	(Minimum value is) −16	B1√	1	FT 'their $-q$'
(d)	Replacing each x by $x+3$ **OR** adding 2 to their quadratic	M1		in original equation or 'their' completed square or factorised form or replacing y by $y-2$
	$\left.\begin{array}{l} y=\left[(x+3)^2-4(x+3)-12\right]+2 \\ \text{or} \quad y=(x+1)^2-14 \\ \text{or} \quad y=x^2+2x-13 \\ \text{or} \quad y-2=(x-3)(x+5) \end{array}\right\}$	A1	2	OE any correct equation in x and y **unsimplified**
	Total		**10**	

19.June 2012

Q	Solution	Marks	Total	Comments
5(a)(i)	$\left(x-\frac{3}{2}\right)^2$	M1		or $p=1.5$ stated
	$\left(x-\frac{3}{2}\right)^2+\frac{11}{4}$	A1	2	$(x-1.5)^2+2.75$
	Mark their final line as their answer			
(ii)	$x=\frac{3}{2}$	B1√	1	correct or FT their "$x=p$"
(b)(i)	$x^2-3x+5=x+5 \Rightarrow x^2=4x$	M1		eliminating x or y and collecting like terms (condone **one** slip) **or** $(y-5)^2-3(y-5)+5=y$ $\Rightarrow y^2-14y+45=0$
	$(x\neq 0) \quad \Rightarrow x=4$	A1		
	$y=9$	A1	3	

(ii)	$\frac{x^3}{3} - \frac{3x^2}{2} + 5x\ (+c)$	M1 A1 A1	3	one of these terms correct another term correct all correct (need not have $+c$)
(iii)	$[\ ]_0^4 = \frac{4^3}{3} - 3\times\frac{4^2}{2} + 5\times 4$ $= 17\frac{1}{3}$	M1 A1		must have earned M1 in part(b)(ii) $F(\text{their } x_B)\{-F(0)\}$ "correctly sub'd" $\left(\frac{64}{3} - 24 + 20 =\right)\ \frac{52}{3}$ or $\frac{104}{6}$ etc condone 17.3 but not $16\frac{4}{3}$ etc
	Area trapezium $= \frac{1}{2}(x_B)(5 + y_B)$ Area of shaded region $= 28 - 17\frac{1}{3}$ $= 10\frac{2}{3}$	B1√ A1	4	FT their numerical values of x_B, y_B Area $= \frac{1}{2}\times 4\times 14$ (= 28) CSO; $\frac{32}{3}$, accept 10.7 or better
	Total		**13**	

20.Jan 2013

Q	Solution	Marks	Total	Comments
4(a)(i)	$(x-3)^2$ $(x-3)^2 + 2$	M1 A1	2	or $p = 3$ seen
(ii)	$(x-3)^2 = -2$ No (real) square root of -2 therefore equation has no real solutions	M1 A1cso	2	FT their positive value of q **not** use of discriminant for graphical approach see below to see if SC1 can be awarded
(b)(i)	$x =$ 'their' p *or* $y =$ 'their' q Vertex is at (3, 2)	M1 A1cao	2	or $x = 3$ found using calculus
(ii)		B1 M1 A1	3	y intercept = 11 ***stated*** or ***marked on y***-axis (as y intercept of any graph) ∪ shape (generous) above x-axis , vertex in first quadrant crossing y-axis into second quadrant
(iii)	Translation through $\begin{bmatrix}-3\\-2\end{bmatrix}$	E1 M1 A1	3	and no other transformation FT negative of BOTH 'their' vertex coords **both** components **correct** for A1; may describe in words or use a column vector
	Total		**12**	

21.Jan 2006

4(a)	$(m+4)^2 = m^2 + 8m + 16$ $b^2 - 4ac = (m+4)^2 - 4(4m+1) = 0$ $m^2 + 8m + 16 - 16m - 4 = 0$ $\Rightarrow m^2 - 8m + 12 = 0$	B1 M1 A1	3	Condone $4m + 4m$ $b^2 - 4ac$ (attempted and involving m's and no x's) or $b^2 - 4ac = 0$ stated **AG** (be convinced – all working correct- $= 0$ appearing more than right at the end)
(b)	$(m-2)(m-6) = 0$ $m = 2$, $m = 6$	M1 A1	2	Attempt at factors or quadratic formula **SC B1** for 2 or 6 only without working
	Total		**5**	