1. (a) $x^2 - 3x - 10 = (x - 5)(x + 2)$ (M1)(A1) (C2)

(b) $x^2 - 3x - 10 = 0 \Rightarrow (x - 5)(x + 2) = 0$ (M1)

$\Rightarrow x = 5$ or $x = -2$ (A1) (C2)

[4]

2. (a) For a reasonable attempt to complete the square, (or expanding) (M1)

e.g. $3x^2 - 12x + 11 = 3(x^2 - 4x + 4) + 11 - 12$

$f(x) = 3(x - 2)^2 - 1$ (accept $h = 2$, $k = 1$) A1A1 N3

(b) **METHOD 1**

Vertex shifted to $(2 + 3, -1 + 5) = (5, 4)$ M1

so the new function is $3(x - 5)^2 + 4$ (accept $p = 5$, $q = 4$) A1A1 N2

METHOD 2

$g(x) = 3((x - 3) - h)^2 + k + 5 = 3((x - 3) - 2)^2 - 1 + 5$ M1

$= 3(x - 5)^2 + 4$ (accept $p = 5$, $q = 4$) A1A1 N2

[6]

3. (a) $p = -\frac{1}{2}$, $q = 2$ (A1)(A1) (C2)

or vice versa

(b) By symmetry C is midway between p, q (M1)

Note: *This (M1) may be gained by implication.*

$\Rightarrow x$-coordinate is $\frac{-\frac{1}{2} + 2}{2} = \frac{3}{4}$ (A1) (C2)

[4]

4. (a) $h = 3$ (A1)

$k = 2$ (A1) 2

(b) $f(x) = -(x - 3)^2 + 2$

$= -x^2 + 6x - 9 + 2$ (must be a correct expression) (A1)

$= -x^2 + 6x - 7$ (AG) 1

(c) $f'(x) = -2x + 6$ (A2) 2

(d) (i) tangent gradient $= -2$ (A1)

gradient of L $= \frac{1}{2}$

(A1) (N2) 2

(ii) **EITHER**

equation of L is $y = \frac{1}{2}x + c$ (M1)

$c = -1.$ (A1)

$y = \frac{1}{2}x - 1$

OR

$y - 1 = \frac{1}{2}(x - 4)$

(A2) (N2) 2

(iii) **EITHER**

$-x^2 + 6x - 7 = \frac{1}{2}x - 1$ (M1)

$2x^2 - 11x + 12 = 0$ (may be implied) (A1)

$(2x - 3)(x - 4) = 0$ (may be implied) (A1)

$x = 1.5$

(A1) (N3) 4

OR

$-x^2 + 6x - 7 = \frac{1}{2}x - 1$ (or a sketch) (M1)

$x = 1.5$

(A3) (N3) 8

[13]

5. Discriminant $\Delta = b^2 - 4ac$ $(= (-2k)^2 - 4)$ (A1)

$\Delta > 0$ (M2)

Note: *Award (M1)(M0) for* $\Delta \geq 0$.

$(2k)^2 - 4 > 0 \Rightarrow 4k^2 - 4 > 0$

EITHER

$4k^2 > 4$ $(k^2 > 1)$ (A1)

OR

$4(k - 1)(k + 1) > 0$ (A1)

OR

$(2k - 2)(2k + 2) > 0$ (A1)

THEN

$k < -1$ or $k > 1$ (A1)(A1) (C6)

Note: *Award (A1) for* $-1 < k < 1$.

[6]

6. $4x^2 + 4kx + 9 = 0$

Only one solution $\Rightarrow b^2 - 4ac = 0$ (M1)

$16k^2 - 4(4)(9) = 0$ (A1)

$k^2 = 9$

$k = \pm 3$ (A1)

But given $k > 0$, $k = 3$ (A1) (C4)

OR

One solution $\Rightarrow (4x^2 + 4kx + 9)$ is a perfect square (M1)

$4x^2 + 4kx + 9 = (2x \pm 3)^2$ by inspection (A2)

given $k > 0$, $k = 3$ (A1) (C4)

[4]

7. (a) $a = 3$, $b = 4$ (A1)

$f(x) = (x - 3)^2 + 4$ A1 (C2)

(b) $y = (x - 3)^2 + 4$

METHOD 1

$x = (y - 3)^2 + 4$ (M1)
$x - 4 = (y - 3)^2$
$\sqrt{x-4} = y - 3$ (M1)
$y = \sqrt{x-4} + 3$ (A1) 3

METHOD 2

$y - 4 = (x - 3)^2$ (M1)
$\sqrt{y-4} = x - 3$ (M1)
$\sqrt{y-4} + 3 = x$
$y = \sqrt{x-4} + 3$
$\Rightarrow f^{-1}(x) = \sqrt{x-4} + 3$ (A1) 3

(c) $x \geq 4$ (A1)(C1)

[6]

8. $(7 - x)(1 + x) = 0$ (M1)
$\Leftrightarrow x = 7$ or $x = -1$ (A1)(C1)(C1)
B: $x = \dfrac{7 + -1}{2} = 3$; (A1)
$y = (7 - 3)(l + 3) = 16$ (A1) (C2)

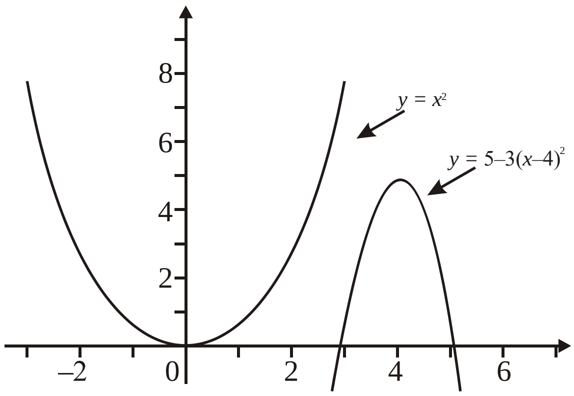
[4]

9. (a) $f(x) = x^2 - 6x + 14$
$f(x) = x^2 - 6x + 9 - 9 + 14$ (M1)
$f(x) = (x - 3)^2 + 5$ (M1)

(b) Vertex is (3, 5) (A1)(A1)

[4]

10.



$q = 5$ (A1) (C1)
$k = 3$, $p = 4$ (A3) (C3)

[4]

11. One solution $\Rightarrow$ discriminant = 0 (M2)

$3^2 - 4k = 0$ (A2)

$9 = 4k$

$k = \frac{9}{4}\left(= 2\frac{1}{4}, 2.25\right)$ (A2) (C6)

Note: *If candidates correctly solve an incorrect equation, award M2 A0 A2(ft), if they have the first line or equivalent, otherwise award no marks.*

[6]

12. (a) $2x^2 - 8x + 5 = 2(x^2 - 4x + 4) + 5 - 8$ (M1)

$= 2(x - 2)^2 - 3$ (A1)(A1)(A1)

=> $a = 2$, $p = 2$, $q = -3$ (C4)

(b) Minimum value of $2(x - 2)^2 = 0$ (or minimum value occurs when $x = 2$) (Ml)

$\Rightarrow$ Minimum value of $f(x) = -3$ (A1) (C2)

OR

Minimum value occurs at (2, –3) (M1)(A1) (C2)

[6]

13. (a) (i) $h = -1$ (A2) (C2)

(ii) $k = 2$ (A1) (C1)

(b) $a(1 + 1)^2 + 2 = 0$ (M1)(A1)

$a = -0.5$ (A1) (C3)

[6]

14. $y = (x + 2)(x - 3)$ (M1)

$= x^2 - x - 6$ (A1)

Therefore, $0 = 4 - 2p + q$ (A1)(A1)(C2)(C2)

OR

$y = x^2 - x - 6$ (C3)

OR

$0 = 4 - 2p + q$ (A1)

$0 = 9 + 3p + q$ (A1)

$p = -1$, $q = -6$ (A1)(A1)(C2)(C2)

[4]