

1	(a)		-4	1	B1
	(b)	$(f(2.6) = 5 \times 2.6 - 7 (= 6) \text{ or } gf(x) = \frac{5(5x-7)}{5x-7+4} \text{ oe}$		2	M1 for finding $f(2.6)$ or $gf(x)$
	(c)	$5\left(\frac{5x}{x+4}\right) - 7 = 2 \text{ or } \frac{5x}{x+4} = \frac{2+7}{5} \text{ oe}$	3	3	A1
		$25x = 9(x+4) \text{ oe}$			M1
					for removing the denominator $(x+4)$ in a correct equation
			2.25		A1
	ALT	$fg(x) = 2 \Rightarrow g(x) = f^{-1}(2) (=9/5) \text{ and attempt at } f^{-1}$			M1
	(c)	or $f^{-1}(2)$			
		$x = g^{-1}("9/5")$			M1
			2.25		A1
					oe
	(d)	$y = \frac{5x}{x+4} \quad \text{or} \quad x = \frac{5y}{y+4}$		3	M1
		$y(x+4) = 5x \quad x(y+4) = 5y$			
		e.g. $4y = x(5-y)$ or e.g. $4x = y(5-x)$			M1
					for a correct rearrangement and factorising
			$\frac{4x}{5-x}$		A1
					oe e.g. $\frac{-4x}{x-5}$
Total 9 marks					

2	c	$(g(2) = \frac{4}{2+3} \left(= \frac{4}{5} \right) \text{ oe}$			M1
			10.24	2	A1
					oe e.g. $\frac{256}{25}$

3		$(fg(x) = (x+3)^2 - 2(x+3) \text{ oe}$		5	M1 for substituting $g(x)$ into $f(x)$
		$(fg(x) = x^2 + 4x + 3$			A1 Allow $y^2 + 4y + 3$
		$(x+2)^2 - 4 + 3 \text{ or } (x+2)^2 - 1$			M1 ft (dep on M1) for correctly completing the square on their 3 term quadratic
		or			or
		$x^2 + 4x + (3-y) = 0 \text{ or}$			Correctly setting up an equation
		$y^2 + 4y + (3-x) = 0$			
		$(x+2)^2 = y+1 \text{ or } (y+2)^2 = x+1$			M1 ft (dep on M2) for a correct rearrangement for their completed the square quadratic
		or			or
		$x = \frac{-4 \pm \sqrt{16-4(3-y)}}{2} \text{ or } x = -2 \pm \sqrt{1+y}$			correctly substituting into the quadratic formula
					Allow same equations with x and y swapped
			$-2 + \sqrt{x+1}$		A1 oe
Total 5 marks					

4	(a)	$g(2) = 7 \times 2 - 6 (= 8)$ or $5(7 \times 2 - 6)^2 - 10(7 \times 2 - 6) + 7$		2	M1
		<i>Working not required, so correct answer scores full marks</i>	247		A1
	(b)	eg $y = 5(x^2 - 2x) + 7$ or $y = 5(x^2 - 2x + \frac{7}{5})$ oe	eg $x = 5(y^2 - 2y) + 7$ or $x = 5(y^2 - 2y + \frac{7}{5})$	4	M1
		eg $y = 5[(x-1)^2 - 1^2] + 7$ or $y = 5\left((x-1)^2 - 1^2 + \frac{7}{5}\right)$ oe	eg $x = 5((y-1)^2 - 1^2) + 7$ or $x = 5\left((y-1)^2 - 1^2 + \frac{7}{5}\right)$ oe		M1
		$(x-1)^2 = \frac{y-2}{5}$ oe	$(y-1)^2 = \frac{x-2}{5}$ oe		M1
		<i>Working not required, so correct answer scores full marks (unless from obvious incorrect working)</i>	$1 + \sqrt{\frac{x-2}{5}}$		A1
Total 6 marks					
	<i>Alternative for (b)</i>	Let $x = 5y^2 - 10y + 7$ [$\Leftrightarrow$] $5y^2 - 10y + (7-x) = 0$ oe		4	M1
		$[y =] \frac{10 \pm \sqrt{100 - 20(7-x)}}{10}$			M1
		$1 \pm \sqrt{\frac{x-2}{5}}$			M1
		<i>Working not required, so correct answer scores full marks (unless from obvious incorrect working)</i>	$1 + \sqrt{\frac{x-2}{5}}$		A1
Total 6 marks					

5	(a)	$g(3) = -7$ or $f(3-10) = (3-10)^2 + 6$ or $3^2 - 20 \times 3 + 106$ oe		2	M1
			55		A1
	(b)	$(x-10)^2 + 6 = x^2 + 6$		3	M1
		$x^2 - 10x - 10x + 100$ oe			M1
			5		A1
	(c)		0	1	B1
	(d)	eg $yx = 2x - 4$ oe or $xy = 2y - 4$ oe or $4 = 2x - yx$ or $4 = 2y - yx$		3	M1
		eg $4 = x(2-y)$ oe or $4 = y(2-x)$ oe or $\frac{4}{x} = 2-y$ or $\frac{4}{y} = 2-x$ or $\frac{4}{2-y} = x$ or $\frac{4}{2-x} = y$			M1
			$\frac{4}{2-x}$ or $\frac{-4}{x-2}$		A1
					oe
Total 9 marks					

6	$y = (x-4)^2 - 4^2 \text{ (+5) oe or } x = (y-4)^2 - 4^2 \text{ (+5)}$		3	M1	for a correct first step in order to complete the square
	$y = 4 \pm \sqrt{11+x} \text{ or } x = 4 \pm \sqrt{11+y}$			A1	allow $y = 4 + \sqrt{11+x}$ or $x = 4 + \sqrt{11+y}$
		$4 - \sqrt{x+11}$		A1	oe
Total 3 marks					
6 ALT	$x^2 - 8x + (5-y) = 0$ $(x =) \frac{8 \pm \sqrt{(-8)^2 - 4 \times 1 \times (5-y)}}{2 \times 1}$ or $y^2 - 8y + (5-x) = 0$ $(y =) \frac{8 \pm \sqrt{(-8)^2 - 4 \times 1 \times (5-x)}}{2 \times 1}$		3	M1	for a correct first step in preparation for use of quadratic formula and substitution into the quadratic formula (allow one sign error)
	$y = 4 \pm \sqrt{11+x} \text{ or } x = 4 \pm \sqrt{11+y}$			A1	allow $y = 4 + \sqrt{11+x}$ or $x = 4 + \sqrt{11+y}$
		$4 - \sqrt{x+11}$		A1	oe
Total 3 marks					

6 ALT	Using $ax^2 + bx + c = a(x+p)^2 + q$				
	$\left(p = \frac{b}{2a}\right) = \frac{-8}{2} (= -4) \text{ and } q = (4)^2 - 8(4) + 5 (= -11)$		3	M1	for finding p and q
	$y = 4 \pm \sqrt{11+x} \text{ or } x = 4 \pm \sqrt{11+y}$			A1	allow $y = 4 + \sqrt{11+x}$ or $x = 4 + \sqrt{11+y}$
		$4 - \sqrt{x+11}$		A1	oe
Total 3 marks					

7	eg $(fg(x)) = (2x+1)^2 - 4$		4	M1	for finding $fg(x)$
	eg $4x^2 + 4x - 3 (> 0)$ or $4x^2 + 4x - 3 (= 0)$ or $(2x+1)^2 > 4$ or $(2x+1)^2 = 4$			M1	For a correct expansion and $fg(x)$ written as a 3 term quadratic or a start to write quadratic in correct form for completing square
	$-\frac{3}{2}$ oe (and) $\frac{1}{2}$ oe			A1	for finding the two correct critical values (dep on previous M1) (values seen with any signs between)
		$x < -\frac{3}{2}, x > \frac{1}{2}$		A1	two fully correct inequalities, oe (dep on 2nd M1)
Total 4 marks					

8	(b)	$y(x-6) = 2x$ or $yx - 6y = 2x$	$x(y-6) = 2y$ or $xy - 6x = 2y$		3	M1 for multiplying the denominator
		$x(y-2) = 6y$	$y(x-2) = 6x$			M1 for isolating the x or y terms and factorising
				$\frac{6x}{x-2}$		A1 accept $\frac{-6x}{2-x}$ (must be a function of x)

9	$x^2 - 12x + 25$ $(x - 6)^2 - 6^2 + 25$ or $(x - 6)^2 - 11$ or $x^2 - 12x + (25 - y) = 0$ oe or $y^2 - 12y + (25 - x) = 0$ oe		4	M1 for substituting $g(x)$ into $f(x)$ M1 ft (dep on M1) for a correct first step in order to complete the square. Allow y in place of x . or Correctly setting up an equation = 0
	$(x - 6)^2 = y + 11$ or $(y - 6)^2 = x + 11$ or $x = \frac{12 \pm \sqrt{44 - 4(25 - y)}}{2}$ oe or $x = 6 \pm \sqrt{11 + y}$			M1 ft (dep on M2) for a correct rearrangement for their completed the square quadratic or correctly substituting into the quadratic formula (allow just + or just - instead of $\pm$) Allow same equations with x and y swapped
		$6 - \sqrt{1 + x}$		A1 oe must be in terms of x and have minus only before the square root.
Total 4 marks				

10	(a)	$(x - 3)^2$ or $(3 - x)^2$ or $(y - 3)^2$ or $(3 - y)^2$ 14 or - 14 $3 \pm \sqrt{14 - x}$ or $3 \pm \sqrt{4 - y}$		4	M1 M1 As part of an expression in x or y or an equation in x and y M1 Can be $\pm$ or - or +
			$3 + \sqrt{14 - x}$		A1 oe must be in x
10	alt (a)	Alternative method: $x^2 - 6x + (y - 5) = 0$ oe or $y^2 - 6y + (x - 5) = 0$ oe $y = \frac{6 \pm \sqrt{36 - 4(x - 5)}}{2}$ or $x = \frac{6 \pm \sqrt{36 - 4(y - 5)}}{2}$		4	M1 rearrange to form a quadratic in x or y terms can be in any order but must be in an equation equal to zero
		$3 \pm \sqrt{14 - x}$ or $3 \pm \sqrt{4 - y}$			M1 correct substitution into quadratic formula M1 Can be $\pm$ or - or +
			$3 + \sqrt{14 - x}$		A1 oe must be in x
	(b)		$x \leq 14$	1	B1 oe must fit from part (a) dep on an answer in correct form
Total 5 marks					

11	(b)	$(3x - 5)y = 2$ or $(3y - 5)x = 2$ or $3xy - 5y = 2$ or $3xy - 5x = 2$ oe or $3y - 5 = \frac{2}{x}$ or $3x - 5 = \frac{2}{y}$ oe		2	M1 remove denominator or get to the stage $3y - 5 = \frac{2}{x}$ or $3x - 5 = \frac{2}{y}$
		Correct answer scores full marks (unless from obvious incorrect working)	$\frac{2 + 5x}{3x}$		A1oe eg $\frac{2}{3x} + \frac{5}{3}$ or $\frac{\frac{2}{x} + 5}{3}$ must be in terms of x

12	(a)		$\frac{k}{x}$	1	B1 allow kx^{-1}
	(b)(i)		-46	1	B1 cao
	(ii)	$\frac{3(2 - 3x^4)}{2 - (2 - 3x^4)}$ or $\frac{6 - 9x^4}{2 - 2 + 3x^4}$ oe or $\frac{6 - 9x^4}{3x^4}$ oe		2	M1
		Correct answer scores full marks (unless from obvious incorrect working)	$\frac{2 - 3x^4}{x^4}$		A1 allow $\frac{2}{x^4} - 3$ oe
Total 4 marks					

13	$y = 3(x^2 - 4x) + 7$ or $y = 3\left(x^2 - 4x + \frac{7}{3}\right)$ or $\frac{y-7}{3} = x^2 - 4x$ or $y = 3(x-2)^2 \dots$		4	M1	for a correct equation for a first step to complete the square
	eg $y = 3((x-2)^2 - 2^2) + 7$ or $y = 3((x-2)^2 - 2^2 + \frac{7}{3})$ or $y = 3(x-2)^2 - 5$ oe or			M1	
	$(x-2)^2 = \frac{y+5}{3}$ oe eg $(x-2)^2 = \frac{y-7}{3} + 4$ or $x-2 = (\pm)\sqrt{\frac{y+5}{3}}$ oe			M1	
	<i>Correct answer scores full marks (unless from obvious incorrect working)</i>	$2 - \sqrt{\frac{x+5}{3}}$		A1 oe	NB: note only negative square root. Must be in terms of x any equivalent form
	Note: Allow candidates to swap x and y when finding the inverse				Total 4 marks
13 Alt	$3x^2 - 12x + (7 - y) = 0$		4	M1	for a correct first step
	$(x =) \frac{12 \pm \sqrt{144 - 12(7 - y)}}{6}$			M1	
	$(x =) 2 \pm \sqrt{\frac{60 + 12y}{36}}$ oe			M1	
	<i>Correct answer scores full marks (unless from obvious incorrect working)</i>	$2 - \sqrt{\frac{x+5}{3}}$		A1 oe	NB: note only negative square root. Must be in terms of x any equivalent form
					Total 4 marks

14	(a)		2.5	1	B1 oe e.g. $2\frac{1}{2}, \frac{5}{2}$ Accept $x = 2.5$ oe and $x \neq 2.5$ oe Any response that contains 2.5 oe is also acceptable, APART FROM $x > 2.5$ oe or $x < 2.5$ oe or $x \geq 2.5$ oe or $x \leq 2.5$ oe
	(b)	$(gh(x) =) \frac{11}{2(x^2 + 4) - 5} (=1)$		3	M1
		$11 - 3 = 2x^2$ oe eg $x^2 = 4$ or $2x^2 - 8 = 0$ or $x^2 - 4 = 0$			M1 correct expansion and rearrangement with x term on one side and number terms the other side or all terms on one side in an equation
		<i>Correct answer scores full marks (unless from obvious incorrect working)</i>	2		A1 cao, an answer of ± 2 gains M2 only If no other marks awarded, award SCB1 for answer of 2.2 oe
					Total 4 marks