Q1, (June 2005, Q1)

(i)	State $f(x) \le 10$	**B1**	**1** [Any equiv but must be or imply $\le$]
(ii)	Attempt correct process for composition of functions	**M1**	[whether algebraic or numerical]
	Obtain 6 or correct expression for $ff(x)$	**A1**	
	Obtain -71	**A1**	**3**

Q2, (Jan 2006, Q4)

(i) State $y \le 2$ — **B1** **1** [or equiv; allow <; allow any letter or none]

(ii) Show correct process for composition of functions — **M1** [numerical or algebraic]
Obtain 0 and hence 2 — **A1** **2** [and no other value]

(iii) State a range of values with 2 as one end-point — **M1** [continuous set, not just integers]
State $0 < k \le 2$ — **A1** **2** [with correct < and $\le$ now]

Q3, (Jun 2009, Q5)

(i) Either: Show correct process for comp'n — M1 — correct way round and in terms of x
Obtain $y = 3(3x+7) - 2$ — A1 — or equiv
Obtain $x = -\frac{19}{9}$ — A1 3 — or exact equiv; condone absence of $y = 0$

Or: Use $fg(x) = 0$ to obtain $g(x) = \frac{2}{3}$ — B1
Attempt solution of $g(x) = \frac{2}{3}$ — M1
Obtain $x = -\frac{19}{9}$ — A1 (3) — or exact equiv; condone absence of $y = 0$

(ii) Attempt formation of one of the equations
$3x + 7 = \frac{x-7}{3}$ or $3x + 7 = x$ or $\frac{x-7}{3} = x$ — M1 — or equiv
Obtain $x = -\frac{7}{2}$ — A1 — or equiv
Obtain $y = -\frac{7}{2}$ — A1√ 3 — or equiv; following their value of x

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(iii) Attempt solution of modulus equation — M1 — squaring both sides to obtain 3-term quadratics or forming linear equation with signs of $3x$ different on each side
Obtain $-12x + 4 = 42x + 49$ or $3x - 2 = -3x - 7$ — A1 — or equiv
Obtain $x = -\frac{5}{6}$ — A1 — or exact equiv; as final answer
Obtain $y = \frac{9}{2}$ — A1 4 — or equiv; and no other pair of answers

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Q4, (Jun 2006, Q6)

(i)	Either:	Obtain f(–3) = –7	**B1**		maybe implied
		Show correct process for compn of functions	**M1**		
		Obtain –47	**A1**	**3**	
	Or:	Show correct process for compn of functions	**M1**		using algebraic approach
		Obtain $2-(2-x^2)^2$	**A1**		or equiv
		Obtain –47	**A1**	**(3)**	
(ii)		Attempt correct process for finding inverse	**M1**		as far as $x = \ldots$ or equiv
		Obtain either one of $x = \pm\sqrt{2-y}$ or both	**A1**		or equiv perhaps involving x
		Obtain correct $-\sqrt{2-x}$	**A1**	**3**	or equiv; in terms of x now
(iii)		Draw graph showing attempt at reflection in $y = x$	**M1**		
		Draw (more or less) correct graph	**A1**		with end-point on x-axis and no minimum point in third quadrant
		Indicate coordinates 2 and $-\sqrt{2}$	**A1**	**3**	accept –1.4 in place of $-\sqrt{2}$

Q5, (Jan 2011, Q9ii)

Differentiate to obtain $2e^{2x} - 2ke^{-2x}$	B1		or unsimplified equiv
Attempt to find x-coordinate of stationary pt	M1		equating to 0 and reaching $e^{4x} = \ldots$ or equiv
Obtain $e^{4x} = k$ and hence $\frac{1}{4}\ln k$ or equiv	A1		or equiv such as $e^{2x} = \sqrt{k}$
Substitute and attempt simplification	M1		using valid processes but allow if only limited progress [note that question can be successfully concluded (without actually finding x) by substitution of $e^{2x} = \sqrt{k}$ and $e^{-2x} = \frac{1}{\sqrt{k}}$]
Obtain $g(x) \geq 2\sqrt{k}$ or $y \geq 2\sqrt{k}$	A1	**5**	or similarly simplified equiv with $\geq$ not $>$
		13	

Q6, (Jan 2013, Q8)

(i)		Attempt completion of square at least as far as $(x+2a)^2$ or differentiation to find stationary point at least as far as linear equation involving two terms	*M1
		Obtain $(x+2a)^2-3a^2$ or $(-2a,-3a^2)$	A1
		Attempt inequality involving appropriate y-value	M1
		State $y \geq -3a^2$ or $f(x) \geq -3a^2$	A1
			[4]
(ii)		Attempt composition of f and g the right way round	*M1
		Obtain or imply $16x^2-3a^2$ or $144-3a^2$	A1
		Attempt to find a from $fg(3)=69$	M1
		Obtain at least $a=5$	A1
		Attempt to solve $4x-10=x$ or $\frac{1}{4}(x+10)=x$ or $4x-10=\frac{1}{4}(x+10)$	M1
		Obtain $\frac{10}{3}$	A1
			[6]

Q7, (Jun 2013, Q7i,ii)

(i)		State $y>3$ or $f(x)>3$ or $f>3$ or 'greater than 3'	B1
			[1]
(ii)		Obtain expression or eqn involving $\ln(\frac{y-3}{4})$ or $\ln(\frac{x-3}{4})$	M1
		Obtain $\ln(\frac{4}{x-3})$ or $-\ln(\frac{x-3}{4})$	A1
		State domain is $x>3$ or equiv	B1FT
		State range is all real numbers or equiv	B1
			[4]

Q8, (Jun 2016, Q8)

i		State range of f is $f(x) \geq 3a$ or $y \geq 3a$ State range of g is all real numbers or equiv such as $y \in \mathbb{R}$ (real numbers)	B1 B1 **[2]**	Allow $f \geq 3a$ or equiv expression in words but $3a$ to be included
ii		State function is not 1 – 1 or different x-values give same y-value or equiv Obtain form $k(y+4a)$ or $k(x+4a)$ Obtain $\frac{1}{5}(x+4a)$ or $\frac{1}{5}x+\frac{4}{5}a$	B1 M1 A1 **[3]**	no credit for 'no inverse due to modulus' nor for 'cannot be reflected across $y = x$' for non-zero constant k Must finally be in terms of x
iii		Either Attempt composition of functions the right way round Obtain $5\lvert 2x+a\rvert +11a = 31a$ or equiv Or Apply their g^{-1} to $31a$ Obtain $\lvert 2x+a\rvert +3a = 7a$ or equiv Either Solve $2x+a=4a$ and obtain $\frac{3}{2}a$ Solve linear equation in which signs of (their) $2x$ and (their) $4a$ are different Obtain $-\frac{5}{2}a$	M1 A1 M1 A1 B1 FT M1 A1	Earned for 5(what they think f(x) is) – $4a$ Following their $\lvert 2x+a\rvert = ka$ Condone other sign slips And no others; obtaining $-\frac{5}{2}a$ and then concluding $\frac{5}{2}a$ is A0