

Q1, (June 2005, Q1)

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

Q2, (Jan 2006, Q4)

- (i)** State $y \leq 2$ **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 $0 < k \leq 2$ **A1 2** [with correct $<$ and \leq 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 $y = 0$
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- (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** $\sqrt{3}$ 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

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 $x = \dots$ 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 $e^{4x} = \dots$ 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 $>$

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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 Obtain $(x + 2a)^2 - 3a^2$ or $(-2a, -3a^2)$ Attempt inequality involving appropriate y -value State $y \geq -3a^2$ or $f(x) \geq -3a^2$	*M1 A1 M1 A1 [4]
(ii)	Attempt composition of f and g the right way round Obtain or imply $16x^2 - 3a^2$ or $144 - 3a^2$ Attempt to find a from $fg(3) = 69$ Obtain at least $a = 5$ Attempt to solve $4x - 10 = x$ or $\frac{1}{4}(x + 10) = x$ or $4x - 10 = \frac{1}{4}(x + 10)$ Obtain $\frac{10}{3}$	*M1 A1 M1 A1 M1 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 $\ln(\frac{x-3}{4})$ Obtain $\ln(\frac{4}{x-3})$ or $-\ln(\frac{x-3}{4})$ State domain is $x > 3$ or equiv State range is all real numbers or equiv	M1 A1 B1FT B1 [4]

Q8, (Jun 2016, Q8)

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