The Modulus Function Exam Questions (From OCR 4723)

Q1 (Jun 2007, Q2)

Identify critical value $x = 2$	B1		
Attempt process for determining both critical values	M1		
Obtain $\frac{1}{3}$ and 2	A1		
Attempt process for solving inequality	M1		table, sketch …; implied by plausible answer
Obtain $\frac{1}{3} < x < 2$	A1	**5**	

Q2 (Jun 2008, Q1)

Either: Obtain $x = 0$	**B1**		ignoring errors in working
Form linear equation with signs of $4x$ and $3x$ different	**M1**		ignoring other sign errors
State $4x - 5 = -3x + 5$	**A1**		or equiv without brackets
Obtain $\frac{10}{7}$ and no other non-zero value(s)	**A1**		or exact equiv
		4	
Or: Obtain $16x^2 - 40x + 25 = 9x^2 - 30x + 25$	**B1**		or equiv
Attempt solution of quadratic equation	**M1**		at least as far as factorisation or use of formula
Obtain $\frac{10}{7}$ and no other non-zero value(s)	**A1**		or exact equiv
Obtain 0	**B1**		ignoring errors in working
		4	

Q3 (Jun 2010, Q5)

(i) Attempt process for finding both critical values	M1		squaring both sides to obtain 3 terms on each side or considering 2 different linear eqns/inequalities
Obtain –4	A1		
Obtain $\frac{2}{3}$	A1		
Attempt process for solving inequality	M1		table, sketch, …; needs two critical values; implied by plausible answer
Obtain $-4 \leq x \leq \frac{2}{3}$	A1	**5**	with ≤ and not <
(ii) Use correct process to find value of $\lvert x+2 \rvert$ using any value	M1		… whether part of answer to **(i)** or not
Obtain $2\frac{2}{3}$ or $\frac{8}{3}$	A1	**2**	dependent on 5 marks awarded in part **(i)**
		7	

Q4 (Jan 2011, Q1)

Either:	Obtain $\frac{1}{3}a$	B1		condone $\lvert x\rvert = \frac{1}{3}a$
	Attempt solution of linear eqn	M1		with signs of $3x$ and $5a$ different; allow M1 only if a given particular value and no recovery occurs; allow M1 only if a in terms of x attempted; allow M1 only if double inequality attempted but with no recovery to state actual values of x
	Obtain $-3a$	A1	**3**	as final answer
Or:	Obtain $9x^2 + 24ax + 16a^2 = 25a^2$	B1		
	Attempt solution of 3-term quad eqn	M1		as far as substitution into correct quadratic formula or correct factorisation of their quadratic; allow M1 only if a given particular value
	Obtain $-3a$ and $\frac{1}{3}a$	A1	**(3)**	or equivs; as final answers; and no others
			3	

Q5 (Jun 2011, Q7)

(i)	Either: Attempt solution of at least one linear eq'n of form $ax + b = 12$	M1		
	Obtain $\frac{1}{3}$	A2	**3**	and (finally) no other answer
	Or: Attempt solution of 3-term quadratic eq'n obtained by squaring attempt at $g(x+2)$ on LHS and squaring 12 or -12 on RHS	M1		
	Obtain $\frac{1}{3}$	A2	**(3)**	and (finally) no other answer
(ii)	Either: Obtain $3(3x+5)+5$ for h	B1		
	Attempt to find inverse function	M1		of function of form $ax + b$
	Obtain $\frac{1}{9}(x-20)$	A1	**3**	or equiv in terms of x
	Or: State or imply g^{-1} is $\frac{1}{3}(x-5)$	B1		
	Attempt composition of g^{-1} with g^{-1}	M1		
	Obtain $\frac{1}{9}(x-5)-\frac{5}{3}$	A1	**(3)**	or more simplified equiv in terms of x
(iii)	State $x \leq 0$	B2	**2**	give B1 for answer $x < 0$
			8	

Q6 (Jun 2015, Q4)

Obtain $2a$ as one value of x	B1	
Attempt to find second value of x	M1	By solving equation with signs of x and $5a$ different, or by squaring both sides and attempting solution of quadratic equation with three terms
Obtain $-8a$	A1	And no other values of x
Substitute each of at most two values of x (involving a) leading to one final answer in each case and showing correct application of modulus signs in at least one case	M1	
Obtain $4a$ as final answer	A1	Obtained correctly from $x = 2a$
Obtain $-14a$ as final answer	A1	Obtained correctly from $x = -8a$
	[6]	

Q7 (Jun 2016, Q8)

i		State range of f is $f(x) \geq 3a$ or $y \geq 3a$	B1	Allow $f \geq 3a$ or equiv expression in words but $3a$ to be included
		State range of g is all real numbers or equiv such as $y \in \mathrm{R}$ (real numbers)	B1 **[2]**	
ii		State function is not 1 – 1 or different x-values give same y-value or equiv	B1	no credit for 'no inverse due to modulus' nor for 'cannot be reflected across $y = x$'
		Obtain form $k(y + 4a)$ or $k(x + 4a)$	M1	for non-zero constant k
		Obtain $\frac{1}{5}(x + 4a)$ or $\frac{1}{5}x + \frac{4}{5}a$	A1 **[3]**	Must finally be in terms of x
iii		Either Attempt composition of functions the right way round	M1	Earned for 5(what they think f(x) is) – $4a$
		Obtain $5\lvert 2x + a\rvert + 11a = 31a$ or equiv	A1	
		Or Apply their g^{-1} to $31a$	M1	
		Obtain $\lvert 2x + a\rvert + 3a = 7a$ or equiv	A1	
		Either Solve $2x + a = 4a$ and obtain $\frac{3}{2}a$	B1 FT	Following their $\lvert 2x + a\rvert = ka$
		Solve linear equation in which signs of (their) $2x$ and (their) $4a$ are different	M1	Condone other sign slips
		Obtain $-\frac{5}{2}a$	A1	And no others; obtaining $-\frac{5}{2}a$ and then concluding $\frac{5}{2}a$ is A0
		Or Square both sides and obtain $4x^2 + 4ax - 15a^2 = 0$	B1 FT	Following their $\lvert 2x + a\rvert = ka$
		Solve 3-term quadratic equation to obtain two values	M1	Allow M1 if factorisation wrong but expansion gives correct first and third terms; allow M1 if incorrect use of formula involves only one error
		Obtain $-\frac{5}{2}a$, $\frac{3}{2}a$	A1 **[5]**	And no others; continuing from two correct answers to conclude $\frac{5}{2}a$, $\frac{3}{2}a$ is A0

Q8 (Jan 2008, Q6)

(i)	Either:	Refer to translation and reflection	**B1**		in either order; allow clear equivs
		State translation by 1 in negative x-direction	**B1**		or equiv but now using correct terminology
		State reflection in x-axis	**B1**	**3**	using correct terminology
	Or:	Refer to translation and reflection	**B1**		in either order; allow clear equivs
		State reflection in y-axis	**B1**		
		State translation by 1 in positive x-direction	**B1**	**(3)**	with order reflection then translation clearly intended
(ii)	Show sketch with attempt at reflection of 'negative' part in x-axis		**M1**		and curve for $0<x<1$ unchanged
	Show (more or less) correct sketch		**A1**	**2**	with correct curvature
(iii)	Attempt correct process for finding at least one value		**M1**		as far as x = …; accept decimal equivs (degrees or radians) or expressions involving $\sin(\frac{1}{3}\pi)$
	Obtain $1-\frac{1}{2}\sqrt{3}$		**A1**		or exact equiv
	Obtain $1+\frac{1}{2}\sqrt{3}$		**A1**	**3**	or exact equiv; give **A1A0** if extra incorrect solution(s) provided

Q9 (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
(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
				10	