

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)

<u>Either:</u> 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
<u>Or:</u> 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 \leq and not $<$

(ii) Use correct process to find value of $ x + 2 $ 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)

<u>Either:</u> Obtain $\frac{1}{3}a$	B1	condone $ x = \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
<u>Or:</u> 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) <u>Either:</u> 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
<u>Or:</u> 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) <u>Either:</u> 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
<u>Or:</u> 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 $y \in \mathbb{R}$ (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	<u>Either</u> Attempt composition of functions the right way round	M1	Earned for 5(what they think $f(x)$ is) – $4a$
	Obtain $5 2x + a + 11a = 31a$ or equiv	A1	
	<u>Or</u> Apply their g^{-1} to $31a$	M1	
	Obtain $ 2x + a + 3a = 7a$ or equiv	A1	
	<u>Either</u> Solve $2x + a = 4a$ and obtain $\frac{3}{2}a$	B1 FT	Following their $ 2x + a = 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
	<u>Or</u> Square both sides and obtain	B1 FT	Following their $ 2x + a = ka$
$4x^2 + 4ax - 15a^2 = 0$			
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)

<p>(i) <u>Either</u>: Refer to translation and reflection State translation by 1 in negative x-direction</p> <p style="padding-left: 40px;">State reflection in x-axis</p> <p><u>Or</u>: Refer to translation and reflection State reflection in y-axis State translation by 1 in positive x-direction</p>	<p>B1 in either order; allow clear equivs B1 or equiv but now using correct terminology</p> <p>B1 3 using correct terminology B1 in either order; allow clear equivs B1 B1 (3) with order reflection then translation clearly intended</p>
<p>(ii) Show sketch with attempt at reflection of 'negative' part in x-axis Show (more or less) correct sketch</p>	<p>M1 and curve for $0 < x < 1$ unchanged A1 2 with correct curvature</p>
<p>(iii) Attempt correct process for finding at least one value</p> <p>Obtain $1 - \frac{1}{2}\sqrt{3}$ Obtain $1 + \frac{1}{2}\sqrt{3}$</p>	<p>M1 as far as $x = \dots$; accept decimal equivs (degrees or radians) or expressions involving $\sin(\frac{1}{3}\pi)$</p> <p>A1 or exact equiv A1 3 or exact equiv; give A1A0 if extra incorrect solution(s) provided</p>

Q9 (Jun 2009, Q5)

<p>(i) <u>Either</u>: Show correct process for comp'n Obtain $y = 3(3x + 7) - 2$ Obtain $x = -\frac{19}{9}$</p> <p><u>Or</u>: Use $fg(x) = 0$ to obtain $g(x) = \frac{2}{3}$ Attempt solution of $g(x) = \frac{2}{3}$ Obtain $x = -\frac{19}{9}$</p>	<p>M1 correct way round and in terms of x A1 or equiv A1 3 or exact equiv; condone absence of $y = 0$</p> <p>B1 M1 A1 (3) or exact equiv; condone absence of $y = 0$</p>

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

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