

C3 Inequality Answers

Specimen

3.  $9 > 2x - 5 > -9.$

B1, B1

$\therefore 14 > 2x > -4$

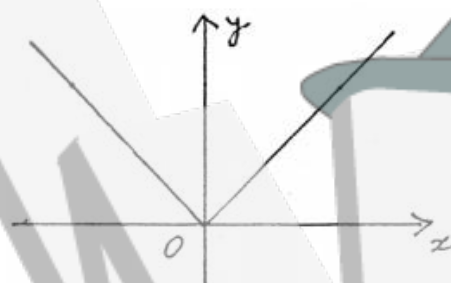
giving  $7 > x > -2$  or  $(-2, 7)$

B1 ( $7 > x$ )

B1 ( $x > -2$ )

2005 Summer

5. (a)



B1 (left hand side)

B1 (right hand side, award only if whole graph above  $x$ -axis)

(b)  $x = \pm \frac{1}{2}$

B1 (both)

(c)  $x > \frac{1}{3}, x < -3$

B1 ( $x > \frac{1}{3}$ ) M1 ( $3x + 4 < -5$ )

A1

[6]

2006 Winter

6. (a)  $3x - 8 \leq 5$

$$x \leq \frac{13}{3}$$

B1

$$3x - 8 \geq -5$$

M1

$$x \geq 1$$

$$1 \leq x \leq \frac{3}{13} \text{ (or } x \geq 1 \text{ and } x \leq \frac{3}{13} \text{)}$$

A1 (must indicate both conditions apply)

(b) Graphs

M1 (for  $|x|$ , V shape through origin)  
A1 (translation in +ve y direction, cusp at  $(\pm 2, 1)$ )  
A1 (cusp at  $(-2, 1)$ )  
A1 (correct relative positions)

2006 Summer

6. (a)  $5|x| = 2$

$$x = \pm \frac{2}{5}$$

B1

B1 (both)

(F.T.  $a|x| = b$ )

(b)  $7x - 5 \geq 3$

$$x \geq \frac{8}{7}$$

B1

$$7x - 5 \leq -3$$

M1 ( $7x - 5 \leq -3$ )

$$x \leq \frac{2}{7}$$

A1

5

2007 Summer

4. (a) Graph

B1

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Graph

M1 (shape)

A1 ((0, 4))

A1 ( $(\pm 2, 0)$ )

(b)  $5x - 3 > 4$   
 $x > \frac{7}{5}$

B1

or  $5x - 3 < -4$   
 $x < -\frac{1}{5}$

M1

A1 (must have 'or' in either part)

(o.e.)

Alternatively  
 $(5x - 3)^2 > 16$

M1 (forming quadratic and attempting to solve)

$25x^2 - 30x - 7 > 0$   
 $(5x + 1)(5x - 7) > 0$

$-\frac{1}{5}, \frac{7}{5}$

A1 (fixed points)

$x < -\frac{1}{5}$  or  $x > \frac{7}{5}$

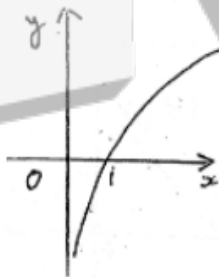
(o.e.)

A1 (F.T. fixed points)

2008 Winter

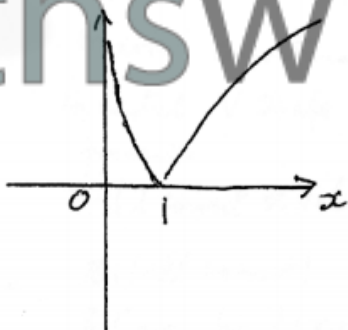
6.

(a) (i)



(i) M1 (shape)  
 A1((1,0), all correct)

(ii)



M1 (graph above x-axis and former shape for  $x > 1$ )  
 A1 ( $x < 1$  correct)  
 F.T -ve parts of graph from (i))

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(b)  $3x - 2 < 4$   
 $x < 2$

B1

$3x - 2 > -4$   
 $x > -\frac{2}{3}$

M1 ( $3x - 2 > -4$ )

A1

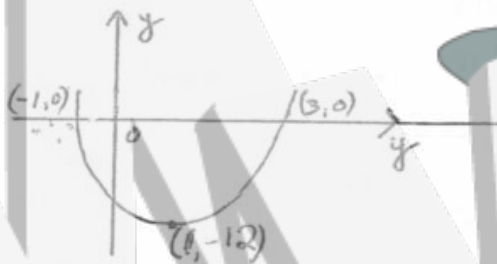
$x > -\frac{2}{3}$  and  $x < 2$

A1 (must indicate both conditions, C.A.O)

(8)

2008 Summer

6. (a)



B1 (2 correct x values)

B1 ( $y = -12$  for st pt)

B1 (all correct, correct shape)

(b)  $4|x| = 1$   
 $x = \pm \frac{1}{4}$

B1 ( $a|x| = b$ ,  $a = 4$ ,  $b = 1$ )

B1 (both values, F.T.  $a$ ,  $b$ )

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(c)  $2x - 9 > 3$   
 $x > 6$  B1

or

$2x - 9 < -3$  M1  
 $x > 3$  A1  
 $x > 6$  or  $x > 3$  (o.e.) e.g.  $(-\infty, 3) \cup (6, \infty)$  A1 (answer must contain 'or') (o.e.)

alternatively

$(2x - 9)^2 > 9$   
 $4x^2 - 36x + 72 > 0$   
 $x^2 - 9x + 18 > 0$   
 $(x - 3)(x - 6) > 0$   
 $x > 6$  or  $x < 3$

B1 (for  $x > 6$ )

M1 A1 for  $x < 3$

A1 for union of intervals

9

2009 Winter

6. (a)  $2|x| + 9 = 5|x| + 5$

$3|x| = 4$

$x = \pm \frac{4}{3}$

B1  $\left( \begin{array}{l} a | x | = b \\ a = 3, b = 4 \end{array} \right)$

B1 (both values)

(F.T.  $a, b$ )

(b)  $5x + 7 \leq -4, x \leq -\frac{3}{5}$  B1

and  $5x + 7 \geq -4$  M1

$x \geq -\frac{11}{5}$

$-\frac{11}{5} \leq x \leq -\frac{3}{5}$  A1

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(5)

2009 Summer

6. (a)  $9x - 7 \leq 3, \quad x \leq \frac{10}{9}$  B1

and

$9x - 7 \geq -3$  M1

$x \geq \frac{4}{9}$  (answer must involve the word 'and' o.e.) A1

$\frac{4}{9} \leq x \leq \frac{10}{9}$  (Note: lose A1 for the omission of '=')

**Alternative Scheme:**  $(9x - 7)^2 \leq 9$

$81x^2 - 126x + 40 \leq 0$

$(9x - 10)(9x - 4)$  B1

Any method M1

Correct answer A1

(b)  $5|x| + 1 = 9$

$5|x| = 8$

$x = \pm \frac{8}{5}$

$(a|x| = b; a = 5, b = 8)$  B1

(both answers, F.T. a, b) B1

2010 Winter

7. (a)  $2|x + 1| - 3 = 7 \Rightarrow |x + 1| = 5$  B1  
 $x = 4, -6$  B1

(b) Trying to solve either  $5x - 8 \geq 3$  or  $5x - 8 \leq -3$  M1

$5x - 8 \geq 3 \Rightarrow x \geq 2.2$

$5x - 8 \leq -3 \Rightarrow x \leq 1$

Required range:  $x \leq 1$  or  $x \geq 2.2$  (both inequalities) A1

(f.t. one slip) A1

**Alternative mark scheme**

$(5x - 8)^2 \geq 9$  (forming and trying to solve quadratic) M1

Critical points  $x = 1$  and  $x = 2.2$  A1

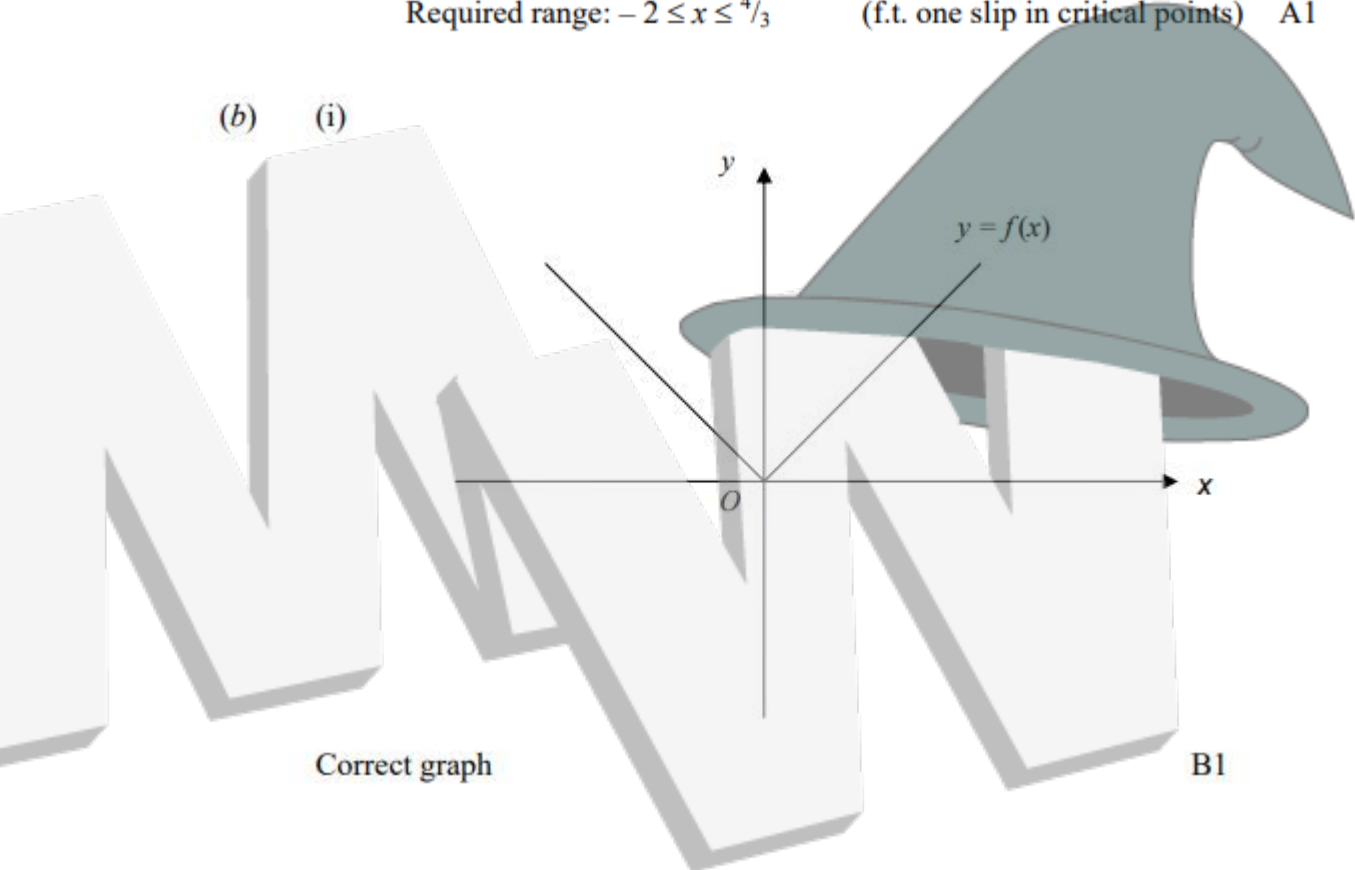
Required range:  $x \leq 1$  or  $x \geq 2.2$  (f.t. one slip in critical points) A1

7. (a) Trying to solve either  $3x + 1 \leq 5$  or  $3x + 1 \geq -5$  M1  
 $3x + 1 \leq 5 \Rightarrow x \leq \frac{4}{3}$   
 $3x + 1 \geq -5 \Rightarrow x \geq -2$  (both inequalities) A1  
 Required range:  $-2 \leq x \leq \frac{4}{3}$  (f.t. one slip) A1

**Alternative mark scheme**

- $(3x + 1)^2 \leq 25$  (forming and trying to solve quadratic) M1  
 Critical points  $x = -2$  and  $x = \frac{4}{3}$  A1  
 Required range:  $-2 \leq x \leq \frac{4}{3}$  (f.t. one slip in critical points) A1

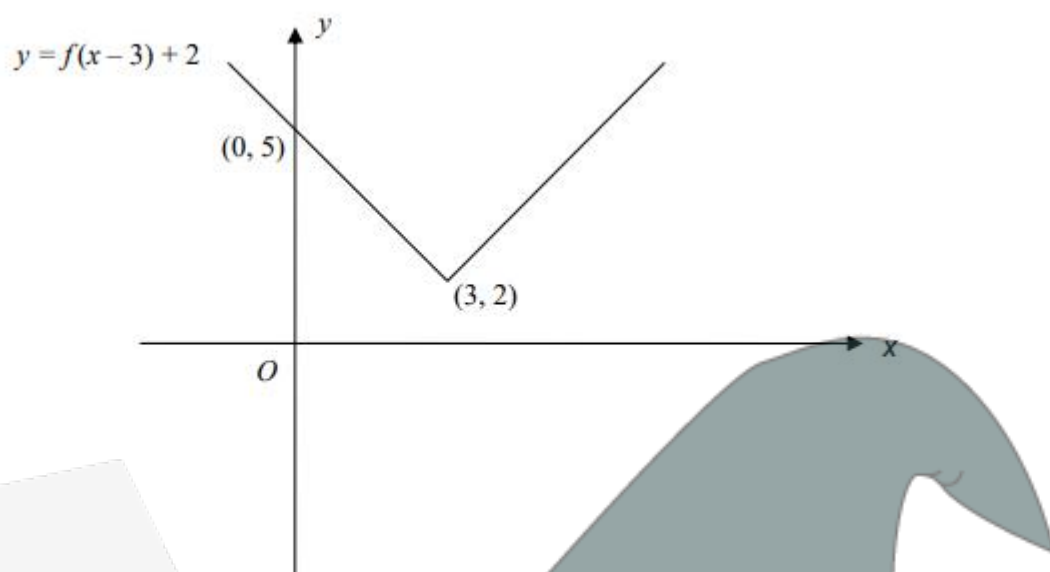
(b) (i)



Correct graph

B1

(ii)



Translation of graph of  $f(x) = |x|$  with vertex at  $(\pm 3, \pm 2)$  M1  
Coordinates of vertex =  $(3, 2)$  A1  
Crosses  $y$ -axis at  $(0, 5)$  A1

2011 Winter

7. (a)  $8|x| = 6$  B1  
 $x = \pm \frac{3}{4}$  A1  
(f.t. candidate's  $a|x| = b$ , with at least one of  $a, b$  correct) B1

(b) Trying to solve either  $3x - 1 > 5$  or  $3x - 1 < -5$  M1  
 $3x - 1 > 5 \Rightarrow x > 2$   
 $3x - 1 < -5 \Rightarrow x < -\frac{4}{3}$  (both inequalities) A1  
Required range:  $x < -\frac{4}{3}$  or  $x > 2$  (f.t. one slip) A1

**Alternative mark scheme**

$(3x - 1)^2 > 25$  (forming and trying to solve quadratic) M1  
Critical values  $x = -\frac{4}{3}$  and  $x = 2$  A1  
Required range:  $x < -\frac{4}{3}$  or  $x > 2$  (f.t. one slip in critical values) A1



2011 Summer

7. (a) Choice of  $a, b$ , with one positive and one negative and one side correctly evaluated M1  
 Both sides of identity evaluated correctly A1
- (b) Trying to solve  $2x + 1 = 3x - 4$  M1  
 Trying to solve  $2x + 1 = -(3x - 4)$  M1  
 $x = 5, x = 0.6$  (both values) A1
- Alternative mark scheme**  
 $(2x + 1)^2 = (3x - 4)^2$  (squaring both sides) M1  
 $5x^2 - 28x + 15 = 0$  (c.a.o.) A1  
 $x = 5, x = 0.6$  (both values, f.t. one slip in quadratic) A1

2012 Winter

7. (a) Trying to solve either  $4x - 5 \geq 3$  or  $4x - 5 \leq -3$  M1  
 $4x - 5 \geq 3 \Rightarrow x \geq 2$   
 $4x - 5 \leq -3 \Rightarrow x \leq \frac{1}{2}$  (solving both inequalities correctly) A1  
 Required range:  $x \leq \frac{1}{2}$  or  $x \geq 2$  (f.t. one slip) A1
- Alternative mark scheme**  
 $(4x - 5)^2 \geq 9$  (forming and trying to solve quadratic) M1  
 Critical values  $x = \frac{1}{2}$  and  $x = 2$  A1  
 Required range:  $x \leq \frac{1}{2}$  or  $x \geq 2$  (f.t. one slip) A1
- (b)  $(3|x| + 1)^{1/3} = 4 \Rightarrow 3|x| + 1 = 4^3$  M1  
 $x = \pm 21$  A1

2012 Summer

7. (a)  $9|x - 3| = 6$  B1  
 $x - 3 = \pm \frac{2}{3}$  (f.t. candidate's  $a|x - 3| = b$ ,  
 with at least one of  $a, b$  correct) B1
- $x = \frac{11}{3}, \frac{7}{3}$  (f.t. candidate's  $a|x - 3| = b$ ,  
 with at least one of  $a, b$  correct) B1

- (b) Trying to solve either  $5x - 2 \leq 3$  or  $5x - 2 \geq -3$  M1  
 $5x - 2 \leq 3 \Rightarrow x \leq 1$   
 $5x - 2 \geq -3 \Rightarrow x \geq -\frac{1}{5}$  (both inequalities) A1  
 Required range:  $-\frac{1}{5} \leq x \leq 1$  (f.t. one slip) A1

**Alternative mark scheme**

- $(5x - 2)^2 \leq 9$  (forming and trying to solve quadratic) M1  
 Critical points  $x = -\frac{1}{5}$  and  $x = 1$  A1  
 Required range:  $-\frac{1}{5} \leq x \leq 1$  (f.t. one slip) A1

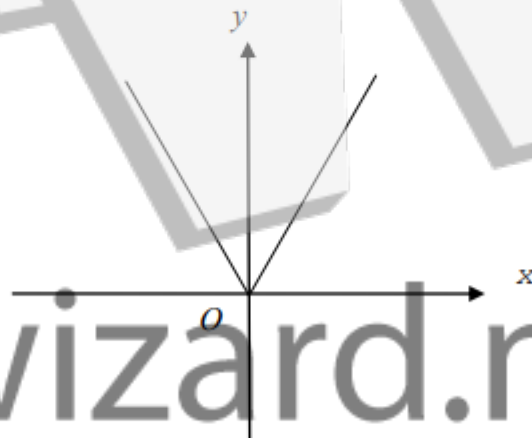
2013 Winter

7. (a) Trying to solve either  $3x - 4 > 5$  or  $3x - 4 < -5$  M1  
 $3x - 4 > 5 \Rightarrow x > 3$   
 $3x - 4 < -5 \Rightarrow x < -\frac{1}{3}$  (both inequalities) A1  
 Required range:  $x < -\frac{1}{3}$  or  $x > 3$  (f.t. one slip) A1

**Alternative mark scheme**

- $(3x - 4)^2 > 25$   
 (squaring both sides, forming and trying to solve quadratic) M1  
 Critical values  $x = -\frac{1}{3}$  and  $x = 3$  A1  
 Required range:  $x < -\frac{1}{3}$  or  $x > 3$  (f.t. one slip in critical values) A1

- (b) (i)



- (ii)  $a = -2$  B1  
 $b = -4$  B1

2013 Summer

7. (a) Choice of  $a \neq -1$  and  $b = -a - 2$  M1  
 Correct verification that given equation is satisfied A1
- (b) Trying to solve either  $x^2 - 10 \leq 6$  or  $x^2 - 10 \geq -6$  M1  
 $x^2 - 10 \leq 6 \Rightarrow x^2 \leq 16$   
 $x^2 - 10 \geq -6 \Rightarrow x^2 \geq 4$  (both inequalities) A1  
 At least one of:  $2 \leq x \leq 4, -4 \leq x \leq -2$  (f.t. one slip) A1  
 Required range:  $2 \leq x \leq 4$  or  $-4 \leq x \leq -2$  (c.a.o.) A1

**Alternative mark scheme**

- $(x^2 - 10)^2 \leq 36$  (forming and trying to solve quadratic in  $x^2$ ) M1  
 Critical values  $x^2 = 4$  and  $x^2 = 16$  A1  
 At least one of:  $2 \leq x \leq 4, -4 \leq x \leq -2$  (f.t. one slip) A1  
 Required range:  $2 \leq x \leq 4$  or  $-4 \leq x \leq -2$  (c.a.o.) A1

2014 Winter

8. Trying to solve  $3x + 4 = 2(x - 3)$  M1  
 Trying to solve  $3x + 4 = -2(x - 3)$  M1  
 $x = -10, x = 0.4$  (c.a.o.) A1

**Alternative mark scheme**

- $(3x + 4)^2 = [2(x - 3)]^2$  (squaring both sides) M1  
 $5x^2 + 48x - 20 = 0$  (at least two coefficients correct) A1  
 $x = -10, x = 0.4$  (c.a.o.) A1

2014 Summer

8. (a) Choice of  $a, b$ , with one positive and one negative and one side correctly evaluated M1  
 Both sides of identity evaluated correctly A1

- (b) Trying to solve  $3x - 2 = 7x$  M1  
 Trying to solve  $3x - 2 = -7x$  M1  
 $x = -0.5, x = 0.2$  (both values) (c.a.o.) A1

**Alternative mark scheme**

- $(3x - 2)^2 = 7^2 \times x^2$  (squaring both sides) M1  
 $40x^2 + 12x - 4 = 0$  (o.e.) (c.a.o.) A1  
 $x = -0.5, x = 0.2$  (both values, f.t. one slip in quadratic) A1

2015

8. (a) Trying to solve either  $3x - 5 \leq 1$  or  $3x - 5 \geq -1$  M1  
 $3x - 5 \leq 1 \Rightarrow x \leq 2$   
 $3x - 5 \geq -1 \Rightarrow x \geq \frac{4}{3}$  (both inequalities) A1  
 Required range:  $\frac{4}{3} \leq x \leq 2$  (f.t. one slip) A1

**Alternative mark scheme**

- $(3x - 5)^2 \leq 1$   
 (squaring both sides, forming and trying to solve quadratic) M1  
 Critical values  $x = \frac{4}{3}$  and  $x = 2$  A1  
 Required range:  $\frac{4}{3} \leq x \leq 2$  (f.t. one slip in critical values) A1

- (b)  $\frac{4}{3} \leq 1/y \leq 2$  (f.t. candidate's  $a \leq x \leq b, a > 0, b > 0$ ) M1  
 $\frac{1}{2} \leq y \leq \frac{3}{4}$  (f.t. candidate's  $a \leq x \leq b, a > 0, b > 0$ ) A1

2016

8. (a) Choice of  $a, b, c, d$  such that  $a$  is a factor of  $c$  and  $b$  is a factor of  $d$  M1  
 Correctly verifying that the candidate's  $a, b, c, d$  are such that  $(a + b)$  is not a factor of  $(c + d)$  and a statement to the effect that this is the case A1

- (b) Trying to solve  $5x + 4 = -7x$  M1  
 Trying to solve  $5x + 4 = 7x$  M1  
 $x = -1/3, x = 2$  (c.a.o.) A1  
 $x = -1/3$  (c.a.o.) A1

**Alternative mark scheme**

- $(5x + 4)^2 = (-7x)^2$  (squaring both sides) M1  
 $24x^2 - 40x - 16 = 0$  (at least two coefficients correct) A1  
 $x = -1/3, x = 2$  (c.a.o.) A1  
 $x = -1/3$  (c.a.o.) A1

- (c) (i)  $a = 5, -3$  B1  
 (ii)  $b = -\frac{2}{3}$  B1