

Question 1

**c(i)**

**15 marks**

**Att 5**

Forming Equations

$$f(x) = 4x^2 + bx + c$$

$$f(2) = 6$$

$$4(2)^2 + b(2) + c = 6$$

$$16 + 2b + c = 6$$

$$2b + c + 10 = 0$$

$$f(-1) = 0$$

$$4(-1)^2 + b(-1) + c = 0$$

$$4 - b + c = 0$$

$$-b + c = -4$$

Solving

$$2b + c = -10 \quad \times -1$$

$$-b + c = -4$$

$$-2b - c = 10$$

$$\underline{-b + c = -4}$$

$$-3b = 6$$

$$b = -2$$

$$b = -2$$

$$2b + c = -10$$

$$2(-2) + c = -10$$

$$-4 + c = -10$$

$$c = -6$$

**c(ii)**

**5 marks**

**Att 2**

**c(ii)**

$$4x^2 - 2x - 6 = -6$$

$$4x^2 - 2x = 0$$

$$2x(2x - 1) = 0$$

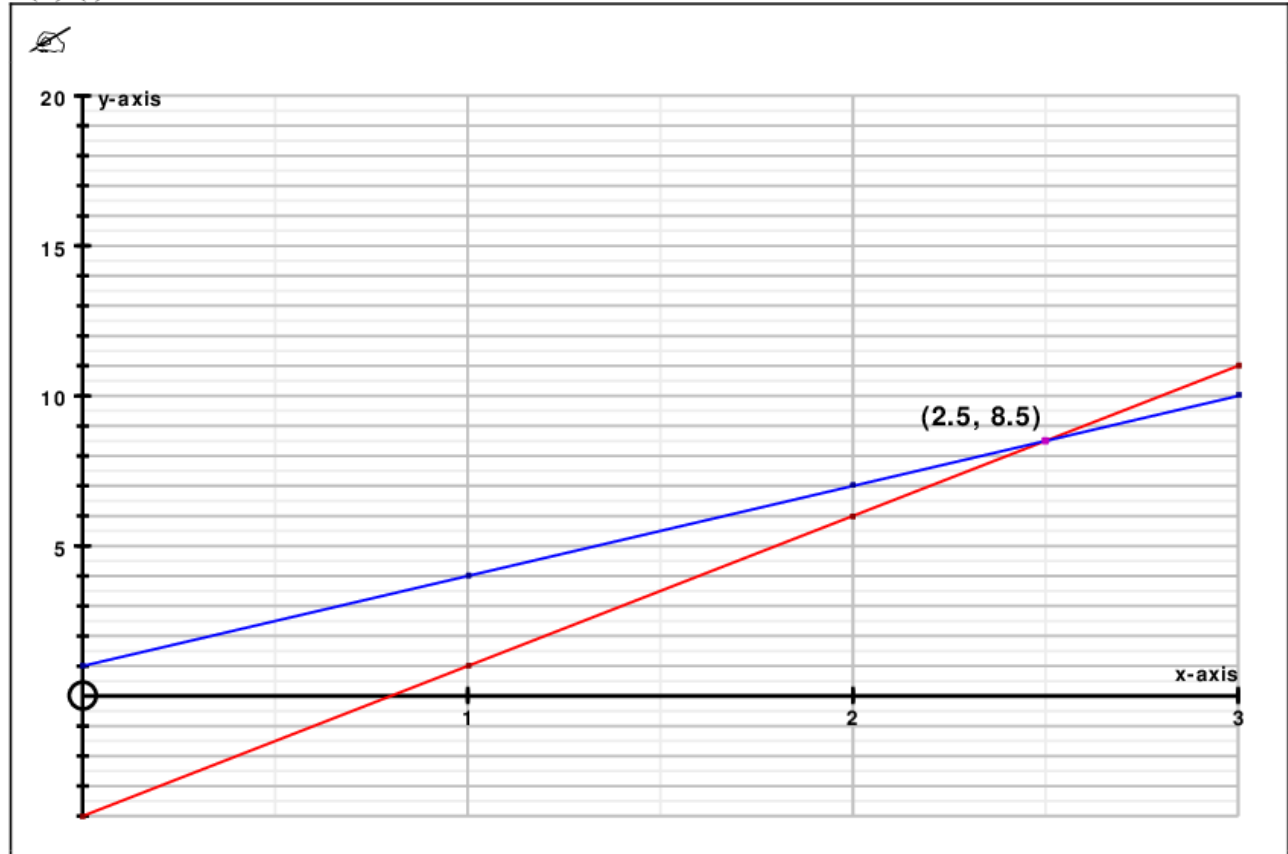
$$2x - 1 = 0 \quad \text{or} \quad 2x = 0$$

$$x = \frac{1}{2} \quad x = 0$$

(b) (i)

15 marks

Att 5



					<b>I</b>					
$f(x) = 5x - 4$						$g(x) = 3x + 1$				
$f(0) = 5(0) - 4 = 0 - 4 = -4 \rightarrow (0, -4)$						$g(0) = 3(0) + 1 = 0 + 1 = 1 \rightarrow (0, 1)$				
$f(1) = 5(1) - 4 = 5 - 4 = 1 \rightarrow (1, 1)$						$g(1) = 3(1) + 1 = 3 + 1 = 4 \rightarrow (1, 4)$				
$f(2) = 5(2) - 4 = 10 - 4 = 6 \rightarrow (2, 6)$						$g(2) = 3(2) + 1 = 6 + 1 = 7 \rightarrow (2, 7)$				
$f(3) = 5(3) - 4 = 15 - 4 = 11 \rightarrow (3, 11)$						$g(3) = 3(3) + 1 = 9 + 1 = 10 \rightarrow (3, 10)$				
					<b>II</b>					
$x$	0	1	2	3		$x$	0	1	2	3
$5x$	0	5	10	15		$3x$	0	3	6	9
$-4$	$-4$	$-4$	$-4$	$-4$		$+1$	$+1$	$+1$	$+1$	$+1$
$f(x)$	$-4$	$1$	$6$	$11$		$g(x)$	$1$	$4$	$7$	$10$
Points	$(0, -4)$	$(1, 1)$	$(2, 6)$	$(3, 11)$		Points	$(0, 1)$	$(1, 4)$	$(2, 7)$	$(3, 10)$

(b) (ii)

5 marks

Att 2

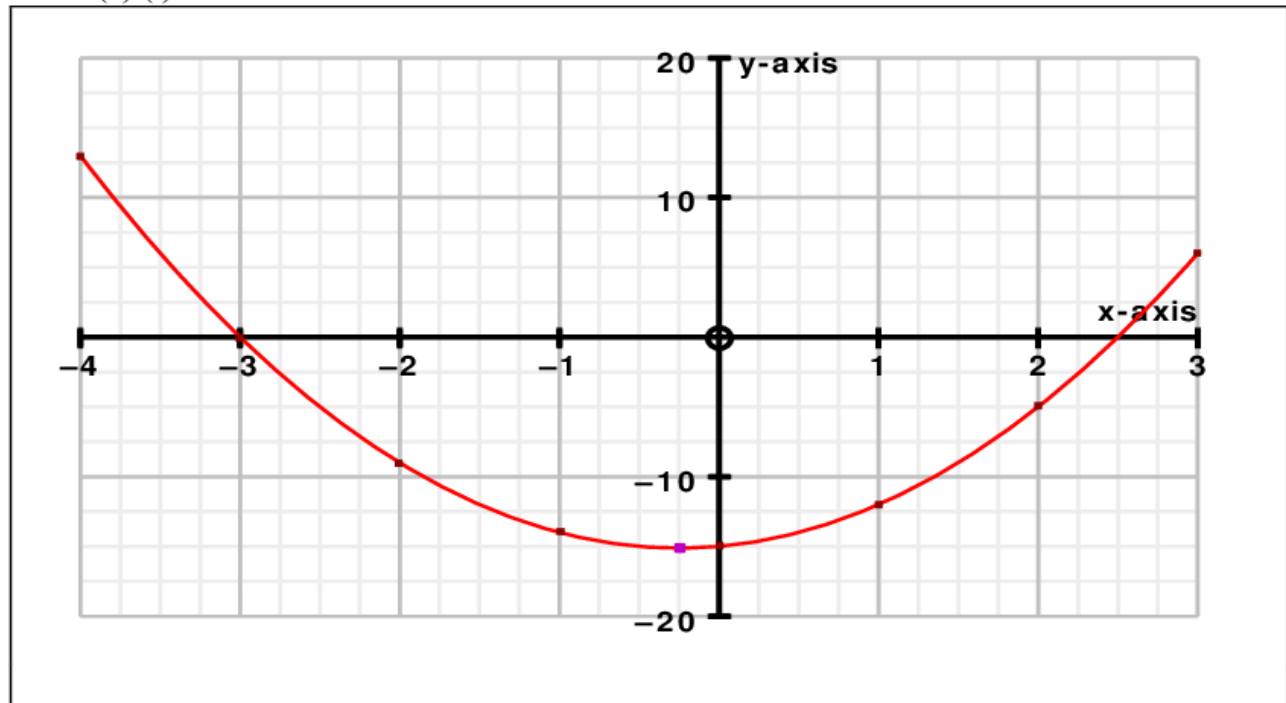
Point of intersection:  $(2.5, 8.5)$

5 (c) (i) ✍ Draw the graph of  $f$  for  $-4 \leq x \leq 3$ ,  $x \in \mathbf{R}$ .

Part (c) (i)

10 marks

Att3



**I**

$$f(x) = 2x^2 + x - 15$$

$$f(-4) = 2(-4)^2 + (-4) - 15 = 2(16) - 4 - 15 = 32 - 19 = 13 \rightarrow (-4, 13)$$

$$f(-3) = 2(-3)^2 + (-3) - 15 = 2(9) - 3 - 15 = 18 - 18 = 0 \rightarrow (-3, 0)$$

$$f(-2) = 2(-2)^2 + (-2) - 15 = 2(4) - 2 - 15 = 8 - 17 = -9 \rightarrow (-2, -9)$$

$$f(-1) = 2(-1)^2 + (-1) - 15 = 2(1) - 1 - 15 = 2 - 16 = -14 \rightarrow (-1, -14)$$

$$f(0) = 2(0)^2 + (0) - 15 = (0) - 0 - 15 = 0 - 15 = -15 \rightarrow (0, -15)$$

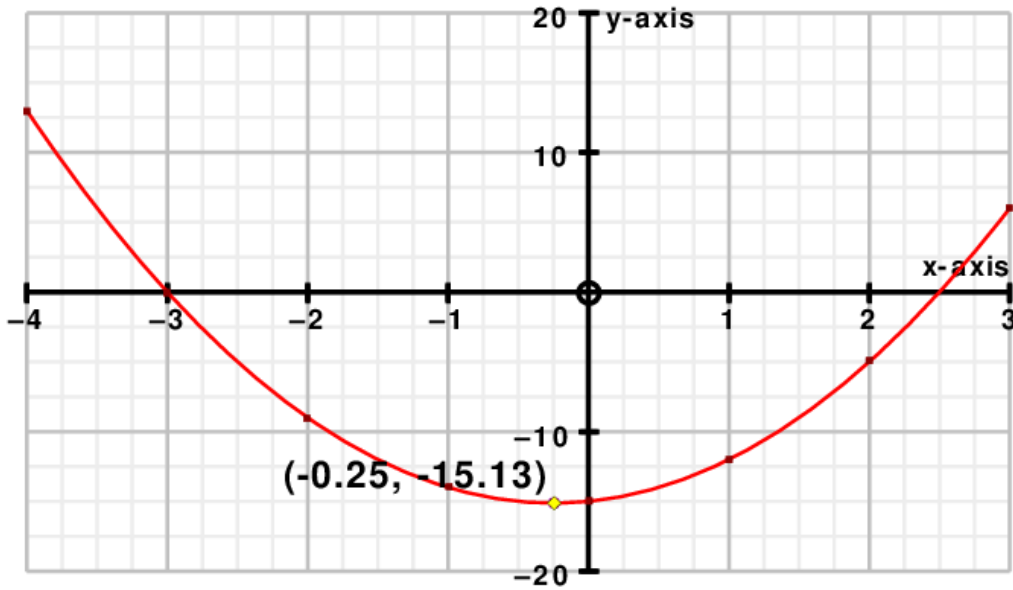
$$f(1) = 2(1)^2 + (1) - 15 = 2(1) + 1 - 15 = 2 + 1 - 15 = 3 - 15 = -12 \rightarrow (1, -12)$$

$$f(2) = 2(2)^2 + (2) - 15 = 2(4) + 2 - 15 = 8 + 2 - 15 = 10 - 15 = -5 \rightarrow (2, -5)$$

$$f(3) = 2(3)^2 + (3) - 15 = 2(9) + 3 - 15 = 18 + 3 - 15 = 21 - 15 = 6 \rightarrow (3, 6)$$

**II**

$x$	-4	-3	-2	-1	0	1	2	3
$2(x)^2$	32	18	8	2	0	2	8	18
$+x$	-4	-3	-2	-1	0	1	2	3
$-15$	-15	-15	-15	-15	-15	-15	-15	-15
$f(x)$	13	0	-9	-14	-15	-12	-5	6
Points	$(-4, 13)$	$(-3, 0)$	$(-2, -9)$	$(-1, -14)$	$(0, -15)$	$(1, -12)$	$(2, -5)$	$(3, 6)$

(ii) Minimum value of  $f(x)$ : =  $-15.1$  [indicated on graph]

(c) (iii)

5 marks

Att 2

(iii)  $x \leq -3$  and  $x \geq 2\frac{1}{2}$  [indicated on graph]

## Question 3

(c) (i)

10 marks

Att 3

$$f : x \rightarrow 2x - 1$$

$$g : x \rightarrow 4x - 4.$$

$$f(0) = 2(0) - 1 = -1 \quad (0, -1)$$

$$g(0) = 4(0) - 4 = -4 \quad (0, -4)$$

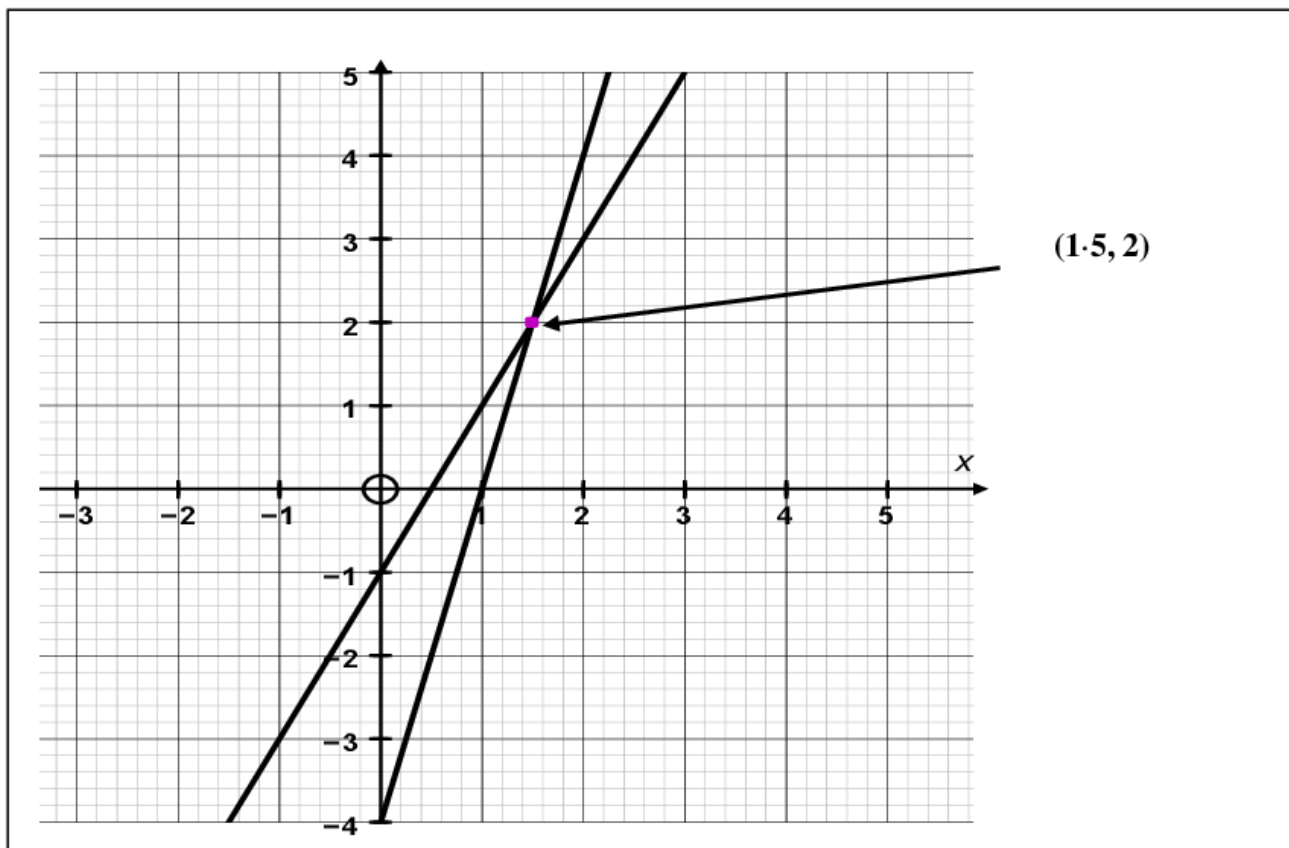
$$f(1) = 2(1) - 1 = 1 \quad (1, 1)$$

$$g(1) = 4(1) - 4 = 0 \quad (1, 0)$$

$$f(2) = 2(2) - 1 = 3 \quad (2, 3)$$

$$g(2) = 4(2) - 4 = 4 \quad (2, 4)$$

$x$	0	1	2		$x$	0	1	2
$2x$	0	2	4		$4x$	0	4	8
$-1$	-1	-1	-1		$-4$	-4	-4	-4
$f(x)$	-1	1	3		$g(x)$	-4	0	4
Point	(0, -1)	(1, 1)	(2, 3)			(0, -4)	(1, 0)	(2, 4)



(ii) Point of intersection = (1.5, 2) tolerance  $\pm 0.3$

(c) (iii)

5 marks

Att 2

c(ii)

$$\begin{array}{l} \text{I} \\ y = 2x - 1 \\ y = 4x - 4 \end{array}$$

$$\begin{array}{l} 4x - 4 = 2x - 1 \\ 2x = 3 \\ x = 1.5 \end{array}$$

$$\begin{array}{l} y = 2(1.5) - 1 \\ y = 3 - 1 \\ y = 2 \end{array}$$

$$\begin{array}{l} \text{II} \\ y = 2x - 1 \quad x - 1 \\ y = 4x - 4 \end{array}$$

$$\begin{array}{l} -y = -2x + 1 \\ \underline{y = 4x - 4} \\ 0 = 2x - 3 \end{array}$$

$$\begin{array}{l} x = 1.5 \\ y = 2(1.5) - 1 \\ y = 3 - 1 \\ y = 2 \end{array}$$

## Question 4

**(c) (i)****15 marks****Att 5****(c) (i)**

$$f(x) = x^2 + bx + c$$

$$f(-1) = (-1)^2 + b(-1) + c = 0 \quad \text{Eq 1}$$

$$1 - b + c = 0$$

$$-b + c = -1$$

$$f(2) = (2)^2 + b(2) + c = 0 \quad \text{Eq 2}$$

$$4 + 2b + c = 0$$

$$2b + c = -4$$

$$-b + c = -1 \quad \times -1$$

$$b - c = 1$$

$$\underline{2b + c = -4}$$

$$3b = -3$$

$$b = -1$$

$$2(-1) + c = -4$$

$$-2 + c = -4$$

$$c = -2$$

**c(ii)****5 marks****Att 2****(ii)**

$$f(x) = x^2 - x - 2$$

$$f(k) = k^2 - k - 2 = -k + 14$$

$$k^2 - k - 2 = -k + 14$$

$$k^2 = 16 \quad \text{or} \quad k^2 - 16 = 0 \quad \text{or} \quad \text{Formula}$$

$$k = 4 \text{ or } k = -4 \quad (k-4)(k+4) = 0$$

$$k = 4 \text{ or } k = -4$$

## Question 5

**Part (c)(i)****(5,5) marks****Att 2,2****(i)**

$$f(-2) = 1 - 3(-2) = 7$$

$$g(5) = 1 - (5)^2 = 1 - 25 = -24$$

**Part (c)(ii)****5 marks****Att 2****(ii)**

$$f(x+1) = 1 - 3(x+1) = 1 - 3x - 3 = -3x - 2$$

**Part (c)(iii)****5 marks****Att 2****(iii)**

$$-3x - 2 = 7 + (-24)$$

$$-3x = 7 - 24 + 2$$

$$-3x = -15$$

$$x = 5$$

**(b) Quadratic Graph****20 marks****Att 7**

$$f(x) = 5 - 3x - 2x^2$$

$$f(-3) = 5 - 3(-3) - 2(-3)^2 = 5 + 9 - 18 = -4 \quad f(0) = 5 - 3(0) - 2(0)^2 = 5 + 0 - 0 = 5$$

$$f(-2) = 5 - 3(-2) - 2(-2)^2 = 5 + 6 - 8 = 3 \quad f(1) = 5 - 3(1) - 2(1)^2 = 5 - 3 - 2 = 0$$

$$f(-1) = 5 - 3(-1) - 2(-1)^2 = 5 + 3 - 2 = 6 \quad f(2) = 5 - 3(2) - 2(2)^2 = 5 - 6 - 8 = -9$$

**or**

$x$	-3	-2	-1	0	1	2
5	5	5	5	5	5	5
$-3x$	9	6	3	0	-3	-6
$-2x^2$	-18	-8	-2	0	-2	-8
$f(x)$	-4	3	6	5	0	-9

**(b) Linear Graph****5 marks****Att 2**

$$g(x) = -2x - 1$$

$$g(-3) = -2(-3) - 1 = 6 - 1 = 5 \quad g(0) = -2(0) - 1 = 0 - 1 = -1$$

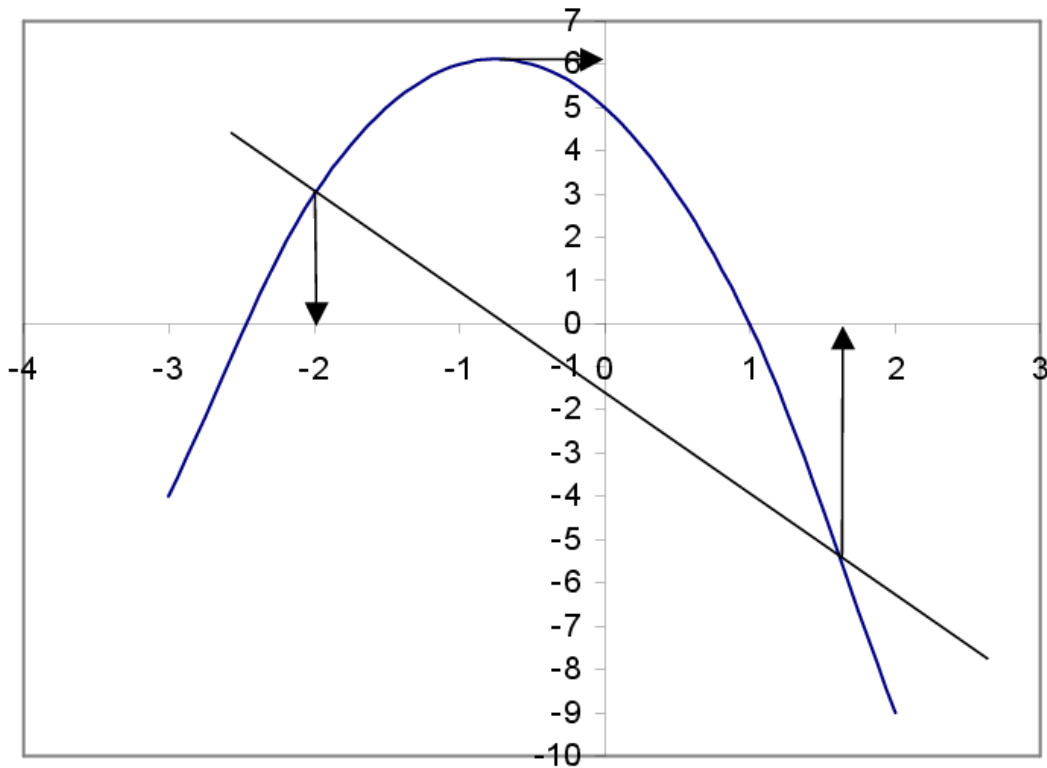
$$g(-2) = -2(-2) - 1 = 4 - 1 = 3 \quad g(1) = -2(1) - 1 = -2 - 1 = -3$$

$$g(-1) = -2(-1) - 1 = 2 - 1 = 1 \quad g(2) = -2(2) - 1 = -4 - 1 = -5$$

**or**

$x$	-3	-2	-1	0	1	2
$-2x$	6	4	2	0	-2	-4
$-1$	-1	-1	-1	-1	-1	-1
$g(x)$	5	3	1	-1	-3	-5

Graph of  $f: x \rightarrow 5 - 3x - 2x^2$  and  $g: x \rightarrow -2x - 1$



(c) (i)

5 marks

Att 2

(i) Maximum value of  $f(x) = 6.1$

(c) (ii)

5 marks

Att 2

(ii)  $x = 1.5$  and  $x = -2$

(c) (iii)

5 marks

Att 2

(iii)  $f(x) \geq g(x) \rightarrow -2 \leq x \leq 1.5.$

Question 7

(c) (i)

15 marks

Att 5

(i) Cuts  $x$  axis  $\Rightarrow y = 0$

$(-3)^2 + b(-3) + c = 0$	$(2)^2 + b(2) + c = 0$	$2b + c = -4$
$9 - 3b + c = 0$	$4 + 2b + c = 0$	$\frac{3b - c = 9}{5b = 5}$
$-3b + c = -9$	$2b + c = -4$	$b = 1$ and $c = -6$



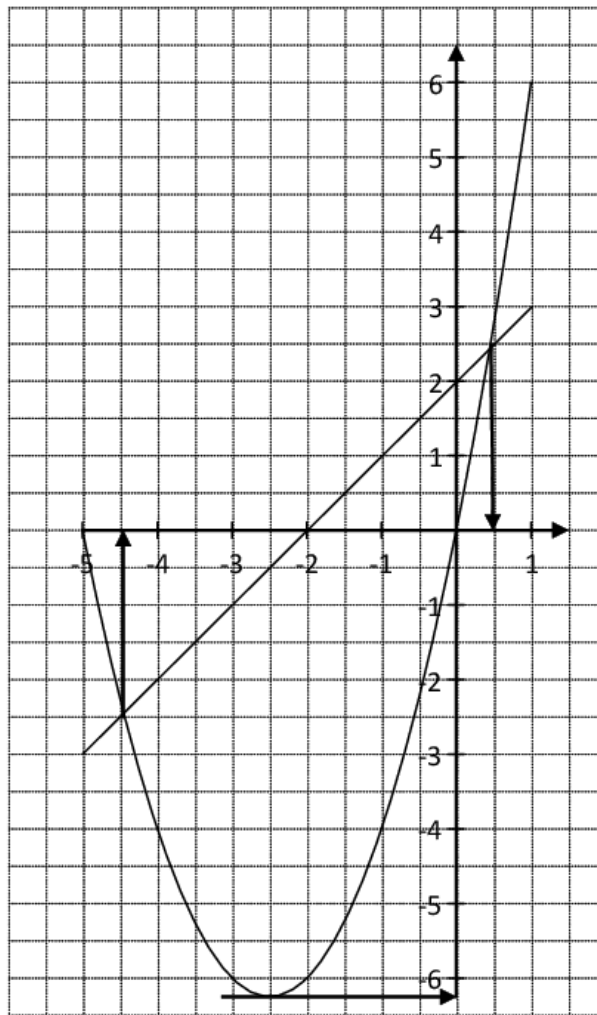
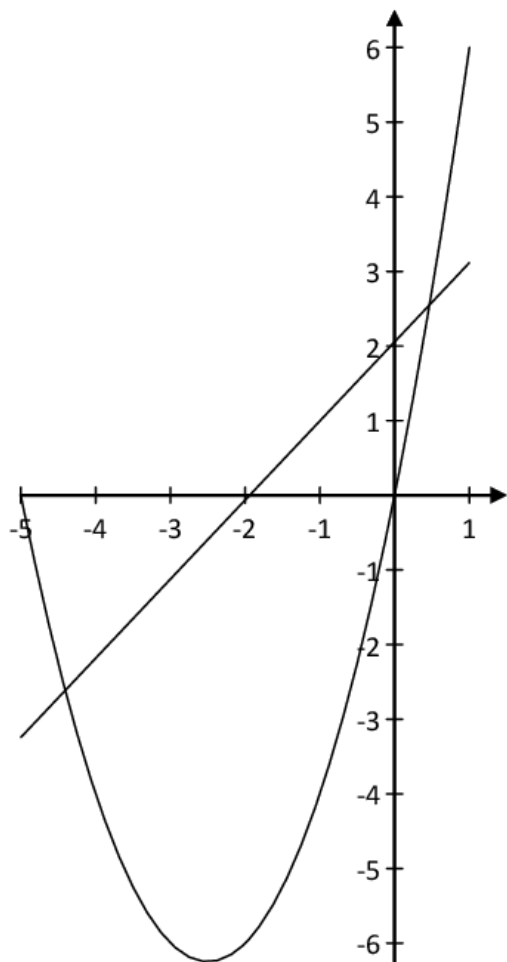
(c) (ii)

5 marks

Att 2

$$\begin{aligned} \text{(ii)} \quad x^2 + x - 6 &= (x + 2)^2 + (x + 2) - 6 \\ x^2 + x - 6 &= x^2 + 4x + 4 + x + 2 - 6 \\ x^2 + x - 6 &= x^2 + 5x \\ -4x &= 6 \\ x &= -1.5 \end{aligned}$$

Question 8



(b) Function  $f$   
 $f: x \rightarrow x^2 + 5x$

20 (10, 10) marks

Att (3, 3)

$x$	-5	-4	-3	-2	-1	0	1
$x^2$	25	16	9	4	1	0	1
$+5x$	-25	-20	-15	-10	-5	0	5
$f(x)$	0	-4	-6	-6	-4	0	6

(b) Function  $g$

10 (5, 5) marks

Att (2, 2)

$g: x \rightarrow x + 2.$

$x$	-5	-4	-3	-2	-1	0	1
+2	2	2	2	2	2	2	2
$g(x)$	-3	-2	-1	0	1	2	3

(c) (i)

5 marks

Att 2

The minimum value of  $f(x) = -6.25$

(c) (ii)

5 marks

Att 2

$f(x) = g(x)$  at  $x = 0.5$  and  $x = -4.5$

(c) (iii)

5 marks

Att 2

The range of values of  $x$  for which  $f(x) \leq g(x).$   
 $-4.5 \leq x \leq 0.5$

Question 9

(c) (i)

10 marks

Att3

Solve  $x^2 - 4x + 3 = 0$       3m

$(x - 1)(x - 3) = 0$       4m

$x = 1, x = 3$       7m

$(1, 0)$  and  $(3, 0)$       9m

$\rightarrow A(1, 0) \quad B(3, 0)$       10m

(c) (ii)

5 marks

Att 2

$g(1) = 1 + k = 0$       2m

$\rightarrow k = -1$       5m

**I**

Solve  $x^2 - 4x + 3 = x - 1$  **2m**

$$x^2 - 4x + 3 - x + 1 = 0$$

$$x^2 - 5x + 4 = 0$$

$$(x - 4)(x - 1) = 0$$

$$x = 1 \text{ and } x = 4$$

$$x^2 - 4x + 3 = y \quad \text{or } x - 1 = y$$

$$(4)^2 - 4(4) + 3 = y \quad 4 - 1 = y$$

$$16 - 16 + 3 = 3 = y \quad 3 = y$$

$\rightarrow$  point (4, 3) **5m**

**II**

Substitute  $x = 4$  into  $f(x) = x^2 - 4x + 3$  and  $g(x) = x - 1$

$$f(x) = x^2 - 4x + 3$$

$$f(x) = (4)^2 - 4(4) + 3 \quad \text{2m}$$

$$f(x) = 16 - 16 + 3$$

$$f(x) = 3$$

(4,3)

$$g(x) = x - 1$$

$$g(x) = 4 - 1$$

$$g(x) = 3$$

(4,3) **4m**

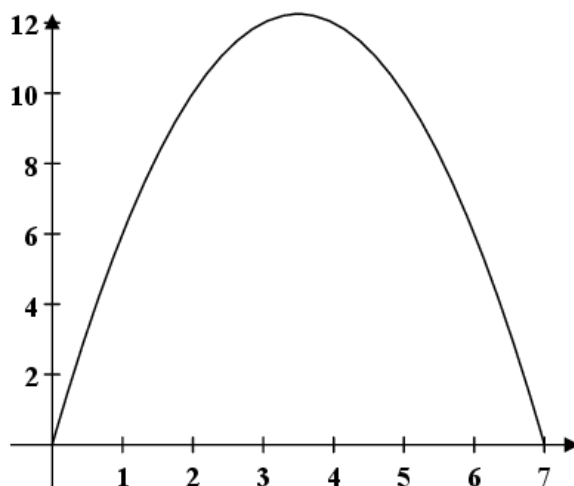
(4,3) on both lines  $\rightarrow$  point of intersection **5m**

Question 10

(b) Function  $f$

20 (10,10) marks

Att 3,3



$x$	0	1	2	3	4	5	6	7
$7x$	0	7	14	21	28	35	42	49
$-x^2$	0	-1	-4	-9	-16	-25	-36	-49

$x$	0	1	2	3	4	5	6	7
$f(x)$	0	6	10	12	12	10	6	0

$f(x)$	0	6	10	12	12	10	6	0
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or

or

$f: x \rightarrow 7x - x^2$   
 $f: x \rightarrow 7(0) - 0^2 = 0 - 0 = 0$   
 $f: x \rightarrow 7(1) - 1^2 = 7 - 1 = 6$   
 $f: x \rightarrow 7(2) - 2^2 = 14 - 4 = 10$   
 $f: x \rightarrow 7(3) - 3^2 = 21 - 9 = 12$   
 $f: x \rightarrow 7(4) - 4^2 = 28 - 16 = 12$   
 $f: x \rightarrow 7(5) - 5^2 = 35 - 25 = 10$   
 $f: x \rightarrow 7(6) - 6^2 = 42 - 36 = 6$   
 $f: x \rightarrow 7(7) - 7^2 = 49 - 49 = 0$

(0,0)   (1,6)   (2, 10)   (3, 12)   (4,12)   (5, 10)   (6, 6)   (7,10)

(c) (i)

5 marks

Att 2

Maximum height $\rightarrow$ 12.25 m
--------------------------------------

Fills in any of the following points (1,5) (2,8) (3,9) (4, 8) (5, 5) (6,0)  
or any other correct points to solve equation  $ax - x^2 = y$

**I**

*e.g.* (1, 5)

$$a(1) - (1)^2 = 5$$

$$a - 1 = 5$$

$$a = 5 + 1$$

Value of  $a = 6$

**II**

$$ax - x^2 = y$$

$$x(a - x) = y$$

Fill in *e.g.* (1, 5)

$$1(a - 1) = 5$$

$$a - 1 = 5$$

$$a = 5 + 1$$

Value of  $a = 6$