(ii)	$x^2+1=\dfrac{36}{x^2-4}\Rightarrow\left(x^2+1\right)\left(x^2-4\right)=36\Rightarrow x^4-4x^2+x^2-4=36$	M1
	$\Rightarrow x^4-3x^2-40=0$ or e.g. $\Rightarrow x^4-3x^2=40$	A1
	$\left(x^2-8\right)\left(x^2+5\right)=0\Rightarrow x^2=...$	**d**M1
	$x=\pm2\sqrt{2}$	A1
		(4)
		(7 marks)

Notes

M1: Attempts to cross multiply and expand to obtain a polynomial equation in x or another variable if a substitution is used e.g. $y=x^2\Rightarrow y+1=\dfrac{36}{y-4}\Rightarrow\left(y+1\right)\left(y-4\right)=36\Rightarrow y^2-4y+y-4=36$

A1: Correct 3 term quadratic equation in x^2. The terms do not have to all be on the same side but must be collected so e.g. $x^4-3x^2=40$ is acceptable.
If the terms are all one side, the "= 0" may be implied by their attempt to solve.
May also be implied by a substitution e.g.
$y=x^2\Rightarrow y+1=\dfrac{36}{y-4}\Rightarrow\left(y+1\right)\left(y-4\right)=36\Rightarrow y^2-4y+y-4=36\Rightarrow y^2-3y=40$

dM1: Attempts to solve 3TQ in x^2 by any **non-calculator** means leading to values for x^2
This may be implied by substitution e.g. $y=x^2\Rightarrow y^2-3y-40=0\Rightarrow\left(y-8\right)\left(y+5\right)=0\Rightarrow y=...$
This may also be implied by their values for x e.g. $\left(x^2-8\right)\left(x^2+5\right)=0\Rightarrow x=\pm2\sqrt{2}$
Note that e.g. $x^4-3x^2-40=0\Rightarrow\left(x-8\right)\left(x+5\right)=0\Rightarrow x=8,-5$ scores dM0
but $x^4-3x^2-40=0\Rightarrow\left(x-8\right)\left(x+5\right)=0\Rightarrow x^2=8,-5$ scores dM1 by implication.

A1: $x=\pm2\sqrt{2}$ o.e. e.g. $\pm\sqrt{8}$ and no other values. Do **not** allow decimal values.
Do not isw if they obtain e.g. $x=\pm\sqrt{8}$ and then $x=\pm4$ score A0
Similarly if they obtain $x=\pm2\sqrt{2}$ and then declare e.g. therefore $x=2\sqrt{2}$ score A0
Must clearly be identified as values of x not any other variable e.g. y or t.

Question Number	Scheme	Marks
5(a)	$2x^2-16x+50\equiv 2\left(x^2-8x+25\right)\equiv 2(x\pm...)^2\pm...$	B1
	$\equiv 2(x-4)^2+18$	M1 A1
		(3)

Notes

(a)

B1: Writes $2x^2-16x+50$ in the form $2(x\pm...)^2\pm...$ or e.g. $2\left[(x\pm...)^2\pm...\right]$

M1: For $2(x-4)^2\pm...$ or e.g. $2\left[(x-4)^2\pm...\right]$. Allow e.g. $-\frac{16}{4}$ or $-\frac{8}{2}$ for -4

A1: For $2(x-4)^2+18$

Condone any spurious " = 0" e.g. $2(x-4)^2+18=0$

(b)	Eqn of l is $y = "\frac{18}{4}"x$ **or** $y = 2x^2 - 16x + 50 \Rightarrow \frac{dy}{dx} = 4x - 16$ At M $4x - 16 = 0 \Rightarrow x = 4$, $y = 18 \Rightarrow y = \frac{18}{4}x$	M1 B1 on ePEN
	$2x^2 - 16x + 50 = \frac{9}{2}x \Rightarrow 4x^2 - 41x + 100 = 0$ or e.g. $2x^2 + 50 = \frac{41}{2}x$	M1 A1
	$4x^2 - 41x + 100 = 0 \Rightarrow (x-4)(4x-25) = 0 \Rightarrow x = ...$	**dd**M1
	$x = \frac{25}{4}$ o.e.	A1
		(5)

Notes

(b)

M1: Deduces that equation of l is $y = "\frac{18}{4}"x$ o.e. Follow through on $y = "\frac{c}{-b}"x$ from (a)

Alternatively finds the coordinates of M (p, q) by using calculus and forms the equation $y = \frac{q}{p}x$

M1: Equates $y = 2x^2 - 16x + 50$ and their l of the form $y = \pm mx$ and collects terms to form a 3 term quadratic equation. Condone a miscopy of $y = 2x^2 - 16x + 50$ as long as the intention is clear.

A1: Correct 3 term quadratic equation. The terms do not have to all be on the same side but must be collected so e.g. $2x^2 + 50 = \frac{41}{2}x$ is acceptable.
If the terms are all one side, the "= 0" may be implied by their attempt to solve.

ddM1: Correct **non calculator** method of solving their 3TQ.
Depends on both previous method marks.
Do not allow for quoting the quadratic formula quoted followed by values e.g.

$$4x^2 - 41x + 100 = 0 \Rightarrow x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{25}{4},\ 4$$

But allow e.g. $4x^2 - 41x + 100 = 0 \Rightarrow x = \frac{41 \pm \sqrt{41^2 - 4 \times 4 \times 100}}{2 \times 4}$

Do not allow obvious use of a calculator where the factors do not correspond with their 3TQ

e.g. $4x^2 - 41x + 100 = 0 \Rightarrow \left(x - \frac{25}{4}\right)(x-4) = 0 \Rightarrow x = \frac{25}{4},\ 4$

or e.g. $2x^2 - \frac{41}{2}x + 50 = 0 \Rightarrow (4x-25)(x-4) = 0 \Rightarrow x = \frac{25}{4},\ 4$

or e.g. $4x^2 - 41x + 100 = 0 \Rightarrow (4x-25)(4x-16) = 0 \Rightarrow x = \frac{25}{4},\ 4$

but allow e.g. $4x^2 - 41x + 100 = 0 \Rightarrow 4\left(x - \frac{25}{4}\right)(x-4) = 0 \Rightarrow x = \frac{25}{4},\ 4$

and allow e.g. $4x^2-41x+100=0 \Rightarrow (4x-25)(4x-16)=(4x-25)(x-4)=0 \Rightarrow x=\frac{25}{4}$, 4

A1: $x=\frac{25}{4}$ only. If $x = 4$ is also seen, it must clearly be rejected or the $x=\frac{25}{4}$ clearly selected.
Ignore any attempts to find y.

(c)	$y \le 2x^2-16x+50, \quad y \ge "\frac{9}{2}x"$	B1ft
	Fully defined region E.g. $\frac{9}{2}x \le y \le 2x^2-16x+50$ and $0 \le x \le 4$	B1ft
		(2)
		(10 marks)

Notes

Some candidates are answering (c) at the bottom of the first page of the question so please check there.

Allow use of f(x) for y.

Do not allow use of R for y e.g. $R \le 2x^2-16x+50$ or e.g. $y >$ line

B1ft: Uses C and l with inequalities in the correct directions and ignore any other inequalities for this mark.
Allow strict or non-strict inequalities and condone a mix of both for this mark.
Follow through on their equation for l and their possibly incorrect completed square form for C.

Examples:

$y < 2x^2-16x+50$ and $y \ge "\frac{9}{2}x"$ or e.g. $"\frac{9}{2}x" < y < 2x^2-16x+50$

B1ft: Correct and fully **consistently** defined region and no incorrect inequalities.
Follow through on their equation for l and their possibly incorrect completed square form for C.
For the restriction on x, allow e.g. $0 < x < 4$ or written separately as e.g. $x > 0$, $x < 4$ and allow $0 < x < a$ where $a < \frac{25}{4}$

If extra inequalities are given that do not contradict then they can be ignored (see example below)

Examples of full marks in (c):

$y \le 2x^2-16x+50, \quad y \ge "\frac{9}{2}x", \quad x \ge 0, \quad x \le 4$

$"\frac{9}{2}x" < y < 2x^2-16x+50, \quad 0 < x < 4$

$"\frac{9}{2}x" < y, \; y < 2x^2-16x+50, \quad 0 < x, \; x < 6.25, \; y > 0$