Equation and Inequalities- Mark Scheme

May 2018 Mathematics Advanced Paper 1: Pure Mathematics 1

1.

Question	Scheme	Marks	AOs
2(i)	$x^2-8x+17=(x-4)^2-16+17$	M1	3.1a
	$=(x-4)^2+1$ with comment (see notes)	A1	1.1b
	As $(x-4)^2 \geqslant 0 \Rightarrow (x-4)^2+1 \geqslant 1$ hence $x^2-8x+17>0$ for all x	A1	2.4
		(3)	
(ii)	For an explanation that it may not always be true Tests say $x=-5$ $(-5+3)^2=4$ whereas $(-5)^2=25$	M1	2.3
	States sometimes true and gives reasons Eg. when $x=5$ $(5+3)^2=64$ whereas $(5)^2=25$ True When $x=-5$ $(-5+3)^2=4$ whereas $(-5)^2=25$ Not true	A1	2.4
		(2)	
			(5 marks)

(i) Method One: Completing the Square

M1: For an attempt to complete the square. Accept $(x-4)^2$ ...

A1: For $(x-4)^2+1$ with either $(x-4)^2 \geqslant 0, (x-4)^2+1 \geqslant 1$ or min at (4,1). Accept the inequality statements in words. Condone $(x-4)^2>0$ or a squared number is always positive for this mark.

A1: A fully written out solution, with correct statements and no incorrect statements. There must be a valid reason and a conclusion

....

$x^2-8x+17$

$=(x-4)^2+1 \geqslant 1$ as $(x-4)^2 \geqslant 0$

Hence $(x-4)^2+1>0$

scores M1 A1 A1

....

$x^2-8x+17>0$

$(x-4)^2+1>0$

This is true because $(x-4)^2 \geqslant 0$ and when you add 1 it is going to be positive

scores M1 A1 A1

....

$x^2-8x+17>0$

$(x-4)^2+1>0$

scores M1 A1 A0

which is true because a squared number is positive — incorrect and incomplete

....

$x^2 - 8x + 17 = (x-4)^2 + 1$ — scores M1 A1 A0

Minimum is (4,1) so $x^2 - 8x + 17 > 0$ — correct but not explained

....

$x^2 - 8x + 17 = (x-4)^2 + 1$ — scores M1 A1 A1

Minimum is (4,1) so as $1 > 0 \Rightarrow x^2 - 8x + 17 > 0$ — correct and explained

....

$x^2 - 8x + 17 > 0$

$(x-4)^2 + 1 > 0$

scores M1 A0 (no explanation) A0

....

Method Two: Use of a discriminant

M1: Attempts to find the discriminant $b^2 - 4ac$ with a correct *a*, *b* and *c* which may be within a quadratic formula. You may condone missing brackets.

A1: Correct value of $b^2 - 4ac = -4$ **and** states or shows curve is U shaped (or intercept is (0,17)) or equivalent such as +ve x^2 etc

A1: Explains that as $b^2 - 4ac < 0$, there are no roots, and curve is U shaped then $x^2 - 8x + 17 > 0$

Method Three: Differentiation

M1: Attempting to differentiate and finding the turning point. This would involve attempting to find $\frac{dy}{dx}$, then setting it equal to 0 and solving to find the *x* value and the *y* value.

A1: For differentiating $\frac{dy}{dx} = 2x - 8 \Rightarrow (4,1)$ is the **turning point**

A1: Shows that (4,1) is the minimum point (second derivative or U shaped), hence $x^2 - 8x + 17 > 0$

Method 4: Sketch graph using calculator

M1: Attempting to sketch $y = x^2 - 8x + 17$, U shape with minimum in quadrant one

A1: As above with minimum at (4,1) marked

A1: Required to state that quadratics only have one turning point and as "1" is above the *x*-axis then $x^2 - 8x + 17 > 0$

(ii)

Numerical approach

Do not allow any marks if the candidate just mentions "positive" and "negative" numbers. Specific examples should be seen calculated if a numerical approach is chosen.

M1: Attempts a value (where it is not true) and shows/implies that it is not true for that value.

For example, for -4 : $(-4+3)^2 > (-4)^2$ and indicates not true (states not true, ✗)

or writing $(-4+3)^2 < (-4)^2$ is sufficient to imply that it is not true

A1: Shows/implies that it can be true for a value **AND** states sometimes true.

For example for +4 : $(4+3)^2 > 4^2$ and indicates true ✓

or writing $(4+3)^2 > 4^2$ is sufficient to imply this is true following $(-4+3)^2 < (-4)^2$

condone incorrect statements following the above such as 'it is only true for positive numbers' as long as they state "sometimes true" and show both cases.

Algebraic approach

M1: Sets the problem up algebraically Eg. $(x+3)^2 > x^2 \Rightarrow x > k$ Any inequality is fine. You may condone one error for the method mark. Accept $(x+3)^2 > x^2 \Rightarrow 6x+9>0$ oe

A1: States sometimes true a**nd** states/implies true for $x > -\frac{3}{2}$ or states/implies not true for $x < -\frac{3}{2}$ In both cases you should expect to see the statement "sometimes true" to score the A1

2.

Question	Scheme	Marks	AOs
6 (a)	Attempts $P = 100 - 6.25(15-9)^2$	M1	3.4
	$= -125$ $\therefore$ not sensible as the company would make a loss	A1	2.4
		(2)	
(b)	Uses $P > 80 \Rightarrow (x-9)^2 < 3.2$ or $P = 80 \Rightarrow (x-9)^2 = 3.2$	M1	3.1b
	$\Rightarrow 9 - \sqrt{3.2} < x < 9 + \sqrt{3.2}$	dM1	1.1b
	Minimum Price = £7.22	A1	3.2a
		(3)	
(c)	States (i) maximum profit =£ 100 000 and (ii) selling price £9	B1 B1	3.2a 2.2a
		(2)	
			(7 marks)

(a)

M1: Substitutes $x = 15$ into $P = 100 - 6.25(x-9)^2$ and attempts to calculate. This is implied by an answer of -125. Some candidates may have attempted to multiply out the brackets before they substitute in the x = 15. This is acceptable as long as the function obtained is quadratic. There must be a calculation seen or implied by the value of -125.

A1: Finds $P = -125$ or states that $P < 0$ **and** explains that (this is not sensible as) the company would make a loss.

Condone $P = -125$ followed by an explanation that it is not sensible as the company would make a loss of £125 rather than £125 000. (They will lose marks later in the question). An explanation that it is not sensible as "the profit cannot be negative" , "the profit is negative" or "the company will not make any money" , "they might make a loss" is incomplete/incorrect. You may ignore any misconceptions or reference to the price of the toy being too cheap for this mark.

Alt: **M1:** Sets P = 0 and finds $x = 5, 13$ A1: States $15 > 13$ and states makes a loss

(b)

M1: Uses $P ... 80$ where ... is any inequality or "=" in $P = 100 - 6.25(x-9)^2$ and proceeds to $(x-9)^2 ... k$ where k >0 and ... is any inequality or "="

Eg. Condone $P < 80$ in $P = 100 - 6.25(x-9)^2 \Rightarrow (x-9)^2 < k$ where k >0 If the candidate attempts to multiply out then allow when they achieve a form $ax^2 + bx + c = 0$

dM1: Award for solving to find the two positive values for x. Allow decimal answers

FYI correct answers are $\Rightarrow 9-\sqrt{3.2} < x < 9+\sqrt{3.2}$ Accept $\Rightarrow x = 9 \pm \sqrt{3.2}$

Condone incorrect inequality work $100-6.25(x-9)^2 > 80 \Rightarrow (x-9)^2 > 3.2 \Rightarrow x > 9 \pm \sqrt{3.2}$

Alternatively award if the candidate selects the lower of their two positive values $9-\sqrt{3.2}$

A1: Deduces that the minimum Price = £7.22 (£7.21 is not acceptable)

Trial and improvement or just answers of £7.22 or £7.21(with no working) then please send to review.

(c)

(i) B1: Maximum Profit = £ 100 000 with units. Accept 100 thousand pound.

(ii) B1: Selling price = £9 with units

SC 1: Missing units in (b) and (c) only penalise once, withhold the final mark. Eg correct values in (c) would be scored B1 B0.

SC 2: If the answers to (c) are both correct, but in the wrong order score SC B1 B0

If (i) and (ii) are not written out score in the order given.

May 2016 Mathematics Advanced Paper 1: Pure Mathematics 1

3.

Question Number	Scheme	Notes	Marks
	WAY 1		
5.	$y = -4x - 1$ $\Rightarrow (-4x-1)^2 + 5x^2 + 2x = 0$	Attempts to makes y the subject of the linear equation and substitutes into the other equation. Allow slips e.g. substituting $y = -4x + 1$ etc.	M1
	$21x^2 + 10x + 1 = 0$	Correct 3 term quadratic (terms do not need to be all on the same side). The "= 0" may be implied by subsequent work.	A1
	$(7x+1)(3x+1) = 0 \Rightarrow (x =) -\frac{1}{7}, -\frac{1}{3}$	dM1: Solves a **3 term** quadratic by the usual rules (see general guidance) to give at least one value for x. **Dependent on the first method mark.** A1: $(x =) -\frac{1}{7}, -\frac{1}{3}$ (two separate correct exact answers). Allow exact equivalents e.g. $(x =) -\frac{6}{42}, -\frac{14}{42}$	dM1 A1
	$y = -\frac{3}{7}, \frac{1}{3}$	M1: Substitutes to find at least one y value (Allow substitution into their rearranged equation above but not into an equation that has not been seen earlier). You may need to check here if there is no working and x values are incorrect. A1: $y = -\frac{3}{7}, \frac{1}{3}$ (two correct exact answers) Allow exact equivalents e.g. $y = -\frac{18}{42}, \frac{14}{42}$	M1 A1
	Coordinates do not need to be paired		
	Note that if the linear equation is explicitly rearranged to $y = 4x + 1$, this gives the correct answers for x and possibly for y. In these cases, if it is not already lost, deduct the final A1.		
			[6]

	WAY 2		
	$x = -\frac{1}{4}y - \frac{1}{4}$ $\Rightarrow y^2 + 5(-\frac{1}{4}y - \frac{1}{4})^2 + 2(-\frac{1}{4}y - \frac{1}{4}) = 0$	Attempts to makes x the subject of the linear equation and substitutes into the other equation. Allow slips in the rearrangement as above.	M1
	$\frac{21}{16}y^2 + \frac{1}{8}y - \frac{3}{16} = 0 \ (21y^2 + 2y - 3 = 0)$	Correct 3 term quadratic (terms do not need to be all on the same side). The "= 0" may be implied by subsequent work.	A1
	$(7y+3)(3y-1) = 0 \Rightarrow (y =) -\frac{3}{7}, \frac{1}{3}$	dM1: Solves a **3 term** quadratic by the usual rules (see general guidance) to give at least one value for y. **Dependent on the first method mark.** A1: $(y =) -\frac{3}{7}, \frac{1}{3}$ (two separate correct exact answers). Allow exact equivalents e.g. $(y =) -\frac{18}{42}, \frac{14}{42}$	dM1 A1
	$x = -\frac{1}{7}, -\frac{1}{3}$	M1: Substitutes to find at least one x value (Allow substitution into their rearranged equation above but not into an equation that has not been seen earlier). You may need to check here if there is no working and y values are incorrect. A1: $x = -\frac{1}{7}, -\frac{1}{3}$ (two correct exact answers) Allow exact equivalents e.g. $x = -\frac{6}{42}, -\frac{14}{42}$	M1 A1
	Coordinates do not need to be paired		
	Note that if the linear equation is explicitly rearranged to $x = (y + 1)/4$, this gives the correct answers for y and possibly for x. In these cases, if it is not already lost, deduct the final A1.		
			[6]
			6 marks

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4.

Question Number	Scheme		Marks
	$y = 2x + 4 \Rightarrow 4x^2 + (2x+4)^2 + 20x = 0$ **or** $2x = y - 4$ or $x = \frac{y-4}{2}$ $\Rightarrow (y-4)^2 + y^2 + 10(y-4) = 0$	Attempts to rearrange the linear equation to $y =$... or $x =$... or $2x =$... and attempts to **fully** substitute into the second equation.	M1
	$8x^2 + 36x + 16 = 0$ or $2y^2 + 2y - 24 = 0$	M1: Collects terms together to produce quadratic expression = 0. The '= 0' may be implied by later work. A1: Correct three term quadratic equation in x or y. The '= 0' may be implied by later work.	M1 A1
	$(4)(2x+1)(x+4) = 0 \Rightarrow x = ...$ or $(2)(y+4)(y-3) = 0 \Rightarrow y = ...$	Attempt to factorise and solve or complete the square and solve or uses a correct quadratic formula **for a 3 term quadratic.**	M1
	$x = -0.5, x = -4$ or $y = -4, y = 3$	Correct answers for either both values of x or both values of y (possibly un-simplified)	A1 cso

	Sub into $y=2x+4$ or Sub into $x=\frac{y-4}{2}$	Substitutes at least one of their values of x into a **correct** equation as far as $y=...$ or substitutes at least one of their values of y into a **correct** equation as far as $y=...$	M1
	$y=3,\ y=-4$ and $x=-4,\ x=-0.5$	Fully correct solutions and simplified. **Pairing not required.** If there are any extra values of x or y, score A0.	A1
			(7 marks)
	Special Case: Uses $y = -2x - 4$		
	$y=2x+4 \Rightarrow 4x^2+(-2x-4)^2+20x=0$		M1
	$8x^2+36x+16=0$		M1A1
	$(4)(2x+1)(x+4)=0 \Rightarrow x=...$		M1
	$x=-0.5, x=-4$		A0
	Sub into $y=2x+4$	Sub into $y=-2x-4$ is M0	M1
	$y=3,\ y=-4$ and $x=-4,\ x=-0.5$		A0

May 2014 Mathematics Advanced Paper 1: Pure Mathematics 1

5.

Question Number	Scheme	Marks
3.	(a) $3x-7>3-x$	
	$4x>10$	M1
	$x>2.5,\quad x>\frac{5}{2},\quad \frac{5}{2}<x\quad$ o.e.	A1
		(2)
	(b) Obtain $x^2-9x-36$ and attempt to solve $x^2-9x-36=0$	
	e.g. $(x-12)(x+3)=0$ so $x=\ \ ,$ or $x=\frac{9\pm\sqrt{81+144}}{2}$	M1
	$12,\ -3$	A1
	$-3\le x\le 12$	M1A1
		(4)
	(c) $2.5<x\le 12$	A1cso
		(1)
		(7 marks)

Notes

(a) M1 Reaching $px > q$ with one or both of p or q correct. Also give for $-4x < -10$

A1 Cao $x > 2.5$ o.e. Accept alternatives to 2.5 like $2\frac{1}{2}$ and $\frac{5}{2}$ even allow $\frac{10}{4}$ and allow $\frac{5}{2}<x$ o.e. This answer must occur and be credited as part (a) A correct answer implies M1A1

Mark parts (b) and (c) together.

(b) M1 Rearrange 3TQ ≤ 0 or 3TQ $= 0$ or even 3TQ > 0 Do not worry about the inequality at this stage AND attempt to solve by factorising, formula or completion of the square with the usual rules (see notes)

A1 12 and -3 seen as critical values

M1 Inside region for their critical values – must be stated – not just a table or a graph

A1 $-3 \leq x \leq 12$ Accept $x \geq -3$ **and** $x \leq 12$ or [-3, 12]

For the A mark: Do not accept $x \geq -3$ **or** $x \leq 12$ nor $-3 < x < 12$ nor (-3, 12) nor $x \geq -3, x \leq 12$
However allow recovery if they follow these statements by a correct statement, either in (b) or as they start part (c)

N.B. $-3 \leq 0 \leq 12$ and $x \geq -3, x \leq 12$ are poor notation and get M1A0 here.

(c) A1 cso $2.5 < x \leq 12$ Accept $x > 2.5$ and $x \leq 12$ Allow $\frac{10}{4}$ Do not accept $x > 2.5$ **or** $x \leq 12$

Accept (2.5, 12] A graph or table is not sufficient. **Must follow correct earlier work** – except for special case

Special case (c) $x > 2.5, x \leq 12$; $2.5 < 0 \leq 12$ are poor notation – but if this poor notation has been penalised in (b) then allow A1 here. Any other errors are penalised in both (b) and (c).

May 2013 Mathematics Advanced Paper 1: Pure Mathematics 1

6.

Question Number	**Scheme**		**Marks**
5 (a)	$6x + x > 1 - 8$	Attempts to expand the bracket and collect x terms on one side and constant terms on the other. Condone sign errors and allow one error in expanding the bracket. Allow $<, \leq, \geq, =$ instead of $>$.	M1
	$x > -1$	Cao	A1
	Do not isw here, mark their final answer.		
			(2)

(b)	$(x+3)(3x-1)[=0]$ $\Rightarrow x=-3$ and $\frac{1}{3}$	M1: Attempt to solve the quadratic to obtain two critical values A1: $x=-3$ **and** $\frac{1}{3}$ (may be implied by their inequality). Allow all equivalent fractions for -3 and 1/3. (Allow 0.333 for 1/3)	M1A1
	$-3 < x < \frac{1}{3}$	M1: Chooses "inside" region (The letter x does not need to be used here) A1ft: Allow $x < \frac{1}{3}$ **and** $x > -3$ or $\left(-3, \frac{1}{3}\right)$ or $x < \frac{1}{3} \cap x > -3$. Follow through their critical values. (must be in terms of x here) Allow all equivalent fractions for -3 and 1/3. Both ($x < \frac{1}{3}$ **or** $x > -3$) and ($x < \frac{1}{3}$, $x > -3$) as a final answer score A0.	M1A1ft
			(4)
			[6]
	Note that use of ≤ or ≥ appearing in an otherwise correct answer in (a) or (b) should only be penalised once, the first time it occurs.		

7.

Question Number	Scheme	Marks	
10(a)	$x^2 - 4k(1-2x) + 5k(=0)$	Makes y the subject from the first equation and substitutes into the second equation (= 0 not needed here) or eliminates y by a correct method.	M1
	So $x^2 + 8kx + k = 0$ *	Correct completion to printed answer. There must be no incorrect statements.	A1cso
			(2)
(b)	$(8k)^2 - 4k$	M1: Use of $b^2 - 4ac$ (Could be in the quadratic formula or an inequality, = 0 not needed yet). There must be some correct substitution but there must be no x's. No formula quoted followed by e.g. $8k^2 - 4k = 0$ is M0. A1: Correct expression. Do not condone missing brackets unless they are implied by later work but can be implied by $(8k)^2 > 4k$ etc.	M1 A1
	$k = \frac{1}{16}$ (oe)	Cso (Ignore any reference to $k = 0$) but there must be no contradictory earlier statements. A fully correct solution with no errors.	A1
			(3)

(b) Way 2 Equal roots	$\Rightarrow x^2+8kx+k=(x+\sqrt{k})^2$ $\Rightarrow 8k=2\sqrt{k}$	M1: Correct strategy for equal roots A1: Correct equation	M1A1
	$k=\frac{1}{16}$ (oe)	Cso (Ignore any reference to $k=0$)	A1
(b) Way 3	Completes the Square $x^2+8kx+k=(x+4k)^2-16k^2+k$ $\Rightarrow 16k^2-k=0$	M1: $(x\pm4k)^2\pm p\pm k,\ \ p\neq0$ A1: Correct equation	M1A1
	$k=\frac{1}{16}$ (oe)	Cso (Ignore any reference to $k=0$)	A1
			(3)
(c)	$x^2+\frac{1}{2}x+\frac{1}{16}=0$ so $(x+\frac{1}{4})^2=0\Rightarrow x=$	Substitutes their value of k into the given quadratic and attempt to solve their 2 or 3 term quadratic as far as $x=$ (may be implied by substitution into the quadratic formula) or starts again and substitutes their value of k into the second equation and solves simultaneously to obtain a value for x.	M1
	$x=-\frac{1}{4}, y=1\frac{1}{2}$	First A1 one answer correct, second A1 both answers correct.	A1A1
	Special Case: $x^2+\frac{1}{2}x+\frac{1}{16}=0\Rightarrow x=-\frac{1}{4},\ \frac{1}{4}\Rightarrow y=1\frac{1}{2},\ \frac{1}{2}$ allow M1A1A0		
			(3)
			[8]

Jan 2012 Mathematics Advanced Paper 1: Pure Mathematics 1

8.

Question	**Scheme**	**Marks**
3. (a)	$5x>20$	M1
	$\underline{x>4}$	A1 (2)
(b)	$x^2-4x-12=0$	
	$(x+2)(x-6)[=0]$	M1
	$x=6,\ -2$	A1
	$x<-2\ ,\ x>6$	M1, A1ft
		(4)
		6 marks

	Notes	
(a)	M1 for reducing to the form $px > q$ with one of p or q correct Using $px = q$ is M0 unless $>$ appears later on A1 $x > 4$ only	
(b)	1st M1 for multiplying out and attempting to solve a 3TQ with at least $\pm 4x$ or ± 12 See **General Principles** for definitions of "attempt to solve" 1st A1 for 6 and -2 seen. Allow $x > 6$, $x > -2$ etc to score this mark. Values may be on a sketch. 2nd M1 for choosing the "outside region" for their critical values. Do not award simply for a diagram or table – they must have chosen their "outside" regions 2nd A1ft follow through their 2 distinct critical values. Allow "," "or" or a "blank" between answers. Use of "and" is M1A0 i.e. loses the final A1 $-2 > x > 6$ scores M1A0 i.e. loses the final A1 but apply ISW if $x > 6$, $x < -2$ has been seen Accept $(-\infty,-2)\cup(6,\infty)$ (o.e) Use of $\leq$ instead of $<$ (or $\geq$ instead of $>$) loses the final A mark in (b) unless A mark was lost in (a) for $x \geq 4$ in which case allow it here.	

May 2011 Mathematics Advanced Paper 1: Pure Mathematics 1

9.

Question Number	Scheme		Marks
4.			
	Either	Or	
	$y^2 = 4 - 4x + x^2$	$x^2 = 4 - 4y + y^2$	M1
	$4(4-4x+x^2) - x^2 = 11$ or $4(2-x)^2 - x^2 = 11$	$4y^2 - (4-4y+y^2) = 11$ or $4y^2 - (2-y)^2 = 11$	M1
	$3x^2 - 16x + 5 = 0$	$3y^2 + 4y - 15 = 0$ Correct 3 terms	A1
	$(3x-1)(x-5) = 0, \quad x =$	$(3y-5)(y+3) = 0, \quad y = \ldots$	M1
	$x = \frac{1}{3} \quad x = 5$	$y = \frac{5}{3} \quad y = -3$	A1
	$y = \frac{5}{3} \quad y = -3$	$x = \frac{1}{3} \quad x = 5$	M1 A1
			(7) **7**

	Notes	
	1st M: Squaring to give 3 or 4 terms (need a middle term) 2nd M: Substitute to give quadratic in one variable (may have just two terms) 3rd M: Attempt to solve a **3 term** quadratic. 4th M: Attempt to find at least one y value (or x value). (The second variable) This will be by substitution or by starting again. If y solutions are given as x values, or vice-versa, penalise accuracy, so that it is possible to score M1 M1A1 M1 A0 M1 A0. <u>"Non-algebraic" solutions:</u> No working, and only one correct solution pair found (e.g. $x = 5$, $y = -3$): M0 M0 A0 M1 A0 M1 A0 No working, and both correct solution pairs found, but not demonstrated: M0 M0 A0 M1 A1 M1 A1 Both correct solution pairs found, and demonstrated: Full marks are possible (send to review)	

May 2010 Mathematics Advanced Paper 1: Pure Mathematics 1

10.

Question Number	Scheme		Marks	
3. **(a)**	$3x-6<8-2x \rightarrow \quad 5x<14$	(Accept $5x-14<0$ (o.e.))	M1	
	$x<2.8$ or $\frac{14}{5}$ or $2\frac{4}{5}$	(condone $\leq$)	A1	(2)
(b)	Critical values are $x=\frac{7}{2}$ and -1		B1	
	Choosing "inside" $-1<x<\frac{7}{2}$		M1 A1	(3)
(c)	$-1<x<2.8$		B1ft	(1)
	Accept any exact equivalents to -1, 2.8, 3.5			**6**

	Notes
(a)	M1 for attempt to rearrange to $kx < m$ (o.e.) Either $k = 5$ or $m = 14$ should be correct Allow $5x = 14$ or even $5x > 14$
(b)	B1 for both correct critical values. (May be implied by a correct inequality) M1 ft their values and choose the "inside" region A1 for fully correct inequality (Must be in part (b): do not give marks if only seen in (c)) Condone seeing $x < -1$ in working provided $-1 < x$ is in the final answer. e.g. $x > -1,\ x < \frac{7}{2}$ <u>or</u> $x > -1$ "or" $x < \frac{7}{2}$ <u>or</u> $x > -1$ "blank space" $x < \frac{7}{2}$ score M1A0 BUT allow $x > -1$ and $x < \frac{7}{2}$ to score M1A1 (the "and" must be seen) Also $\left(-1, \frac{7}{2}\right)$ will score M1A1 NB $x < -1, x < \frac{7}{2}$ is of course M0A0 and a number line even with "open" ends is M0A0 Allow 3.5 instead of $\frac{7}{2}$
(c)	B1ft for $-1 < x < 2.8$ (ignoring their previous answers) <u>or</u> ft their answers to part (a) and part (b) provided both answers were regions and not single values. Allow use of "and" between inequalities as in part (b) If their set is empty allow a suitable description in words or the symbol $\varnothing$. <u>Common error:</u> If (a) is correct and in (b) they simply leave their answer as $x < -1$, $x < 3.5$ then in (c) $x < -1$ would get B1ft as this is a correct follow through of these 3 inequalities. Penalise use of $\leq$ only on the A1 in part (b). [i.e. condone in part (a)]

Jan 2010 Mathematics Advanced Paper 1: Pure Mathematics 1

11.

Question number	Scheme	Marks
Q5	$y = 3x - 2 \qquad (3x-2)^2 - x - 6x^2 (= 0)$	M1
	$9x^2 - 12x + 4 - x - 6x^2 = 0$ $3x^2 - 13x + 4 = 0$ (or equiv., e.g. $3x^2 = 13x - 4$)	M1 A1cso
	$(3x-1)(x-4) = 0 \qquad x = \ldots \qquad x = \frac{1}{3}$ (or <u>exact</u> equivalent) $x = 4$	M1 A1
	$y = -1 \quad y = 10$ (Solutions need not be "paired")	M1 A1
		[7]

1st M: Obtaining an equation in x only (or y only). Condone missing "= 0"
Condone sign slips, e.g. $(3x+2)^2 - x - 6x^2 = 0$, but <u>not</u> other algebraic mistakes (such as squaring individual terms... see bottom of page).

2nd M: Multiplying out their $(3x-2)^2$, which must lead to a 3 term quadratic, i.e. $ax^2 + bx + c$, where $a \neq 0, b \neq 0, c \neq 0$, <u>and</u> collecting terms.

3rd M: Solving a 3-term quadratic (see general principles at end of scheme).
2nd A: Both values.
4th M: Using an x value, found algebraically, to attempt at least one y value (or using a y value, found algebraically, to attempt at least one x value)… allow b.o.d. for this mark in cases where the value is wrong but working is not shown.
3rd A: Both values.

If y solutions are given as x values, or vice-versa, penalise at the end, so that it is possible to score M1 M1A1 M1 A1 M0 A0.

<u>"Non-algebraic" solutions:</u>
No working, and only one correct solution pair found (e.g. $x = 4, y = 10$):
M0 M0 A0 M0 A0 M1 A0

<u>"Non-algebraic" solutions:</u>
No working, and only one correct solution pair found (e.g. $x = 4, y = 10$):
M0 M0 A0 M0 A0 M1 A0
No working, and both correct solution pairs found, but not demonstrated:
M0 M0 A0 M1 A1 M1 A1
Both correct solution pairs found, and demonstrated: Full marks

<u>Alternative:</u>

$x = \frac{y+2}{3}$ $\quad y^2 - \frac{y+2}{3} - 6\left(\frac{y+2}{3}\right)^2 = 0$ M1

$y^2 - \frac{y+2}{3} - 6\left(\frac{y^2+4y+4}{9}\right) = 0$ $\quad y^2 - 9y - 10 = 0$ M1 A1

$(y+1)(y-10) = 0$ $\quad y = \ldots$ $\quad y = -1 \quad y = 10$ M1 A1

$x = \frac{1}{3} \quad x = 4$ M1 A1

<u>Squaring each term in the first equation,</u>
e.g. $y^2 - 9x^2 + 4 = 0$, and using this to obtain an equation in x only could score at most 2 marks: M0 M0 A0 M1 A0 M1 A0.