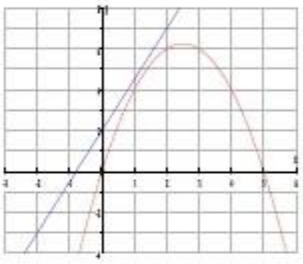
## Question 1

| Question | Scheme | Marks |
|---|---|---|
| (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<br>Using $px = q$ is M0 unless $>$ appears later on<br>A1 $x > 4$ only | |
| (b) | 1st M1 for multiplying out and attempting to solve a 3TQ with at least $\pm 4x$ or $\pm 12$<br>See **General Principles** for definitions of "attempt to solve"<br>1st A1 for 6 and $-2$ seen. Allow $x > 6$ , $x > -2$ etc to score this mark.<br>Values may be on a sketch.<br>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<br>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<br>$-2 > x > 6$ scores M1A0 i.e. loses the final A1 but apply ISW if $x > 6$ , $x < -2$ has been seen<br>Accept $(-\infty,-2)\cup(6,\infty)$ (o.e)<br>Use of $\le$ instead of $<$ (or $\ge$ instead of $>$) loses the final A mark in (b) unless A mark was lost in (a) for $x \ge 4$ in which case allow it here. | |

**Question 2**

| Question | Scheme | Marks |
|---|---|---|
| (a) | $x(5-x)=\frac{1}{2}(5x+4)$ (o.e.) | M1 |
| | $2x^2-5x+4(=0)$ (o.e.) e.g. $x^2-2.5x+2(=0)$ | A1 |
| | $b^2-4ac=(-5)^2-4\times2\times4$ | M1 |
| | $=25-32$ $<0$, so no roots <u>or</u> no intersections <u>or</u> no solutions | A1 (4) |
| (b) |  | |
| | Curve: $\cap$ shape and passing through $(0, 0)$ | B1 |
| | $\cap$ shape and passing through $(5, 0)$ | B1 |
| | Line: +ve gradient and no intersections with $C$. If no $C$ drawn score B0 | B1 |
| | Line passing through $(0, 2)$ and $(-0.8, 0)$ marked on axes | B1 (4) |
| | | **8 marks** |
| | **Notes** | |
| (a) | 1st M1 for forming a suitable equation in one variable | |
| | 1st A1 for a correct 3TQ equation. Allow missing "$=0$" Accept $2x^2+4=5x$ etc | |
| | 2nd M1 for an attempt to evaluate discriminant for their 3TQ. Allow for $b^2>4ac$ or $b^2<4ac$ | |
| | Allow if it is part of a solution using the formula e.g. $(x=)\frac{5\pm\sqrt{25-32}}{4}$ | |
| | Correct formula quoted and some correct substitution or a correct expression | |
| | False factorising is M0 | |
| | 2nd A1 for correct evaluation of discriminant for a correct 3TQ e.g. 25 – 32 (or better) <u>and</u> a comment indicating no roots or equivalent. For <u>contradictory</u> statements score A0 | |
| ALT | 2nd M1 for attempt at completing the square $a\left[\left(x\pm\frac{b}{2a}\right)^2-q\right]+c$ | |
| | 2nd A1 for $\left(x-\frac{5}{4}\right)^2=-\frac{7}{16}$ and a suitable comment | |
| (b) | **Coordinates must be seen <u>on</u> the diagram. Do not award if only in the body of the script.** | |
| | **"Passing through" means <u>not</u> stopping at and <u>not</u> touching.** | |
| | **Allow $(0, x)$ and $(y, 0)$ if marked on the correct places on the correct axis.** | |
| | 1st B1 for correct shape and passing through origin. Can be assumed if it passes through the intersection of axes | |
| | 2nd B1 for correct shape and 5 marked on $x$-axis | |
| SC | for $\cap$ shape stopping at <u>both</u> $(5, 0)$ <u>and</u> $(0, 0)$ award B0B1 | |
| | 3rd B1 for a line of positive gradient that (if extended) has no intersection with their $C$ (possibly extended). Must have both graphs on same axes for this mark. If no $C$ given score B0 | |
| | 4th B1 for straight line passing through $-0.8$ on $x$-axis and $2$ on $y$-axis | |
| | Accept exact fraction equivalents to $-0.8$ or 2(e.g. $\frac{4}{2}$) | |

## Question 3

| Question Number | Scheme | Marks |
|---|---|---|
| | | |
| (a) | **Method 1:** Attempts $b^2 - 4ac$ for $a = (k+3)$, $b = 6$ and their $c$. $c \neq k$ | M1 |
| | $b^2 - 4ac = 6^2 - 4(k+3)(k-5)$ | A1 |
| | $(b^2 - 4ac =)\quad -4k^2 + 8k + 96$ or $-(b^2 - 4ac =)\quad 4k^2 - 8k - 96$ ( with no prior algebraic errors) | B1 |
| | As $b^2 - 4ac > 0$, then $-4k^2 + 8k + 96 > 0$ and so, $k^2 - 2k - 24 < 0$ | A1 * |
| | **Method 2:** Considers $b^2 > 4ac$ for $a = (k+3)$, $b = 6$ and their $c$. $c \neq k$ | M1 |
| | $6^2 > 4(k+3)(k-5)$ | A1 |
| | $4k^2 - 8k - 96 < 0$ or $-4k^2 + 8k + 96 > 0$ or $9 > (k+3)(k-5)$ (with no prior algebraic errors) | B1 |
| | and so, $k^2 - 2k - 24 < 0$ following correct work | A1 *<br>[4] |
| (b) | Attempts to solve $k^2 - 2k - 24 = 0$ to give $k =$ ($\Rightarrow$ Critical values, $k = 6, -4$.) | M1 |
| | $k^2 - 2k - 24 < 0$ gives $-4 < k < 6$ | M1 A1<br>[3]<br>**7 marks** |
| | **Notes** | |
| (a) | **Method 1: M1:** Attempts $b^2 - 4ac$ for $a = (k+3)$, $b = 6$ and their $c$. $c \neq k$ or uses quadratic formula and has this expression under square root. (ignore $> 0$, $< 0$ or $= 0$ for first 3 marks)<br>**A1:** Correct expression for $b^2 - 4ac$ - need not be simplified (may be under root sign)<br>**B1:** Uses algebra to manipulate result **without error** into **one of these** three term quadratics. Again may be under root sign in quadratic formula. If inequality is used early in "proof" may see $4k^2 - 8k - 96 < 0$ and B1 would be given for $4k^2 - 8k - 96$ correctly stated.<br>**A1:** Applies $b^2 - 4ac > 0$ correctly ( **or writes** $b^2 - 4ac > 0$ ) to achieve the **result given** in the question. No errors should be seen. Any incorrect line of argument should be penalised here. There are several ways of reaching the answer; either multiplication of both sides of inequality by $-1$, or taking every term to other side of inequality. **Need conclusion i.e. printed answer.**<br>**Method 2: M1:** Allow $b^2 > 4ac$, $b^2 < 4ac$ or $b^2 = 4ac$ for $a = (k+3)$, $b = 6$ and their $c$. $c \neq k$<br>**A1:** Correct expressions on either side (ignore $>$, $<$ or $=$).<br>**B1:** Uses algebra to manipulate result into one of the two three term quadratics or divides both sides by 4 **again without error**<br>**A1:** Produces result with no errors seen from initial consideration of $b^2 > 4ac$ . | |
| (b) | **M1:** Uses factorisation, formula, completion of square method to find two values for $k$, or finds two **correct** answers with no obvious method<br>**M1:** Their Lower Limit $< k <$ Their Upper Limit Allow the M mark mark for $\leq$ . (Allow $k <$ upper and $k >$ lower)<br>**A1:** $-4 < k < 6$ Lose this mark for $\leq$ Allow (-4, 6) [not square brackets] or $k > -4$ **and** $k < 6$ (must be **and** not or) Can also use intersection symbol $\cap$ **NOT** $k > -4$, $k < 6$ (M1A0) | |
| | **Special case** : **In part (a)** uses $c = k$ instead of $k - 5$ - scores 0 . Allow $k + 5$ for method marks | |
| | **Special Case: In part (b)** Obtaining $-6 < k < 4$ This is a common wrong answer. Give M1 M1 A0 special case. | |
| | **Special Case: In part (b)** Use of $x$ instead of $k$ – M1M1A0 | |
| | **Special Case:** $-4 < k < 6$ and $k < -4$, $k > 6$ both given is M0A0 for last two marks. Do not treat as isw. | |

**Question 4**

| Question Number | Scheme | | Marks |
|---|---|---|---|
| (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<br>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)<br>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.<br>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 $\leq$ or $\geq$ appearing in an otherwise correct answer in (a) or (b) should only be penalised once, the first time it occurs. | | |

## Question 5

| Question Number | Scheme | Marks | |
|---|---|---|---|
| (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: <u>Use</u> 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.<br>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 | $\Rightarrow x^2 + 8kx + k = (x + \sqrt{k})^2$<br>$\Rightarrow 8k = 2\sqrt{k}$ | M1: Correct strategy for equal roots<br>A1: Correct equation | M1A1 |
| | $k = \frac{1}{16}$ (oe) | Cso (Ignore any reference to $k = 0$) | A1 |
| (b) Way 3 | Completes the Square<br>$x^2 + 8kx + k = (x+4k)^2 - 16k^2 + k$<br>$\Rightarrow 16k^2 - k = 0$ | M1: $(x \pm 4k)^2 \pm p \pm k,\ p \neq 0$<br>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<br>$(x + \frac{1}{4})^2 = 0 \Rightarrow x =$ | 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] |

**Question 6**

| Question Number | Scheme | Notes | Marks |
|---|---|---|---|
| | **Ignore any references to the units in this question** | | |
| (a) | length is '$x+4$' | May be implied | B1 |
| | $x+x+x+4+x+4>19.2 \Rightarrow x>..$ | $2x+2(x\pm4)>19.2$ and proceeds to $x>$ ..... (Accept 'invisible' brackets) Attempts 2 widths + 2 lengths > 19.2 leading to $x>$ ....... | M1 |
| | E.g. $x+x+4x+4x>19.2 \Rightarrow x>1.92$ scores B0M1A0 | | |
| | $x>2.8$ * | Achieves $x>2.8$ with no errors | A1(*) |
| | | | (3) |
| | **Mark parts (b) and (c) together** | | |
| **(b)(i)** | $x(x+4)<21$ | Cao | B1 |
| **b(ii)** | $x^2+4x-21<0$<br>$(x+7)(x-3)<0 \Rightarrow x=...$ | Multiply out lhs, produce 3TQ = 0 and attempt to solve leading to $x=$... according to general guidelines | M1 |
| | Either $-7<x<3$ or $0<x<3$ | M1: Attempts the 'inside' for their critical values (may be from a 2TQ here)<br>A1: Accept either $-7<x<3$ or $0<x<3$ or ($x>-7$ **and** $x<3$) or ($x>0$ **and** $x<3$) but not e.g. ($x>-7$, $x<3$) or ($x>-7$ **or** $x<3$) (There is no specific need for them to realise $x>0$) | M1A1 |
| | **Note that <u>many</u> candidates stop here** | | |
| | | | **(4)** |
| (c) | $2.8<x<3$ | Follow through their answers to (a) and (b) Provided "their 3" > 2.8 | B1ft |
| | | | **(1)** |
| | | | **[8]** |
| | **Examples** | | |
| | $x(x-4)<21 \Rightarrow x^2-4x-21<0$<br>$(x-7)(x+3)<0,\ x=7, x=-3$<br>$-3<x<7 \text{ or } 0<x<7$<br>$2.8<x<7$<br>Scores B0M1M1A0B1ft | $x\times4x<21 \Rightarrow 4x^2-21<0$<br>$(2x-\sqrt{21})(2x+\sqrt{21})<0,\ x=\pm\frac{\sqrt{21}}{2}$<br>$-\frac{\sqrt{21}}{2}<x<\frac{\sqrt{21}}{2} \text{ or } 0<x<\frac{\sqrt{21}}{2}$<br>$2.8<x<\frac{\sqrt{21}}{2}$<br>Scores B0M0M1A0B0 | |

## Question 7

| Question Number | Scheme | Marks |
|---|---|---|
| (a) | $y = x + 2 \Rightarrow x^2 + 4(x+2)^2 - 2x = 35$ | M1 |
| | Alternative: $\frac{2x - x^2 + 35}{4} = (x+2)^2$ or $\sqrt{\frac{2x - x^2 + 35}{4}} = (x+2)$ | |
| | $5x^2 + 14x - 19 = 0$ | M1 |
| | $(5x+19)(x-1) = 0 \Rightarrow x = ..$ | dM1 |
| | $x = -\frac{19}{5}, x = 1$ | A1 for both |
| | $y = -\frac{9}{5}, y = 3$ | M1 |
| | Coordinates are ( $-\frac{19}{5}, -\frac{9}{5}$ ) and (1, 3) | A1 |
| | | **(6)** |
| (b) | $d^2 = (1 - -\frac{19}{5})^2 + (3 - -\frac{9}{5})^2$ or | |
| | $d = \sqrt{(1 - -\frac{19}{5})^2 + (3 - -\frac{9}{5})^2}$ | M1A1ft |
| | $d = \frac{24}{5}\sqrt{2}$ | A1cao |
| | | **(3)** |
| | | **[9]** |

**Question 8**

| Question Number | Scheme | Marks |
|---|---|---|
| | (a) $3x-7>3-x$ | |
| | $4x>10$ | M1 |
| | $x>2.5, \quad x>\frac{5}{2}, \quad \frac{5}{2}<x$ 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 $3TQ\le 0$ 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 $-3\le x\le 12$ Accept $x\ge -3$ **and** $x\le 12$ or [-3, 12]

For the A mark: Do not accept $x\ge -3$ **or** $x\le 12$ nor $-3<x<12$ nor (-3, 12) nor $x\ge -3, x\le 12$

However allow recovery if they follow these statements by a correct statement, either in (b) or as they start part (c)

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

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

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

**Special case** (c) $x>2.5, x\le 12$; $2.5<0\le 12$ 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).

## Question 9

| Question Number | Scheme | Marks |
|---|---|---|
| (a). | $P = 20x + 6$ o.e<br>$20x + 6 > 40 \Rightarrow x >$<br>$x > 1.7$ | B1<br>M1<br>A1*<br>(3) |
| (b) | Mark parts (b) and (c) together<br>$A = 2x(2x+1) + 2x(6x+3) = 16x^2 + 8x$<br><br>$16x^2 + 8x - 120 < 0$<br><br>Try to solve their $2x^2 + x - 15 = 0$ e.g. $(2x-5)(x+3) = 0$ so $x =$<br>Choose inside region<br>$-3 < x < \frac{5}{2}$ or $0 < x < \frac{5}{2}$ ( as $x$ is a length ) | <br>B1<br><br>M1<br><br>M1<br>M1<br>A1<br>(5) |
| (c ) | $1.7 < x < \frac{5}{2}$ | B1cao<br>(1) |
| | | (9 marks) |

(a) B1 Correct expression for perimeter but may not be simplified so accept $2x + 1 + 2x + 4x + 2 + 2x + 6x + 3 + 4x$ or $2(10x + 3)$ or any equivalent

M1: Set $P > 40$ with their linear expression for $P$ (this may not be correct but should be a sum of sides) and manipulate to get $x > \ldots$

A1* cao $x > 1.7$. This is a given answer, there must not be any errors, but accept $1.7 < x$

(b) Marks parts (b) and (c) together

B1 Writes a correct statement in $x$ for the area. It need not be simplified. You may isw Amongst numerous possibilities are.
$2x(2x+1) + 2x(6x+3)$, $16x^2 + 8x$, $4x(6x+3) - 2x(4x+2)$, $4x(2x+1)+2x(4x+2)$

M1 Sets their quadratic expression $< 120$ and collects on one side of the inequality

M1 For an attempt to solve a 3 Term quadratic equation producing two solutions by factorising, formula or completion of the square with the usual rules (see notes)

M1 For choosing the 'inside' region. Can follow through from their critical values – must be stated – not just a table or a graph. Can also be implied by $0 < x <$ upper value

A1 $-3 < x < \frac{5}{2}$. Accept $x > -3$ **and** $x < 2.5$ or ( -3, 2.5)

As $x$ is a width, accept $0 < x < \frac{5}{2}$ Also accept $\frac{10}{4}$ or 2.5 instead of $\frac{5}{2}$. $\leq$ would be M1A0

Allow this final answer to part (b) to appear as answer to part (c) This would score final M1A1 in (b) then B0 in (c)

(c ) B1cao $1.7 < x < \frac{5}{2}$. Must be correct. [ This does not imply final M1 in (b)]

## Question 10

| Question Number | Scheme | | Marks |
|---|---|---|---|
| | $y-2x-4=0,\ \ 4x^2+y^2+20x=0$ | | |
| | $y=2x+4 \Rightarrow 4x^2+(2x+4)^2+20x=0$ **or** $2x=y-4$ or $x=\dfrac{y-4}{2}$ $\Rightarrow (y-4)^2+y^2+10(y-4)=0$ | 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.<br>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 $x=\dfrac{y-4}{2}$ | 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.<br>**Pairing not required.**<br>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 |

## Question 11

| Question Number | Scheme | | Marks |
|---|---|---|---|
| (a) | $b^2-4ac<0 \Rightarrow$ e.g. $4^2-4(p-1)(p-5)<0$ or $0>4^2-4(p-1)(p-5)$ or $4^2<4(p-1)(p-5)$ or $4(p-1)(p-5)>4^2$ | M1: Attempts to use $b^2-4ac$ with at least two of $a$, $b$ or $c$ correct. May be in the quadratic formula. Could also be, for example, comparing or equating $b^2$ and $4ac$. Must be considering the given quadratic equation. Inequality sign not needed for this M1. There must be no $x$ terms.<br>A1: For a correct un-simplified **inequality** that is not the given answer | M1A1 |
| | $4<p^2-6p+5$ | | |
| | $p^2-6p+1>0$ | Correct solution with **no** errors that includes an expansion of $(p-1)(p-5)$ | A1* |
| | | | (3) |
| (b) | $p^2-6p+1=0 \Rightarrow p=\ldots$ | For an attempt to solve $p^2-6p+1=0$ (**not <u>their</u> quadratic**) leading to 2 solutions for $p$ (do not allow attempts to **factorise** – must be using the quadratic formula or completing the square) | M1 |
| | $p=3\pm\sqrt{8}$ | $p=3\pm2\sqrt{2}$ or any equivalent correct expressions e.g. $p=\dfrac{6\pm\sqrt{32}}{2}$ (May be implied by their inequalities)<br>Discriminant must be a single number not e.g. 36 - 4 | A1 |
| | **Allow the M1A1 to score anywhere for solving the given quadratic** | | |
| | $p<3-\sqrt{8}$ or $p>3+\sqrt{8}$ | M1: Chooses outside region – **not dependent on the previous method mark**<br>A1: $p<3-\sqrt{8}$, $p>3+\sqrt{8}$ or equivalent e.g. $p<\dfrac{6-\sqrt{32}}{2}$, $p>\dfrac{6+\sqrt{32}}{2}$<br>$(-\infty,\ 3-\sqrt{8})\cup(3+\sqrt{8},\ \infty)$<br>Allow ",", "or" or a space between the answers but do **not** allow $p<3-\sqrt{8}$ **and** $p>3+\sqrt{8}$ (this scores M1A0)<br>**Apply ISW if necessary.** | M1A1 |

| | | |
|---|---|---|
| **A correct solution to the quadratic followed by $p>3\pm\sqrt{8}$ scores M1A1M0A0** | | |
| $3+\sqrt{8}<p<3-\sqrt{8}$ scores M1A0 | | |
| **Allow candidates to use $x$ rather than $p$ but must be in terms of $p$ for the final A1** | | |
| | | (4) |
| | | (7 marks) |

## Question 12

| Question Number | Scheme | Notes | Marks |
|---|---|---|---|
| | **WAY 1** | | |
| | $y = -4x - 1$<br>$\Rightarrow (-4x-1)^2 + 5x^2 + 2x = 0$ | 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).<br>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.**<br>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.<br>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 |

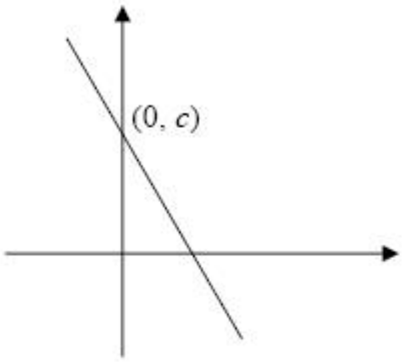
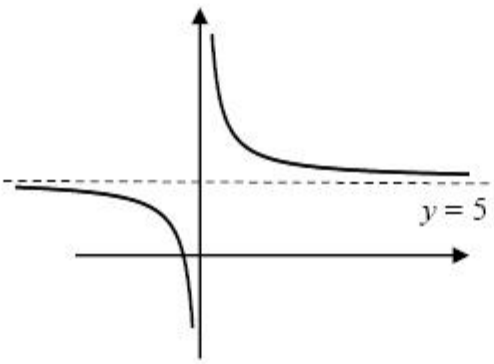
| | | | |
|---|---|---|---|
| | **Coordinates do not need to be paired** | | |
| | **Note that if the linear equation is explicitly rearranged to $y = 4x + 1$, this gives the correct answers for $x$ and possibly for $y$. In these cases, if it is not already lost, deduct the final A1.** | | |
| | | | **[6]** |
| | **WAY 2** | | |
| | $x = -\frac{1}{4}y - \frac{1}{4}$ <br> $\Rightarrow y^2 + 5(-\frac{1}{4}y - \frac{1}{4})^2 + 2(-\frac{1}{4}y - \frac{1}{4}) = 0$ | Attempts to makes $x$ the subject of the linear equation and substitutes into the other equation. Allow slips in the rearrangement as above. | M1 |
| | $\frac{21}{16}y^2 + \frac{1}{8}y - \frac{3}{16} = 0 \ \left(21y^2 + 2y - 3 = 0\right)$ | 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.** <br> 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. <br> 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** |

## Question 13

| Question Number | Scheme | Notes | Marks |
|---|---|---|---|
| (a) | $2px^2-6px+4p"="3x-7$ or $y=2p\left(\frac{y+7}{3}\right)^2-6p\left(\frac{y+7}{3}\right)+4p$ | **Either:** Compares the given quadratic expression with the given linear expression using $<, >, =, \neq$ (May be implied) **or** Rearranges $y=3x-7$ to make $x$ the subject and substitutes into the given quadratic | M1 |
| | **Examples** $2px^2-6px+4p-3x+7(=0)$, $-2px^2+6px-4p+3x-7(=0)$ $2p\left(\frac{y+7}{3}\right)^2-6p\left(\frac{y+7}{3}\right)+4p-y(=0)$, $2py^2+(10p-9)y+8p(=0)$ $y=2px^2-6px+4p-3x+7$ | | dM1 |
| | Moves all the terms to one side allowing sign errors only. Ignore $>0$, $<0$, $=0$ etc. **The terms do not need to be collected. Dependent on the first method mark.** | | |
| | E.g. $b^2-4ac=(-6p-3)^2-4(2p)(4p+7)$ $b^2-4ac=(10p-9)^2-4(2p)(8p)$ | Attempts to use $b^2-4ac$ with their $a$, $b$ and $c$ where $a=\pm 2p$, $b=\pm(-6p\pm 3)$ and $c=\pm(4p\pm 7)$ or for the quadratic in $y$, $a=\pm 2p$, $b=\pm(10p\pm 9)$ and $c=\pm 8p$. This could be as part of the quadratic formula or as $b^2<4ac$ or as $b^2>4ac$ or as $\sqrt{b^2-4ac}$ etc. If it is part of the quadratic formula only look for use of $b^2-4ac$. There must be no $x$'s or $y$'s. **Dependent on both method marks.** | ddM1 |
| | $4p^2-20p+9<0$ * | Obtains printed answer with **no errors** seen (Allow $0>4p^2-20p+9$) **but this $<0$ must** been seen at some stage before the last line. | A1* |
| | | | **[4]** |

| | | | |
|---|---|---|---|
| (b) | $(2p-9)(2p-1)=0\Rightarrow p=...$ to obtain $p=$ | Attempt to solve the <u>given</u> quadratic to find 2 values for $p$. See general guidance. | M1 |
| | $p=\frac{9}{2}, \quad \frac{1}{2}$ | Both correct. May be implied by e.g. $p<\frac{9}{2}$, $p<\frac{1}{2}$. Allow equivalent values e.g. 4.5, $\frac{36}{8}$, 0.5 etc. If they use the quadratic formula allow $\frac{20\pm 16}{8}$ for this mark but not $\sqrt{256}$ for 16 and allow e.g. $\frac{5}{2}\pm 2$ if they complete the square. | A1 |
| | $\frac{1}{2}<p<4\frac{1}{2}$ Allow equivalent values e.g. $\frac{36}{8}$ for $4\frac{1}{2}$ | M1: Chooses 'inside' region i.e. Lower Limit $<p<$ Upper Limit or e.g. Lower Limit $\leq p\leq$ Upper Limit<br>A1: Allow $p\in(\frac{1}{2},4\frac{1}{2})$ or just $(\frac{1}{2},4\frac{1}{2})$ and allow $p>\frac{1}{2}$ and $p<4\frac{1}{2}$ and $4\frac{1}{2}>p>\frac{1}{2}$ but $p>\frac{1}{2}$, $p<4\frac{1}{2}$ scores M1A0 $\frac{1}{2}>p>4\frac{1}{2}$ scores M0A0 | M1A1 |
| | **Allow working in terms of $x$ in (b) but the answer must be in terms of $p$ for the final A mark.** | | **[4]** |
| | | | **8 marks** |

**Question 14**

| Question Number | Scheme | | Marks |
|---|---|---|---|
| **(a)(i)** |  | B1: Straight line with negative gradient anywhere even with no axes. | B1 |
| | | B1: Straight line with an intercept at (0, $c$) or just $c$ marked on the positive $y$-axis provided the line passes through the positive $y$-axis. Allow ($c$, 0) as long as it is marked in the correct place. Allow (0, $c$) in the body of the script but in any ambiguity, the sketch has precedence. **Ignore any intercepts with the $x$-axis.** | B1 |
| **(a)(ii)** |  | **Either:** For the shape of a $y = \frac{1}{x}$ curve in any position. It must have two branches and be asymptotic horizontally and vertically with no obvious "overlap" with the asymptotes, but otherwise be generous. The curve may bend away from the asymptote a little at the end. Sufficient curve must be seen to suggest the asymptotic behaviour, both vertically and horizontally and the branches must approach the same asymptote **Or the equation** $y = 5$ seen independently i.e. whether the sketch has an asymptote here or not. Do not allow $y \neq 5$ or $x = 5$. | B1 |
| | | B1: Fully correct graph **and** with a horizontal asymptote on the positive $y$-axis. The asymptote does not have to be drawn but the **equation** $y = 5$ must be seen. The shape needs to be reasonably accurate with the "ends" not bending away significantly from the asymptotes and the branches must approach the same asymptote. Ignore $x = 0$ given as an asymptote. | B1 |
| | **Allow sketches to be on the same axes.** | | |
| | | | **(4)** |

| | | | |
|---|---|---|---|
| **(b)** | $\frac{1}{x}+5=-3x+c \Rightarrow 1+5x=-3x^2+cx$ <br> $\Rightarrow 3x^2+5x-cx+1=0$ | Sets $\frac{1}{x}+5=-3x+c$, attempts to multiply by $x$ and collects terms (to one side). Allow e.g. ">" or "<" for "=". At least 3 of the terms must be multiplied by $x$, e.g. allow one slip. The ' = 0' may be implied by subsequent work and provided correct work follows, full marks are still possible in (b). | M1 |
| | $b^2-4ac=(5-c)^2-4\times1\times3$ | Attempts to use $b^2-4ac$ with **their** $a$, $b$ and $c$ from **their equation** where $a=\pm3$, $b=\pm5\pm c$ and $c=\pm1$. This could be as part of the quadratic formula or as $b^2<4ac$ or as $b^2>4ac$ or as $\sqrt{b^2-4ac}$ etc. If it is part of the quadratic formula only look for use of $b^2-4ac$. There must be no $x$'s. | M1 |
| | $(5-c)^2>12$ * | Completes proof with **no errors or incorrect statements** and with the ">" appearing correctly before the final answer, which could be from $b^2-4ac>0$. Note that the statement $3x^2+5x-cx+1>0$ or starting with e.g. $\frac{1}{x}+5>-3x+c$ would be an error. | A1* |
| | **Note: A minimum for (b) could be,** <br> $\frac{1}{x}+5=-3x+c \Rightarrow 3x^2+5x-cx+1(=0)$ (M1) <br> $b^2>4ac \Rightarrow (5-c)^2>12$ (M1A1) <br> If $b^2>4ac$ is not seen then $4\times3\times1$ needs to be seen explicitly. | | |
| | | | (3) |

| | | | |
|---|---|---|---|
| **(c)** | $(5-c)^2=12 \Rightarrow (c=)5\pm\sqrt{12}$ <br> or <br> $(5-c)^2=12 \Rightarrow c^2-10c+13=0$ <br> $\Rightarrow (c=)\dfrac{-10\pm\sqrt{(-10)^2-4\times13}}{2}$ | M1: Attempts to find at least one critical value using the result in (b) or by expanding and solving a 3TQ (See General Principles) (the "= 0" may be implied) <br> A1: Correct critical values in any form. Note that $\sqrt{12}$ may be seen as $2\sqrt{3}$. | M1A1 |
| | $c<"5-\sqrt{12}",\ c>"5+\sqrt{12}"$ | Chooses outside region. The '0 <' can be ignored for **this** mark. So look for $c <$ their $5-\sqrt{12}$, $c >$ their $5+\sqrt{12}$. This could be scored from $5+\sqrt{12}<c<5-\sqrt{12}$ or $5-\sqrt{12}>c>5+\sqrt{12}$. Evidence is to be taken from their answers not from a diagram. | M1 |
| | $0<c<5-\sqrt{12},\ c>5+\sqrt{12}$ | Correct ranges including the '0 <' e.g. answer as shown or each region written separately or e.g. $\left(0,5-\sqrt{12}\right),\ \left(5+\sqrt{12},\infty\right)$. The critical values may be un-simplified but must be at least $\dfrac{10+\sqrt{48}}{2},\ \dfrac{10-\sqrt{48}}{2}$. Note that $0<c<5-\sqrt{12}$ **and** $c>5+\sqrt{12}$ would score M1A0. | A1 |
| | **Allow the use of $x$ rather than $c$ in (c) but the final answer must be in terms of $c$.** | | |
| | | | (4) |
| | | | **(11 marks)** |