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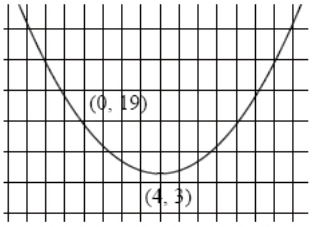
Mark Scheme

Q1.

Question Number	Scheme		Marks
(a)	$f(x)=(x-4)^2+3$	M1: $f(x)=(x\pm4)^2\pm\alpha,\ \alpha\neq0$ (where α is a single number or a numerical expression $\neq 0$)	M1A1
		A1: Allow $(x+^-4)^2+3$ and ignore any spurious "= 0"	
	Allow a = -4, b = 3 to score both marks		
			(2)
(b)		B1: U shape anywhere even with no axes. Do not allow a "V" shape i.e. with an obvious vertex.	B1
		B1: $P(0, 19)$. Allow (0, 19) or just 19 marked in the correct place as long as the curve (or straight line) passes through or touches here and allow (19, 0) as long as it is marked in the correct place. Correct coordinates may be seen in the body of the script as long as the curve (or straight line) passes through or touches here. If there is any ambiguity, the sketch has precedence. **(There must be a sketch to score this mark)**	B1
		B1: $Q(4, 3)$. Correct coordinates that can be scored without a sketch but if a sketch is drawn then it must have a minimum in the first quadrant and no other turning points. May be seen in the body of the script. If there is any ambiguity, the sketch has precedence. Allow this mark if 4 is clearly marked on the x-axis below the minimum and 3 is marked clearly on the y-axis and corresponds to the minimum.	B1
			(3)

(c)	$PQ^2=(0-4)^2+(19-3)^2$	**Correct** use of Pythagoras' Theorem on 2 points of the form $(0, p)$ and (q, r) where $q\neq0$ and $p\neq r$ with p, q and r numeric.	M1
	$PQ=\sqrt{4^2+16^2}$	Correct un-simplified numerical expression for PQ including the square root. **This must come from a correct P and Q.** Allow e.g $PQ=\sqrt{(0-4)^2+(19-3)^2}$. Allow $\pm\sqrt{(0-4)^2+(19-3)^2}$	A1
	$PQ=4\sqrt{17}$	Cao and cso i.e. **This must come from a correct P and Q.**	A1
	Note that it is possible to obtain the correct value for PQ from (-4,3) and (0, 19) and e.g. (0, 13) and (4, -3) but the A marks in (c) can only be awarded for the correct P and Q.		
			(3)
			(8 marks)

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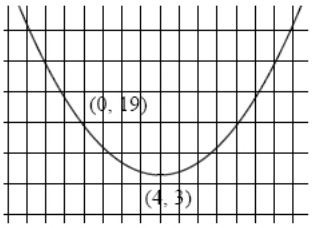
Q2.

Question Number	Scheme		Marks
(a)	$f(x) = (x-4)^2 + 3$	M1: $f(x) = (x \pm 4)^2 \pm \alpha$, $\alpha \neq 0$ (where α is a single number or a numerical expression $\neq 0$)	M1A1
		A1: Allow $(x + {}^{-}4)^2 + 3$ and ignore any spurious "= 0"	
	Allow $a = -4$, $b = 3$ to score both marks		
			(2)
(b)		B1: U shape anywhere even with no axes. Do not allow a "V" shape i.e. with an obvious vertex.	B1
		B1: $P(0, 19)$. Allow (0, 19) or just 19 marked in the correct place as long as the curve (or straight line) passes through or touches here and allow (19, 0) as long as it is marked in the correct place. Correct coordinates may be seen in the body of the script as long as the curve (or straight line) passes through or touches here. If there is any ambiguity, the sketch has precedence. **(There must be a sketch to score this mark)**	B1
		B1: $Q(4, 3)$. Correct coordinates that can be scored without a sketch but if a sketch is drawn then it must have a minimum in the first quadrant and no other turning points. May be seen in the body of the script. If there is any ambiguity, the sketch has precedence. Allow this mark if 4 is clearly marked on the x-axis below the minimum and 3 is marked clearly on the y-axis and corresponds to the minimum.	B1
			(3)
(c)	$PQ^2 = (0-4)^2 + (19-3)^2$	**Correct** use of Pythagoras' Theorem on 2 points of the form $(0, p)$ and (q, r) where $q \neq 0$ and $p \neq r$ with p, q and r numeric.	M1
	$PQ = \sqrt{4^2 + 16^2}$	Correct un-simplified numerical expression for PQ including the square root. **This must come from a correct P and Q.** Allow e.g $PQ = \sqrt{(0-4)^2 + (19-3)^2}$. Allow $\pm\sqrt{(0-4)^2 + (19-3)^2}$	A1
	$PQ = 4\sqrt{17}$	Cao and cso i.e. **This must come from a correct P and Q.**	A1
	Note that it is possible to obtain the correct value for PQ from (-4,3) and (0, 19) and e.g. (0, 13) and (4, -3) but the A marks in (c) can only be awarded for the correct P and Q.		
			(3)
			(8 marks)

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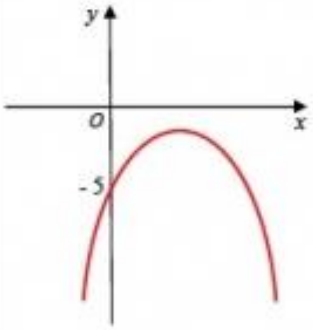
Q3.

Question Number	Scheme	Marks
(a)	$4x-5-x^2 = q-(x-p)^2$, p, q are integers. $\{4x-5-x^2 =\} -[x^2-4x+5] = -[(x-2)^2-4+5] = -[(x-2)^2+1]$ $= -1-(x-2)^2$	M1 A1 A1 [3]
(b)	$\{''b^2-4ac''=\}\ 4^2-4(-1)(-5)\quad \{=16-20\}$ $=-4$	M1 A1 [2]
(c)	 Correct ∩ shape Maximum within the 4th quadrant Curve cuts through -5 or (0, −5) marked on the y-axis	M1 A1 B1 [3] 8

Q4.

Question Number	Scheme	Marks
(a)	Discriminant: $b^2-4ac=(k+3)^2-4k$ or equivalent	M1 A1 (2)
(b)	$(k+3)^2-4k=k^2+2k+9=(k+1)^2+8$	M1 A1 (2)
(c)	For real roots, $b^2-4ac\geq 0$ or $b^2-4ac>0$ or $(k+1)^2+8>0$ $(k+1)^2\geq 0$ for all k, so $b^2-4ac>0$, so roots are real for all k (or equiv.)	M1 A1 cso (2) 6
	Notes (a) M1: attempt to find discriminant – substitution is required If formula b^2-4ac is seen at least 2 of a, b and c must be correct If formula b^2-4ac is **not** seen all 3 of a, b and c must be correct Use of b^2+4ac is M0 A1: correct unsimplified (b) M1: Attempt at completion of square (see earlier notes) A1: both correct (no ft for this mark) (c) M1: States condition as on scheme **or** attempts to explain that their $(k+1)^2+8$ is greater than 0 A1: The final mark (A1cso) requires $(k+1)^2\geq 0$ and conclusion. We will allow $(k+1)^2>0$ (or word positive) also allow $b^2-4ac\geq 0$ and conclusion.	

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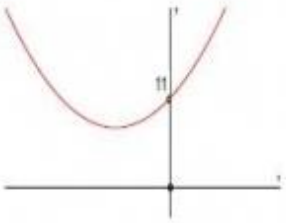
Q5.

Question Number	Scheme	Marks
(a)	$(x+3)^2+2$ or $p=3$ or $\frac{6}{2}$ $q=2$	B1 B1 (2)
(b)	 U shape with min in 2nd quad (Must be above x-axis and not on y=axis) U shape crossing y-axis at (0, 11) only (Condone (11,0) marked on y-axis)	B1 B1 (2)
(c)	$b^2-4ac=6^2-4\times11$ $=\ \underline{-8}$	M1 A1 (2) 6

	Notes
(a)	Ignore an "= 0" so $(x+3)^2+2=0$ can score both marks
(b)	The U shape can be interpreted fairly generously. Penalise an obvious V on 1st B1 only. The U needn't have equal "arms" as long as there is a clear min that "holds water" 1st B1 for U shape with minimum in 2nd quad. Curve need not cross the y-axis but minimum should NOT touch x-axis and should be left of (not on) y-axis 2nd B1 for U shaped curve crossing at (0, 11). Just 11 marked on y-axis is fine. The point must be marked on the sketch (do not allow from a table of values) Condone stopping at (0, 11)
(c)	M1 for some correct substitution into b^2-4ac. This may be as part of the quadratic formula but must be in part (c) and must be only numbers (no x terms present). Substitution into $b^2<4ac$ or $b^2=4ac$ or $b^2>4ac$ is M0 A1 for -8 only. If they write $-8<0$ treat the <0 as ISW and award A1 If they write $-8\geq0$ then score A0 A substitution in the quadratic formula leading to -8 inside the square root is A0. So substituting into $b^2-4ac<0$ leading to $-8<0$ can score M1A1. Only award marks for use of the discriminant in part (c)

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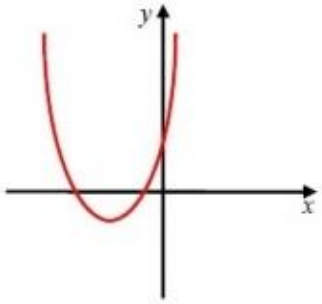
Q6.

Question Number	Scheme	Marks
(a)	This may be done by completion of square or by expansion and comparing coefficients	
	$a = 4$	B1
	$b = 1$	B1
	All three of $a = 4$, $b = 1$ and $c = -1$	B1
		[3]
(b)	 U shaped quadratic graph.	M1
	The curve is correctly positioned with the minimum in the third quadrant. . It crosses x axis twice on negative x axis and y axis once on positive y axis.	A1
	Curve cuts y-axis at $(\{0\}, 3)$. only	B1
	Curve cuts x-axis at $(-\frac{3}{2}, \{0\})$ and $(-\frac{1}{2}, \{0\})$.	B1
		[4]
		7 marks

	Notes
(a)	**B1:** States $a = 4$ or obtains $4(x+b)^2 + c$,
	B1: States $b = 1$ or obtains $a(x+1)^2 + c$,
	B1: States $a = 4$, $b = 1$ **and** $c = -1$ or $4(x+1)^2 - 1$ (Needs all 3 correct for final mark)
	Special cases: If answer is left as $(2x+2)^2 - 1$ treat as misread B1B0B0
	or as $2(x+1)^2 - 1$ then the mark is B0B1B0 from scheme
(b)	**M1:** Any position provided U shaped (be generous in interpretation of U shape but V shape is M0)
	A1 : The curve is correctly positioned with the minimum in the third quadrant. It crosses x axis twice on negative x axis and y axis once on positive y axis.
	B1: Allow 3 on y axis and allow either $y = 3$ or $(0, 3)$ if given in text Curve does not need to pass through this point and this mark may be given even if there is no curve at all or if it is drawn as a line.
	B1: Allow $-3/2$ and $-1/2$ if given on x axis – need co-ordinates if given in text or $x = -3/2$, $x = -1/2$. Accept decimal equivalents. Curve does not need to pass through these points and this mark may be given even if there is no curve. Ignore third point of intersection and allow touching instead of cutting. So even a cubic curve *might* get M0A0 B1 B1.
	A V shape with two ruled lines for example might get M0A0B1B1

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Q7.

Question	Scheme	Marks	AOs
(a)	$f(x)=(x-2)^2\pm...$	M1	1.2
	$f(x)=(x-2)^2+1$	A1	1.1b
		(2)	
(b)(i)	$P=(0,\ 5)$	B1	1.1b
(b)(ii)	$Q=(2,\ 1)$	B1ft	1.1b
		(2)	
			(4 marks)
Notes			

(a)

M1: Achieves $(x-2)^2\pm...$ or states $a=-2$

A1: Correct expression $(x-2)^2+1$ ISW after sight of this

Condone $a=-2$ and $b=1$. Condone $(x-2)^2+1=0$

(b)

(i) B1: Correct coordinates for P. Allow to be expressed $x=0,\ y=5$

(ii) B1ft: Correct coordinates for Q. Allow to be expressed $x=2,\ y=1$ (Score for the correct answer or follow through their part (a) so allow $(-a,\ b)$ where a and b are numeric)

Score in any order if they state $P=(0,\ 5)$ and $Q=(2,\ 1)$

.....

Allow part (b) to be awarded from a sketch. So award

First B1 from a sketch crossing the y-axis at 5

Second B1 from a sketch with minimum at $(2,\ 1)$

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