Mark Scheme (Results)

January 2012

GCE Core Mathematics C1 (6663) Paper 1

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January 2012
Publications Code US030304

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 75.

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes and can be used if you are using the annotation facility on ePEN.

- bod – benefit of doubt
- ft – follow through
- the symbol $\sqrt{}$ will be used for correct ft
- cao – correct answer only
- cso - correct solution only. There must be no errors in this part of the question to obtain this mark
- isw – ignore subsequent working
- awrt – answers which round to
- SC: special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- dp decimal places
- sf significant figures
- * The answer is printed on the paper
- □ The second mark is dependent on gaining the first mark

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

General Principals for Core Mathematics Marking

(But note that specific mark schemes may sometimes override these general principles).

Method mark for solving 3 term quadratic:

1. Factorisation

$(x^2 + bx + c) = (x + p)(x + q)$, where $|pq| = |c|$, leading to x = ...

$(ax^2 + bx + c) = (mx + p)(nx + q)$, where $|pq| = |c|$ and $|mn| = |a|$, leading to x = …

2. Formula

Attempt to use correct formula (with values for a, b and c), leading to x = …

3. Completing the square

Solving $x^2 + bx + c = 0$: $\left(x \pm \frac{b}{2}\right)^2 \pm q \pm c, \quad q \neq 0$, leading to x = …

Method marks for differentiation and integration:

1. Differentiation

Power of at least one term decreased by 1. ($x^n \to x^{n-1}$)

2. Integration

Power of at least one term increased by 1. ($x^n \to x^{n+1}$)

Use of a formula

Where a method involves using a formula that has been learnt, the advice given in recent examiners' reports is that the formula should be quoted first.

Normal marking procedure is as follows:

Method mark for quoting a correct formula and attempting to use it, even if there are mistakes in the substitution of values.

Where the formula is not quoted, the method mark can be gained by implication from correct working with values, but may be lost if there is any mistake in the working.

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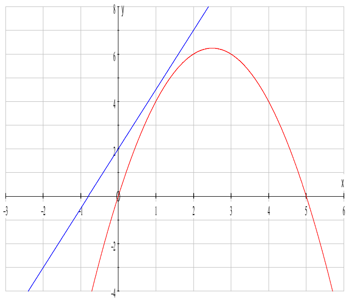
C1 6663
Mark Scheme

Question	Scheme	Marks
1. **(a)**	$4x^3+3x^{-\frac{1}{2}}$	M1A1A1 (3)
(b)	$\frac{x^5}{5}+4x^{\frac{3}{2}}+C$	M1A1A1 (3)
		6 marks
	Notes	
(a)	M1 for $x^n \rightarrow x^{n-1}$ i.e. x^3 or $x^{-\frac{1}{2}}$ seen 1st A1 for $4x^3$ <u>or</u> $6\times\frac{1}{2}\times x^{-\frac{1}{2}}$ (o.e.) (ignore any + c for this mark) 2nd A1 for simplified terms i.e. <u>both</u> $4x^3$ <u>and</u> $3x^{-\frac{1}{2}}$ or $\frac{3}{\sqrt{x}}$ and no $+c$ $\left[\frac{3}{1}x^{-\frac{1}{2}}\text{ is A0}\right]$ Apply ISW here and award marks when first seen	
(b)	M1 for $x^n \rightarrow x^{n+1}$ applied to y only so x^5 or $x^{\frac{3}{2}}$ seen. Do not award for integrating their answer to part (a) 1st A1 for $\frac{x^5}{5}$ or $\frac{6x^{\frac{3}{2}}}{\frac{3}{2}}$ (or better). Allow $1/5x^5$ here but not for 2nd A1 2nd A1 for fully correct and simplified answer with $+C$. Allow $(1/5)x^5$ If + C appears earlier but not on a line where 2nd A1 could be scored then A0	

Question	Scheme	Marks
2. (a)	$\sqrt{32} = 4\sqrt{2}$ or $\sqrt{18} = 3\sqrt{2}$	B1
	$\left(\sqrt{32}+\sqrt{18}=\right)$ $\underline{7\sqrt{2}}$	B1 (2)
(b)	$\times\frac{3-\sqrt{2}}{3-\sqrt{2}}$ or $\times\frac{-3+\sqrt{2}}{-3+\sqrt{2}}$ seen	M1
	$\left[\frac{\sqrt{32}+\sqrt{18}}{3+\sqrt{2}}\times\frac{3-\sqrt{2}}{3-\sqrt{2}}=\right]$ $\frac{a\sqrt{2}\left(3-\sqrt{2}\right)}{[9-2]}$ $\rightarrow$ $\frac{3a\sqrt{2}-2a}{[9-2]}$ (or better)	dM1
	$=$ $\underline{3\sqrt{2}, -2}$	A1, A1 (4)
ALT	$(b\sqrt{2}+c)(3+\sqrt{2}) = 7\sqrt{2}$ leading to: $3b+c=7$, $3c+2b=0$ e.g. $3(7 - 3b) + 2b = 0$ (o.e.)	M1 dM1
		6 marks
	Notes	
(a)	1st B1 for either surd simplified 2nd B1 for $7\sqrt{2}$ or accept $a = 7$. Answer only scores B1B1 NB Common error is $\sqrt{32}+\sqrt{18}=\sqrt{50}=5\sqrt{2}$ this scores B0B0 but can use their "5" in (b) to get M1M1	
(b)	1st M1 for an attempt to multiply by $\frac{3-\sqrt{2}}{3-\sqrt{2}}$ (o.e.) Allow poor use of brackets 2nd dM1 for using $a\sqrt{2}$ to correctly obtain a numerator of the form $p + q\sqrt{2}$ where p and q are non-zero integers. Allow arithmetic slips e.g. $21\sqrt{2}-28$ or $3\sqrt{2}\times\sqrt{2}=3$ Follow through their a = 7 or a new value found in (b). Ignore denominator. Allow use of letter a. Dependent on 1st M1 So $3\sqrt{32}-\sqrt{64}+3\sqrt{8}-\sqrt{36}$ is M0 until they reduce $p + q\sqrt{2}$ 1st A1 for $3\sqrt{2}$ or accept $b = 3$ from correct working 2nd A1 for -2 or accept $c = -2$ from correct working	
ALT	**Simultaneous Equations** 1st M1 for $(b\sqrt{2}+c)(3+\sqrt{2}) = 7\sqrt{2}$ and forming 2 simultaneous equations. Ft their a = 7 2nd dM1 for solving their simultaneous equations: reducing to a linear equation in one variable	

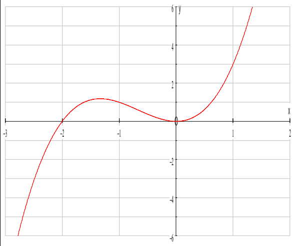
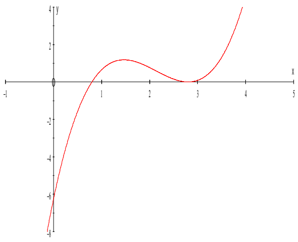
Question	Scheme	Marks
3. (a)	$5x > 20$	M1
	$\underline{\boldsymbol{x > 4}}$	A1 (2)
(b)	$x^2 - 4x - 12 = 0$	
	$(x+2)(x-6)$ [= 0]	M1
	$x = 6,\ -2$	A1
	$x < -2\ ,\ x > 6$	M1, A1ft
		(4)
		6 marks
	Notes	
(a)	M1 for reducing to the form $px > q$ with one of p or q correct Using $px = q$ is M0 unless $>$ 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 $\le$ 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	Scheme	Marks
4. (a)	$(x_2 =)\ a + 5$	B1 (1)
(b)	$(x_3) = a"(a+5)"+5$	M1
	$= a^2 + 5a + 5$ **(*)**	A1cso (2)
(c)	$41 = a^2 + 5a + 5 \Rightarrow a^2 + 5a - 36 (= 0)$ or $36 = a^2 + 5a$	M1
	$(a + 9)(a - 4) = 0$	M1
	$a = 4$ or -9	A1 (3)
		6 marks
	Notes	
(a)	B1 accept $a1 + 5$ or $1 \times a + 5$ (etc)	
(b)	M1 must see a(their x_2) + 5 A1cso must have seen a(a[1] + 5) + 5 (etc or better) Must have both brackets (....) and no incorrect working seen	
(c)	1st M1 for forming a suitable equation using x_3 and 41 and an attempt to collect like terms and reduce to 3TQ (o.e). Allow one error in sign. Accept for example $a^2 + 5a + 46 (= 0)$ If completing the square should get to $\left(a \pm \frac{5}{2}\right)^2 = 36 + \frac{25}{4}$ 2nd M1 Attempting to solve their relevant 3TQ (**see General Principles**) A1 for both 4 and -9 seen. If $a = 4$ and -9 is followed by $-9 < a < 4$ apply ISW. No working or trial and improvement leading to <u>both</u> answers scores 3/3 but no marks for only one answer. Allow use of other letters instead of a	

Question	Scheme	Marks
5. (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) $\cap$ shape and passing through (5, 0)	B1 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	Scheme	Marks
6. (a)	$(m=)\frac{2}{3}$ (or exact equivalent)	B1 (1)
(b)	B: (0, 4) [award when first seen – may be in (c)]	B1
	Gradient: $\frac{-1}{m}=-\frac{3}{2}$	M1
	$y-4=-\frac{3x}{2}$ or equiv. e.g. $\left(y=-\frac{3x}{2}+4, \quad 3x+2y-8=0\right)$	A1 (3)
(c)	A: $(-6,0)$ [award when first seen – may be in (b)]	B1
	C: $\frac{3x}{2}=4 \Rightarrow x=\frac{8}{3}$ [award when first seen – may be in (b)]	B1ft
	Area: Using $\frac{1}{2}(x_C-x_A)y_B$	M1
	$=\frac{1}{2}\left(\frac{8}{3}+6\right)4=\frac{52}{3} \left(=17\frac{1}{3}\right)$	A1 cso (4)
ALT	$BC=\frac{4}{6}\sqrt{52}$ (from similar triangles) (or possibly using C)	2nd B1ft
	Area: Using $\frac{1}{2}(AB\times BC)$ N.B. $AB=\sqrt{6^2+4^2}=\sqrt{52}$	M1
	$=\frac{1}{2}\times\sqrt{52}\times\left(\frac{2}{3}\sqrt{52}\right)=\frac{52}{3} \left(=17\frac{1}{3}\right)$	A1
		8 marks
	Notes	
(a)	B1 for $\frac{2}{3}$ seen. Do not award for $\frac{2}{3}x$ and must be in part (a)	
(b)	B1 for coordinates of B. Accept 4 marked on y-axis (clearly labelled) M1 for use of perpendicular gradient rule. Follow through their value for m A1 for a correct equation (any form, need not be simplified). Answer only 3/3	
(c)	1st B1 for the coordinates of A (clearly labelled). Accept – 6 marked on x-axis 2nd B1ft for the coordinates of C (clearly labelled) or $AC=\frac{26}{3}$. Accept $x=\frac{8}{3}$ marked on x-axis. Follow through from l_2 if >0 M1 for an expression for the area of the triangle (all lengths > 0). Ft their 4, - 6 and $\frac{8}{3}$ A1 cso for $\frac{52}{3}$ or exact equivalent seen but must be a single fraction or $17\frac{1}{3}$ or $17\frac{2}{6}$ etc $17\frac{1}{3}$ on its own can only score full marks if A, B and C are all correct.	
ALT	2nd B1ft If they use this approach award this mark for C (if seen) or BC	
Use of Det	2nd M1 must get as far as: $\frac{1}{2}\lvert x_A\times y_B-x_C\times y_B\rvert$	

Question	Scheme	Marks
7.	$\left[\mathrm{f}(x) =\right] \frac{3x^3}{3} - \frac{3x^2}{2} + 5x [+c]$ $\quad$ <u>or</u> $\left\{ x^3 - \frac{3}{2}x^2 + 5x (+c) \right\}$	M1A1
	$10 = 8 - 6 + 10 + c$	M1
	$c = -2$	A1
	$\mathrm{f}(1) = 1 - \frac{3}{2} + 5 \quad "-2" = \underline{\frac{5}{2}}$ (o.e.)	A1ft (5)
		5 marks
	Notes	
	1st M1 for attempt to integrate $x^n \to x^{n+1}$ 1st A1 all correct, possibly unsimplified. Ignore $+c$ here. 2nd M1 for using $x = 2$ <u>and</u> f(2) = 10 to form a linear equation in c. Allow sign errors. They should be substituting into a <u>changed</u> expression 2nd A1 for $c = -2$ 3rd A1ft for $\frac{9}{2} + c$ Follow through their <u>numerical</u> c ($\neq 0$) This mark is dependent on 1st M1 and 1st A1 only.	

Question	Scheme	Marks
8. (a)	$[\,y = x^3 + 2x^2\,]$ so $\dfrac{dy}{dx} = 3x^2 + 4x$	M1A1 (2)
(b)	 Shape 	B1
	Touching x-axis at origin	B1
	Through and not touching or stopping at -2 on x –axis. Ignore extra intersections.	B1 (3)
(c)	At $x = -2$: $\dfrac{dy}{dx} = 3(-2)^2 + 4(-2) = 4$	M1
	At $x = 0$: $\dfrac{dy}{dx} = 0$ (Both values correct)	A1 (2)
(d)	 Horizontal translation (touches x-axis still)	M1
	$k-2$ and k marked on positive x-axis	B1
	$k^2(2-k)$ (o.e) marked on negative y-axis	B1 (3)
		10 marks
	Notes	
(a)	M1 for attempt to multiply out and then some attempt to differentiate $x^n \to x^{n-1}$ Do not award for $2x(x+2)$ or $2x(1+2)$ etc	
Prod Rule	Award M1 for a correct attempt: 2 products with a + and at least one product correct A1 for both terms correct. (If $+c$ or extra term is included score A0)	
(b)	1st B1 for correct shape (anywhere). Must have 2 clear turning points. 2nd B1 for graph touching at origin (not crossing or ending) 3rd B1 for graph passing through (not stopping or touching at) -2 on x axis and -2 marked on axis	
SC	B0B0B1 for $y = x^3$ <u>or</u> cubic with straight line between $(-2, 0)$ and $(0, 0)$	
(c)	M1 for attempt at $y'(0)$ or $y'(-2)$. Follow through their 0 or – 2 and their $y'(x)$ <u>or</u> for a <u>correct</u> statement of zero gradient for an identified point on their curve that touches x-axis A1 for both correct answers	
(d)	For the M1 in part (d) ignore any coordinates marked – just mark the shape. M1 for a horizontal translation of their (b). Should still touch x – axis if it did in (b) <u>Or</u> for a graph of correct shape with min. and intersection in correct order on +ve x-axis 1st B1 for k and $k-2$ on the positive x-axis. Curve must pass through $k-2$ and touch at k 2nd B1 for a correct intercept on negative y-axis in terms of k. Allow $(0, 2k^2 - k^3)$ (o.e.) seen in script if curve passes through –ve y-axis	

Question	Scheme	Marks
9. (a)	$S_{10} = \frac{10}{2}[2P + 9\times 2T]$ or $\frac{10}{2}(P+[P+18T])$	M1
	e.g. $5[2P+18T]$ = (£) (10*P* + 90*T*) or (£) 10*P* + 90*T* **(*)**	A1cso (2)
(b)	Scheme 2: $S_{10} = \frac{10}{2}[2(P+1800)+9T] = \{10P + 18000 + 45T\}$	M1A1
	10*P* + 90*T* = 10*P* + 18000 + 45*T*	M1
	90*T* = 18000 + 45*T*	
	T = 400 (only)	A1 (4)
(c)	Scheme 2, Year 10 salary: $[a+(n-1)d =](P+1800)+9T$	B1ft
	P + 1800 + "3600" = 29850	M1
	P = (£) <u>24450</u>	A1 (3)
		9 marks
	Notes	
(a)	M1 for identifying *a* = *P* or *d* = 2*T* and attempt at S_{10}. Using *n* = 10 and one of *a* or *d* correct. Must see evidence for M mark, at least one line before the answer. A1cso for simplifying to given answer. No incorrect working seen. Do not penalise missing end bracket in working eg 5(2*P* + 18*T*	
List	M1A1 for a full list seen (with + signs or written in columns) and no incorrect working seen. Any missing terms is M0A0	
(b)	1st M1 for attempting S_{10} for scheme 2 (allow missing (…) brackets e.g. 2*P* + 1800 + 9*T*) Using *n* = 10 and at least one of *a* or *d* correct. 1st A1 for a correct expression for S_{10} using scheme 2 (needn't be multiplied out)	
List	Allow M1A1 if they reach 10*P* + 18000 + 45*T* with no incorrect working seen 10*P* + 18000 + 45*T* with no working is M1A1 2nd M1 for forming an equation using the two sums that would enable *P* to be eliminated. Follow through their expressions provided *P* would disappear. 2nd A1 for *T* = 400 Answer only (4/4)	
(c)	B1 for using u_{10} for scheme 2 . Can be 9*T* or follow through their <u>value</u> of *T* M1 for forming an equation based on u_{10} for scheme 2 and using 29850 and their <u>value</u> of *T* A1 for 24450 seen Answer only (3/3)	
MR	If they misread scheme 2 as scheme 1 in part (c) apply MR rule and award B0M1A0 max for an equation based on u_{10} for scheme 1 and using 29850 and their <u>value</u> of *T*	

Question	Scheme	Marks
10. (a)	$\left(\frac{1}{2}, 0\right)$	B1 (1)
(b)	$\frac{dy}{dx} = x^{-2}$	M1A1
	At $x = \frac{1}{2}$, $\frac{dy}{dx} = \left(\frac{1}{2}\right)^{-2} = 4$ $(= m)$	A1
	Gradient of normal $= -\frac{1}{m}$ $\left(= -\frac{1}{4}\right)$	M1
	Equation of normal: $y - 0 = -\frac{1}{4}\left(x - \frac{1}{2}\right)$	M1
	$2x + 8y - 1 = 0$ **(*)**	A1cso (6)
(c)	$2 - \frac{1}{x} = -\frac{1}{4}x + \frac{1}{8}$	M1
	$[= 2x^2 + 15x - 8 = 0]$ <u>or</u> $[8y^2 - 17y = 0]$	
	$(2x-1)(x+8) = 0$ leading to $x = \ldots$	M1
	$x = \left[\frac{1}{2}\right]$ or -8	A1
	$y = \frac{17}{8}$ (or exact equivalent)	A1ft (4)
		11 marks
	Notes	
(a)	B1 accept $x = \frac{1}{2}$ if evidence that $y = 0$ has been used. Can be written on graph. Use ISW	
(b)	1st M1 for kx^{-2} even if the '2' is not differentiated to zero. If no evidence of $\frac{dy}{dx}$ seen then 0/6 1st A1 for x^{-2} (o.e.) only 2nd A1 for using $x = 0.5$ to get $m = 4$ (correctly) (or $m = 1/0.25$) To score final A1cso must see at least one intermediate equation for the line after $m = 4$ 2nd M1 for using the perpendicular gradient rule on their m coming from their $\frac{dy}{dx}$ Their m must be a value not a letter. 3rd M1 for using a changed gradient (based on y') and their A to find equation of line 3rd A1cso for reaching printed answer with no incorrect working seen. Accept $2x + 8y = 1$ or equivalent equations with $\pm 2x$ and $\pm 8y$ Trial and improvement requires sight of first equation.	
(c)	1st M1 for attempt to form a suitable equation in one variable. Do not penalise poor use of brackets etc. 2nd M1 for simplifying their equation to a 3TQ and attempting to solve. May be $\Rightarrow$ by $x = -8$ 1st A1 for $x = -8$ (ignore a second value). If found y first allow ft for x if $x < 0$ 2nd A1ft for $y = \frac{17}{8}$ Follow through their x value in line or curve provided answer is > 0 This second A1 is dependent on <u>both</u> M marks	

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Order Code US030304 January 2012

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