Mark Scheme (Results)

Summer 2018

Pearson Edexcel GCE Mathematics

Core Mathematics C1 (6663/01)

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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.

PEARSON 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.

   - 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)
   - d… or dep – dependent
   - indep – independent
   - dp decimal places
   - sf significant figures
   - * The answer is printed on the paper or ag- answer given
   - $\sqcup$ or d… 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.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. If a candidate makes more than one attempt at any question:
    - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
    - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

7. Ignore wrong working or incorrect statements following a correct answer.

General Principles 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

$(x^2 + bx + c) = (x + p)(x + q),\ \text{where} |pq| = |c|$, leading to x = …

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

2. Formula

Attempt to use the correct formula (with values for a, b and c).

3. Completing the square

Solving $x^2 + bx + c = 0$: $\left(x \pm \frac{b}{2}\right)^2 \pm q \pm c = 0,\ \ q \neq 0$, 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 small errors 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.

Exact answers

Examiners' reports have emphasised that where, for example, an exact answer is asked for, or working with surds is clearly required, marks will normally be lost if the candidate resorts to using rounded decimals.

Question Number	Scheme		Marks
1.(i) Way 1	$\sqrt{48}=\sqrt{16}\sqrt{3}$ or $\dfrac{6}{\sqrt{3}}=6\dfrac{\sqrt{3}}{3}$	Writes one of the terms of the given expression correctly in terms of $\sqrt{3}$	M1
	$\Rightarrow \sqrt{48}-\dfrac{6}{\sqrt{3}}=2\sqrt{3}$	A correct answer of $2\sqrt{3}$. A correct answer with **no** working implies both marks.	A1
			(2)
(i) Way 2	$\sqrt{48}=2\sqrt{12}$ or $\dfrac{6}{\sqrt{3}}=\sqrt{12}$	Writes one of the terms of the given expression correctly in terms of $\sqrt{12}$	M1
	$2\sqrt{12}-\sqrt{12}=\sqrt{12}=2\sqrt{3}$	A correct answer of $2\sqrt{3}$. A correct answer with **no** working implies both marks.	A1
			(2)
(i) Way 3	$\sqrt{48}=\dfrac{12}{\sqrt{3}}$ or $\sqrt{48}=\dfrac{\sqrt{144}}{\sqrt{3}}$	Writes $\sqrt{48}$ correctly as $\dfrac{12}{\sqrt{3}}$ or $\dfrac{\sqrt{144}}{\sqrt{3}}$	M1
	$\dfrac{12}{\sqrt{3}}-\dfrac{6}{\sqrt{3}}=\dfrac{6}{\sqrt{3}}=2\sqrt{3}$	A correct answer of $2\sqrt{3}$. A correct answer with **no** working implies both marks.	A1
			(2)
(i) Way 4	$\sqrt{48}-\dfrac{6}{\sqrt{3}}=\dfrac{\sqrt{3}\sqrt{48}-\ldots}{\sqrt{3}}=\dfrac{12-\ldots}{\sqrt{3}}$ or $\sqrt{48}-\dfrac{6}{\sqrt{3}}=\dfrac{\sqrt{3}\sqrt{48}-\ldots}{\sqrt{3}}=\dfrac{\sqrt{144}-\ldots}{\sqrt{3}}$	Writes $\sqrt{48}$ correctly as $\dfrac{12}{\sqrt{3}}$ or $\dfrac{\sqrt{144}}{\sqrt{3}}$	M1
	$\dfrac{12-6}{\sqrt{3}}=\dfrac{6}{\sqrt{3}}=2\sqrt{3}$	A correct answer of $2\sqrt{3}$. A correct answer with **no** working implies both marks.	A1
			(2)

(ii) **Way 1**	$81=3^4$ or $\log_3 81=6x-3$	For $81=3^4$ or $\log_3 81=6x-3$. This may be implied by subsequent work.	B1
	$3^{6x-3}=3^4$ or $\log_3 81=6x-3$ $\Rightarrow 4=6x-3\Rightarrow x=...$	Solves an equation of the form $6x-3=k$ where k is their power of 3.	M1
	$\Rightarrow x=\frac{4+3}{6}=\frac{7}{6}$	$\frac{7}{6}$ or $1\frac{1}{6}$ or $1.1\dot{6}$	A1
			(3)
Way 2	$3=81^{\frac{1}{4}}$	For $3=81^{\frac{1}{4}}$. This may be implied by subsequent work.	B1
	$81^{\frac{6x-3}{4}}=81\Rightarrow\frac{6x-3}{4}=1\Rightarrow x=...$	Solves an equation of the form $k(6x-3)=1$ where k is their power of 81.	M1
	$\Rightarrow x=\frac{4+3}{6}=\frac{7}{6}$	$\frac{7}{6}$ or $1\frac{1}{6}$ or $1.1\dot{6}$	A1
			(3)
Way 3	$81=9^2$ **and** $3=9^{\frac{1}{2}}$	For $81=9^2$ **and** $3=9^{\frac{1}{2}}$. This may be implied by subsequent work.	B1
	$9^{\frac{6x-3}{2}}=9^2\Rightarrow\frac{6x-3}{2}=2\Rightarrow x=...$	Solves an equation of the form $p(6x-3)=q$ where p is their power of 9 for the 3 and q is their power of 9 for the 81.	M1
	$\Rightarrow x=\frac{4+3}{6}=\frac{7}{6}$	$\frac{7}{6}$ or $1\frac{1}{6}$ or $1.1\dot{6}$	A1
			(3)
Way 4	$3^{6x-3}=3^{6x}\times 3^{-3}$	For writing 3^{6x-3} correctly in terms of 3^{6x}	B1
	$3^{6x}=81\times 3^3=3^7$ $\Rightarrow 6x=7\Rightarrow x=...$	Solves an equation of the form $6x=k$ where k is their $3^3\times 81$ written as a power of 3.	M1
	$\Rightarrow x=\frac{7}{6}$	$\frac{7}{6}$ or $1\frac{1}{6}$ or $1.1\dot{6}$	A1
			(3)
Way 5	$\log 3^{6x-3}=\log 81$	Takes logs of both sides	B1
	$6x-3=\frac{\log 81}{\log 3}$ $6x-3=4\Rightarrow x=...$	Solves an equation of the form $6x-3=k$ where k is their $\frac{\log 81}{\log 3}$	M1
	$\Rightarrow x=\frac{7}{6}$	$\frac{7}{6}$ or $1\frac{1}{6}$ or $1.1\dot{6}$	A1
			(3)
			(5 marks)

Note:

The question does not specify the form of the final answer in (b) and so if answers are left un-simplified as e.g. $\frac{\log_3 81+3}{6}$, $\frac{\log_3 2187}{6}$ **then allow full marks if correct.**

Question Number	Scheme		Marks
2.(a)	$2x^{1.5} - 3x^2 + 4x + c$	M1: For $x^n \to x^{n+1}$ i.e. $x^{1.5}$ or x^2 or x seen (not for "+ c") A1: For two out of three terms correct un-simplified or simplified (Ignore + c for this mark) A1: cao $2x^{1.5} - 3x^2 + 4x + c$. All correct and simplified and on one line including "+ c". Allow $\sqrt{x^3}$ for $x^{1.5}$ but not x^1 for x.	M1A1A1
	Ignore any spurious integral signs.		
			(3)
(b)(i)	**Mark (b)(i) and (ii) together and must be differentiating the original function not their answer to part (a)**		
	$\frac{3}{2}x^{-0.5} - 6$	M1: For $x^n \to x^{n-1}$ i.e. $x^{0.5} \to x^{-0.5}$ or $6x \to 6$ A1: For $\frac{3}{2}x^{-0.5} - 6$ or equivalent. May be un-simplified. Allow $\frac{3/2}{\sqrt{x}} - 6$.	M1A1
			(2)
(ii)	$\frac{3}{2}x^{-0.5} - 6 = 0 \Rightarrow x^n = ...$	Sets their $\frac{dy}{dx} = 0$ (may be implied by their working) and reaches $x^n = C$ (including $n = 1$) **with correct processing allowing sign errors only** – this may be implied by e.g. $\sqrt{x} = \frac{1}{4}$ or $\frac{1}{\sqrt{x}} = 4$.	M1
	$x = \frac{1}{16}$ cso	Allow equivalent fractions e.g. $\frac{9}{144}$ or 0.0625. If other solutions are given (e.g. likely to be $x = 0$ or $x = -1/16$) then this mark should be withheld.	A1
			(2)
			(7 marks)

Question Number	Scheme		Marks
3.(a)	$x^2-10x+23=(x\pm5)^2\pm A$	For an attempt to complete the square. Note that if their A = 23 then this is M0 by the General Principles.	M1
	$(x-5)^2-2$	Correct expression. Ignore "= 0".	A1
			(2)
(b)	$(x\pm5)^2-A\Rightarrow x=\dots$ or $x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}\Rightarrow x=\dots$ $\left(x=\frac{10\pm\sqrt{10^2-4(1)(23)}}{2}\right)$	Uses their completion of the square for **positive** A or uses the correct quadratic formula to obtain at least one value for x	M1
	$x=5\pm\sqrt{2}$	Correct exact values. If using the quadratic formula must reach as far as $\frac{10\pm\sqrt{8}}{2}$	A1
			(2)
(c)	$(5\pm\sqrt{2})^2=27+10\sqrt{2}$	Attempts to square **any** solution from part (b). Allow poor squaring e.g. $(5+\sqrt{2})^2=25+2=27$. **Do not allow** for substituting e.g. $5+\sqrt{2}$ into $x^2-10x+23$.	M1
	$=27+10\sqrt{2}$	Accept equivalent forms such as $27+\sqrt{200}$. If any extra answers are given, this mark should be withheld.	A1
			(2)
	Allow candidates to start again:		
	$y-10y^{0.5}+23=0\Rightarrow y^{0.5}=\frac{10\pm\sqrt{10^2-4\times23}}{2}=5\pm\sqrt{2}$ $y=(5\pm\sqrt{2})^2=\dots$		M1
	$=27+10\sqrt{2}$	Accept equivalent forms such as $27+\sqrt{200}$. If any extra answers are given, this mark should be withheld.	A1
			(6 marks)

Question Number	Scheme		Marks
4 (a)	$a+(n-1)d=600+9\times120$	This mark is for: $600+9\times120$ or $600+8\times120$	M1
	$=(£)1680$	1680 with or without the "£"	A1
	Answer only scores both marks		
	<u>Listing</u> M1: Lists ten terms starting £600, £720, £840, £960, … A1: Identifies the 10^{th} term as $(£)1680$		
			(2)
(b)	**Allow the use of *n* instead of *N* throughout in (b)**		
	$d=80$ for Kim	Identifies or uses $d=80$ for Kim	B1
	$\frac{N}{2}\{2\times600+(N-1)\times120\}$ OR $\frac{N}{2}\{2\times130+(N-1)\times80\}$	Attempts a sum formula for Andy or Kim. A correct formula must be seen or implied with: *a* = 600, *d* = 120 for Andy **or** *a* = 130, *d* = 80 for Kim. If B0 was scored, allow M1 here if Kim's incorrect "*d*" is used.	M1
	$\frac{N}{2}\{2\times600+(N-1)\times120\}=2\times\frac{N}{2}\{2\times130+(N-1)\times80\}$ A **<u>correct</u>** equation in any form		A1
	$20N=360\Rightarrow N=...$	Proceeds to find a value for *N*. (Allow if it leads to $N<0$) **Dependent on the first method mark and must be an equation that uses Andy's and Kim's sum.**	dM1
	$(N=)18$	Ignore *N*/*n* = 0 and if a correct value of *N* is seen, isw any further reference to years etc.	A1
	See below for listing approach		
	If you see *N* = 18 with no working send to Review		
			(5)
			(7 marks)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Andy	600	1320	2160	3120	4200	5400	6720	8160	9720	11400	13200	15120	17160	19320	21600	24000	26520	29160
Kim	130	340	630	1000	1450	1980	2590	3280	4050	4900	5830	6840	7930	9100	10350	11680	13090	14580
Kimx2	260	680	1260	2000	2900	3960	5180	6560	8100	9800	11660	13680	15860	18200	20700	23360	26180	29160

B1: States or uses $d=80$ for Kim
M1: Attempts to find the total savings for Andy or Kim – must see the correct pattern for Andy (600, 1320, 2160,…) or Kim (130, 340, 630,…) (or Kimx2)
A1: Correct totals for Andy and Kim (or Kimx2) at least as far as *n* = 18
M1: Identifies when Andy's total = 2xKim's total
A1: *N* = 18

Question Number	Scheme		Marks
5(a)	(4, 7)	Accept (4, 7) or $x = 4$, $y = 7$ or a sketch of $y = \mathrm{f}\left(x-2\right)$ with a maximum point marked at (4, 7). (Condone missing brackets) There should be no other coordinates.	B1
			(1)
(b)	(x =) 2.5	Allow (2.5, 0) (condone missing brackets) but no other values or points. Allow a sketch of f(2x) with the only x-intercept marked at x = 2.5 (Allow (0, 2.5) marked in the correct place.	B1
			(1)
(c)	$y = 1$ (oe e.g. $y - 1 = 0$)	Must be an equation and not just '1' and no other asymptotes stated.	B1
			(1)
(d)	$k \le 1$ **or** $k = 7$	Either of $k \le 1$ or $k = 7$ Accept either of $y \le 1$ or $y = 7$ Note that k = 7 may sometimes be seen embedded in e.g. k = 0, 1, 7 and can score B1 here.	B1
	$k \le 1 \quad k = 7$	Both correct and in terms of k with no other solutions.	B1
			(2)
			(5 marks)

Question Number	Scheme		Marks
6 (a)	$a_1 = 4 \Rightarrow a_2 = \frac{4}{4+1}$	Attempts to use the given recurrence relation correctly at least once e.g. $a_2 = \frac{4}{4+1}$ or $a_3 = \frac{\text{their } a_2}{(\text{their } a_2)+1}$ or $a_4 = \frac{\text{their } a_3}{(\text{their } a_3)+1}$. May be implied by their term(s).	M1
	$\frac{4}{5}, \frac{4}{9}, \frac{4}{13}$	A1: Two of $\frac{4}{5}, \frac{4}{9}, \frac{4}{13}$ which may be un-simplified. Accept for example $0.8, \frac{0.8}{1.8}, \ldots$ or $\frac{4}{5}, \frac{\frac{4}{5}}{1+\frac{4}{5}}, \ldots$	A1A1
		A1: $\frac{4}{5}, \frac{4}{9}, \frac{4}{13}$ (Allow 0.8 for $\frac{4}{5}$)	
			(3)
(b)	$p = 4$ or e.g. $4 = \frac{4}{p+q}$, $"\frac{4}{5}" = \frac{4}{2p+q}$ $\Rightarrow p = \ldots \text{ or } q = \ldots$	$a_n = \frac{4}{4n \pm ..}$ or $p = 4$ **OR** Uses 2 terms to set up and solve two <u>**correct equations**</u> **for their fractions** in p and q to obtain a value for p or a value for q.	M1
	$a_n = \frac{4}{4n-3} \Rightarrow p = 4$ and $q = -3$	Either $a_n = \frac{4}{4n-3}$ OR $p = 4$ and $q = -3$	A1
	Correct answer only scores both marks.		
			(2)
(c)	$\frac{4}{4N-3} = \frac{4}{321} \Rightarrow N = \ldots$	Solves their $\frac{4}{pN+q} = \frac{4}{321}$ to obtain a value for N or n.	M1
	$(N =) 81$	Cao (ignore what they use for N)	A1
	Allow trial and improvement if 81 is clearly identified and then award both marks following a correct answer in (b) but just trying random values is M0		
			(2)
			(7 marks)

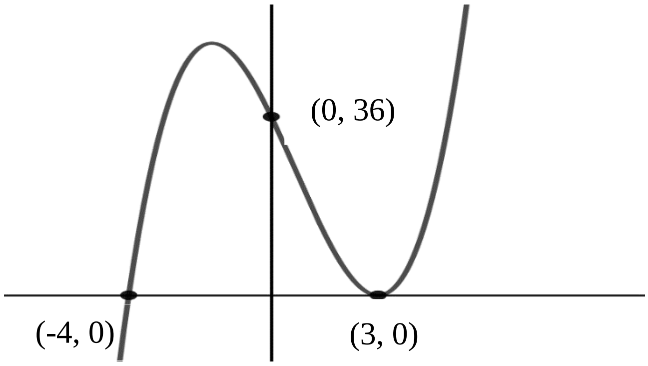
Question Number	Scheme		Marks
7(a)	$b^2 - 4ac = (4k)^2 - 4(-2)(20+13k)$	Attempts to use $b^2 - 4ac$ with $a = \pm(20 \pm 13k)$, $b = \pm 4k$, $c = \pm 2$. This could be as part of the quadratic formula or as $b^2 < 4ac$ or as $b^2 > 4ac$ or as $\sqrt{b^2 - 4ac}$ etc. If it is part of the quadratic formula only look for use of $b^2 - 4ac$. There must be no x's. If they gather to the lhs, condone the omission of the "– " on the "4k".	M1
	$(4k)^2 - 4(-2)(20+13k)$	For a correct un-simplified expression.	A1
	$b^2 - 4ac < 0$ $\Rightarrow (4k)^2 - 4(-2)(20+13k) < 0$	Uses $b^2 - 4ac < 0$ or e.g. $b^2 < 4ac$ with their values of a, b and c in terms of k. The " < 0" must appear before the final printed answer but can appear as $b^2 - 4ac < 0$ at the start.	M1
	$16k^2 + 160 + 104k < 0$ $\Rightarrow 2k^2 + 13k + 20 < 0$*	Reaches the printed answer with no errors, including bracketing errors, or contradictory statements and sufficient working shown. Note that the statement $(20 + 13k)x^2 - 4kx - 2 < 0$ or starting with e.g. $20x^2 < 4kx - 13kx^2 + 2$ would be an error.	A1*
			(4)
(b)	$2k^2 + 13k + 20 = 0 \Rightarrow k = ...$ e.g. $(2k+5)(k+4) = 0 \Rightarrow k = ...$	Attempt to solve the **__given__** quadratic to find 2 values for k. See general guidance.	M1
	$\Rightarrow k = -\frac{5}{2}, -4$	Both correct. May be implied by e.g. $k < -\frac{5}{2}$, $k < -4$ or seen on a sketch. If they use the quadratic formula allow $\frac{-13 \pm 3}{4}$ for this mark but not $\sqrt{9}$ for 3 and allow e.g. $-\frac{13}{4} \pm \frac{3}{4}$ if they complete the square.	A1
	$-4 < k < -\frac{5}{2}$ Allow equivalent values e.g. $-\frac{10}{4}$ i.e. the critical values must be in the form $\frac{a}{b}$ where a and b are integers	M1: Chooses 'inside' region for **their critical values** i.e. Lower Limit $< k <$ Upper Limit or e.g. Lower Limit $\le k \le$ Upper Limit A1: Allow $k \in (-4, -\frac{5}{2})$ or just $(-4, -\frac{5}{2})$ and allow $k > -4$ **and** $k < -2.5$ and $-\frac{5}{2} > k > -4$ but $k > -4$, $k < -\frac{5}{2}$ scores M1A0. $-\frac{5}{2} < k < -4$ is M0A0	M1A1
	Allow working in terms of x in (b) but the answer must be in terms of k for the final mark.		
			(4)
			(8 marks)

Question Number	Scheme		Marks
8(a)	$\frac{5}{4}$ oe	$\frac{5}{4}$ or exact equivalents such as 1.25 but **not** $\frac{5}{4}x$.	B1
			(1)
(b)	$y = \frac{5}{4}x + c$	Uses a line with a parallel gradient $\frac{5}{4}$ oe or their gradient from part (a). Evidence is $y = "\frac{5}{4}"x + c$ or similar.	M1
	$12,5 \Rightarrow 5 = '\frac{5}{4}' \times 12 + c \Rightarrow c = ..$	Method of finding an equation of a line with numerical gradient and passing through $12,5$. Score even for the perpendicular line. Must be seen in part (a).	M1
	$y = \frac{5}{4}x - 10$	Correct equation. Allow $-\frac{40}{4}$ for -10	A1
			(3)
(c)	$B = \ 0,-10$	$B = \ 0,-10$ Follow through on their 'c'. Allow also if -10 is marked in the correct place on the diagram. Allow *x* = 0, *y* = -10 (the *x* = 0 may be seen "embedded" but not just *y* = -10 with no evidence that *x* = 0)	B1ft
	$C = \ 8,0$	$C = \ 8,0$ Correct coordinates. Allow also if 8 is marked in the correct place on the diagram. Allow *y* = 0, *x* = 8 (the *y* = 0 may be seen "embedded" but not just *x* = 8 with no evidence that *y* = 0)	B1
	Do not penalise lack of "0" twice so penalise it at the first occurrence but check the diagram if necessary.		
			(2)

(d) **Way 1**	Area of Parallelogram = $(3+'10')\times'8'$	Uses area of parallelogram = $bh=(3+'10')\times''8''$ Follow through on their 10 and their 8	M1
	= 104	cao	A1
	Correct answer only scores both marks		**(2)**
(d) **Way 2**	Trapezium *AOCD* + Triangle *OCB* $=\frac{1}{2}(3+3+'10')\times'8'+\frac{1}{2}\times'8'\times'10'$	A correct method using their values for *AOCD* + *OCB*.	M1
	= 104	cao	A1
			(2)
(d) **Way 3**	2 Triangles + Rectangle $=2\times\frac{1}{2}('8'\times'10')+'8'\times3$	A correct method using their values for 2x*OBC* + rectangle.	M1
	= 104	cao	A1
			(2)
(d) **Way 4**	Triangle *ACD* + Triangle *ACB* $=2\times\frac{1}{2}('10'+3)\times'8'$	A correct method using their values for *ACD* + *ABC*.	M1
	= 104	cao	A1
			(2)
			(8 marks)

Question Number	Scheme		Marks
9.(a)	$(x-3)(3x+5)=3x^2-4x-15$ Allow $3x^2+5x-9x-15$	Correct expansion simplified or un-simplified.	B1
	$\text{f}(x)=x^3-2x^2-15x+c$	M1: $x^n \to x^{n+1}$ for any term. Follow through on incorrect indices but not for "+ c" A1: All terms correct. Need not be simplified. No need for + c here.	M1A1
	$x=1, y=20 \Rightarrow 20=1-2-15+c$ $\Rightarrow c=36$	Substitutes x = 1 and y = 20 into their f(x) to find c. Must have + c at this stage. **Dependent on the first method mark.**	**d**M1
	$(\text{f}(x)=)\,x^3-2x^2-15x+36$	Cao $(\text{f}(x)=)\,x^3-2x^2-15x+36$ (All together and on one line)	A1
			(5)
(b) **Way 1**	A = 4	Correct value (may be implied)	B1
	$\text{f}(x)=(x-3)^2(x+A)=(x^2-6x+9)(x+A)$ $\text{f}(x)=x^3+(A-6)x^2+(9-6A)x+9A$ $A-6=-2 \Rightarrow A=4 \quad 9-6A=-15 \Rightarrow A=4 \quad 9A=36 \Rightarrow A=4$ M1: Expands $(x-3)^2(x+A)$ and compares coefficients with their f(x) from part (a) to **form 3 equations** and attempts to solve **at least two of them** in an attempt to show that A is the same in each case or substitutes their A to show that the coefficients are the same. A1: Fully correct proof – must use all 3 coefficients		M1A1
			(3)
Way 2	A = 4	Correct value (may be implied)	B1
	$\text{f}(x)=(x-3)^2(x+4)=(x^2-6x+9)(x+4)$ $=x^3-6x^2+4x^2+9x-24x+36=x^3-2x^2-15x+36$ M1: Expands $(x-3)^2(x+\text{"4"})$ fully in an attempt to show that the expansion gives the same expression found as found in part (a) A1: Fully correct proof (Condone invisible brackets here e.g. around x + 4 provided sufficient working is shown)		M1A1
			(3)
Way 3	A = 4	Correct value (may be implied)	B1
	$(x^3-2x^2-15x+36)\div(x-3)=x^2+x-12$ $(x^2+x-12)\div(x-3)=x+4$ or $(x^2+x-12)=(x+4)(x-3)$ M1: Divides their f(x) from part (a) by (x – 3) and divides their quotient by (x – 3) in an attempt to establish the value of A. Alternatively divides their f(x) from part (a) by $(x-3)^2$ (Allow $x^2 \pm 6x \pm 9$) in an attempt to establish the value of A. A1: Fully correct proof		M1A1
			(3)
	Note that this is an acceptable proof: A = 4 (may be implied) $x^3-2x^2-15x+36=(x-3)(x^2+x-12)$ $=(x-3)(x-3)(x+4)$ $=(x-3)^2(x+4)$		

<u>Remember to check the last page for their sketch</u>

9(c)		
	A positive cubic shape. Its position is not important but must be a curve and not straight lines and the "ends" must not clearly turn back in on themselves.	B1
	Touches at the point (3, 0) (could be a maximum). Accept 3 marked on the *x*-axis and accept (0, 3) as long as it is in the correct place. Allow (3, 0) in the body of the script but it must correspond with the sketch. If ambiguous, the sketch takes precedence.	B1
	Crosses or reaches the *x*-axis at $\left(-4,0\right)$. Accept -4 marked on the *x*-axis and accept (0, -4) as long as it is in the correct place. FT on their $-A$ from part (b) and allow "–*A*" and allow a "made up" *A*. Allow $\left(-4,0\right)$ in the body of the script but it must correspond with the sketch. If ambiguous, the sketch takes precedence.	B1ft
	Crosses the *y*-axis at (0, 36) **and with a maximum in the second quadrant**. Accept 36 marked on the *y* – axis and accept (36, 0) as long as it is in the correct place. FT on their numerical '*c*' **<u>from part (a) only</u>**. Allow (0, 36) in the body of the script but it must correspond with the sketch. If ambiguous, the sketch takes precedence.	B1ft
		(4)
		(12 marks)

Question Number	Scheme		Marks
10(a)	$\frac{dy}{dx}=\frac{1}{2}-\frac{27}{x^2}$	M1: $\frac{1}{2}$ or $-\frac{27}{x^2}$ A1: $\frac{dy}{dx}=\frac{1}{2}-\frac{27}{x^2}$ oe e.g. $\frac{1}{2}x^0-27x^{-2}$	M1A1
	$x=3\Rightarrow\frac{dy}{dx}=\frac{1}{2}-\frac{27}{9}=\left(-\frac{5}{2}\right)$	Substitutes x = 3 into their $\frac{dy}{dx}$ to obtain a numerical gradient	M1
	$m_T=-\frac{5}{2}\Rightarrow m_N=-1\div-\frac{5}{2}$ $\Rightarrow y-\left(-\frac{3}{2}\right)=\frac{2}{5}(x-3)$	The correct method to find the equation of a normal. Uses $-\frac{1}{m_T}$ with $\left(3,-\frac{3}{2}\right)$ where m_T has come from calculus. If using $y = mx + c$ must reach as far as c = …	M1
	$10y=4x-27$*	Cso (correct equation must be seen in (a))	A1*
			(5)
(b)	$\frac{1}{2}x+\frac{27}{x}-12=\frac{4x-27}{10}$ or $y=\frac{10y+27}{8}+\frac{108}{10y+27}-12$	Equate equations to produce an equation just in x or just in y. Do not allow e.g. $\frac{1}{2}x^2+27-12x=\frac{4x-27}{10}$ Unless $\frac{1}{2}x+\frac{27}{x}-12=\frac{4x-27}{10}$ was seen previously. **Allow sign slips only.**	M1
	$x^2-93x+270=0$ or $20y^2-636y-999=0$	Correct 3 term quadratic equation (or any multiple of). Allow terms on both sides e.g. $x^2-93x=-270$ (The "= 0" may be implied by their attempt to solve)	A1
	$(x-90)(x-3)=0\Rightarrow x=...$ or $x=\frac{93\pm\sqrt{93^2-4\times270}}{2}$ or $(10y-333)(2y+3)=0\Rightarrow y=...$ or $y=\frac{636\pm\sqrt{636^2-4\times20\times(-999)}}{2\times20}$	Attempt to solve a 3TQ (see general guidance) leading to at least one for x or y. **Dependent on the first method mark.**	dM1
	$x=90$ **or** y = 33.3 oe	Cso. The x must be 90 and the y an equivalent number such as e.g. $\frac{333}{10}$	A1
	$x=90$ **and** y = 33.3 oe	Cso. The x must be 90 and the y an equivalent number such as e.g. $\frac{333}{10}$	A1
			(5)
			(10 marks)

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