Mark Scheme (Results)

Summer 2017

Pearson Edexcel GCE Mathematics

Core Mathematics 1 (6663/01)

Edexcel and BTEC Qualifications

Pearson: helping people progress, everywhere

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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
   - $\llcorner$ 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).

<u>Method mark for solving 3 term quadratic:</u>

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 = …

<u>Method marks for differentiation and integration:</u>

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.	$\int\left(2x^5 - \frac{1}{4}x^{-3} - 5\right)\mathrm{d}x$		
	Ignore any spurious integral signs throughout		
	$x^n \to x^{n+1}$	Raises any of their powers by 1. E.g. $x^5 \to x^6$ or $x^{-3} \to x^{-2}$ or $k \to kx$ or $x^{\text{their } n} \to x^{\text{their } n+1}$. Allow the powers to be un-simplified e.g. $x^5 \to x^{5+1}$ or $x^{-3} \to x^{-3+1}$ or $kx^0 \to kx^{0+1}$.	M1
	$2\times\frac{x^{5+1}}{6}$ or $-\frac{1}{4}\times\frac{x^{-3+1}}{-2}$	Any one of the first two terms correct **<u>simplified or un-simplified</u>**.	A1
	Two of: $\frac{1}{3}x^6,\ \frac{1}{8}x^{-2},\ -5x$	Any two correct **<u>simplified</u>** terms. Accept $+\frac{1}{8x^2}$ for $+\frac{1}{8}x^{-2}$ but not x^1 for x. Accept 0.125 for $\frac{1}{8}$ but $\frac{1}{3}$ would clearly need to be identified as 0.3 recurring.	A1
	$\frac{1}{3}x^6 + \frac{1}{8}x^{-2} - 5x + c$	All correct and simplified and including + c all on one line. Accept $+\frac{1}{8x^2}$ for $+\frac{1}{8}x^{-2}$ but not x^1 for x. Apply isw here.	A1
			(4 marks)

Question Number	Scheme		Marks
2.	$y=\sqrt{x}+\dfrac{4}{\sqrt{x}}+4=x^{\frac{1}{2}}+4x^{-\frac{1}{2}}+4$		
	$x^n \to x^{n-1}$	Decreases any power by 1. Either $x^{\frac{1}{2}} \to x^{-\frac{1}{2}}$ or $x^{-\frac{1}{2}} \to x^{-\frac{3}{2}}$ or $4 \to 0$ or $x^{\text{their } n} \to x^{\text{their } n-1}$ for fractional n.	M1
	$\left(\dfrac{dy}{dx}=\right)\dfrac{1}{2}x^{-\frac{1}{2}}+4\times-\dfrac{1}{2}x^{-\frac{3}{2}}$ $\left(=\dfrac{1}{2}x^{-\frac{1}{2}}-2x^{-\frac{3}{2}}\right)$	Correct derivative, simplified or un-simplified including indices. E.g. allow $\frac{1}{2}-1$ for $-\frac{1}{2}$ and allow $-\frac{1}{2}-1$ for $-\frac{3}{2}$	A1
	$x=8 \Rightarrow \dfrac{dy}{dx}=\dfrac{1}{2}8^{-\frac{1}{2}}+4\times-\dfrac{1}{2}8^{-\frac{3}{2}}$	Attempts to substitute x = 8 into their 'changed' (even integrated) expression that is clearly not y. If they attempt algebraic manipulation of their dy/dx before substitution, this mark is still available.	M1
	$=\dfrac{1}{2\sqrt{8}}-\dfrac{2}{\left(\sqrt{8}\right)^3}=\dfrac{1}{2\sqrt{8}}-\dfrac{2}{8\sqrt{8}}=\dfrac{1}{8\sqrt{8}}=\dfrac{1}{8\sqrt{2}}=\dfrac{1}{16}\sqrt{2}$	B1: $\sqrt{8}=2\sqrt{2}$ seen or implied anywhere, including from substituting x = 8 into y. May be seen explicitly or implied from e.g. $8^{\frac{3}{2}}=16\sqrt{2}$ or $8^{\frac{5}{2}}=128\sqrt{2}$ or $4\sqrt{8}=8\sqrt{2}$ A1: cso $\dfrac{1}{16}\sqrt{2}$ or $\dfrac{\sqrt{2}}{16}$ and allow rational equivalents for $\dfrac{1}{16}$ e.g. $\dfrac{32}{512}$ Apply isw so award this mark as soon as a correct answer is seen.	B1A1
			(5 marks)

Question Number	Scheme		Marks
3.(a)	$(a_2 =) 2k$	$2k$ only	B1
	$(a_3 =) \dfrac{k("2k"+1)}{"2k"}$	For substituting their a_2 into $a_3 = \dfrac{k(a_2+1)}{a_2}$ to find a_3 in terms of just k	M1
	$(a_3 =) \dfrac{2k+1}{2}$	$(a_3 =) \dfrac{2k+1}{2}$ or exact simplified equivalent such as $(a_3 =) k + \dfrac{1}{2}$ or $\dfrac{1}{2}(2k+1)$ but not $k + \dfrac{k}{2k}$ **Must be seen in (a)** but isw once a correct simplified answer is seen.	A1
			(3)
	Note that there are <u>no</u> marks in (b) for using an AP (or GP) sum formula unless their terms do form an AP (or GP).		
(b)	$\sum_{r=1}^{3} a_r = 10 \Rightarrow 1 + "2k" + "\dfrac{2k+1}{2}" = 10$	Writes 1 + their a_2 + their a_3 = 10. E.g. $1 + 2k + \dfrac{2k^2+k}{2k} = 10$. Must be a correct follow through equation in terms of k only.	M1
	$\Rightarrow 2 + 4k + 2k + 1 = 20 \Rightarrow k = ...$ or e.g. $\Rightarrow 6k^2 - 17k = 0 \Rightarrow k = ...$	Solves their equation in k which has come from the sum of 3 terms = 10, and reaches $k = \ldots$ Condone poor algebra but if a quadratic is obtained then the usual rules apply for solving – see General Principles. (Note that it does not need to be a 3-term quadratic in this case)	M1
	$(k =) \dfrac{17}{6}$	$k = \dfrac{17}{6}$ or exact equivalent e.g. $2\dfrac{5}{6}$ Do **not** allow $k = \dfrac{8.5}{3}$ or $k = \dfrac{17/2}{3}$ Ignore any reference to k = 0. Allow 2.83 recurring as long as the recurring is clearly indicated e.g. a dot over the 3.	A1
			(3)
			(6 marks)

Question Number	Scheme		Marks
4. (a)	$206 = 140 + (12-1) \times d \Rightarrow d = ...$	Uses $206 = 140 + (12-1) \times d$ and proceeds as far as $d = ...$	M1
	$(d =)6$	Correct answer only can score both marks.	A1
			(2)
(b)	$S_{12} = \frac{12}{2}(140+206)$ or $S_{12} = \frac{12}{2}(2\times140+(12-1)\times"6")$ or $S_{11} = \frac{11}{2}(140+206-"6")$ or $S_{11} = \frac{11}{2}(2\times140+(11-1)\times"6")$	Attempts $S_n = \frac{n}{2}(a+l)$ or $S_n = \frac{n}{2}(2a+(n-1)d)$ with n =12, $a = 140, l = 206, d = '6'$ **WAY 1** Or Attempts $S_n = \frac{n}{2}(a+l)$ or $S_n = \frac{n}{2}(2a+(n-1)d)$ with n =11, $a = 140, l = 206 - '6', d = '6'$ **WAY2** If they are using $S_n = \frac{n}{2}(2a+(n-1)d)$, the n must be used consistently.	M1
	$S = 2076$ **WAY1** or $S = 1870$ **WAY 2**	Correct sum (may be implied)	A1
	$(52-12)\times 206 = ...$ or $(52-11)\times 206 = ...$	Attempts to find $(52-12)\times 206$ or $(52-11)\times 206$. Does **not** have to be consistent with their n used for the first Method mark.	M1
	Total $= "2076" + "8240" = ...$ **(WAY 1)** or Total $= "1870" + "8446" = ...$ **(WAY 2)**	Attempts to find the total by adding the sum to 12 terms with (52 - 12) lots of 206 or attempts to find the total by adding the sum to 11 terms with (52 - 11) lots of 206. I.e. consistency is now required for this mark. **Dependent on both previous method marks.**	**dd**M1
	10316	cao	A1
			(5)
			(7 marks)

Listing in (b):

Week	1	2	3	4	5	6	7
Bicycles	140	146	152	158	164	170	176
Total	140	286	438	596	760	930	1106

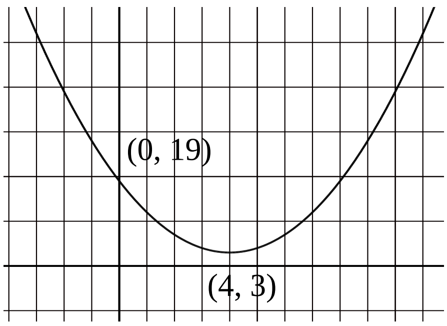
8	9	10	11	12	13	…	52
182	188	194	200	206	206	…	206
1288	1476	1670	1870	2076	2282	…	10316

M1: Attempts the sum of either 12 or 11 terms of a series with first term 140 and their d up to 140 +11d or 140 + 10d.
A1: S = 2076 or 1870
Then follow the scheme

Special case in (b) – Treats as single AP with *n* = 52

$S_n = \frac{52}{2}\left(2\times 140 + (52-1)\times "6"\right) = 15236$ Scores 11000

M1: $S_n = \frac{n}{2}\left(2a + (n-1)d\right)$ with n = 52, a = 140, d = "6" **A1:** 15236

Question Number	Scheme		Marks
5.(a)	$\mathrm{f}(x) = (x-4)^2 + 3$	M1: $\mathrm{f}(x) = (x \pm 4)^2 \pm \alpha,\ \alpha \neq 0$ (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. **<u>This must come from a correct *P* and *Q*</u>**. 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. **<u>This must come from a correct *P* and *Q*</u>**.	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)

Question Number	Scheme		Marks
6.(a)	Replaces 2^{2x+1} with $2^{2x}\times 2$ or states $2^{2x+1}=2^{2x}\times 2$ or states $\left(2^{x}\right)^{2}=2^{2x}$	Uses the addition **or** power law of indices on 2^{2x} or 2^{2x+1}. E.g. $2^{x}\times 2^{x}=2^{2x}$ or $\left(2^{x}\right)^{2}=2^{2x}$ or $2^{2x+1}=2\times 2^{2x}$ or $2^{x+0.5}=2^{x}\times\sqrt{2}$ or $2^{2x+1}=\left(2^{x+0.5}\right)^{2}$.	M1
	$2^{2x+1}-17\times 2^{x}+8=0$ $\Rightarrow 2y^{2}-17y+8=0$*	Cso. Complete proof that includes explicit statements for the addition **and** power law of indices on 2^{2x+1} with no errors. The equation needs to be as printed including the "= 0". If they work backwards, they do not need to write down the printed answer first but must end with the version in 2^{x} including '= 0'.	A1*
	The following are examples of acceptable proofs.		
	$2^{2x+1}=\left(2^{x+0.5}\right)^{2}=\left(2^{x}\sqrt{2}\right)^{2}=\left(y\sqrt{2}\right)^{2}=2y^{2}$ $\Rightarrow 2^{2x+1}-17\left(2^{x}\right)+8=2y^{2}-17y+8=0$		
	$2y^{2}=2\times 2^{x}\times 2^{x}=2^{2x+1}$ $\Rightarrow 2^{2x+1}-17\left(2^{x}\right)+8=2y^{2}-17y+8=0$		
	$2y^{2}-17y+8=0\Rightarrow 2\left(2^{x}\right)^{2}-17\left(2^{x}\right)+8=0$ $\Rightarrow 2\times 2^{2x}-17\left(2^{x}\right)+8=0\Rightarrow 2^{2x+1}-17\left(2^{x}\right)+8=0$		
	$2^{2x+1}=2\times 2^{2x}\Rightarrow 2\times 2^{2x}-17\left(2^{x}\right)+8=0$ $\Rightarrow 2y^{2}-17y+8=0$ Scores **M1A0** as $2^{2x}=\left(2^{x}\right)^{2}$ has not been shown explicitly		
	Special Case: $2^{2x+1}=2^{1}\times\left(2^{x}\right)^{2}$ or $2^{2x+1}=\left(2^{x}\right)^{2}\times 2^{1}$ **With or without the multiplication signs and with no subsequent explicit evidence of the power law scores M1A0**		
	Example of insufficient working: $2^{2x+1}=2\left(2^{x}\right)^{2}=2y^{2}$ **scores no marks as neither rule has been shown explicitly.**		
			(2)

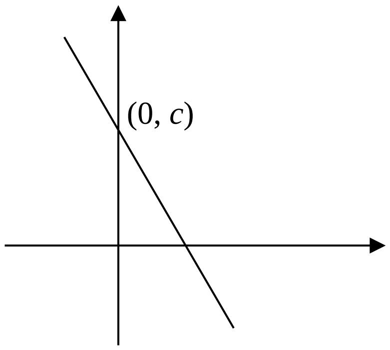
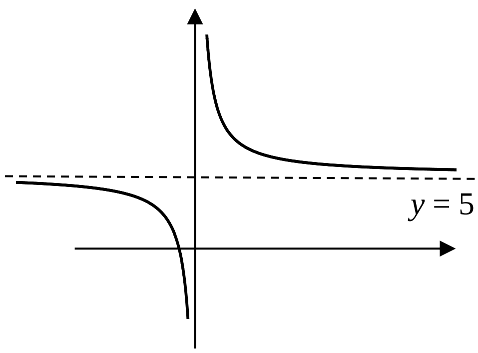
<table>
<tr><td rowspan="5">(b)</td><td colspan="2">$2y^2-17y+8=0 \Rightarrow (2y-1)(y-8)(=0) \Rightarrow y=...$
or
$2(2^x)^2-17(2^x)+8=0 \Rightarrow (2(2^x)-1)((2^x)-8)(=0) \Rightarrow 2^x=...$
Solves the given quadratic either in terms of y or in terms of 2^x
See General Principles for solving a 3 term quadratic
Note that completing the square on e.g. $y^2-\frac{17}{2}y+4=0$ requires
$\left(y\pm\frac{17}{4}\right)^2 \pm q \pm 4=0 \Rightarrow y=...$</td><td>M1</td></tr>
<tr><td>$(y=)\frac{1}{2},8$ or $(2^x=)\frac{1}{2},8$</td><td>Correct values</td><td>A1</td></tr>
<tr><td>$\Rightarrow 2^x=\frac{1}{2},8 \Rightarrow x=-1,3$</td><td>M1: Either finds one correct value of x for their 2^x or obtains a correct numerical expression in terms of logs e.g. for $k>0$
$2^x=k \Rightarrow x=\log_2 k$ or $\frac{\log k}{\log 2}$

A1: $x=-1,3$ only. Must be values of x.</td><td>M1 A1</td></tr>
<tr><td colspan="2"></td><td>(4)</td></tr>
<tr><td colspan="2"></td><td>(6 marks)</td></tr>
</table>

Question Number	Scheme		Marks
7.(a)	$\text{f}'(4)=30+\dfrac{6-5\times 4^2}{\sqrt{4}}$	Attempts to substitutes $x=4$ into $\text{f}'(x)=30+\dfrac{6-5x^2}{\sqrt{x}}$ or their algebraically manipulated $\text{f}'(x)$	M1
	$\text{f}'(4)=-7$	Gradient = -7	A1
	$y-(-8)="-7"\times(x-4)$ or $y="-7"x+c\Rightarrow -8="-7"\times 4+c$ $\Rightarrow c=...$	Attempts an equation of a tangent using their numeric $\text{f}'(4)$ which has come from substituting x = 4 into the given $\text{f}'(x)$ or their algebraically manipulated $\text{f}'(x)$ and $(4,-8)$ with the 4 and -8 correctly placed. If using $y = mx + c$, must reach as far as c = …	M1
	$y=-7x+20$	Cao. Allow $y=20-7x$ and allow the "y =" to become "detached" but it must be present at some stage. E.g. y = ... $=-7x+20$	A1
			(4)
(b)	**Allow the marks in (b) to score in (a) i.e. <u>mark (a) and (b) together</u>**		
	$\Rightarrow \text{f}(x)=30x+6\dfrac{x^{\frac{1}{2}}}{0.5}-5\dfrac{x^{\frac{5}{2}}}{2.5}(+c)$	M1: $30\to 30x$ or $\dfrac{6}{\sqrt{x}}\to \alpha x^{\frac{1}{2}}$ or $-\dfrac{5x^2}{\sqrt{x}}\to \beta x^{\frac{5}{2}}$ (these cases only)	M1A1A1
		A1: Any 2 correct terms which can be simplified or un-simplified. This includes the powers – so allow $-\frac{1}{2}+1$ for $\frac{1}{2}$ and allow $\frac{3}{2}+1$ for $\frac{5}{2}$ (With or without + c)	
		A1: All 3 terms correct which can be simplified or un-simplified. (With or without + c)	
	Ignore any spurious integral signs		
	$x=4, \text{f}(x)=-8\Rightarrow$ $-8=120+24-64+c\Rightarrow c=...$	Substitutes $x=4, \text{f}(x)=-8$ into their f(x) (not $\text{f}'(x)$) i.e. a changed $\text{f}'(x)$ containing +c and rearranges to obtain a value or numerical expression for c.	M1
	$\Rightarrow (\text{f}(x)=)30x+12x^{\frac{1}{2}}-2x^{\frac{5}{2}}-88$	Cao and cso (Allow $\sqrt{x}$ for $x^{\frac{1}{2}}$ and e.g. $\sqrt{x^5}$ or $x^2\sqrt{x}$ for $x^{\frac{5}{2}}$). Isw here so as soon as you see the correct answer, award this mark. Note that the "f(x) =" is not needed.	A1
			(5)
			(9 marks)

Question Number	Scheme		Marks
8.(a)	Gradient of $l_1 = \frac{4}{5}$ oe	States or implies that the gradient of $l_1 = \frac{4}{5}$. E.g. may be implied by a perpendicular gradient of $-\frac{5}{4}$. Do not award this mark for just rearranging to $y = \frac{4}{5}x + ...$ unless they then state e.g. $\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{4}{5}$	B1
	Point P = (5, 6)	States or implies that P has coordinates (5, 6). y = 6 is sufficient. **May be seen on the diagram.**	B1
	$-\frac{5}{4} = \frac{y - "6"}{x - 5}$ or $y - "6" = -\frac{5}{4}(x-5)$ or $"6" = -\frac{5}{4}(5) + c \Rightarrow c = ...$	Correct straight line method using P(5, "6") and gradient of $-\frac{1}{\text{grad } l_1}$. Unless $-\frac{5}{4}$ or $-\frac{1}{4}$ is being used as the gradient here, the gradient of l_1 clearly needs to have been identified and its negative reciprocal attempted to score this mark.	M1
	$5x + 4y - 49 = 0$	Accept any integer multiple of this equation including "= 0"	A1
			(4)

8(b)	$y=0 \Rightarrow 5x+4(0)-49=0 \Rightarrow x=...$ **or** $y=0 \Rightarrow 5(0)=4x+10 \Rightarrow x=...$	Substitutes $y = 0$ into their l_2 to find a value for x **or** substitutes $y = 0$ into l_1 or their rearrangement of l_1 to find a value for x. **This may be implied by a correct value on the diagram.**	M1
	$y=0 \Rightarrow 5x+4(0)-49=0 \Rightarrow x=...$ **and** $y=0 \Rightarrow 5(0)=4x+10 \Rightarrow x=...$	Substitutes $y = 0$ into their l_2 to find a value for x **and** substitutes $y = 0$ into l_1 or their rearrangement of l_1 to find a value for x. **This may be implied by correct values on the diagram.**	M1
	(Note that at T, x = 9.8 and at S, x = -2.5)		
	Fully correct method using their values to find the area of triangle SPT with vertices at points of the form (5, "6"), (p, 0) and (q, 0) where $p \neq q$ **Attempts to use integration should be sent to your team leader** **<u>Method 1:</u>** $\frac{1}{2}ST \times "6"$ $\frac{1}{2}\times('9.8'-'-2.5')\times'6'=...$ **<u>Method 2:</u>** $\frac{1}{2}SP \times PT$ $\frac{1}{2}\times\sqrt{(5-'-2.5')^2+('6')^2}\times\sqrt{('9.8'-5)^2+('6')^2}=...$ $\left(=\frac{1}{2}\times\frac{3\sqrt{41}}{2}\times\frac{6\sqrt{41}}{5}\right)$ **Note that if the method is correct but slips are made when simplifying any of the calculations, the method mark can still be awarded** **<u>Method 3:</u>** 2 Triangles $\frac{1}{2}\times(5+'2.5')\times'6'+\frac{1}{2}\times('9.8'-5)\times'6'=...$ **<u>Method 4:</u>** Shoelace method $\frac{1}{2}\begin{vmatrix}5 & 9.8 & -2.5 & 5\\ 6 & 0 & 0 & 6\end{vmatrix}=\frac{1}{2}\left\|(0+0-15)-(58.8+0+0)\right\|=\frac{1}{2}\left\|-73.8\right\|=...$ **(must see a correct calculation i.e. the middle expression for this determinant method)** **<u>Method 5:</u>** Trapezium + 2 triangles $\frac{1}{2}\times('2.5')\times'2'+\frac{1}{2}("2"+"6")\times5+\frac{1}{2}\times("9.8"-5')\times'6'=...$		**dd**M1
	$=36.9$	36.9 cso oe e.g $\frac{369}{10}$, $36\frac{9}{10}$, $\frac{738}{20}$ but not e.g. $\frac{73.8}{2}$	A1
	Note that the final mark is cso so beware of any errors that have fortuitously resulted in a correct area.		
			(4)
			(8 marks)

Question Number	Scheme		Marks
9.(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)		<u>**Either:**</u> 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 <u>**Or**</u> 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)	$\frac{1}{x}+5=-3x+c \Rightarrow 1+5x=-3x^2+cx$ $\Rightarrow 3x^2+5x-cx+1=0$	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, $\frac{1}{x}+5=-3x+c \Rightarrow 3x^2+5x-cx+1(=0)$ (M1) $b^2>4ac \Rightarrow (5-c)^2>12$ (M1A1) If $b^2>4ac$ is not seen then $4\times3\times1$ needs to be seen explicitly.		
			(3)

(c)	$(5-c)^2=12 \Rightarrow (c=)5\pm\sqrt{12}$ or $(5-c)^2=12 \Rightarrow c^2-10c+13=0$ $\Rightarrow (c=)\dfrac{-10\pm\sqrt{(-10)^2-4\times13}}{2}$	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) 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)

<table>
<tr><th>Question Number</th><th colspan="2">Scheme</th><th>Marks</th></tr>
<tr><td rowspan="2">10.(a)(i)</td><td rowspan="2">$k=\left(-5\right)^2\times 3=75$</td><td>M1: Attempts to find the 'y' intercept. Accept as evidence $\left(-5\right)^2\times 3$ with or without the bracket. If they expand f(x) to polynomial form here then they must then select their constant to score this mark. May be implied by sight of 75 on the diagram.</td><td rowspan="2">M1A1</td></tr>
<tr><td>A1: $k=75.$ Must clearly be identified as k. Allow this mark even from an incorrect or incomplete expansion as long as the constant k = 75 is obtained. Do not isw e.g. if 75 is seen followed by k = -75 score M1A0.</td></tr>
<tr><td rowspan="2">(ii)</td><td>$c=\frac{5}{2}$ only</td><td>$c=\frac{5}{2}$ oe (and no other values). Do not award just from the diagram – must be stated as the value of c.</td><td>B1</td></tr>
<tr><td colspan="2"></td><td>(3)</td></tr>
<tr><td rowspan="4">(b)</td><td colspan="2">$\mathrm{f}(x)=(2x-5)^2(x+3)=\left(4x^2-20x+25\right)(x+3)=4x^3-8x^2-35x+75$
Attempts f(x) as a cubic polynomial by attempting to square the first bracket and multiply by the linear bracket or expands $(2x-5)(x+3)$ and then multiplies by $2x-5$
Must be seen or used in (b) but may be done in part (a).
Allow poor squaring e.g. $(2x-5)^2=4x^2\pm 25$</td><td>M1</td></tr>
<tr><td rowspan="2">$\left(\mathrm{f}\,'(x)=\right)12x^2-16x-35*$</td><td>M1: Reduces powers by 1 in all terms including any constant $\to 0$</td><td rowspan="2">M1A1*</td></tr>
<tr><td>A1: Correct proof. Withhold this mark if there have been any errors including missing brackets earlier e.g. $(2x-5)^2(x+3)=4x^2-20x+25(x+3)=...$</td></tr>
<tr><td colspan="2"></td><td>(3)</td></tr>
</table>

(c)	$f'(3) = 12\times3^2 - 16\times3 - 35$	Substitutes x = 3 into **their** $f'(x)$ **or the given** $f'(x)$. Must be a changed function i.e. not into f(x).	M1
	$12x^2 - 16x - 35 = '25'$	Sets **their** $f'(x)$ **or the given** $f'(x) =$ their $f'(3)$ with a consistent f'. **Dependent on the previous method mark.**	**d**M1
	$12x^2 - 16x - 60 = 0$	$12x^2 - 16x - 60 = 0$ or equivalent 3 term quadratic e.g. $12x^2 - 16x = 60$. (A correct quadratic equation may be implied by later work). **This is cso so must come from correct work – i.e. they must be using the <u>given</u>** $f'(x)$.	A1 cso
	$(x-3)(12x+20) = 0 \Rightarrow x = ...$	Solves 3 term quadratic by suitable method – see General Principles. **Dependent on both previous method marks.**	**dd**M1
	$x = -\frac{5}{3}$	$x = -\frac{5}{3}$ oe clearly identified. If x = 3 is also given and not rejected, this mark is withheld. (allow -1.6 recurring as long as it is clear i.e. a dot above the 6). **This is cso and must come from correct work – i.e. they must be using the <u>given</u>** $f'(x)$.	A1 cso
			(5)
			(11 marks)
Alt (b) Product rule.	$f(x) = (2x-5)^2(x+3) \Rightarrow f'(x) = (2x-5)^2\times1 + (x+3)\times4(2x-5)$ M1: Attempts product rule to give an expression of the form $p(2x-5)^2 + q(x+3)(2x-5)$ M1: Multiplies out and collects terms A1: $f'(x) = 12x^2 - 16x - 35$*		M1 M1A1*