edexcel

Mark Scheme (Results)

Summer 2016

Pearson Edexcel GCE in Core Mathematics 1 (6663/01)

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Summer 2016
Publications Code 6663_01_1606_MS

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.
- 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
- $\ast$ The answer is printed on the paper or ag- answer given
- $\sqsubset$ 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.

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

$(x^2 + bx + c) = (x + p)(x + q)$, 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 the correct formula (with values for a, b and c).

3. Completing the square

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

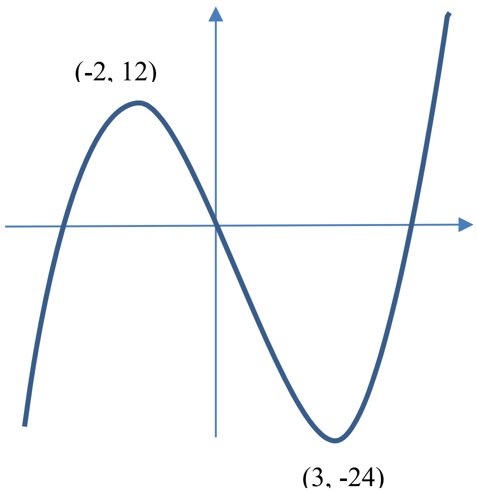
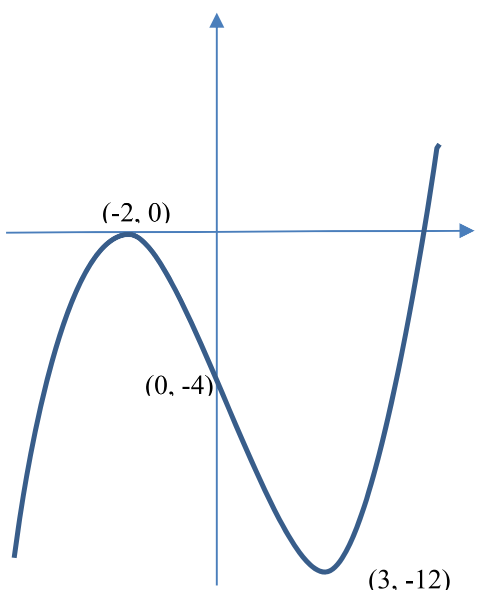
Exact answers

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	Notes	Marks
1	$\int (2x^4 - \frac{4}{\sqrt{x}} + 3)\mathrm{d}x$		
	$\frac{2}{5}x^5 - \frac{4}{\frac{1}{2}}x^{\frac{1}{2}} + 3x$	M1: $x^n \to x^{n+1}$. One power increased by 1 but not for just + c. This could be for 3 → $3x$ or for $x^n \to x^{n+1}$ on what they think $\frac{1}{\sqrt{x}}$ is as a power of x.	M1A1A1
		A1: One of these 3 terms correct. Allow un-simplified e.g. $\frac{2x^{4+1}}{4+1}$, $-\frac{4x^{-\frac{1}{2}+1}}{-\frac{1}{2}+1}$, $3x^1$	
		A1: Two of these 3 terms correct. Allow un-simplified e.g. $\frac{2x^{4+1}}{4+1}$, $-\frac{4x^{-\frac{1}{2}+1}}{-\frac{1}{2}+1}$, $3x^1$	
	$= \frac{2}{5}x^5 - 8x^{\frac{1}{2}} + 3x + c$	**<u>Complete fully correct simplified expression appearing all on one line with constant</u>**. Allow 0.4 for $\frac{2}{5}$. Do not allow $3x^1$ for $3x$ Allow $\sqrt{x}$ or $x^{0.5}$ for $x^{\frac{1}{2}}$	A1
	Ignore any spurious integral signs and ignore subsequent working following a fully correct answer.		
			[4]
			4 marks

Question Number	Scheme	Notes	Marks
2	$9^{3x+1} =$ for example $3^{2(3x+1)}$ or $\left(3^2\right)^{3x+1}$ or $\left(3^{(3x+1)}\right)^2$ or $3^{3x+1}\times 3^{3x+1}$ or $(3\times 3)^{3x+1}$ or $3^2\times\left(3^2\right)^{3x}$ or $\left(9^{\frac{1}{2}}\right)^y$ or $9^{\frac{1}{2}y}$ or $y = 2(3x+1)$	Expresses 9^{3x+1} correctly as a power of 3 or expresses 3^y correctly as a power of 9 or expresses y correctly in terms of x (**This mark is <u>not</u> for just** $3^2 = 9$)	M1
	$= 3^{6x+2}$ or $y = 6x + 2$ or $a = 6$, $b = 2$	Cao (isw if necessary)	A1
	Providing there is no incorrect work, allow sight of $6x + 2$ to score both marks Correct answer only implies both marks **Special case:** 3^{6x+1} **only** scores M1A0		
			[2]
	Alternative using logs		
	$9^{3x+1} = 3^y \Rightarrow \log 9^{3x+1} = \log 3^y$		
	$(3x+1)\log 9 = y\log 3$	Use power law correctly on both sides	M1
	$y = \dfrac{\log 9}{\log 3}(3x+1)$		
	$y = 6x+2$	cao	A1
			2 marks

Question Number	Scheme	Notes	Marks
3.(a)	$\sqrt{50}-\sqrt{18}=5\sqrt{2}-3\sqrt{2}$	$\sqrt{50}=5\sqrt{2}$ or $\sqrt{18}=3\sqrt{2}$ **and** the other term in the form $k\sqrt{2}$. This mark may be implied by the correct answer $2\sqrt{2}$	M1
	$=2\sqrt{2}$	Or $a = 2$	A1
			[2]
(b) **WAY 1**	$\dfrac{12\sqrt{3}}{\sqrt{50}-\sqrt{18}}=\dfrac{12\sqrt{3}}{"2"\sqrt{2}}$	Uses part (a) by replacing denominator by their $a\sqrt{2}$ where a is numeric. This is all that is required for this mark.	M1
	$=\dfrac{12\sqrt{3}}{"2"\sqrt{2}}\times\dfrac{\sqrt{2}}{\sqrt{2}}=\dfrac{12\sqrt{6}}{4}$	Rationalises the denominator by a correct method e.g. multiplies numerator and denominator by $k\sqrt{2}$ to obtain a multiple of $\sqrt{6}$. Note that multiplying numerator and denominator by $2\sqrt{2}$ or $-2\sqrt{2}$ is quite common and is acceptable for this mark. May be implied by a correct answer. **This is dependent on the first M1.**	dM1
	$=3\sqrt{6}$ or $b = 3$, $c = 6$	Cao and cso	A1
			[3]
(b) WAY 2	$\dfrac{12\sqrt{3}}{\sqrt{50}-\sqrt{18}}\times\dfrac{\sqrt{50}+\sqrt{18}}{\sqrt{50}+\sqrt{18}}$ **or** $\dfrac{12\sqrt{3}}{5\sqrt{2}-3\sqrt{2}}\times\dfrac{5\sqrt{2}+3\sqrt{2}}{5\sqrt{2}+3\sqrt{2}}$	For rationalising the denominator by a correct method i.e. multiplying numerator and denominator by $k\left(\sqrt{50}+\sqrt{18}\right)$	M1
	$\dfrac{60\sqrt{6}+36\sqrt{6}}{50-18}$	For replacing numerator by $\alpha\sqrt{6}+\beta\sqrt{6}$. **This is dependent on the first M1 and there is no need to consider the denominator for this mark.**	dM1
	$=3\sqrt{6}$ or $b = 3$, $c = 6$	Cao and cso	A1
			[3]
(b) WAY 3	$\dfrac{12\sqrt{3}}{\sqrt{50}-\sqrt{18}}=\dfrac{12\sqrt{3}}{"2"\sqrt{2}}$	Uses part (a) by replacing denominator by their $a\sqrt{2}$ where a is numeric. This is all that is required for this mark.	M1
	$=\dfrac{12\sqrt{3}}{2\sqrt{2}}=\dfrac{6\sqrt{3}}{\sqrt{2}}=\dfrac{\sqrt{108}}{\sqrt{2}}=\sqrt{54}=\sqrt{9}\sqrt{6}$	Cancels to obtain a multiple of $\sqrt{6}$. **This is dependent on the first M1.**	dM1
	$=3\sqrt{6}$ Or $b = 3$, $c = 6$	Cao and cso	A1
			[3]
(b) WAY 4	$\dfrac{12\sqrt{3}}{\sqrt{50}-\sqrt{18}}=\dfrac{12\sqrt{3}}{"2"\sqrt{2}}$	Uses part (a) by replacing denominator by their $a\sqrt{2}$ where a is numeric. This is all that is required for this mark.	M1
	$\left(\frac{12\sqrt{3}}{"2"\sqrt{2}}\right)^2=\frac{432}{8}$		
	$\sqrt{54}=\sqrt{9}\sqrt{6}$	Obtains a multiple of $\sqrt{6}$. **This is dependent on the first M1.**	dM1
	$=3\sqrt{6}$ Or $b = 3$, $c = 6$	Cao and cso (do not allow $\pm3\sqrt{6}$)	A1
			5 marks

Question Number	Scheme	Notes	Marks
	Note original points are *A*(-2, 4) and *B*(3, -8)		
4.(a)		Similar shape to given figure passing through the origin. A cubic shape with a maximum in the second quadrant and a minimum in the 4th quadrant. There must be evidence of a change in at least one of the *y*-coordinates (inconsistent changes in the y-coordinates are acceptable) but **not the *x*-coordinates**.	B1
		Maximum at (-2, 12) and minimum at (3, -24) with coordinates written the right way round. Condone missing brackets. The coordinates may appear on the sketch, or separately in the text (not necessarily referenced as *A* and *B*). If they are on the sketch, the *x* and *y* coordinates can be positioned correctly on the axes rather than given as coordinate pairs. In cases of ambiguity, the sketch has precedence. The origin does not need to be labelled. Nor do the *x* and *y* axes.	B1
			[2]
(b)		A positive cubic which does not pass through the origin with a maximum to the left of the *y*-axis and a minimum to the right of the *y*-axis.	M1
		Maximum at (-2, 0) and minimum at (3, -12). Condone missing brackets. For the max allow just -2 or (0, -2) if marked in the correct place. If the coordinates are in the text, they must appear as (-2, 0) and must not contradict the sketch. The curve must **touch** the *x*-axis at (-2, 0). For the min allow coordinates as shown or 3 and -12 to be marked in the correct places on the axes. In cases of ambiguity, the sketch has precedence.	A1
		Crosses *y*-axis at (0, -4). Allow just -4 (not +4) and allow (-4, 0) if marked in the correct place. If the coordinates are in the text, they must appear as (0, -4) and must not contradict the sketch. In cases of ambiguity, the sketch has precedence.	A1
			[3]
			5 marks

Question Number	Scheme	Notes	Marks
	WAY 1		
5.	$y=-4x-1$ $\Rightarrow(-4x-1)^2+5x^2+2x=0$	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). 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.** 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. 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		
	$x=-\frac{1}{4}y-\frac{1}{4}$ $\Rightarrow y^2+5(-\frac{1}{4}y-\frac{1}{4})^2+2(-\frac{1}{4}y-\frac{1}{4})=0$	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.** 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. 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 Number	Scheme	Notes	Marks
	$a_1 = 4,\ a_{n+1} = 5 - ka_n\ ,\ n \ldots 1$		
6. (a)	$a_2 = 5 - ka_1 \ = 5 - 4k$ $a_3 = 5 - ka_2 \ = 5 - k(5 - 4k)$	M1: Uses the recurrence relation correctly at least once. This may be implied by $a_2 = 5 - 4k$ or by the use of $a_3 = 5 - k(\text{their } a_2)$ A1: Two correct expressions – need not be simplified but must be seen in (a). Allow $a_2 = 5 - k4$ and $a_3 = 5 - 5k + k^2 4$ Isw if necessary for a_3.	M1A1
			[2]
(b)	$\sum_{r=1}^{3}(1) = 1+1+1$	Finds 1+1+1 or 3 somewhere in their solution (may be implied by e.g. $5 + 6 - 4k + 6 - 5k + 4k^2$). Note that $5 + 6 - 4k + 6 - 5k + 4k^2$ would score B1 and the M1 below.	B1
	$\sum_{r=1}^{3} a_r = 4 + "5 - 4k" + "5 - 5k + 4k^2"$	Adds 4 to their a_2 and their a_3 where a_2 and a_3 are functions of k. The statement as shown is sufficient.	M1
	$\sum_{r=1}^{3}(1 + a_r) = 17 - 9k + 4k^2$	Cao but condone '= 0' after the expression	A1
	Allow full marks in (b) for correct answer only		
			[3]
(c)	500	cao	B1
			[1]
			6 marks

Question Number	Scheme	Notes	Marks
7.	$y = 3x^2 + 6x^{\frac{1}{3}} + \dfrac{2x^3 - 7}{3\sqrt{x}}$		
	$\dfrac{2x^3-7}{3\sqrt{x}} = \dfrac{2x^3}{3\sqrt{x}} - \dfrac{7}{3\sqrt{x}} = \dfrac{2}{3}x^{\frac{5}{2}} - \dfrac{7}{3}x^{-\frac{1}{2}}$	Attempts to split the fraction into 2 terms and obtains either $\alpha x^{\frac{5}{2}}$ or $\beta x^{-\frac{1}{2}}$. This may be implied by a correct power of x in their differentiation of one of these terms. But beware of $\beta x^{-\frac{1}{2}}$ coming from $\dfrac{2x^3-7}{3\sqrt{x}} = 2x^3 - 7 + 3x^{-\frac{1}{2}}$	M1
	$x^n \to x^{n-1}$	Differentiates by reducing power by one for any of their powers of x	M1
	$\left(\dfrac{\mathrm{d}y}{\mathrm{d}x} =\right)\ 6x + 2x^{-\frac{2}{3}} + \dfrac{5}{3}x^{\frac{3}{2}} + \dfrac{7}{6}x^{-\frac{3}{2}}$	A1: $6x$. Do not accept $6x^1$. Depends on second M mark only. Award when first seen and isw. A1: $2x^{-\frac{2}{3}}$. Must be simplified so do not accept e.g. $\dfrac{2}{1}x^{-\frac{2}{3}}$ but allow $\dfrac{2}{\sqrt[3]{x^2}}$. Depends on second M mark only. Award when first seen and isw. A1: $\dfrac{5}{3}x^{\frac{3}{2}}$. Must be simplified but allow e.g. $1\dfrac{2}{3}x^{1.5}$ or e.g. $\dfrac{5}{3}\sqrt{x^3}$. Award when first seen and isw. A1: $\dfrac{7}{6}x^{-\frac{3}{2}}$. Must be simplified but allow e.g. $1\dfrac{1}{6}x^{-1\frac{1}{2}}$ or e.g. $\dfrac{7}{6\sqrt{x^3}}$. Award when first seen and isw.	A1A1A1A1
	In an otherwise <u>fully correct solution</u>, penalise the presence of + c by deducting the final A1		
			[6]
	Use of Quotient Rule: First M1 and final A1A1 (Other marks as above)		
	$\dfrac{\mathrm{d}\left(\dfrac{2x^3-7}{3\sqrt{x}}\right)}{\mathrm{d}x} = \dfrac{3\sqrt{x}\left(6x^2\right) - \left(2x^3-7\right)\frac{3}{2}x^{-\frac{1}{2}}}{\left(3\sqrt{x}\right)^2}$	Uses **<u>correct</u>** quotient rule	M1
	$= \dfrac{10x^{\frac{5}{2}} + 7x^{-\frac{1}{2}}}{6x}$	A1: Correct first term of numerator and correct denominator A1: All correct as simplified as shown	A1A1
	So $\dfrac{\mathrm{d}y}{\mathrm{d}x} = 6x + 2x^{-\frac{2}{3}} + \dfrac{10x^{\frac{5}{2}} + 7x^{-\frac{1}{2}}}{6x}$ scores full marks		
			6 marks

Question Number	Scheme	Notes	Marks
8.(a)	$2px^2-6px+4p\text{"}=\text{"}3x-7$ 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 <, >, = , ≠ (May be implied) **or** Rearranges $y = 3x - 7$ to make x the subject and substitutes into the given quadratic	M1
	<u>Examples</u> $2px^2-6px+4p-3x+7(=0)$, $-2px^2+6px-4p+3x-7(=0)$ $2p\left(\frac{y+7}{3}\right)^2-6p\left(\frac{y+7}{3}\right)+4p-y(=0)$, $2py^2+(10p-9)y+8p(=0)$ $y=2px^2-6px+4p-3x+7$		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 $\le p\le$ Upper Limit 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 Number	Scheme	Notes	Marks
9.(a)	John; arithmetic series, $a = 60$, $d = 15$.		
	$60 + 75 + 90 = 225^*$ or $S_3 = \frac{3}{2}\left(120 + (3-1)(15)\right) = 225^*$	Finds and adds the first 3 terms or uses sum of 3 terms of an AP and obtains the printed answer, with no errors.	B1 *
	<u>Beware:</u> **The 12th term of the sequence is 225 also so look out for** $60 + (12-1)\times 15 = 225$. **This is B0.**		
			[1]
(b)	$t_9 = 60 + (n-1)15 = (£)180$	M1: Uses $60 + (n-1)15$ with $n = 8$ or 9 A1: (£)180	M1 A1
	<u>Listing:</u> M1: Uses $a = 60$ and $d = 15$ to select the 8th or 9th term (allow arithmetic slips) A1: (£)180 (Special case (£)165 **only** scores M1A0)		
			[2]
(c)	$S_n = \frac{n}{2}\left(120 + (n-1)(15)\right)$ or $S_n = \frac{n}{2}\left(60 + 60 + (n-1)(15)\right)$	Uses correct formula for sum of n terms with $a = 60$ and $d = 15$ (must be a correct formula but ignore the value they use for n or could be in terms of n)	M1
	$S_n = \frac{12}{2}\left(120 + (12-1)(15)\right)$	Correct numerical expression	A1
	$= (£)1710$	cao	A1
	<u>Listing:</u> M1: Uses $a = 60$ and $d = 15$ and finds the sum of at least 12 terms (allow arithmetic slips) A2: (£)1710		
			[3]
(d)	$3375 = \frac{n}{2}\left(120 + (n-1)(15)\right)$	Uses correct formula for sum of n terms with $a = 60$, $d = 15$ and puts $= 3375$	M1
	$6750 = 15n\left(8 + (n-1)\right) \Rightarrow 15n^2 + 105n = 6750$	**Correct three term** quadratic. E.g. $6750 = 105n + 15n^2$, $3375 = \frac{15}{2}n^2 + \frac{105}{2}n$ This may be implied by equations such as $6750 = 15n(n+7)$ or $3375 = \frac{15}{2}\left(n^2 + 7n\right)$	A1
	$n^2 + 7n = 25 \times 18^*$	Achieves the printed answer with no errors but must see the 450 or 450 in factorised form or e.g. 6750, 3375 in factorised form i.e. an intermediate step.	A1*
			[3]
(e)	$n = 18 \Rightarrow$ Aged 27	M1: Attempts to solve the given quadratic or states $n = 18$ A1: Age = 27 or just 27	M1 A1
	Age = 27 only scores both marks (i.e. $n = 18$ need not be seen)		
	Note that (e) is not hence so allow valid attempts to solve the given equation for M1		
			[2]
			11 marks

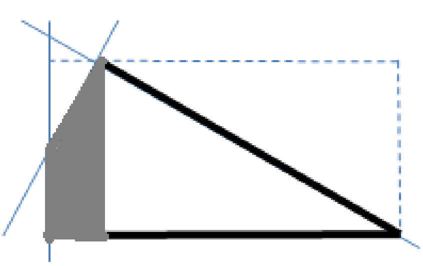
n	1	2	3	4	5	6	7	8	9
u_n	60	75	90	105	120	135	150	165	180
S_n	60	135	225	330	450	585	735	900	1080
Age	10	11	12	13	14	15	16	17	18

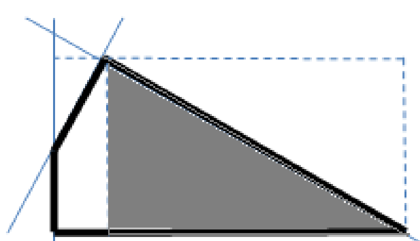
n	10	11	12	13	14	15	16	17	18
u_n	195	210	225	240	255	270	285	300	315
S_n	1275	1485	1710	1950	2205	2475	2760	3060	3375
Age	19	20	21	22	23	24	25	26	27

Question Number	Scheme	Notes	Marks
10.(a)	l_1 : passes through (0, 2) and (3, 7) l_2 : goes through (3, 7) and is perpendicular to l_1		
	Gradient of l_1 is $\frac{7-2}{3-0}\left(=\frac{5}{3}\right)$	$m(l_1)=\frac{7-2}{3-0}$. Allow un-simplified. May be implied.	B1
	$m(l_2)=-1\div their\ \frac{5}{3}$	Correct application of perpendicular gradient rule	M1
	$y-7="-\frac{3}{5}"(x-3)$ or $y="-\frac{3}{5}"x+c,\ \ 7="-\frac{3}{5}"(3)+c\ \Rightarrow\ c=\frac{44}{5}$	M1: Uses $y-7=m(x-3)$ with their **changed** gradient or uses $y=mx+c$ with $(3, 7)$ and their **changed** gradient to find a value for c A1ft: Correct ft equation for their perpendicular gradient **(this is dependent on both M marks)**	M1A1ft
	$3x+5y-44=0$	Any positive or negative integer multiple. Must be seen in (a) and must include "= 0".	A1
			[5]
(b)	When $y=0$ $x=\frac{44}{3}$	M1: Puts y = 0 and finds a value for x from their equation A1: $x=\frac{44}{3}\left(\text{or } 14\frac{2}{3} \text{ or } 14.\dot{6}\right)$ or exact equivalent. (y = 0 not needed)	M1 A1
	Condone 3x – 5y – 44 = 0 only leading to the correct answer and condone coordinates written as (0, 44/3) but allow recovery in (c)		
			[2]
(c)	**GENERAL APPROACH:**		
	Correct attempt at finding the area of any one of the triangles or one of the trapezia but not just one rectangle. The correct pair of 'base' and 'height' must be used for a triangle and the correct formula used for a trapezium. If Pythagoras is required, then it must be used correctly with the correct end coordinates. **Note that the first three marks apply to their calculated coordinates e.g. their $\frac{44}{3}$, $\frac{44}{5}$, $-\frac{6}{5}$ etc. But the given coordinates must be correct e.g. (0, 2) and (3, 7).**		M1
	A correct numerical **expression** for the area of one **triangle** or one **trapezium** for **their coordinates**.		A1ft
	Combines the correct areas together correctly for their chosen "way". Note that if correct numerical expressions for areas have been incorrectly simplified before combining them, then this M1 may still be given. **Dependent on the first method mark.**		dM1
	Correct numerical expression for the area of *ORQP*. **The expressions must be fully correct for this mark i.e. no follow through.**		A1
	Correct exact area e.g. $54\frac{1}{3}$, $\frac{163}{3}$, $\frac{326}{6}$, $54.\dot{3}$ or any exact equivalent		A1

	Shape	Vertices	Numerical Expression	Exact Area	
	Shape	**Vertices**	**Numerical Expression**	**Exact Area**	
	Triangle	*TRQ*	$\frac{1}{2}\times7\times\left(\frac{44}{3}-3\right)$	$\frac{245}{6}$	
	Triangle	*SPO*	$\frac{1}{2}\times\frac{6}{5}\times2$	$\frac{6}{5}$	
	Triangle	*PWQ*	$\frac{1}{2}\times\left(\frac{44}{5}-2\right)\times3$	$\frac{51}{5}$	
	Triangle	*PVQ*	$\frac{1}{2}\times(7-2)\times3$	$\frac{15}{2}$	

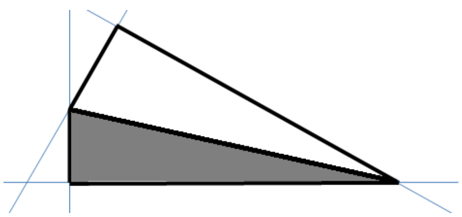
	Triangle	*VWQ*	$\frac{1}{2}\times\left(\frac{44}{5}-7\right)\times 3$	$\frac{27}{10}$	
	Triangle	*QUR*	$\frac{1}{2}\times\left(\frac{44}{3}-3\right)\times 7$	$\frac{245}{6}$	
	Triangle	*PQR*	$\frac{1}{2}\times\sqrt{34}\times\frac{7}{3}\times\sqrt{34}$	$\frac{119}{3}$	
	Triangle	*PNQ*	$\frac{1}{2}\times\frac{34}{3}\times 5$	$\frac{85}{3}$	
	Triangle	*OPQ*	$\frac{1}{2}\times 2\times 3$	3	
	Triangle	*OQR*	$\frac{1}{2}\times\frac{44}{3}\times 7$	$\frac{154}{3}$	
	Triangle	*OWR*	$\frac{1}{2}\times\frac{44}{3}\times\frac{44}{5}$	$\frac{968}{15}$	
	Triangle	*SQR*	$\frac{1}{2}\times\left(\frac{44}{3}+\frac{6}{5}\right)\times 7$	$\frac{833}{15}$	
	Triangle	*OPR*	$\frac{1}{2}\times\frac{44}{3}\times 2$	$\frac{44}{3}$	
	Trapezium	*OPQT*	$\frac{1}{2}(2+7)\times 3$	$\frac{27}{2}$	
	Trapezium	*OPNR*	$\frac{1}{2}\times\left(\frac{34}{3}+\frac{44}{3}\right)\times 2$	26	
	Trapezium	*OVQR*	$\frac{1}{2}\times\left(3+\frac{44}{3}\right)\times 7$	$\frac{371}{6}$	
	EXAMPLES				
(c)	**WAY 1**				
	$OPQT = \frac{1}{2}(2+7)\times 3$ or $TRQ = \frac{1}{2}\times 7\times\left(\frac{44}{3}-3\right)$		M1: Correct method for *OPQT* or *TRQ* A1ft: $OPQT = \frac{1}{2}(2+7)\times 3$ or $TRQ = \frac{1}{2}\times 7\times\left(\frac{44}{3}-3\right)$		M1A1ft
	$\frac{1}{2}(2+7)\times 3+\frac{1}{2}\times 7\times\left(\frac{44}{3}-3\right)$		dM1: Correct numerical combination of areas that have been calculated correctly A1: **Fully Correct** numerical expression for the area *ORQP*		dM1A1
	$54\frac{1}{3}$		Any exact equivalent e.g. $\frac{163}{3}$, $\frac{326}{6}$, $54.\dot{3}$		A1

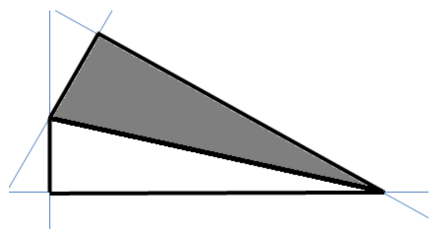




$$\frac{1}{2}\times(7+2)\times 3 + \frac{1}{2}\times\frac{"35"}{3}\times 7$$
$$=\frac{27}{2}+\frac{245}{6}=\frac{326}{6}$$

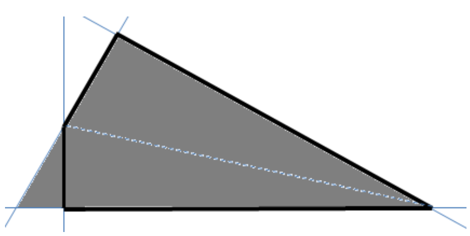
	WAY 2		
	$PQR = \frac{1}{2}\times\sqrt{34}\times\frac{7}{3}\times\sqrt{34}$ **or** $OPR = \frac{1}{2}\times\frac{44}{3}\times 2$	M1: Correct method for *PQR* or *OPR* A1ft: $PQR = \frac{1}{2}\times\sqrt{34}\times\frac{7}{3}\times\sqrt{34}$ or $OPR = \frac{1}{2}\times\frac{44}{3}\times 2$	M1A1ft
	$\frac{1}{2}\times\sqrt{34}\times\frac{7}{3}\times\sqrt{34}+\frac{1}{2}\times\frac{44}{3}\times 2$	dM1: Correct numerical combination of areas that have been calculated correctly A1: **Fully Correct** numerical expression for the area *ORQP*	dM1A1
	$54\frac{1}{3}$	Any exact equivalent e.g. $\frac{163}{3}$, $\frac{326}{6}$, $54.\dot{3}$	A1

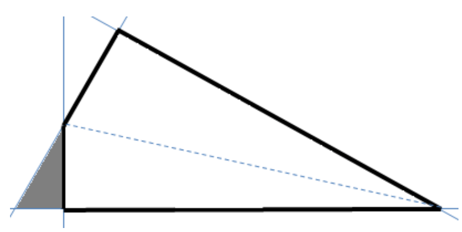




$$\frac{1}{2}\times\frac{"44"}{3}\times 2+\frac{1}{2}\times\sqrt{34}\times"\frac{7}{3}\sqrt{34}"$$
$$=\frac{88}{6}+\frac{238}{6}=\frac{326}{6}$$

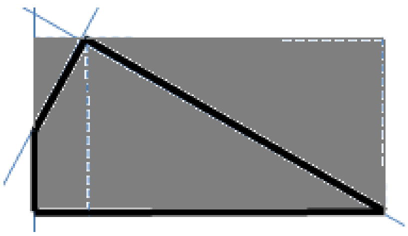
	WAY 3		
	$SQR = \frac{1}{2}\times 7\times\frac{238}{15}$ **or** $SPO = \frac{1}{2}\times\frac{6}{5}\times 2$	M1: Correct method for *SQR* or *SPO* A1ft: $SQR = \frac{1}{2}\times 7\times\frac{238}{15}$ or $SPO = \frac{1}{2}\times\frac{6}{5}\times 2$	M1A1ft
	$\frac{1}{2}\times 7\times\frac{238}{15}-\frac{1}{2}\times\frac{6}{5}\times 2$	dM1: Correct numerical combination of areas that have been calculated correctly A1: **Fully Correct** numerical expression for the area *ORQP*	dM1A1
	$54\frac{1}{3}$	Any exact equivalent e.g. $\frac{163}{3}$, $\frac{326}{6}$, $54.\dot{3}$	A1

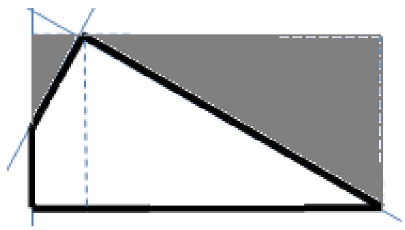




$$\frac{1}{2}\times\frac{"238"}{15}\times 7-\frac{1}{2}\times\frac{"6"}{5}\times 2$$
$$=\frac{1666}{30}-\frac{6}{5}=\frac{1630}{30}$$

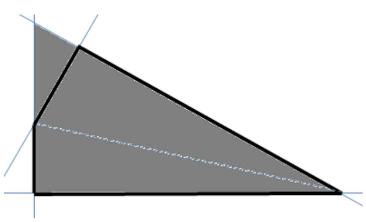
	WAY 4		
	$PVQ = \frac{1}{2}\times 5\times 3$ **or** $QUR = \frac{1}{2}\times 7\times\frac{35}{3}$	M1: Correct method for *PVQ* or *QUR* A1ft: $PVQ = \frac{1}{2}\times 5\times 3$ or $QUR = \frac{1}{2}\times 7\times\frac{35}{3}$	M1A1ft
	$OVUR\ 7\times\frac{44}{3}-\frac{1}{2}\times 5\times 3-\frac{1}{2}\times 7\times\frac{35}{3}$	dM1: Correct numerical combination of areas that have been calculated correctly A1: **Fully Correct** numerical expression for the area *ORQP*	dM1A1
	$54\frac{1}{3}$	Any exact equivalent e.g. $\frac{163}{3}, \frac{326}{6}, 54.\dot{3}$	A1

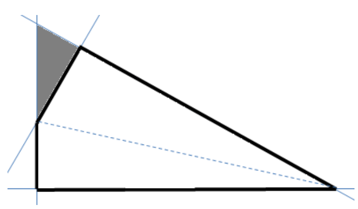




$$7\times\frac{\text{"44"}}{3}-\frac{1}{2}\times 5\times 3-\frac{1}{2}\times\frac{\text{"35"}}{3}\times 7$$
$$=\frac{308}{3}-\frac{15}{2}-\frac{245}{6}=\frac{326}{6}$$

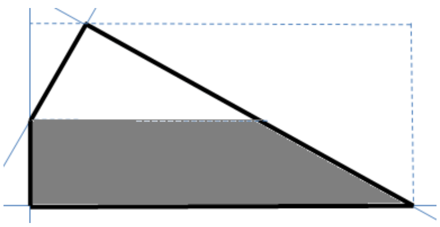
	WAY 5		
	$OWR = \frac{1}{2}\times\frac{44}{3}\times\frac{44}{5}$ **or** $PWQ = \frac{1}{2}\times\left(\frac{44}{5}-2\right)\times 3$	M1: Correct method for *OWR* or *PWQ* A1ft: $OWR = \frac{1}{2}\times\frac{44}{3}\times\frac{44}{5}$ or $PWQ = \frac{1}{2}\times\left(\frac{44}{5}-2\right)\times 3$	M1A1ft
	$\frac{1}{2}\times\frac{44}{3}\times\frac{44}{5}-\frac{1}{2}\times\left(\frac{44}{5}-2\right)\times 3$	dM1: Correct numerical combination of areas that have been calculated correctly A1: **Fully Correct** numerical expression for the area *ORQP*	dM1A1
	$54\frac{1}{3}$	Any exact equivalent e.g. $\frac{163}{3}, \frac{326}{6}, 54.\dot{3}$	A1

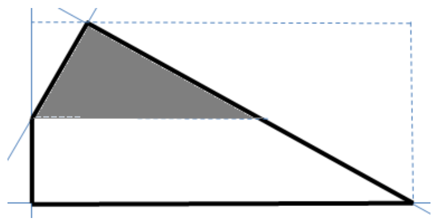




$$\frac{1}{2}\times\frac{\text{"44"}}{5}\times\frac{\text{"44"}}{3}-\frac{1}{2}\times\left(\frac{44}{5}-2\right)\times 3$$
$$=\frac{968}{15}-\frac{51}{5}=\frac{163}{3}$$

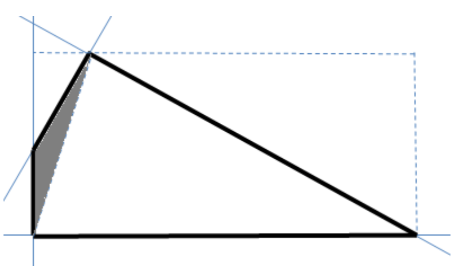
	WAY 6		
	$OPNR=\frac{1}{2}\times\left(\frac{34}{3}+\frac{44}{3}\right)\times 2$ **or** $PNQ=\frac{1}{2}\times\frac{34}{3}\times 5$	M1: Correct method for *OPNR* or *PNQ* A1ft: $OPNR=\frac{1}{2}\times\left(\frac{34}{3}+\frac{44}{3}\right)\times 2$ **or** $PNQ=\frac{1}{2}\times\frac{34}{3}\times 5$	M1A1ft
	$\frac{1}{2}\times\left(\frac{34}{3}+\frac{44}{3}\right)\times 2+\frac{1}{2}\times\frac{34}{3}\times 5$	dM1: Correct numerical combination of areas that have been calculated correctly A1: **Fully Correct** numerical expression for the area *ORQP*	dM1A1
	$54\frac{1}{3}$	Any exact equivalent e.g. $\frac{163}{3}$, $\frac{326}{6}$, $54.\dot{3}$	A1

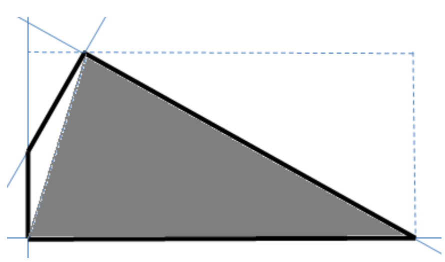




$$\frac{1}{2}\times\left(\frac{"34"}{3}+\frac{"44"}{3}\right)\times 2+\frac{1}{2}\times\frac{"34"}{3}\times 5$$
$$=\frac{156}{6}+\frac{170}{6}=\frac{326}{6}$$

	WAY 7		
	$OPQ=\frac{1}{2}\times 3\times 2$ **or** $OQR=\frac{1}{2}\times\frac{44}{3}\times 7$	M1: Correct method for *OPQ* or *OQR* A1ft: $OPQ=\frac{1}{2}\times 3\times 2$ **or** $OQR=\frac{1}{2}\times\frac{44}{3}\times 7$	M1A1ft
	$\frac{1}{2}\times 3\times 2+\frac{1}{2}\times\frac{44}{3}\times 7$	dM1: Correct numerical combination of areas that have been calculated correctly A1: **Fully Correct** numerical expression for the area *ORQP*	dM1A1
	$54\frac{1}{3}$	Any exact equivalent e.g. $\frac{163}{3}$, $\frac{326}{6}$, $54.\dot{3}$	A1

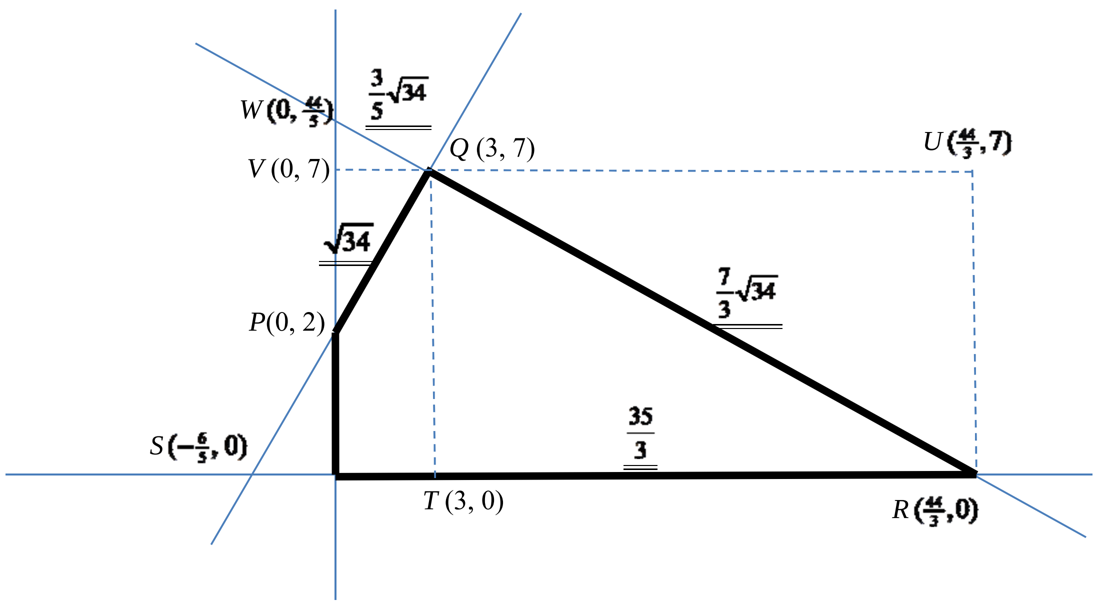


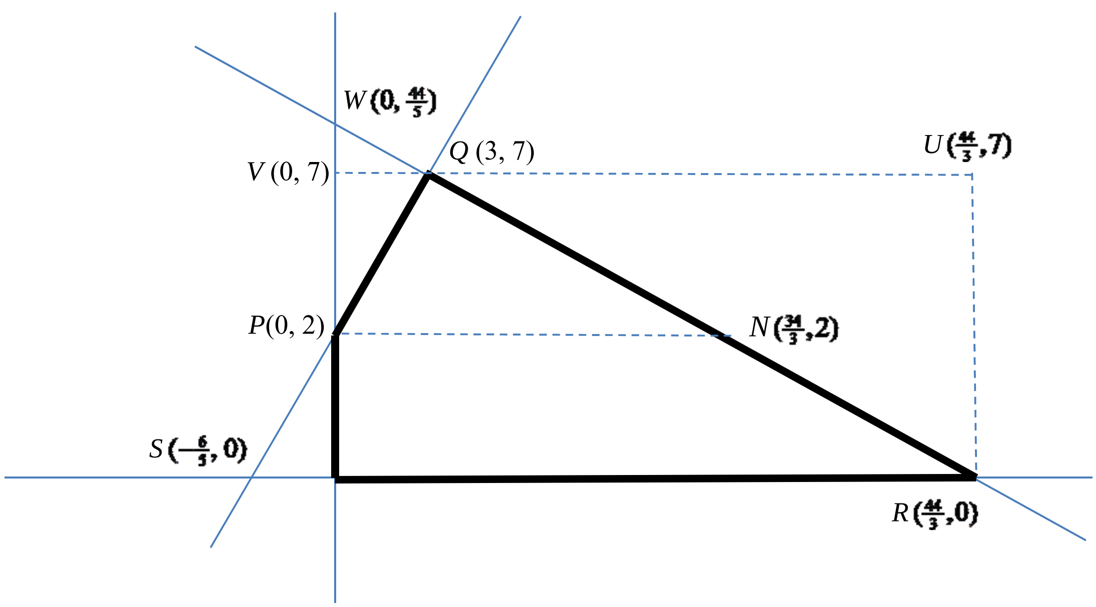


$$\frac{1}{2}\times 3\times 2+\frac{1}{2}\times\frac{"44"}{3}\times 7$$
$$=3+\frac{308}{6}=\frac{326}{6}$$

	WAY 8		
	$\frac{1}{2}\begin{vmatrix} 0 & \frac{44}{3} & 3 & 0 & 0 \\ 0 & 0 & 7 & 2 & 0 \end{vmatrix}$	M1: Uses the vertices of the quadrilateral to form a determinant $\begin{vmatrix} 0 & \frac{44}{3} & 3 & 0 & 0 \\ 0 & 0 & 7 & 2 & 0 \end{vmatrix}$	M1A1ft
		A1ft: $\frac{1}{2}\begin{vmatrix} 0 & \frac{44}{3} & 3 & 0 & 0 \\ 0 & 0 & 7 & 2 & 0 \end{vmatrix}$	
	$\frac{1}{2}\left(\frac{44}{3}\times 7 + 3\times 2\right)$	dM1: Fully correct determinant method with no errors	dM1A1
		A1: **Fully Correct** numerical expression for the area *ORQP*	
	$54\frac{1}{3}$	Any exact equivalent e.g. $\frac{163}{3}$, $\frac{326}{6}$, $54.\dot{3}$	A1

There will be other ways but the same approach to marking should be applied.





Question Number	Scheme		Marks
11. (a)	$y = 2x^3 + kx^2 + 5x + 6$		
	$\left(\frac{dy}{dx} =\right) 6x^2 + 2kx + 5$	M1: $x^n \to x^{n-1}$ for one of the terms including $6 \rightarrow 0$ A1: Correct derivative	M1 A1
			[2]
(b)	Gradient of given line is $\frac{17}{2}$	Uses or states $\frac{17}{2}$ or equivalent e.g. 8.5. Must be stated or used in (b) and not just seen as part of $y = \frac{17}{2}x + \frac{1}{2}$.	B1
	$\left(\frac{dy}{dx}\right)_{x=-2} = 6(-2)^2 + 2k(-2) + 5$	Substitutes $x = -2$ into their derivative **(not the curve)**	M1
	$"24 - 4k + 5" = "\frac{17}{2}" \Rightarrow k = \frac{41}{8}$	dM1: Puts their expression = their $\frac{17}{2}$ (Allow BOD for 17 or -17 but **not** the normal gradient) and solves to obtain a value for k. **Dependent on the previous method mark**. A1: $\frac{41}{8}$ or $5\frac{1}{8}$ or 5.125	dM1 A1
	<u>Note:</u> $6x^2 + 2kx + 5 = \frac{17}{2}x + \frac{1}{2}$ scores no marks on its own but may score the first M mark if they substitute x = -2 into the lhs. If they rearrange this equation and then substitute x = -2, this scores no marks.		
			[4]
(c)	$y = -16 + 4k - 10 + 6 = 4"k" - 20 = \frac{1}{2}$	M1: Substitutes $x = -2$ and their numerical k into $y = \ldots$ A1: $y = \frac{1}{2}$	M1 A1
	Allow the marks for part (c) to be scored in part (b).		
			[2]
(d)	$y - "\frac{1}{2}" = "\frac{17}{2}"(x - {}^{-}2) \Rightarrow -17x + 2y - 35 = 0$ or $y = "\frac{17}{2}"x + c \Rightarrow c = \ldots \Rightarrow -17x + 2y - 35 = 0$ or $2y - 17x = 1 + 34 \Rightarrow -17x + 2y - 35 = 0$	M1: Correct attempt at linear equation with their 8.5 gradient (not the normal gradient) using x = -2 and their $\frac{1}{2}$ A1: cao (allow any integer multiple)	M1 A1
			[2]
			10 marks

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