Further Maths transition work

This booklet requires knowledge of the discriminant.

The key knowledge is described below:

The Discriminant

The expression $b^2 - 4ac$ is called the discriminant. The value obtained using the discriminant expression on a quadratic function will indicate how many roots a given function $f(x)$ has.

For the quadratic function $f(x) = ax^2 + bx + c$

- If the discriminant $b^2 - 4ac > 0$, then the function $f(x)$ has two distinct real roots.
- If the discriminant $b^2 - 4ac = 0$, then the function $f(x)$ has one repeated real root.
- If the discriminant $b^2 - 4ac < 0$, then the function $f(x)$ has no real roots.

C1 Jun 2016

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2. Express 9^{3x+1} in the form 3^y, giving y in the form $ax + b$, where a and b are constants.

(2)

Q2

(Total 2 marks)

1. Algebraic Expressions C1 questions Mark Scheme

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

Leave blank

3. (a) Simplify

$$\sqrt{50} - \sqrt{18}$$

giving your answer in the form $a\sqrt{2}$, where a is an integer.

(2)

(b) Hence, or otherwise, simplify

$$\frac{12\sqrt{3}}{\sqrt{50} - \sqrt{18}}$$

giving your answer in the form $b\sqrt{c}$, where b and c are integers and $b \neq 1$

(3)

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
	$\left(\dfrac{12\sqrt{3}}{"2"\sqrt{2}}\right)^2=\dfrac{432}{8}$		
	$\sqrt{54}=\sqrt{9}\sqrt{6}$	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 $\pm 3\sqrt{6}$)	A1
			5 marks

Leave blank

1. Simplify

(a) $(2\sqrt{5})^2$

(1)

(b) $\dfrac{\sqrt{2}}{2\sqrt{5} - 3\sqrt{2}}$ giving your answer in the form $a + \sqrt{b}$, where a and b are integers.

(4)

Question Number	Scheme		Marks
1.(a)	20	Sight of 20. (4×5 is not sufficient)	B1
			(1)
(b)	$\frac{\sqrt{2}}{2\sqrt{5}-3\sqrt{2}}\times\frac{2\sqrt{5}+3\sqrt{2}}{2\sqrt{5}+3\sqrt{2}}$	Multiplies top and bottom by a correct expression. This statement is sufficient. NB $2\sqrt{5}+3\sqrt{2}\equiv\sqrt{20}+\sqrt{18}$	M1
	(Allow to multiply top and bottom by $k(2\sqrt{5}+3\sqrt{2})$)		
	$=\frac{...}{2}$	Obtains a denominator of 2 or sight of $\left(2\sqrt{5}-3\sqrt{2}\right)\left(2\sqrt{5}+3\sqrt{2}\right)=2$ with no errors seen in this expansion. May be implied by $\frac{...}{2k}$	A1
	Note that M0A1 is not possible. The 2 must come from a correct method.		
	Note that if M1 is scored there is no need to consider the numerator. e.g. $\frac{2(MR?)}{2\sqrt{5}-3\sqrt{2}}\times\frac{2\sqrt{5}+3\sqrt{2}}{2\sqrt{5}+3\sqrt{2}}=\frac{...}{2}$ scores M1A1		
	Numerator = $\sqrt{2}(2\sqrt{5}\pm3\sqrt{2})=2\sqrt{10}\pm6$	An attempt to multiply the numerator by $\pm\left(2\sqrt{5}\pm3\sqrt{2}\right)$ and obtain an expression of the form $p+q\sqrt{10}$ where p and q are integers. This may be implied by e.g. $2\sqrt{10}+3\sqrt{4}$ or by their final answer.	M1
	(Allow attempt to multiply the numerator by $k(2\sqrt{5}\pm3\sqrt{2})$)		
	$\frac{\sqrt{2}}{2\sqrt{5}-3\sqrt{2}}=\frac{2\sqrt{10}+6}{2}=3+\sqrt{10}$	Cso. For the answer as written or $\sqrt{10}+3$ or a statement that $a=3$ and $b=10$. Score when first seen and ignore any subsequent attempt to 'simplify'. Allow $1\sqrt{10}$ for $\sqrt{10}$	A1
			(4)
			(5 marks)
	Alternative for (b)		
	$\frac{\sqrt{2}}{2\sqrt{5}-3\sqrt{2}}=\frac{1}{\sqrt{10}-3}$ or $\frac{2}{2\sqrt{10}-6}$	M1: Divides or multiplies top and bottom by $\sqrt{2}$ A1: $\frac{k}{k\left(\sqrt{10}-3\right)}$	M1A1
	$=\frac{1}{\sqrt{10}-3}\times\frac{\sqrt{10}+3}{\sqrt{10}+3}$	M1: Multiplies top and bottom by $\sqrt{10}+3$	M1
	$=3+\sqrt{10}$		A1
2.	$y-2x-4=0,\ \ 4x^2+y^2+20x=0$		

Leave blank

7. Given that $y = 2^x$,

(a) express 4^x in terms of y.

(1)

(b) Hence, or otherwise, solve

$$8(4^x) - 9(2^x) + 1 = 0$$

(4)

Question Number	Scheme		Marks
7.(a)	$\left(4^x =\right) y^2$	Allow y^2 or $y\times y$ or "y squared" "$4^x =$" not required	B1
	Must be seen in part (a)		
			(1)
(b)	$8y^2-9y+1=(8y-1)(y-1)=0\Rightarrow y=...$ or $(8(2^x)-1)((2^x)-1)=0\Rightarrow 2^x=...$	For attempting to solve the given equation as a 3 term quadratic in y or as a 3 term quadratic in 2^x leading to a value of y or 2^x (Apply usual rules for solving the quadratic – see general guidance) Allow x (or any other letter) instead of y for this mark e.g. an attempt to solve $8x^2-9x+1=0$	M1
	$2^x(\text{or } y)=\frac{1}{8},\ 1$	Both correct answers of $\frac{1}{8}$ (oe) and 1 for 2^x or y or their letter but not x unless 2^x(or y) is implied later	A1
	$x=-3 \quad x=0$	M1: A correct attempt to find one numerical value of x from their 2^x(or y) which must have come from a 3 term quadratic equation. If logs are used then they must be evaluated. A1: Both $x=-3$ and/or $x=0$ May be implied by e.g. $2^{-3}=\frac{1}{8}$ and $2^0=1$ and no extra values.	M1A1
			(4)
			(5 marks)

Leave blank

2. (a) Write down the value of $32^{\frac{1}{5}}$

(1)

(b) Simplify fully $(32x^5)^{-\frac{2}{5}}$

(3)

Q2

(Total 4 marks)

Question Number	Scheme	Marks
2.	(a) $32^{\frac{1}{5}} = 2$	B1 (1)
	(b) For 2^{-2} or $\frac{1}{4}$ or $\left(\frac{1}{2}\right)^2$ or 0.25 as coefficient of x^k, for any value of k including $k = 0$	M1
	Correct index for x so $A\,x^{-2}$ or $\frac{A}{x^2}$ o.e. for any value of A	B1
	$= \frac{1}{4x^2}$ or $0.25\,x^{-2}$	A1 cao (3)
		4 Marks

Notes

(a) B1 Answer 2 must be in part (a) for this mark

(b) Look at their final answer

M1 For 2^{-2} or $\frac{1}{4}$ or $\left(\frac{1}{2}\right)^2$ or 0.25 in their answer as coefficient of x^k for numerical value of k (including $k = 0$) so final answer $\frac{1}{4}$ is M1 B0 A0

B1 Ax^{-2} or $\frac{A}{x^2}$ or equivalent e.g. $Ax^{-\frac{10}{5}}$ or $Ax^{-\frac{50}{25}}$ i.e. correct power of x seen in final answer

May have a bracket provided it is $(Ax)^{-2}$ or $\left(\frac{A}{x}\right)^2$

A1 $\frac{1}{4x^2}$ or $\frac{1}{4}x^{-2}$ or $0.25\,x^{-2}$ oe but must be correct power **and** coefficient combined correctly and must not be followed by a different wrong answer.

Poor bracketing: $2x^{-2}$ earns M0 B1 A0 as correct power of x is seen in this solution (They can recover if they follow this with $\frac{1}{4x^2}$ etc)

Special case $(2x)^{-2}$ as a **final** answer and $\left(\frac{1}{2x}\right)^2$ can have M0 B1 A0 if the correct expanded answer is not seen

The correct answer $\frac{1}{4x^2}$ etc. followed by $\left(\frac{1}{2x}\right)^2$ or $(2x)^{-2}$, treat $\frac{1}{4x^2}$ as final answer so M1 B1 A1 isw

But the correct answer $\frac{1}{4x^2}$ etc clearly followed by the wrong $2x^{-2}$ or $4x^{-2}$, gets M1 B1 A0 do not ignore subsequent wrong work here

Leave blank

6 (a) Write $\sqrt{80}$ in the form $c\sqrt{5}$, where c is a positive constant.

(1)

A rectangle R has a length of $(1 + \sqrt{5})$ cm and an area of $\sqrt{80}$ cm^2.

(b) Calculate the width of R in cm. Express your answer in the form $p + q\sqrt{5}$, where p and q are integers to be found.

(4)

Question Number	Scheme	Marks
6.	(a) 80 =5×16	
	$\sqrt{80} = 4\sqrt{5}$	B1
		(1)
	Method 1	
	(b) $\frac{\sqrt{80}}{\sqrt{5}+1}$ or $\frac{c\sqrt{5}}{\sqrt{5}+1}$	B1ft
	$=\frac{\sqrt{80}}{\sqrt{5}+1}\times\frac{\sqrt{5}-1}{\sqrt{5}-1}$ or $\frac{\sqrt{80}}{1+\sqrt{5}}\times\frac{1-\sqrt{5}}{1-\sqrt{5}}$	M1
	$=\frac{20-4\sqrt{5}}{4}$ or $\frac{4\sqrt{5}-20}{-4}$	A1
	$=5-\sqrt{5}$	A1cao
	Method 2	
	(p+q√5)(√5+1)=√80	B1ft
	p√5+q√5+p+5q = 4√5	M1
	$p+5q=0$ $p+q=4$	A1
	$p=5,\ q=-1$	A1cao
		(4)
		(5 marks)

Notes

(a) B1 Accept 4√5 or c = 4 – no working necessary

(b)

(Method 1)

B1ft Only ft on c See $\frac{\sqrt{80}}{\sqrt{5}+1}$ or $\frac{c\sqrt{5}}{\sqrt{5}+1}$

M1 State intention to multiply by √5 – 1 or 1– √5 in the numerator **and** the denominator

A1 Obtain denominator of 4 (for √5 – 1) **or** -4 (for 1– √5) **or** correct simplified numerator of 20 – 4√5 or 4(5 – √5) **or** 4√5 – 20 or 4(√5 –5) **So either numerator or denominator must be correct**

A1 Correct answer only. Both **numerator and denominator must have been correct and d**ivision of numerator and denominator by 4 has been performed.

Accept p= 5, $q=-1$ or accept $5-\sqrt{5}$ or $-\sqrt{5}+5$ Also accept $5-1\sqrt{5}$

(Method 2)

B1ft Only ft on c (p+q√5)(√5+1)=√80 or c√5

M1 Multiply out the lhs and replace √80 by c√5

A1 Compare rational and irrational parts to give $p + q = 4$, **and** $p + 5q = 0$

A1 Solve equations to give $p = 5,\ q = -1$

Common error:

$\frac{\sqrt{80}}{1+\sqrt{5}}\times\frac{1-\sqrt{5}}{1-\sqrt{5}} = \frac{4\sqrt{5}-20}{4} = \sqrt{5}-5$ gets B1 M1 A1 (for correct numerator – denominator is wrong for their product) then A0

Correct answer with no working – send to review – have they used a calculator?

Correct answer after trial and improvement with evidence that (5- √5)(√5+1)=√80 could earn all four marks

Leave blank

1. Factorise fully $25x - 9x^3$

(3)

Q1

(Total 3 marks)

Question Number	Scheme	Marks
1.	$25x-9x^3 = x(25-9x^2)$	B1
	$(25-9x^2)$=(5+3x)(5-3x)	M1
	$25x-9x^3 = x(5+3x)(5-3x)$	A1
		(3)

B1 Take out a common factor, usually x, to produce $x(25-9x^2)$. Accept $(x\pm 0)(25-9x^2)$ or $-x(9x^2-25)$ Must be correct.

Other possible options are $(5+3x)(5x-3x^2)$ or $(5-3x)(5x+3x^2)$

M1 For factorising their quadratic term, usually $(25-9x^2)$= (5+3x)(5-3x) Accept sign errors

If $(5\pm 3x)$ has been taken out as a factor first, this is for an attempt to factorise $(5x\mp 3x^2)$

A1 cao $x(5+3x)(5-3x)$ or any equivalent with three factors

e.g. $x(5+3x)(-3x+5)$ or x(3x-5)(-3x-5) etc including –x(3x+5)(3x-5)

isw if they go on to show that $x = 0,\ \pm\frac{5}{3}$

Leave blank

2. (a) Evaluate $81^{\frac{3}{2}}$

(2)

(b) Simplify fully $x^2\left(4x^{-\frac{1}{2}}\right)^2$

(2)

Q2

(Total 4 marks)

Question Number	Scheme	Marks
2.(a)	$81^{\frac{3}{2}} = (81^{\frac{1}{2}})^3 = 9^3$ or $81^{\frac{3}{2}} = (81^3)^{\frac{1}{2}} = (531441)^{\frac{1}{2}}$	M1
	$=729$	A1
		(2)
(b)	$(4x^{-\frac{1}{2}})^2 = 16x^{-\frac{2}{2}}$ or $\dfrac{16}{x}$ or equivalent	M1
	$x^2(4x^{-\frac{1}{2}})^2 \quad = 16x$	A1
		(2)
		(4 marks)

(a) M1 Dealing with either the 'cube' or the 'square root' first. A correct answer will imply this mark.

Also accept a law of indices approach $81^{\frac{3}{2}} = 81^1 \times 81^{\frac{1}{2}} = 81 \times 9$

A1 Cao 729. Accept $(\pm)729$

(b) M1 For correct use of power 2 on both 4 and the $x^{-\frac{1}{2}}$ term.

A1 Cao $= 16x$

Leave blank

5. Solve the equation

$$10 + x\sqrt{8} = \frac{6x}{\sqrt{2}}$$

Give your answer in the form $a\sqrt{b}$ where a and b are integers.

(4)

Question Number	Scheme	Marks
5 **Method 1**	$x\sqrt{8}+10=\dfrac{6x}{\sqrt{2}}$ $\times\sqrt{2}\Rightarrow x\sqrt{16}+10\sqrt{2}=6x$ $4x+10\sqrt{2}=6x\Rightarrow 2x=10\sqrt{2}$ $x=5\sqrt{2}$ or a = 5 and b = 2	 M1,A1 M1A1 (4)
5 **Method 2**	$x\sqrt{8}+10=\dfrac{6x}{\sqrt{2}}$ $2\sqrt{2}x+10=3\sqrt{2}x$ $\sqrt{2}x=10\Rightarrow x=\dfrac{10}{\sqrt{2}}=\dfrac{10\sqrt{2}}{2},=5\sqrt{2}$ oe	 M1A1 M1,A1 (4)

Method 1

M1 For multiplying both sides by √2 – allow a slip e.g. $\sqrt{2}x\sqrt{8}+10=\dfrac{6x}{\sqrt{2}}\times\sqrt{2}$ or

$\sqrt{2}\times10+x\sqrt{8}=\dfrac{6x}{\sqrt{2}}\times\sqrt{2}$, where one term has an error or the correct $\sqrt{2}(10+x\sqrt{8})=\dfrac{6x}{\sqrt{2}}\times\sqrt{2}$

NB $x\sqrt{8}+10=6x\sqrt{2}$ is M0

A1 A correct equation in x with no fractional terms. Eg $x\sqrt{16}+10\sqrt{2}=6x$ oe.

M1 An attempt to solve their linear equation in x to produce an answer of the form $a\sqrt{2}$ or $a\sqrt{50}$

A1 $5\sqrt{2}$ oe (accept $1\sqrt{50}$)

Method 2

M1 For writing √8 as 2√2 or $\dfrac{6}{\sqrt{2}}$ as 3√2

A1 A correct equation in x with no fractional terms. Eg $2\sqrt{2}x+10=3\sqrt{2}x$ *or* $x\sqrt{8}+10=3\sqrt{2}x$ oe.

M1 An attempt to solve their linear equation in x to produce an answer of the form $a\sqrt{2}$ or $a\sqrt{50}$

$\sqrt{2}x=10\Rightarrow x=\dfrac{10}{\sqrt{2}}=\dfrac{10\sqrt{2}}{2},=5\sqrt{2}$

or $\sqrt{2}x=10\Rightarrow 2x^2=100\Rightarrow x^2=50\Rightarrow x=\sqrt{50}$ or $5\sqrt{2}$

A1 $5\sqrt{2}$ oe Accept $1\sqrt{50}$

Leave blank

1. Simplify

$$\frac{7 + \sqrt{5}}{\sqrt{5} - 1}$$

giving your answer in the form $a + b\sqrt{5}$, where a and b are integers.

(4)

Q1

(Total 4 marks)

Question Number	Scheme		Marks
1	$\frac{7+\sqrt{5}}{\sqrt{5}-1} \times \frac{(\sqrt{5}+1)}{(\sqrt{5}+1)}$	Multiplies top and bottom by a correct expression. This statement is sufficient.	M1
	(Allow to multiply top and bottom by $k(\sqrt{5}+1)$)		
	$= \frac{\dots}{4}$	Obtains a denominator of 4 or sight of $(\sqrt{5}-1)(\sqrt{5}+1)=4$	A1cso
	Note that M0A1 is not possible. The 4 must come from a correct method.		
	$(7+\sqrt{5})(\sqrt{5}+1) = 7\sqrt{5}+5+7+\sqrt{5}$	An attempt to multiply the numerator by $(\pm\sqrt{5}\pm1)$ and get 4 terms with at least 2 correct for their $(\pm\sqrt{5}\pm1)$. (May be implied)	M1
	$3+2\sqrt{5}$	Answer as written or a = 3 and $b = 2$. (Allow $2\sqrt{5}+3$)	A1cso
	Correct answer with no working scores full marks		
			[4]
Way 2	$\frac{7+\sqrt{5}}{\sqrt{5}-1} \times \frac{(-\sqrt{5}-1)}{(-\sqrt{5}-1)}$	Multiplies top and bottom by a correct expression. This statement is sufficient.	M1
	(Allow to multiply top and bottom by $k(-\sqrt{5}-1)$)		
	$= \frac{\dots}{-4}$	Obtains a denominator of -4	A1cso
	$(7+\sqrt{5})(-\sqrt{5}-1) = -7\sqrt{5}-5-7-\sqrt{5}$	An attempt to multiply the numerator by $(\pm\sqrt{5}\pm1)$ and get 4 terms with at least 2 correct for their $(\pm\sqrt{5}\pm1)$. (May be implied)	M1
	$3+2\sqrt{5}$	Answer as written or a = 3 and $b = 2$	A1cso
	Correct answer with no working scores full marks		
			[4]
	Alternative using Simultaneous Equations: $\frac{(7+\sqrt{5})}{\sqrt{5}-1} = a+b\sqrt{5} \Rightarrow 7+\sqrt{5} = (a-b)\sqrt{5}+5b-a$ M1 Multiplies and collects rational and irrational parts $a-b=1,\ \ 5b-a=7$ A1 Correct equations $a=3,\ b=2$ M1 for attempt to solve simultaneous equations A1 both answers correct		`

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3. (a) Find the value of $8^{\frac{5}{3}}$

(2)

(b) Simplify fully $\dfrac{\left(2x^{\frac{1}{2}}\right)^3}{4x^2}$

(3)

Question Number	Scheme		Marks
3(a)	$8^{\frac{1}{3}}=2$ or $8^5=32768$	A correct attempt to deal with the $\frac{1}{3}$ or the 5. $8^{\frac{1}{3}}=\sqrt[3]{8}$ or $8^5=8\times8\times8\times8\times8$	M1
	$\left(8^{\frac{5}{3}}=\right)$ 32	Cao	A1
	A correct answer with no working scores full marks		
	Alternative $8^{\frac{5}{3}}=8\times8^{\frac{2}{3}}=8\times2^2=$ M1 (Deals with the 1/3) = 32 A1		
			(2)
(b)	$\left(2x^{\frac{1}{2}}\right)^3=2^3x^{\frac{3}{2}}$	One correct power either 2^3 or $x^{\frac{3}{2}}$. $\left(2x^{\frac{1}{2}}\right)\times\left(2x^{\frac{1}{2}}\right)\times\left(2x^{\frac{1}{2}}\right)$ on its own is not sufficient for this mark.	M1
	$\dfrac{8x^{\frac{3}{2}}}{4x^2}=2x^{-\frac{1}{2}}$ or $\dfrac{2}{\sqrt{x}}$	M1: Divides coefficients of x **and** subtracts their powers of x. **Dependent on the previous M1**	dM1A1
		A1: Correct answer	
	Note that unless the power of x implies that they have subtracted their powers you would need to see evidence of subtraction. E.g. $\dfrac{8x^{\frac{3}{2}}}{4x^2}=2x^{\frac{1}{2}}$ would score dM0 unless you see some evidence that 3/2 – 2 was intended for the power of x.		
	Note that there is a misconception that $\dfrac{\left(2x^{\frac{1}{2}}\right)^3}{4x^2}=\left(\dfrac{2x^{\frac{1}{2}}}{4x^2}\right)^3$ - this scores 0/3		
			(3)
			[5]

Leave blank

2. Solve the simultaneous equations

$$y - 2x - 4 = 0$$

$$4x^2 + y^2 + 20x = 0$$

(7)

P 4 3 1 4 5 A 0 4 3 2

3. Equations and Inequalities Mark Scheme

Question Number	Scheme		Marks
2	$y=2x+4 \Rightarrow 4x^2+(2x+4)^2+20x=0$ or $2x=y-4$ or $x=\frac{y-4}{2}$ $\Rightarrow (y-4)^2+y^2+10(y-4)=0$	Attempts to rearrange the linear equation to $y=$... or $x=$... or $2x=$... and attempts to fully substitute into the second equation.	M1
	$8x^2+36x+16=0$ or $2y^2+2y-24=0$	M1: Collects terms together to produce quadratic expression = 0. The '= 0' may be implied by later work. A1: Correct three term quadratic equation in x or y. The '= 0' may be implied by later work.	M1 A1
	$(4)(2x+1)(x+4)=0 \Rightarrow x=...$ or $(2)(y+4)(y-3)=0 \Rightarrow y=...$	Attempt to factorise and solve or complete the square and solve or uses a correct quadratic formula for a 3 term quadratic.	M1
	$x=-0.5, x=-4$ or $y=-4, y=3$	Correct answers for either both values of x or both values of y (possibly un-simplified)	A1 cso
	Sub into $y=2x+4$ or Sub into $x=\frac{y-4}{2}$	Substitutes at least one of their values of x into a correct equation as far as $y=$... or substitutes at least one of their values of y into a correct equation as far as $y=$...	M1
	$y=3,\ y=-4$ and $x=-4,\ x=-0.5$	Fully correct solutions and simplified. Pairing not required. If there are any extra values of x or y, score A0.	A1
			(7 marks)
	Special Case: Uses $y = -2x - 4$		
	$y=2x+4 \Rightarrow 4x^2+(-2x-4)^2+20x=0$		M1
	$8x^2+36x+16=0$		M1A1
	$(4)(2x+1)(x+4)=0 \Rightarrow x=...$		M1
	$x=-0.5, x=-4$		A0
	Sub into $y=2x+4$	Sub into $y=-2x-4$ is M0	M1
	$y=3,\ y=-4$ and $x=-4,\ x=-0.5$		A0

Leave blank

5. The equation

$$(p - 1)x^2 + 4x + (p - 5) = 0, \text{ where } p \text{ is a constant}$$

has no real roots.

(a) Show that p satisfies $p^2 - 6p + 1 > 0$

(3)

(b) Hence find the set of possible values of p.

(4)

Question Number	Scheme		Marks
5(a)	$b^2-4ac<0\Rightarrow$ e.g. $4^2-4(p-1)(p-5)<0$ or $0>4^2-4(p-1)(p-5)$ or $4^2<4(p-1)(p-5)$ or $4(p-1)(p-5)>4^2$	M1: Attempts to use b^2-4ac with at least two of a, b or c correct. May be in the quadratic formula. Could also be, for example, comparing or equating b^2 and $4ac$. Must be considering the given quadratic equation. Inequality sign not needed for this M1.There must be no x terms. A1: For a correct un-simplified inequality that is not the given answer	M1A1
	$4<p^2-6p+5$		
	$p^2-6p+1>0$	Correct solution with no errors that includes an expansion of $(p-1)(p-5)$	A1*
			(3)
(b)	$p^2-6p+1=0\Rightarrow p=...$	For an attempt to solve $p^2-6p+1=0$ (not their quadratic) leading to 2 solutions for p (do not allow attempts to factorise – must be using the quadratic formula or completing the square)	M1
	$p=3\pm\sqrt{8}$	$p=3\pm2\sqrt{2}$ or any equivalent correct expressions e.g. $p=\dfrac{6\pm\sqrt{32}}{2}$ (May be implied by their inequalities) Discriminant must be a single number not e.g. 36 - 4	A1
	Allow the M1A1 to score anywhere for solving the given quadratic		
	$p<3-\sqrt{8}$ or $p>3+\sqrt{8}$	M1: Chooses outside region – not dependent on the previous method mark A1: $p<3-\sqrt{8}$, $p>3+\sqrt{8}$ or equivalent e.g. $p<\dfrac{6-\sqrt{32}}{2}$, $p>\dfrac{6+\sqrt{32}}{2}$ $\left(-\infty,\ 3-\sqrt{8}\right)\cup\left(3+\sqrt{8},\ \infty\right)$ Allow “,”, “or” or a space between the answers but do not allow $p<3-\sqrt{8}$ and $p>3+\sqrt{8}$ (this scores M1A0) Apply ISW if necessary.	M1A1
A correct solution to the quadratic followed by $p>3\pm\sqrt{8}$ scores M1A1M0A0			
$3+\sqrt{8}<p<3-\sqrt{8}$ scores M1A0			
Allow candidates to use x rather than p but must be in terms of p for the final A1			
			(4)
			(7 marks)

Leave blank

3. Find the set of values of x for which

(a) $3x - 7 > 3 - x$

(2)

(b) $x^2 - 9x \leqslant 36$

(4)

(c) **both** $3x - 7 > 3 - x$ **and** $x^2 - 9x \leqslant 36$

(1)

Question Number	Scheme	Marks
3.	(a) $3x-7>3-x$	
	$4x>10$	M1
	$x>2.5,\quad x>\frac{5}{2},\quad \frac{5}{2}<x$ o.e.	A1
		(2)
	(b) Obtain $x^2-9x-36$ and attempt to solve $x^2-9x-36=0$	
	e.g. $(x-12)(x+3)=0$ so $x=\ ,$ or $x=\frac{9\pm\sqrt{81+144}}{2}$	M1
	$12,\ -3$	A1
	$-3\le x\le 12$	M1A1
		(4)
	(c) $2.5<x\le 12$	A1cso
		(1)
		(7 marks)

Notes

(a) M1 Reaching $px > q$ with one or both of p or q correct. Also give for $-4x < -10$

A1 Cao $x > 2.5$ o.e. Accept alternatives to 2.5 like $2\frac{1}{2}$ and $\frac{5}{2}$ even allow $\frac{10}{4}$ and allow $\frac{5}{2}<x$ o.e. This answer must occur and be credited as part (a) A correct answer implies M1A1

Mark parts (b) and (c) together.

(b) M1 Rearrange 3TQ ≤ 0 or 3TQ = 0 or even 3TQ > 0 Do not worry about the inequality at this stage AND attempt to solve by factorising, formula or completion of the square with the usual rules (see notes)

A1 12 and –3 seen as critical values

M1 Inside region for their critical values – must be stated – not just a table or a graph

A1 $-3\le x\le 12$ Accept $x\ge -3$ **and** $x\le 12$ or [-3, 12]

For the A mark: Do not accept $x\ge -3$ **or** $x\le 12$ nor $-3 < x < 12$ nor (-3, 12) nor $x\ge -3,\ x\le 12$

However allow recovery if they follow these statements by a correct statement, either in (b) or as they start part (c)

N.B. $-3\le 0\le 12$ and $x\ge -3,\ x\le 12$ are poor notation and get M1A0 here.

(c) A1 cso $2.5<x\le 12$ Accept $x>2.5$ and $x\le 12$ Allow $\frac{10}{4}$ Do not accept $x>2.5$ **or** $x\le 12$

Accept (2.5, 12] A graph or table is not sufficient. **Must follow correct earlier work** – except for special case

Special case (c) $x>2.5,\ x\le 12$; $2.5<0\le 12$ are poor notation – but if this poor notation has been penalised in (b) then allow A1 here. Any other errors are penalised in both (b) and (c).

Leave blank

5. Find the set of values of x for which

(a) $2(3x + 4) > 1 - x$

(2)

(b) $3x^2 + 8x - 3 < 0$

(4)

Question Number	Scheme		Marks
5 (a)	$6x + x > 1 - 8$	Attempts to expand the bracket and collect x terms on one side and constant terms on the other. Condone sign errors and allow one error in expanding the bracket. Allow $<, \leq, \geq, =$ instead of $>$.	M1
	$x > -1$	Cao	A1
	Do not isw here, mark their final answer.		
			(2)
(b)	$(x+3)(3x-1)[=0]$ $\Rightarrow x = -3$ and $\frac{1}{3}$	M1: Attempt to solve the quadratic to obtain two critical values A1: $x = -3$ **and** $\frac{1}{3}$ (may be implied by their inequality). Allow all equivalent fractions for -3 and 1/3. (Allow 0.333 for 1/3)	M1A1
	$-3 < x < \frac{1}{3}$	M1: Chooses "inside" region (The letter x does not need to be used here) A1ft: Allow $x < \frac{1}{3}$ **and** $x > -3$ or $\left(-3, \frac{1}{3}\right)$ or $x < \frac{1}{3} \cap x > -3$. Follow through their critical values. (must be in terms of x here) Allow all equivalent fractions for -3 and 1/3. Both ($x < \frac{1}{3}$ **or** $x > -3$) and ($x < \frac{1}{3}$, $x > -3$) as a final answer score A0.	M1A1ft
			(4)
			[6]
	Note that use of $\leq$ or $\geq$ appearing in an otherwise correct answer in (a) or (b) should only be penalised once, the first time it occurs.		

Leave blank

10. Given the simultaneous equations

$$2x + y = 1$$
$$x^2 - 4ky + 5k = 0$$

where k is a non zero constant,

(a) show that

$$x^2 + 8kx + k = 0$$

(2)

Given that $x^2 + 8kx + k = 0$ has equal roots,

(b) find the value of k.

(3)

(c) For this value of k, find the solution of the simultaneous equations.

(3)

Question Number	Scheme	Marks	
10(a)	$x^2 - 4k(1-2x) + 5k(=0)$	Makes y the subject from the first equation and substitutes into the second equation (= 0 not needed here) or eliminates y by a correct method.	M1
	So $x^2 + 8kx + k = 0$ *	Correct completion to printed answer. There must be no incorrect statements.	A1cso
			(2)
(b)	$(8k)^2 - 4k$	M1: Use of $b^2 - 4ac$ (Could be in the quadratic formula or an inequality, = 0 not needed yet). There must be some correct substitution but there must be no x's. No formula quoted followed by e.g. $8k^2 - 4k = 0$ is M0. A1: Correct expression. Do not condone missing brackets unless they are implied by later work but can be implied by $(8k)^2 > 4k$ etc.	M1 A1
	$k = \frac{1}{16}$ (oe)	Cso (Ignore any reference to $k = 0$) but there must be no contradictory earlier statements. A fully correct solution with no errors.	A1
			(3)
(b) Way 2 Equal roots	$\Rightarrow x^2 + 8kx + k = (x + \sqrt{k})^2$ $\Rightarrow 8k = 2\sqrt{k}$	M1: Correct strategy for equal roots A1: Correct equation	M1A1
	$k = \frac{1}{16}$ (oe)	Cso (Ignore any reference to $k = 0$)	A1
(b) Way 3	Completes the Square $x^2 + 8kx + k = (x+4k)^2 - 16k^2 + k$ $\Rightarrow 16k^2 - k = 0$	M1: $(x \pm 4k)^2 \pm p \pm k,\ p \neq 0$ A1: Correct equation	M1A1
	$k = \frac{1}{16}$ (oe)	Cso (Ignore any reference to $k = 0$)	A1
			(3)
(c)	$x^2 + \frac{1}{2}x + \frac{1}{16} = 0$ so $(x + \frac{1}{4})^2 = 0 \Rightarrow x =$	Substitutes their value of k into the given quadratic and attempt to solve their 2 or 3 term quadratic as far as $x =$ (may be implied by substitution into the quadratic formula) or starts again and substitutes their value of k into the second equation and solves simultaneously to obtain a value for x.	M1
	$x = -\frac{1}{4},\ y = 1\frac{1}{2}$	First A1 one answer correct, second A1 both answers correct.	A1A1
	Special Case: $x^2 + \frac{1}{2}x + \frac{1}{16} = 0 \Rightarrow x = -\frac{1}{4},\ \frac{1}{4} \Rightarrow y = 1\frac{1}{2},\ \frac{1}{2}$ allow M1A1A0		
			(3)
			[8]

Leave blank

6.

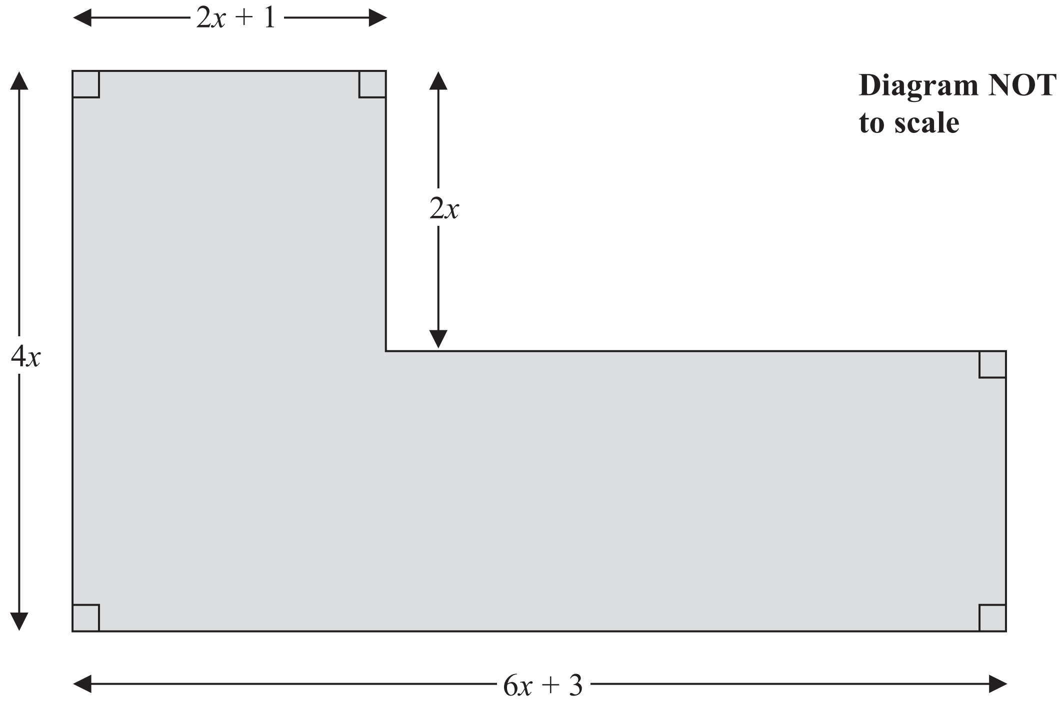


Figure 1

Figure 1 shows the plan of a garden. The marked angles are right angles.

The six edges are straight lines.

The lengths shown in the diagram are given in metres.

Given that the perimeter of the garden is greater than 40 m,

(a) show that $x > 1.7$

(3)

Given that the area of the garden is less than 120 m^2,

(b) form and solve a quadratic inequality in x.

(5)

(c) Hence state the range of the possible values of x.

(1)

Question Number	Scheme	Marks
6(a).	$P = 20x + 6$ o.e	B1
	$20x + 6 > 40 \Rightarrow x >$	M1
	$x > 1.7$	A1*
		(3)
	Mark parts (b) and (c) together	
(b)	$A = 2x(2x+1) + 2x(6x+3) = 16x^2 + 8x$	B1
	$16x^2 + 8x - 120 < 0$	M1
	Try to solve their $2x^2 + x - 15 = 0$ e.g. $(2x-5)(x+3) = 0$ so $x =$	M1
	Choose inside region	M1
	$-3 < x < \frac{5}{2}$ or $0 < x < \frac{5}{2}$ (as x is a length)	A1
(c)		(5)
	$1.7 < x < \frac{5}{2}$	B1cao
		(1)
		(9 marks)

(a) B1 Correct expression for perimeter but may not be simplified so accept $2x + 1 + 2x + 4x + 2 + 2x + 6x + 3 + 4x$ or $2(10x + 3)$ or any equivalent

M1: Set $P > 40$ with their linear expression for P (this may not be correct but should be a sum of sides) and manipulate to get $x >$…

A1* cao $x > 1.7$. This is a given answer, there must not be any errors, but accept $1.7 < x$

(b) Marks parts (b) and (c) together

B1 Writes a correct statement in x for the area. It need not be simplified. You may isw Amongst numerous possibilities are.
$2x(2x+1) + 2x(6x+3)$, $16x^2 + 8x$, $4x(6x+3) - 2x(4x+2)$, $4x(2x+1)+2x(4x+2)$

M1 Sets their quadratic expression < 120 and collects on one side of the inequality

M1 For an attempt to solve a 3 Term quadratic equation producing two solutions by factorising, formula or completion of the square with the usual rules (see notes)

M1 For choosing the 'inside' region. Can follow through from their critical values – must be stated – not just a table or a graph. Can also be implied by $0 < x <$ upper value

A1 $-3 < x < \frac{5}{2}$. Accept $x > -3$ **and** $x < 2.5$ or (-3, 2.5)

As x is a width, accept $0 < x < \frac{5}{2}$ Also accept $\frac{10}{4}$ or 2.5 instead of $\frac{5}{2}$. $\leq$ would be M1A0

Allow this final answer to part (b) to appear as answer to part (c) This would score final M1A1 in (b) then B0 in (c)

(c) B1cao $1.7 < x < \frac{5}{2}$. Must be correct. [This does not imply final M1 in (b)]

Leave blank

9.

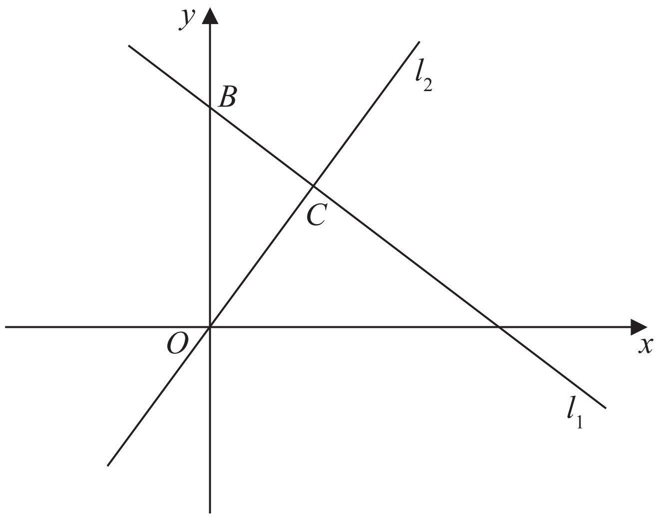


Figure 2

The line l_1, shown in Figure 2 has equation $2x + 3y = 26$

The line l_2 passes through the origin O and is perpendicular to l_1

(a) Find an equation for the line l_2

(4)

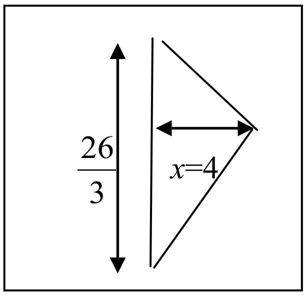
The line l_2 intersects the line l_1 at the point C.

Line l_1 crosses the y-axis at the point B as shown in Figure 2.

(b) Find the area of triangle OBC.

Give your answer in the form $\frac{a}{b}$, where a and b are integers to be determined.

(6)

Question Number	Scheme	Marks
9.	(a) $2x+3y=26 \Rightarrow 3y=26\pm 2x$ and attempt to find m from $y = mx + c$	M1
	$\left(\Rightarrow y=\frac{26}{3}-\frac{2}{3}x\right)$ so gradient = $-\frac{2}{3}$	A1
	Gradient of perpendicular $=\frac{-1}{\text{their gradient}}$ $\left(=\frac{3}{2}\right)$	M1
	Line goes through (0,0) so $y=\frac{3}{2}x$	A1
		(4)
	(b) Solves their $y=\frac{3}{2}x$ with their $2x+3y=26$ to form equation in x or in y	M1
	Solves their equation in x or in y to obtain x = **or** y =	dM1
	x=4 or any equivalent e.g. 156/39 or y = 6 o.a.e	A1
	B= $(0,\frac{26}{3})$ used or stated in (b)	B1
	 **Method 1** (see other methods in notes below)	
	Area $=\frac{1}{2}\times\text{"4"}\times\frac{\text{"26"}}{3}$	dM1
	$=\frac{52}{3}$ (oe with integer numerator and denominator)	A1
		(6) **(10 marks)**

Notes

(a) M1 Complete method for finding gradient. (This may be implied by later correct answers.)
e.g. Rearranges $2x+3y=26 \Rightarrow y=mx+c$ so m =
Or finds coordinates of two points on line and finds gradient e.g. $(13,0)$ *and* $(1,8)$ *so* $m=\frac{8-0}{1-13}$

A1 States or implies that gradient = $-\frac{2}{3}$ - condone $-\frac{2}{3}x$ if they continue correctly. Ignore errors in constant term in straight line equation

M1 Uses $m_1 \times m_2 = -1$ to find the gradient of l_2. This can be implied by the use of $\frac{-1}{\text{their gradient}}$

A1 $y=\frac{3}{2}x$ or $2y-3x=0$ Allow $y=\frac{3}{2}x+0$ Also accept $2y=3x$, $y=39/26x$ or even $y-0=\frac{3}{2}(x-0)$ and isw

Notes Continued

(b) M1 Eliminates variable between their $y = \frac{3}{2}x$ and their (possibly rearranged) $2x + 3y = 26$ to form an equation in *x* or *y*. (They may have made errors in their rearrangement)

dM1 (Depends on previous M mark) Attempts to solve their equation to find the value of *x* or *y*

A1 $x = 4$ or equivalent or $y = 6$ or equivalent

B1 *y* coordinate of *B* is $\frac{26}{3}$ (stated or implied) - isw if written as ($\frac{26}{3}$, 0). **Must be used or stated in (b)**

dM1 (Depends on previous M mark) Complete method to find area of triangle *OBC* (using their values of *x* and/or *y* at point *C* and their 26/3)

A1 Cao $\frac{52}{3}$ or $\frac{104}{6}$ or $\frac{1352}{78}$ o.e

Method 1:
Uses the area of a triangle formula ½×*OB* ×(*x* coordinate of *C*)

Alternative methods: Several Methods are shown below. The only mark which differs from Method 1 is the last M mark and its use in each case is described below:

Method 2 in 9(b) using $\frac{1}{2} \times BC \times OC$

dM1 Uses the area of a triangle formula ½×*BC* ×*OC* Also finds OC (=√52) and BC= ($\frac{4}{3}\sqrt{13}$)

Method 3 in 9(b) using $\frac{1}{2}\begin{vmatrix} 0 & 4 & 0 & 0 \\ 0 & 6 & \frac{26}{3} & 0 \end{vmatrix}$

dM1 States the area of a triangle formula $\frac{1}{2}\begin{vmatrix} 0 & 4 & 0 & 0 \\ 0 & 6 & \frac{26}{3} & 0 \end{vmatrix}$ or equivalent with their values

Method 4 in 9(b) using area of triangle *OBX* – area of triangle *OCX* where *X* is point (13, 0)

dM1 Uses the correct subtraction $\frac{1}{2} \times 13 \times "\frac{26}{3}" - \frac{1}{2} \times 13 \times "6"$

Method 5 in 9(b) using area = ½ (6 × 4) + ½ (4 × 8/3) drawing a line from C parallel to the *x* axis and dividing triangle into two right angled triangles

dM1 for correct method area = ½ (“6” × “ 4”) + ½ (“4” × [“26/3”-“6”])

Method 6 Uses calculus

dM1 $\int_0^4 "\frac{26}{3}" - \frac{2x}{3} - \frac{3x}{2} \mathrm{d}x = \left[\frac{26}{3}x - \frac{x^2}{3} - \frac{3x^2}{4} \right]_0^4$

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7.

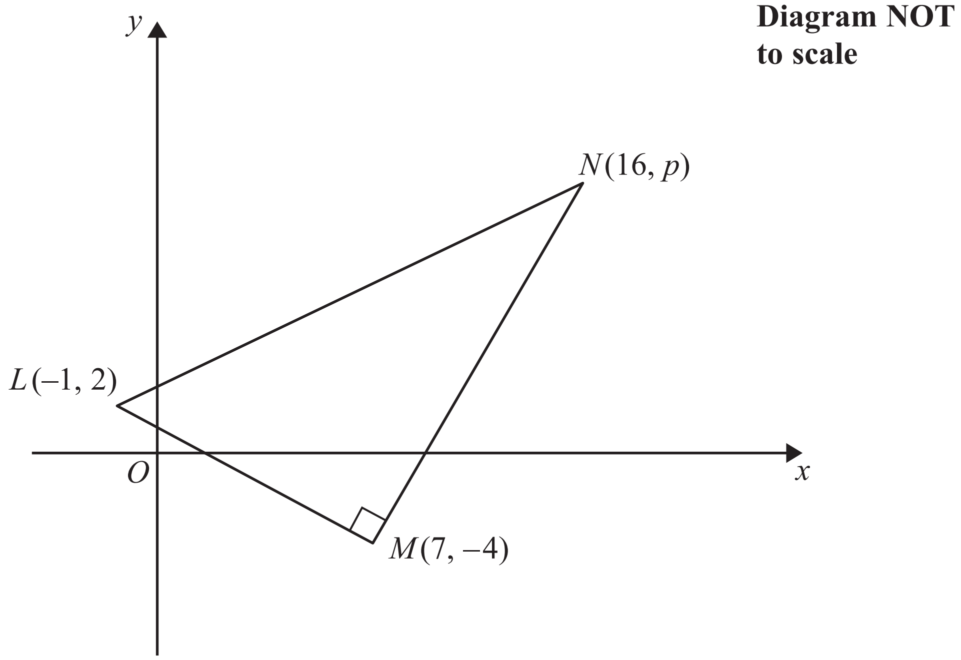

Figure 2

Figure 2 shows a right angled triangle *LMN*.

The points *L* and *M* have coordinates (–1, 2) and (7, –4) respectively.

(a) Find an equation for the straight line passing through the points *L* and *M*.

Give your answer in the form $ax + by + c = 0$, where a, b and c are integers.

(4)

Given that the coordinates of point *N* are (16, *p*), where *p* is a constant, and angle *LMN* = 90°,

(b) find the value of *p*.

(3)

Given that there is a point *K* such that the points *L*, *M*, *N*, and *K* form a rectangle,

(c) find the *y* coordinate of *K*.

(2)

Question Number	Scheme	Marks
7.(a)	Method 1: $gradient = \frac{y_1 - y_2}{x_1 - x_2} = \frac{2-(-4)}{-1-7}, = -\frac{3}{4}$ Method 2: $\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$, so $\frac{y - y_1}{6} = \frac{x - x_1}{-8}$	M1, A1
	$y - 2 = -\frac{3}{4}(x+1)$ or $y + 4 = -\frac{3}{4}(x-7)$ or $y = their\ '-\frac{3}{4}'x + c$	M1
	$\Rightarrow \pm(4y + 3x - 5) = 0$	A1 (4)
	Method 3: Substitute x = -1, y = 2 and x = 7, y = -4 into $ax + by + c = 0$	M1
	$-a + 2b + c = 0$ and $7a - 4b + c = 0$	A1
	Solve to obtain $a = 3$, $b = 4$ and $c = -5$ or multiple of these numbers	M1 A1 (4)
(b)	Attempts $gradient\ LM \times gradient\ MN = -1$ so $-\frac{3}{4} \times \frac{p+4}{16-7} = -1$ or $\frac{p+4}{16-7} = \frac{4}{3}$ Or $(y+4) = \frac{4}{3}(x-7)$ equation with x = 16 substituted	M1
	$p + 4 = \frac{9 \times 4}{3} \Rightarrow p = ...$, $p = 8$ So y =, $y = 8$	M1, A1
		(3)
Alternative for (b)	Attempt Pythagoras: $(p+4)^2 + 9^2 + (6^2 + 8^2) = (p-2)^2 + 17^2$	M1
	So $p^2 + 8p + 16 + 81 + 36 + 64 = p^2 - 4p + 4 + 289 \Rightarrow p = ...$	M1
	$p = 8$	A1
		(3)
(c)	Either (y=) $p + 6$ or $2 + p + 4$ Or use 2 perpendicular line equations through L and N and solve for y	M1
	(y =) 14	A1
		(2) (9 marks)

(a) M1 Uses the gradient formula with points L and M i.e. quote $gradient = \frac{y_1 - y_2}{x_1 - x_2}$ and attempt to substitute correct numbers. Formula may be implied by the correct $\frac{2-(-4)}{-1-7}$ or equivalent.

A1 Any correct single fraction gradient i.e $\frac{6}{-8}$ or equivalent

M1 Uses their gradient with either (-1, 2) or (7, -4) to form a linear equation

Eg $y - 2 = their\ '-\frac{3}{4}'(x+1)$ or $y + 4 = their\ '-\frac{3}{4}'(x-7)$ or $y = their\ '-\frac{3}{4}'x + c$ then find a value for c by substituting (-1,2) or (7, -4) in the correct way(not interchanging x and y)

A1 Accept $\pm k(4y + 3x - 5) = 0$ with k an integer (This implies previous M1)

(b) M1 Attempts to use $gradient\ LM \times gradient\ MN = -1$. ie. $-\frac{3}{4} \times \frac{p+4}{16-7} = -1$ (allow sign errors)

Or Attempts Pythagoras correct way round (allow sign errors)

M1 An attempt to solve their linear equation in 'p'. A1 cao $p = 8$

(c) M1 For using their numerical value of p and adding 6 . This may be done by any complete method (vectors, drawing, perpendicular straight line equations through L and N) or by no method. Assuming x = 7 is M0

A1 Accept 14 for both marks as long as no incorrect working seen (Ignore left hand side – allow k) . If there is wrong working resulting fortuitously in 14 give M0A0. Allow (8, 14) as the answer.

Leave blank

6. The straight line L_1 passes through the points (–1, 3) and (11, 12).

(a) Find an equation for L_1 in the form $ax + by + c = 0$,

where a, b and c are integers.

(4)

The line L_2 has equation $3y + 4x - 30 = 0$.

(b) Find the coordinates of the point of intersection of L_1 and L_2.

(3)

Question Number	Scheme		Marks
6	(-1, 3) , (11, 12)		
(a)	$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{12-3}{11-(-1)}, = \frac{3}{4}$	M1:Correct method for the gradient A1: Any correct fraction or decimal	M1,A1
	$y - 3 = ¾ (x+1)$ or $y - 12 = ¾ (x - 11)$ or $y = ¾ x + c$ with attempt at substitution to find c	Correct straight line method using either of the given points and a numerical gradient.	M1
	$4y - 3x - 15 = 0$	Or equivalent with integer coefficients (= 0 **is** required)	A1
	This A1 should only be awarded in (a)		
			(4)
(a) Way 2	$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1} \Rightarrow \frac{y-3}{12-3} = \frac{x+1}{11+1}$	M1: Use of a correct formula for the straight line A1: Correct equation	M1A1
	$12(y-3) = 9(x+1)$	Eliminates fractions	M1
	$4y - 3x - 15 = 0$	Or equivalent with integer coefficients (= 0 **is** required)	A1
			(4)
(b)	Solves their equation from part (a) and L_2 simultaneously to eliminate one variable	Must reach as far as an equation in x only or in y only. (Allow slips in the algebra)	M1
	$x = 3$ or $y = 6$	One of $x = 3$ or $y = 6$	A1
	Both $x = 3$ **and** $y = 6$	Values can be un-simplified fractions.	A1
	Fully correct answers with no working can score 3/3 in (b)		
			(3)
(b) Way 2	$(-1,3) \rightarrow -a + 3b + c = 0$ $(11,12) \rightarrow 11a + 12b + c = 0$	Substitutes the coordinates to obtain two equations	M1
	$\therefore a = -\frac{3}{4}b,\ b = -\frac{4}{15}c$	Obtains sufficient equations to establish values for a, b and c	A1
	e.g. $c = 1 \Rightarrow b = -\frac{4}{15},\ a = \frac{3}{15}$	Obtains values for a, b and c	M1
	$\frac{3}{15}x - \frac{4}{15}y + 1 = 0 \Rightarrow 4y - 3x - 15 = 0$	Correct equation	A1
			(4)
			[7]

Leave blank

4. The line L_1 has equation $4x + 2y - 3 = 0$

(a) Find the gradient of L_1.

(2)

The line L_2 is perpendicular to L_1 and passes through the point (2, 5).

(b) Find the equation of L_2 in the form $y = mx + c$, where m and c are constants.

(3)

Question Number	Scheme	Notes	Marks
4.(a)	$4x+2y-3=0 \Rightarrow y=-2x+\frac{3}{2}$	Attempt to write in the form $y=$	M1
	$\Rightarrow$ gradient $=-2$	Accept any un-simplified form and allow even with an incorrect value of "c"	A1
(a) Way 2	Alternative: $4+2\frac{dy}{dx}=0$	Attempt to differentiate Allow $p \pm q\frac{dy}{dx}=0,\ p,q \neq 0$	M1
	$\Rightarrow$ gradient $=-2$	Accept any un-simplified form	A1
	Answer only scores M1A1		
			[2]
(b)	Using $m_N = -\frac{1}{m_T}$	Attempt to use $m_N = -\frac{1}{\text{gradient from }(a)}$	M1
	$y-5='\frac{1}{2}'(x-2)$ or Uses $y=mx+c$ in an attempt to find c	Correct straight line method using a 'changed' gradient and the point (2, 5)	M1
	$y=\frac{1}{2}x+4$	Cao (Isw)	A1
			(3)
			[5]

Leave blank

5. The line l_1 has equation $y = -2x + 3$

The line l_2 is perpendicular to l_1 and passes through the point (5, 6).

(a) Find an equation for l_2 in the form $ax + by + c = 0$, where a, b and c are integers.
(3)

The line l_2 crosses the x-axis at the point A and the y-axis at the point B.

(b) Find the x-coordinate of A and the y-coordinate of B.
(2)

Given that O is the origin,

(c) find the area of the triangle OAB.
(2)

Question Number	Scheme	Marks
5.		
(a)	Gradient of l_2 is $\frac{1}{2}$ or 0.5 or $\frac{-1}{-2}$	B1
	Either $y-6="\frac{1}{2}"(x-5)$ or $y="\frac{1}{2}"x+c$ and $6="\frac{1}{2}"(5)+c \Rightarrow c=("\frac{7}{2}")$	M1
	$x-2y+7=0$ or $-x+2y-7=0$ or $k(x-2y+7)=0$ with ***k* an integer**	A1
		[3]
(b)	Puts $x = 0$, or $y = 0$ in **their** equation and solves to find appropriate co-ordinate	M1
	x-coordinate of A is -7 and y-coordinate of B is $\frac{7}{2}$.	A1 cao
		[2]
(c)	Area $OAB = \frac{1}{2}(7)\left(\frac{7}{2}\right) = \frac{49}{4}$ (units)^2 — Applies $\pm\frac{1}{2}$(base)(height)	M1
	$\frac{49}{4}$	A1**cso**
		[2]
		7 marks
	Notes	
(a)	**B1**: Must have ½ or 0.5 or $\frac{-1}{-2}$ o.e. stated and stops, or used in their line equation **M1:** Full method to obtain an equation of the line through (5,6) with their "m". So $y-6=m(x-5)$ with their gradient or uses $y=mx+c$ with $(5, 6)$ and their gradient to find c. Allow any numerical gradient here including –2 or –1 but **not zero** . (Allow (6,5) as a slip **if** $y-y_1=m(x-x_1)$ is quoted first) **A1:** Accept any multiple of the correct equation, provided that the coefficients are integers and equation = 0 e.g. $-x+2y-7=0$ or $k(x-2y+7)=0$ or even $2y-x-7=0$	
(b)	**M1:** Either one of the x or y coordinates using their equation **A1:** Needs both correct values. Accept any correct equivalent.. Need not be written as co-ordinates. **Even** just –7 and 3.5 with **no** indication which is which may be awarded the A1.	
(c)	**M1:** Any correct method for area of triangle AOB, with their values for co-ordinates of A and B (may include negatives) *Method usually half base times height but determinants could be used.* **A1**: Any exact equivalent to 49/4, e.g. 12.25. (**negative final** answer is A0 but replacing by **positive** is A1) Do not need units. **c.s.o.** implies if A0 is scored in (b) then A0 is scored in (c) as well**. However** if candidate has correct line equation in (a) of wrong form may score A0 in (a) and A1 in (b) and (c)	
	Note: Special cases: $\frac{1}{2}(-7)\left(+\frac{7}{2}\right)=-\frac{49}{4}$ (units)^2 is M1 A0 but changing sign to area = $+\frac{49}{4}$ gets M1A1 (recovery) **N.B.** Candidates making sign errors in (b) and obtaining +7 and $-\frac{7}{2}$. may also get $\frac{49}{4}$ as their answer following previous errors. They should be awarded A0 as this answer is not ft and is for correct **solution** only **Special Case**: In (a) and (b): Produces parallel line instead of perpendicular line: So uses m = -2 This is not treated as a misread as it simplifies the question. The marks will usually be B0 M1 A0, M1 A0, M1 A0 i.e. maximum of 3/7	

Leave blank

9. The line L_1 has equation $4y + 3 = 2x$

The point A $(p, 4)$ lies on L_1

(a) Find the value of the constant p.

(1)

The line L_2 passes through the point C $(2, 4)$ and is perpendicular to L_1

(b) Find an equation for L_2 giving your answer in the form $ax + by + c = 0$, where a, b and c are integers.

(5)

The line L_1 and the line L_2 intersect at the point D.

(c) Find the coordinates of the point D.

(3)

(d) Show that the length of CD is $\frac{3}{2}\sqrt{5}$

(3)

A point B lies on L_1 and the length of $AB = \sqrt{(80)}$

The point E lies on L_2 such that the length of the line CDE = 3 times the length of CD.

(e) Find the area of the quadrilateral $ACBE$.

(3)

Question Number	Scheme	Marks
	$L_1: 4y+3=2x \Rightarrow y=\frac{1}{2}x-\frac{3}{4}$; $A(p,4)$ lies on L_1.	
9. (a)	$\{p=\}\ 9\frac{1}{2}$ or $\frac{19}{2}$ or 9.5	B1
		[1]
(b)	$\{4y+3=2x\} \Rightarrow y=\frac{2x-3}{4} \Rightarrow m(L_1)=\frac{1}{2}$ or $\frac{2}{4}$	M1 A1
	So $m(L_2)=-2$	B1ft
	$L_2:\ y-4=-2(x-2)$	M1
	$L_2:\ 2x+y-8=0$ or $L_2:\ 2x+1y-8=0$	A1
		[5]
(c)	$\{L_1=L_2 \Rightarrow\}\ 4(8-2x)+3=2x$ or $-2x+8=\frac{1}{2}x-\frac{3}{4}$	M1
	$x=3.5,\ y=1$	A1, A1 cso
		[3]
(d)	$CD^2=("3.5"-2)^2+("1"-4)^2$	"M1"
	$CD=\sqrt{("3.5"-2)^2+("1"-4)^2}$	A1 ft
	$=\sqrt{1.5^2+3^2}=1.5\sqrt{1^2+2^2}=1.5\sqrt{5}$ or $\frac{3}{2}\sqrt{5}$ **(*)**	A1 **cso**
		[3]
(e)	Area = triangle ABC + triangle ABE	
	$=\frac{1}{2}\times\frac{3}{2}\sqrt{5}\times\sqrt{80}+\frac{1}{2}\times3\sqrt{5}\times\sqrt{80}$ Finding the area of any triangle.	M1
	$=\frac{3}{4}\sqrt{5}\times4\sqrt{5}+\frac{3}{2}\sqrt{5}\times4\sqrt{5}$	
	$=\frac{3}{4}(20)+\frac{3}{2}(20)$	B1
	$=45$	A1
		[3] **15**
	Notes	
9. (a) (b)	**B1:** 9.5 oe. **1st M1:** for an attempt to rearrange $4y+3=2x$ into $y=mx+c$. This mark can be implied by the correct gradient of L_1 or L_2. **1st A1:** for gradient of $L_1=\frac{1}{2}$ or $\frac{2}{4}$. Stating $m(L_1)=\frac{1}{2}$ without working is M1A1. **B1ft:** for applying $m(L_2)=\frac{-1}{\text{their } m(L_1)}$. Need not be simplified. **Note:** Writing down $m(L_2)=-2$ with ***no earlier incorrect working*** gains M1A1B1 **2nd M1:** for applying $y-4=\pm\lambda(x-2)$ where λ is a numerical value, $\lambda\neq0$. or full method of $y=mx+c$, with $x=2$, $y=4$ and (their $\pm\lambda$) to find c. **2nd A1:** $2x+y-8=0$ or $-2x-y+8=0$ or $y+2x-8=0$ or $4x+2y-16=0$ or $2x+1y-8=0$ etc. Must be " = 0". So do not allow $2x+y=8$ etc. **Note:** Condone the error of incorrectly rearranging L_1 to give $y=\frac{1}{2}x-3 \Rightarrow m(L_1)=\frac{1}{2}$.	

(c)	**M1:** for an attempt to solve. Must form a linear equation in one variable. **1st A1:** for $x = 3.5$ (correct solution only). **2nd A1:** for $y = 1$ (correct solution only). **Note:** If $x = 3.5,\ y = 1$ is found from no working, then send to review. **Note:** Use of trial and error to find one of *x* or *y* and then substitution into one of L_1 or L_2 can achieve M1A1A1.
(d)	**M1:** for an attempt at CD^2 - ft their point *D*. Eg: $("3.5" - 2)^2 + ("1" - 4)^2$ or simplified. This mark can be implied by finding *CD*. **1st A1ft:** for finding their *CD* - ft their point *D*. Eg: $\sqrt{("3.5" - 2)^2 + ("1" - 4)^2}$ or correctly simplified. **2nd A1:cso** for no incorrect working seen. **Note:** A candidate initially writing down $\sqrt{1.5^2 + 3^2}$ can be awarded M1A1. ***<u>Alternatives part (d): Final accuracy</u>*** **1.** $\left\{\sqrt{1.5^2 + 3^2} =\right\}\ \sqrt{\frac{9}{4} + 9} = \sqrt{\frac{9}{4} + \frac{36}{4}} = \sqrt{\frac{45}{4}} = \frac{3\sqrt{5}}{2}$ **2.** $\left\{\sqrt{1.5^2 + 3^2} =\right\}\ \sqrt{11.25} = \sqrt{2.25}\sqrt{5} = 1.5\sqrt{5}$
(e)	**M1:** for an attempt at finding the area of either triangle *ABC* or triangle *ABE*. **B1:** Correct method for removing a square root. Eg: $\sqrt{80}\sqrt{5} = \sqrt{400} = 20$ or $\sqrt{5} \times 4\sqrt{5} = 20$ **Note:** This mark can be implied. **A1:** for 45 only. ***<u>Alternative 1 to part (e):</u>*** Area $= \frac{1}{2}\left(\frac{3}{2}\sqrt{5} + 3\sqrt{5}\right)\left(\sqrt{80}\right) = \frac{1}{2}(30 + 60) = 45$ **M1:** $\frac{1}{2}(AB)(CE)$. **B1:** Evidence of correct surd removal. **A1:** for 45. **Note:** Multiplying the diagonals (usually to find 90) is M0, B1 if surds are removed correctly, A0. ***<u>Alternative 2 to part (e):</u>*** Area = triangle DAC + triangle DCB + triangle DEA + triangle DBE $= \left(\frac{1}{2} \times \frac{3}{2}\sqrt{5} \times \sqrt{45}\right) + \left(\frac{1}{2} \times \frac{3}{2}\sqrt{5} \times \left(\sqrt{80} - \sqrt{45}\right)\right) + \left(\frac{1}{2} \times 3\sqrt{5} \times \sqrt{45}\right) + \left(\frac{1}{2} \times 3\sqrt{5} \times \left(\sqrt{80} - \sqrt{45}\right)\right)$ $= \left(\frac{1}{2} \times \frac{3}{2}(15)\right) + \left(\frac{1}{2} \times \frac{3}{2}(5)\right) + \left(\frac{1}{2} \times 3\,(15)\right) + \left(\frac{1}{2} \times 3(5)\right)$ $= \left(\frac{45}{4}\right) + \left(\frac{15}{4}\right) + \left(\frac{45}{2}\right) + \left(\frac{15}{2}\right)$ $= 45$ **M1:** For finding the area of one of the four triangles. **B1:** Evidence of correct surd removal. **A1:** for 45. ***<u>Alternative 3 to part (e):</u>*** $\left\{CE = CD + DE = \frac{3}{2}\sqrt{5} + 3\sqrt{5} = \frac{9}{2}\sqrt{5}\right\},\ \left\{BD = DA + \underline{AB} = 3\sqrt{5} + \underline{4\sqrt{5}} = 7\sqrt{5}\right\}$ Area = triangle BCE − triangle ACE $= \frac{1}{2}(CE)(BD) - \frac{1}{2}(CE)(BD)$ $= \frac{1}{2} \times \frac{9}{2}\sqrt{5} \times 7\sqrt{5} - \frac{1}{2} \times \frac{9}{2}\sqrt{5} \times 3\sqrt{5}$ **M1:** for an attempt at the area of triangle *BCE* or triangle *ACE*. $= \frac{63(5)}{4} - \frac{27(5)}{4} = \frac{36(5)}{4} = 9(5)$ **B1:** Evidence of correct surd removal. $= 45$ **A1:** for 45 only.