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Mark Scheme (Results)

November 2021

Pearson Edexcel International GCSE
Mathematics A (4MA1)
Paper 1H

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November 2021
Publications Code 4MA1_1H_2111_MS
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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.

- **Types of mark**
  - M marks: method marks
  - A marks: accuracy marks
  - B marks: unconditional accuracy marks (independent of M marks)
- **Abbreviations**
  - cao – correct answer only
  - ft – follow through
  - isw – ignore subsequent working

- SC - special case
- oe – or equivalent (and appropriate)
- dep – dependent
- indep – independent
- awrt – answer which rounds to
- eeoo – each error or omission

- **No working**

  If no working is shown then correct answers normally score full marks
  If no working is shown then incorrect (even though nearly correct) answers score no marks.

- **With working**

  If there is a wrong answer indicated on the answer line always check the working in the body of the script (and on any diagrams), and award any marks appropriate from the mark scheme.
  If it is clear from the working that the "correct" answer has been obtained from incorrect working, award 0 marks.
  If a candidate misreads a number from the question. Eg. Uses 252 instead of 255; method marks may be awarded provided the question has not been simplified. Examiners should send any instance of a suspected misread to review. If there is a choice of methods shown, mark the method that leads to the answer on the answer line; where no answer is given on the answer line, award the lowest mark from the methods shown.
  If there is no answer on the answer line then check the working for an obvious answer.

- **Ignoring subsequent work**

  It is appropriate to ignore subsequent work when the additional work does not change the answer in a way that is inappropriate for the question: eg. Incorrect cancelling of a fraction that would otherwise be correct.
  It is not appropriate to ignore subsequent work when the additional work essentially makes the answer incorrect eg algebra.

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Transcription errors occur when candidates present a correct answer in working, and write it incorrectly on the answer line; mark the correct answer.

- **Parts of questions**

  Unless allowed by the mark scheme, the marks allocated to one part of the question CANNOT be awarded to another.

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International GCSE Maths				
Apart from Questions 6, 7, 13, and 18 (where the mark scheme states otherwise), the correct answer, unless clearly obtained by an incorrect method, should be taken to imply a correct method.				
Q	**Working**	**Answer**	**Mark**	**Notes**
1 (a)		e^6	1	B1 cao
(b)	$x^2 - 3x + x - 3$		2	M1 for any 3 correct terms **or** for 4 out of 4 correct terms ignoring signs **or** for $x^2 - 2x \ldots$ **or** for $\ldots -2x - 3$
	Correct answer scores full marks (unless from obvious incorrect working)	$x^2 - 2x - 3$		A1
				Total 3 marks

2	$30^2 + h^2 = 52^2$ oe or $900 + h^2 = 2704$ $(h^2 =)\ 52^2 - 30^2\ (= 1804)$ or $(h^2 =)\ 2704 - 900\ (= 1804)$		3	M1 for applying Pythagoras theorem correctly
	$(h =)\ \sqrt{52^2 - 30^2}\ (= \sqrt{1804})$ (= 42.47352..) or $(h =)\ \sqrt{2704 - 900}\ (= \sqrt{1804})$ (= 42.47352..)			M1 for square rooting
	Correct answer scores full marks (unless from obvious incorrect working)	42.5		A1 awrt 42.5 or allow $2\sqrt{451}$
				Total 3 marks

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3	(a)	54 ÷ 9 × 4 oe or $\frac{4}{9}\times 54$ oe		2	M1 Allow 0.44(44…) × 54 or $\frac{24}{54}$
		Correct answer scores full marks (unless from obvious incorrect working	24		A1
	(b)	$\frac{"24"+n}{54+n}=\frac{1}{2}$ or $\frac{30}{60}$ or 54 – "24" (= 30) and "30" – "24" or 2 × "30" – 54		2	M1 ft if "24" < 27 or $\frac{6}{60}$
		Correct answer scores full marks (unless from obvious incorrect working)	6		A1
					Total 4 marks

4	2 × 0.75 (= 1.5) oe or 2 × 0.75 × 2 (= 3) oe		5	M1 for area of rectangle
	π × (0.5 ÷ 2)^2 (= 0.1963) or $\frac{1}{2}\times\pi$ × (0.5 ÷ 2)^2 (= 0.09817)			M1 for area of circle **or** area of semicircle
	"1.5" – "0.09817" (= 1.4018…) or "3" – "0.1963" (= 2.8036…)			M1
	"1.4018" × 2 × 250 ÷ 4 (= 175.228…) or "2.8036" × 250 ÷ 4 (= 175.228…) or "1.4018" × 250 ÷ 4 (= 87.6…)			M1or for 87 – 88
	Correct answer scores full marks (unless from obvious incorrect working)	175		A1 Allow 175 – 176
				Total 5 marks

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5	LW = 180 oe ($9LW$ = 1620) or $4L \times (L + W) = 1620$ oe or $5W \times (L + W) = 1620$ oe or $4L = 5W$ oe ($L = \frac{5}{4}W$ oe or $W = \frac{4}{5}L$ oe)		5	M2 for any two correct equations from (i) LW = 180 oe ($9LW$ = 1620) (ii) $4L \times (L + W) = 1620$ oe (iii) $5W \times (L + W) = 1620$ oe (iv) $4L = 5W$ oe ($L = \frac{5}{4}W$ oe or $W = \frac{4}{5}L$ oe) (M1 for one correct equation **or** 1620 ÷ 9 (= 180))
	$L \times "\frac{4}{5}L" = "180"$ oe or $W \times "\frac{5}{4}W" = "180"$ oe or $4L \times \left(L + \frac{4}{5}L\right) = 1620$ oe or $5W \times \left(\frac{5}{4}W + W\right) = 1620$ oe or $9L\left("\frac{4}{5}L"\right) = 1620$ oe or $9\left("\frac{5}{4}W"\right)W = 1620$ oe or $4\left("\frac{180}{W}"\right)^2 + 4("180") = 1620$ oe or $5("180") + 5\left("\frac{180}{L}"\right)^2 = 1620$ oe			M1 for a correct equation in terms of one variable only
	Correct answer scores full marks (unless from obvious incorrect working)	L = 15 and W = 12		A2 for both correct (A1 for one correct) Award 4 marks for L = 12 and W = 15 dep on M3
				Total 5 marks

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<table>
<tr><td colspan="7">Elimination</td></tr>
<tr><td>6</td><td colspan="2">$5a+3p=1.96$ and $3a+2p=1.22$ oe
or
$5a+3p=196$ and $3a+2p=122$ oe</td><td rowspan="3">M2 for an arithmetical method (must see the calculation to find 0.22 or 0.26 or 0.74 and 0.48 oe)
E.g.
6.1(0) – 5.88 (= 0.22) oe
or
3.92 – 3.66 (= 0.26) oe
or
1.96 – 1.22 (= 0.74) oe
and 1.22 – “0.74” (= 0.48)</td><td></td><td>5</td><td>M1 for setting up both equations oe
Allow the use of apples and pears oe throughout, e.g.
5 apples + 3 pears = 1.96 and
3 apples + 2 pears = 1.22</td></tr>
<tr><td></td><td>E.g.
$15a+9p=5.88$
$15a+10p=6.1\ 0$
Subtracting
$(-p=-0.22)$</td><td>E.g.
$10a+6p=3.92$
$9a+6p=3.66$
Subtracting
$(a=0.26)$</td><td></td><td></td><td>M1 for a correct method to eliminate a or p: coefficients of a or p the same and correct operation to eliminate selected variable (condone any one arithmetic error) or
to find the cost of 1 apple and 1 pear</td></tr>
<tr><td></td><td colspan="2">E.g. $5a+3p=1.96$ and $6a+4p=2.44$ oe
Subtracting</td><td></td><td></td></tr>
<tr><td></td><td>E.g.
$5a+3("0.22")=1.96$
or
$3a+2("0.22")=1.22$</td><td>E.g.
$5("0.26")+3p=196$
or
$3("0.26")+2p=1.22$</td><td rowspan="2">E.g.
3 × 0.22 (= 0.66)
1.96 – “0.66” (= 1.3(0))
“1.3(0)” ÷ 5 (= 0.26)
or
5 × 0.26 (= 1.3(0))
1.96 – “1.3(0)” (= 0.66)
“0.66” ÷ 3 (= 0.22)
or
Apple and pear is 0.48 oe</td><td></td><td></td><td>M1 (dep on M2) for substituting their value found (must be > 0) of one variable into one of the equations or
for repeating above method to find second variable or
for third working column allow $k(a+p)=k(0.48)$ or
for a complete arithmetical method to find the other value</td></tr>
<tr><td></td><td colspan="2">E.g
$a+p=0.48$ oe</td><td></td><td></td></tr>
<tr><td></td><td colspan="3">$10\times"0.26"+10\times"0.22"$ or $(a+p=)\,0.48\times10$ oe or $k(a+p)=k(0.48)\times\frac{10}{k}$</td><td></td><td></td><td>M1 (dep on M3) can be implied by $10(a+p)$ provided a and p must be > 0</td></tr>
<tr><td></td><td colspan="3">Working required</td><td>4.8(0)</td><td></td><td>A1 dep M2</td></tr>
<tr><td></td><td colspan="3"></td><td></td><td></td><td>Total 5 marks</td></tr>
</table>

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Substitution				
6	$5a+3p=1.96$ and $3a+2p=1.22$ oe **or** $5a+3p=196$ and $3a+2p=122$ oe		5	M1 for setting up both equations oe Allow the use of apples and pears oe throughout, e.g. 5 apples + 3 pears = 1.96 and 3 apples + 2 pears = 1.22
	E.g. $3\left(\frac{1.96-3p}{5}\right)+2p=1.22$ or $5\left(\frac{1.22-2p}{3}\right)+3p=1.96$ or $3a+2\left(\frac{1.96-5a}{3}\right)=1.22$ or $5a+3\left(\frac{1.22-3a}{2}\right)=1.96$ or $p = 0.22$ or $a = 0.26$			M1 for correctly writing a or p in terms of the other variable **and** correctly substituting (condone any one arithmetic error)
	E.g. $(a=)\frac{1.96-3(0.22)}{5}$ or $(a=)\frac{1.22-2(0.22)}{3}$ or $(p=)\frac{1.96-5(0.26)}{3}$ or $(p=)\frac{1.22-3(0.26)}{2}$			M1 (dep on M2) for substituting their value found (must be > 0) of one variable into one of the equations **or** for repeating above method to find second variable
	$10\times"0.26"+10\times"0.22"$			M1 (dep on M3) can be implied by $10(a + p)$ provided a and p must be > 0
	Working required	4.8(0)		A1 dep M2
				Total 5 marks

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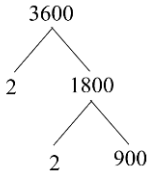
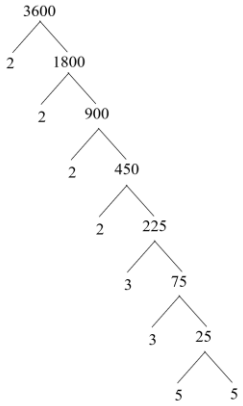
<table>
<tr>
<td>7</td>
<td>E.g.
$2 \times 2 \times 900$ or $2^2 \times 900$ or $2 \times 3 \times 600$ or
$2 \times 5 \times 360$ or $3 \times 3 \times 400$ or $3^2 \times 400$ or
$3 \times 5 \times 240$ or $5 \times 5 \times 144$ or $5^2 \times 144$
E.g.
<table>
<tr><td>2</td><td>3600</td></tr>
<tr><td>2</td><td>1800</td></tr>
<tr><td></td><td>900</td></tr>
</table>
E.g.


</td>
<td></td>
<td>3</td>
<td>M1 for at least 2 correct stages in prime factorisation which give 2 prime factors – may be in a factor tree or a table or listed eg 2, 2, 900
(see LHS for examples of the amount of work needed for the award of this mark, allow no more than one mistake ft in factor tree or table
(eg one mistake with 2 prime factors ft: $3600 = 1800 \times 20 = 2 \times 900 \times 4 \times 5$ or $360 = 2 \times 2 \times 90$)</td>
</tr>
<tr>
<td></td>
<td>E.g. $2 \times 2 \times 2 \times 2 \times 3 \times 3 \times 5 \times 5$
E.g.
<table>
<tr><td>2</td><td>3600</td></tr>
<tr><td>2</td><td>1800</td></tr>
<tr><td>2</td><td>900</td></tr>
<tr><td>2</td><td>450</td></tr>
<tr><td>3</td><td>225</td></tr>
<tr><td>3</td><td>75</td></tr>
<tr><td>5</td><td>25</td></tr>
<tr><td>5</td><td>5</td></tr>
<tr><td></td><td>(1)</td></tr>
</table>
E.g.


</td>
<td></td>
<td></td>
<td>M1 for 2, 2, 2, 2, 3, 3, 5, 5 or 2^4 , 3^2 , 5^2 or $2^4 + 3^2 + 5^2$ (ignore 1s) (may be a fully correct factor tree or ladder)</td>
</tr>
<tr>
<td></td>
<td>Working required</td>
<td>$2^4 \times 3^2 \times 5^2$</td>
<td></td>
<td>A1 dep on M2
can be any order (allow $2^4 . 3^2 . 5^2$)
(SCB1 for $3.6 \times 2^3 \times 5^3$)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total 3 marks</td>
</tr>
</table>

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8	$0.22x = 5.48$ oe or (1% =) $5.48 \div 22$ (= 0.24909…) or $100 \div 22$ (= 4.54…)			M1
	(x =) $5.48 \div 0.22$ oe or (100% =) $5.48 \div 22 \times 100$ or "0.24909…" × 100 or 5.48 × "4.54…"			M1
	Correct answer scores full marks (unless from obvious incorrect working)	24.9		A1 awrt 24.9
				Total 3 marks

8 **ALT** **1**	$0.22x = 5\,480\,000$ oe or (1% =) $5\,480\,000 \div 22$ (= 249 090.9091…) or $100 \div 22$ (= 4.54…)			M1
	$5\,480\,000 \div$ "0.22" oe or (100% =) $5\,480\,000 \div 22 \times 100$ or "249 090.9091…"× 100 or $5\,480\,000 \times$ "4.54…"			M1
	Correct answer scores full marks (unless from obvious incorrect working)	24 900 000		A1 awrt 24 900 000
				Total 3 marks

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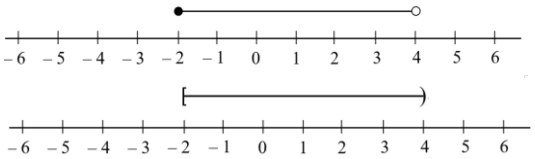
9	(i)	$-7+3 \leq 2x < 5+3$ oe or $\frac{-7}{2} \leq x - \frac{3}{2} < \frac{5}{2}$ oe or $-7+3 \leq 2x$ oe **and** $2x < 5+3$ oe or (x =) −2 or (x =) 4		3	M1 or one side of the inequality correct, i.e.. $x \geq -2$ oe or $x < 4$ Condone = rather than ≤ or < or any other sign for the M marks.
		$\frac{-7+3}{2} \leq x < \frac{5+3}{2}$ or $\frac{-7}{2} + \frac{3}{2} \leq x < \frac{5}{2} + \frac{3}{2}$ or $\frac{-7+3}{2} \leq x$ oe **and** $x < \frac{5+3}{2}$ or (x =) −2 and (x =) 4			M1
		Correct answer scores full marks (unless from obvious incorrect working)	$-2 \leq x < 4$		A1 allow $x \geq -2$ and $x < 4$ Allow [−2, 4)
	(ii)			2	M1 ft for drawing a line from −2 to 4 or (indep) for a closed circle or [at −2 or (indep) for an open circle or) or [at 4 Only allow a follow through for a double ended inequality in (i)
			Correct diagram		A1 ft for correct diagram Only allow a follow through for a double ended inequality in (i)
					Total 5 marks

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10	$0.0027 = \frac{5.4}{(V)}$ oe		5	M1 for correctly using $\text{density} = \frac{\text{mass}}{\text{volume}}$
	$(V =) \frac{5.4}{0.0027} = 2000$			M1 for correctly rearranging for V
	$\pi \times 10^2 \times h = 2000$ oe			M1ft their 2000 for $\pi \times 10^2 \times h =$ their V
	$(h =) \frac{2000}{\pi \times 10^2}$ oe (= 6.3661…)			M1ft their 2000 dep on previous M1 for correctly rearranging for h
	Correct answer scores full marks (unless from obvious incorrect working)	6.4		A1 awrt 6.4
				Total 5 marks

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11	(a)		(12), 36, 64, 76, 86, 90	1	B1
	(b)			2	M1 ft from table for at least 5 points plotted correctly (± 0.5 squares) at end of interval **or** ft from (CF) table for all 6 points plotted consistently (± 0.5 squares) within each interval in the **freq table** at the correct height
			Correct cf diagram		A1 accept curve or line segments accept graph that is not joined to (25, 0)
	(c)	E.g. reading at 42 minutes and reading at 52 minutes		2	M1 for correct use of 42 and 52, ft from a cum freq graph provided method is shown – e.g. a line vertically drawn to the graph from readings of 42 and 52 on the Time axis to meet the graph and then a horizontal line to the CF axis (even if wrongly read scale) **or** clear marks on the graph and CF axis that correspond to the correct readings **or** correct values from the CF axis
		Correct answer scores full marks (unless from obvious incorrect working)	25 – 29		A1 ft Accept a single value in range 25 to 29 or ft from their cumulative frequency graph provided method is shown
					Total 5 marks

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12	(a)	$\tan 20 = \frac{100}{d}$ oe or $\tan(90-20) = \frac{d}{100}$ oe or $\frac{d}{\sin(90-20)} = \frac{100}{\sin 20}$ oe		3	M1
		$(d =)\frac{100}{\tan 20}$ (= 274.747…) or $(d =)100 \times \tan(90-20)$ (= 274.747…) or $(d =)\frac{100}{\sin 20} \times \sin(90-20)$ (= 274.747…)			M1
		Correct answer scores full marks (unless from obvious incorrect working)	275		A1 awrt 275
	(b)	$\tan 25 = \frac{100+h}{275}$ oe or $\tan 25 = \frac{y}{275}$ oe or $275 \times \tan 25$ (= 128....) or $\tan(90-25) = \frac{275}{100+h}$ oe or $\tan(90-25) = \frac{275}{y}$ oe or $\frac{100+h}{\sin 25} = \frac{275}{\sin(90-25)}$ or 128.1 – 128.2 (y is the height of cliff and radio mast)		3	M1 ft part (a) Allow $(hyp =)\sqrt{100^2 + 275^2}$ (= $\sqrt{85486.321} = 292.380$) or $(hyp =)\frac{100}{\sin 20} \times \sin 90$ (= 292.380)
		$(h =)275 \times \tan 25 - 100$ = 28.1169... or $(h =)\frac{275}{\tan\ 90-25} - 100$ (= 28.1169...) or $(h =)\frac{275}{\sin(90-25)} \times \sin 25 - 100$ (= 28.1169...)			M1 ft part (a) $(h =)\frac{"292.380"}{\sin(90-25)} \times \sin(25-20)$ (= 28.1169...)
		Correct answer scores full marks (unless from obvious incorrect working)	28.1		A1 Accept answers in the range 28 – 28.2
					Total 5 marks

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13	15.5 or 16.5 or 24.5 or 25.5 or 125 or 135		3	B1 Accept $16.4\dot{9}$ for 16.5 $25.4\dot{9}$ for 25.5 $134.\dot{9}$ for 135
	$\frac{(YZ)}{\sin(125)} = \frac{16.5}{\sin(24.5)}$ oe			M1 for substitution into sine rule $\frac{(YZ)}{\sin(LB_2)} = \frac{UB_1}{\sin(LB_3)}$ oe where $16 < UB_1 \leq 16.5$ **and** $125 \leq LB_2 < 130$ **and** $24.5 \leq LB_3 < 25$
	Working required	32.6		A1 Accept 32.5 to 32.6 from correct working
				Total 3 marks

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14	(a)(i)		**b** – **a**	1	B1 oe
	(ii)	E.g. (*KI* = *KJ* + *JI* =) 2(**b** – **a)** + 2**b** oe		2	M1ft (i) for any valid correct path (oe) in capitals or lower case letters
		Correct answer scores full marks (unless from obvious incorrect working)	4**b** – 2**a**		A1 oe simplified
	(iii)	E.g. (*LD* = *LF* + *FE* + *ED* =) (**b** – **a)** + (**b** – **a)** – **a** oe		2	M1ft (i) for any valid correct path (oe) in capitals or lower case letters
		Correct answer scores full marks (unless from obvious incorrect working)	2**b** – 3**a**		A1 oe simplified
	(b)	(*GHIJKL* =) $6 \times 5 \times 2^2$ (= 120) or (*GABH* =) $5 \times 2^2 - 5$ (= 15) or 3×5 (= 15) or (Number of triangles in shaded region =) $(6 \times 4) - 6$ (= 18)		3	M1
		"120" – (6×5) or $6 \times$ "15" or "18" × 5			M1
		Correct answer scores full marks (unless from obvious incorrect working)	90		A1
					Total 8 marks

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15	(a)		$\frac{3}{9}$ $\frac{2}{9}, \frac{4}{9}, \frac{3}{9}$	2	B1 for lower 1st game branch probability B1ft for all values correct on 2nd game branches
	(b)	$\left(\frac{2}{9}\times\frac{3}{9}\right)$ or $\left(\frac{3}{9}\times\frac{2}{9}\right)$ or $\left(\frac{4}{9}\times\frac{4}{9}\right)$ oe or		3	M1 ft from their tree diagram for one correct product from *WL* or *L W* or *DD* (allow probabilities to 2 dp truncated or rounded)
		$\left(\frac{2}{9}\times\frac{3}{9}\right) + \left(\frac{3}{9}\times\frac{2}{9}\right) + \left(\frac{4}{9}\times\frac{4}{9}\right)$ oe			M1 ft for a fully correct method
		Correct answer scores full marks (unless from obvious incorrect working)	$\frac{28}{81}$		A1 Allow 0.345 ... (2 dp truncated or rounded) or 34.5% (2 sf truncated or rounded)
	(c)	$\left(\frac{2}{9}\times\frac{4}{9}\times\frac{3}{9}\right)$ or $\left(\frac{4}{9}\times\frac{4}{9}\times\frac{4}{9}\right)$		3	M1ft from their tree diagram for any combination of *WLD* or *DDD* (allow probabilities to 2 dp truncated or rounded)
		$6\times\left(\frac{2}{9}\times\frac{4}{9}\times\frac{3}{9}\right) + \left(\frac{4}{9}\times\frac{4}{9}\times\frac{4}{9}\right)$			M1ft for a fully correct method
		Correct answer scores full marks (unless from obvious incorrect working)	$\frac{208}{729}$		A1 Allow 0.285 ... (2 dp truncated or rounded) or 28.5% (2 sf truncated or rounded)
					Total 8 marks

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15 (a) **ALT**		$\frac{3}{9}$ $\frac{2}{9}, \frac{4}{9}, \frac{3}{9}$	2	B1 for lower 1st game branch probability B1ft for all values correct on 2nd game branches
(b)	1 and $\left(\frac{2}{9}\times\frac{2}{9}\right)$ or $\left(\frac{4}{9}\times\frac{2}{9}\right)$ or $\left(\frac{4}{9}\times\frac{3}{9}\right)$ or $\left(\frac{3}{9}\times\frac{3}{9}\right)$ oe		3	M1ft from their tree diagram for 1 and one correct product from *WW*, *DW*, *DL* or *LL* (allow probabilities to 2 dp truncated or rounded)
	$1-\left[\left(\frac{2}{9}\times\frac{2}{9}\right)+2\left(\frac{4}{9}\times\frac{2}{9}\right)+2\left(\frac{4}{9}\times\frac{3}{9}\right)+\left(\frac{3}{9}\times\frac{3}{9}\right)\right]$ oe			M1ft for a fully correct method
	Correct answer scores full marks (unless from obvious incorrect working)	$\frac{28}{81}$		A1 Allow 0.345 ... (2 dp truncated or rounded) or 34.5% (2 sf truncated or rounded)
(c)	1 and $\left(\frac{2}{9}\times\frac{2}{9}\times\frac{2}{9}\right)$ or $\left(\frac{2}{9}\times\frac{2}{9}\times\frac{4}{9}\right)$ or $\left(\frac{2}{9}\times\frac{2}{9}\times\frac{3}{9}\right)$ or $\left(\frac{2}{9}\times\frac{4}{9}\times\frac{4}{9}\right)$ or $\left(\frac{2}{9}\times\frac{3}{9}\times\frac{3}{9}\right)$ or $\left(\frac{4}{9}\times\frac{4}{9}\times\frac{3}{9}\right)$ or $\left(\frac{4}{9}\times\frac{3}{9}\times\frac{3}{9}\right)$ or $\left(\frac{3}{9}\times\frac{3}{9}\times\frac{3}{9}\right)$ oe		3	M1ft from their tree diagram for 1 and one correct product from *WWW* or *WWD* or *WWL* or *WDD* or *WLL* or *DDL* or *DLL* or *LLL* (allow probabilities to 2 dp truncated or rounded)
	$1-\left[\begin{array}{l}\left(\frac{2}{9}\times\frac{2}{9}\times\frac{2}{9}\right)+3\left(\frac{2}{9}\times\frac{2}{9}\times\frac{4}{9}\right)+3\left(\frac{2}{9}\times\frac{2}{9}\times\frac{3}{9}\right)+3\left(\frac{2}{9}\times\frac{4}{9}\times\frac{4}{9}\right)\\+3\left(\frac{2}{9}\times\frac{3}{9}\times\frac{3}{9}\right)+3\left(\frac{4}{9}\times\frac{4}{9}\times\frac{3}{9}\right)+3\left(\frac{4}{9}\times\frac{3}{9}\times\frac{3}{9}\right)+\left(\frac{3}{9}\times\frac{3}{9}\times\frac{3}{9}\right)\end{array}\right]$ oe			M1ft for a fully correct method
	Correct answer scores full marks (unless from obvious incorrect working)	$\frac{208}{729}$		A1 Allow 0.285 ... (2 dp truncated or rounded) or 28.5% (2 sf truncated or rounded)
				Total 8 marks

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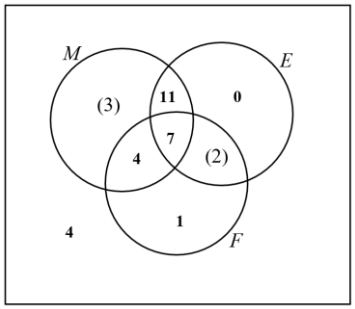
16	(a)	$(11 - x) + (x) + (18 - x) + 3 = 25$ oe or $(11 - x) + (x) + (18 - x) + 3 + 7 = 25 + 7$ oe or $x + y + z = 25 - 3$ and $x + z = 11$ and $x + y = 18$ oe where $y = M \cap E \cap F'$ and $z = M \cap F \cap E'$		2	M1 for setting up a correct equation
		Correct answer scores full marks (unless from obvious incorrect working)	7		A1 (allow 7 in the Venn diagram if no answer is given in (a))
	(b)			2	B2 ft for $18 - x$, x and $11 - x$ dep on M1 in part (a) and ($x < 12$) (NB 0, 1 and 4 are fixed) for 6 correct remaining values (B1 ft for 4 or 5 correct remaining values) Allow just E to be blank if other sections are populated with a number
	(c)	$\frac{3+"11"}{25}$ or $\frac{3+(18-"7")}{25}$ or 0.56 oe	$\frac{14}{25}$	1	B1ft for $18 - x$, x and $11 - x$ oe
					Total 5 marks

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17	(a)	$6y(y-1)+5(y-1)$ or $y(6y+5)-1(6y+5)$		2	M1 for $(6y \pm 5)(y \pm 1)$ or $(6y \pm 1)(y \pm 5)$ or $(ay+5)(by-1)$ where $ab=6$ or $5b-a=-1$ or $(6y+p)(y+q)$ where $pq=-5$ or $6q+p=-1$ Condone use of a different letter to y
		Correct answer scores full marks (unless from obvious incorrect working)	$(6y+5)(y-1)$		A1 oe
	(b)	$8w-fw=2f+3$ oe		3	M1 for multiplying by denominator and expanding in a correct equation
		$8w-3=2f+fw$ oe or $-2f-fw=3-8w$ oe			M1 for gathering terms in f on one side and other terms the other side in a correct equation ft their equation dep on 2 terms in f and two other terms
		Correct answer scores full marks (unless from obvious incorrect working)	$f=\frac{8w-3}{2+w}$		A1 oe accept $f=\frac{3-8w}{-2-w}$ oe
	(c)	$4(x^2-2x)+7$ or $4\left(x^2-2x+\frac{7}{4}\right)$ oe		3	M1
		$4\left[(x-1)^2-1^2\right]+7$ oe or $4\left[(x-1)^2-1^2+\frac{7}{4}\right]$ oe			M1 for a complete method
		Correct answer scores full marks (unless from obvious incorrect working)	$4(x-1)^2+3$		A1 allow $a=4$, $b=-1$ and $c=3$
					Total 8 marks

17 ALT	(c)	$ax^2+2bax+b^2a+c$		3	M1 for correctly expanding $a(x+b)^2+c$ to give $ax^2+2bax+b^2a+c$
		$2ba=-8$ and $b^2a+c=7$			M1 for a complete method (equating coefficients)
		Correct answer scores full marks (unless from obvious incorrect working)	$4(x-1)^2+3$		A1 allow $a=4$, $b=-1$ and $c=3$

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18	E.g. $y = 0.4x....$ **and** $10y = 4.x....$ $(10y - y = 4.x - 0.4$ oe) **or** $10y = 4.x....$ **and** $100y = 4x.x....$ $(100y - 10y = 4x - 4$ oe) **or** $100y = 4x.x....$ **and** $1000y = 4xx.x....$ $(1000y - 100y = 4xx - 4x$ oe)		3	M1 for selecting 2 correct recurring decimal expressions and then a demonstration to subtract (If recurring dots not shown then allow each expression to 1 dp e.g. $y = 0.4x....$ **and** $100y = 4x.x....$ as a pair **and** $100y - y$ or $4x.x.... - 0.4x....$) or an answer of $y = \frac{4x-4}{90}$ oe
	E.g. $9y = 4\frac{x}{10} - \frac{4}{10} = \frac{40+x-4}{10}$ oe or $90y = 40 + x - 4$ oe or $900y = 400 + 10x + x - 40 - x$ oe			M1 for a correct subtraction with correct expressions simplified
	Working required	$\frac{36+x}{90}$		A1 dep on M2 oe
				Total 3 marks

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19 (a)	E.g. $x+y+x+y+x=100$ oe or $3x + 2y = 100$ oe $\left(y=\frac{100-3x}{2}\right)$			3	M1 for a correct equation for the perimeter of the shape **or** for a correct expression for the area of triangle *CED*
	E.g. $\frac{1}{2}\times x\times x\times\sin 60$ $\left(=\frac{1}{2}\times x\times x\times\frac{\sqrt{3}}{2}\right)$ $\left(=\frac{x^2\sqrt{3}}{4}\right)$	E.g. $x^2=\left(\frac{x}{2}\right)^2+h^2$ **and** $=\frac{1}{2}\times x\times\frac{x\sqrt{3}}{2}\left(=\frac{x^2\sqrt{3}}{4}\right)$			
	x"$\left(\frac{100-3x}{2}\right)$"+"$\frac{x^2\sqrt{3}}{4}$" oe				M1 for the area of the shape in terms of x only
	E.g. $x\left(\frac{200-6x}{4}\right)+\frac{x^2\sqrt{3}}{4}$ or $\frac{x}{4}(200-6x+x\sqrt{3})$ or $\frac{200x-6x^2}{4}+\frac{x^2\sqrt{3}}{4}$ or $\frac{x}{4}(200x-6x^2+x^2\sqrt{3})$		Shown		A1 for the area given in correct form with full working shown (at least one intermediate step before the answer)
(b) (i)	$\left(\frac{dR}{dx}=\right)50-\frac{3}{2}\times 2\times x+2\times\frac{x\sqrt{3}}{4}=0$ oe			2	M1 for differentiation of correct expression with 2 out of 3 terms correct and equated to 0 (can be implied by subsequent working)
	Correct answer scores full marks (unless from obvious incorrect working)		$\frac{100}{6-\sqrt{3}}$		A1 for a correct expression
(ii)			Correct reason	1	B1 for correct reason R is a quadratic with negative coefficient of x^2 E.g. the graph of R is $\cap$ shaped or (allow $\frac{d^2R}{dx^2}<0$ oe)
					Total 6 marks

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20	$\left(\frac{-6+5}{2}, \frac{2+3}{2}\right) = \left(-\frac{1}{2}, \frac{5}{2}\right)$ oe		7	M1 for finding the midpoint of *AB*
	$\frac{2-3}{-6-5}\left(=\frac{-1}{-11}=\frac{1}{11}\right)$ oe			M1 for finding the gradient of *AB*
	$\frac{1}{11} = -1$ **or** $(m =) -11$			M1ft their gradient of *AB* (indep) for the correct use of $m_1 \times m_2 = -1$
	$"\frac{5}{2}" = "-11"\left("-\frac{1}{2}"\right) + c$ oe **or** $y - "\frac{5}{2}" = "-11"\left(x - "-\frac{1}{2}"\right)$ **and** $(y =) "-11"(-1) - 3 (= 8)$ **or** $(y =) "-11"\left(-1 - "-\frac{1}{2}"\right) + "\frac{5}{2}" (= 8)$			M1 for an expression that gives the *y* value at *C*
See alt methods	(Perp =) $\sqrt{\left(8-\frac{5}{2}\right)^2 + \left(-1--\frac{1}{2}\right)^2}\left(=\frac{\sqrt{122}}{2}\right)$ **and** $(AB =) \sqrt{3-2^{\,2} + 5--6^{\,2}}\ (=\sqrt{122})$			M1
	(Area of triangle =) $\frac{1}{2} \times \sqrt{122} \times \frac{\sqrt{122}}{2}$			M1 for a complete method
	Correct answer scores full marks (unless from obvious incorrect working)	30.5		A1 oe Allow answers in the range 30.4 – 30.5
				Total 7 marks

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Q20 Alternative ways of finding the area of the triangle (final 2 M marks)				
Alt1	$(11 \times 6) - (0.5 \times 1 \times 11) - (0.5 \times 5 \times 6) - (0.5 \times 5 \times 6)$			M1 for any 3 correct triangles
	$(11 \times 6) - (0.5 \times 1 \times 11) - (0.5 \times 5 \times 6) - (0.5 \times 5 \times 6)$			M1 for a complete method
	Correct answer scores full marks (unless from obvious incorrect working)			
Alt 2	$(AC = BC =)\sqrt{5^2 + 6^2}\ (= \sqrt{61})$			M1 for *AC* is perp to *BC*
	(Area of triangle =) $\frac{1}{2} \times \sqrt{61} \times \sqrt{61}$			M1 for a complete method
	Correct answer scores full marks (unless from obvious incorrect working)			
Alt 3	$\sqrt{\left(8 - \frac{5}{2}\right)^2 + \left(-1 - -\frac{1}{2}\right)^2}\left(= \frac{\sqrt{122}}{2}\right)$ **and** $(AM =)\sqrt{\left(-6 - -\frac{1}{2}\right)^2 + \left(2 - \frac{5}{2}\right)^2}\left(= \frac{\sqrt{122}}{2}\right)$ or $(BM =)\sqrt{\left(5 - -\frac{1}{2}\right)^2 + \left(3 - \frac{5}{2}\right)^2}\left(= \frac{\sqrt{122}}{2}\right)$			M1 for the height of the triangle, *AM* and *BM* where *M* is the midpoint of *AB*
	(Area of triangle =) $2 \times \frac{1}{2} \times \frac{\sqrt{122}}{2} \times \frac{\sqrt{122}}{2}$			M1 for a complete method
	Correct answer scores full marks (unless from obvious incorrect working)			
Alt 4	$(AC = BC =)\sqrt{5^2 + 6^2}\ (= \sqrt{61})$ and $(AB =)\sqrt{3 - 2^{\ 2} + 5 - -6^{\ 2}}\ (= \sqrt{122})$			M1 for finding *AC*, *BC* and *AB*
	$\sqrt{\left(\frac{\sqrt{122} + 2\sqrt{61}}{2}\right)\left(\frac{\sqrt{122} + 2\sqrt{61}}{2} - \sqrt{122}\right)\left(\frac{\sqrt{122} + 2\sqrt{61}}{2} - \sqrt{61}\right)\left(\frac{\sqrt{122} + 2\sqrt{61}}{2} - \sqrt{61}\right)}$			M1 for applying Heron's formula
	Correct answer scores full marks (unless from obvious incorrect working)			