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Paper 2E

Mark scheme

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Key to mark types and abbreviations

M	Method marks are awarded for a correct method which could lead to a correct answer.
A	Accuracy marks are awarded when following on from a correct method. It is not necessary to always see the method. This can be implied.
B	Marks awarded independent of method.
ft	Follow through marks. Marks awarded for correct working following a mistake in an earlier step.
SC	Special case. Marks awarded for a common misinterpretation which has some mathematical worth.
M dep	A method mark dependent on a previous method mark being awarded.
B dep	A mark that can only be awarded if a previous independent mark has been awarded.
oe	Or equivalent. Accept answers that are equivalent. eg accept 0.5 as well as $\frac{1}{2}$
[a, b]	Accept values between a and b inclusive.
[a, b)	Accept values $a \leq \text{value} < b$
3.14...	Accept answers which begin 3.14 eg 3.14, 3.142, 3.1416
Use of brackets	It is not necessary to see the bracketed work to award the marks.

Q	Answer	Mark	Comments
1	$25x^6$	B1	
2	B and D	B1	
3	250%	B1	
4	5	B1	
5	0.2 or $\frac{1}{5}$ or 8000 or 20	M1	
	4 with correct working	A1	0.2 or $\frac{1}{5}$ and 8000 or 20 must be seen
	Additional Guidance		
	Do not allow misread of cube root as square root		
	20 must not be from rounding 20.04(4...)		

Q	Answer	Mark	Comments
6	12^2 and 5^2 seen or 144 and 25 seen or 119	M1	
	$\sqrt{12^2 - 5^2}$ or $\sqrt{\text{their } 144 - \text{their } 25}$ or $\sqrt{119}$	M1dep	oe
	[10.9, 10.91]	A1	
	Additional Guidance		
	12 cm ² is not 12^2 unless recovered		
	$12^2 = 24$ and $5^2 = 10$, $\sqrt{24 - 10}$		M1M1A0
	$\sqrt{12^2 + 5^2}$ or $\sqrt{144 + 25}$ or $12^2 + 5^2$ or $144 + 25$		M1M0A0
	Only $\sqrt{169}$ or only 169 or only 13		M0
	Using trigonometry		M0
	Using scale drawing		M0
7(a)	2, 3, 4, 5, 6 in any order	B2	B1 4 correct and 1 missing eg 2, 3, 4, 5 or 5 correct and 1 incorrect eg 1, 2, 3, 4, 5, 6 or $1 < x \leq 6$ oe inequality (x any letter)
	Additional Guidance		
	$2 \leq x \leq 6$		B1
	2 errors eg 1, 2, 3, 4, 5		B0
7(b)	-64	B1	
	Additional Guidance		

Q	Answer	Mark	Comments
8	$\frac{1}{5} \times 80$ or 16 or 28 in $(B \cup D)'$	M1	oe eg 16 seen in $B \cap D$
	their 16 + 28 or 44	M1dep	their 16 must be from a correct method may be implied by $80 - 16 - 28$
	$2x + \text{their } 44 = 80$ or $\frac{80 - \text{their } 44}{2}$ or $\frac{36}{2}$ or 18	M1dep	oe eg 18 seen in $B \cap D'$ or 18 seen in $D \cap B'$
	34	A1	
	Additional Guidance		
	A fully correct Venn diagram will scored at least M3		
	16 (with no method shown) seen anywhere in Venn diagram implies M1		
	36 without working is not enough to imply the 44		
	34 on answer line (even if 16, 18 and 28 in Venn diagram are in incorrect places)		M1M1M1A1
	34 on answer line with incorrect numbers in Venn diagram		M1M1M1A1
	18 seen in both $B \cap D'$ and $D \cap B'$ in Venn diagram (even if 16 and 28 are incorrectly placed) and answer line not 34		M1M1M1A0
	18 with no incorrect working		M1M1M1
	44 with no incorrect working		M1M1
	16 + 28 + 22 without seeing 44		M1M0
9(a)	$(3 - x)(3 + x)$	B1	oe fully factorised expression
	Additional Guidance		

Q	Answer	Mark	Comments
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9(b)	Alternative method 1		
	$\frac{1}{10} \times (10 + 10)$ or $\frac{1}{10} \times 20$ or $\frac{1}{10} \times 10 + 1$ or $1 + 1$	M1	oe correct expression using $\frac{1}{10} = 10$
	2	A1	
	Alternative method 2		
	$10x + 1$	M1	
	2	A1	
	Additional Guidance		

9(c)	$12x^3y + 3xy^3$	B2	B1 one term correct
	Additional Guidance		
	Condone $12 \times x^3 \times y + 3 \times x \times y^3$ for B1 only		B1
	Further work following a B2 answer		B1
	Further work following a B1 answer		B1

Q	Answer	Mark	Comments
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10(a)	$\frac{7}{25}$	B1	
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10(b)	Valid reason	B1	eg C was the biggest sample
	Additional Guidance		
	More men in C		B1
	The sample size of C is large		B1
	More trials in C		B1
	More men completed in C		B0
	More men in C and more completed the program		B0
	It's more accurate		B0
	It has the lowest probability		B0

10(c)	'Women' ticked and valid comparison	B1	eg 0.24 or 0.24(6...) or 0.247 or 0.25 or (0.38 × 200 =) 76
	Additional Guidance		
	The comparison must be using sample C or a combination of samples that includes sample C		
	If the comparison is based on relative frequencies, they must be in comparable form, eg 24% and 38%		
	'Women' ticked and 0.38 is more than 0.3 and 0.28 and 0.24		B1
	Calculations must be correct eg $0.38 \times 200 = 70$		B0
	'Women' ticked and 0.38 is more than 0.3		B0
	'Women' ticked and 0.38 is more than 0.28		B0

Q	Answer	Mark	Comments
11	All correct	B3	B2 three correct B1 one or two correct
	Additional Guidance		
		True	May be true
	a is a factor of bc	☒	☐
	a is a factor of $(b + c)$	☒	☐
12	b is a factor of c	☐	☒
	c is a factor of a	☐	☒
12	$\frac{1}{2} \times 12 \times 14$ or 84	M1	oe
	$\left(\frac{6+10}{2}\right)h$ or $6h + \left(\frac{1}{2} \times 4 \times h\right)$ or $8h$	M1	oe
	$\frac{\text{their } 84}{\text{their } 8}$	M1dep	oe dep on M2
	10.5	A1	
	Additional Guidance		
	Area of triangle = 168, area of trapezium = $16h$, $168 \div 16 = 10.5$		M0M0M0A0

Q	Answer	Mark	Comments
13	Alternative method 1		
	$6 \times 3x + 6 \times 2x = 22.8$ or $18x + 12x = 22.8$ or $30x = 22.8$	M1	oe
	$(x =) 22.8 \div 30$ or 0.76	M1dep	
	their 0.76×3	M1dep	
	2.28	A1	
	Alternative method 2		
	$6k + 6f = 22.8$	M1	oe
	$(k + f =) 22.8 \div 6$ or 3.8	M1dep	
	their $3.8 \div 5 \times 3$ or 0.76×3	M1dep	
	2.28	A1	
	Alternative method 3		
	$6k + 6f = 22.8$	M1	oe
	$2k = 3f$	M1	oe
	$6k + 4k = 22.8$ or $10k = 22.8$ or $9f + 6f = 22.8$ or $15f = 22.8$ or $f = 1.52$	M1dep	oe dep on M1M1
	2.28	A1	
	Additional Guidance		
	Accept use of any consistent letters		
	Equations may be implied by correct subsequent working eg in Alt 2 $6k + 6f = 22.8$ may be implied by $k + f = 3.8$ eg in Alt 3 $6k + 6f = 22.8$ and $2k = 3f$ may be implied by $6k + 4k = 22.8$		

Q	Answer	Mark	Comments
14(a)	(2) 6 29 44 48	B1	cumulative frequencies implied by points plotted (± 0.5 square)
	Points plotted with upper class boundaries and cf values (± 0.5 square)	M1	ft their cumulative frequencies must be increasing and not a single straight line
	Smooth curve or polygon starting at correct point for their points and going through all their points (± 0.5 square)	A1ft	ft their cumulative frequency must be increasing and not a single straight line
	Additional Guidance		
	For A1 the graph should start at (0, 0) or (10 000, 2)		
	For A1 the graph should end at $x = 50\,000$ unless it is continued by a horizontal line adjoining (50 000, 48)		
	Histogram only		M0A0
	Histogram and cumulative frequency diagram		Mark diagram

Q	Answer	Mark	Comments
14(b)	Alternative method 1 – using graph		
	Correctly reads a value from their graph at \$25 000 (± 0.5 square)	M1	must be from an increasing graph may be a decimal or rounded or truncated whole number
	Correct value for their graph	A1ft	ft 48 – their reading must be a positive whole number
	Alternative method 2 – using table		
	11 or 12 or 11.5 or 2 + 4 + 11.5 or 17.5 or 11.5 + 15 + 4 or 30.5	M1	oe
	30 or 31	A1	
	Alternative method 3 – using midpoint of third interval		
	$\frac{6+29}{2}$ or 17.5	M1	oe
	30 or 31	A1	
	Additional Guidance		
15	$\frac{n}{n+7} = \frac{8}{9}$	M1	
	$9n = 8(n+7)$ or $9n = 8n + 56$	M1dep	oe eg $9n - 8n - 56 = 0$
	56	A1	
	Additional Guidance		
	Embedded answer eg $\frac{56}{63} \left(= \frac{8}{9} \right)$		M1M1A0

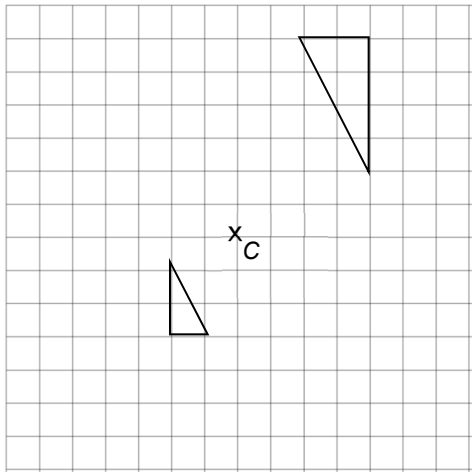
Q	Answer	Mark	Comments
16	Alternative method 1		
	$\frac{2}{15}$ or 0.13... or $\frac{12}{20}$ or 0.6 or $\frac{11}{15}$ or 0.73(...)	M1	oe
	$(2 + 12) \div (\text{their } \frac{2}{15} + \text{their } \frac{12}{20})$ or $14 \div \frac{11}{15}$ or $14 \div 0.73(\dots)$	M1dep	oe
	$19\frac{1}{11}$ or [19, 19.2]	A1	oe eg $\frac{210}{11}$
	Alternative method 2		
	8 (mins) 36 (mins)	M1	implied by (time A to C =) 44 (mins)
	$\frac{2 + 12}{\text{their } 8 + \text{their } 36} \times 60$ or $\frac{14}{44} \times 60$	M1dep	oe
	$19\frac{1}{11}$ or [19, 19.2]	A1	oe eg $\frac{210}{11}$
	Additional Guidance		
	$\frac{2 \times 15 + 12 \times 20}{2 + 12} = 19.(\dots)$		M0M0A0
17	$\frac{b-a}{ab}$	B1	

Q	Answer	Mark	Comments
18	Alternative method 1		
	$28 \div 0.7$ or 40	M1	oe $12 : 28$ scores M2 $28 \times \frac{3}{7}$ scores M2
	their 40×0.3 or their $40 - 28$ or 12 or $\frac{12}{40}$	M1dep	
	3	A1	
	Alternative method 2		
	$\frac{9+x}{9+28+x} = \frac{30}{100}$ or $\frac{y}{y+28} = \frac{30}{100}$	M1	oe eg $9+x = (37+x) \times 0.3$
	$100x - 30x = 1110 - 900$ or $70x = 210$ or $100y - 30y = 840$ or $70y = 840$ or 12	M1dep	oe
	3	A1	
	Additional Guidance		
	Embedded correct answer with no answer given or embedded correct answer with answer of 12 or 30% given		M1M1A0
	Trial(s) with answer 3		M1M1A1
	Trial(s) without answer 3		M0M0A0

Q	Answer	Mark	Comments
19	Alternative method 1		
	$x^2 - x - 2x + 2$ with at least three terms correct or $x^2 - 3x + k$ where k is a non-zero constant	M1	oe no omissions or extra terms
	$x^3 - x^2 - 2x^2 + 2x$ or $x^3 - 3x^2 + 2x$ or $3x^2 - 3x - 6x + 6$ or $3x^2 - 9x + 6$	M1dep	attempt at full expansion with correct multiplication of their 3 or 4 terms by one of the terms in the remaining bracket
	$x^3 - 3x^2 + 2x + 3x^2 - 9x + 6$	A1	oe eg $x^3 - x^2 - 2x^2 + 2x + 3x^2 - 9x + 6$ implied by correct final answer
	$x^3 - 7x + 6$	A1	
	Alternative method 2		
	$x^2 - 2x + 3x - 6$ with three terms correct or $x^2 + x + k$ where k is a non-zero constant	M1	oe no omissions or extra terms
	$x^3 - 2x^2 + 3x^2 - 6x$ or $x^3 + x^2 - 6x$ or $-x^2 + 2x - 3x + 6$ or $-x^2 - x + 6$	M1dep	attempt at full expansion with correct multiplication of their 3 or 4 terms by one of the terms in the remaining bracket
	$x^3 + x^2 - 6x - x^2 - x + 6$	A1	oe eg $x^3 - 2x^2 + 3x^2 - 6x - x^2 + 2x - 3x + 6$ implied by correct final answer
	$x^3 - 7x + 6$	A1	

Alternative method and Additional Guidance continues on the next page

Q	Answer	Mark	Comments
19 cont	Alternative method 3		
	$x^2 - x + 3x - 3$ with three terms correct or $x^2 + 2x + k$ where k is a non-zero constant	M1	oe no omissions or extra terms
	$x^3 - x^2 + 3x^2 - 3x$ or $x^3 + 2x^2 - 3x$ or $-2x^2 + 2x - 6x + 6$ or $-2x^2 - 4x + 6$	M1dep	attempt at full expansion with correct multiplication of their 3 or 4 terms by one of the terms in the remaining bracket
	$x^3 + 2x^2 - 3x - 2x^2 - 4x + 6$	A1	oe eg $x^3 - x^2 + 3x^2 - 3x - 2x^2 + 2x - 6x + 6$ implied by correct final answer
	$x^3 - 7x + 6$	A1	
	Additional Guidance		
	For the first two marks terms may be seen in a grid		
	If an attempt at the expansion of all three brackets is made in one go it must be fully correct to gain M2A1, otherwise M0		
	Ignore equating to zero or solving an equation		
20	The boys have a smaller interquartile range	B1	

Q	Answer	Mark	Comments
21	$3 \times -\frac{1}{4}x^2$ or $-\frac{3}{4}x^2$	M1	oe
	Substitutes -2 into their $-\frac{3}{4}x^2$ or $-\frac{3}{4} \times (-2)^2$	M1	oe their gradient function must be of the form $(10) \pm ax^2$
	-3	A1	
	Additional Guidance		
	Do not ignore further working after -3 eg answer line is from $x = -3$ substituted back into the equation of the curve		
22	Fully correct enlargement	B2	B1 triangle with correct size and orientation in an incorrect position or triangle with two vertices in correct position or three correct vertices plotted but not joined
	Additional Guidance		
			B2

Q	Answer	Mark	Comments
23	$y(1-x) = 3x + 2$	M1	
	$y - xy = 3x + 2$	M1dep	
	$3x + xy = y - 2$ or $x(3 + y) = y - 2$ or $-xy - 3x = 2 - y$ or $x(-y - 3) = 2 - y$ or $\frac{y-2}{3+y}$ or $\frac{2-y}{-y-3}$	M1dep	oe isolating x terms
	$x = \frac{y-2}{3+y}$ or $x = \frac{2-y}{-y-3}$	A1	oe
	Additional Guidance		
	Must have $x =$ or $= x$ but allow this to be in the working eg $\frac{y-2}{3+y}$ on answer line but $x = \frac{y-2}{3+y}$ in working		M1M1M1A1
24	$\sqrt{100 \times 3} = 10\sqrt{3}$ or $\sqrt{100} \times \sqrt{3} = 10\sqrt{3}$ or $\sqrt{10 \times 10 \times 3} = 10\sqrt{3}$ or $\sqrt{10^2 \times 3} = 10\sqrt{3}$ or $10\sqrt{3} \times 10\sqrt{3} = 100 \times 3 = 300$	B1	
	Additional Guidance		
	$\sqrt{(2 \times 2 \times 3 \times 5 \times 5)}$ followed by $2 \times 5 \times \sqrt{3} = 10\sqrt{3}$		B1
	$\sqrt{(2 \times 2 \times 3 \times 5 \times 5)}$ without $2 \times 5 \times \sqrt{3} = 10\sqrt{3}$		B0

Q	Answer	Mark	Comments
25	$(8^{\frac{1}{3}} =) 2$ or $(2^3)^{\frac{1}{3}}$	M1	may be implied by eg 2×2^5 or 4×2^4
	$(4 \times 2^5 =)$ $2^2 \times 2^5$ or 2^{2+5} or 2^7 or 128	M1	2^{2+5-1} implies M1M1 64 implies M1M1 $\frac{4 \times 2^5}{2} = 2 \times 2^5$ implies M1M1
	2^6	A1	with correct method seen
	Additional Guidance		
	$64 = 2^6$		M1M1A1
	$8^{\frac{1}{3}} = 2$ $2^7 - 2 = 2^6$		M1M1A0
	4×2^4 and $2^2 \times 2^4$ implies M1M1		M1M1

Q	Answer	Mark	Comments
26	$A = (4, 0)$ and $B = (0, 3)$	B1	may be implied by numbers on the axes or implied by later working
	Gradient $AB = \frac{\text{their } 3 - 0}{0 - \text{their } 4}$ or $-\frac{3}{4}$ or $y = -\frac{3}{4}x \dots$	M1	may be implied by gradient of perpendicular
	Grad perp = $\frac{-1}{\text{their gradient of } AB}$ or $-\frac{1}{-\frac{3}{4}}$ or $\frac{4}{3}$ or 1.33(...)	M1	
	Midpoint $AB =$ $\left[\left(\frac{\text{their } 4 + 0}{2} \right), \left(\frac{0 + \text{their } 3}{2} \right) \right]$ or $(2, 1\frac{1}{2})$	M1	ft their A and B
	$y - \text{their } 1\frac{1}{2} = \text{their } \frac{4}{3}(x - \text{their } 2)$ or $\text{their } 1\frac{1}{2} = \frac{4}{3} \times \text{their } 2 + c$ or $c = -\frac{7}{6}$ or $-1.16(\dots)$ or -1.17	M1dep	dep on previous two method marks
	$y = \frac{4}{3}x - \frac{7}{6}$	A1	oe in the form $y = mx + c$
	Additional Guidance		
	Accept 1.33(...) for m and $-1.16(\dots)$ or -1.17 for c in final answer		

Q	Answer	Mark	Comments
27	$x = -3$	B1	
28(a)	Opposite angles of a cyclic quadrilateral sum to 180°	B1	oe
	Additional Guidance		
	Ignore irrelevant statements but do not accept incorrect statements alongside a correct statement		
	Do not accept polygon for $PQRS$ unless there is a reference to four sides		
	Do not accept an incorrect name (eg rectangle, pentagon, etc) for $PQRS$		
	If a geometrical proof is given it must have full reasoning for each stage		
	References to all the vertices being on the circle		B1

Q	Answer	Mark	Comments
28(b)	Alternative method 1		
	A correct expression for any angle not given in the question in terms of x or y or both or a correct equation using angles not given in the question in terms of x or y or both	M1	eg angle $BPQ = y - x$ angle $APS = 180 - x - y$ angle $BRS = 180 - x - y$ angle $BQP = 180 - y$ angle $ASP = y$ $y = \text{angle } BPQ + x$ angle $QRA + x + y = 180$
	A correct single equation in x or y or both which would lead to the solution $y = 90$ or two or more equations in x and y which taken together by eliminating unknowns would lead to the solution $y = 90$	M1dep	working for M1 needs to be seen equation(s) needs to be established equation(s) need not be simplified
	$y = 90$	A1	
	Correct reasons given for all stages of working	A1	
	Alternative method 2 – triangles BPQ and APS and cyclic quadrilateral		
	A, B, Q, S are concyclic points	M1	using angle $SBR = \text{angle } RAQ$ (angles in the same segment)
	Angle $ASP = \text{angle } BQP$ and $180 - y = y$ or $2y = 180$	M1dep	using angles in the same segment
	$y = 90$	A1	
	Correct reasons given for all stages of working	A1	

Additional Guidance continues on the next page

Q	Answer	Mark	Comments
28(b) cont	Additional Guidance		
	Angles marked on diagram alone are not sufficient for M1		
	Throughout, expressions and equations may be in terms of x , y or angle notation or both eg angle $BPQ = \text{angle } PQR - \text{angle } PBQ$ is equivalent to angle $BPQ = y - x$		
	Accept A for the angle at A and B for the angle at B but other angles must be specified by three letters eg PSR		
	Acceptable reasons include Angles on a straight line Vertically opposite angles Angle sum of triangle Exterior angle of a triangle Exterior angle of a cyclic quadrilateral Similar triangles Angle in a semicircle		
	Condone the word 'angle' or angle symbol missing, eg APS instead of angle APS		
	Angle $PSR = 180 - y$ does not count in awarding M1 since it is given in (a)		
	$y = 90$ with no correct supporting working		M0
	Arguments which rely on $PQRS$ being a kite or distances being equal		M0
	$180 - y = y$ with no other relevant working to establish the equation		M0M0
	Angle $APS = \text{angle } BPQ$ with no other relevant working		M0

Additional Guidance continues on the next page

Q	Answer	Mark	Comments
29	Alternative method 1		
	$\frac{BT}{\sin 32} = \frac{50}{\sin(46 - 32)}$	M1	
	$BT = \frac{50 \times \sin 32}{\sin(\text{their}14)}$ or 109.5... or 110	M1dep	
	$\sin 46 = \frac{CT}{\text{their}BT}$	M1dep	
	$CT = \text{their}BT \times \sin 46$	M1dep	
	[78.7, 78.8]	A1	
	Alternative method 2		
	$\frac{AT}{\sin(180 - 46)} = \frac{50}{\sin(46 - 32)}$	M1	
	$AT = \frac{50 \times \sin(\text{their}134)}{\sin(\text{their}14)}$ or 148.67... or 149	M1dep	
	$\sin 32 = \frac{CT}{\text{their}AT}$	M1dep	
	$CT = \text{their}AT \times \sin 32$	M1dep	
	[78.7, 78.8]	A1	

Alternative method and Additional Guidance continues on the next page

Q	Answer	Mark	Comments
29 cont	Alternative method 3		
	$\tan 46 = \frac{h}{x}$ or $\tan(90 - 46) = \frac{x}{h}$	M1	$BC = x$ and $CT = h$ (any letters) oe
	$\tan 32 = \frac{h}{x + 50}$ or $\tan(90 - 32) = \frac{x + 50}{h}$	M1	oe
	Eliminates either x or h	M1dep	eg $(x + 50)\tan 32 = h$ and $\left(\frac{h}{\tan 46} + 50\right)\tan 32 = h$ or $(x + 50)\tan 32 = x \tan 46$
	$50 = h\left(\frac{1}{\tan 32} - \frac{1}{\tan 46}\right)$ or $50 \tan 32 = x(\tan 46 - \tan 32)$ or $x = 76.08\dots$	M1dep	oe equation with h or x terms collected eg $50 = h(\tan 58 - \tan 44)$ accept $x = [76.0, 76.1]$
	[78.7, 78.8]	A1	
	Additional Guidance		
	The fourth method mark may be implied by a correct evaluation using their rounded trigonometric values eg in alt 4, using $\tan 32 = 0.62$ and $\tan 46 = 1.04$ $50 \times 0.62 + 0.62x = 1.04x$ (with $31 = 0.42x$ not seen) followed by $x = 73.8\dots$ or 73.81		M1M1M1M1
	78 from $32 + 46$		M0

Q	Answer	Mark	Comments
30	Alternative method 1		
	$\frac{8}{13} \times \frac{7}{12}$ or $\frac{56}{156}$ or $\frac{5}{13} \times \frac{4}{12}$ or $\frac{20}{156}$	M1	oe fraction, decimal or percentage
	$\frac{8}{13} \times \frac{7}{12} + \frac{5}{13} \times \frac{4}{12}$	M1dep	oe fraction, decimal or percentage
	$\frac{19}{39}$ or 0.487(...) or 0.49 or 48.7(...) % or 49%	A1	oe fraction
	Alternative method 2		
	$\frac{8}{13} \times \frac{5}{12}$ or $\frac{5}{13} \times \frac{8}{12}$ or $\frac{40}{156}$	M1	oe fraction, decimal or percentage
	$1 - \frac{8}{13} \times \frac{5}{12} - \frac{5}{13} \times \frac{8}{12}$	M1dep	oe fraction, decimal or percentage
	$\frac{19}{39}$ or 0.487(...) or 0.49 or 48.7(...) % or 49%	A1	oe fraction
	Additional Guidance		
	Answer $\frac{19}{39}$ seen but then incorrectly converted to a decimal or percentage	M1M1A1	

Q	Answer	Mark	Comments
31	Alternative method 1 Working with 0.648...		
	$(10x =) 6.48(48\dots)$ or $(100x =) 64.84(84\dots)$ or $(1000x =) 648.48(48\dots)$	M1	oe multiplication by a power of 10
	$1000x - 10x = 642$ or $990x = 642$ or $648.48(48\dots) - 6.48(48\dots) = 642$ <div style="text-align: right;">$\text{and } \frac{642}{990}$</div> or $100x - x = 64.2$ or $99x = 64.2$ or $64.84(84\dots) - 0.648(48\dots) = 64.2$ <div style="text-align: right;">$\text{and } \frac{64.2}{99}$</div>	M1dep	oe subtraction to eliminate recurring digits working for M1 must be shown
	$\frac{107}{165}$	A1	working for M2 must be shown

Alternative method and Additional Guidance continues on the next page

Q	Answer	Mark	Comments
31 cont	Alternative method 2 Working with 0.048...		
	$(10x =) 0.48(48\dots)$ or $(100x =) 4.84(84\dots)$ or $(1000x =) 48.48(48\dots)$	M1	oe multiplication by a power of 10
	$1000x - 10x = 48$ or $990x = 48$ or $48.48(48\dots) - 0.48(48\dots) = 48$ and $\frac{48}{990}$ or $100x - x = 4.8$ or $99x = 4.8$ or $4.84(84\dots) - 0.048(48\dots) = 4.8$ and $\frac{4.8}{99}$	M1dep	oe subtraction to eliminate recurring digits working for M1 must be shown
	$\frac{48}{990} + \frac{6}{10} = \frac{107}{165}$ or $\frac{4.8}{99} + \frac{6}{10} = \frac{107}{165}$	A1	working for M2 must be shown accept any equivalent fractions for $\frac{48}{990}$ or $\frac{4.8}{99}$
	Additional Guidance		
	$642 \div 990$ is equivalent to $\frac{642}{990}$ in the second method mark (alt 1)		
	$\frac{107}{165}$ with no working		M0
	$0.048(48\dots) = \frac{48}{990}$ with no working		M0

Q	Answer	Mark	Comments
32	$\frac{1}{3} \times \pi \times 4^2 \times 5$ or $26\frac{2}{3}\pi$ or $\frac{80}{3}\pi$ or [83.7, 83.8]	M1	oe
	$\frac{r}{4} = \frac{3}{5}$ or $3 \times 4 \div 5$ or 2.4	M1	oe
	$\pi \times \text{their } 2.4^2 \times 14$ or $80\frac{16}{25}\pi$ or $\frac{2016}{25}\pi$ or [253.2, 253.4]	M1dep	oe dep on second M mark
	$107\frac{23}{75}\pi$ or $\frac{8048}{75}\pi$ or [336.9, 337.2]	A1	
	Additional Guidance		
	$\frac{1}{3} \times \pi \times 2.4^2 \times 3$ (evaluating the volume of the top cone only)		M0M1

Q	Answer	Mark	Comments
33	Alternative method 1		
	$4x^2 + 8x + 3 = x + 5$	M1	
	$4x^2 + 7x - 2 (= 0)$ or $4x^2 + 7x = 2$	M1dep	
	$(4x - 1)(x + 2) (= 0)$ or $\frac{-7 \pm \sqrt{7^2 - 4 \times 4 \times -2}}{2 \times 4}$ or $-\frac{7}{8} \pm \sqrt{\frac{81}{64}}$	M1	oe from their 3-term quadratic
	$x = \frac{1}{4}, y = 5\frac{1}{4}$ or $x = -2, y = 3$ or $x = -2$ and $x = \frac{1}{4}$	A1	oe
	$(-2, 3)$ and $(\frac{1}{4}, 5\frac{1}{4})$	A1	oe
	Alternative method 2		
	$y = 4(y - 5)^2 + 8(y - 5) + 3$	M1	
	$4y^2 - 33y + 63 (= 0)$ or $4y^2 - 33y = 63$	M1dep	
	$(4y - 21)(y - 3) (= 0)$ $\frac{33 \pm \sqrt{33^2 - 4 \times 4 \times 63}}{2 \times 4}$ or $\frac{33}{8} \pm \sqrt{\frac{81}{64}}$	M1	oe from their 3-term quadratic
	$x = \frac{1}{4}, y = 5\frac{1}{4}$ or $x = -2, y = 3$ or $y = 3$ and $y = 5\frac{1}{4}$	A1	oe
	$(-2, 3)$ and $(\frac{1}{4}, 5\frac{1}{4})$	A1	oe
	Additional Guidance		
	Solving $4x^2 + 8x + 3 = 0$	M0	