OXFORD

INTERNATIONAL
AQA EXAMINATIONS

INTERNATIONAL GCSE
MATHEMATICS EXTENSION
9260/2E

Paper 2E

Mark scheme

June 2019

Version: 1.0 Final

196y9260/2E/MS

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Examiner.

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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 $a \leq$ 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	120°	B1	
2	$27x^6$	B1	
3	$(x + 3)^2 = 0$	B1	
4	reflection in $y = –5$	B1	
5	8 × 7 or 56 or 4 + 10 + 16 + 4 + 9 or 43 or $\frac{4+10+16+4+9+a+b}{7} = 8$	M1	oe
	their 56 – their 43 or 13	M1dep	
	1 and 12 or 2 and 11 or 4 and 9	A1	numbers can be in either order SC2 fulfils 3 of the 4 criteria SC1 fulfils 2 of the 4 criteria
	Additional Guidance		
	Allow non-integer values of a and b for B2 and B1		
	6 and 7		SC2
	4 and 10 (with no working for M2)		SC2
	6.5 and 6.5		SC1
	5 and 9 (with no working for M2) (mode is no longer 4)		SC1

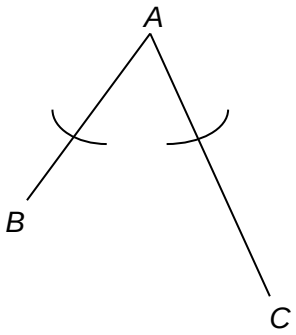
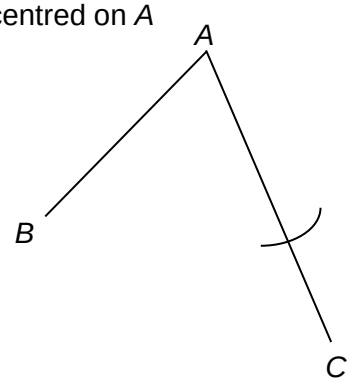
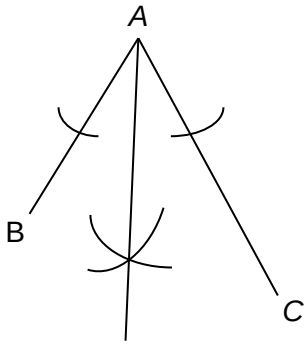
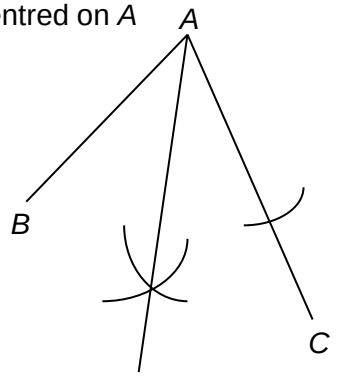
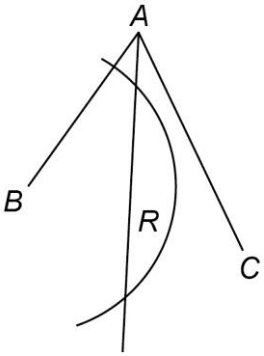
Q	Answer	Mark	Comments
6	**Alternative method 1**		
	$\frac{1}{5}$ × 30 or 6 or $\frac{1}{5}$ × 30 × 2.15 or 12.9(0) or $\frac{4}{5}$ × 30 or 24 or $\frac{4}{5}$ × 30 × 1.8(0) or 43.2(0)	M1	oe
	their 6 × 2.15 + (30 – their 6) × 1.8(0) or their 6 × 2.15 + their 24 × 1.8(0) or 12.9(0) + 43.2(0)	M1dep	oe
	56.1(0)	A1	
	Alternative method 2		
	$\frac{1}{5}$ × 2.15 or 0.43 or $\frac{4}{5}$ × 1.8(0) or 1.44	M1	oe
	(their 0.43 + their 1.44) × 30 or 1.87 × 30	M1dep	oe
	56.1(0)	A1	

Q	Answer	Mark	Comments
7	**Alternative method 1**		
	55 – 40 or 15	M1	
	$\frac{\text{their } 15}{40}(\times 100)$ or 0.375 (× 100)	M1dep	
	37.5	A1	
	Alternative method 2		
	$\frac{55}{40}$ (×100) or 137.5 or 1.375	M1	
	their 1.375 – 1 or their (1.375 – 1) × 100 or 0.375 (× 100) or their 137.5 – 100	M1dep	
	37.5	A1	

Q	Answer	Mark	Comments
8	(x =) 42	B1	
	8 ÷ 20 or 0.4 or $\frac{2}{5}$ or 20 ÷ 8 or 2.5 or $\frac{5}{2}$ or 25 ÷ 20 or 1.25 or $\frac{5}{4}$ or 20 ÷ 25 or 0.8 or $\frac{4}{5}$ or 25 × 8 ÷ 20	M1	oe
	(y =) 10	A1	
	Additional Guidance		
	Angle only of 105 implies correct scale factor		B0M1A0

9(a)	$3n - 13$	B1	

Q	Answer	Mark	Comments
9(b)	**Alternative method 1**		
	a and a + 8 or b and b – 8	M1	may choose any letter
	a + a + 8 = 130 or b + b – 8 = 130	M1dep	oe equation
	61 and 69	A1	
	Alternative method 2		
	130 – 8 or 122 or 130 + 8 or 138	M1	
	their 122 ÷ 2 or 61 or their 138 ÷ 2 or 69	M1dep	
	61 and 69	A1	
	Alternative method 3		
	$8n + 5 + 8(n + 1) + 5 = 130$ or $16n + 18 = 130$	M1	oe
	$n = 7$ and $8 \times 7 + 5$ or 61 or $n = 7$ and $n = 8$	M1dep	
	61 and 69	A1	
	Additional Guidance		
	Accept numbers in either order		

Q	Answer	Mark	Comments
10	Two arcs with the same radius, centred on *A* intersecting *AB* and *AC* 	M1	tolerance $\pm$ 2 mm may be seen as one arc on *AC* of radius *AB* centred on *A* 
	Construction with all arcs shown in tolerance 	A1	tolerance $\pm$ 2 mm may be seen as one arc on *AC* of radius *AB* centred on *A* 
	Construct arc, centre *B*, radius 4 cm	B1	tolerance $\pm$ 2 mm
	Correct region with label 	B1ft	angle bisector must be a straight line coming from A arc must be centred on B accept unambiguous indication of their closed region eg shading

Q	Answer	Mark	Comments
11(a)	$6 \leqslant h < 8$	B1	accept any unambiguous indication eg 6 to 8 or 6 – 8
	Additional Guidance		
	A single value answer eg 6.(…) or 7 or 7.(…)		B0
11(b)	7500 ÷ 250 or 30 or 0.08 (× 7500) or $\frac{20}{250}(\times 7500)$ or $\frac{250}{7500} = \frac{20}{x}$	M1	oe implied by 8%
	600	A1	
12	0.5 × h × (8 + 14) or 0.5 × (14 – 8) × h + 8 × h or 3h + 8h or 11h	M1	oe
	55 ÷ (8 + 14) × 2 or 55 ÷ 11 or 5	M1dep	oe may be seen on diagram
	15	A1	
	Additional Guidance		
	NB 55 ÷ 22 = 2.5, h = 2.5, answer 15		M0M0A0

Q	Answer	Mark	Comments
13	**Alternative method 1**		
	810 – 442 or 368	M1	mass used
	their 368 ÷ 4 or 92 or their 368 ÷ 4 × 5 or 460	M1dep	mass per 100 ml of oil oe
	442 – their 92 or 810 – 5 × their 92 or 810 – their 460	M1dep	dep on M2
	350	A1	
	Alternative method 2		
	810 – 442 or 368	M1	mass used
	their 368 ÷ 400 or 0.92	M1dep	mass per ml of oil
	442 – 100 × their 0.92 or 810 – 500 × their 0.92	M1dep	
	350	A1	
	Alternative method 3		
	$500x + y = 810$ and $100x + y = 442$	M1	correct pair of equations
	$500x - 100x = 810 – 442$ or $x = 0.92$	M1dep	correct method to eliminate one variable
	substitutes their 0.92 correctly in one of the original pair of equations	M1dep	dep on M2
	350	A1	

Alternative methods 4 and 5 and Additional Guidance continued on next page

Q	Answer	Mark	Comments
13 cont	**Alternative method 4**		
	500x + y = 810 and 100x + y = 442	M1	correct pair of equations
	correct equations with equal coefficients of y eg 500x + y = 810 and 500x + 5y = 2210	M1dep	
	Correctly eliminates one variable eg 5 y – y = 2210 - 810	M1dep	dep on M2
	350	A1	
	Alternative method 5		
	$\frac{810-m}{5} = 442 - m$	M1	
	(810 – m) = 5(442 – m)	M1dep	
	5m - m = 2210 - 810	M1dep	dep on M2
	350	A1	
	Additional Guidance		
	Follow schemes as set out for 5 instead of 500 and 1 instead of 100 with the appropriate change in subsequent values		

Q	Answer	Mark	Comments
14(a)	$A' \cap B$	B1	
14(b)	5, 6, 8 and 9 only	B2	B1 two correct and no incorrect values or three correct with 0 or 1 incorrect values or four correct with 0, 1 or 2 incorrect values

15	**Alternative method 1**		
	$11 = 2(4) + c$ or $c = 3$	M1	oe
	$y = 2x + 3$	A1	oe
	Alternative method 2		
	$2 = \frac{y - 11}{x - 4}$	M1	oe eg $y - 11 = 2(x - 4)$
	$y = 2x + 3$	A1	oe
	Additional Guidance		
	Accept equivalent equations in 3 terms eg $y - 2x = 3$		

Q	Answer	Mark	Comments
16	$4(x + 2) + 5(x - 3)$	M1	ignore denominators
	$4x + 8 + 5x - 15$ or $9x - 7$	M1dep	allow one error
	their $(4x + 8)$ + their $(5x - 15) = 10 \times 5 \times 4$ or $9x - 7 = 200$ or $9x = 207$	M1dep	collects their terms oe equation
	23	A1	
17	$18^2 \times \pi \times \frac{60}{360}$ or [169.56, 169.7]	M1	oe allow [3.14, 3.142] for π
	54π	A1	
18	$\begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$	B1	

Q	Answer	Mark	Comments
19	**Alternative method 1**		
	x^2	M1	
	$6 \times 4 - x^2$ or $24 - x^2$	M1	
	x^2 = their $(24 - x^2)$ or $2x^2 = 24$ or $x^2 = 12$	M1dep	dep on M2
	$\sqrt{12}$ or $2\sqrt{3}$	A1	oe exact value
	Alternative method 2		
	x^2	M1	
	$(6 \times 4) \div 2$ or 12	M1	
	x^2 = their 12	M1dep	dep on M2
	$\sqrt{12}$ or $2\sqrt{3}$	A1	oe exact value
	Alternative method 3		
	x^2	M1	
	$4(6 - x) + x(4 - x)$ or $6(4 - x) + x(6 - x)$ or $24 - x^2$	M1	
	x^2 = their $(24 - x^2)$ or $2x^2 = 24$ or $x^2 = 12$	M1dep	dep on M2
	$\sqrt{12}$ or $2\sqrt{3}$	A1	oe exact value
	Additional Guidance		
	$\sqrt{12}$ or $2\sqrt{3}$		M3A1
	$\pm 2\sqrt{3}$ or $\pm\sqrt{12}$		M3A0
	Ignore attempts to simplify $\sqrt{12}$ eg $\sqrt{12} = 3\sqrt{2}$		
	Writing $\sqrt{12}$ as a decimal is not an attempt to simplify, 3.464(…)		M3A0

Q	Answer	Mark	Comments
20(a)	$y(x-2) = x+1$	M1	
	$xy - 2y = x + 1$	M1dep	
	$xy - x = 1 + 2y$ or $x(y-1) = 1 + 2y$ or $x - xy = -1 - 2y$ or $x(1-y) = -1 - 2y$ or $\frac{1+2y}{y-1}$ or $\frac{-1-2y}{1-y}$	M1dep	oe isolating x terms
	$x = \frac{1+2y}{y-1}$ or $x = \frac{-1-2y}{1-y}$	A1	oe must have $x =$
20(b)	$3(m+2p)(m-2p)$ or $-3(m+2p)(2p-m)$	B3	B2 $(3m+6p)(m-2p)$ or $(m+2p)(3m-6p)$ or $\left(\sqrt{3}m+\sqrt{12}p\right)\left(\sqrt{3}m-\sqrt{12}p\right)$ or $\left(\sqrt{3}m+2\sqrt{3}p\right)\left(\sqrt{3}m-2\sqrt{3}p\right)$ or $\sqrt{3}(m+2p)\sqrt{3}(m-2p)$ B1 $3(m^2-4p^2)$
	Additional Guidance		
	Condone extra brackets or use of ×		

Q	Answer	Mark	Comments
21	**Alternative method 1**		
	$0.25 = \frac{k}{1360}$	M1	oe
	$(k =)$ 340	A1	
	$0.8 = \frac{\text{their } 340}{f}$	M1dep	oe dep on M1
	425	A1ft	
	Alternative method 2		
	0.8 ÷ 0.25 or 0.25 ÷ 0.8	M1	oe
	3.2 or 0.3125	A1	
	1360 ÷ their 3.2 or 1360 × their 0.3125	M1dep	oe dep on M1
	425	A1ft	
	Additional Guidance		
	$w = \frac{k}{f}$, $w = \frac{1}{f}$ or $w \propto \frac{1}{f}$ not sufficient unless recovered		
22	(10, 7)	B1	

Q	Answer	Mark	Comments
23	**Alternative method 1**		
	OA = *OB*	M1	may be seen on diagram
	Angle *OAP* = angle *OBP* or Angle *OAB* = angle *OBA*	M1	may be seen on diagram do not accept angle *AOP* = angle *BOP*
	AP = *PB* (given) and △s *OAP* and *OBP* congruent (≅) and angle *OPA* = angle *OPB* = 90°	A1	
	Reasons for each statement: ie radii isosceles triangle SAS Angles on a straight line or bisector of a chord	A1	
	Alternative method 2		
	OA = *OB*	M1	may be seen on diagram
	OP is common	M1	may be seen on diagram
	AP = *PB* (given) and △s *OAP* and *OBP* congruent (≅) and angle *OPA* = angle *OPB* = 90°	A1	
	Reasons for each statement: ie radii OP is a common length SSS Angles on a straight line or bisector of a chord	A1	

Q	Answer	Mark	Comments
24	$9 \times 4 : 5 \times 4$ or $36 : 20$ and $4 \times 5 : 7 \times 5$ or $20 : 35$	M1	oe common value for QR eg $36 : 20 : 35$ or $1 : \frac{5}{9} : \frac{5}{9} \times \frac{7}{4}$ or $n : \frac{5n}{9} : \frac{35n}{36}$
	(their 36 + their 20) : their 35 or $56 : 35$	M1dep	oe ratio eg $\frac{14n}{9} : \frac{35n}{36}$
	$8 : 5$	A1	
	Additional Guidance		
	Accept fractions or decimals within a ratio for M2		

25(a)	$2n + 2$ or $2(n + 1)$	B1	

Q	Answer	Mark	Comments
25(b)	$(2n + 2)^2 – (2n)^2$	M1	oe
	$4n^2 + 4n + 4n + 4 – 4n^2$ or $8n + 4$ or $(2n + 2 – 2n)(2n + 2 + 2n)$ or $2(4n + 2)$	M1dep	oe allow one error in the expansion
	$4(2n + 1)$ and $2n + 1$ is odd or valid reason why $8n + 4$ is an odd multiple of 4	A1	
	Additional Guidance		
	If expansion is in a table the middle terms must be added		
	$8n + 4$ divided by 4 to give $2n + 1$ and $2n + 1$ is odd		M1M1A1
	$8n + 4$ followed by 8 (or $8n$) and 4 are multiples of 4		M1M1A0
	$8n + 4$ on its own		M1M1A0
	$2n + 2^2 – 2n^2$ unless recovered		M0
	$2(n + 1)^2 – 2n^2$ unless recovered		M0

Q	Answer	Mark	Comments
26	2nd expression: $18+2x^2-9x-x^3$	M1	allow one error or omission
	1st term: any pair of brackets multiplied correctly	M1	$(x+1)(x+3)=x^2+x+3x+3$ or $(x-6)(x+1)=x^2-6x+x-6$ or $(x-6)(x+3)=x^2-6x+3x-18$ oe
	Multiply by remaining bracket correctly	M1dep	dep on second M1 allow one error or omission $(x-6)(x^2+x+3x+3)=$ $x^3+x^2+3x^2+3x-6x^2-6x-18x-18$ or $(x+3)(x^2-6x+x-6)=$ $x^3-6x^2+x^2-6x+3x^2-18x+3x-18$ or $(x+1)(x^2-6x+3x-18)=$ $x^3-6x^2+3x^2-18x+x^2-6x+3x-18$ or $x^3-2x^2-21x-18$ oe
	$-30x$	A1	
	Additional Guidance		
	Terms may be crossed out as part of the working		
27	$\sqrt{2}\sqrt{6}+7\sqrt{3}+\sqrt{3}\sqrt{6}+7\sqrt{2}$	M1	oe correct expansion of brackets showing all 4 terms
	$2\sqrt{3}$ or $3\sqrt{2}$	M1	correct simplification of $\sqrt{2}\sqrt{6}$ or $\sqrt{3}\sqrt{6}$
	$10\sqrt{2}+9\sqrt{3}$	A1	with full method seen
	Additional Guidance		
	Accept a = 10 and b = 9 with full working shown		

Q	Answer	Mark	Comments
28(a)	**Alternative method 1**		
	$-\mathbf{a}-\mathbf{a}+\mathbf{b}+\mathbf{b}+2\mathbf{a}+2\mathbf{a}$ $(=2\mathbf{a}+2\mathbf{b})$	M1	oe
	$\frac{1}{2}(2\mathbf{a}+2\mathbf{b})=\mathbf{a}+\mathbf{b}$	A1	
	Alternative method 2		
	$\overrightarrow{SQ}=3\mathbf{a}$	M1	oe $\overrightarrow{SQ}$ need not be explicitly stated
	$-2\mathbf{a}+\mathbf{b}+3\mathbf{a}=\mathbf{a}+\mathbf{b}$	A1	
	Additional Guidance		
	A proof using only vectors written in vertex form can only score M1		
28(b)	**Alternative method 1**		
	$\overrightarrow{SR}=2\mathbf{a}+\mathbf{b}$	B1	oe
	$\overrightarrow{PQ}=\mathbf{a}+\mathbf{a}+\mathbf{b}=2\mathbf{a}+\mathbf{b}$	B1	oe using $\overrightarrow{PX}$ and $\overrightarrow{XQ}$
	Alternative method 2		
	$\overrightarrow{SR}=2\mathbf{a}+\mathbf{b}$	B1	
	$\overrightarrow{PQ}=-\mathbf{a}+\mathbf{b}+3\mathbf{a}=2\mathbf{a}+\mathbf{b}$ or $\overrightarrow{PQ}=-\mathbf{a}+2\mathbf{b}+4\mathbf{a}-(\mathbf{a}+\mathbf{b})=2\mathbf{a}+\mathbf{b}$	B1	oe using $\overrightarrow{PW}+\overrightarrow{WS}+\overrightarrow{SQ}$ oe using $\overrightarrow{PW}+\overrightarrow{WZ}+\overrightarrow{ZY}+\overrightarrow{YQ}$
	Additional Guidance		
	Full working for PQ must be seen, not just $\overrightarrow{PQ}=2\mathbf{a}+\mathbf{b}$		

Q	Answer	Mark	Comments
28(c)	**Alternative method 1**		
	parallelogram and *PQ* is parallel to *SR* and *PQ* = *SR*	B2	B1 Parallelogram and one reason
	Alternative method 2		
	parallelogram and If you join the midpoints of a quadrilateral/trapezium you will get a parallelogram	B2	
	Additional Guidance		
	$\overrightarrow{PQ} = \overrightarrow{SR}$ needs to be interpreted geometrically without vector notation		
	Reasons may also refer to *PS* and *QR*		
	Parallelogram because opposite sides are parallel and equal		B1B1
	Parallelogram because PQ is parallel to SR and SP is parallel to RQ		B1B1
	Parallelogram because PQ = SR and SP = RQ		B1B1
	Parallelogram because $\overrightarrow{PQ} = \overrightarrow{SR}$		B1B0
	Parallelogram because *PQ* and *SR* are parallel and $\overrightarrow{PQ} = \overrightarrow{SR}$		B1B0

Q	Answer	Mark	Comments
29	$\left(2^3\right)^{\frac{2}{3}}$ or 2^2 or 4 or 2^5 or 0.125 or $32 = 8^{\frac{5}{3}}$	M1	
	$\frac{\left(2^3\right)^{\frac{2}{3}}}{2^5}$ or $\frac{2^2}{2^5}$ or $\frac{4}{32}$ or $\frac{1}{8}$ or 8^{-1}	M1dep	
	2^{-3}	A1	with full method seen
	Additional Guidance		
	Ignore incorrect evaluation of 2^{-3}		
	$\frac{4}{32}$ then 2^{-3}		M1M1A1

30	$\frac{27}{64} = k^3$ or $\sqrt[3]{\frac{27}{64}}$	M1	oe
	$\frac{3}{4}$	A1	oe

Q	Answer	Mark	Comments
31	**Alternative method 1**		
	Any **one** of (1st red) $\frac{2}{10}$ and (2nd red) $\frac{8}{10}\times\frac{2}{9}$ or $\frac{8}{45}$ and (3rd red) $\frac{8}{10}\times\frac{7}{9}\times\frac{2}{8}$ or $\frac{7}{45}$	M1	oe accept $0.\dot{2}$ or 0.22 for $\frac{2}{9}$ accept $0.1\dot{7}$ or 0.18 for $\frac{8}{45}$ accept $0.\dot{7}$ or 0.78 for $\frac{7}{9}$ accept $0.1\dot{5}$ or 0.16 for $\frac{7}{45}$
	Any **two** of (1st red) $\frac{2}{10}$ and (2nd red) $\frac{8}{10}\times\frac{2}{9}$ or $\frac{8}{45}$ and (3rd red) $\frac{8}{10}\times\frac{7}{9}\times\frac{2}{8}$ or $\frac{7}{45}$	M1dep	
	$\frac{2}{10}+\frac{8}{10}\times\frac{2}{9}+\frac{8}{10}\times\frac{7}{9}\times\frac{2}{8}$ or $\frac{1}{5}+\frac{8}{45}+\frac{7}{45}$	M1dep	
	$\frac{8}{15}$ or $0.5\dot{3}$ or 0.53	A1	oe

Alternative method and Additional guidance continued on the next page

Q	Answer	Mark	Comments
31	**Alternative method 2**		
	(1st blue) $\frac{8}{10}$	M1	oe
	(1st two blue) $\frac{8}{10}\times\frac{7}{9}$ or $\frac{28}{45}$	M1dep	oe accept $0.\dot{7}$ or 0.78 for $\frac{7}{9}$ accept $0.6\dot{2}$ or 0.62 for $\frac{28}{45}$
	$1-\frac{8}{10}\times\frac{7}{9}\times\frac{6}{8}$ or $1-\frac{7}{15}$	M1dep	oe accept $0.\dot{7}$ or 0.78 for $\frac{7}{9}$ accept $0.4\dot{6}$ or 0.47 for $\frac{7}{15}$
	$\frac{8}{15}$ or $0.5\dot{3}$ or 0.53	A1	oe
	Additional Guidance		
	Do not accept probability given as a ratio even if seen correctly in working		

Q	Answer	Mark	Comments
32	$3x^2$ or (–) $18x$	M1	
	their $3x^2 - 18x = 0$	M1dep	ft their derivative provided there are at least two terms, at least one of which is correct
	$3x(x - 6) = 0$ or correct substitution into quadratic formula or correct method using completing the square	M1dep	oe ft their quadratic equation of 2 or more terms
	(0, 24) and (6, –84)	A2	A1 one correct point or $x = 0$ and $x = 6$
	Additional Guidance		
	Ignore any working determining the nature of the stationary points		
	Do not award A2 if additional points are given		
	Eg Differentiates to get $3x^2 - 18x + 24$ $3x^2 - 18x + 24 = 0$ $(x - 2)(x - 4) = 0$		M1 M1M1A0
	Eg $3x^2 - 18x = 0$ $3x^2 = 18x$ $x = 6$ (6, –84) only		M1M1 M0A1
	Eg $3x^2 - 9x + 24$ $3x^2 - 9x + 24 = 0$ Correct substitution into quadratic formula Cannot progress further since the roots are not real		M1 M1 M1A0