Pearson Edexcel

Mark Scheme (Results)

January 2021

Pearson Edexcel International GCSE
In Mathematics B (4MB1)
Paper 02R

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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 the final answer is wrong 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, then award the lowest mark, unless the subsequent working makes clear the method that has been used.

  If there is no answer achieved then check the working for any marks appropriate from the mark scheme.

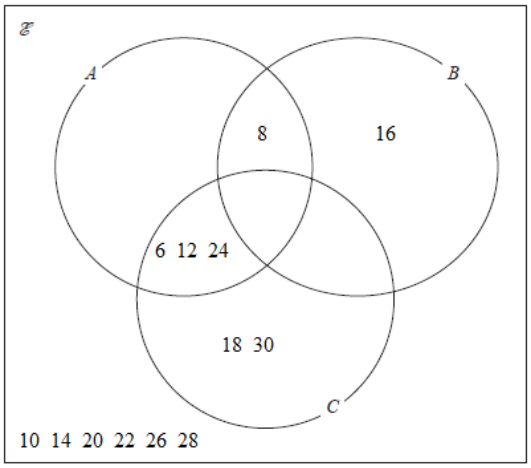
- **Ignoring subsequent work**

  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: e.g. 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 e.g. algebra.

  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.

Question		Working	Answer	Mark	Notes
1	(a)		Correct Venn diagram	3	B3 all regions (including empty regions) correct B2 for at least three (non-empty) regions correct, B1 for two (non-empty) regions correct Repeated values do not gain additional penalties (eg. if region $A \cap B \cap C'$ contains 8 and region $A' \cap B \cap C'$ contains 8 and 16. The first would be considered correct and the second incorrect)
	(b)		6, 12, 24	1	B1 correct or ft their Venn diagram – accept in any brackets eg. {6,12,24}
	(c)		10, 14, 20, 22, 26, 28	1	B1 correct or ft their Venn diagram – accept in any brackets eg, {10, 14, 20, 22, 26, 28}
	(d)		8	1	B1 correct or ft their Venn diagram **SC** (d) 10,14,18,20,22,26,28,30 (e) 6,8,12,18,24,30 ft their Venn diagram scores B0B1
	(e)		6	1	B1 correct or ft their Venn diagram
	(f)	$\frac{2}{\text{their } n}$			M1 where n is 13 or the number of elements in their $\mathcal{E}$, may be seen in working
			$\frac{2}{13}$	2	A1 oe cao
					Total 9 marks

2	(a)	675×1.2 or $675 + 0.2 \times 675$			M1 complete method to increase by 20%
			($)810	2	A1
	(b)	$\frac{19}{19+16}\times385$			M1 oe e.g. $\frac{385}{19+16}\times19$
			209	2	A1
	(c)	$"209"\times8.50+(385-"209")\times4.50$			M1
			($)2568.50	2	A1 allow ($)2568.5
	(d)	$\frac{"2568.50"-2\times"675"}{2\times"675"}\times100$ or $\frac{"2568.50"}{2\times"675"}\times100-100$			M1 complete method to find % profit.
			90.3(%)	2	A1 allow awrt 90.3
					Total 8 marks

3	(a)		1.36, –0.27, 2.23	2	B2 awrt. Penalise rounding to 1dp once only. (–1eeoo)
	(b)	Plots 9 points with at least 6 correct ± 1 small square		3	M1 Attempts to plot the 9 points with at least 6 correct ±1 small square. (Allow if curve goes through the points)
		Draws a smooth curve through at least 6 points			M1 drawing a smooth curve through at least 6 of their points. Do not allow if they use straight lines. Allow ±1 small square from their point.
			Fully correct curve		A1 A fully correct curve. All Points plotted correctly with a smooth curve through all the points.
	(c)		–0.36 to – 0.55	1	B1ft (answer must be consistent with their graph) Condone value given as a coordinate with an x ordinate of $-1.4 \leq x < -1.2$
					Total 6 marks

4	(a)		$\frac{1}{3}$	1	B1 (oe e.g. $\frac{2}{6}$) Accept 0.33 or better
	(b)	$\frac{4}{6}\times\frac{3}{5}$		2	M1
			$\frac{2}{5}$		A1 (oe)
	(c)	$2\left(\frac{1}{6}\times\frac{1}{5}\right)+2\left(\frac{2}{6}\times\frac{1}{5}\right)$		2	M1
			$\frac{1}{5}$		A1 (oe)
		SC $2\left(\frac{1}{6}\times\frac{1}{6}\right)+2\left(\frac{2}{6}\times\frac{1}{6}\right)$ $\left(=\frac{6}{36}\right)$			B1
	(d)	$\frac{2}{6}+\left(\frac{4}{6}\times\frac{2}{5}\right)+\left(\frac{4}{6}\times\frac{3}{5}\times\frac{2}{4}\right)$ or $1-\left(\frac{4}{6}\times\frac{3}{5}\times\frac{2}{4}\times\frac{2}{3}\right)-\left(\frac{4}{6}\times\frac{3}{5}\times\frac{2}{4}\times\frac{1}{3}\right)$ or $1-\frac{4}{6}\times\frac{3}{5}\times\frac{2}{4}$		2	M1 Allow $\frac{2}{6}+\frac{4}{15}+\frac{1}{5}$ or $1-\frac{2}{15}-\frac{1}{15}$ or $1-\frac{1}{5}$ for this mark
			$\frac{4}{5}$		A1 (oe)
	(e)	$\frac{2+4+4+7+9+10+x}{7}=8$		2	M1 (oe)
			20		A1
					Total 9 marks

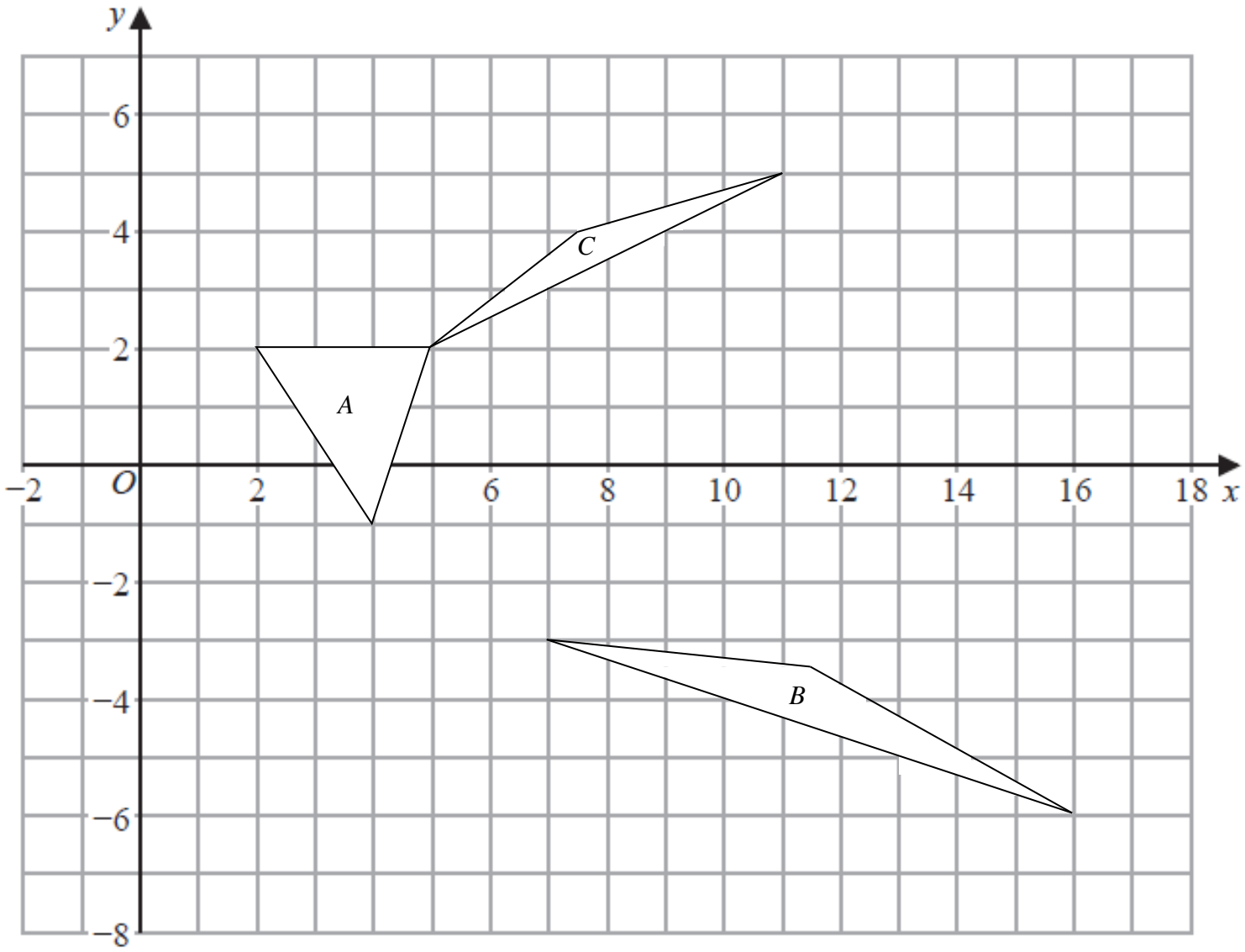
5	(a)	$BD^2 = 10.6^2 + 9.2^2 - 2(10.6)(9.2)\cos 65$			M1 Any correct method to find *BD* or BD^2 allow once a correct equation in *BD* is formed
			10.7 (cm)	2	A1 awrt 10.7
	(b)		**Opp**osite **angles** in a **cyclic quad**rilateral sum to 180°	1	B1 (minimum reasoning shown in bold)
	(c)	$\frac{BC}{\sin 31} = \frac{"10.7"}{\sin 115}$			M1 Any correct method to find *BC* allow once a correct equation in *BC* is formed
			6.08 (cm)	2	A1 awrt 6.08
	(d)	Area of $\Delta BDC = \frac{1}{2} \times "10.7" \times "6.08" \sin 34 (= 18.2)$			M1 Any correct method to find area of ΔBDC
		Height of $\Delta BDE, h = \frac{0.5 \times "10.7"}{\tan 32.5} (= 8.40)$ or $\frac{"10.7"}{\sin 65} = \frac{BE}{\sin 57.5}$ Or $"10.7"^2 = BE^2 + BE^2 - 2 \times BE \times BE \times \cos 65$			M1 Any correct method to find the height of ΔBDE or *BE* or *DE* (*BE* = *DE* = 9.96)
		Area of $\Delta BDE = \frac{1}{2} \times "10.7" \times "8.40"$ or Area of $\Delta BDE = \frac{1}{2} \times ("9.96")^2 \times \sin 65$			M1dep (dependent on previous M mark) using their *h* and *BD* or their *BE* or *DE* (for reference: = 44.960…)
			63.2 (cm^2)	4	A1 awrt 63.1 or 63.2
					Total 9 marks

6	(a)(i)		7		B1
	(ii)		-2	2	B1
	(b)		$\mathrm{g}(x) \geq -2$	1	B1 Accept $y \geq -2$, $\mathrm{g} \geq -2$, $[-2,\infty)$ or $[-2,\infty[$
	(c)		$(3x+1)^2 - 2$	1	B1 oe ISW if expanded
	(d)	$2x-1 = x+3$			M1 Correct equation with fraction removed
			$x = 4$	2	A1
	(e)(i)	$y(x+3) = 2x-1$ or $x(y+3) = 2y-1$ or $y = 2 - \dfrac{7}{x+3}$ or $x = 2 - \dfrac{7}{y+3}$			M1 for removing fraction (oe)
		$x(2-y) = 1+3y$ or $y(2-x) = 1+3x$ or $x+3 = \dfrac{7}{2-y}$ or $y+3 = \dfrac{7}{2-x}$			M1dep for collecting terms in x and factorising allow one slip
			$\left(\mathrm{h}^{-1} : x \mapsto\right) \dfrac{1+3x}{2-x}$		A1 oe (must be in terms of x) Accept $\dfrac{7}{2-x} - 3$
	(ii)		2	4	B1ft – follow through their inverse provided of the form $\dfrac{ax+b}{cx+d}$ or $a + \dfrac{b}{cx+d}$ for non-zero a, b, c and d

	(f)	$\text{fh}^{-1}(1) = \text{f}(4)(=13)$			M1 for correct order of operations to find their $\text{fh}^{-1}(1)$ may be embedded within working
		$3p+1 = \pm\sqrt{\frac{21}{4}}$ or $(p=)\frac{-24\pm\sqrt{24^2-4\times36\times-17}}{2\times36}$			M1dep – correct order of operations to find p or correct formations of quadratic trinomial $(36p^2+24p-17(=0))$ and substitution into a correct formula ft their gf as long as this is a quadratic trinomial (eg. Do not ft gf(x) = $9x^2 - 1$)
			$p=\frac{-2\pm\sqrt{21}}{6}$	3	A1 (oe exact)
					Total 13 marks

7	(a)		Triangle *A* drawn correctly	1	B1 Don't penalise missing labels in any part of this question.
	(b)	$\begin{pmatrix} 3 & \frac{1}{2} \\ -1 & -\frac{1}{2} \end{pmatrix}\begin{pmatrix} 2 & 5 & 4 \\ 2 & 2 & -1 \end{pmatrix}$			M1 for correct matrix multiplication with at least one correct coordinate or two correct coordinates found or one correct coordinate plotted.
			Triangle *B* drawn correctly	2	A1 For reference coordinates are $(7,-3),(16,-6),(11.5,-3.5)$
	(c)	$\begin{pmatrix} \frac{1}{2} & -\frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} \end{pmatrix}\begin{pmatrix} 7 & 16 & 11.5 \\ -3 & -6 & -3.5 \end{pmatrix}$			M1 ft for correct matrix multiplication with at least one correct coordinate or two correct coordinates found or one correct coordinate plotted. (following through their answer to (b))
			Triangle *C* drawn correctly	2	A1 cao For reference coordinates are $(5,2),(11,5),(7.5,4)$
	(d)	$\frac{1}{\left(\frac{1}{2}\right)\left(\frac{1}{2}\right)-\left(\frac{1}{2}\right)\left(-\frac{1}{2}\right)}\begin{pmatrix} \frac{1}{2} & \frac{1}{2} \\ -\frac{1}{2} & \frac{1}{2} \end{pmatrix}$ or 2 equations from each set of 3 $5a + 2b = 7$, $11a + 5b = 16$, $7.5a + 4b = 11.5$ $5c + 2d = -3$, $11c + 5d = -6$, $7.5c + 4d = -3.5$			M1 for attempt at $\mathbf{N}^{-1}$ with either correct determinant or correct elements in 2 by 2 matrix or sufficient linear equations to find the terms of the matrix $\mathbf{N}^{-1}$ seen.
			$\begin{pmatrix} 1 & 1 \\ -1 & 1 \end{pmatrix}$	2	A1 oe do not ISW

	(e)	$\mathbf{Q} = \mathbf{NM} = \begin{pmatrix} \frac{1}{2} & -\frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} \end{pmatrix}\begin{pmatrix} 3 & \frac{1}{2} \\ -1 & -\frac{1}{2} \end{pmatrix}$ or 2 equations from each set of 3 $2a + 2b = 5,\ 5a + 2b = 11,\ 4a - b = 7.5$ $2c + 2d = 2,\ 5c + 2d = 5,\ 4c - d = 4$			M1 Matrix multiplication seen, must be in the correct order or sufficient linear equations to find the terms of the matrix **Q** seen.
			$\begin{pmatrix} 2 & \frac{1}{2} \\ 1 & 0 \end{pmatrix}$	2	A1 oe
					Total 9 marks


y
6
4
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O
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6
8
10
12
14
16
18
x
−2
−4
−6
−8
A
B
C

8	(a)	[Volume of *ACDFGHJK* =] $3x\times 2x\times(x-2)\left[=6x^3-12x^2\right]$ or [Area of *ABC* =] $\frac{1}{2}\times x\times 2x\left[=x^2\right]$ or [Half Area of *ABCJH* =] $\frac{1}{2}\times\ 3x+4x\ \times x\left[=\frac{7}{2}x^2\right]$			M1 correct expression for the volume of *ACDFGHJK* or the area of *ABC* or half the area of *ABCJH*
		[Volume of *ABCDEF* =] $\frac{1}{2}x\times 2x\times(x-2)\left[=x^3-2x^2\right]$ or [Area of *ABCJH* =] $\frac{1}{2}\times x\times 2x+2x\times 3x\left[=7x^2\right]$ or [Area of *ABCJH* =] $2\times\frac{1}{2}\times\ 3x+4x\ \times x\left[=7x^2\right]$			M1 correct expression for the volume of *ABCDEF* or the area of *ABCJH*
		$3x(2x)(x-2)+\frac{1}{2}x(2x)(x-2)=1008$ or $\left(\frac{1}{2}\times x\times 2x+2x\times 3x\right)\times(x-2)=1008$ or $\left(2\times\frac{1}{2}\times\ 3x+4x\ \times x\right\}\times\ x-2\ =1008$			M1 dep on both previous M marks
		$6x^2(x-2)+x^2(x-2)=1008$ $\Rightarrow 6x^3-12x^2+x^3-2x^2=1008$ $\Rightarrow 7x^3-14x^2-1008=0$	$x^3-2x^2-144=0$	4	A1 – note that AG so sufficient working must be shown Must see all M marks and at least additional stage towards the final answer.
	(b)	$6^3-2(6)^2-144$		2	M1 (M0 if long division used)
			$6^3-2(6)^2-144=0$		A1 – must have = 0

	(c)(i)	$(x-6)(x^2+4x+24)$		4	M1 Any two terms of the quadratic correct
		$(x-6)(x^2+4x+24)$	$p = 1$, $q = 4$, $r = 24$		A1 Accept correct quadratic factor given
	(c)(ii)	$(x+2)^2+20=0$ or $(x=)\dfrac{-4\pm\sqrt{4^2-4(1)(24)}}{2}$ or $(\Delta=)4^2-4(1)(24)[=-80]$			M1 for correct first step for solving quadratic for x or considering discriminant. FT their quadratic found in (i)
			$f(x)=0$ has only one solution with a reason why quadratic has no real roots		A1 – note that answer given so sufficient working must be shown Must correctly evaluate discriminant (–80) and refer to sign or correctly show solving involves square rooting a negative.
					Total 10 marks

9		$y = x\left(2x^2 + x - 6\right) = 2x^3 + x^2 - 6x$			M1 for attempt to expand (allow one error)
		Attempt to differentiate			M1 for at least two terms of their y differentiated correctly
		$\frac{\mathrm{d}y}{\mathrm{d}x} = 6x^2 + 2x - 6$			A1
		$"6a^2 + 2a - 6" \geq -2$			M1 dep on first 2 M marks for setting up suitable inequality. Allow > sign rather than $\geqslant$ May be implied by the final method mark.
		$(3a-2)(a+1) \geq 0$ $\Rightarrow$ c.v. $\frac{2}{3}, -1$			M1 indep. attempt to solve their three-term quadratic allow any trinomial inequality or equation seen. Factorising must expand to give two terms of their quadratic. Formula substitution into correct formula attempted (either correct expression seen or correct formula seen and an expression with a maximum of one error seen,)
					M1 for $a \geq b, a \leq c$ with their critical values b, c where $b > c$ (choosing the outside region) Allow > sign rather than $\geqslant$
			$a \geq \frac{2}{3}$ or $a \leq -1$	7	A1 (oe) – condone x for a for full marks
					Total 7 marks

10	(a)(i)		$\frac{1}{2}\mathbf{a}$		B1
	(ii)		$\frac{2}{5}\mathbf{c}$	2	B1
	(b)	$\left(\overrightarrow{OX}=\right)\lambda\left(\mathbf{a}+"\frac{2}{5}\mathbf{c}"\right)$			M1 ft their $\overrightarrow{AD}$
		$\left(\overrightarrow{AX}=\right)\mu\left(\mathbf{c}-\frac{1}{2}\mathbf{a}\right)$			M1 ft their $\dot{CF}$ $\mu\left(\mathbf{c}+\mathbf{a}-"\frac{1}{2}\mathbf{a}"\right)$
		$\left(\overrightarrow{OX}=\right)\mathbf{a}+\mu\left(\mathbf{c}-\frac{1}{2}\mathbf{a}\right)$ or using $\dot{OX}-\dot{AX}=\dot{OA}$ to set up an equation with λ and μ			M1
		$"\lambda\left(\mathbf{a}+\frac{2}{5}\mathbf{c}\right)"="\mathbf{a}+\mu\left(\mathbf{c}-\frac{1}{2}\mathbf{a}\right)"$			M1 oe correct vector equations following through their answers in (a)
		$\lambda=1-\frac{1}{2}\mu$ and $\frac{2}{5}\lambda=\mu$			M1 dep on previous mark for comparing components of **a** and **c**
		$\frac{2}{5}\left(1-\frac{1}{2}\mu\right)=\mu$ or $\lambda=1-\frac{1}{2}\left(\frac{2}{5}\lambda\right)$ oe			M1 for attempt to solve for μ or λ Award for an equation in one variable that follows from their comparison of components.
			$\mu=\frac{1}{3},\lambda=\frac{5}{6}$	7	A1
	(c)	$\dot{OX}=\frac{5}{6}\dot{OD}$	5	1	B1ft using their value of λ Accept 5:1 for the final answer.

	(d)	$\lvert\mathbf{c}\rvert = 12.5 \Rightarrow \lvert\overrightarrow{AD}\rvert = 5$			B1
		Area of $\Delta OAD = \frac{1}{2} \times 12 \times "5" \left[= 30\right]$ or Area of $\Delta ADX = \frac{1}{2} \times "5" \times \left(\frac{1}{6} \times 12\right) \left[= 5\right]$ or $\frac{1}{2} \times \sin\left(\tan^{-1}\left(\frac{6}{12.5}\right)\right) \times "5" \times "\frac{1}{3}" \times \sqrt{6^2 + 12.5^2} \left[= 5\right]$			M1 Correct method to find area of triangle *OAD* or *ADX*
		Area of $\Delta ADX = \left(1 - "\frac{5}{6}"\right) \times "30" \left[= 5\right]$ **and** Area of $\Delta ABF = \frac{1}{2} \times 12.5 \times 6 \left[= 37.5\right]$			M1 Correct method to find area of triangle *ABF* and *ADX*
			32.5 (cm^2)	4	A1
					Total 14 marks

11		[Length of rectangle =]72		6	B1 (May be seen within working)
		[Area of circles =] $6\left(\pi\left(12\right)^2\right)\left[=2714(4\text{sf})\right]$			B1 Accept 864π
		$\sqrt{24^2-12^2}\left[=20.8\right]$ or $\sqrt{48^2-24^2}$ [= 41.6] or 2 × 12 × sin 60 or 4 × 12 × sin 60			M1 for finding the vertical distance between the centres of two circles on adjacent rows or between the top circle and the bottom row
		$2\times12+2\times\text{"}20.8\text{"}\left[=65.6\right]$			M1dep for finding total height of the rectangle oe e.g. $2\left(12\right)+\text{"}41.6\text{"}$ or $24+24\sqrt{3}$
		$\frac{\text{"}2714\text{"}}{\text{"}72\text{"}\times\text{"}65.6\text{"}}\times100$			M1 dep NB 72 × 65.6 = value between 4720 and 4724
			57.5%		A1 AG must see sufficient working to award all method marks their expression must evaluate to awrt 57.5

SC Misread diameter =12cm can gain B0B0M1M1M1A1					
		[Length of rectangle =]36		6	B0
		[Area of circles =] $6\left(\pi\left(6\right)^2\right)\left[=678.6(4\text{sf})\right]$			B0
		$\sqrt{12^2-6^2}$ [= 10.4] or $\sqrt{24^2-12^2}\left[=20.8\right]$ or $2\times6\times\sin 60$ or $4\times6\times\sin 60$			M1 for finding the vertical distance between the centres of two circles on adjacent rows or between the top circle and the bottom row
		$2\times6+2\times\text{"10.4"}\left[=32.8\right]$			M1dep for finding total height of the rectangle oe e.g. $2\left(6\right)+\text{"20.8"}$ or $12+12\sqrt{3}$
		$\frac{\text{"678.6"}}{\text{"36"}\times\text{"32.8"}}\times100$			M1 dep NB 36 × 32.8 = value between 1180 and 1181
			57.5%		A1 AG must see sufficient working to award all method marks their expression must evaluate to awrt 57.5
					Total 6 marks

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