Mark Scheme (Results)

January 2023

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

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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: 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.

  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	$60\times2+3x$ oe		4	M1	Finding the correct total distance travelled as a linear expression in x (possibly implied as part of an expression or equation)
	$\frac{60\times2+3x}{5}=64.2$ oe			M1	Equating their average speed to 64.2. Their average speed must be equivalent to $\frac{ax+b}{5}=64.2$ where a and b are any non-zero constants (allow $\frac{x+b}{5}=64.2$ where b is any non-zero constant)
	$3x=5\times64.2-60\times2$ oe			M1dep	Dependent on second M mark. Isolating the term in x correctly ($ax=5(64.2)-b$). The correct equation $3x=321-120$ (or equivalent or better e.g. $x=\frac{321-120}{3}$) implies all three M marks
	Correct answer scores full marks (unless from obvious incorrect working)	67		A1	
					Total 4 marks

Qu	Working	Answer	Mark	Notes
2	**SEE ALTERNATIVE ON NEXT PAGE** $BC = 9$		5	M1 May be seen on diagram or for a completely correct method to find BC (eg $AE = \sqrt{8^2 - 3^2} = \sqrt{55}$ then finding $\angle DAE$ (e.g. $\sin(\angle DAE) = \frac{3}{8}, \cos(\angle DAE) = \frac{"\sqrt{55}"}{8}, \tan(\angle DAE) = \frac{3}{"\sqrt{55}"}$) and then $BC = ("\sqrt{55}" + 2"\sqrt{55}")\tan(\angle DAE)$ (where if correct $\angle DAE = 22.0243...$)
	$AE = \sqrt{8^2 - 3^2}\left[= \sqrt{55}\right]$ **or** $DB = 16$			M1 A correct method to find either AE **or** DB. If $AE = \sqrt{73}$ from $AE = \sqrt{8^2 + 3^2}$ then M0 but if $AE = \sqrt{73}$ from a correct application of Pythagoras e.g. from seeing $AE^2 + 3^2 = 8^2$ then M1 May be seen on diagram (for reference: AE = 7.41619…)
	$EC = "\sqrt{55}" \times 2$ **or** $EC = \sqrt{"16"^2 - ("9" - 3)^2}$ **or** $EC = \sqrt{"3 \times 8"^2 - "9"^2} - "\sqrt{55}"$ **or** $EC = 2\sqrt{55}$ $AC = 3 \times "\sqrt{55}"$ **or** $\sqrt{(3 \times 8)^2 - "9"^2}$ or $AC = \sqrt{495}$			M1 A correct method to find EC or AC (for reference: EC = 14.8323…, AC = 22.2485…)
	Area = $\frac{1}{2} \times "2\sqrt{55}" \times (3 + "9")$ or $\frac{1}{2} \times "\sqrt{495}" \times "9" - \frac{1}{2} \times "\sqrt{55}" \times 3$ oe			M1 Correct method to find the area of the correct trapezium. Sides must be clearly labelled to ft if incorrect. A common error is using BC = 6 which can score 3 marks maximum
	Correct answer scores full marks (unless from obvious incorrect working)	89		A1 awrt 89 (accept $12\sqrt{55}$ or exact equivalent)

Alt	$AE = \sqrt{8^2 - 3^2}\left[= \sqrt{55}\right]$			M1	A correct method to find AE. If $AE = \sqrt{73}$ from $AE = \sqrt{8^2 + 3^2}$ then M0 but M1 can be scored for an incorrect expression for AE following from a correct application of Pythagoras e.g. from $AE^2 + 3^2 = 8^2$ May be seen on diagram (for reference: AE = 7.41619…)
	Area of triangle $AED = \frac{1}{2} \times 3 \times "\sqrt{55}"$			M1	Correct method to find area of triangle AED (e.g. $\frac{1}{2} \times 8 \times "\sqrt{55}" \times \sin("22.02...")$, $\frac{1}{2} \times 8 \times 3 \times \sin(90 - "22.02...")$ (For reference: Area of triangle AED = 11.1242…)
	Area of triangle $ABC = 3^2 \times \frac{1}{2} \times "3\sqrt{55}"$			M1	Correct method to find area of triangle ABC (e.g. $\frac{1}{2} \times 3"\sqrt{55}" \times \sqrt{"9"^2 + 3"\sqrt{55}"^2} \times \sin "22.02..."$ (For reference: Area of triangle ABC = 100.11867…)
	Area $BCED = 3^2 \times \frac{1}{2} \times "\sqrt{55}" - \frac{1}{2} \times 3 \times "\sqrt{55}"$			M1dep	Dependent on second and third M marks. Subtracting area of triangle AED from the area of triangle ABC
	Correct answer scores full marks (unless from obvious incorrect working)	89		A1	awrt 89 (accept $12\sqrt{55}$ or exact equivalent)
					Total 5 marks

Qu	Working	Answer	Mark	Notes
3	$\left((3x+17)-(3x+2)\right)^2+...^2 \left[=15^2+...^2\right]$ **or** $...^2+\left(\frac{(3x+21)-(3x+5)}{2}\right)^2 \left[=...^2+8^2\right]$		5	M1 For an attempt to find the length of CD^2 **or** AB^2. Condone lack of brackets (so allow $(3x+17-3x+2)^2+...^2[=19^2+...^2]$ **or** $...^2+\left(\frac{3x+21-3x+5}{2}\right)^2 \left[=...^2+13^2\right]$)
	$CD/AB=\sqrt{"15"^2+"8"^2}\,[=17]$			M1dep Correct method to find the length CD **or** AB (including division by 2 for horizontal distance from AB/CD). Dependent on first M mark
	$"17"+(3x+5)+"17"+(3x+2)+(3x+21)+(3x+2)=172$			M1dep Dependent on first M mark. For a correct equation for the perimeter with their AB and CD numerical and equal in value (so not involving x)
	$12x=142-2\times"17"$			M1dep Dependent on third M mark. Rearranging correctly (no slips/errors) to get x's on one side and number(s) on the other
	Correct answer scores full marks (unless from obvious incorrect working)	9		A1
				Total 5 marks

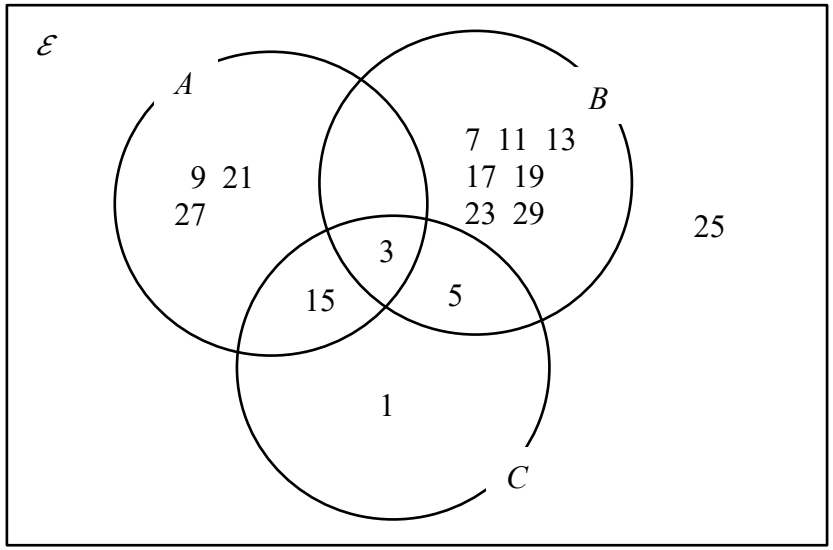
Notes:

- Assuming/stating that AB (or CD) = 15 or x (or any other incorrectly stated value/expression without working) scores no marks.
- Summing all given linear expressions and equating to 172 (so assuming the perimeter is only the expressions given in Figure 2) scores no marks.
- If no attempt to find AB/CD by a correct method (e.g. Pythagoras) then no marks.
- Including the height of the hexagon ($3x$ + 17) in the perimeter equation implies M0 M0 for the third and fourth M marks.
- If 17 seen on the diagram for either CD or AB then this implies the first two M marks.

Qu	Working	Answer	Mark	Notes	
4	$[AC =]\dfrac{3.8}{\tan 35}$ [=5.426…] or $[OC =]\dfrac{3.8}{\sin 35}$ [= 6.625…]		6	M1	A correct method to find AC /BC or OC eg $[AC =]3.8\tan(90-0.5\times 70)$ or $[OC =]\dfrac{3.8}{\cos 55}$ or $[AC =]\dfrac{3.8\sin 55}{\sin 35}$
	[Area of $OAC =]\dfrac{1}{2}\times$"5.42..."$\times 3.8$ [= 10.31…] or [Area of $OAC =]\dfrac{1}{2}\times$"5.42..."$\times$"6.62..."$\times\sin 35$ or [Area of $OACB =]$"5.42..."$\times 3.8$ [= 20.62…] or [Area of $OACB =]$"6.62..."$\times 3.8\times\cos 35$ or [Area of $OACB =]$"5.42..."$\times$"6.62..."$\times\sin 35$			M1dep	A correct method to find Area of OAC/OBC **or** $OACB$. Dependent on first M mark (For reference if correct: Area of OAC = 10.31… and Area of $OACB$ = 20.62…). Another valid approach for $OACB$ is OAB + ABC (possibly implied using the minor segment) which is $\dfrac{1}{2}\times$"5.426..."$^2\sin 70+\dfrac{1}{2}\times(3.8)^2\times\sin$"110"
	$\angle BOA = 110$ **or** $\angle AOC$ / $BOC = 55$			B1	May be seen on diagram **or** in calculating the area of sector OAB (or half this sector)
	[Area of sector $OAB =]\dfrac{"110"}{360}\times\pi\times 3.8^2$			M1	A correct method to find the area of a sector of a circle with radius 3.8, their angle can be either acute or obtuse but not 90 or greater than or equal to 180 (For reference: area of sector $OAB = \dfrac{3971}{900}\pi$ or 13.8614…)
	Shaded area = $"20.62..."-\dfrac{"110"}{360}\times\pi\times 3.8^2$ or $\dfrac{1}{2}\times$"5.426..."$^2\times\sin 70-\left(\dfrac{"110"}{360}\times\pi\times(3.8)^2-\dfrac{1}{2}\times(3.8)^2\times\sin"110"\right)$			M1dep	A correct method to find the shaded area with $90° < BOA < 180°$. Dependent on 2nd and 3rd M marks
	Correct answer scores full marks (unless from obvious incorrect working)	6.76		A1	Accept answers to two decimal places from 6.74 to 6.78 inclusive (with no incorrect working)
					Total 6 marks

Qn	Working	Answer	Mark	Notes
5	$(7-5y)^2+3y(7-5y)=13$ or $x^2+3x\left(\frac{7-x}{5}\right)=13$ or $x+5\left(\frac{13-x^2}{3x}\right)=7$		6	M1 for substituting a **correct** linear equation into the **correct** quadratic equation (or a **correct** quadratic equation into the **correct** linear equation) **or** correct start to eliminate one variable eg multiply first equation by $3x$ and the second equation by 5
	$49+25y^2-70y+21y-15y^2=13$ or $x^2+\frac{21}{5}x-\frac{3}{5}x^2=13$ or $3x^2+65-5x^2=21x$			M1 correct expansion of brackets, condone one **sign** error with no x terms in the denominator of any fractions **or** a correct method to eliminate one variable (so an equation in one variable with no brackets). Independent of first M mark (e.g. could have incorrectly rearranged $x+5y=7$ to $x=5y+7$)
	$10y^2-49y+36[=0]$ or $2x^2+21x-65[=0]$			A1 Dependent on both previous M marks – a correct three-term quadratic equation or expression in either x or y
	eg $(10y-9)(y-4)$ or $(2x-5)(x+13)$ or $\frac{49\pm\sqrt{(-49)^2-4\times10\times36}}{2\times10}$ $\frac{-21\pm\sqrt{21^2-4\times2\times(-65)}}{2\times2}$			M1 M1 dependent on one of the two previous M marks. Method may be implied by 2 correct solutions to a correct equation. Solving their 3 term quadratic equation using any correct method - if factorising must multiply out to give 2 correct terms. If using formula or completing the square allow one sign error. We will condone some simplification as their first step but no further than $\frac{49\pm\sqrt{2401-1440}}{20}$ Working must be shown if their quadratic is incorrect to gain this method mark
	$y=0.9$ (oe) and $y=4$ **or** $x=2.5$ (oe) and $x=-13$			A1 both x values correct or both y values correct or one pair of correct values (allow if stated as coordinates).
	Working required	$x=2.5,\ y=0.9$ $x=-13,\ y=4$		A1 dependent on 1st 2 method marks being awarded. It must be clear which value of x goes with which value of y (allow if stated as a pair of coordinates)
				Total 6 marks

Qu	Working	Answer	Mark	Notes	
6(a)	$\overrightarrow{AB} = 5\mathbf{b} - 4\mathbf{a}$ **or** $\overrightarrow{BA} = 4\mathbf{a} - 5\mathbf{b}$		3	M1	A correct expression for $\overrightarrow{AB}$ or $\overrightarrow{BA}$
	$\overrightarrow{OC} = 4\mathbf{a} + \frac{3}{5}("5\mathbf{b} - 4\mathbf{a}")$ or $\overrightarrow{OC} = 5\mathbf{b} + \frac{2}{5}("4\mathbf{a} - 5\mathbf{b}")$			M1	A correct method to find $\overrightarrow{OC}$ where $"5\mathbf{b} - 4\mathbf{a}"$ must include **a** and **b**
	Correct answer scores full marks (unless from obvious incorrect working)	$\frac{8}{5}\mathbf{a} + 3\mathbf{b}$		A1	Must be two terms only (e.g. $1.6\mathbf{a} + 3\mathbf{b}$, $\frac{8\mathbf{a} + 15\mathbf{b}}{5}$)
(b)	$\overrightarrow{OD} = \lambda\left("\frac{8}{5}\mathbf{a} + 3\mathbf{b}"\right)$ or $\overrightarrow{OD} = 5\mathbf{b} + \mu\mathbf{a}$ or $\overrightarrow{BD} = \lambda\mathbf{a}$ or $\overrightarrow{BD} = \lambda(4\mathbf{a})$ or $\overrightarrow{BD} = -5\mathbf{b} + \delta\left("\frac{8}{5}\mathbf{a} + 3\mathbf{b}"\right)$		4	M2	2 correct (but different) ways to find $\overrightarrow{OD}$ **or** 2 correct (but different) ways to find $\overrightarrow{BD}$ (e.g. $\overrightarrow{OD} = "\frac{8}{5}\mathbf{a} + 3\mathbf{b}" + \lambda\left("\frac{8}{5}\mathbf{a} + 3\mathbf{b}"\right)$ or $\overrightarrow{OD} = 5\mathbf{b} + \mu(4\mathbf{a})$) (M1 one correct way to find $\overrightarrow{OD}$ or $\overrightarrow{BD}$) NB $\overrightarrow{BD} = \lambda\mathbf{a}$ may be implied by realising coefficients of **b** = 0. Condone for both M marks if using the same scalar parameter in both ways of expressing $\overrightarrow{OD}$ / $\overrightarrow{BD}$
	$3\lambda\mathbf{b} = 5\mathbf{b}$ oe			M1dep	Equating like terms (dependent on both previous M marks). Must have used different scalar parameters to express the two different ways of expressing $\overrightarrow{OD}$ / $\overrightarrow{BD}$
	Correct answer scores full marks (unless from obvious incorrect working)	$\frac{8}{3}\mathbf{a} + 5\mathbf{b}$		A1	Must be two terms only e.g. $\frac{8\mathbf{a} + 15\mathbf{b}}{3}$ scores A1 (but $2.67\mathbf{a} + 3\mathbf{b}$ or equivalent non-exact answer is A0)
ALT (b)	$\left(\overrightarrow{OA} = 4\mathbf{a} \Rightarrow\right)\overrightarrow{OD} = 5\mathbf{b} + \mu(4\mathbf{a})$			M1	A correct expression for $\overrightarrow{OD}$ e.g. $5\mathbf{b} + \lambda\mathbf{a}$
	$\overrightarrow{OD} = 5\mathbf{b} + \frac{2}{3}(4\mathbf{a})$			M2 dep	Dependent on previous M mark. M2 for $5\mathbf{b} + \frac{2}{3}(4\mathbf{a})$ (most likely by similar triangles). M1 for $5\mathbf{b} + \frac{3}{2}(4\mathbf{a})$.
	Correct answer scores full marks (unless from obvious incorrect working)	$\frac{8}{3}\mathbf{a} + 5\mathbf{b}$		A1	Must be two terms only (see above)
					Total 7 marks

Question	Working	Answer	Mark	Notes
7(a)			3	B3 All 8 regions correct B2 5 or 6 or 7 regions correct B1 3 or 4 regions correct Do not condone 0 as representing an empty region of the Venn diagram and do not condone repeated values in part (a) (so if the same number appears in two regions (once in the correct region and therefore somewhere else incorrectly) then this counts as **two** incorrect regions) **In part (b) if the answer(s) is incorrect then there is no follow through if a region is incorrectly empty**
(b)(i)		2	2	B1ft For the answer of 2 **or** ft their Venn diagram (the total number of values in the 'empty', '3' and '5' regions with the '3' and '5' regions not being empty for the ft but condone a value(s) in the 'empty' region)
(ii)		10		B1ft For the answer of 10 **or** ft their Venn diagram (the total number of values in the '1', '5','7,11,13,17,19,23,29' and '25' regions with none of these regions being empty for the ft) **SC B1** for stating {3, 5} **and** {1,5,7,11,13,17,19,23,25,29} as the two answers

(c)	$\frac{"2"}{n}$ or $\frac{m}{"15"}$		2	M1	M1 for **either** $\frac{2}{n}$ where $n > 2$ **or** $\frac{m}{15}$ where $0 < m < 15$ **or** follow through their Venn diagram if $n >$ their numerator where their "2" is the '1', '5' regions (neither can be blank)) **or** follow through their Venn diagram if $m <$ their denominator but $m > 0$ where their "15" is their $n(\varepsilon)$ with no repeated values but allow missing or additional values. If P $C \cap A' = 0$ then M0
	Correct answer scores full marks (unless from obvious incorrect working)	$\frac{2}{15}$		A1	cao oe allow awrt 0.13
(d)	$\frac{"2"}{a}$ or $\frac{b}{"5"}$		2	M1	M1 for **either** $\frac{2}{a}$ where $a > 2$ **or** $\frac{b}{5}$ where $0 < b < 5$ or follow through their Venn diagram if $a >$ their numerator where their "2" is the '3', '15' regions (neither can be blank)) **or** $b <$ their denominator and b must be > 0 and their "5" is the 'empty', '9, 21, 27', '3','15' regions (none of the three that should contain elements can be empty)). If P $C \mid A = 0$ then M0
	Correct answer scores full marks (unless from obvious incorrect working)	$\frac{2}{5}$		A1	cao oe
					Total 9 marks

Question	Working	Answer	Mark	Notes	
8(a)	$\frac{80}{2}\times 7$		2	M1	A correct method to find weight of oats
	Correct answer scores full marks (unless from obvious incorrect working)	280		A1	
(b)	$\frac{270}{2+3+7}\times 2\left[=45\right]$		3	M1	A correct method to find the weight of nuts
	$\frac{"45"}{500}\times 26$			M1dep	A correct method to find cost of nuts. Follow through their weight of nuts but must have been a correct method to find the weight of nuts
	Correct answer scores full marks (unless from obvious incorrect working)	[$] 2.34		A1	
(c)	$10\times 3.7\times 1.25\left[=46.25\right]$		5	M1	A correct method to increase the UK cost by 25%. Allow $3.7\times 1.25\left[=4.625\right]$ or $10\times 1.25\left[=12.5\right]$ condone $23.7\times 1.25\left[=29.625\right]$ or $57\times 1.25\left[=71.25\right]$ for this mark (note that 66.25 seen implies this and the next M mark)
	$10\times 3.7\times 1.25+20\left[=66.25\right]$			M1	A correct method to calculate cost in £ for UK
	$3\times 30+5\left[=95\right]$			M1	A correct method to calculate cost in $ for US
	$"95"\times 0.71$ **or** $\frac{"66.25"}{0.71}$			M1	This mark can be awarded for multiplying or dividing any number (but not 0, 1 or any negative value) by 0.71. This mark is not dependent on any other M mark
	£67.45 and £66.25 **or** $95 and $93.31	UK cheaper		A1	oe Both costs correct in the same unit and a correct conclusion (ignore calculation of difference between the two countries even if incorrect). Allow awrt 67, awrt 66 and awrt 93
					Total 10 marks

Qu	Working	Answer	Mark	Notes	
9(a)	Area of triangle $FGH = \frac{1}{2}\times 12\times 5\left[\times 2 = 60\right]$		4	M1	Correct complete method to find the area of triangle FGH/IJK (e.g. $\frac{1}{2}\times 12\times 13\times \sin\theta$ where $\cos\theta = \frac{12}{13}$ (or equivalent) - for reference $\theta = 22.619...$). Must be seen as a separate area calculation and not embedded in another (possibly volume) calculation (apart from multiplying by 2)
	Area of $FHIK = 12\times 20$ [=240] Area of $GHIJ = 5\times 20$[=100] Area of $FGJK = 13\times 20$[=260]			M2	Correct method for the areas of all 3 rectangular sides M1for correct method to find at least 2 of the rectangular sides (do not accept embedded as part of a possible volume calculation e.g. $2\times 12\times 20$ unless clear that two separate rectangles are being considered)
	Correct answer scores full marks (unless from obvious incorrect working)	660		A1	Must be exact (allow 659.997… followed by 660)
(b)	$FI = \sqrt{12^2 + 20^2}$ **or** $FJ = \sqrt{12^2 + 20^2 + 5^2}$ (or $= \sqrt{13^2 + 20^2}$)		3	M1	$\sqrt{544}$ or $4\sqrt{34}$ or 23.32... or awrt 23.3 $\sqrt{569}$ or 23.85... or awrt 23.9
	$\text{Tan}\angle FJI = \frac{"23.32..."}{5}$ or $\cos\angle FJI = \frac{5}{"23.85..."}$ or $\sin\angle FJI = \frac{"23.32..."}{"23.85..."}$			M1dep	A correct trigonometric ratio for $\angle FJI$ or equivalent (for example, $\cos\angle FJI = \frac{"23.85..."^2 + 5^2 - "23.32..."^2}{2\times 5\times "23.85..."}$ Dependent on first M mark
	Correct answer scores full marks (unless from obvious incorrect working)	77.9		A1	Awrt 78 provided no incorrect working (e.g. $\tan^{-1}\left(\frac{4\sqrt{34}}{5}\right) = 77.5$ is incorrect and scores A0)
(c)	$\left[2\times\right]12\times 3\times 5$ or 60^3 **and** $\left[0.5\times\right]12\times 5\times 20$ oe		2	M1	Calculating how many along each side (condone missing 2) **or** calculate volume of wedge (condone missing half) **and** cube
	Correct answer scores full marks (unless from obvious incorrect working)	360		A1	
					Total 9 marks

Qu	Working	Answer	Mark	Notes
10(a)	$\frac{8}{10}\times\frac{2}{9}$ or $\frac{2}{10}\times\frac{8}{9}$		3	M1 Correctly calculating the probability of green followed by white **or** white followed by green
	$\frac{8}{10}\times\frac{2}{9}+\frac{2}{10}\times\frac{8}{9}$ oe			M1 Allow $\frac{8}{10}\times\frac{2}{9}\times 2$ or $\frac{2}{10}\times\frac{8}{9}\times 2$ but condone $\frac{8}{10}\times\frac{2}{10}\times 2$
	Correct answer scores full marks (unless from obvious incorrect working)	$\frac{16}{45}$		A1 oe awrt 0.36 Allow 0.35(555…) from correct working
(b)	$\frac{n}{n+28}=\frac{6}{11}$		3	M1 Setting up a correct equation
	$11n-6n=168$			M1dep Correct method to solve equation and collecting like terms in n on one side
		$n=33.6$ which is not an integer		A1 n = 33.6 (oe e.g. $\frac{168}{5}$) and the idea that it is not an integer (oe) but not just for saying that 33.6 is not possible (accept 'it is a fraction', 'it has a remainder', 'it is a decimal' etc. as valid reasons for why the probability stated is not correct)

(c)	$\frac{28}{28+n}\times\frac{n}{28+n-1}\times 2=\frac{1}{2}$ oe		5	M1	Setting up a correct equation e.g. $112n=n^2+55n+756$ or $1-\left(\frac{n}{28+n}\times\frac{n-1}{27+n}+\frac{28}{n+28}\times\frac{27}{n+27}\right)=\frac{1}{2}$ (oe)
	$n^2-57n+756[=0]$			M1	Multiplying out and combining terms to form a 3 term quadratic from $\frac{28}{28+n}\times\frac{n}{28+n-1}[\times 2]=\frac{1}{2}$ (so condone lack of 2) Condone also $n^2-56n+784=0$ coming from replacement $\left(\frac{28}{28+n}\times\frac{n}{28+n}\times 2=\frac{1}{2}\text{ or }1-\left(\frac{n}{28+n}\times\frac{n}{28+n}+\frac{28}{n+28}\times\frac{28}{n+28}\right)=\frac{1}{2}\right)$ Allow 1 sign error and 1 numerical error when simplifying to their 3 term quadratic equation/expression
	$(n-21)(n-36)$ [= 0]			M1	Solving their 3 term quadratic equation using any correct method - if factorising must multiply out to give 2 correct terms. If using formula or completing the square allow one sign error. We will condone some simplification as their first step but no further than $\frac{57\pm\sqrt{3249-3024}}{2}$ Working must be shown if their quadratic is incorrect to gain this method mark. Implied by $n = 36$ or $n = 21$. Note that this mark is not dependent on the first two M marks
	$\frac{28}{28+"36"}\times\frac{27}{28+"36"-1}$			M1dep	Correct method to work out probability of 2 blues using their value for $n > 28$. Dependent on third M mark only. Award this mark even if the probability is calculated for their $n = 21$ too. This mark can be awarded if they use a rounded value of n from the solution to their 3 term quadratic (provided the value used is an integer > 28)
	Working required	$\frac{3}{16}$		A1	Dependent on 1st and 4th M1 Allow awrt 0.19 or 0.18 if from correct working. A0 if the probability for $n = 21$ is stated too and not subsequently rejected
					Total 11 marks

Qu	Working	Answer	Mark	Notes	
11(a)	$y = kx^{-1} + 9x^{-2} + 1$		4	M1	Rewriting first two terms – one term correct. Allow with 12 rather than k – this mark can be implied by the next M mark
	$\frac{dy}{dx} = -kx^{-2} - 18x^{-3}$			M1	Attempting to differentiate – one term correct. Allow with 12 rather than k
	$-k(-1.5)^{-2} - 18(-1.5)^{-3} = 0$ or $-12(-1.5)^{-2} - 18(-1.5)^{-3}$			M1dep	Equating their derivative to 0 and substitute $x = -1.5$ **or** for substituting $x = -1.5$ and $k = 12$ into their derivative. Dependent on 2nd M mark
	Working required	$k = \frac{-\frac{16}{3}}{-\frac{4}{9}}$ [=12]		A1	All previous method marks awarded. **Either** a correct numerical expression for k required **or** a correct linear equation of the form $ak = b$ (e.g. $\frac{4}{9}k = \frac{16}{3}$) then k = 12. If k = 12 is substituted, then must = 0 **and** conclude k = 12
(b)	–0.75, –1.04, 0.06		2	B2	All 3 correct (Allow 0.063 or 0.0625 for 0.06) B1 for 2 correct
(c)	Plot Minimum point at (–1.5, –3)		4	B1	
		Fully correct graph		B3	Fully correct graph with minimum at (–1.5, –3) Allow ± 1 small square for points (use overlay). B2 for a single curve going through at least 5 points from "their table" B1 straight lines joining points rather than a curve going through at least 5 points from "their table" or all points from "their table" plotted but not connected
(d)	Line $y = 0.5x - 2$ drawn		3	M1	Line must be at least between (–2, –3) and (–1, –2.5)
	CV -1.1 and -1.8			M1dep	Dependent on previous M1. Ft their graph if only x-values given awrt -1.1 to -1.3 and -1.8 ± 0.1
	Working required	$-1.8 \leqslant x \leqslant -1.1$		A1	Correct inequality of the form $-1.8 \leqslant x \leqslant -1.1$ or $-1.1 \geqslant x \geqslant -1.8$ awrt -1.1 to -1.3 and -1.8 ± 0.1 Allow use of < (dependent on both M marks)
					Total 13 marks

Qu	Working	Answer	Mark	Notes
12(a)		-5	1	B1 Condone $x \neq -5$
(b)	$\frac{20}{5+k}=8$		3	M1 Setting up a correct equation for k (condone x for k)
	$2.5=5+k$			M1dep Correctly remove fraction to obtain a linear equation with no brackets (e.g. $20 = 40 + 8k$ oe) (condone x for k). Dependent on first M mark
	Correct answer scores full marks (unless from obvious incorrect working)	–2.5		A1
(c)	g(–3) = $\frac{20}{5-3}$ or 10		2	M1 For $\frac{20}{5-3}$ or 10 or embedded in their attempt at fg(–3) for example, $2\left(\frac{20}{5-3}\right)^2-4\left(\frac{20}{5-3}\right)+1$
	Correct answer scores full marks (unless from obvious incorrect working)	161		A1

(d)	$[f(x)=]2(x-...)^2+...$		4	M1	$2\left((x\pm...)^2+...\right)$ or for $y=2\left((x\pm...)^2\pm...\right)\pm...$ or for $y=2\left((x\pm...)^2\pm...\pm...\right)$
	$[f(x)=]2(x-1)^2+...$			M1dep	$2\left((x\pm1)^2+...\right)$ or for $y=2\left((x\pm1)^2\pm...\right)\pm...$ **or** $y=2\left((x\pm1)^2\pm...\pm...\right)$ **or** $y=2(x\pm...)^2\pm...$ Dependent on first M mark
	$y="2(x-1)^2-1"$ oe leading to $(x-1)^2=\frac{y+1}{2}$			M1	Allow use of their completed square if in the form $c(x\pm d)^2\pm e$ or $c\left((x\pm d)^2\pm f\right)$
		$\left[f^{-1}:x\mapsto\right]\ 1+\sqrt{\frac{x+1}{2}}$		A1	oe **Note: Allow candidates to swap *x* and *y* when finding the inverse but final answer must be in terms of *x***
ALT	$2x^2-4x+(1-y)[=0]$			M1	For a correct first step of arranging all terms on the same side of an equation/expression
	$[x=]\frac{4\pm\sqrt{16-8(1-y)}}{4}$			M1dep	Applying quadratic formula correctly but allow one sign error, or with positive sign only $[x=]\frac{4+\sqrt{16-8(1-y)}}{4}$
	$[x=]\frac{4\pm\sqrt{8+8y}}{4}$			M1	Simplifying their $x=\frac{4\pm\sqrt{16-8(1-y)}}{4}$ correctly
		$\left[f^{-1}:x\mapsto\right]\ \frac{4+\sqrt{8+8x}}{4}$		A1	oe **Note: Allow candidates to swap *x* and *y* when finding the inverse but final answer must be in terms of *x***

(e)	$2a+b=12$		5	M1	A correct equation from h(2) = 4, for example, $\frac{2a+b}{3}=4$
	$[\text{h}(1.7)=]\frac{1.7a+b}{3}$			M1	A correct expression for h(1.7) (this mark can be implied if the correct expression (possibly with a or b substituted from $2a + b = 12$) is seen embedded in their attempt at the inverse of f)
	$\frac{1.7a+b}{3}=2\times2.5^2-4\times2.5+1\,(=3.5)$ **or** $1+\sqrt{\frac{\frac{1.7a+b}{3}+1}{2}}=2.5$ oe **or** $\frac{4+\sqrt{8+8\left(\frac{1.7a+b}{3}\right)}}{4}=2.5$			M1dep	Dependent on previous M mark for **either** applying $\text{h}(1.7)=\text{f}(2.5)$ leading to $1.7a+b=10.5$ (or equivalent – allow any correct unsimplified equation in a and b) **Or** formulating the composite $\text{f}^{-1}\text{h}(x)$ by correctly substituting h(1.7) into their $\text{f}^{-1}(x)$ provided their inverse is either of the form $\pm a\pm\sqrt{\pm bx\pm c}$ (where a, b and c are all non-zero) or $\frac{\pm a\pm\sqrt{\pm bx\pm c}}{d}$ (where a, b, c and d are all non-zero)
	$0.3a=1.5$ or $0.15b=0.3$			M1dep	Correct method to eliminate a or b to form a linear equation in either a or b – dependent on 1st and 3rd M marks
	Working required	$a = 5,\ b = 2$		A1	Dependent on the 1st and 3rd M marks
					Total 15 marks

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