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Mark Scheme (Results)

Summer 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
  - cas – Correct answer scores full marks (unless from obvious incorrect working)
  - wr – working required

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- **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.

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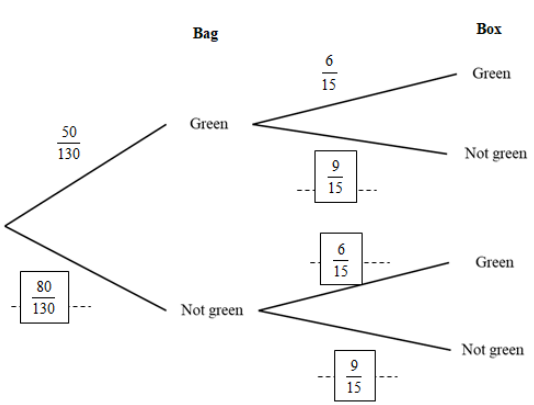
Question	Working	Answer	Mark	Notes
1(a)	$\frac{72}{360}\times 130$ or $\frac{360}{130}x = 72$ oe		2	M1 correct calculation or equation to find the number of red bricks
		26		A1 cas check the table for the answer
(b)			2	M1 for 2 correct probabilities. Allow as decimals 0.62 (actual 0.61538…), 0.6, 0.4, 0.6
		Fully correct		A1 oe fully correct with exact probabilities
(c)	$\frac{50}{130}\times"\frac{9}{15}"+"\frac{80}{130}"\times"\frac{6}{15}"$ or $1-\frac{50}{130}\times\frac{6}{15}-"\frac{80}{130}"\times"\frac{9}{15}"$		2	M1ft their Tree diagram. Allow $\frac{3}{13}+\frac{16}{65}$ May be seen on tree diagram at the end but must be added. If tree diagram is incorrect they need to show working.
		$\frac{31}{65}$		A1 cas oe awrt 0.48 (actual answer 0.47692…) ignore subsequent incorrect changes to decimal form
				Total 6 marks

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Qu	Working	Answer	Mark	Notes
2(a)	$\frac{1.3}{1.25}$ or $\frac{1.3-1.25}{1.25}$ oe		2	M1 Allow $\frac{1.3n-1.25n}{1.25n}$ or 1.04 or 104
		4		A1 cas
(b)	1.3×1.2 or $1.30+0.2\times1.3$		2	M1 Condone 1.25×1.2 or $1.25+0.2\times1.25$
		1.56		A1 cas
(c)	0.28×300		2	M1
		84		A1 cas
(d)	$\frac{5}{3+5}\times(300-"84")$ or $(300-"84")-\frac{3}{3+5}\times(300-"84")$		2	M1 ft their answer to part (c)
		135		A1 cas
(e)	$(50\times0.3)[\times P=15P]$ **and** $40\times0.6[\times P=24P]$ oe		4	M1 working out the profit for the first 90 pumpkins where *P* can be omitted or can be any value (providing both have same value for *P*). Do not allow 30 % × 50 and /or 60% × 40 unless followed by 15*P* **and** 24 *P* **or** 39 *P*
	$("135"-50-40)\times0.9[\times P][=40.5P]$ oe			M1 working out the profit for the remaining pumpkins where *P* can be omitted or can be any value (providing same as value used for previous method). Ft their part (d) for indicating need 90% of $("\text{their }135"-50-40)$ or 90% of $45P$ or 0.9×45 but do **NOT** allow 40.5 if it comes from incorrect working eg $0.3\times135=40.5$ which will be M0 79.5 with **no incorrect** working will gain the 1st and 2nd M1
	$\frac{("39"P+"40.5"P)}{"135"P}[\times100]$			M1 dep on both method marks awarded ft their part (d) *P* can be omitted or can be any value providing the same value throughout
		59		A1 awrt 59 (actual answer 58.888…)

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	See next page for alternative for (e)			***Total 12 marks***

ALT				
(e)	$(50\times1.3)[\times C=65C]$ **and** $40\times1.6[\times C=64C]$ oe		4	M1 working out the selling price for the first 90 pumpkins where *C* can be omitted or can be any value (providing both have same value for *C*). Do not allow 130 % × 50 and /or 160% × 40 unless followed by 65*C* **and** 64*C* **or** 129*C*
	$("135"-50-40)\times1.9[\times C][=85.5C]$ oe			M1 working out the selling price for the remaining pumpkins where *P* can be omitted or can be any value (providing same as value used for previous method). Ft their part (d) for indicating need 90% of $("\text{their }135"-50-40)$ or 190% of $45C$ or 1.9×45 but 214.5 with **no incorrect** working will gain the 1st and 2nd M1
	$\frac{("129"C+"85.5"C)}{"135"C}[\times100]$			M1 dep on both method marks awarded ft their part (d) *C* can be omitted or can be any value providing the same value throughout
		59		A1 awrt 59 (actual answer 58.888…)

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Qu	Working	Answer	Mark	Notes
3	$9000\times3+16000\times23+27000\times21+37000\times34+51000\times10$ $[=2730000]$		4	M2 for at least 4 correct products using midpoints with intention to add. Allow 27000 + 368000 + 567000 + 1258000 + 510000 or seeing 2730000 M1 for • at least 4 products using frequency and a value within the interval with intention to add. Condone use of the lower class bound. • at least 4 correct products using midpoints without adding. Allow consistent use of changed size of number eg $9\times3+16\times23+27\times21+37\times34+51\times10$
	$\frac{"2730000"}{3+23+21+10+34[=91]}$			M1 dep on M1 for forming an equation ft their product Allow consistent use of changed size of number $\frac{9\times3+16\times23+27\times21+37\times34+51\times10}{3+23+21+10+34}$ oe
		30000		A1 cas
				Total 4 marks

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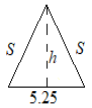
Qu	Working	Ans	Mark	Notes
4(a)	$\frac{360}{180-172}$ or $(2n-4)90=172n$ oe		2	M1 A correct method or equation to find the number of sides eg $(n-2)180=172n$
		45		A1 cas
(b)	[UB =] 5.25 **or** [LB =] 5.15		6	B1 a correct upper or lower bound seen or used. Allow $\left[UB/2 =\right]$ 2.625 or $\left[LB/2 =\right]$ 2.575
	$\tan(86)=\frac{h}{UB/2}$ **or** $\tan(4)=\frac{UB/2}{h}$ **or** $\frac{h}{\sin(86)}=\frac{UB/2}{\sin(4)}$ $\cos(86)=\frac{UB/2}{S}$ **or** $\sin(90-86[=4])=\frac{UB/2}{S}$ **or** $\frac{S}{\sin(86)}=\frac{UB}{\sin 8}$ **or** $5.25^2=S^2+S^2-2S^2\cos 8$			M1 for setting up an equation to find the height of the triangle (h) or side length (S)  allow $5.1\leqslant UB\leqslant 5.3$ **or** $2.55\leqslant UB/2\leqslant 2.65$ condone if use $171.5\leqslant$ angle $\leqslant 172.5$
	$h=UB/2\tan(86)$ [= 37.539…] **or** $h=\frac{UB/2}{\tan(4)}$ **or** $h=\frac{UB/2}{\sin(4)}\times\sin(86)$ $S=\frac{UB/2}{\cos(86)}[=37.63...]$ **or** $S=\frac{UB/2}{\sin(90-86)}[=37.63]$ **or** $S=\frac{UB}{\sin(8)}\times\sin(86)$ **or** $S=\sqrt{\frac{5.25^2}{2-2\cos(8)}}$			M1 for correct method to find h or S Allow $5.1\leqslant UB\leqslant 5.3$ **or** $2.55\leqslant UB/2\leqslant 2.65$ or awrt 37.5 or awrt 37.6 If previous method mark is awarded allow for awrt $36.5\leqslant h\leqslant$ awrt 37.9 or awrt $36.5\leqslant S\leqslant$ awrt 40.0 This mark implies the previous M1
	Area of triangle = $\frac{1}{2}\times UB\times"h"$[Area = 98.54…] **or** $\frac{1}{2}\times"h"\times"S"\times\sin(4)$ **or** $\frac{1}{2}\times UB\times"S"\times\sin(86)$ **or** $\frac{1}{2}\times"S"\times"S"\sin(8)$			M1 for finding the area of the triangle  **where** $5.1\leqslant UB\leqslant 5.3$ **and** $S<5$ or $S>5.5$ or $h<5$ or $h>5.5$ allow awrt 98.5 **NB** $0.5\times UB\times UB\sin 172$ is M0

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	or $R = \frac{\text{UB} + \text{UB} + S}{2}$ **and** $\sqrt{R(R-\text{UB})(R-\text{UB})(R-S)}$			
	Area of polygon = "45"×"98.54…" or 2×"45"×"49.27…"			M1 dep on the 3rd M mark being awarded
		4430		A1dep on seeing 5.25or 2.625 for UB throughout awrt 4430
				Total 8 marks

Question	Working	Answer	Mark	Notes
5(a)	Line $y = 3$ drawn		2	M1 line drawn.
		−0.4, 2.4		A1
(b)		3.38, −1, 1.13	2	B2 for all 3 correct. Allow 3.375 / 1.125 (B1 for 2 correct we will allow 3.4 or 3.3 or 3.37 for 3.38 and 1.1 or 1.12 for 1.13 for B1 only)
(c)		Correct graph drawn	2	B2 Fully correct graph. (B1 All points plotted correctly or 4 points plotted correctly with smooth line joining them.) if you are unable to see the points then allow if the lines goes through them within/on the circles.
(d)(i)		(1.8, 3.7) and (−0.8, 2.4)	1	B1 ft their graph allow values within ± 0.1(inclusive) or allow "their values " within ± 0.1 (inclusive) ignore incorrect extras
(ii)	$m = \frac{\text{"3.7"}-\text{"2.4"}}{\text{"1.8"}-(\text{"}-0.8\text{"})}$ or $y = 0.5x + \ldots$		3	M1 correct method to find the gradient (allow figures within ± 0.1 (inclusive)) or $y = (\text{values within } 0.5 \pm 0.1 \text{(inclusive)})x \pm \ldots$ or their coordinates which may be from part(d)(i) or any coordinates on their line from the graph. Full working for finding the gradient from 2 points must be seen if line is incorrect.
	$y = \ldots x + 2.8$ or $y - \text{"3.7"} = \frac{\text{"3.7"}-\text{"2.4"}}{\text{"1.8"}-(\text{"}-0.8\text{"})}(x - \text{"1.8"})$			M1 point of intersection with y-axis (ft values within ± 0.1 (inclusive) where their line crosses y–axis) **or** $y_1 = \text{"0.5"} \times x_1 + c$ where (x_1, y_1) is a point on their line **or** $y = \ldots x + (\text{values within } 2.8 \pm 0.1 \text{(inclusive)})$ **or** correct equation for their coordinates if working shown
		$y = 0.5x + 2.8$		A1 allow any value in the ranges $0.4 \leqslant m \leqslant 0.6$ and / or $2.7 \leqslant c \leqslant 2.9$ Allow fractions providing they lie in the range

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				Total 10 marks

Question	Working	Answer	Mark	Notes
6(a)		19	1	B1
(b)(i)		9	1	B1
(ii)		41	1	B1
(iii)		35	1	B1
				SC for (b) answers of (i) 2, (ii) 6, (iii) 5 Allow B1 for all 3 of these values – mark as 100 for(i) and 0 for (ii) and (iii).
(c)	$\frac{3+4}{12+6+3+4}$		2	M1 Allow $\frac{7}{n}$ with (integer n) > 7 **or** $\frac{m}{25}$ with (integer m) < 25 but must see the 7 or 25 in the fraction
		$\frac{7}{25}$		A1 cas oe Do not allow 0.28
				Total 6 marks

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Question	Working	Answer	Mark	Notes
7(a)		15	1	B1
(b)	$y(x+3)=5x-4$ **or** $x(y+3)=5y-4$ oe		3	M1 for multiplying by $(x + 3)$ other letters may be used. Condone missing brackets if recovered
	$xy-5x=-3y-4$ **or** $xy-5y=-3x-4$ oe			M1 Isolating term in x. Other letters may be used Allow 1 sign error. This implies the previous method mark
		$\left[h^{-1}: x \mapsto\right] \frac{-3x-4}{x-5}$		A1 cas oe eg $\frac{3x+4}{5-x}$ must be in terms of x Do not ISW
(c)	$\left(1+\frac{2}{x}\right)^2-2\left(1+\frac{2}{x}\right)$ or $\left(\frac{x+2}{x}\right)^2-2\left(\frac{x+2}{x}\right)$		4	M1 correct expression for fg(x) or $f^{-1}(x)=\sqrt{x+1}+1$
	$\left(1+\frac{4}{x}+\frac{4}{x^2}\right)$ or $\left(1+\frac{4}{x}+\left(\frac{2}{x}\right)^2\right)$ $\left(\frac{x^2+4x+4}{x^2}\right)$			M1 dep on 1st M1 being awarded. Correct method to multiply out the squared brackets leading to 3 or 4 terms or correct expression for $\left[f^{-1}(g)=\right]\sqrt{\frac{x}{54}+1-1}+1$ oe
	$\frac{4}{x^2}=\frac{x}{54}$ or $\frac{4}{x^2}-\frac{x}{54}=0$ or $x^3=216$			M1for simplifying down to get a correct equation with a maximum of 2 algebraic terms eg $4=\frac{x^3}{54}$ or a correct expression for x
		6		A1 cas Allow $x=\sqrt[3]{216}$
				Total 8 marks

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Qu	Working	Answer	Mark	Notes
8	$\angle ABC = 90°$		7	M1 using circle theorem. May be seen on diagram with right angle symbol or $90°$
	[let $x = BC$ then] $\left[AC^2 =\right] x^2 + (x-2)^2$ **or** $\left[BC^2 =\right]\left(\frac{5}{4}x\right)^2 - (x-2)^2$ **or** $\cos\angle ACB = \frac{4}{5}$ **or** $\sin\angle CAB = \frac{4}{5}$ $\sin\angle ACB = \frac{3}{5}$ **or** $\cos\angle CAB = \frac{3}{5}$			M1 using Pythagoras where *AB* is 2 less than *BC* eg [let $y = AB$ then] $\left[AC^2 =\right] y^2 + (y+2)^2$ or $\left[BC^2 =\right]\left(\frac{5}{4}(y+2)\right)^2 - y^2$ Allow if square rooted or if finding angles must clear which angle 4/5 is. This implies the previous method mark **Note** that Students may use *BC* or any letter instead of *x* throughout the question
	$(x-2)^2 + x^2 \leqslant \left(\frac{5}{4}x\right)^2$ or $\cos\angle CAB = \frac{4(x-2)}{5x}$ or $\sin\angle ACB = \frac{4(x-2)}{5x}$			M1 Allow any inequality or = sign. For using $AB^2 + BC^2 \leqslant \left(\frac{5}{4}BC\right)^2$ where *AB* is 2 less than *BC* and all 3 terms are in terms of the same letter. Allow if square rooted eg $\sqrt{(x-2)^2 + x^2} \leqslant \frac{5}{4}x$ or $y^2 + (y+2)^2 \leqslant \left(\frac{5}{4}(y+2)\right)^2$ (implies the previous M mark) or for $\frac{4(x-2)}{5x}$ seen. If $x^2 + (x-2)^2$ oe seen allow their multiplied out version. Condone $\frac{5}{4}x^2$
	$7x^2 - 64x + 64\ [\leqslant 0]$ or $\frac{4(x-2)}{5x} \leqslant \frac{3}{5}$ oe			M1 Allow any inequality or = sign. reducing to a correct 3 term quadratic eg $\frac{7}{16}x^2 - 4x + 4[\leqslant 0]$. No need for $\leqslant 0$ eg $7y^2 - 36y \leqslant -36$ or setting up a correct linear equation. Implies the previous 3 method marks
	$(7x-8)(x-8) \leqslant 0$ or $4(x-2) = 3x$			M1 eg $(7y+6)(y-6) \leqslant 0$ correct method to solve their 3TQ – Must multiply out to give 2 of their terms. Allow use of correct formula or completing the square/ Allow 1 sign error

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				for both methods. Working must be shown if quadratic is incorrect Implied by $[x=]\frac{8}{7}$ or 8 or $[y=]-\frac{6}{7}$ or 6 or remove x from the denominator to form a correct linear equation
	$x \leqslant 8$			M1 for the single inequality $x \leqslant 8$ on its own with no other given. For $x \leqslant 8$ allow $n \leqslant x \leqslant 8$ (or $x \geqslant n$ and $x \leqslant 8$) where $0 < n < 8$ Allow < for $\leqslant$
		$2 < x \leqslant 8$		A1 cas ***Total 7 marks***

Qu	Working	Answer	Mark	Notes
9(a)	$3(-4)^3 + a(-4)^2 - 20(-4) + b = 0$ or $3(2)^3 + a(2)^2 - 20(2) + b = 0$		3	M1 substituting in –4 or 2 and equating to 0 (the equating to 0 may be implied when linear equations formed) Do not condone missing brackets around (–4) unless recovered.
	$16a + b = 112$ $16a + b = 112$ $4a + b = 16$ $4a + ("112 - 16a") = 16$			A1 2 simplified linear equations - one must be correct but we will allow one error only in the other one
		$a = 8$ and $b = -16$		A1wr dep on M1 This mark will imply the previous A mark
				SC $a = 8$ and $b = -16$ with no working or no method mark awarded award B2
(b)	$(2x - 3)$		5	B1 $(2x - 3)$ seen or used
	$4x^2 \pm nx - 2$			M1 for a quadratic with any value of n seen. Allow multiples
	$4x^2 - 3x - 2$			A1 for a correct quadratic seen. Allow multiples
	$x = \frac{-(-3) \pm \sqrt{(-3)^2 - 4 \times 4 \times (-2)}}{2 \times 4}$			M1 dep on the **1st M1** for correctly solving their 3 term quadratic. Condone missing brackets around the –3. Allow simplified as far as $x = \frac{3 \pm \sqrt{9 + 32}}{8}$ oe Allow completing the square. $4\left(\left(x - \frac{3}{8}\right)^2 - \left(\frac{3}{8}\right)^2 - \frac{1}{2}\right)$ or $4\left(x - \frac{3}{8}\right)^2 - \left(\frac{9}{16}\right) - 2$ oe
		$x = \frac{3 \pm \sqrt{41}}{8}$		A1wr dep on B1 and 2 M awarded – needs to be simplified ignore subsequent changes to decimal form if exact form seen. Ignore extra root of 3/2
				Total 8 marks

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ALT (b)	$\left(x-\frac{3}{2}\right)$			B1 $\left(x-\frac{3}{2}\right)$ seen or used
	$8x^2 \pm mx - 4$			M1 allow multiples eg $4x^2 \pm mx - 2$
	$8x^2 - 6x - 4$			A1 allow multiples eg $4x^2 - 3x - 2$
	$x = \frac{-(-6) \pm \sqrt{(-6)^2 - 4\times 8\times(-4)}}{2\times 8}$			M1 dep on the **1st M1** Allow simplified as far as $x = \frac{6 \pm \sqrt{36+128}}{16}$
		$x = \frac{3 \pm \sqrt{41}}{8}$		A1wr dep on B1 and 2 M awarded ignore subsequent changes to decimal form if exact form seen

Qu	Working	Answer	Mark	Notes
10(a)		Rotation	3	B1 condone rotated. Do not allow if multiple transformations given. Multiple transformation are when **more than one** of reflection, rotation (turn), translation(move), enlargement(stretch/squash) is stated. Giving an equation of a line, SF, vector does not count as multiple transformations
		90° clockwise		B1allow 270 anticlockwise
		Centre (3, 2)		B1allow for just (3, 2)
(b)		Correct triangle drawn (−3, 4) (3, 4) (6, 1)	2	B2 Fully correct triangle drawn (B1 for triangle drawn with same orientation and sides 3 times the length of *A* (implies SF of 3 used) or 2 correct points plotted)
(c)		Correct triangle drawn (3, −6) (5, −6) (6, −5)	2	B2 Fully correct triangle drawn (B1 2 correct points plotted or triangle reflected in any horizontal line)
(d)	$\mathbf{N} = \begin{pmatrix} k & 1 \\ k^2-1 & k \end{pmatrix}\begin{pmatrix} -k & 1 \\ k-3 & 0 \end{pmatrix}$		7	M1 matrices in terms of *k* in correct order. Implied by fully correct matrix for **N**
	$\mathbf{N} = \begin{pmatrix} -k^2+k-3 & k \\ -k^3+k+k^2-3k & k^2-1 \end{pmatrix}$			M1 for a 2 by 2 matrix with at least 2 correct entries If matrices in incorrect order it gives $\begin{pmatrix} -1 & 0 \\ k^2-3k & k-3 \end{pmatrix}$ allow for at least 2 non zero entries correct
	Det **N** = $\left(-k^2+k-3\right)\left(k^2-1\right) - k\left(-k^3+k+k^2-3k\right)$			M1 Correct method for determinant of their 2 x 2 matrix ft their matrix **N** (need not be labelled) as long as at least 2 entries in the matrix are in terms of *k* (Allow max of 1 zero)

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	$-k^4+k^3-3k^2+k^2-k+3+k^4-k^2-k^3+3k^2=2$			M1 dep on previous M being awarded for equating their det to 2
	$k=1$			A1 dep on 1st M1 this does not imply the previous marks
	N$=\begin{pmatrix} "-1^2+1-3" & "1" \\ "-1^3+1+1^2-3\times1" & "1^2-1" \end{pmatrix}\begin{pmatrix} 1 & 0 & 1 \\ 0 & -1 & 2 \end{pmatrix}$			M1 ft their value of k and their 2×2 matrix **N** Must show working if k is incorrect. Points can be in any order. May be implied by correct points
		$(-1, -2)$, $(-3, -2)$, $(-1, 0)$		A1 dependent on all previous marks being awarded. Allow $\begin{pmatrix} -1 & -3 & -1 \\ -2 & -2 & 0 \end{pmatrix}$ or correct triangle drawn. Points can be in any order
	NEXT PAGE for alternative method for (d) **Use the MS that gives the highest mark. but do not use both**			***Total 14 marks***
ALT				
(d)	$\left[\text{Det}\right]\mathbf{P}=-(k-3)$ **and** $\left[\text{Det}\right]\mathbf{Q}=(k^2-k^2+1)$			M1Correct method for determinant of their **P and Q** Working shown or clearly labelled **P** and **Q**
	Det **N** $=-(k-3)\times(k^2-k^2+1)$			M1dep on 1st M1being awarded. For multiplying their det **P** by det **Q**
	$-(k-3)\times(k^2-k^2+1)$ = 2 oe			M1dep on previous M being awarded for equating their det to 2 eg $-k+3=2$
	$k=1$			A1dep on 2nd M1 this does not imply the previous marks
	$\begin{pmatrix} -k & 1 \\ k-3 & 0 \end{pmatrix}\begin{pmatrix} 0 & 1 & 1 \\ -1 & 0 & 2 \end{pmatrix}=\begin{pmatrix} -1 & -k & -k+2 \\ 0 & k-3 & k-3 \end{pmatrix}$ or $\begin{pmatrix} k & 1 \\ k^2-1 & k \end{pmatrix}\begin{pmatrix} -k & 1 \\ k-3 & 0 \end{pmatrix}=\begin{pmatrix} -k^2+k-3 & k \\ -k^3+k+k^2-3k & k^2-1 \end{pmatrix}$			M1 for attempt to multiply matrices. Must be a 2 by 3 or a 2 by 2 matrix and have at least 2 correct entries in terms of k or with their k value substituted. Points can be in any order If k = 1 then matrices are $\begin{pmatrix} -1 & -1 & 1 \\ 0 & -2 & -2 \end{pmatrix}$ or $\begin{pmatrix} -3 & 1 \\ -2 & 0 \end{pmatrix}$
	$\begin{pmatrix} k & 1 \\ k^2-1 & k \end{pmatrix}\begin{pmatrix} -k & 1 \\ k-3 & 0 \end{pmatrix}\begin{pmatrix} 0 & 1 & 1 \\ -1 & 0 & 2 \end{pmatrix}$			M1 matrices in correct order with either k or their k value substituted eg $\begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}\begin{pmatrix} -1 & 1 \\ -2 & 0 \end{pmatrix}\begin{pmatrix} 0 & 1 & 1 \\ -1 & 0 & 2 \end{pmatrix}$ may be done in steps Points can be in any order. May be implied by correct points
		$(-1, -2)$, $(-3, -2)$, $(-1, 0)$		A1 dependent on all previous marks being awarded. Allow $\begin{pmatrix} -1 & -3 & -1 \\ -2 & -2 & 0 \end{pmatrix}$ or correct triangle drawn. Points can be in any order

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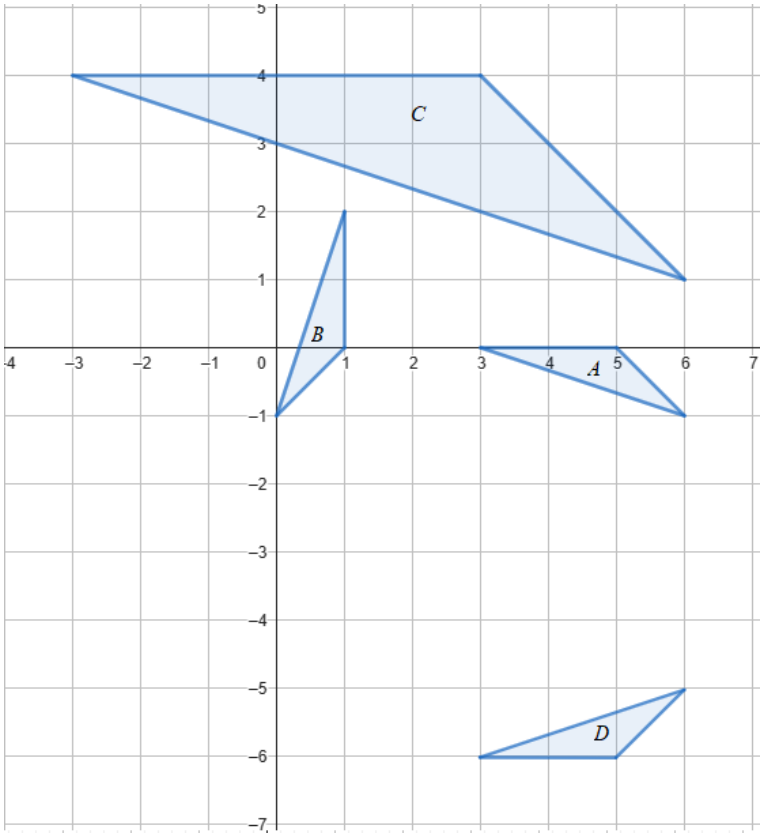

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Question	Working	Answer	Mark	Notes
11(a)	10 or $\pm 12t$		2	M1 one non zero term correct
		$10-12t$		A1 cas
(b)	$"10-12t"=0$		2	M1 ft for equating their expression in *t* from part (a) to 0
		$\frac{5}{6}$		A1 cas oe awrt 0.83 ignore subsequent changes to decimal form if a correct exact form seen
(c)	$0=4+10t-6t^2$		5	M1 for equating $4+10t-6t^2$ to 0 This may be awarded if seen in part (b) This could be implied by gaining either 2 or $-\frac{1}{3}$ as a solution
	$d=4\times"2"+5\times"2"^2-2\times"2"^3\left[=12\right]$			M1 substituting a positive time into *d* Working *m*ust be seen if *t* is incorrect. This can be any value including 5/6
	$d=4\times2+5\times2^2-2\times2^3\left[=12\right]$ or $20=k+d$			M1 substituting *t* = 2 in to find the distance travelled, *d* or for realising $20=k+d$
	$20=k+4\times2+5\times2^2-2\times2^3$			M1 Setting up the equation using *d* and substituting *t* = 2
		8		A1 cas
				Total 9 marks

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Question	Working	Answer	Mark	Notes
12(a)	$\left[\overrightarrow{OC} =\right] 3\mathbf{a}+\frac{1}{3}(15\mathbf{b}-3\mathbf{a})[=2\mathbf{a}+5\mathbf{b}]$ **or** $\left[\overrightarrow{OC} =\right] 15\mathbf{b}+\frac{2}{3}(3\mathbf{a}-15\mathbf{b})[=2\mathbf{a}+5\mathbf{b}]$ **or** $\left[\overrightarrow{CO} =\right] -3\mathbf{a}-\frac{1}{3}(15\mathbf{b}-3\mathbf{a})[=-2\mathbf{a}-5\mathbf{b}]$		3	M1 A correct method to find $\overrightarrow{OC}$ or $\overrightarrow{CO}$ May be embedded in $\overrightarrow{BN}$ condone $\overrightarrow{OC}$ for $\overrightarrow{CO}$
	$\left[\overrightarrow{BN} =\right] -15\mathbf{b}+\frac{3}{4}(\text{"}2\mathbf{a}+5\mathbf{b}\text{"})$ **or** $\left[\overrightarrow{BN} =\right] -\frac{1}{4}(\text{"}2\mathbf{a}+5\mathbf{b}\text{"})+\frac{2}{3}(3\mathbf{a}-15\mathbf{b})$ **or** $\left[\overrightarrow{BN} =\right] 2\mathbf{a}-10\mathbf{b}+\frac{1}{4}(\text{"}-2\mathbf{a}-5\mathbf{b}\text{"})$			M1 Correct method to find $\overrightarrow{BN}$ or $\overrightarrow{NB}$ Allow any correct method ft their $\overrightarrow{OC}$ condone $\overrightarrow{BN}$ for $\overrightarrow{NB}$
		$\frac{3}{2}\mathbf{a}-\frac{45}{4}\mathbf{b}$		A1 cas oe

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(b)	$\overrightarrow{OM} = 3\lambda\mathbf{a}$ or $\overrightarrow{OM} = \mu\mathbf{a}$		5	M1 Allow $\overrightarrow{OM}$ or $\overrightarrow{MO}$ or $\overrightarrow{AM}$ or $\overrightarrow{MA} = \pm 3\lambda\mathbf{a}$ or $\pm\mu\mathbf{a}$ This may be embedded in working
	eg $\overrightarrow{OM} = 15\mathbf{b} + \beta\left("\frac{3}{2}\mathbf{a} - \frac{45}{4}\mathbf{b}"\right)$ **or** $\overrightarrow{AM} = -3\mathbf{a} + 15\mathbf{b} + \varphi\left("\frac{3}{2}\mathbf{a} - \frac{45}{4}\mathbf{b}"\right)$ **or** using $\overrightarrow{MN} = \overrightarrow{MO} + \overrightarrow{ON}$ gives $\gamma\left(-3\lambda\mathbf{a} + 15\mathbf{b}\right) = 3\lambda\mathbf{a} + \frac{3}{4}\left("2\mathbf{a} + 5\mathbf{b}"\right)$ using $\overrightarrow{OM} = \overrightarrow{OB} + \overrightarrow{BM}$ gives $3\lambda\mathbf{a} = 15\mathbf{b} + \beta\left("\frac{3}{2}\mathbf{a} - \frac{45}{4}\mathbf{b}"\right)$ using $\overrightarrow{OM} = \overrightarrow{ON} + \overrightarrow{NM}$ gives $3\lambda\mathbf{a} = \frac{3}{4}\left("2\mathbf{a} + 5\mathbf{b}"\right) + \alpha\left("\frac{3}{2}\mathbf{a} - \frac{45}{4}\mathbf{b}"\right)$ using $\overrightarrow{BA} = \overrightarrow{BM} + \overrightarrow{MA}$ gives $3\mathbf{a} - 15\mathbf{b} = \mu\left("\frac{3}{2}\mathbf{a} - \frac{45}{4}\mathbf{b}"\right) + 3\lambda\mathbf{a}$			M1 A correct method to find a second expression for $\overrightarrow{OM}$ or $\overrightarrow{MO}$ or $\overrightarrow{AM}$ or $\overrightarrow{MA}$ (has to be the same vector as for M1) eg $\overrightarrow{OM} = \frac{3}{4}\left("2\mathbf{a} + 5\mathbf{b}"\right) + \alpha\left("\frac{3}{2}\mathbf{a} - \frac{45}{4}\mathbf{b}"\right)$ **or** using resultant vectors using $\overrightarrow{OM}$ or $\overrightarrow{MO}$ or $\overrightarrow{AM}$ or $\overrightarrow{MA}$ to gain an equation in terms of **a** and **b** **or** for 2 correct expressions in terms of **a** and **b** for the same vector with at least one involving $\overrightarrow{OM}$ or $\overrightarrow{MO}$ or $\overrightarrow{AM}$ or $\overrightarrow{MA}$ eg $\overrightarrow{OB} = 15\mathbf{b}$ and $\overrightarrow{OB} = 3\lambda\mathbf{a} - \beta\left("\frac{3}{2}\mathbf{a} - \frac{45}{4}\mathbf{b}"\right)$
	eg $15 - \frac{45}{4}\beta = 0\left[\Rightarrow \beta = \frac{4}{3}\right]$ or $\frac{15}{4} - \frac{45}{4}\alpha = 0\left[\Rightarrow \alpha = \frac{1}{3}\right]$			M1 equating coefficients of **b** eg $15 = \frac{45}{4}\beta = 0\left[\Rightarrow \beta = \frac{4}{3}\right]$
	$\overrightarrow{OM} = 2\mathbf{a}$			A1 Correct vector for $\overrightarrow{OM}$ or $\overrightarrow{AM}$ Implied by correct ratio
		2 : 1		A1 dependent on at least one method mark being awarded. ft their $\overrightarrow{OM}$ or $\overrightarrow{AM}$ providing it is < 3**a** Allow equivalent eg $4:2$
				NB If they gain any method mark then get 2 : 1 is full marks
				Total 8 marks

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