Mark Scheme (Results)

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International GCSE Mathematics (4MB0) 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
  - 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 there is a wrong answer indicated on the answer line 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.

Any case of suspected misread loses A (and B) marks on that part, but can gain the M marks.

If working is crossed out and still legible, then it should be given any appropriate marks, as long as it has not been replaced by alternative work.

If there is a choice of methods shown, then no marks should be awarded, unless the answer on the answer line makes clear the method that has been used.

If there is no answer on the answer line then check the working for an obvious answer.

- **Follow through marks**

Follow through marks which involve a single stage calculation can be awarded without working since you can check the answer yourself, but if ambiguous do not award.

Follow through marks which involve more than one stage of calculation can only be awarded on sight of the relevant working, even if it appears obvious that there is only one way you could get the answer given.

- **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.

- **Probability**

Probability answers must be given a fractions, percentages or decimals. If a candidate gives a decimal equivalent to a probability, this should be written to at least 2 decimal places (unless tenths).

Incorrect notation should lose the accuracy marks, but be awarded any implied method marks.

If a probability answer is given on the answer line using both incorrect and correct notation, award the marks.

If a probability fraction is given then cancelled incorrectly, ignore the incorrectly cancelled answer.

- **Linear equations**

Full marks can be gained if the solution alone is given on the answer line, or otherwise unambiguously indicated in working (without contradiction elsewhere). Where the correct solution only is shown substituted, but not identified as the solution, the accuracy mark is lost but any method marks can be awarded.
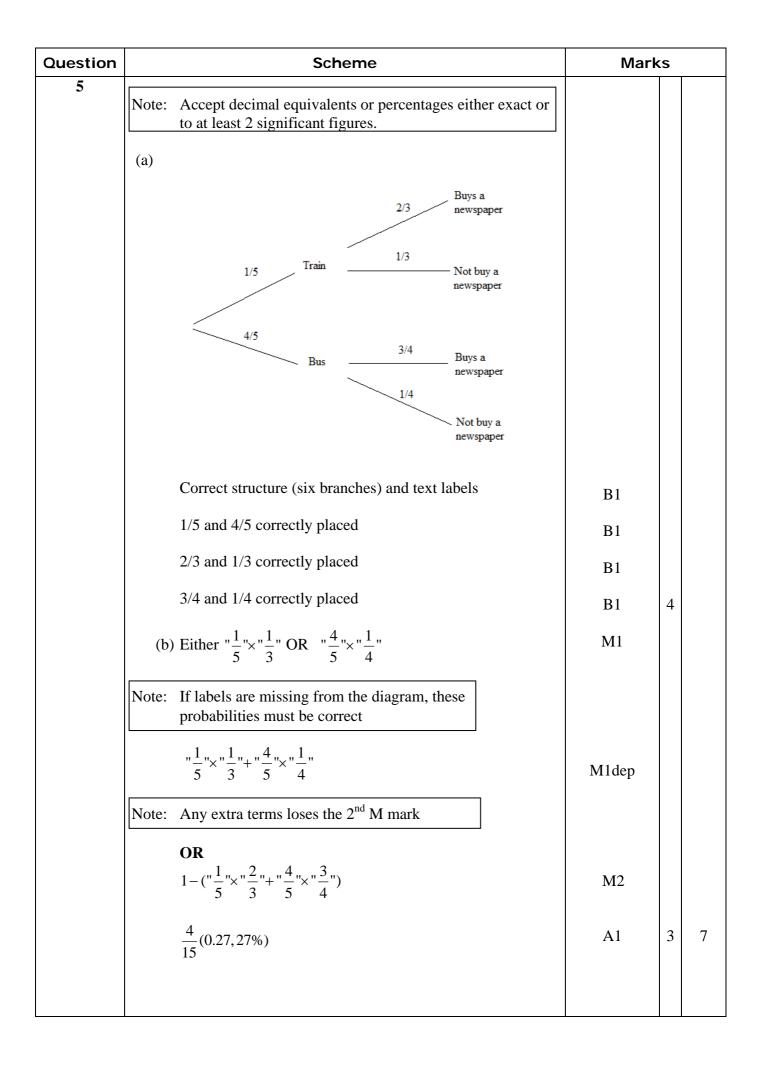
- **Parts of questions**

Unless allowed by the mark scheme, the marks allocated to one part of the question CANNOT be awarded in another.

Question	Scheme	Marks		
	In general, all numerical answers must be exact or answers which round (awrt) to the 3 significant figures given in the scheme. The only accuracy penalty will be, at most, one mark in Question 11.			
1	Notes: Ignore brackets and repeated elements			
	(a) 1, 10	B1	1	
	(b) 4	B1	1	
	(c) 2, 4, 5, 6, 8	B2 (-1eeoo)	2	4
	Notes: 'eeoo' stands for each error or omission So, one error here would be marked B1, B0 SC: Accept $(A \cap C =)$ $2, 4, 6, 8$ for first B1 then Isw if the answer given would invoke B0, B0			

Question	Scheme	Marks		
2	(a) $x + y = 104$ (o.e.)	B1	1	
	(b) $2x + 4y = 404$ (o.e.)	B1	1	
	(c) Correct method for solving two simultaneous eqs	M1		

Notes: 'correct method' (i)
Making x/y the subject of one equation and
Substituting into other equation (no errors)
e.g.
$2(104 - y) + 4y = 404 \quad \Rightarrow \quad$ M1

'correct method' (ii)
Correctly balancing and correctly deciding to add or subtract (no errors)
e.g.
$2x + 2y = 208$

$2x + 4y = 404$

$2y = 196 \quad \Rightarrow \quad$ M1

	$x = 6$, $y = 98$	A1, A1	3	5

Notes: x and y the wrong way round loses, at most one mark.
This will either be the mark in (b) or the **final** A mark.

The first A mark is for x, the second A mark is for y.

Question	Scheme	Marks		
3	(a) $\dfrac{360}{5}$ OR $180 - \dfrac{6 \times 90}{5}$	M1		
	72°	A1	2	

Notes: Having evaluated the required answer of 72°:
    (i)   If the candidate writes $108^{°}$ and clearly identifies
            this as the exterior angle, then the A mark is lost
    (ii)   If the candidate simply writes down 72° and
            $108^{°}$ and does not identify which is the
            exterior angle then again, M1, A0

| | (b) $\angle BAE = 108°$ or $\angle BAM = 72°$ or $\angle NAE = 72°$ | B1 | | |
| | $\angle EFD = 72°$ | B1 | | |

Note: Allow angles to be marked on the diagram.

| | One valid reason, related to the found angles, stating or implying the use of *AB*//*FD* | M1 | | |

Note: '*parallel lines*' or even '*angles between parallel lines*' is
           not sufficient reasoning – there should be some indication
           of corresponding angles, allied angles, supplementary
           angles (between parallel lines)….

| | $\angle EFD = \angle FED = 72°$ + conclusion | A1 | 4 | 6 |

Notes: (i) The candidate who states that *BD*//*AE* may pick up the
first B mark but must prove that BD//AE before any more
marks can be earned.
(ii) Once proven, the mark for a valid reason could be
awarded with a statement involving angles in a
parallelogram.

SC: (no numerical values seen)

$\angle BAE + \angle EFD = 180°$ (allied angles) $\Rightarrow$ B1, M1

$\angle DEA + \angle DEF = 180°$ **AND** $\angle BAE = \angle DEA \Rightarrow$ B1

So $\angle EFD = \angle FED$ + conclusion $\Rightarrow$ A1

Question	Scheme	Marks	
4	Note: Correct answers seen in any part, award full marks.		
	(a) $\dfrac{80}{N} = \dfrac{48}{360}$ (o.e.) OR $\dfrac{80 \times 312}{48} + 80$	M1	
	600	A1	2
	(b) $\dfrac{115}{"600"} \times 360$ OR $\dfrac{115 \times 48}{80}$	M1	
	69°	A1	2
	(c) $\dfrac{2}{3} \times \left("600" - [115 + 80]\right)$ OR $\dfrac{2}{3}(360 - [48 + "69"]) \times \dfrac{80}{48}$	M1	
	Note: $\dfrac{2}{3} \times \left("600" - [115 + 80]\right) = \dfrac{2}{3} \times "405"$ $\dfrac{2}{3}(360 - [48 + "69"]) \times \dfrac{80}{48} = "162" \times \dfrac{80}{48}$		
	270	A1	2	6
	Note: If the candidate writes 270 followed by 135 isw here and award full marks		

Question	Scheme	Marks		
5	Note: Accept decimal equivalents or percentages either exact or to at least 2 significant figures.			

(a)

Correct structure (six branches) and text labels — B1

1/5 and 4/5 correctly placed — B1

2/3 and 1/3 correctly placed — B1

3/4 and 1/4 correctly placed — B1 | 4

(b) Either $"\frac{1}{5}" \times "\frac{1}{3}"$ OR $"\frac{4}{5}" \times "\frac{1}{4}"$ — M1

Note: If labels are missing from the diagram, these probabilities must be correct

$"\frac{1}{5}" \times "\frac{1}{3}" + "\frac{4}{5}" \times "\frac{1}{4}"$ — M1dep

Note: Any extra terms loses the 2nd M mark

OR

$1 - ("\frac{1}{5}" \times "\frac{2}{3}" + "\frac{4}{5}" \times "\frac{3}{4}")$ — M2

$\frac{4}{15}$ (0.27, 27%) — A1 | 3 | 7

Question	Scheme	Marks		
6	Note: 'Simplification' means to gather like vector components together in any acceptable form.			
	(a) (i) $\mathbf{b} - \mathbf{a}$	B1		
	(ii) $\mathbf{a} + \dfrac{1}{2}(\text{"}\mathbf{b} - \mathbf{a}\text{"})$ or $\mathbf{b} - \dfrac{1}{2}(\text{"}\mathbf{b} - \mathbf{a}\text{"})$	M1		
	$\dfrac{1}{2}(\mathbf{a} + \mathbf{b})$	A1	3	
	Note: Accept $\dfrac{\mathbf{a} + \mathbf{b}}{2}$ (o.e.)			
	(b) $\overrightarrow{OD} = \dfrac{3}{4}\mathbf{b}$ (o.e.) **OR** $\overrightarrow{BD} = -\dfrac{1}{4}\mathbf{b}$ (o.e.)	B1		
	$\overrightarrow{CD} = -(\text{"}\dfrac{1}{2}\mathbf{a} + \dfrac{1}{2}\mathbf{b}\text{"}) + \dfrac{3}{4}\mathbf{b}$ or $\dfrac{1}{2}(\text{"}\mathbf{b} - \mathbf{a}\text{"}) - \dfrac{1}{4}\mathbf{b}$	M1		
	Note: The B mark can be implied (if used correctly) in the method			
	$= \dfrac{1}{4}\mathbf{b} - \dfrac{1}{2}\mathbf{a}$	A1	3	
	Note: Accept $\dfrac{1}{4}(\mathbf{b} - 2\mathbf{a})$ (o.e.)			
	(c) Seeing a scale factor of 2	M1		
	$2(\text{"}\dfrac{1}{4}\mathbf{b} - \dfrac{1}{2}\mathbf{a}\text{"})$ or $\dfrac{1}{2}\mathbf{b} - \mathbf{a}$	A1ft	2	
	Note: An answer which is twice their (b) implies both marks			
	(d) $1 : 1$ (o.e.)	B1	1	9
	Note: Accept $m = 1$, $n = 1$ (o.e.)			

Question	Scheme	Marks	
7	Note: To award A1 fts, answers must be whole number values (not rounded values)		
	(a) $\dfrac{36}{100} \times 3750$	M1	
	1350	A1	2
	(b) $\dfrac{3}{5} \times (3750 - "1350")$	M1	
	1440	A1 ft	2
	(c) $\dfrac{75}{100} \times "1440"$ or $"1440" - \dfrac{25}{100} \times "1440"$	M1	
	1080	A1 ft	2
	(d) "1080" + $\dfrac{2}{5} \times (3750 - "1350") +$ "1350" (3390)	M1	
	Notes: For $\dfrac{2}{5} \times (3750 - "1350")$ accept $\dfrac{2}{3} \times "1440"$ For $\dfrac{2}{5} \times (3750 - "1350") + "1350"$ accept $3750 - "1440"$		
	$\dfrac{"1080" + \dfrac{2}{5} \times (3750 - "1350") + "1350"}{0.75}$	M1	
	Note: This second M mark is an independent mark and is for dividing **any** number by 0.75		
	4520	A1	3	9

Question	Scheme	Marks	
8	Notes: (i) Do not penalise lack of labelling		
	(ii) As well as coordinates, accept column vectors and embedded coordinates in 2 x 3 matrices		
	(iii) The diagram alone does not imply B marks for Parts (b) and (d)		
	(a) Triangle *A* drawn	B1	1
	(b) (-1, 1), (-6, 5), (-1, 2)	B2 (-1eeoo)	2
	(c) Triangle *B* drawn	B1 ft	1
	(d) (1, 1), (4, 2), (3, 5)	B2 ft (-1eeoo)	2
	Note: Only ft where candidate shows working		
	(e) Triangle *C* drawn	B1 ft	1
	(f) reflection, *x* – axis	M1, A1	
	Notes: For the A mark accept *y* = 0 For the M mark, the diagram must be consistent for a Reflection but isw after A mark awarded. For both marks to be awarded, both triangle *A* and triangle *C* must be correct. SC: IF MN is calculated as $\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$ award M1 The A1 is available for reflection and *x* – axis		
	OR Rotation *x*° anticlockwise, centre (8, 0)	M1, A1	2 9
	Note: You probably won't see it but…for method, we require Rotation *x*° anticlockwise where $50 \le x \le 55$		

Question	Scheme	Marks		
9	(a) (i) 22	B1		
	(ii) 2+12, 148	B1, B1	3	

Note: SC. Award B1 for $(2+\dfrac{4}{x})^2 - 3(2+\dfrac{4}{x}) - 6$

	(b) $x = 0$ OR $x \neq 0$	B1	1	

Note: Accept 0
Any extra values $\Rightarrow$ B0

	(c) $2+\dfrac{4}{x^2-3x-6}(=0)$ OR f$(x) = -2$	M1		
	$2x^2 - 6x - 8(=0)$ (o.e.)	A1		
	Attempt to solve c's quadratic	M1		

Notes: *Attempt to solve c's quadratic* by

Factorisation: c's quadratic must be a trinomial and, when the two factors are multiplied out, the resultant quadratic must give at least two of the three terms
Formula: A correct substitution into a correct formula.

	$x = 4, \ x = -1$	A1, A1	5	

Note: The A marks can only be awarded where 2nd M is earned and no wrong working seen

	(d) $y = 2 + \dfrac{4}{x}$			
	$xy = 2x + 4$	M1		
	$xy - 2x = 4$	M1 dep		
	$x(y - 2) = 4$	M1 dep		
	OR			
	$y - 2 = \dfrac{4}{x}$	M1		
	$x(y-2) = 4$ or $\dfrac{x}{4} = \dfrac{1}{y-2}$	M1,M1 (M2 dep)		

Question	Scheme	Marks		
	$\mathrm{g}^{-1} : x \mapsto \dfrac{4}{x-2}$ (c.a.o)	A1	4	13
	Note: Accept the interchange of the letter x with the letter y (but **not** for the A mark.)			

Question	Scheme	Marks		
10	(a) $\pi r^2 h - \dfrac{4}{3}\pi r^3$	B1	1	
	(b) $h + 2r = 20$ OR $h = 20 - 2r$	B1	1	
	Note: No isw here.			
	(c) substituting c's expression for h into c's(a)	M1		
	conclusion (with no errors)	A1	2	
	Note: No errors and at least one intermediary step.			
	(d) 16, 32, 25	B1, B1, B1	3	
	(e) graph penalties -1 mark for: any straight line segments* each point missed ($\pm$ ½ small square) each missed segment each point incorrectly plotted ($\pm$ ½ small square) tramlines very poor curve	B3	3	
	Notes: (i) Tramlines must be seen in two or more segments (ii) A poor curve is deemed one which is too thick or crosses $r = 6$ above the axis (iii) *Allow straight line segments between $x = 1$ and $x = 3$			
	(f) vertical line drawn at $r = 3.3$ OR	M1		
	horizontal line drawn in correct place			
	$28.5 \rightarrow 29.5$	A1	2	
	Note: If answer is in range, (even if calculated),award both marks.			
	(g) $\dfrac{180 \times 3}{10 \times \pi}$ (or 17.2)	M1		
	horizontal line drawn at position given above	M1 dep		
	2.1 (± 0.05) and 5.4 (± 0.1)	M1, A1	4	16
	Note: If **both** answers within acceptable limits, award all four marks.			

Question	Scheme	Marks	
11	Notes: (i) In parts (c), (d), (e) and (f) penalise answers which are not correct to 3 SF once only – the first time the error occurs in a final answer (ii) Do not award marks for lengths or angles marked on the diagram. (iii) Ignore units		
	(a) Angle between <u>tangent</u> and <u>radius</u>	B1	1
	Note: Accept diameter for radius.		
	(b) $6 \times PB = 144$	M1	
	Note: Accept $6(x+6) = 12^2$		
	conclusion	A1	2
	(c) $(BC^2 =) \ 24^2 + 12^2 - 2 \times 24 \times 12 \times \cos 50°$ (o.e.)	M1, A1	
	Notes: Award M1 for a substitution into the cosine rule Award A1 for a correct substitution		
	$BC = 18.7$ cm	A1	3
	Note: If 6 is used instead of 24, the length of $BC = 9.35$ cm.		
	(d) $\dfrac{"18.7"}{\sin 50^0} = \dfrac{24}{\sin BCP}$ (o.e.)	M1, A1ft	
	Notes: Award M1 for a substitution into the sine rule for $\angle BCP$ Award A1ft for a correct substitution using their values		
	$\angle BCP = 100.5°/100.6°$	A1	
	$\angle BCO = 10.5°/10.6°$	A1	
	Notes: In all methods, a final answer of 10.5°/10.6° implies both of these A marks are earned SC: Allow A1 for 79.4°/79.5° Allow A1 for 10.5°/10.6°		

Question	Scheme	Marks		
	OR			
	$24^2 = 12^2 + "18.7"^2 - 2 \times 12 \times "18.7" \times \cos BCP$ (o.e.)	M1, A1ft		
	Notes: Award M1 for a substitution into the cosine rule for $\angle BCP$ Award A1ft for a correct substitution using their values			
	$\angle BCP = 100.5°/100.6°$	A1		
	$\angle BCO = 10.5°/10.6°$	A1		
	OR			
	$\dfrac{12}{\sin PBC} = \dfrac{"18.7"}{\sin 50°}$ (o.e.)	M1, A1ft		
	Notes: Award M1 for a substitution into the sine rule for $\angle PBC$ Award A1ft for a correct substitution using their values			
	$(\angle PBC = 29.4°/29.5°)$			
	$\angle PCB = 100.6°/100.5°$	A1		
	$\angle BCO = 10.5°/10.6°$	A1		
	OR			
	$AC^2 = 6^2 + 12^2 - 2 \times 6 \times 12 \times \cos 50°$			
	$AC = 9.35....$			
	$\cos PAC = \dfrac{"9.35"^2 + 6^2 - 12^2}{2 \times 6 \times "9.35"}$	M1, A1ft		
	Notes: Award M1 for a substitution into the second cosine rule for $\angle PAC$ Award A1ft for a correct substitution using their values			
	$\angle PAC = 100.5°/100.6°$	A1		
	$\angle BCO = 10.5°/10.6°$	A1	4	

Question	Scheme	Marks		
	(e) $\dfrac{1}{2} \times "18.7"$	B1ft		
	$(OC =\ )\ \dfrac{\dfrac{1}{2} \times "18.7"}{\cos "10.5"}$	M1		
	OR			
	$\dfrac{OC}{\sin "10.5°\ "} = \dfrac{"18.7"}{\sin "159"}$	M1, A1ft*		
	Note: Award M1 for a substitution into the sine rule for $\Delta\ BOC$ Award A1 for substituting their values. *The A1ft mark is equivalent to the B1ft (for ePen purposes)			
	9.51 cm	A1	3	
	Note: Accept numeric answer in the range $9.47 \rightarrow 9.51$			
	(f) 158.8° or 159°	B1		
	Note: Do not award this B1 for the appearance in part (e) unless it appears again in this part of the question. This value can be seen embedded in a numerical expression for the area			
	$\dfrac{"159"}{360} \times \pi \times "9.51" \times "9.51"$	M1		
	125 (cm^2)	A1	3	16
	Note: Accept numeric answer in the range $124 \rightarrow 125$			