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Mark Scheme (Results)

January 2020

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 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.
  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.

- **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	(a)		90	1	B1oe Allow $2\times3^2\times5$ ISW
	(b)		1 247 400	1	B1oe Allow $2^3\times3^4\times5^2\times7\times11$ ISW
					SC If both answers correct but the wrong way round award (a) B1 (b) B0.
	(c)		70	1	B1 oe $2\times5\times7$ ISW
	(d)	15×10^{410} or 1.5×10^{n} where n is an integer		2	M1 Allow $3\times5\times10^{410}$
			1.5×10^{411}		A1
					Total 5 marks

Question		Working	Answer	Mark	Notes
2		**They do not need to label their shapes to gain the marks.**			
	(a)		Parallelogram drawn at (2,1), (5,1), (3,3) and (6,3)	1	B1
	(b)	for an attempt to translate their parallelogram *A*		2	M1 Allow 3 points of their shape moved +2 horizontally **or** 3 points of their shape moved -5 vertically
			Translation $\begin{pmatrix} 2 \\ -5 \end{pmatrix}$		A1ft their shape *A* **or** Vertices at $(5,-2),(8,-2)$ $(4,-4),(7,-4)$
	(c)	for line $x = 2$ drawn and one correct point ft their shape *B* **or** 2 correct ft points of their shape *B* given **or** their shape *A* correctly reflected in the line $x = 2$		2	M1
			Parallelogram *C* drawn		A1ft their shape *B*. **or** Vertices at $(-1,-2),(0,-4)$ $(-4,-2),(-3,-4)$
	(d)	for a correct orientation $\pm 90°$ of their shape *C*		2	M1 May be in the wrong place. Ft their shape C.
			Parallelogram *D* drawn		A1cao Vertices at $(-3,1),(-1,2)$ $(-3,4),(-1,5)$.
					Total 7 marks

Question		Working	Answer	Mark	Notes
3	(a)	$[OA =]15\tan 25$ oe		3	M1 A correct method for finding *OA* eg $\frac{15}{\tan 65}$ or $\sqrt{\left(\frac{15}{\cos 25}\right)^2 - 15^2}$ or awrt 6.99
		$[\text{Area of circle} =]\pi("OA")^2$			M1 Correct method for finding the area of the circle. Allow use of their *OA*(may be on diagram) and 22/7 for π
			154 or 153 [cm^2]		A1 Allow awrt 154 or awrt 153, Ignore units
	(b)	[Area of triangle =] $\frac{1}{2}(15)("6.9946...")$		4	M1 Correct method for finding the area of the triangle. ft their *OA* from part(a) if working shown eg $\frac{1}{2}(15)\left(\frac{15}{\cos 25}\right)\sin 25$ or $\frac{1}{2}(15)\left(\sqrt{15^2 + "6.9946..."^2}\right)\sin 25$ or awrt 52.4 or 52.5
		[Area of sector =] $\frac{65}{360}\pi("OA")^2$ or $\frac{65}{360}\times$(a)			M1 Allow 22/7 for π . ft their part(a) or *OA* if working shown or awrt 8.83π or awrt 27.8/ 27.7
		[Area of shaded *ABC* =] "52.4596…" $-\frac{65}{360}("153.70128...")$			M1 dependent on both previous M marks Implied by awrt 24.7
			24.7 [cm^2]		A1 awrt 24.6 – 24.8 with no incorrect working. Ignore units
					Total 7 marks

Question		Working	Answer	Mark	Notes
4	(a)	$x = \dfrac{8x^2 - 105}{6x + 1}$		2	M1 for a correct equation. May be see in part (b)
		$x(6x+1) = 8x^2 - 105$	$2x^2 - x - 105$		A1 Note that answer is given so sufficient working must be given. At least one step between initial equation and final given equation. May be see in part (b) – no incorrect working
	(b)	$(2x-15)(x+7) = 0$		4	M1 May be seen in part(a) For solving the **given** 3TQ - 2 terms correct when multiplied out. Allow use of quadratic formula / completing the square with no errors for the **given** 3TQ (Not implied by correct values of x)
		$x = 7.5 \quad (x = -7)$			A1 Correct working must be shown. 7.5 with no algebraic method shown gains M0A0 May be seen in part(a)
		$8(7.5)^2 - 105$			M1Substituting at least one of their x values into $8x^2 - 105$ (allow subst of –ve values). Working must be shown. May be seen in part(a)
			345[m]		A1dependent on at least 1 M mark being awarded Do not ISW. No need for units. Do not award if more than one value given. Do not award from incorrect working (eg use of -7.5) May be seen in part(a)
					Total 6 marks

Question		Working	Answer	Mark	Notes
5	(a)		$\frac{5}{8}, \frac{3}{8}$ $\frac{1}{4}, \frac{3}{4}$ $\frac{1}{6}, \frac{5}{6}$	3	B1 for each correct pair of values in the correct place Allow 0.625 and 0.375 Allow 0.25 and 0.75 Allow awrt 0.17 awrt 0.83 Allow as percentages
	(b)	$'\frac{3}{8}'\times'\frac{5}{6}'$ oe		2	M1 ft their probabilities if $0 < p < 1$
			$\frac{5}{16}$		A1 oe allow awrt 0.31
	(c)	$\left('\frac{5}{8}'\times'\frac{3}{4}'\right)+\left('\frac{3}{8}'\times'\frac{1}{6}'\right)$ oe		2	M1 ft their probabilities if $0 < p < 1$ Allow $1-\left('\frac{5}{8}'\times'\frac{1}{4}'\right)+\left('\frac{3}{8}'\times'\frac{5}{6}'\right)$
			$\frac{17}{32}$		A1 oe allow awrt 0.53
	(d)	$'\frac{5}{8}'\times'\frac{1}{4}'\times\frac{3}{5}$ or $'\frac{5}{8}'\times'\frac{1}{4}'\times\frac{2}{5}$		3	M1 ft their probabilities if $0 < p < 1$ Allow even if embedded in an incorrect calculation
		$1-\left('\frac{5}{8}'\times'\frac{1}{4}'\times\frac{3}{5}\right)$ oe or $'\frac{5}{8}'\times'\frac{1}{4}'\times\frac{2}{5}+'\frac{5}{8}'\times'\frac{3}{4}'+'\frac{3}{8}'$ oe			M1dep on previous method mark being awarded ft if $0 < p < 1$. $'\frac{5}{8}'\times'\frac{1}{4}'\times\frac{2}{5}+'\frac{5}{8}'\times'\frac{3}{4}'+'\frac{3}{8}'$ oe
			$\frac{29}{32}$		A1 oe Allow awrt 0.91
					SC $"\frac{3}{8}"\times"\frac{5}{6}"\times\frac{2}{5}$ seen as method can earn the first M1
					Total 10 marks

Question		Working	Answer	Mark	Notes
6	(a)		$[x =]1.5$	1	B1 oe eg allow $[x \neq]1.5$ or 1.5 on its own
	(b)		$\left(x+\frac{1}{2}\right)^2-\frac{25}{4}$	2	B1 for $a=\frac{1}{2}$ oe B1 for $b=-\frac{25}{4}$ oe
	(c)		$\mathrm{f}(x)\geq-\frac{25}{4}$	1	B1 ft correct answer or follow through their value of *b*. Allow f or *y* instead of f(x) but do not allow *x*
	(d)	$\frac{2c-24}{3-2c}=0$		2	M1 Set g(x) equal to zero or for $\left[g^{-1}(x)=\right]\frac{3x+24}{2+2x}$ oe
			$c=12$		A1 check for incorrect working
	(e)	$\left(x^2+x-6\right)(3-2x)=2x-24$		3	M1 Equate and multiply both sides by 3 – 2x. Implied by next line. Condone missing brackets if clear from following line they are there.
		$3x^2-2x^3+3x-2x^2-18+12x=2x-24$			M1 dep dependent on previous method mark being awarded. Expanding brackets (allow one slip)
			$2x^3-x^2-13x-6=0$		A1 Note: the answer is given so sufficient working must be seen. Both Method marks must be awarded and a fully correct solution with no errors.
	(f)	Substitute – 0.5 into the cubic		2	M1 Allow 1 slip
		$2\left(-\frac{1}{2}\right)^3-\left(-\frac{1}{2}\right)^2-13\left(-\frac{1}{2}\right)-6=0$	= 0		A1 must have = 0
	(g)	x^2+ax-6 or $2x^2+ax-12$		4	M1 dividing by $2x + 1$ to get quadratic of form x^2+ax-6 or $2x^2+ax-12$ May be seen in part (f). May be implied by a correct quadratic. NB $x^2 + x – 6$ scores M0 because this is f(x)
		x^2-x-6 or $2x^2-2x-12$			A1 May be seen in part (f)
		$(x-3)(x+2)$ or $2(x-3)(x+2)$ oe			M1dep on previous M mark being awarded. Solving their 3TQ from division - 2 terms correct when × out.
					NB use of calculator to gain values of – 0.5, – 2 and 3 gains M1A1M1 and
			$(3,6)$		A1 only one set of coordinates must be given.
					Total 15 marks

Question		Working	Answer	Mark	Notes
7	(a)	eg $\left[r^2 =\right] 16 - h^2$ or $\left[r =\right] \sqrt{16 - h^2}$		3	M1 Use of Pythagoras' to find r^2 or r eg $\frac{\sqrt{8^2 - (2h)^2}}{2}$
		$V = \pi\left(16 - h^2\right)(2h)$			M1dep dependent on previous method mark being awarded. ft their r if previous M awarded
			$V = 32\pi h - 2\pi h^3$		A1 Note that answer given so sufficient working must be given. No incorrect working seen.
	(b)	$\left[\frac{\mathrm{d}V}{\mathrm{d}h} =\right] 32\pi - 6\pi h^2$		4	M1 Differentiate – at least one term correct
		$\frac{\mathrm{d}V}{\mathrm{d}h} = 0 \Rightarrow h = ...$			M1dep dependent on previous method mark being awarded. Set derivative equal to zero and solve for h
		$V_{\max} = 32\pi\left(\frac{4}{\sqrt{3}}\right) - 2\pi\left(\frac{4}{\sqrt{3}}\right)^3$			M1 Substitute their h into correct V – dependent on both previous M marks Allow subst of awrt 2.31
			155		A1 awrt 155
	(c)		1.0 to 1.1 inclusive	2	B1
			3.3 to 3.4 inclusive		B1
					Total 9 marks

Question		Working	Answer	Mark	Notes
8	(a)	[Perimeter =] $x+2x+2y+y+(2y-x)+(2x-y)$ (oe)		2	M1 Correct perimeter eg $4y + 4x$ Implied by a correct simplified equation
			$x+y=17$		A1 oe
	(b)	[Area =] $(2y)(2x)-(2y-x)(2x-y)$ or $2x\times x+2y\times y-xy$ with $FE = 2y$ and $DE = 2x$ clear		3	M1 Valid method for finding the area Allow $2x\times x+2y\times y-xy$ but must not be $2x^2$ etc and must be clear $FE = 2y$ and $DE = 2x$. May be on diagram
		$4xy-(4xy-2y^2-2x^2+xy)$ oe Or explanation of why subtracting xy eg $CD\times AF$ or square highlighted on diagram			M1 correct expansion of brackets Or reason why subtracting
					NB Allow M2 for $2x^2+y(2y-x)$ or $2y^2+x(2x-y)$
			$2y^2+2x^2-xy=248$		A1 Note that answer given so sufficient working must be given. Previous M marks must be awarded. No incorrect working seen.
	(c)	$2(17-x)^2+2x^2-x(17-x)=248$ (oe)		5	M1 Substitute to eliminate either x or y using their answer to (a) and the equation given in (b)
		$2(289-34x+x^2)+2x^2-17x+x^2=248$ $\Rightarrow x^2-17x+66=0$ (oe)			M1 dep dependent on the previous method mark being awarded. Correctly expand and reduce theirs to a 3TQ in terms of x or y (does not need to equal zero eg allow $x^2-17x=-66$)
		$(x-11)(x-6)=0$			M1 correct method seen for solving their three term quadratic. Allow correct use of formula.
		$x=11$ and $y = 6$ or $y=11$ and $x = 6$			A1 dep on at least two M1 being awarded. At least one correct pair
			AB = 1 m or 16 m		A1 dep on at least two M1 being awarded. Both answers needed including units.
					Total 10 marks

Question		Working	Answer	Mark	Notes
9		$\mathbf{A} = \mathbf{CB}$ **or** $\begin{pmatrix} 3 & 4 \\ -1 & 2 \end{pmatrix} = \mathbf{C}\begin{pmatrix} 3 & -1 \\ 2 & -2 \end{pmatrix}$ oe		5	M1 setting up the correct equation Allow if written or used $\mathbf{C} = \mathbf{AB}^{-1}$
		$\begin{pmatrix} 3 & -1 \\ 2 & -2 \end{pmatrix}^{-1} = \frac{1}{-6+2}\begin{pmatrix} -2 & 1 \\ -2 & 3 \end{pmatrix}$			B1 for determinant – may be unsimplified. B1 for $\begin{pmatrix} d & -b \\ -c & a \end{pmatrix}$
		$\mathbf{C} = "-\frac{1}{4}"\begin{pmatrix} 3 & 4 \\ -1 & 2 \end{pmatrix}"\begin{pmatrix} -2 & 1 \\ -2 & 3 \end{pmatrix}"$			M1dep dependent on the first M1 and at least one B1 Must use their $\mathbf{B}^{-1}$
			$\mathbf{C} = -\frac{1}{4}\begin{pmatrix} -14 & 15 \\ -2 & 5 \end{pmatrix}$		A1 oe eg $\begin{pmatrix} 3.5 & -3.75 \\ 0.5 & -1.25 \end{pmatrix}$
					Total 5 marks
Alternative					
		$\mathbf{A} = \mathbf{CB}$ or $\begin{pmatrix} 3 & 4 \\ -1 & 2 \end{pmatrix} = \mathbf{C}\begin{pmatrix} 3 & -1 \\ 2 & -2 \end{pmatrix}$ or $\begin{pmatrix} 3 & 4 \\ -1 & 2 \end{pmatrix} = \begin{pmatrix} a & b \\ c & d \end{pmatrix}\begin{pmatrix} 3 & -1 \\ 2 & -2 \end{pmatrix}$ oe			M1 setting up the correct equation. Implied by 4 correct equations.
		$3 = 3a + 2b$ $4 = -a - 2b$ $-1 = 3c + 2d$ $2 = -c - 2d$			B2 for 4 correct equations. Implied by both a and b correct and both c and d correct (B1 for 2 correct equations. Implied by both a and b correct or both c and d correct)
		$a = \frac{7}{2}$ $b = -\frac{15}{4}$ $c = \frac{1}{2}$ $d = -\frac{5}{4}$			M1dep dependent on the first M1 and at least one B1. For solving to gain 2 correct values
			$\mathbf{C} = -\frac{1}{4}\begin{pmatrix} -14 & 15 \\ -2 & 5 \end{pmatrix}$		A1 oe eg $\begin{pmatrix} 3.5 & -3.75 \\ 0.5 & -1.25 \end{pmatrix}$
NB Correct answer with no incorrect working gains full marks					

Question		Working	Answer	Mark	Notes
10	(a)	eg $6^2 = 10^2 + 7^2 - 2\times10\times7\times\cos(\theta)$ (oe)		5	M1 Use of cosine rule in any form to find any angle (ignore incorrect labels). May be seen in part (b) Use of Heron's formula $S = \frac{6+7+10}{2}\left[=11.5\right]$
		$\cos\angle\theta = \frac{10^2+7^2-6^2}{2(10)(7)}$ (oe)			M1dep Dependent on first M mark. Ignore incorrect labels. Using Heron's $"11.5"\times(6-"11.5")\times(7-"11.5")\times(10-"11.5")$ $\left[=426.9375\right]$ May be seen in part (b)
		$\left[\angle ABC =\right]36.1822...$ or $\left[\angle ACB =\right]100.2865...$ or $\left[\angle CAB =\right]43.5311...$			A1 one correct angle. Allow awrt 3 sf. Ignore incorrect labels. Using Heron's awrt 427 May be seen in part (b)
		Area $= \frac{1}{2}(10)(7)\sin(36.1822...)$ or Area $= \frac{1}{2}(7)(6)\sin(100.2865...)$ or Area $= \frac{1}{2}(10)(6)\sin(43.5311...)$			M1dep Dependent on first M mark. Must use the correct sides with the correct angle. For angle allow awrt 36, awrt 44, awrt 100 Using Heron's $\sqrt{"426.9375"}$ May be seen in part (b)
			20.7 [cm^2]		A1 awrt 20.7 May be seen in part (b)
	(b)	Splitting up triangle into 3 each with height *r*		3	M1
		$\frac{1}{2}(10)(r)+\frac{1}{2}(6)(r)+\frac{1}{2}(7)(r)=20.6624.$			M1dep Dependent on first M mark
			1.8 [cm]		A1 Please check working is valid
					Total 8 marks
NB Alternative for (b) on next page					

Alternative for (b)					
		eg $\frac{r}{XB} = \tan\left(\frac{"36.1822"}{2}\right)$ and $\frac{r}{AX} = \tan\left(\frac{"43.531"}{2}\right)$		3	M1 Setting up two equations, in any form, to find the length of any side of triangle
		eg. $\frac{r}{\tan("18.09...")} + \frac{r}{\tan("21.765...")} = 10$			M1dep Dependent on first M mark. For adding the 2 parts and equating
			1.8 [cm]		A1 Please check working is valid

Question		Working	Answer	Mark	Notes
11		$2x+3(4-3x)<8x \Rightarrow 15x>12$		7	M1 Reduce linear inequality to $ax > b$ with either a or b correct or allow $15x < 12$ oe
		$6x-5 \le 4x^2-12x+9$			M1 Expand brackets in an equation or inequality – allow one sign or numerical error(simplified or unsimplified)
		$2x^2-9x+7 \ge 0$			M1 a correct 3TQ in an equation or inequality
		$(2x-7)(x-1)[\ge 0]$			M1 Factorise their 3TQ (oe) to find 2 critical values. 2 terms correct when multiplied out. Or a correct method if formula used. Implied by 1 and 7/2
		$x \le$"1" and $x \ge$"$\frac{7}{2}$"			M1 Choose outside region for their 2 different critical values obtained from their 3TQ. Allow "$\frac{7}{2}$" $\le x \le$ "1"
		$x > \frac{4}{5}$ **OR** $x \le 1$ and $x \ge \frac{7}{2}$			A1 Dependent on at least one M1
			$\frac{4}{5} < x \leqslant 1$ and $x \geqslant \frac{7}{2}$		A1 Dependent on at least 4 M1's
					Total 7 marks

Question		Working	Answer	Mark	Notes
12	(a)	$\frac{3}{8+3+1}\times 30$		2	M1
			7.5 [kg]		A1
	(b)	$\frac{15.04}{1.175}$		2	M1
			[$]12.8(0)		A1
	(c)	$6\times 60\times 60$ [=21600]		4	M1 Correctly converting 6 hours into seconds
		"21600" × 530 [=11448000]			M1dep for no of grams in 6 hours
		$\frac{"11448000"}{30000}$ [=381.6 oe] or			M1dep Dependent on both previous M marks
			381 [bags]		A1 cao
		Alternative			
		$6\times 60\times 60$ [=21600]			M1 Correctly converting 6 hours into seconds
		$\frac{"21600"}{30000}$ [=0.72]			M1dep for no of seconds per gram
		"0.72" × 530 [=381.6 oe]			M1dep Dependent on both previous M marks
			381 [bags]		A1 cao
	(d)	There are many ways of comparing the costs. Some are below but this is not an exhaustive list.			
		e.g. Farmer *A*: $\frac{150.75}{30}$ (= £5.025 per kg)		3	M1 Calculate the cost per kg for either farmer
		Farmer *B*: $\frac{162.35}{1.315\times 25}$ (= £4.938... per kg)			M1 Calculate comparable cost(s) for both farmers with same units
			Farmer *B* is cheaper		A1 Dependent on both previous M marks. No incorrect working seen. Allow truncation or rounding of £/$
					Total 11 marks
NB Alternatives for (d) M1M1 next page					

Alternatives for (d) M1M1					
A1		Farmer *B*: $\frac{162.35}{25}$ (= \$6.494 per kg)			M1 Calculate the cost per kg for either farmer
		Farmer *A*: $\frac{150.75}{30} \times 1.315$ (= \$6.607... per kg)			M1 Calculate comparable cost(s) for both farmers with same units
A2		Farmer A: £150.75 × 1.315 [=\$198.24]			M1 Converting cost of 30kg to \$
		Farmer B : $\frac{162.35}{25} \times 30$ [=\$194.82]			M1 Calculate comparable cost(s) for both farmers for the same weight
A3		Farmer B: $\frac{162.35}{1.315}$ [=£123.46]			M1 Converting cost of 25kg to £
		Farmer A : $\frac{150.75}{30} \times 25$ [=£125.625]			M1 Calculate comparable cost(s) for both farmers for the same weight
Helpful figures					
		Kg/\$ 0.151 and 0.153	Kg/£ 0.199 and 0.202		

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