GCE

Mathematics A

H230/01: Pure Mathematics and Statistics

AS Level

Mark Scheme for June 2022

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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Text Instructions

1. Annotations and abbreviations

Annotation in RM assessor	Meaning
✓and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
^	Omission sign
MR	Misread
BP	Blank Page
Seen	
Highlighting	
Other abbreviations in mark scheme	**Meaning**
dep*	Mark dependent on a previous mark, indicated by *. The * may be omitted if only one previous M mark
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working
AG	Answer given
awrt	Anything which rounds to
BC	By Calculator
DR	This question included the instruction: In this question you must show detailed reasoning.

2. Subject-specific Marking Instructions for A Level Mathematics A

a Annotations must be used during your marking. For a response awarded zero (or full) marks a single appropriate annotation (cross, tick, M0 or ^) is sufficient, but not required.

For responses that are not awarded either 0 or full marks, you must make it clear how you have arrived at the mark you have awarded and all responses must have enough annotation for a reviewer to decide if the mark awarded is correct without having to mark it independently.

It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

Award NR (No Response)

- if there is nothing written at all in the answer space and no attempt elsewhere in the script
- OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
- OR if there is a mark (e.g. a dash, a question mark, a picture) which isn't an attempt at the question.

Note: Award 0 marks only for an attempt that earns no credit (including copying out the question).

If a candidate uses the answer space for one question to answer another, for example using the space for 8(b) to answer 8(a), then give benefit of doubt unless it is ambiguous for which part it is intended.

b An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct solutions leading to correct answers are awarded full marks but work must not always be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly. Correct but unfamiliar or unexpected methods are often signalled by a correct result following an apparently incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
If you are in any doubt whatsoever you should contact your Team Leader.

c The following types of marks are available.

M
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e.g. by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.
A method mark may usually be implied by a correct answer unless the question includes the DR statement, the command words "Determine" or "Show that", or some other indication that the method must be given explicitly.

A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B
Mark for a correct result or statement independent of Method marks.

Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

d When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep*' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

e The abbreviation FT implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only – differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, what is acceptable will be detailed in the mark scheme. If this is not the case please, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

f We are usually quite flexible about the accuracy to which the final answer is expressed; over-specification is usually only penalised where the scheme explicitly says so.

- When a value **is given** in the paper only accept an answer correct to at least as many significant figures as the given value.
- When a value **is not given** in the paper accept any answer that agrees with the correct value to **3 s.f.** unless a different level of accuracy has been asked for in the question, or the mark scheme specifies an acceptable range.

NB for Specification B (MEI) the rubric is not specific about the level of accuracy required, so this statement reads "2 s.f".
Follow through should be used so that only one mark in any question is lost for each distinct accuracy error.
Candidates using a value of 9.80, 9.81 or 10 for *g* should usually be penalised for any final accuracy marks which do not agree to the value found with 9.8 which is given in the rubric.

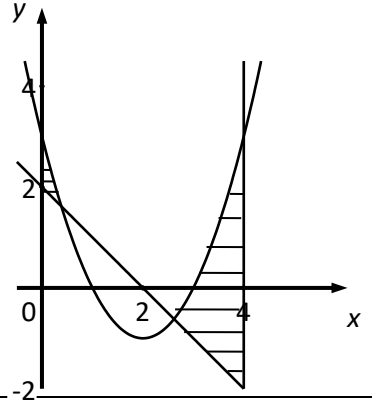
g Rules for replaced work and multiple attempts:

- If one attempt is clearly indicated as the one to mark, or only one is left uncrossed out, then mark that attempt and ignore the others.
- If more than one attempt is left not crossed out, then mark the last attempt unless it only repeats part of the first attempt or is substantially less complete.
- if a candidate crosses out all of their attempts, the assessor should attempt to mark the crossed out answer(s) as above and award marks appropriately.

h For a genuine misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A or B mark in the question. Marks designated as cao may be awarded as long as there are no other errors.
If a candidate corrects the misread in a later part, do not continue to follow through. Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

i If a calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers, provided that there is nothing in the wording of the question specifying that analytical methods are required such as the bold "In this question you must show detailed reasoning", or the command words "Show" or "Determine". Where an answer is wrong but there is some evidence of method, allow appropriate method marks. Wrong answers with no supporting method score zero. If in doubt, consult your Team Leader.

j If in any case the scheme operates with considerable unfairness consult your Team Leader.

Question			Answer	Marks	AO	Guidance
1			${}^5C_2 \times 3^2 \times (-2x)^3$ $= -720x^3$ ISW	**B1** **B1** **[2]**	**1.1** **1.1**	${}^5C_2$ or ${}^5C_3$ soi or $3^2 \times (-2x)^3$ or ±720 soi cao
2	(a)		**DR** $5 \times 2^3 - 4 \times 2^2 + 2a - 2 = 0$ oe or $40 - 16 + 2a - 2 = 0$ oe $a = -11$	**M1** **A1** **[2]**	**1.1** **1.1**	Substitute $x = 2$ and equate to 0. May be implied or ÷ by $(x - 2)$ & obtain $5x^2 + 6x + 1$ $a = -11$, with no working SC: B1
2	(b)		**DR** $5x^3 - 4x^2 - 11x - 2 = (x - 2)(px^2 + qx + r)$ oe $= (x - 2)(5x^2 + 6x + 1)$ $= (x - 2)(5x + 1)(x + 1)$ ISW	**M1** **A1** **A1** **[3]**	**1.1** **1.1** **1.1**	attempted, or attempt $(5x^3 - 4x^2 - 11x - 2) \div (x - 2)$ ft (a) May be implied by next line Above method must be seen. Use of solutions: M0A0A0
3	(a)		$x^2 - 3x + 1 \Rightarrow x^2 - 4x + 3 = -x + 2$ $m = -1,\ c = 2$ or $y = -x + 2$	**M1** **A1** **[2]**	**1.1** **1.1**	Attempt form equation of form $x^2 - 4x + 3 = mx + c$ NB $x^2 - 3x + 1 = x^2 - 4x + 3$: M0 unless this leads to $y = mx + c$ seen
3	(b)		Line $y = -x + 2$ drawn $x = 0.4$ (±0.1), $x = 2.6$ (±0.1)	**M1** **A1** **[2]**	**1.1** **2.2a**	Good attempt at draw their line from (a) Ignore y-coords cao NB, correct answers do NOT score marks unless they clearly come from the correct line seen, except:. SC: correct answers from graph of $y = x^2 - 3x + 1$ B0B1
3	(c)		 	 **B1ft** **B1ft** **B1** **[3]**	 **1.1** **1.1** **1.1**	At least one region indicated that is: wholly above the line $y = -x + 2$, ft their line, no omission Follow only correct line or their line from (a) wholly below the curve $y = x^2 - 4x + 3$, no omissions Follow their line as drawn with its shading All correct cao Accept any correct indication, eg shading in, shading out, arrows, letters etc

Question			Answer	Marks	AO	Guidance
4	(a)		**DR** $x = \tan^{-1}(\frac{3}{2})$	**M1**	**2.1**	Attempt inverse tan of $\frac{3}{2}$ may be implied by result and eg $\tan x = \frac{3}{2}$
			$x = 56.3^o$ (3 sf)	**A1**	**1.1**	
			$x = 236^o$ (3 sf) with no extras	**A1** **[3]**	**1.1**	Allow omission of degrees sign throughout SC: If no working shown, B2 both correct, no extras B1 one correct, no extras or both correct with extras.
4	(b)		**DR** $5\sin x - 1 = 2(1 - \sin^2 x)$ $2\sin^2 x + 5\sin x - 3 = 0$	**M1**	**3.1a**	Use of $\sin^2 + \cos^2 = 1$. May be implied
			$(2\sin x - 1)(\sin x + 3)\ (= 0)$ or $\sin x = \frac{-5\pm\sqrt{25+24}}{4}$	**M1**	**2.1**	or $(2u - 1)(u + 3)\ (= 0)$ or $u = \frac{-5\pm\sqrt{25+24}}{4}$ Correct method **seen**. ft their equation
			$\sin x = 0.5$ (or -3) or $u = 0.5$ (or -3)	**A1f**	**1.1**	ft their equation. Allow without $\sin x = -3$ Dep 1st M1, not 2nd M1
			$\sin x = -3$ is not possible, or no solution oe	**B1**	**2.3**	Appropriate comment needed, eg "N/A", not just crossing out
			$x = 30^o$ or 150^o	**A1** **[5]**	**1.1**	cao. Both, with no extras. Dep 1st M1, not 2nd M1
5	(a)		$\int (x^2 - 3x)\mathrm{d}x$	**M1**	**3.1a**	≥ one term or both powers correct. May be implied by result
			$= \frac{x^3}{3} - \frac{3x^2}{2} + c$	**A1**	**1.1**	Allow without "+ c"
			$20 = \frac{6^3}{3} - \frac{3\times 6^2}{2} + c$ $(\Rightarrow c = 2)$	**M1**	**2.1**	Substitute $x = 6$ into their integral, dep M1, & = 20
			$y = \frac{x^3}{3} - \frac{3x^2}{2} + 2$	**A1**	**1.1**	Correct answer, including "$y =$ ". Allow f(x) = …
				[4]		NB, if no working seen for finding c, but fully correct answer given: SC3

Question			Answer	Marks	AO	Guidance
5	(b)		$\int_1^p (\frac{x^3}{3} - \frac{3x^2}{2} + 2)\mathrm{d}x$	M1	2.1	ft their equation, dep cubic. ≥ two terms or all three powers correct. May be implied by result
			$= \left[\frac{x^4}{12} - \frac{x^3}{2} + 2x\right]_1^p$	A1ft	1.1	Correct integral of their curve, dep quartic
				M1	1.1	Substitute limits 1 and p, dep integration attempted
			$= \frac{p^4}{12} - \frac{p^3}{2} + 2p - \frac{19}{12}$ oe	A1ft	1.1	ft their integral, dep their integral is a quartic.
				[4]		
6	(a)	(i)	5460 (3 sf)	B1	1.1	
				[1]		
6	(a)	(ii)	$9000 = 100e^t$			
			$t = \ln 90$	M1	3.1a	May be implied by answer
			$= 4.50$ (3 sf) Allow 4.5 ISW	A1	1.1	Ignore units. Decimal answer needed
				[2]		
6	(b)	(i)	$\log_{10} P = \log_{10}(ka^t)$			No marks yet
			$\log_{10} P = \log_{10} k + \log_{10}(a^t)$	M1	1.1	At least two terms correct, may be implied by next line
			$\log_{10} P = \log_{10} k + t\log_{10} a$	A1	1.1	All correct, in this form
				[2]		
6	(b)	(ii)	Points plotted correctly ±0.1	B1	1.1	NB. May be implied by correct line of best fit
			Line of best fit drawn, between (1, 2.0) and (1, 2.4) and between (5, 4.2) and (5, 4.5)	B1f	1.1	ft reasonable line through their points
				[2]		

Question			Answer	Marks	AO	Guidance
6	(b)	(iii)	Read off c and attempt 10^c . May be implied by value of k k = 19.9 to 63.1	M1 A1	3.1a 2.1	ft their line. Probably c = 1.3 to 1.8, $k = 10^{1.3}$ to $10^{1.8}$
			Attempt gradient of their graph AND correct ft equation in a. May be implied by value of a a = 3.16 to 5.01 (3 sf)	M1 A1	1.1 1.1	ft their line. Probably m = 0.5 to 0.7 AND $\log_{10}a$ = 0.5 to 0.7 OR $a = 10^{0.5}$ to $10^{0.7}$ scores NB Use of two points and simultaneous equations: no marks unless the two points used are on their line of best fit. If first method used for k or a and then one point substituted in equation to find the other letter, no marks for second letter unless point used is on line of best fit.
				[4]		
7	(a)		**DR** $x^2 + (mx)^2 - 6x - 2mx + 5 = 0$ $(1 + m^2)\,x^2 - (6 + 2m)x + 5 = 0$ (I) $(6 + 2m)^2 - 20(1 + m^2)$ (≥ 0) $\Delta = -16m^2 + 24m + 16$ (≥ 0) Roots of $-16m^2 + 24m + 16 = 0$ are $m = 2$ and $m = -\frac{1}{2}$ Range for real solutions is $-\frac{1}{2} \leq m \leq 2$	 M1 M1 M1 A1 A1 [5]	 1.1 3.1a 1.1 1.1 2.2a	Substitute $y = mx$ into the other equation, in original form or rearranged form even if incorrectly rearranged Attempt find Δ. ft their equation Attempt rearrange Δ as a quadratic expression in m or critical values are 2 and $-\frac{1}{2}$ cao cao Not "<"

Question			Answer	Marks	AO	Guidance
7	(b)		$m = 2 \Rightarrow x^2 + 4x^2 - 6x - 4x + 5 = 0$ $(\Rightarrow 5x^2 - 10x + 5 = 0)$	M1	1.1	Substitute $m = 2$ into their (I) or substitute $y = 2x$ into $x^2 + y^2 - 6x - 2y + 5 = 0$
			$x = 1$, & repeated root or only one root oe or $x = 1$, $x = 1$ NB May be implied by next line.	A1		
			Line is a tangent	A1	2.1	or "Only one intersection point" oe dep M1 only
			Alternative method 1 $m = 2$ gives $\Delta = -16\times2^2 + 24\times2 + 16$	M1		Substitute $m = 2$ into their Δ
			$= 0$. hence repeated root or only one root oe NB May be implied by next line.	A1		
			Line is a tangent	A1		or "Only one intersection point" oe
			Alternative method 2 Attempt draw circle centre (3, 1) and line through O	M1		NB Question allows for diagrammatic solution.
			Approximately correct diagram showing line touching circle	A1		
			State "Tangent" or "Only one intersection point" oe	A1		Dep M1A1
				[3]		.
8	(a)		Basic scheme: B1 for negative correlation in context soi B1 for any indication of caution about conclusion			Must be in context
			Negative correlation between hours and money stated or implied, eg by such as: Time spent on earning reduces time on school work	B1	1.2	
			Except for one student (or one point) or There is an outlier or anomaly oe or Small sample so unreliable	B1	2.2b	Allow without context Or Poor (or no) correlation between hours and money B1 because of the outlier B1
				[2]		

Question			Answer	Marks	AO	Guidance
8	(b)		Mean = 28.9 SD = 7.93 (3 sf)	B1 B1 [2]	3.1a 1.1	Allow 28.8 cao Ignore all else
9	(a)	(i)	B(150, 0.08) or B(150, $\frac{2}{25}$) oe	B1 [1]	3.3	or n =150, p = 0.08 Ignore all else
9	(a)	(ii)	$(0.92 + 0.08)^{150}$ oe Allow a = 0.92, b = 0.08, n = 150	B1 [1]	1.2	or $(0.08 + 0.92)^{150}$ Not eg $\binom{150}{x}0.92^{(150-x)}0.08^{x}$

Question			Answer	Marks	AO	Guidance
9	(b)					**Allow 2 sf throughout**
			H_0: $p = 0.08$ where p = proportion of adults (in the town) who use coffee shop. Allow "probability". Allow 8%.	**B1**	**1.1**	Allow "where p is the population proportion" Subtract B1 for each error eg: Allow other letters, including x if defined as proportion
			H_1: $p > 0.08$	**B1**	**2.5**	2-tail B1B0 Not include 0.08 B0B0 undefined p B1B0 eg $H_0 = 0.08$ etc: B0B0 not in terms of parameter B1B0 p = sample proportion soi B1B0
			B(150, 0.08) & $X = 18$ stated or used Allow $X = 17$ or 19	**M1**	**3.3**	Correct distribution and value of X, stated or implied eg by 0.055 or 0.031 ($X \geq 19$) or 0.0923 ($X \geq 17$) or 0.0239 ($X = 18$) or 0.945 or 0.969 or 0.908 or 0.976 even if within incorrect statement eg $P(X = 18) = 0.0552$
			$P(X \geq 18) = (1 - 0.945 =) 0.055(1)$ (2 sf)	**A1**	**3.4**	cao **BC**
			comp 0.05	**A1**	**1.1**	Explicit comparison, dep 0.055(1) or 0.031 or 0.0923
			Not reject H_0 Allow Accept H_0 or Reject H_1	**M1**	**1.1**	dep $P(X \geq 18 \text{or} 19 \text{or} 17)$ seen or 0.055 or 0.031 or 0.0923 Might be implied by conclusion NB Allow opposite conclusion on ft from 0.031
			Insufficient evidence that proportion who use coffee shop is more than 0.08 (or has increased)	**A1f**	**2.2b**	Any equivalent statement, in context, eg allow "likelihood", "percentage" Ignore all else Dep $P(X \geq 18)$ oe or 0.055 seen; ft their $P(X \geq 18)$ only (not 19 or 17) Not definite, eg Not "Proportion who use coffee shop has not increased" Not "Insufficient evidence that proportion has changed"
9	(b)	ctd	**Alternative (incorrect) method, using 2 tails:**			
			Hypotheses:	**B1B0**		
			Calculation: as above	**M1A1**		
			Comparison: for compare 0.025 oe	**A1**		No more marks
				[7]		

Question			Answer	Marks	AO	Guidance
9	(c)		State or imply *p* not constant or sample not representative, or not random, with reason EG: Fri population (or probability) may be different from Sat Fri/Sat may be different from other days Those shopping are more likely to use coffee shop People who work full-time more likely to shop on Sat People who work can't buy coffee on Fri People may buy coffee on the way to work, not on Sat People in town may not be representative of everyone OR State or imply that one person using the shop may not be independent (of other people using the shop) with reason EG: Friends (groups, families etc) may visit the shop together A person may have been in the shop on both Fri & Sat	B1 [1]	3.5b	NOT just "Not random" NOT There may be more people on Fri & Sat NOT People in town may not live in the town NOT just "Shoppers may not be independent" Ignore all else
10	(a)		Metropolitan (borough)	B1 [1]	2.2a	Allow 08. Ignore all else.
10	(b)		Increase (in most LAs) in % driving Decrease everywhere in % passengers Decrease in % bus (& metro)	B1 B1 [2]	2.2b 2.2b	Any 2 of these, (not "metro" without "bus" but allow "public transport"). Allow "proportion", condone "number", instead of % Ignore all else
10	(c)		Those in age range 55–65 in 2001 will mostly not be included in 2011; replaced by those in range 10–20 in 2001 Hence 35 years' worth out of 45 77.8(%) (3 sf) or ≈ 78(%)	M1 A1 [2]	2.4 2.1	Both 35 and 45 must be seen or implied Allow 77.7(%)

Question			Answer	Marks	AO	Guidance
10	(d)		Older people using public transport or walking have been replaced by younger people in cars Or young people prefer to drive own car (in 2011 or now) More young people learn to drive (in 2011 or now) Cars have become cheaper, or more popular	B1 [1]	2.2b	oe Any plausible explanation that is consistent with answer to (c). NOT Any reference to an ageing population Ignore all else
11	(a)	(i)	$\left(\frac{3}{25}\right)^2 \times \frac{1}{5}$ (× 3) $= \frac{27}{3125}$ or 0.00864 ISW	M1 A1 [2]	3.1a 1.1	Correct product seen, not necessarily alone. Allow without "× 3" May be implied by the answer NB $\left(\frac{1}{5}\right)^3 = 0.008$ M0A0
11	(a)	(ii)	$\left(\frac{3}{25}\right)^2 \times \frac{22}{25} + \left(\frac{1}{5}\right)^2 \times \frac{4}{5} + \left(\frac{8}{25}\right)^2 \times \frac{17}{25} + \left(\frac{7}{25}\right)^2 \times \frac{18}{25} + \left(\frac{2}{25}\right)^2 \times \frac{23}{25}$ or 0.0127 + 0.032 + 0.0696 + 0.0564 + 0.00589 or $\frac{198}{15625} + \frac{4}{125} + \frac{1088}{15625} + \frac{882}{15625} + \frac{92}{15625}$ = 0.177 (3 sf) or $\frac{552}{3125}$ or $\frac{2760}{15625}$	M1 M1 A1	3.4 1.1 1.1	M2 for all 5 correct products M1 for 2 correct products Correct answer with no working scores M1M0A1 SC. If no marks scored, but all 20 cases listed: B1
			Alternative method. P(1st 2 the same) − P(all 3 same) $\left(\frac{3}{25}\right)^2 + \left(\frac{1}{5}\right)^2 + \left(\frac{8}{25}\right)^2 + \left(\frac{7}{25}\right)^2 + \left(\frac{2}{25}\right)^2$ $- \left(\left(\frac{3}{25}\right)^3 + \left(\frac{1}{5}\right)^3 + \left(\frac{8}{25}\right)^3 + \left(\frac{7}{25}\right)^3 + \left(\frac{2}{25}\right)^3\right)$ = 0.177 (3 sf) or $\frac{552}{3125}$	 M2 A1		 M1 for either P(1st 2 the same) or P(all 3 same) correct

Question	Answer	Marks	AO	Guidance
	Alternative method using 20 cases $\left(\frac{3}{25}\right)^2\times\frac{1}{5}+\left(\frac{3}{25}\right)^2\times\frac{8}{25}+\left(\frac{3}{25}\right)^2\times\frac{7}{25}+\left(\frac{3}{25}\right)^2\times\frac{2}{25}$ or 0.00288 + 0.004608 + 0.004032 + 0.001152 or $+\frac{45}{15625}+\frac{72}{15625}+\frac{63}{15625}+\frac{18}{15625}$ $+\left(\frac{1}{5}\right)^2\times\frac{3}{25}+\left(\frac{1}{5}\right)^2\times\frac{8}{25}+\left(\frac{1}{5}\right)^2\times\frac{7}{25}+\left(\frac{1}{5}\right)^2\times\frac{2}{25}$ or + 0.0048 + 0.0128 + 0.0112 + 0.0032 or $\frac{3}{625}+\frac{8}{625}+\frac{7}{625}+\frac{2}{625}$ $+\left(\frac{8}{25}\right)^2\times\frac{3}{25}+\left(\frac{8}{25}\right)^2\times\frac{1}{5}+\left(\frac{8}{25}\right)^2\times\frac{7}{25}+\left(\frac{8}{25}\right)^2\times\frac{2}{25}$ or + 0.01229 + 0.0205 + 0.0287 + 0.00819 or $+\frac{192}{15625}+\frac{64}{3125}+\frac{448}{15625}+\frac{128}{15625}$ $+\left(\frac{7}{25}\right)^2\times\frac{3}{25}+\left(\frac{7}{25}\right)^2\times\frac{1}{5}+\left(\frac{7}{25}\right)^2\times\frac{8}{25}+\left(\frac{7}{25}\right)^2\times\frac{2}{25}$ or + 0.00941 + 0.0157 + 0.0251 + 0.00627 or $\frac{147}{15625}+\frac{49}{3125}+\frac{392}{15625}+\frac{98}{15625}$ $+\left(\frac{2}{25}\right)^2\times\frac{3}{25}+\left(\frac{2}{25}\right)^2\times\frac{1}{5}+\left(\frac{2}{25}\right)^2\times\frac{8}{25}+\left(\frac{2}{25}\right)^2\times\frac{7}{25}$ or 0.000768 + 0.00128 + 0.00205 + 0.00179 or $\frac{12}{15625}+\frac{4}{3125}+\frac{32}{15625}+\frac{28}{15625}$ = 0.177 (3 sf) or $\frac{552}{3125}$	**A1**		M2 for all 20 products M1 for 8 correct products
		[3]		

Question			Answer	Marks	AO	Guidance
11	(b)		Basic scheme: Must refer to some aspect of the model that makes ≈3 goals per match unlikely Must mention or imply ≈3 goals per match EG: Current model seems to underestimate probabilities of higher numbers of goals Or about 3 goals per match, but mean in the model is < 3 Or about 3 goals per match, but mean = 2 or median = 2 Or model suggests more matches < than 3 than > 3 Or model suggests < 3 goals per match	**B1** **[1]**	**3.5a**	oe. Or eg P($X > 4$) should be more than 0 or model suggests impossible to score more than 4 goals or model says P(3 or more) = 0.36 which is small NOT ≈3 goals per match, but P($X = 3$) = $\frac{7}{25}$, too small. NOT ≈3 goals per match, but $(\frac{7}{25})^{10}$ is tiny NOT ≈3 goals per match unlikely given this model NOT 3 is not the most likely number of goals NOT Highest probability is 2 Ignore all else
				75		

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