GCE

Further Mathematics A

Y532/01: Statistics

AS Level

Mark Scheme for June 2023

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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.

MARKING INSTRUCTIONS

PREPARATION FOR MARKING
RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **number of required** standardisation responses.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. **Annotations**

Annotation	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.

5. **Subject Specific Marking Instructions**

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	**(a)**	Flaws occur independently of one another	**B1**	3.3	At least one contextualised reason, ignore "singly".
		and at constant average rate (or "uniform rate" which is equivalent)	**B1** **[2]**	3.3	A second assumption, not "singly". Allow "fixed average rate". *Not*: "constant rate" or "average constant rate" or "constant average number" or "constant probability" or "probability same for each 1 km". More than 2 different assumptions (ignore "singly"): max B1.
	(b)	P($\leq$ 11) – P($\leq$ 7)	**M1**	1.1	Allow M1 for 0.109(24)... *Not*, eg, P($\leq$ 11) – (1 – P($\leq$ 7)) = 0.77
		= 0.202 (0.20171)	**A1 [2]**	1.1	Awrt 0.202
	(c)	Po(5.7 × 5) (= Po(28.5))	**M1**	3.3	Stated or implied
		their P($\leq$ 29)×(1 – *their* P($\leq$ 29))×2 (= 0.586 × 0.414 × 2)	**M1**	1.1	Or 1 – [*their* P($\leq$ 29)]^2 – [1 – *their* P($\leq$ 29)]^2 (= 1 – 0.586^2 – 0.414^2) Allow M1 for 2 omitted or e.g. P($\leq$ 29)×(1 – P($\leq$ 30))×2 (both: M0)
		= 0.485(19)	**A1** **[3]**	1.1	Awrt 0.485

Question		Answer	Marks	AO	Guidance
2	**(a)**	Class Baroque CDs as single unit	**M1**	3.1b	e.g. 23!×7! seen, with or without other terms, *or* 24! (with 7! omitted)
		24! × 7! (= 6.2×10^{23} × 5040)	**A1**	1.1	These, and no other terms, in numerator (allow even if no denominator)
		÷ 30! = 1.18×10^{-5} = 0.000 011 8	**A1** **[3]**	1.1	Awrt 1.2×10^{-5}, or $\frac{1}{84825}$
	(b)	6: $^7C_6 \times {}^{23}C_4$ (= 7×8855 or 61 985)	**M1***	2.1	Clear attempt at one (allow for $^7C_6 \times {}^{23}C_4 \times$ other things), allow $^{10}C_6 \times \ldots$
		7: $1 \times {}^{23}C_3$ (= 1771)	**A1**	1.1	Both expressions correct
		Add, and divide by $^{30}C_{10}$ (= 30 045 015)	**depM1**	3.1b	[$= \frac{7}{3393} + \frac{1}{16\,965}$] Needs two terms, allow dividing by $^{30}P_{10}$ if consistent
		$= \frac{4}{1885}$ or 0.002 12 (0.002 122 ...)	**A1** **[4]**	1.1	Any equivalent exact fraction, or 0.00212 or better
					SC: B(10, $\frac{7}{30}$), 0.014(0): B1 max
					SC: ($^7P_6 \times {}^{23}P_4$) + ($^7P_7 \times {}^{23}P_3$), M1; × 20!/30!, M1 (same as ÷ $^{30}P_{10}$)
	OR	$^7C_6 \times[{}^{10}C_4 + {}^{10}C_3 \times 13 + {}^{10}C_2 \times {}^{13}C_2 + 10 \times {}^{13}C_3 + {}^{13}C_4] + [{}^{10}C_3 + {}^{10}C_2 \times 13 + 10 \times {}^{13}C_2 + {}^{13}C_3] = 7 \times(210+1560+3510+2860+715) + (120+585+780+286)$			

Question		Answer	Marks	AO	Guidance
3	**(a)**	$64282/32 - (1340/32)^2 = 255(.297)$	**B1** [1]	1.1	Awrt 255. Allow 263.52 from $n/(n-1)$. Don't give ISW for $\sqrt{255}$
	(b)	$y = 8.02 + 0.265(2)x$ $[\frac{131039}{16339} + \frac{4333}{16339}x]$	**B2** [2]	1.1 1.1	Coefficients exact or correct to 3 sf, allow 8.03, letters correct. One error: B1
	(c)	$8.02 + 0.2652 \times 48 = £20\,700$ (3 sf) (20749)	**B1** [1]	1.1	Awrt 20700 (not 20.7) or in range [20740, 20 750]. Ignore absence of £ NB: can be obtained from calculator even if **(b)** is wrong; B1 for this
	(d)	SD is $\sqrt{255} \approx 16$ and 48 is less than 6 away from $\bar{x}$ so extremely likely that range includes 48	**B1** **B1** [2]	1.1 2.3	Relevant calculation, e.g. $1340/32 \pm 2\sqrt{255}$, or difference is 0.383σ SD or variance mentioned and nuanced conclusion e.g. "very likely that Tom is wrong" or more extreme, but not "Tom is wrong" SC: Only variance mentioned: max (B0)B1
	(e)	(48 almost certainly within range but) correlation only moderate so not very reliable.	**M1** **A1** [2]	2.4 2.4	Comment on size of PMCC, allow comparison with CV Nuanced conclusion, but *not* from "significant evidence of correlation" OE (a significance test asks "is there evidence that $\rho > 0$?", but here the issue is "how close is ρ to ± 1?", so a significance test is irrelevant)

(d)

(A)	The standard deviation is ≈ 16, so Tom is likely to be right	B0
(B)	Variance is large so very likely that Tom is wrong *(SC – but not "variance is very large so results inaccurate")*	B0B1
(C)	Less than 2 SD above mean, so Tom is incorrect *(B1, but not nuanced so B0)*	B1B0
(D)	Variance is large so results vary a lot, so likely to be data above 48, so unlikely that Tom's claim is correct	B0B1
(E)	Less than one standard deviation away from mean [consistent with **(a)**], so Tom is very unlikely to be right *(minimum for B1B1)*	B1B1

(e)

(F)	PMCC shows quite strong correlation and probably within range, so reliable	M1A0
(G)	PMCC shows quite strong correlation so fairly reliable	M1A1
(H)	Not very reliable as PMCC is low and might be extrapolating	M1A1
(I)	Not very reliable as PMCC is low	M1A1

Question		Answer	Marks	AO	Guidance
4		$a + b = 0.4$	**B1**	1.1	Allow $a + b + 0.6 = 1$, *or* use both $2a + b \pm = 0.55$ and $58a + 59b = 23.45$
		$-2a - b + 0.2 + 0.2 + 0.3 = 0.15$	**M1**	1.1	Use $\Sigma(W - 60)P(w) = 0.15$
		$2a + b = 0.55$	**A1**	1.1	Correct simplified equation
		$a = 0.15, b = 0.25$	**A1**	1.1	
		$4a + b + 1{\times}0.2 + 4{\times}0.1 + 9{\times}0.1 \; (= 2.35)$	**M1**	2.1	Find $\Sigma(W - 60)^2 P(w)$
		$- 0.15^2$ and $\times 16$	**M1**	1.1	(independent of previous M1)
		$= 37.24$	**A1** [7]	1.1	Or $\frac{931}{25}$
	Or	$a + b = 0.4$	**B1**		Allow $a + b + 0.6 = 1$
		$58a + 59b + 60{\times}0.2 + \ldots + 63{\times}0.1 = 60.15$	**M1**		Use $\Sigma WP(w) = 0.15 + 60$
		$58a + 59b = 23.45$	**A1**		Correct simplified equation
		$a = 0.15, b = 0.25$	**A1**		
		$16{\times}(58^2 a + 59^2 b + \ldots + 63^2{\times}0.1) \; (= 57925.6)$	**M1**		$16 \times \Sigma w^2 P(w)$
		$- (4{\times}60.15)^2$	**M1**		$- (4 \times their \; \overline{w})^2$ (independent of previous M1)
		$= 37.24$	**A1** [7]		Or $\frac{931}{25}$
	Or	(last 3 marks) $58^2 a + 59^2 b \ldots + 63^2{\times}0.1 - 60.15^2$	**M1**		$= 3620.35 - 3618.0225 = 2.3275$
		$\times 16$	**M1**		Allow for $16{\times} \Sigma w^2 P(w)$ without having subtracted 60.15^2
		$= 37.24$	**A1**		
	SC	If B0M0, give SC B1 for $\mathrm{Var}(4W - 60) = 16\mathrm{Var}(W)$ used	**B1**		

Question		Answer	Marks	AO	Guidance
5	(a)	$H_0: \rho = 0$, $H_1: \rho > 0$ where ρ is the population product-moment correlation coefficient between the test scores.	**B2**	1.1 2.5	One error, e.g. two-tailed, or ρ not defined: B1. Allow $H_0: \rho \leq 0$ Symbols: Definition of ρ needs "population" or context or both, and "correlation". Allow r in place of ρ. Do *not* allow "association" here Verbal: H_0: no correlation between openness and creativity, H_1: positive correlation: max B1 unless "population" explicit. Needs "positive". *Allow "association" here.*
		$\rho = 717 \div \sqrt{(1075.6 \times 2016)}$ $= 0.487$ (0.48691)	**M1** **A1**	1.1 1.1	Art 0.487 seen gets M1A1. Else allow M1 for correct subs into formula, or any two of 1075.6, 2016 and 717, or any two of 71.7, 134.3 and 47.8
		$0.487 > 0.4409$ so reject H_0.	**M1ft**	1.1	Compare their r with 0.4409 or 0.441 and reject (ft on TS)
		There is significant evidence of positive association between openness and creativity.	**A1ft** **[6]**	2.2b	Correct contextualised conclusion, not too assertive, allow omission of "positive", FT on their r, no FT for hypotheses wrong way round
	(b)	Points lie fairly (but not very) close to straight line	**B1**	2.4	Must refer to diagram of points, not just to correlation. Not "points lie close to a line" – some level of nuance needed. Allow general statement, e.g. "it shows how close to a straight line the points are"
		… with positive gradient	**B1** **[2]**	2.4	Any wrong statement: max B1B0
	(c)	Disagree as ρ is unchanged by linear scaling	**B1** **[1]**	1.2	"Disagree" oe and correct reason, allow omission of "linear". Allow "It wouldn't affect the value"

(b)

(A)	Points will lie roughly in an ellipse *(that is a necessary condition for validity of a test, not a consequence of the value of ρ)*	B0
(B)	Points are vaguely scattered with weak indication of positive correlation *(no mention of line)*	B0
(C)	Positively correlated but points are not very close to a straight line	B1B0
(D)	It shows its gradient and how close to a straight line the points are	B1B0
(E)	The closer ρ is to $+1/{-1}$, the closer the points are to a straight line, with positive/negative gradient	B2

Question		Answer	Marks	AO	Guidance
6	**(a)**	*Either* $6p = 3.35 \Rightarrow p = 0.558(33)$	**M1**	3.4	Use np and npq Attempt to use Poisson: M0
		$\Rightarrow$ variance should be 1.48 (1.47958)	**A1**	1.1	Correct relevant calculation, e.g. $q = 1.025...$, or $p = -0.0125$
					or solve $6p^2 - 6p + 3.392$ to get both $p \approx 1.4$ or -0.4, but *not* from $p = 0.5$
		Not close to 3.392 so B(6, p) not a good model	**A1**	3.2b	Validly deduce that B(6, p) not valid, e.g. $0 < p < 1$, and state conclusion
			[3]		SC: 0.5 used: M1A0A1
		Or $npq > np$; so $q > 1$ which is impossible	**M1A1**		(qualitative argument)
		Hence B(6, p) not a good model	**A1**		
	(b)	Expected frequencies 10, 12, 14, 16, 14, 12, 10	**B1**	3.3	
		Use $(O - E)^2/E$	**M1**	1.1	Allow from at least one of 0.083(…) and 1.6 correct
		0.083(3…), 1.6 and total 3.3362 or 3.3363	**A1**	1.1	Allow 3.34, 3.336 or better. If total omitted, or "0", in **(b)**, can be
			[3]		recovered from **(c)** ("0" probably comes from misunderstanding "Total")
	(c)	H$_0$: data consistent with proposed model, H$_1$: not so	**B1**	1.1	Allow "data follows …" but *not* "data is in ratio ..." nor "evidence that ..."
		$3.336(2) < 10.64$	**B1ft**	1.1	Compare *their* 3.336 with correct CV (3.336 may be from calculator)
		Do not reject H$_0$	**M1ft**	1.1	Correct first conclusion, FT on their TS and on CV 9.236 or 12.59
		Insufficient evidence that proposed model does not fit data	**A1ft**	2.2b	Contextualised, not over-assertive. Needs 'double negative', *not*
			[4]		"significant evidence that data is consistent", etc.
					A0 if hypotheses wrong way round
	(d)	Inferences from a hypothesis test are not "definite"	**B1**	2.2b	"Definite" stated to be too strong, oe (not *just* "Rosa is wrong")
		All we have is evidence / Sample size is small / other experiments might produce different results	**B1**	3.5a	Relevant valid comment, e.g. "data might be misleading", "second model
			[2]		likely to be correct", "either could be correct", and no wrong extras
					"Neither/both good" etc, from wrong conclusion to **(a)** or **(c)**: max B1B0

Hypotheses

(A)	H$_0$: data (results) are in ratio 5:6:7:8:7:6:5, H$_1$: they are not *(the <u>data</u> are definitely <u>not</u> in that ratio!)*	B0
(B)	H$_0$: model follows ratio, H$_1$: it doesn't *(the <u>model</u> is known; hypotheses concern the population)*	B0
(C)	H$_0$: follows given ratio, H$_1$: doesn't follow given ratio *(BOD)*; also (D) H$_0$: data fits ratio, H$_1$: it doesn't	B1

(d)

(E)	Wrong: first model could be either and second model shows definitely independent	B0
(F)	Cannot be definite as first model has mean $\approx$ variance so binomial is a good model	B1B0
(G)	Not enough to be certain as it could change with a different significance level	B1B0
(H)	Not definite as the second shows only that the proposed model is not a good fit for the data *(from wrong conclusion in (c))*	B1B0
(I)	Not definite as correlation does not imply causation *(the second clause is a 'wrong extra' and so B0)*	B1B0
(J)	I agree with Rosa as it is likely that the second model is correct.	B0B1
(K)	Cannot say "definitely" as there is a 10% chance that the second test is wrong *(condone this inaccurate second clause)*	B2
(L)	Neither is definitely correct but the second model is quite likely to be correct	B2

Question		Answer	Marks	AO	Guidance
7	**(a)**	Geo(0.1)	**M1**	3.3	Geo(0.1) stated or implied, e.g. by 0.1×0.9^{13}
		$P(R > 13) = (1 - p)^{13}$	**M1**	1.1	Or sum. Allow 0.9^{14} (= 0.229) or 0.9^{12} (= 0.282) or 1 term omitted or extra in sum, but not $1 - (0.9)^{\text{anything}}$
		$= 0.254$	**A1** **[3]**	1.1	Awrt 0.254, needs one of first two lines ("Determine"). Assume that, e.g. $1 - 0.746$ is from calculator. SC no working: 0.254 B2
	(b)	$pq^2 - 0.4pq - ap = 0$	**M1**	3.1b	Use formula for Geo(p) to get equation involving 3 terms
		$p^2 - 1.6p + 0.6 - a = 0$ or $q^2 - 0.4q - a = 0$	**A1**	1.1	Correct quadratic stated or implied, e.g. by correct use of '$b^2 - 4ac$'
		$p = \dfrac{1.6 \pm \sqrt{0.16 + 4a}}{2}$ or $q = \dfrac{0.4 \pm \sqrt{0.4^2 + 4a}}{2}$	**M1**	1.1	Obtain explicit formula for p or q, e.g. from $(q - 0.2)^2 = a + 0.04$, needn't be simplified
		$p > 0 \Rightarrow 0.8 - \sqrt{0.04 + a} > 0$ or $q < 1 \Rightarrow 0.2 + \sqrt{0.04 + a} < 1$	**M1**	2.2a	Use $p > 0$ from negative sign or $q < 1$ from positive sign (ignore other combinations of inequality and sign). Allow $p \geq 0$ or $q \leq 1$.
		$\sqrt{0.04 + a} < 0.8 \Rightarrow a < 0.6$	**A1**	1.1	Obtain $a < 0.6$, allow $a \leq 0.6$ here
		$p = 0.8 - \sqrt{0.04 + a}$ decreases with a (so any small positive a gives a valid value of p) *(or similar for q)*	**B1**	2.2a	Reason why the lower limit is (not greater than) 0, e.g. sketch of p against a, or other valid justification other than just "$a > 0$ is given"
		$0 < a < 0.6$ *(strict inequalities only)*	**A1** **[7]**	3.2a	Fully correct, allow just $a < 0.6$, needs all previous marks apart from B1
	OR	$a = p^2 - 1.6p + 0.6$ (or $a = q^2 - 0.4q$)	**M1**		Write a in terms of p or q and draw graph
		Intersections (0, 0.6), (0.6, 0) (and (1, 0))	**A1**		Correct parabolic shape, and intersections at (0.6, 0) and (0, 0.6) clear
		$0 < p < 1 \Rightarrow -0.04 < a < 0.6$	**M1**		Identify range of a for which $0 < p < 1$
		But $a > 0$ so a satisfies $0 < a < 0.6$	**A2**		$0 < a < 0.6$ ($\leq$ used, or $-0.04 < a < 0.6$: A1) Max 7/7

Question		Answer	Marks	AO	Guidance
	OR	T&I: Test values of p or q, or a, from 0 to 1 by increments of at most 0.25; at least 3 correct values Reject $p > 0.6$ or $q < 0.4$, as giving $a < 0$ p decreases as a increases (hence lower limit is 0) Conclude $0 < a < 0.6$	**M1** **A1** **A1** **B1** **A1**		$(p, a) = (0, 0.6), (0.1, 0.45), (0.2, 0.32), (0.25, 0.2625), (0.3, 0.21),$ $(0.4, 0.12), (0.5, 0.05), (0.6, 0)$ Clear rejection of wrong values OE, as above Fully correct, allow just $a < 0.6$, needs all previous marks apart from B1
	OR	Let $f(a, p) = p^2 - 1.6p + 0.6 - a$ $f(a, 0) \times f(a, 1) < 0 \Rightarrow f(a, p) = 0$ for some $0 < p < 1$ $\Rightarrow (0.6 - a) \times (-a) < 0$ $\Rightarrow a^2 - 0.6a < 0$ $\Rightarrow 0 < a < 0.6$	 **M1** **A1** **M1** **A1**		This method is not fully valid as it does not consider the possibility of there being a solution to $f(a, p) = 0$ even when $f(a, 0) \times f(a, 1) > 0$ (which occurs for $-0.04 < a < 0$ and it needs to be established that there are no positive values of a for which this happens) Max 6/7
	SC	$p = 0$ (or $q = 1$) $\Rightarrow a = 0.6$; $p = 1$ (or $q = 0$) $\Rightarrow a = 0$ so $0 < a < 0.6$	**M1** **A1**		Both 0 and 1 substituted and a found Same marks if insufficient working. Max 4/7
	SC	Use '$b^2 - 4ac$' only: no more marks			Max 2/7 (the issue is not "are there any solutions for p?" but "are there any solutions in the range $0 < p < 1$?")

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