



Level 3 Certificate

Quantitative Reasoning (MEI)

H866/02: Critical Maths

OCR Level 3 Certificate

Mark Scheme for June 2019

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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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Annotations and abbreviations

Annotation in scoris	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
Highlighting	
Other abbreviations in mark scheme	Meaning
E1	Mark for explaining
U1	Mark for correct units
G1	Mark for a correct feature on a graph
M1 dep*	Method mark dependent on a previous mark, indicated by *
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working

1. Subject-specific Marking Instructions

- a Annotations should be used whenever appropriate during your marking.

The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

- 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 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, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) 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, eg 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

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.

E

A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg 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, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

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 Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise. Candidates are expected to give numerical answers to an appropriate degree of accuracy, with 3 significant figures often being the norm. Small variations in the degree of accuracy to which an answer is given (e.g. 2 or 4 significant figures where 3 is expected) should not normally be penalised, while answers which are grossly over- or under-specified should normally result in the loss of a mark. The situation regarding any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, contact your Team Leader.
- g Rules for replaced work

If a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests.

If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

NB Follow these maths-specific instructions rather than those in the assessor handbook.

- 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 components. This is achieved by withholding one A mark in the question.

Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

- i Anything in the mark scheme which is in square brackets [...] is not required for the mark to be earned, but if present it must be correct.

Question			Answer	Marks	Guidance	AOs
1	(i)		8000	B1 [1]		AO2
	(ii)		8000 ÷ 16 [or 16 000 ÷ 32] 500	M1 M1 A1 [3]	Repeated halving oe (minimum twice) Correct division (4 times) SC 250 B1 for 2/3	AO2 AO1 AO1
1	(iii)	(A)	$\frac{28+17}{\text{their } 500}$ 9[%]	M1 A1 √ [2]	FT from 250 only in (i) to give 18%	AO2 AO1
		(B)	No with suitable reason eg 'do not know how many men and women in the sample' eg 'only a small number of people responded'	E1 [1]	There may have been more women invited than men Accept reference to small sample, therefore unreliable Accept 'more data is needed to draw a conclusion' oe Calculations involving women/men who replied is E0	AO3
2	(i)		No , with a robust justification for E2	E2 [2]	E2 eg No because whilst percentage growth rates are decreasing.. growth rates are still positive so population is always increasing.. or population didn't increase as much E1 No, with partial answer: eg growth rates did not increase as much as before eg growth rate is decreasing (by stating 2 examples) eg population is increasing all the time eg population grows at slower rate Population (rather than rate) is decreasing is E0 Any justification of yes is E0	AO3

Question			Answer	Marks	Guidance	AOs
2	(ii)	(A)	Suitable method 2.5[%]	M1 A1 [2]	Any suitable method that gives an approximate answer eg $\frac{1+4}{2}$ eg $\frac{3+2}{2}$ eg $\frac{3.2+2.3}{2}$ or multiple values used Implied by correct answer Using a (horizontal or sloping) line on graph to read off an average value can earn M1 Value in range 2.3 to 2.8	AO2 AO3
2	(ii)	(B)	3 750 000 $\times 1.025^{(56)}$ 14 947 000 FT leading to answer in range: 2.0% \rightarrow 11.4M 3.2% \rightarrow 21.9M	M1 B1 A1 \checkmark [3]	<i>their</i> 1.025 or finding at least one 2.5% increase Power 56 Must be whole number but need not be rounded more than that (Note: 2.3% \rightarrow 13.4M 2.8% \rightarrow 17.6M) 0/3 for simple interest approach eg <i>their</i> $0.025 \times \text{pop'n} \times 56$ (unless population after first year is seen explicitly for M1)	AO1 AO2 AO3
	(iii)		Appropriate conclusion FT <i>their</i> (ii) which may be an under-estimate, over-estimate, or about right	E1 \checkmark [1]	eg (population growth rate) was an underestimate eg 'so far out that it must be wrong' Accept 'inaccurate' only when their estimate is very different, otherwise should refer to over-estimate / under-estimate	AO3
3	(i)		Highest point circled	B1 [1]		AO3
	(ii)		T F F T	B2 [2]	Minus 1 for each one wrong (min mark zero) B1 for only 2 or 3 attempted and all correct	AO3

Question		Answer	Marks	Guidance	AOs
	(iii) (A)	No; correlation does not imply causation	E1 [1]	oe described in words/context Accept 'there could be another cause' Accept 'other factors will affect life expectancy' Accept 'need other evidence of a link' Accept 'getting married later does not make you live longer' or vice versa	AO3
	(B)	No with reason eg because there is a lot of scatter oe	E1 [1]	May refer to the outliers (in this graph) May refer to line of best fit giving an 'average' value oe (graph) shows different life expectancies for any particular age oe contextual argument, that other factors will affect life expectancy Not a reference to causation here	AO3

Question	Answer	Marks	Guidance	AOs
4	<p>Width of car / parking space in range 2 to 4 m Length of car / parking space in range 4 m to 8 m</p> <p>EITHER <u>Division of areas method:</u> Area of rectangle = $40 \times 30 = 1200 \text{ m}^2$</p> <p><i>Their</i> area of rectangle \div <i>their</i> area of car space</p> <p>Reduction of space available to allow for vehicle manoeuvring (may appear earlier in calculations)</p> <p>Number of cars in range 20 to 120</p>	<p>B1 B1</p> <p>M1</p> <p>M1</p> <p>M1</p> <p>A1</p> <p>[6]</p>	<p>Accept dimensions whether car size or space size Estimate of (smaller) dimension of car space Estimate of (larger) dimension of car space SC B1 for micro-car approx $3\text{m} \times 1.5\text{m}$</p> <p>OR <u>Dimensioning / spatial method:</u> Considers 1st dimension wrt how many cars fit in any row eg one dimension of rectangle \div one dimension of car space (may be implied on drawing)</p> <p>Clear consideration of 2nd dimension or how many rows will fit, to find how many spaces could be fitted into rectangle (may be implied on drawing)</p> <p>Reduction of space for vehicle manoeuvring stated or implied in drawing or when dimensioning earlier</p> <p>Dep on at least one M1. Must be whole number</p> <p>Note: if both or combination of methods presented then mark best of EITHER/OR</p>	<p>AO2 AO2</p> <p>AO1</p> <p>AO2</p> <p>AO2</p> <p>AO3</p>
5	<p>Just over 1000 (1003) toilets lost In 8 years To lose 5084 would take just over 5×8 years = 40 $2008 + 40 = 2048$ oe strategy with convincing completion</p>	<p>B1 M1 E1</p> <p>[3]</p>	<p>soi embedded in calculation B1M1 implied by 125 loos per year Accept negative number of loos presented (eg -163 or -182) with comment eg ‘therefore consistent’ oe Accept small number of loos in 2048, therefore consistent</p> <p><u>ALT:</u> B1 16(.5)% decrease ($\frac{6087-5084}{6087} \times 100$) M1 in 8 years (= 6.25 or 6 periods) E1 $6.25 \times 16.5\% = 103\%$ loss of all loos convincing oe</p>	<p>AO1 AO1 AO3</p>

Question			Answer	Marks	Guidance	AOs
6	(i)	(A)	64[%]	B1 [1]		AO1
		(B)	75 ÷ 11 About 7	M1 A1 [2]	Must be working on correct age group Final answer integer, accept 6 from rounding down from 6.8 Accept ratio 1:7	AO2 AO1
6	(ii)	(A)	16-24 Lowest (total percentage) of those who smoke and those who have quit	B1 B1 [2]	Accept without workings (For info: smoke or have quit 43% 65% 72% 74% 86%) oe implied by '57%' (highest who have never smoked) oe 'lowest sum of all age groups' oe 'is the only age group where more than half of people haven't smoked'	AO2 AO3
		(B)	100 – 23 – 20 57[%]	M1 A1 √ [2]	F.t. <i>their</i> age group from (ii) (A)	AO2 AO1
	(iii)		More people in 35-49 age range than 25-34 About 1.5 times as many people aged 35 to 49 as 25 to 34 21% of '150' is more than 24% of '100' oe From group totals ratio no higher than to 2:1	B1 B1 B1 [3]	Allow 1.25–1.75 times as many B0: if population numbers are presented then they must be feasible (cap at 15M and 10M) Conclusion may be implied by their two figures Note: equal population in the two age categories scores 0/3 (Note: B1B0B1 is possible)	AO2 AO2 AO3

Question		Answer	Marks	Guidance	AOs				
7	(i)	80 – 25 – 35 – 17 or 80 – 28 – 12 – 37 3	M1 A1 [2]	soi	AO2 AO1				
7	(ii)	Suitable reason based on votes	E1 [1]	eg Victor had the most 4 th place votes eg Victor had very few 2 nd place votes oe	AO3				
7	(iii)	Appropriate method indicated eg “1 st + 2 nd ” or “range 1 st – 4 th ” or “points” Sufficient detail given to deduce how their method would be applied Application of their method to the names (at least 3 done) Winning name consistent with appropriate method	B1 E1 M1 A1 [4]	Method must not be “pick the one with the highest number of 1 st places” – scores zero First mark can be implied by workings SC B1 ‘Lowest number of 4 th places’ is max 1/4 eg ‘4 points for 1 st , 3 points for 2 nd .. and highest score wins’ eg ‘add the votes for 1 st and 2 nd preferences, highest wins’ eg ‘take 4 th place votes from 1 st place.. highest wins’ Any indication of a restart or voting again is 0/4 <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%;">Example ‘Top Two’ 1+2: E = 10+26 = 36 V = 35+2 = 37 L = 28+12 = 40 W = 7 +40 = 47</td> <td style="width: 25%;">Example ‘range’ 1-4: E = 10-25 = -15 V = 35-35 = 0 L = 28-3 = 25 W = 7-17 = -10 (or reversed)</td> <td style="width: 25%;">Example Points based: 1st = 4 E = 181 2nd = 3 V = 197 3rd = 2 L = 225 4th = 1 W = 197 (or reversed)</td> <td style="width: 25%;">Example ‘1+2’ – ‘3+4’ E=36-44=-8 V=37-43=-6 L=40-40 = 0 W=47-33=14</td> </tr> </table>	Example ‘Top Two’ 1+2: E = 10+26 = 36 V = 35+2 = 37 L = 28+12 = 40 W = 7 +40 = 47	Example ‘range’ 1-4: E = 10-25 = -15 V = 35-35 = 0 L = 28-3 = 25 W = 7-17 = -10 (or reversed)	Example Points based: 1 st = 4 E = 181 2 nd = 3 V = 197 3 rd = 2 L = 225 4 th = 1 W = 197 (or reversed)	Example ‘1+2’ – ‘3+4’ E=36-44=-8 V=37-43=-6 L=40-40 = 0 W=47-33=14	AO3 AO2 AO2 AO1
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Question		Answer			Marks	Guidance	AOs													
8	(i)	(A)	So that the results are not biased.			B1 [1]	To ensure test is fair Accept a description of bias Avoid demand characteristics B0 for 'Placebo effect' unless explained wrt bias	AO3												
		(B)	Double blind			B1 [1]		AO1												
	(ii)	(A)	<table border="1"> <thead> <tr> <th>Expected numbers</th> <th>Taking medication</th> <th>Not taking medication</th> </tr> </thead> <tbody> <tr> <td>Catch illness</td> <td>10</td> <td>25</td> </tr> <tr> <td>Do not catch illness</td> <td>240</td> <td>225</td> </tr> <tr> <td>Total</td> <td>250</td> <td>250</td> </tr> </tbody> </table>	Expected numbers	Taking medication	Not taking medication	Catch illness	10	25	Do not catch illness	240	225	Total	250	250			B1 B1 √ B1 [3]	10 250 – <i>their</i> 10 25 & 225	AO1(1) AO2(2)
Expected numbers	Taking medication	Not taking medication																		
Catch illness	10	25																		
Do not catch illness	240	225																		
Total	250	250																		
		(B)	$\frac{10}{35}$ oe 0.29 or 0.286 or 29% or 28.6% Note: probability tree gives $\frac{4}{14}$ or $\frac{2}{7}$ from: $\frac{0.5 \times 0.04}{0.5 \times 0.04 + 0.5 \times 0.10}$ oe $\frac{0.02}{0.07}$			M1 A1 √ [2]	For denominator (soi by decimal or %), using <i>their</i> values FT from values in ii Accept fraction, decimal, percentage	AO2 AO2												

Question		Answer	Marks	Guidance	AOs
9	(i)	200	B1 [1]		AO2
	(ii)	$\frac{\sqrt{400}}{2}$ oe 10	M1 A1 [2]		AO2 AO1
	(iii)	Income = $400 \times £40 = £16\,000$ Mean + 2sd or + 3sd = 220 or 230 FT <i>their</i> sd from ii Max pay-out = <i>their</i> 230 $\times 70 = £16\,100$ Compares Mean ± 2 sd or ± 3 sd or other suitable range of pay-outs to 16000, and draws an appropriate conclusion	B1 M1 A1 E1 [4]	<u>SC1 if M0:</u> SC B1 for max 2/4: average pay-out $200 \times 70 = £14\,000 \rightarrow$ £2000 profit, along with a clear indication of uncertainty in the number of screen replacements that may be required (not just '50/50 chance') OR 228 / 229 phone repairs identified as the break-even point 3sd required here <u>SC2 if B0M0:</u> E1 for a relevant contextual comment for max 1/4 eg comment that people with protection plan might be more careless and more likely to get a cracked screen eg comment that if people with expensive phones insure then it may cost more than £70 a phone to replace screen	AO2 AO2 AO2 AO3

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