Level 3 Certificate

Quantitative Problem Solving (MEI)

H867/01: Introduction to Quantitative Reasoning

OCR Level 3 Certificate

Mark Scheme for June 2019

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

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.

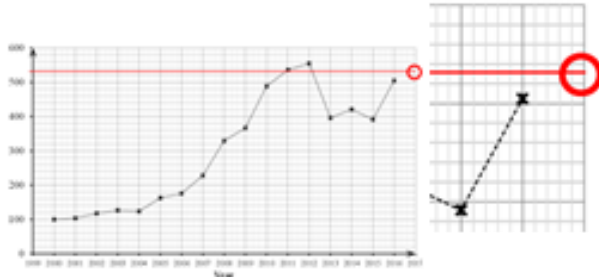NB Follow these maths-specific instructions rather than those in the assessor handbook.

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 units. This is achieved by withholding one A mark in the question.
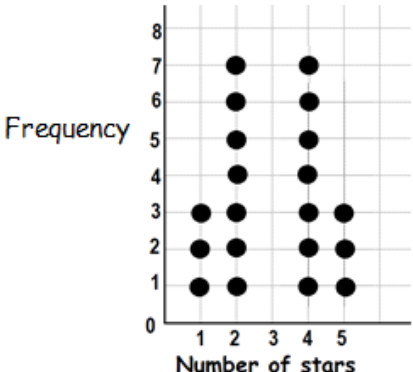
Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

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	AO	Level
1	**(i)(A)**	12[%]	**B1**		1	E
			[1]			
	(i)(B)	"45 700" or "3" seen as denominator or numerator respectively oe.	**M1**	Accept 3 000 000 and 45 700 000 000 Condone for the M1 mixed units i.e. in units of a million with say standard form in the same fraction.	1	E
		$\dfrac{3}{45700}$ oe isw for attempts to simplify	**A1**	(e.g. 0.000065(6 ...)0.0065(6 ...)% i.e. need the % unless clear from working e.g. a"×100 apparent) Condone 0.007% / 0.00007 _____ OR _____ If probabilities given in 1 in xxx form M1 for 45700 ÷ 3 seen A1 for 1 in 15 233 or 1 in 15 233. . rot (do not allow 3 in 45700)	1	E
			[2]			
	(i)(C)	17992.6 ... or 17993 or 18404 (from rounding to 3 million) seen	**B1**	Just the originating calculation not sufficient must have a result.	2	E
		1 in 18 000	**B1**	(Independent marks)	2	E
			[2]			

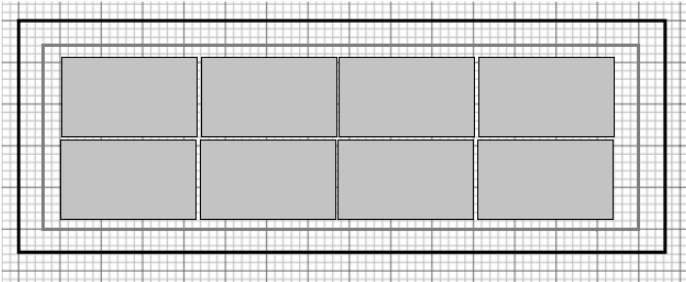| Question		Answer	Marks	Guidance	AO	Level
	(ii)	" $\times 1.02^{10}$ " or 1.2189 ...... seen	**M1**	Condone if repetitive calculation at least first 3 correct steps (i.e. 1020 / 1040.4 / 1061.2 … or 1020 / 1040 / 1060.8 or 1061)	1	C
		(£)1218.99(442)	**A1**		1	C
		(£)1219	**B1**	CAO	3	C
				1200 automatically fails to gain credit (simple interest)		
			[3]			
	(iii)(A)	(980.5(0))×100 ÷ 183.7 oe	**M1**	Condone if 183.7 is rounded to 184	1	E
		=533.75... or 533.75 rot	**A1**	If 184 used should be 532.608 …	1	E
		534	**A1**	If 184 used should be 533 FT on *their* 533.75 … SC1 for 5 seen (omission of ×100) Or SC2 for convoluted or less than transparent methods involving ratio or similar based on using other years from the graph but resulting in a number which is clearly the answer which is an integer in the range 532 – 536.	3	E
			[3]			

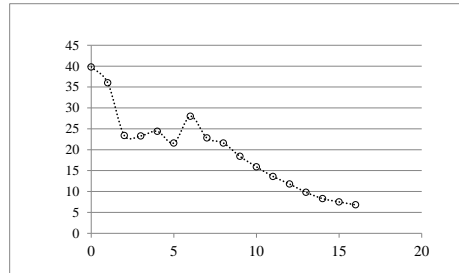| Question		Answer	Marks	Guidance	AO	Level
1	**(iii)(*B*)**	Point (2017, 534) indicated	**B1**	FT from part **(iii)(*A*)** Use overlay, centre of cross oe between the two "tram lines".	1	E
			[1]			

	(iv)	Premium Bonds
		 1 valid positive/negative reason
		 e.g. + Original money/investment/stake not lost.
		       _ May not get any prizes, so no increase in the investment.
		
		 Savings account
		 1 valid positive/negative reason
		 e.g. + Guaranteed return/increase.
		       _ Cannot withdraw money, not a very good rate of interest.
		
		 Buying gold
		 1 valid positive/negative reason
		 e.g. + Seems to increase in value overall.
		       _ Possibility of dips in value
			E1
			
			 E1
			
			 E1
				Reasons involve simplistic pay-off and risk/uncertainty.
				 See LIST after coordination.
					3
					
					 3
					
					 3
						E
						
						 E
						
						 E

			[3]			
			15			

Question		Answer	Marks	Guidance	AO	Level
2	(i)	Correct labelling of axes frequency / Star rating and graduated.	B1	Any sensible scale acceptable (Although unit for unit most probable.) Minimum of both axes numerically labelled. If a form of bar chart or histogram used the labelling of bars rather than lines is allowed for this mark.	1	E
		Correct frequencies on a chart. (cales can be in any reasonable graduation – probably 1 or 2)	B1	If both/either scales not numerically labelled the second B1 can be gained only by assuming a unit scale and marking against this. Accept (with 3/7/0/7/3 frequency):- Standard dot plot Stick graph. Individual points (not necessarily zero) Bar chart (with gaps between bars) Do not accept:- Histogram (bar chart with bars touching) Line graph (this data not continuous)	1	E
			[2]			
	(ii)	Because the mean is 3 but all the ratings/results are either higher or lower than this. oe	E1	Mean not representative as bimodal. Condone "because no one gets a 3" as a BOD for implying some form of bimodal distribution.	3	E
			[1]			

Question		Answer	Marks	Guidance	AO	Level
	(iii)	5×4 + 3×2 +4×1 (=30)	**M1**	At least two instances of star rating × weight, can be implied from 20/6/4/	2	C
		30 ÷7 (= 4.2857…)	**M1**	For *their* 30 "÷7" soi	2	C
				The above marks may be embedded in $5 \times \left(\frac{4}{7}\right)$ (or 57%)+3× $\left(\frac{2}{7}\right)$ (or 29%) $+ 5 \times (\frac{4}{7})$ (or 14%) e.g. first M1 for 2 correct %	2	E
		4.3 (stars)	**B1**	Follow through from *their* mean stars to 1 dp (must have one decimal place e.g. 4.0) (mean must be result of "number"÷ 7 to count)		
			[3]			
2	**(iv)(A)**	Cell G4 indicated in some way	**B1**	Repeating contents of cell is sufficient	3	A
			[1]			
	(iv)(B)	$B$2*B4+$C$2*C4+$D$2*D4+$E$2*E4+$F$2*F4 or B2*B4+C2*C4+D2*D4+E2*E4+F2*F4	**B1**	Correct coding but lack of "=" Must use standard * for × but condone surplus brackets iff produce correct result.	3	A
		=$B$2*B4+$C$2*C4+$D$2*D4+$E$2*E4+$F$2*F4 or =B2*B4+C2*C4+D2*D4+E2*E4+F2*F4	**B1**	Correct coding and "="	3	A
			[2]			

Question		Answer	Marks	Guidance	AO	Level
	(iv)(C)	Favours those with a very small number of mainly high ratings oe or Specific examples from table showing the above: R/T or W/S	**E1**	No credit for simply "Different number of stars"	3	A
			[1]			
			10			
3	**(i)(A)**	(US$)95	**B1**	Condone 95% and £95	1	E
			[1]			
	(i)(B)	1985 to 1990	**B1**		3	C
			[1]			
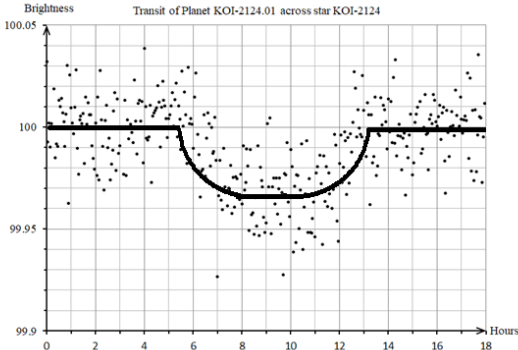
(ii)(A)	A relevant estimate or assumption stated	**E1**	eg	Rough daily average between 2 and 4 (kW/m^2) or "30 days in a month"	3	A
	Evidence of *their* average daily "× 365" Or (37 to 41) × 30 (total from graph × 30/31 days a month)	**M1**	Condone "360/370/400 days in a year". This mark may be implied by multiplying each month's daily average by (28 or 29 or 30) / 30 / 31 days i.e. by brute force.		2	C
	730 to 1460 (kW/m^2)	**A1**			2	C
			_____ if zero scored _____ Very common error is to mis-read average daily solar flux as monthly solar flux – counting this as a mis-read. SC1 for adding all the 12 bars with an answer in the range (37 to 41)			
		[3]				
(ii)(B)	(182 to 365)	**B1**	FT	from 25% of (ii)(A)	1	E
		[1]				

3	(iii)					
				Using overlay for panel size (usual $\pm\frac{1}{2}$ a small division tolerance)		
		Drawing with 4 panels across and 2 deep (as above)	**B1**		2	E
		At least three panels drawn correctly to scale.	**B1**		2	E
		Clearance of 30 cm of panels from roof edge (as per instructions).	**B1**	Dependent of the first B1 but allow iff no panels drawn i.e. just the permitted rectangle for them all 30 cm or more round	3	E
			[3]			
	(iv)(*A*)	(Total cost =) £6000 + (£)3000((=(£) 9000)	**B1**	isw	2	E
		2800×0.1405 (=393.4) or 2800 × 14.05 = 39340 (Annual savings = 2800×0.1405=) (£) 393.4(0)	**B1**	Note p calculation (2800 × 14.05) must have correct answer.	2	C
		Their "total cost" ÷ *their* "savings" (=22.87 ….)	**M1**		2	C
		23 years	**A1**	Follow through – but must be rounded up – to next year. Special case for candidates who assume **and** state that Amy does not take up the special offer of insurance Award first B1 (giving 16 years as the final answer)	2	C
			[4]			

	(iv)(B)	(Unit) cost of electricity will (probably) increase over 25 years oe (not paying insurance/maintenance)	**E1**	Remember payback time = total cost (£9000) ÷ (cost of electricity × usage)	2	E
			[1]			
	(iv)(C)	12×44.71×4 (=2146.08) soi (£)146.08 or (£)146	**M1** **A1**	May be imbedded in an unnecessary % interest calculation, in this case isw after the correct amount. If zero SC1 for correct "A calculated sum" - £2000	2 2	E E
			[2]			
			16			
4	**(i)(A)**	3 (years)	**B1**	Condone correct years 2000, 2001, 2006	1	E
			[1]			
	(i)(B)	As a minimum "percentage oe deceases" oe isw (any reasonable comment e.g. "It has dropped from 39.8 to 6.8") (Dips /decreases – goes up a little – drops a little – rises a little then slowly declines)	**B1**	Condone numbers or percentages. Do not accept any reference to constancy without a time scale. See LIST after coordination The general shape is: 	3	E
			[1]			

	(i)(C)	1.9 ÷ 1.41	**M1**		1	E
		=(£)1.35	**A1**	CAO (1.347 …. Gains no credit)	1	E
			[2]			
	(i)(D)	$\frac{1}{10}$ of 7400 million = 740 million or 700 ÷ 7400 = 0.0945 or 7400 ÷ 700 = 10.571 … rot oe	**B1**	(Allow via using percentages)	2	E
		"No" or "Yes" supported with reference to *their* above working.	**E1**	Must specifically reference to the result of *their* calculation Condone FT but must have working – possibly erroneous. .	3	E
			[2]			
4	**(ii)**	$2.56 \times 10^{14} \div 7.4 \times 10^{9}$ or better	**M1**		2	C
		= (US$) 34 594. ...	**A1**	Allow standard form	2	C
		(US$)35 000 or (US$)34 600 or (US$)34 595 or (US$)34 590	**A1**	Allow standard form	2	A
			[3]			
	(iii)(A)	(14000 ÷ 28700) = 0.4878 ... rot or 0.5 or 0.49	**B1**	i.e. taking account of mental rounding from calculator.	1	E
		Moderate prosperity	**B1**	FT on first part or if 0.5 clearly used (e.g. last number in the calculation) then "only basic needs met"	3	E
			[2]			
	(iii)(B)	116 000 (peso)	**B1**		2	C
			[1]			
			12			

5	(i)(A)	Point (200, 0.6) plotted.	B1	Condone if point identified by two intersecting lines from the axes.	1	C
			[1]			
	(i)(B)	Explanation or line extended or point itself marked	B1	(Independent marks)	1	C
		0.008 to 0.012 (%)	B1		3	A
			[2]			
	(i)(C)	(35 to 45) (reading scale)	B1	Ignore any attached units	2	A
		Reciprocal of *their* reading (0.022 to 0.028)	B1	FT reciprocal of *their* length Allow reciprocal as a fraction	2	A
			[2]			
	(i)(D)	25 (cm)	B1	0.25 m is not acceptable from the question.	2	C
			[1]			
	(ii)(A)	4.4 m oe	B1	Must have correct units.	1	E
			[1]			
	(ii)(B)	2 (years)	B1	Condone 1979 and 1982 or 4.8 and 4.9	1	E
			[1]			
	(ii)(C)	5.3 (m)	B1		2	E
			[1]			

5	(iii)	Attempt to multiply at least two pairs of results	M1	0.06×29.6 0.30×5.7 0.31×5.8 0.81×2.1 2.85×0.64	2	A
		Stating a conclusion regarding the rule e.g. all similar size/value conclusion based on at least three correctly calculated values for c	A1	1.776 / 1.71 / 1.798 / 1.701 / 1.824 A conclusion may be implied by a correct mean.	2	A
		Value of c in the range $1.701 < c <$ to 1.824 soi	A1		2	A
			[3]			
			12			
6	(i)(A)		B1	Mark for intent – be moderately liberal A curve between 6 and 13 – no straight line segments (but may have at the ends) - but end points may have a curve. The curve/line must cover the full range 0 to 18 hours. If multi-attempts mark worst. (See LIST after coordination)	3	C
			[1]			

(i)(B)	Fractional dip from brightness graph = (2 to 6)×10⁻⁴ (0.0002 to 0.0006)	**B1**	Within correct range only but full follow through subsequently	3	A
	$\sqrt{their\ \text{fractional dip}}$ (=0.024 .. to 0.044 …)	**M1**	FT on *their* brightness	3	A
	Radius of exoplanet = $3.8\times10^5 \times \sqrt{their\ \text{fractional dip}}$ (planet radius = 5300 to 9300 (km))	**A1**	FT Accept in standard form OR __ if approaching directly from area __ B1 for fractional dip as above M1 for $$\frac{r^2}{\left(3.8\times10^5\right)^2} = their\ \text{fractional dip}$$ or better A1 (planet radius = 5300 to 9300 (km)) FT from the M1 OR For candidates who erroneously work with the proportional brightness rather than the proportional dip in brightness and who obviously loose the B1 allow for what is effectively a FT M1 on evidence of $\sqrt{their\ \text{fractional dip}} = 0.999$ iff it is clear that a square root has been taken - this can then be followed through if warranted.	3	A

			[3]			
6	**(i)(C)**	41.666 … rot or 42 (days)	**B1**		3	C
			[1]			
	(ii)	There are at least two planets One planet has an orbit time of 16 days The other had an orbit time of 26 days One planet is larger than the other planet oe (These must be deductions drawn for the brightness graph)	**B1** **B1**	1 for first correct response 1 for second correct response (ignore erroneous ones) One planet is faster so its smaller i.e. a deduction not possible from the brightness graph only gains one. But as separate statement could gain 1 + 1	2 3	A A
			[2]			
			7			