OCR
Oxford Cambridge and RSA

GCE

Mathematics B MEI

H640/02: Pure Mathematics and Statistics

A 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 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
E	Explanation mark 1
SC	Special case
^	Omission sign
MR	Misread
BP	Blank page
Highlighting	
Other abbreviations in mark scheme	**Meaning**
E1	Mark for explaining a result or establishing a given result
dep*	Mark dependent on a previous mark, indicated by *. The * may be omitted if only 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 indicates that the instruction **In this question you must show detailed reasoning** appears in the question.

2. Subject-specific Marking Instructions for AS Level Mathematics B (MEI)

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.

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, 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 Unless units are specifically requested, there is no penalty for wrong or missing units as long as the answer is numerically correct and expressed either in SI or in the units of the question. (e.g. lengths will be assumed to be in metres unless in a particular question all the lengths are in km, when this would be assumed to be the unspecified unit.)
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 **2 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 A the rubric specifies 3 s.f. as standard, so this statement reads "3 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:

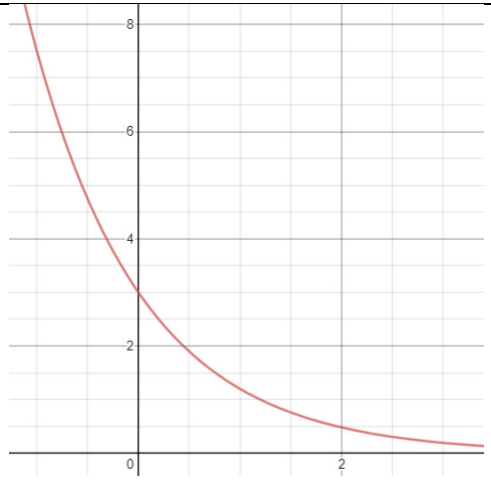
- If one attempt is clearly indicated as the one to mark, or only one is left uncrossed out, then mark that attempt and ignore the others.
- If more than one attempt is left not crossed out, then mark the last attempt unless it only repeats part of the first attempt or is substantially less complete.
- 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.

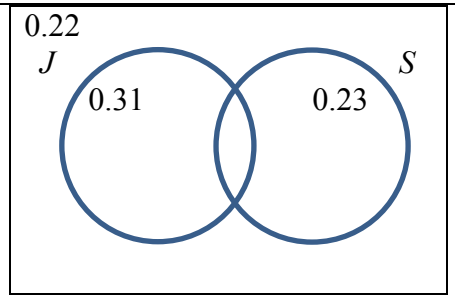
h For a genuine misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some 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. E marks are lost unless, by chance, the given results are established by equivalent working. Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

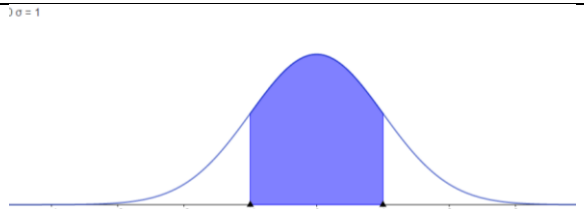
i If a calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers provided that there is nothing in the wording of the question specifying that analytical methods are required such as the bold "In this question you must show detailed reasoning", or the command words "Show" and "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			$R^2 = 1^2 + \sqrt{3}^2$	M1	1.1	may be implied by correct answer
			$\tan\alpha = \frac{\sqrt{3}}{1}$ or $\sin\alpha = \frac{\sqrt{3}}{2}$ or $\cos\alpha = \frac{1}{2}$ **soi**	M1	1.1	may see eg $\alpha = \tan^{-1}\left(\frac{\sqrt{3}}{1}\right)$ may be implied by correct answer
			$R = 2$ **or** $\alpha = \frac{\pi}{3}$ **or** $\alpha = 60^\circ$ seen	A1	1.1	
			$2\cos(\theta - \frac{\pi}{3})$ or $2\cos(\theta - 60^\circ)$ **isw**	A1	1.1	
				[4]		
			Alternatively $\cos\theta + \sqrt{3}\sin\theta = R\cos\theta\cos\alpha + R\sin\theta\sin\alpha$ so $1 = R\cos\alpha$ and $\sqrt{3} = R\sin\alpha$ $\frac{1}{\cos\alpha} = \frac{\sqrt{3}}{\sin\alpha}$ $\alpha = \frac{\pi}{3}$ **or** $\alpha = 60^\circ$ seen $2\cos(\theta - \frac{\pi}{3})$ or $2\cos(\theta - 60^\circ)$ **isw**	 M1 M1 A1 A1		 for equating coefficients for eliminating R
2			$\frac{50}{1-0.5}$ **soi**	M1	1.1	
			100	A1	1.1	
				[2]		

Question			Answer	Marks	AO	Guidance
3	(a)			**M1** **B1** **A1**	**1.1** **1.1** **1.1**	decreasing concave up curve in 1st and 2nd quadrants which does not cut the x-axis; mark intent decreasing curve with intercept (0,3); may be in one quadrant only smooth curve from (–0.5, a) through (2.5, b), where $4.5 \leq a \leq 5$ and $0 < b < 0.5$
				[3]		
3	(b)		$\log(3 \times 0.4^x) = \log(0.8)$ **oe** $x\log 0.4 = \log 0.8 - \log 3$ **oe** 1.44 **cao**	**M1** **M1** **A1**	**3.1a** **1.1** **1.1**	taking logarithms in any base 3rd law of logs used correctly if **M0M0** allow **SC1** for 1.44 unsupported
			Alternatively $0.4^x = \frac{0.8}{3}$ $x = \log_{0.4}\left(\frac{0.8}{3}\right)$ $x = 1.44$ **cao**	**M1** **M1** **A1**		 may see $x\log 0.4 = \log\left(\frac{0.8}{3}\right)$ **oe**
				[3]		

Question			Answer	Marks	AO	Guidance
4	(a)			M1 A1	1.1 1.1	Venn diagram with 2 overlapping regions and 0.22 correctly placed; condone incorrect or no labelling all probabilities or percentages correctly placed and correctly labelled; ignore values in intersection allow if no box drawn if labels are eg A and B, A and B need to be defined
				[2]		
4	(b)		0.31 + 0.23 + p($J \cap S$) = 1 – 0.22 **oe** 0.24 **oe isw**	M1 A1	1.1a 1.1	may be implied by correct answer or by 24% do not allow 24%
				[2]		
5			$2^n - 1$ correctly evaluated for any odd positive integer $2^n - 1$ correctly evaluated for any odd positive integer for which Tom's conjecture is false eg 511 is divisible by 7 with 9 seen [so not prime]	B1 B1 B1	1.1 2.1 2.2a	$n \geq 3$ **B0** if only rounded number in standard form seen eg $2^9 - 1 = 511$, eg $2^{15} - 1 = 32767$ eg $2^{21} - 1 = 2097151$ **NB** 32767 and 2097151 both divisible by 7; 2047 divisible by 23 correct value of n may be embedded in formula **NB B0** if answer spoiled by eg so 511 is prime
				[3]		

Question			Answer	Marks	AO	Guidance
6				M1 A1	3.1a 1.1	area identified which is symmetrical about the mean $x = \mu \pm \sigma$ at points of inflection
				[2]		
7			$0.4 \times 20 + 1.3 \times 10 + 3.6 \times 5 + 2 \times 10 + 0.8 \times 15$ 71	M1 A1 [2]	1.1 1.1	allow one incorrect frequency density and/or one incorrect class width **NB** 8 + 13 + 18 + 20 +12 **soi** with four of five correct implies **M1** may be implied by 71 if **M0** allow **SC1** for 8, 13, 18, 20, 12 and no others seen
8	(a)		population since all distances of at least 120 km are used **oe**	B1	1.2	
				[1]		
8	(b)		161-163 km	B1	1.1	
				[1]		
8	(c)		we need to see two elements: Ali's complaint is justified **oe** and correct numerical reasoning with reference to upper tail	B1	2.2a	eg 10 riders rode more than 160 km **or** 14 rode 156 km or more **or** the reserve should have ridden (approximately) 161 km so (Ali's complaint is) justified **oe**
				[1]		

Question			Answer	Marks	AO	Guidance
9	(a)		mean 112.4 **isw or** 112 **isw**	**B1**	**1.1**	
			variance 8.8 or $\sqrt{8.8^2}$ **cao isw**	**B1**	**1.1**	**B0** for 8.757 explicitly rounded to 8.8
				[2]		
9	(b)		N(their 112.4, their 8.8)	**M1**	**3.3**	allow **M1** for 8.8^2 or $\sqrt{8.8}$
			N(a, b)	**A1**	**1.1**	a = 112.4 or 112 and b = 8.8 or 2.97^2
				[2]		
9	(c)		P(mark < 104.5) or P(mark < 105) found from their distribution in part **(b)**	**M1**	**3.4**	may see N$(-\infty, 104.5, 112.4, \sqrt{8.8})$ **NB** 0.00387 or 0.0063(06) implies **M1** **NB** 0.00573 or 0.00914 implies **M1** **NB** 0.00379(69..) or 0.00619(81…) may imply **M1 FT** use of variance = 8.757 **NB** 0.200(199…) and 0.184(665…) may imply **M1 FT** use of sd = 8.8 if probability is correctly found to be 0 eg from use of N(112.4, $\frac{8.8}{205}$) allow **M1** only – no further marks available
			205 × *their* non-zero 0.00387	**M1**	**3.1a**	**or** compare $\frac{1}{205}$ (≈ 0.00488) with *their* non-zero 0.00387
			0.79 to 0.794 **or** 1.17 to 1.175 so consistent **oe**	**A1**	**3.5a**	**or** probabilities similar so consistent **oe**
				[3]		

Question			Answer	Marks	AO	Guidance
			Alternatively InvNorm$\left(\frac{1}{205}, 112.4, \sqrt{8.8}\right)$ or InvNorm$\left(\frac{1}{205}, 112, \sqrt{8.8}\right)$ used to find their mark	**M1**		**FT** their distribution
			compares their mark with 105	**M1**		
			104.7 or 104.3 is close to 105 so good fit	**A1**		
9	**(d)**		P(mark between 114.5 and 115.5) found	**M1**	**3.4**	**NB** awrt 0.0915 or awrt 0.0807 implies **M1**
			18.75 to 18.77 so allow 18 or 19 **or** 16.5 to 16.534 so allow 16 or 17	**A1**	**3.5a**	unsupported answers score **M0**
				[2]		

Question			Answer	Marks	AO	Guidance
10	(a)		$(x-2)=5\cos\theta$ and $(y-1)=5\sin\theta$	M1	3.1a	allow sign errors
			$(x-2)^2+(y-1)^2=(5\cos\theta)^2+(5\sin\theta)^2$ **oe**	M1	1.1	**or** $\left(\frac{x-2}{5}\right)^2+\left(\frac{y-1}{5}\right)^2=\cos^2\theta+\sin^2\theta$ **oe**
			$(x-2)^2+(y-1)^2=5^2$ **oe isw**	A1	1.1	may see eg $x^2-4x+y^2-2y=20$
			or $\frac{(x-2)^2}{5^2}+\frac{(y-1)^2}{5^2}=1$ **oe isw**			if **M0M0** allow **SC1** for $y=1+5\sin\left(\cos^{-1}\left(\frac{x-2}{5}\right)\right)$ or $x=2+5\cos\left(\sin^{-1}\left(\frac{y-1}{5}\right)\right)$
				[3]		
			Alternatively $x^2=(2+5\cos\theta)^2$ and $y^2=(1+5\sin\theta)^2$	M1		if only seen in expanded form, allow one coefficient error; allow sign errors
			$x^2+y^2=5+20\cos\theta+10\sin\theta+25\sin^2\theta+25\cos^2\theta$	M1		must have terms in $\cos\theta$ and $\sin\theta$
			$x^2+y^2=20+4x+2y$ **oe isw**	A1		
			Alternatively radius = 5 and centre is (2, 1)	M1		allow sign error in coordinates of centre
			$(x-2)^2+(y-1)^2=5^2$	M1 A1		**FT** their centre all correct

Question			Answer	Marks	AO	Guidance
10	(b)		gradient of radius is $\frac{-4}{3}$	B1	3.1a	
			gradient of tangent is $\frac{3}{4}$	M1	2.1	**FT** $1 \div their -\frac{4}{3}$
			$(y - -3) = \frac{3}{4}(x - 5)$ **oe**	M1	2.4	allow one sign error; **FT** their $\frac{3}{4}$ may see $-3 = \frac{3}{4} \times 5 + c$
			$3x - 4y - 27 = 0$ *or* $-3x + 4y + 27 = 0$	A1	1.1	
				[4]		
			Alternatively $\frac{dy}{dx} = \frac{5\cos\theta}{-5\sin\theta}$ **oe**	B1		**or** $\frac{dy}{dx} = \frac{2-x}{y-1}$ **oe** eg $2(x-2) + 2(y-1)\frac{dy}{dx} = 0$
			substitution of $\cos\theta = \frac{3}{5}$ and $\sin\theta = -\frac{4}{5}$ **oe** **or** (5,–3) in their $\frac{dy}{dx}$	M1		$\frac{dy}{dx} = \frac{3/5}{-(-4/5)}$ **or** $\frac{2-5}{-3-1}$ **oe**; allow one sign error;
			$(y - -3) = \frac{3}{4}(x - 5)$ **oe**	M1		allow one sign error; **FT** their $\frac{3}{4}$ may see $-3 = \frac{3}{4} \times 5 + c$
			$3x - 4y - 27 = 0$ *or* $-3x + 4y + 27 = 0$	A1		
				[4]		

Question			Answer	Marks	AO	Guidance
11	(a)		Nina's, because hers is the largest sample size **oe**	**B1**	**2.2a**	allow eg Nina's, because with a larger sample size the probabilities get closer to the true probabilities **oe**
				[1]		
11	(b)		$11p + kp = 1$ $p = \frac{1}{11+k}$	**M1** **A1**	**3.1a** **1.1**	
				[2]		
11	(c)		$their\ \frac{1}{11+k} \times k$ or $their\ \frac{1}{11+k} \times 120$ $120 \times their\ \frac{k}{11+k}$ $\frac{120k}{11+k}$ **oe**	**M1** **M1** **A1**	**2.1** **1.2** **1.1**	multiply by k or by 120; may be embedded multiplying by both k and 120
				[3]		
11	(d)		32 = their $\frac{120k}{11+k}$ **oe** $k = 4$	**M1** **A1**	**1.1** **1.1**	
				[2]		

Question			Answer	Marks	AO	Guidance
			Alternatively $11p = 1 - \frac{32}{120}$ may be implied by $p = \frac{1}{15}$ (from $\left(P(X \neq 12)\right)$ $k = 4$	**M1** **A1**		**or** $\frac{kf}{120} = \frac{32}{120}$ (from $11f = 120 - 32 = 88$ so $f = 8$ and so $kp = \cdots$) $k = 4$
11	**(e)**		$Y \sim \text{B}\left(30, their\ \frac{4}{11+4}\right)$ or $Y \sim \text{B}\left(30, \frac{32}{120}\right)$ used to find P($Y = 8$) 0.16 – 0.163 **BC**	**M1** **A1**	**3.1a** **1.1**	Y is the number of 12s obtained in 30 rolls; allow **B2** for 0.1628 – 0.163 unsupported
				[2]		
12	**(a)**		$H_0 : \mu = 1.5$ $H_1 : \mu < 1.5$ μ is the **population mean** weight of flour in a bag	**B1** **B1**	**1.1** **2.5**	both hypotheses in terms of μ allow μ is the **population mean** weight of a bag of flour
				[2]		

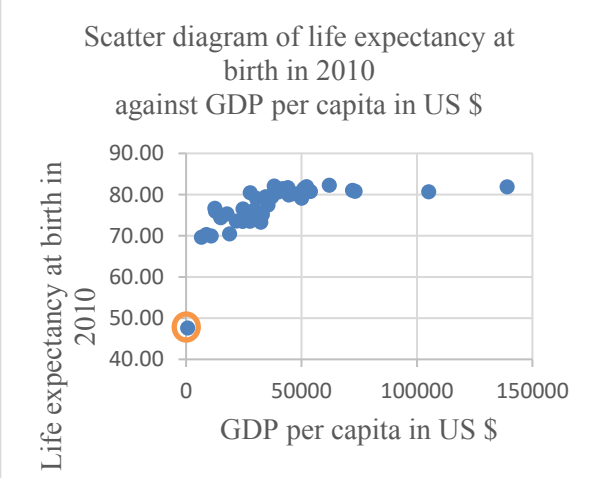
Question			Answer	Marks	AO	Guidance
12	(b)		$N(a, b)$ $a = 1.5$ or $b = \frac{0.24^2}{32}$ or 0.0018 $N(1.5, \frac{0.24^2}{32})$ **isw** or $N(1.5, 0.0018)$ **isw**	**M1** **A1** **A1**	**3.3** **2.2a** **3.1a**	a and b are numerical values allow 0.0424^2 for variance **A0** if answer spoiled by wrong variable quoted eg $\mu \sim N(1.5, \frac{0.24^2}{32})$ or $X \sim N(1.5, \frac{0.24^2}{32})$; allow only $\bar{X}$ **oe** if variable included
				[3]		
12	(c)		$0.0786 > 0.05$ or $-1.4142 > -1.645$ do not reject H_0 there is **insufficient evidence** at the 5% level to **suggest** that the **mean** weight of the flour in the bags is **less** than 1.5 kg	**M1** **A1** **A1**	**3.4** **1.1** **2.2b**	**or** $1.44 > 1.43(02586 \ldots)$ **NB** 1.43(02586…) is from InvNorm(0.05, 1.5,0.0424) allow accept H_0 **or** not significant **or** reject H_1 do not allow eg conclude / prove / indicate or other assertive statement instead of suggest if calculated values are used full marks may be awarded for awrt 0.07865 or 0.0786, **or** $-1.415 \leq z \leq -1.414$; otherwise award a maximum of **M1A1** for 0.07…or –1.4… other calculated values score **M0**
				[3]		

Question			Answer	Marks	AO	Guidance
13	(a)		it can't be fully justified because eg different samples may lead to different conclusions **oe** eg the proportion could be 0.35 and 61/140 may have arisen by chance **oe** eg the sample may not be representative **oe** eg the researcher used a sample not a population **oe**	**B1**	**2.4**	do not allow eg the sample is too small eg the sample is too small to be representative
				[1]		

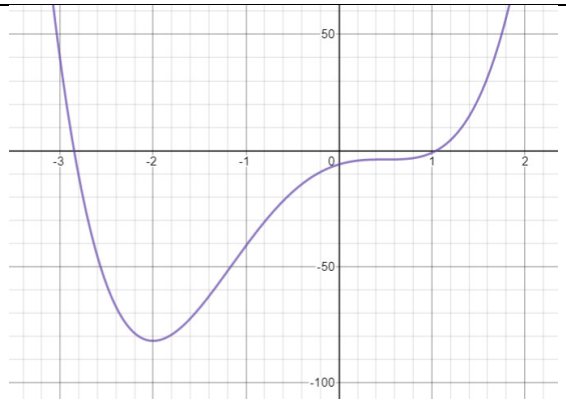
Question			Answer	Marks	AO	Guidance
13	(b)		$H_0 : p = 0.35$ $H_1 : p > 0.35$	**B1**	**1.1**	allow equivalent in words; do not allow percentages
			p is the probability that a baby (selected at random) is born without wisdom teeth	**B1**	**2.5**	or p is the proportion of babies that are born without wisdom teeth **B1B1** if other symbol instead of p used if correctly defined
			$P(X \geq k)$ found using B(140, 0.35), where $k = 60$, 61 or 62 **NB** $P(X \geq 60) = 0.03272 – 0.033$ or $P(X \geq 62) = 0.01438 – 0.015$ **NB** 0.967…, 0.978… and 0.985…imply **M1**	**M1***	**3.3**	**or** critical region is $X \geq k$ found from calculation of probability; allow $k = 58$, 59 or 60
			$P(X \geq 61) = 0.02197 – 0.022$	**A1**	**1.1**	or critical region is $X \geq 59$ from 0.0475…. or 0.048
			their 0.022 correctly compared with 0.05	**M1dep***	**3.4**	or 61 correctly compared with their 59; allow their 0.978 correctly compared with 0.95
			do not accept H_0 **or** reject H_0 **or** accept H_1 or significant	**A1FT**	**1.1**	**A0** if their 0.022 > 0.05 or 61 < their 59
			sufficient evidence at the 5% level to **suggest** that the **probability** that a baby is born without wisdom teeth **is more** than 0.35	**A1**	**1.1**	dependent on award of all other marks apart from second **B1** do not allow eg conclude / prove / indicate or other assertive statement instead of suggest
				[7]		

Question			Answer	Marks	AO	Guidance
14	(a)		0.2 × {0.96154 + 0.86207 + 0.73529 + 0.60976 + 0.5} **soi** 0.73373… ≈ 0.7337 **AG**	**M1** **A1**	**2.1** **2.4**	allow **M1A1** for calculation of exact values using formula in parts **(a)** and **(b)** need to see 0.73373… as well as 0.7337 for **A1**
				[2]		
14	(b)		0.2 × {1 + 0.96154 + 0.86207 + 0.73529 + 0.60976} 0.8337 correct to 4 dp	**M1** **A1**	**1.1** **1.1**	**or** (3.66866 - 0.5 + 1) × 0.2
				[2]		
14	(c)		0.1	**B1**	**1.1**	**FT** their 0.8337(32) – 0.7337(32), dependent on award of **M1** in part **(b)**
				[1]		
14	(d)		0.79162 – 0.77912 0.0125	**M1** **A1**	**3.1a** **2.4**	if **M0** allow **SC1** for correct interval identified eg 0.77912 to 0.79162
				[2]		
14	(e)		increase *n* **oe** use rectangles of smaller width **oe**	**B1**	**2.2a**	do not allow eg reduce interval eg just ‘smaller’ rectangles – need to specify width reduction
				[1]		
15	(a)		51.635 or 51.64 or 51.6	**B1**	**3.4**	
				[1]		

Question			Answer	Marks	AO	Guidance
15	(b)		1995 estimate (probably) reliable since it is interpolation 2025 estimate (probably) not reliable since it is extrapolation	B1 B1	2.2b 2.2b	allow eg the first estimate.. allow eg the second estimate…
				[2]		
15	(c)		No, because trends in life expectancy at birth may vary considerably between nations	B1	2.4	LDS advantage
				[1]		
15	(d)		series 2 (the top one) is Italy – life expectancy (generally) higher in **Europe** (than Africa) the values are decreasing (from 1990) in South Africa (– unusual since most show an upward trend) **or** little (or no) overall increase in South Africa (since 1970) **or** South Africa has lower life expectancy (than most developed countries)	B1 B1	2.4 2.4	LDS advantage LDS advantage
				[2]		

Question			Answer	Marks	AO	Guidance
15	(e)			B1	1.1	Point at (700, 47.56) ringed LDS advantage
				[1]		
15	(f)		the diagram supports this statement for values of GDP per capita from k to n where $0 < k \leq 20\,000$ and $40\,000 \leq n \leq 60\,000$ since there appears to be positive correlation **oe**	B1	2.3	must give specific range of values ; must say supports statement **oe**
			for values of GDP per capita $\geq K$ where $40\,000 \leq K \leq 60\,000$ there appears to be no association between GDP per capita and life expectancy at birth so the diagram does not support Sundip's statement for these values	B1	2.2b	the range may be implied by reference to a specific range identified for the first mark; must say does not support statement **oe**
				[2]		

Question	Answer	Marks	AO	Guidance
16 (a)	$\frac{dy}{dx} = 24x^3 + 24x^2 - 42x + 12$	M1	3.1a	allow one sign or coefficient error; must be four terms
	their $\frac{dy}{dx} = 0$	M1	1.1	at least two terms correct
	f(k) evaluated, where k is a factor of ±12 or $\pm\frac{a}{12}$, where a = 1,2,3,4 or 6	M1	2.1	may be implied by $x = -2$ seen unsupported or $(x + 2)$ identified as factor
	$(x + 2)(4x^2 - 4x + 1)$ or $(2x - 1)(2x^2 + 3x - 2)$	M1	3.1a	by inspection or long division; allow one sign error or one coefficient error in trinomial may be implied by $x = ½$ seen unsupported or $(2x - 1)$ **oe** identified as factor
	$x = -2$ and $x = \frac{1}{2}$ and no others	A1	1.1	may see $x = \frac{1}{2}$ (repeated) **A0** for $x = -2$ (repeated)
	$\left(\frac{1}{2}, -\frac{31}{8}\right)$ and $(-2, -82)$ and no others	A1	1.1	
	$\frac{d^2y}{dx^2} = 72x^2 + 48x - 42$	M1*	1.1	allow one sign or one coefficient error, **FT** their $\frac{dy}{dx}$; allow **M1** for $12x^2 + 8x - 7$
	$\frac{d^2y}{dx^2} = 150$ when $x = -2$ so minimum value	A1	1.1	**NB** test indecisive at $x = ½$ **A0** for just eg $\frac{d^2y}{dx^2} > 0$ so minimum
	or eg x : –2.1 | (–2) | –1.9 $\frac{dy}{dx}$: –16.224 | (0) | 13.824			award **M1A1** for consideration of gradient either side of –2, values must be correct to at least 2sf for **A1**

Question			Answer	Marks	AO	Guidance
			eg x | 0 | (½) | 1 $\frac{dy}{dx}$ | 12 | (0) | 18 dependent on at least two terms correct in derivative; must see values	**M1**	**3.1a**	or eg x | 0 | (½) | 1 y | –6 | (-3.875) | –1 or eg x | 0 | (½) | 1 $\frac{d^2y}{dx^2}$ | –42 | (0) | 78
			inflection at $\left(\frac{1}{2}, -\frac{31}{8}\right)$	**A1**	**3.2a**	values in table must be correct
			their $72x^2 + 48x - 42 = 0$	**M1dep***	**1.1**	
			$x = -\frac{7}{6}$ **isw**	**A1**	**1.1**	ignore calculation of associated y-value allow any correct decimals to 3 sf or more
				[12]		
16	**(b)**			**M1**	**1.1**	curve with a minimum in 3rd quadrant and stationary point of inflection in 4th quadrant and no other stationary points
				B1	**1.1**	(0, –6) identified as y-intercept (intercept must be below the x-axis and above –20)
				A1	**1.1**	correct curve with intercepts at $(-a,0)$ and $(b,0)$, where $-3 < a < -2.6$ and $0.8 < b < 1.2$; minimum at $(-2, y)$ where $-90 < y < -80$ and inflection for $0 < x < 1$ and y is between the x-axis and the y-intercept
				[3]		

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