GCE

Further Mathematics B MEI

Y422/01: Statistics major

A Level

Mark Scheme for June 2024

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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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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. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone or the RM Assessor messaging system, or by email.

5. **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
E	Explanation mark 1
SC	Special case
^	Omission sign
MR	Misread
BP	Blank Page
Seen	
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 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.
BP	Blank Page
Seen	
Highlighting	

6. **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 No Response (NR) if:

- there is nothing written in the answer space

Award Zero '0' if:

- anything is written in the answer space and is not worthy of credit (this includes text and symbols).

Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

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" 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)		E(X) = 2.9 Var(X) = 2.09	**B1** **B1** **[2]**	**1.1** **1.1**	
1	(b)		Mean = £2450 Variance of salary = $500^2 \times 2.09$ (= 522500) Standard deviation = £723 [£722.84]	**B1FT** **M1** **A1FT** **[3]**	**3.3** **1.1** **1.1**	 For $500^2 \times$ *their* variance Do not allow M1 for use of 2.9 unless stated to be Var(X). Do not allow M1 for simply $500^2 \times \text{Var}(X)$ without substituting in a value for Var(X) Allow 722.8. Do not allow to greater accuracy than the nearest penny. Do not allow answer given only in surds.

Question			Answer	Marks	AO	Guidance
2	(a)		Variance = 0.36 Mean = 0.36	M1 A1 [2]	3.3 1.1	soi
2	(b)	(i)	P(X = 1) = 0.2512	B1 [1]	3.4	**BC** FT their mean Mean = 0.6 P(X = 1) = 0.3293
2	(b)	(ii)	P(X > 1) = $1 - 0.9488$ $= 0.0512$	M1 A1 [2]	1.1 1.1	Or [P(X > 1) =] 1 – P($X \leq 1$) FT their mean Mean = 0.6 P(X > 1) = $1 - 0.8781 = 0.1219$
2	(c)		Mean = $20 \times$ *their* 0.36 [= 7.2] P(Y < 5) = 0.1555	M1 A1 [2]	3.3 1.1	 **BC** FT their mean Mean = 0.6 P(Y < 5) = 0.0076

Question			Answer	Marks	AO	Guidance
3	(a)		$N(46, 3.1^2)$ P(> 50 mins) = 0.0985	B1 [1]	1.1	BC
3	(b)		$N(35, 2.4^2)$ inv(0.99) $\Rightarrow$ 40.6 mins	B1 [1]	3.1b	BC
3	(c)		$N(46 - 35 - 12, 3.1^2 + 2.4^2 + 2.2^2)$ N(−1, 20.21) P(< 0) = 0.5880	B1 B1 B1 [3]	3.3 1.1 3.4	For Normal and mean. Allow mean = +1 For variance $(4.4955 ...^2)$ awrt 20.2 BC
3	(d)		Time for 1 load ~ $N(35 + 46 + 12, 2.4^2 + 3.1^2 + 2.2^2)$ (N(93, 20.21)) Mean time for 5 loads ~ N(93, 20.21/5) So P(Mean < 90) = 0.0678	B1 M1 A1 [3]	3.3 1.1 3.4	For correct distribution soi For distribution BC

Question			Answer	Marks	AO	Guidance
4	(a)		$\frac{1}{2}\times 50\times 50a=1$ $a=\frac{1}{1250}$	M1 A1 [2]	2.1 1.1	Or by integration $\int_0^5 ax\mathrm{d}x=1$
4	(b)		$\mathrm{P}(X\leq 5)=\frac{1}{2}\times\frac{1}{1250}\times 5\times 5$ $=\frac{1}{100}$	M1 A1 [2]	3.4 1.1	Or by integration $\int_0^5 \frac{1}{1250}x\mathrm{d}x$ Using their a
4	(c)		$\frac{1}{2}\times\frac{1}{1250}\times m\times m=\frac{1}{2}$ $m^2=1250$ m = 35.4 or $25\sqrt{2}$ (35.35533…) aef	M1 M1 A1 [3]	2.1 1.1 1.1	Or by integration $\int_0^m \frac{1}{1250}x\mathrm{d}x$ Using their a Using their a $m^2=\frac{1}{\text{their } a}$

Question			Answer	Marks	AO	Guidance
5	(a)		The sample is large And the central limit theorem states that, for sufficiently large sample size, the sample means are approximately Normally distributed	B1 B1 [2]	2.4 2.4	Allow 'n > 20' or greater value than 20 Do not allow 40 > 30 oe Must mention central limit theorem and sample mean for second mark Do not allow 'parent population is Normally distributed' or 'sample data is Normally distributed' or anything else wrong for second B1 even if above is mentioned
5	(b)		Confidence interval does not contain zero … …which suggests that there is a difference in the mean sleep score.	B1* DB1 [2]	3.4 2.2b	Do not allow simply 'All values are positive' There must be some uncertainty in the answer. Do not allow 'higher' or 'lower' Condone 'change' rather than 'difference'
5	(c)	(i)	Standard error is the standard deviation of the sample mean	B1 [1]	1.2	Do not allow standard deviation divided by square root of sample size Allow standard deviation for $\bar{X}$. Condone $\bar{x}$
5	(c)	(ii)	$\frac{2.14}{\sqrt{40}}$ $(= 0.3384)$	B1 [1]	1.1	
5	(d)		Interval is given by 0.586 ± 1.96 $\times 0.3384$ $-0.077 < \mu < 1.249$ interval limits are 0.586 ± 0.6633 So in this case the interval does contain zero so this suggests that there may be no difference in the mean sleep score	 M1 M1 A1 B1 [4]	 3.4 1.1 1.1 2.2b	 Accept using t-value of 2.02(2691…) Accept based on t-distribution (-0.098, 1.270) Condone if only mention lower limit. Allow $0.586 - 0.6633$ 'Yes it has made a difference since it does contain zero' oe Do not FT from incorrect part (b) and do not award if incorrect statement seen.

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO</th><th>Guidance</th></tr>
<tr><td>6</td><td>(a)</td><td></td><td>Because the scatter diagram appears to be curvilinear rather than elliptical,
there is not enough evidence to suggest that the distribution is bivariate Normal.</td><td>M1

A1

[2]</td><td>3.5a

2.4</td><td>For elliptical or curvilinear
For full answer (dependent on first mark)
Condone ‘not based on bivariate Normal’
Do not condone ‘the data is not bivariate Normal’
Do not condone ‘Normal bivariate’ rather than bivariate Normal’</td></tr>
<tr><td>6</td><td>(b)</td><td></td><td>The sample must be random</td><td>B1
[1]</td><td>1.2</td><td>Do not allow ‘Random on random’</td></tr>
<tr><td>6</td><td>(c)</td><td></td><td>DR
<table><tr><td>Age</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr><tr><td>Grip</td><td>6</td><td>8</td><td>7</td><td>10</td><td>5</td><td>9</td><td>4</td><td>2</td><td>3</td><td>1</td></tr></table>
$\sum d^2 = 284$

Spearman’s rank coefficient = −0.7212

H_0: There is no association between age and grip strength in the population
H_1: There is negative association between age and grip strength in the population

For n = 10, 5% 1-tailed critical value is 0.5636

−0.7212 < −0.5636

Reject H_0. There is sufficient evidence to suggest that there is negative association between age and grip strength (in the population)

Please annotate page 9</td><td>B1

B1

B1

B1

B1

M1

A1

[8]</td><td>1.1

1.1

1.1

3.3

2.5

3.4

1.1

2.2b</td><td>For any ranking.
Could rank in reverse order leading to +0.7212 and still get full marks

BC

B0B0 for correlation Do not allow ρ_s unless defined

Need to see population in one or other of the hypotheses in order to get two B1 marks

For comparison provided |rs| < 1. (provided sensibly obtained) Allow |0.7212| > |0.5636|.
Dep on H_1 negative association .
Must be in context.
Allow ‘We can assume that…’
Do not allow correlation. No marks for PMCC test</td></tr>
</table>

Question			Answer	Marks	AO	Guidance
7	(a)		Estimate of population mean = 11.07 (11.069) Estimate of population standard deviation = 3.33 (3.3299...)	**B1** **B1** **[2]**	**1.1** **1.1**	
7	(b)		Normal probability plot is roughly straight Very high *p*-value Both suggest that the data may be from a Normal distribution	**B1** **B1** **B1** **[3]**	**1.1** **1.1** **2.2b**	No marks if Wilcoxon suggested Allow 'not too low' Dep on at least one previous B mark Do not allow 'from bivariate Normal' oe Do not allow 'the data is Normally distributed'
7	(c)		H_0: the Normal distribution fits the data Condone H_0: the data comes from or follows a Normal distribution Condone H_0: Population is Normally distributed	**B1** **[1]**	**1.2**	Do not allow 'The data is Normal'
7	(d)		**DR** H_0: $\mu = 9.4$ H_1: $\mu \neq 9.4$ Where μ is the population mean selenium level in carrots from these fields Test statistic is $\frac{11.069-9.4}{3.3299/\sqrt{10}}$ = 1.585 Refer to t_9 Critical value (2-tailed) at 5% level is 2.262 1.585 < 2.262 so not significant (do not reject H_0) Insufficient evidence to suggest that the selenium level is different (from 9.4 ng/g)	 **B1** **B1** **M1** **A1** **M1** **A1** **M1** **A1** **[8]**	 **1.1a** **1.2** **3.3** **1.1** **3.4** **1.1** **2.2b** **3.5a**	No marks for Wilcoxon Hypotheses in words only must include "population". For definition in context including "population" FT their mean and/or sd For confidence interval method $99.4 \pm \text{Crit value} \times \frac{3.3299}{\sqrt{10}}$ **BC** For confidence interval method 7.018 to 11.782 No FT if not t_9. Can be implied by 2.262 or 1.833 Or *p*-value = 1 − 0.926 = 0.074. M1 A1 Or using *p*-value 7.4% > 2.5% Or compare 11.069 with confidence limit FT their sensibly obtained test statistic and cv (2.262 or 1.833) for M1 only Answer must be in context.

Question			Answer	Marks	AO	Guidance
7	(e)		A Wilcoxon test (or A Wilcoxon signed rank test) Since the population would be unlikely to be Normally distributed.	**B1** **B1** **[2]**	**1.2** **2.2b**	Do not allow 'bivariate Normally distributed'

Question			Answer	Marks	AO	Guidance
8	(a)		Label flat A at the point approx. (120, 600) Label flat B at the point approx. (90, 1000)	**B1** **B1** **[2]**	**3.3** **1.1**	B0 unless point labelled A B0 unless point labelled B
8	(b)		**DR** NB: $\bar{x} = \frac{652.5}{11} = 59.318$, $\bar{y} = \frac{5067}{11} = 460.63$ $b = \frac{S_{xy}}{S_{xx}} = \frac{315928.2-(652.5\times5067/11)}{41987.35-652.5^2/11} = \frac{15362.97}{3282.236}$ $= 4.6806\ldots$ For correct line (y on x) so equation is $y - \bar{y} = b(x - \bar{x})$ $y - 460.63 = 4.6806(x - 59.318)$ $y = 4.6806x + 182.99$	**M1** **A1** **B1** **M1** **A1** **[5]**	**1.1a** **1.1** **3.3** **1.1** **1.1**	For attempt at gradient (b) Use of 13 instead of 11 can get Max M1A0B1M1A0 which would lead to $y = 6.669x + 55.05$ Allow 4.7 or better For equation of line Condone use of x on y regression line for Max M1A0B0M1A0
8	(c)		Area 40 ⇒ £370 thousand Area 110 ⇒ £698 thousand	**B1** **B1** **[2]**	**1.1** **1.1**	FT provided y on x. Allow B1B0 if answers given to more than nearest whole number of thousands or if thousands omitted and B0B0 if both FT provided y on x. n = 13 leads to £321 thousands and £788 thousands
8	(d)		Although prediction for 40 m^2 lies within the data (interpolation), the points do not lie too close to the line, so it is not too reliable. and the value of r^2 is 0.585 which is not close to 1 which further suggests that the estimate is only moderately reliable. The prediction for 110 m^2 is even less reliable since it is an extrapolation.	**B1** **B1** **B1** **[3]**	**2.2a** **3.5b** **3.5b**	Allow first B1 for any correct comment about 40 m^2 Condone 'Near the centre of the data' Condone comment about the PMCC for first B1 Allow second B1 for all 3 correct comments about 40 m^2 and must use r^2 rather than r Allow r^2 is reasonably close to 1 and the points are fairly close to a straight line Max 2 out of 3 if any wrong comments seen

Question			Answer	Marks	AO	Guidance
8	(e)		The regression line of x on y would be needed. It would not be sensible since the line in part (b) only measures the average cost for a given area and not the reverse	**B1** **B1** **[2]**	**3.5b** **3.5c**	Any suitable context The regression line of floor area on price would be needed gets B1B1. Condone 'the regression coefficient will be calculated using $\frac{S_{xy}}{S_{xx}}$ so the line found in part (b) cannot be used' for B1

Question			Answer	Marks	AO	Guidance
9	(a)		Road < 25 = $\frac{42\times15}{120} = 5.25$ Gravel < 25 = $\frac{42\times68}{120} = 23.80$ Road ≥ 25 = $\frac{78\times15}{120} = 9.75$ Gravel ≥ 25 = $\frac{78\times68}{120} = 44.20$	**B1** **B1** **[2]**	**3.4** **1.1**	B1 for any one correct B1 for the other 3 (perhaps by subtraction)
9	(b)		$\frac{(18-24.05)^2}{24.05}$ = 1.5219	**M1** **A1** **[2]**	**1.1** **1.1**	For $\frac{(O-E)^2}{E}$ Must be given to 4d.p.
9	(c)		**DR** H_0: no association between type of bicycle and (whether the) maximum speed (is 25mph or greater). H_1: some association between type of bicycle and (whether the) maximum speed (is 25mph or greater). Test statistic = 7.9503 Degrees of freedom = 2 Critical value = 5.991 7.9503 > **5.991** so reject H_0 There is sufficient evidence to suggest that there is some association between type of bicycle and (whether the) maximum speed (is 25mph or greater). Please annotate page 15	**B1** **B1** **B1** **M1** **A1** **[6]**	**2.5** **1.1** **3.3** **1.1** **2.2b** **3.5a**	For both. Allow independent/not independent. Do NOT allow relationship in place of association BC Can be implied by correct critical value or *p*-value Or *p*-value = 0.0188 Or $X_2^2(7.9503) = 0.9812$ For comparison (or 0.0188 < 0.05 or $0.9812 > 0.95$ oe) Must have correct test statistic and critical value If hypotheses wrong way around allow MAX B0B1B1B1M0A0

Question			Answer	Marks	AO	Guidance
9	(d)		For the road bike, the contribution of 2.0119 shows that fewer journeys than expected have max speed < 25 mph whereas the contribution of 1.0833 shows that more journeys than expected have max speed ≥ 25 mph.	**B1**	**2.2b**	
			For the gravel bike, the levels are as expected.	**B1**	**3.5a**	Do not allow comments which suggest that gravel has more over 25 than expected and fewer 25 or less unless mention that contributions are (very) small so effect is very slight
			For the electric bike, the contribution of 2.8264 shows that more journeys than expected have max speed < 25 mph whereas the contribution of 1.5219 shows that fewer journeys than expected have max speed ≥ 25 mph.	**B1**	**3.5a**	If B0B0B0 or if more marks gained below then SC B2 for 5 correct comments without mentioning the actual values of the contributions or the size of contributions and no incorrect comments SC B1 for any 2 correct comments without mentioning contributions SCB2 for one correct comment in each case and mentioning actual values of the contributions or the size of contributions.
				[3]		

Question			Answer	Marks	AO	Guidance
10	(a)		$E(X) = 3$ or $E(Y) = 2$ $E(Z) = 5$	B1 B1 [2]	3.3 1.1	Can be implied by $E(Z) = 5$
10	(b)		$Var(X) = \frac{16}{12} = \frac{4}{3}$ $Var(Y) = \frac{36}{12} = 3$ $Var(Z) = \frac{16}{12} + \frac{36}{12} = \frac{52}{12} = \frac{13}{3}$ Cts uniform on [0, 10] has var $\frac{100}{12} = \frac{25}{3}$ which is very different (so Ben is wrong)	M1 A1 B1 [3]	1.1 1.1 2.2a	For either. Must be considering variances Do not allow $\frac{13}{3} \neq \frac{25}{3}$ since question says well modelled. Allow very different, not very close oe
10	(c)		Estimate of $P(Z > 6) = 0.3$	B1 [1]	1.1	
10	(d)		Distribution is $N\left(40 \times 5, 40 \times \frac{52}{12}\right)$ $N\left(200, \frac{520}{3}\right)$ or $N(200, 173.33)$ $P(Total > 210) = 0.224$ (0.22376…)	M1 A1 B1 [3]	3.3 1.1 1.1	For mean FT their $E(Z)$ For variance FT their $Var(Z)$ Condone without N(,) **BC** Allow equivalent method eg using mean rather than total B0 if continuity correction attempted

Question			Answer	Marks	AO	Guidance
11	(a)		For n even, the probability $= \frac{1}{2}$	B1	1.1	
			Number of values of X is $n - 24$	M1	3.1a	For $n - 24$ seen
			For n odd, the number that are less than $\frac{n+25}{2}$ is $\frac{n-25}{2}$	M1	3.1a	For $\frac{n-25}{2}$ seen
			For n odd, the probability = $\frac{n-25}{2(n-24)}$	A1	1.1	If odd and even answers reversed allow B0M1M1A0
				[4]		
11	(b)		Var(X) = $\frac{1}{12}((n-24)^2 - 1)$	B1	3.1a	For correct use of formula
			Var of mean of 100 values = $\frac{1}{1200}((n-24)^2 - 1)$	B1	2.1	For division of their Var by 100
			$= \left(\frac{1}{1200}(n^2 - 48n + 575)\right)$			
				[2]		
11	(c)		Mean = $\frac{75+25}{2} = 50$	B1	1.1	
			Variance = $\frac{((75-24)^2-1)}{1200} = \frac{2600}{1200} = \frac{13}{6}$ = 2.1666…	M1	3.1a	For substituting n = 75 into their variance from part (b) NB Standard error = $\sqrt{\frac{2600}{1200}} = \sqrt{\frac{13}{6}} = 1.4719$ ... scores M1
			By CLT distribution is approx. N(50, $\frac{13}{6}$)	M1	2.2a	For distribution with correct mean but their variance
			For P(Mean < 48) use a continuity correction to find P(Mean < 47.995)	M1	3.4	For correct continuity correction
			P(Mean < 47.995) = 0.0866	A1	1.1	Allow max 4 marks for P(Mean < 48) = 0.0871 (without correct continuity correction) Allow equivalent method eg using total rather than mean
				[5]		

Question			Answer	Marks	AO	Guidance
12	(a)		$F(20) = 0, F(30) = 1, F(25) = \frac{11}{24}$	B1	2.2a	Soi For at least 2 of the three
			$a(400 + 20b + c) = 0$	M1	2.2a	For $F(20) = 0$
			$a(900 + 30b + c) = 1$	M1	1.1	For $F(30) = 1$
			$a(625 + 25b + c) = \frac{11}{24}$	M1	1.1	For $F(25) = \frac{11}{24}$
			$a = \frac{1}{600}, b = 10, c = -600$	A1	1.1	For solving either by elimination or by calculator
			$P(X > 27) = 1 - \frac{1}{600}(27^2 + 10 \times 27 - 600)$	M1	3.1a	For calculation using their non-zero values of *a*, *b* and *c*. oe
			$P(X > 27) = 0.335$ or $\frac{67}{200}$	A1	1.1	
			Alternative method			
			$F(30) - F(20) = 1$	B1	2.2a	soi
			$a(900 + 30b + c) - a(400 + 20b + c) = 1$	M1	2.2a	
			$F(25) - F(20) = \frac{11}{24}$	B1	1.1	soi
			$a(625 + 25b + c) - a(400 + 20b + c) = \frac{11}{24}$	M1	1.1	
			$a = \frac{1}{600}, b = 10$	A1	1.1	For solving either by elimination or by calculator
			$P(X > 27) = \frac{1}{600}(30^2 + 10 \times 30 + c) - \frac{1}{600}(27^2 + 10 \times 27 + c)$	M1	3.1a	For calculation using their non-zero values of *a*, *b* and *c*
			$P(X > 27) = 0.335$ or $\frac{67}{200}$	A1	1.1	
			Please annotate page 19	[7]		
12	(b)		$\frac{1}{600}(n^2 + 10n - 600) = 0.9$	M1	3.1a	For equation using their non-zero values of *a*, *b* and *c*
			Or $\frac{1}{600}(n^2 + 10n + c) - \frac{1}{600}(20^2 + 10 \times 20 + c) = 0.9$			Or For equation using their non-zero values of *a* and *b*
			$n = 29.1$ (29.132 ...)	A1	1.1	
				[2]		

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