OCR

SPECIMEN

Advanced Subsidiary GCE

QUANTITATIVE METHODS (MEI)

G245 Statistics 1

Specimen Question Paper

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book G245
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Duration: 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found in the centre of the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the Printed Answer Book**. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

INFORMATION FOR CANDIDATES

This information is the same on the Printed Answer Book and the Question Paper.

- The number of marks is given in brackets **[ ]** at the end of each question or part question on the Question Paper.
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- The total number of marks for this paper is **72**.
- The Printed Answer Book consists of **12** pages. The Question Paper consists of **4** pages. Any blank pages are indicated.

INSTRUCTION TO EXAMS OFFICER / INVIGILATOR

- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

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Section A (36 marks)

1 At a garden centre there is a box containing 50 hyacinth bulbs. Of these, 30 will produce a blue flower and the remaining 20 will produce a red flower. Unfortunately they have become mixed together so that it is not known which of the bulbs will produce a blue flower and which will produce a red flower.

Karen buys 3 of these bulbs.

(i) Find the probability that all 3 of these bulbs will produce blue flowers. **[3]**

(ii) Find the probability that Karen will have at least one flower of each colour from her 3 bulbs. **[3]**

2 An examination paper consists of two sections. Section A has 5 questions and Section B has 9 questions. Candidates are required to answer 6 questions.

(i) In how many different ways can a candidate choose 6 questions, if 3 are from Section A and 3 are from Section B? **[3]**

(ii) Another candidate randomly chooses 6 questions to answer. Find the probability that this candidate chooses 3 questions from each section. **[3]**

3 At a call centre, 85% of callers are put on hold before being connected to an operator. A random sample of 30 callers is selected.

(i) Find the probability that exactly 29 of these callers are put on hold. **[3]**

(ii) Find the probability that at least 29 of these callers are put on hold. **[3]**

(iii) If 10 random samples, each of 30 callers, are selected, find the expected number of samples in which at least 29 callers are put on hold. **[2]**

4 It is known that 8% of the population of a large city use a particular web browser. A researcher wishes to interview some people from the city who use this browser. He selects people at random, one at a time.

(i) Find the probability that the first person that he finds who uses this browser is

(*A*) the third person selected **[3]**

(*B*) the second or third person selected. **[2]**

(ii) Find the probability that at least one of the first 20 people selected uses this browser. **[3]**

5 A manufacturer produces titanium bicycle frames. The bicycle frames are tested before use and on average 5% of them are found to be faulty. A cheaper manufacturing process is introduced and the manufacturer wishes to check whether the proportion of faulty bicycle frames has increased. A random sample of 18 bicycle frames is selected and it is found that 4 of them are faulty. Carry out a hypothesis test at the 5% significance level to investigate whether the proportion of faulty bicycle frames has increased. **[8]**

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Section B (36 marks)

6 The engine sizes $x\,\text{cm}^3$ of a sample of 80 cars are summarised in the table below.

Engine size x	$500 \leqslant x \leqslant 1000$	$1000 < x \leqslant 1500$	$1500 < x \leqslant 2000$	$2000 < x \leqslant 3000$	$3000 < x \leqslant 5000$
Frequency	7	22	26	18	7

(i) Draw a histogram to illustrate the distribution. **[5]**

(ii) A student claims that the midrange is $2750\,\text{cm}^3$. Discuss briefly whether he is likely to be correct. **[1]**

(iii) Calculate estimates of the mean and standard deviation of the engine sizes. Explain why your answers are only estimates. **[5]**

(iv) Hence investigate whether there are any outliers in the sample. **[3]**

(v) A vehicle duty of £1000 is proposed for all new cars with engine size greater than $2000\,\text{cm}^3$. Assuming that this sample of cars is representative of all new cars in Britain and that there are 2.5 million new cars registered in Britain each year, calculate an estimate of the total amount of money that this vehicle duty would raise in one year. **[3]**

(vi) Why in practice might your estimate in part **(v)** turn out to be too high? **[1]**

7 Yasmin has 5 coins. One of these coins is biased with P(heads) = 0.6. The other 4 coins are fair. She tosses all 5 coins once and records the number of heads, X.

(i) Show that $P(X = 0) = 0.025$. **[2]**

(ii) Show that $P(X = 1) = 0.1375$. **[4]**

The table shows the probability distribution of X.

r	0	1	2	3	4	5
$P(X=r)$	0.025	0.1375	0.3	0.325	0.175	0.0375

(iii) Draw a vertical line chart to illustrate the probability distribution. **[2]**

(iv) Comment on the skewness of the distribution. **[1]**

(v) Find $E(X)$ and $\text{Var}(X)$. **[5]**

(vi) Yasmin tosses the 5 coins three times. Find the probability that the total number of heads is 3. **[4]**

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SPECIMEN

Advanced Subsidiary GCE

QUANTITATIVE METHODS (MEI)

G245 Statistics 1

Specimen Printed Answer Book

Candidates answer on this Printed Answer Book.

OCR supplied materials:
- Question Paper G245 (inserted)
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Duration: 1 hour 30 minutes

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

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Section A (36 marks)

1 (i)	
1 (ii)	

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2 (i)	
2 (ii)	
3 (i)	

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3 (ii)

3 (iii)

4 (i) (A)

4 (i) (*B*)

4 (ii)

5	

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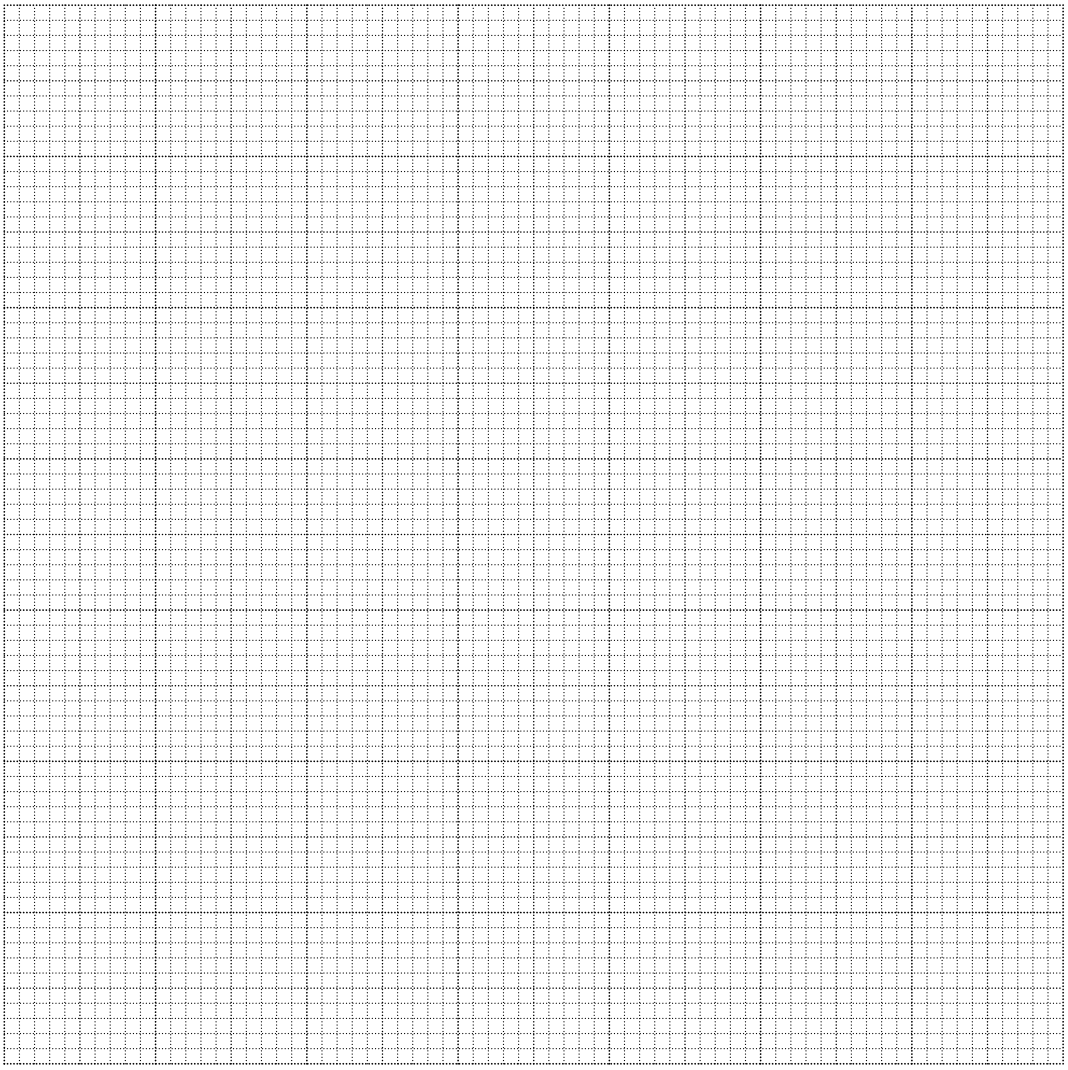
Section B (36 marks)

6 (i)



6 (ii)	
6 (iii)	

6 (iv)	
6 (v)	
6 (vi)	

7 (i)	
7 (ii)	
7 (iii)	

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7 (iv)	
7 (v)	

7 (vi)	

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SPECIMEN

Advanced Subsidiary GCE
QUANTITATIVE METHODS (MEI)
G245 Statistics 1 (S1)

Specimen Mark Scheme

The maximum mark for this paper is 72.

This document consists of 24 printed pages

GENERIC MARKING INSTRUCTIONS

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 scoris 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 scoris messaging system, or by email.

5. Work crossed out:
   a. where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks
   b. if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.

7. There is a NR (No Response) option. Award NR (No Response):
   - if there is nothing written at all in the answer space
   - OR if there is a comment which does not in anyway 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) which is not an attempt at the question.

   Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

8. The scoris **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
   If you have any questions or comments for your Team Leader, use the phone, the scoris messaging system, or email.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. **Annotations**

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
awrt	Answer which rounds to

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, 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
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, 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.

Question			Answer	Marks	Guidance	
1	(i)		P(All blue) $= \frac{30}{50} \times \frac{29}{49} \times \frac{28}{48} = 0.2071$	M1	For $\frac{30}{50} \times$ (as part of a triple product)	$(30/50)^3 = 0.216$ scores M1M0A0 $\frac{k}{50} \times \frac{(k-1)}{49} \times \frac{(k-2)}{48}$ for values of k other than 30 scores M1M0A0 Zero for binomial unless simplified to $(3/5)^3$
				M1	For product of other two fractions	Correct working but then multiplied or divided by some factor scores M1M0A0
				A1	CAO	Accept 0.21 with working and 0.207 without working Allow unsimplified fraction as final answer 24360/117600 oe
					SC2 for P(All red) = 0.0582	
				[3]		
			OR $\binom{30}{3} / \binom{50}{3} = 4060/19600 = 29/140 = 0.2071$ M2 for the complete method			
1	(ii)		P(All red) $= \frac{20}{50} \times \frac{19}{49} \times \frac{18}{48} = 0.0582$ or $\binom{20}{3} / \binom{50}{3} = 0.0582$	M1	For P(All red)	SC2 for $1 - (30/50)^3 - (20/50)^3 = 1 - 0.216 - 0.064 = 0.72$, providing consistent with (i) . If not consistent with (i) M0M0A0
			P(At least one of each colour) $= 1 - (0.2071 + 0.0582) = 0.7347$ or $1 - \left(\frac{29}{140} + \frac{57}{980}\right) = 1 - \frac{260}{980} = 1 - \frac{13}{49} = \frac{36}{49}$	M1	For $1 - (0.2071 + 0.0582)$	
				A1	CAO	Allow 0.73 with working Allow unsimplified fraction as final answer 86400/117600 oe
				[3]		

Question			Answer	Marks	Guidance	
			OR P(2b,1r)+P(1b,2r)	(M1)	For either $\frac{30}{50}\times\frac{29}{49}\times\frac{20}{48}$ or $\frac{20}{50}\times\frac{19}{49}\times\frac{30}{48}$	Allow M1 for $3\times(30/50)^2\times(20/50)$ or $3\times(30/50)\times(20/50)^2$ and second M1 for sum of both if = 0.72 If not consistent with (i) M0M0A0
			$= 3\times\frac{30}{50}\times\frac{29}{49}\times\frac{20}{48}+3\times\frac{20}{50}\times\frac{19}{49}\times\frac{30}{48}$	(M1)	For sum of both or for 3× either	NB M2 also for $\frac{30}{50}\times\frac{20}{49}\left(\times\frac{48}{48}\right)$ even if not multiplied by 3
			= 3 × 0.1480 + 3 × 0.0969 = 0.7347	(A1)	CAO	Allow 0.73 or better with working
			OR Either $\binom{30}{2}\times\binom{20}{1}/\binom{50}{3}$ or $\binom{30}{1}\times\binom{20}{2}/\binom{50}{3}$	(M1) (M1) (A1)	For sum of both CAO	
2	**(i)**		$^9C_3 \times {}^5C_3 = 84 \times 10 = 840$	M1 M1 A1 **[3]**	For either $^9C_3$ or $^5C_3$ For product of both correct combinations CAO	Zero for permutations
2	**(ii)**		Total number of ways of answering 6 from 14 is $^{14}C_6 = 3003$ Probability $= \frac{840}{3003} = \frac{40}{143} = 0.27972 = 0.280$	M1 M1 A1 **[3]**	For $^{14}C_6$ seen in part (ii) For their 840/ 3003 or their 840/$^{14}C_6$ FT their 840	Allow full marks for unsimplified fractional answers
			OR $^6C_3 \times 5/14 \times 4/13 \times 3/12 \times 9/11 \times 8/10 \times 7/9 = 0.280$	(M1) (M1) (A1)	For product of fractions For $^6C_3\times$ correct product	SC1 for $^6C_3 \times (5/14)^3 \times (9/14)^3 = 0.2420$

Question			Answer	Marks	Guidance	
3	(i)		X ~ B(30, 0.85) P(X = 29) = $\binom{30}{29} \times 0.85^{29} \times 0.15^{1} = 30 \times 0.0013466 = 0.0404$	M1 M1 A1 **[3]**	For $0.85^{29} \times 0.15^{1} = 0.0013466$ For $\binom{30}{29} \times p^{29} \times q^{1}$ CAO	 With $p + q = 1$ Allow 0.04 www If further working (EG P(X=29) –P(X=28)) give M2A0
3	(ii)		P(X = 30) = 0.85^{30} = 0.0076 P(X ≥ 29) = 0.0404 + 0.0076 = 0.0480	M1 M1 A1 **[3]**	For 0.85^{30} For P(X = 29) + P(X = 30) (not necessarily correct, but both attempts at binomial, including coefficient in **(i)**) CAO	 Allow eg 0.04+0.0076=0.0476 Allow 0.05 with working
3	(iii)		Expected number = 10 × 0.0480 = 0.480	M1 A1 **[2]**	For 10 × their **(ii)** FT their **(ii)** but if answer to **(ii)** leads to a whole number for **(iii)** give M1A0	**Provided (ii) between 0 and 1** Do not allow answer rounded to 0 or 1.

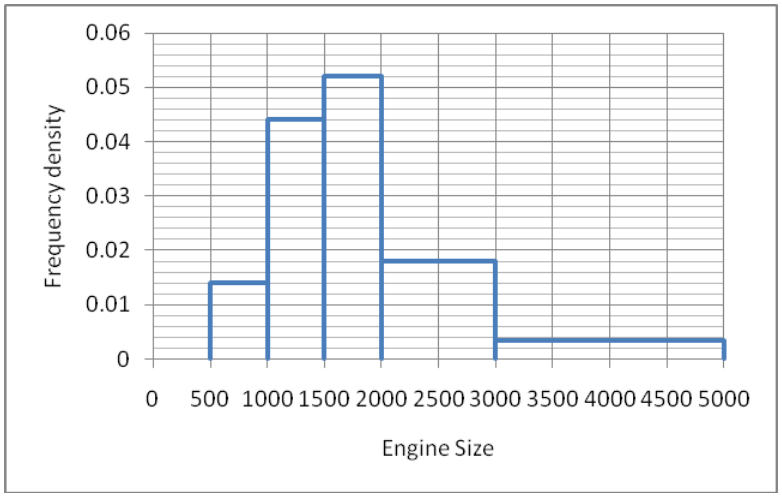
Question			Answer	Marks	Guidance	
4	(i)	(*A*)	P(third selected) = $0.92^2 \times 0.08 = 0.0677$ Or = 1058/15625	M1 M1 A1 **[3]**	For 0.92^2 For $p^2 \times q$ CAO SC1 for 'without replacement' method 92/100×91/99×8/98 =0.0690	 With $p + q = 1$ With no extra terms Allow 0.068 but not 0.067 nor 0.07
4	(i)	(*B*)	P (second) + P(third) = (0.92 × 0.08) + ($0.92^2 \times 0.08$) = 0.0736 + 0.0677 = 0.1413 = 2208/15625	M1 A1 **[2]**	For 0.92 × 0.08 FT their 0.0677 SC1 for answer of 0.143 from 'without replacement' method	With no extra terms Allow 0.141 to 0.142 and allow 0.14 with working
4	(ii)		P(At least one of first 20) = 1 - P(None of first 20) = $1 - 0.92^{20} = 1 - 0.1887$ = 0.8113	M1 M1 A1 **[3]**	0.92^{20} $1 - 0.92^{20}$ CAO	Accept answer of 0.81 or better from P(1) + P(2) + ... , or SC2 if all correct working shown but wrong answer No marks for 'without replacement' method' Allow 0.81 with working but not 0.812

Question			Answer	Marks	Guidance	
5			Let p = probability that a randomly selected frame is faulty	B1	For definition of p in context Minimum needed for B1 is p = probability that frame/bike is faulty. Do not allow is p = probability that it is faulty Allow p = P(frame faulty) Definition of p must include word probability (or chance or proportion or percentage or likelihood but NOT possibility). Preferably as a separate comment. However, can be at end of H_0 as long as it is a clear definition ' p = the probability that frame is faulty, NOT just a sentence 'probability is 0.05' Do NOT allow 'p = the probability that faulty frames have increased'	
			H_0: $p = 0.05$	B1	H_0 : p(frame faulty) = 0.05, H_1 : p(frame faulty) > 0.05 gets B0B1B1 Allow p=5%, allow θ or π and ρ but not x. However, allow any single symbol <u>if defined</u> Allow $H_0 = p$=0.05, Allow $H_0 : p = {}^1/_{20}$ Do not allow H_0 : P(X=x) = 0.05, H_1 : P(X=x) > 0.05 Do not allow H_0: =0.05, =5%, P(0.05), p(0052), p(x)=0.05, x=0.05 (unless x correctly defined as a probability) Do not allow H_1:$p \geq 0.05$, Do not allow H_0 and H_1 reversed Allow NH and AH in place of H_0 and H_1 For hypotheses given in words allow Maximum B0B1B1 Hypotheses in words must include probability (or chance or proportion or percentage) and the figure 0.05 oe	
			H_1: $p > 0.05$	B1		
			P($X \geq 4$)	B1	For notation P($X \geq 4$) or 1- P($X \leq 3$) This mark may be implied by 0.0109 as long as no incorrect notation	No further marks if point probs used - P($X = 4$) = 0.0094 DO NOT FT wrong H_1 But if H_1 is $p \geq 0.05$ allow the rest of the marks if earned so max 7/8
			= 1- P($X \leq 3$) = 1 – 0.9891 = 0.0109	B1*	For 0.0109, indep of previous mark	Or for 1 – 0.9891

Question	Answer	Marks	Guidance	
	0.0109 < 0.05	M1* dep	For comparison with 5%	
	So reject H_0	A1*	or significant or 'accept H_1'	
	There is evidence to suggest that the proportion of faulty frames has increased	E1* Dep on A1	Must include 'sufficient evidence' or something similar such as 'to suggest that' ie an element of doubt for E1. 'Sufficient evidence' or similar can be seen in either the A mark or the E mark.	
		[8]		
	OR *Critical region method:*			No marks if CR not justified
	Let $X \sim B(18, 0.05)$			Do not insist on correct notation
	$P(X \geq 3) = 1 - P(X \leq 2) = 1 - 0.9419 = 0.0581 > 5\%$	(B1)	For 0.0581	as candidates have to work out two probabilities for full marks
	$P(X \geq 4) = 1 - P(X \leq 3) = 1 - 0.9891 = 0.0109 < 5\%$	(B1)	For 0.0109	
		(M1)	For at least one correct comparison with 5%	
	So critical region is {4,5,6,7,8,9,10,11,12,13,14,15,16,17,18}	(A1)	CAO for critical region and significant oe	Condone {4,5 ..}, $X \geq 4$, oe but not $P(X \geq 4)$
	4 lies in the critical region, so significant			
	There is evidence to suggest that the proportion of faulty frames has increased	(E1)		
	See ADDITIONAL NOTES for other methods			

Question			Answer	Marks	Guidance
6	(i)				

Engine size	Frequency	Group width	Frequency density
$500 \leq x \leq 1000$	7	500	0.014
$1000 < x \leq 1500$	22	500	0.044
$1500 < x \leq 2000$	26	500	0.052
$2000 < x \leq 3000$	18	1000	0.018
$3000 < x \leq 5000$	7	2000	0.0035



INCORRECT DIAGRAMS:
Frequency diagrams can get M0, A0, G0, G1, G0 MAXIMUM
Thus frequency density = frequency × width, frequency/midpoint, etc gets MAX M0A0G0G1G0
Frequency polygons MAX M1A1G0G0G0

M1
A1
G1(L1)
G1(W1)

At least 4 fds correct for M1
M1 can be also be gained from freq per 1000 – 14, 44, 52, 18, 3.5 (at least 4 correct) and A1 for all correct
or freq per 500 - 7, 22, 26, 9, 1.75
Accept any suitable unit for fd, eg freq per 1000, BUT NOT FD per 1000
Allow fds correct to at least three dp
If fd not explicitly given, M1 A1 can be gained from all heights correct (within one square) on histogram (and M1A0 if at least 4 correct)
Allow restart with correct heights if given fd wrong

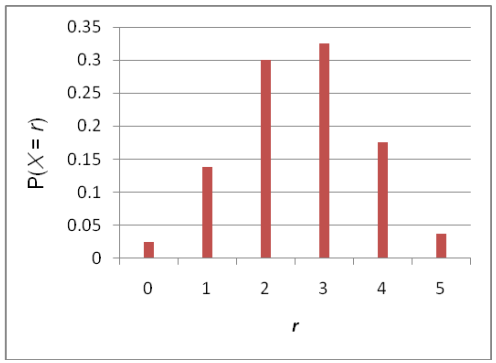
For fd's all correct
Linear scales on both axes and label on vertical axis
Label required on vert axis **IN RELATION** to first M1 mark ie fd or frequency density or if relevant freq/1000, etc (NOT fd/1000, but allow fd×1000, etc)
Accept f/w or f/cw (freq/width or freq/class width)
Ignore horizontal label and allow horizontal scale to start at 500

Can also be gained from an accurate key

Width of bars
Must be drawn at 500, 1000etc NOT 499.5 or 500.5 etc NO GAPS ALLOWED
Must have linear scale.
No inequality labels on their own such as 500≤S<1000, etc but allow if a clear horizontal linear scale is also given

Question			Answer	Marks	Guidance
				G1(H1) **[5]**	Height of bars FT of heights *dep* on at least 3 heights correct and all must agree with their fds If fds not given and one height is wrong then max M1A0G1G1G0 – visual check only (within one square) – no need to measure precisely
6	**(ii)**		Do not know exact highest and lowest values so cannot tell what the midrange is. **OR** No and a counterexample to show it may not be 2750 **OR** (500 + 5000) / 2 = 2750. But very unlikely to be absolutely correct but probably close to the true value. Some element of doubt needed. Allow 'Likely to be correct'	E1 **[1]**	Allow comment such as 'Highest value could be 5000 and lowest could be 500 therefore midrange could be 2750' NO mark if incorrect calculation Sight of 1750 AND 3000 (min and max of midrange) scores E1
6	**(iii)**		Mean = $\frac{(750\times 7)+(1250\times 22)+(1750\times 26)+(2500\times 18)+(4000\times 7)}{80}$ $=\frac{151250}{80}=1891$ $\Sigma x^2 f = (750^2\times 7)+(1250^2\times 22)+(1750^2\times 26)+(2500^2\times 18)+(4000^2\times 7)$ = 3937500 + 34375000 + 79625000 + 112500000 + 112000000 =342437500 $Sxx = 342437500 - \frac{151250^2}{80} = 56480469$ $s=\sqrt{\frac{56480469}{79}}=\sqrt{714943}=846$ Only an estimate since the data are grouped	M1 A1 M1 A1 E1 indep **[5]**	For midpoints (at least 3 correct) No marks for mean or sd unless using midpoints Answer must **NOT** be left as improper fraction CAO Accept correct answers for mean (1890 or 1891) and sd (850 or 846 or 845.5) from calculator even if eg wrong S_{xx} given For sum of at least 3 correct multiples fx^2 Allow M1 for anything which rounds to 342400000 Only penalise once in part (iii) for over specification, even if mean and standard deviation both over specified. Allow SC1 for RMSD 840.2 or 840 from calculator Or for any mention of midpoints or 'don't have actual data' or 'data are not exact' oe

Question			Answer	Marks	Guidance
6	(iv)		$\bar{x} - 2s = 1891 - (2 \times 846) = 199$ Allow 200	M1	For either. FT any positive mean and their positive sd/rmsd for M1 Only follow through numerical values, not variables such as *s*, so if a candidate does not find *s* but then writes here 'limit is 40.76+ 2 × standard deviation', do NOT award M1 No marks in (iv) unless using $\bar{x} + 2s$ or $\bar{x} - 2s$
			$\bar{x} + 2s = 1891 + (2 \times 846) = 3583$ Allow 3580 or 3600	A1	For both (FT) Do **NOT** penalise over specification here as it is not the final answer
			So there are probably some outliers	E1 **[3]**	Must include an element of doubt Dep on upper limit in range 3000 – 5000 Allow comments such as 'any value over 3583 is an outlier' Ignore comments about possible outliers at lower end
6	(v)		Number of cars over 2000 cm^3 = 25/80 × 2.5 million = 781250 So duty raised = 781250 × £1000 = £781 million	M1 M1 indep A1 **[3]**	For 25/80× 2.5 million or (18+7) /80× 2.5 million For something × £1000 even if this is the first step CAO NB £781250000 is over specified so max 2/3
6	(vi)		Because the numbers of cars sold with engine size greater than 2000 cm^3 might be reduced due to the additional duty	E1 **[1]**	Allow any other reasonable suggestion Condone 'sample may not be representative' Allow 'sample is not of **NEW** cars'

Question			Answer	Marks	Guidance
7	(i)		$P(X = 0) = 0.4 \times 0.5^4 = 0.025$ **NB ANSWER GIVEN**	M1 A1 **[2]**	For 0.5^4
7	(ii)		$P(X = 1) = (0.6 \times 0.5^4) + (4 \times 0.4 \times 0.5 \times 0.5^3)$ $= 0.0375 + 0.1 = 0.1375$ **NB ANSWER GIVEN**	M1* M1* M1* dep A1 **[4]**	For 0.6×0.5^4 seen as a single term (not multiplied or divided by anything) For $4 \times 0.4 \times 0.5^4$ Allow 4×0.025 Watch out for incorrect methods such as (0.4/4) 0.1 **MUST** be justified For sum of both, dep on both M1s
7	(iii)			 G1 G1 **[2]**	 For labelled linear scales on both axes Dep on attempt at vertical line chart. Accept P on vertical axis For heights – visual check only but last bar taller than first and fifth taller than second and fourth taller than third Lines must be thin (gap width > line width). All correct. Zero if vertical scale not linear Everything correct but joined up tops G0G1 MAX Everything correct but f poly G0G1 MAX Everything correct but bar chart G0G1 MAX Curve only (no vertical lines) gets G0G0 Best fit line G0G0 Allow transposed diagram

Question			Answer	Marks	Guidance
7	(iv)		'Negative' or 'very slight negative'	E1 [1]	E0 for symmetrical but E1 for (very slight) negative skewness even if also mention symmetrical Ignore any reference to unimodal
7	(v)		$E(X) = (0\times0.025) + (1\times0.1375) + (2\times0.3) + (3\times0.325) + (4\times0.175) + (5\times0.0375)$ $= 2.6$ $E(X^2) = (0\times0.025) + (1\times0.1375) + (4\times0.3) + (9\times0.325) + 16\times0.175) + (25\times0.0375) = 0 + 0.1375 + 1.2 + 2.925 + 2.8 + 0.9375 = 8$ $\text{Var}(X) = 8 - 2.6^2$ $= 1.24$	M1 A1 M1* M1* dep A1 [5]	For Σrp (at least 3 terms correct) CAO For $\Sigma r^2 p$ (at least 3 terms correct) for – their $E(X)^2$ FT their E(X) provided $\text{Var}(X) > 0$ USE of $E(X-\mu)^2$ gets M1 for attempt at $(x-\mu)^2$ should see $(-2.6)^2$, $(-1.6)^2$, $(-0.6)^2$, 0.4^2, 1.4^2, 2.4^2 (if $E(X)$ correct but FT their $E(X)$) (all 5 correct for M1), then M1 for $\Sigma p(x-\mu)^2$ (at least 3 terms correct) Division by 5 or other spurious value at end gives max M1A1M1M1A0, or M1A0M1M1A0 if $E(X)$ also divided by 5 Unsupported correct answers get 5 marks
7	(vi)		$P(\text{Total of 3}) = (3\times0.325\times0.025^2) + (6\times0.3\times0.1375\times0.025) + 0.1375^3 = 3\times0.000203 + 6\times0.001031 + 0.002600 =$ $0.000609 + 0.006188 + 0.002600 = 0.00940$ $(= 3\times13/64000 + 6\times33/32000 + 1331/512000)$	M1 M1 M1 A1 [4]	For decimal part of first term 0.325×0.025^2 For decimal part of second term $0.3\times0.1375\times0.025$ For third term – ignore extra coefficient All M marks above depend on triple probability products CAO: AWRT 0.0094. Allow 0.009 with working

NOTE RE OVER-SPECIFICATION OF ANSWERS

If answers are grossly over-specified, deduct the final answer mark in every case. Probabilities should also be rounded to a sensible degree of accuracy. In general final non-probability answers should not be given to more than 4 significant figures. Allow probabilities given to 5 sig fig. In general accept answers which are correct to 3 significant figures when given to 4 or 5 significant figures.

If answer given as a fraction and as an over-specified decimal – ignore decimal and mark fraction.

ADDITIONAL NOTES RE Q5

Comparison with 95% method:
If 95% seen anywhere then
B1 for P($X \leq 3$)
B1 for 0.9891
M1* for comparison with 95% dep on B1
A1* for significant oe
E1*

Smallest critical region method:

Either:
Smallest critical region that 4 could fall into is {4,5,6,7,8,9,10,11,12,13,14,15, 16, 17, 18} gets B1 and has size 0.0109 gets B1, This is < 5% gets M1*, A1*, E1* as per scheme
NB These marks only awarded if 4 used, not other values.

Use of *k* method with no probabilities quoted:

P($X \geq 3$) = 1 – P($X \leq 2$) > 5%
P($X \geq 4$) = 1 – P($X \leq 3$) < 5%
These may be seen in terms of *k* or *n*.
Either $k = 4$ or $k - 1 = 3$ so $k = 4$ gets SC1
so CR is {4,5,6,7,8,9,10,11,12,13,14,15, 16, 17, 18} gets another SC1and conclusion gets another SC1

Use of *k* method with one probability quoted:

1 - 0.9891 < 5% or 0.0109 < 5% gets B0B1M1
P($X \leq k - 1$) = P($X \leq 3$)
so $k - 1 = 3$ so $k = 4$ (or just $k = 8$)
so CR is {4,5,6,7,8,9,10,11,12,13,14,15, 16, 17, 18} and conclusion gets A1E1

Two tailed test done but with correct H_1: $p>0.05$:
Hyp gets max B1B1B1
if compare with 5% ignore work on lower tail and mark upper tail as per scheme but withhold A1E1
if compare with 2.5% no marks B0B0M0A0E0

Line diagram method:
B1 for squiggly line between 3 and 4 or on 4 exclusively (ie just one line), B1*dep* for arrow pointing to right, M1 0.0109 seen on diagram from squiggly line or from 4, A1E1 for correct conclusion

Bar chart method:
B1 for line clearly on boundary between 3 and 4 or within 4 block exclusively (ie just one line), B1*dep* for arrow pointing to right, M1 0.0109 seen on diagram from boundary line or from 8, A1E1 for correct conclusion.

Using P(Not faulty) method:
H_0: $p=0.95$, H_1: $p<0.95$ where p represents the prob that a frame is faulty gets B1B1B1.
$P(X\leq 14)=0.0109 < 5\%$ So significant, etc gets B1B1M1A1E1

NB
If H_0: $p=0.5$, H_1: $p>0.5$, etc seen, but then revert to 0.05 in working allow marks for correct subsequent working. However if 0.5 used consistently throughout, then max B1 for definition of p and possibly B1 for notation $P(X \geq 4)$.

Assessment Objectives (AO) Grid

Question	AO1	AO2	AO3	AO4	AO5	Total
1(i)		3				3
1(ii)		1		2		3
2(i)		2	1			3
2(ii)		2	1			3
3(i)			3			3
3(ii)			3			3
3(iii)		2				2
4(i)A		3				3
4(i)B		1	1			2
4(ii)			3			3
5		2	2	3	1	8
6(i)	5					5
6(ii)		1				1
6(iii)			2		3	5
6(iv)				3		3
6(v)				3		3
6(vi)				1		1
7(i)	2					2
7(ii)	4					4
7(iii)				2		2
7(iv)		1				1
7(v)			5			5
7(vi)	4					4
Totals	**15**	**18**	**21**	**14**	**4**	**72**

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