



Mark Scheme (Results)

Summer 2013

GCE Statistics 3 (6691/01)

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## General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

## EDEXCEL GCE MATHEMATICS

### General Instructions for Marking

1. The total number of marks for the paper is 75.
2. The Edexcel Mathematics mark schemes use the following types of marks:
  - **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
  - **A** marks: accuracy marks can only be awarded if the relevant method (M) marks have been earned.
  - **B** marks are unconditional accuracy marks (independent of M marks)
  - Marks should not be subdivided.
3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes:

- bod – benefit of doubt
  - ft – follow through
  - the symbol  $\surd$  will be used for correct ft
  - cao – correct answer only
  - cso - correct solution only. There must be no errors in this part of the question to obtain this mark
  - isw – ignore subsequent working
  - awrt – answers which round to
  - SC: special case
  - oe – or equivalent (and appropriate)
  - dep – dependent
  - indep – independent
  - dp decimal places
  - sf significant figures
  - \* The answer is printed on the paper
  - $\square$  The second mark is dependent on gaining the first mark
4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.
  5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.
  6. If a candidate makes more than one attempt at any question:
    - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
    - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.
  7. Ignore wrong working or incorrect statements following a correct answer.
  8. In some instances, the mark distributions (e.g. M1, B1 and A1) printed on the candidate's response may differ from the final mark scheme.

Question Number	Scheme				Marks																																				
<p><b>1.</b></p> <p><math>H_0</math> : Cholesterol level is independent of intake of saturated fats(no association)  <math>H_1</math> : Cholesterol level is not independent of intake of saturated fats (association)</p> <table border="1" data-bbox="284 506 1134 801"> <thead> <tr> <th><math>O</math></th> <th><math>E</math></th> <th><math>\frac{(O-E)^2}{E}</math></th> <th><math>\frac{O^2}{E}</math></th> </tr> </thead> <tbody> <tr> <td>12</td> <td>7.6</td> <td>2.547... or <math>\frac{242}{95}</math></td> <td>18.947... or <math>\frac{360}{19}</math></td> </tr> <tr> <td>8</td> <td>12.4</td> <td>1.56129... or <math>\frac{242}{155}</math></td> <td>5.161... or <math>\frac{160}{31}</math></td> </tr> <tr> <td>26</td> <td>30.4</td> <td>0.6368... or <math>\frac{121}{190}</math></td> <td>22.236... or <math>\frac{845}{38}</math></td> </tr> <tr> <td>54</td> <td>49.6</td> <td>0.3903... or <math>\frac{121}{310}</math></td> <td>58.790... or <math>\frac{3645}{62}</math></td> </tr> </tbody> </table> <p><math>\sum \frac{(O-E)^2}{E} = 5.1358234..</math> or <math>\frac{1.2^2}{7.6} + \frac{8^2}{12.4} + \frac{26^2}{30.4} + \frac{54^2}{49.6} - 100 = 5.14</math> (awrt <b>5.14</b>)</p> <p><math>\nu = (2-1)(2-1) = 1</math>  <math>\chi_1^2(0.05) = 3.841</math>  <math>5.14 &gt; 3.841</math> so sufficient evidence to reject <math>H_0</math> [Condone “accept <math>H_1</math>”]                      Association between cholesterol level and saturated fat intake</p>	$O$	$E$	$\frac{(O-E)^2}{E}$	$\frac{O^2}{E}$	12	7.6	2.547... or $\frac{242}{95}$	18.947... or $\frac{360}{19}$	8	12.4	1.56129... or $\frac{242}{155}$	5.161... or $\frac{160}{31}$	26	30.4	0.6368... or $\frac{121}{190}$	22.236... or $\frac{845}{38}$	54	49.6	0.3903... or $\frac{121}{310}$	58.790... or $\frac{3645}{62}$	<table border="1"> <thead> <tr> <th>Cholesterol Level</th> <th>High</th> <th>Low</th> <th></th> </tr> </thead> <tbody> <tr> <td>High</td> <td>7.6</td> <td>12.4</td> <td>20</td> </tr> <tr> <td>Low</td> <td>30.4</td> <td>49.6</td> <td>80</td> </tr> <tr> <td></td> <td>38</td> <td>62</td> <td>100</td> </tr> </tbody> </table>	Cholesterol Level	High	Low		High	7.6	12.4	20	Low	30.4	49.6	80		38	62	100				<p>M1A1 (2)</p>
	$O$	$E$	$\frac{(O-E)^2}{E}$	$\frac{O^2}{E}$																																					
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<p><b>Minimum working</b> use part marks: <math>E_i</math> (2), Hyp (1), 5.14 (3), 3.841 (2), Conclusion (2)</p> <p>1<sup>st</sup> M1 for some use of <math>\frac{\text{Row Total} \times \text{Col.Total}}{\text{Grand Total}}</math>. May be implied by correct <math>E_i</math></p> <p>1<sup>st</sup> A1 for all expected frequencies correct. Allow M1A0 for <math>E_i</math> rounded to integers</p> <p>1<sup>st</sup> B1 for both hypotheses. Must mention “cholesterol” and “fats” at least once                      Use of “relationship” or “correlation” or “connection” is B0</p> <p>2<sup>nd</sup> dM1 for at least 2 correct terms (as in 3<sup>rd</sup> or 4<sup>th</sup> column) or correct expressions with their <math>E_i</math>                      Dependent on 1<sup>st</sup> M1 Accept 2sf accuracy for the M mark</p> <p>2<sup>nd</sup> A1 for all correct terms. May be implied by a correct ans.(2 dp or better)                      Allow truncation eg 2.54... 3<sup>rd</sup> A1 for awrt 5.14</p> <p>2<sup>nd</sup> B1 for correct degrees of freedom (may be implied by a cv of 3.841)</p> <p>3<sup>rd</sup> M1 for a correct statement linking their test statistic and their cv(cv could be 2.705 or <math>&gt; 3.5</math>)                      Contradictory statements score M0 e.g. “significant, do not reject <math>H_0</math>”</p> <p>4<sup>th</sup> A1 for a correct comment in context - must mention “cholesterol” and “fats”                      condone “relationship” or “connection” here but <b>not</b> “correlation”.                      e.g. “There is evidence of a relationship between cholesterol level and fat intake”                      No follow through. If e.g hypotheses are the wrong way round A0 here.</p>																																									

Question Number	Scheme									Marks
2(a)	Uni	A	B	C	D	E	F	G		M1A1A1
	Staff-Stu	2	4	3	5	7	1	6		
	Satisfaction	3	2	6	4	5	1	7		
	[ d ]	-1	2	-3	1	2	0	-1		
	$d^2$	1	4	9	1	4	0	1	20	
	$r_s = 1 - \frac{6 \times 20}{7(49-1)} = 0.642857\dots \quad \left( \text{accept } \frac{9}{14} \right) \quad \text{(awrt } \mathbf{0.643} \text{)}$									dM1A1 (5)
(b)	<p><math>H_0: \rho = 0</math>  <math>H_1: \rho \neq 0</math> (<math>\rho &gt; 0</math>)  Critical value is <math>\pm 0.7857</math> (<math>\pm 0.7143</math> for a one tailed test)  <math>0.643 &lt; cv</math> so insufficient evidence to reject <math>H_0</math>  There is insufficient evidence to suggest a (positive) correlation between staff-student ratio and satisfaction.</p>									B1 B1 B1ft (3) <b>Total 8</b>
<b>Notes</b>										
(a)	<p>1<sup>st</sup> M1 for an attempt to rank the staff-students ratio <u>or</u> satisfaction ( at least 4 correct)  1<sup>st</sup> A1 for correct rankings for both (one or both may be reversed)  2<sup>nd</sup> A1 for <math>\sum d^2 = 20</math> or correct <math>d^2</math> row (NB <math>\sum d^2 = 92</math> for one set of reversed ranks)  2<sup>nd</sup> dM1 for use of the correct formula, follow through their <math>\sum d^2</math> (Dependent on 1<sup>st</sup> M1)  If answer is not correct, a correct expression is required.  3<sup>rd</sup> A1 If <math>\sum d^2 = 20</math> for awrt 0.643 <u>or</u> if <math>\sum d^2 = 92</math> for awrt <math>-0.643</math> (accept <math>\pm \frac{9}{14}</math>)</p>									
(b)	<p>1<sup>st</sup> B1 for both hypotheses in terms of <math>\rho</math>, one tail <math>H_1</math> must be compatible with their ranking  Hypotheses just in words e.g. “no correlation” score B0  2<sup>nd</sup> B1 for cv of 0.7857 <u>or</u> 0.7143 for one-tailed test (accept <math>\pm</math>)  Their cv must be compatible with their <math>H_1</math> which may be in words  If hypotheses are the wrong way around this must be B0 but 3<sup>rd</sup> B1 is possible.  3<sup>rd</sup> B1ft for a correct contextualised comment. Must mention “ratio” or “no. of students per member of staff” <u>and</u> “satisfaction”  Follow through their <math>r_s</math> and their cv (provided it is <math> cv  &lt; 1</math>)  Don’t insist on the word “positive” for a one-tailed test  Use of “association” is B0  Independent of 1<sup>st</sup> B1 so if <math> r_s  &gt;  cv </math> must say there is sufficient evidence of .....(o.e.)  and if <math> r_s  &lt;  cv </math> must say insufficient evidence of ... (o.e.) regardless of their hypotheses  Contradictory statements score B0  (This mark is just testing interpretation of comparison of their <math>r_s</math> and their cv)</p>									

Question Number	Scheme	Marks
<p><b>3(a)i</b> e.g.</p> <p><b>3(a)ii</b> e.g.</p> <p><b>3(b)</b></p> <p><b>3(c)</b></p>	<p><b>Quota Sampling:</b> Advantages: Fieldwork can be done <b>quickly</b>, <u>or</u> administering the test is <b>easy</b>, <u>or</u> costs are kept to a minimum (<b>cheap</b>), <u>or</u> gives estimates for each course. <u>or</u> OK for large populations <u>or</u> sampling frame not required (o.e.) Disadvantages: <b>Non-random</b> process <u>or</u> not possible to estimate the sampling errors, <u>or</u> non response not recorded, <u>or</u> interviewer can introduce <b>bias</b> in sample choice. (o.e.)</p> <p><b>Stratified Sampling:</b> Advantages: Can give accurate estimates as it is a <b>random</b> process, <u>or</u> gives estimates for each course <u>or</u> <b>representative</b> of [BUT not “proportional” to] the whole population. (o.e.) Disadvantages: Sampling frame required, <u>or</u> strata may not be clear as some students overlap courses <u>or</u> not suitable for large populations. (o.e.)</p> <p>Total enrolments=1000 (may be implied by calculations) Leisure and Sport=<math>\frac{420}{1000} \times 100 = 42</math> Information Technology=<math>\frac{337}{1000} \times 100 = 33.7 = 34</math> Health and Social Care=<math>\frac{200}{1000} \times 100 = 20</math> Media Studies=<math>\frac{43}{1000} \times 100 = 4.3 = 4</math></p> <p>The college’s information system would be used to identify each student and which course they are enrolled on. i.e. idea of <b>sampling frame</b> or <b>list</b> for <b>each course</b>. Use of <b>random numbers</b> to select required number of students <b>from each course</b></p>	<p>B1</p> <p>B1</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>B1</p> <p>B1</p> <p>(2)</p> <p>(3)</p> <p>(2)</p> <p><b>Total 7</b></p>
<b>Notes</b>		
<p><b>(a)</b></p> <p><b>(b)</b></p> <p><b>(c)</b></p>	<p style="text-align: center;">Do not penalise for lack of context in part (a)</p> <p>1<sup>st</sup> B1 for an advantage and a disadvantage for quota sampling (must be 1<sup>st</sup> or labelled (i)) 2<sup>nd</sup> B1 for an advantage and a disadvantage for stratified sampling (2<sup>nd</sup> or labelled (ii)) Do not allow opposite pairs e.g. “quicker/easier” for quota sampling and “takes a long time/more difficult” for stratified <u>or</u> quota “easy to use” but strat. “hard for large populations” Do not allow same reason for both e.g. “gives estimates for each course”</p> <p>M1 for one correct calculation, ft their “1000” A1 for 42, 34, 20 and 4 only</p> <p>1<sup>st</sup> B1 for some mention of a suitable <u>sampling frame</u>. Need not give the specific term but a suitable source of <u>list</u> is required for all students <u>in each course</u>. 2<sup>nd</sup> B1 for mentioning use of <u>random numbers</u> or some random selection process <u>for each course</u>. If they are describing systematic sampling score B0 here</p>	

Question Number	Scheme	Marks																														
4	(a) $\bar{x} = \frac{8 \times 1.5 + 12 \times 4 + 13 \times 5.5 + 9 \times 7 + 8 \times 10}{50} = \frac{274.5}{50} = 5.49$ (*)	B1cso																														
	$s^2 = \frac{8 \times 1.5^2 + 12 \times 4^2 + 13 \times 5.5^2 + 9 \times 7^2 + 8 \times 10^2}{49} - \frac{50}{49} 5.49^2 = 6.88$ (*)	M1, A1cso																														
	(b) $a = 50 \times P(6 < X < 8) = 50 \times P(0.194.. < Z < 0.956..)$ $a = 12.81$ (tables) <u>or</u> $12.68$ (calc) $b = 50 - (28.85 + a)$ $= 8.34$ (tables) <u>or</u> $8.47$ (calc)	M1 A1 A1ft																														
	(c) $H_0$ : Normal distribution is a good fit $H_1$ : Normal distribution is not a good fit	B1																														
	<table border="1"> <thead> <tr> <th>Class</th> <th><math>O</math></th> <th><math>E</math></th> <th><math>\frac{O^2}{E}</math></th> <th><math>\frac{(O-E)^2}{E}</math></th> </tr> </thead> <tbody> <tr> <td>0-3</td> <td>8</td> <td>8.56</td> <td>7.4766...</td> <td>0.0366...</td> </tr> <tr> <td>3-5</td> <td>12</td> <td>12.73</td> <td>11.31186....</td> <td>0.0418...</td> </tr> <tr> <td>5-6</td> <td>13</td> <td>7.56</td> <td>22.354497...</td> <td>3.9144...</td> </tr> <tr> <td>6-8</td> <td>9</td> <td>12.68 or (12.81)</td> <td>(6.32) ~ 6.38801..</td> <td>1.0680...~ (1.13)</td> </tr> <tr> <td>8-12</td> <td>8</td> <td>(8.34) or 8.47</td> <td>7.556080...~ (7.67)</td> <td>(0.013) ~ 0.0260..</td> </tr> </tbody> </table>	Class	$O$	$E$	$\frac{O^2}{E}$	$\frac{(O-E)^2}{E}$	0-3	8	8.56	7.4766...	0.0366...	3-5	12	12.73	11.31186....	0.0418...	5-6	13	7.56	22.354497...	3.9144...	6-8	9	12.68 or (12.81)	(6.32) ~ 6.38801..	1.0680...~ (1.13)	8-12	8	(8.34) or 8.47	7.556080...~ (7.67)	(0.013) ~ 0.0260..	M1
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$\sum \frac{O^2}{E} - N = 5.087 \dots \sim 5.1400 \dots$ awrt (5.09 ~ 5.14)	A1																															
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$\chi^2(0.05) = 5.991$	B1																															
5.09 < 5.991 so insufficient evidence to reject $H_0$ Normal distribution is a good fit.	M1 A1																															
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(a)	B1cso for denominator of 50 and at least 3 products on num <u>or</u> 274.5 on num M1 for a correct expression with at least 3 correct products on num <u>or</u> $\frac{1844.25}{49} - \frac{1507.005}{49}$ <u>or</u> $\frac{337.245}{49}$ <u>or</u> $\left(\frac{7377}{200} - 5.49^2\right) \times \frac{50}{49}$ etc Allow 3sf accuracy A1cso for 6.88 with M1 scored and no incorrect working seen																															
(b)	M1 a full method for $a$ or $b$ using the normal dist. Correct use of (6), 8, 5.49 and $\sqrt{6.88}$ seen 1 <sup>st</sup> A1 for $a$ in range 12.68 ~ 12.81 or $b$ in range 8.34~ 8.47 or awrt these values 2 <sup>nd</sup> A1ft for $50 - 28.85 -$ their $a$ (or $b$ ) (but requires M1). Allow awrt 3sf. Must add up to 50																															
(c)	1 <sup>st</sup> B1 for both hypotheses. B0 if they include 5.49 or 6.88. Condone $X \sim N(\mu, \sigma^2)$ etc 1 <sup>st</sup> M1 for attempting $\frac{(O-E)^2}{E}$ or $\frac{O^2}{E}$ , at least 3 correct expressions or values. 1 <sup>st</sup> A1 for at least 4 correct calcs - 3 <sup>rd</sup> or 4 <sup>th</sup> column. (2 dp or better and allow e.g. 7.47) Allow any value in the ranges for the last two rows. 2 <sup>nd</sup> A1 for a test statistic that is awrt 5.09 ~ 5.14. Award M1A1A1 if this is obtained. 2 <sup>nd</sup> M1 for a correct statement based on their test statistic ( $> 1$ ) and their cv ( $> 3.8$ ) Contradictory statements score M0 e.g. "significant" do not reject $H_0$ . 3 <sup>rd</sup> A1 for a correct comment suggesting that normal model is suitable <u>or</u> manager's belief is correct. <b>No f t</b> . Condone mention of 5.49 or 6.88 here. Hypotheses wrong way round scores A0																															



Question Number	Scheme	Marks
<p><b>5 (a)</b></p> <p><b>(b)</b></p>	<p>Let <math>L \sim N(50, 25)</math> and <math>S \sim N(15, 9)</math>  Let <math>X = L - (S_1 + S_2 + S_3)</math>  <math>E(X) = 50 - 3 \times 15 = 5</math>  <math>\text{Var}(X) = 25 + 3 \times 9 = 52</math>  <math>P(X &lt; 0) = P\left(Z &lt; \frac{-5}{\sqrt{52}}\right)</math>  <math>= P(Z &lt; -0.693..)</math>  <math>= 0.244</math> or <math>0.2451</math> (tables) (awrt <b>0.244 ~ 0.245</b>)</p> <p>Let <math>Y = L - 3S</math>  <math>E(Y) = 50 - 3 \times 15 = 5</math>  <math>\text{Var}(Y) = 25 + 3^2 \times 9 = 106</math>  <math>P(Y &gt; 0) = P\left(Z &gt; \frac{-5}{\sqrt{106}}\right)</math>  <math>= P(Z &gt; -0.4856..)</math>  <math>= 0.686</math> or <math>0.6879</math> (tables) (awrt <b>0.686 ~ 0.688</b>)</p>	<p>B1  B1  M1A1  dM1  A1  (6)</p> <p>B1  B1  M1A1  dM1  A1  (6)</p> <p><b>Total 12</b></p>
<b>Notes</b>		
<p><b>(a)</b></p> <p><b>(b)</b></p>	<p>1<sup>st</sup> B1 for forming a suitable variable <math>X</math> <u>explicitly</u> seen. Do not give for <math>L - 3S</math> but allow <math>L - (S + S + S)</math>  2<sup>nd</sup> B1 for <math>E(X) = 5</math> (or <math>-5</math> if their <math>X</math> is defined the other way around)  1<sup>st</sup> M1 for an attempt at <math>\text{Var}(X) = \text{Var}(L) + 3\text{Var}(S)</math>. Do not condone 5 for “25” or 3 for “9”  1<sup>st</sup> A1 for 52  2<sup>nd</sup> dM1 for attempting the correct probability and standardising with their mean and sd.  This mark is dependent on 1<sup>st</sup> M1 so if <math>X</math> is not being used or wrong variance score M0  If their method is not crystal clear then they must be attempting <math>P(Z &lt; -\text{ve value})</math>  or  <math>P(Z &gt; +\text{ve value})</math> i.e. their probability <u>after</u> standardisation should lead to a prob. <math>&lt; 0.5</math>  2<sup>nd</sup> A1 for awrt 0.244 ~ 0.245  Correct ans. only scores 5/6 (or 6/6 if 1<sup>st</sup> B1) but must be clearly labelled as (a) or the first answer.</p> <p>1<sup>st</sup> B1 for defining a new variable <math>[Y = ]_{\pm} (L - 3S)</math>. May be implied by a correct variance.  2<sup>nd</sup> B1 for <math>E(Y) = 5</math> (or <math>-5</math> if their <math>Y</math> is defined as <math>Y = 3S - L</math>)  1<sup>st</sup> M1 for an attempt at <math>\text{Var}(Y) = \text{Var}(L) + 3^2 \text{Var}(S)</math>. Do not condone 5 for “25” or 3 for “9”  1<sup>st</sup> A1 for 106 only  2<sup>nd</sup> dM1 for attempting the correct probability and standardising with their mean and sd.  This mark is dependent on 1<sup>st</sup> M1 so if <math>Y</math> is not being used or wrong variance score M0  If their method is not crystal clear then they must be attempting <math>P(Z &gt; -\text{ve value})</math>  or  <math>P(Z &lt; +\text{ve value})</math> i.e. their probability <u>after</u> standardisation should lead to a prob. <math>&gt; 0.5</math>  2<sup>nd</sup> A1 for an awrt 0.686 ~ 0.688  Correct answer only scores 6/6 but must be clearly labelled as (b) or the second answer.</p>	

Question Number	Scheme	Marks
<p><b>6 (a)</b></p> <p><math>H_0 : \mu_{new} - \mu_{old} = 1</math>  <math>H_1 : \mu_{new} - \mu_{old} &gt; 1</math></p> $z = \frac{7 - 5.5 - 1}{\sqrt{\frac{0.5}{60} + \frac{0.75}{70}}} = 3.62254\dots$ <p>(awrt <b>3.62</b>)</p> <p>Critical value <math>z = 1.6449</math> (allow <math>\pm</math>)  <math>[3.62 &gt; 1.6449]</math> so sufficient evidence to reject <math>H_0</math>  Evidence that the mean yield of new variety is more than 1 kg greater than the old variety.</p> <p><b>(b)</b> Mean yield is normally distributed  Sample size is large. Must state or imply that <b>in this case</b> sample size is large</p>		<p>B1 B1</p> <p>M1 A1A1 A1</p> <p>B1 dM1</p> <p>A1</p> <p>(9)</p> <p>B1 B1</p> <p>(2)</p> <p><b>Total 11</b></p>
<b>Notes</b>		
<p><b>(a)</b></p> <p><b>ALT</b></p> <p><b>(b)</b></p>	<p>1<sup>st</sup> &amp; 2<sup>nd</sup> B1 for hypotheses. Accept <math>\mu_1, \mu_2</math> or <math>\mu_A, \mu_B</math> etc if there is some indication of which is which e.g. <math>A \sim N(\mu_A, 0.5)</math></p> <p>1<sup>st</sup> M1 for an attempt at se. Condone switching 0.5 and 0.75 <math>\sqrt{\frac{0.5 \text{ or } 0.75}{60} + \frac{0.75 \text{ or } 0.5}{70}}</math></p> <p>1<sup>st</sup> A1 for a correct expression for denominator of test statistic or 0.138... or <math>\sqrt{0.0190\dots}</math></p> <p>2<sup>nd</sup> A1 for a correct numerator of test statistic (must have the - 1)</p> <p>3<sup>rd</sup> A1 for awrt 3.62  [Allow - 3.62 from numerator of <math>5.5 - 7 - - 1</math> and compatible <math>H_1</math>]</p> <p>3<sup>rd</sup> B1 for <math>\pm 1.6449</math> seen <u>or</u>  probability of 0.0002 (tables) or 0.000145...(calc) [allow 0.0001]</p> <p>2<sup>nd</sup> dM1 dep. on 1<sup>st</sup> M1 for a correct statement based on their normal cv and their test statistic</p> <p>2<sup>nd</sup> A1 for correct comment in context. Must mention “yield” <u>and</u> “varieties” or “old” and “new” <u>and</u> “1”  If second B mark is B0 award A0 here</p> <p><b>Pooled estimate:</b> If they calculate <math>s_p = \sqrt{0.41845\dots} = 0.64688\dots</math> allow 1<sup>st</sup> M1, 1<sup>st</sup> A1 for expression (or awrt 0.114) and 2<sup>nd</sup> A1 if numerator correct but A0 for test statistic (4.39)</p> <p>1<sup>st</sup> B1 for mention of <u>mean</u> (yield) and <u>normal</u> (distribution)  2<sup>nd</sup> B1 for mention of <u>sample</u> (size) being <u>large</u> in <u>this case</u></p>	

Question Number	Scheme	Marks
7 (a)	$\hat{\mu} = \bar{x} = \frac{33.29}{8} = 4.16125 \quad (\text{awrt } \mathbf{4.16})$ $\hat{\sigma}^2 = s^2 = \frac{4.12^2 + 5.12^2 + \dots - 8 \times \bar{x}^2}{7}$ $\hat{\sigma}^2 = s^2 = \frac{141.4035 - 138.528013}{7} = 0.41078\dots \quad (\text{awrt } \mathbf{0.411})$	B1 M1 A1 (3)
(b)	$\sum x = 33.29 + 32 \times 4.55 = 178.89, \quad (\text{awrt } \mathbf{179})$ $\sum x^2 = "141.4035" + 31 \times 0.25 + 32 \times 4.55^2 (= 811.6335) \quad (\text{awrt } \mathbf{812})$	B1 M1A1
	$\text{Combined sample: } s^2 = \frac{811.6335 - \frac{178.89^2}{40}}{39} = 0.29724865\dots \quad (\text{awrt } \mathbf{0.297})$	M1A1
	$\frac{s}{\sqrt{n}} = \frac{\sqrt{0.297\dots}}{\sqrt{40}} = 0.0862 \quad (\text{awrt } \mathbf{0.0862})$	M1A1 (7)
(c)	$\bar{x} \pm 1.96 \frac{\sigma}{\sqrt{n}} = \frac{178.89}{40} \pm 1.96 \frac{0.67}{\sqrt{40}}$ $= (4.2646\dots, 4.67988\dots) \quad \text{awrt } (\mathbf{4.26}[\text{or } 4.265], \mathbf{4.68})$	M1B1 A1 (3)
	<b>Notes</b>	<b>Total 13</b>
(a)	<p>M1 for an attempt at <math>s^2</math>: correct denom, clear attempt at <math>\sum x^2</math> and ft their <math>\bar{x}</math> Ans only 2/2</p>	
(b)	<p>B1 for correct sum or mean or fully correct expression (accept mean = awrt 4.47) <b>May be in (c)</b>  1<sup>st</sup> M1 for their <math>141.4035 + 31 \times 0.25 + 32 \times 4.55^2</math> or "141.4035" + 7.75 + 662.48 (accept 3sf)  <b>Beware:</b> <math>32(0.25 + 4.55^2) + "141.4035"</math> = awrt 812 but scores M0A0.  1<sup>st</sup> A1 for a fully correct expression (all to 3sf or better) or answer only = awrt 812  2<sup>nd</sup> M1 for a correct expression using their values  3<sup>rd</sup> M1 dependent on using a changed <math>s^2</math> (not their 0.411 or 0.25) for <math>\frac{\sqrt{"0.297"}}{\sqrt{40}}</math>  This <math>s^2</math> must be based on a <u>combination</u> of their 0.411 and 0.25 e.g. 0.661</p>	
(c)	<p>M1 for <math>\bar{x} \pm z \times \frac{\sigma}{\sqrt{n}}</math> for any <math>z (&gt; 1.5)</math> and ft their <math>\bar{x}</math> based on combining their 4.16 and 4.55,  do not award for simply using 4.55 or their 4.16. Condone <math>\sigma = \sqrt{\text{their } 0.297}</math> or their (b)  B1 for <math>z = 1.96</math> used in an attempt at a CI, may for example miss <math>\sqrt{n}</math>  A1 for both limits awrt 3sf. Allow lower limit of 4.265</p>	

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