#### UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary Level and GCE Advanced Level

# MARK SCHEME for the October/November 2007 question paper

## 9709 MATHEMATICS

9709/07

Paper 7, maximum raw mark 50

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began.

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 must be read in conjunction with the question papers and the report on the examination.

• CIE will not enter into discussions or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the October/November 2007 question papers for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level syllabuses and some Ordinary Level syllabuses.



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### **Mark Scheme Notes**

Marks are of the following three types:

- M Method mark, awarded for a valid method applied to the problem. Method marks are not 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. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.
- 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).
- B Mark for a correct result or statement independent of method marks.
- When a part of a question has two or more "method" steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly when there are several B marks allocated. The notation DM or DB (or dep\*) is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.
- The symbol √ implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only. A and B marks are not given for fortuitously "correct" answers or results obtained from incorrect working.
- Note: B2 or A2 means that the candidate can earn 2 or 0.
  B2/1/0 means that the candidate can earn anything from 0 to 2.

The marks indicated in the scheme may not be subdivided. If there is genuine doubt whether a candidate has earned a mark, allow the candidate the benefit of the doubt. Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored.

- Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise.
- For a numerical answer, allow the A or B mark if a value is obtained which is correct to 3 s.f., or which would be correct to 3 s.f. if rounded (1 d.p. in the case of an angle). As stated above, an A or B mark is not given if a correct numerical answer arises fortuitously from incorrect working. For Mechanics questions, allow A or B marks for correct answers which arise from taking *q* equal to 9.8 or 9.81 instead of 10.



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The following abbreviations may be used in a mark scheme or used on the scripts:

| AEF | Any Equivalent Form (of answer is equally acceptable)   |  |  |  |
|-----|---|--|--|--|
| AG  | Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)   |  |  |  |
| BOD | Benefit of Doubt (allowed when the validity of a solution may not be absolutely clear)  |  |  |  |
| CAO | Correct Answer Only (emphasising that no "follow through" from a previous error is allowed)   |  |  |  |
| CWO | Correct Working Only - often written by a 'fortuitous' answer   |  |  |  |
| ISW | Ignore Subsequent Working   |  |  |  |
| MR  | Misread   |  |  |  |
| PA  | Premature Approximation (resulting in basically correct work that is insufficiently accurate)   |  |  |  |
| SOS | See Other Solution (the candidate makes a better attempt at the same question)  |  |  |  |
| SR  | Special Ruling (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance) |  |  |  |

### **Penalties**

- MR -1 A penalty of MR -1 is deducted from A or B marks when the data of a question or part question are genuinely misread and the object and difficulty of the question remain unaltered. In this case all A and B marks then become "follow through  $\sqrt{}$ " marks. MR is not applied when the candidate misreads his own figures this is regarded as an error in accuracy. An MR-2 penalty may be applied in particular cases if agreed at the coordination meeting.
- PA -1 This is deducted from A or B marks in the case of premature approximation. The PA -1 penalty is usually discussed at the meeting.



| Page 4 | Mark Scheme                            | Syllabus | Paper |  |
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| $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$  |  |        |    |  |
|---|--|--------|----|--|
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| $ \begin{array}{c} + 0.3^3 \times 0.7^{16} \times _{16}C_{3} \\ = 0.001628 + 0.01256 + 0.04576 \\ = 0.0599 \end{array} $ Sum needed $ \begin{array}{c} - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0115 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.01256 + 0.04576 \\ - 0.0599 \\ - 0.01526 + 0.04576 \\ - 0.01628 + 0.04576 \\ - 0.01599 \\ - 0.0116 \\ - 0$   | $H_1 p < 0.3$  | B1     |    | Both hypotheses correct                                |
| $ \begin{array}{c} + 0.3^3 \times 0.7^{16} \times _{16}C_{3} \\ = 0.001628 + 0.01256 + 0.04576 \\ = 0.0599 \end{array} $ Sum needed $ \begin{array}{c} - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0115 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.0599 \\ - 0.01256 + 0.04576 \\ - 0.0599 \\ - 0.01526 + 0.04576 \\ - 0.01628 + 0.04576 \\ - 0.01599 \\ - 0.0116 \\ - 0$   |  |        |    |  |
| $ \begin{array}{c} + 0.3^2 \times 0.7^{16} \times _{16}C_2 \\ = 0.001628 + 0.01256 + 0.04376 \\ = 0.0599 \end{array} $ sum needed $ \begin{array}{c} \text{sum needed} \\ \text{Correct answer accept } 0.06(0) \\ \text{This is } > 0.05 \\ \text{Accept Isaac's claim.} \\ \text{OR Using N}(0.3,0.0116) \\ \text{H}_0 p = 0.3 \\ \text{H}_1 p = 0.3 \\ \text{Accept Isaac's claim} \\ \text{OR Using N}(5.4,3.78) \\ \text{H}_0 = 1.49159 \times 1.645 \\ \text{H}_1 \mu \leq 5.4 \\ \text{H}_1 \mu \leq 5.4 \\ \text{H}_2 \mu \leq 5.4 \\ \text{Accept Isaac's claim} \\ \text{Accept Isaac's claim} \\ \text{All} \\ \text{All} \\ \text{Accept Isaac's claim} \\ \text{All} \\ Al$   | $P(0, 1, 2) = 0.7^{18} + 0.3 \times 0.7^{17} \times {}_{18}C_1$          | M1     |    | For finding $P(0, 1, 2)$ at least two terms of this    |
| $= 0.001628 + 0.01256 + 0.04576 \\ = 0.0599$ A1  Correct answer accept $0.06(0)$ This is > 0.05  Accept Isaac's claim.  OR Using N(0.3,0.0116) H <sub>0.0</sub> p=0.3 H <sub>1.0</sub> p=0.3 H <sub>1.</sub>  |  |        |    | sum needed   |
| This is > 0.05    Accept Isaac's claim.  OR Using N(0.3,0.0116) H <sub>0.p=0.3</sub> H <sub>1.p=0.3</sub> $z=0.111 \pm 1/36 = 0.3 = -1.49159$ $\sqrt{0.0116}$ -1.49159>-1.645 Accept Isaac's claim  OR Using N(5.4,3.78) H <sub>0.p=5.4</sub> H <sub>1.p=5.4</sub> H <sub>1.p=5.4</sub> H <sub>1.p=5.4</sub> Accept Isaac's claim  OR Using N(5.4,3.78) Accept Isaac's claim  OR Using N(5.4,3.78) H <sub>0.p=5.4</sub> H <sub>1.p=5.4</sub> Accept Isaac's claim  OR Using N(5.4,3.78) Accept Isaac's claim  OR Using N(5.4,3.78) H <sub>0.p=5.4</sub> H <sub>1.p=5.4</sub> H <sub>1.p=5.4</sub> A <sub>1.p=5.1</sub> |  |        |    |  |
| This is > 0.05    Accept Isaac's claim.  OR Using N(0.3,0.0116)    H <sub>0</sub> p=0.3    H <sub>1</sub> p=0.3 $\frac{z=0.111+1/36-0.3}{\sqrt{0.0116}} = -1.49159$ $\frac{\sqrt{0.0116}}{\sqrt{0.0116}} = -1.49159 - 1.645$ Accept Isaac's claim  OR Using N(5.4,3.78)    H <sub>0</sub> µ=5.4    H <sub>1</sub> µ≤5.4 $\frac{z=2.5-5.4}{\sqrt{3.78}} = -1.49159$ $\frac{\sqrt{3.78}}{\sqrt{3.78}} = -1.49159 = -1.645$ Accept Isaac's claim  OR 1 Sing N(5.4,3.78)    H <sub>0</sub> µ=5.4    H <sub>1</sub> µ≤5.4    For attempt at z with or without ce For correct z    For orrect z    For correct z    For orrect  | = 0.0599   | A1     |    | Correct answer accept 0.06(0)                          |
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| Contradictions  Contradictions  Contradictions  Contradictions  B1  Both hypotheses correct  M1  For attempt at z with or without ce  For correct z  For comparison  Correct conclusion ft their test statistic  Correct conclusion ft their test statistic  B1  Both hypotheses correct  M1  For comparison  Correct conclusion ft their test statistic  Correct z  For comparison  Correct z  For comparison  Correct z  For correct z  For correct z  For correct z  For correct z  Alf for correct z  For comparison  Correct conclusion ft their test statistic   Correct conclusion ft their test statistic   M1  For comparison  Correct conclusion ft their test statistic   M1  For comparison  Correct conclusion ft their test statistic   M1  For comparison  Correct conclusion ft their test statistic   M1  For comparison  Correct conclusion ft their test statistic   M1  For standardising, must have sq rt. and z value  For ± 1.645 used  For ± 1.645 used  For ± 1.645 used  For ± 1.645 used  For inequality correct way round (ft their 2.47 but must be <3.2)  M1  For inequality correct way round (ft their 2.47 but must be <3.2)  M1  For inequality correct way round (ft their 2.47 but must be <3.2)  M1  For proportion used  M1  Correct shape $\bar{x} \pm zs / \sqrt{n}$ Correct z value 1.96 used  A1  A1  Correct z value 1.96 used  A1  A1  Correct z value 1.96 used  A1  A1  Correct z value 1.96 used  A1  Correct limits (written as interval)  M1*  M1*  Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used  For equation of correct form   | Accept Isaac's claim.  |        |    |  |
| $ \begin{array}{c ccccccccccccccccccccccccccccccccccc$  |  | 71111  |    |  |
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$   | <b>OR</b> Using N(0 3 0 0116)  |        |    | contradictions   |
| H <sub>1</sub> p<0.3 $\frac{7-0.111+1/36-0.3}{\sqrt{0.0116}} = -1.49159$ $\sqrt{0.0116}$ -1.49159>-1.645 $Accept Isaac's claim$ B1 B0th hypotheses correct  M1 For attempt at z with or without cc For correct z For comparison Correct conclusion ft their test statistic  R1 For attempt at z with or without cc For correct z For comparison Correct conclusion ft their test statistic  R1 For attempt at z with or without cc For correct z For comparison Correct conclusion ft their test statistic  R1 For attempt at z with or without cc For correct z  R1 For attempt at z with or without cc For correct z  R1 For comparison Correct conclusion ft their test statistic  R1 For comparison Correct conclusion ft their test statistic  R1 For comparison Correct conclusion ft their test statistic  R1 For comparison Correct conclusion ft their test statistic  R1 For comparison Correct conclusion ft their test statistic  R1 For comparison Correct conclusion ft their test statistic  R1 For comparison Correct conclusion ft their test statistic  R1 For comparison Correct conclusion ft their test statistic  R1 For comparison Correct conclusion ft their test statistic  R1 For comparison Correct conclusion ft their test statistic  R1 For comparison Correct conclusion ft their test statistic  R1 For comparison Correct conclusion ft their test statistic  R1 For comparison Correct conclusion ft their test statistic  R1 For comparison Correct conclusion ft their test statistic  R1 For comparison Correct conclusion ft their test statistic  R1 For comparison Correct conclusion ft their test statistic  R1 For comparison Correct z R1 For comparison Correct test statistic  R1 For comparison Correct   |  | D1     |    | Dath hypothogog garrent                                |
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| Accept Isaac's claim  OR Using N(5.4,3.78)  H <sub>0</sub> $\mu$ =5.4  H <sub>1</sub> $\mu$ <5.4 $\chi$ =2.5-5.4=-1.49159 $\chi$ 3.78  -1.49159>-1.645  Accept Isaac's claim  OR Using N(5.4,3.78)  B1  Both hypotheses correct  For attempt at z with or without cc For correct z  All For comparison Correct conclusion ft their test statistic  Provided Security of Se  |  |        |    |  |
| OR Using N(5.4,3.78) $H_0 \mu = 5.4$ $H_1 \mu \le 5.4$ $z = 2.5 - 5.4 = -1.49159$ $\sqrt{3.78}$ Accept Isaac's claim $2 \text{ (i) } -1.645 = \frac{c - 3.2}{1.4/\sqrt{10}} \qquad c = 2.47$ $\text{rejection region is } \overline{x} < 2.47$ $\text{(ii) } m < 2.47$ $\text{B1ft}  1$ $3 \text{ (i) a sample where every element has an equal chance of being picked.}$ B1 $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.629)}{n}} = 0.02$ B1 $0.321, 0.422$ B1 $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.629)}{n}} = 0.02$ B1 $0.301 = 80th hypotheses correct$ For attempt at z with or without cc For correct z  For comparison Correct conclusion ft their test statistic  For standardising, must have sq rt. and z value For $\pm 1.645$ used For $2.47$ For inequality correct way round (ft their $2.47$ but must be $< 3.2$ )  B1 $1$ $1$ Correct shape $\overline{x} \pm zs / \sqrt{n}$ Correct z value 1.96 used Correct limits (written as interval)  Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used For equation of correct form   |  |        |    |  |
| H <sub>0</sub> $\mu$ =5.4<br>H <sub>1</sub> $\mu$ <5.4<br>z=2.5 - 5.4 = -1.49159<br>$\sqrt{3.78}$<br>-1.49159>-1.645<br>Accept Isaac's claim  M1 Alft 5  For comparison Correct conclusion ft their test statistic  2 (i) -1.645 = $\frac{c-3.2}{1.4/\sqrt{10}}$ $c$ = 2.47  rejection region is $\bar{x}$ < 2.47  M1 B1 Alft 4 For standardising, must have sq rt. and z value For ± 1.645 used For 2.47 For inequality correct way round (ft their 2.47 but must be <3.2)  (ii) $m$ < 2.47  B1ft 1 ft on their (i)  3 (i) a sample where every element has an equal chance of being chosen OR a random sample of size n is a sample chosen in such a way that each possible group of size n has the same chance of being picked.  B1 1 For proportion used  Correct z value 1.96 used Correct limits (written as interval)  (iii) $1.96\sqrt{\frac{(0.371)(0.629)}{n}} = 0.02$ M1* Secing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used For equation of correct form  | Accept Isaac's claim   | Alft   |    | Correct conclusion ft their test statistic             |
| H <sub>0</sub> $\mu$ =5.4<br>H <sub>1</sub> $\mu$ <5.4<br>z=2.5 - 5.4 = -1.49159<br>$\sqrt{3.78}$<br>-1.49159>-1.645<br>Accept Isaac's claim  M1 Alft 5  For comparison Correct conclusion ft their test statistic  2 (i) -1.645 = $\frac{c-3.2}{1.4/\sqrt{10}}$ $c$ = 2.47  rejection region is $\bar{x}$ < 2.47  M1 B1 Alft 4 For standardising, must have sq rt. and z value For ± 1.645 used For 2.47 For inequality correct way round (ft their 2.47 but must be <3.2)  (ii) $m$ < 2.47  B1ft 1 ft on their (i)  3 (i) a sample where every element has an equal chance of being chosen OR a random sample of size n is a sample chosen in such a way that each possible group of size n has the same chance of being picked.  B1 1 For proportion used  Correct z value 1.96 used Correct limits (written as interval)  (iii) $1.96\sqrt{\frac{(0.371)(0.629)}{n}} = 0.02$ M1* Secing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used For equation of correct form  | 07.77  |        |    |  |
| H <sub>1</sub> $\mu$ <5.4 $z=2.5-5.4=-1.49159$ $\sqrt{3.78}$ $-1.49159>-1.645$ Accept Isaac's claim  2 (i) -1.645 = $\frac{c-3.2}{1.4/\sqrt{10}}$ $c=2.47$ Rejection region is $\bar{x} < 2.47$ 3 (i) a sample where every element has an equal chance of being chosen OR a random sample of size n is a sample chosen in such a way that each possible group of size n has the same chance of being picked.  B1  | · · · · · · · · · · · · · · · · · · ·                                    | B1     |    | Both hypotheses correct                                |
| The standardising in the statistic  | •  |        |    |  |
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$   | $H_1 \mu < 5.4$  | M1     |    | For attempt at z with or without cc                    |
| For comparison Correct conclusion ft their test statistic  2 (i) $-1.645 = \frac{c - 3.2}{1.4/\sqrt{10}}$ $c = 2.47$ rejection region is $\overline{x} < 2.47$ (ii) $m < 2.47$ B1ft 1  3 (i) a sample where every element has an equal chance of being chosen OR a random sample of size n is a sample chosen in such a way that each possible group of size n has the same chance of being picked.  B1 1  For comparison Correct conclusion ft their test statistic  For standardising, must have sq rt. and z value For $\pm 1.645$ used For $2.47$ For inequality correct way round (ft their $2.47$ but must be $< 3.2$ )  If no their (i)  For proportion used for $\pm 1.645$   | z = 2.5 - 5.4 = -1.49159   | A1     |    | For correct z  |
| Accept Isaac's claim  Alft 5 Correct conclusion ft their test statistic  2 (i) -1.645 = $\frac{c-3.2}{1.4/\sqrt{10}}$ $c = 2.47$ $alg 1$ $alg 2$ $alg 2$ $alg 2$ $alg 3$ $alg 4$ $alg 2$ $alg 4$ $alg 2$ $alg 2$ $alg 4$ $alg 2$ $alg 4$ $alg 2$ $alg 4$ $alg 4$ $alg 2$ $alg 4$  | $\sqrt{3.78}$  |        |    |  |
| Accept Isaac's claim  A1ft 5 Correct conclusion ft their test statistic  2 (i) -1.645 = $\frac{c-3.2}{1.4/\sqrt{10}}$ $c = 2.47$ rejection region is $\overline{x} < 2.47$ A1ft 4  B1   For standardising, must have sq rt. and z value For $\pm 1.645$ used For $2.47$ For inequality correct way round (ft their $2.47$ but must be $< 3.2$ )  (ii) $m < 2.47$ B1ft 1 ft on their (i)  3 (i) a sample where every element has an equal chance of being chosen OR a random sample of size n is a sample chosen in such a way that each possible group of size n has the same chance of being picked.  B1 1 1  (ii) $1.30/350 (0.371)$ $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.629)}{350}}$ $= 0.371 \pm 0.050609$ $= (0.321, 0.422)$ B1   Correct conclusion ft their test statistic  For standardising, must have sq rt. and z value For $\pm 1.645$ used For inequality correct way round (ft their $2.47$ but must be $< 3.2$ )  If to n their (i)  Correct shape $\overline{x} \pm 2s / \sqrt{n}$ Correct shape $\overline{x} \pm 2s / \sqrt{n}$ Correct z value 1.96 used Correct limits (written as interval)  (iii) $1.96 \sqrt{\frac{(0.371)(0.629)}{n}} = 0.02$ M1*  Seeing an equation involving $0.02$ or $0.04$ , $n$ in denom and a sq rt and proportions used For equation of correct form  | -1.49159>-1.645  | M1     |    | For comparison   |
| 2 (i) $-1.645 = \frac{c - 3.2}{1.4/\sqrt{10}}$ $c = 2.47$ Rejection region is $\overline{x} < 2.47$ (ii) $m < 2.47$ B1ft 1 from their (i)  3 (i) a sample where every element has an equal chance of being chosen OR a random sample of size n is a sample chosen in such a way that each possible group of size n has the same chance of being picked.  B1 1 For proportion used  (ii) $130/350 (0.371)$ $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.629)}{350}}$ $= 0.371 \pm 0.050609$ $= (0.321, 0.422)$ B1 A1 4  For standardising, must have sq rt. and z value For $\pm 1.645$ used For $\pm 1.645$ used For inequality correct way round (ft their 2.47 but must be $< 3.2$ )  B1 ft on their (i)  For proportion used  Correct shape $\overline{x} \pm zs / \sqrt{n}$ Correct shape $\overline{x} \pm zs / \sqrt{n}$ Correct plane $\overline{x} \pm zs / \sqrt{n}$ Correct limits (written as interval)  (iii) $1.96 \sqrt{\frac{(0.371)(0.629)}{n}} = 0.02$ M1*  Seeing an equation involving $0.02$ or $0.04$ , $n$ in denom and a sq rt and proportions used For equation of correct form   |  | A1ft   | 5  | •  |
| 2 (i) $-1.645 = \frac{1}{1.4/\sqrt{10}}$ $c = 2.47$ $A1ft = 4$ For $\pm 1.645$ used For $2.47$ For inequality correct way round (ft their $2.47$ but must be $<3.2$ )  (ii) $m < 2.47$ B1 ft on their (i)  3 (i) a sample where every element has an equal chance of being chosen OR a random sample of size n is a sample chosen in such a way that each possible group of size n has the same chance of being picked.  B1 1  (ii) $130/350$ (0.371) $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.629)}{350}}$ $= 0.371 \pm 0.050609$ $= (0.321, 0.422)$ B1 A1   | Troop round a dimin  |        |    |  |
| 2 (i) $-1.645 = \frac{1}{1.4/\sqrt{10}}$ $c = 2.47$ $A1ft = 4$ For $\pm 1.645$ used For $2.47$ For inequality correct way round (ft their $2.47$ but must be $<3.2$ )  (ii) $m < 2.47$ B1 ft on their (i)  3 (i) a sample where every element has an equal chance of being chosen OR a random sample of size n is a sample chosen in such a way that each possible group of size n has the same chance of being picked.  B1 1  (ii) $130/350$ (0.371) $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.629)}{350}}$ $= 0.371 \pm 0.050609$ $= (0.321, 0.422)$ B1 A1   | c-3 2  | M1     |    | For standardising, must have so rt, and z value        |
| rejection region is $\overline{x} < 2.47$ Alft  4  Alft  4  For inequality correct way round (ft their 2.47 but must be <3.2)  (ii) $m < 2.47$ Blft  1 ft on their (i)  3 (i) a sample where every element has an equal chance of being chosen OR a random sample of size n is a sample chosen in such a way that each possible group of size n has the same chance of being picked.  (ii) $130/350 (0.371)$ $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.629)}{350}}$ $= 0.371 \pm 0.050609$ $= (0.321, 0.422)$ Bl  Correct shape $\overline{x} \pm zs / \sqrt{n}$ Correct z value 1.96 used Alft  Alft  4  For inequality correct way round (ft their 2.47 but must be <3.2)  Bl  Correct shape $\overline{x} = \frac{1}{2}$ Correct shape $\overline{x} = \frac{1}{2}$ Correct shape $\overline{x} = \frac{1}{2}$ Correct z value 1.96 used Alft  Alft  Alft  4  For inequality correct way round (ft their 2.47 but must be <3.2)  Bl  Correct shape $\overline{x} = \frac{1}{2}$ Correct shape $\overline{x} = \frac{1}{2}$ Correct z value 1.96 used Alft  Alft  Alft  4  Correct limits (written as interval)  M1*  Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used For equation of correct form  | <b>2</b> (i) -1.645 = $\frac{c}{c} = \frac{3.2}{1.0000}$ $c = 2.47$      |        |    |  |
| rejection region is $\bar{x} < 2.47$ A1ft 4 For inequality correct way round (ft their 2.47 but must be <3.2)  (ii) $m < 2.47$ B1ft 1 ft on their (i)  3 (i) a sample where every element has an equal chance of being chosen OR a random sample of size n is a sample chosen in such a way that each possible group of size n has the same chance of being picked.  B1 1  For proportion used  M1 Correct shape $\bar{x} \pm zs / \sqrt{n}$ $= 0.371 \pm 0.050609$ $= (0.321, 0.422)$ B1 Correct z value 1.96 used A1 4 Correct limits (written as interval)  M1* Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used For equation of correct form  |  |        |    |  |
| but must be <3.2)  (ii) $m < 2.47$ B1ft 1 ft on their (i)  3 (i) a sample where every element has an equal chance of being chosen OR a random sample of size n is a sample chosen in such a way that each possible group of size n has the same chance of being picked.  B1 1  (ii) $130/350 (0.371)$ $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.629)}{350}}$ $= 0.371 \pm 0.050609$ $= (0.321, 0.422)$ B1 Correct shape $\overline{x} \pm zs / \sqrt{n}$ Correct z value 1.96 used Correct limits (written as interval)  (iii) $1.96 \sqrt{\frac{(0.371)(0.629)}{n}} = 0.02$ M1*  Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used For equation of correct form  | rejection region is $\bar{x} < 2.47$                                     |        | 4  |  |
| (ii) $m < 2.47$ B1ft 1 ft on their (i)  3 (i) a sample where every element has an equal chance of being chosen  OR a random sample of size n is a sample chosen in such a way that each possible group of size n has the same chance of being picked.  B1 1  (ii) $130/350 (0.371)$ $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.629)}{350}}$ $= 0.371 \pm 0.050609$ $= (0.321, 0.422)$ B1 For proportion used  Correct shape $\bar{x} \pm zs / \sqrt{n}$ Correct z value 1.96 used  Correct limits (written as interval)  M1*  Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used  For equation of correct form  |  | 7 1110 | •  | * * *  |
| 3 (i) a sample where every element has an equal chance of being chosen  OR a random sample of size n is a sample chosen in such a way that each possible group of size n has the same chance of being picked.  B1 1  For proportion used  O.371 ± 1.96 × $\sqrt{\frac{(0.371)(0.629)}{350}}$ $= 0.371 \pm 0.050609 = (0.321, 0.422)$ B1 Correct shape $\overline{x} \pm zs / \sqrt{n}$ Correct z value 1.96 used  Correct limits (written as interval)  M1*  Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used  For equation of correct form   |  |        |    | out must be (3.2)                                      |
| 3 (i) a sample where every element has an equal chance of being chosen  OR a random sample of size n is a sample chosen in such a way that each possible group of size n has the same chance of being picked.  B1 1  (ii) $130/350 (0.371)$ $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.629)}{350}}$ $= 0.371 \pm 0.050609$ $= (0.321, 0.422)$ B1 For proportion used  Correct shape $\bar{x} \pm zs / \sqrt{n}$ Correct z value 1.96 used  Correct limits (written as interval)  M1*  Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used  For equation of correct form  | (ii) $m < 2.47$  | R1ft   | 1  | ft on their (i)  |
| equal chance of being chosen OR a random sample of size n is a sample chosen in such a way that each possible group of size n has the same chance of being picked.  (ii) $130/350 (0.371)$ (ii) $130/350 (0.371)$ B1  For proportion used $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.629)}{350}}$ $= 0.371 \pm 0.050609$ $= (0.321, 0.422)$ B1  Correct shape $\overline{x} \pm zs / \sqrt{n}$ Correct z value 1.96 used  Correct limits (written as interval)  M1*  Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used  For equation of correct form   |  | Diit   | •  | it on then (i)   |
| OR a random sample of size n is a sample chosen in such a way that each possible group of size n has the same chance of being picked.  B1 1  (ii) $130/350 (0.371)$ B1 For proportion used $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.629)}{350}}$ $= 0.371 \pm 0.050609$ $= (0.321, 0.422)$ B1 Correct shape $\overline{x} \pm zs / \sqrt{n}$ Correct z value 1.96 used Correct limits (written as interval)  (iii) $1.96 \sqrt{\frac{(0.371)(0.629)}{n}} = 0.02$ M1*  Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used For equation of correct form   | 3 (i) a sample where every element has an                                |        |    |  |
| OR a random sample of size n is a sample chosen in such a way that each possible group of size n has the same chance of being picked.  B1 1  (ii) $130/350 (0.371)$ B1 For proportion used $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.629)}{350}}$ $= 0.371 \pm 0.050609$ $= (0.321, 0.422)$ B1 Correct shape $\overline{x} \pm zs / \sqrt{n}$ Correct z value 1.96 used Correct limits (written as interval)  (iii) $1.96 \sqrt{\frac{(0.371)(0.629)}{n}} = 0.02$ M1*  Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used For equation of correct form   | equal chance of being chosen   |        |    |  |
| chosen in such a way that each possible group of size n has the same chance of being picked.  B1 1  (ii) $130/350 (0.371)$ $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.629)}{350}}$ $0.371 \pm 0.050609 = (0.321, 0.422)$ B1 For proportion used  M1 Correct shape $\overline{x} \pm zs / \sqrt{n}$ Correct z value 1.96 used Correct limits (written as interval)  M1*  Correct z value 1.96 used Correct limits (written as interval)  M1*  Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used For equation of correct form  |  |        |    |  |
| group of size n has the same chance of being picked.  (ii) $130/350 (0.371)$ $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.629)}{350}}$ $= 0.371 \pm 0.050609$ $= (0.321, 0.422)$ B1 Correct shape $\overline{x} \pm zs / \sqrt{n}$ Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used For equation of correct form   |  |        |    |  |
| being picked.  (ii) $130/350 \ (0.371)$ $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.629)}{350}}$ $= 0.371 \pm 0.050609$ $= (0.321, 0.422)$ B1  Correct shape $\bar{x} \pm zs / \sqrt{n}$ Correct z value 1.96 used  Correct limits (written as interval)  M1*  Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used  For equation of correct form  |  | B1     | 1  |  |
| (ii) $130/350 (0.371)$ $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.629)}{350}}$ $= 0.371 \pm 0.050609$ $= (0.321, 0.422)$ B1 Correct shape $\bar{x} \pm zs / \sqrt{n}$ B1 Correct z value 1.96 used Correct limits (written as interval)  (iii) $1.96 \sqrt{\frac{(0.371)(0.629)}{n}} = 0.02$ M1* Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used For equation of correct form  |  |        |    |  |
| 0.371 ± 1.96 × $\sqrt{\frac{(0.371)(0.629)}{350}}$ M1 Correct shape $\bar{x} \pm zs / \sqrt{n}$<br>= 0.371 ± 0.050609<br>= (0.321, 0.422) B1 Correct z value 1.96 used Correct limits (written as interval)  (iii) 1.96 $\sqrt{\frac{(0.371)(0.629)}{n}} = 0.02$ M1* Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used For equation of correct form  |  |        |    |  |
| 0.371 ± 1.96 × $\sqrt{\frac{(0.371)(0.629)}{350}}$ M1 Correct shape $\bar{x} \pm zs / \sqrt{n}$<br>= 0.371 ± 0.050609<br>= (0.321, 0.422) B1 Correct z value 1.96 used Correct limits (written as interval)  (iii) 1.96 $\sqrt{\frac{(0.371)(0.629)}{n}} = 0.02$ M1* Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used For equation of correct form  |  | 1      |    |  |
| 0.371 ± 1.96 × $\sqrt{\frac{(0.371)(0.629)}{350}}$ M1 Correct shape $\bar{x} \pm zs / \sqrt{n}$<br>= 0.371 ± 0.050609<br>= (0.321, 0.422) B1 Correct z value 1.96 used Correct limits (written as interval)  (iii) 1.96 $\sqrt{\frac{(0.371)(0.629)}{n}} = 0.02$ M1* Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used For equation of correct form  | (ii) 130/350 (0.371)   | B1     |    | For proportion used                                    |
| $= 0.371 \pm 0.050609$ $= (0.321, 0.422)$ B1 A1 4 Correct z value 1.96 used Correct limits (written as interval)  M1* Seeing an equation involving 0.02 or 0.04, n in denom and a sq rt and proportions used For equation of correct form   |  |        |    | * *  |
| $= 0.371 \pm 0.050609$ $= (0.321, 0.422)$ B1 A1 4 Correct z value 1.96 used Correct limits (written as interval)  M1* Seeing an equation involving 0.02 or 0.04, n in denom and a sq rt and proportions used For equation of correct form   | $0.371 \pm 1.96 \times \sqrt{\frac{(0.371)(0.029)}{0.371}}$              | M1     |    | Correct shape $\overline{x} + 75 / \sqrt{n}$           |
| = (0.321, 0.422) $A1$   |  |        |    | Correct shape $x \perp zs / \sqrt{n}$                  |
| (iii) $1.96\sqrt{\frac{(0.371)(0.629)}{n}} = 0.02$ M1*  Seeing an equation involving 0.02 or 0.04, $n$ in denom and a sq rt and proportions used For equation of correct form   |  | B1     |    | Correct z value 1.96 used                              |
| (iii) $1.96\sqrt{\frac{(0.371)(0.629)}{n}} = 0.02$  | =(0.321, 0.422)  |        | 4  |  |
| M1*dep For equation of correct form   |  |        |    |  |
| M1*dep For equation of correct form   | (iii) $1.96 \left  \frac{(0.371)(0.629)}{(0.371)(0.629)} \right  = 0.02$ | M1*    |    | Seeing an equation involving $0.02$ or $0.04$ , $n$ in |
| M1*dep For equation of correct form   | n  |        |    |  |
|   |  | M1*de  | ер |  |
|   | <i>n</i> = 2241or 2242 or 2243 or 2240                                   | A1     | 3  |  |
|   | 1  |        |    |  |



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| <b>4 (i)</b> E (cost to Stella) = $600 + 5.52 \times 500$   | M1            |   | For multiplying by 5.52 and adding 600                        |
|---|---------------|---|---|
| = 3360  | A1            |   | Correct mean  |
| $Var (cost to Stella) = 5.52^2 \times 7.1^2$  | M1            |   | For mult $7.1/7.1^2/50.41^2$ by <b>5.52</b> <sup>2</sup>      |
| = 1540 (1536)   | M1            |   | For $5.52^{(2)}$ x $7.1^{(2)}$ or $50.41^2$ with <b>no</b>    |
| 10.10 (1000)  | 1,11          |   | addition/subtraction  |
|   | A1            | 5 | For correct answer  |
|   | - <del></del> |   | 1 of correct diswer   |
| (ii) $P(D > 2S) = P(D - 2S > 0)$  | M1            |   | For attempt ( $D$ - $2S$ ) (or equiv) either $<$ or $>$ 0     |
| $D - 2S \sim N(-120, 421 + 4 \times 1536)$  | B1            |   | For correct mean (seen or implied)                            |
| l i   | Alft          |   |   |
| ~ N(-120, 6565)   | AIII          |   | For correct unsimplified variance                             |
| $P(D-2S > 0) = P(z > \frac{120}{\sqrt{6565}})$  | 2.61          |   | <b>7</b>  |
| $\sqrt{6565}$   | M1            |   | For standardising attempt                                     |
| = P(z > 1.481)  |               |   |   |
| = 0.0693  | A1            | 5 | For correct answer, accept 0.069                              |
| 0.0055  | 111           |   | Tor correct answer, accept one                                |
|   |               |   |   |
| $\Gamma 2 \exists b$  | B1            |   | Correct answer (accept unsimplified)                          |
| <b>5 (i)</b> $E(X) = \int_{0}^{b} \frac{x}{b} dx = \left[ \frac{x^2}{2b} \right]_{0}^{b} = \frac{b}{2}$                       |               |   | (market property)   |
| $\begin{vmatrix} b & b & b \end{vmatrix} = \begin{vmatrix} b & b & b \end{vmatrix} = \begin{vmatrix} b & b & b \end{vmatrix}$ | M1            |   | For (substituted) attempt at $\int x^2 f(x) dx - [E(X)^2]$ ie |
| 2 30  | 1,11          |   | For (substituted) attempt at $\int x \int (x) dx = [L(X)]$ is |
| h 2 12 12   |               |   | $-[E(X^2)]$ must be seen even if ignored in next line         |
| $Var(X) = \int_{0}^{b} \frac{x^{2}}{h} - \frac{b^{2}}{4} = \frac{b^{2}}{12}$  |               |   | [2(11 )] must be seen even it ignored in next inte            |
| $ \stackrel{\circ}{b} b = 4 = 12 $  | A1            | 3 | Correct answer. Accept unsimplified – but must be a           |
|   | 7 11          |   | single fraction.  |
|   |               |   | Single fraction.  |
| (ii) $9.5 = b/2$  | M1            |   | Equating their mean to their 9.5                              |
| b = 19  AG  | A1            | 2 | Correct answer  |
|   | 111           | _ | Correct answer  |
|   | 1             |   |   |
| (iii) 8/19 or 0.421   | B1            | 1 | Correct answer  |
|   | 1             |   |   |
| (iv) $\overline{X} \sim N(9.5, 30.08/336)$  | M1            |   | Dividing their $b^2/12$ by 336                                |
|   | A1ft          |   | Correct mean and variance                                     |
| or using totals N(3192,10106.88)  | AIII          |   | Contot mean and variance                                      |
| $P(\overline{X} < 9) = P\left(z < \frac{9 - 9.5}{\sqrt{30.08/336}}\right)$ or equiv   |               |   | Standardising (must involve 336) and area < 0.5               |
| $P(A < 9) = P \left[ Z < \frac{\sqrt{30.08/336}}{\sqrt{30.08/336}} \right]$ or equiv  | M1            |   |   |
|   |               |   | or consistent with their figures                              |
| = P(z < -1.671)   |               |   |   |
| = 1 - 0.9526  |               |   |   |
| = 0.0474  | A1            | 4 | Correct answer  |
|   |               |   |   |



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| $6 (i) \qquad \frac{e^{-\lambda} \lambda^2}{2!} = 3 \frac{e^{-\lambda} \lambda^4}{4!}$           | M1                   |   | Poisson equation involving $\lambda$   |
|--|----------------------|---|--|
| $2! \qquad 4!$ $\lambda = 2$   | A1                   |   | Correct mean   |
| $new \lambda = 7$  | B1ft                 |   | New mean ft $3.5 \times \text{previous one}$   |
| $P(X > 3) = 1 - e^{-7} \left( 1 + 7 + \frac{7^2}{2!} + \frac{7^3}{3!} \right)$                   | M1                   |   | Poisson probs with their mean (at least 3 probs) and 1-  |
| = 0.918  | A1                   | 5 | Correct answer   |
| (ii) (a) $\lambda = 1.3k$<br>$P(X > 0) = 1 - e^{-1.3k} = 0.96$<br>$0.04 = e^{-1.3k}$<br>k = 2.48 | B1<br>M1<br>A1<br>A1 | 4 | Correct new mean Equation with $k$ or $\lambda$ in involving $1 - P(0) = 0.96$ correct equation correct answer |
| <b>(b)</b> <i>X</i> ~ N(1300, 1300)  | B1                   |   | correct mean and variance  |
| $P(X > 1250) = P\left(z > \frac{1250.5 - 1300}{\sqrt{1300}}\right)$                              | M1                   |   | standardising must have sq rt with or without cc   |
| = P(z > -1.373)<br>= 0.915   | A1                   | 3 | correct answer   |
|  |                      |   |  |

