GCE Examinations

Advanced Subsidiary / Advanced Level

# Statistics

# Module S3

## Paper B

# MARKING GUIDE

This guide is intended to be as helpful as possible to teachers by providing concise solutions and indicating how marks should be awarded. There are obviously alternative methods that would also gain full marks.

Method marks (M) are awarded for knowing and using a method.

Accuracy marks (A) can only be awarded when a correct method has been used.

(B) marks are independent of method marks.




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# S3 Paper B – Marking Guide

**1.** *(a)* divide poulation into distinct groups
sample sizes from each group determined by proportions in population
sample any member of group until quota is filled — B3

*(b)* e.g. non-random sample within strata so may be biased — B1

*(c)* e.g. survey on political attitudes according to age group
too time-consuming / impractical to random sample within strata — B2 **(6)**

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**2.** exp. freq. 0-45 = $\frac{45}{360} \times 96 = 12$ etc. giving exp. freqs. 12, 12, 24, 24, 12, 12 — M1 A1

$H_0$ : continuous uniform distribution is a suitable model
$H_1$ : continuous uniform distribution is not a suitable model — B1

| $O$ | $E$ | $(O-E)$ | $\frac{(O-E)^2}{E}$ |
|---|---|---|---|
| 18 | 12 | 6 | 3 |
| 19 | 12 | 7 | 4.0833 |
| 15 | 24 | −9 | 3.375 |
| 20 | 24 | −4 | 0.6667 |
| 9 | 12 | −3 | 0.75 |
| 15 | 12 | 3 | 0.75 |

$\therefore \Sigma \frac{(O-E)^2}{E} = 12.625$ — M1 A2

$\nu = 6 - 1 = 5$, $\chi^2_{crit}(5\%) = 11.070$ — M1 A1

$12.625 > 11.070$ $\therefore$ reject $H_0$
continuous uniform distribution is not a suitable model — A1 **(9)**

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**3.** *(a)* mean = $\frac{(46\times60)+15}{20} = 138.75$ — M1

C.I. $\bar{x} \pm 1.6449 \frac{\sigma}{\sqrt{n}} = 138.75 \pm 1.6449 . \frac{23}{\sqrt{20}}$ — M1 A1

giving (130.3, 147.2) — A2

*(b)* width $= 2 \times 1.6449 \times \frac{23}{\sqrt{n}}$ $\therefore 2 \times 1.6449 \times \frac{23}{\sqrt{n}} < 10$ — M1 A1

$\therefore \sqrt{n} > 7.56654$ — A1

giving $n > 57.25$ so min. value of $n = 58$ — M1 A1

*(c)* e.g. she might buy big-budget movies with longer credits — B1 **(11)**

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**4.** expected freq. 8am-6pm/minor = $\frac{108\times56}{148} = 40.86$

6pm-2am/minor = $\frac{108\times71}{148} = 51.81$ — M1 A2

giving expected freqs 40.86 15.14
51.81 19.19
15.33 5.67 — A1

$H_0$ : proportion of serious injuries independent of time
$H_1$ : proportion of serious injuries varies with time — B1

| $O$ | $E$ | $(O-E)$ | $\frac{(O-E)^2}{E}$ |
|---|---|---|---|
| 45 | 40.86 | 4.14 | 0.4195 |
| 11 | 15.14 | −4.14 | 1.1321 |
| 49 | 51.81 | −2.81 | 0.1524 |
| 22 | 19.19 | 2.81 | 0.4115 |
| 14 | 15.33 | −1.33 | 0.1154 |
| 7 | 5.67 | 1.33 | 0.3120 |

$\therefore \Sigma \frac{(O-E)^2}{E} = 2.543$ — M1 A2

$\nu = 2$, $\chi^2_{crit}(5\%) = 5.991$ — M1 A1

$2.543 < 5.991$ $\therefore$ not significant
there is no evidence of prop'n of serious injuries varying with time — A1 **(11)**

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**5.** *(a)*

| bottle | *A* | *B* | *C* | *D* | *E* | *F* | *G* | *H* | *I* | *J* |
|---|---|---|---|---|---|---|---|---|---|---|
| enth. rank | 4 | 7 | 2 | 1 | 8 | 6 | 5 | 10 | 9 | 3 |
| price rank | 1 | 6 | 2 | 3 | 10 | 7 | 9 | 4 | 8 | 5 |
| $d^2$ | 9 | 1 | 0 | 4 | 4 | 1 | 16 | 36 | 1 | 4 |

$\Sigma d^2 = 76$ M2 A2

$r_s = 1 - \frac{6\times76}{10\times99} = 0.5394$ M1 A1

*(b)* $H_0 : \rho = 0 \quad H_1 : \rho > 0$ B1

$n = 10$, 5% level $\therefore$ C.R. is $r_s > 0.5636$ M1 A1

$0.5394 < 0.5636$ $\therefore$ not significant

there is no evidence of positive correlation A1

*(c)* share ranks, both 6.5, use pmcc B2 **(12)**

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**6.** *(a)* $\hat{\mu} = \bar{V} = \frac{10367}{80} = 129.6$ cm M1 A1

$\hat{\sigma}^2 = s^2 = \frac{80}{79}\left(\frac{1350314}{80} - 129.5875^2\right) = 87.09$ M2 A1

*(b)* $H_0 : \mu_V = \mu_M \quad H_1 : \mu_V \neq \mu_M$ B1

1% level $\therefore$ C.R. is $z < {}^-2.5758$ or $z > 2.5758$ B1

test statistic $= \frac{129.6-130.5}{\sqrt{\frac{87.09}{80}+\frac{96.24}{280}}} = {}^-0.7520$ M2 A2

not in C.R. do not reject $H_0$ M1

no evidence of difference in mean heights A1 **(13)**

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**7.** *(a)* let $X$ = time to mark P1 paper

let $A = X_1 - X_2$ $\therefore A \sim N(0, 2\times17^2) = \sim N(0, 578)$ M1 A1

$P({}^-5 < A < 5) = P\left(\frac{-5-0}{\sqrt{578}} < Z < \frac{5-0}{\sqrt{578}}\right)$ M1 A1

$= P({}^-0.21 < Z < 0.21) = 0.5832 - (1 - 0.5832) = 0.166$ M1 A1

*(b)* let $M$ = time to mark M1 paper, let $S$ = time to mark S1 paper

let $T = M_1 + \ldots + M_{45} + S_1 + \ldots + S_{80}$

$\therefore T \sim N(45\times314 + 80\times284, 45\times42^2 + 80\times29^2) = \sim N(36\,850, 146\,660)$ M2 A2

$P(\text{time} < 10 \text{ hours}) = P(T < 36\,000) = P\left(Z < \frac{36000-36850}{\sqrt{146660}}\right)$ M1

$= P(Z < {}^-2.22) = 1 - 0.9868 = 0.0132$ M1 A1 **(13)**

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Total **(75)**

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# Performance Record – S3 Paper B

| Question no. | **1** | **2** | **3** | **4** | **5** | **6** | **7** | Total |
|---|---|---|---|---|---|---|---|---|
| Topic(s) | sampling | goodness of fit, cont. unif. | confidence interval | conting. table | Spearman's, hyp. test | unbiased estimates, diff. of means hyp. test | linear comb. of Normal r.v. | |
| Marks | 6 | 9 | 11 | 11 | 12 | 13 | 13 | 75 |
| Student | | | | | | | | |
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