GCE Examinations

Advanced Subsidiary / Advanced Level

# Statistics

# Module S3

Paper E

# 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 E – Marking Guide

**1.** *(a)* total = 500 ∴ require $\frac{1}{5}$ — M1

giving 33, 28, 21, 18 respectively — A1

*(b)* e.g. know that each group is represented proportionately
provides data for each strata as well for whole — B2 **(4)**

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**2.** $H_0$ : discrete uniform is a suitable model

$H_1$ : discrete uniform is not a suitable model — B1

exp. freqs = 80 ÷ 5 = 16 — M1 A1

| $O$ | $E$ | $(O-E)$ | $\frac{(O-E)^2}{E}$ |
|---|---|---|---|
| 16 | 16 | 0 | 0 |
| 20 | 16 | 4 | 1 |
| 14 | 16 | $^-2$ | 0.25 |
| 17 | 16 | 1 | 0.0625 |
| 13 | 16 | $^-3$ | 0.5625 |

$\therefore \Sigma \frac{(O-E)^2}{E} = 1.875$ — M1 A2

$v = 5 - 1 = 4$, $\chi^2_{\text{crit}}(10\%) = 7.779$ — M1 A1

$1.875 < 7.779$ ∴ do not reject $H_0$

discrete uniform is a suitable model supporting psychologist's theory — A1 **(9)**

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**3.** *(a)* $H_0 : \mu = 5'6''$  $H_1 : \mu > 5'6''$ — B1

5% level ∴ C.R. is $z > 1.6449$ — B1

require = $\frac{\bar{X}-66}{\frac{2.3}{\sqrt{150}}} > 1.6449$ — M2 A1

giving C.R. $\bar{X} > 66.31$ inches — A1

*(b)* $\bar{X} = \frac{832\times12}{150} = 66.56$ — M1 A1

$66.56 > 66.31$ ∴ reject $H_0$ — M1

there is evidence that mean height of women is > 5'6" — A1 **(10)**

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**4.** *(a)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| capacity | 1.1 | 1.3 | 1.6 | 2.1 | 2.4 | 2.6 | 2.8 | 3.0 |
| sales | 527 | 632 | 840 | 619 | 350 | 425 | 487 | 401 |
| cap. rank | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| sales rank | 4 | 2 | 1 | 3 | 8 | 6 | 5 | 7 |
| $d^2$ | 16 | 25 | 25 | 4 | 16 | 9 | 9 | 36 |

$\Sigma d^2 = 140$ — M2 A2

$r_s = 1 - \frac{6\times140}{8\times63} = {}^-0.6667$ — M1 A1

*(b)* $H_0 : \rho = 0$  $H_1 : \rho \neq 0$ — B1

$n = 8$, 5% level ∴ C.R. is $r_s < {}^-0.7381$ or $r_s > 0.7381$ — M1 A1

not in C.R. ∴ no evidence of correlation — A1

*(c)* need variables to be jointly normally distributed for pmcc test
engine capacities are discrete so use Spearman's — B2 **(12)**

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**5.** *(a)* let $A$ = amount side length of red cube is longer than blue cube

$\therefore A \sim N(14.5 - 12.2, 16.0 + 9.0) = \sim N(2.3, 25)$ M1 A1

$P(A > 3) = P(Z > \frac{3-2.3}{5})$ M1

$= P(Z > 0.14) = 1 - 0.5557 = 0.4443$ M1 A1

*(b)* let $C$ = amount red tower is taller than blue tower

$\therefore C \sim N(4\times14.5 - 5\times12.2, 4\times16 + 5\times9) = \sim N(^-3, 109)$ M1 A2

$P(C > 0) = P(Z > \frac{0+3}{\sqrt{109}})$ M1

$= P(Z > 0.29) = 1 - 0.6141 = 0.3859$ M1 A1

*(c)* e.g. likely to use smaller blocks higher up the tower B1 **(12)**

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**6.** *(a)* expected freq. family/ITV = $\frac{101\times132}{240}$ = 55.55

family/Ch4 = $\frac{85\times132}{240}$ = 46.75

sports/ITV = $\frac{101\times66}{240}$ = 27.78

sports/Ch4 = $\frac{85\times66}{240}$ = 23.38 M1 A2

giving expected freqs

| | | |
|---|---|---|
| 55.55 | 46.75 | 29.70 |
| 27.78 | 23.38 | 14.84 |
| 17.67 | 14.87 | 9.46 |

M1 A1

$H_0$ : no difference in proportion of adverts on different channels

$H_1$ : difference in proportion of adverts on different channels B1

| $O$ | $E$ | $(O-E)$ | $\frac{(O-E)^2}{E}$ |
|---|---|---|---|
| 69 | 55.55 | 13.45 | 3.2566 |
| 35 | 46.75 | $^-11.75$ | 2.9532 |
| 28 | 29.70 | $^-1.7$ | 0.0973 |
| 20 | 27.78 | $^-7.78$ | 2.1788 |
| 28 | 23.38 | 4.62 | 0.9129 |
| 18 | 14.84 | 3.16 | 0.6729 |
| 12 | 17.67 | $^-5.67$ | 1.8194 |
| 22 | 14.87 | 7.13 | 3.4188 |
| 8 | 9.46 | $^-1.46$ | 0.2253 |

$\therefore \Sigma\frac{(O-E)^2}{E} = 15.535$ M1 A3

$\nu = 4, \chi^2_{crit}(5\%) = 9.488$ M1 A1

$15.535 > 9.488 \;\therefore$ significant

there is evidence of different proportion of adverts on different channels A1

*(b)* e.g. advertisers perception of the type of people who watch each channel B1 **(14)**

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**7.** *(a)* when a sample from any dist. is large, the dist. of the sample mean is approximately normal with same mean and variance $\frac{\sigma^2}{n}$ B3

*(b)* binomial with $n = 10, p = \frac{1}{6}$ B2

*(c)* mean = $np = 10 \times \frac{1}{6} = \frac{5}{3}$ A1

variance = $npq = 10 \times \frac{1}{6} \times \frac{5}{6} = \frac{25}{18}$ M1 A1

*(d)* let $X$ = no. of sixes when throw 10 dice $\therefore X \sim B(10, \frac{1}{6})$

$\therefore \bar{X} \sim N(\frac{5}{3}, \frac{\frac{25}{18}}{100}) = \sim N(\frac{5}{3}, \frac{1}{72})$ M1 A2

$P(\bar{X} > 1.8) = P(Z > \frac{1.8-\frac{5}{3}}{\sqrt{\frac{1}{72}}})$ M1

$= P(Z > 1.13) = 1 - 0.8708 = 0.1292$ M1 A1 **(14)**

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Total **(75)**

# Performance Record – S3 Paper E

| Question no. | **1** | **2** | **3** | **4** | **5** | **6** | **7** | Total |
|---|---|---|---|---|---|---|---|---|
| Topic(s) | sampling | goodness of fit, discrete uniform | hyp. test on mean | Spearman's, hyp. test | linear comb. of Normal r.v. | conting. table | CLT, dist. of sample mean | |
| Marks | 4 | 9 | 10 | 12 | 12 | 14 | 14 | 75 |
| Student | | | | | | | | |
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