Mark Scheme (Results)

Summer 2018

Pearson Edexcel GCE

In Statistics (8ST0) Paper 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.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Question	Scheme	Marks	AO	Notes
1(a)(i)	Correct **statistics**: $\sum x_i^3$ $\quad$ $\overline{x}$ $\quad$ $\sum (x_i - \overline{x})^2$	B1, B1, B1	1.1, 1.1, 1.1	B3: All three correct, no errors B2: Two/three correct, allow one error B1: One correct, allow one error
1(a)(ii)	Correct **parameters**: σ^2	B1	1.1	No errors
	Total	**4**		

Question	Scheme	Marks	AO	Notes
2(a)	The distribution is symmetrical.	E1	2.1b	oe Condone 'distribution is uniform/ rectangular' Condone 'not skewed'
2(b)	$p = 20 \times 0.011834$ **or** $p = 1 - \frac{64.5}{84.5}$ $= \frac{20}{84.5} = 0.237$	M1 A1	1.1 1.1	PI **or** 0.76~0.77 seen oe awfw 0.23~0.24
2(c)	[Let X = number of eruptions seen in a week] $X \sim B(7, 0.237)$ $P(X \geq 2) = 1 - P(X \leq 1)$ $= 1 - 0.479$ $= 0.521$	 B1 M1 A1	 2.1a 1.2 1.2	 PI any sensible p PI awfw 0.52~0.522 Actual: 0.5213096889
	Total	**6**		

Question	Scheme	Marks	AO	Notes
3(a)	Snowball sampling	E1	1.1	
3(b)	**Possible advantages (not exhaustive)** The process is low cost. The process is very quick/simple to organise. No sampling frame required. You can reach a population of young people who may be difficult to sample elsewhere. You can reach large amounts of people by initially reaching out to a small group. As it is online, people can do it whenever they want (e.g. on phone) Almost all young people use social media.	E1, E1	1.1, 1.1	E1 for each sensible comment Do not accept 'sample is unbiased'

3(c)	H_0: $p = 0.61$ H_1: $p \neq 0.61$ [Let X represent the number of diabetic under-25s in a sample of 68 who answer yes to question 5] (Under H_0), $X \sim B(68, 0.61)$ $P(X \leq 38)$ = 0.228 $0.228 > 0.025$ so accept H_0. Conclude that there is **insufficient evidence** (at the 5% significance level) to suggest that the <u>proportion</u> of (<u>diabetic</u>) <u>people</u> (<u>under 25</u>) in the population who would answer 'yes' to question 5 is not equal to 61%.	B1 B1 M1 A1 B1dep E1dep	1.3 1.3 1.3 1.3 2.1b 2.1a	oe in words PI for finding $P(X \leq 38)$ or $P(X < 38)$[= 0.16113] from a binomial distribution awfw 0.227~0.23 Comparison of p-value with 0.025 and correct conclusion Dep on correct p-value Must be in context. Should not be definite in conclusion. Dep on correct p-value, correct hypotheses, and sensible comparison.

	Alternative 1 H_0: $p = 0.61$ H_1: $p \neq 0.61$	(B1)		oe
	$\hat{p} = \frac{38}{68} = 0.559$	(B1)		awrt
	ts = $\frac{0.559 - 0.61}{\sqrt{\frac{0.61(1-0.61)}{68}}}$	(M1)		Correct formula for ts applied (ignore sign) or use of X=38, normal approx… (38.5…)
	$= -0.865$	(A1)		awfw -0.87 ~ -0.86
	cv = –1.96 $-1.96 > -0.865$ (**or** $p = 0.193 > 0.05$) so accept H_0.	(B1dep)		Comparison of ts with cv **or** p-value with 0.05 and correct conclusion Dep on correct ts & cv value **or** correct p-value
	Conclude that there is **insufficient evidence** (at the 5% significance level) to suggest that the proportion of diabetic people under 25 in the population who would answer 'yes' to question 5 is not equal to 61%.	(E1dep)		Must be in context. Must not be definite in conclusion. Dep on correct ts, correct hypotheses, and sensible cv.

	Alternative 2 H_0: $p = 0.61$ H_1: $p \neq 0.61$	(B1)		oe
	[Let X represent the number of diabetic under-25s in a sample of 68 who answer yes to question 5] (Under H_0), $X \sim B(68, 0.61)$ $Y \sim N(41.48, 16.1772)$	(B1)		Either seen PI
	$P(X \leq 38) = P(Y < 38.5)$	(M1)		for finding $P(Y < 38.5)$ or $P(Y < 38)$ from a normal distr
	= 0.229	(A1)		awfw 0.226~0.23
	$0.229 > 0.025$ so accept H_0.	B1dep	2.1b	Comparison of p-value with 0.025 and correct conclusion Dep on correct p-value
	Conclude that there is **insufficient evidence** (at the 5% significance level) to suggest that the <u>proportion</u> of (<u>diabetic</u>) <u>people</u> (<u>under 25</u>) in the population who would answer 'yes' to question 5 is not equal to 61%.	E1dep	2.1a	Must be in context. Should not be definite in conclusion. Dep on correct p-value, correct hypotheses, and sensible comparison.

3(d)	**Possible explanations** People may have been lying to improve their score in the test (or about their age). People may have selected the wrong option as a mistake (mis-click) The sample may contain bias due to the method of collection, as it may contain groups of similar internet contacts. The sample will not include people that aren't on social media. Children may not be able to answer all of the questions, so all under-25s may not be represented. The title, 'Are you as fit as Usain Bolt', may only appeal to certain people. People may not know exactly how much exercise they do. People may not be sure whether the exercise they do is vigorous or moderate. People may do different amounts of exercise each week. People who are less fit may not want to take the test, as it might make them feel bad.	E1, E1	3.1a, 3.1a	E1 for each sensible comment (max E2)
	Total	**11**		

Question	Scheme	Marks	AO	Notes
4(a)	[Let X represent the max temp on a randomly chosen October day]			
	$X \sim N(13.47, 8.27)$	B1	2.1a	oe in words **'normal distribution'** must be seen or used Condone t-distribution
	The normal distribution is suitable as the data is bell-shaped.	E1dep	2.1a	**'bell shape'** or equivalent should be seen. Condone 'correct shape' Dep on previous B1
	$P(X < 11.5) = 0.247$	B1	1.2	awfw: 0.245~0.25 Actual: 0.24666055
4(b)	**Possible explanations (not exhaustive)** There may have been other days colder than 11.5°C earlier in the autumn. The bluebells may be in a particularly warm/cold spot. Long-term trends (e.g. global warming). The data shows the air temperature, not the ground temperature. There may be other environmental factors affecting the germination of bluebells. The temperature is more likely to be colder than 11.5°C towards the end of October.	E1	3.1a	Any sensible explanation

4(c)	$\bar{X} \sim N\left(13.47, \frac{8.27}{5}\right)$	M1	2.1b	Normal dist seen or used PI
		M1	1.2	Correct Variance **or** SD Var: 1.654 oe SD: 1.2860793 oe PI
	$P\left(\bar{X} < 11.5\right) = 0.0628$	A1	1.2	awfw 0.0626~0.063 Actual: 0.06278746
4(d)	**Possible criticisms** Possible solutions			
	Temperature at the start of October is likely to be warmer than at the end of October. Further split data by (e.g.) week/day.			Different temp throughout October.
	October 2018 may be a particularly warm/cool month. Split data by warm/medium/cool years (then check long-term weather forecast for Oct 18).			Different temp between years.
	The data does not take long-term trends (e.g. global warming) into account. Only use recent data.			Accept 'study trends over time'

	The data may not have been recorded from the same location in Central England. Only use data gathered in the same location **Only one place in Central England is being represented.** Use data gathered from multiple locations. **The model includes outliers which are likely to skew the summary statistics.** Remove outliers **The equipment used for the early data may not be as accurate or reliable as modern equipment.** Only use recent data	**E1, E1** E1dep, E1dep	**3.1a, 3.1a** 3.1a, 3.1a	**E1 for each sensible criticism (max E2)** E1 for sensible solution (max E1 per criticism) Dep on previous E1
	Total	**11**		

Question	Scheme	Marks	AO	Notes
5(a)	(If Deshandra's theory is correct) the intersection of the two sets of countries is likely to be very small	E1	3.1a	**Accept** 'not many countries in both tables'. **Do not accept** comparison of sample sizes **Condone** difference between country and nation.
5(b)	**Sort** each table by country (alphabetically) **(then)** Move data into adjacent columns/rows **(then)** Check for differences/errors in the lists of countries, and correct or remove them. **Alternative** Use VLOOKUP (or LOOKUP) function… …to look up the country in the other table… …and return the consumption value.	E1 E1 E1 (E1) (E1) (E1)	1.1 1.1 1.1	'**Sort**' should be seen or copy & paste etc Condone 'fields'
	Special case +E1 for suggestion of scatter diagram (but may not score E3 in this case)			
	Special case If database language used: E1 for 'query' seen E1 for 'join' between country fields (condone link oe)			

5(c)	**Assumption** A) The population (of coffee and tea consumption) data has a **bivariate normal** distribution. **or** B) The data contains **no outliers**.	E1	1.3	**May appear in (d)**
	H_0: No correlation between tea and coffee consumption H_1: Negative correlation between tea and coffee consumption	B1	1.3	Both correct Condone $\rho = 0$, $\rho < 0$
	ts: $r = -0.461$	B1	1.2	awfw -0.463 ~ -0.46 Actual: -0.4612533
	cv $= -0.5494$	B1	1.3	Ignore sign
	$-0.461 > -0.5494$ (or ts > cv) so accept H_0	B1dep	2.1b	Clear comparison of (their) ts with cv in **same tail** Condone comparison with: -0.4428, -0.6319, -0.7155, -0.7646 Dep ts **must** be <u>negative</u>
	There is insufficient evidence to suggest that countries which consume more <u>coffee</u>, consume less <u>tea</u>. **or** There is insufficient evidence to support Deshandra's belief.	E1dep	2.1a	Must be in context. Should not be definite in conclusion. Dep correct ts ft from correct comparison in previous mark Note: cv=-0.4428 should **reject H_0**

5(d)	**Assumption A** **(Bivariate normality)**			
	The tea data is not normally distributed…	E1	2.1a	**or** not bell-shaped oe Accept 'skewed'
	…hence the (tea and coffee) data will not have a bivariate normal distribution.	E1dep	3.1a	Dep on previous E1 Must see 'bivariate normal'
	Assumption B **(No outliers)**			
	The Netherlands…	(E1)		'Netherlands' singled out (referring to figure 6)
	…is clearly an outlier.	(E1)		Outlier in the data is pointed out.
5(e)	Use Spearman's rank correlation coefficient	E1	3.1a	'**Spearman**' must be seen.
5(f)	The information is measured in kilograms, not in cups… **or** This only tells us that twice as much coffee (as tea) is consumed, in kilograms…	E1	3.1b	Different units pointed out, possibly implicitly.
	…and a greater mass (or weight) of coffee may be needed to make one cup (than for tea).	E1	3.1b	Suggestion that tea cups/kg ratio is not the same as coffee.
	Alternatives			
	Coffee cups tend to be smaller/bigger than tea cups (or suggestion of different sized cups)	(E1)		This solution scores E1 max.
	The secondary data may not be reliable.	(E1)		This solution scores E1 max.
	Total	**15**		

<table>
<tr><th>Question</th><th>Scheme</th><th>Marks</th><th>AO</th><th>Notes</th></tr>
<tr><td>6(a)</td><td>Clear intention to test for association

H_0: No association between ethnic group and expectation to buy (in private renters in 2015-16)
H_1: Some association between ethnic group and expectation to buy (in private renters in 2015-16)

Observed values for private renters:
Note: Correct figures include zeroes (as data is in thousands), but this oversight will not be penalised.

<table><tr><th></th><th>Expect</th><th>Don’t</th><th>Total</th></tr><tr><td>White</td><td>2 077 (000)</td><td>1 446 (000)</td><td>3 524 (000) or 3 523 (000)</td></tr><tr><td>Other</td><td>497 (000)</td><td>309 (000)</td><td>806 (000)</td></tr><tr><td>Total</td><td>2 574 (000)</td><td>1 755 (000)</td><td>4 329 (000) or 4 330 (000)</td></tr></table></td><td>B1

B1

B1</td><td>2.1a

1.3

1.1</td><td>

oe

Accept ‘…independent’ and ‘…not independent’

Correct two-way table selected.

PI</td></tr>
</table>

(Under H_0),
Expected values:

	Expect	**Don't**
White	2095 (000)	1 428~1 429 (000)
Other	479 (000)	327 (000)

M1 1.2

Clear attempt at finding expected values

or

at least one correct expected value seen

PI

A1 1.2

All four correct

awrt

PI

Contributions to χ^2 statistic:

	Expect	**Don't**
White	150~170 **or** 0.15~0.17	200~230 **or** 0.20~0.23
Other	650~680 **or** 0.65~0.68	950~1000 **or** 0.95~1.00

M1 1.2

Clear attempt at finding contributions

or

at least one correct contribution

PI

A1 1.2

All four correct

PI

Condone use of Yates's correction:

140~160 **or** 0.14 ~0.16	190~220 **or** 0.19 ~0.22
620~640 **or** 0.62 ~0.64	900~940 **or** 0.90 ~0.94

	ts = 1 994 (**or** 1.99) (1-tail, $\nu = 1$) 5% cv = 3.84 1 994 > 3.84 so reject H_0 **or** 1.99 < 3.84 so accept H_0 **If ts = 1 994** There is sufficient evidence (at the 5% level of significance) to suggest that there is an association between <u>ethnic</u> <u>group</u> and <u>expectation to buy</u> (for private renters in 2015-16) **or** **If ts = 1.99** There is insufficient evidence (at the 5% level of significance) to suggest that there is an association between <u>ethnic</u> <u>group</u> and <u>expectation to buy</u> (for private renters in 2015-16)	B1 B1 B1dep E1dep	1.3 1.3 2.1b 2.1a	1 990~2 050 **or** 1.99~2.05 Condone use of Yates's correction: 1 880~1 940 **or** 1.88~1.94 **SC**: nms 1 800~2 100 or 1.8~2.1 loses this mark only awrt Correct comparison & conclusion dep on ts in acceptable range & cv Must be in context. Must be consistent with ts. Should **not** be definite in conclusion. dep on previous B1
6(b)	The sample size is the number of households, whereas the total is the number of renters (people)… …and there may be more than one renter (person) in the household (but not fewer).	E1 E1	2.1a 2.1a	Correctly identify that one is counting households and one is counting people. Must see '**more**' or equivalent.
	Total	**13**		

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