Qu 2	Scheme	Marks	AO
(a)	Negative	B1 **(1)**	1.2
(b)	Marc's suggestion <u>is compatible</u> because it's <u>negative correlation</u>	B1 **(1)**	2.4
(c)	$(r =)$ $-0.54458266\ldots$ awrt **<u>-0.545</u>**	B1 **(1)**	1.1b
(d)	$H_0 : \rho = 0$ $H_1 : \rho < 0$ [5% 1-tail cv =] $(\pm)$ 0.4259 (significant result / reject H_0) There <u>is</u> evidence of negative <u>correlation</u> between the <u>number of letters</u> in (or <u>length</u> of) a student's last <u>name</u> and their first <u>name</u>	B1 M1 A1 **(3)**	2.5 1.1a 2.2b
		(6 marks)	

	Notes
(a)	B1 for "negative" Allow "slight" or "weak" etc Allow a description e.g. "as x increases y decreases" or in context e.g. "people with longer last names tend to have shorter first names" A comment of "negative skew" is B0 **Need to see distinct or separate responses for (a) and (b)**
(b)	B1 for a comment that suggests data is compatible with the suggestion **and** a suitable reason such as "there is negative correlation" <u>or</u> a description in x and y or in context <u>or</u> the points lie close to a line with <u>negative gradient</u> <u>or</u> draw line $y = x$ and state that <u>more points below the line</u> so <u>supports (or is compatible with)</u> his suggestion A reason based on just a **single point** is B0 e.g. " 11 letters in last name has only 5 in first name"
(c)	B1 for awrt -0.545
(d)	B1 for both hypotheses correct in terms of ρ M1 for a critical value compatible with their H_1: 1-tail: awrt $\pm$ 0.426 (condone $\pm$ 0.425) **or** 2-tail (B0 scored for H_1) : awrt $\pm$ 0.497 If hypotheses are in words and can deduce whether one or two-tail then use their words. If no hypotheses or their H_1 is not clearly one or two tail assume one-tail A1 for compatible signs between cv and r **and** a correct conclusion in context mentioning <u>correlation</u> and <u>number of letters</u> or <u>length</u> and <u>name</u> (ft their value from (c)) Do NOT award this A mark if contradictory comments or working seen e.g. "accept H_0" or comparison of 0.426 with significance level of 0.05 etc **NB** The M1A1 can be scored independently of the hypotheses

Question	Scheme	Marks	AOs
5(a)	$12 \times 1 + 2 \times 2$	M1	1.1b
	$= 16$ awrt 16	A1	1.1b
		(2)	
(b)	$\mu = \frac{7171.2}{260} = 27.581538 \ldots$ awrt 27.6 (cm)	B1	1.1b
	$\sigma_x = \sqrt{\frac{1379.0}{260}}$	M1	1.1b
	$= 2.303 \ldots$ awrt 2.30 (cm)	A1	1.1b
		(3)	
(c)	$'27.6' - 3 \times' 2.30'[= 20.7]$ or $'27.6' + 3 \times' 2.30'[= 34.5]$	M1	1.1b
	20.7 **and** 34.5	A1	1.1b
	Concluding that there is at least one value below the lower outlier boundary on the histogram	A1	2.2a
		(3)	
(d)	Mean for males is greater than mean for females so (scientist is correct that) males pelvic breadth is larger on average	B1	2.4
	Standard deviation for males is smaller than standard deviation for females so (scientists is not correct) pelvic breadth of males is less variable	B1	2.4
		(2)	
(e)(i)	The outlier(s) lie below the mean so if they had been removed the mean would have increased	B1	2.2a
	Removing outliers would have decreased the standard deviation	B1	2.2a
(e)(ii)	If outliers had been removed (it is likely that) the males would still have had a larger mean or The standard deviation of the females would have been reduced so conclusion on variability might have changed / conclusion on variability unlikely to have changed as female and male standard deviations were not close including outliers.	B1	2.2b
		(3)	
			(13 marks)

Notes

(a)
M1 for complete method to find the frequency of females with pelvic breadth 32cm or above
A1 for awrt 16

(b)
B1 for a correct mean (awrt 27.6)
M1 for a correct expression for the sd (including $\sqrt{\square}$)
A1 for awrt 2.30 (allow $s = 2.3074$ ... awrt 2.31)

(c)
M1 for complete method for either lower outlier limit or upper outlier limit (allow ft on their mean and sd)
A1 for both outlier limits correct
A1 for identifying that the 18-19 bar on the histogram contains value below the lower outlier limit

(d)
B1 for a suitable comparison of means to comment on average pelvic breadth (allow ft on their mean for females)
B1 for a suitable comparison of standard deviations to comment on variability of pelvic breadth (allow ft on their sd for females)

(e)(i)
B1 for considering the effect of removing outliers on female mean
B1 for considering the effect of removing outliers on female standard deviation

(e)(ii)
B1 for explaining how their conclusion in (d) would have been effected had outliers been removed (either comment)

Question	Scheme	Marks	AOs
6 (a)	For independent events $\mathrm{P}(A \cap C) = \mathrm{P}(A) \times \mathrm{P}(C)$		
	Here $\mathrm{P}(A \cap C) = 0$ Therefore A and C not independent	B1	2.4
		(1)	
(b)	$\mathrm{P}((A \cup C)') = 0.25 + 0.3 = 0.55$	B1	1.1b
		(1)	
(c)(i) & (ii)	Use of $\mathrm{P}(A \cap B) = \mathrm{P}(A) \times \mathrm{P}(B)$	M1	2.1
	$p = \left(p + \frac{2}{15}\right)\left(p + \frac{2}{5}\right)$	A1	1.1b
	$p^2 - \frac{7}{15}p + \frac{4}{75} = 0$	M1	1.1b
	$p = \frac{4}{15}$ or $p = \frac{1}{5}$	A1	1.1b
	Check value of q : $p = \frac{4}{15}$ gives negative q (-0.05)	M1	2.1
	But $p = \frac{1}{5}$ gives $q = \frac{1}{60}$ So $p = 0.2$	A1	2.2a
		(6)	
(d)	Use of $\mathrm{P}(A \mid (B \cup C)') = \frac{\mathrm{P}(A \cap (B \cup C)')}{\mathrm{P}((B \cup C)')}$ or $= \frac{2/15}{2/15 + 1/4}$	M1	3.1a
	$= \frac{8}{23}$ oe	A1	1.1b
		(2)	
			(10 marks)

Notes

(a)

B1 definition of independent events and stating $P(A \cap C) = 0$

Or

Stating that A and C are mutually exclusive therefore not independent oe

(b) B1 no working required, 0.55 oe

(c)

1st M1 equation for independence must be used

1st A1 correct equation

2nd M1 expanding brackets to form quadratic in p

2nd A1 both values obtained correct, must be exact values (fractions oe)

3rd M1 Attempt to check the value of q for at least one of their p values

3rd A1 for correctly deducing that $p = 0.2$ (o.e.) only

(d)

M1 use of equation for conditional probability, correct expression in symbols or correct ratio of probabilities. May be implied by a correct answer.

2nd A1 cao

Question		Scheme	Marks
6.	(a)	For sight of $0.6^2 \times 0.4$ (o.e.)	B1cso (1)
	(b)(i)	$P(X=1) = \mathbf{0.4}$	B1
	(ii)	$P(X=4) = 1 - \text{"0.4"} - 0.24 - 0.144$ or $0.6^3 \times 0.4 + 0.6^4$ or 0.6^3 $= \mathbf{0.216}$	M1 A1 (3)
	(e)	stop after 1 head so 1 is the max value and can get no heads for 4 tails $P(H=\mathbf{0}) = \mathbf{0.1296}$ and $P(H=\mathbf{1}) = \mathbf{0.8704}$	B1 B1 (2)
	(f)(i)	$\left[P(\{X=3\} \cap \{H=0\}) =\right] = \mathbf{0}$	B1
	(ii)	$\left[P(\{X=4\} \cap \{H=0\}) =\right]$ $P(H=0) = 0.6^4 = \mathbf{0.1296}$ or $\frac{81}{625}$	B1ft (2)
	(g)	$[s]$: 2, 3, 4, 5 $[P(S=s)]$: 0.4, 0.24, 0.2736, 0.0864	B1ft B1 B1ft B1 (4)

4. (a)	$P(L > 100) = P\left(Z > \frac{100-\mu}{0.5}\right) = 0.3$		
	$\Rightarrow \frac{100-\mu}{0.5} =, \ 0.5244$		**M1 B1**
	$\mu = 99.7378...$ cm	awrt 99.7	**A1**
			(3)
(b)	X represents number more than 100cm. $X \sim B(12, 0.3)$		**B1**
	$P(X \leq 2) = 0.2528$	awrt 0.253	**M1A1**
			(3)
(c)	Normal approximation $\mu = 400 \times 0.3 = 120, \ \sigma^2 = 84$		**M1, A1**
	$P(X > 127) \approx 1 - P(Z < \frac{127.5-120}{\sqrt{84}})$	± 0.5, standardise	**M1, M1, A1**
	$\approx 1 - P(Z < 0.818\ )$		
	$= 1 - 0.7939$		
	$= 0.206$ or 0.207		**A1** **(6)**
			[12]

[NB] Part C is nowadays worth only 3 marks (since no need to standardise anymore)

1 mark for calculating mean = 120, and Var = 84

1 mark for using calculator/ stating we are looking for **P (X > 127.5) (mark is for awarding continuity correction)**

1 mark for getting awrt 0.206 or 0.207.