Hypothesis Tests For Correlation Mark Scheme (Edexcel)

Q1.

	Scheme	Marks	AO
(a)	Negative	B1 **(1)**	1.2
(b)(i)	Rainfall	B1	2.2b
(ii)	mm or Pressure hPa or Pascals or hectopascals or mb or millibars	B1ft **(2)**	1.1b
(c)	$H_0 : \rho = 0$ $H_1 : \rho \neq 0$	B1	2.5
	Critical value: $-0.361(0)$	M1	1.1b
	$r < -0.3610$ so significant result and there is evidence of a correlation between Daily Total Sunshine and Daily Maximum Relative Humidity	A1 **(3)**	2.2b
(d)	Humidity is high and there is evidence of correlation and $r < 0$ So expect amount of sunshine to be lower than the average for Heathrow(oe)	B1 **(1)**	2.2b
		(7 marks)	

	Notes
(a)	B1 for stating negative. "Negative skew" is B0 though
(b)(i)	B1 for mentioning "rainfall" (allow "rain" or "precipitation") or "pressure" (if more than 1 answer both must be correct) NB the other quantitative variable for Perth is: Daily Mean Wind Speed and scores B0 [Not allowed "wind speed" since $r = +0.15$ and in winter might expect wind to raise temp]
(ii)	B1ft for giving the correct units. If Daily Mean Wind Speed (kn) or knots "Wind speed" and "knots" would score B0B1 but any other variable scores B0B0
(c)	B1 for both hypotheses correct in terms of ρ M1 for the correct critical value compatible with their H_1: allow $\pm 0.361(0)$ If the hypotheses are 1-tail then allow cv of ± 0.3061 e.g. Alternative hypothesis with $r < \pm 0.377$ implies a one-tail test or H_0 and H_1 in words saying "H_0: there is no correlation, H_1: there is correlation" is two-tail If there are no hypotheses (or they are nonsensical) assume 2-tail so M1 for $\pm 0.361(0)$ A1 for a correct conclusion in context based on comparing -0.377 with their cv. Condone incorrect inequality e.g. $-0.3610 < -0.377$ as long as they reject H_0 Do not accept contradictory statements such as "accept H_0 so there is evidence of …" Can say "support for Stav's belief"(o.e.e.g. "claim") or "evidence of a correlation between sunshine and humidity" condone "negative correlation" or comments such as "if humidity is high amount of sunshine will be low"
(d)	B1 for stating low amount of sunshine (o. e.) **and** some reference to $r < 0$ or fog Check for the following 2 features: (i) **low** sunshine: allow $\leqslant 5$ hrs (LDS mean for 2015 is 5.3, humidity 97% is 4.1, $\geqslant 97\%$ is 3.1) (ii) **negative** correlation may be described in words e.g. "high humidity gives low sunshine" or **fog** (LDS says >95% humidity is foggy) so less sunshine

Q2.

	Scheme	Marks	AO
(a)	Negative	B1 (1)	1.2
(b)	Marc's suggestion is compatible because it's negative correlation	B1 (1)	2.4
(c)	$(r=)$ $-0.54458266\ldots$ awrt -0.545	B1 (1)	1.1b
(d)	$H_0 : \rho = 0$ $H_1 : \rho < 0$	B1	2.5
	[5% 1-tail cv =] (±) 0.4259	M1	1.1a
	(significant result / reject H_0) There is evidence of negative correlation between the number of letters in (or length of) a student's last name and their first name	A1 (3)	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" or a description in x and y or in context or the points lie close to a line with negative gradient or draw line $y = x$ and state that more points below the line so supports (or is compatible with) 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 ± 0.426 (condone ± 0.425) **or** 2-tail (B0 scored for H_1) : awrt ± 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 correlation and number of letters or length and name (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

Q3.

Question	Scheme		Marks	AOs
(a)	eg As the number of minutes exercise (m) increases the resting heart rate (h) decreases **or** the gradient of the curve is becoming flatter with increasing m: diminishing effect of each additional minute of exercise		B1	2.4
			(1)	
(b)	$H_0 : \rho = 0$ $H_1 : \rho < 0$		B1	2.5
	Critical value – 0.3887 (Allow ±)		M1	1.1b
	There is evidence that the product moment **correlation** is **less than 0**/ **there is a negative correlation**		A1	2.2b
			(3)	
(c)	$\log_{10} h = -0.05 \log_{10} m + 1.92$	$h = am^k \rightarrow \log_{10} h = \log_{10} am^k$	M1	1.1b
	$\log_{10} h = -\log_{10} m^{0.05} + 1.92$ or $\log_{10} h = \log_{10} m^{-0.05} + 1.92$ or $h = 10^{1.92 - 0.05 \log_{10} m}$ oe	$\log_{10} h = \log_{10} a + \log_{10} m^k$ or $\log_{10} a = 1.92$	M1	2.1
	$\log_{10} hm^{0.05} = 1.92$ or $\log_{10}\left(\frac{h}{m^{-0.05}}\right) = 1.92$ or $h = 10^{1.92} \times 10^{-0.05 \log_{10} m}$ oe	$\log_{10} h = \log_{10} a + k \log_{10} m$	M1	1.1b
	$hm^{0.05} = 10^{1.92}$ or $\frac{h}{m^{-0.05}} = 10^{1.92}$ or $h = 10^{1.92} \times 10^{\log_{10} m^{-0.05}}$	$\log_{10} a = 1.92$ and $k = -0.05$	M1	1.1b
	$h = 10^{1.92} m^{-0.05}$ or $h = 83.17...m^{-0.05}$ or a = awrt 83.17 **and** $k = -0.05$		A1	1.1b
			(5)	

		Notes: (9 marks)
(a)	B1	eg Idea as one increases the other decreases (in context). Allow use of m and h eg As m increases h decreases. Do not allow negative correlation with no context or $\rho < 0$ Allow there is a negative correlation/association/relationship/exponential between minutes exercise(m) and resting heart rate (h) oe
(b)	B1	Both hypotheses correct in terms of ρ (allow p)
	M1	For the cv of −0.3887 or any cv such that $0.3 < \lvert cv \rvert < 0.5$
	A1	Independent of hypotheses. Correct conclusion that implies reject H_0 on basis of seeing – 0.3887 or if they give 0.3887 we must see the comparison 0.3887 < 0.897 **and** which mentions "pmcc/correlation/relationship" and less than 0/ negative or $\rho < 0$ A contradictory statement scores A0 eg Accept H_0 therefore negative correlation
(c)		**In this part once M0 is scored no more marks can be scored. Condone no base**
	M1	**May be implied by 2nd M1 mark** Method 1: Correct substitution for both x and y Method 2 : Taking the log of both sides
	M1	**May be implied by 3rd M1 mark** Method 1: Correct use of the power log rule **or** making h the subject Method 2 : Correct use of the addition/subtraction log rule
	M1	**This line implies M1M1M1** Method 1: Correct use of the addition/subtraction log rule or eq^n in the form $h = 10^{1.92} \times 10^{-0.05 \log m}$ Method 2: A second correct step for correct use of the power log rule
	M1	**This line implies M1M1M1M1** Method 1: Correct removal of logs or $h = 10^{1.92} \times 10^{\log m^{-0.05}}$ Method 2: Log a (or a) and k correct
	A1	Allow h = awrt $83.2m^{-0.05}$ NB award 5/5 for a = awrt 83.2 and $k = -0.05$ or h = awrt $83.2...m^{-0.05}$ or $h = 10^{1.92} m^{-0.05}$

Q4.

Question	Scheme		Marks	AOs
(a)	$H_0 : \rho = 0 \qquad H_1 : \rho > 0$		B1	2.5
	Critical value 0.3438		M1	1.1a
	(0.446 > 0.3438) so there is evidence that the product moment correlation coefficient (pmcc) is greater than 0/there is positive correlation		A1	2.2b
			(3)	
(b)	The value is close(r) to 1 **or** there is strong(er) (positive) correlation		B1	2.4
			(1)	
(c)	$\log_{10} y = -1.82 + 0.89(\log_{10} x)$	$y = ax^n \rightarrow$ $\log_{10} y = \log_{10}(ax^n)$	M1	1.1b
	$y = 10^{-1.82+0.89(\log_{10} x)}$	$\log_{10} y = \log_{10} a + \log_{10} x^n$	M1	2.1
	$y = 10^{-1.82} \times 10^{0.89(\log_{10} x)}$ $[= 10^{-1.82} \times 10^{(\log_{10} x)^{0.89}}]$	$\log_{10} y = \log_{10} a + n\log_{10} x$ $[\log_{10} a = -1.82, n = 0.89]$	M1	1.1b
	$y = 0.015x^{0.89}$	$y = 0.015x^{0.89}$	A1A1	1.1b 1.1b
			(5)	
				(9 marks)

Notes	
(a)	**B1:** for both hypotheses correct in terms of ρ **M1:** for the critical value: sight of 0.3438 or any cv such that $0.25 < \|cv\| < 0.45$ **A1:** a comment suggesting a significant result/ H_0 is rejected on the basis of seeing +0.3438 **and** which mentions "pmcc/correlation/relationship" and "greater than 0/positive" (not just $\rho > 0$) or an answer in context e.g. 'as "income"(o.e.) increases, "CO_2/emissions"(o.e.) increases' A **contradictory** statement scores A0 e.g. 'Accept H_0, therefore positive correlation'
(b)	**B1:** for suitable reason e.g. r is close(r) to 1 or "strong(er)"/"near perfect" "correlation" Do not allow 'association'
(c)	**For both methods, once an M0 is scored, no further marks can be awarded and condone missing base 10 throughout** **Method 1: (working to the model)** **M1:** Correct substitution for both c and m (may be implied by 2nd M1 mark) **M1:** Making y the subject to give an equation in the form $y = 10^{a+b(\log_{10} x)}$ (may be implied by 3rd M1 mark) **M1:** Correct multiplication to give an equation in the form $y = 10^a \times 10^{b(\log_{10} x)}$ (this line implies M1M1M1 provided no previous incorrect working seen) **Method 2: (working from the model)** **M1:** Taking the log of both sides (may be implied by 2nd M1 mark) **M1:** Correct use of addition rule (may be implied by 3rd M1 mark) **M1:** Correct multiplication of power (this line implies M1M1M1 provided no previous incorrect working seen) **A1:** $n = 0.89$ **or** $a =$ awrt 0.015 **or** $y = ax^{0.89}$ **or** $y =$ awrt$0.015x^n$ **(dep on M3)** **A1:** $n = 0.89$ **and** $a =$ awrt 0.015 / $y =$ awrt$0.015x^{0.89}$ **(dep on M3)** do not award the final A1 if answer is given in an incorrect form e.g $y = 0.015 + x^{0.89}$

Q5.

Qu	Scheme	Marks	AO
(a)	$H_0 : \rho = 0$ $H_1 : \rho < 0$	B1	2.5
	Critical value: -0.6215 (Allow any cv in range $0.5 < \|cv\| < 0.75$)	M1	1.1a
	$r < -0.6215$ so significant result and there is evidence of a negative correlation between w and t	A1	2.2b
		(3)	
(b)	e.g. As temperature increases people spend more time on the beach and less time shopping (o.e.)	B1	2.4
		(1)	
(c)	Since r is close to -1, it is consistent with the suggestion	B1	2.4
		(1)	
(d)	t will be the explanatory variable since sales are likely to depend on the temperature	B1	2.4
		(1)	
(e)	Every degree rise in temperature leads to a drop in weekly earnings of £171	B1	3.4
		(1)	
		(7 marks)	

	Notes
(a)	B1 for both hypotheses in terms of ρ M1 for the critical value: sight of ± 0.6215 or any cv such that $0.5 < \|cv\| < 0.75$ A1 must reject H_0 on basis of comparing -0.915 with -0.6215 (if $-0.915 < 0.6215$ is seen then A0 but may use $\|r\|$ o.e. which is fine) and mention "negative", "correlation/relationship" and at least "w" and "t"
(b)	B1 for a suitable reason to explain negative correlation using the context given. e.g. "As temperature drops people are more likely to go shopping (than to the beach)" e.g. "As temperature increases people will be outside rather than in shops" A mere description in context of negative correlation is B0 SO e.g. "As temperature increases people don't want to go shopping/buy clothes" is B0 e.g. "Less clothes needed as temp increases" is B0
(c)	B1 for a suitable reason e.g. "strong"/"significant"/"near perfect" "correlation", $\|r\|$ close to 1 and saying it is consistent with the suggestion. Allow "yes" followed by the reason.
(d)	B1 For identifying t and giving a suitable reason. Need idea that "w depends on t" or "w responds to t" or "t affects w" (o.e.) Allow t (temperature) affects the other variable etc Just saying "t is the independent variable" or "t explains change in w" is B0 N. B. Suggesting causation is B0 e.g. "t causes w to decrease"
(e)	B1 for a description that conveys the idea of rate per degree Celsius. Must have 171, condone missing "£" sign.

Q6.

Question	Scheme	Marks	AOs
(a)	e.g. It requires extrapolation so will be unreliable (o.e.)	B1	1.2
		(1)	
(b)	e.g. Linear association between w and t	B1	1.2
		(1)	
(c)	H_0: $\rho = 0$ H_1: $\rho > 0$	B1	2.5
	Critical value 0.5822	M1	1.1a
	Reject H_0		
	There is evidence that the product moment correlation coefficient is greater than 0	A1	2.2b
		(3)	
(d)	Higher $\bar{t}$ suggests overseas and not Perth…lower wind speed so perhaps not close to the sea so suggest **Beijing**	B1	2.4
		(1)	
			(6 marks)

Notes:

(a)
B1: for a correct statement (unreliable) with a suitable reason

(b)
B1: for a correct statement

(c)
B1: for both hypotheses in terms of ρ
M1: for selecting a suitable 5% critical value compatible with their H_1
A1: for a correct conclusion stated

(d)
B1: for suggesting Beijing with some supporting reason based on t or w
Allow Jacksonville with a reason based just on higher $\bar{t}$