

Qu	Scheme	Marks	AO
3. (a)	Systematic (sampling)	B1 (1)	1.2
(b)(i)	[Daily Mean] Wind Speed	B1	2.2a
(ii)	Light	B1 (2)	1.2
(c)	Variable A occurs most (around 80~90%) of the time	B1 (1)	2.2b
Notes			
(a)	B1 for identifying the correct sampling technique Allow slight misspelling e.g. “sysmatic”, “sytmatic” Do NOT allow “systemic”		
(b)(i)	B1 for identifying appropriate qualitative variable. {LDS mark} Allow “Wind speed” or “Wind strength” but NOT just “wind” or “wind direction”		
(ii)	B1 for realising that modal wind speed is “Light” {LDS mark} Allow just “light” or “most light”		
NB	These two B marks are independent so can score B0B1 for e.g. “rainfall” and “light”		
(c)	B1 for inferring that frequency of A can be estimated fairly reliably: {underestimates B and over estimates C} e.g. “A is the most frequent” [can then ignore comments about B and C]		

Qu 3	Scheme	Marks	AO
(a)	Hectopascal <u>or</u> hPa	B1 (1)	1.2
(b)	$\bar{x} = \bar{y} + 1010$ <u>or</u> $\frac{214}{30} + 1010$ $= 1017.1333\dots$ awrt 1017	M1 A1 (2)	1.1b 1.1b
(c)	$\sigma_x = \sigma_y$ (or statement that standard deviation is not affected by this type of coding) $[\sigma_y =] \sqrt{\frac{5912}{30} - ("7.13[33\dots]")^2}$ <u>or</u> $\sqrt{146.1822\dots}$ $= 12.0905\dots$ awrt 12.1	M1 M1 A1 (3)	3.1b 1.1b 1.1b
(d)	High pressure (since approx. mean + sd) so clockwise Locations are (from North to South): Leuchars, Heathrow, Hurn Wind direction is direction wind blows <u>from</u> So: Heathrow (NE) Hurn (E) Leuchars (W)	B1 B1 (2)	2.4 2.2a
		(8 marks)	
Notes			
FYI	1 hPa = 100 Pa; 10hPa = 1 kPa; 1Pa = 1 Nm ⁻²		
(a)	B1 for “hectopascal” <u>or</u> hPa (condone pascals, allow millibars <u>or</u> mb) o.e. Do NOT allow kPa <u>or</u> kilopascals <u>or</u> Pa on its own		
(b)	M1 for a strategy to find \bar{x} Allow an attempt to find $\sum x$ that gets as far as $\sum x = \sum y + 30 \times 1010 [= 30\ 514]$ A1 for awrt 1017 (accept 1020) [Ignore incorrect units]		
(c)	1 st M1 for an overall strategy using the fact $\sigma_x = \sigma_y$ (can be implied by correct <u>final</u> ans) <u>or</u> for $\sum x = 30\ 514$ and $\sum x^2 = 31\ 041\ 192$ (both seen and correct) 2 nd M1 for a correct expression (with $\sqrt{\quad}$) (ft their \bar{y} to 3sf) allow awrt 146 for 146.1822.. <u>or</u> for correct expression in x can ft their $\sum x > 30\ 000$ or their answer to (b) A1 (dep on 2 nd M1) for awrt 12.1 [Ignore incorrect units]		
Final answer	Final ans of awrt 12.1 scores 3/3 but if they then adjust for x e.g. add 1010 (M0M1A1)		
(d)	1 st B1 for at least one of these reasons (these 2 lines) clearly stated (may see diagram) Need “high pressure” and “clockwise” to score on 1 st line Contradictory statements B0 e.g. correct N~S list but say “anticlockwise” 2 nd B1 (indep of 1 st B1) for deducing the 3 correct directions either in the table or stated as above If the answers in table and text are different we take the table (as question says)		

Section A: STATISTICS

Qu 1	Scheme										Marks	AO
(a)	c	0	1	2	3	4	5	6	7	8	B1	1.2
	$P(C = c)$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$	B1ft	1.2
(b)	$P(C < 4) = \frac{4}{9}$ (accept 0.444 or better)										(2)	
(c)	Probability lower than expected suggests model is <u>not</u> good										B1	3.4
(d)	e.g. Cloud cover will vary from month to month and place to place So e.g. use a non-uniform distribution										(1)	
											B1ft	3.5a
											(1)	
											B1	3.5c
											(1)	
											(5 marks)	
Notes												
(a)	1 st B1 for a correct set of values for c . Allow $\{\frac{1}{8}, \frac{2}{8}, \dots, \frac{8}{8}\}$ 2 nd B1ft for correct probs from their values for c , consistent with discrete uniform distrib'n Maybe as a prob. function. Allow $P(X = x) = \frac{1}{9}$ for $0 \leq x \leq 8$ provided $x = \{0, 1, 2, \dots, 8\}$ is clearly defined somewhere.											
(b)	B1 for using correct model to get $\frac{4}{9}$ (o.e.)											
SC	Sample space {1, ..., 8} If scored B0B1 in (a) for this allow $P(C < 4) = \frac{3}{8}$ to score B1 in (b)											
(c)	B1ft for comment that states that the model proposed is or is not a good one based on their model in part (a) and their probability in (b) (b) – 0.315 > 0.05 Allow e.g. “it is not suitable”; “it is not accurate” etc (b) – 0.315 ≤ 0.05 Allow a comment that suggests it <u>is</u> suitable No prob in (b) Allow a comparison that mentions 50% or 0.5 and rejects the model No prob in (b) and no 50% or 0.5 or (b) > 1 scores B0 Ignore any comments about location or weather patterns.											
(d)	B1 for a sensible refinement considering variations in month or location Just saying “not uniform” is B0 Context & “non-uniform” Allow mention of different locations, months <u>and</u> non-uniform <u>or</u> use more locations to form a new distribution with probabilities based on frequencies Context & “binomial” Allow mention of different locations, months <u>and</u> binomial Just refined model Model must be outlined and discrete and non-uniform e.g. higher probabilities for more cloud cover <u>or</u> lower probabilities for less cloud cover Continuous model Any model that is based on a continuous distribution. e.g. normal is B0											

Question	Scheme	Marks	AOs	
2(a)	IQR = 26.6 – 19.4 [= 7.2]	B1	2.1	
	19.4 – 1.5 × ‘7.2’ [= 8.6] or 26.6 + 1.5 × ‘7.2’ [= 37.4]	M1	1.1b	
	Plotting one upper whisker to 32.5 and one lower whisker to 8.6 or 9.1	A1	1.1b	
	Plotting 7.6 and 8.1 as the only two outliers	A1	1.1b	
		(4)		
(b)	<u>October</u> (since it is the month with the coldest temperatures between May and October in Beijing)	B1	2.4	
		(1)		
(c)	$[\sigma =] \sqrt{\frac{4952.906}{184}}$ or e.g. $[\sigma =] \sqrt{\frac{S_{xx}}{n}} = 5.188\dots$ [=5.19*]	B1cso*	1.1b	
		(1)		
(d)	$z = (\pm) 1.28(16)$	$[P_{90} =]29.251\dots$ or $[P_{10} =]15.948\dots$	B1	3.1b
	$2 \times 1.2816 \times 5.19$	‘29.251...’ – ‘15.948...’	M1	1.1b
		= awrt 13.3	A1	1.1b
			(3)	
(e)	Daily mean <u>wind speed</u> /Beaufort conversion since it is <u>qualitative</u> <u>Rainfall</u> since it is not symmetric/lots of days with 0 rainfall	B1 B1	2.4 2.4	
		(2)		
(11 marks)				
Notes				
(a)	B1: for a correct calculation for the IQR (implied by 10.8 or 8.6 or 37.4 seen)			
	M1: for a complete method for either lower outlier limit or upper outlier limit (allow ft on their IQR) (may be implied by the 1 st A1 or a lower whisker at 8.6)			
(c)	A1: both whiskers plotted correctly (allow ½ square tolerance)			
	A1: only two outliers plotted, 7.6 and 8.1 (must be disconnected from whisker)			
(d)	NOTE: A fully correct box plot with no incorrect working scores 4/4			
	B1cso*: Correct expression with square root or correct formula and 5.188 or better			
(e)	Allow a complete correct method finding $\sum x^2 = \text{awrt } 98720$ and $\sigma = \sqrt{\frac{98715.9\dots}{184} - \left(\frac{4153.6}{184}\right)^2}$			
	B1: Identifying z-value for 10th or 90th percentile (allow awrt (±) 1.28) or for identifying $[P_{90} =]29.251\dots$ (awrt 29.3) or $[P_{10} =]15.948\dots$ (awrt 15.9) (This may be implied by a correct answer awrt 13.3)			
(d)	M1: for $2 \times z \times 5.19$ where $1 < z < 2$ or for their $P_{90} - P_{10}$ where $25 < P_{90} < 35$ and $10 < P_{10} < 20$			
	A1: awrt 13.3			
(e)	B1: for one variable identified and a correct supporting reason			
	B1: for two variables identified and a correct supporting reason for each			
(e)	Allow any two of the following:			
	<ul style="list-style-type: none"> • <u>Wind speed/Beaufort</u> since the data is <u>non-numeric</u> (o.e.). They need not mention Beaufort provided there is a description of the data as non-numeric (Do not allow wind direction/wind gust) • <u>Rainfall</u> as not symmetric/is skewed/is not bell shaped/lots of 0s /many days with no rain/mean≠mode or median • <u>Date</u> since each data value appears once/it is uniformly distributed • Daily mean <u>pressure</u> since it is not symmetric/is skewed/not bell shaped • Daily mean <u>wind speed</u> since it is not symmetric/is skewed/not bell shaped 			
Do not allow ‘not continuous’ or ‘discrete’ as a supporting reason. Ignore extraneous non-contradicting statements				

Question	Scheme	Marks	AOs
4 (a)	$\frac{132}{184} = 0.71739\dots$ awrt <u>0.717</u>	B1	1.1b
		(1)	
(b)(i)	$P(X \geq 6) = 1 - P(X \leq 5)$ or $P([X =]6) + P([X =]7) + P([X =]8)$	M1	3.4
	$= 1 - 0.296722\dots$ awrt <u>0.703</u>	A1	1.1b
(b)(ii)	$184 \times P(X = 7)$ [= $184 \times 0.2811\dots$]	M1	1.1b
	$= 51.7385\dots$ awrt <u>51.7</u>	A1	1.1b
(c)	Part (a) and part (b)(i) are similar and the expected number of 7s (51.7 or 0.281) matches with the number of 7s found in the data set (52 or 0.283) so Magali's model is supported.	B1ft	3.5a
		(1)	
(d)	$\frac{23}{28} = 0.82142\dots$ awrt <u>0.821</u>	B1	1.1b
		(1)	
(e)	Any one of... <ul style="list-style-type: none"> Part (d)/'0.821' differs from part (a)/(b)(i)/(0.7...) there is a greater/different probability of high cloud cover/more likely to have high cloud cover if the previous day had high cloud cover independence(o.e.) does not hold 	B1	2.4
	...therefore Magali's (binomial) model may not be suitable.	dB1	3.5a
		(2)	
(9 marks)			
Notes			
Allow fractions, decimals or percentages throughout this question.			
(a)	Allow equivalent fraction, e.g. $\frac{33}{46}$		
(b)(i)	M1: for writing or using $1 - P(X \leq 5)$ or $P(X = 6) + P(X = 7) + P(X = 8)$ A1: awrt 0.703 (correct answer scores 2 out of 2)		
(b)(ii)	M1: for $184 \times P(X = 7)$ o.e. e.g., $184 \times [P(X \leq 7) - P(X \leq 6)]$ A1: awrt 51.7		
(c)	B1ft: comparing '0.717' with '0.703' and '51.7 or '0.281' with 52 or 0.283 and concluding that Magali's model is supported (must be comparing prob. with prob. <u>and</u> days with days). Allow not supported or mixed conclusions if consistent with their f.t. answers in (a) and (b)		
(e)	B1: Any bullet point dB1: (dep on previous B1) for Magali's model may not be suitable (o.e.) Condone not accurate for not suitable SC: part (d) is similar to part (a)/(b)(i) and a compatible conclusion (i.e. Magali's model is supported) to score B1B1.		

Qu 2	Scheme	Marks	AO
(a)	Negative	B1 (1)	1.2
(b)(i)	Rainfall	B1	2.2b
(ii)	mm <u>or</u> Pressure hPa or Pascals or hectopascals or mb or millibars	B1ft (2)	1.1b
(c)	$H_0 : \rho = 0$ $H_1 : \rho \neq 0$ Critical value: $-0.361(0)$ $r < -0.3610$ so significant result and there is evidence of a correlation between Daily Total <u>Sunshine</u> and Daily Maximum Relative <u>Humidity</u>	B1 M1 A1 (3)	2.5 1.1b 2.2b
(d)	Humidity is high and there is evidence of correlation and $r < 0$ So expect amount of sunshine to be <u>lower</u> than the <u>average</u> 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” <u>or</u> “precipitation”) <u>or</u> “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 <u>or</u> 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 <u>belief</u> ”(o.e.e.g. “claim”) or “evidence of a correlation between <u>sunshine</u> and <u>humidity</u> ” condone “negative correlation” or comments such as “if humidity is high amount of sunshine will be low”		
(d)	B1 for stating <u>low</u> amount of sunshine (o. e.) and some reference to $r < 0$ or fog Check for the following 2 features: (i) low sunshine: allow ≤ 5 hrs (LDS mean for 2015 is 5.3, humidity 97% is 4.1, $\geq 97\%$ is 3.1) (ii) negative correlation may be described in words e.g. “high humidity gives low sunshine” <u>or</u> fog (LDS says $>95\%$ humidity is foggy) so less sunshine		

Paper 3: Statistics and Mechanics Mark Scheme

Question	Scheme	Marks	AOs
1(a)	Area = $8 \times 1.5 = 12 \text{ cm}^2$ Frequency = 8 so $1 \text{ cm}^2 = \frac{2}{3} \text{ hour (o.e.)}$	M1	3.1a
	Frequency of 12 corresponds to area of 18 so height = $18 \div 2.5 = 7.2 \text{ (cm)}$	A1	1.1b
	Width = $5 \times 0.5 = 2.5 \text{ (cm)}$	B1cao	1.1b
		(3)	
(b)	$[\bar{y} =] \frac{205.5}{31} = \text{awrt } 6.63$	B1cao	1.1b
	$[\sigma_y =] \sqrt{\frac{1785.25}{31} - \bar{y}^2} = \sqrt{13.644641} = \text{awrt } 3.69$	M1	1.1a
	allow $[s =] \sqrt{\frac{1785.25 - 31\bar{y}^2}{30}} = \text{awrt } 3.75$	A1	1.1b
		(3)	
(c)	Mean of Heathrow is higher than Hurn and standard deviation smaller suggesting Heathrow is more reliable	M1	2.4
	Hurn is South of Heathrow so does <u>not</u> support his belief	A1	2.2b
		(2)	
(d)	$\bar{x} + \sigma \approx 10.3$ so number of days is e.g. $\frac{(11 - "10.3")}{3} \times 8 (+5)$	M1	1.1b
	= 6.86 so 7 days	A1	1.1b
		(2)	
(e)	$[H = \text{no. of hours}] \quad P(H > 10.3) \text{ or } P(Z > 1) = [0.15865\dots]$	M1	3.4
	Predict $31 \times 0.15865\dots = \underline{\underline{4.9 \text{ or } 5 \text{ days}}}$	A1	1.1b
		(2)	
(f)	(5 or) 4.9 days < (7 or) 6.9 days so model may not be suitable	B1	3.5a
		(1)	
			(13 marks)

Question	Scheme	Marks	AOs
2(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}		