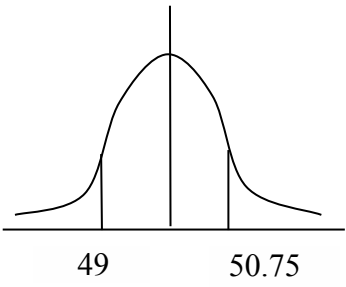


Paper 3: Statistics and Mechanics Mark Scheme

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 1 continued**Notes:****(a)****M1:** for clear attempt to relate the area to frequency. Can also award if their height \times their width = 18**A1:** for height = 7.2 (cm)**(b)****M1:** for a correct expression for σ or s , can ft their value for mean**A1:** awrt 3.69 (allow $s = 3.75$)**(c)****M1:** for a suitable comparison of standard deviations to comment on reliability.**A1:** for stating Hurn is south of Heathrow and a correct conclusion**(d)****M1:** for a correct expression – ft their $\bar{x} + \sigma \approx 10.3$ **A1:** for 7 days but accept 6 (rounding down) following a correct expression**(e)****M1:** for a correct probability attempted**A1:** for a correct prediction**(f)****B1:** for a suitable comparison and a compatible conclusion

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}			

Question	Scheme	Marks	AOs
Q3(a)			
	$P(L > 50.98) = 0.025$	B1cao	3.4
	$\therefore \frac{50.98 - \mu}{0.5} = 1.96$	M1	1.1b
	$\therefore \mu = 50$	A1cao	1.1b
	$P(49 < L < 50.75)$	M1	3.4
	$= 0.9104\dots$ awrt 0.910	A1ft	1.1b
		(5)	
(b)	$S =$ number of strips that cannot be used so $S \sim B(10, 0.090)$	M1	3.3
	$= P(S \leq 3) = 0.991166\dots$ awrt 0.991	A1	1.1b
		(2)	
(c)	$H_0 : \mu = 50.1$ $H_1 : \mu > 50.1$	B1	2.5
	$\bar{X} \sim N\left(50.1, \frac{0.6^2}{15}\right)$ and $\bar{X} > 50.4$	M1	3.3
	$P(\bar{X} > 50.4) = 0.0264$	A1	3.4
	$p = 0.0264 > 0.01$ or $z = 1.936\dots < 2.3263$ and not significant	A1	1.1b
	There is insufficient evidence that the mean length of strips is greater than 50.1	A1	2.2b
		(5)	
(12 marks)			

Question 3 continued**Notes:****(a)****1st M1:** for standardizing with μ and 0.5 and setting equal to a z value ($|z| > 1$)**2nd M1:** for attempting the correct probability for strips that can be used**2nd A1ft:** awrt 0.910 (allow ft of their μ)**(b)****M1:** for identifying a suitable binomial distribution**A1:** awrt 0.991 (from calculator)**(c)****B1:** hypotheses stated correctly**M1:** for selecting a correct model (stated or implied)**1st A1:** for use of the correct model to find $p =$ awrt 0.0264 (allow $z =$ awrt 1.94)**2nd A1:** for a correct calculation, comparison and correct statement**3rd A1:** for a correct conclusion in context mentioning “mean length” and 50.1

Question	Scheme	Marks	AOs
4(a)	$P(A' B') = \frac{P(A' \cap B')}{P(B')} \text{ or } \frac{0.33}{0.55}$	M1	3.1a
	$= \frac{3}{5} \text{ or } 0.6$	A1	1.1b
		(2)	
(b)	e.g. $P(A) \times P(B) = \frac{7}{20} \times \frac{9}{20} = \frac{63}{400} \neq P(A \cap B) = 0.13 = \frac{52}{400}$ or $P(A' B') = 0.6 \neq P(A') = 0.65$	B1	2.4
		(1)	
(c)		B1	2.5
		M1	3.1a
		A1	1.1b
		M1	1.1b
		A1	1.1b
(d)	$P(B \cup C)' = 0.22 + 0.22 \text{ or } 1 - [0.56]$ or $1 - [0.13 + 0.23 + 0.09 + 0.11]$	M1	1.1b
	$= 0.44$	A1	1.1b
		(2)	
(10 marks)			
Notes:			
(a) M1: for a correct ratio of probabilities formula and at least one correct value. A1: a correct answer			
(b) for a fully correct explanation: correct probabilities and correct comparisons.			
(c) B1: for box with B intersecting A and C but C not intersecting A . (Or accept three intersecting circles, but with zeros entered for $A \cap C$ and $A \cap B \cap C$) No box is B_0 M1: for method for finding $P(B \cap C)$ A1: for 0.09 M1: for 0.13 and their 0.09 in correct places and method for their 0.23 A1: fully correct			
(d) M1: for a correct expression – fit their probabilities from their Venn diagram. A1: cao			

Question	Scheme	Marks	AOs
5 (a)	The seeds would be destroyed in the process so they would have none to sell	B1	2.4
		(1)	
(b)	$[S = \text{no. of seeds out of 24 that germinate, } S \sim B(24, 0.55)]$		
	$T = \text{no. of trays with at least 15 germinating. } T \sim B(10, p)$	M1	3.3
	$p = P(S \geq 15) = 0.299126\dots$	A1	1.1b
	So $P(T \geq 5) = 0.1487\dots$ awrt <u>0.149</u>	A1	1.1b
		(3)	
(c)	n is large and p close to 0.5	B1	1.2
		(1)	
(d)	$X \sim N(132, 59.4)$	B1	3.4
	$P(X \geq 149.5) = P\left(Z \geq \frac{149.5 - 132}{\sqrt{59.4}}\right)$	M1	1.1b
	$= 0.01158\dots$ awrt <u>0.0116</u>	A1cso	1.1b
		(3)	
(e)	e.g The probability is very small therefore there is evidence that the company's claim is incorrect.	B1	2.2b
		(1)	
(9 marks)			
Notes:			
(a) B1: cao			
(b) M1: for selection of an appropriate model for T 1st A1: for a correct value of the parameter p (accept 0.3 or better) 2nd A1: for awrt 0.149			
(c) B1: both correct conditions			
(d) B1: for correct normal distribution M1: for correct use of continuity correction A1: cso			
(e) B1: correct statement			