Q	Scheme	Marks	AOs	Pearson Progression Step and Progress Descriptor
1a	$X \sim \text{Po}(5)$	**B1**	3.3	3rd Use the Poisson distribution to model real-world situations
		(1)		
1b	$H_0: \lambda = 5$	**B1**	2.5	3rd Understand the language of hypothesis testing
	$H_1: \lambda < 5$	**B1**	2.5	
		(2)		
1c	$P(X \leqslant 2)$	**M1**	1.1b	4th Carry out one-tailed tests for the mean of a Poisson distribution
	$= 0.1247$	**A1**	1.1b	
	$0.1247 > 0.05$ so do not reject H_0. There is no evidence at the 5% level of significance that the number of drivers caught speeding has reduced.	**A1**	2.2b	
		(3)		
				(6 marks)

Notes

1a **B1** for $X \sim \text{Po}(5)$ (Do not allow $\lambda = 5$ on its own)

1b **B1** for $\lambda = 5$ (accept $\mu = 5$)

B1 for $\lambda < 5$ (accept $\mu < 5$)

1c **M1** for writing or using $P(X \leqslant 2)$ or an attempt to find the critical region

A1 for awrt 0.125 or critical region $X \leqslant 1$

A1 for a correct conclusion in context

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress Descriptor
2a	$X \sim \text{Po}(0.25)$	**B1**	3.3	3rd Use the Poisson distribution to model real-world situations
		(1)		
2b	Distribution is $Y \sim \text{Po}(1)$	**B1**	3.3	5th Carry out two-tailed tests for the mean of a Poisson distribution
	$H_0: \lambda = 0.25$; $H_1: \lambda \neq 0.25$	**B1**	2.5	
	P(at least 4 breakdowns) = $1 - P(Y \leqslant 3)$	**M1**	1.1b	
	$= 0.0190$	**A1**	1.1b	
	$0.0190 < 0.025$ therefore reject H_0. There is evidence to suggest that the figure quoted on the website is incorrect.	**A1**	2.2b	
		(5)		
				(6 marks)

Notes

2a **B1** for $X \sim \text{Po}(0.25)$ (Do not allow $\lambda = 0.25$ on its own)

2b **B1** for stating or implying new distribution with $\lambda = 1$

B1 for $\lambda = 0.25$ (accept $\mu = 0.25$ and parameter of 1) and for $\lambda < 5$ (accept $\mu < 5$ and parameter of 1)

M1 for writing or using $P(Y \leqslant 3)$ or an attempt to find the critical region

A1 for awrt 0.019 or critical region $Y \geqslant 4$

A1 for a correct conclusion in context

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress Descriptor
3a	$Y \sim \text{Po}(200 \times 0.2) = Y \sim \text{Po}(4)$	**B1** **B1**	3.3 2.5	6th Use the Poisson distribution as an approximation to the binomial distribution
	Suitable since n is large and p is small.	**B1**	2.4	
		(3)		
3bi	$P(Y = 3) = 0.1954$	**B1**	1.1b	2nd Understand the basics of the Poisson distribution
		(1)		
3bii	$P(Y \geqslant 6) = 1 - P(Y \leqslant 5)$	**M1**	1.1b	2nd Understand the basics of the Poisson distribution
	$= 0.2149$	**A1**	1.1b	
		(2)		
3c	$H_0: \lambda = 4$; $H_1: \lambda > 4$	**B1**	2.5	4th Carry out one-tailed tests for the mean of a Poisson distribution
	$0.2149 > 0.1$	**M1**	1.1b	
	Therefore do not reject H_0. There is no evidence to suggest that the change in supplier has increased the number of imperfections.	**A1**	2.2b	
		(3)		
				(9 marks)

Notes	
3a	**B1** for 'Poisson' and **B1** for correct λ and correct format, accept any letter for the random variable
	B1 for reason that must include both parts
3bi	**B1** for awrt 0.195 (**ft** *their* λ)
3bii	**M1** for writing or using P($Y \geqslant 6$)
	A1 for awrt 0.215 (**ft** *their* λ)
3c	**B1** for $\lambda = 4$ (accept $\mu = 4$) and for $\lambda > 4$ (accept $\mu > 4$) (**ft** *their* λ)
	M1A1ft *their* **3bii** if consistent and conclusion correct and in context

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress Descriptor
4a	Distribution is $X \sim \text{Po}(7.5)$	**B1**	3.3	4th Carry out one-tailed tests for the mean of a Poisson distribution
	$P(X \leqslant 2) = 0.0203$ $P(X \leqslant 3) = 0.0591$	**M1**	1.1b	
	Hence critical region is $X \leqslant 3$ faults.	**A1**	2.2b	
		(3)		
4b	Actual significance level is 5.91%	**B1**	2.2b	3rd Understand the language of hypothesis testing
		(1)		
4c	2 lies in the critical region…	**M1**	1.1a	4th Carry out one-tailed tests for the mean of a Poisson distribution
	…therefore evidence to suggest average fault rate is less than 0.15 per metre.	**A1**	2.2b	
		(2)		
				(6 marks)

Notes

4a **B1** for $\lambda = 7.5$, seen or implied

M1 for either probability correct for *their* λ

A1 awarded with *evidence*, i.e. both probabilities calculated

4b **B1ft** *their* **4a** if consistent and A1 awarded

4c **M1A1ft** *their* critical region if consistent and conclusion correct and in context

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress Descriptor
5	From tables: $P(Y \leqslant 3) = 0.0424$ when $\lambda = 8$ $P(Y \leqslant 3) = 0.0212$ when $\lambda = 9$	**M1**	1.1b	5th Carry out two-tailed tests for the mean of a Poisson distribution
	Hence $\lambda = 9$	**A1**	2.2b	
	$P(Y \geqslant 16) = 0.0220$	**M1**	1.1a	
	$0.0212 + 0.0220$	**M1**	1.1b	
	$= 0.0432$	**A1**	1.1b	
				(5 marks)

Notes

1st **M1** for either value found correctly from tables

A1 awarded if *evidence*, i.e. both values found

2nd **M1** for attempt to find $P(Y \geqslant 16)$ for *their* λ

3rd **M1** (indep) for adding *their* probabilities

A1ft *their* two probabilities if consistent, added and both less than 0.025

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress Descriptor
6a	$X \sim \text{Geo}(0.3)$	**B1**	3.3	5th Use the geometric distribution to model real-world situations
	The probability of success is constant; the attempts are independent (both required).	**B1**	3.5b	
		(2)		
6bi	$P(X = 5) = 0.3 \times 0.7^4$	**M1**	1.1b	4th Understand the basics of the geometric distribution
	$=0.0720$	**A1**	1.1b	
		(2)		
6bii	$P(X \leqslant 6) = 1 - (0.7)^6$	**M1**	1.1b	4th Understand the basics of the geometric distribution
	$= 0.8824$	**A1**	1.1b	
		(2)		
6c	$H_0: p = 0.45$; $H_1: p < 0.45$	**B1**	2.5	8th Carry out hypothesis tests for the parameter p of the geometric distribution
	Assume $X \sim \text{Geo}(0.45)$	**M1**	3.3	
	$P(X \geqslant 8) = 0.55^7$	**M1**	1.1b	
	$= 0.0152$	**A1**	1.1b	
	$0.0152 < 0.05$ therefore reject H_0. There is evidence he is overstating the probability of success.	**A1**	2.2b	
		(5)		
				(11 marks)

Notes

6a **B1** for Geo(0.3) and **B1** for reasons (both required)

6bi **M1** for attempt to find P($X = 5$) using *their p*

A1 awrt 0.072

6bii **M1** for attempt to find P($X \leqslant 6$) using *their p*

A1 awrt 0.882

6c **B1** for both hypotheses stated correctly

M1 for Geo(0.45), seen or implied

M1 (indep) for attempt to find P($X \geqslant 8$)

A1 awrt 0.015

A1ft for correct conclusion in context (ft *their* probability if both M marks awarded)

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress Descriptor
7a	Distribution is Geo(0.25)	**B1**	3.3	8th Carry out hypothesis tests for the parameter p of the geometric distribution
	Require $P(X \geqslant c) < 0.1$	**M1**	3.1a	
	$0.75^{c-1} < 0.1$	**M1**	1.1a	
	$c - 1 > \dfrac{\ln 0.1}{\ln 0.75} = 8.0039\ldots$	**M1**	1.1b	
	Hence $c > 9.0039\ldots$ giving c.r. as $X \geqslant 10$	**A1**	2.2b	
		(5)		
7b	$P(X \geqslant 10) = (0.75)^9$	**M1**	1.1b	3rd Understand the language of hypothesis testing
	$= 0.0751$	**A1**	1.1b	
		(2)		
				(7 marks)

Notes

7a **B1** for correct distribution, seen or implied

1st **M1** for probability statement < 0.1

2nd **M1** for use of correct formula with index $c - 1$ or 'k'

3rd **M1** (indep) for attempt to solve equation using logs

A1 (cao) critical region must be an integer

7b **M1** for attempt to find $P(X \geqslant$ *their* critical value)

A1ft *their* critical value