

Question Number	Scheme		Marks
1(a)	[F(1) = 1 so] $k(6 \times 1^2 - 1^4) = 1$ leading to $k = \frac{1}{5}^*$		B1*
			(1)
(b)	$[1 - F(0.6) =] 1 - \frac{1}{5}(6 \times 0.6^2 - 0.6^4)$		M1
	= 0.59392 awrt 0.594		A1
			(2)
(c)(i)	$\frac{1}{5}(6m^2 - m^4) = \frac{1}{2}$		M1
	$2m^4 - 12m^2 + 5 = 0$ oe		A1
(ii)	$m = 0.6711\dots$ awrt 0.671		A1
			(3)
(d)	$\left[\frac{d}{dx} \left(\frac{6}{5}x^2 - \frac{1}{5}x^4 \right) \right] = \frac{12}{5}x - \frac{4}{5}x^3$		M1
	$\left[\frac{d}{dx} \left(\frac{12}{5}x - \frac{4}{5}x^3 \right) \right] = \frac{12}{5} - \frac{12}{5}x^2 = 0$		M1
	$x = 1$		A1
			(3)
(e)	Mean < “Median” < “Mode”		M1
	So negative [skew]		A1ft
			(2)
	Notes		Total 11
(a)	B1*	for use of F(1) = 1 leading to the given answer (minimum required is $k(6 - 1) = 1$) Allow use of F(1) – F(0) = 1 e.g. $k(6 - 1) - k(0 - 0) = 1$ The answer is given so no incorrect working can be seen	
(b)	M1	for using $1 - F(0.6)$ May be implied by $1 - \frac{1269}{3125}$ or $\frac{1856}{3125}$	
	A1	awrt 0.594 Allow $\frac{1856}{3125}$	
(c)(i)	M1	for setting F(m) = 0.5 Allow any letter (including x)	
	A1	for a correct 3TQ oe NB the values of a, b and c must be integers	
(ii)	A1	awrt 0.671 Allow $\sqrt{\frac{6 - \sqrt{26}}{2}}$ (must reject other roots if seen) NB It is possible to score M1A0A1	
(d)	M1	for differentiating F(x) with at least one $x^n \rightarrow x^{n-1}$ May be left in terms of k eg. $k(12x - 4x^3)$ Condone missing k	
	M1	for differentiating twice with at least one $x^n \rightarrow x^{n-1}$ and setting = 0 oe May be left in terms of k eg. $k(12 - 12x^2) = 0$ Condone missing k	
	A1	Cao (Must reject $x = -1$ if seen)	
(e)	M1	a correct justification using the Mean and their Median and/or their Mode. This must be correct for their values Allow use of figures e.g. $0.64 < “0.671” < “1”$ Allow comparisons of “median” and “mode” on its own. Comparison with 0.5 is M0 unless 0.5 is their median or mode	
	A1ft	a correct conclusion based on their comparison (Do not allow a conclusion that is not fully supported by their comparison)	

Question Number	Scheme		Marks
2(a)	Poisson with $\lambda = 10$		B1
			(1)
(b)	Customers [enter the shop] singly/randomly/independently/at a constant rate		B1
			(1)
(c)	$H_0 : \lambda = "10"$ $H_1 : \lambda \neq "10"$		B1ft
			(1)
(d)	$[P(X,, \mathbf{3}) =]$ awrt 0.0103 $[P(X,, \mathbf{4}) =]$ awrt 0.0293		M1
	$[P(X...17) =]$ awrt 0.0270 $[P(X...18) =]$ awrt 0.0143		M1
	$X,, \mathbf{3} \cup X...18$ oe		A1
			(3)
(e)	$0.0103 + 0.0143 = 0.0246$		M1
	So 2.46%		A1ft
			(2)
(f)	[16 is] not in the CR/Do not reject H_0 /Not significant		M1
	There is insufficient evidence to suggest that the rate/number/amount of customers entering the shop has changed /[is] different oe		A1ft
			(2)
	Notes		Total 10
(a)	B1	for Poisson/Po and $\lambda = 10$	
(b)	B1	for a correct assumption (must have context of customers/people) Ignore irrelevant or incorrect statements	
(c)	B1ft	both hypotheses correct. Must be correctly attached to H_0 and H_1 in terms of λ or μ ft part a Allow $H_0 : \lambda = 20$ $H_1 : \lambda \neq 20$	
(d)	M1	for use of Po(10) to find the lower critical value. May be implied by awrt 0.0103 or awrt 0.0293 or a correct lower critical region (These must be seen in part (d))	
	M1	for use of Po(10) to find the upper critical value. May be implied by awrt 0.027 or awrt 0.0143 or awrt 0.973 or awrt 0.9857 or a correct upper critical region (These must be seen in part (d))	
	A1	for a correct critical region oe e.g. $X < 4$ and $X > 17$ Allow $0 \leq x \leq 3$ and $18 \leq x \leq 20$ or $\{0, 1, 2, 3\}$ $\{18, 19, \dots\}$ Condone use of () or [] for {} Do not allow if written as probability statements Allow any letter. Accept $CR \leq 3$ $CR \geq 18$	
(e)	M1	for adding the probabilities for the 2 tails of their CR together May be implied by a correct answer	
	A1ft	awrt 0.0246 or ft their CR	
(f)	M1	dependent on having found a 2 tailed CR in part (d) for a correct statement (ft their 2 tailed CR) – no context needed but do not allow contradicting non contextual comments. May be implied by a correct contextual statement on its own. We ignore any comparison of numbers/probabilities	
	A1ft	correct conclusion in context (ft their 2 tailed CR). Must contain the words in bold oe. No hypotheses in part (c) then A0 Allow equivalent statements e.g. The mean rate has not changed /still 10	

Question Number	Scheme		Marks
3(a)	$np = 3$ and $np(1 - p) = 2.55$		M1
	$p = 0.15$ oe $n = 20$		A1 A1
			(3)
(b)	[B(40, 0.2) so] $E(X) = 8$		B1
	$[P(X > 8) =] 1 - P(X \leq 8)$		M1
	$= 0.4069$ Calc: 0.40687 ...	awrt 0.407	A1
			(3)
(c)(i)	[Po($n \times p$) =] Po(8)		M1
	$[P(X \leq 12) =] 1 - P(X \leq 11)$		M1
	$= 0.1119$ Calc: 0.11192	awrt 0.112	A1
	(ii) because n is large and p is small		B1
			(4)
	Notes		Total 10
(a)	M1	for both $np = 3$ and $np(1 - p) = 2.55$ Allow q to imply $1 - p$	
	A1	either $p = 0.15$ oe or $n = 20$	
	A1	both $p = 0.15$ oe and $n = 20$	
(b)	B1	for $E(X) = 8$ Condone $\mu/np = 8$ May be implied by $40 \times 0.2 = 8$ or $P(X > 8)$ or $1 - P(X \leq 8)$ or $P(X = 8)$	
	M1	for writing or using $1 - P(X \leq 8)$	
	A1	awrt 0.407 NB cao scores 3 out of 3	
(c)(i)	M1	for writing or using Po(8) May be implied by awrt 0.112 or 0.888	
	M1	for writing or using $1 - P(X \leq 11)$	
	A1	awrt 0.112 (NB exact binomial gives awrt 0.1004 and would score M0M1A0) NB cao scores 3 out of 3	
(ii)	B1	allow $n > 50$ and $p < 0.2$ or equivalent worded statements. Allow p is close to 0. Do not allow because mean $\approx$ variance. Ignore any reference to np and $np(1 - p)$	

Question Number	Scheme					Marks					
4(a)	3, 6, 9, 12					B1					
	$[P(\text{black})=]\frac{2}{7}$ and $[P(\text{white})=]\frac{5}{7}$					B1					
	$[P(X = 3)]=\left(\frac{5}{7}\right)^3$ or $[P(X = 12)]=\left(\frac{2}{7}\right)^3$					M1					
	$[P(X = 6)]=3\times\left(\frac{5}{7}\right)^2\times\frac{2}{7}$					M1					
	$[P(X = 9)]=3\times\frac{5}{7}\times\left(\frac{2}{7}\right)^2$					M1					
	<table><tr><td>X</td><td>3</td><td>6</td><td>9</td><td>12</td></tr><tr><td>P(X = x)</td><td>$\frac{125}{343}$ (0.3644...)</td><td>$\frac{150}{343}$ (0.4373...)</td><td>$\frac{60}{343}$ (0.1749...)</td><td>$\frac{8}{343}$ (0.0233...)</td></tr></table>	X	3	6	9	12	P(X = x)	$\frac{125}{343}$ (0.3644...)	$\frac{150}{343}$ (0.4373...)	$\frac{60}{343}$ (0.1749...)	$\frac{8}{343}$ (0.0233...)
X	3	6	9	12							
P(X = x)	$\frac{125}{343}$ (0.3644...)	$\frac{150}{343}$ (0.4373...)	$\frac{60}{343}$ (0.1749...)	$\frac{8}{343}$ (0.0233...)							
						(6)					
(b)	$\left(\frac{283}{343}\right)^n < 0.05$ oe					M1					
	$n > 15.57\dots$ or $n > \frac{\log(0.05)}{\log\left(\frac{283}{343}\right)}$ or $n > \log_{\left(\frac{283}{343}\right)}(0.05)$					dM1					
	$n = 16$					A1					
						(3)					
	Notes					Total 9					
(a)	B1	for all 4 possible outcomes and no extras									
	B1	for writing or using $\frac{5}{7}$ and $\frac{2}{7}$. May be implied by a correct probability for $P(X = 6)$ or $P(X = 9)$ or $P(X = 3)$ and $P(X = 12)$ Allow awrt 0.714 and awrt 0.286									
	M1	for p^3 where $0 < p < 1$ May be implied by $\frac{125}{343}$ or awrt 0.364 or $\frac{8}{343}$ or awrt 0.023									
	M1	for $3 \times p^2 \times (1 - p)$ where $0 < p < 1$ May be implied by $\frac{150}{343}$ or awrt 0.437 or $\frac{60}{343}$ or awrt 0.175									
	M1	for $3 \times p \times (1 - p)^2$ where $0 < p < 1$ May be implied by $\frac{150}{343}$ or awrt 0.437 and $\frac{60}{343}$ or awrt 0.175 or 4 probabilities that add to 1									
	A1	for all 4 probabilities correct and associated with the correct values. Need not be in a table but probabilities must be attached to the correct total. If decimals are used then they must be awrt 0.364, awrt 0.437, awrt 0.175 and awrt 0.023									
(b)	M1	for $\left(1 - \frac{60}{343}\right)^n < 0.05$ oe Condone $\neq \leq$ instead of $<$									
	dM1	Dependent on the previous M mark for $n > \text{awrt } 15.6$ or $n > \frac{\log(0.05)}{\log\left(\frac{283}{343}\right)}$ ft their $\frac{283}{343}$ or $n > \log_{\left(\frac{283}{343}\right)}(0.05)$ ft their $\frac{283}{343}$ or for the two trials between $n = 15$ and 16 Allow $=$ instead of $> / \geq$. Condone $< / \leq$									
	A1	cao (do not allow an inequality)									

Question Number	Scheme			Marks
5(a)	$\frac{2}{21} \int_0^k x \, dx +$ $\frac{2}{15} \int_k^6 (6-x) \, dx = 1$	$\frac{1}{2}(k-0) \times \frac{2}{21}k$ and $\frac{1}{2}(6-k) \times \frac{2}{15}(6-k)$	For $0 \leq x \leq k$ $F(x) = \frac{1}{21}x^2$	M1
	$\frac{2}{21} \left[\frac{x^2}{2} \right]_0^k +$ $\frac{2}{15} \left[6x - \frac{x^2}{2} \right]_k^6 [=1]$	$\frac{1}{2}(k-0) \times \frac{2}{21}k +$ $\frac{1}{2}(6-k) \times \frac{2}{15}(6-k) = 1$	For $k < x \leq 6$ $F(x) = \frac{2}{15} \left(6x - \frac{x^2}{2} \right) - \frac{7}{5}$ oe	M1
	$\frac{1}{21}k^2 +$ $\frac{2}{15} \left(18 - \left(6k - \frac{k^2}{2} \right) \right) [=1]$	$\frac{1}{21}k^2 +$ $\frac{1}{15}(36 - 12k + k^2) [=1]$ oe	$\frac{1}{21}x^2 = \frac{2}{15} \left(6x - \frac{x^2}{2} \right) - \frac{7}{5}$	dM1
	$4k^2 - 28k + 49 = 0$ oe			dM1
	e.g. $(2k - 7)^2 = 0$ leading to $k = 3.5$ *			A1*
				(5)
(b)	$E(X) = \frac{2}{21} \int_0^{3.5} x^2 \, dx + \frac{2}{15} \int_{3.5}^6 (6x - x^2) \, dx$			M1
	$\frac{2}{21} \left[\frac{x^3}{3} \right]_0^{3.5} + \frac{2}{15} \left[3x^2 - \frac{x^3}{3} \right]_{3.5}^6$			dM1
	$\frac{2}{21} \left(\frac{343}{24} \right) + \frac{2}{15} \left(36 - \left(\frac{147}{4} - \frac{343}{24} \right) \right) = \frac{19}{6}$			dM1A1
				(4)
(c)	$\text{Var}(X) = \frac{277}{24} - \left(\frac{19}{6} \right)^2 = \frac{109}{72}$			M1A1
				(2)
Notes				Total 11
(a)	M1	for writing/using the integral of $f(x)$ and setting = 1 ignore limits or both areas identified (these do not need to be added nor set = 1) or a correct expression for $F(x)$ between $0 \leq x \leq k$		
	M1	for an attempt at integration on either part with $x^n \rightarrow x^{n+1}$ ignore limits or adding the area of the 2 triangles and set = 1 or a correct expression for $F(x)$ between $k \leq x \leq 6$		
	dM1	dependent on 1 st M1 for substitution of k , 0 and 6 into the integral of $f(x)$ or an un-simplified 3TQ quadratic or setting the 2 parts of $F(x)$ equal to each other		
	dM1	dependent on previous M1 for a correct 3TQ equal to 0 e.g. $\frac{4}{35}k^2 - \frac{12}{15}k + \frac{7}{5} = 0$ oe		
	A1*	for solving the 3TQ leading to the given answer (Working must be shown)		

NB Solution based on the assumption that $\frac{2}{21}k = \frac{2}{15}(6-k)$ scores M0M0dM0dM0A0

e.g. $\frac{2}{21}k = \frac{2}{15}(6-k)$ or $\frac{1}{2} \times 6 \times \frac{2}{21}k = 1$ or $\frac{1}{2}(k-0) \times \frac{2}{21}k + \frac{1}{2}(6-k) \times \frac{2}{21}k = 1$

Use of verification can score M1M1dM0dM0A0

e.g. $\frac{2}{21} \left[\frac{x^2}{2} \right]_0^{3.5} + \frac{2}{15} \left[6x - \frac{x^2}{2} \right]_{3.5}^6 [=1]$ or $\frac{1}{2}(3.5-0) \times \frac{2}{21}(3.5) + \frac{1}{2}(6-3.5) \times \frac{2}{15}(6-3.5) = 1$

(b)	M1	for writing or using the integral of $xf(x)$ ignore limits but must be both parts
	dM1	dependent on 1 st M1 for an attempt at integration on both parts with $x^n \rightarrow x^{n+1}$ ignore limits
	dM1	dependent on previous M1 for substitution of 3.5, 0 and 6 ($\frac{49}{36}$ and $\frac{65}{36}$ is the minimum required to imply this mark)
	A1	allow awrt 3.17
(c)	M1	for use of $E(X^2) - E(X)^2$ ft their $E(X)$
	A1	allow awrt 1.51

Question Number	Scheme		Marks
6(a)	$\frac{5-2}{b-a} = \frac{3}{16}$ oe or $1 - \left(\frac{2-a}{b-a} + \frac{b-5}{b-a} \right) = \frac{3}{16}$	$\frac{5-a}{b-a} = \frac{3}{16}$ oe	M1
	$\frac{a+b}{2} = 6$ oe		M1
	$a = -2$ and $b = 14$	$a = 4.4$ and $b = 7.6$	A1
			(3)
(b)	$[cE(X) + 1 = 3 \Rightarrow] 6c + 1 = 3$		M1
	$c = \frac{1}{3}$		A1
			(2)
(c)	$\left[\text{Var}X = \frac{(b-a)^2}{12} = \right] \frac{64}{3}$ oe	$\left[\text{Var}X = \frac{(b-a)^2}{12} = \right] \frac{64}{75}$ oe	B1ft
			(1)
(d)	$E(X^2) = \left(\frac{64}{3} \right) + 6^2 = \frac{172}{3}$ or	$E(X^2) = \left(\frac{64}{75} \right) + 6^2 = \frac{2764}{75}$	M1A1
			(2)
(e)	$P\left(\frac{3}{2}X - b > a\right) \Rightarrow P(X > 8) = \frac{3}{8}$	$P\left(\frac{3}{2}X - b > a\right) \Rightarrow P(X > 8) = 0$	M1A1
			(2)
	Notes		Total 10
(a)	M1	for using $P(2 < X < 5) = \frac{3}{16}$ or $P(a < X < 5) = \frac{3}{16}$ to form a correct equation in a and b May be implied by $b - a = 16$	
	M1	for using $E(X) = 6$ to form a correct equation in a and b May be implied by $a + b = 12$	
	A1	for $a = -2$ and $b = 14$ or $a = 4.4$ and $b = 7.6$	
(b)	M1	for use of $cE(X) + 1 = 3$ or fully correct integration seen e.g. $c \int_{-2}^{14} \frac{1}{16} x \, dx + 1 [= 3]$ May be implied by $c = \frac{1}{3}$	
	A1	Cao	
(c)	B1ft	ft their a and b Allow decimal answers correct to 3sf e.g 21.3	
(d)	M1	for use of $\text{Var}(X) + E(X)^2$ ft their $\text{Var}(X)$ or a fully correct integration seen e.g. $\int_{-2}^{14} \frac{1}{16} x^2 \, dx \left[= \frac{172}{3} \right]$ or $\int_{4.4}^{7.6} \frac{5}{16} x^2 \, dx \left[= \frac{2764}{75} \right]$ ft their a and b	
	A1	for $\frac{172}{3}$ oe or awrt 57.3 or $\frac{2764}{75}$ or awrt 36.9 oe NB Answer must match the method used	
(e)	M1	for $P(X > 8)$ or $P\left(X > \frac{2(a+b)}{3}\right)$ ft their a and b May be implied by a correct answer	
	A1	for $\frac{3}{8}$ oe or 0 Answer must match the method used	

Question Number	Scheme		Marks
7(a)	$X \sim B(40, 0.3)$		B1
			(1)
(b)	Constant probability of buying insurance or Customers buy insurance independently		B1
			(1)
(c)	$[P(X \leq 7) = P(X < 8) =] 0.0553$ $[P(X \leq 6) = P(X < 7) =] 0.0238$		M1
	So $r = 7$		A1
			(2)
(d)	B(200, 0.3) implies N(60, 42)		M1
	$\frac{t - 0.5 - "60"}{\sqrt{"42"}} = -1.62$ or $\frac{"60" - t + 0.5}{\sqrt{"42"}} = 1.62$		M1M1 B1
	$[t = 50.001 \dots \text{ so}] t = 50$		A1
			(5)
(e)	$H_0 : p = 0.3$ $H_1 : p > 0.3$		B1
	$[P(X \leq 11) =] 1 - P(X \leq 10)$		M1
	$= 0.0978$ or $CR \geq 11$		A1
	Reject H_0 /Significant/In CR		M1
	Evidence to suggest that percentage/proportion/probability/number/amount of customers who buy insurance has increased or		A1ft
			(5)
	Notes		Total 14
(a)	B1	Allow Binomial $n = 40$ $p = 0.3$	
(b)	B1	for a suitable assumption in context. Must include ‘insurance’ If multiple reasons given ignore any irrelevant or incorrect reasons provided, they are non-contradictory	
(c)	M1	for either probability. May be implied by $r = 7$	
	A1	Cao	
(d)	M1	for writing or using N(60, 42) May be seen in a standardisation. If N(60, $\sqrt{42}$) written but 60 and $\sqrt{42}$ used in a standardisation then award M1	
	M1	for standardising using t or $t - 0.5$ or $t + 0.5$ with their mean and their standard deviation	
	M1	for a fully correct standardisation with their mean and their standard deviation	
	B1	for ± 1.62 or better (calc: 1.620150314) seen or used. Must be compatible with their standardisation	
	A1	Cao Do not allow $t = 50$ from incorrect working	
(e)	B1	for both hypotheses in terms of p or π	
	M1	for writing or using $1 - P(X \leq 10)$ May be implied by a correct CR	
	A1	for 0.0978 or correct CR	
	M1	for a correct non contextual conclusion. ft their probability/CR provided a binomial distribution is used. Do not allow contradictory statements. May be implied by a correct contextual statement on its own.	
	A1ft	a correct contextual statement with words in bold (Allow equivalent statements) ft their probability/CR provided a binomial distribution is used	
	SC	If a two tailed test is used, then it is possible to score B0M1A1M1A1 $H_0 : p = 0.3$ $H_1 : p \neq 0.3$ B0 $[P(X \leq 11) =] 1 - P(X \leq 10)$ or $[P(X \leq 12) =] 1 - P(X \leq 11)$ M1 $= 0.0978$ or $CR \geq 12$ A1 Do not reject H_0 /Not significant/Not in CR M1 Proportion who buy insurance has not increased or A1	