

Question Number	Scheme	Marks
<p>1.(a)</p> <p>(b)</p> <p>(c)</p>	<p>Let X be the random variable the number of heads.</p> <p>$X \sim \text{Bin}(4, 0.5)$</p> <p>$P(X = 2) = C_2^4 0.5^2 0.5^2$</p> <p>$= 0.375$</p> <p>$P(X = 4) \text{ or } P(X = 0)$</p> <p>$= 2 \times 0.5^4$</p> <p>$= 0.125$</p> <p>$P(\text{HHT}) = 0.5^3$</p> <p>$= 0.125$</p> <p>or</p> <p>$P(\text{HHTT}) + P(\text{HHTH})$</p> <p>$= 2 \times 0.5^4$</p> <p>$= 0.125$</p>	<p>Use of Binomial including ${}^n C_r$</p> <p>or equivalent</p> <p>M1</p> <p>A1</p> <p>(2)</p> <p>B1</p> <p>$(0.5)^4$</p> <p>M1</p> <p>or equivalent</p> <p>A1</p> <p>(3)</p> <p>no ${}^n C_r$</p> <p>or equivalent</p> <p>M1</p> <p>A1</p> <p>(2)</p> <p>Total 7 marks</p>
	<p>1a) 2,4,6 acceptable as use of binomial.</p>	

Question Number	Scheme	Marks
2.(a)	Let X be the random variable the no. of accidents per week $X \sim \text{Po}(1.5)$	B1 need poisson and must be in part (a) (1)
(b)	$P(X = 2) = \frac{e^{-1.5} 1.5^2}{2}$ $= 0.2510$	λ $\frac{e^{-\mu} \mu^2}{2}$ or $P(X \leq 2) - P(X \leq 1)$ M1 awrt 0.251 A1 (2)
(c)	$P(X \geq 1) = 1 - P(X = 0) = 1 - e^{-1.5}$ $= 0.7769$ P(at least 1 accident per week for 3 weeks)	correct exp awrt 0.777 B1
(d)	$= 0.7769^3$ $= 0.4689$ $X \sim \text{Po}(3)$ $P(X > 4) = 1 - P(X \leq 4)$ $= 0.1847$	$(p)^3$ M1 awrt 0.469 A1 may be implied B1 M1 awrt 0.1847 A1 (3)
Total 9 marks		
	c) The 0.7769 may be implied	

<p>3.(a)</p>		<p>B1 -1,5 B1 $\frac{1}{6}$ B1 (3)</p>
<p>(b)</p>	<p>$E(X) = 2$ by symmetry</p>	<p>B1 (1)</p>
<p>(c)</p>	<p>$\text{Var}(X) = \frac{1}{12}(5+1)^2 \quad \text{or} \quad \int \frac{x^2}{6} dx - 4 = \left[\frac{x^3}{18} \right]_{-1}^5 - 4$</p> <p>$= 3$</p>	<p>M1 A1 (2)</p>
<p>(d)</p>	<p>$P(-0.3 < X < 3.3) = \frac{3.6}{6} \quad \text{or} \quad \int_{-0.3}^{3.3} \frac{1}{6} dx = \left[\frac{x}{6} \right]_{-0.3}^{3.3}$</p> <p>$= 0.6$</p>	<p>M1 full correct method for the correct area A1 (2)</p> <p>Total 8 marks</p>

Question Number	Scheme	Marks
4.	$X = \text{Po}(150 \times 0.02) = \text{Po}(3)$ $\text{po}, 3$ $P(X > 7) = 1 - P(X \leq 7)$ $= 0.0119$ <p style="text-align: right;">awrt 0.0119</p> <p>Use of normal approximation max awards B0 B0 M1 A0 in the use $1 - p(x < 7.5)$</p> $z = \frac{7.5 - 3}{\sqrt{2.94}} = 2.62$ $p(x > 7) = 1 - p(x < 7.5)$ $= 1 - 0.9953$ $= 0.0047$	<p>B1, B1(dep)</p> <p>M1</p> <p>A1</p> <p>Total 4 marks</p>
5.(a)	$\int_2^3 kx(x-2)dx = 1$ $\left[\frac{1}{3}kx^3 - kx^2 \right]_2^3 = 1$ $(9k - 9k) - \left(\frac{8k}{3} - 4k \right) = 1$ $k = \frac{3}{4} = 0.75$ <p style="text-align: center;">*</p>	$\int f(x) = 1$ <p>attempt \int need either x^3 or x^2</p> <p>correct \int</p> <p>CSO</p> <p>A1</p> <p>(4)</p>

Question Number	Scheme	Marks
(b)	$E(X) = \int_2^3 \frac{3}{4}x^2(x-2)dx$ $= \left[\frac{3}{16}x^4 - \frac{1}{2}x^3 \right]_2^3$ $= 2.6875 = 2\frac{11}{16} = 2.69 \text{ (3sf)}$	attempt $\int xf(x)$ M1 correct \int A1 awrt 2.69 A1 (3)
(c)	$F(x) = \int_2^x \frac{3}{4}(t^2 - 2t)dt$ $= \left[\frac{3}{4} \left(\frac{1}{3}t^3 - t^2 \right) \right]_2^x$ $= \frac{1}{4}(x^3 - 3x^2 + 4)$ $F(x) = \begin{cases} 0 & x \leq 2 \\ \frac{1}{4}(x^3 - 3x^2 + 4) & 2 < x < 3 \\ 1 & x \geq 3 \end{cases}$	$\int f(x)$ with variable limit or +C M1 correct integral A1 lower limit of 2 or $F(2) = 0$ or $F(3) = 1$ A1 middle, ends B1✓, B1 A1 (6)
(d)	$F(x) = \frac{1}{2}$ $\frac{1}{4}(x^3 - 3x^2 + 4) = \frac{1}{2}$ $x^3 - 3x^2 + 2 = 0$ $x = 2.75, x^3 - 3x^2 + 2 > 0$ $x = 2.70, x^3 - 3x^2 + 2 < 0 \Rightarrow \text{root between 2.70 and 2.75}$ (or $F(2.7) = 0.453, F(2.75) = 0.527 \Rightarrow$ median between 2.70 and 2.75)	their $F(x) = 1/2$ M1 M1 (2) Total 15 marks

6.(a)	<table border="1" style="margin: auto;"> <tr> <td>X</td> <td>1</td> <td>2</td> <td>5</td> </tr> <tr> <td>$P(X = x)$</td> <td>$\frac{1}{2}$</td> <td>$\frac{1}{3}$</td> <td>$\frac{1}{6}$</td> </tr> </table>	X	1	2	5	$P(X = x)$	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{6}$								
X	1	2	5														
$P(X = x)$	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{6}$														
	$\text{Mean} = 1 \times \frac{1}{2} + 2 \times \frac{1}{3} + 5 \times \frac{1}{6} = 2 \quad \text{or } 0.02$	$\Sigma x \cdot p(x)$ need $\frac{1}{2}$ and $\frac{1}{3}$	M1A1														
	$\text{Variance} = 1^2 \times \frac{1}{2} + 2^2 \times \frac{1}{3} + 5^2 \times \frac{1}{6} - 2^2 = 2 \quad \text{or } 0.0002$	For M	M1A1														
			(4)														
(b)	$\Sigma x^2 \cdot p(x) - \lambda^2$ <p style="margin-left: 20px;">(1,1) (1,2) and (2,1) (1,5) and (5,1)</p> <p>e.e.</p> <p style="margin-left: 20px;">(2,2) (2,5) and (5,2) (5,5)</p>	LHS -1	B2 B1														
		repeat of "theirs" on RHS	B1														
			(3)														
(c)	<table border="1" style="margin: auto;"> <tr> <td>\bar{x}</td> <td>1</td> <td>1.5</td> <td>2</td> <td>3</td> <td>3.5</td> <td>5</td> </tr> <tr> <td>$P(\bar{X} = \bar{x})$</td> <td>$\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$</td> <td>$\frac{1}{3}$</td> <td>$\frac{1}{3} \times \frac{1}{3} = \frac{1}{9}$</td> <td>$\frac{1}{6}$</td> <td>$2 \times \frac{1}{3} \times \frac{1}{6} = \frac{1}{9}$</td> <td>$\frac{1}{36}$</td> </tr> </table>	\bar{x}	1	1.5	2	3	3.5	5	$P(\bar{X} = \bar{x})$	$\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{3} \times \frac{1}{3} = \frac{1}{9}$	$\frac{1}{6}$	$2 \times \frac{1}{3} \times \frac{1}{6} = \frac{1}{9}$	$\frac{1}{36}$		$\frac{1}{4}$ M1A1
\bar{x}	1	1.5	2	3	3.5	5											
$P(\bar{X} = \bar{x})$	$\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{3} \times \frac{1}{3} = \frac{1}{9}$	$\frac{1}{6}$	$2 \times \frac{1}{3} \times \frac{1}{6} = \frac{1}{9}$	$\frac{1}{36}$											
			1.5+, -1ee	M1A2													
				(6)													
				Total 13 marks													
	Two tail																

<p>7.(a)(i)</p>	<p>$H_0 : p = 0.2, H_1 : p \neq 0.2$ $p =$</p> <p>$P(X \geq 9) = 1 - P(X \leq 8)$ or attempt critical value/region</p> <p>$= 1 - 0.9900 = 0.01$ CR $X \geq 9$</p> <p>$0.01 < 0.025$ or $9 \geq 9$ or $0.99 > 0.975$ or $0.02 < 0.05$ or lies in interval with correct interval stated.</p> <p>Evidence that the percentage of pupils that read Deano is not 20%</p>	<p>B1B1</p> <p>M1</p> <p>A1</p> <p>A1</p>
<p>(ii)</p>	<p>$X \sim \text{Bin}(20, 0.2)$ may be implied or seen in (i) or (ii)</p> <p>So 0 or [9,20] make test significant. 0,9,between "their 9" and 20</p>	<p>B1</p> <p>B1B1B1 (9)</p>
<p>(b)</p>	<p>$H_0 : p = 0.2, H_1 : p \neq 0.2$</p> <p>$W \sim \text{Bin}(100, 0.2)$</p> <p>$W \sim N(20, 16)$ normal; 20 and 16</p> <p>$P(X \leq 18) = P(Z \leq \frac{18.5 - 20}{4})$ or $\frac{x(+\frac{1}{2}) - 20}{4} = \pm 1.96$ \pm cc, standardise</p> <p>$= P(Z \leq -0.375)$ or use z value, standardise</p> <p>$= 0.352 - 0.354$ CR $X < 12.16$ or 11.66 for $\frac{1}{2}$</p> <p>[$0.352 > 0.025$ or $18 > 12.16$ therefore insufficient evidence to reject H_0]</p> <p>Combined numbers of Deano readers suggests 20% of pupils read Deano</p>	<p>B1</p> <p>B1; B1</p> <p>M1M1A1</p> <p>A1</p> <p>A1 (8)</p>
<p>(c)</p>	<p>Conclusion that they are different.</p> <p>Either large sample size gives better result</p> <p>Or</p> <p>Looks as though they are not all drawn from the same population.</p>	<p>B1</p> <p>B1 (2)</p>
<p>Total 19 marks</p>		
<p>7(a)(i)</p>	<p>One tail $H_0 : p = 0.2, H_1 : p > 0.2$</p>	<p>B1B0</p>

	<p>$P(X \geq 9) = 1 - P(X \leq 8)$ or attempt critical value/region $= 1 - 0.9900 = 0.01$ CR $X \geq 8$</p> <p>0.01 < 0.05 or $9 \geq 8$ (therefore Reject H_0,)evidence that the percentage of pupils that read Deano is not 20%</p> <p>$X \sim \text{Bin}(20, 0.2)$ may be implied or seen in (i) or (ii)</p> <p>So 0 or [8,20] make test significant. 0,9,between “their 8” and 20</p>	<p>M1 A0 A1 B1 B1B0B1 (9)</p>
(b)	<p>$H_0 : p = 0.2, H_1 : p < 0.2$</p> <p>$W \sim \text{Bin}(100, 0.2)$</p> <p>$W \sim N(20, 16)$ normal; 20 and 16</p> <p>$P(X \leq 18) = P(Z \leq \frac{18.5 - 20}{4})$ or $\frac{x - 20}{4} = -1.6449$ \pm cc, standardise or standardise, use z value $= P(Z \leq -0.375)$ $= 0.3520$ CR $X < 13.4$ or 12.9 awrt 0.352</p> <p>[0.352 > 0.05 or $18 > 13.4$ therefore insufficient evidence to reject H_0]</p> <p>Combined numbers of Deano readers suggests 20% of pupils read Deano</p>	<p>B1 \checkmark B1; B1 M1M1A1 A1 A1 (8)</p>
(c)	<p>Conclusion that they are different.</p> <p>Either large sample size gives better result Or Looks as though they are not all drawn from the same population.</p>	<p>B1 B1 (2) Total 19 marks</p>