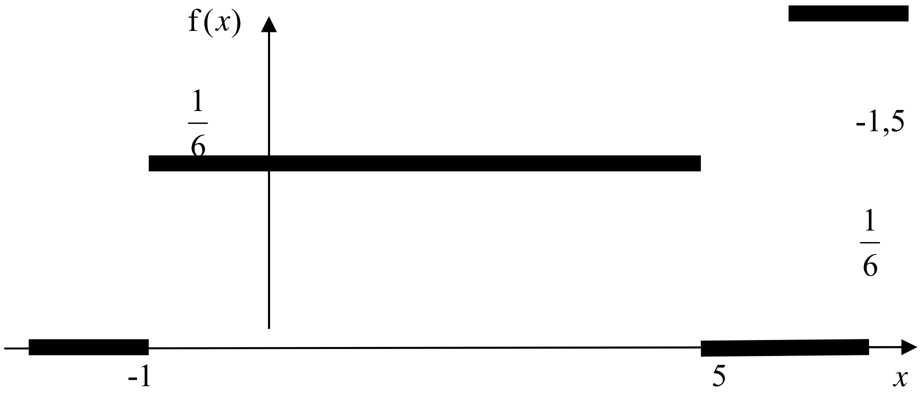
Question Number	Scheme	Marks
1.(a)	Let X be the random variable the number of heads.	
	$X \sim \text{Bin}\ (4, 0.5)$	
	$\text{P}(X = 2) = C_2^4 0.5^2 0.5^2$ Use of Binomial including ^nCr	M1
	$=0.375$ or equivalent	A1
		(2)
(b)	$\text{P}(X = 4)$ or $\text{P}(X = 0)$	B1
	$= 2 \times 0.5^4$ $(0.5)^4$	M1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

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

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

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

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

6.(a)

X	1	2	5
P($X = x$)	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{6}$

$\text{Mean} = 1\times\frac{1}{2}+2\times\frac{1}{3}+5\times\frac{1}{6}=2$ or 0.02 $\Sigma\, x.p(x)$ need ½ and 1/3 M1A1

For M

$\text{Variance}==1^2\times\frac{1}{2}+2^2\times\frac{1}{3}+5^2\times\frac{1}{6}-2^2=2$ or 0.0002 M1A1

(4)

(b) $\Sigma x^2.p(x)-\lambda^2$

(1,1) B2
(1,2) and (2,1)
(1,5) and (5,1) LHS -1 B1
e.e. (3)
(2,2)
(2,5) and (5,2) repeat of "theirs" on RHS B1
(5,5)

(c)

$\bar{x}$	1	1.5	2	3	3.5	5
P($\bar{X} = \bar{x}$)	$\frac{1}{2}\times\frac{1}{2}=\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{3}\times\frac{1}{3}=\frac{1}{9}$	$\frac{1}{6}$	$2\times\frac{1}{3}\times\frac{1}{6}=\frac{1}{9}$	$\frac{1}{36}$

¼ M1A1

1.5+,-1ee M1A2

(6)

Total 13 marks

Two tail

7.(a)(i)	$H_0 : p = 0.2, H_1 : p \neq 0.2$ $p =$	B1B1
	$P(X \geq 9) = 1 - P(X \leq 8)$ or attempt critical value/region $= 1 - 0.9900 = 0.01$ CR $X \geq 9$	M1
	$0.01 < 0.025$ or $9 \geq 9$ or $0.99 > 0.975$ or $0.02 < 0.05$ or lies in interval with correct interval stated.	A1
	Evidence that the percentage of pupils that read Deano is not 20%	A1
(ii)	X ~ Bin (20, 0.2) may be implied or seen in (i) or (ii)	B1
	So 0 or [9,20] make test significant. 0,9,between “their 9” and 20	B1B1B1 (9)
(b)	$H_0 : p = 0.2, H_1 : p \neq 0.2$	B1
	$W \sim \text{Bin}(100, 0.2)$	
	$W \sim \text{N}(20, 16)$ normal; 20 and 16	B1; B1
	$P(X \leq 18) = P(Z \leq \frac{18.5 - 20}{4})$ or $\frac{x(+\frac{1}{2}) - 20}{4} = \pm 1.96$ ± cc, standardise or use z value, standardise $= P(Z \leq -0.375)$	M1M1A1
	$= 0.352 - 0.354$ CR $X < 12.16$ or 11.66 for ½	A1
	[0.352 >0.025 or 18 > 12.16 therefore insufficient evidence to reject H_0]	
	Combined numbers of Deano readers suggests 20% of pupils read Deano	A1 (8)
(c)	Conclusion that they are different.	B1
	Either large sample size gives better result Or Looks as though they are not all drawn from the same population.	B1 (2)
		Total 19 marks
7(a)(i)	One tail $H_0 : p = 0.2$, $H_1 : p > 0.2$	B1B0

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