January 2018

Question	Scheme	Marks
2. (a)	$\frac{n^3}{(n+1)^3} = 0.729 \Rightarrow \frac{n}{n+1} = \sqrt[3]{0.729} \Rightarrow n = 9$	M1A1cso (2)
(b)	$P(T = 24) = 0.9^2(1-0.9) \times 3$ $P(T = 30) = 0.9(1-0.9)^2 \times 3$ $P(T = 36) = (1-0.9)^3$	M1 M1
	T | [18] | 24 | 30 | 36 $P(T = t)$ | [0.729] | 0.243 | 0.027 | 0.001	A1 A1 (4)
(c)	$P(R = 0) = P(T = 18) + P(T = 36) = 0.73$ $P(R = 6) = P(T = 24) + P(T = 30) = 0.27$	M1 A1 (2) **Total 8**

June 2018

Question Number	Scheme	Marks
4. (a)	Every possible sample (of size 12 cartons) has an equal chance of being selected. **Or** sample selected without bias from the dairy/factory (o.e.) **Or** sample where all cartons have the same chance/prob of being chosen (o.e.)	B1 (1)
(b)	[The volumes of] all the cartons of milk **Or** the cartons of milk from the dairy/factory (o.e.)	B1 (1)
(c)	N(0,1)	B1 (1)
(d)	The probability distribution of X **or** the distribution of all possible values of X **Or** all the values of the statistic and their probabilities (o.e.)	B1 (1)
(e)	Only (II) is not a statistic as it contains (unknown) parameters μ and/or σ **Or** it contains unknown parameters (o.e.)	B1 B1d (2)

October 2018

Question	Scheme	Marks
Question	Scheme	Marks
4.(a)	P($D = -1$) [=P(1 blue and 2 red marbles selected)] $= 3\times0.2\times0.8^2 = 0.384$*	M1A1cso (2)
(b)	d | -3 | $[-1]$ | 1 | 3 | 0.8^3 | $[3\times0.2\times0.8^2]$ | $3\times0.2^2\times0.8$ | 0.2^3 P($D = d$) | $0.512 = \frac{64}{125}$ | $[0.384 = \frac{48}{125}]$ | $0.096 = \frac{12}{125}$ | $0.008 = \frac{1}{125}$	B1 M1 A1 (3)
(c)	-3	B1 (1)
(d)	$X \sim$ B(12, 0.2) P($X \leq 4$) = 0.9274 P($X \geq 5$) = 0.0726 < 0.10 P($X \leq 3$) = 0.7946 P($X \geq 4$) = 0.2054 > 0.10 CR: $X \geq 5$	M1 A1 (2)
(e)	0.0726	B1ft (1)

June 2019

Question Number	Scheme	Marks
2. (a)	[$X \sim$ Po(2)] P($X < 5$) = P($X \leq 4$) = 0.947346…. awrt **0.947**	 M1 A1 (2)
(b)	$Y \sim$ Po(6) $e^{-6}\frac{6^n}{(n)!} = e^{-6}\frac{6^{n+1}}{(n+1)!} \rightarrow (n+1) = 6$ **or** P($Y = 4$) = 0.13385… P($Y = 5$) = 0.16062… P($Y = 6$) = 0.16062… ***n* = 5**	B1 M1 A1 (3)
(c)	[$D \sim$ Po(9)] P($c \leq D \leq 12$) = P($D \leq 12$) – P($D \leq c-1$) or P($X \leq d$) = 0.8758 – 0.8546 0.8546 = 0.8758 – P($D \leq c-1$) = 0.0212 P($D \leq c-1$) = 0.0212 P($X \leq 3$) = 0.0212 $c - 1 = 3$ ***c* = 4** ***c* = 4**	M1 dM1 A1 (3)
(d)	P($X = 2$) = 0.27067… $W \sim$ B(6, awrt 0.27067…) P($W = 4$) = $^6C_4$("0.27067…")^4(1 – "0.27067…")^2 = 0.0428… awrt **0.043**	B1 B1ft M1 A1 (4)

October 2019

Question	Scheme	Marks
5(a)	$(1,1,2) \rightarrow \frac{2}{5}\times\frac{2}{5}\times\frac{1}{5}$	B1
	$(1,1,5) \rightarrow \frac{2}{5}\times\frac{2}{5}\times\frac{4}{5}$	B1
	$(1,2,2)(2,1,2) \rightarrow 2\times\frac{2}{5}\times\frac{3}{5}\times\frac{1}{5}$	M1
	$(1,2,5)(2,1,5) \rightarrow 2\times\frac{2}{5}\times\frac{3}{5}\times\frac{4}{5}$	M1
	$(2,2,2) \rightarrow \frac{3}{5}\times\frac{3}{5}\times\frac{1}{5}$	
	$(2,2,5) \rightarrow \frac{3}{5}\times\frac{3}{5}\times\frac{4}{5}$	
	$[t]$: 4 | 5 | 6 | 7 | 8 | 9	B1
	$[\mathrm{P}(T=t)]$: $\frac{4}{125}$ (0.032) | $\frac{12}{125}$ (0.096) | $\frac{9}{125}$ (0.072) | $\frac{16}{125}$ (0.128) | $\frac{48}{125}$ (0.384) | $\frac{36}{125}$ (0.288)	A1 A1
		(7)
(b)	$m=1 \quad m=2$	B1
	$\mathrm{P}(M=1)=\left(\frac{4}{125}\right)+\left(\frac{16}{125}\right)$	M1 dM1
	$\mathrm{P}(M=2)=\left(\frac{12}{125}\right)+\left(\frac{9}{125}\right)+\left(\frac{48}{125}\right)+\left(\frac{36}{125}\right)$ or $1-\left(\left(\frac{4}{125}\right)+\left(\frac{16}{125}\right)\right)$	
	$[M]$: 1 | 2	A1
	$[\mathrm{P}(M=m)]$: $\frac{4}{25}$ or (0.16) | $\frac{21}{25}$ or (0.84)	
		(4)

June 2020

Question Number	Scheme	Marks
6(a)	A sampling distribution is **all** the **values** of a **statistic** and the associated **probabilities** **or** the **probability distribution** of the **statistic**.	B1
		(1)
(b)	P(small(40)) = 0.5, P(medium(80)) = 0.3, P(large(150)) = 0.2	B1
	Range (R) 0, 40, 70, 110	B1
	$[\mathrm{P}(R=0)=]"0.5"^3+"0.3"^3+"0.2"^3=0.16$	M1
	(40,40,80) (40,80,80) (80,80,150) (80,150,150) (40,40,150) (40,80,150) (40,150,150)	B1
	$[\mathrm{P}(R=40)=]3\times("0.5"\times"0.3"^2)+3\times("0.5"^2\times"0.3")$	M1
	$[\mathrm{P}(R=70)=]3\times("0.3"^2\times"0.2")+3\times("0.3"\times"0.2"^2)=0.09$	M1
	$[\mathrm{P}(R=110)=]3\times("0.5"^2\times"0.2")+3\times("0.5"+"0.2"^2)+6\times("0.5"\times"0.3"\times"0.2")=0.39$	
	R: 0 | 40 | 70 | 110 r: 0.16 | 0.36 | 0.09 | 0.39	A1cao
		(7)
(c)	$(1-"0.09")^n<0.2$ or $("0.91")^n<0.2$	M1
	$[n>]17.065...$	M1
	$n=18$	A1
		(3)

January 2021

Question Number	Scheme	Marks
6(a)	Taking a random sample is quicker/cheaper/easier (compared to asking all of the youth club members).	B1
		(1)
(b)	A list/register/database of all the youth club members	B1
		(1)
(c)	The members	B1
		(1)
(d)	$p^2 = \frac{25}{64}$	M1
	$p = \frac{5}{8}$	A1
	$"\frac{5}{8}"+q+r=1$ or $2qr=\frac{1}{16}$ or $\frac{25}{64}+2"\frac{5}{8}"q+2"\frac{5}{8}"r+q^2+\frac{1}{16}+r^2=1$	B1
	Any two equations from above	B1
	$\frac{3}{8}q-q^2=\frac{1}{32}$	dM1
	$q=\frac{1}{4}$	A1
	$P(M=50)=\frac{1}{4}\times\frac{1}{4}=\frac{1}{16}$ *	A1cso*
		(7)

June 2021

Question Number	Scheme	Marks
4.	[A = the number on the ball] $P(A=1)=\frac{2}{9}$ $P(A=2)=\frac{1}{3}$ $P(A=5)=\frac{4}{9}$	B1
(i)	Possible samples with a range of 4 are: (1,1,5) (1,2,5) (1,5,5)	M1
	(1,1,5) $"\frac{2}{9}"\times"\frac{2}{9}"\times"\frac{4}{9}"\times 3=\frac{16}{243}$ or (1,5,5) $"\frac{2}{9}"\times"\frac{4}{9}"\times"\frac{4}{9}"\times 3=\frac{32}{243}$	M1
	(1,2,5) $"\frac{2}{9}"\times"\frac{1}{3}"\times"\frac{4}{9}"\times 6=\frac{16}{81}$	M1
	$P(B=4)=\frac{16}{243}+\frac{32}{243}+\frac{16}{81}=\underline{\underline{\frac{32}{81}}}$	A1
(ii)	$P(B=0)=\left("\frac{2}{9}"\right)^3+\left("\frac{1}{3}"\right)^3+\left("\frac{4}{9}"\right)^3=\frac{11}{81}$	M1
	$P(B=1)=3\times\frac{2}{9}\times\left(\frac{1}{3}\right)^2+3\times\frac{1}{3}\times\left(\frac{2}{9}\right)^2=\frac{10}{81}$ or $P(B=3)=3\times\frac{1}{3}\times\left(\frac{4}{9}\right)^2+3\times\frac{4}{9}\times\left(\frac{1}{3}\right)^2=\frac{28}{81}$	M1
	$1-"\frac{11}{81}"-"\frac{10}{81}"-"\frac{32}{81}"=\frac{28}{81}$ or $1-"\frac{11}{81}"-"\frac{28}{81}"-"\frac{32}{81}"=\frac{10}{81}$	M1
	b: 0, 1, 3, 4 — $P(B=b)$: $\frac{11}{81}$, $\frac{10}{81}$, $\frac{28}{81}$, $\frac{32}{81}$	B1 A1
		(10)

October 2021

uestion Number	Scheme	Marks
5(a)	P(score 8) = $0.25 \times 0.35 = 0.0875$	B1
		(1)
(b)		

sample	Score (y)	calculation	P($Y = y$)
(1,3)	–2	0.4×0.25	0.1
(1,2)	0	0.4×0.35	0.14
(1,1) (2,3)	2	$0.4^2 + 0.35 \times 0.25$	0.2475
(2,2)	4	0.35^2	0.1225
(2,1) (3,3)	6	$0.35 \times 0.4 + 0.25^2$	0.2025
(3,1)	10	0.25×0.4	0.1

B1
M1
M1
M1

Y	–2	0	2	4	6	8	10
P($Y = y$)	0.1 $\left[\frac{1}{10}\right]$	0.14 $\left[\frac{7}{50}\right]$	0.2475 $\left[\frac{99}{400}\right]$	0.1225 $\left[\frac{49}{400}\right]$	0.2025 $\left[\frac{81}{400}\right]$	0.0875 $\left[\frac{7}{80}\right]$	0.1 $\left[\frac{1}{10}\right]$

A1

(5)

(c)	$E(Y) = -2 \times "0.1" + [0 \times "0.14"] + 2 \times "0.2475" + 4 \times "0.1225" + 6 \times "0.2025" + 8 \times 0.0875 + 10 \times "0.1"$	M1
	$= 3.7$	A1
		(2)

January 2022

Question Number	Scheme	Marks
6 (a)	A sampling distribution is **all** the **values** of a **statistic** (obtained from a random sample) and the associated **probabilities** **or** the **probability distribution** of the **statistic** (under random sampling).	B1 (1)
(b)	$P(6)=\frac{6}{11}$ $P(7)=\frac{3}{11}$ $P(8)=\frac{2}{11}$	B1
	Totals (T) 12, 13, 14, 15, 16	B1
	(6, 6) (6, 7) (6, 8) (7, 6) (7, 7) (7, 8) (8, 6) (8, 7) (8, 8)	B1
	$[P(T=12)=]\ "\left(\frac{6}{11}\right)"^2=\left[\frac{36}{121}\right]$	
	$[P(T=13)=]2\times"\left(\frac{6}{11}\right)"\times"\left(\frac{3}{11}\right)"=\left[\frac{36}{121}\right]$	M1
	$[P(T=14)=]2\times"\left(\frac{6}{11}\right)"\times"\left(\frac{2}{11}\right)"+"\left(\frac{3}{11}\right)"^2=\left[\frac{33}{121}\right]$	M1
	$[P(T=15)=]2\times"\left(\frac{3}{11}\right)"\times"\left(\frac{2}{11}\right)"=\left[\frac{12}{121}\right]$	M1
	$[P(T=16)=]\ "\left(\frac{2}{11}\right)"^2=\left[\frac{4}{121}\right]$	
	T: 12, 13, 14, 15, 16 $P(T=t)$: $\frac{36}{121}$, $\frac{36}{121}$, $\frac{33}{121}$, $\frac{12}{121}$, $\frac{4}{121}$	A1 (7)
(c)	$E(T)="12"\times"\frac{36}{121}"+"13"\times"\frac{36}{121}"+"14"\times"\frac{33}{121}"+"15"\times"\frac{12}{121}"+"16"\times"\frac{4}{121}"$	M1
	$=\frac{1606}{121}=\frac{146}{11}=13.272...$ awrt 13.3	A1 (2)

June 2022

Question	Scheme	Marks
7. (a)	$Y\sim B(20,p)$ $p=P(\text{sample contains counter with a 9 on it})$	
	$p=\left(1-\frac{9}{10}\times\frac{8}{9}\times\frac{7}{8}\right)$ oe **or** $\left(\frac{1}{10}\times\frac{9}{9}\times\frac{8}{8}\times3\right)$ oe **or** $\left(\frac{6}{10}\times\frac{5}{9}\times\frac{1}{8}\times3+\frac{6}{10}\times\frac{3}{9}\times\frac{1}{8}\times6+\frac{3}{10}\times\frac{2}{9}\times\frac{1}{8}\times3\right)$ oe $\left[=\frac{3}{10}\right]$	M1A1
(i)	$E(Y)=20\times"\frac{3}{10}"[=6]$	B1
(ii)	$Var(Y)=20\times"\frac{3}{10}"\times(1-"\frac{3}{10}")=4.2$	M1A1
		(5)
(b)	(7,7,7) (7,7,8), [(7,8,7), (8,7,7)] (7,7,9), [(7,9,7), (9,7,7)]	B2
		(2)
(c)	m: 7, 8 $P(M=m)$: $\frac{6}{10}\times\frac{5}{9}\times\frac{4}{8}+3\times\frac{6}{10}\times\frac{5}{9}\times\frac{3}{8}+3\times\frac{6}{10}\times\frac{5}{9}\times\frac{1}{8}=\frac{2}{3}$; $1-P(M=1)=\frac{1}{3}$	B1 M1 M1 A1 A1 (5)

October 2022

Question Number	Scheme	Marks
6(a)	$\left(2\times\frac{a}{a+7}\times\frac{1}{4}\times\frac{3}{4}\right)+\left(\frac{a}{a+7}\times\frac{1}{4}\times\frac{1}{4}\right)=\frac{63}{256}$ or $\frac{a}{a+7}\times\left(1-\left(\frac{3}{4}\right)^2\right)=\frac{63}{256}$ or $\frac{a}{a+7}\times\left[\left(\frac{1}{4}\right)^2+2\times\frac{1}{4}\times\frac{3}{4}\right]=\frac{63}{256}$	M1 M1
	$\frac{a}{7+a}=\frac{63}{256}\div\frac{7}{16}$ or $\frac{a}{7+a}=\frac{9}{16}$ $\therefore a=9$ *	A1*
		(3)
(b)	Range (R) 0, 5, 10 (and 15)	B1
	Bag: $\mathrm{P}(20)=\frac{9}{16}$ and $\mathrm{P}(5)=\frac{5}{16}$ and $\mathrm{P}(10)=\frac{2}{16}$	B1
	$\left[\mathrm{P}(R=0)=\right]\frac{5}{16}\times\frac{1}{4}\times\frac{1}{4}+\frac{2}{16}\times\frac{3}{4}\times\frac{3}{4}$	M1
	$\left[\mathrm{P}(R=5)=\right]2\times\frac{5}{16}\times\frac{1}{4}\times\frac{3}{4}+\frac{5}{16}\times\frac{3}{4}\times\frac{3}{4}+2\times\frac{2}{16}\times\frac{1}{4}\times\frac{3}{4}+\frac{2}{16}\times\frac{1}{4}\times\frac{1}{4}$	M1
	$\left[\mathrm{P}(R=10)=\right]\frac{9}{16}\times\frac{3}{4}\times\frac{3}{4}$	M1
	R: 0, 5, 10, 15 — r: $\frac{23}{256}$, $\frac{89}{256}$, $\frac{81}{256}$, $\frac{63}{256}$	A1cao
		(6)

January 2023

Question Number	Scheme	Marks
2 (a)	20, 20, 20 20, 20, 50 (×3) 20, 50, 50 (×3) 50, 50, 50	B2
		(2)
(b)	$a=30$ and $b=40$	B1
		(1)
(c)	$p^3=\frac{4913}{8000}$ or $q^3=\frac{27}{8000}$	M1
	$p=\frac{17}{20}$ (0.85) and $q=\frac{3}{20}$ (0.15)	A1
		(2)
(d)	$\left[\mathrm{P}(30)\right]=3\times"p^2"\times"q"$ $\left[\mathrm{P}(40)\right]=3\times"p"\times"q^2"$	M1 M1
	$c=\frac{2601}{8000}$ $d=\frac{459}{8000}$	A1
		(3)
(e)	M: 20, 50 — $\mathrm{P}(M=m)$: $\frac{3757}{4000}$, $\frac{243}{4000}$	B1 M1 A1ft
		(3)

June 2023

Question Number	Scheme	Marks
2. (a)	e.g. Population is small	B1 (1)
(b)(i)	list/register/database of **all** members (of the leisure centre)	B1
(ii)	A member (of the leisure centre)	B1 (2)
(c)	*C* is the statistic as it is (a quantity) based only on values (oe) taken from the sample/it contains no unknown parameters/population values	B1 (1) **[4 marks]**

October 2023

Question Number	Scheme	Marks
4 (a)	$0.2\times£10+0.3\times£12+0.5\times£15$	M1
	$=[£]13.10$	A1
		(2)
(b)	10 10 10 10 10 12 (×3) 10 10 15 (×3) 10 12 15 (×6) 12 12 12 12 12 15 (×3) 10 12 12 (×3) 15 15 15 12 15 15 (×3) 10 15 15 (×3)	B1 B1
		(2)
(c)	$P(10)=0.2$ $P(12)=0.3$ $P(15)=0.5$	B1
	Median can be 10, 12 or 15	B1
	$P(M=10)=0.2^3+0.2^2\times0.3\times3+0.2^2\times0.5\times3$ **or** $1-0.8^3-3\times0.8^2\times0.2$	M1
	$P(M=12)=0.3^3+0.3^2\times0.5\times3+0.3^2\times0.2\times3+0.2\times0.3\times0.5\times6$	M1
	$P(M=15)=0.5^3+0.5^2\times0.3\times3+0.5^2\times0.2\times3$ **or** $1-0.5^3-3\times0.5^2\times0.5$	M1
	M | 10 | 12 | 15 $P(M=m)$ | $\frac{13}{125}=0.104$ | $\frac{99}{250}=0.396$ | $\frac{1}{2}=0.5$	A1
		(6)

January 2024

<table>
<tr><th>Question Number</th><th>Scheme</th><th>Marks</th></tr>
<tr><td>6(a)</td><td>8, 11, 14, 17, 20</td><td>M1</td></tr>
<tr><td></td><td>$\left[\mathrm{P}(\text{even})=\right]\frac{1}{5}$ and $\left[\mathrm{P}(\text{odd})=\right]\frac{4}{5}$</td><td>M1</td></tr>
<tr><td></td><td>$\left[\mathrm{P}(X=8)=\right]\left(\frac{4}{5}\right)^4$ or $\left[\mathrm{P}(X=20)=\right]\left(\frac{1}{5}\right)^4$</td><td>M1</td></tr>
<tr><td></td><td>$\left[\mathrm{P}(X=11)=\right]4\times\left(\frac{1}{5}\right)\left(\frac{4}{5}\right)^3$ or $\left[\mathrm{P}(X=17)=\right]4\times\left(\frac{4}{5}\right)\left(\frac{1}{5}\right)^3$</td><td>M1</td></tr>
<tr><td></td><td>$\left[\mathrm{P}(X=14)=\right]{}^4C_2\times\left(\frac{1}{5}\right)^2\left(\frac{4}{5}\right)^2$</td><td>M1</td></tr>
<tr><td></td><td><table><tr><td>X</td><td>8</td><td>11</td><td>14</td><td>17</td><td>20</td></tr><tr><td>$\mathrm{P}(X=x)$</td><td>$\frac{256}{625}$ (0.4096)</td><td>$\frac{256}{625}$ (0.4096)</td><td>$\frac{96}{625}$ (0.1536)</td><td>$\frac{16}{625}$ (0.0256)</td><td>$\frac{1}{625}$ (0.0016)</td></tr></table></td><td>A1</td></tr>
<tr><td></td><td></td><td>(6)</td></tr>
<tr><td>(b)</td><td>$1-(1-\text{"0.1536"})^n>0.95$ or $(\text{"0.8464"})^n<0.05$</td><td>M1</td></tr>
<tr><td></td><td>$n>17.96$ or $n>\frac{\log(0.05)}{\log(\text{"0.8464"})}$ or $n>\log_{\text{"0.8464"}}(0.05)$</td><td>M1</td></tr>
<tr><td></td><td>$n=18$</td><td>A1</td></tr>
<tr><td></td><td></td><td>(3)</td></tr>
</table>