EXPECTED AND BINOMIAL 1 ANSWERS

1) **QUESTION 5**

(a) For using $\sum p = 1 \quad (0.4 + p + 0.2 + 0.07 + 0.02 = 1)$ ***(M1)***

$p = 0.31$ ***A1*** ***N2***

(b) For using $\mathrm{E}(X) = \sum x \mathrm{P}(X = x)$ ***(M1)***

$\mathrm{E}(X) = 1(0.4) + 2(0.31) + 3(0.2) + 4(0.07) + 5(0.02)$ ***A1***

$= 2$ ***A2*** ***N2***

2) **Part A**

(a) Adding probabilities ***(M1)***

Evidence of knowing that sum $= 1$ for probability distribution ***R1***

e.g. Sum greater than 1, sum $= 1.3$, sum does not equal 1 ***N2***

[2 marks]

(b) Equating sum to 1 $(3k + 0.7 = 1)$ ***M1***

$k = 0.1$ ***A1*** ***N1***

[2 marks]

(c) (i) $\mathrm{P}(X = 0) = \dfrac{0+1}{20}$ ***(M1)***

$= \dfrac{1}{20}$ ***A1*** ***N2***

(ii) Evidence of using $\mathrm{P}(X > 0) = 1 - \mathrm{P}(X = 0) \quad \left(\text{or } \dfrac{4}{20} + \dfrac{5}{20} + \dfrac{10}{20}\right)$ ***(M1)***

$= \dfrac{19}{20}$ ***A1*** ***N2***

[4 marks]

Sub-total [8 marks]

3)

(a) (i) $\mathrm{P}(B)=\frac{3}{4}$ ***A1*** ***N1***

(ii) $\mathrm{P}(R)=\frac{1}{4}$ ***A1*** ***N1***

[2 marks]

(b) $p=\frac{3}{4}$ ***A1*** ***N1***

$s=\frac{1}{4}$, $t=\frac{3}{4}$ ***A1*** ***N1***

[2 marks]

(c) (i) $\mathrm{P}(X=3)$

$=\mathrm{P}(\text{getting 1 and 2})=\frac{1}{4}\times\frac{3}{4}$ ***A1***

$=\frac{3}{16}$ ***AG*** ***N0***

(ii) $\mathrm{P}(X=2)=\frac{1}{4}\times\frac{1}{4}+\frac{3}{4}\ \left(\text{or } 1-\frac{3}{16}\right)$ ***(A1)***

$=\frac{13}{16}$ ***A1*** ***N2***

[3 marks]

(d) (i)

X	2	3
$\mathrm{P}(X=x)$	$\frac{13}{16}$	$\frac{3}{16}$

A2 ***N2***

(ii) evidence of using $\mathrm{E}(X)=\sum x\,\mathrm{P}(X=x)$ ***(M1)***

$\mathrm{E}(X)=2\left(\frac{13}{16}\right)+3\left(\frac{3}{16}\right)$ ***(A1)***

$=\frac{35}{16}\ \left(=2\frac{3}{16}\right)$ ***A1*** ***N2***

[5 marks]

(e) win \$10 $\Rightarrow$ scores 3 one time, 2 other time ***(M1)*** *continued ...*

$\mathrm{P}(3)\times\mathrm{P}(2)=\frac{13}{16}\times\frac{3}{16}$ (seen anywhere) ***A1***

evidence of recognising there are different ways of winning \$10 ***(M1)***

e.g. $\mathrm{P}(3)\times\mathrm{P}(2)+\mathrm{P}(2)\times\mathrm{P}(3)$, $2\left(\frac{13}{16}\times\frac{3}{16}\right)$, $\frac{36}{256}+\frac{3}{256}+\frac{36}{256}+\frac{3}{256}$

$\mathrm{P}(\text{win \$10})=\frac{78}{256}\ \left(=\frac{39}{128}\right)$ ***A1*** ***N3***

[4 marks]

Total [16 marks]

4) (a) evidence of binomial distribution (may be seen in parts (b) or (c)) ***(M1)***
e.g. np, 100×0.04
mean $= 4$ ***A1*** ***N2***

(b) $P(X = 6) = \binom{100}{6}(0.04)^6 (0.96)^{94}$ ***(A1)***
$= 0.105$ ***A1*** ***N2***

(c) for evidence of appropriate approach ***(M1)***
e.g. complement, $1 - P(X = 0)$
$P(X = 0) = (0.96)^{100} = 0.01687...$ ***(A1)***
$P(X \geq 1) = 0.983$ ***A1*** ***N2***
[7 marks]

5) (a) evidence of using $\sum p_i = 1$ ***(M1)***
correct substitution ***A1***
e.g. $10k^2 + 3k + 0.6 = 1$, $10k^2 + 3k - 0.4 = 0$
$k = 0.1$ ***A2*** ***N2***

(b) evidence of using $E(X) = \sum p_i x_i$ ***(M1)***
correct substitution ***(A1)***
e.g. $-1 \times 0.2 + 2 \times 0.4 + 3 \times 0.3$
$E(X) = 1.5$ ***A1*** ***N2***
[7 marks]

6) (a) correct substitution into formula for $E(X)$ ***(A1)***
e.g. 0.05×240

$E(X) = 12$ ***A1*** ***N2***
[2 marks]

(b) evidence of recognizing binomial probability (may be seen in part (a)) ***(M1)***
e.g. $\binom{240}{15}(0.05)^{15} (0.95)^{225}$, $X \sim B(240, 0.05)$

$P(X = 15) = 0.0733$ ***A1*** ***N2***
[2 marks]

(c) $P(X \leq 9) = 0.236$ ***(A1)***
evidence of valid approach ***(M1)***
e.g. using complement, summing probabilities

$P(X \geq 10) = 0.764$ ***A1*** ***N3***
[3 marks]

Total [7 marks]

7)

correct substitution into $\mathrm{E}(X) = \sum px$ (seen anywhere) ***A1***

e.g. $1s + 2\times 0.3 + 3q = 1.7$, $s + 3q = 1.1$

recognizing $\sum p = 1$ (seen anywhere) ***(M1)***

correct substitution into $\sum p = 1$ ***A1***

e.g. $s + 0.3 + q = 1$

attempt to solve simultaneous equations ***(M1)***

correct working ***(A1)***

e.g. $0.3 + 2q = 0.7, 2s = 1$

$q = 0.2$ ***A1*** ***N4***

[6 marks]

8)

Note: There may be slight differences in answers, depending on whether candidates use tables or GDCs, or their 3 sf answers in subsequent parts. Do not penalise answers that are consistent with **their** working and check carefully for ***FT***.

(a) evidence of recognizing binomial (seen anywhere in the question) ***(M1)***

e.g. ${}_nC_r\, p^r\, q^{n-r}$, $\mathrm{B}(n,\ p)$, ${}^{10}C_1 (0.012)^1 (0.988)^9$

$p = 0.108$ ***A1*** ***N2***

[2 marks]

(b) valid approach ***(M1)***

e.g. $\mathrm{P}(X \le 1)$, $0.88627\ldots + 0.10764\ldots$

$p = 0.994$ ***A1*** ***N2***

[2 marks]