

1

(a) $1 - 0.2 - 0.3 - 0.25 = 0.25$ (B1)

(b) $0.3 + 0.25 = 0.55$ (B1)

(c)

x	0	1	2	3
$F(x)$	0.2	0.45	0.75	1

- Correct $F(1)$ and $F(2)$ (M1)
- Fully correct table (A1)

(Total for question 1 is 4 marks)

2

(a)

x	1	2	3	4	5	6
$P(X = x)$	$\frac{1}{36}$	$\frac{3}{36}$	$\frac{5}{36}$	$\frac{7}{36}$	$\frac{9}{36}$	$\frac{11}{36}$

- At least 3 correct probabilities (M1)
- Fully correct table (A1)

(b) $\frac{3}{36} + \frac{5}{36} = \frac{8}{36}$ (B1)

(c)

x	1	2	3	4	5	6
$F(x)$	$\frac{1}{36}$	$\frac{4}{36}$	$\frac{9}{36}$	$\frac{16}{36}$	$\frac{25}{36}$	1

- Correct method for cumulative values (M1)
- Fully correct table (A1)

(Total for question 2 is 5 marks)

3

(a)

y	1	2	3	4	5	6
$P(Y = y)$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$

- All probabilities correct (B2)

(b) Discrete uniform distribution (B1)

(Total for question 3 is 3 marks)

4 $c = 0.2$ (B1) $e = 1$ (B1) $0.2 + a + 0.3 = 0.78 \implies a = 0.28$ (M1) $b = 1 - 0.78 = 0.22$
 (A1) $d = 0.2 + 0.28 = 0.48$ (A1)

(Total for question 4 is 5 marks)

- 5
- (a) Binomial PD: $P(X = 5) = 0.2123... \approx 0.212$ (B1)
- (b) Binomial CD: $P(X \leq 3) = 0.1727... \approx 0.173$ (B1)
- (c) Binomial CD: $P(X \leq 10) = 0.9972... \approx 0.997$ (B1)

(Total for question 5 is 3 marks)

- 6
- (a) $X \sim B(30, 0.1)$ $P(X = 1) = 0.1413... \approx 0.141$ (B1)
- (b) $P(X > 4) = 1 - P(X \leq 4) = 1 - 0.8245... = 0.1755... \approx 0.175$ (B1)
- (c) $P(X < 3) = P(X \leq 2) = 0.4113... \approx 0.411$ (B1)

(Total for question 6 is 3 marks)

- 7
- (a) $P(X = 1) = P(X = 2) = 0.16$ $P(X = 3) = P(X = 4) = \frac{1-0.32}{2} = 0.34$

x	1	2	3	4
$P(X = x)$	0.16	0.16	0.34	0.34

- Correct $P(X = 2)$ (B1)
 - Correct $P(X = 3)$ and $P(X = 4)$ (B1)
- (b) $n = 50, p = 0.34$ $P(X > 20) = 1 - P(X \leq 20)$ (M1) $= 1 - 0.8518... = 0.1482... \approx 0.148$ (A1)
- (c) $Y + X = (8 - 3X) + X = 8 - 2X$ $8 - 2X \geq 1 \implies 2X \leq 7 \implies X \leq 3.5$ (M1)
 $P(X \leq 3) = P(X = 1) + P(X = 2) + P(X = 3)$ (M1) $= 0.16 + 0.16 + 0.34 = 0.66$
 (A1)

(Total for question 7 is 8 marks)

- 8
- (a) Discrete uniform distribution (B1)
- (b) $X \sim B(40, 0.25)$ $P(X = 10) = 0.1443... \approx 0.144$ (B2)
- (c) $P(6 \leq X \leq 9) = P(X \leq 9) - P(X \leq 5)$ (M1) $= 0.4395... - 0.0432... = 0.3963... \approx 0.396$ (A1)

(Total for question 8 is 6 marks)

- 9 $P(X > 5) = 3 \times P(X \leq 5)$ Let $P(X \leq 5) = x$, then $x + 3x = 1 \Rightarrow x = 0.25$ $P(X \leq 5) = a + 0.2 = 0.25 \Rightarrow a = 0.05$ (M1) $P(X > 5) = b + 0.15 + 0.3 = 0.75 \Rightarrow b = 0.3$ (A1) Possible combinations for 25: (5, 20), (20, 5), (10, 15), (15, 10) (M1) $P(5, 20) = 0.2 \times 0.3 = 0.06$ $P(20, 5) = 0.3 \times 0.2 = 0.06$ $P(10, 15) = 0.3 \times 0.15 = 0.045$ $P(15, 10) = 0.15 \times 0.3 = 0.045$ (M1) Total probability = $0.06 + 0.06 + 0.045 + 0.045 = 0.21$ (A1)

(Total for question 9 is 6 marks)

- 10 (a) $X \sim B(8, 0.2)$ $P(X \geq 3) = 1 - P(X \leq 2)$ (M1) $= 1 - 0.7969... = 0.2031... \approx 0.203$ (A1)
- (b) Let $p = 0.2031...$ (from part a) $Y \sim B(3, p)$ $P(Y = 1) = 3 \times p \times (1 - p)^2$ (M1) $= 3 \times 0.2031 \times 0.7969^2 = 0.3869... \approx 0.387$ (A1)

(Total for question 10 is 4 marks)

11

s	0	1	2	3	4
$P(S = s)$	0.2	0.2	0.2	0.2	0.2

- Correct probabilities (1/5 or 0.2) (B2)

(Total for question 11 is 2 marks)

12

- (a) The probability of each throw landing in the bucket is independent OR the probability p is constant for each throw. (B2)
- (b) $P(X = 2) = 0.3087$ (B1)
- (c) $P(Y = 5)$ means 4 misses then 1 hit. $0.7^4 \times 0.3$ (M1) $= 0.07203$ (A1)

(Total for question 12 is 5 marks)

- 13 Sum of probabilities = 1 $0.05 + (0.05 + a) + (0.05 + 2a) + (0.05 + 3a) + (0.05 + 4a) = 1$ (M1) $0.25 + 10a = 1 \Rightarrow 10a = 0.75 \Rightarrow a = 0.075$ (A1)

s	1	2	3	4	5
$P(S = s)$	0.05	0.125	0.2	0.275	0.35

- Correct a (A1)
- At least 2 correct probabilities (M1)
- Fully correct table (A1)

(Total for question 13 is 5 marks)

14

- (a) $P(X \geq 3) = 1 - P(X \leq 2)$ (M1) $= 1 - 0.8202... = 0.1798... \approx 0.180$ (A1)
- (b) $P(X = 0) = 0.85^{10} = 0.19687...$ (M1) Expected games $= 38 \times 0.19687 = 7.48... \approx 7$ games (A1)
- (c) Expected ≥ 3 goals: $0.180 \times 38 = 6.84$. 6.84 is close to 6 and 7.48 is close to 7. This supports Erik's model. (B1)

(Total for question 14 is 5 marks)

15

- (a) $k + \frac{k}{2} + \frac{k}{3} + \frac{k}{4} + \frac{k}{5} = 1$ (M1) $\frac{60k+30k+20k+15k+12k}{60} = 1 \implies \frac{137k}{60} = 1$ (M1) $k = \frac{60}{137}$ (A1)
- (b) Combinations for 7: (2, 5), (5, 2), (3, 4), (4, 3) (M1) $P(2, 5) = \frac{k}{2} \times \frac{k}{5} = \frac{k^2}{10}$ $P(5, 2) = \frac{k^2}{10}$
 $P(3, 4) = \frac{k}{3} \times \frac{k}{4} = \frac{k^2}{12}$ $P(4, 3) = \frac{k^2}{12}$ (M1) Total $= 2(\frac{k^2}{10}) + 2(\frac{k^2}{12}) = k^2(\frac{1}{5} + \frac{1}{6}) = \frac{11k^2}{30}$
(M1) $= \frac{11}{30} \times (\frac{60}{137})^2 \approx 0.0703$ (A1)

(Total for question 15 is 7 marks)