A-LEVEL MATHS (EDEXCEL 9MA0) · STATISTICS YEAR 1 · CHAPTER 6: STATISTICAL DISTRIBUTIONS · A* EXAM PRACTICE

Hints online, answers free with an account:
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Statistical distributions: A* questions

73 marks

Date

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X A* exam questions

A to A*

Extended Edexcel-style questions. Show every step. The hints are at the end of the sheet. Use one at a time.

X1 Ada and Bo take turns to spin a spinner, Ada first. On each spin the spinner shows "win" with probability p, independently. The first player to get "win" wins the game. The game also stops after 6 spins (three each) if nobody has won. N is the number of spins made. The probability that the game ends with no winner is $0.262\,144$.

(a) Find p. [2 marks]

Answer .....

(b) Show that $\mathrm{P}(N = 6) = 0.327\,68$, and explain why this is not the same as the probability of no winner. [3 marks]

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(c) Find the probability that Ada wins. [3 marks]

Answer .....

(d) Find the probability that Bo wins. Hence find the probability that N is an even number. [3 marks]

Answer .....

Total for X1: 11 marks

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X2 The discrete random variable X has probability function $\mathrm{P}(X = x) = \dfrac{k}{x(x+1)}$ for $x = 1, 2, \ldots, n$, where k is a constant and $n \geqslant 2$. You may use $\dfrac{1}{x(x+1)} = \dfrac{1}{x} - \dfrac{1}{x+1}$. Find k in terms of n. Find the least value of n for which $\mathrm{P}(X > 1) > 0.48$, and for this value of n find $\mathrm{P}(X \leqslant 5)$. [9 marks]

Answer .....

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X3 Each item made by a machine is faulty with probability 0.03, independently.

(a) A sample of n items is checked. Find the least value of n for which the probability of at least 2 faulty items in the sample is more than 0.5. [4 marks]

Answer .....

(b) Samples of 56 items are checked one sample at a time. Checking stops when a sample has at least 2 faulty items, or after 4 samples. S is the number of samples checked. Find $\mathrm{P}(S = 4)$. [3 marks]

Answer .....

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(c) Find $\mathrm{P}(S \leqslant 2)$. [2 marks]

Answer .....

(d) Explain why S does not have a binomial distribution. [2 marks]

Total for X3: 11 marks

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X4 In a game, X is the number of heads when three fair coins are tossed, and Y is the score on a fair four-sided spinner numbered $0, 1, 2, 3$. X and Y are independent. Ann wins the game if $X > Y$, Bob wins if $Y > X$, and the game is a draw if $X = Y$.

(a) Find the probability that the game is a draw. [3 marks]

Answer .....

(b) Show that Ann and Bob are equally likely to win. [3 marks]

Answer .....

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(c) They play 8 games. Find the probability that at least 2 of them are draws. [3 marks]

Answer .....

(d) On another day they keep playing until a game is not a draw. Find the probability that more than 3 games are needed. [2 marks]

Answer .....

Total for X4: 11 marks

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X5 A buyer checks a random sample of n items from each large batch and accepts the batch if the sample has at most c faulty items. The buyer wants two things: a batch with 5% faulty items is accepted with probability at least 0.95, and a batch with 25% faulty items is accepted with probability at most 0.1. Show that $c = 2$ can never meet both conditions for any n, and find the least n, with its value of c, that meets both. [10 marks]

Answer .....

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X6 A survey of 80 families with 4 children each recorded the number of girls in each family. A researcher models the number of girls in a family by $G \sim \mathrm{B}(4, p)$.

Number of girls	0	1	2	3	4
Number of families	9	17	24	18	12

(a) Use the data to show that an estimate of p is 0.522 to 3 significant figures. [3 marks]

Answer .....

(b) Using $p = 0.522$, find the expected number of families with 0 girls and with 4 girls. [3 marks]

Answer .....

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(c) Compare these with the data. Give a reason, in context, why the binomial model may not suit these families. [3 marks]

(d) Using the model, find the probability that a family of 4 children has more girls than boys. [2 marks]

Answer .....

Total for X6: 11 marks

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X7 The discrete random variable X has the probability distribution $\mathrm{P}(X = 0) = \theta$, $\mathrm{P}(X = 1) = 2\theta^2$, $\mathrm{P}(X = 2) = 1 - \theta - 2\theta^2$, where θ is a constant.

(a) Find the set of values of θ for which this is a probability distribution. [4 marks]

Answer .....

(b) Two independent observations X_1 and X_2 of X are taken. Given that $\mathrm{P}(X_1 + X_2 = 1) = 0.032$, find θ and write down the distribution of X. [3 marks]

Answer .....

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(c) Ten independent observations of X are taken. Find the probability that at least 8 of them are equal to 2. [3 marks]

Answer .....

Total for X7: 10 marks

F How did it go?

Colour one circle on each line.

	Not yet	Nearly	Yes
I can build a probability distribution from a game or a series, find an unknown constant and use it.	○	○	○
I can find the least n, or the least c, that meets one or two conditions on binomial probabilities.	○	○	○
I can define a new random variable when each sample, day or game succeeds with a probability I have found.	○	○	○
I can fit a binomial model to data and criticise it in context.	○	○	○

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Hints

Use one hint at a time. Cover the ones below it with a sheet of paper.

X1

Hint 1 No winner means six spins in a row that are not "win".

Hint 2 $N = 6$ only needs the first five spins to fail. What can happen on the sixth spin?

Hint 3 Ada spins on turns 1, 3 and 5. Bo spins on turns 2, 4 and 6. N is even if Bo wins, and also if nobody wins.

X2

Hint 1 Write out the first few terms of $\sum\left(\frac{1}{x} - \frac{1}{x+1}\right)$. Most of them cancel.

Hint 2 $\mathrm{P}(X > 1)$ is $1 - \mathrm{P}(X = 1)$, and $\mathrm{P}(X = 1) = \frac{k}{2}$.

Hint 3 At $n = 25$ the probability is exactly 0.48, which is not more than 0.48. $\mathrm{P}(X \leqslant 5)$ is the same telescoping sum stopped at $x = 5$.

X3

Hint 1 "At least 2" is $1 - \mathrm{P}(X \leqslant 1)$. Try values of n in the fifties and show the values either side of 0.5.

Hint 2 Each sample now succeeds or fails with the probability you found in (a). Call it q.

Hint 3 $S = 4$ does not need the fourth sample to have 2 faulty items: checking stops after 4 samples anyway.

X4

Hint 1 Write the distribution of X first. Every value of Y has probability $\frac{1}{4}$.

Hint 2 For $X > Y$, fix $Y = y$ and find $\mathrm{P}(X > y)$ for each y. The three results (Ann, Bob, draw) add to 1.

Hint 3 For (c) each game is a trial whose "success" is a draw. For (d), more than 3 games means the first 3 are draws.

X5

Hint 1 Write both conditions as $\mathrm{P}(\ldots \leqslant c)$ for two different binomial distributions with the same n.

Hint 2 For a fixed c, both probabilities get smaller as n gets bigger. So the first condition gives an upper limit on n and the second a lower limit.

Hint 3 With $c = 2$ the upper limit is below the lower limit. Try $c = 3$: find the least n for the second condition, then check the first at that n.

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X6

Hint 1 The estimate of p is the proportion of all the children who are girls.

Hint 2 An expected frequency is $80\times$ the probability from the model.

Hint 3 Look at the two ends of the table together. What would make families with all girls or all boys more common than chance?

X7

Hint 1 Every probability must be at least 0. Which one can become negative? Solve that quadratic inequality, then combine it with $\theta \geqslant 0$.

Hint 2 A total of 1 needs one observation to be 0 and the other to be 1. There are two orders.

Hint 3 Each observation is 2 or not, independently, with the probability you found in (b): count them with a binomial distribution.

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