

QQQ – Statistics Year 1 – Chapter 6 – DRVs & Binomial Distribution (Version 2)

Total Marks: 24

(24 = Platinum, 22 = Gold, 19 = Silver, 16 = Bronze)

1. The probability distribution for the discrete random variable X is shown below.

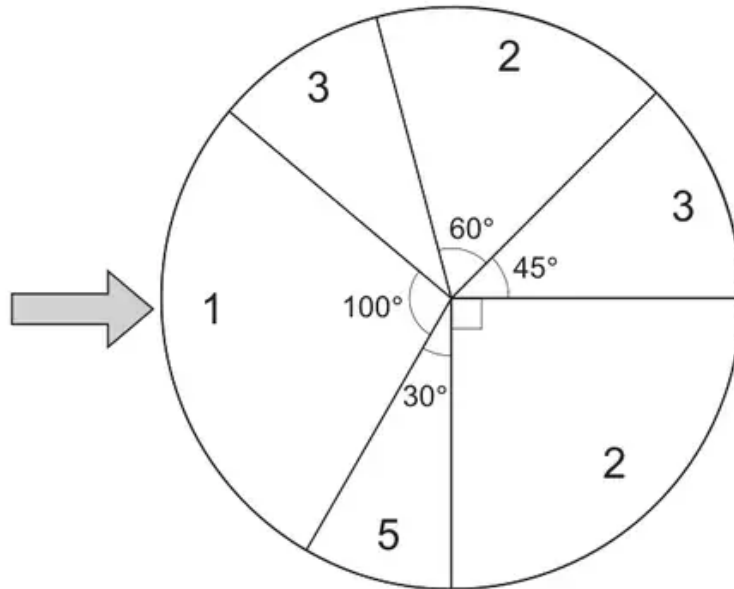
x	1	2	3	4	5
$P(X = x)$	0.2	0.15	a	0.27	0.14

Find the value of a .

[1]

(Total 1 marks)

2. A game consists of spinning a circular wheel divided into numbered sectors as shown below.



On each spin the score, X , is the value shown in the sector that the arrow points to when the spinner stops.

The probability of the arrow pointing at a sector is proportional to the angle subtended at the centre by that sector.

(a) Show that $P(X = 1) = \frac{5}{18}$ [1 mark]

(b) Complete the probability distribution for X in the table below.

x	1			
$P(X = x)$	$\frac{5}{18}$			

[2 marks]

(Total 3 marks)

3. It is known that 3% of the batteries sold in a supermarket are faulty.

Batteries are sold in packs of 12.

It can be assumed that the number of faulty batteries in a pack can be modelled by a binomial distribution.

(a) State **one** assumption, in context, necessary for the binomial distribution to be valid.

[1 mark]

(b) A pack of batteries is chosen at random.

Find the probability that exactly one battery in this pack is faulty.

[1 mark]

(c) A quality control supervisor tests 10 randomly chosen packs for faulty batteries.

Find the probability that at least two of the chosen packs have exactly one battery which is faulty.

[2 marks]

(Total 4 marks)

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4. The discrete random variable X is modelled by the probability distribution defined by:

$$P(X = x) = \begin{cases} cx & x = 1, 2 \\ kx^2 & x = 3, 4 \\ 0 & \text{otherwise} \end{cases}$$

where k and c are constants.

(a) State, in terms of k , the probability that $X = 3$

[1 mark]

(b) Given that $P(X \geq 3) = 3 \times P(X \leq 2)$

Find the exact value of k and the exact value of c .

[4 marks]

(Total 5 marks)

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5. The probability that Janice sees a kingfisher on any particular day is 0.3. She notes the number, X , of days in a week on which she sees a kingfisher.

- (i) State one necessary condition for X to have a binomial distribution. [1]

Assume now that X has a binomial distribution.

- (ii) Find the probability that, in a week, Janice sees a kingfisher on exactly 2 days. [1]

Each week Janice notes the number of days on which she sees a kingfisher.

- (iii) Find the probability that Janice sees a kingfisher on exactly 2 days in a week during at least 4 of 6 randomly chosen weeks. [3]

(Total 5 marks)

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6. A fair 5-sided spinner has sides numbered 1, 2, 3, 4 and 5

The spinner is spun once and the score of the side it lands on is recorded.

- (a) Write down the name of the distribution that can be used to model the score of the side it lands on. (1)

The spinner is spun 28 times.

The random variable X represents the number of times the spinner lands on 2

- (b) (i) Find the probability that the spinner lands on 2 at least 7 times.
(ii) Find $P(4 \leq X < 8)$ (5)

(Total 6 marks)

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Solutions

1.

Scheme	Marks	AO
$a = 0.24$	B1	1.1
	[1]	

Notes

$$\text{NB } 0.2 + 0.15 + a + 0.27 + 0.14 = 1$$

2.

Mark scheme (a)

Scheme	Marks	AO
Shows clearly where $\frac{5}{18}$ comes from.	B1	3.1b
Need to see $\frac{100}{360}$ and simplification.		
	(1)	

Typical solution

$$\begin{aligned} P(X = 1) &= \frac{100}{360} \\ &= \frac{5}{18} \end{aligned}$$

Mark scheme (b)

Scheme	Marks	AO
States at least one pair of $(X, P(X = x))$ correctly	M1	1.1a
Completes table correctly ACF	A1	1.1b
	(2)	
	(3 marks)	

Typical solution

X	2	3	5
$P(X = x)$	$\frac{5}{12}$	$\frac{2}{9}$	$\frac{1}{12}$

3.

Mark scheme (a)

Scheme	Marks	AO
States one assumption in context. Accept - One battery being faulty is independent of any other battery OE - Two possible outcomes Battery is faulty or not faulty - The probability of a battery being faulty is constant at 3% But not fixed number of trials	E1	3.5b
	(1)	

Typical solution

One battery being faulty is independent of any other battery being faulty.

Mark scheme (b)

Scheme	Marks	AO
Obtains AFWF [0.2575, 0.26]	B1	1.1b
	(1)	

Typical solution

$P(1 \text{ battery is faulty}) = 0.2575$

Mark scheme (c)

Scheme	Marks	AO
States $B(10, \text{their } p)$ from (b)	M1	3.4
Obtains AFWF [0.77, 0.78]	A1	1.1b

	(2)	
	(4 marks)	

Typical solution

Use a $X \sim B(10, 0.2575)$ model

$$\begin{aligned}
 P(X \geq 2) &= 1 - P(X \leq 1) \\
 &= 1 - 0.2275 \dots \\
 &= 0.772
 \end{aligned}$$

4.

Mark scheme (a)

Scheme	Marks	AO
Obtains $9k$	B1	1.1b
	(1)	

Typical solution

$$9k$$

Mark scheme (b)

Scheme	Marks	AO
Uses probabilities $c, 2c, 9k, 16k$	B1	1.1b
Uses $\Sigma p = 1$ to obtain an equation in k and c , at least one term in k or c correct or Uses ratio of 1:3(:4) to obtain an equation either in c related to 0.25 or in k related to 0.75. At least one term in k or c correct [$c + 2c = 0.25$; $9k + 16k = 0.75$]	M1	3.1a
Uses ratio of 1:3 to find an equation in k and c , at least one term in k or c correct or	M1	1.1a

Obtains a second equation in k or c using the ratio of 1:3(:4), at least one term in k or c correct		
Obtains correct exact values for k and c (ACF but must be exact)	A1	1.1b
	(4)	
	(5 marks)	

Typical solution

$$c + 2c + 9k + 16k = 1$$

$$3c + 25k = 1$$

$$9k + 16k = 3(c + 2c)$$

$$25k = 9c$$

$$c = \frac{1}{12}$$

$$k = \frac{3}{100}$$

5.

Mark scheme (i)

Scheme	Marks	AO
Prob of seeing a kingfisher is the same each day OR Seeing a kingfisher on one day is independent of other days	B1	3.5b
	[1]	

Notes

B1: oe

In context

Not: Prob of seeing kingfisher is indep

Mark scheme (ii)

Scheme	Marks	AO
0.318 (3 sf)	B1	3.4

	[1]	
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Notes

B1: BC Allow 0.32 or 0.317

Mark scheme (iii)

Scheme	Marks	AO
0.318 or their (ii) used in a calculation	M1	3.1b
$1 - P(X \leq 3)$ using $p = 0.318$ or their (ii)	M1	1.1
$= 0.0854$	A1	1.1
	[3]	

Notes

M1 (first): or $B(6, \text{their (ii)})$ stated

M1 (second): or $P(X = 4, 5, 6)$ attempted using $p = 0.318$ or their (ii)

A1: Allow 0.0845 to 0.0875 Allow 2 sf **BC**

6.

Mark scheme (a)

Scheme	Marks	AO
(Discrete) uniform (distribution)	B1	1.2
	(1)	

Notes

Continuous uniform is B0

Mark scheme (b)

Scheme	Marks	AO
$B(28, 0.2)$	B1	3.3
(i) $P(X \geq 7) = 1 - P(X \leq 6)$ [$= 1 - 0.6784 \dots$]	M1	3.4
awrt 0.322	A1	1.1b

(ii) $P(4 \leq X < 8) = P(X \leq 7) - P(X \leq 3) [= 0.818 \dots - 0.160 \dots]$	M1	3.1b
awrt <u>0.658</u>	A1	1.1b
	(5)	
	(6 marks)	

Notes

B1: for identifying correct model, $B(28, 0.2)$

allow B, bin or binomial

may be implied by one correct answer or sight one correct probability i.e. awrt 0.678, awrt 0.818 or awrt 0.160

$B(0.2, 28)$ is B0 unless it is used correctly

(i)

M1: Writing or using $1 - P(X \leq 6)$ or $1 - P(X < 7)$

A1: awrt 0.322 (correct answer only scores M1A1)

(ii)

M1: Writing or using $P(X \leq 7) - P(X \leq 3)$

or $P(X < 8) - P(X < 4)$

or $P(X = 4) + P(X = 5) + P(X = 6) + P(X = 7)$

Condone $P(4)$ as $P(X = 4)$, etc.

A1: awrt 0.658 (correct answer only scores M1A1)