Cambridge International AS & A Level

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Mathematics 9709/52

Paper 5 Probability & Statistics 1 **October/November 2025**

Question No (2)

2 Kayla has a bag containing 3 red marbles, 1 blue marble and 2 green marbles. She selects one marble from the bag at random and does not replace it in the bag. She repeats this process until she obtains a green marble. The random variable X is the number of marbles that she needs to select until she obtains a green marble.

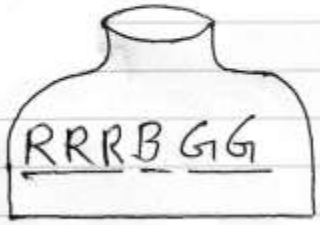
(a) Draw up the probability distribution table for X.

(b) Find $\text{Var}(X)$.

Solution:

(a)

Total marbles = 6



Non-Green marbles = 4 (3R+1B)

Green marbles = 2

Since she stops when the first green is obtained (without replacement)

X can be

$X = 1, 2, 3, 4, 5$

(It can not be 6 because there are only 4 non-green marbles)

P(X=1)

First pick is green

$$P(X=1) = \frac{2}{6}$$

$$= \frac{1}{3}$$

P(X = 2)

First non-green then green

$$P(X=2) = \frac{4}{6} \times \frac{2}{5}$$

$$= \frac{4}{15}$$

$P(X=3)$

Two non-Green Then green

$$P(X=3) = \frac{4}{6} \times \frac{3}{5} \times \frac{2}{4}$$

$$= \frac{1}{5}$$

$P(X=4) =$

Three non-Green, Then green

$$P(X=4) = \frac{4}{6} \times \frac{3}{5} \times \frac{2}{4} \times \frac{2}{3}$$

$$= \frac{2}{15}$$

$P(X=5)$

Four non-Green Then green

$$P(X=5) = \frac{4}{6} \times \frac{3}{5} \times \frac{2}{4} \times \frac{1}{3} \times \frac{2}{2}$$

$$= \frac{1}{15}$$

Probability distribution table

X	1	2	3	4	5
P(X)	1/3	4/15	1/5	2/15	1/15

(b)

$$E(X) = \sum x\,p(x)$$

$$= 1\cdot\frac{1}{3} + 2\cdot\frac{4}{15} + 3\cdot\frac{1}{5} + 4\cdot\frac{2}{15} + 5\cdot\frac{1}{15}$$

$$= \frac{5}{15} + \frac{8}{15} + \frac{9}{15} + \frac{8}{15} + \frac{5}{15}$$

$$= \frac{5+8+9+8+5}{15}$$

$$E(X) = \frac{35}{15} = \frac{7}{3}$$

$$Var(X) = \sum x^2 p(x) - (E(X))^2$$

$$= (1)^2\frac{1}{3} + (2)^2\left(\frac{4}{15}\right) + (3)^2\frac{1}{5} + (4)^2\frac{2}{15} + (5)^2\frac{1}{15} - \left(\frac{7}{3}\right)^2$$

$$= \frac{1}{3} + \frac{16}{15} + \frac{9}{5} + \frac{32}{15} + \frac{25}{15} - \frac{49}{9}$$

$$= \frac{15+48+81+96+75-245}{45}$$

$$= \frac{70}{45}$$

$$Var(X) = \frac{14}{9}$$