I.G.C.S.E. Probability

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Question 1

A fair die is thrown once. Find the probability of obtaining a
a. a one
b. an odd number
c. number less than three
d. a prime number

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Solution to question 1

a. The possibility space is \( \{1, 2, 3, 4, 5, 6\} \)
\[ p(\text{a one}) = \frac{1}{6} \]

b. The odd numbers are \( \{1, 3, 5\} \)
\[ p(\text{an odd number}) = \frac{3}{6} = \frac{1}{2} \]

c. The numbers less than three are \( \{1, 2\} \)
\[ p(\text{a number less than three}) = \frac{2}{6} = \frac{1}{3} \]

d. The prime numbers are \( \{2, 3, 5\} \). Note: 1 is not a prime number.
\[ p(\text{a prime number}) = \frac{3}{6} = \frac{1}{2} \]

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**Question 2**

One letter is selected from the word ‘MATHEMATICS’. Find the probability of selecting

a. an A
b. a M
c. a M or a T
d. a vowel
e. a K

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Solution to question 2

Considering the word ‘MATHEMATICS’, there are eleven letters.

a. There are two A’s, therefore \( p(\text{an A}) = \frac{2}{11} \)

b. There are two M’s, therefore \( p(\text{a M}) = \frac{2}{11} \)

c. The event picking a M or a T are mutually exclusive, (they cannot happen at the same time). Therefore we must add the corresponding probabilities.
\[
p(\text{a M or a T}) = p(\text{a M}) + p(\text{a T})
= \frac{2}{11} + \frac{2}{11}
= \frac{4}{11}
\]

d. The vowels are \{a, e, i, o, u\}. The word MATHEMATICS contains two A’s, one E, and one I, which makes four in total.
\[
p(\text{a vowel}) = \frac{4}{11}
\]

e. There are no K’s in the word MATHEMATICS.
\[
p(\text{a K}) = 0
\]

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Question 3

A red die and a blue die are both thrown. Display all the possible outcomes on a probability space diagram. Find the probability of scoring

a. a total of 7,
b. more than 8,
c. less than 5.

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Solution to question 3

Displaying all the possible outcomes on a probability space diagram

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**a.** From the diagram we can see that there are 36 possible outcomes. There are six ways that we can get a 7 shown in red on the diagram.

\[
p(\text{a total of 7}) = \frac{6}{36} = \frac{1}{6}
\]

**b.** The numbers more than 8 are marked in green on the diagram.

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There are 10 possible outcomes.

\[
p(\text{more than 8}) = \frac{10}{36} = \frac{5}{18}
\]

**c.** The numbers less than 5 are marked in orange in the diagram.

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There are 10 possible outcomes.

\[
p(\text{less than 5}) = \frac{6}{36} = \frac{1}{6}
\]
Question 4

A coin and a die are thrown. Write down the probability of obtaining
a. a head and an even number on the die
b. a tail and 3 or 4 on the die.

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Solution to question 4

A coin and a die are thrown. Write down the probability of obtaining

a. The events a head and an even number on the die are independent i.e one event does not affect the other.

Either

\[ p(\text{a head on a coin}) = \frac{1}{2} \] and the \[ p(\text{an even number on a die}) = \frac{3}{6} = \frac{1}{2} \]

\[ p(\text{a head and an even number}) = p(\text{a head}) \times p(\text{an even number}) \]

\[ = \frac{1}{2} \times \frac{1}{2} \]

\[ = \frac{1}{4} \]

or drawing a possibility space diagram we can see that the possibility space is 12. There are three possible outcomes of getting a head and a even number.

\[
\begin{array}{ccccccc}
\text{coin} & \text{H} & \text{H,1} & \text{H,2} & \text{H,3} & \text{H,4} & \text{H,5} & \text{H,6} \\
\text{T} & \text{T,1} & \text{T,2} & \text{T,3} & \text{T,4} & \text{T,5} & \text{T,6} \\
\text{die} & 1 & 2 & 3 & 4 & 5 & 6 \\
\end{array}
\]

\[ p(\text{a head and an even number}) = \frac{3}{12} = \frac{1}{4} \]

b. The events of getting a tail and 3 or 4 on the die are mutually exclusive i.e cannot happen at the same time. The two outcomes are marked on the possibility space in green.

\[
\begin{array}{ccccccc}
\text{coin} & \text{H} & \text{H,1} & \text{H,2} & \text{H,3} & \text{H,4} & \text{H,5} & \text{H,6} \\
\text{T} & \text{T,1} & \text{T,2} & \text{T,3} & \text{T,4} & \text{T,5} & \text{T,6} \\
\text{die} & 1 & 2 & 3 & 4 & 5 & 6 \\
\end{array}
\]

\[ p(\text{a tail and 3 or 4 on the die}) = \frac{2}{12} = \frac{1}{6} \]

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Question 5

A bag contains 5 green balls and 3 blue balls. A ball is drawn and is **not** replaced. A second ball is drawn. Draw a tree diagram to show all the possible outcomes.
Find the probability of drawing,
**a.** two green balls,
**b.** one green ball and one blue ball.
**c.** at least one blue ball.

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Solution to question 5

Drawing a tree diagram to show all the possible outcomes.

\[
\begin{align*}
p(G_1) &= \frac{4}{7} \\
p(G_2) &= \frac{3}{7} \\
p(B_1) &= \frac{5}{7} \\
p(B_2) &= \frac{2}{7}
\end{align*}
\]

\[
p(G_1 \text{ and } G_2) = \left(\frac{5}{8}\right) \left(\frac{4}{7}\right) = \frac{20}{56}
\]

\[
p(G_1 \text{ and } B_2) = \left(\frac{5}{8}\right) \left(\frac{3}{7}\right) = \frac{15}{56}
\]

\[
p(B_1 \text{ and } G_2) = \left(\frac{3}{8}\right) \left(\frac{5}{7}\right) = \frac{15}{56}
\]

\[
p(B_1 \text{ and } B_2) = \left(\frac{3}{8}\right) \left(\frac{2}{7}\right) = \frac{6}{56}
\]

a. \( p(\text{two green balls}) = p(G_1 \text{ and } G_2) = \left(\frac{5}{8}\right) \left(\frac{4}{7}\right) = \frac{20}{56} = \frac{5}{14} \)

b. Considering the tree diagram

\[
p(\text{one green ball and one blue ball}) = p(G_1 \text{ and } B_2) + p(B_1 \text{ and } G_2)
\]

\[
= \left(\frac{5}{8}\right) \left(\frac{3}{7}\right) + \left(\frac{3}{8}\right) \left(\frac{5}{7}\right)
\]

\[
= \frac{15}{56} + \frac{15}{56}
\]

\[
= \frac{30}{56}
\]

\[
= \frac{15}{28}
\]

c. \( p(\text{at least one blue ball}) = 1 - p(\text{two green balls})
\]

\[
= 1 - \frac{5}{14}
\]

\[
= \frac{9}{14}
\]

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Question 6

A study is made of a group of students. In the group there are 14 boys and 16 girls. Of the boys it is found 8 of them like Mathematics and of the girls 10 like Mathematics. Draw a tree diagram and find the probability that a student chosen at random

a. is a boy and likes Mathematics.

b. is a girl and does not like Mathematics

c. likes Mathematics.

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Solution to question 6

Drawing the tree diagram

a. \( p(\text{a boy and likes Mathematics}) = p(B \text{ and } M) = \left(\frac{14}{30}\right) \left(\frac{8}{14}\right) = \frac{8}{30} = \frac{4}{15} \)

b. \( p(\text{a girl and does not like Mathematics}) = p(G \text{ and } M') = \left(\frac{16}{30}\right) \left(\frac{6}{16}\right) = \frac{6}{30} = \frac{1}{5} \)

c. \( p(\text{likes Mathematics}) = p(B \text{ and } M) + p(G \text{ and } M) \)

\[
= \left(\frac{14}{30}\right) \left(\frac{8}{14}\right) + \left(\frac{16}{30}\right) \left(\frac{10}{16}\right) \\
= \frac{10}{30} + \frac{8}{30} \\
= \frac{18}{30} \\
= \frac{3}{5}
\]

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