

Lesson 4

A-Level Applied Mathematics : Statistics : Year 2 Set Theory and Probability II

4.1 The Addition Rule

At GCSE level, the phrase is often used that “or means add” and this is true when two events, A and B , are mutually exclusive.

That is $P(A \cup B) = P(A) + P(B)$ when $P(A \cap B) = \emptyset$

However, the full rule, without the “mutually exclusive” restriction is this;

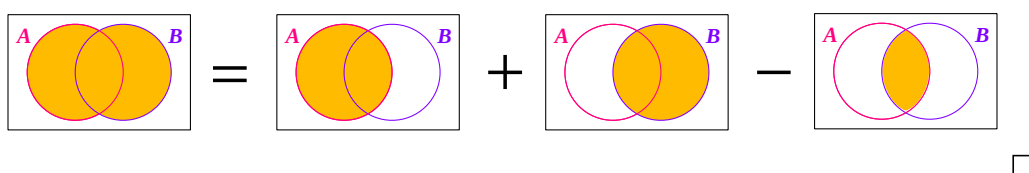
The Addition Rule

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

Often the rule is rearranged and used to find $P(A \cap B)$

Proof

The truth of the Addition Rule is made obvious by thinking of Venn Diagrams;



© MAZK ANDERSON, WWW.ANDERSTOONS.COM



"This Venn diagram tells us nothing,
but it's so cute!"

4.2 Exercise

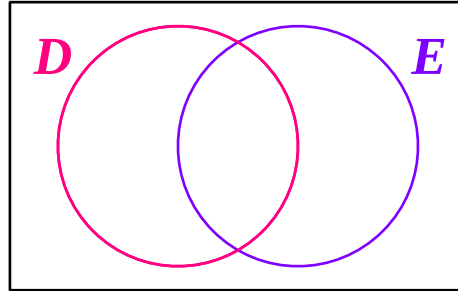
Any solution based entirely on graphical or numerical methods is not acceptable

Marks Available: 50

Question 1

Given that $P(D) = 0.6$, $P(E) = 0.3$ and $P(D \cup E) = 0.8$,

(a) annotate the Venn Diagram with the appropriate probabilities.



[3 marks]

(b) Find,

(i) $P(D \cap E)$

(ii) $P(D' \cap E)$

(iii) $P(D \cap E')$

(iv) $P(D' \cap E')$

(v) $P(D \cup E')$

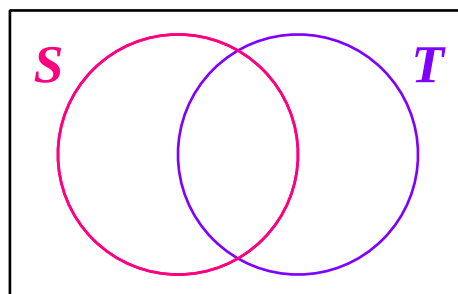
(vi) $P(D' \cup E)$

[6 marks]

Question 2

Given that, $P(T) = 0.4$, $P(S \cap T) = 0.15$ and $P(S' \cap T') = 0.5$.

(a) annotate the Venn Diagram with the appropriate probabilities.



[3 marks]

(b) Find,

(i) $P(S \cap T')$

(ii) $P(S)$

(iii) $P(S \cup T)$

(iv) $P(S' \cap T)$

(v) $P(S' \cup T')$

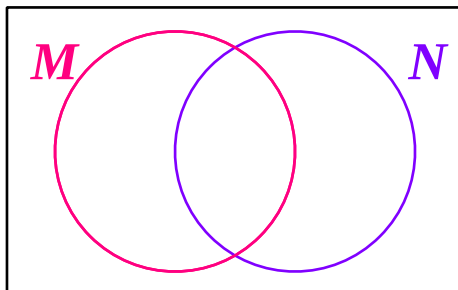
[5 marks]

Question 3

The events M and N are such that $P(M) = P(N) = 2P(M \cap N)$

Furthermore, $P(M \cup N) = 0.6$

(a) annotate the Venn Diagram with the appropriate probabilities.



[3 marks]

(b) Find,

(i) $P(M \cap N)$

(ii) $P(M)$

(iii) $P(M' \cap N')$

(iv) $P(M \cap N')$

[4 marks]

Question 4

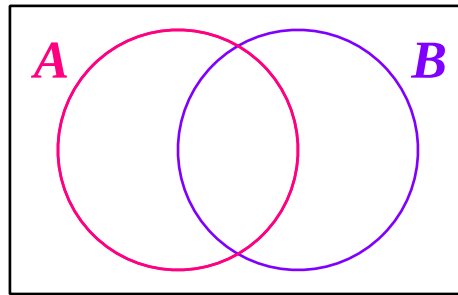
Of the households in Shrewsbury, 85% have an internet connection and 35% have satellite TV. Given that 25% of the households have both an internet connection and satellite TV, calculate the percentage probability that a household has either an internet connection or satellite TV but not both.

[5 marks]

Question 5

Given that, $P(A) = 0.7$, $P(B) = 0.4$ and $P(A \cup B) = 0.8$,

(a) annotate the Venn Diagram with the appropriate probabilities.



[3 marks]

(b) Find,

(i) $P(A \cap B)$

(ii) $P(A | B)$

(iii) $P(B | A)$

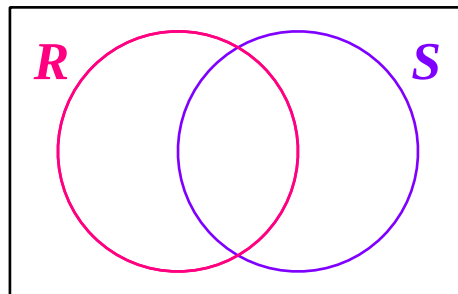
(iv) $P(A | B')$

[4 marks]

Question 6

Given that, $P(R | S) = 0.5$, $P(R | S')$ and $P(S) = 0.6$,

(a) annotate the Venn Diagram with the appropriate probabilities.



[3 marks]

(b) Find,

(i) $P(R)$

(ii) $P(S | R)$

(iii) $P(S' | R)$

(iv) $P(S' | R')$

[4 marks]

Question 7



In a forest are red squirrels and grey squirrels.

55% of the squirrels are red.

During a sunny autumn afternoon 65% of the squirrels gather nuts.

Only 40% of the grey squirrels gather nuts.

A squirrel is selected at random.

Find the probability that the squirrel is,

- (i) a red who is gathering nuts,
- (ii) a grey who is not gathering nuts,
- (iii) a red given that it is gathering nuts.

[7 marks]

This document is a part of a **Mathematics Community Outreach Project** initiated by Shrewsbury School

It may be freely duplicated and distributed, unaltered, for non-profit educational use

In October 2020, Shrewsbury School was voted "**Independent School of the Year 2020**"

© 2021 Number Wonder

Teachers may obtain detailed worked solutions to the exercises by email from mhh@shrewsbury.org.uk