

# Sets and Venn Diagrams

Probability 1  
Chapter 1, Pages 3 - 11  
Chapter 2, Pages 331 - 351

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## Set Notation

- Elements of a set are written in curly brackets { }
- $U$  = the universal set
- $A \cup B$  = the union of sets A and B (everything in both sets)
- $A \cap B$  = the intersection of sets A & B
- $A^c$  = the complement of set A (everything in U but not in A)
- $A \subset B$  = A is a proper subset of B (totally inside another set)
- $A \subseteq B$  = A is a subset of B (either inside or equal to another set)
- $A \not\subseteq B$  = A is not a subset of B
- $\emptyset$  = the empty set
- $n(A)$  = the number of elements in set A
- $6 \in A$  = 6 is a member of set A
- $5 \notin A$  = 5 is not a member of set A

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## Set Notation

- Uses set brackets, if the number set isn't listed, assume it is the set of real numbers.
- $S = \{x \mid 2 < x \leq 5, x \in \mathbb{R}\}$  *often left out*
- "the set S, of all x such that x is a real number greater than 2 and less than or equal to 5, x is a member of the real numbers."
- (number line representation)
- $T = \{x \mid -5 \leq x \leq -1, x \in \mathbb{Z}\}$
- "the set T, of all x such that x is an integer greater than or equal to -5 and less than or equal to -1"
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## Interval Notation

- Interval notation uses brackets to represent the  $<$  and  $\geq$  symbols. Only the lower and upper boundaries of the interval are written.
- $[ ]$  = closed interval = includes the numbers listed  
[-2, 4] = the set  $\{x: -2 \leq x \leq 4\}$
- $( )$  = open interval = doesn't include the numbers listed  
(-2, 4) = the set  $\{x: -2 < x < 4\}$
- $S = \{x \mid x \leq 15, x \in \mathbb{R}\}$   
(the set of all real numbers less than or equal to 15)  
In interval notation, this is:  $(-\infty, 15]$
- NOTE  $(\infty)$  is not a number so you can't use a closed square bracket

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## Examples to Try

- Use interval notation to describe all the numbers: *(assume  $\in \mathbb{R}$ )*
  - from -180 to 150 inclusive  $[-180, 150]$
  - less than 16.3  $(-\infty, 16.3)$
  - greater than or equal to 16.3  $[16.3, \infty)$
  - between 0 and  $4\pi$  including  $4\pi$  but not 0  $(0, 4\pi]$
- For each interval above, show the interval on a number line.
  - 
  - 
  - 
  -

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## Examples to Try

- Write down two proper subsets of the interval [1, 9] which contain the number 7.  $\{2, 7, 8\}$ ,  $\{7\}$ ,  $\{4, 7\}$
- State which of these subset relations are correct & which are incorrect.
  - $(-1, 1) \subset [-1, 1]$
  - $[-1, 1] \subset (-1, 1)$
  - $(-1, 1) \subset [-1, 1]$
  - $0 \subset [-1, 1]$
  - $(-1, 1) \subset [-1, 1]$

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## Number Sets

- $\mathbb{N}$  to represent the set of all **natural numbers**  $\{0, 1, 2, 3, 4, 5, 6, \dots\}$
- $\mathbb{Z}$  to represent the set of all **integers**  $\{0, \pm 1, \pm 2, \pm 3, \pm 4, \pm 5, \pm 6, \dots\}$
- $\mathbb{Z}^+$  to represent the set of all **positive integers**  $\{1, 2, 3, 4, 5, 6, \dots\}$
- $\mathbb{Z}^-$  to represent the set of all **negative integers**  $\{-1, -2, -3, -4, \dots\}$

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## Number Sets

- $\mathbb{Q}$  to represent the set of all **rational numbers** *fractions, decimals that end, or repeat in a pattern*
- Rational numbers have the form  $\frac{p}{q}$  where  $p$  and  $q$  are integers and  $q \neq 0$ .  
For example:  $\frac{15}{4}$ ,  $10$  ( $= \frac{10}{1}$ ),  $0.5$  ( $= \frac{1}{2}$ ),  $-\frac{3}{8}$  are all rational numbers.
- Numbers which cannot be written in rational form are called **irrational numbers**.
- For example: Radicals (or surds) such as  $\sqrt{2}$  and  $\sqrt{7}$  are irrational.  
 $\pi$  which is 3.14159265... is an irrational number.  
Non-recurring decimal numbers and numbers such as 0.122333444455... are irrational. *decimals with no pattern*
- $\mathbb{R}$  to represent the set of all **real numbers**

Real numbers include all numbers which can be placed on the number line.  
For example,  $\frac{1}{8} = 0.125$ ,  $\sqrt{2} = 1.41421356\dots$ ,  $\pi = 3.14159265\dots$  are all real numbers.  
 $\frac{2}{3}$  and  $\sqrt{-2}$  are not real numbers because we cannot write them in decimal form.

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## Number Sets

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## Venn Diagrams

$U$  universal set  
*must draw for every diagram*

$A \cap B$  intersection  
in both A and B

$A \cup B$  union  
anything in A or B

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## Venn Diagrams

$A'$  = complement of A

$A \subset B$  subset

A and B are disjoint  
 $A \cap B = \emptyset$

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## Examples to Try

5. If  $U = \{\text{positive integers less than } 10\}$ ,  $A = \{2, 3, 5, 7\}$  and  $B = \{2, 4, 6, 8\}$

a) Draw a Venn diagram to represent this information.

Find the sets represented by:  
(sketch a small diagram shaded to show each solution)

b)  $A \cup B = \{2, 3, 4, 5, 6, 7, 8\}$

c)  $A \cap B = \{2\}$

d)  $A' = \{1, 4, 6, 8, 9\}$

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### Examples to Try

5. If  $U = \{\text{positive integers less than } 10\}$ ,  $A = \{2, 3, 5, 7\}$  and  $B = \{2, 4, 6, 8\}$

Find the sets represented by:  
(sketch a small diagram shaded to show each solution)

e)  $B'$  =  $\{1, 3, 5, 7, 9\}$

f)  $A \cap B$  =  $\{2, 4, 6, 8\}$  *answer = both colours*

g)  $A \cup B$  =  $\{2, 3, 4, 5, 6, 7, 8\}$  *answer = any colour*

h)  $(A \cup B)'$  =  $\{1, 9\}$

i) What is  $n(B)$ ? = 4 (counting not making a set)

$A \cap B$

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### Examples to Try

6. Given  $U = \{1, 2, 3, 4, 5, 6, 7, 8, 9\}$ , illustrate on a Venn diagram the sets:

a)  $A = \{2, 4, 8\}$  and  $B = \{1, 3, 5, 9\}$   
 b)  $A = \{2, 4, 6, 8\}$  and  $B = \{1, 3, 5, 7, 9\}$

i)  $\{1, 3, 5, 9\}$   
ii)  $\emptyset$

i)  $\{1, 3, 5, 7, 9\}$   
ii)  $\emptyset$

c) For each example, find the sets:

i)  $A' \cap B$  both colours

ii)  $A \cap B$

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### Examples to Try

7. A squash club has 27 members. 19 have black hair, 14 have brown eyes and 11 have both black and brown eyes.

a) Place this information on a Venn diagram.  
 b) Hence, find the number of members with:

i) black hair or brown eyes (but not both)  
 ii) black hair, but not brown eyes

$27 - (8 + 11 + 3) = 5$

b) i) BH or BE =  $8 + 3 + 11 = 22$

ii) 8

*always start here*  
*"both" = intersection*

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### Examples to Try

8. This diagram shows the numbers of students taking the IB diploma in a school and also the numbers attending lessons in certain subjects.

The classes are represented by sets S: {Mathematical studies}, G: {German} and M: {Music}

Find the number of IB students studying:

a) None of the 3 subjects 73

b) Music and German but not math studies 6

c) Music or German, but not both  $\{8 + 9 + 3 + 13\} = 33$

d) Math studies or music but not German  $\{22 + 3 + 13\} = 38$

e) All three subjects, if there are 136 students in this sample.

$136 - (73 + 22 + 8 + 9 + 6 + 13 + 3) = 2 = x$

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### Examples to Try

9. A poll was taken of the leisure time activities of 90 students. 60 students watch TV (T), 60 students read (R), 70 students go to the cinema (C). 26 students watch TV, read and go to the cinema. 20 students watch TV and go to the cinema only. 18 students read and go to the cinema only. 10 students read and watch TV only.

a) Draw a Venn diagram to illustrate the above information.  
 b) Calculate how many students

i) only watch TV  
 ii) only go to the cinema

i)  $60 - (20 + 26 + 10) = 4$

ii)  $70 - (20 + 26 + 18) = 6$

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### Examples to Try

10. A city has three newspapers A, B and C. Of the adult population, 1% read none of these newspapers, 36% read A, 40% read B, 52% read C, 8% read A and B, 11% read B and C, 13% read A and C and 3% read all three papers.

a) Draw a Venn diagram to represent this information  
 b) What percentage of the adult population read:

i) newspaper A only = 18%  
 ii) newspaper B or newspaper C = 24 + 5 + 3 + 8 + 10 + 3 + 1 = 54%  
 iii) newspaper A or B but not C. or  $100 - 19 = 81\%$

$36 - (10 + 3 + 5) = 18$

B only =  $40 - (8 + 5 + 3) = 24$

C only =  $52 - (10 + 3 + 8) = 31$

ii)  $24 + 5 + 18 = 47\%$

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# Homework

**Chapter 1, p34: Q1, 2 and 10**  
**Ex 8A, p334: Q2, and 3**  
**Ex 8C, p337: Q1; Ex 8D, p340: Q1-3**  
**Ex 8F, p344: Q2-4**

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