英语版

全日制普通高级中学教科书（试验修订本·必修）

MATHEMATICS

第一册（上）

课程教材研究所
双语课程教材研究开发中心
组译

数学

人民教育出版社
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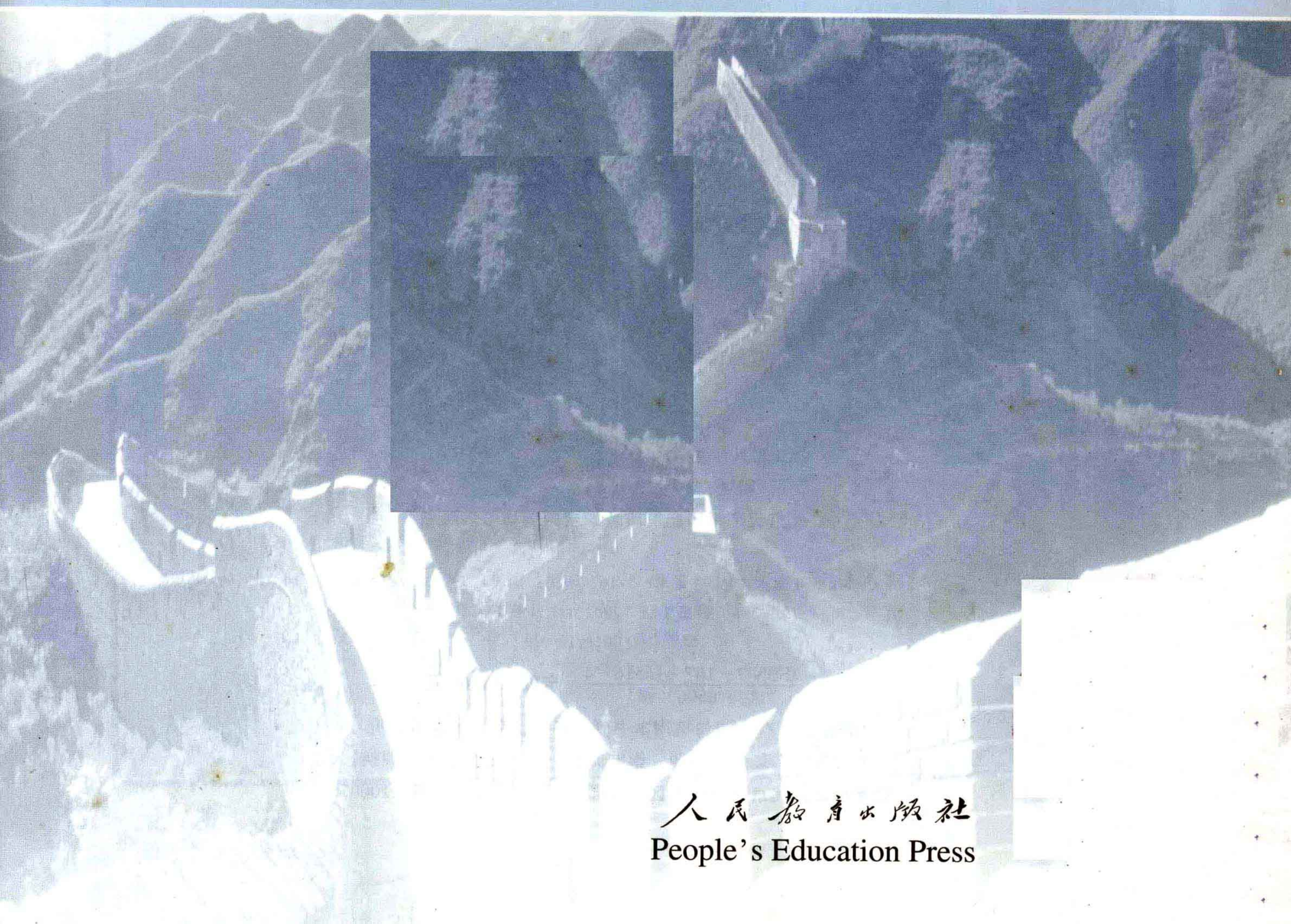

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英语版普通高中教科书

说　明

随着改革开放的不断扩大，中国在经济、文化、教育等诸多方面与各国间的交往日益增强，中国人学习英语的热情也日趋高涨。当今社会，是否熟练掌握英语，已成为衡量一个人的知识结构甚至综合素质的一个重要方面。在这样的形势下，多角度、多渠道提高人们的英语水平，特别是提高基础教育阶段在校高中学生的英语水平，已经成为社会的迫切需要。

为了适应这种新的形势和需要，作为教育部直属单位的课程教材研究所着手研究开发这套英语版普通高中教材，包括数学、物理、化学、生物、历史、地理六门必修课程，由人民教育出版社出版。

这套英语版高中教材，根据经国家教育部审查通过、人民教育出版社出版的《全日制普通高级中学教科书（试验修订本·必修）》翻译而成，主要供实行双语教学的学校或班级使用，也可以作为高中生的课外读物，其他有兴趣的读者也可以作为参考书使用，使学科知识的掌握与英语能力的提高形成一种双赢的局面。

为了使这套新品种的教材具有较高的编译质量，课程教材研究所双语课程教材研究开发中心依托所内各科教材研究开发中心，在国内外特聘学科专家和英语专家联袂翻译，且全部译稿均由中外知名专家共同审校。

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2002年6月

高中《数学》教科书

说　明

《全日制普通高级中学教科书（试验修订本）·数学》是根据教育部2000年颁布的《全日制普通高级中学课程计划（试验修订稿）》和《全日制普通高级中学数学教学大纲（试验修订版）》的规定，遵照1999年全国教育工作会议的精神，在两省一市进行试验的《全日制普通高级中学教科书（试验本）·数学》的基础上进行修订的。此次修订的指导思想是：遵循“教育要面向现代化，面向世界，面向未来”的战略思想，贯彻教育必须为社会主义现代化建设服务，必须与生产劳动相结合，培养德、智、体、美全面发展的社会主义事业的建设者和接班人的方针，以全面推进素质教育为宗旨，全面提高普通高中教育质量。

普通高中教育，是与九年义务教育相衔接的高一层次的基础教育。高中教材的编写，旨在进一步提高学生的思想道德品质、文化科学知识、审美情趣和身体心理素质，培养学生的创新精神、实践能力、终身学习的能力和适应社会生活的能力，促进学生的全面发展，为高一级学校和社会输送素质良好的合格的毕业生。

《全日制普通高级中学教科书（试验修订本）·数学》（以下简称《数学》）包括三册，其中第一册、第二册是必修课本，分别在高一、高二学习，每周4课时；第三册是选修课本，在高三学习，它又分为选修Ⅰ和选修Ⅱ两种，每周分别为2课时和4课时。

这套书的第一册又分为上、下两个分册，分别供高一上、下两个学期使用。本书是《数学》第一册（上），内容包括集合与简易逻辑、函数、数列三章。

全套书在体例上有下列特点：

1. 每章均配有章头图和引言，作为全章内容的导入，使学生初步了解学习这一章的必要性。

2. 书中习题共分三类：练习、习题、复习参考题。

练习　以复习相应小节的教学内容为主，供课堂练习用。

习题　每小节后一般配有习题，供课内、外作业选用，少数标有*号的题在难度上略有提高，仅供学有余力的学生选用。

复习参考题　每章最后配有复习参考题，分A、B两组，A组题是属于基本要求范围的，供复习全章使用；B组题带有一定的灵活性，难度上略有提高，仅供学有余力的学生选用。

3. 每章在内容后面均安排有小结与复习，包括内容提要、学习要求和需要注意的问题、参考例题三部分，供复习全章时参考。

4. 每章附有一至两篇不作教学要求的阅读材料，供学生课外阅读，借以扩大知识面、激发学习兴趣、培养应用数学的意识。

本套书由人民教育出版社中学数学室编写，其中《数学》第一册（上）原试验本由饶汉昌、方明一主持编写，参加编写的有：袁明德、方明一、薛彬、饶汉昌等，责任编辑为田载今、张劲松，审稿为饶汉昌。

《数学》第一册（上）原试验本在编写过程中蒙孔令颐、吴之季、烟学敏、蒋佩锦、戴佳珉等同志提出宝贵意见，在此表示衷心感谢。参加本次修订的有：袁明德、方明一、薛彬、饶汉昌等，责任编辑为田载今、张劲松，审稿为饶汉昌。

本册教材经教育部中小学教材审定委员会审读，尚待审查。

人民教育出版社中学数学室

2000年3月

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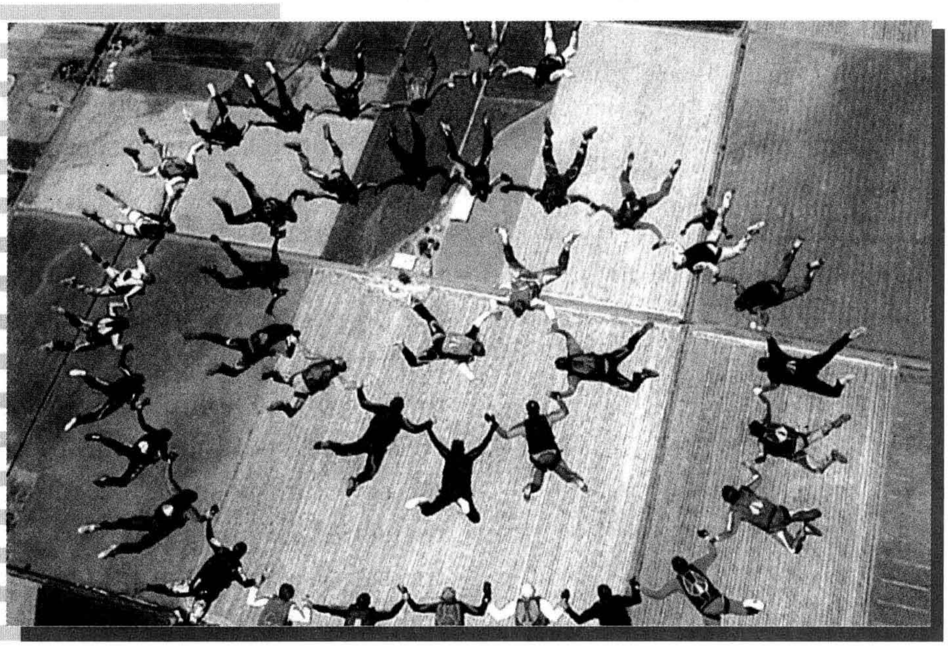
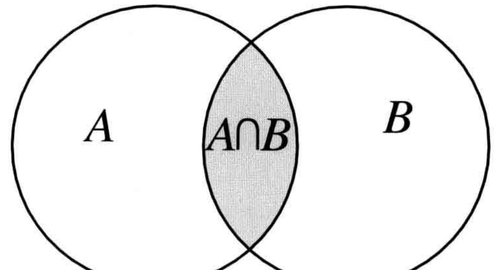
Some Common Symbols in This Book

$\in$	$x \in A$	x belongs to A; x is an element of set A.
$\notin$	$y \notin A$	y does not belong to A; y is not an element of set A.
$\{,\cdots,\}$	$\{a, b, c, \cdots, n\}$	the set consists of elements $a, b, c, \cdots, n$
$\{\mid\}$	$\{x \in A \mid p(x)\}$	the set consists of all elements in A with the proposition $p(x)$ being true.
$\varnothing$		empty set.
N		the set of all non-negative integers; the set consists of all natural numbers.
$\mathbf{N}^*$ or $\mathbf{N}_+$		the set of all positive integers.
Z		the set of all integers.
Q		the set of all rational numbers.
R		the set of all real numbers.
C		the set of all complex numbers.
$\subseteq$	$B \subseteq A$	B is contained in A; B is a subset of A.
$\subsetneqq$	$B \subsetneqq A$	B is contained properly in A; B is a proper subset of A.
$\nsubseteq$	$B \nsubseteq A$	B is not contained in A; B is not a subset of A.
$\cup$	$A \cup B$	the union of A and B.
$\cap$	$A \cap B$	the intersection of A and B.
$\complement$	$\complement_A B$	the complementary set of subset B in A.
$[,]$	$[a, b]$	the closing interval of numbers in **R** from a to b.
$(,)$	(a, b)	the opening interval of numbers in **R** from a to b.
$[,)$	$[a, b)$	the right-hand-opening interval of numbers in **R** from a (included) to b.
$(,]$	$(a, b]$	the left-hand-opening interval of numbers in **R** from a to b (included).
$f: A \to B$		the mapping from set A to set B.

Chapter 1 Set and Simple Logic





$A \cap B = \{x \mid x \in A \text{ and } x \in B\}$

See the following problem.

A school held a track and field event in which, 8 students from a class participated. The school then held a ball game in which 12 students from this class participated. How many students from the class participated in these two events? If your answer is 20, you might not be correct, since it is possible that some students could participate in both events. The answer 20 is correct, only if each student participated in only one event.

To solve and describe the above problem involves knowledge of set and simple logic that we will learn in this chapter. Preliminary knowledge of set and logic is an important basis for studying mathematics in senior middle school.

I Set

1.1 Set

The word *set* was already encountered in junior middle school mathematics.

While studying the classification of numbers in Algebra for junior middle school, some terminologies like "the set of all positive numbers", "the set of all negative numbers", and so forth, had been used. For the one-variable linear inequality

$$2x-1>3,$$

all real numbers greater than 2 are its solutions. We may also say that those numbers form the set of the solution to this inequality, and the set is called simply, the solution set to this inequality.

From studying circles in Geometry for junior middle school, we know that a circle is defined as a set that consists of all points with distances to a fixed point equal to a certain length. Any geometric graph can be considered as a set of certain points.

In general, the collection of certain specified objects form **a set.** For example, "all members of the basketball team in our school" form a set; "the pacific Ocean, the Atlantic Ocean, the Indian Ocean and Arctic Ocean" form a set as well. A set is expressed generally by a pair of braces. The above two sets can be expressed respectively by {all members of the basketball team in our school}, and {the Pacific Ocean, the Atlantic Ocean, the Indian Ocean, the Arctic Ocean}. For convenience, capital Latin alphabets are used to denote sets. For example, $A=$ {the Pacific Ocean, the Atlantic Ocean, the Indian Ocean, the Arctic Ocean}, $B=\{1, 2, 3, 4, 5\}$.

The following are some common number sets and their notations:

The set that consists of all non-negative integers is simply called **the set of non-negative integers** (or **the set of natural numbers**), denoted by $\mathbf{N}$. The set of non-negative integers except zero is called **the set of positive integers**, denoted by $\mathbf{N}^*$ or $\mathbf{N}_+$.

The set that consists of all integers is commonly called **the set of**

integers, denoted by **Z**.

The set that consists of all rational numbers is simply called **the set of rational numbers**, denoted by **Q**.

The set that consists of all real numbers is simply called **the set of real numbers**, denoted by **R**.

Each object in a set is defined as an **element** of this set. For example, the elements of the set "the largest four oceans in the world" are: the Pacific Ocean, the Atlantic Ocean, the Indian Ocean, and the Artic Ocean.

Elements of a set are usually denoted by lowercase Latin alphabets. If a is an element of set A, then we say that a belongs to set A, denoted by $a \in A$. If a is not an element of set A, we say that a does not belong to set A, denoted by $a \notin A$ (or $a \overline{\in} A$).

For example, let $B=\{1, 2, 3, 4, 5\}$, then

$$5 \in B, \ \frac{3}{2} \notin B.$$

More examples, $6 \in \mathbf{N}$, $\frac{3}{2} \in \mathbf{Q}$, $\frac{3}{2} \notin \mathbf{Z}$.

Elements in a set must be defined clearly. When a set is given, it is definite for any object whether it is an element of the set or not. For example, for the set of "the largest four oceans in the world", it contains only four elements: the Pacific Ocean, the Atlantic Ocean, the Indian Ocean and the Arctic Ocean, but any other object is not its element. As a further example, "all small rivers in our country" can not form a set, since objects that form the set are not defined clearly.

Elements in a set are distinct from each other. That is, elements in a set can not appear repeatedly. If two of the same objects appear in a set, they must be considered as one element of the set.

Training Exercises

1. (Answer Orally) Identify the elements of each of the following sets:
   (1) {all even numbers greater than 3 and less than 11};
   (2) {all numbers whose squares are equal to 1};
   (3) {all divisors of 15}❶.
2. Insert a symbol $\in$, or $\notin$, in each of the following blanks:

❶ All divisors appearing in this book are positive, unless otherwise specified.

1 __ **N**,	0 __ **N**,	−3 __ **N**,	0.5 __ **N**,	$\sqrt{2}$ __ **N**;
1 __ **Z**,	0 __ **Z**,	−3 __ **Z**,	0.5 __ **Z**,	$\sqrt{2}$ __ **Z**;
1 __ **Q**,	0 __ **Q**,	−3 __ **Q**,	0.5 __ **Q**,	$\sqrt{2}$ __ **Q**;
1 __ **R**,	0 __ **R**,	−3 __ **R**,	0.5 __ **R**,	$\sqrt{2}$ __ **R**.

Enumeration and **description** are the usual methods to express sets.

Enumeration is a method of listing all elements of a set, one by one.

Example The set of all solutions to the equation $x^2-1=0$ can be expressed by

$$\{-1, 1\}.$$

Remark In the set $\{-1, 1\}$, there are two elements. In general, a set that contains a finite number of elements is called a **finite set.**

For one more example, the set that consists of all odd numbers greater than zero and less than 10 can be expressed by

$$\{1, 3, 5, 7, 9\}.$$

Description is a method of specifying a set by a defined condition which determines whether certain objects belong to this set or not.

For example, the set of all solutions defined by the inequality $x-3>2$ can be expressed by

$$\{x\in \mathbf{R} \mid x-3>2\}❶.$$

Conventionally, if the sense of $x\in \mathbf{R}$ is well defined from the context, the set can also be expressed by

$$\{x \mid x-3>2\}.$$

Remark In the set of $\{x \mid x-3>2\}$, there are infinite elements. In general, a set that contains infinite elements is called **an infinite set.**

As a further example, the set of all right-triangles can be expressed by

$$\{x \mid x \text{ is a right-triangle}\}.$$

To see one more example, the set that consists of all real number solutions to the equation $x^2+1=0$ can be expressed by

$$\{x\in \mathbf{R} \mid x^2+1=0\}.$$

In this set, there are no elements. In general, a set that does not contain any elements is called an **empty set**, denoted by $\varnothing$.

❶ Sometimes, the vertical line can be replaced by a colon or semicolon, denoted by

$$\{x\in \mathbf{R}: x-3>2\}$$

or $\{x\in \mathbf{R}; x-3>2\}$.

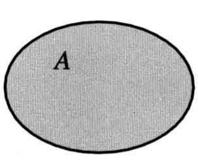


Fig. 1-1

To represent a set graphically, we draw a closed curve, the interior of which represents the set.

For example, Figure 1-1 represents any set A; Figure 1-2 represents the set of $\{1, 2, 3, 4, 5\}$.

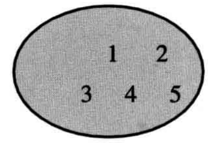


Fig. 1-2

Training Exercises

1. Express each of the following sets by an appropriate method, then tell which are finite sets and which are infinite sets:
   (1) The set of all natural numbers greater than 10;
   (2) The set of all common divisors of 24 and 30;
   (3) The set of all solutions to the equation $x^2-4=0$;
   (4) The set of all prime numbers less than 10.
2. Express each of the following sets by the description method, then tell of which are finite sets and which are infinite sets:
   (1) The set of all common multiples of 4 and 6;
   (2) The set of all even numbers;
   (3) The set of all solutions to the equation $x^2-2=0$;
   (4) The set of all solution to the inequality $4x-6<5$.

Exercises 1.1

1. With symbols $\in$, or $\notin$, fill in blanks:
   (1) If $A=\{x \mid x^2=x\}$, then -1 ____ A;
   (2) If $B=\{x \mid x^2+x-6=0\}$, then 3 ____ B;
   (3) If $C=\{x\in \mathbf{N} \mid 1\leq x\leq 10\}$, then 8 ____ C;
   (4) If $D=\{x\in \mathbf{Z} \mid -2<x<3\}$, then 1.5 ____ D.
2. Each of the following problems indicates all elements in a set. Try to express the set by an appropriate method and tell if it is a finite set or an infinite set:
   (1) Colors of the national flag of China;
   (2) The highest mountain in the world;
   (3) All natural numbers composed of part or all numbers from 1, 2 and 3 without repeat;
   (4) All points in a plane with a constant distance $l(l>0)$ to a fixed point.
3. Express each of the following sets by an alternative method:
   (1) $\{1, 5\}$; (2) $\{x \mid x^2+x-1=0\}$;
   (3) $\{2, 4, 6, 8\}$; (4) $\{x\in \mathbf{N} \mid 3<x<7\}$.

1.2 Subset, Universe, Complementary Set

1. Subset

There exists containing relation and equivalent relation, between sets.

First, let us look at the containing relation between sets. Suppose that

$$A=\{1,\ 2,\ 3\},\qquad B=\{1,\ 2,\ 3,\ 4,\ 5\}.$$

Set A is a part of set B, then we say that set B contains set A.

In general, for two sets A and B, if any element of set A is also an element of set B, then we say that set A **is contained in** set B, or that set B **contains** set A, denoted by

$$A\subseteq B \text{ (or } B\supseteq A).$$

In this case, we also say that set A is a **subset** of set B.

If set A is not contained in set B, or set B does not contain set A, then it is denoted by

$$A\nsubseteq B \text{ (or } B\nsupseteq A)❶.$$

❶ $\subseteq$ can be replaced also by $\subset$, $\supseteq$ by $\supset$; and $\nsubseteq$ by $\not\subset$, $\nsupseteq$ by $\not\supset$.

We agree that the **empty** set is a subset of any set. That is, for any set A, we have

$$\varnothing\subseteq A.$$

Now let us look at the equivalent relation between sets. Suppose that

$$A=\{x \mid x^2-1=0\},\qquad B=\{-1,\ 1\},$$

where set A and set B have the same elements. Then we say that set A is equal to set B.

In general, for two sets A and B, if any element of set A is an element of set B, and conversely, any element of set B is an element of set A, then we say that set A **equals** set B, denoted by

$$A=B.$$

The following conclusions deduced from the containing relations and the equivalent relation between sets.

(1) For any set A, its any element belongs to set A itself, hence

$$A\subseteq A,$$

any set is a subset of itself.

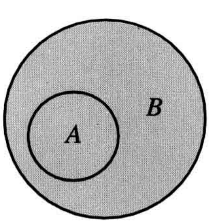


Fig. 1-3

The concept of "true subset" is often of concern. For two sets A and B, if $A\subseteq B$, and $A\neq B$, then we say that set A is **a proper subset** of set B, denoted by

$$A \subsetneqq B \text{ (or } B \supsetneqq A).$$

It can be illustrated by Figure 1-3.

Clearly, **empty set is a proper subset of any non-empty set.**

It is easy to see that for sets of A, B, C, **if** $A \subseteq B$, $B \subseteq C$, **then** $A \subseteq C$. In fact, let x be any element of A, then $x \in B$ since $A \subseteq B$, and $x \in C$ since $B \subseteq C$, therefore $A \subseteq C$.

Similarly, for sets of A, B, C, if $A \subsetneqq B$, $B \subsetneqq C$, then $A \subsetneqq C$.

(2) For sets of A and B, if $A \subseteq B$, **and** $B \subseteq A$, **then** $A = B$.

Example 1 Write out all subsets of the set $\{a, b\}$, and tell of its proper subsets.

Solution All subsets of the set $\{a, b\}$ are $\varnothing$, $\{a\}$, $\{b\}$, $\{a, b\}$. Among them, $\varnothing$, $\{a\}$, $\{b\}$ are proper subsets of $\{a, b\}$.

Example 2 Solve the inequality $x - 3 > 2$, and express the result as a set.

Solution $x > 5$

The solution set of the inequality is $\{x \mid x > 5\}$.

Training Exercises

1. Write out all subsets of the set of $\{a, b, c\}$, and identify its proper subsets.
2. With an appropriate symbol of $\in$, $\notin$, $=$, $\supsetneqq$ and $\subsetneqq$, fill in each of the blanks:

   (1) a ______ $\{a\}$;

   (2) a ______ $\{a, b, c\}$;

   (3) d ______ $\{a, b, c\}$;

   (4) $\{a\}$ ______ $\{a, b, c\}$;

   (5) $\{a, b\}$ ______ $\{b, a\}$;

   (6) $\{3, 5\}$ ______ $\{1, 3, 5, 7\}$;

   (7) $\{2, 4, 6, 8\}$ ______ $\{2, 8\}$;

   (8) $\varnothing$ ______ $\{1, 2, 3\}$.
3. (1) Solve the equation $x + 3 = \frac{x}{2} - 5$, and express the result as a set;

   (2) Solve the inequality $3x + 2 < 4x - 1$, and express the result as a set.

2. Universe and Complementary Set

Let us look at an example.

Suppose set S is the set of all students in a class, set A is the set