# Chapter 01
# Number Systems

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# Learning Outcomes

(a) Define natural numbers (N), whole numbers (W), integers (Z), prime numbers, rational numbers (Q) and irrational numbers ( $\overline{Q}$ ).

(b) Represent rational and irrational numbers in decimal form.

(c) Represent the relationship of number sets in a real number system diagrammatically showing $N \subset W \subset Z \subset Q$ and $Q \cup \overline{Q} = R$.

(d) Represent open, closed and half-open intervals and their representations on the number line.

(e) Simplify union, $\cup$, and intersection, $\cap$ , of two or more intervals with the aid of number line.

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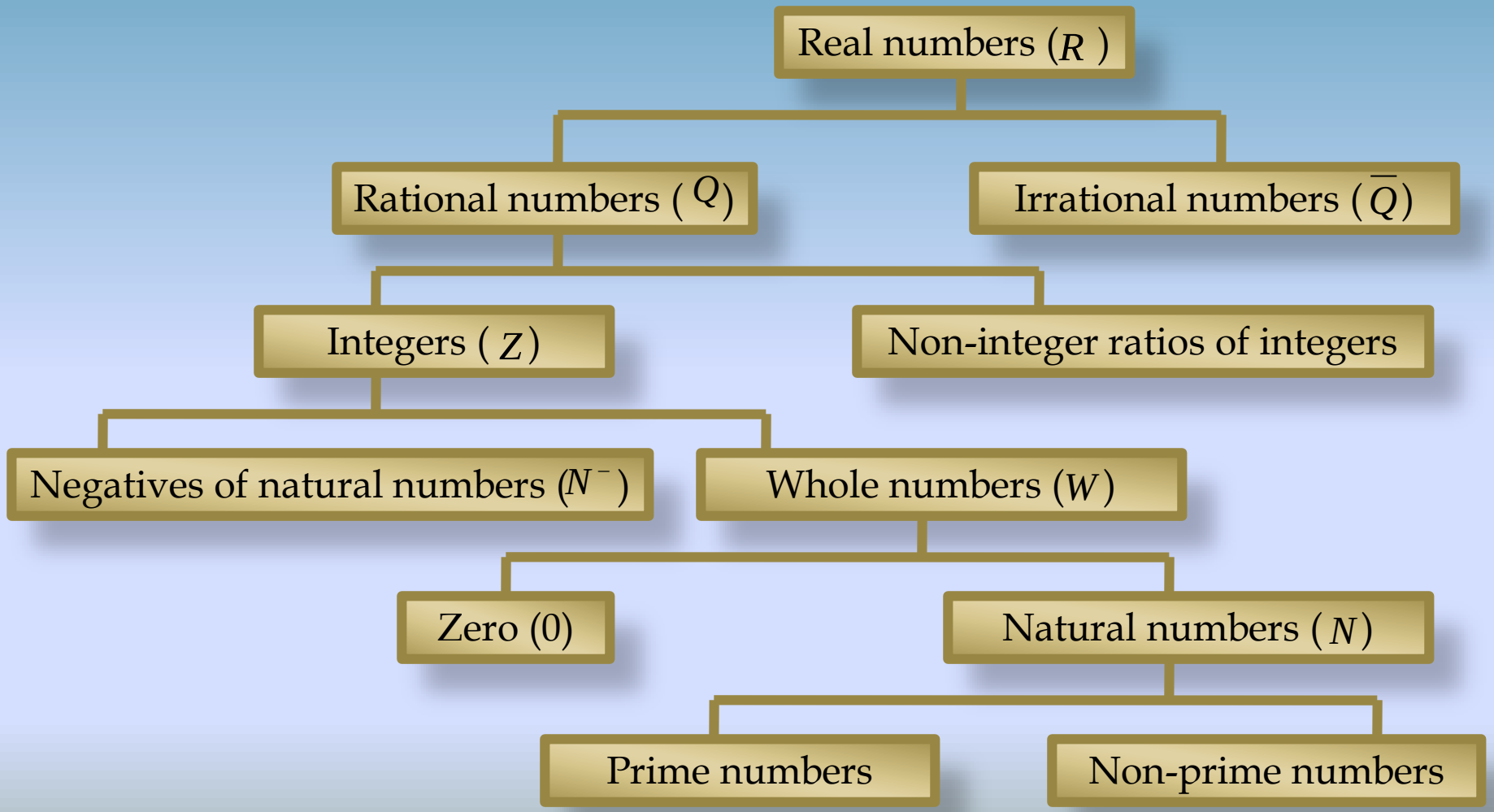
# Relationship of number sets




*Bloom: Remembering*

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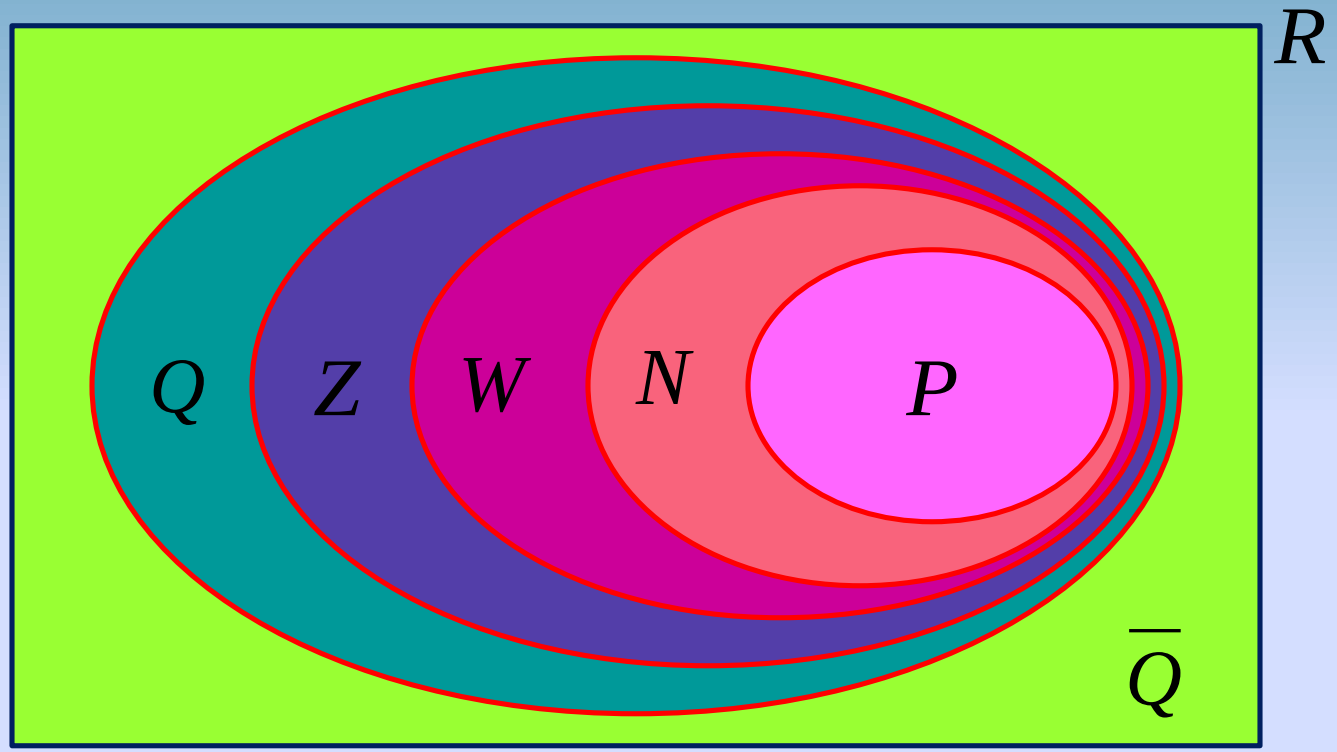
# Relationship of number sets in Venn diagram




$$P \subset N \subset W \subset Z \subset Q$$

$$Q \cup \overline{Q} = R$$

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Bloom: Remembering

# Example

Determine whether each statement is true or false.

(a) $\sqrt{64} \in Q$

(b) $7.2525\ldots\ldots \in \overline{Q}$

(c) $0.21212212 \notin Q$

(d) $0.58 \in Q$

(e) $Z \subset N$

Bloom: Understanding

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**Solution:**

(a) True, because $\sqrt{64} = \frac{8}{1}$ is a rational number.

(b) False, because $7.2525\ldots$ is a repeating decimal rational number.

(c) True, because $0.21212212\ldots$ cannot be expressed as a ratio of integers since it is a non-repeating decimal and non-terminating.

(d) True, because $0.58$ can be written as $\frac{58}{100}$.

(e) False, because the natural number do not include the negative integers.

*Bloom: Understanding*

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# Example:

Classify the set of numbers

$$\left\{-2, \frac{1}{3}, 0.23, e, \sqrt{5}, 2.31515151\ ...\right\}$$

as integer, rational, irrational and real numbers.

Bloom: Understanding

**Solution:**

Integer numbers: $\{-2\}$

Rational numbers: $\left\{-2, \frac{1}{3}, 0.23, 2.31515151\ ...\right\}$

Irrational numbers: $\{e, \sqrt{5}\}$

Real numbers: $\left\{-2, \frac{1}{3}, 0.23, e, \sqrt{5}, 2.31515151\ ...\right\}$

*Bloom: Understanding*

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# Self-check

1. State whether each of the following statements is true or false.

   (a) All whole numbers are integers.

   (b) All integers are natural numbers.

   (c) All natural numbers are whole numbers.

   (d) $\sqrt{7}$ is a rational number.

   (e) 4.58 is a rational numbers.

   (f) 0.121212… is an irrational number.

   (g) 6.313313331… is an irrational number.

*Bloom: Applying*

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# Self-check

2. Which elements of the set

$$\left\{-5,-\sqrt{7},-0.25,2,0,e,\frac{3}{5},3.142,\cos 0^{o}\right\}$$

are

(a) Natural numbers

(b) Whole numbers

(c) Integers

(d) Rational numbers

(e) Irrational numbers

(f) Real numbers

(g) Prime numbers

*Bloom: Applying*

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# Answer Self-check

1. (a) True
   (b) False
   (c) True
   (d) False
   (e) True
   (f) False
   (g) True

# Answer Self-check

2. (a) $\{2, \cos 0^o\}$

(b) $\{0, \cos 0^o, 2\}$

(c) $\{-5, 0, \cos 0^o, 2\}$

(d) $\left\{-5, -0.25, 0, \frac{3}{5}, \cos 0^o, 2, 3.142\right\}$

(e) $\{-\sqrt{7}, e\}$

(f) $\left\{-5, -\sqrt{7}, -0.25, 2, 0, e, \frac{3}{5}, 3.142, \cos 0^o\right\}$ or All

(g) $\{2\}$

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# Key Terms

Real numbers

Rational numbers

Irrational numbers

Integers

Non-integers

Whole numbers

Negative numbers

Natural numbers

Prime numbers