Sets of Numbers

1) A set is a collection of objects. To denote a set, we often enclose a list of its elements with braces.
\{20, 40, 70\} denotes the set with elements 20, 40 and 70.

2) The set of natural numbers includes the numbers we use for counting:
\{1, 2, 3, \ldots\}

Note that each group of three dots, called an ellipsis, indicates that the numbers in that set continue forever.

3) The set of whole numbers includes all the natural numbers and 0:
\{0, 1, 2, 3, \ldots\}

4) The prime numbers are the natural numbers greater than 1 that have exactly 2 factors. For example, 17 is a prime number because it has exactly two factors, 1 and 17 because the only we can get the product of 17 using natural numbers is by multiplying 1 times 17.

\{2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, \ldots\}

5) The composite numbers are the natural numbers greater than 1 that have three factors or more. For example, 20 is a composite number because we can get the product of 20 by multiplying 1 times 20, 2 times 10, or 4 times 5. The factors of 20 are \{1, 2, 4, 5, 10, 20\}.

\{4, 6, 8, 9, 10, 12, 14, 15, 16, 18, 20, 21, 22, 24, 25, 26, 27, 28, 30, \ldots\}
6) The set of **integers** includes the natural numbers, 0, and the negatives of the natural numbers.

\{..., −4, −3, −2, −1, 0, 1, 2, 3, 4,...\}

7) The set of **even integers** are the integers that are exactly divisible by 2.

\{..., −4, −2, 0, 2, 4,...\}

8) The set of **odd integers** are the integers that are not exactly divisible by 2.

\{..., −7, −5, −3, −1, 1, 3, 5, 7,...\}

9) The set of **rational numbers** is the set of numbers that can be written in the form \( \frac{a}{b} \) where \( a \) and \( b \) are integers and \( b \neq 0 \).

0, \( \frac{3}{4} \), 2.5, \(-7\) and \( \sqrt{100} \) are all rational numbers because they can be expressed in the form \( \frac{a}{b} \).

\[
0 = \frac{0}{1}, \frac{3}{4} = \frac{3}{4}, \ 2.5 = \frac{25}{10} = \frac{5}{2}, \ -7 = \frac{-7}{1} \text{ and } \sqrt{100} = 10 = \frac{10}{1}
\]

10) The set of **irrational numbers** is the set of numbers that can not be expressed in the form \( \frac{a}{b} \) and have a decimal portion that is nonterminating and nonrepeating.
Examples of irrational numbers:
\[ \sqrt{2} = 1.414213562... \]
\[ \pi = 3.1415926535897932384626433832795... \]
3.8294038476634...

11) The set of **real numbers** are all the numbers that can be represented by points on the number line. The set of real numbers is the union of the sets of rational and irrational numbers. Every real number is either rational or irrational.

Practice Problem:

List the elements in the set \{-3, 0, \frac{2}{3}, 1, \sqrt{3}, 2, 9\} that satisfy the given condition.

a) **natural number** : 1, 2, 9
b) **whole number** : 0, 1, 2, 9
c) **integer** : -3, 0, 1, 2, 9
d) **rational number** : -3, 0, \frac{2}{3}, 1, 2, 9
e) **irrational number** : \sqrt{3}
f) **real number** : -3, 0, \frac{2}{3}, 1, \sqrt{3}, 2, 9
g) **even natural number** : 2
h) **odd integer** : -3, 1, 9
i) **prime number** : 2
j) **composite number** : 9
k) **odd composite number** : 9
l) **even prime number** : 2