Fundamentals of MATHEMATICS

SELECTED TOPICS

1ST EDITION

Author
Ts. Nor Hafizah binti Md Desa
Fundamentals of Mathematics : Selected Topics (1st Edition)

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PREFACE

Dear Readers,

Welcome to this educational journey through the fundamentals of Basic Mathematics. This eBook aims to provide a comprehensive reference for both educators and students alike, offering clear explanations, practice questions, and step-by-step solutions. It is designed to enhance your understanding and mastery of essential mathematical concepts.

I trust that you will find this book not only informative but also inspiring as you delve into the world of numbers, sets, relations, functions, and more. May it serve as a guiding light in your academic pursuits.

Warm regards,

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ABOUT THIS BOOK

The material in this book is designed to answer the following big questions and develop the following skills:

This book aims to explain fundamental mathematical concepts in the areas of number systems, accuracy control, sets, relations, functions, and counting principles.

State solutions for solving mathematical equations through clear and demonstrated methods.

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CHAPTER 1.0
NUMBER SYSTEM

1.0 Concept of Number System

What is Number System?

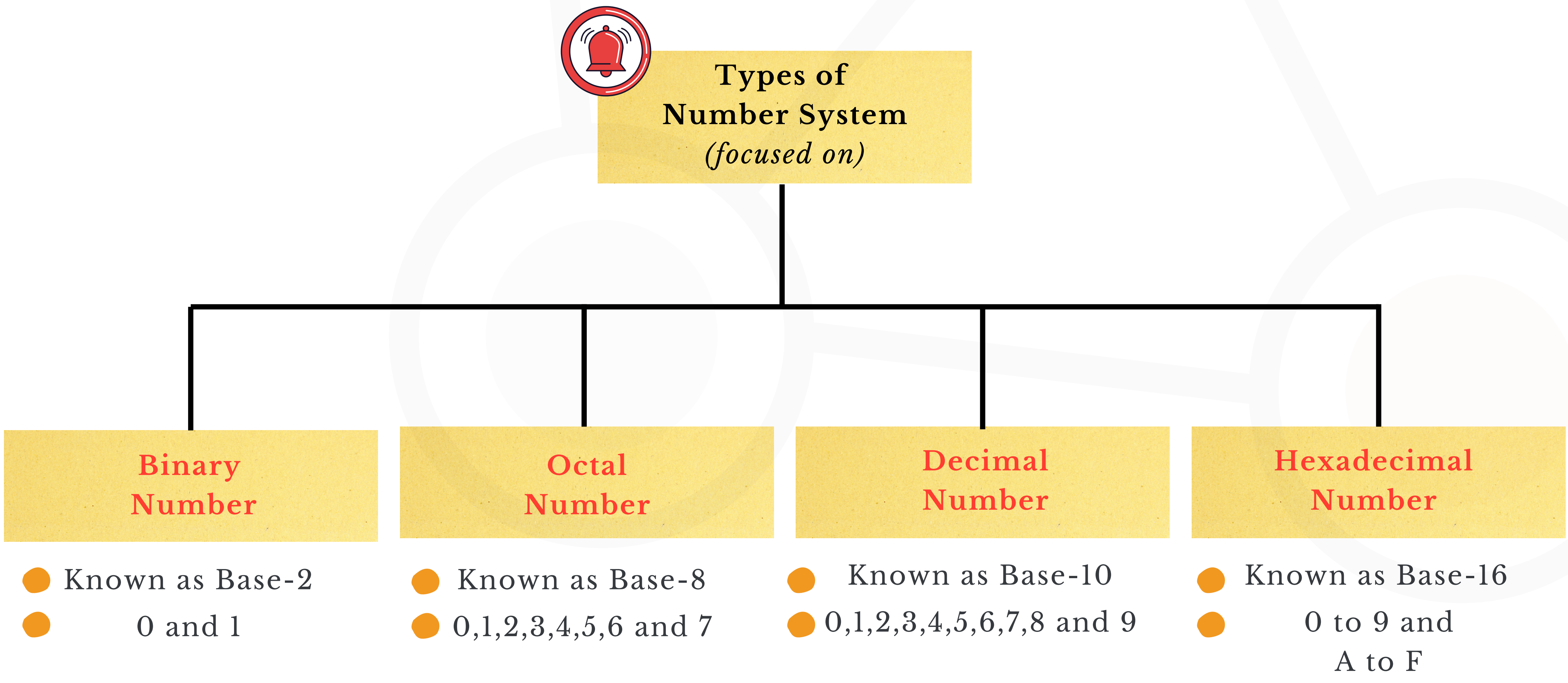
A number system is defined as a **system of writing to express numbers**. It is the **mathematical notation for representing numbers** of a given set by using digits or other symbols in a consistent manner. It provides a unique representation of every number and represents the arithmetic and algebraic structure of the figures. It also allows us to operate arithmetic operations like addition, subtraction, multiplication and division.

The value of any digit in a number can be determined by:

a) The digit
b) Its position in the number
c) The base of the number system

Types of Number System

There are various types of number systems in mathematics. The **four most common number system types** are:



Basic Info

Type of number system must start with zero (0)

Number that frequently use in daily life is Decimal Number (Base 10)

CHAPTER 1.0
NUMBER SYSTEM

Let's Review the Types of Number System

Binary Number

The binary number system **uses only two digits: 0 and 1. The numbers in this system have a base of 2. Digits 0 and 1 are called bits and 8 bits together make a byte.**

The data in computers is stored in terms of bits and bytes. **The binary number system does not deal with other numbers such as 2,3,4,5 and so on.**

Octal Number

The octal number system **uses eight digits: 0,1,2,3,4,5,6 and 7 with the base of 8. The advantage of this system is that it has lesser digits when compared to several other systems.**

Hence, there would be fewer computational errors. **Digits like 8 and 9 are not included in the octal number system.** Just as the binary, the octal number system is used in minicomputers but with digits from 0 to 7.

Decimal Number

The decimal number system **uses ten digits: 0,1,2,3,4,5,6,7,8 and 9 with the base number as 10**. The **decimal number system is the system that we generally use to represent numbers in real life.**

If any number is represented without a base, it means that its base is 10.

Hexadecimal Number

The hexadecimal number system **uses sixteen digits/alphabets: 0,1,2,3,4,5,6,7,8,9 and A,B,C,D,E,F with the base number as 16**. Here, A-F of the hexadecimal system means the numbers 10-15 of the decimal number system respectively.

This system is used in computers to reduce the large-sized strings of the binary system.

Ways of Conversion Rules

A number can be converted from one number system to another number system using number system formulas. Let us see the ways and steps required in converting number systems.

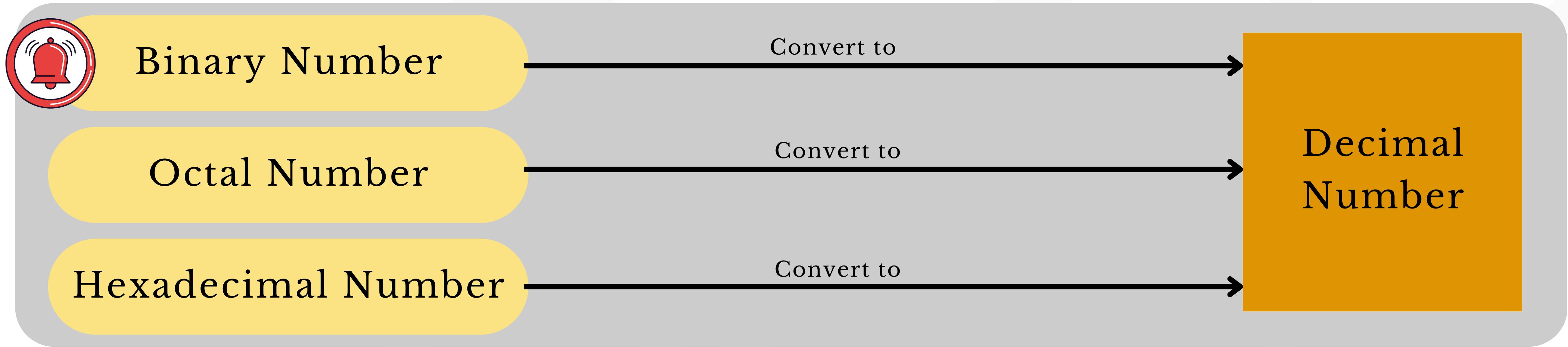


Figure 1 : Conversion from Binary, Octal and Hexadecimal Number to Decimal Number

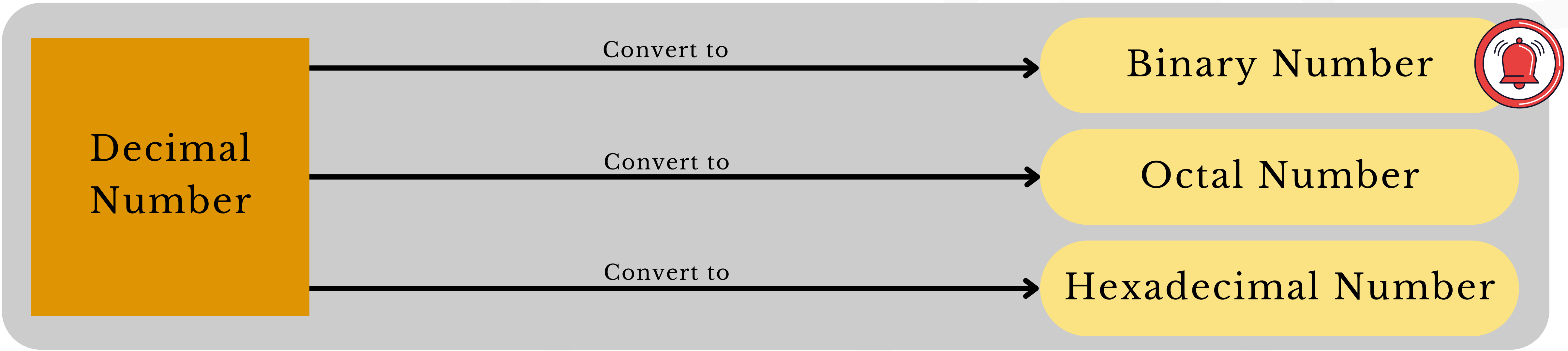


Figure 2 : Conversion from Decimal Number to Binary, Octal and Hexadecimal Number

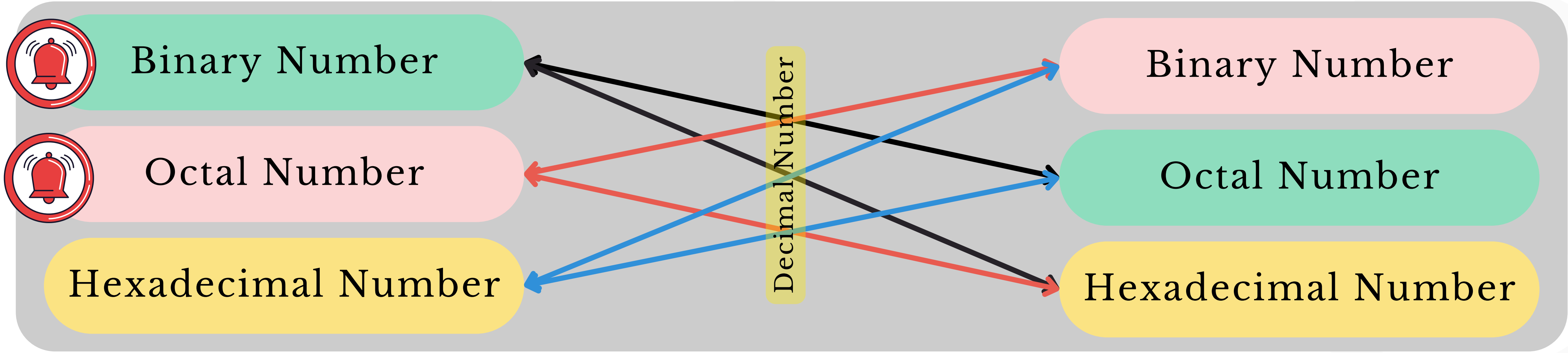


Figure 3 : Conversion from One Number System to another Number System

Basic Info

Conversion from one number system to another number system, have three (3) ways need to be remembered.

Conversion Steps *(Way 1)*

- **Conversion Steps from Binary, Octal and Hexadecimal Number to Decimal Number**

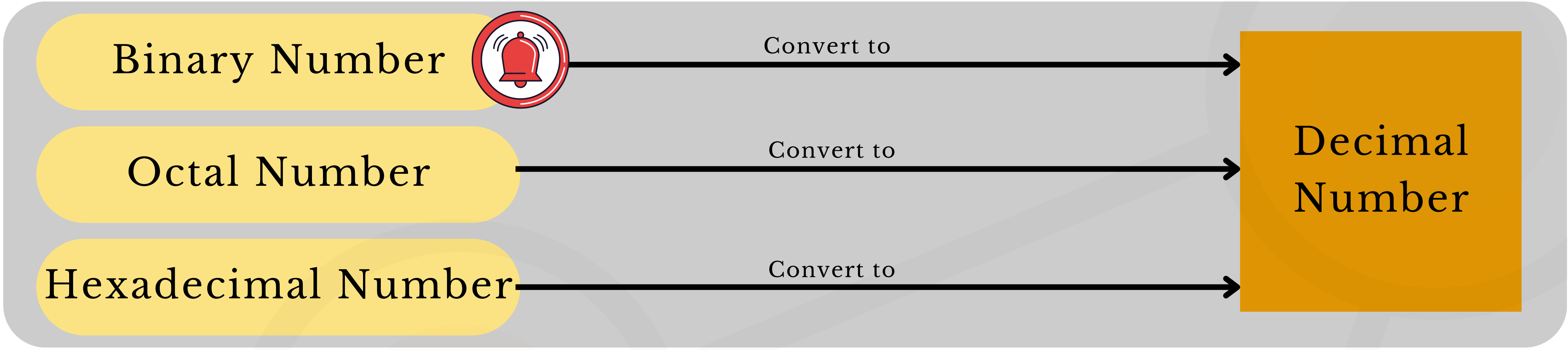


Figure 1 : Conversion from Binary, Octal and Hexadecimal Number to Decimal Number

To convert a number from the binary, octal or hexadecimal number to the decimal number, we may use these steps:

Step 1

Multiply each digit of the given number, starting from the rightmost digit, with the exponents of the base.

Step 2

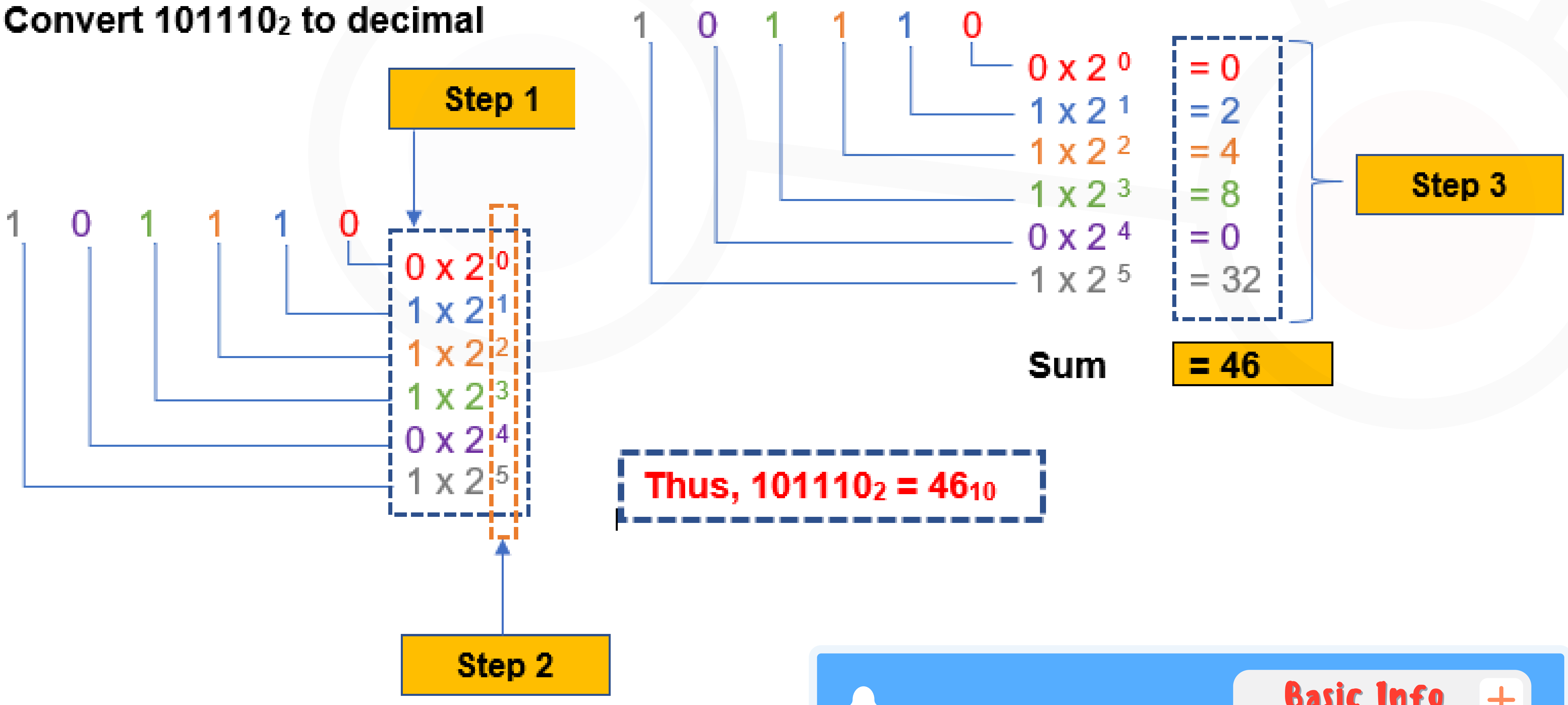
The **exponents** should start with 0 and increase by 1 every time we move from right to left.

Step 3

Simplify each of the above products and **add** them.

Example 1.1

Convert 101110_2 to decimal



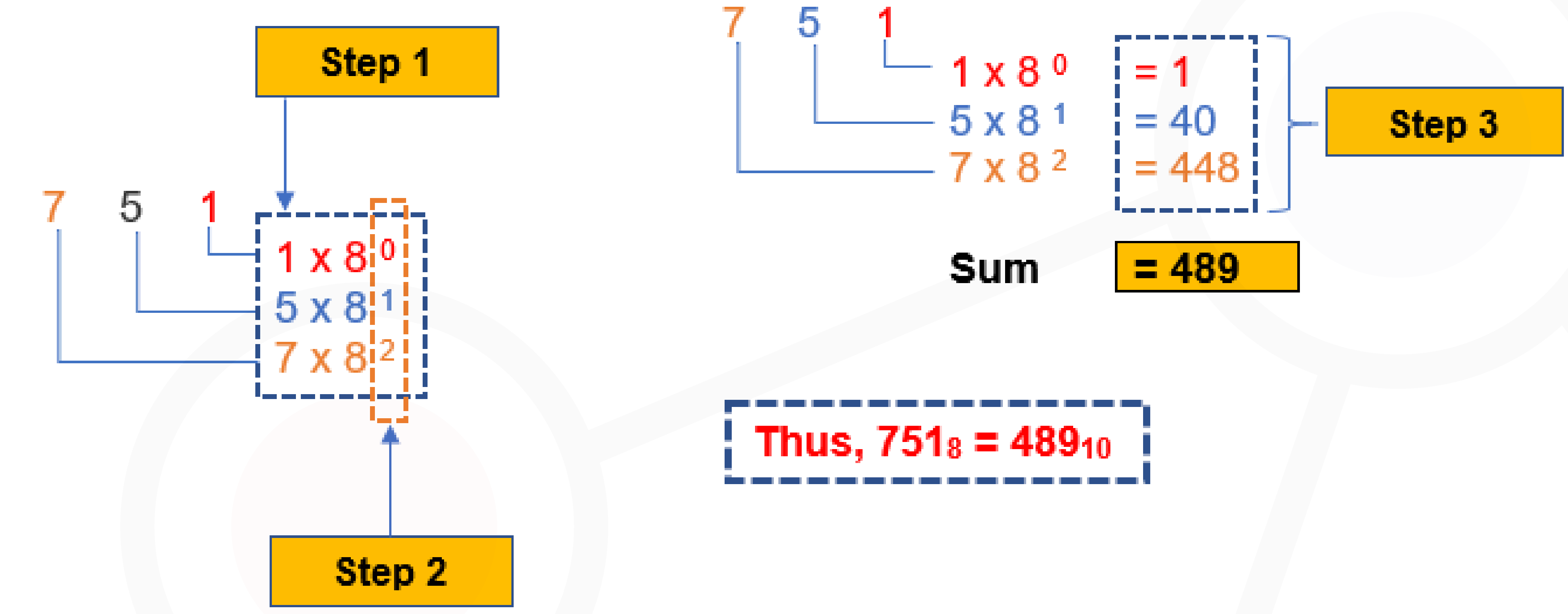
Basic Info

exponents should start with 0 and increase by 1 every time we move from right to left.

use multiply concept for this conversion

Example 1.2

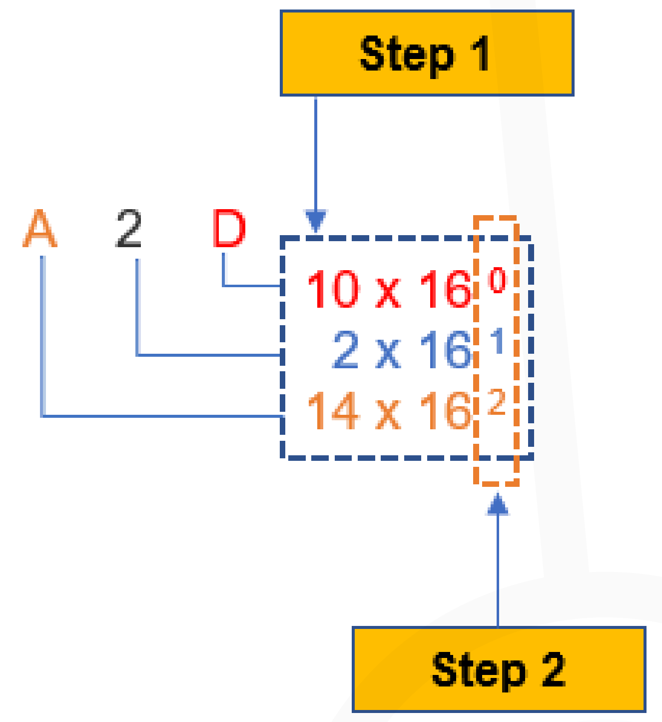
Convert 751_8 to decimal



Thus, $751_8 = 489_{10}$

Example 1.3

Convert $A2D_{16}$ to decimal

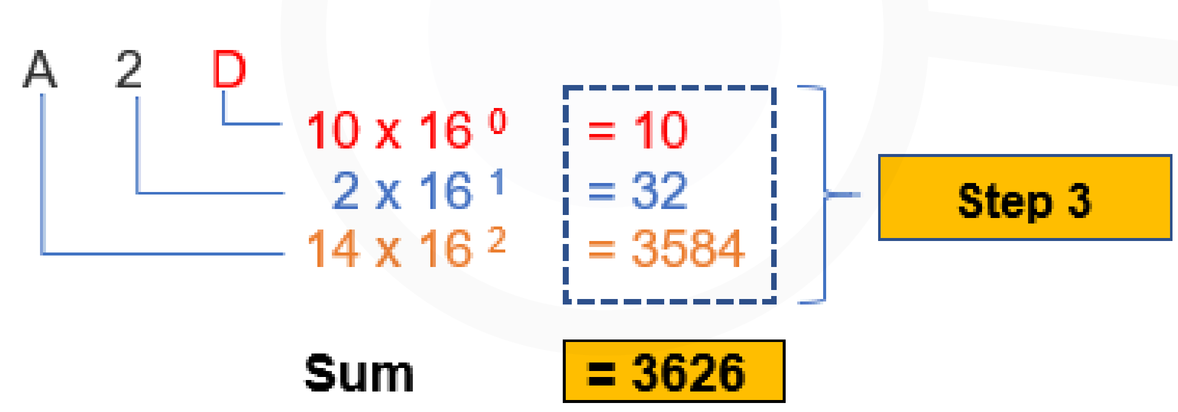


Things to Remember for Hexadecimal Number

Before proceed with step 1, you must convert the alphabet first:

A = 10

D = 14



Thus, $A2D_8 = 3626_{10}$

Conversion Steps *(Way 2)*

- **Conversion Steps from Decimal Number to Binary, Octal and Hexadecimal Number**

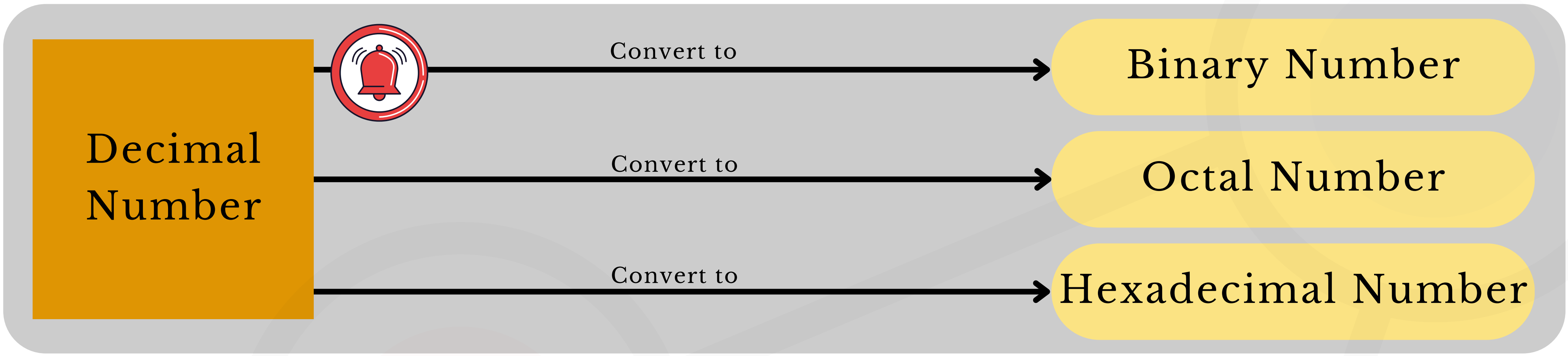


Figure 2 : Conversion from Decimal Number to Binary, Octal and Hexadecimal Number

To convert a number from the decimal number system to a binary/octal/hexadecimal number system, we use the following steps. The steps are shown on how to convert a number from the decimal system to the octal system.

Step 1

Identify the base of the required number.

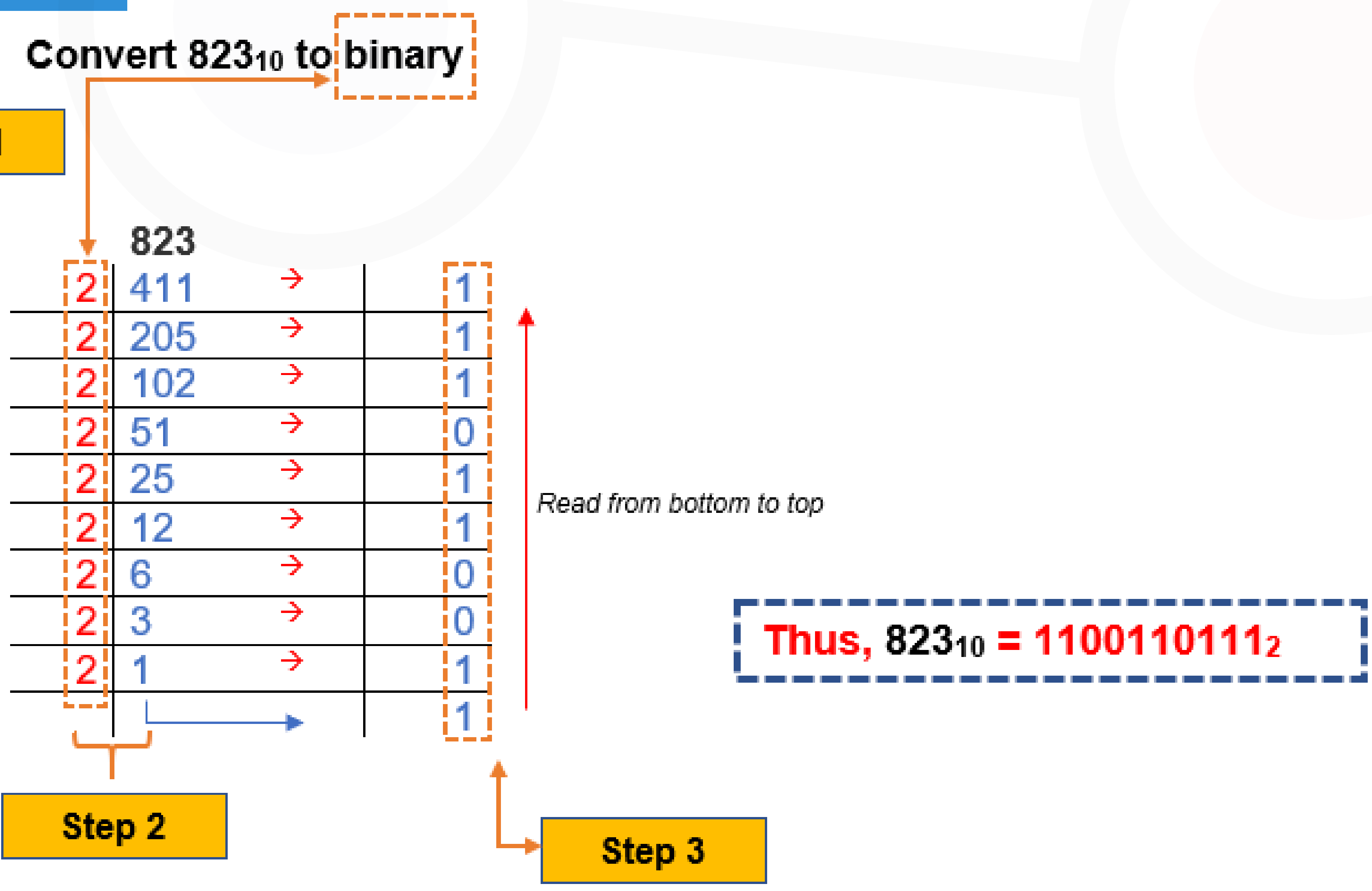
Step 2

Divide the given number by the base of the required number and note down the quotient and the remainder in the quotient-remainder form. Repeat this process (dividing the quotient again by the base) until we get the quotient less than the base.

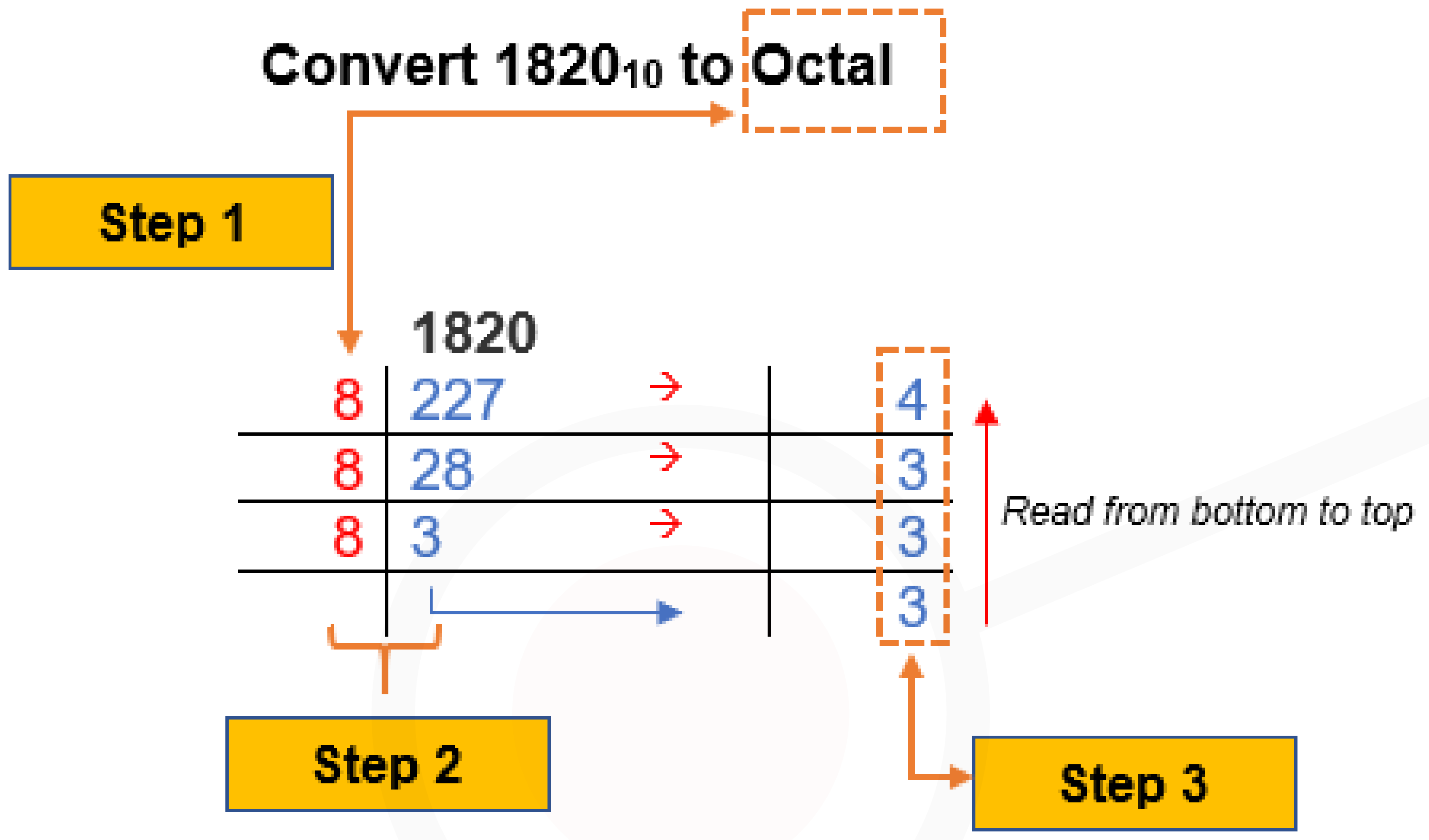
Step 3

The given number in the octal number system is obtained just by **reading all the remainders and the last quotient from bottom to top.**

Example 2.1

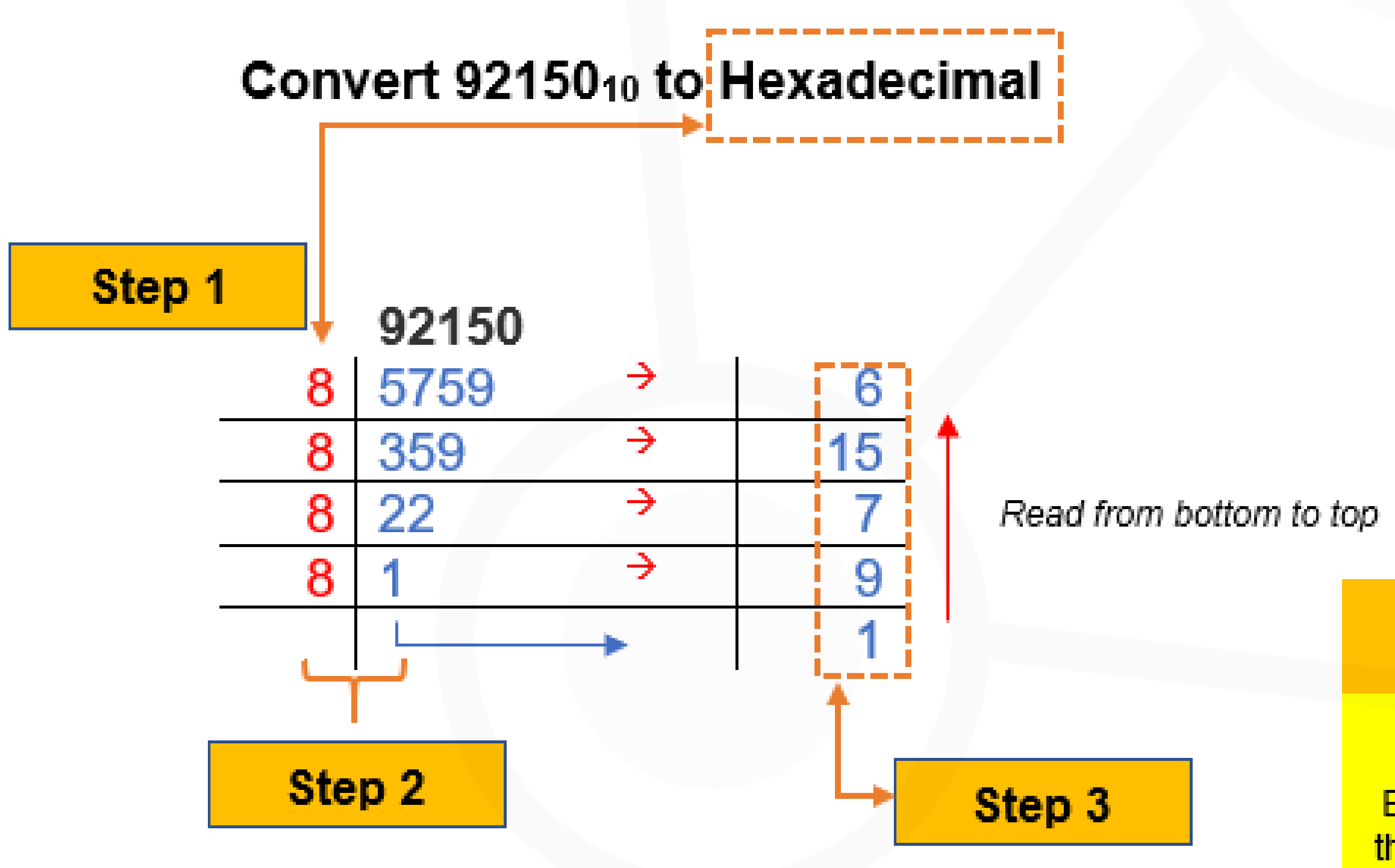


Example 2.2



Thus, $1820_{10} = 3334_8$

Example 2.3



Thus, $92150_{10} = 197F6_{16}$

Things to Remember for Hexadecimal Number

IMPORTANT

Before end step 3, you must check the value. If the value > 9, you have to convert into alphabet which contain A to F in hexadecimal number

15 = F

Thus, the answer must $197F6_{16}$

Conversion Steps *(Way 3)*

- **Conversion Steps from One Number System to Another Number System.**

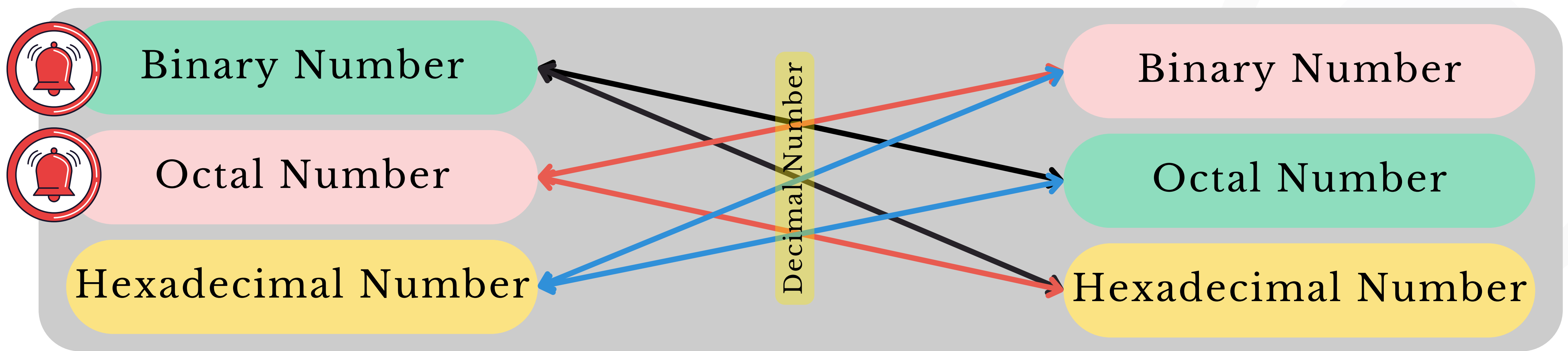


Figure 3 : Conversion from One Number System to another Number System

To convert a number from one of the binary/octal/hexadecimal systems to one of the other systems, we first convert it into the decimal system, and then we convert it to the required systems by using the above-mentioned processes.

Step 1

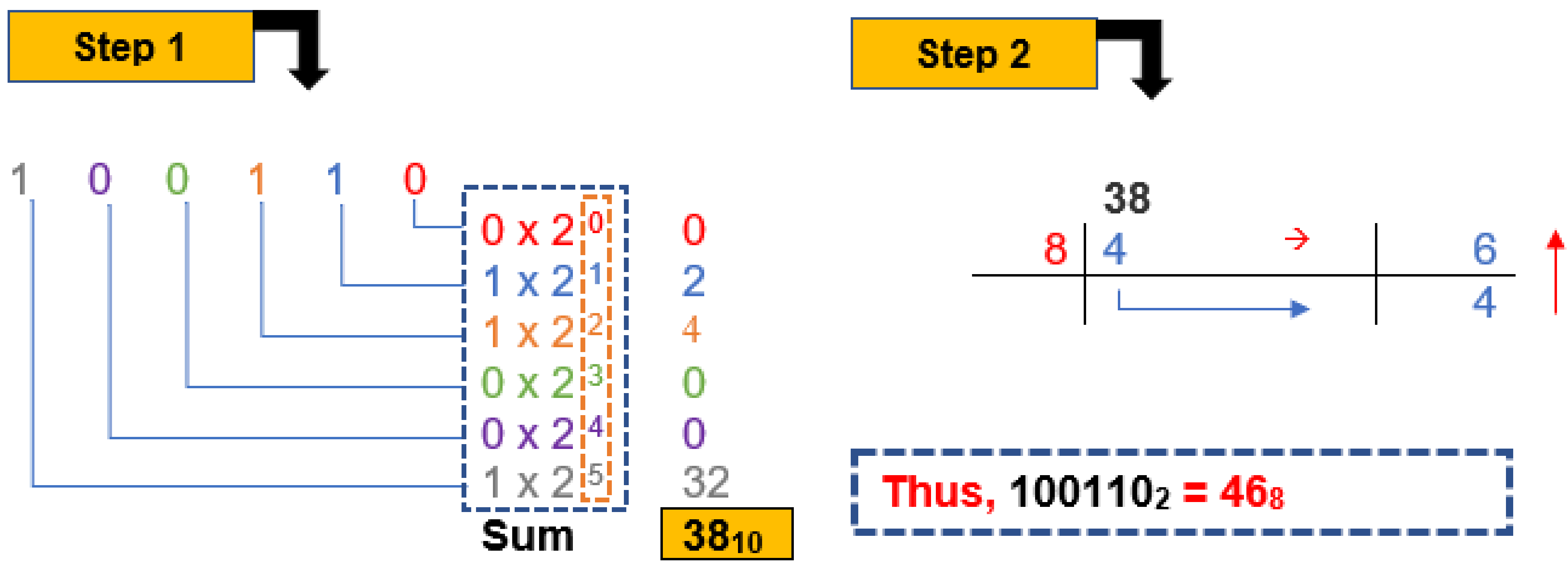
Convert number to the decimal number system as explained in the above process.

Step 2

Convert the above number (which is in the decimal system), into the required number system.

Example 3.1

Convert 100110_2 to Octal



Example 3.2

Convert 111110_2 to Hexadecimal

Step 1

1 1 1 1 1 0

$0 \times 2^0 = 0$
$1 \times 2^1 = 2$
$1 \times 2^2 = 4$
$1 \times 2^3 = 8$
$1 \times 2^4 = 16$
$1 \times 2^5 = 32$

Sum 62_{10}

Step 2

	62	
16	3	14
		3

Thus, 111110_2 = $3E_{16}$

Things to Remember for Hexadecimal Number

IMPORTANT

Before end step 2, you must check the value. If the value > 9, you have to convert into alphabet which contain A to F in hexadecimal number

14 = E

Thus, the answer must $3E_{16}$

Exercise

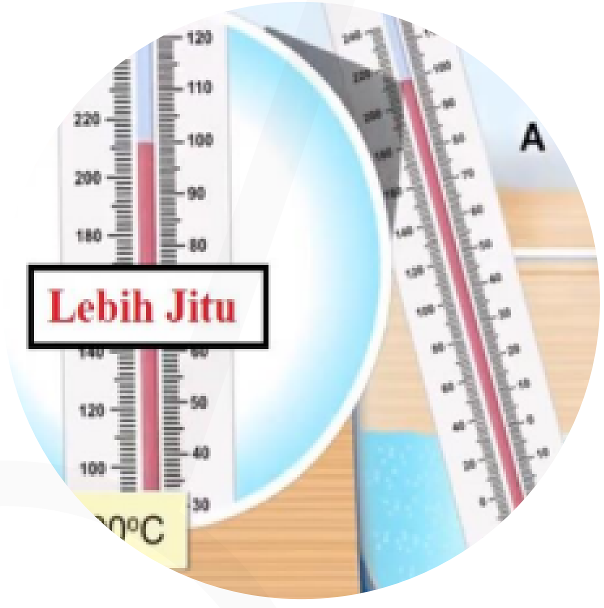
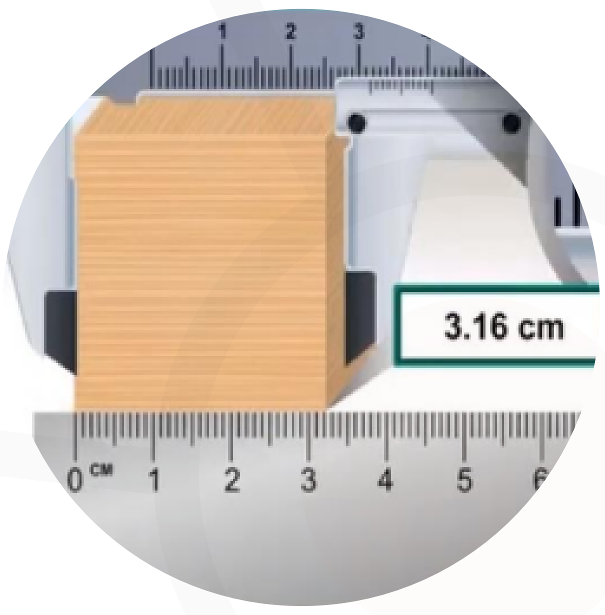
#MathQuotes

The only way to learn Mathematics is to do Mathematics

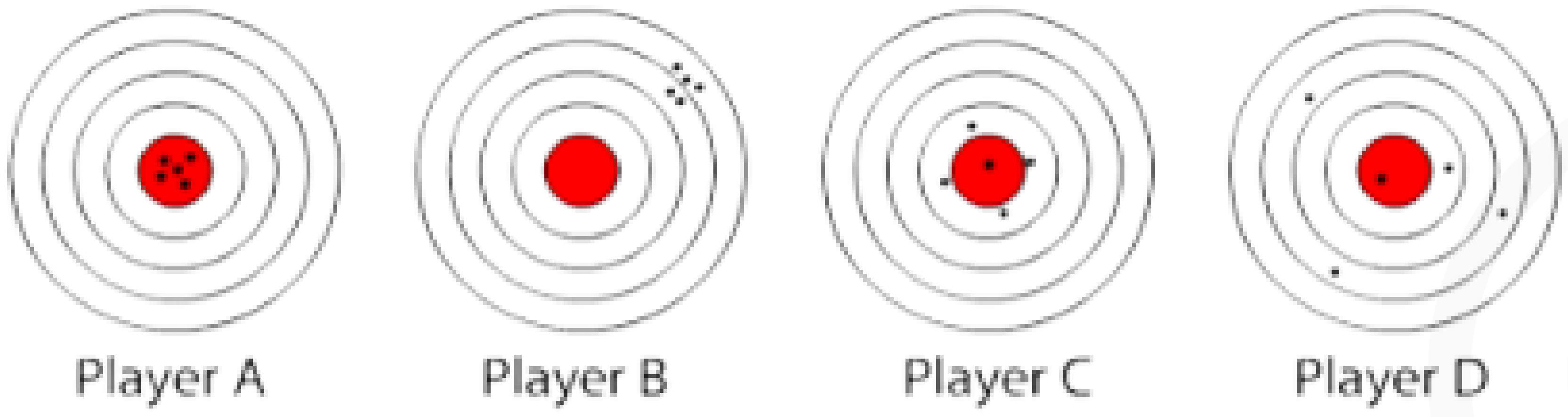
(Paul Halmos)

2.0 Concept of Control of Accuracy

There are three types Control of Accuracy concept:

	Types	Definition	Example
I	**Consistency** *(Kejituan)*	The ability of the measuring device to obtain readings approaching the actual value	
II	**Accuracy** *(Kepersisan)*	The ability of the measuring device to obtain the readings are almost the same when the measurements are repeated.	
III	**Sensitivity** *(Kepekaan)*	The ability of gauges to detect small changes in a measured quantity	

CHAPTER 2.0
CONTROL OF ACCURACY



The diagram shows the result for four shooters. Player A, B, C and D in a tournament. Every shooter shot five times.

Shooter	Consistency	Accuracy
A	High	High
B	High	Low
C	High	Low
D	Low	Low

Context of Errors

When managing error through the concept of control of accuracy, it is a smart thought to recognize what we truly mean by error. **To start with, we should discuss what error isn't. An error isn't a silly mistake, for example, neglecting to put the decimal point in a perfect spot, utilizing the wrong units, transposing numbers, etc.** The error isn't your lab accomplice breaking your hardware. The error isn't even the distinction between your very own estimation and some commonly accepted value.

Error alludes to the contradiction between estimation and the genuine or accepted value. You might be shocked to find that error isn't that vital in the discourse of experimental outcomes.

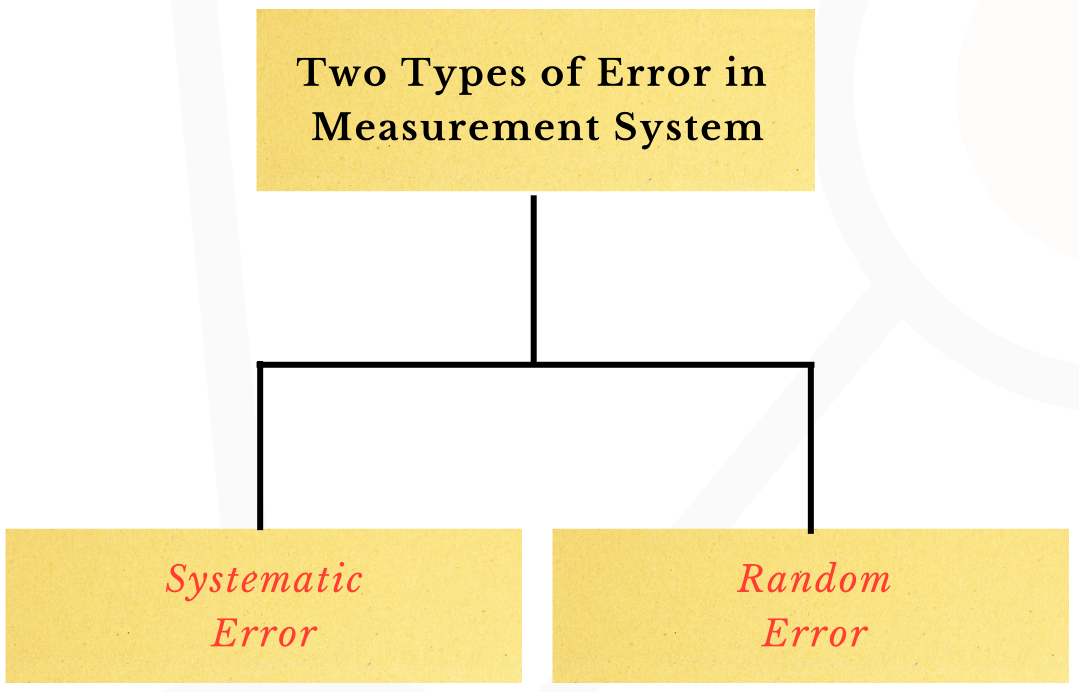
CHAPTER 2.0
CONTROL OF ACCURACY

Errors in Measurement System

An error may be **defined as the difference between the measured value and the actual value.** For example, if the two operators use the same device or instrument for finding the errors in measurement, it is not necessary that they may get similar results. There may be a difference between both measurements. The difference that occurs between both the measurements is referred to as an ERROR.

Sequentially, **to understand the concept of errors in measurement, you should know the two terms that define the error. They are true value and the measured value. The true value is impossible to find out the truth of quantity by experimental means.** It may be defined as the average value of an infinite number of measured values. Measured value can be defined as the estimated value of true value that can be found by taking several measured values during an experiment.

Types of Errors in Measurement System



i. Systematic Error

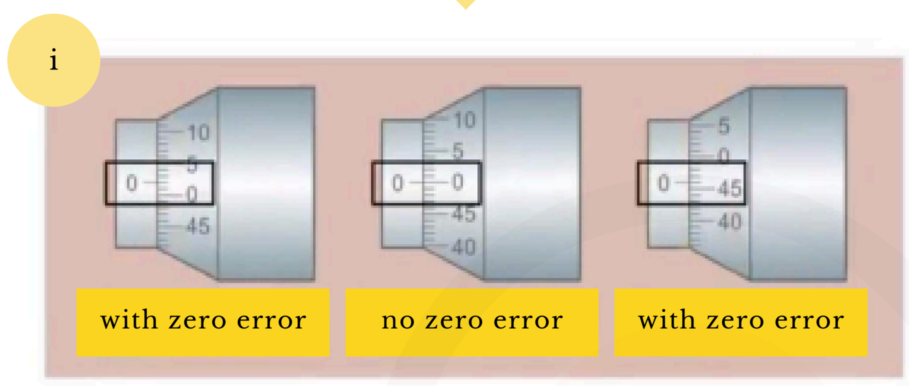
The **Systematic errors that occur due to fault in the measuring device are known as systematic errors. Usually they are called as Zero Error – a positive or negative error.** These errors can be detached by correcting the measurement device. These errors may be classified into different categories.

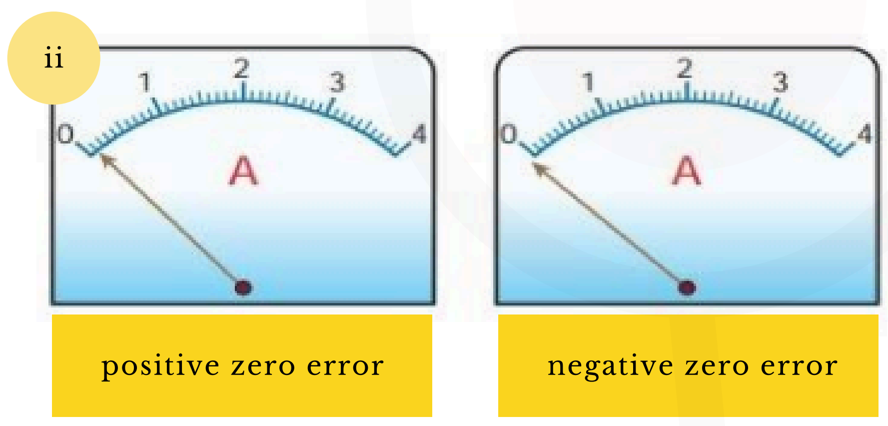
ii. Random Error

Random errors are caused by the sudden change in experimental conditions and noise and tiredness in the working persons. These errors are either positive or negative. An example of the random errors is during changes in humidity, unexpected change in temperature and fluctuation in voltage. These errors may be reduced by taking the average of a large number of readings.

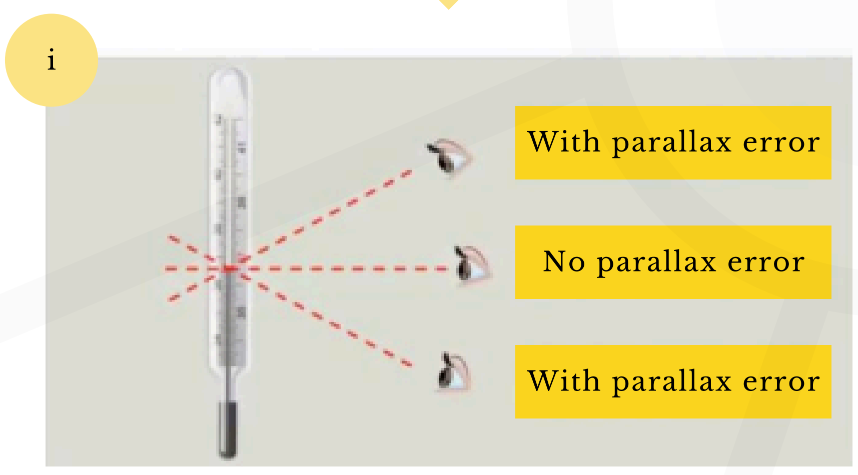
Example

Systematic Error





Random Error



How to identify zero error?

When the jaws are closed, the vernier zero mark coincides with the zero mark on its fixed main scale.

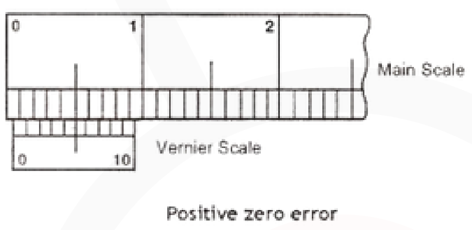
Before taking any reading, it is good practice to close the jaws or faces of the instrument to make sure that the reading is zero. If it is not, then note the reading. This reading is called "zero error".

How to identify positive and negative zero error?

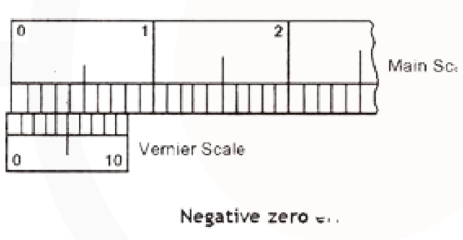
The zero error is of two types:

1. Positive zero error; and
2. Negative zero error.

Positive Zero Error
(Example: Vernier calipers)
If the zero on the vernier scale is to the right of the main scale, then the error is said to be positive zero error and so the zero correction should be subtracted from the reading which is measured.



Negative Zero Error
(Example: Vernier calipers)
If the zero on the vernier scale is to the left of the main scale, then the error is said to be negative zero error and so the zero correction should be added from the reading which is measured.



How to identify parallax error?

The parallax error is one that occurs when a measurement is made from different viewing angles. A simple example of what is meant by parallax is seen when we close the left eye in front of an object, and then immediately open the left eye and close the right eye: the object will appear to have moved to the right. But when we have both eyes open, we will see the object in the middle.

How to Calculate Error?

There are three (3) ways to calculate an error:

i. Absolute Error

The difference between the actual value and the measured value of a quantity. It determines how large the error is:

Formula

Absolute Error (Δx) = |Actual Value(x_0) - Measured Value (x)|

Example and Solution (i)

Suppose, we are measuring the length of an eraser. The actual length is 35 mm and the measured length is 34.13 mm. Find absolute error.

35 mm – 34.13 mm = **0.87 mm**

ii. Relative Error

The ratio of absolute error of a measurement and the the actual value of the quantity. It determines how good or bad the error is

Formula

$$\text{Relative Error } (x_r) = \frac{|\text{ Absolute Error } (\Delta x)\ |}{\text{Actual Value } (x_0)}$$

$$= \frac{|\text{Actual Value}(x_0) - \text{Measured Value } (x)|}{\text{Actual Value } (x_0)}$$

Example and Solution (ii)

Suppose, we are measuring the length of an eraser. The actual length is 35 mm and the measured length is 34.13 mm. Find relative error.

$$\frac{35\text{mm} - 34.13\text{mm}}{35\text{mm}} = \mathbf{0.02485mm}$$

iii. Percentage Error

Formula

$$\text{Percentage Error } (x_r) = \frac{|\text{ Absolute Error } (\Delta x)\ |}{\text{Actual Value } (x_0)} \times 100\%$$

$$= \frac{|\text{Actual Value}(x_0) - \text{Measured Value } (x)|}{\text{Actual Value } (x_0)} \times 100\%$$

Example and Solution (iii)

Suppose, we are measuring the length of an eraser. The actual length is 35 mm and the measured length is 34.13 mm. Find percentage error.

$$\frac{35\text{mm} - 34.13\text{mm}}{35\text{mm}} \text{ X } 100\% = \mathbf{2.485\%}$$

CHAPTER 2.0
CONTROL OF ACCURACY

Simplify Accuracy

How to use the right measuring device?

Measuring length


Measuring tape


Ruler

Measuring electric current


Ammeter

Measuring mass


Lever Balance


Triple beam balance

Measuring time


Stopwatch *(Jam Randik)*

Measuring temperature

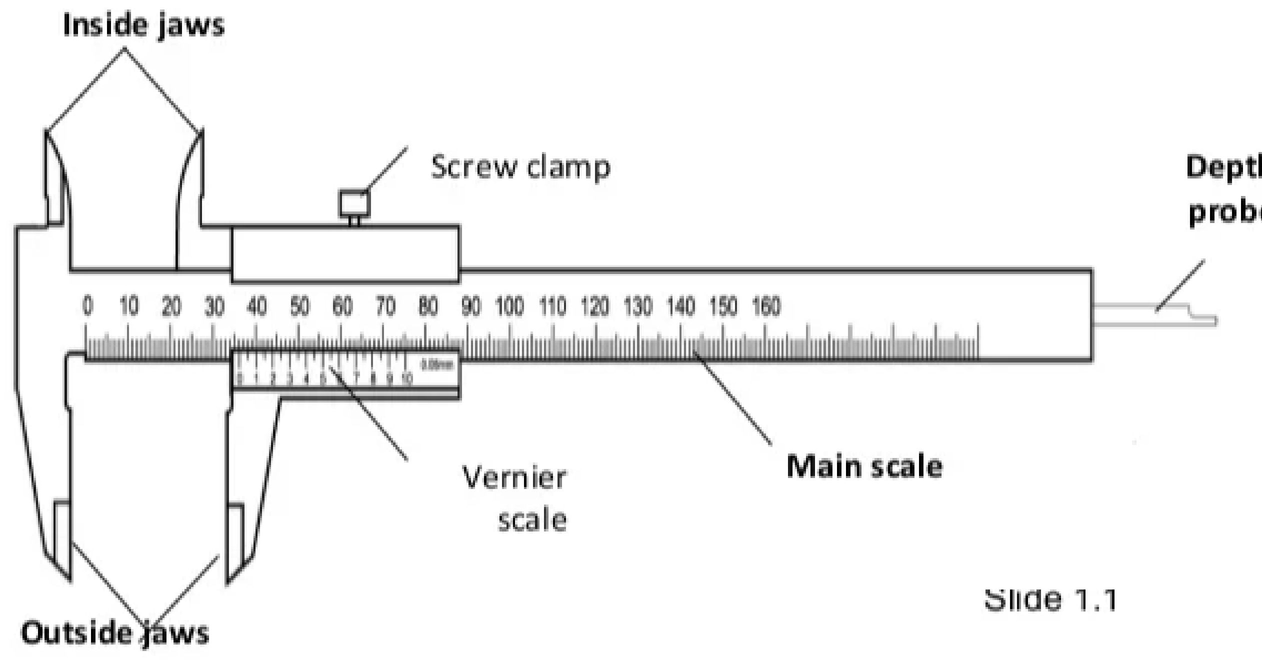

Laboratory thermometer


Clinic thermometer

Measuring the volume of water


Measuring cylinders

Practice Measuring Instruments using Vernier Caliper



Part of Vernier Caliper

A **vernier caliper is usually used to** *measure the diameter of circular objects***.** The circular jaws of the vernier caliper fit perfectly on the circumference of round objects. Vernier caliper consists of two scales, the main scale which is fixed, and a moving vernier scale.

Uses of Vernier Caliper

There are three major uses of Vernier Calipers which are as follows:

- i. It is used to measure the internal diameter of a tube or cylinder.
- ii. It is useful in measuring the length of the object.
- iii. Traditionally; a vernier caliper is used to measure the diameter of circular objects.

Apart from these Vernier calipers are useful for many purposes such as for the industrial domain as well as for professionals and engineering purposes.

How to use Vernier Caliper?

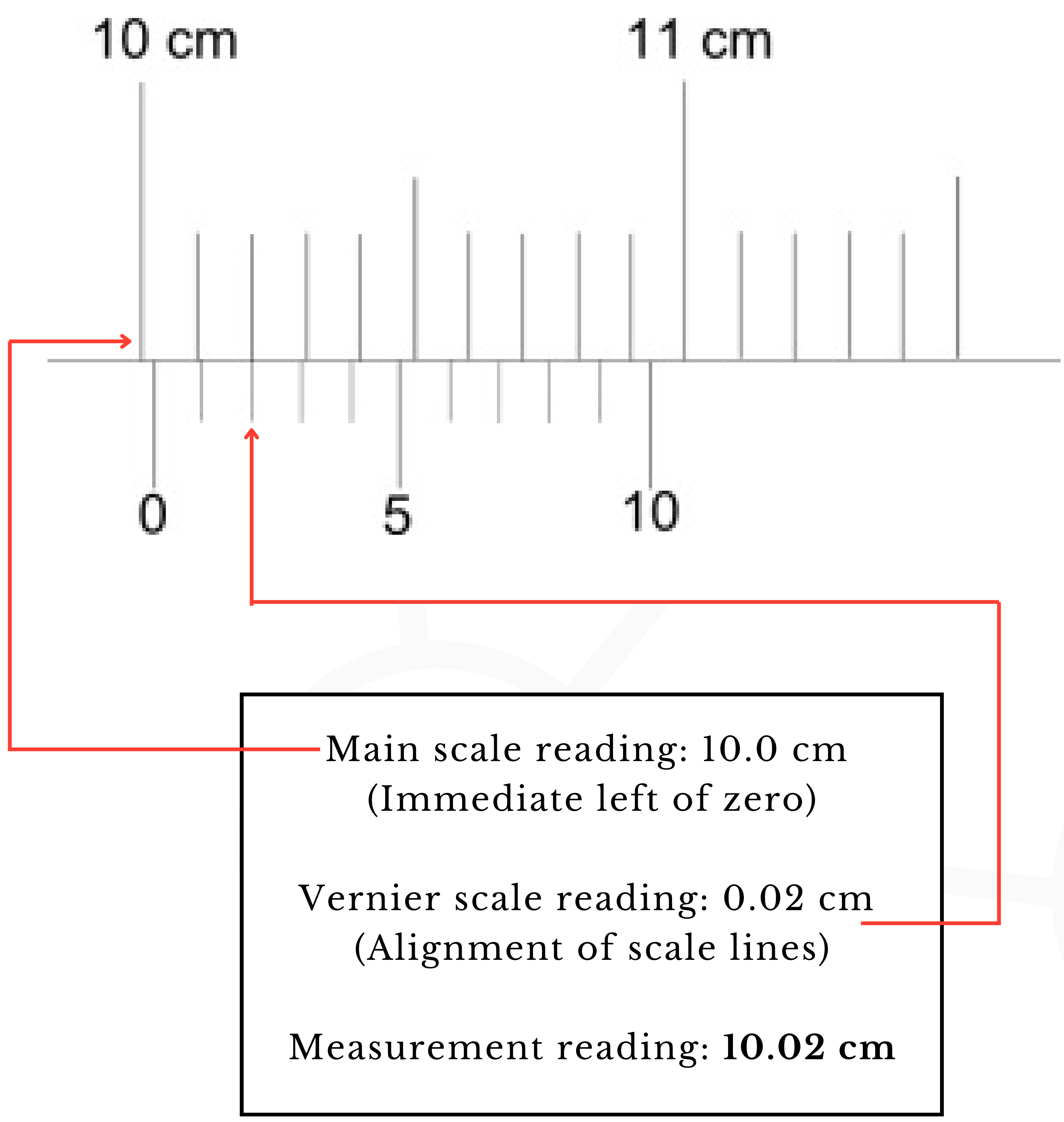
A vernier caliper is usually used to measure the diameter of circular objects. The circular jaws of the vernier caliper fit perfectly on the circumference of round objects. Vernier caliper consists of two scales, the main scale which is fixed, and a moving vernier scale. The main scale has readings in millimeters. Unlike standard scales, **a vernier caliper can measure readings precisely up to 0.001 cm.** For accurate measurement, a vernier scale is used along with a vernier caliper.

Practice Measuring Instruments using Vernier Caliper

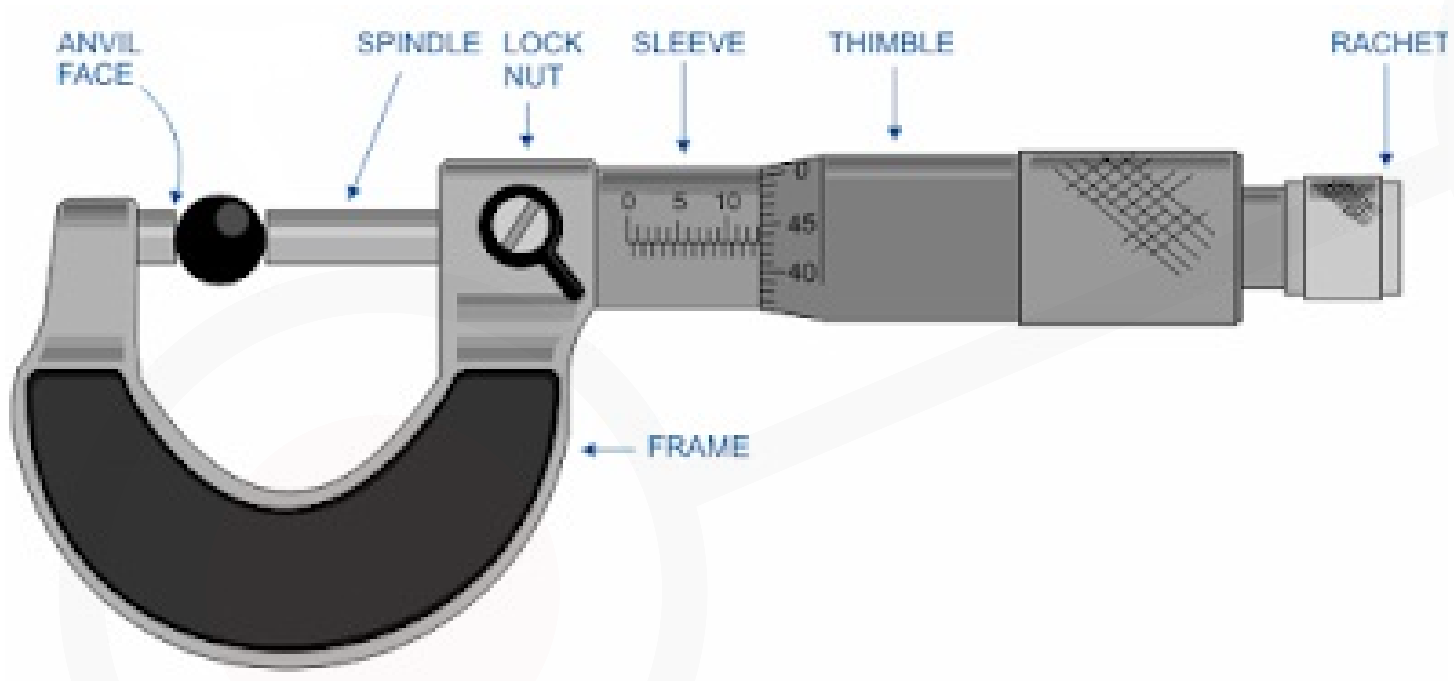
How to read Vernier Caliper?

Use the following formula:

Obtained reading = **Main scale reading** + **Vernier scale reading**
Let's go through another example to ensure that you understand the above steps:



Practice Measuring Instruments using Micrometer Screw Gauge



Part of Micrometer Screw Gauge

Uses of Micrometer Screw Gauge

A micrometer screw gauge is a device widely *used in the mechanical engineering field for measuring extremely small dimensions.* Though it belongs to the family of calipers, and also consists of two different scales.
The **precision even reaches 0.01 mm or 0.1 cm.**

How to use Micrometer Screw Gauge?

After understanding with certainty the parts of a screw micrometer, the next thing to do is to know how to use it, namely:

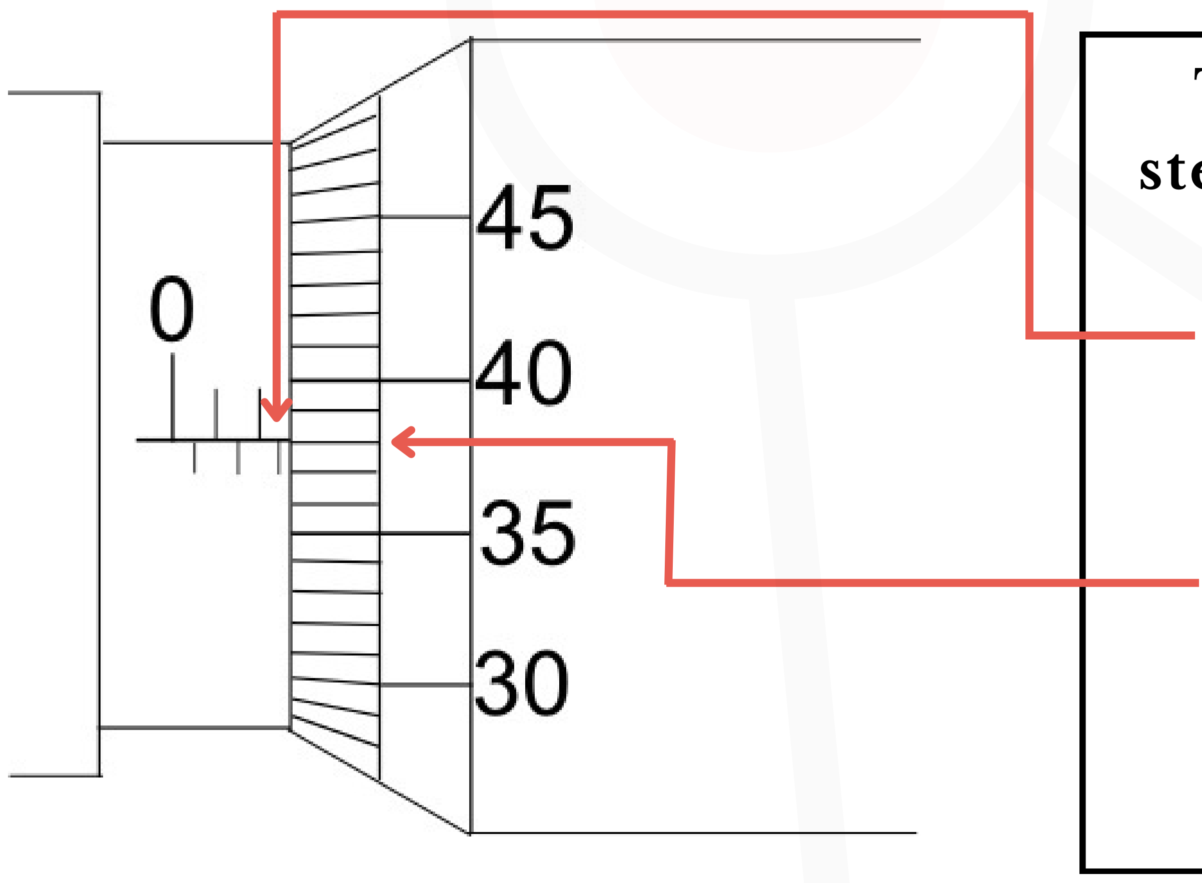
1. Place the object to be measured on the part between the anvil or fixed shaft and the spindle or sliding shaft
2. Rotate the thimble and ratchet until the object is clamped perfectly by the anvil and spindle
3. Turn the lock nut to the maximum position or until it can no longer be turned
4. Read the results of the main and nonius scales listed

Practice Measuring Instruments using Micrometer Screw Gauge

How to read Micrometer Screw Gauge?

Use the following formula:

Obtained reading = First Part Measurement + Second Part Measurement



To ensure that you understand the steps above, here's one more example:

First part of the measurement:
2.5 mm

Second part of the measurement:
0.38 mm

Final measurement: **2.88 mm**

CHAPTER 3.0
SET, RELATION AND FUNCTION

3.0 Set, Relation and Function

In mathematics, "**sets, relations and functions**" is one of the most important topics of set theory. Sets, relations and functions are three different words having different meaning mathematically. Let's go through together.

3.1 Set

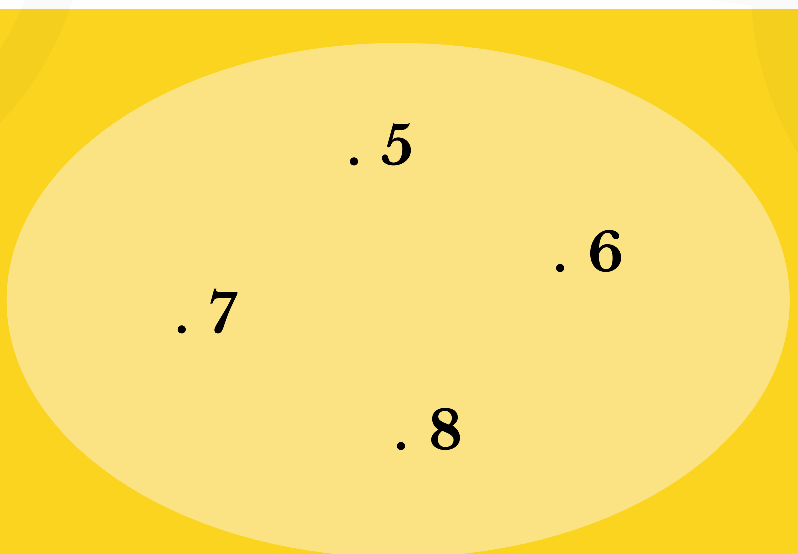
Definition of Set

A set is a collection of well defined objects called elements. The objects of a set are taken as distinct only on the ground of simplicity.
A set of sets is frequently called a family or collection of sets.

For example, suppose we have a family of sets consisting :

> A_1, A_2, A_3,….. up to A_n, that is the family {A_1, A_2, A_3,….., A_n } and could be denoted as
>
> S = {A_i | i belongs to N and $1 \leq i \leq n$}

A set can be **represented** by three (3) ways:

i. by description	**example:** B is a set of whole numbers from 5 to 8
ii. using set notation	**example:** B = {5, 6, 7, 8} or B = {x | $5 \leqslant x \leqslant 8$} which read as B is a set of all x such that x is from 5 to 8
iii. venn diagram	**example:** 

Basic Info

Notation:

A set is denoted by a capital letter and represented by listing all its elements between curly brackets such as { }.

Types of Set Notation

In sets theory, there are many types of sets. *Some of them are discussed below.*

Types	Definition	Example
Empty Set/Null Set	An empty set is a set with no element.	It is denoted by A = **{ }** or A = **ϕ.**
Subset	The subset symbol is used to represent a set formed by taking a few elements of a given set.	For a set A = {a, b, c, d, e}, if a new set B = {b, c, d} is formed by taking a few elements of set A, then we say that B is a subset of A, and this is denoted as B **⊂** A.
Power Set	The collection of all subsets of a set is the power set of that set. The number of elements contained by any power set can be calculated by **n[P(A)] = 2n** where n is the number of elements in set A.	If A = {1, 2} then, P(A) = {∅, {1}, {2}, {1, 2}} Number of elements in **P(A) = 2^2 = 4**
Finite Set	A set contains finite number of elements.	A = { 2, 4, 6, 8, 10} and B = { a, v, t}. There are 5 objects in set A and 3 elements **contained** by set B.
Infinite set	If the number of elements in a set is infinite, the set is called an infinite set.	N = set of whole numbers = { 0, 1, 2, 3, 4, 5, **......}**
Universal Set	Any set which is a superset of all the sets under consideration and usually it is denoted as ξ.	Let P = {3, 4, 7} and Q = {1, 2, 3} then we take **ξ** = {1, 2, 3, 4, 7} as universe set
Equal Sets	Two sets P and Q are equal if both are a subset of each other. Mathematically: If P ⊆ Q and Q ⊆ P then P = Q.	P = {3, 6, 8} and Q = {6, 3, 8} Here P and Q have exactly the same elements. Satisfy the condition P ⊆ Q and Q ⊆ P. Thus P **=** Q.
Complement of A Set	The complement of a set is all the elements of the universal set, except the elements of the set A.	For a set A, its complement is A**'** = µ - A. If the set A = {2, 3, 4, 5} , and µ = {1, 2, 3, 4, 5, 6, 7, 8, 9, 10}, then A**'** = µ - A = {1, 6, 7, 8, 9, 10}.

Reference : https://www.geeksforgeeks.org/empty-set/

Element of Set

Element of set:
∈ - an object is an element of a set
∉ - an object is not an element of a set

Example (i)

Let's go through below example (i) to ensure that you understand the definition of elements of set:

B = { 5, 6, 7, 8 }
a) 6 [∈] B
b) 4 [∉] B

Number of Elements

The number of elements is also known as the order of sets. The order of a set is represented as n(set_name).

Example (ii)

Let's go through below example (ii) to ensure that you understand the definition of number of elements in set:

A = {o, p, q, r, s, t}
n(A) = [6]
X = {5, 10, 20, 60}
n(X) = [4]
F = {Banana, Durian, Mango}
n(F) = [3]

Exercise

Let's go through below exercise to ensure that you understand the definition of elements of set.

List all the elements in set below

a) P = {letter in word 'MALAYSIA'}

Answer:	P =

b) Q = {odd number less than 20}

Answer:	Q =

c) R = {prime number less than 10}

Answer:	R =

d) S = {factor of 10}

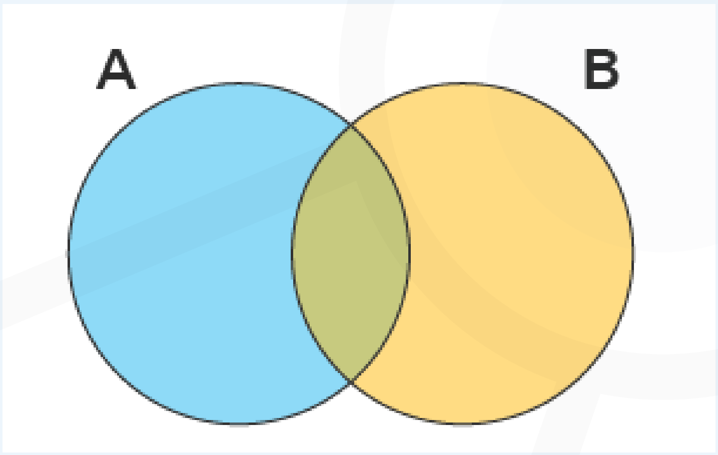
Answer:	S =

Venn Diagram

A Venn diagram is a diagram that **helps us visualize the logical relationship between sets and their elements and helps us solve examples based on these sets.** A Venn diagram typically uses intersecting and non-intersecting circles *(although other closed figures like squares may be used)* to denote the relationship between sets.

Sample

Let's go through below sample of venn diagram image:



Example

Question

Given ξ = {x: x is an integer from 10 to 20}, A = {Odd numbers}, B = {prime numbers} and C= {Sum of two digits less than 5}

a) List the elements of A, B and C

b) Sketch all set in Venn diagrams

Solution (a)

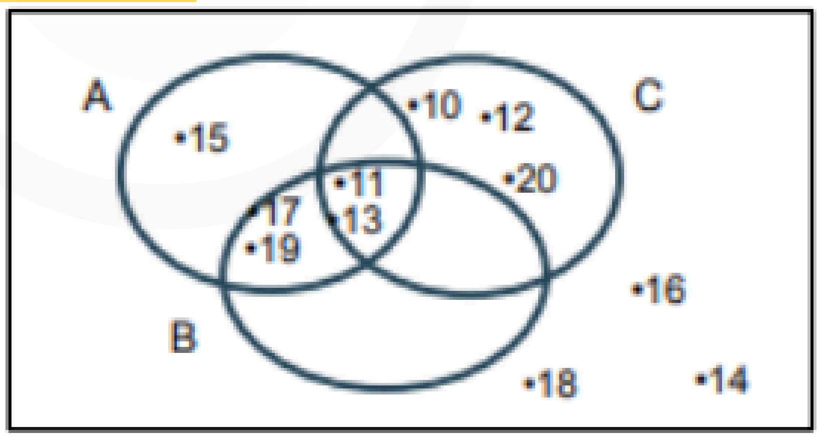
ξ = { 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20}

A = {11, 13, 15, 17, 19}

B = { 11, 13, 17, 19}

C = { 10, 11, 12, 13, 20}

Solution (b)



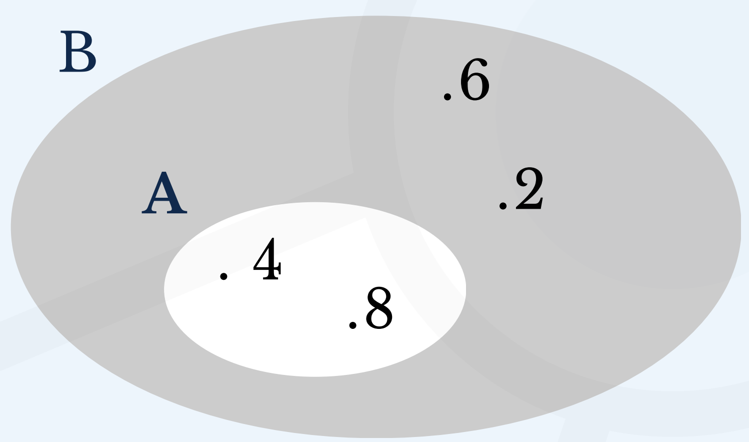
Sub Set

Sub set are a sets where elements are contained within another set. It defined as **a collection of objects or elements in a set.**

In set theory, a subset is denoted by the symbol ⊆ and read as 'is a subset of'. Using this symbol we can express subsets as follows:
A ⊆ B;
which means Set A is a subset of Set B.

Example

Let's go through below sample of venn diagram for sub set:



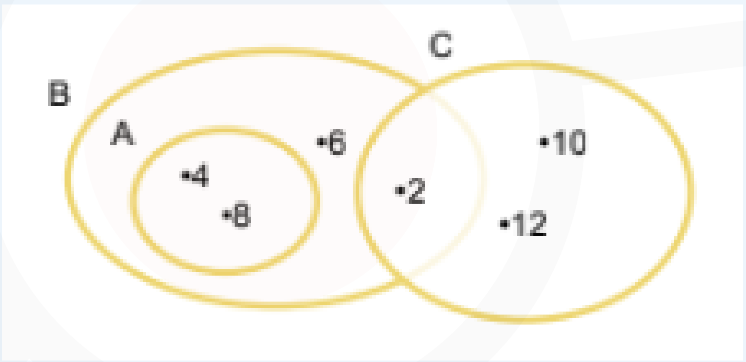
A = {4, 8}
B = {2, 4, 6, 8}
Thus, *A is a subset of B* **or** *A ⊆ B*

Universal Set

The universal set is the set of all elements or members of all related sets. It is usually denoted by the symbol ξ.

Example

Let's go through below sample of venn diagram for universal set:



A = { 4, 8}
B = {2, 4, 6, 8}
C = { 2, 10, 12}
Thus, *ξ = { 2, 4, 6, 8, 10, 12}*

Info

Wait! Before we go through about next subtopic. Let's discover more about the differences between universal and unison of set.

Usually, students have confusion in differentiating between the union of sets and the universal set. We can understand the difference better by looking at their definitions.

Universal Set	Union of Set
The universal set is the set of all elements or members of all related sets.	The union of sets is one of the set operations between two sets where the resultant set contains all the elements belonging to both the initial sets.
A universal set can be denoted by the symbol ξ. *(Refer above example)*	The union operation between sets can be denoted by the symbol ∪. Example: A ∪ B(A union B)

Basic Info +

Just a quick info "differences between universal set and union of set.

For more example of union of set, you may refer to page xx.

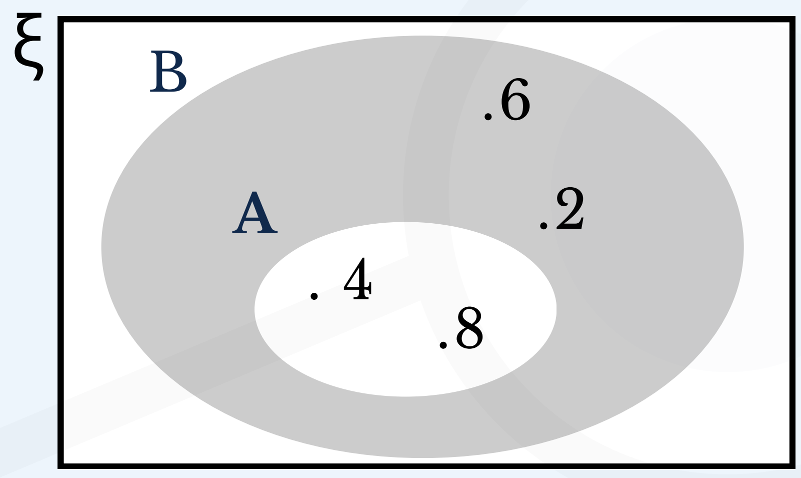
Complement Set

The complement of a set is all the elements of the universal set, except the elements of the set A.
It can be understand as a set in which contains all the elements in ξ but not in A.

It is usually denoted by the symbol '.

Example

Let's go through below sample of venn diagram for Complement Set:

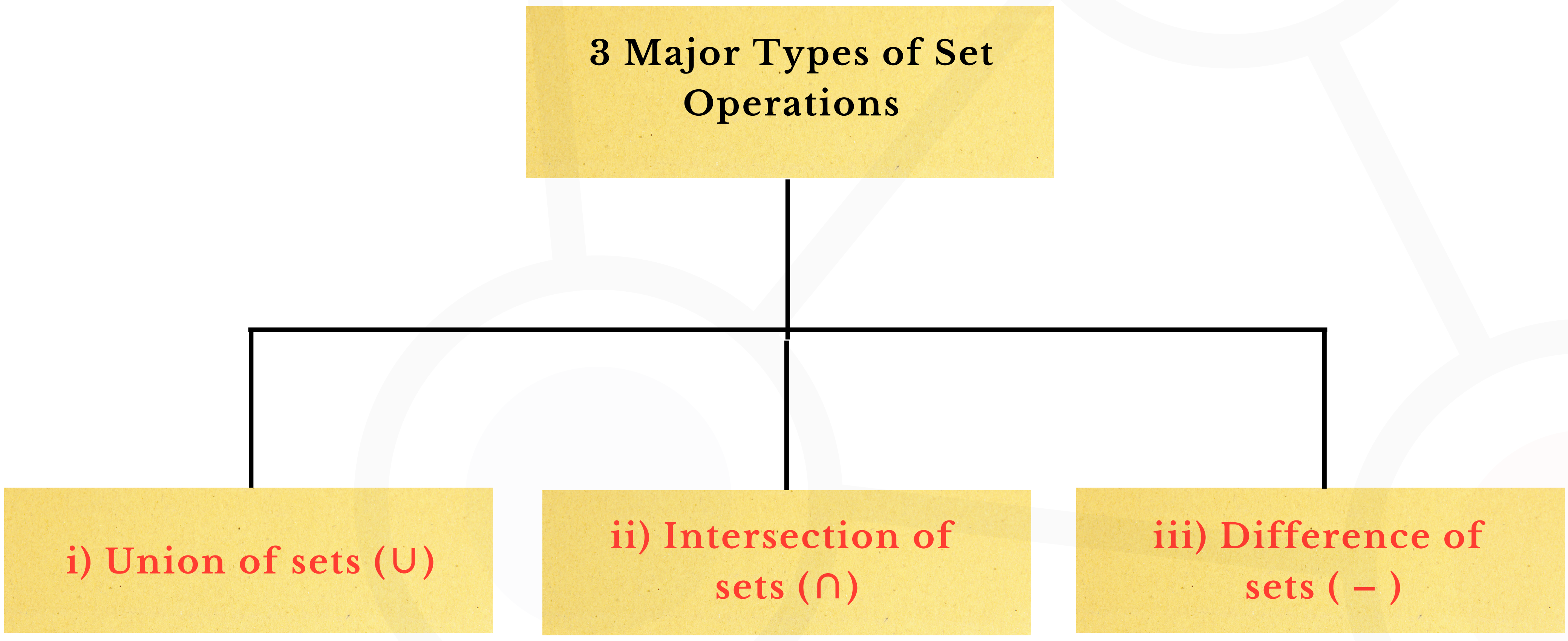


ξ = { 2, 4, 6, 8}
A = { 4, 8}
A' = {2, 6}

Set Operations

The set operations are performed on two or more sets to obtain a combination of elements as per the operation performed on them.

In a set theory, there are **three major types** of operations performed on sets, such as:



Basic Info

Just a quick info "differences between universal set and union of set.

For more example of union of set, you may refer to page xx.

CHAPTER 3.0
SET, RELATION AND FUNCTION

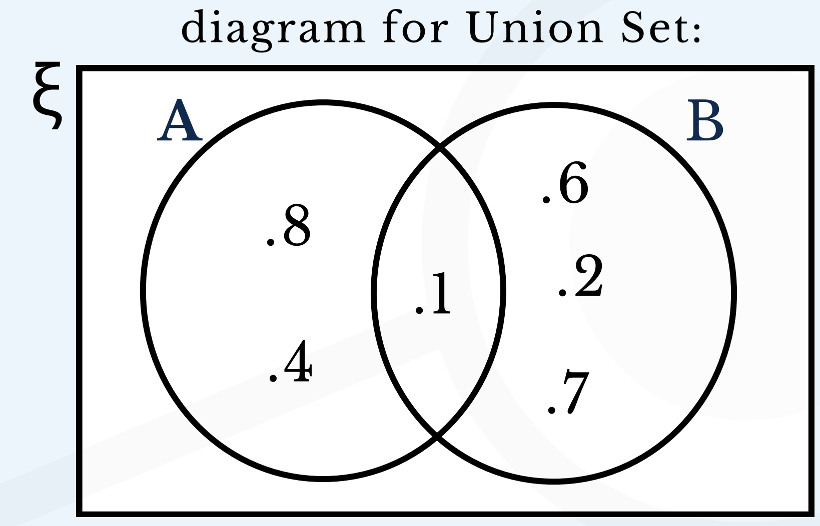
i) Union Set

If two sets A and B are given, then the union of A and B is equal to the set that contains all the elements present in set A and set B.

This operation can be represented as;
$A \cup B = \{x: x \in A \text{ or } x \in B\}$
Where x is the elements present in both sets A and B.

Example

Let's go through below **sample** of venn diagram for Union Set:



A = {1, 4, 8}
B = {1, 2, 6, 7}
Thus, A ∪ B = {1, 2, 4, 6, 7, 8}

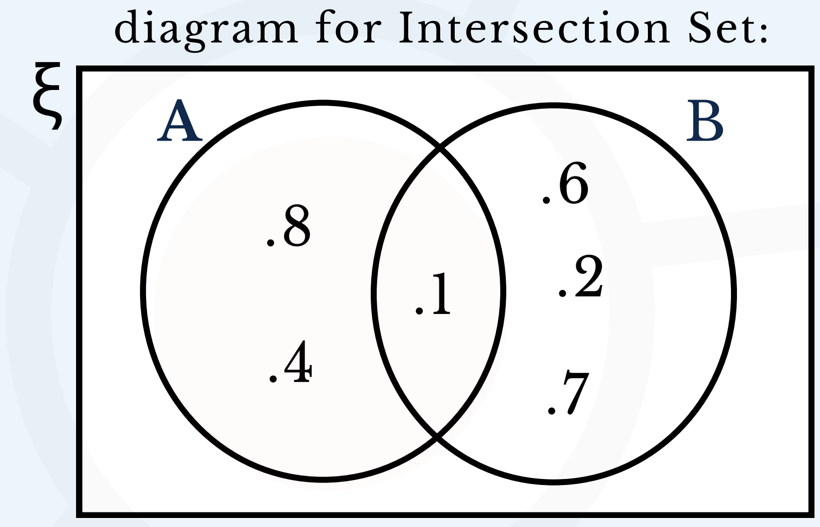
ii) Intersection Set

If two sets A and B are given, then the intersection of A and B is the subset of universal set U, which consist of elements common to both A and B. It is denoted by the symbol '∩'.

This operation is represented by:
$A \cap B = \{x : x \in A \text{ and } x \in B\}$
Where x is the common element of both sets A and B.

Example

Let's go through below **sample** of venn diagram for Intersection Set:



A = {1, 4, 8}
B = {1, 2, 6, 7}
Thus, A ∩ B = {1}

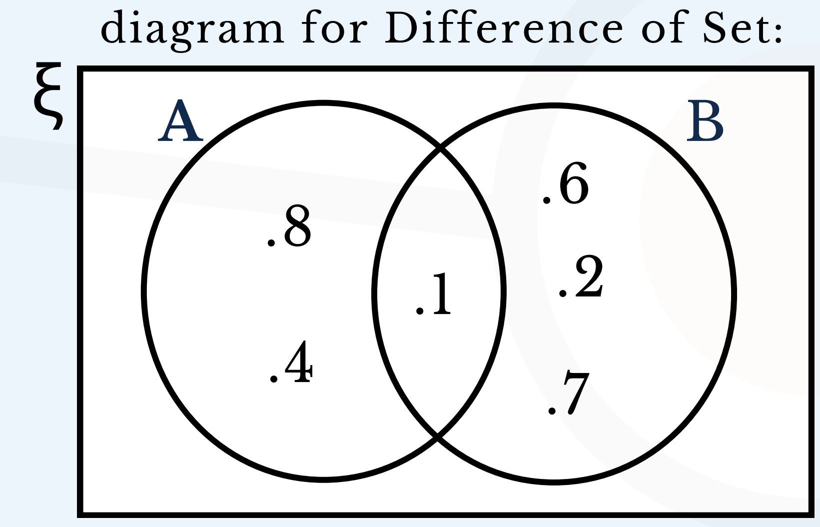
iii) Difference of Sets

If there are two sets A and B, then the difference of two sets A and B is equal to the set which consists of elements present in A but not in B. It is represented by A-B.

We can also say that the difference of set A and set B is equal to the intersection of set A with the complement of set B. Hence,
$A-B=A\cap B'$

Example

Let's go through below **sample** of venn diagram for Difference of Set:



A = {1, 4, 8}
B = {1, 2, 6, 7}
Thus, A - B = {4, 8}

Basic Info +

Just a quick info "differences between universal set and union of set.

For more example of union of set, you may refer to page xx.

CHAPTER 3.0
SET, RELATION AND FUNCTION

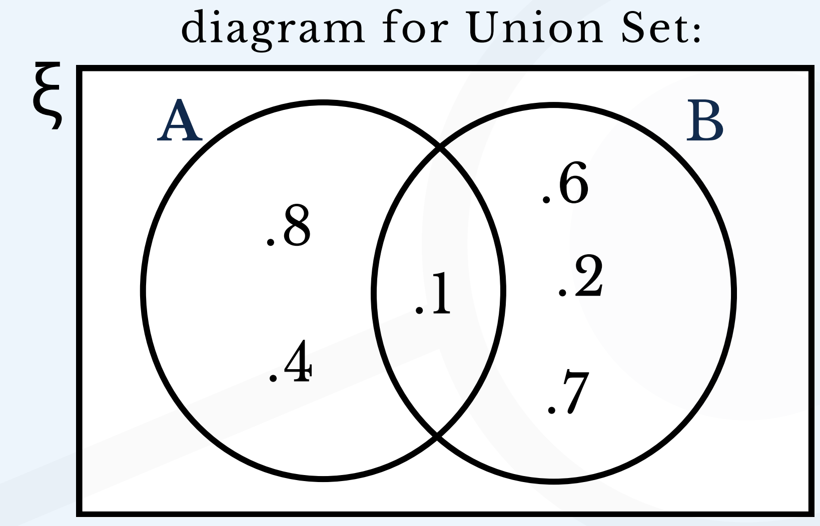
i) Union Set

If two sets A and B are given, then the union of A and B is equal to the set that contains all the elements present in set A and set B.

This operation can be represented as;
A ∪ B = {x: x ∈ A or x ∈ B}
Where x is the elements present in both sets A and B.

Example

Let's go through below **sample** of venn diagram for Union Set:



A = {1, 4, 8}
B = {1, 2, 6, 7}
Thus, A ∪ B = {1, 2, 4, 6, 7, 8}

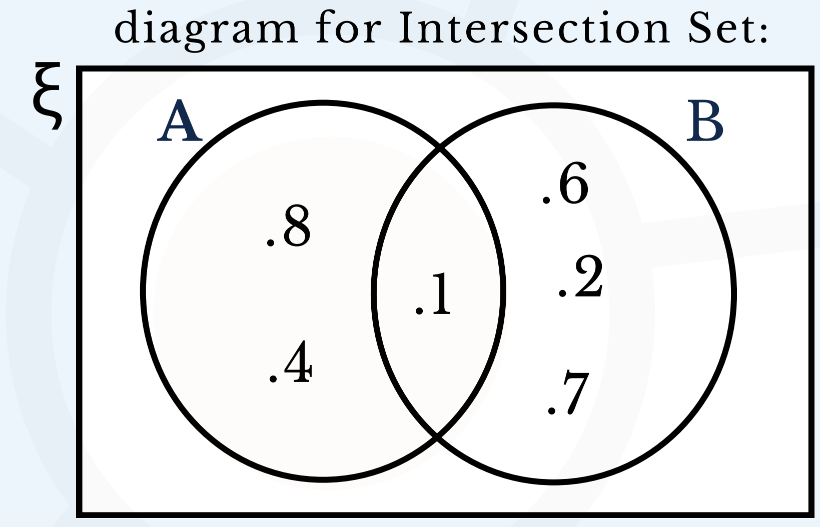
ii) Intersection Set

If two sets A and B are given, then the intersection of A and B is the subset of universal set U, which consist of elements common to both A and B. It is denoted by the symbol '∩'.

This operation is represented by:
A∩B = {x : x ∈ A and x ∈ B}
Where x is the common element of both sets A and B.

Example

Let's go through below **sample** of venn diagram for Intersection Set:



A = {1, 4, 8}
B = {1, 2, 6, 7}
Thus, A ∩ B = {1}

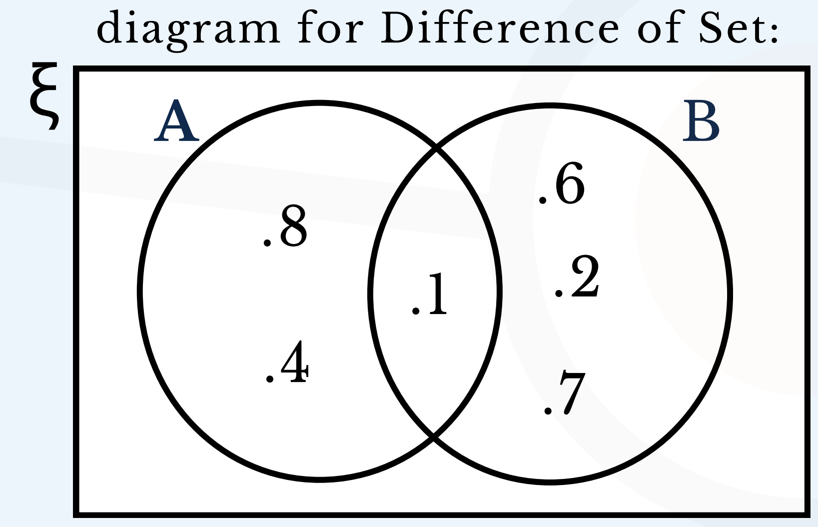
iii) Difference of Sets

If there are two sets A and B, then the difference of two sets A and B is equal to the set which consists of elements present in A but not in B. It is represented by A-B.

We can also say that the difference of set A and set B is equal to the intersection of set A with the complement of set B. Hence,
A−B=A∩B'

Example

Let's go through below **sample** of venn diagram for Difference of Set:



A = {1, 4, 8}
B = {1, 2, 6, 7}
Thus, A - B = {4, 8}

Basic Info

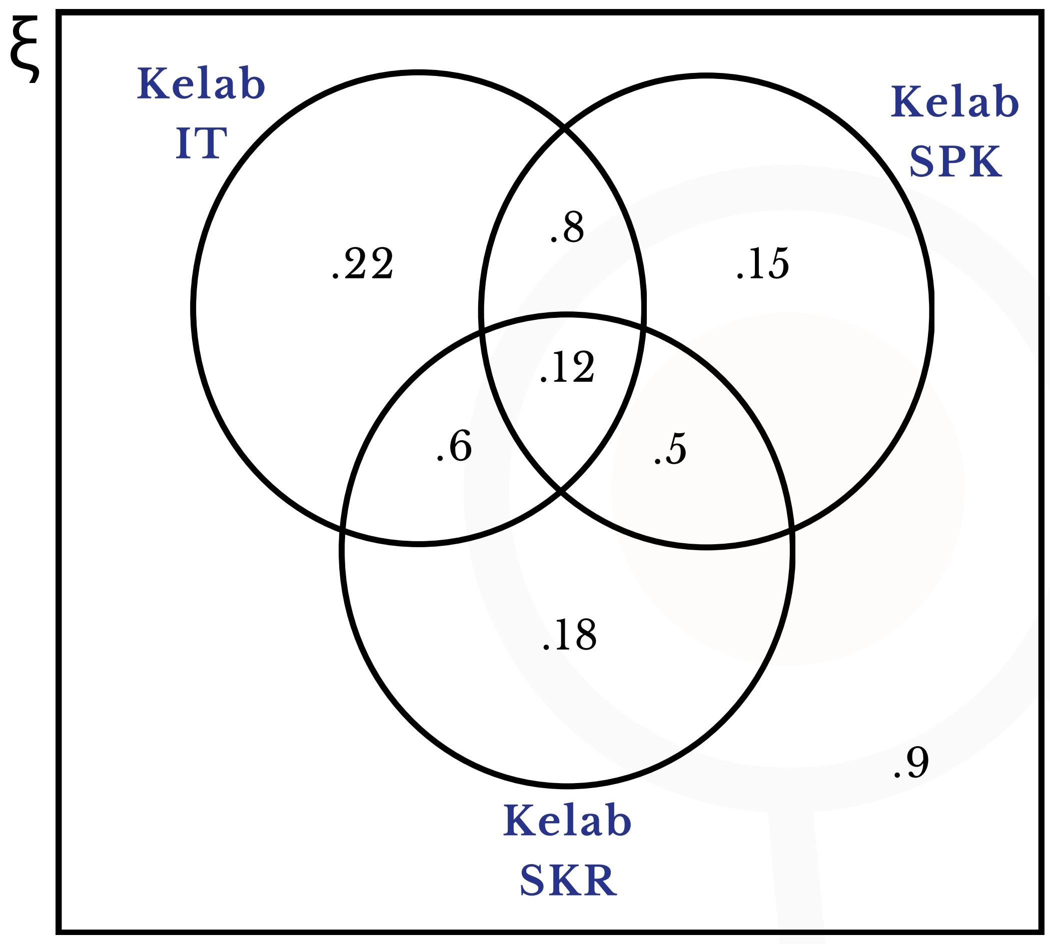
Just a quick info "differences between universal set and union of set.

For more example of union of set, you may refer to page xx.

CHAPTER 3.0
SET, RELATION AND FUNCTION

Exercise

1. Below Venn Diagram shows KKPS students who joined the three club which includes Kelab IT, Kelab SPK and Kelab SKR. Answer all question as below:



- How many students joined only the Kelab IT?

  Answer:

- How many students joined the Kelab SPK?

  Answer:

- How many students joined a Kelab SPK but did not join the Kelab IT or Kelab SPK?

  Answer:

- How many students did not join any club?

  Answer:

- How many students all the three club?

  Answer:

2. Given ξ = {x:1⩽x⩽20, x is an integer},
P = {multiples of 3},
Q = {prime numbers},
R = { perfect squares}

a) List the elements of sets P, Q and R

Answer:

b) Draw a Venn diagram

Answer:

c) Based on question (b), find Q ∪ R and (P ∪Q ∪ R)’

Answer:

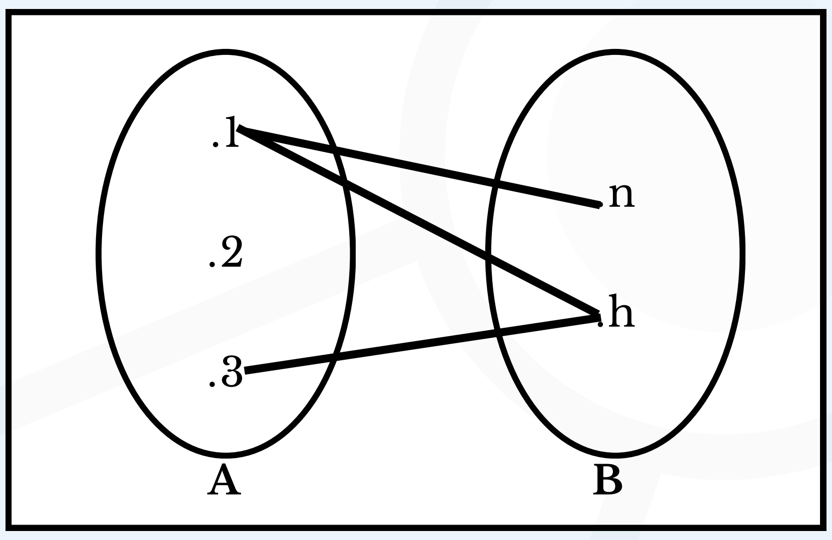
3.2 Relation

Definition of Relation

A relation from set A to the set B in the subset of Cartesian product AxB. The elements of R are ordered pairs where the first element belongs to A and the second belongs to B.
The symbol of relation is R.

Note : *Relation is helpful to find the relationship between input and output of a function.*

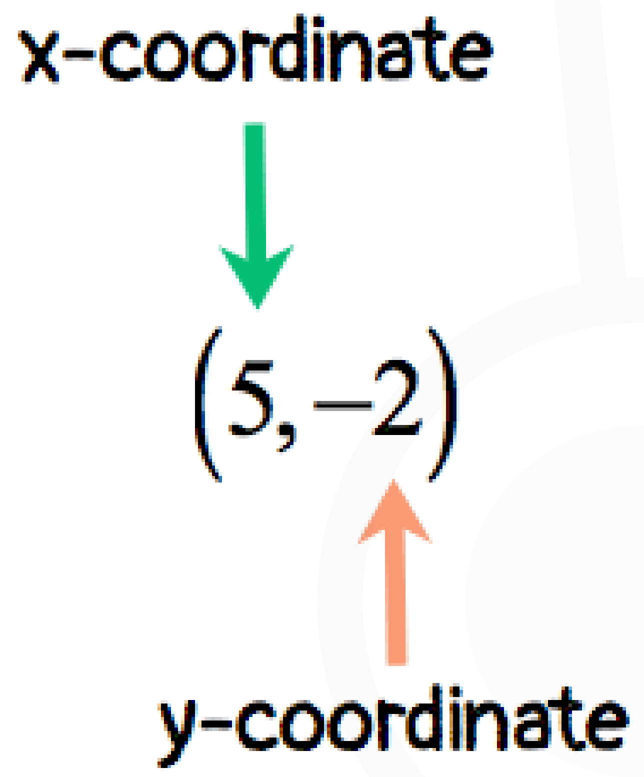
Example



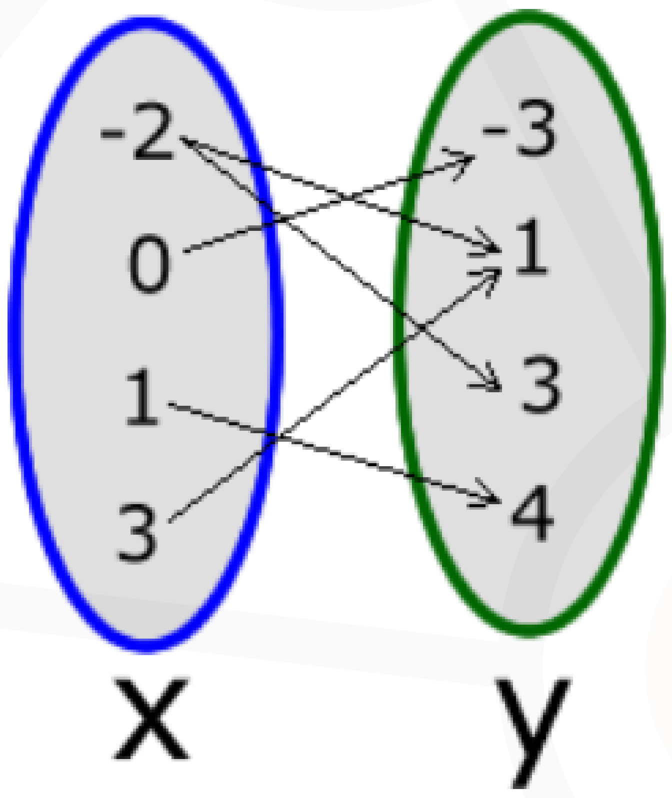
<u>**Sample Question:**</u>
Find Relation from Set B to A.
<u>**Solution:**</u>
R = { (n,1),(h,1),(h,3) }

Let's start by saying that **a relation is simply a set or collection of ordered pairs.** Nothing really special about it. An ordered pair, commonly known as a point, has two components which are the xx and yy coordinates.

This is an example of an ordered pair.



Example 1: Example of an Ordered Pair X,Y



Example 2: Example of Relation in Mapping Diagram

Types of Relation

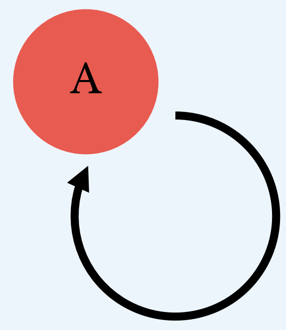
Types of relations are **based on the linking of the elements of one set with the elements of another set.**
Basically, there are nine (9) types of relation but **we focused on three (3) major types of relation in this subtopic:**

3 Major Types of Relation (R)

i) Reflexive

A relation R such that every element a ∈ A, is such that every element is related to itself. (a, a) ∈ R.

Sample Diagram



Looping to itself

ii) Symmetric

A relation R on a set A such that a1, a2 are elements of A, and if (a1, a2) ∈ R, and also if (a2, a1) ∈ R, then the relation R is a symmetric relation. A real-life example of this is, if John is a brother of Sam, then Sam can also be said to be a brother of John.

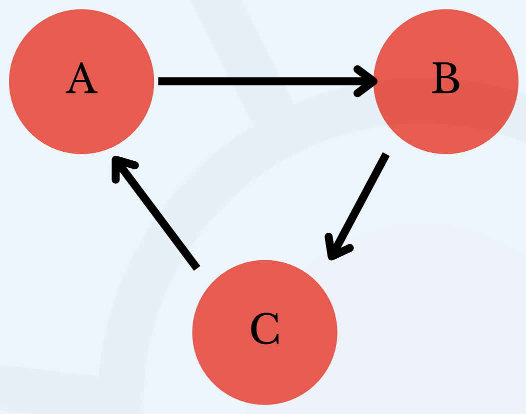
Sample Diagram

if A is related to B and B is related to A in R

iii) Transitive

A relation R on a set A such that the elements a1, a2, a3 belongs to set A, such that (a1, a2) ∈ R, (a2, a3) ∈ R, then it implies that (a1, a3) ∈ R, and the relation R is a transitive relation. This can also be understood with a simple example, If P, Q, R are three persons such that P is a friend of Q, Q is a friend of R, then P is said to be a friend of R.

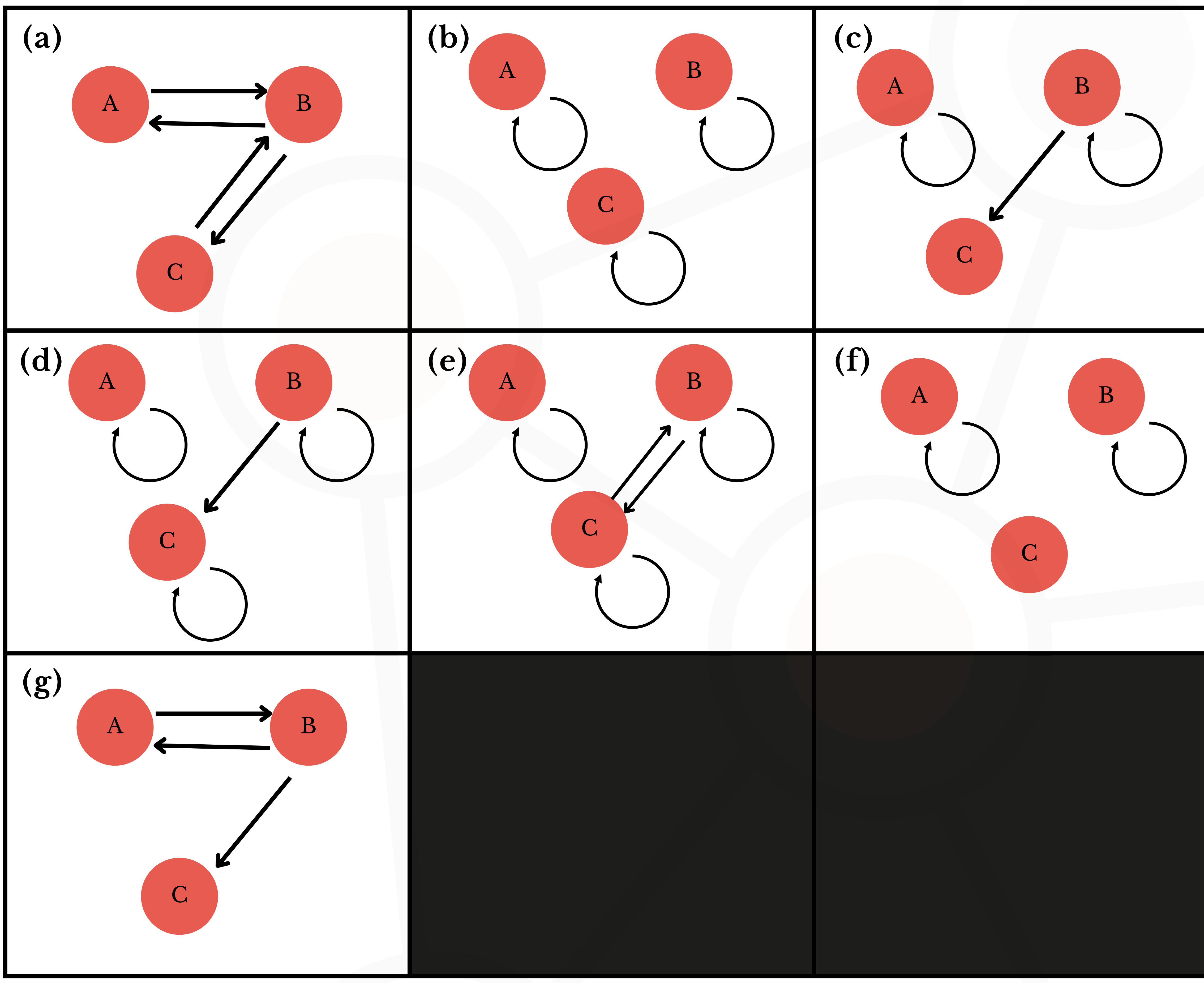
Sample Diagram



a relation on a set A is transitive if (A,B) and (B,C) are alements of R, then (A,C) also the element of R.

Example (i)

Let's go through below example to ensure that you understand *"How relation works"*.



Solution (i)

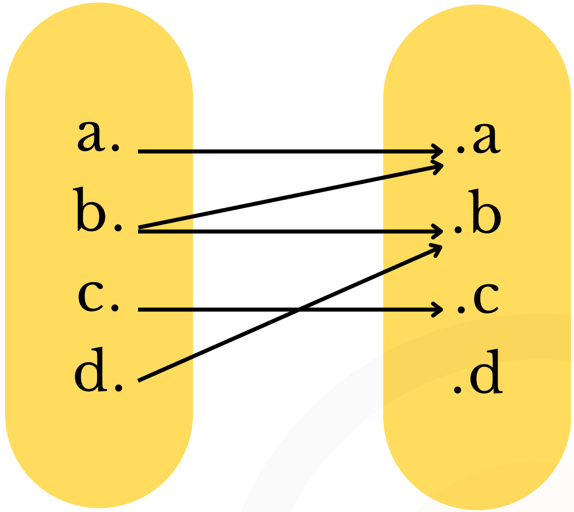
...continue (refer previous "example" table.)

No.	Reflexive	Symmetric	Transitive	e-Relation
a	NO	YES	NO	NO
b	YES	YES	YES	YES
c	NO	NO	YES	NO
d	YES	NO	YES	NO
e	YES	YES	YES	YES
f	NO	YES	YES	NO
g	NO	NO	NO	NO

Example (ii)

Use the **diagram** to answer the following question whether Reflexive, Symmetric or/and Transitive condition

(a)



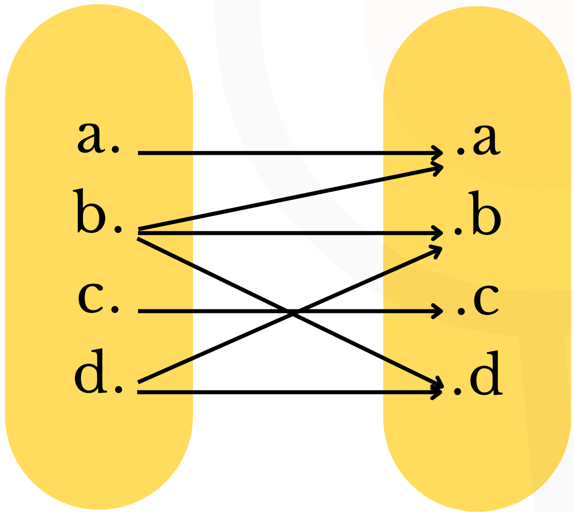
Solution ii (a)

Not reflexive because (d,d) relation not exist

Not symmetric. (b,a) but no (a,b) and (d,b) but no (b,d)

Not transitive

(b)



Solution ii (b)

Reflexive.

Not symmetric. (b,a) but no (a,b)

Not transitive

#QRCodeInfo

Need more practical task on this subtopic? You may scan QRcode for more info !

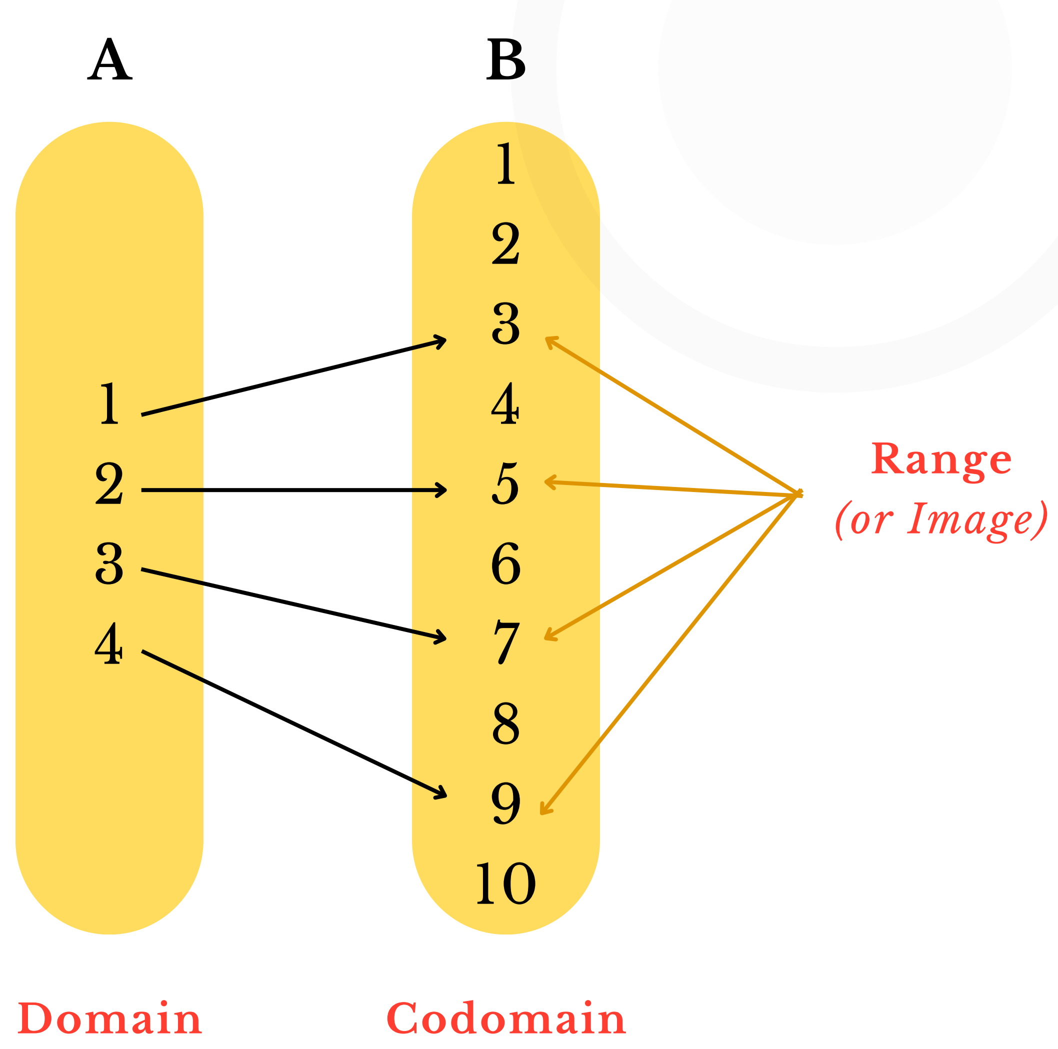
3.3 Function

A function is a relation which describes that there should be only one output for each input (or) we can say that a special kind of relation (a set of ordered pairs), which follows a rule i.e., every X-value should be associated with only one y-value is called a function.

Let's discover a differences between Relations and functions:

Parameter	Relation	Function
Definition	The relation shows the relationship between INPUT and OUTPUT.	A function is a relation which derives one OUTPUT for each given INPUT.
Denotation	A relation denoted by "R"	A function is denoted by "*F*" or "*f*". It also can be represented by small letter such as *f*, *g* and so on.
Example	R = {(2, x), (9, y), (2, z)} ** It is not a function, as "2" is input for both x and z.	F = {(2, x), (9, y), (5, x)} f : x ⟶ y or f (x) = y
Note	Every relation is not a function.	Every function is a relation.

There are special names for what we can go into and what can come out of a function:



Example

- The set "A" is the Domain
- The set "B" is the Codomain
- The set of elements that get pointed to in B (The actual values produced by the function) are the Range, also called the Image.
- And we have:
  i. Domain: {1, 2, 3, 4}
  ii. Codomain : { 1, 2, 3, 4, 5, 6, 7, 8, 9, 10}
  iii. Range : {3, 5, 7, 9}
  iv. Image : {3, 5, 7, 9}

How to determine Function?

A function expresses the relationship between variables.
A **function describes a rule or process that associates each input of the function to a unique output.** When we were first introduced to equations in two variables, we saw them in terms of x and y:

$$y = 2x$$

When we have a function, x is the input and $f(x)$ is the output.

$$f(x) = 2x$$

Commonly functions are denoted by the letter f but this is not a strict notation since other letters may also be used. Typically the $f(x)$ takes place of the y value to explicitly identify the independent variable being used in the function.

Example

Let's go through below example by given the equation

$$y = 3x + 4$$

y is a function

x is an argument.

this equation can also be written as:

$$f(x) = 3x + 4$$

Basic Info

How to determine that a function has an Inverse Function?

It must either be a :
i) one-to-one function OR
ii) a restricted many-to-one function

How to determine Inverse Function?

Some functions have inverses that have the effect of **undoing whatever operations the function had done on a variable.** The inverse of a function can be thought of as the opposite of that function. For example, given a function

$$f(x) = 2x + 1$$

- and assuming that an inverse function for $f(x)$ exists, let this function be $g(x)$. The inverse function would have the effect of the following:

$$g(x) = \frac{y - 1}{2}$$

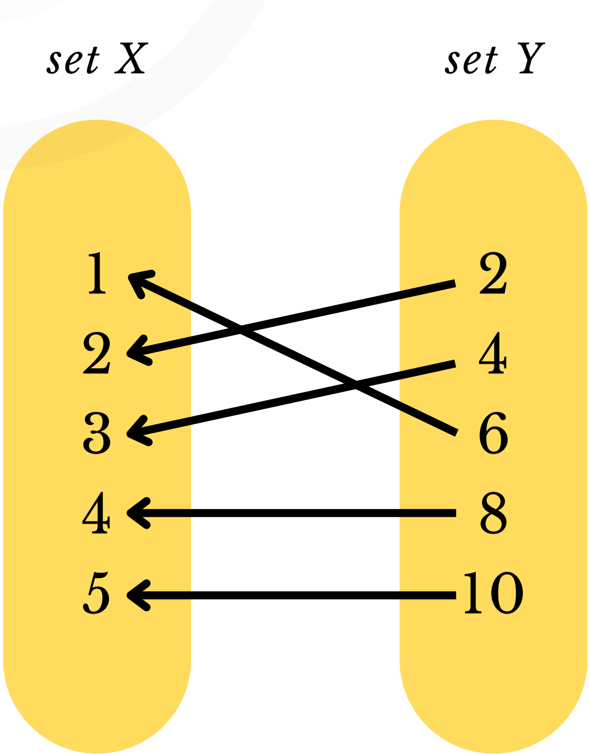
- The inverse of a function $f(x)$ is more correctly denoted by:

$$f^{-1}(x)$$

- The inverses of some of the most common functions are given below.

Function	Inverse of the Function
+	–
×	/
1/x	1/y
x^2	$\sqrt{y}$

- Remember we talked about function, and we also talking a **set X mapping into set Y**. An inverse function would reverse that process and map from set Y back into set X.



Example

1. Find the inverse, if it exists,

$$f(x) = 3x^2 + 2$$

Step 1: Switch x and y — $x = 3y^2 + 2$

Step 2: Solve for y — $x = 3y^2 + 2$

$$\frac{x-2}{3} = y^2$$

$$\sqrt{\frac{x-2}{3}} = y$$

Step 3: Replace y with $f^{-1}(x)$

Thus, $f^{-1}(x)$:

$$f^{-1}(x) = \sqrt{\frac{x-2}{3}}$$

2 (a) Find the inverse, if it exists,

$$f(x) = \frac{4x+6}{5}$$

Step 1: Switch x and y — $x = \frac{4y+6}{5}$

Step 2: Solve for y — $5x = 4y + 6$

$$5x - 6 = 4y$$

$$\frac{5x-6}{4} = y$$

$$y = \frac{5x-6}{4}$$

Step 3: Replace y with $f^{-1}(x)$

Thus, $f^{-1}(x)$:

$$f^{-1}(x) = \frac{5x-6}{4}$$

2 (b) Based on 2(a), find $f^{-1}(5)$

Step 1: Replace x with 5

$$f^{-1}(5) = \frac{5(5)-6}{4}$$

$$= \frac{25-6}{4}$$

Thus, $f^{-1}(5)$;

$$= \frac{19}{4} \ \#$$

IMPORTANT!

Function	Inverse of the Function
+	–
×	/
1/x	1/y
x^2	$\sqrt{y}$

Exercise

1 Find the inverse, if it exists, $f(x) = x^5 - 4$

Answer:

2 Find the inverse equation of $f(x) = 2x^3 + 5$

Answer:

3 Find the inverse equation of $g(x) = x^2 - 3$

Answer:

4 Find the inverse equation of

i) $f(x) = -3x + 6$

ii) $f^{-1}(5)$

Answer:

CHAPTER 4.0
COUNTING PRINCIPLES

4.0 Counting Principles

What is Counting Principles

The counting principle is a **fundamental rule of counting**; it is usually taken under the head of the permutation rule and the combination rule.

It states that if a work X can be done in m ways, and work Y can be done in n ways, then provided X and Y are mutually exclusive, the number of ways of doing both X and Y is m x n.

Definition of Counting Principles

Strategies for finding the number of ways an outcome can occur.

Types of counting principles

i. Sum rule	**ii. Product rule**	**iii. Substraction rule**	**iv. Division rule**
If a first task can be performed in m ways, while a second task can be performed in n ways.	If a procedure can be broken down into first and second stages, and if there are m possible outcome (1st stage) and n possible outcome (2nd stage).		
The two task cannot be performed in the same time, then performing either task m or n.	The procedure can be solved by implemented mn ways.		
Also called addition rule.	Also called multiplication rule.		
We have to **choose** either m way OR n way.	We have to **implement** m way and n way.		
Keyword	**Keyword**		
Keyword that usually can be used such as : **select, choose, pick one**, and **OR**.	Keyword that usually can be used such as : **have,need,must have**,and **AND**.		

Example (i)

If there are 14 boys and 12 girls in a class, find the number of ways of selecting one student as class representative

Solution (i)

14 + 12 = 26 ways

Example (ii)

If a student is getting admission in 4 different IT college and 5 art colleges, find the number of ways of choosing one of the above colleges.

Solution (ii)

4 + 5 = 9 ways

Example (iii)

There are 3 ways from Sabak Bernam to Ipoh and there are 5 ways from Ipoh to Sungai Petani. How many possible ways will Hafiza get from Sabak Bernam to Ipoh and then to Sungai Petani?

Solution (iii)

3 * 5 = 15 ways

Example (iv)

Haikal always wear a shirt and a pant as his suit. He has 4 choices of shirts and 7 pants. How many possible suits can he use?

Solution (iv)

4 * 7 = 28 suits

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Ts. Nor Hafizah binti Md Desa, graduate of Universiti Tun Hussein Onn Malaysia, holding a degree in Information Technology with a specialization in Information Systems. She was awarded the Vice Chancellor's Award in 2015

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This eBook focused on Mathematics (Basic/Fundamentals) stands as a testament to her commitment to providing comprehensive educational references for lecturers and students alike, focusing on foundational topics in Basic Mathematics. Through detailed explanations, practice questions, and step-by-step solutions, Ts. Nor Hafizah aims to support academic achievement and foster a deeper understanding of these crucial subjects.

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