



S.P. MANDALI'S

R. A. Podar College of Commerce & Economics

Department of Mathematics, Statistics & Computers

Objective:

The main objective of this course is to bridge the 2 years gap between high school and first-year undergraduate syllabus of commerce so that they can be comfortable when they start the course Mathematical and Statistical Techniques in the first-year degree Program of Commerce.

Courses Outcome:

After successful completion of the course, the learner shall be confident & enhanced with quantitative aptitude (numerical ability), catering to the needs of candidates who wish to learn Mathematics and also for those who intend to appear for all the competitive or entrance examinations to get admissions to different professional courses. Students are trained with different data analysis techniques.

Module No.	Description of Module
1	Sequence of Mathematical Operations — BODMAS
2	Basic Operations on fractions
3	Graph- Basic Graph plotting, Linear equation
4	Basic Concepts of Permutation and Combination
5	Introduction to Profit and Loss



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Bridge course on

1. Sequence of Mathematical Operations — BODMAS

BODMAS meaning

When presented with a number sentence containing more than one operation (such as $3 + 4 \times 2$) the operations cannot be completed from left to right, but instead in their order of “importance”, which is what BODMAS stands for.

BODMAS stands for:

Brackets

Orders

Division/Multiplication

Addition/Subtraction

“Orders” means square roots and indices (which you may know as square numbers, powers or exponents.)

Question 1: $6 + 2 \times 7$

The correct answer is 20.

The multiplication must be completed first ($2 \times 7 = 14$) and then the addition ($6 + 14 = 20$).

This may be commonly miscalculated as 56 by working from left to right ($6 + 2 = 8$, $8 \times 7 = 56$).

Question 2: $3 \times (2 + 4) + 52$

The correct answer is 43.

The BODMAS rule states we should calculate the Brackets first ($2 + 4 = 6$), then the Orders ($52 = 25$), then any Division or Multiplication (3×6 (the answer to the brackets) = 18), and finally any Addition or Subtraction ($18 + 25 = 43$).

Worksheet

1) Find the answer to this questions

a) $3+4 \div 2 =$ _____

b) $3+22 \div 4 =$ _____

c) $8*4 \div 4+1=$ _____

d) $3*(3+5) \div 4 =$ _____

2) Complete the boxes to make the statements correct.

a) _____ \div _____ $+ 90 = 100$

b) $8 + 4 \div 2 * \underline{\hspace{2cm}} = 14$

c) _____ $+ \underline{\hspace{2cm}} * 3 = 9$

Video for reference:- <https://youtu.be/Cb8JvTXqPcl?feature=shared>



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Bridge course on

2. Basic Operations on fractions

A Whole and it's Parts

Martin had two equal-sized chocolate bars with different placement of grooves such that he could divide one of them into four pieces and the other one into just two pieces. He gave one piece to each of his six friends. Each one kept wondering if they got an equal share. To answer such questions, fractions come into play! A fraction is a number representing a part of a whole or a group of objects. Let us understand fractions, interestingly and easily, through this article.

What are Fractions?

You have a part of something but only some of it. If I ask you how much you have, what will be your answer? Take for example the below scenario:

- You ate 2 slices of pizza which has a total of 8 slices.
- You have 1 piece from a cake that has a total of 6 pieces

In both the above cases, you don't have the complete object but only a part of it. In other words, you have a fraction of the object. When any object is divided into equal numbers of parts and you pick up one or more of those parts, you have a fraction of the object.

Now one very important characteristic of these parts of a fraction is that Each part of a fraction has to be equal to other parts.

Next, let us understand how to represent a fraction. A fraction is represented by a combination of 2 numbers arranged one above the other separated by a horizontal dash. **The number above the separating line is called a Numerator and the number below is called a Denominator.**

The numerator represents the concerned portion (which may be the parts you have or the parts you don't have depending on your concern or query) and the Denominator represents the total number of parts or the divisions of the whole or total number of objects in the group.

For example, if you ate 2 slices out of 4 equal slices, you can say that you ate $\frac{2}{4}$ of the pizza or half of the pizza. This means that you have 2 equal parts out of 4 equal parts. The 4 equal parts together make up one object. So this means that you don't have one complete object and neither do you have none of the objects. You have **more than zero but less than one**. That is you have a fraction of something.

Similarly, if you eat one more slice out of these, then you have eaten $\frac{3}{4}$ the pizza and $\frac{1}{4}$ of the pizza is left or one quarter is left.



Video for reference:- <https://youtu.be/rl7e0djo9Go?feature=shared>

1. Elements of a fraction

The fraction $\frac{a}{b}$ is composed of a numerator (a) and a denominator (b).

2. Equivalent fractions

It is important to remember that there are many ways to represent the same fraction. For example, the fractions $\frac{1}{2}$ and $\frac{2}{4}$ are equivalent. But how do we go from one fraction to another and conserve the equivalence relation?

A fraction remains equivalent if the numerator *and* the denominator are multiplied or divided by the same number.

Example

$$\frac{2}{3} = \frac{2 \times 5}{3 \times 5} = \frac{10}{15}$$

$$\frac{24}{30} = \frac{24 \div 6}{30 \div 6} = \frac{4}{5}$$

3. Simplification of a fraction

A fraction is written in its simplified form if the numerator and the denominator have no common factor. In other words, it is impossible to find a number that is a divisor to both the numerator and the denominator in a fraction's simplified form.

Example

The fraction $\frac{120}{200}$ is not written in its simplified form since there are numbers that divide both 120 and 200. The largest common divisor (factor) of 120 and 200 is 40, where

$$\frac{120}{200} = \frac{120 \div 40}{200 \div 40} = \frac{3}{5}$$

Since we divided the numerator and the denominator by the same number (40), the fraction $\frac{3}{5}$ is equivalent to $\frac{120}{200}$. In addition, $\frac{3}{5}$ is the simplified form of $\frac{120}{200}$ since no other common factor exists for 3 and 5.

A simplification can be done in many steps if we do not recognize at once the largest common factor for the numerator and the denominator.

Example

$$\frac{108}{144} = \frac{108 \div 2}{144 \div 2} = \frac{54}{72} = \frac{54 \div 9}{72 \div 9} = \frac{6}{8} = \frac{6 \div 2}{8 \div 2} = \frac{3}{4}$$

"Countdown" enthusiasts will have noticed that 108 and 144 have 36 as a common factor:

$$\frac{108}{144} = \frac{108 \div 36}{144 \div 36} = \frac{3}{4}$$

In the end, no matter how many steps taken, the same simplified form will be found...

5. Multiplication rule for two fractions

$$\frac{a}{b} \times \frac{c}{d} = \frac{a \times c}{b \times d} = \frac{ac}{bd}$$

It is important to note that contrary to sums, the multiplication rule does not impose constraints to the denominator values. This means they do not need to be common.

Example

$$\frac{4}{7} \times \frac{3}{11} = \frac{4 \times 3}{7 \times 11} = \frac{12}{77}$$

$$\frac{-3}{2} \times \frac{5}{4} = \frac{-3 \times 5}{2 \times 4} = \frac{-15}{8}$$

Note: It may be useful to simplify fractions before multiplying. In addition to simplifying each fraction individually, simplifying the denominator of one fraction with the numerator of the other fraction is permitted, *provided that both have common factors*.

Example

Evaluate the following product $\frac{27}{16} \times \frac{8}{81}$.

You will note that the two fractions, $\frac{27}{16}$ and $\frac{8}{81}$ are already simplified. Nonetheless, the denominator 16 and the numerator 8 have 8 as a common factor. The denominator 81 and the numerator 27 have 27 as common factor. It is therefore possible to simplify before multiplying

$$\frac{27}{16} \times \frac{8}{81} = \frac{27 \div 27}{16 \div 8} \times \frac{8 \div 8}{81 \div 27} = \frac{1}{2} \times \frac{1}{3} = \frac{1}{6}$$

6. Division rule of two fractions

$$\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \times \frac{d}{c} = \frac{ad}{bc}$$

The rule allows us to transform a division into a multiplication.

Example

$$\frac{2}{7} \div \frac{3}{8} = \frac{2}{7} \times \frac{8}{3} = \frac{16}{21}$$

Pay attention to the following notation that describes the same division :

$$\frac{2/7}{3/8} = \frac{2}{7} \times \frac{8}{3} = \frac{16}{21}$$

A few final remarks

- Working with fractions does not modify the priority of operations.

Example

$$\frac{2}{3} + \frac{4}{5} \times \frac{2}{3} = \frac{2}{3} + \frac{8}{15} = \frac{10}{15} + \frac{8}{15} = \frac{18}{15} = \frac{6}{5}$$

- A whole number can always be written as a fraction if an operation is to be done between the number and a fraction.

Example

$$8 - \frac{5}{3} = \frac{8}{1} - \frac{5}{3} = \frac{24}{3} - \frac{5}{3} = \frac{19}{3}$$

- Avoid working with mixed numbers... transform them into simple fractions.

Example

$$4^{2/7} = 4 + \frac{2}{7} = \frac{28}{7} + \frac{2}{7} = \frac{30}{7}$$

7. Exercises - Operations with numbers

Calculate the following while respecting the priorities :

a) $8 - 2 \times (3 - 2 \times 5)$

b) $4 - 2 \times (-4) + 6 \div 2$

c) $8 - 2 \times 5 + 2 \times ((-2) - 3)$

d) $(8 - 2) \times (-3) - 2 \times ((-1) - 6)$

e) $\frac{2}{7} - \frac{5}{3} \times \frac{27}{35}$

f) $\frac{5}{8} + \frac{9}{25} \div \frac{18}{15}$

g) $\frac{2}{7} - \frac{5}{3}$

h) $\frac{1}{4} + \frac{3}{5}$

i) $\frac{5}{36} \times \frac{9}{25}$

j) $\frac{3}{8} \div \frac{4}{5}$

Solutions

a) 22

b) 15

c) -12

d) -4

e) -1

f) $\frac{37}{40}$

g) $-\frac{29}{21}$

h) $\frac{17}{20}$

i) $\frac{1}{20}$

j) $\frac{15}{32}$



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3. Graph- Basic Graph plotting, Linear equation

Graph Linear Equations in Two Variables

Learning Objectives

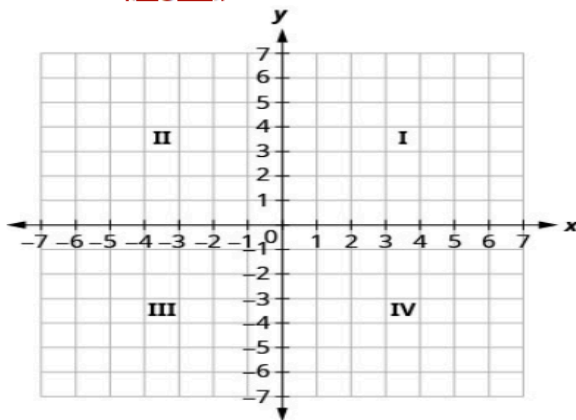
By the end of this course, you will be able to:

- Plot points in a rectangular coordinate system
- Graph a linear equation by plotting points
- Graph vertical and horizontal lines
- Find the x - and y -intercepts
- Graph a line using the intercepts

Plot Points on a Rectangular Coordinate System

Just like maps use a grid system to identify locations, a grid system is used in algebra to show a relationship between two variables in a rectangular coordinate system. The rectangular coordinate system is also called the xy -plane or the “coordinate plane.”

The rectangular coordinate system is formed by two intersecting number lines, one horizontal and one vertical. The horizontal number line is called the x -axis. The vertical number line is called the y -axis. These axes divide a plane into four regions, called quadrants. The quadrants are identified by Roman numerals, beginning on the upper right and proceeding counterclockwise. See [\(Figure\)](#).



In the rectangular coordinate system, every point is represented by an ordered pair. The first number in the ordered pair is the x -coordinate of the point, and the second number is the y -coordinate of the point. The phrase “ordered pair” means that the order is important.

Ordered Pair

An **ordered pair**, (x, y) gives the coordinates of a point in a rectangular coordinate system. The first number is the x -coordinate. The second number is the y -coordinate.

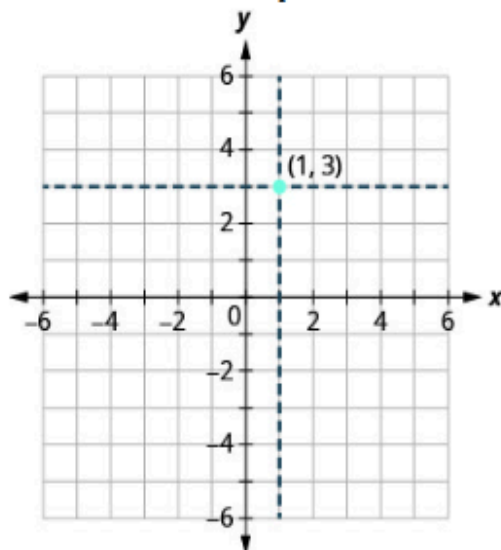


What is the ordered pair of the point where the axes cross? At that point both coordinates are zero, so its ordered pair is $(0, 0)$. The point $(0, 0)$ has a special name. It is called the origin.

The Origin

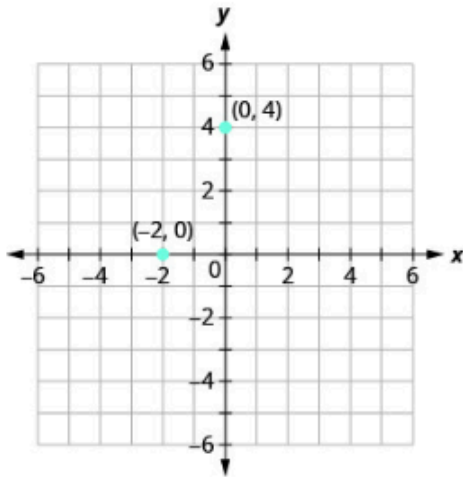
The point $(0, 0)$ is called the **origin**. It is the point where the x -axis and y -axis intersect.

We use the coordinates to locate a point on the xy -plane. Let's plot the point $(1, 3)$ as an example. First, locate 1 on the x -axis and lightly sketch a vertical line through $x = 1$. Then, locate 3 on the y -axis and sketch a horizontal line through $y = 3$. Now, find the point where these two lines meet—that is the point with coordinates $(1, 3)$. See [\(Figure\)](#).



Notice that the vertical line through $x = 1$ and the horizontal line through $y = 3$ are not part of the graph. We just used them to help us locate the point $(1, 3)$.

When one of the coordinate is zero, the point lies on one of the axes. In [\(Figure\)](#) the point $(0, 4)$ is on the y -axis and the point $(-2, 0)$ is on the x -axis.



Points on the Axes

Points with a y -coordinate equal to 0 are on the x -axis, and have coordinates $(a, 0)$.

Points with an x -coordinate equal to 0 are on the y -axis, and have coordinates $(0, b)$.

Plot each point in the rectangular coordinate system and identify the quadrant in which the point is located:

Ⓐ $(-5, 4)$ Ⓑ $(-3, -4)$ Ⓒ $(2, -3)$ Ⓓ $(0, -1)$ Ⓔ $(3, \frac{5}{2})$.

The first number of the coordinate pair is the x -coordinate, and the second number is the y -coordinate. To plot each point, sketch a vertical line through the x -coordinate and a horizontal line through the y -coordinate. Their intersection is the point.

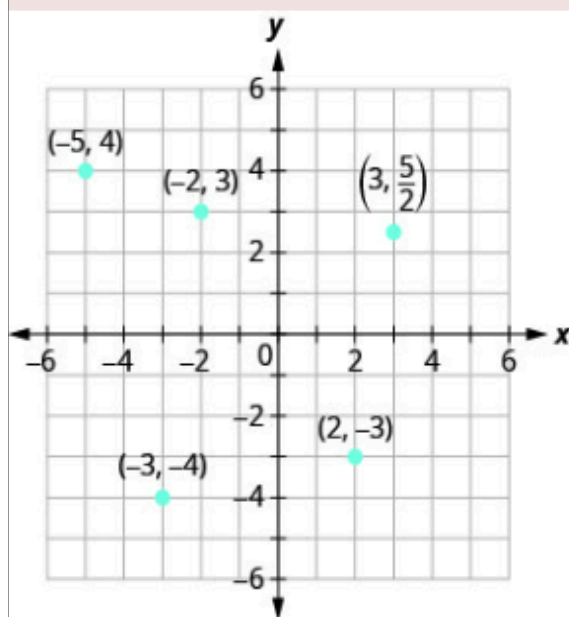
Ⓐ Since $x = -5$, the point is to the left of the y -axis. Also, since $y = 4$, the point is above the x -axis. The point $(-5, 4)$ is in Quadrant II.

Ⓑ Since $x = -3$, the point is to the left of the y -axis. Also, since $y = -4$, the point is below the x -axis. The point $(-3, -4)$ is in Quadrant III.

Ⓒ Since $x = 2$, the point is to the right of the y -axis. Since $y = -3$, the point is below the x -axis. The point $(2, -3)$ is in Quadrant IV.

Ⓓ Since $x = 0$, the point whose coordinates are $(0, -1)$ is on the y -axis.

Ⓔ Since $x = 3$, the point is to the right of the y -axis. Since $y = \frac{5}{2}$, the point is above the x -axis. (It may be helpful to write $\frac{5}{2}$ as a mixed number or decimal.) The point $(3, \frac{5}{2})$ is in Quadrant I.



An equation of the form $Ax + By = C$, where A and B are not both zero, is called a **linear equation** in two variables.

Here is an example of a linear equation in two variables, x and y .

$$Ax + By = C$$

$$x + 4y = 8$$

$$A = 1, B = 4, C = 8$$

The equation $y = -3x + 5$ is also a linear equation. But it does not appear to be in the form $Ax + By = C$. We can use the Addition Property of Equality and rewrite it in $Ax + By = C$ form.

Add to both sides.

$$y = -3x + 5$$

$$y + 3x = 3x + 5 + 3x$$

Simplify.

$$y + 3x = 5$$

Use the Commutative Property to put it in

$Ax + By = C$ form.

$$3x + y = 5$$

By rewriting $y = -3x + 5$ as $3x + y = 5$, we can easily see that it is a linear equation in two variables because it is of the form $Ax + By = C$. When an equation is in the form $Ax + By = C$, we say it is in standard form of a linear equation.

Standard Form of Linear Equation

A linear equation is in **standard form** when it is written $Ax + By = C$.

Most people prefer to have A , B , and C be integers and $A \geq 0$ when writing a linear equation in standard form, although it is not strictly necessary.

Linear equations have infinitely many solutions. For every number that is substituted for x there is a corresponding y value. This pair of values is a solution to the linear equation and is represented by the ordered pair (x, y) . When we substitute these values of x and y into the equation, the result is a true statement, because the value on the left side is equal to the value on the right side.

Solution of a Linear Equation in Two Variables

An ordered pair (x,y) is a solution of the linear equation $Ax+By=C$ if the equation is a true statement when the x - and y -values of the ordered pair are substituted into the equation.

Linear equations have infinitely many solutions. We can plot these solutions in the rectangular coordinate system. The points will line up perfectly in a straight line. We connect the points with a straight line to get the graph of the equation. We put arrows on the ends of each side of the line to indicate that the line continues in both directions.

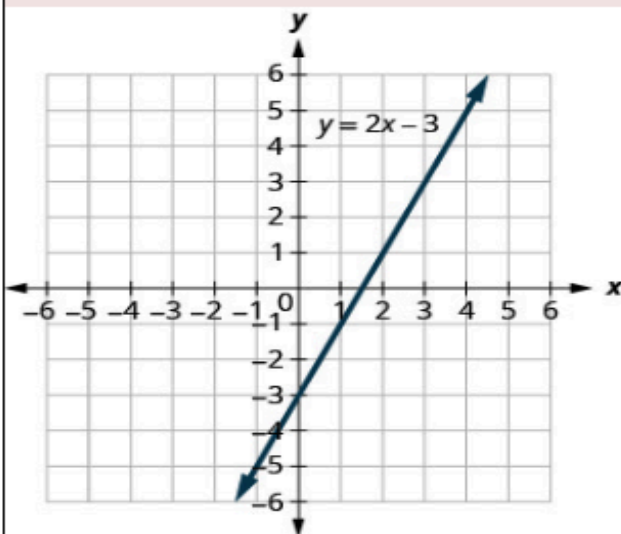
A graph is a visual representation of all the solutions of the equation. It is an example of the saying, "A picture is worth a thousand words." The line shows you all the solutions to that equation. Every point on the line is a solution of the equation. And, every solution of this equation is on this line. This line is called the graph of the equation. Points not on the line are not solutions!

Graph of a Linear Equation

The graph of a linear equation $Ax+By=C$ is a straight line.

- Every point on the line is a solution of the equation.
- Every solution of this equation is a point on this line.

The graph of $y = 2x - 3$ is shown.



For each ordered pair, decide:

- Ⓐ Is the ordered pair a solution to the equation?
Ⓑ Is the point on the line?

A: $(0, -3)$ B: $(3, 3)$ C: $(2, -3)$ D: $(-1, -5)$

Substitute the x - and y -values into the equation to check if the ordered pair is a solution to the equation.

Ⓐ

A: $(0, -3)$

$$y = 2x - 3$$

$$-3 \stackrel{?}{=} 2(0) - 3$$

$$-3 = -3 \checkmark$$

B: $(3, 3)$

$$y = 2x - 3$$

$$3 \stackrel{?}{=} 2(3) - 3$$

$$3 = 3 \checkmark$$

C: $(2, -3)$

$$y = 2x - 3$$

$$-3 \stackrel{?}{=} 2(2) - 3$$

$$-3 \neq 1$$

D: $(-1, -5)$

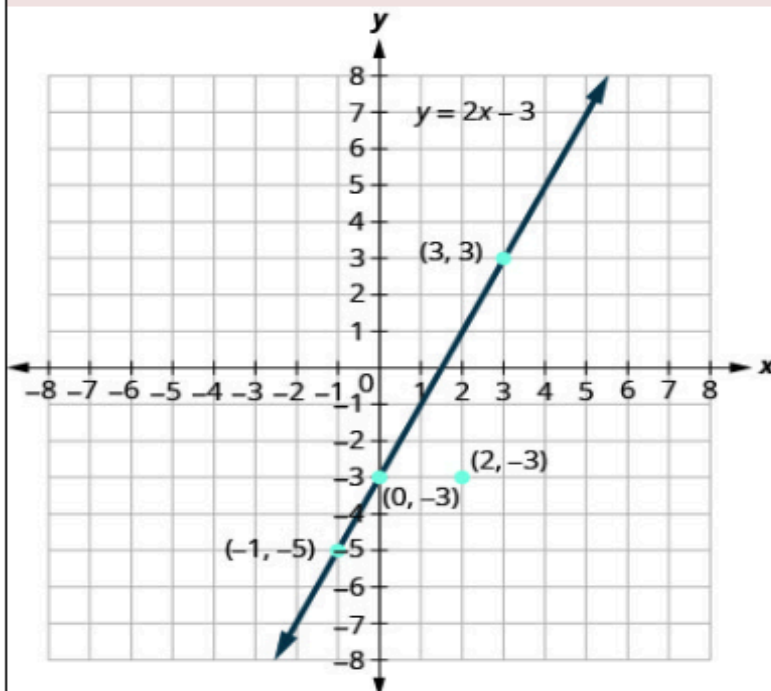
$$y = 2x - 3$$

$$-5 \stackrel{?}{=} 2(-1) - 3$$

$$-5 = -5 \checkmark$$

$(0, -3)$ is a solution. $(3, 3)$ is a solution. $(2, -3)$ is not a solution. $(-1, -5)$ is a solution.

ⓐ Plot the points $(0, -3)$, $(3, 3)$, $(2, -3)$, and $(-1, -5)$.



The points $(0, -3)$, $(3, -3)$, and $(-1, -5)$ are on the line $y = 2x - 3$, and the point $(2, -3)$ is not on the line.

The points that are solutions to $y = 2x - 3$ are on the line, but the point that is not a solution is not on the line.

Graph $4x - 3y = 12$ using the intercepts.

Find the intercepts and a third point.

x-intercept, let $y = 0$

$$4x - 3y = 12$$

$$4x - 3(0) = 12$$

$$4x = 12$$

$$x = 3$$

y-intercept, let $x = 0$

$$4x - 3y = 12$$

$$4(0) - 3y = 12$$

$$-3y = 12$$

$$y = -4$$

third point, let $y = 4$

$$4x - 3y = 12$$

$$4x - 3(4) = 12$$

$$4x - 12 = 12$$

$$4x = 24$$

$$x = 6$$

We list the points in the table and show the graph.

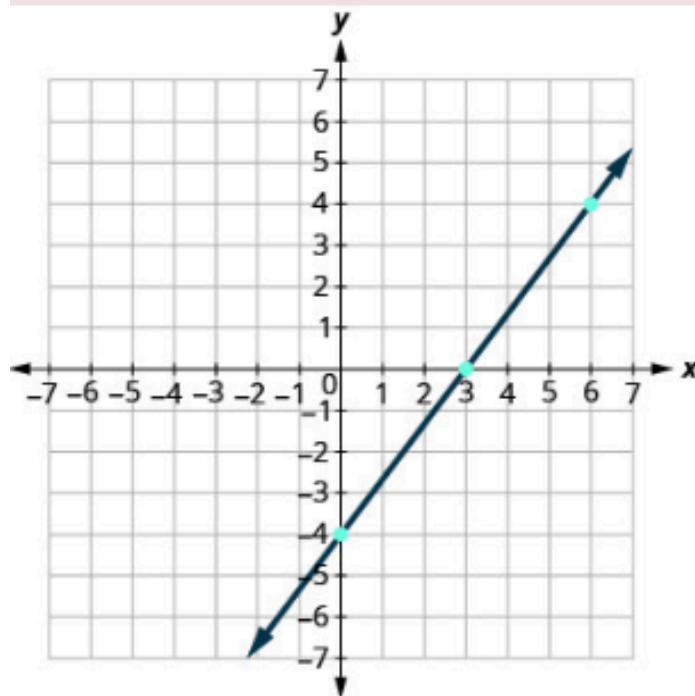
$$4x - 3y = 12$$

x y (x, y)

3 0 (3, 0)

0 -4 (0, -4)

6 4 (6, 4)



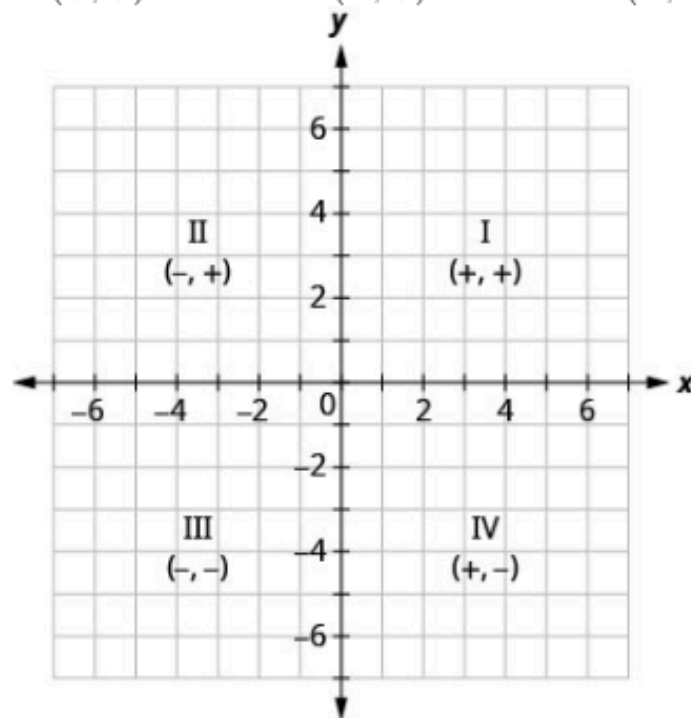
Key Concepts

- **Points on the Axes**

- Points with a y -coordinate equal to 0 are on the x -axis, and have coordinates $(a, 0)$.
- Points with an x -coordinate equal to 0 are on the y -axis, and have coordinates $(0, b)$.

- **Quadrant**

Quadrant I	Quadrant II	Quadrant III	Quadrant IV
(x, y)	(x, y)	(x, y)	(x, y)
$(+, +)$	$(-, +)$	$(-, -)$	$(+, -)$



- **Graph of a Linear Equation:** The graph of a linear equation $Ax + By = C$ is a straight line.
Every point on the line is a solution of the equation.
Every solution of this equation is a point on this line.

- **How to graph a linear equation by plotting points.**

1. Find three points whose coordinates are solutions to the equation. Organize them in a table.
2. Plot the points in a rectangular coordinate system. Check that the points line up. If they do not, carefully check your work.
3. Draw the line through the three points. Extend the line to fill the grid and put arrows on both ends of the line.

- **x -intercept and y -intercept of a Line**

- The x -intercept is the point $(a, 0)$ where the line crosses the x -axis.
- The y -intercept is the point $(0, b)$ where the line crosses the y -axis.

- The x -intercept occurs when y is zero.
- The y -intercept occurs when x is zero.

x	y
a	0
0	b

- **Find the x - and y -intercepts from the Equation of a Line**

- Use the equation of the line. To find:
the x -intercept of the line, let $y = 0$ and solve for x .
the y -intercept of the line, let $x = 0$ and solve for y .

- **How to graph a linear equation using the intercepts.**

1. Find the x - and y -intercepts of the line.
Let $y = 0$ and solve for x .
Let $x = 0$ and solve for y .
2. Find a third solution to the equation.
3. Plot the three points and check that they line up.
4. Draw the line

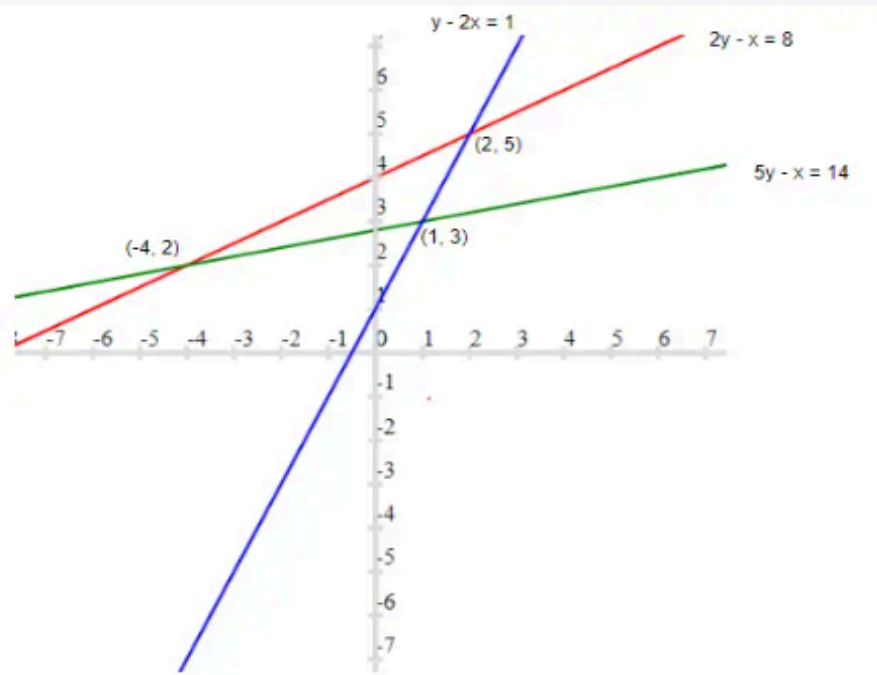
Determine graphically the vertices of the triangles, the equations of whose sides are given below:

(i) $2y - x = 8$, $5y - x = 14$ and $y - 2x = 1$

(ii) $y = x$, $y = 0$ and $3x + 3y = 10$

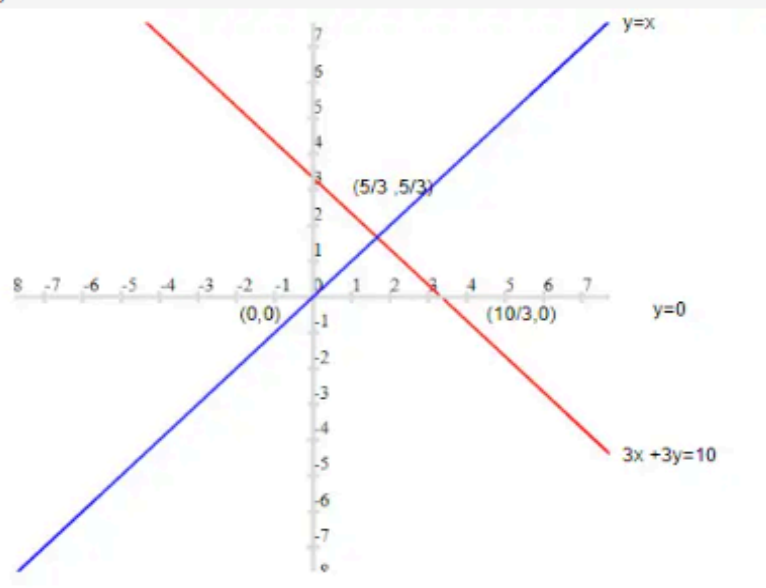
▼ Answer

(i)



Vertices of the triangle so obtained are $(-4, 2)$ $(1, 3)$ $(2, 5)$

(ii)



$(0, 0)$ $(10/3, 0)$ $(5/3, 5/3)$



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4. Basic concepts of Permutation and Combination

Permutation and combination form the principles of counting and they are applied in various situations. A permutation is a count of the different arrangements which can be made from a given set of things.

Factorial:- $n! = n \times (n-1) \times (n-2) \times (n-3) \times \dots \times 1!$

Example:- 1) $5! = 5 \times 4 \times 3 \times 2 \times 1 = 120$

2) $8! = 8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1 = 40320$

Permutation:- Arrangements of r objects from n objects. There are basically two types of permutation:

Arranging people, digits, numbers, alphabets, letters, and colors are examples of permutations.

1. Permutations with Repetition

.These are the easiest to calculate.

When a thing has n different types ... we have n choices each time!

Where n is the number of things to choose from, and we choose r of them and order matters. We go for n^r

Example: in the lock above, there are 10 numbers to choose from (0,1,...9) and we choose 3 of them:

$10 \times 10 \times \dots$ (3 times) $= 10^3 = 1,000$ permutations

2. Permutation without repetition

In this case, we have to **reduce** the number of available choices each time.

For example, what order could 16 pool balls be in? After choosing, say, the number "14" we can't choose it again.

So, our first choice has 16 possibilities, and our next choice has 15 possibilities, then 14, 13, etc. And the total permutations are:

$$16 \times 15 \times 14 \times 13 \times \dots = 20,922,789,888,000$$

But maybe we don't want to choose them all, just 3 of them, so that is only:

$$16 \times 15 \times 14 = 3,360$$

In other words, there are 3,360 different ways that 3 pool balls could be arranged out of 16 balls.

Without repetition our choices get reduced each time. ${}^n P_r$.

Ex:- How many permutations of 4 different letters are there, chosen from the twenty six letters of the alphabet?

Sol:- The number of permutations of 4 letters chosen from 26 is ${}^{26}P_4 = 26 \times 25 \times 24 \times 23 = 358,800$.

Example: Jones is the Chairman of a committee. How many ways can a committee of 5 be chosen from 10 people given that Jones must be one of them?

Sol: Jones is already chosen, so we need to choose another 4 from 9.

In choosing a committee, the order doesn't matter; so we need the number of combinations of 4 people chosen from 9

$$= {}^9C_4$$

$$= 9!/(4!)(5!)$$

$$= (9 \times 8 \times 7 \times 6)/(4 \times 3 \times 2 \times 1)$$

$$= 3,024/24$$

$$= 126$$

Combination:- Number of selection of r objects from n objects.

The combination is defined as “An arrangement of objects where the order in which the objects are selected does not matter.” The combination means “Selection of things”, where the order of things has no importance

Selection of menu, food, clothes, subjects, the team are examples of combinations.

Example

Example 1: A group of 3 lawn tennis players S, T, U. A team consisting of 2 players is to be formed. In how many ways can we do so?

Solution- In a combination problem, we know that the order of arrangement or selection does not matter.

Thus ST= TS, TU = UT, and SU=US.

Thus we have 3 ways of team selection.

By combination formula we have-

$$\begin{aligned} {}_3C_2 &= \frac{3!}{2!(3-2)!} \\ &= \frac{(3*2*1)}{(2*1*1)} = 3 \end{aligned}$$

Example 2: Find the number of subsets of the set {1, 2, 3, 4, 5, 6, 7, 8, 9, 10} having 3 elements.

Solution: The set given here has 10 elements. We need to form subsets of 3 elements in any order. If we select {1,2,3} as the first subset then it is the same as {3,2,1}. Hence, we will use the formula of combination here.

Therefore, the number of subsets having 3 elements = ${}_{10}C_3$

$$= \frac{10!}{(10-3)!3!}$$

$$= \frac{10*9*8*7!}{7!*3!}$$

$$= \frac{10*9*8}{3*2}$$

$$= 120 \text{ way}$$



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5. Introduction to Profit and Loss

In our daily life, consumers buy various articles from the shopkeepers. These articles are either directly bought from manufacturers or through wholesalers. Shopkeepers sell these articles higher than the rate at which they bought them to earn money.

Cost Price

The money paid by the shopkeeper to buy the goods from the manufacturer or wholesaler is known as Cost Price (C.P).

Selling Price

The price at which a shopkeeper sells the goods/products is known as Selling Price (S.P).

Profit

If the selling price (S.P) of a goods is greater than the cost price (C.P), then the shopkeeper makes profit / gain.

$$\text{Profit} = \text{Selling Price} - \text{Cost Price}$$

Let's see some examples.

Example 1. Cost price of a dress is Rs. 500 and selling price of it is Rs. 650. Find the amount of profit made by the shopkeeper.

Solution. Cost Price = Rs. 500
Selling Price = Rs. 650
Profit = Selling Price – Cost Price
= 650 – 500
= Rs. 150

Hence, the profit made by the shopkeeper is equal to Rs. 150

Example 2. Selling price of an article is Rs. 2460 and profit made by the shopkeeper is Rs. 120.50. Find the cost price of the article.

Solution. Profit = Selling Price – Cost Price
=> Cost Price = Selling Price – Profit
Cost Price = Rs. 2460 – Rs. 120.50

$$= \text{Rs. } 2339.50$$

Hence, the cost price of the article is Rs. 2339.50.

Example 3. Cost price of an article is Rs. 98. If the shopkeeper sells the article with a profit of Rs. 27, then what is the selling price?

Solution. Profit = Selling Price – Cost Price

$$\Rightarrow \text{Selling Price} = \text{Cost Price} + \text{Profit}$$

$$= \text{Rs. } 98 + \text{Rs. } 27$$

$$= \text{Rs. } 125$$

Hence, selling price of the article is Rs. 125.

Loss

If the selling price (S.P) of a goods is less than the cost price (C.P), then the shopkeeper makes a loss.

$$\text{Loss} = \text{Cost Price} - \text{Selling Price}$$

Let's see some examples.

Example 1. If cost price of an article is 725 and selling price of it is Rs. 715, then find the loss incurred by the shopkeeper.

Solution. Loss = Cost Price – Selling Price

$$= \text{Rs. } 725 - \text{Rs. } 715$$

$$= \text{Rs. } 10$$

Hence, loss incurred by the shopkeeper is Rs. 10.

Example 2. One man bought a cycle for Rs. 3780. He used it for 1 year, then sold it at a loss of Rs. 750. Find the selling price of the cycle.

Solution. Cost price of the cycle = Rs. 3780

Loss incurred by the man = Rs. 750

Selling Price = Cost Price – Loss

$$= \text{Rs. } 3780 - \text{Rs. } 750$$

$$= \text{Rs. } 3030$$

Hence, selling price of the cycle is Rs. 3030.

Example 3. An article was sold for Rs. 400 at a loss of Rs. 72. Find the cost price of the article.

Solution. Loss = Cost Price – Selling Price

$$\Rightarrow \text{Cost Price} = \text{Selling Price} + \text{Loss}$$

$$= \text{Rs. } 400 + \text{Rs. } 72$$

$$= \text{Rs. } 472$$

Hence, cost price of the article is Rs. 472.

Profit Percent

The profit percentage is the profit that would be obtained for a cost price of Rs. 100.

$$\text{Profit percent} = \frac{\text{Profit}}{\text{Cost Price}} \times 100$$

Let's see some examples.

Example 1. If cost price of an article is Rs. 500 and selling price is Rs. 575, then find the profit percentage.

Solution. Cost Price = Rs. 500

Selling Price = Rs. 575

Profit = Rs. 575 – Rs. 500

$$= \text{Rs. } 75$$

$$\text{Profit Percentage} = \frac{\text{Profit}}{\text{Cost Price}} \times 100$$

$$= \frac{75}{500} \times 100 = 15\%$$

Hence, the profit percentage is 15%

Example 2. Maria bought apples at Rs. 120 per kg. If she had to sell them at a profit of 20%, then find the selling price.

Solution. Cost price of apple per kg = Rs. 120

$$\text{Profit Percentage} = \frac{\text{Profit}}{\text{Cost Price}} \times 100$$

$$\Rightarrow 20 = \frac{\text{Profit}}{120} \times 100$$

$$\Rightarrow \text{Profit} = \frac{(20 \times 120)}{100}$$

$$\Rightarrow \text{Profit} = \text{Rs. } 24$$

Selling Price = Cost Price + Profit

$$= \text{Rs. } 120 + \text{Rs. } 24$$

$$= \text{Rs. } 144$$

Hence, the selling price is equal to Rs. 144.

Loss Percent

The loss percentage is the loss that would be obtained for a cost price of Rs. 100.

$$\text{Loss percent} = \frac{\text{Loss}}{\text{Cost Price}} \times 100$$

Let's see some examples.

Example 1. A chair was bought for Rs. 800 and sold for Rs. 736. Find the loss and loss percentage.

Solution. Cost price of the chair = Rs. 800

Selling price of the chair = Rs. 736

Here the selling price is less than cost price, so shopkeeper incurred a loss.

Loss = Cost Price – Selling Price

$$= \text{Rs. } 800 - \text{Rs. } 736$$

$$= \text{Rs. } 64$$

$$\text{Loss Percentage} = \frac{64}{800} \times 100 = 8\%$$

Hence, loss is equal to Rs. 64 and percentage of loss is equal to 8%.

Example 2. Find the selling price of a wall clock whose cost price is Rs. 650 and loss percentage is 6%.

Solution. Cost price of wall clock = Rs. 650

Let's assume loss = L

$$\text{Loss percent} = \frac{\text{Loss}}{\text{Cost Price}} \times 100$$

$$\Rightarrow 6 = \frac{L}{650} \times 100$$

$$\Rightarrow L = \frac{(650 \times 6)}{100}$$

$$\Rightarrow L = \text{Rs. } 39$$

$$\text{Selling Price} = \text{Cost Price} - \text{Loss}$$

$$= \text{Rs. } 650 - \text{Rs. } 39$$

$$= \text{Rs. } 611$$

Hence, the selling price of the wall clock is Rs. 611.

Formulae to Remember

$$\text{Profit} = \text{SP} - \text{CP}$$

$$\text{Loss} = \text{CP} - \text{SP}$$

$$\text{Profit\%} = \frac{\text{Profit}}{\text{Cost Price}} \times 100$$

$$\text{Loss\%} = \frac{\text{Loss}}{\text{Cost Price}} \times 100$$

$$\text{SP} = \left\{ \frac{(100 + \text{Profit\%})}{100} \times \text{CP} \right\}$$

$$\text{SP} = \left\{ \frac{(100 - \text{Loss\%})}{100} \times \text{CP} \right\}$$

$$\text{CP} = \left\{ \frac{100}{(100 + \text{Profit\%})} \times \text{SP} \right\}$$

$$\text{CP} = \left\{ \frac{100}{(100 - \text{Loss\%})} \times \text{SP} \right\}$$



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6. Simple and compound interest

Let's begin by looking at simple interest, and then see how banks extend this idea to everyday business. First, what does it mean to invest a principal amount of money P in a bank at a simple interest rate r ? The bank's customers are letting the bank use their money for a period of time, and in return the bank is willing to return their original amount at the end of the period plus extra money called Interest. The amount of extra money depends on the interest rate that the bank pays and the period of time.

INTEREST

Interest is the fixed amount paid on borrowed money.

The sum lent is called the **Principal**.

The sum of the principal and interest is called the **Amount**.

Interest is of two kinds:

(i) Simple interest (ii) Compound interest

(i) Simple interest: When interest is calculated on the original principal for any length of time, it is called simple interest.

$$\diamond \text{ Simple interest} = \frac{\text{Principal} \times \text{Time} \times \text{Rate}}{100}$$

$$\text{i.e. S.I.} = \frac{P \times R \times T}{100}$$

$$\diamond \text{ Amount} = \text{Principal} + \text{Interest}$$

$$\text{i.e. } A = P + I = P + \frac{PRT}{100} = P \left[1 + \frac{RT}{100} \right]$$

$$\diamond \text{ Principal}(P) = \frac{100 \times \text{S.I.}}{R \times T}$$

$$\diamond \text{ Rate}(R) = \frac{100 \times \text{S.I.}}{T \times P}$$

$$\diamond \text{ Time}(T) = \frac{100 \times \text{S.I.}}{P \times R}$$

\diamond If rate of simple interest differs from year to year, then

$$\text{S.I.} = P \times \frac{(R_1 + R_2 + R_3 + \dots)}{100}$$

Example 1:

Find the amount to be paid back on a loan of
Find the amount to be paid back on a loan of
`18,000 at 5.5% per annum for 3 years

Solution:

$$P = \text{`}18000, R = 5.5\%, T = 3 \text{ years}$$

$$\text{S.I.} = \frac{P \times R \times T}{100} = \frac{18000 \times 5.5 \times 3}{100} = \text{Rs.}2970$$

$$\text{Amount} = P + I = 18000 + 2970 = \text{Rs.}20970$$

Example 2:

In how many years will a sum of money triple itself, at 25% per annum simple interest.

Solution:

Let the sum of money be `P. So, $A = 3P$ and

$$\text{S.I.} = A - P = 3P - P = 2P$$

$$R = 25\%$$

$$\therefore T = \frac{100 \times \text{S.I.}}{P \times R} = \frac{100 \times 2P}{P \times 25} = 8 \text{ years}$$

Example 3:

What rate per cent annum will produce `250 as simple interest on `6000 in 2.5 years

Solution:

$$P = \text{`}6000; \text{ Time } (T) = 2.5 \text{ years; S.I.} = \text{`}250$$

$$\therefore \text{Rate} = \frac{\text{S.I.} \times 100}{P \times T} = \frac{250 \times 100}{6000 \times 2.5} = \frac{10}{6} = \frac{5}{3} = 1 \frac{2}{3} \%$$

Example 4:

To buy furniture for a new apartment, Sylvia Chang borrowed `5000 at 11% simple interest for 11 months. How much interest will she pay?

Solution:

From the formula, $I = \frac{PRT}{100}$, with $P = 5000$, $r = 11$, and $t = 11/12$ (in years). The total interest she will pay is

$$I = 5000(11) \left(\frac{11}{12} \right) = 504.17$$

Or `504.17

(ii) Compound interest: Money is said to be lent at compound interest when at the end of a year or other fixed period, the interest that has become due is not paid to the lender, but is added to the sum lent, and the amount thus obtained becomes the principal in the next year or period. The process is repeated until the amount for the last period has been found. Hence, When the interest charged after a certain specified time period is added to form new principal for the next time period, the interest is said to be compounded and the total interest accrued is compounded and the total interest accrued is compound interest.

$$\diamond \text{ C.I.} = P \left[\left(1 + \frac{r}{100} \right)^n - 1 \right];$$

$$\diamond \text{ Amount}(A) = P \left(1 + \frac{r}{100} \right)^n$$

Where n is number of time period.

- ❖ If rate of compound interest differs from year to year, then

$$\text{Amount} = P\left(1 + \frac{r_1}{100}\right)\left(1 + \frac{r_2}{100}\right)\left(1 + \frac{r_3}{100}\right)\dots$$

Example 5:

If ₹60000 amounts to ₹68694 in 2 years then find the rate of interest.

Solution:

$$\text{Given: } A = ₹68694$$

$$P = ₹60000$$

$$n = 2 \text{ years}$$

$$r = ?$$

$$\therefore A = P\left(1 + \frac{r}{100}\right)^n$$

$$\therefore 68694 = 60000\left(1 + \frac{r}{100}\right)^2$$

$$\Rightarrow \frac{68694}{60000} = \left(1 + \frac{r}{100}\right)^2$$

$$\Rightarrow \frac{11449}{10000} = \left(1 + \frac{r}{100}\right)^2$$

$$\Rightarrow 1 + \frac{r}{100} = \sqrt{\frac{11449}{10000}} = \sqrt{1.1449}$$

$$\Rightarrow 1 + \frac{r}{100} = 1.07$$

$$\Rightarrow \frac{r}{100} = 1.07 - 1 = 0.07$$

$$\therefore r = 0.07 \times 100 = 7\%$$

Example 6:

In how many years, the sum of ₹10000 will become ₹10920.25 if the rate of compound interest is 4.5% per annum?

Solution:

$$A = ₹10920.25$$

$$P = ₹10000$$

$$\text{Rate of interest} = 4.5\%$$

$$\text{Time (n)} = ?$$

$$\therefore A = P\left(1 + \frac{r}{100}\right)^n$$

$$\therefore 10920.25 = 10000\left(1 + \frac{4.5}{100}\right)^n$$

$$\frac{10920.25}{10000} = \left(1 + \frac{0.9}{20}\right)^n = \left(\frac{20.9}{20}\right)^n = 436.81/400$$

$$\left(\frac{20.9}{20}\right)^n = \left(\frac{20.9}{20}\right)^n = \left(\frac{20.9}{20}\right)^n$$

Hence ₹10000 will become ₹10920.25 in 2 years at 4.5%.

- ❖ **Compound interest – when interest is completed annually but time is in fraction**

If time = $t \frac{p}{q}$ years, then

$$A = P\left(1 + \frac{r}{100}\right)^t \left(\frac{p}{q}\right)$$

Example 7:

Find the compound interest on ₹8000 at 15% per annum for 2 year 4 months, compound annually.

Solution:

$$\text{Time} = 2 \text{ years } 4 \text{ months} = 2\frac{4}{12} \text{ years} = 2\frac{1}{3} \text{ years}$$

$$\text{Amount} = \left[8000 \left\{\left(1 + \frac{15}{100}\right)\right\}^2 \left(1 + \frac{1 \times 15}{3 \times 100}\right)\right]$$

$$= \left(8000 \times \frac{23}{20} \times \frac{23}{20} \times \frac{21}{20}\right) = ₹11109$$

$$\therefore \text{C.I.} = ₹(11109 - 8000) = ₹3109$$

- ⇒ **Compound interest – when interest is calculated half-yearly**

Since r is calculated half-yearly therefore the rate per cent will become half and the time will become twice, i.e.,

$$\text{Rate per cent when interest is paid half-yearly} = \frac{r}{2}\%$$

$$\text{and time} = 2 \times \text{time given in years}$$

Hence,

$$A = P\left(1 + \frac{r}{2 \times 100}\right)^{2n}$$

Example 8:

What will be the compound interest on ₹4000 in 4 years at 8 per cent annum. If the interest is calculated half-yearly.

Solution:

$$\text{Given: } P = \text{Rs.}4000, r = 8\%, n = 4 \text{ years}$$

Since interest is calculated half-yearly, therefore,

$$r = \frac{8}{2}\% = 4\% \text{ and } n = 4 \times 2 = 8 \text{ half years}$$

$$\begin{aligned}\therefore A &= 4000 \left(1 + \frac{4}{100}\right)^8 = 4000 \times \left(\frac{26}{25}\right)^8 \\ &= 4000 \times 1.3685 = 5474.2762\end{aligned}$$

$$\text{Amount} = \text{`5474.28}$$

$$\therefore \text{Interest} = \text{Amount} - \text{Principal}$$

$$= \text{`5474.28} - \text{`4000} = \text{`1474.28}$$

❖ **Compound Interest-when interest is calculated quarterly**

Since 1 year has 4 quarters, therefore rate of interest will become $\frac{1}{4}$ th of the rate of interest per annum, and the time period will be 4 times the time given in years

Hence, for quarterly interest

$$A = P \left(1 + \frac{r/4}{100}\right)^{4 \times n} = P \left(1 + \frac{r}{400}\right)^{4n}$$

Example 9:

Find the compound interest on `25625 for 12 months at 16% per annum, compound quarterly.

Solution:

$$\text{Principal}(P) = \text{`25625}$$

$$\text{Rate}(r) = 16\% = \frac{16}{4}\% = 4\%$$

$$\text{Time} = 12 \text{ months} = 4 \text{ quaters}$$

$$A = 25625 \left(1 + \frac{4}{100}\right)^4 = 25625 \left(\frac{26}{25}\right)^4$$

$$25625 \times \frac{26}{25} \times \frac{26}{25} \times \frac{26}{25} \times \frac{26}{25} = \text{`29977.62}$$

$$\text{C.I.} = A - P = 29977.62 - 25625 = \text{`4352.62}$$

❖ **Difference between compound Interest and Simple Interest**

When T=2

$$(i) \text{ C.I.-S.I.} = P \left(\frac{R}{100}\right)^2$$

$$(ii) \text{ C.I.-S.I.} = \frac{R \times \text{S.I.}}{2 \times 100}$$

When T=3

$$(i) \text{ C.I.-S.I.} = \frac{PR^2}{10^4} \left(\frac{300 \times R}{100}\right)$$

$$(ii) \text{ C.I.-S.I.} = \frac{\text{S.I.}}{3} \left[\left(\frac{R}{100}\right)^2 + 3 \left(\frac{R}{100}\right) \right]$$

When C.I. is compound annually, the ratio of S.I. to C.I. at the same rate per annum and for the same period is given

$$\text{by } \frac{\text{S.I.}}{\text{C.I.}} = \frac{r1}{100 \left[\left(1 + \frac{r}{100}\right)^t - 1 \right]}$$

Example 10:

The difference between compound interest and simple interest on a certain amount of money at 5% per annum for 2 years is `15. Find the sum:

$$(a) \text{ `4500} \quad (b) \text{ `7500}$$

$$(c) \text{ `5000} \quad (d) \text{ `6000}$$

Solution:

$$(d) \text{ Let the sum be `100.}$$

$$\text{Therefore, SI} = \frac{100 \times 5 \times 2}{100} = \text{`10}$$

$$\text{and CI} = 100 \left(1 + \frac{5}{100}\right)^2 - 100$$

$$= 100 \times \frac{21 \times 21}{20 \times 20} - 100 = \frac{41}{4}$$

$$\text{Difference of CI and SI} = \frac{41}{4} - 10 = \frac{1}{4}$$

$$\text{If the difference is } \frac{1}{4}, \text{ the sum} = 100$$

$$\Rightarrow \text{If the difference is `15, the sum}$$

$$= 400 \times 15 = \text{Rs.6000}$$

❖ **POPULATION FORMULA**

The original population of a town is P and the annual increase is R%, then the population in years is $p \left(\frac{R}{100}\right)^n$ and if the annual decrease is P

$\left(1 + \frac{R}{100}\right)^n$ R%, then the population in a year is given by a change of sign in the formula i.e $P \left(1 - \frac{R}{100}\right)^n$

Example 11:

If the annual increase in the population of a town is 4% and the present population is 15625 what will be the population in 3 years.

Solution:

$$15625 \left(1 + \frac{4}{100}\right)^3$$

$$\text{Required population: } 15625(1.04)^3 = 17576$$

NOTE: