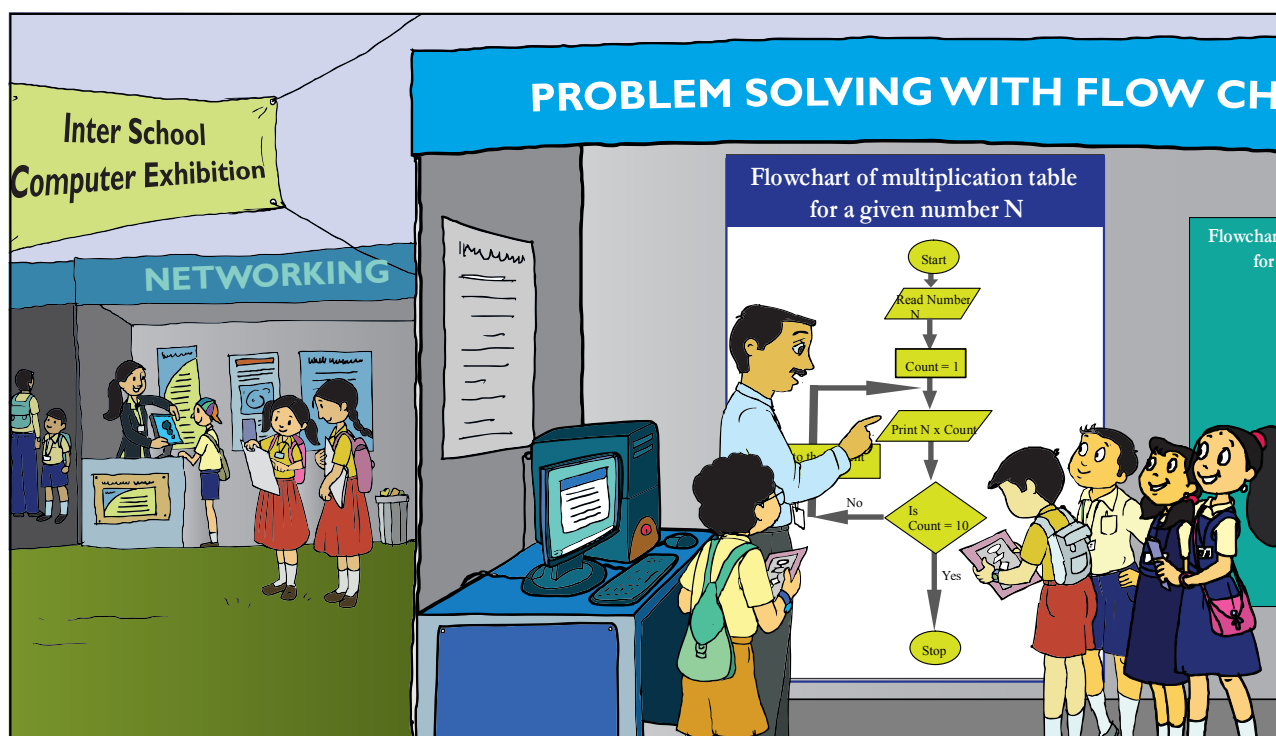# 7. Flowchart

Aim: In this lesson, you will learn:
  To draw a flowchart for problem solving.
  Some uses of flowchart.

Tejas: We visited a computer exhibition for school students. We saw a super computer, demonstration of many uses of computer and many interesting applications.

Jyoti: In one of the stalls, we could enter any number as input and the computer was displaying the multiplication table of the number. The picture shown above was used by the person at the stall, to explain the sequence of steps followed by the computer, to display the table.
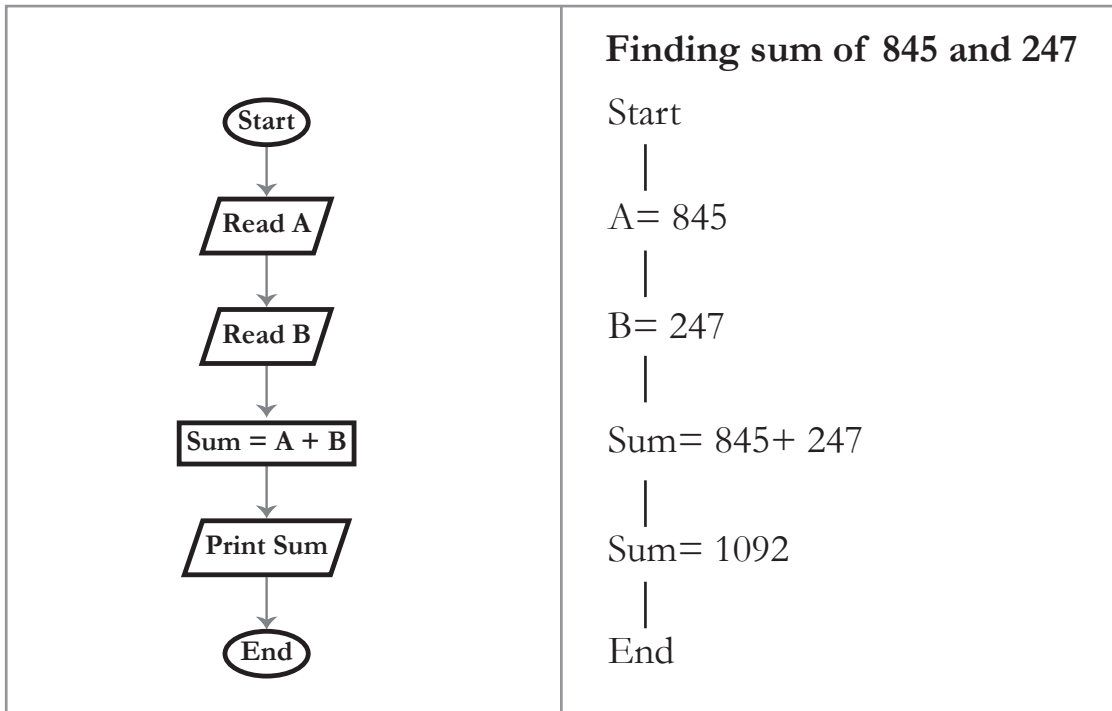
Jyoti: We observed that those who did not know about computers and programming could also understand what was explained by the picture.

Moz: This picture is called a **flowchart**. One of the uses of flowchart is to describe the sequence of steps and logic of solving a problem, before writing a computer program. Flowchart also helps in communicating the steps of the solution to others.

Tejas: I see that various geometrical shapes are used in this representation. We are eager to learn about flowcharts.

Moz: Let us start with a simple example. Look at the following flowchart of adding two natural numbers A and B. Let us discuss the problem solution and the geometrical shapes used.

	Finding sum of 845 and 247
Start	Start
Read A	A= 845
Read B	B= 247
Sum = A + B	Sum= 845+ 247
Print Sum	Sum= 1092
End	End

Jyoti: Start and also end of the flowchart are shown with an ellipse.

Moz: A flowchart should give a clear indication as to where the problem solving flow starts and where it ends. The start of a problem solving process and the end are indicated using the ellipse.

Tejas: Our goal is addition of two given numbers. So, first we identify the data that is given. In this problem we have the two numbers A and B. Reading their values are represented by parallelograms.

Moz: Right. What would you call *reading in values* in computer terms?

Jyoti: Input.

Moz: The data or information that is available, (which is called *input*) is represented using a parallelogram in the flowchart.

Moz: What is the next step?

Tejas: The next step is to add the numbers, which is called processing in computer terms. We learned this term in "Inside computer" lesson. The details of processing of data is represented in a rectangle.

Moz: Correct.

Jyoti: The next step is to write the result of the addition, which is *output* in computer terms. This is also specified in a parallelogram.

Moz: Right. A parallelogram is used to specify both input and output in a flowchart. What else do you notice in the flowchart?

Tejas: An arrow points from one step to the next step in the flowchart.

Moz: In a flowchart arrows are used to connect the steps in a sequence and show the flow of the problem solving process.

Jyoti: We learnt *step by step thinking* to solve a problem in Level III. Using flowcharts we can show the sequence of these steps.

Moz: Yes. The step by step method of solving the problem is specified using a flowchart. This helps you to be clear about the input, procedure and output. It also helps you to communicate the solution.

Flowchart

What is a flowchart?
- A flowchart is a picture (graphical representation) of the problem solving process.
- A flowchart gives a step-by-step procedure for solution of a problem.

Elements of a flowchart:
- Various geometrical shaped boxes represent the steps of the solution.
- The boxes are connected by directional arrows to show the flow of the solution.

Uses of a flowchart:
- To specify the method of solving a problem.
- To plan the sequence of a computer program.
- Communicate ideas, solutions.

Guidelines

Drawing a flowchart

- **Identify** input and output.
- **Apply** reasoning skills to solve the problem.
- **Draw** the flowchart using the appropriate symbols and arrows to show the sequence of steps in solving the problem.

Moz: Now consider the following problem and draw the flowchart for its solution.

Savani bought a toy for Rs. 325 and sold the same for Rs. 458. Explain how we can find if Savani has made a profit or a loss.

Tejas: In this problem the goal is to find whether Savani makes a profit or loss.

Jyoti: We know the Cost Price and the Selling Price. We can read them as input, so they are represented as parallelograms.

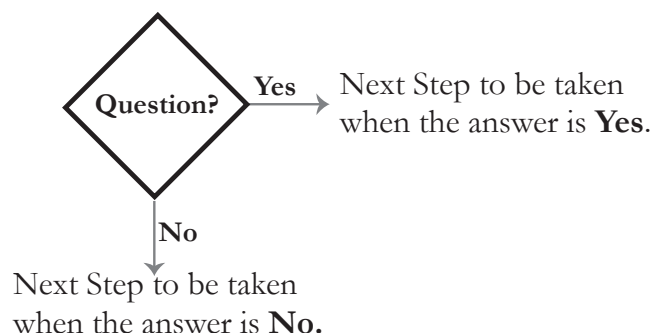Read Cost price (CP)
Read Selling price (SP)
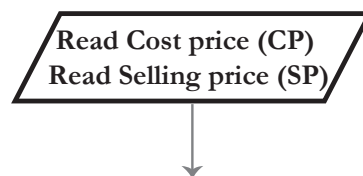
Tejas: Next we have to compare Selling Price and Cost Price to find which price is more. This will tell us whether Savani has made profit or loss. How do we show comparison in a flowchart?

Moz: Can you phrase this step as a question with the two possible answers?

Tejas: We can ask a question "Is selling price more than cost price?"

Moz: Right. The answer to this question can be "Yes" or "No". If, answer is "Yes" we have to calculate profit. If, answer is "no" we have to calculate loss. This decision taking step is represented as follows in a flowchart.

Question? — Yes → Next Step to be taken when the answer is **Yes**.

No

Next Step to be taken when the answer is **No.**

Jyoti: If the answer is "Yes", it means that selling price is more than the cost price and Savani has made profit. Profit is calculated as *Selling price – Cost price.*
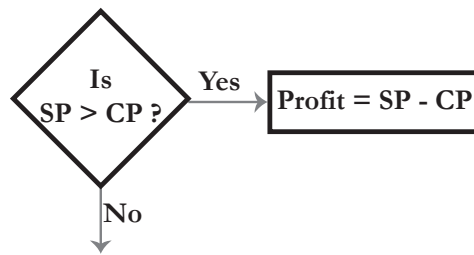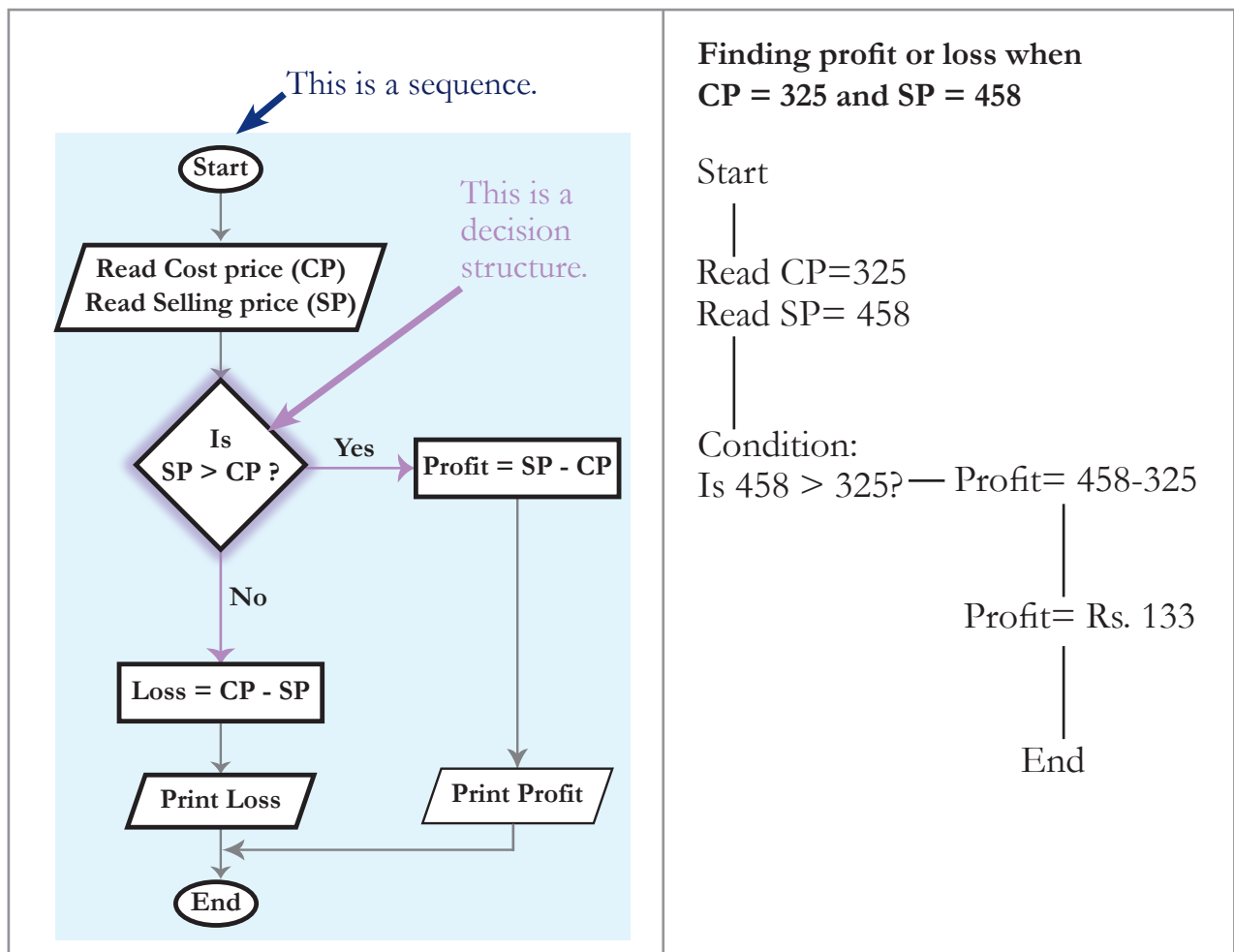

Tejas: If the answer is "No", it means that cost price is less than selling price and Savani has made loss. Loss is calculated as *Cost price – Selling price.*
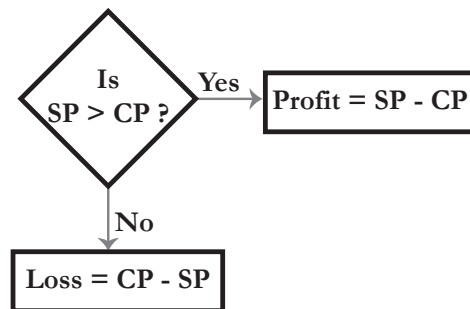
Moz: Good. You have used logical reasoning to solve this problem. Now complete the flowchart.

Flowchart - How to find profit or loss.

This is a sequence.

This is a decision structure.

Finding profit or loss when CP = 325 and SP = 458

Start

Read CP=325
Read SP= 458

Condition:
Is 458 > 325? ― Profit= 458-325

Profit= Rs. 133

End

Flowchart symbols and their purpose
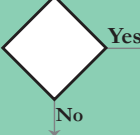
Flowchart symbols	Geometric shape	Purpose
Ellipse		Ellipse is used to indicate the start and end of a flowchart. Start written in the ellipse indicates the beginning of a flowchart. End or Stop or Exit written in the ellipse indicates the end of the flowchart.
Parallelogram		A parallelogram is used to read data (input) or to print data (output).
Rectangle		A rectangle is used to show the processing that takes place in the flowchart.
Diamond	Yes / No	A diamond with two branches is used to show the decision making step in a flowchart. A question is specified in the diamond. The next step in the sequence is based on the answer to the question which is "Yes" or "No".
Arrows		Arrows are used to connect the steps in a flowchart, to show the flow or sequence of the problem solving process

Moz: Suppose you have to write a Scratch program using the flowchart that you have just drawn. Can you do it now?
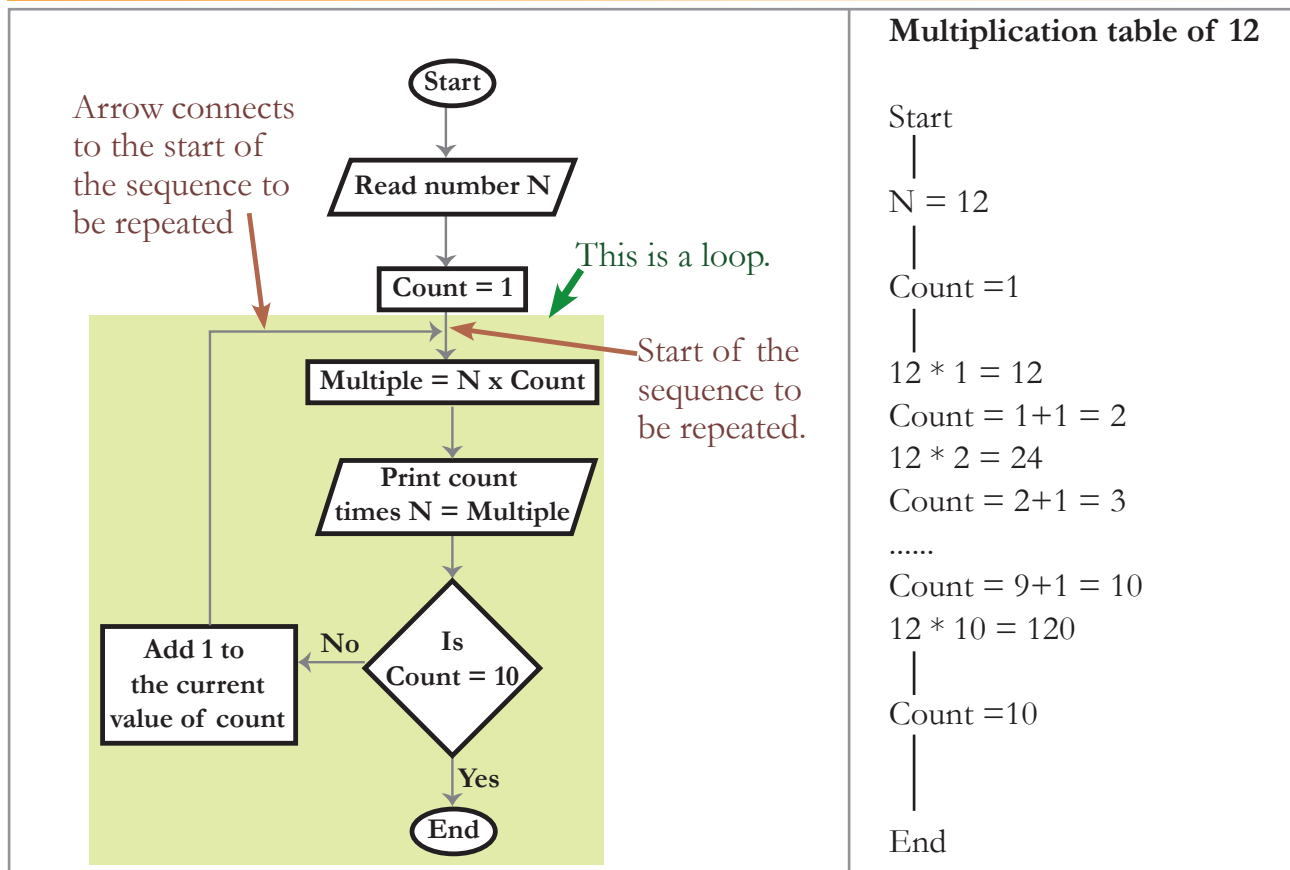
Tejas: Yes. We can!

Jyoti: This is great. We can also plan a computer program using flowcharts.

Jyoti: Sometimes we need to repeat a sequence. How do we represent this in the flowchart?

Moz: Let us consider the multiplication table flowchart that you saw at the exhibition. See how repetition is represented in a flowchart. This is also called a **loop**.

Flowchart of multiplication table for a given number N

Arrow connects to the start of the sequence to be repeated

Start

Read number N

Count = 1

This is a loop.

Start of the sequence to be repeated.

Multiple = N x Count

Print count times N = Multiple

Add 1 to the current value of count — No ← Is Count = 10

Yes

End

Multiplication table of 12

Start
|
N = 12
|
Count =1
|
12 * 1 = 12
Count = 1+1 = 2
12 * 2 = 24
Count = 2+1 = 3
......
Count = 9+1 = 10
12 * 10 = 120
|
Count =10
|
End

Jyoti: The repetition sequence starts with Count =1. N is multiplied with 1 and output is printed. Next since count is not equal to 10 we add 1 to count. N is multiplied with 2 and output is printed. The sequence is repeated next for 3, 4 and so on.

Tejas: The repetition sequence stops when Count =10.

Moz: Correct. A decision structure has been used to start and stop the repetition.

Jyoti: In this flowchart output is not coming at the end and there are multiple outputs.

Moz: Good observation. The output need not always come at the end of a flowchart. Similarly in some flowcharts input need not always be at the beginning of the flowchart.

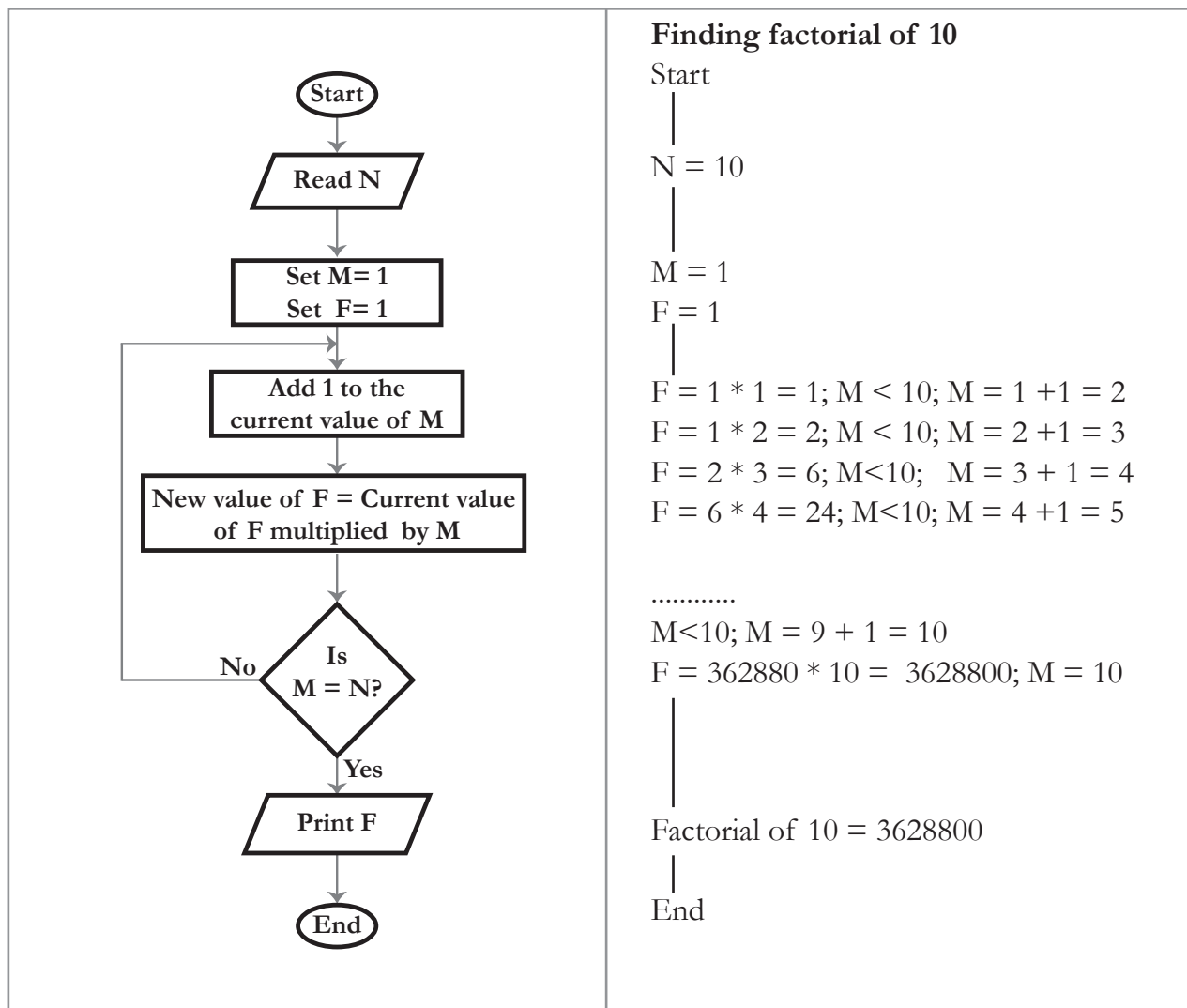Moz: Try out another problem how do you find the factorial of a number?

Jyoti: Suppose the number is 10. Then factorial of ten is calculated as

$$10! = 1*2*3*4*5*6*7*8*9*10$$

Moz: Can you draw the flowchart for finding factorial of any given number?

Jyoti: Yes. We can. We have to use both decision and loop in this flowchart.

Find factorial of a given number N

	Finding factorial of 10
Start	Start
Read N	N = 10
Set M= 1 Set F= 1	M = 1 F = 1
Add 1 to the current value of M New value of F = Current value of F multiplied by M	$F = 1 * 1 = 1$; $M < 10$; $M = 1 + 1 = 2$ $F = 1 * 2 = 2$; $M < 10$; $M = 2 + 1 = 3$ $F = 2 * 3 = 6$; $M < 10$; $M = 3 + 1 = 4$ $F = 6 * 4 = 24$; $M < 10$; $M = 4 + 1 = 5$
No ◄── Is M = N? Yes	.... $M < 10$; $M = 9 + 1 = 10$ $F = 362880 * 10 = 3628800$; $M = 10$
Print F	Factorial of 10 = 3628800
End	End

Moz: Explain the logic that is used in the loop and specifically the following processing box of the flowchart.

New value of F = current value of F multiplied by M

Jyoti: N is the number for which we have to find the factorial.

At the start of the loop

We start with F =1 and M =1.

Since we have to start with 1 multiplied by 2 we add 1 to M.

Current value of F which is equal to 1 is multiplied by 2.

The result of this multiplication is equal to 2.

Since M is less than N we enter the loop again with current value of F=2.

Next we add 1 to M which becomes 3.

Current value of F which is equal to 2 is multiplied by 3.

The result of this multiplication is equal to 6.

Since M is less than N we enter the loop again with current value of F = 6.
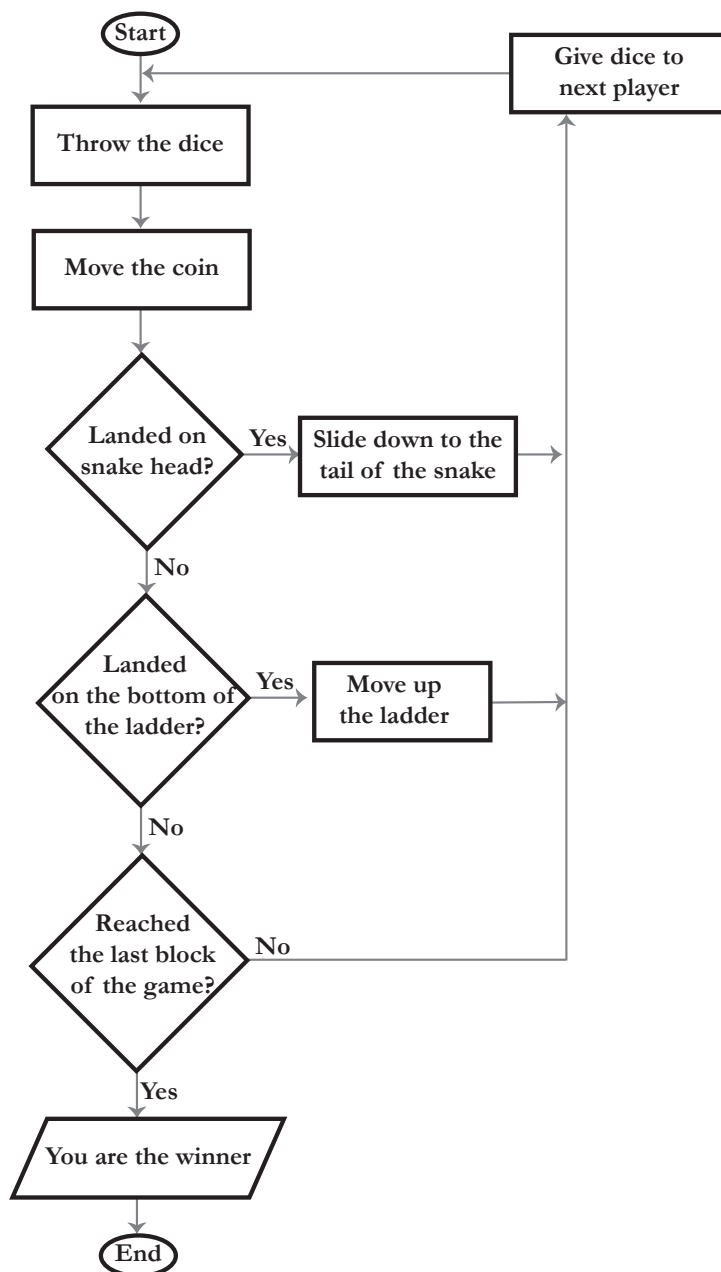
Moz: Good. Now let us consider a game. Do you know the game of snakes and ladders?

Tejas: Yes.

Moz: Ok. Draw a flowchart to show how the game is played.

Tejas and Jyoti draw this flowchart.

Flowchart - Snakes and Ladder game

Playing snakes and ladders between two players

Start

Throw the dice: the number indicated by dice is 3.

Move the coin: through 3 blocks on the board.

Landed on snake head?: No.

Landed on the bottom of the ladder?: Yes (See the snakes and ladders board given).

Move up the ladder: reached block 14 on the board.

Reached the last block of the game?: No.

Give dice to next player.

Enter the loop till the last block of the game is reached.

End

Uses of flowchart:

Graphical representation of instructions- for example games, building models etc.

Tejas: The flowchart itself can be put into the box of the game so that those who want to play know the rules of the game and can easily understand how they win.

Moz: We have seen some examples where flowcharts are used. There are many more uses of flowcharts and they can be used whenever you feel that you can communicate better with this graphical representation.
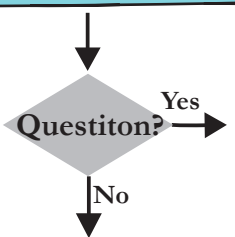
Info

Other uses of flowchart

- Communicating ideas.
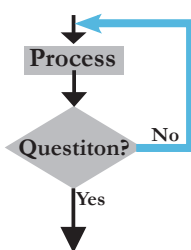- Show the logic of classification of data.
- To teach and also to learn.

Tejas: We are eager to learn another programming language.

Moz: Sure. Next you will be learning BASIC where you can use some of the flowcharts that you have drawn in this lesson. Chin Chinaki...
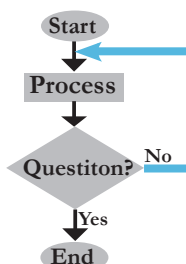
Decision

Questiton? — Yes / No

Loop

Process → Questiton? — No / Yes
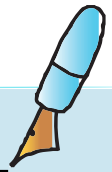
Sequence

Start → Process → Questiton? — No / Yes → End

Lesson Outcome

At the end of the lesson, you will be able to:
- List some uses of flowchart.
- List the steps to be followed while drawing a flow chart and apply it to draw a flow chart.
- Recognise various structures like sequence, selection and repetition in a flowchart.

WORKSHEETS

1. **Which is not true about the arrows used in a flowchart?**

   i.   Direction of arrow shows the flow in a flowchart.

   ii. Arrows are used show the sequence of the problem solving.

   iii. Arrows are used to connect boxes in a flowchart.

   iv. Arrows can be used to represent an input.

2. **Match the elements of a flowchart and their purpose of use in the following:**

 | Purpose | Use |
   |---|---|
   | Calculate total of A, B, C | Loop |
   | Indicate that the problem has been solved. | Start |
   | Find if a number is greater than the other | Process |
   | Read a number and calculate the factorial of the number. | Input |
   | Read three numbers | Stop |
   | Print the total | Decision |
   | Indicate beginning of a problem solving flow. | Output |

3. **Complete the crossword puzzle.**
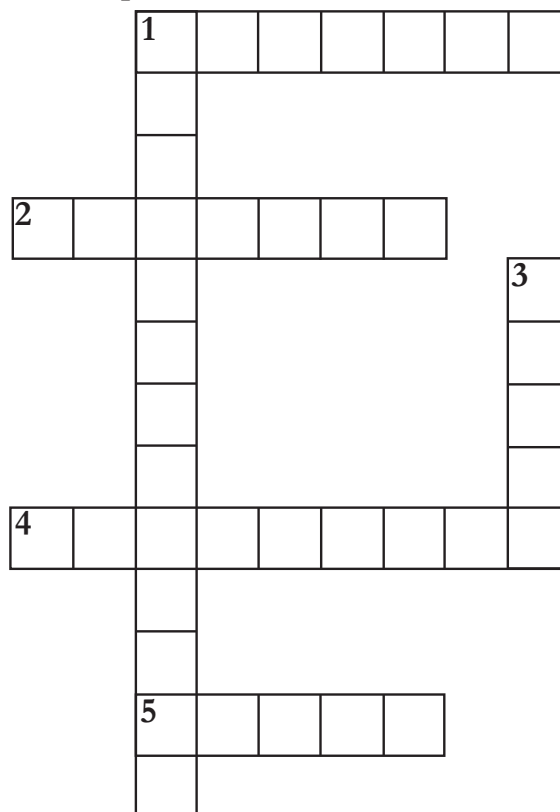
Across

   1. I am a rectangle in a flowchart. What do I represent?.
   2. When you want to show a decision making step, you can use this box.
   4. You can use me to communicate ideas, graphically represent a problem solving process.
   5. I connect two geometrical boxes in a flowchart.

Down

   1. In the flowchart, I represent data or information that is available.
   3. All flowcharts begin with me. I am elliptical in shape.

WORKSHEETS
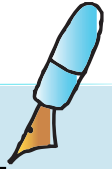
4. The following flowchart classifies animals as herbivore or carnivore. Lion is a meat eating animal. Elephants eat only plants. Study the flowchart and answer the questions.
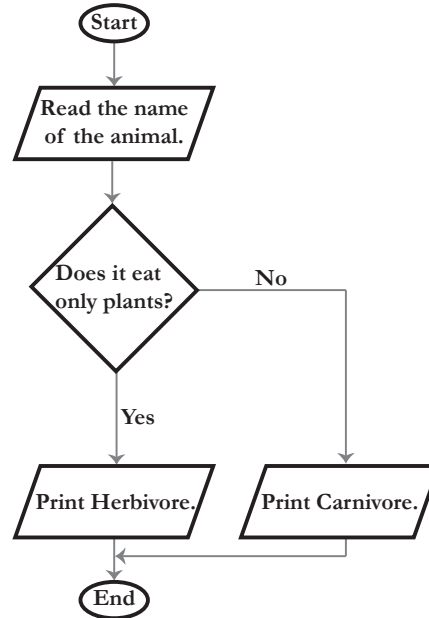
a. Indicate each element of the flowchart by putting 'I' for input, 'O' for output, 'D' for decision in the circles provided next to the boxes.

b. Put a rectangle around the decision structure.
    Hint: See page .... in the lesson. **(Page no to be put.)**

c. What is the condition which classifies an animal as carnivore?

    _____

d. Write the Execution steps if the input is a Lion.

    _____

    _____

    _____

e. What is the condition which classifies an animal as herbivore?

    _____

f. Write the Execution steps if the input is an elephant.

    _____

    _____

WORKSHEETS
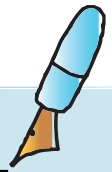
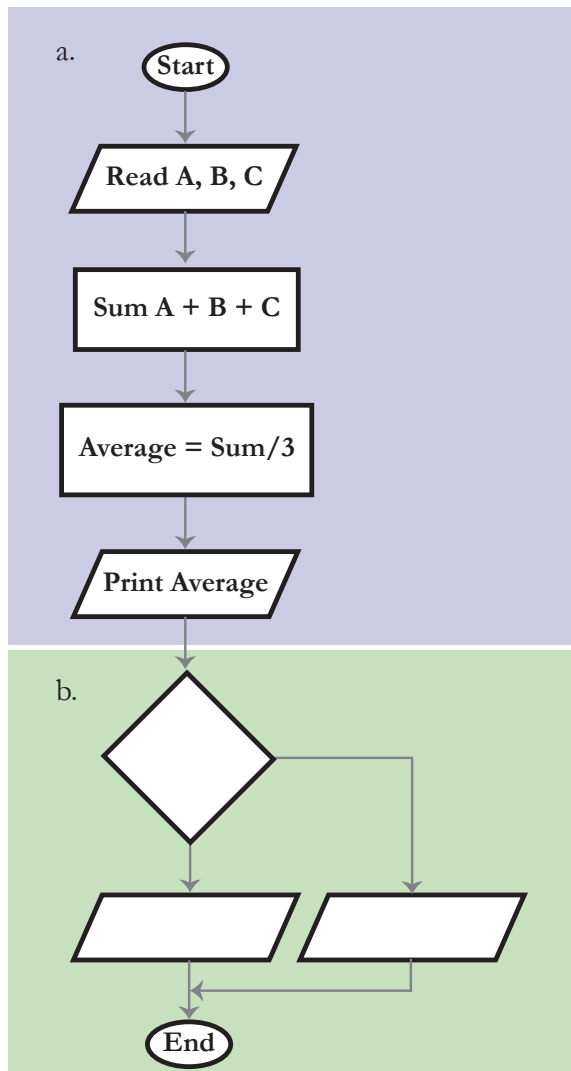**5. A, B, C are the marks scored by a student in Science, Mathematics and English. Refer the flowchart and answer the questions.**

a.

```
        ( Start )
           │
           ▼
    / Read A, B, C /
           │
           ▼
    [ Sum A + B + C ]
           │
           ▼
    [ Average = Sum/3 ]
           │
           ▼
    / Print Average /
           │
```

a.   Sweta, who scores 60 marks in Science, 70 marks in mathematics and 75 marks in English. Use the adjacent flowchart and provide the execution steps in calculating the average marks of Sweta. The first step is given.

60, 70, 75 _____

_____

_____

_____

b.

```
           │
           ▼
          ◇ ──────────┐
         ╱ ╲          │
        ╱   ╲         │
        ╲   ╱         │
         ╲ ╱          │
          │           │
          ▼           ▼
     / _____ /   / _____ /
          │           │
          └────┬──────┘
               ▼
            ( End )
```

b.   A student whose average marks is above 75 is awarded a star. Fill in the following phrases in the flowchart for finding if a student gets a star or not.

    Yes,
    No,
    Award a star,
   Do better to get a star,
    Is average greater than 75.

c.   Is Sweta awarded a star? Yes or No?
    Ans: _____

d.   Marks of two more students are given below. Study it and fill in the blanks with the average marks of each student and whether the student is awarded a star or not.

	Science	Mathematics	English
Riya	75	80	72
Suman	72	70	82

i.   Riya's average is _____. So she is _____ a star.

ii. Suman's average is _____. So she is _____ a star.
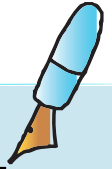
e. The three main steps in the given flowchart are:
   i. Read marks of three students.
   ii. _____
   iii. _____

6. The following empty flowchart gives the steps to be followed while seeking admission to new school. The phrases to be filled in the boxes are also given. Complete the flowchart by filling in the number of the correponding phrase, inside each box. For example: the number corresponding to the first box in the flowchart is 7.
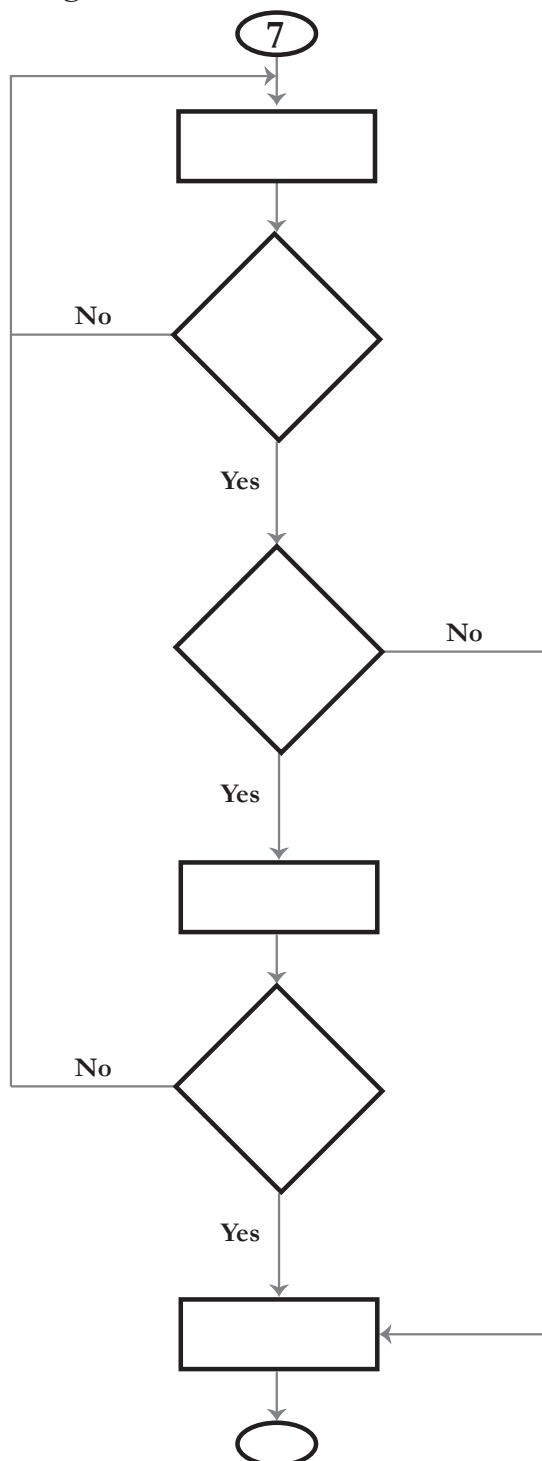
1. Search for a school
2. Prepare for the admission test and write the test.
3. Did you pass the exam?
4. Submit necessary documents and get admission.
5. End
6. Are seats available?
7. Start
8. Is there an admission test?

7. **The following flowchart gives the steps followed while taking attendance in a class. Three arrows and a loop are missing. Complete the flowchart as follows:**
    a. **Draw the three missing arrows and loop at the correct place.**
    b. **Label the decision arrows with yes or no.**
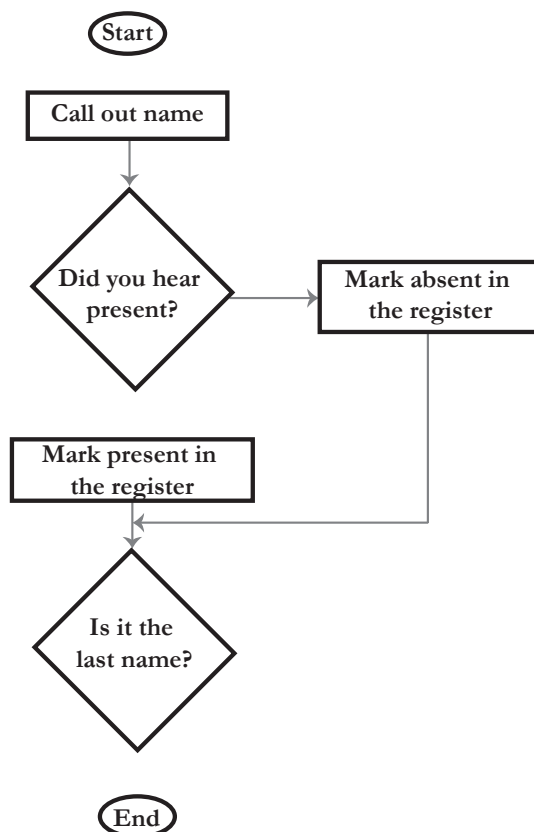
8. **Frame a question(Hint: Try to make a question, which will have the answer given below)**
   For example: The answer given is:
   Some of the boxes of different shapes used in a flowchart are
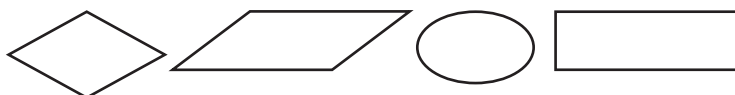

   The question can be:
   Draw some of the symbols used in a flowchart?
   Now frame a question for each of the answers given below:
   a. The answer given is: In a flowchart, we use a rectangular box to represent a process .
      The question can be: _____

   b. The answer given is : In a repetition structure, the process is repeated till the condition is satisfied.
      The question can be: _____
   c. The answer given is : The decision structure has two branches, Yes or No.
   The question can be: _____

WORKSHEETS
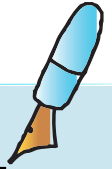
9. **There are four types of fruits Apples, Oranges, Bananas and Grapes. Each student can pick up two fruits. There are some conditions which have to be used to pick up the fruits. Draw a flow chart which can take the name of first fruit as an input and print the names of second fruit or fruits that can be picked up. The conditions are:**

- If you pick an apple you can pick banana.
- If you pick orange you can pick grapes.
- If you pick grapes you can pick banana.

Hint: There will be one input box to read the first fruit, three decision boxes and four output boxes in the flowchart.
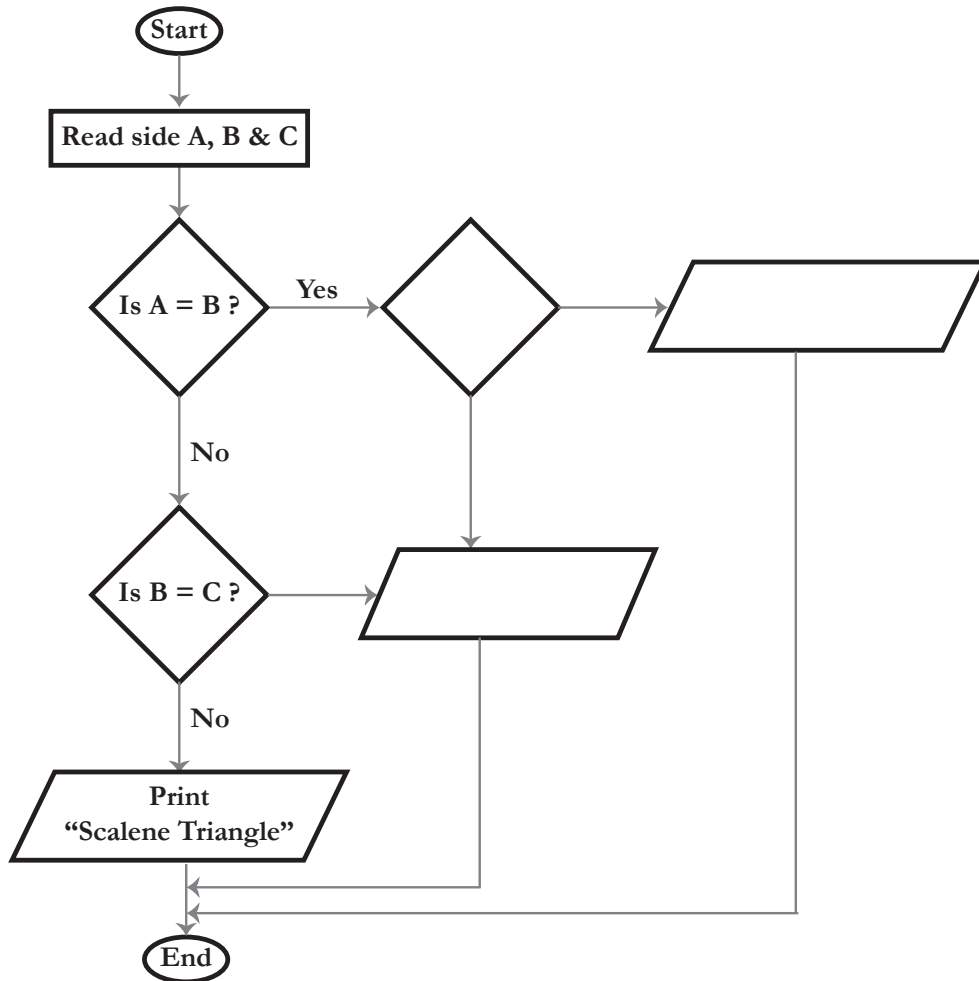
WORKSHEETS
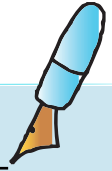
10. **Lengths of three sides of a triangle a, b, c are given as input. The following flowchart finds if the triangle is isosceles, equilateral, or scalene. Some boxes in the flowchart are filled in for you, fill in the rest of the details.**

Hint: In an equilateral triangle three sides are equal.

     In an isosceles triangle two sides are equal.

     In a scalene triangle three sides are not equal.

```
                  ( Start )
                      |
              [ Read side A, B & C ]
                      |
             < Is A = B ? >  --Yes-->  < >  -->  [ ]
                      |
                     No
                      |
             < Is B = C ? >  -->  [ ]
                      |
                     No
                      |
             / Print
               "Scalene Triangle" /
                      |
                  ( End )
```

a. Use the above flowchart and provide the execution steps in finding whether the given triangle with sides 5 cms, 5 cms and 3 cms is scalene or isosceles or equilateral triangle.

_____

_____

_____

_____

5 cms   5 cms

3 cms
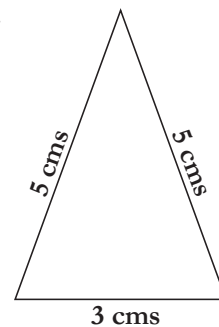
1. **Select one of the games given below from GCompris and draw a flowchart to explain the rules of the game.**
    *   Memory games with images
    *   Image name (drag and drop each item above its name)
    *   Numbers with dice

2. **Use one of the following applications- open office draw or Kivio (available for Linux) or Diagram Ring (available for Windows)- to draw a flow chart for the above using the computer.**
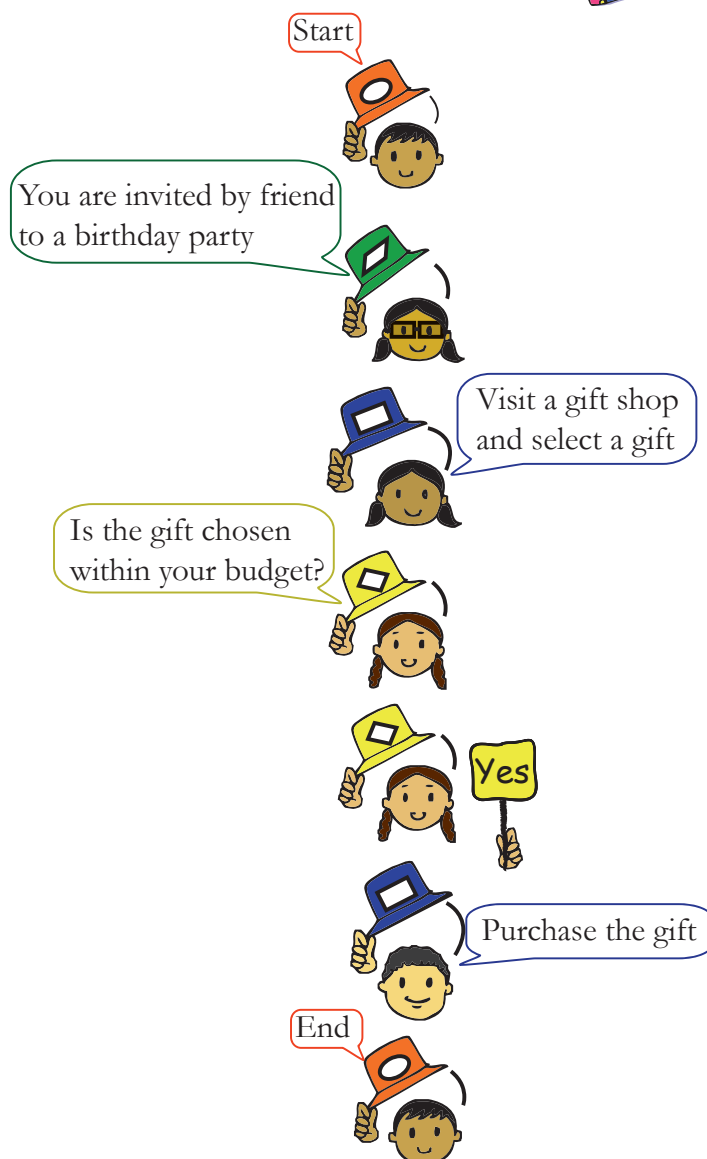
Group Activity

3. **Play Computer Class:**

    Divide the class into four teams- INPUT DATA, OPERATIONS, DECISION, and OUTPUT. Nominate one person from input and output team to play the role of start and end box respectively. Each group has a set task to perform based on instructions given to them by another team.

    For example: Let the situation be to purchase a birthday 🎁 for your friend.

    Start

    You are invited by friend to a birthday party

    Visit a gift shop and select a gift

    Is the gift chosen within your budget?

    Yes

    Purchase the gift

    End

You can give one the following situations for students to work through the process of flow chart.

i.   A wired telephone in your house rings and you have to attend the call.

ii. You visit a pediatrician for check up.

iii. You go to a post office with a note of Rupees 10 to purchase stamps worth Rupees 5.

Project

4.   a.   Input, output and decision phrases are given in the table given below. Note that one input phrase corresponds to one flowchart. Draw three flow charts using the phrases in the table for the following:

   i.   A flowchart which conveys the rules in AWARE.

   ii. A flowchart which conveys Accept rule of SMART.

   iii. A flowchart which conveys Meet rule of SMART.

Input phrases	Decision phrases	Output phrases
An image to be used in presentation.	Is permission given to use image? Is it from a resource with Creative commons (CC)? Is the image copyrighted?	Take permission. Acknowledge use of image. Do not use the image.
New Email in inbox	Is the mail from a friend? Is it marked SPAM in Subject of mail?	Delete mail. Might have virus. Do not open. Read the mail
Online request to meet	Is the Meet request from friend?	Meet the person. Meet in the presence of an adult family member.

b.   There are three more rules of SMART which are Safety, Reliability, and Tell. Draw a flowchart for each of these rules by creating the phrases on your own. Compare your flowcharts with other groups in the class.

c.   The teacher can evaluate and select the flowcharts that can be converted to posters for SMART and AWARE and put them up for display.

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