Chapter One

Problem Solving

By the end of this chapter, student will be able to:

- **Define the problem**
- **Identify the problem solving stages**
- **Write steps that solve the problem "Algorithm"**
- **Draw flowcharts**

PREFACE

In your daily life, you may face problems through various activities. A problem means an objective or an output that we have to achieve, for example preparing a meal is considered a problem, and we have to follow consecutive steps sequentially to attain the required objective and get the meal.

1–1 Problem Solving:

The problem is defined as the objective or the specific output that we want to attain; through a sequence of steps and activities and, specific input.

Consider the following problem:

The problem is: Baking a cake according to certain specifications, input available are the ingredients (such as eggs, flour, milk …etc.), then followed by activities or procedures that should be done sequentially, taking into consideration that any mistake happens by doing any procedure before the other, results in an unsuitable and undesirable cake.

In this book, we focus on Problem Solving techniques using the computer.

1–2 Problem Solving Stages:

First: Problem Definition:

Problem definition implies the identification of required outputs, available inputs and, arithmetic and logical operations to be executed.

Second: Performing step-by-step instructions (Algorithm) to solve a Problem

Algorithm is defined as a group of logically arranged procedures to be executed to attain a goal or precise output, out of specific inputs.

After identifying and analyzing the problem, outputs and, inputs; a plan in the form of a series of successive steps is made, which is called an (Algorithm), devised by the Mathematician and the founder of Algebra "Muḥammed ibn Mūsā al-Jwārizmī".The algorithm is represented by drawing "Flowcharts" that will be explained later in this chapter.

Third: Program design

Having drawn a "Flowchart", to solve the problem, using a computer; we have to translate this flowchart into one of the programming languages.

Fourth: Program Testing

During writing a program we unintentionally make some mistakes; e.g. writing a minus sign (-) instead of (+). We can't detect errors unless we begin entering data to the program with previously known results; to compare the results of the current program to those of the well-known results; therefore we check the errors and debug them.

Fifth: Program Documentation

All steps taken for solving the problem that include: given Input, output, plan for solving the problem, drawn flowchart, programming language used for coding and, instructions, date of last modification of the program and, people who contribute to the program development process, to have the program documented to go back for feedback and correction.

The documentation is beneficial when more than one person participate in writing or modifying the program.

1–3 Flowchart:

Flowchart is a diagram that uses standard graphical symbols; to illustrate the sequence of steps required for solving a problem or specific question.

Flowchart promotes understanding of a problem and shows what tasks should be performed when writing program codes; and so coding becomes an easy task for a programmer. A Flowchart explains the program to others, and that it is also considered a convenient tool for documenting a program especially if it is complicated.

Most Flowcharts are drawn using standards (commonly used) symbols that have specific meanings. Special symbols can also be used for exceptional cases.

The most commonly used symbols are as follows:

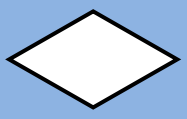
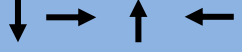
Significance	symbol
(Terminal)	
(Input/Output)	
(Process)	
(Decision)	
(Flow Lines)	

Table (1-1) Common symbols for Flowcharts

We will demonstrate problem solving steps (Algorithm) using flowcharts, through the following progressive examples:

1–3–1 Simple Flowchart:

Exercise (1–1):

Draw a flowchart for a program that will calculate the sum of two numbers entered by the user and display the result.

First: Define the problem
Output: The sum of two numbers
Input: The first number is "A "and the second number is "B"
Solution: C =A+B where the result is C

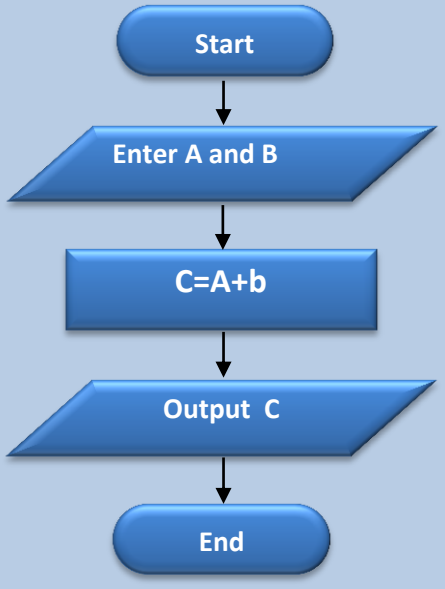
Second :Algorithm	Third :Flowchart
1 Start 2 Enter the number A and the number B 3 Performing the sum of the two numbers using this equation C=A+B, the output is C 4 Print C 5 End	

Table (1-2) Algorithm and Flowchart to add two numbers

To construct a Flowchart we should consider the following

1-The flowchart should start with the Start symbol and end with the End  symbol.

2-A,B,C are variable names .A Variable refers to a memory storage that holds a value.

3-The equation: C =A+B, indicates the sum of the value of A, to the value of B, and stores the result in C.

4-Entering values in A and B is done by using the term "Enter", inside the parallelogram,  you can also use another term to get the same meaning like "Read" or "Input".

5-The sum equation is written inside the rectangle,  as it represents an arithmetic operation.

6-The output is expressed with a parallelogram  using the term "Output", we can also use another term like "Print".

7-Note that Lines with arrows (flow lines) are from top to bottom and show the exact order of an Algorithm.

Exercise (1-2)

Draw a flowchart for a program that will compute the average and Product of three numbers.

First: Define the problem
Output: The average of three numbers.
Input: The number X, the number Y, and the number Z.
Solution: Average =(X+Y+Z)/3 and, Product= X*Y*Z.

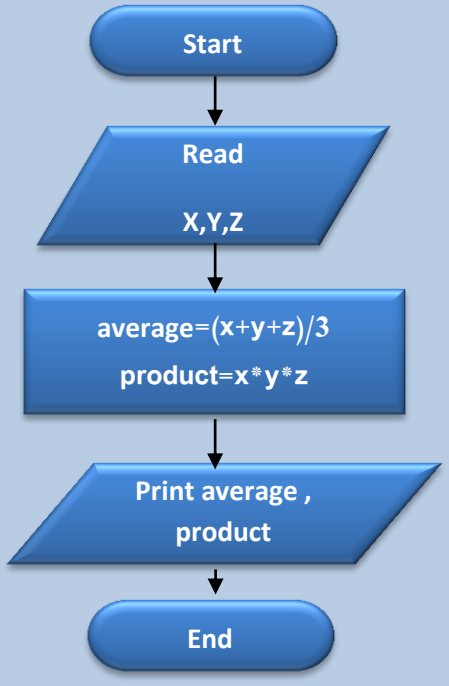
Second :Algorithm	Third :Flowchart
1 Start 2 Read the values of X,Y,Z 3 Average =(X+Y+Z)/3 and Product= X*Y*Z 4 Print the Average and the Product 5 End	

Table (1-3) Algorithm and Flowchart to compute the average and Product of three numbers

Exercise (1–3)

Solving a first degree equation Y=3x+2.

First: Define the problem

Output: The value of "Y".

Input: X.

Solution: Compute the value of "Y" from the equation Y=3x+2.

REMEMBER:

1- **The expression on the left side of any equation should contain only one variable; the value of this variable will be the (output) or the solution of the equation.**

2- **The expression on the right side of the equation may contain values or arithmetic expressions that have one or more variables (inputs).**

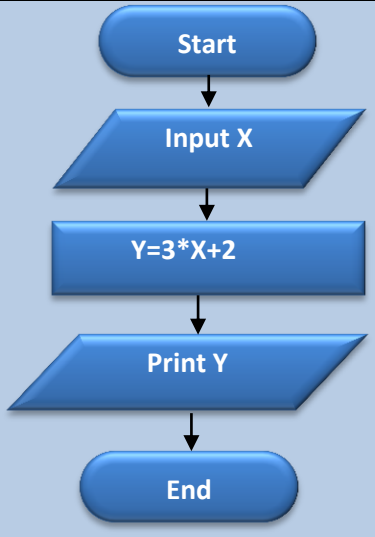
Second :Algorithm	Third :Flowchart
1 Start 2 Enter value of X 3 Calculate Y =(3*X+2) 4 Output value of Y 5 End	

Table (1-4) Algorithm and Flowchart to solve a first degree equation

Activity (1–1)

Write down the Algorithm, and draw a flowchart to compute the area and the perimeter of a rectangle ,whose length and width are known , bearing in mind that the equation of the area is : Area =L*W and that of the Perimeter is: Perimeter =2*(L+W).

NOTICE

The word "Area" refers to a Variable name, whose value is the calculated area of the rectangle; also "Perimeter" is a variable name whose value is the calculated perimeter of the rectangle.

Variable names are chosen to reflect and indicate the content of the variables .

First: Define the problem

Output:

Input:

Solution :

Second :Algorithm	Third :Flowchart

Like the previous example, do the following activities in your notebook

Activity (1-2)

Write down the Algorithm, and draw a flowchart to calculate the area of a circle whose radius "R" is known, bearing in mind that the equation of the area is: Area =3.14*R*R.

Activity (1-3)

Write down the Algorithm, and draw a flowchart to calculate the number of years, bearing in mind that the number of months is known.

1–3–2 The use of Branching (Decision) in Flowcharts

Most problems include a decision point, such as yes/no question, where two possible answers are available a "yes" and a "no", in a flowchart the decision point has two paths (branches), each presents one of the possible answers, you can also find more than two answers.

Exercise (1–4)

Draw a flowchart for a program that will obtain exam scores from the user. Determine whether the score is greater than or equal 50 and display the message " ناجح".

First: Define the problem
Output: print the word " ناجح".
Input: the score X.
Solution: If the value of X is greater than or equal 50; the word "ناجح" will be printed.

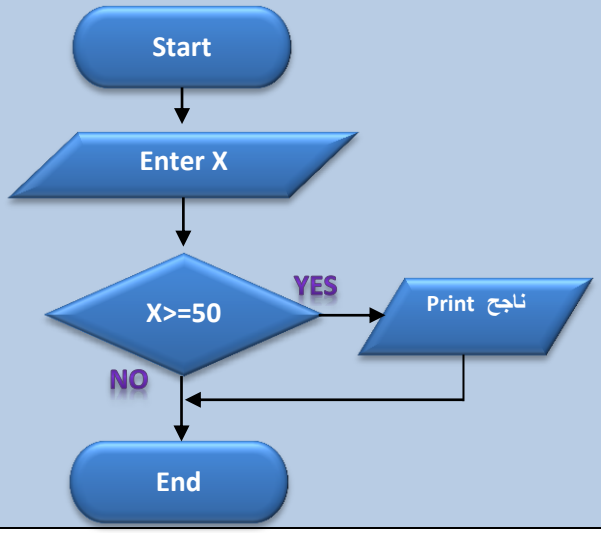
Second :Algorithm	Third :Flowchart
1 Start 2 Enter the values of X 3 If X> =50 then 3-1 Print " ناجح " 4 End	

Table (1-5) Algorithm and Flowchart to print the message "ناجح"

NOTICE

The execution of step (3-1) will be done only when the value of x is greater than or equal 50 (the result of the condition is True), then it passes to step (4); otherwise when the value of x is less than 50 (the result of the condition is False), then the execution is transferred to step 4 directly.

Exercise (1-5):

Draw a flowchart for a program that will calculate the division of two numbers. Determine whether the divisor equal (zero) and display the message "unknown ".

First: Define the problem

Output: print the result of dividing two numbers "R" or print the word "غير معرف".

Input: the dividend is "num1", and the divisor is "num2".

Solution: if num2=0 then print "غير معرف", otherwise print the result of the division "R".

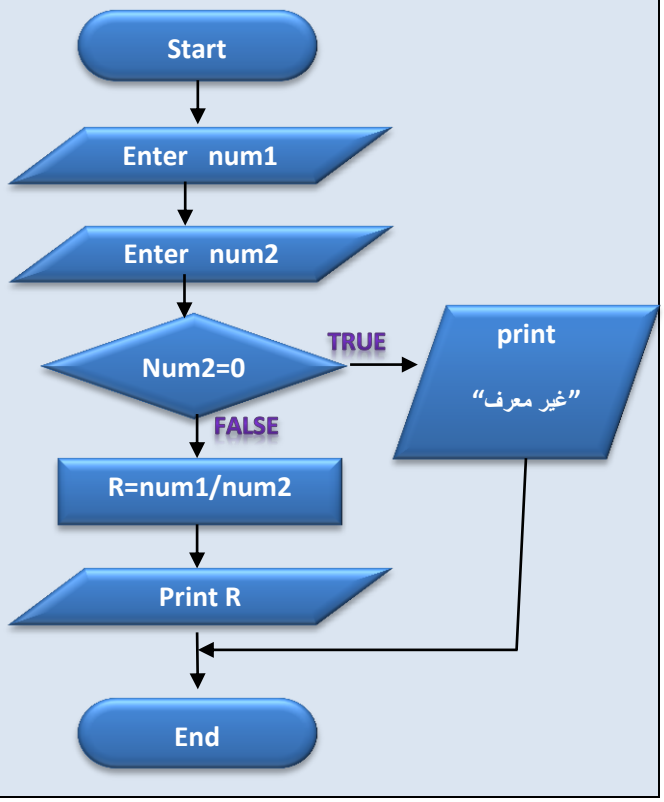
Second :Algorithm	Third :Flowchart
1 Start 2 Enter the dividend num1 3 Enter the divisor num2 4 If num2 =0 then 4-1 Print "غير معرف" 4-2 Go to step 7 5 R=num1/num2 6 Print R 7 End	

Table (1-6) Algorithm and Flowchart to print the division of two numbers

NOTICE

1. Step (4) is a decision (presented by a diamond) it is a comparison that evaluates this question (is num2=0?) If the result is Yes then the word " غير معرف"will be printed (this; according to mathematical rules); then the execution will be transferred to step (7) to end the program and prevent the execution of any division.
2. If the result of the question in (step 4) is No, the execution will be transferred to step (5) directly because step (4-1) and (4-2) won't be executed.

Exercise (1-6)

Draw a flowchart for a program that obtains a number from the user.

Determine the number type (even or odd) and print the result

First: Define the problem

Output: print the number type (even or odd).

Input: the number "N".

Solution: the even number is determined if the entered number is divisible by 2 without remainder, otherwise it will be odd.

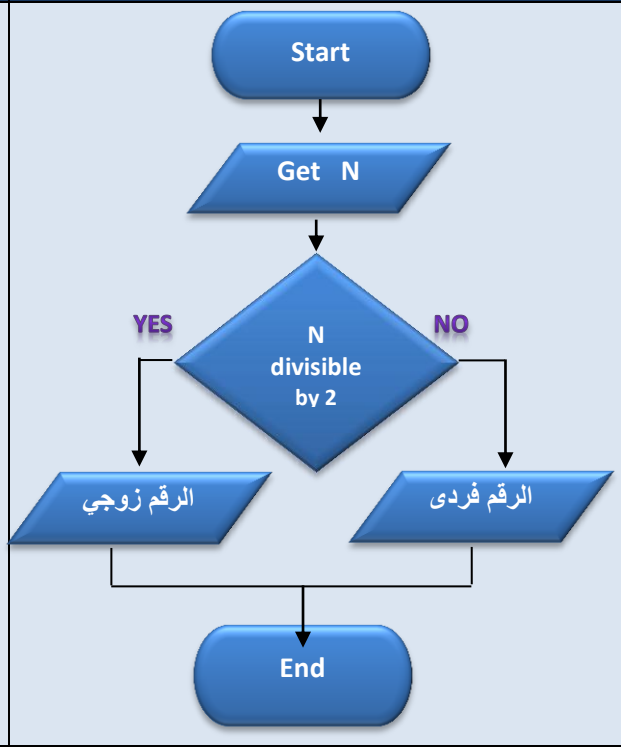
Second :Algorithm	Third :Flowchart
1 Start 2 Enter N 3 If N is divisible by 2 without remainder then 3-1 Print "الرقم زوجي" 4 Else 4-1 Print "الرقم فردى " 5 End	

Table (1-7) Algorithm and Flowchart to enter a number and print its type (odd or even)

NOTICE

In this example unlike the previous ones, there are two cases for the condition, the case when the condition is true (step 3-1); the output will be to print out "Even", the case when the condition is false (step 4-1); the output will be to print out "Odd".

Exercise (1-7)

Get a temperature degree from the user, and print out the following results "greater than zero" – "less than zero "– "equal zero".

First: Define the problem

Output: print out "greater than zero" – "less than zero "- "equal zero".

Input: degree Celsius "D".

Solution: the temperature degree entered will be compared to zero.

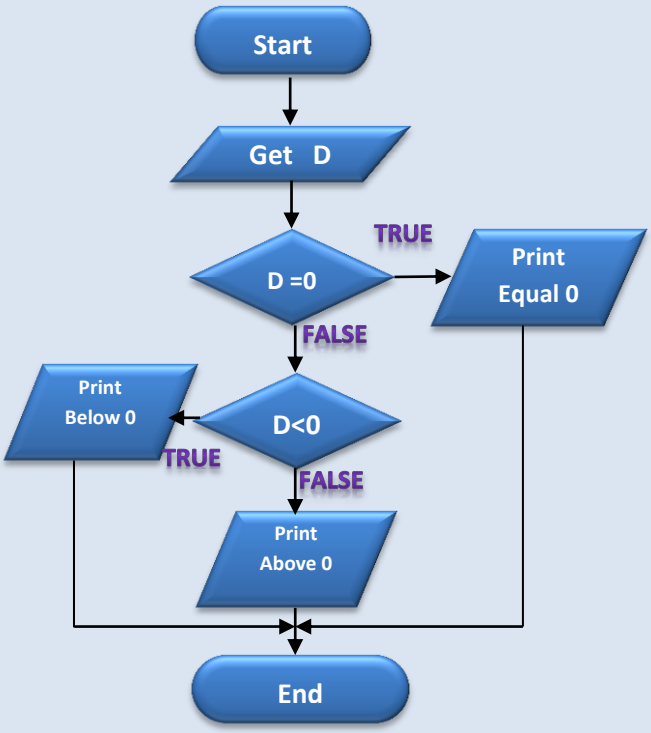
Second :Algorithm	Third :Flowchart
1 Start 2 Enter D (temperature degree) 3 If D=o then 3-1 Print "Equal zero" 4 Else 4-1 if D<0 then 4-1-1 Print "Below zero" 4-2 Else 4-2-1 Print "Above zero" 5 End	

Table (1-8) Algorithm and Flowchart to get the temperature

Activity (1–4)

Write down the Algorithm, and draw a flowchart to enter two numbers, then Print "the largest is …? "and, "the smallest number is…? ".

First: Define the problem

Output: print out "the largest number is ……? "– "the smaller number is ……? "

Input: X, Y.

Solution:

Second :Algorithm	Third :Flowchart

Activity (1–5)

The following flowchart is used to calculate the Area of a circle whose radius "R". Repeat drawing the Flowchart so that it displays the message "not allowed "and exits from the program (When the value of "R" is negative).

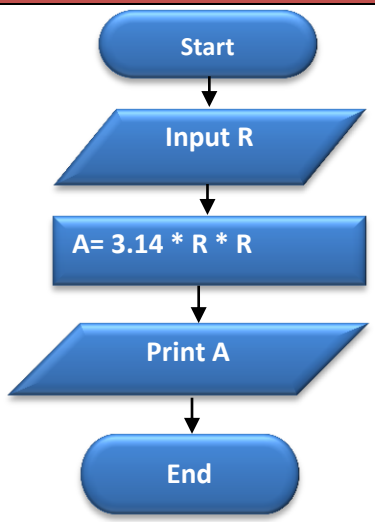
Flowchart	Modified Flowchart
	

Table (1-9) Flowchart to calculate the area of a circle

1–3–3 The use of Loop in Flowcharts

Exercise (1–8)

Print out the numbers from 1 to 3.

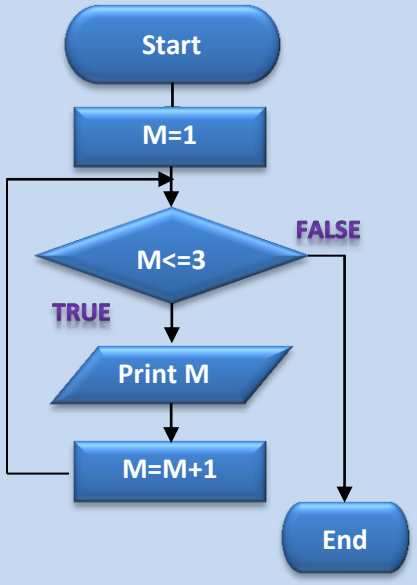
Second :Algorithm	Third :Flowchart
1 Start 2 M=1 3 If M<=3 then 3-1 Print M 3-2 M=M+1 3-3 Go To step(3) 4 End	

Table (1-10) Algorithm and Flowchart to print the numbers from 1 to 3

NOTICE

1-As long as the value of M does not exceed 3, the program prints value of M. When M becomes 4 ;(M=4) the program goes to step (4).

2- The following figure is the same flowchart drawn above but in a different way, so it does not matter the figure drawn, what really matters is the sequence of steps.

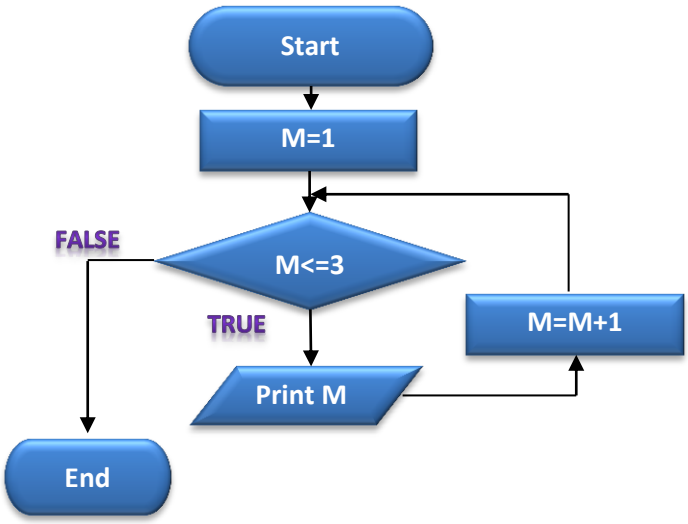


Figure (1-1) Flowchart to print the numbers from 1 to 3

You can track the progress of the solution steps and follow each step of the code as shown in table (1-11).

	Step	Result	value of M
	1-Start	There is No variable	
	2-M=1	1	
	3-If M<=3 (True)	1	
1	3-1 Print M	1	1
	3-2 M=M+1	2	
	3-3 Go to step (3)	2	
	3-If M<=3 (True)	2	
2	3-1 Print M	2	2
	3-2 M=M+1	3	
	3-3 Go to step (3)	3	
	3-If M<=3 (True)	3	
3	3-1 Print M	3	3
	3-2 M=M+1	4	
	3-3 Go to step (3)	4	
	3-If M<=3 (False)	4	
	4-End	4	

Table (1-11) Tracking the variables and the corresponding result of exercise (1-8)

How many times was the content of the loop executed? ……
What will be the value of M at the end of the loop? ……

NOTICE

1-When the value of M equals 4, the condition becomes (False).
2-We conclude that the number of repetition in the loop is pre known in this exercise.
3- The variable M is a counter; as it causes the steps (3-1) and (3-2) and (3-3) to be repeated for a defined number of times (3 times).

Exercise (1–9)

Modify the Flowchart of the previous exercise to print the multiplication table of No 3.

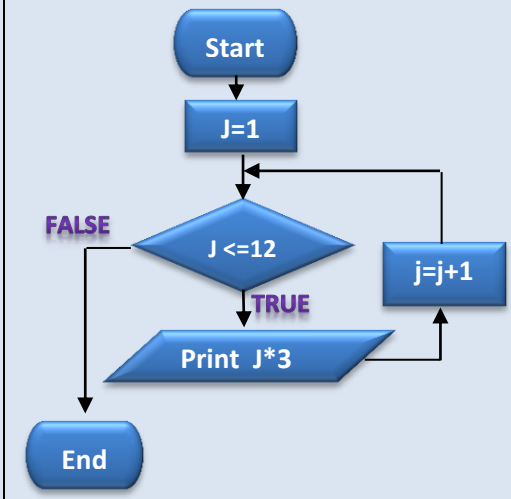
Second :Algorithm	Third :Flowchart
1 Start 2 J=1 3 If J <=12 then 3-1 Print J*3 3-2 J=J+1 3-3 Go To step(3) 4 End	

Table (1-12) Algorithm and Flowchart to print the multiplication table of No 3.

Compare this flowchart to the one in the previous exercise (what are the differences).

Activity (1–6)

Track the values of the variable (J), and the printed value on executing every step in the previous exercise (write down in your notebook).
What is the value of the variable (J), when the result of the condition is "False", and the loop ends?

Activity (1–7)

Make the necessary modifications to the Flowchart of the previous exercise, so that you can enter the required multiplication table; instead of printing the multiplication table of "3" constantly.

Algorithm	Flowchart
1 Start 2 Enter N 3 J=1 4 If J<=12 then 4-2 Print J*N 4-3 J=J+1 4-4 Go To step(4) 5 End	

Table (1-13) Algorithm to print the multiplication table of an entered number

Activity (1–8)

Write down the Algorithm, and draw a flowchart to print out even numbers from 1 to 10.

Second :Algorithm	Third :Flowchart

Exercise (1-10)

Print out the sum of integer numbers from 1 to 3.

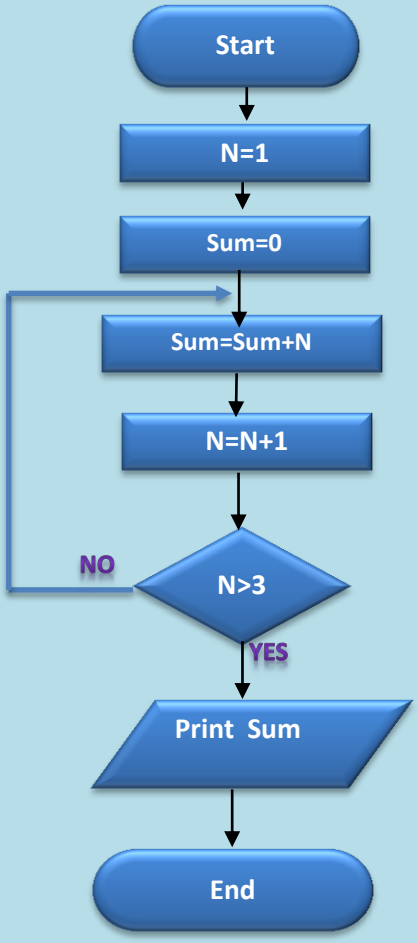
Algorithm	Flowchart
1 Start 2 N=1 3 Sum=0 4 Sum =Sum + N 5 N=N+1 6 If N>3 Then 6-1 Print Sum 7 Else 7-1 Go to step (4) 8 End	

Table (1-14) Algorithm and flowchart to print the sum of integer numbers from 1 to 3

You can track the values of variables as shown in table (1-15)

Step	Value of N	Value of M	Result
1-Start	No variable	No variable	
2-N=1	1	No variable	
3-Sum=0	1	0	
4-Sum=Sum+N	1	1	
5-N=N+1	2	1	
6-if N>3 (False)	2	1	
7-1 Go To step (4)	2	1	
4-Sum=Sum+N	2	3	
5-N=N+1	3	3	
6-if N>3 (False)	3	3	
7-1 Go To step (4)	3	3	
4-Sum=Sum+N	3	6	
5-N=N+1	4	6	
6-if N>3 (True)	4	6	
6-1 Print Sum	4	6	6

Table (1-15) tracking the values of variables and corresponding results of exercise (1-10)

NOTICE

Variable N is considered a Counter, while variable Sum is an accumulating variable.

Activity (1–9)

Draw the Flowchart of the previous exercise in your notebook, after modifying it; to print out the sum of odd numbers from 1 to 10.

Activity (1–10)

After executing the previous activity, draw the flowchart in your notebook; to print out the sum of even numbers instead of the odd ones.

Questions

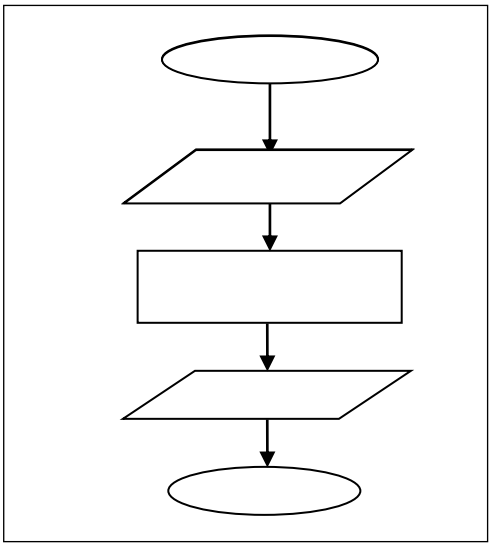
First: State whether the following statements are true (√) or false (X)

1- Flowcharts use symbols and lines with arrows to represent an Algorithm	( )
2- You can use any Geometric shape to represent Algorithms when drawing flowcharts	( )
3- Flowcharts can be drawn using software only and can't be drawn on paper	( )
4- The symbol ..  ....is used to represent both the start and the end	( )
5- The rectangle symbol represents only one processing operation	( )
6- The flow of steps will always be from top to bottom or from left to right.	( )
7- The symbol ..  .....is used when a question has more than one alternative	( )
8- Two paths (lines)should come out from the diamond ...  .....symbol	( )
9- The line with an arrow (flow line) should be from left to right or from top to bottom.	( )
10-The (Algorithm) is the first stage of Problem Solving	( )

Second: Inside each symbol of the following Flowcharts write the appropriate instructions.

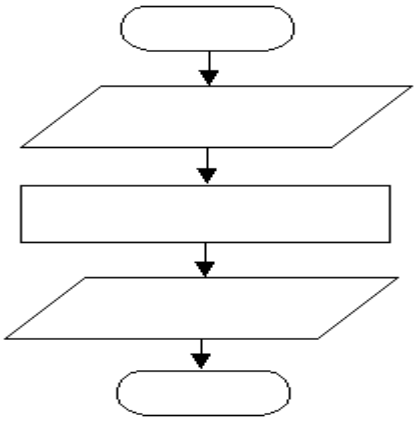
1- The Figure shows a flow chart for calculating the area and circumference for a circle ,given: the radius of the circle R

A= 3.14 * R * R C= 2 * 3.14 * R
START
END
OUTPUT A OUTPUT C
READ R



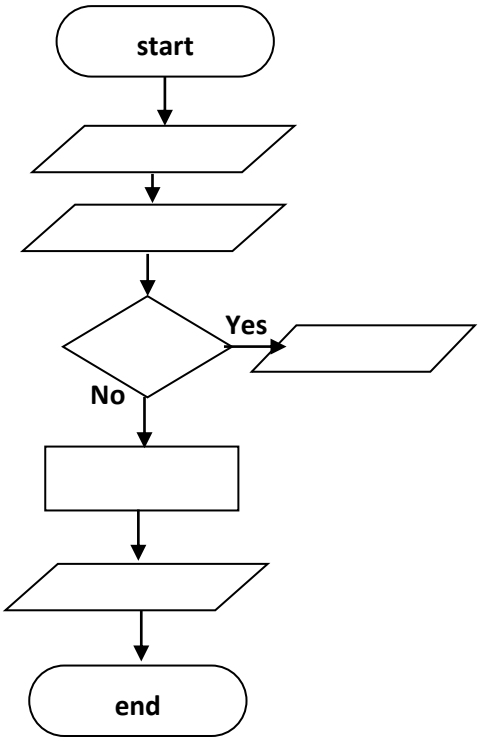
2- The Figure shows a flowchart that calculates the interest value for the balance (with fixed interest rate)

Interest=balance*rate
END
Read name , balance , rate
Output name,balance,interest
START



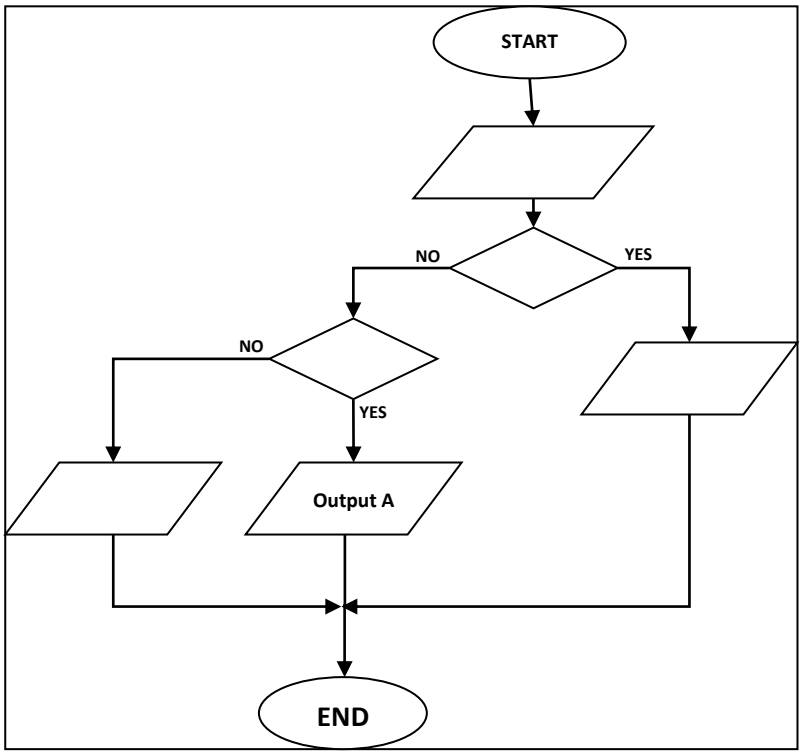
3- The Figure shows a flow chart for calculating the division of two numbers

Read number1
is number2=0
Print "not defined"
Start
End
Read number2
Output the result
result=number1/number2



4- The Figure shows a flow chart to find the maximum number among two numbers .In the case of equality output the message "equal"

IS A=B
IS A > B
Output "equal"
Read A,B
Output B



5- The Figure shows a flow chart that will print even integer numbers from 1 and 10 .

N=N+2
N>10
Sum=0
Sum=Sum+N
Print Sum
N=2