

Topic No.	Title	Page No.
1.1	Problem Solving Steps - Defining a problem - Understanding a Problem - Planning a solution - Defining a candid solution - Selecting the best solution	02
1.2	Flowcharts - Definitions - Importance of flowchart in problem solving - Determining the requirements for a flowchart - Flowchart symbols - Examples of flowcharts	10
1.3	Algorithms - Definition - Role of algorithms in problem solving - Formulation of an algorithms - Examples of algorithms - Efficiency of algorithms - Difference between an algorithm and a flowchart	21
1.4	Test Data - Importance of Testing - Types of test data	30
1.5	Verification and validation	33
1.6	Identification and correction of errors - Trace Table - Using invalid data for testing	34
*	Exercise - Long Questions - Choose the Correct Option (MCQs) - Fill in the Blanks - Flowcharts - Activity	39

1.1 PROBLEM SOLVING STEPS**LONG QUESTIONS**

Q.1 What is meant by 'defining a problem'? Write down different strategies to define a problem.

Ans: DEFINING A PROBLEM (K.B+U.B)

Definition:

A well-defined problem is the one that does not contain ambiguities. All the conditions are clearly specified and it has a clear goal. It is easy to understand and solve."

Explanation:

Given a problem statement, first we need to see whether the problem is defined well or not.

If the problem is not defined well then we can use one of the following strategies to define the problem:

- Gain Background knowledge
- Use Guesses
- Draw a Picture

Gain Background Knowledge:

We try to know the situation and circumstances in which the problem is happening. In this way, we can identify the given state. It also helps to know what a good solution will look like. How we shall be able to measure the solution.

Use Guesses:

We try to guess the unknown information through appropriate guesses. These guesses may be based upon our past experiences.

Draw a Picture:

If the problem is not well-defined, we can draw a picture and fill the undefined information.

Q.2 Define problem analysis. Explain your answer along with an example. (Ex. Q-2) (K.B+A.B)

Ans: PROBLEM ANALYSIS

Definition:

Problem analysis is the process to figure out 5 W's (what, who, when, where, and why) from a problem statement. Problem analysis helps to understand a given problem. These are the basic elements which lead towards the solution of a given problem.

Understanding a Problem:

It is important to understand the problem before jumping into the solution of the problem. For example, a riddle or a puzzle can be answered only after clear understanding.

A clear understanding of a problem makes it easier to solve and helps to save money, time and resources.

Example:

Consider the following problem statement:

"Suppose your class teacher assigns you a task to prepare a list of students in your school whose names start with letter 'A'. The list is required in order to prepare an alphabetical directory of all school students and there is only one week to complete the task."

We can analyse this problem by identifying 5Ws in the problem statement as given below:

- **What:** List of students' names starting with letter 'A'.

- **Who:** Students.
- **Why:** To prepare the directory of students.
- **When:** Within a week.
- **Where:** School.

Metaphorical Representation:

The following figure shows the metaphorical representation of problem where the red light presents a problem, the yellow light represents its analysis and the green light presents the solution. It shows that problem analysis makes us closer to a solution.



Fig: From problem to solution

Q.3 Write down different strategies for planning a solution. How can we select best strategy for a solution? (K.B+U.B)

Ans:

PLANNING A SOLUTION

After analyzing a problem, we formulate a plan that may lead us towards the solution of a problem.

Strategies:

This phase includes finding the right strategy for problem solving. Some of the strategies are:

- Divide and Conquer
- Guess, Check and Improve
- Act it Out
- Prototype (Draw)

Divide and Conquer:

This strategy divides a complex problem into smaller problems.

Guess, Check and Improve:

The designer guesses a solution to a problem and then checks the correctness of the solution. If the solution is not according to expectations, then he/she refines the solution. The refinement is an iterative process.

Act it Out:

In this strategy the designer defines the list of "to-do" tasks. Afterwards he/she performs the task.

Prototype (Draw):

This technique draws a pictorial representation of the solution. It is not the final solution. However, it may help a designer to understand the important components of the solution.

SELECT A BEST STRATEGY

The selection of a strategy depends upon the problem. It is quite important that one strategy maybe more suitable to implement a solution than the other one. Very specifically, the selection of the strategy depends upon the nature of a problem.

Q.4 What is meant by candid solutions? Explain with an example. (K.B+U.B+A.B)

Ans:

CANDID SOLUTIONS

Candid and Candid Solution:

The word candid refers to something spontaneous and unplanned. The solution which you think is a candid solution. It is not necessary that the candid solution is the actual solution of a problem.

Example:

If you are asked to find number of students in your school who can play cricket. You can estimate by finding cricket players in your class and then multiplying it by the total number of classes in your school. Your answer in this way is the candid solution. To find exact number of cricket players, you have to opt some other way, like visiting each class or getting data from teachers. One can think of a candid solution anytime. A candid solution can help to save time.

The following figure, there are different ways shown to reach a certain place (which can be reached either by going across the wall or by going sideways) and the one you think can work, is the candid solution. It is not necessary that the candid solution is the actual solution of a problem.

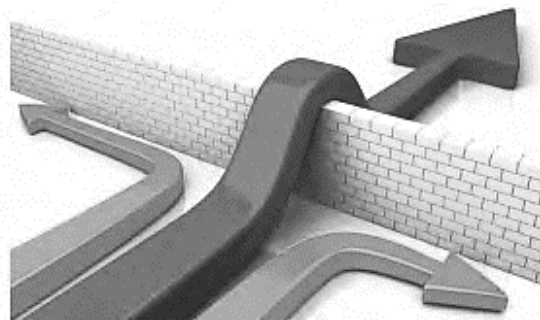


Figure: Multiple solutions of a problem

Q.5 How can we select the best solution of a problem? Explain.

(K.B+U.B)

Ans:

SELECTING THE BEST SOLUTION

Sometimes we find more than one solution of a problem and select the best one amongst them.

Example:

Assume that names of all the students in your school are available on a website and you are asked to search a particular name. You can solve this search problem by either of the following methods:

- Look at each name on the website one by one until the name is found or the list is over.
- Take printouts and search the required name.
- Copy names, put them in Excel sheet and sort them in alphabetical order. Searching in a sorted list is comparatively easy.
- Just press Ctrl + F, when the list is available in a web browser. You can type the name to search automatically.

There can be other solutions as well. Now we can identify a solution that has less number of steps or that seems more effective based on some criteria.

Following figure describe the levels of solution:



Figure: Levels of a solution

SHORT QUESTIONS

Q.1 Define problem solving. Enlist different steps of problem-solving process. (K.B)

Ans:

PROBLEM SOLVING**Definition:**

Problem solving is a systematic approach that we can follow to solve a problem systematically.

Problem Solving Steps:

Problem solving steps are as follows:

- Defining a Problem
- Understanding a Problem
- Planning a Solution
- Defining Candid Solutions
- Selecting the Best Solution

Q.2 What is meant by defining a problem? (K.B)

Ans:

DEFINING A PROBLEM**Definition:**

A well-defined problem is the one that does not contain ambiguities. All the conditions are clearly specified and it has a clear goal. It is easy to understand and solve.

Q.3 Describe some strategies to define a problem. (K.B)

Ans:

STRATEGIES TO DEFINE A PROBLEM

If the problem is not defined well then we can use one of the following strategies to define the problem.

- Gain Background knowledge
- Use Guesses
- Draw a Picture

Q.4 Why we draw a picture of a problem? (U.B)

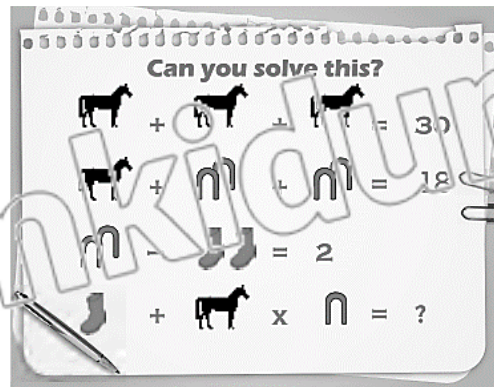
Ans:**DRAW A PICTURE**

‘Draw a picture’ is a strategy to define the problem. If the problem is not well-defined, we can draw a picture and fill the undefined information.

Pictorial representation of a problem is a best and easy way to define the problem.

Q.5 Solve the following problem.

(A.B)



Ans:

SOLUTION**Method 1:**

Can you solve this?	Assume values to make a total
+ + = 30	10 + 10 + 10 = 30
+ + = 18	10 + 4 + 4 = 18
- = 2	4 - 2 = 2
+ x = ?	1 + 10 x 2 = 21

Method 2:

$$\begin{aligned}
 \text{Horse} + \text{Horse} + \text{Horse} &= 30 \rightarrow \text{condition 1} \\
 \text{Horse} + \text{Horseshoe} + \text{Horseshoe} &= 18 \rightarrow \text{condition 2} \\
 \text{Horseshoe} - \text{Boot} &= 2 \rightarrow \text{condition 3} \\
 \text{Boot} + \text{Horse} \times \text{Horseshoe} &= ? \rightarrow \text{condition 4}
 \end{aligned}$$

Let pictures

$$\text{Horse} = x$$

$$\text{Horseshoe} = y$$

$$\text{Boot} = z$$

According to condition 1

$$\begin{aligned}
 x + x + x &= 30 \\
 3x &= 30 \\
 x &= 10
 \end{aligned}$$

According to condition 2

$$\begin{aligned}
 x + y + y &= 18 \\
 x + 2y &= 18 \\
 \text{put } x &= 10 \\
 10 + 2y &= 18 \\
 2y &= 18 - 10 \\
 2y &= 8 \\
 y &= 4
 \end{aligned}$$

According to condition 3

$$\begin{aligned}
 y - z &= 2 \\
 \text{put } y &= 4 \\
 4 - z &= 2 \\
 -z &= 2 - 4 \\
 -z &= -2 \\
 z &= 2
 \end{aligned}$$

According to condition 4

$$a = \frac{z}{2} = \frac{2}{2} = 1$$

$$b = \frac{y}{2} = \frac{4}{2} = 2$$

$$\begin{aligned}
 a + x \times b &= 1 + 10 \times 2 \\
 &= 1 + 20 \\
 &= 21
 \end{aligned}$$

Q.6 What is the importance of understanding a problem? (K.B)

Ans: UNDERSTANDING A PROBLEM

It is very important to understand the problem before jumping into the solution of the problem because no one can solve the problem without understanding it. A clear understanding of a problem makes it easier to solve and helps to save money, time and resources.

Example:

A riddle or a puzzle can be answered only after clear understanding.

Q.7 Define problem analysis. (K.B)

Ans: PROBLEM ANALYSIS

Definition:

Problem analysis is the process to figure out 5 W's (what, who, when, where, and why) from a problem statement. Problem analysis helps to understand a given problem. These are the basic elements which lead towards the solution of a given problem.

Q.8 What is meant by planning a solution? Name some strategies for planning a solution. (K.B)

Ans: PLANNING A SOLUTION

Definition:

After analyzing a problem, we formulate a plan that may lead us towards the solution of a problem. This phase includes finding the right strategy for problem solving.

STRATEGIES FOR PLANNING A SOLUTION

Some of the strategies for planning a solution are:

- Divide and Conquer
- Guess, Check and Improve
- Act it Out
- Prototype (Draw)

Q.9 Define divide and conquer. (K.B)

Ans: DIVIDE AND CONQUER

Definition:

It is a strategy for planning a solution. In this strategy, divides a complex problem into smaller problems.

Q.10 What is meant by prototype? (K.B)

Ans: PROTOTYPE

Definition:

It is a strategy for planning a solution. This technique draws a pictorial representation of the solution. It is not the final solution. However, it may help a designer to understand the important components of the solution.

Q.11 How can we select best strategy for planning a solution? (K.B+U.B)

Ans: SELECTION

The selection of a strategy depends upon the problem. It is quite important that one strategy maybe more suitable to implement a solution than the other one. Very specifically, the selection of the strategy depends upon the nature of a problem.

Q.12 What is candid and candid solutions? (K.B)

Ans: CANDID AND CANDID SOLUTIONS

The word candid refers to something spontaneous and unplanned. There are multiple solutions for a problem. The one you think can work, is the candid solution. It is not necessary that the candid solution is the actual solution of a problem.

MULTIPLE CHOICE QUESTIONS

1. **Problem solving is the process of solving _____.** (U.B)
 (A) Simple Problems (B) Language problems
 (C) Mathematical Problems (D) Complex Problems
2. **Steps of problem solving:** (K.B)
 (A) 4 (B) 5 (C) 6 (D) 7
3. **The first step of problem-solving method is:** (K.B)
 (A) Defining a problem (B) Understanding a problem
 (C) Planning a solution (D) Defining candid solutions
4. **The last step of problem-solving method is:** (K.B)
 (A) Defining a problem (B) Understanding a problem
 (C) Selecting the best solution (D) Defining candid solutions
5. **Gain Background Knowledge is a strategy of:** (U.B)
 (A) Defining a problem (B) Understanding a problem
 (C) Selecting the best solution (D) Defining candid solutions
6. **Use guesses and draw a picture is a strategy of:** (U.B)
 (A) Defining a problem (B) Understanding a problem
 (C) Selecting the best solution (D) Defining candid solutions
7. **Albert Einstein said, "If I were given one hour to save the planet, I would spend _____ minutes defining the problem and _____ minute resolving it".:** (K.B)
 (A) 30, 30 (B) 40, 20 (C) 59, 1 (D) 20, 40
8. **5 Ws are the part of which step?** (K.B)
 (A) Defining a problem (B) Understanding a problem
 (C) Selecting the best solution (D) Defining candid solutions
9. **Divide and Conquer rule is a part of:** (K.B)
 (A) Defining a problem (B) Planning a solution
 (C) Selecting the best solution (D) Defining candid solutions
10. **This strategy divides a complex problem divides into smaller problems:** (K.B+U.B)
 (A) Divide and Conquer rule (B) Prototype
 (C) Guesses (D) Candid solutions
11. **Prototype means:** (K.B)
 (A) Selecting the best solution (B) Planning a solution
 (C) Draw pictorial representation of a solution (D) Defining candid solutions
12. **Defines a list of "to-do" task means:** (K.B)
 (A) Prototype (B) Act it out (C) Divide and Conquer (D) Candid solution
13. **The word _____ refers to something spontaneous and unplanned.** (K.B+U.B)
 (A) Problem (B) Best (C) Select (D) Candid
14. **Mark this statement: "Candid solution is the actual solution of a problem."** (K.B+U.B)
 (A) Sometimes True (B) Sometimes False (C) Both A and B (D) None of these
15. **There can be _____ solution of a problem.** (K.B)
 (A) Only one (B) Exactly three (C) Many (D) Only four

ACTIVITY QUESTIONS**Activity 1.1 (A.B)**

Students are put in groups of two or three, and each group is provided two different lists of students' names.

One list contains the marks of students in mathematics subject while the other list is for physics subject. Each group is supposed to prepare the following lists.

- a) Top 5% students in mathematics.
 - b) Top 5% students in physics.
 - c) Students having more than 90% marks in both subjects.
- Identify 5Ws for this problem.

SOLUTION

We can analyse the above problem by identifying 5Ws in the problem statement as given below:

- **What:** List of marks of students in two subjects physics and mathematics.
- **Who:** Students.
- **Why:** To prepare the marks list in descending order (top marks to bottom marks) and to identify top 5% students of both subject and students having more than 90% marks in both subjects.
- **When:** Within a class time. (Approx 40 minutes)
- **Where:** School.

Activity 1.2 (A.B)

Your task is to find average height of your class fellows. Give a candid answer and also the method to find the exact solution.

One method is to use a measuring tape. Mark the height on the tape and then read the exact measurement from the tape. After recording the height of every student, you can calculate the average height of all the students in your classroom.

Or you can even find out the candid height of a student through some object of known height, like a book. Let's say that the height of your textbook is 8cm. You can mark the height of the book on a wall. Using the book several times, you can make a scale with intervals of 8cm. Then, by standing next to the wall you can get a candid solution to the student's height.

SOLUTION**Method 1: (Candid Answer)**

We can find out the candid height of a student through some object of known height, like a book. Let's say that the height of textbook is 8cm. You can mark the height of the book on a wall. Using the book several times, you can make a scale with intervals of 8cm. Then, by standing next to the wall we can get a candid solution to the student's height.

Suppose there are 30 students in a class. We use a book or scale to mark on the wall and then make three to four students stand against the wall and measure their height. The measurement of heights of these students are 5'4", 5'3", 5'5" and 5'6". According to these measurements we assume that average of all boys in the class is 5'5". This is a candid solution.

Candid solution: 5'5"

Method 2: (Exact Solution)

To find out the exact solution, we use a measuring tape.

Suppose there are only three students in a class. Mark the height on the tape and then read the exact measurement from the tape.

Student	Height
1	5'4"
2	5'8"
3	5'6"
Total	16'6"

After recording the height of every student, we calculate the average height of all the students in classroom by the following formula:

$$\text{Average height} = \frac{\text{Sum of height}}{\text{Number of Students}} = \frac{16'6''}{3} = 5'6''$$

So, the exact solution: 5'6"

Note: we can calculate exact height of 30 students by applying the same technique.

1.2 FLOWCHARTS

LONG QUESTIONS

Q.1 Define flowchart. Write the importance of flowchart in problem solving. (K.B+U.B)

Ans:

FLOWCHARTS

Definition:

A flowchart is a graphical presentation of the steps to solve a problem.

IMPORTANCE OF FLOWCHARTS IN PROBLEM SOLVING

The importance of flowchart are as follows:

- Flowcharts are helpful to know about the steps used to solve a problem.
- We use symbols for each step, and these symbols are connected with the help of arrows to show the flow of processing.
- In problem solving, flowcharts can be used to plan a solution.
- If a flowchart is already there, we can quickly understand the way a problem is solved.
- It is more effective to visualize a solution graphically than a text.
- A graphical representation also makes it effective to verify whether a solution is correct or not.
- It is also a good way to communicate the solution of a problem to other people.

Q.2 How do you determine requirement for a flowchart. (Ex Q.5) (U.B)

Ans:

REQUIREMENTS FOR A FLOWCHART

In a flowchart we use input, output, decision making and processing:

- **Inputs:** Input means taking data from the user. It is important to know; how many and what type of inputs are required.
- **Processing:** A flowchart also contains processing steps. The processing steps are used for performing calculations and storing the results of calculations. These may include increasing/decreasing a value, adding/multiplying/dividing two values etc.
- **Decision Making:** To determine whether a statement is true or false, and taking appropriate steps accordingly, is called decision making.
- **Outputs:** Outputs are used to display information and usually this information exhibits the processed results.

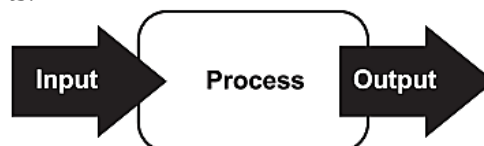


Figure: Flow from input to output

Q.3 Write a note on flowchart symbols.

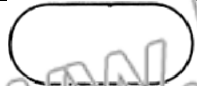
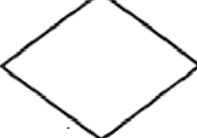
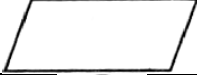
(K.B+U.B)

Ans:

FLOWCHART SYMBOLS

Flowcharts explain a process clearly through symbols and text. They use special shapes to represent different types of actions or steps in a process.

Some widely used symbols in flowcharts are as follows:

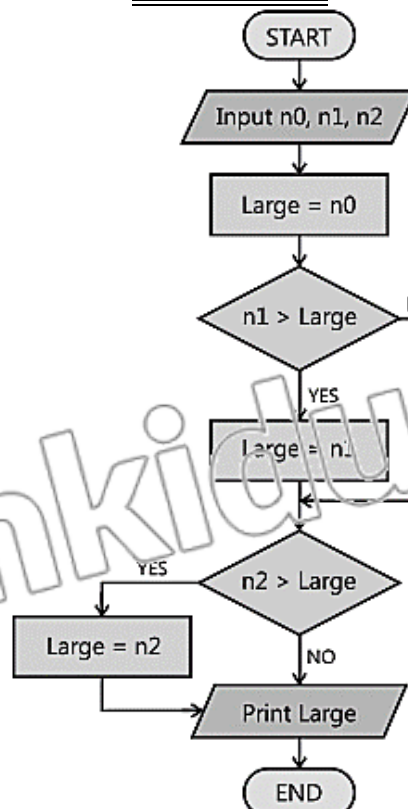
Symbol	Name	Description
→	Flow line	It is used to determine the flow of steps in a flowchart.
	Terminal	It indicates start and end of a flowchart.
	Process	It represents operations to change values.
	Decision	It shows a conditional operation that determines which one of the two paths to take. The operation is commonly a yes/no question or a true/false test.
	Input / Output	It indicates the input of data from user or displaying results to user.
	Connector	If a flowchart doesn't fit on a page, then we use connector to connect parts of a flowchart on different pages.

Q.4 Draw a flowchart to display the larger one out of the three given unequal numbers.

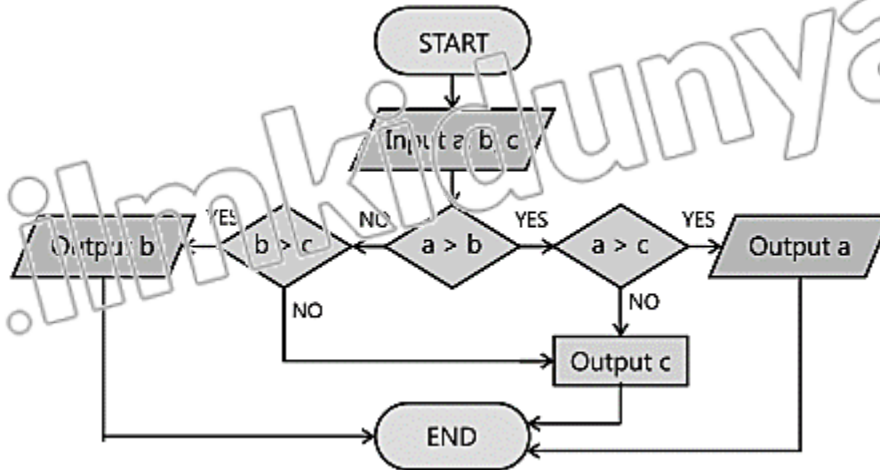
(A.B)

Ans:

FLOWCHART



Following flowchart shows another solution to find a maximum value among three number a, b and c .

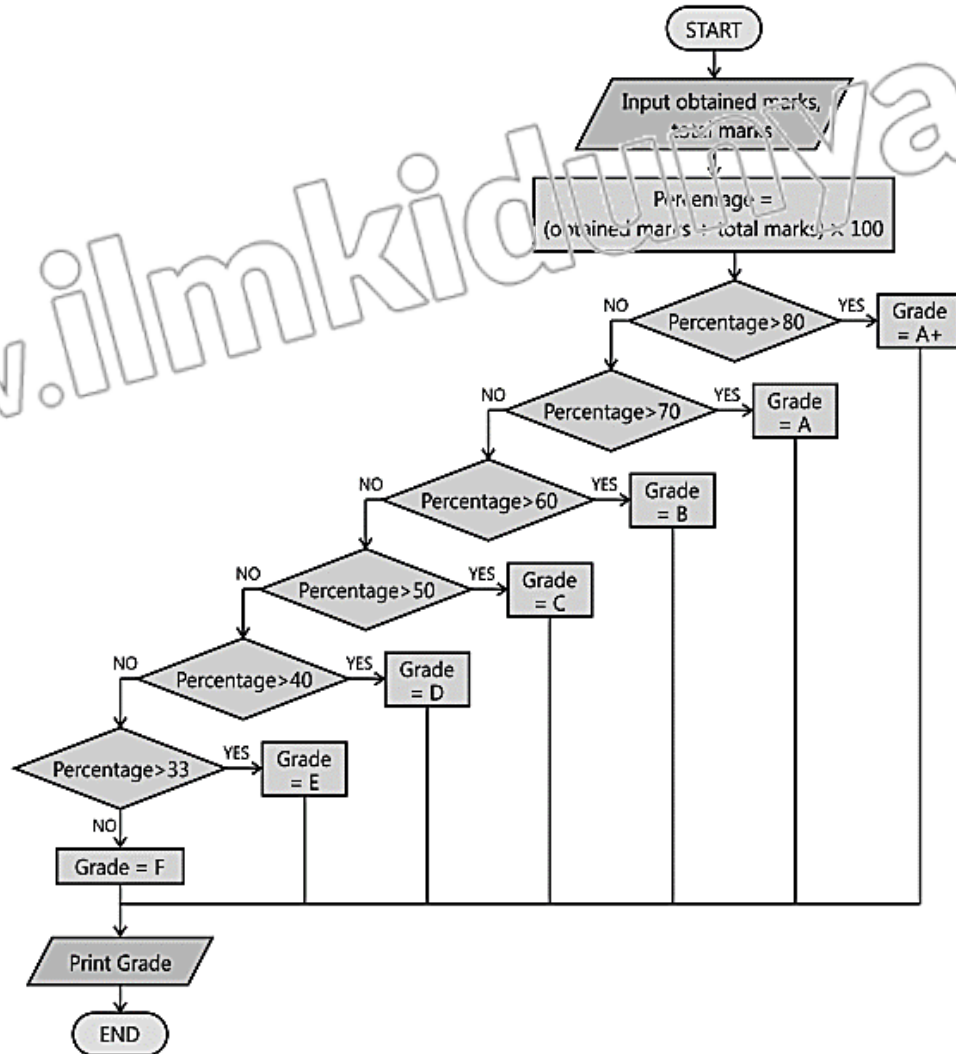


Q.5 Draw a flowchart to assign grade to a subject based on total marks and obtained marks.

(A.B)

Ans:

FLOWCHART

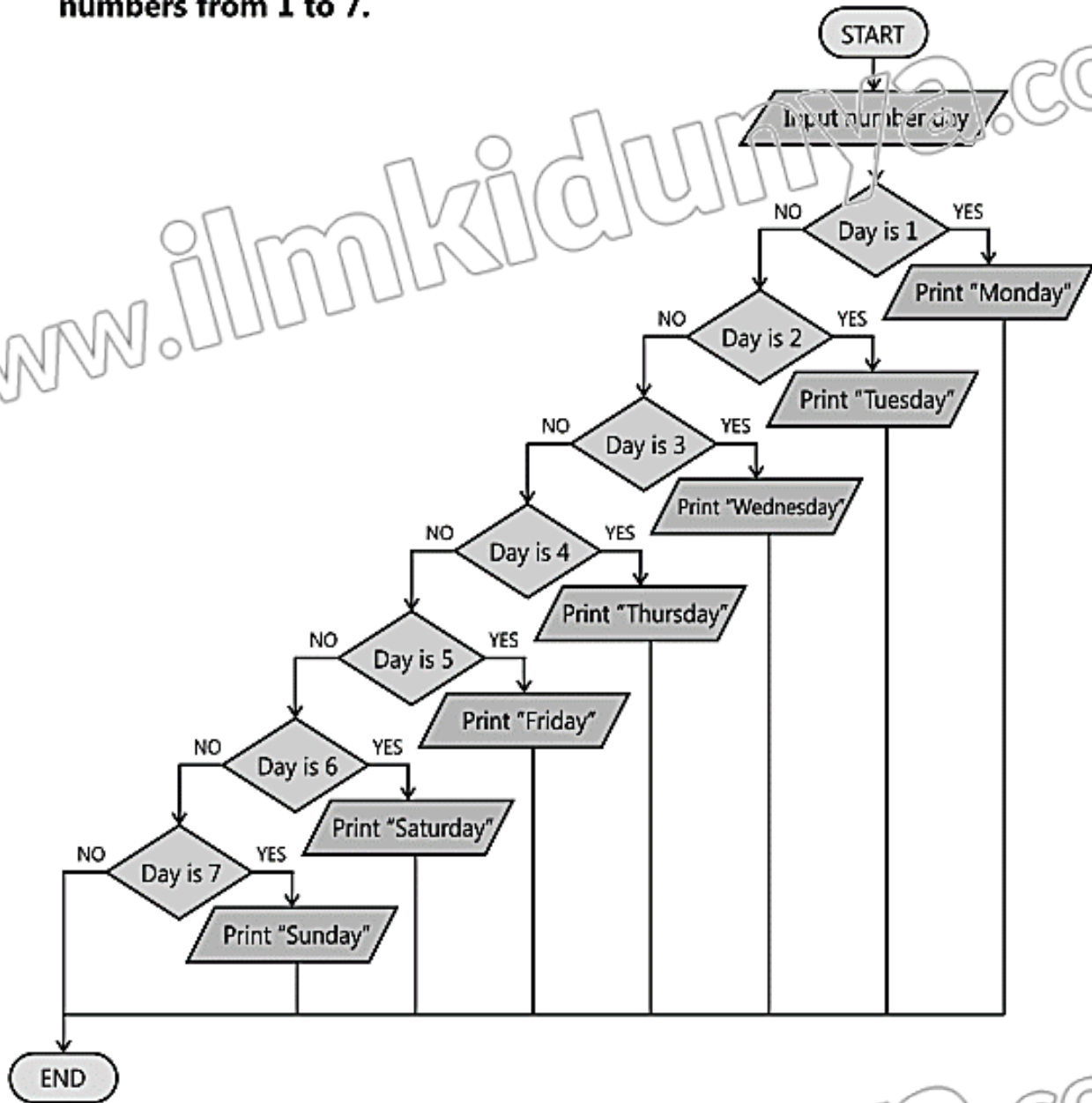


Q.6 Draw a flowchart to determine name of a week day from a given number where weekdays are assumed from Monday to Sunday and their respective. (A.B)

Ans:

FLOWCHART

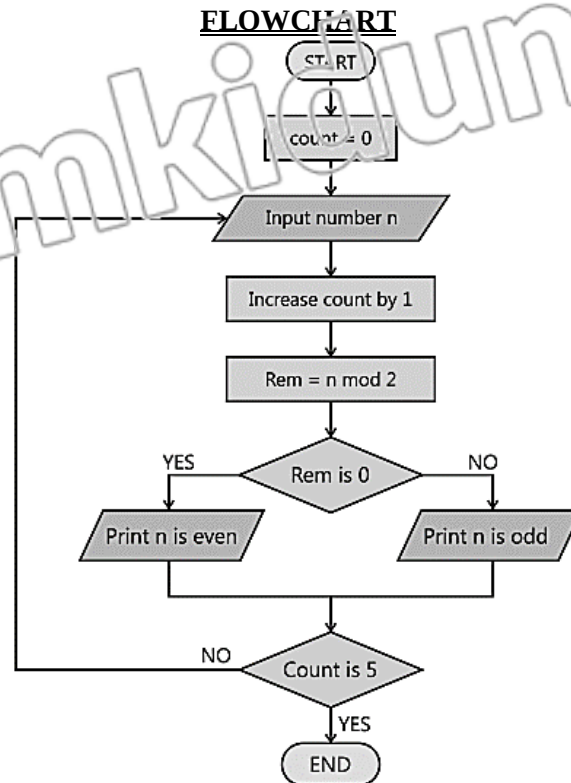
numbers from 1 to 7.



Q.7 Draw a flowchart to input 5 value one by one and determine if the given value is odd or even.

(A.3)

Ans:



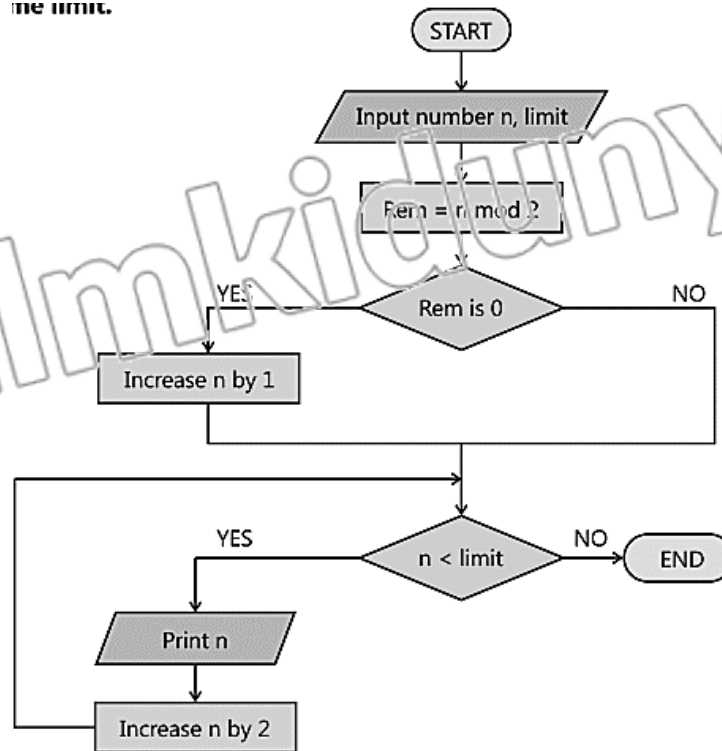
Q.8 Draw a flowchart to find a sequence of odd numbers starting from a given number till some limit.

(A.B)

Ans:

FLOWCHART

no limit.



SHORT QUESTIONS

Q.1 Define flowchart.

(K.B)

Ans:

FLOWCHART

Definition:

A flowchart is a graphical presentation of the steps to solve a problem.

Q.2 What is the importance of flowchart?

(K.B)

Ans:

IMPORTANCE OF FLOWCHART

The importance of flowchart are as follows:

- Flowcharts are helpful to know about the steps used to solve a problem.
- In problem solving, flowcharts can be used to plan a solution.

Q.3 What is meant by input/output?

(K.B)

Ans:

INPUT/OUTPUT

Input/Output:

It indicates the input of data from user or displaying results to user.

Q.4 What is meant by processing in flowchart?

(K.B)

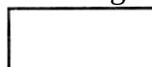
Ans:

PROCESSING

A flowchart also contains processing steps. The processing steps are used for performing calculations and storing the results of calculations. These may include increasing / decreasing a value, adding / multiplying / dividing two values etc.

Symbol:

The following symbol is used for processing.



Q.5 What is the purpose of  symbol?

(K.B)

Ans:

DECISION MAKING

The purpose of  symbol to determine whether a statement is true or false, and

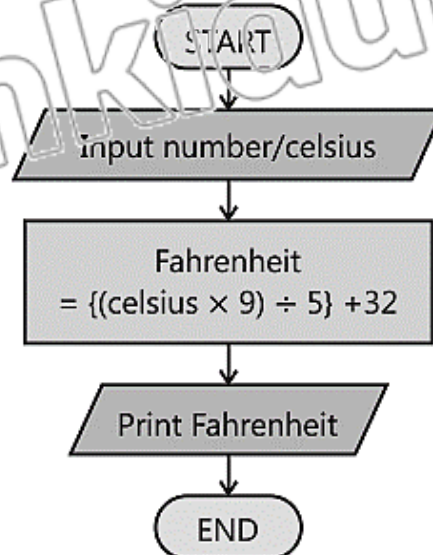
taking appropriate steps accordingly. it is called decision making symbol.

It shows a conditional operation that determines which one of the two paths to take. The operation is commonly a yes/no question or a true/false test.

Q.6 Draw a flowchart to convert Celsius to Fahrenheit temperature (A.B)

Ans:

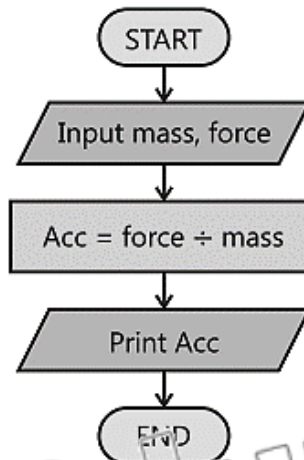
FLOWCHART



Q.7 Draw a flowchart to find acceleration of a moving object with given mass and force applied. (A.B)

Ans:

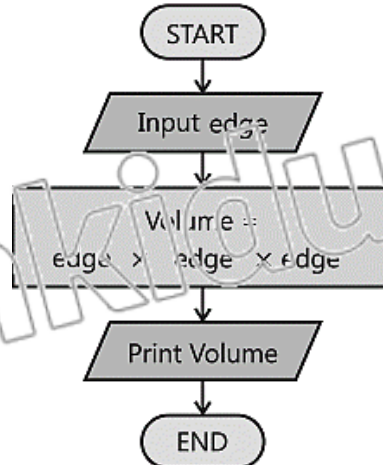
FLOWCHART



Q.8 Draw a flowchart to find the volume of a cube. (A.B)

Ans:

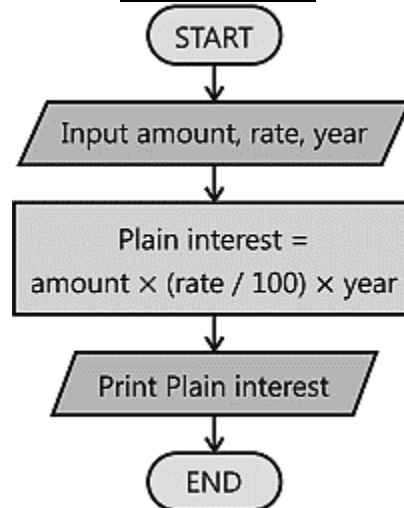
FLOWCHART



Q.9 Draw a flowchart to find plain the interest on an amount. (A.B)

Ans:

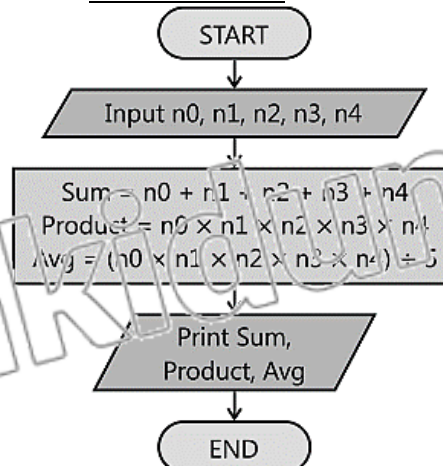
FLOWCHART



Q.10 Draw a flowchart to find the sum, product and average of five given numbers. (A.B)

Ans:

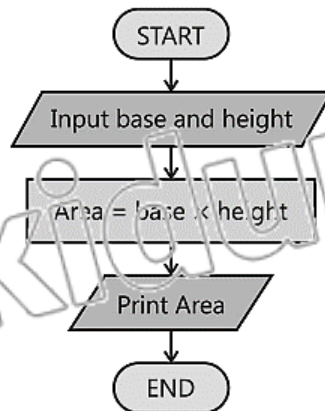
FLOWCHART



Q.11 Draw a flowchart to find the area of a parallelogram. (A.B)

Ans:

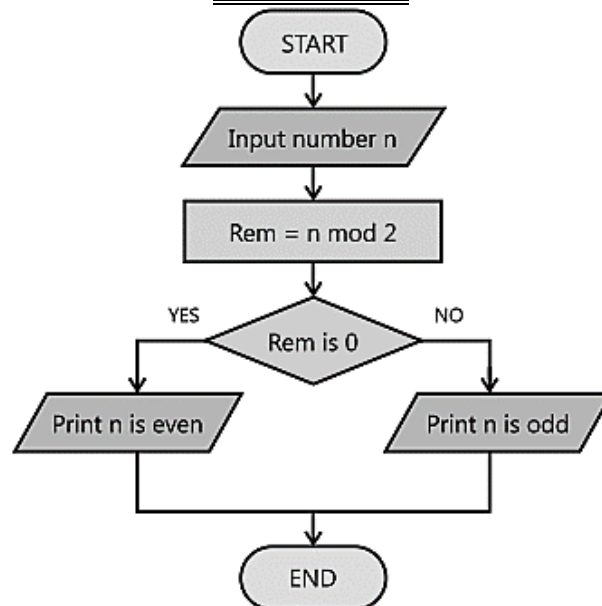
FLOWCHART



Q.12 Draw a flowchart to determine whether a given number is odd or even. (A.B)

Ans:

FLOWCHART



MULTIPLE CHOICE QUESTIONS

- Pictorial representation of the steps to solve a problem is: (K.B)
 (A) Algorithm (B) Flowchart (C) Map (D) design document
- Flowcharts are designed with the help of: (K.B)
 (A) Symbols (B) Picture (C) Lines (D) None of these
- ◇ Symbol of flowchart represents: (K.B)
 (A) Processing (B) Decision making (C) Computation (D) Calculation
- A symbol used in flow chart for both input and output functions: (K.B+U.B)
 (A) Parallelogram (B) Rectangle (C) Diamond (D) Oval
- Flow lines is denoted by symbol: (K.B+U.B)

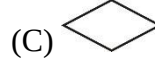
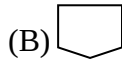
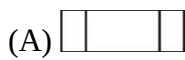
(A) →

(B) ○

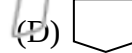
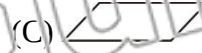
(C) ┌

(D) ◇

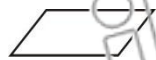
6. Symbol of processing is: (K.B)



7. _____ is symbol is used to start/end the program. (K.B)



8. _____ symbol represent in flowchart: (K.B)



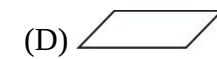
(A) Processing

(B) Input/Output

(C) Connector

(D) branching

9. _____ symbol used to show connection in flowchart: (K.B)



10. The rectangle symbol in flowchart indicates: (K.B+U.B)

(A) Processing

(B) Condition

(C) Input

(D) Output

11. In a flow chart parallelogram symbol represents: (K.B+U.B)

(A) Decision making

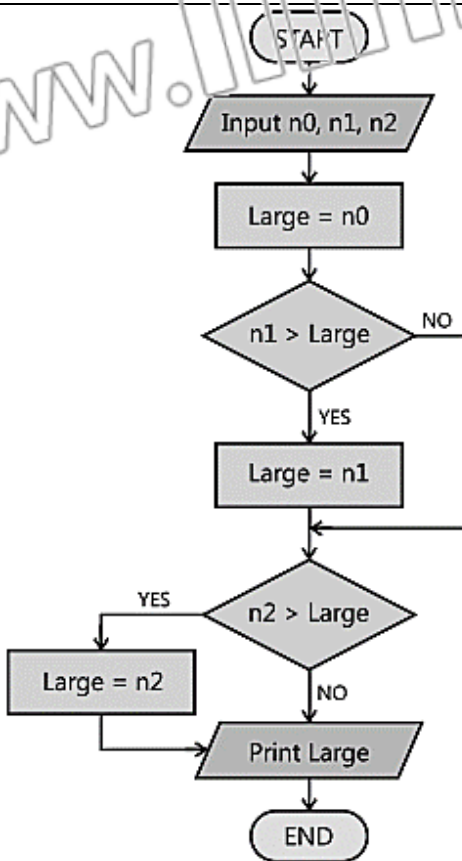
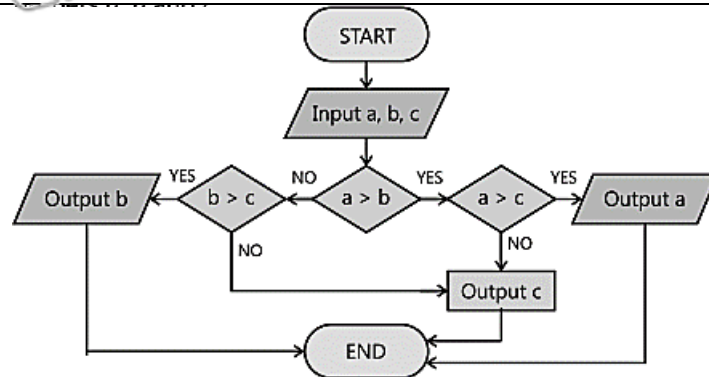
(B) Input/Output

(C) Remarks

(D) Processing

ACTIVITY QUESTIONS**Activity 1.3 (A.B)**

Investigate both the approaches presented to find a maximum value among three numbers and compare them. Which approach has advantage(s) over the other? Write your findings and discuss with your class teacher.

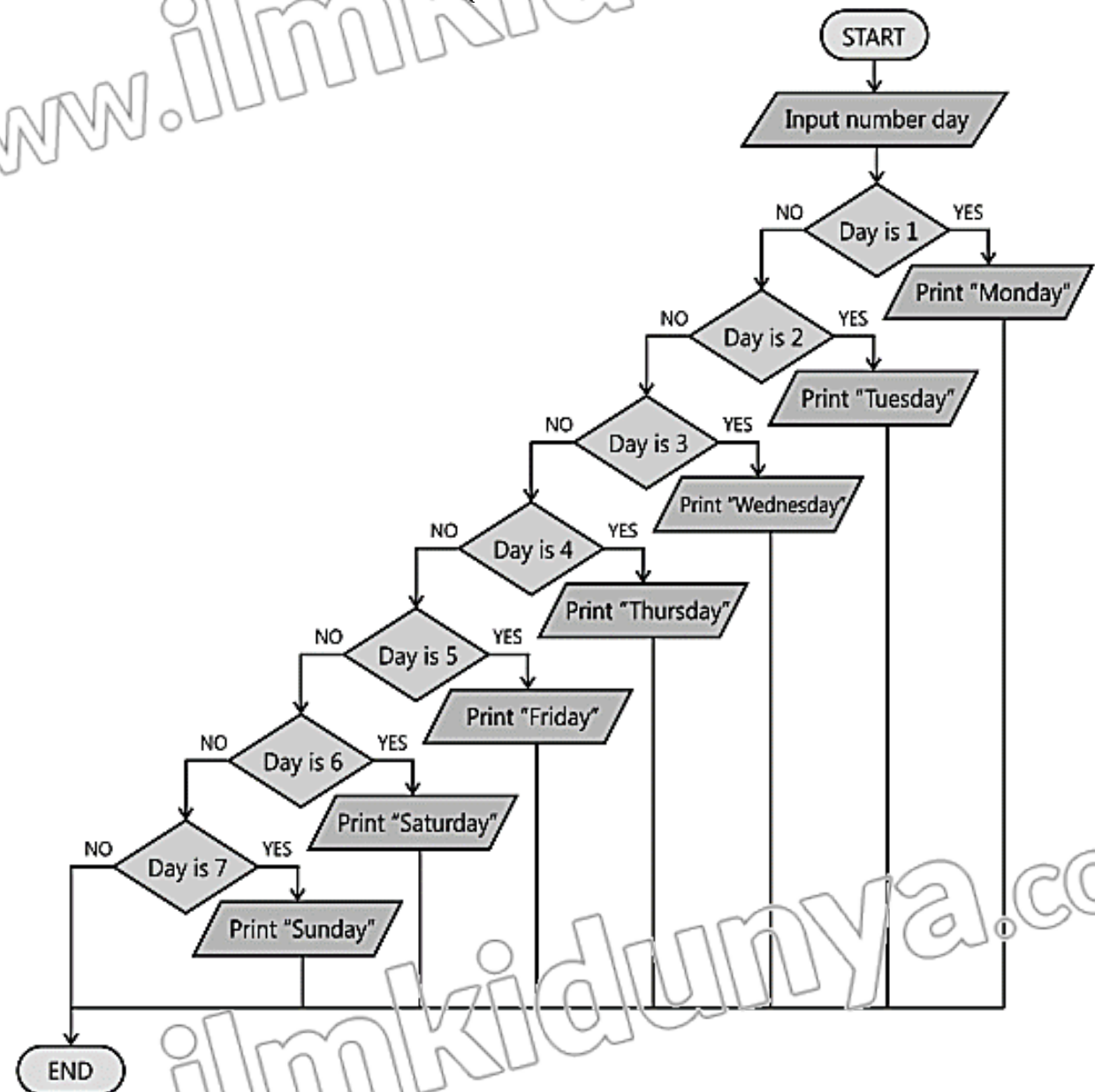
Flowchart 1**Flowchart 2****SOLUTION**

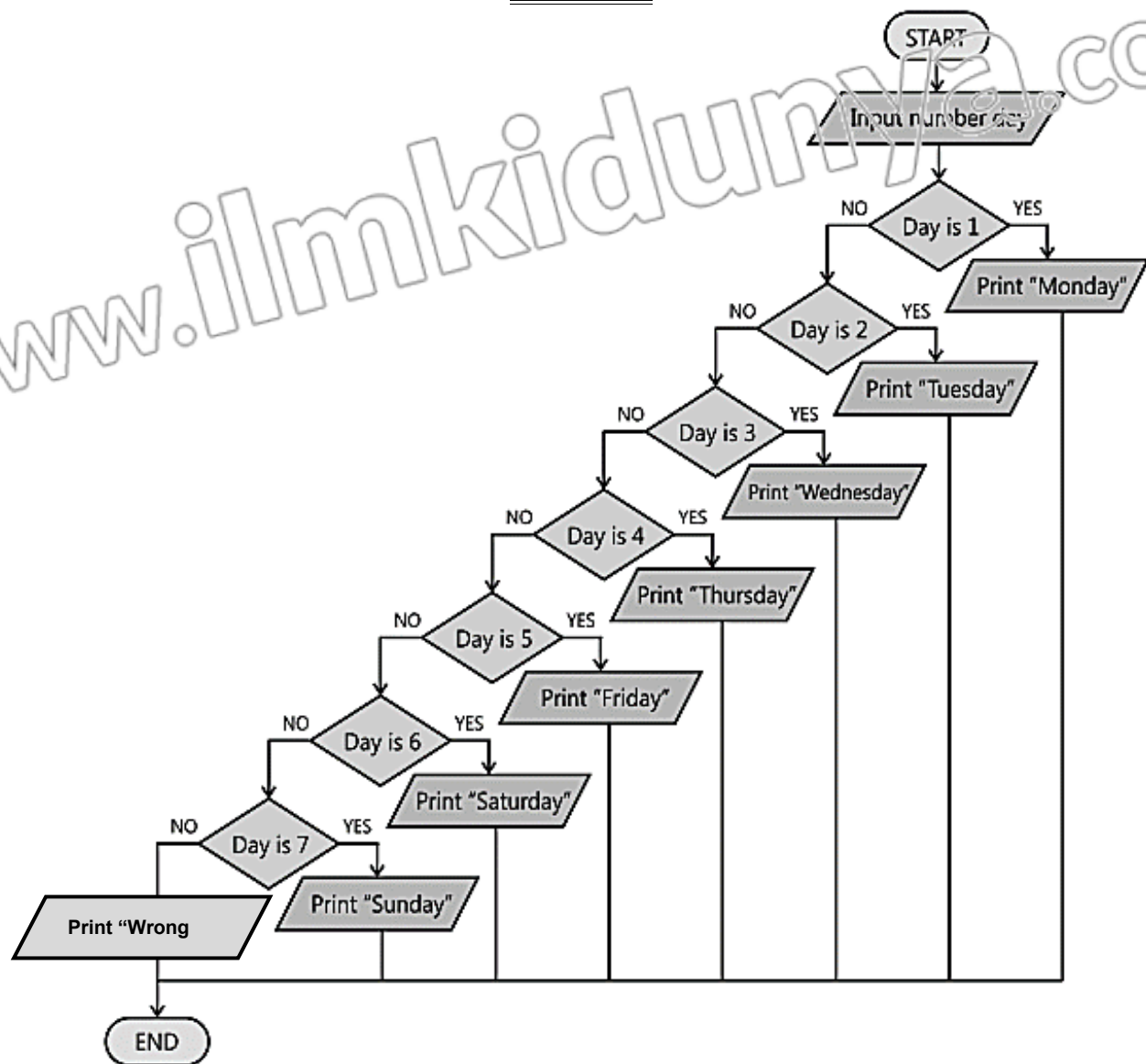
Purpose	
Both the flowcharts find the greatest number out of 3 input numbers .	
Better (advantage over other)	
Flowchart 2 is better.	
Reasons (Findings)	
The first flowchart declares the n0 (first number) as greater and saves it in a variable (Large) and after that starts comparing itself with the other two numbers So it is complex and consumption of space.	while 2nd flowchart does not do this. It does direct and simple comparison so For both these two reasons the above flowchart is better in performance and memory consumption.

Activity 1.4 (A.B)

In the following flowchart, a user is supposed to provide the input value from 1 to 7, but it is possible that the input value is less than 1 or more than 7. We need to take care of such values and display appropriate messages, like “Your value is less than 1” or “Your value is more than 7”. Modify the flowchart with respect to proper error messages.

To determine name of a week day from a given number where weekdays are assumed from Monday to Sunday and their respective.



SOLUTION**1.3 ALGORITHMS****LONG QUESTIONS**

Q.1 Define algorithm and argue on its role and importance in problem solving. (Ex Q.3) (K.B)

Ans:

ALGORITHM**Definition:**

An algorithm is a set of steps to solve a problem. It is written in a natural language, so it is easily understandable by humans.

Example:

To solve the problem of preparing tea, we can follow the following steps.

- Start.
- Take a kettle.
- Pour water in it.
- Put the kettle on fire.

- Add sugar and milk.
- Wait till it boils.
- Remove the kettle from fire.
- End.

The above set of steps can be called an algorithm for tea preparation.

ROLE OF ALGORITHMS IN PROBLEM SOLVING

An algorithm has a vital role in problem solving as it provides a step-by-step guide to the problem solver as follows:

- It is a complete description of the solution.
- Usually a computer programmer first writes an algorithm and then translates it into the code of some programming language.
- Sometimes, the designer of the program first makes a flowchart to solve a problem and then encodes the flowchart into an algorithm.

The following figure shows the role of algorithm in problem solving.

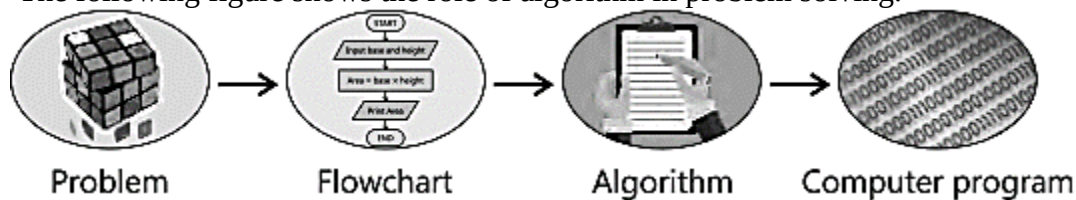


Figure: Role of Algorithm

Q.2 Explain formulation of an algorithm.

(K.B+U.B)

Ans:

FORMULATION OF AN ALGORITHM

There are different notations (keywords) to write an algorithm as in table:

Notation	Meaning
Start	It is the starting point of an algorithm. Every algorithm must have one starting (entry) point.
Input	It is used to get input from a user and store it in computer memory with some name.
Set	It is used to give name to data in computer memory. It is also used to update the value of existing data.
If, Else	It is used to check the condition. For example, the condition like <i>if</i> ($a < b$). A condition is evaluated as <i>true</i> or <i>false</i> . In case the condition is <i>true</i> then the statements related with <i>if</i> part are executed otherwise the statements of <i>else</i> part are executed. Usage: Suppose $a=5$ and $b=7$, if ($a < 5$) Set c to 10 else Set c to 20 Writing <i>else</i> part is optional.
Goto	It is used to transfer control to a certain step of an algorithm. It is usually required in loops.
Output	It is used to display values.
Stop	It is the termination point of an algorithm.

Q.3 Explain efficiency of algorithms with example.

OR

Suppose a problem has multiple algorithms. How would you choose the most efficient one? Explain with examples.

(Ex Q.4) (K.B+U.B)

Ans:

EFFICIENCY OF ALGORITHMS

There can be more than one algorithm to solve the same problem. Which one is better, depends upon the efficiency of the available solution algorithms. Efficiency of an algorithm is measured on the basis of two metrics as follows:

1- Number of steps:

An algorithm is considered more efficient if it takes less number of steps to reach the results.

2- Space used in computer memory:

We have observed in algorithms that some data is stored in computer memory which is latter used to give results. An algorithm using less space in computer memory is considered more efficient with respect to memory space.

Explanation:

It is quite possible that one algorithm takes less space in memory and has more number of steps whereas the other algorithm takes more memory and has less number of steps. In this case there is a trade-off between number of steps and the consumed memory. The designer can take decision according to the requirements.

Example 1:

Let's suppose we have two algorithms to solve a certain problem. One algorithm has N steps whereas the other algorithm has N^2 steps. In this case the former algorithm is considered more efficient than the latter one.

Example 2:

We need to compute the following.

$$1 + 2 + 3 + 4 + 5 + \dots + 99$$

How can we find its answer?

Solution1:

Different minds can find different solutions to solve this problem. One solution is to start adding numbers from beginning and keep adding till the end.

Solution2:

Other solution is to start making pairs as $(1 + 99)$, $(2 + 98)$, $(3 + 97)$, $(4 + 96)$, $(5 + 95) \dots (49, 51)$ where each pair gives answer 100. We count the number of pairs and multiply that count with 100 and then in the result we add 50 as it is nowhere in any pair.

Solution3:

Another solution is to use formula $\frac{n(n+1)}{2}$ where n is the last term. So, the solution is

just to solve $\frac{99(99+1)}{2}$.

This example shows different approaches to solve one problem and if these approaches are used in computer then accordingly there may be different memory usage and number of steps.

Q.4 Explain the differences between algorithm and flowchart.**(K.B+U.B)****Ans:****DIFFERENTIATION**

Difference between an algorithm and a flowchart is just like the difference between a story and a movie.

Flowchart	Algorithm
A flowchart is a graphical representation of the process to solve a problem.	An algorithm writes the same steps in a human understandable language.
It is easy to draw.	It is easy to write.
It is easy to understand problem solving.	The techniques to write an algorithm are easy to understand.
It is easy to identify errors (if any).	The usage of Goto makes it difficult to identify errors.
It is easy to observe flow from one step to the other.	It is not very easy to show the flow from one step to the other.
Modifying a flowchart is very difficult every time.	Modifying an existing algorithm is easy as compared flowchart.
More time is required to draw a flowchart.	Less time is required to draw an algorithm.

It is not suitable for very large problems.	To solve a large problem, algorithms are helpful.
---	---

SHORT QUESTIONS**Q.1 Define algorithm. Also make an algorithm for preparing tea.****(K.B+U.B+A.E)****Ans:****ALGORITHM****Definition:**

An algorithm is a set of steps to solve a problem. It is written in a natural language, so it is easily understandable by humans.

Algorithm for Making Tea:

To solve the problem of preparing tea, we can follow the following steps:

- Start.
- Take a kettle.
- Pour water in it.
- Put the kettle on fire.
- Add sugar and milk.
- Wait till it boils.
- Remove the kettle from fire.
- End.

Q.2 Write some advantages of flowchart.**(K.B)****Ans:****ADVANTAGES OF A FLOWCHART**

Advantages of a flowchart are as follows:

- It is easy to draw.
- It is easy to understand problem solving.
- It is easy to identify errors (if any).
- It makes easy to observe flow from one step to the other.

Q.3 Write some disadvantages of flowchart.**(K.B)****Ans:****DISADVANTAGES OF A FLOWCHART**

Disadvantages of a flowchart are as follows:

- More time is required to draw a flowchart.
- Modifying a flowchart is not very easy every time.
- It is not suitable for very large problems.

Q.4 Write some advantages of algorithm.**(K.B)****Ans:****ADVANTAGES OF AN ALGORITHM**

Some advantages of an algorithm are as follows:

- It is easy to write.
- Techniques to write an algorithm are easy to understand.
- To solve a large problem, algorithms are helpful.

Q.5 Write some disadvantages of algorithm.**(K.B)****Ans:****DISADVANTAGES OF AN ALGORITHM**

Some disadvantages of an algorithm are as follows:

- Modifying an existing algorithm is not very easy every time.
- Showing the flow from one step to the other is not very easy.
- Usage of Goto makes it difficult to identify errors.

Q.6 What is the use of 'set' in writing algorithms?**(K.B+U.B)****Ans:****USE OF SET**

It is used to give name to data in computer memory. It is also used to update the value of

existing data.

Q.7 Write an algorithm to find the sum, product and average of five given numbers. (A.B)

Ans:

ALGORITHM

Step 1. Start

Step 2. Input numbers, n_0, n_1, n_2, n_3, n_4

Step 3. Set sum to $n_0 + n_1 + n_2 + n_3 + n_4$

Step 4. Set product to $n_0 \times n_1 \times n_2 \times n_3 \times n_4$

Step 5. Set average to $\frac{n_0 + n_1 + n_2 + n_3 + n_4}{5}$

Step 6. Output sum, product, average

Step 7. End

Q.8 Write an algorithm to find acceleration of a moving object with given mass and the applied force. (A.B)

Ans:

ALGORITHM

Step 1. Start

Step 2. Input numbers, *mass, force*

Step 3. Set *acceleration* to $\frac{\text{force}}{\text{mass}}$

Step 4. Output *acceleration*

Step 5. End

Q.9 Write an algorithm to find the volume of a cube. (A.B)

Ans:

ALGORITHM

Step 1. Start

Step 2. Input number, *side*

Step 3. Set volume to $\text{side} \times \text{side} \times \text{side}$.

Step 4. Output volume

Step 5. End

Q.10 Write an algorithm to find the area of a parallelogram. (A.B)

Ans:

ALGORITHM

Step 1. Start

Step 2. Input numbers, *base, height*

Step 3. Set area to $\text{base} \times \text{height}$

Step 4. Output area

Step 5. End

Q.11 Write an algorithm to display the larger one out of the three given numbers. (A.B)

Ans:

ALGORITHM

Step 1. Start

Step 2. Input numbers, n_0, n_1, n_2

Step 3. Set *large* to n_0

Step 4. if $n_1 > \text{large}$ Set *large* to n_1

Step 5. if $n_2 > \text{large}$ Set *large* to n_2

Step 6. Output *large*

Step 7. End

Q.12 Write an algorithm to assign grade to a subject based on the achieved marks. (A.B)

Ans: **ALGORITHM**

Step 1. Start

Step 2. Input numbers, *obtained_marks*, *total_marks*

Step 3. Set percentage to $\frac{\text{obtained_marks}}{\text{total_marks}} \times 100$

Step 4. if *percentage* > 80 Set grade to A +

else

if *percentage* > 70 Set grade to A

else

if *percentage* > 60 Set grade to B

else

if *percentage* > 50 Set grade to C

else

if *percentage* > 40 Set grade to D

else

if *percentage* > 33 Set grade to E

else

Set grade to F.

Step 5. Output *grade*

Step 6. End

Q.13 Write an algorithm to find the interest on an amount. (A.B)

Ans: **ALGORITHM**

Step 1. Start

Step 2. Input numbers, amount, rate, years

Step 3. Set plain_interest to $\left(\text{amount} \times \frac{\text{rate}}{100} \right) \times \text{years}$

Step 4. Output plain_interest

Step 5. End

Q.14 Write an algorithm to convert Celsius to Fahrenheit temperature and vice versa. (A.B)

Ans: **ALGORITHM**

Step 1. Start

Step 2. Input number, *Celsius*

Step 3. Set fahrenheit to $\frac{\text{celsius} \times 9}{5} + 32$

Step 4. Output *fahrenheit*

Step 5. Input number, *fahrenheit*

Step 6. Set Celsius to $(\text{fahrenheit} - 32) \times \frac{5}{9}$

Step 7. Output Celsius

Step 8. End

Q.15 Write an algorithm to find even numbers in integers ranging from n_1 to n_2 (where n_2 is greater than n_1). (A.B)

Ans: **ALGORITHM**

Step 1. Start

Step 2. Input numbers, n_1 , n_2

Step 3. if ($n_1 < n_2$) {

Step 4. if ($n_1 \bmod 2$ equal 0) Output n_1

Step 5. Set n_1 to $n_1 + 1$

Step 6. go to Step 3

}

Step 7. End

Q.16 How can we measure the efficiency of algorithms? (U.B)

Ans:

EFFICIENCY OF AN ALGORITHM

Efficiency of an algorithm is measured on the basis of two metrics as follows:

1- Number of steps: An algorithm is considered more efficient if it takes less number of steps to reach the results.

2- Space used in computer memory: We have observed in algorithms that some data is stored in computer memory which is latter used to give results. An algorithm using less space in computer memory is considered more efficient with respect to memory space.

MULTIPLE CHOICE QUESTIONS

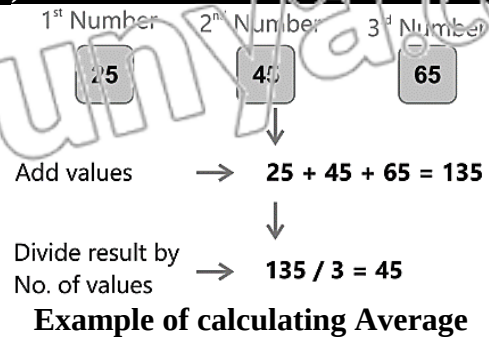
- The steps to solve a problem is called: (K.B+U.B)**
(A) Algorithm (B) Flowchart (C) Map (D) Design
- Algorithm is written in which language? (K.B)**
(A) Urdu (B) Natural (C) Programming (D) Binary
- Algorithm include: (K.B+U.B)**
(A) Input (B) Processing (C) Output (D) All of these
- The word "algorithm" comes from the name of Arabic writer: (Do you know page no. 16) (K.B)**
(A) Abu Qasim (B) Al Beroni
(C) Jabar bin Hayan (D) Muhammad ibn Musa al-Khwarizmi
- The starting point of an algorithm is: (K.B)**
(A) Start (B) Input (C) Set (D) Output
- Which one is used to give name to data in computer memory? (K.B+U.B)**
(A) Start (B) Input (C) Set (D) Output
- Which one is required for loops? (K.B)**
(A) Start (B) Goto (C) Set (D) Output
- The termination point of an algorithm is: (K.B)**
(A) Start (B) Goto (C) Set (D) Stop
- Efficiency of an algorithm is measured on the basis of: (U.B)**
(A) 1 metric (B) 2 metrics (C) 3 metrics (D) 4 metrics
- Let's suppose we have two algorithms to solve a certain problem. One algorithm has N_1 steps whereas the other algorithm has N_2 steps. In this case which is more efficient? (U.B+A.B)**
(A) First algorithm (B) Second algorithm (C) Both (D) None
- How many squares are on chess board? (Do you know page no. 23) (K.B+U.B)**
(A) 100 (B) 80 (C) 64 (D) 50

www.ilmkidunya.com

www.ilmkidunya.com

ACTIVITY QUESTIONS**Activity 1.6 (A.B)**

The Figure shows a simple example of calculating average of three numbers, 25, 45 and 65. Write an algorithm with these fixed values to calculate and display average values. Note that in this case no input is required from a user.

**SOLUTION**

Step 1. Start

Step 2. Set a to 25

Step 3. Set b to 45

Step 4. Set c to 65

Step 5. Set *average* to $\frac{a+b+c}{3}$

Step 6. Output average

Step 7. End

Activity 1.7 (A.B)

Change the algorithm for finding volume of a Cylinder and Sphere. The formula for the volume of a Sphere is $\frac{4}{3} \times \pi r^3$ where r is radius. The formula for the volume of cylinder is $\pi r^2 h$ where r is radius and h is height.

To find the volume of a cube.

Step 1. Start

Step 2. Input number, side

Step 3. Set volume to side × side × side.

Step 4. Output volume

Step 5. End

SOLUTION

Step 1. Start

Step 2. Input radius

Step 3. Set pi(π) to 3.1415

Step 4. Set volume_sphere to $\frac{4}{3} \times \pi \times \text{radius} \times \text{radius} \times \text{radius}$

Step 5. Output volume_sphere

Step 6. Input height

Step 7. Set volume_cylinder to $\pi \times \text{radius} \times \text{radius} \times \text{height}$

Step 8. Output volume_cylinder

Step 9. End

Activity 1.8 (A.B)

Change the algorithm for finding the area of a triangle, rhombus, or trapezium.

To find the area of a parallelogram.

- Step 1.** Start
Step 2. Input numbers, base, height
Step 3. Set area to base $\times$ height
Step 4. Output area
Step 5. End

SOLUTION

Area of a Triangle:

- Step 1.** Start
Step 2. Input base, height
Step 3. Set area to $\frac{1}{2} \times \text{base} \times \text{height}$
Step 4. Output area
Step 5. End

Area of a Rhombus:

- Step 1.** Start
Step 2. Input d1, d2
Step 3. Set area to $\frac{1}{2} \times d1 \times d2$
Step 4. Output area
Step 5. End

Area of a Trapezium:

- Step 1.** Start
Step 2. Input a, b, height
Step 3. Set area to $\frac{1}{2} \times (a + b) \times \text{height}$
Step 4. Output area
Step 5. End

Activity 1.9 (A.B)

Compare the algorithm 9 presented in Section 1.3.4 with the following one and try to find which one is efficient. Note that both are solving the same problem. In order to answer this question, assume two values for n1 and n2 and start count the number of steps used in both algorithms.

Algorithm 1.9

- Step 1.** Start
Step 2. Input numbers, n1, n2
Step 3. if n1 is odd, set n1 to n1 + 1
Step 4. Output n1
Step 5. Set n1 to n1 + 2
Step 6. if n1 < n2 go to Step 4
Step 7. End

Algorithm 9 (Section 1.3.4)

- Step 1.** Start
Step 2. Input numbers, n1, n2
Step 3. if (n1 < n2) {
Step 4. if (n1 mod 2 equal 0) Output n1
Step 5. Set n1 to n1+1
Step 6. go to Step 3
Step 7. End

SOLUTION

Steps	In the above algorithm (algorithm 1.9)	In the above algorithm (algorithm 9)
Step 1.	Algorithm starts.	Algorithm starts.
Step 2.	It inputs two numbers n1(starting value)	It inputs two numbers n1(starting value)

	and n2(ending value).	and n2(ending value).
Step 3.	If n1 is odd, it increments 1 into n1 to convert n1 into an even number.	It checks if n1 is less than n2 or not.
Step 4.	It displays n1 i.e. it displays first even number.	It checks if n1 is even or not. If n1 is even then display n1 as a first even number.
Step 5.	It increments 2 in n1. (jump to next even number)	It increments 1 in n1. (jump to next number)
Step 6.	It repeats itself until the ending value. (Step 4, 5, 6 is repeated) to display only even number.	It repeats itself until the ending value. (Step 3, 4, 5, 6 is repeated) to check if it is even or not and then display even number.
Step 7.	Algorithm ends.	Algorithm ends.

So, Algorithm used in activity 1.9 is more efficient because it is very easy and uses less number of steps.

1.4 TEST DATA

LONG QUESTIONS

Q.1 Describe the importance of testing.

(K.B+U.B)

Ans:

IMPORTANCE OF TESTING

Testing is essential to point out the defects and errors made during finding a solution to some problem. It helps in improving a solution. If one solves a problem and someone else uses that solution for commercial purposes, then the commercial activities depend upon the correctness of that solution.

Example 1:

If we develop a solution for finance management and some bank starts using it then any error in that solution may result in a financial loss. So, testing is important for a solution.

Example 2:

A car is delivered to a customer after testing. Upon launching a new car, it is usually tested with a robot driver who hits the car with a wall. It is used to test whether the air bags and other security systems are functioning or not. Moreover, it also allows the car designers to suggest further security measures to reduce the damage. This test can help to make a car safe. So, testing helps to improve quality.

Q.2 Explain types of test data.

(Ex Q.) (K.B)

Ans:

TEST DATA

Definition:

After solving a problem, we need to test whether the solution is correct or not, and for testing, we need "Test Data".

TYPES OF TEST DATA

Creation of proper and sufficient test data is one of the key activities to improve quality of a solution. Each type of solution requires different data.

Types of Test Data include:

- Valid test data
- Invalid test data
- Boundary test data values
- Wrong data formats
- Absent data

www.ilmkidunya.com

www.ilmkidunya.com

Valid Test Data:

It is the test data that complies with the input requirements of the algorithm. If an algorithm is supposed to take a numeric value between 1 and 100 as input, then any value between 1 and 100 is a valid test data.

Invalid Test Data:

It is the data that does not comply with the input requirements of the algorithm. It is necessary to make sure that the solution correctly works for invalid values, shows the relevant messages notifying the user that the provided input values are improper.

Boundary Test Data values:

A solution is tested on extreme values. For example, to calculate interest we can consider principal amount as 0 or a very huge amount.

Wrong Data Formats:

It is wise to check how the system reacts on entering data in an inappropriate format. For example, giving an alphabet as input when a numeric value is expected.

Absent data:

It is also important to investigate that the solution still works if less number of inputs are given than expected. For example, if a system asks to enter driving license number, then every one cannot provide this information. It is important to see how the system reacts in such situations.

SHORT QUESTIONS**Q.1 Define test data.****(K.B)****Ans:****TEST DATA****Definition:**

After solving a problem, we need to test whether the solution is correct or not, and for testing, we need "Test Data".

Example:

If we want to test the algorithm to find the largest among three given numbers n_0 , n_1 and n_2 , then we need three values. These values can be positive, negative or zero, e.g., ($n_0 = 5$, $n_1 = 15$, $n_2 = 3$), ($n_0 = 27$, $n_1 = -6$, $n_2 = 35$), ($n_0 = 24$, $n_1 = 0$, $n_2 = 11$), etc. So, for thinking about testing, we also need to think about test data.

Q.2 Name the types of test data.**(K.B+U.B)****Ans:****TYPES OF TEST DATA**

Creation of proper and sufficient test data is one of the key activities to improve quality of a solution. Each type of solution requires different data.

Types of Test Data include:

- Valid test data
- Invalid test data
- Boundary test data values
- Wrong data formats
- Absent data

Q.3 Differentiate between valid test data and invalid test data.**(U.B)****Ans:****DIFFERENTIAL**

The difference between valid and invalid test data is as follows:

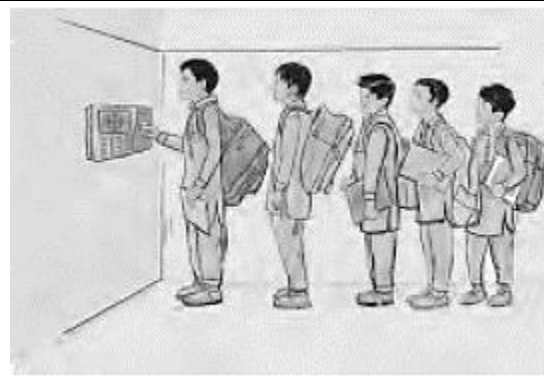
Valid Test Data	Invalid Test Data
It is the test data that complies with the input requirements of the algorithm.	It is the test data that does not comply with the input requirements of the algorithm.
If an algorithm is supposed to take a numeric value between 1 and 100 as input, then any value between 1 and 100 is a valid test data.	It is necessary to make sure that the solution correctly works for invalid values, shows the relevant messages notifying the user that the provided input values are improper.

MULTIPLE CHOICE QUESTIONS

1. After solving a problem, we need to test whether the solution is correct or not, and for testing, we need “_____”. (K.B+U.B)
(A) Algorithm (B) Flowchart (C) Test data (D) Design
2. Types of test data are: (K.B)
(A) 2 (B) 4 (C) 5 (D) 6
3. A solution is tested on extreme values is called: (K.B)
(A) Valid Test Data (B) Invalid Test Data
(C) Wrong Data Formats (D) Boundary Test Data Values
4. A test data which complies with input requirements: (K.B+U.B)
(A) Valid Test Data (B) Invalid Test Data
(C) Wrong Data Formats (D) Boundary Test Data Values
5. A test data which does not comply with input requirements: (K.B+U.B)
(A) Valid Test Data (B) Invalid Test Data
(C) Wrong Data Formats (D) Boundary Test Data Values

ACTIVITY QUESTIONS**Activity 1.10 (A.B)**

Assume that you are given an automatic attendance system for testing. In this system, a camera observes each student entering in the classroom. The camera is connected to a computer which contains the database of pictures of all the students. The solution compares each student with the pictures in database and mark the attendance is picture is found there. You are asked to provide test data for the system. Write your points in a way that can help the solution provider to check and improve quality of the solution. You can think about different dresses in different weathers, identical twins, different haircuts or any other points where one can look different in front of camera.

**SOLUTION**

The following test data will be provided to system in order to check the performance and accuracy of the system:

- The students will be dressed in different clothes (winter and summer uniform) along with cap or without cap, with face mask or without face mask glasses or without glasses.
- Moreover, the looks of students will be changed with haircut and without haircut and also by wearing school bag or without school bag.
- Students will have to stand in front of camera while smiling or without smiling.
- Similarly, students will be standing in different poses in front of camera.
- In case of twins, their thumb recognition will be required.

1.5 VERIFICATION AND VALIDATION

LONG QUESTIONS

Q.1 Describe verification and validation with examples (K.B+U.B)

Ans: VERIFICATION AND VALIDATION

Verification:

Verification means to test if the solution is actually solving the same problem for which it was designed.

Example:

If you are asked to give a solution for calculating compound interest then verification means to know that it is giving results for compound interest not for the plain interest.

Validation:

Validation means to test whether the solution is correct or not.

For example, if you are asked to give a solution for calculating compound interest then validation means to know whether it is finding the correct compound interest or not. If a solution is verified, then it is validated with the help of test data.

Example 1:

Let's assume that you go to a pizza shop and order a chicken pizza. You state your requirement that it should be less spicy. You also expect that it would taste good. When the pizza arrives, you can observe that it is a chicken pizza. This is called verification. Now, when you eat the pizza, you can check whether it is less spicy or not, it tastes good or not. This is called validation.

Example 2:

Let's assume that you are asked to write an algorithm that takes as input a list of numbers. The algorithm should display the list arranged in ascending order. After writing the algorithm you submit it to your teacher. Your teacher provides a list of numbers to the algorithm. If your algorithm displays a list of numbers then it is verified. Instead if your algorithm displays an answer in yes or no, or displays something else, then it is not verified. If your algorithm is verified, your teacher moves to the next step of validation. He checks whether the list of numbers displayed are actually in ascending order or not. If the list is in ascending order and no element is missing then your solution is also validated.

SHORT QUESTIONS

Q.1 What is difference between verification and validation. (K.B+U.B)

Ans: DIFFERENTIATE

The difference between valid and invalid test data is as follows:

Verification	Validation
Definition	
Verification means to test if the solution is actually solving the same problem for which it was designed.	Validation means to test whether the solution is correct or not.
Example	
If you are asked to give a solution for calculating compound interest then verification means to know that it is giving results for compound interest not for the plain interest.	If you are asked to give a solution for calculating compound interest then validation means to know whether it is finding the correct compound interest or not. If a solution is verified, then it is validated with the help of test data.

MULTIPLE CHOICE QUESTIONS

- To test if the solution is actually solving the same problem for which it was designed means: (K.B+U.B)
(A) Design (B) Verification (C) Validation (D) Reservation
- To test whether the solution is correct or not means. (K.B+U.B)
(A) Design (B) Verification (C) Validation (D) Reservation

1.6 IDENTIFICATION AND CORRECTION OF ERRORS**LONG QUESTIONS**

Q.1 Write a note on trace table.

(Ex Q.7) (K.B+U.B)

Ans:

TRACE TABLE**Definition:**

A trace table is a technique used to test algorithms, in order to make sure that no logical errors occur while the algorithm is being processed.

Explanation:

The table usually takes the form of a multi-column, multi-row table; with each column showing names of data, and each row showing values of the data at each step.

Example:

To recruit students for our school volleyball team, we need students having height between 144 cm and 164 cm. To count qualified students, we develop the following algorithm.

Step 1. Start**Step 2.** Set count to 0**Step 3.** Set all_heights to [154, 140, 155, 164, 144, 166, 160, 143]**Step 4.** For each height in the list all_heights**Step 5.** If height > 144 and height ≤ 164 then Set count to count + 1**Step 6.** Output count**Step 7.** Stop

We can make a trace table for the above algorithm:

In the following table, the blank means there is no change and -- means that a value is not concerned. In the following table Step 1 has no effect on data. Step 2 is assigning 0 to count and in Step 3, list all_heights is introduced. In Step 4, there is no change in both count and all-heights but the data 154 is stored in height. It is compared in Step 5 and the value in count is updated if data is in given range. Steps 4 and 5 are repeated for each value.

	count	All heights	
Step 1	--		--
Step 2	0	--	--
Step 3		[154, 140, 155, 164, 144, 166, 160, 143]	
Step 4			154
Step 5	1		
Step 4			140
Step 5	1		
Step 4			155

Step 5	2		
Step 4			164
Step 5	3		
Step 4			144
Step 5	3		
Step 4			166
Step 5	4		
Step 4			160
Step 5	5		
Step 4			143
Step 5	5		
Step 6			
Step 7			

SHORT QUESTIONS

Q.1 Why we use trace table? (U.B)

Ans: TRACE TABLE

A trace table is a technique used to test algorithms, in order to make sure that no logical errors occur while the algorithm is being processed.

Q.2 Why we use invalid data for testing? (U.B)

Ans: INVALID DATA FOR TESTING

Testing an algorithm using invalid data ensures that the algorithm can gracefully handle unexpected data inputs. If an algorithm requires your age in number of days but you give date of birth as input then the algorithm may not work properly. The purpose of testing using invalid test data is to detect such situations. In this case error messages are shown as output. Moreover, this kind of testing helps you to improve the quality of solution.

MULTIPLE CHOICE QUESTIONS

1. The solution is working but not giving required results. This type of error is called: (K.B+U.B)

(A) Syntax Error (B) Runtime Error (C) Logical Error (D) Random Error

2. A technique used to test algorithms is: (K.B+U.B)

(A) Design (B) Trace Table (C) Validation (D) Correctness

ACTIVITY QUESTIONS

Activity 1.11 (A.B)

Write all the above discussed algorithms keeping in mind the invalid test data inputs. Class teacher may divide class in few groups and assign them one or more algorithm(s). Students are supposed to discuss and rewrite algorithms so that upon invalid inputs, appropriate messages are displayed.

SOLUTION

Algorithm 1	
To find the sum, product and average of five given numbers.	
Original	Apply Test Data
Step 1. Start	Step 1. Start
Step 2. Input numbers, n_0, n_1, n_2, n_3, n_4	Step 2. Input numbers, n_0, n_1, n_2, n_3, n_4
Step 3. Set sum to $n_0 + n_1 + n_2 + n_3 + n_4$.	Step 3. If (n_0, n_1, n_2, n_3, n_4 are positive integers) goto step 4
Step 4. Set $product$ to $n_0 \times n_1 \times n_2 \times n_3 \times n_4$	else print "Invalid input, Enter only"

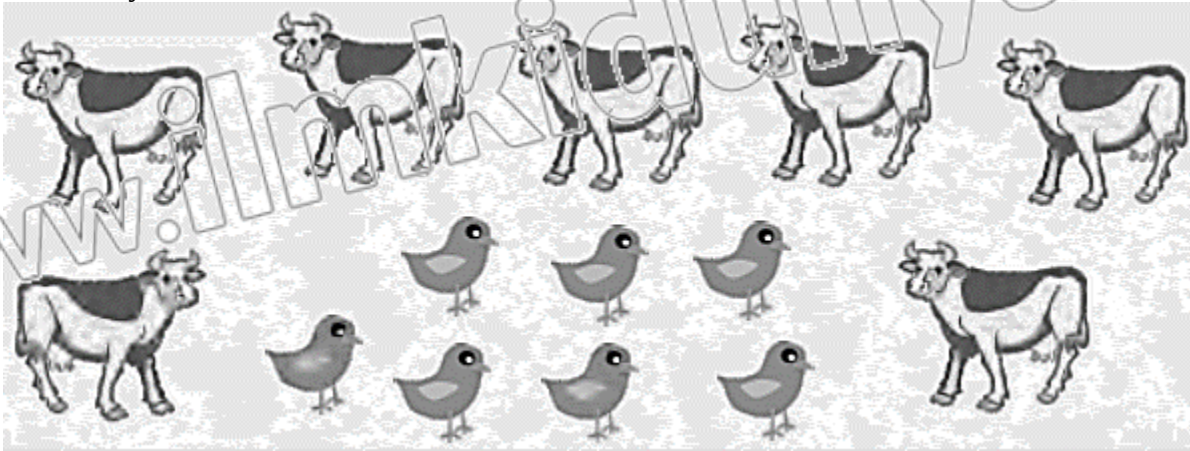
Step 5. Set <i>average</i> to $\frac{n0+n1+n2+n3+n4}{5}$ Step 6. Output <i>sum, product, average</i> Step 7. End	positive numbers” goto step 2 Step 4. Set <i>sum</i> to $n0 + n1 + n2 + n3 + n4$. Step 5. Set <i>product</i> to $n0 \times n1 \times n2 \times n3 \times n4$ Step 6. Set <i>average</i> to $\frac{n0+n1+n2+n3+n4}{5}$ Step 7. Output <i>sum, product, average</i> Step 8. End
Algorithm 2 To find acceleration of a moving object with given mass and the applied force.	
Original Step 1. Start Step 2. Input numbers, <i>mass, force</i> Step 3. Set <i>acceleration</i> to $\frac{force}{mass}$ Step 4. Output <i>acceleration</i> Step 5. End	Apply Test Data Step 1. Start Step 2. Input numbers, <i>mass, force</i> Step 3. If (<i>mass, force</i> is positive integer) goto step 4 else print “Invalid input, Enter only positive numbers” goto step 2 Step 4. if (<i>mass</i> is equal to 0) print “cannot divide by zero” goto step 2 else goto step 5 Step 5. Set <i>acceleration</i> to $\frac{force}{mass}$ Step 6. Output <i>acceleration</i> Step 7. End
Algorithm 3 To find the volume of a cube.	
Original Step 1. Start Step 2. Input number, <i>side</i> Step 3. Set <i>volume</i> to $side \times side \times side$. Step 4. Output <i>volume</i> Step 5. End	Apply Test Data Step 1. Start Step 2. Input number, <i>side</i> Step 3. If (<i>side</i> is positive integer) goto step 4 else print “Invalid input, Enter only positive numbers” goto step 2 Step 4. Set <i>volume</i> to $side \times side \times side$. Step 5. Output <i>volume</i> Step 6. End
Algorithm 4 To find the area of a parallelogram	
Original Step 1. Start Step 2. Input numbers, <i>base, height</i> Step 3. Set <i>area</i> to $base \times height$ Step 4. Output <i>area</i> Step 5. End	Apply Test Data Step 1. Start Step 2. Input numbers, <i>base, height</i> Step 3. If (<i>base and height</i> are positive integers) goto step 4 else print “Invalid input, Enter only positive numbers” goto step 2 Step 4. Set <i>area</i> to $base \times height$

	Step 5. Output area Step 6. End
Algorithm 5 To display the larger one out of the three given numbers.	
Original	Apply Test Data
Step 1. Start Step 2. Input numbers, n_0, n_1, n_2 Step 3. Set large to n_0 Step 4. if $n_1 > \text{large}$ Set large to n_1 Step 5. if $n_2 > \text{large}$ Set large to n_2 Step 6. Output large Step 7. End	Step 1. Start Step 2. Input numbers, n_0, n_1, n_2 Step 3. Set large to n_0 Step 4. if $n_1 > \text{large}$ Set large to n_1 Step 5. if $n_2 > \text{large}$ Set large to n_2 Step 6. Output large Step 7. End
Algorithm 6 To assign grade to a subject based on the achieved marks.	
Original	Apply Test Data
Step 1. Start Step 2. Input numbers, <i>obtained_marks</i> , <i>total_marks</i> Step 3. Set percentage to $\frac{\text{obtained_marks}}{\text{total_marks}} \times 100$ Step 4. if <i>percentage</i> > 80 Set <i>grade</i> to A + else if <i>percentage</i> > 70 Set <i>grade</i> to A else if <i>percentage</i> > 60 Set <i>grade</i> to B else if <i>percentage</i> > 50 Set <i>grade</i> to C else if <i>percentage</i> > 40 Set <i>grade</i> to D else if <i>percentage</i> > 33 Set <i>grade</i> to E else Set <i>grade</i> to F. Step 5. Output <i>grade</i> Step 6. End	Step 1. Start Step 2. Input numbers, <i>obtained_marks</i> , <i>total_marks</i> Step 3. If (<i>obtained_marks</i> , <i>total_marks</i> are positive integers) goto step 4 else print "Invalid input, Enter only positive numbers" goto step 2 Step 4. if (<i>total_marks</i> is equal to 0) print "cannot divide by zero" goto step 2 else goto step 5 Step 5. Set percentage to $\frac{\text{obtained_marks}}{\text{total_marks}} \times 100$ Step 6. if <i>percentage</i> > 80 Set <i>grade</i> to A + else if <i>percentage</i> > 70 Set <i>grade</i> to A else if <i>percentage</i> > 60 Set <i>grade</i> to B else if <i>percentage</i> > 50 Set <i>grade</i> to C else if <i>percentage</i> > 40 Set <i>grade</i> to D else if <i>percentage</i> > 33 Set <i>grade</i> to E else Set <i>grade</i> to F. Step 7. Output <i>grade</i> Step 8. End
Algorithm 7 To find the interest on an amount.	
Original	Apply Test Data

Step 1. Start Step 2. Input numbers, amount, rate, years Step 3. Set plain_interest to $\left(amount \times \frac{rate}{100} \right) \times years$ Step 4. Output plain_interest Step 5. End	Step 1. Start Step 2. Input numbers, amount, rate, years Step 3. Set plain_interest to $\left(amount \times \frac{rate}{100} \right) \times years$ Step 4. Output plain_interest Step 5. End
Algorithm 8 To convert Celsius to Fahrenheit temperature and vice versa.	
Original	Apply Test Data
Step 1. Start Step 2. Input number, <i>Celsius</i> Step 3. Set fahrenheit to $\frac{celsius \times 9}{5} + 32$ Step 4. Output <i>fahrenheit</i> Step 5. Input number, <i>fahrenheit</i> Step 6. Set Celsius to $(fahrenheit - 32) \times \frac{5}{9}$ Step 7. Output Celsius Step 8. End	Step 1. Start Step 2. Input number, <i>Celsius</i> Step 3. Set fahrenheit to $\frac{celsius \times 9}{5} + 32$ Step 4. Output <i>fahrenheit</i> Step 5. Input number, <i>fahrenheit</i> Step 6. Set Celsius to $(fahrenheit - 32) \times \frac{5}{9}$ Step 7. Output Celsius Step 8. End
Algorithm 9 Find even numbers in integers ranging from n1 to n2 (where n2 is greater than n1).	
Original	Apply Test Data
Step 1. Start Step 2. Input numbers, <i>n1</i> , <i>n2</i> Step 3. if (<i>n1</i> < <i>n2</i>) { Step 4. if (<i>n1</i> mod 2 equal 0) Output <i>n1</i> Step 5. Set <i>n1</i> to <i>n1</i> +1 Step 6. go to Step 3 } Step 7. End	Step 1. Start Step 2. Input numbers, <i>n1</i> , <i>n2</i> Step 3. if (<i>n1</i> < <i>n2</i>) { Step 4. if (<i>n1</i> mod 2 equal 0) Output <i>n1</i> Step 5. Set <i>n1</i> to <i>n1</i> +1 Step 6. go to Step 3 } Step 7. End

EXERCISE**1.1 Answer the following questions.**

1. In a farm there are some cows and birds. If there are total 35 heads and 110 legs then how many cows and birds are there? (C.B)



Ans:

SOLUTION

Each cow has 1 head and 4 legs. Each bird has 1 head and 2 legs.

Let x = number of cows and y = number of birds

$$\text{Then } x + y = 35$$

$$4x + 2y = 110$$

Multiply the first equation by -2

$$-2x - 2y = -70$$

Add the equations

$$-2x - 2y = -70$$

$$4x + 2y = 110$$

Then

$$2x = 40$$

$$\text{Then } x = 20$$

Put this in first equation

$$20 + y = 35$$

$$y = 35 - 20 = 15$$

So, x = number of cows = 20 and y = number of birds = 15

2. Define problem analysis. Explain your answer along with an example. (K.B+U.B)

See LQ .2 (Topic 1.1)

3. Define an algorithm and argue on its role and importance in problem solving. (K.B+U.B)

See LQ.1 (Topic 1.3)

4. Suppose a problem has multiple algorithms. How would you choose the most efficient one? Explain with examples. (U.B+A.B)

See LQ.3 (Topic 1.3)

5. How do you determine requirements for a flowchart? (K.B+U.B)

See LQ.2 (Topic 1.2)

6. Explain types of test data. (K.B)

See LQ.2 (Topic 1.4)

7. Describe a trace table. (K.B)

See LQ. (Topic 1.6)

- 1.2 Choose the correct option.**
- Which solutions are not reached through proper algorithms or work planning? (U.B)
 (i) Prepared solution (ii) Candid solution
 (iii) Strategized solution (iv) Best solution
 - _____ is a graphical representation of an algorithm. (K.B)
 (i) Matrix (ii) Graph
 (iii) Flowchart (iv) Solution
 - Which symbol in the flowchart is used to either start or end the flowchart? (U.B)
 (i) Terminal (ii) Connector
 (iii) Process (iv) Decision
 - _____ means to test if the required solution is there. (K.B)
 (i) Verification (ii) Algorithm
 (iii) Validation (iv) Flowchart
 - In a _____ error, the solution is working but not giving required results. (K.B)
 (i) Random error (ii) Logical error
 (iii) Syntax error (iv) Runtime error

ANSWER KEY

1	(ii)	2	(iii)	3	(i)	4	(i)	5	(ii)
---	------	---	-------	---	-----	---	-----	---	------

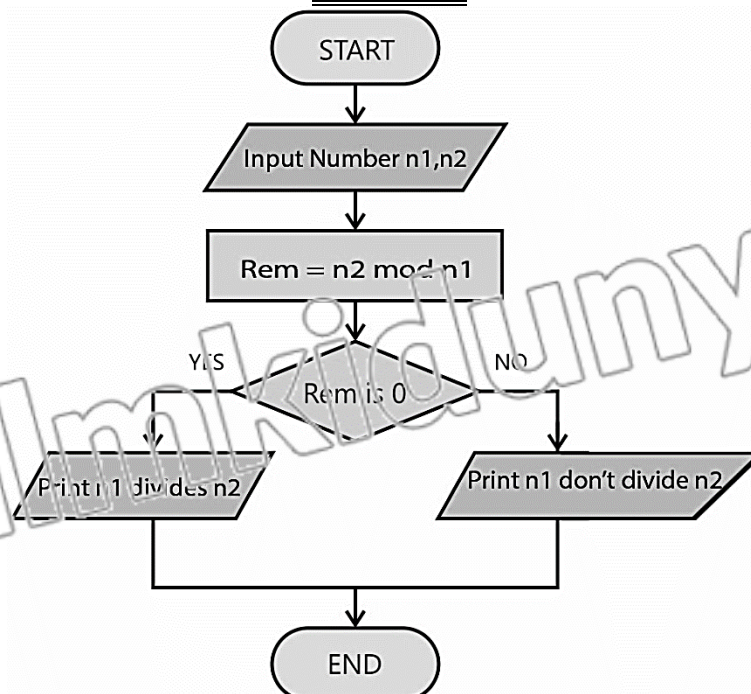
- 1.3 Fill in the blanks.**
- Before problem solving, we need to first _____ a problem. (K.B+U.B)
 - An algorithm produces a defined set of _____. (K.B)
 - A flowchart utilizes various _____ and _____ to map out the order of steps. (K.B+U.B)
 - In flowcharts symbol $\diamond$ is used to show a _____. (K.B+U.B)
 - _____ is used to test the solutions. (U.B)

ANSWERS

1	Analyse	2	Steps	3	Symbols, text	4	Decision making	5	Verification
---	---------	---	-------	---	---------------	---	-----------------	---	--------------

- 1.4 Draw the flowcharts for the following problems.** (A.B)
- Input two numbers n_1 and n_2 . Determine whether n_1 divides n_2 or not.

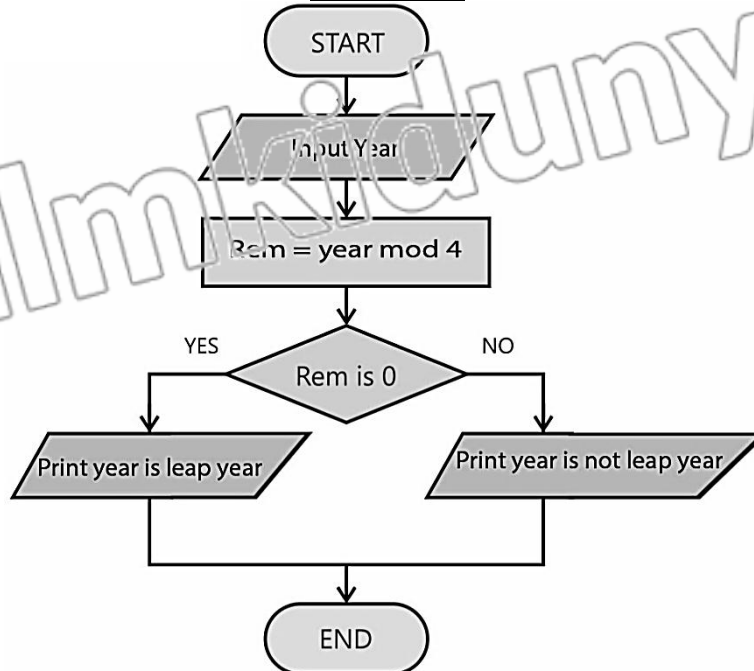
Ans:

SOLUTION

2. Input a year and determine whether it is a leap year or not.

Ans:

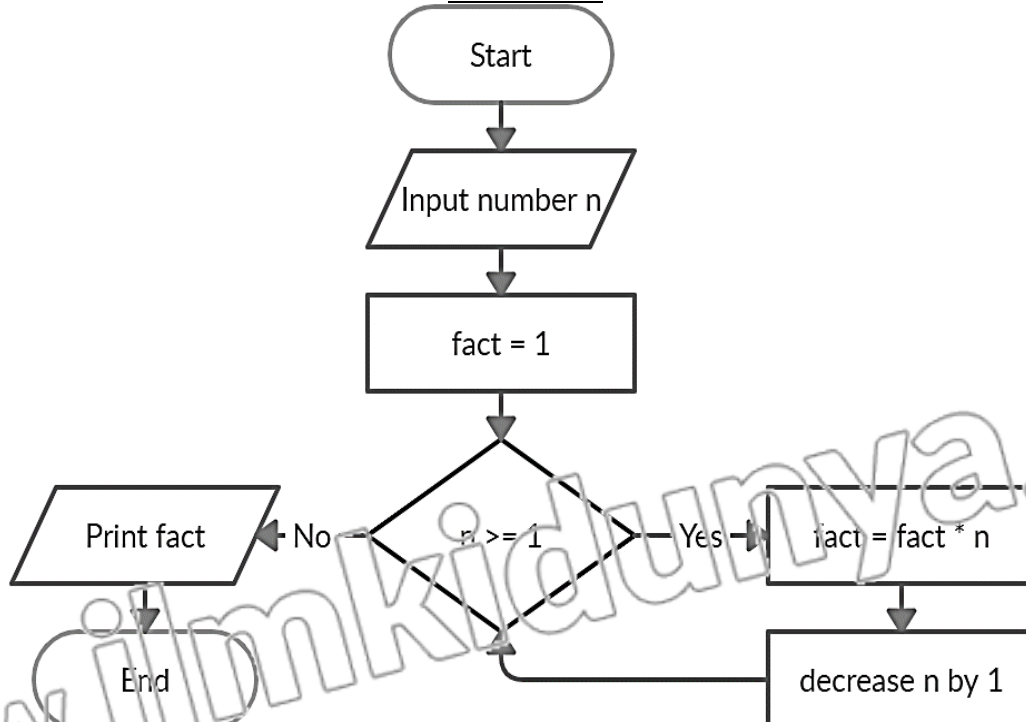
SOLUTION



3. Input a number and calculate its factorial.

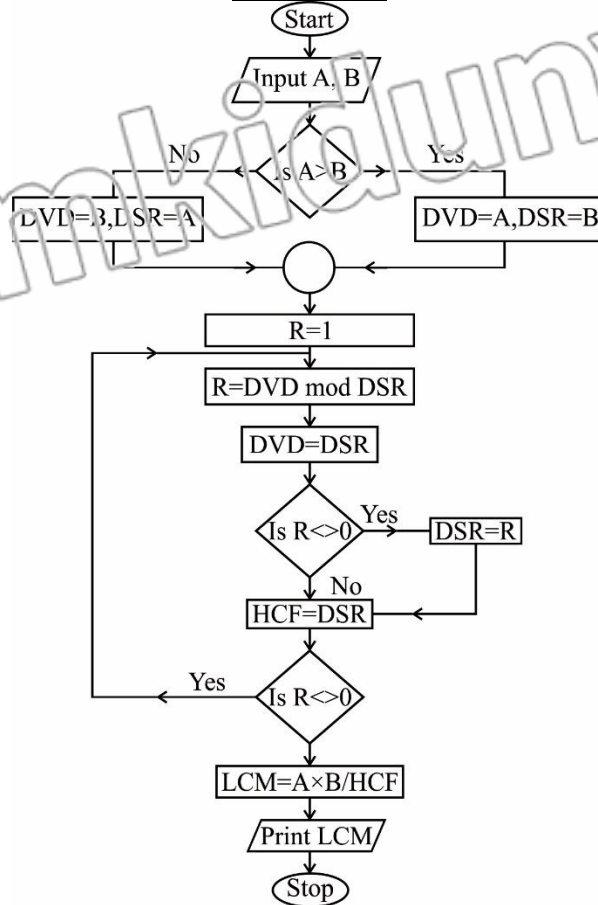
Ans:

SOLUTION



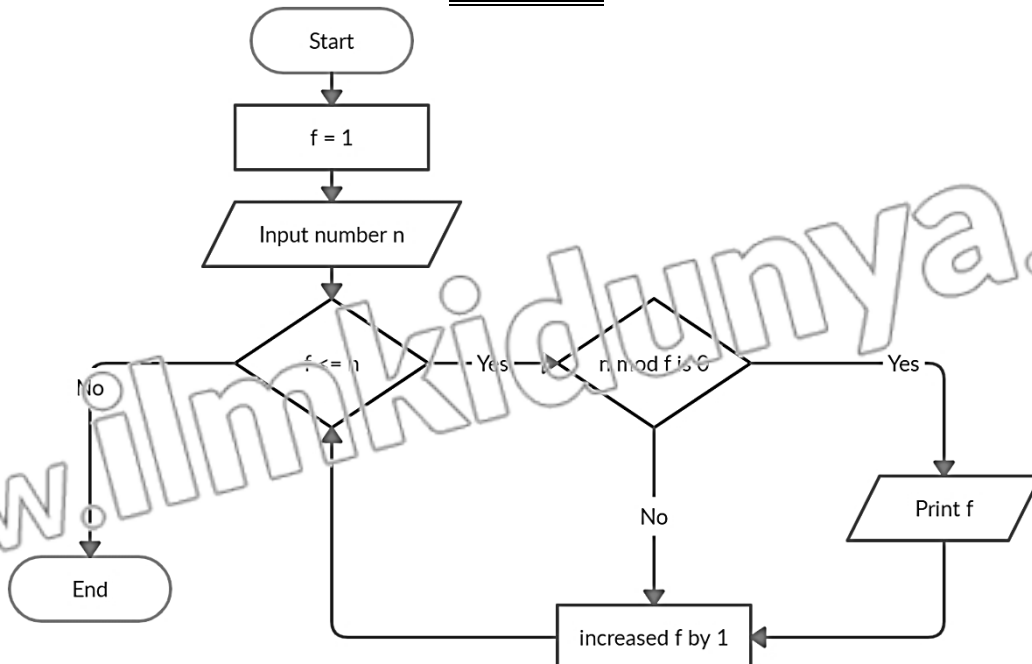
4. Find LCM (Least Common Multiple) of two numbers.

Ans:

SOLUTION

5. Input a number and display its factors.

Ans:

SOLUTION

Activity 1.12 (A.B)

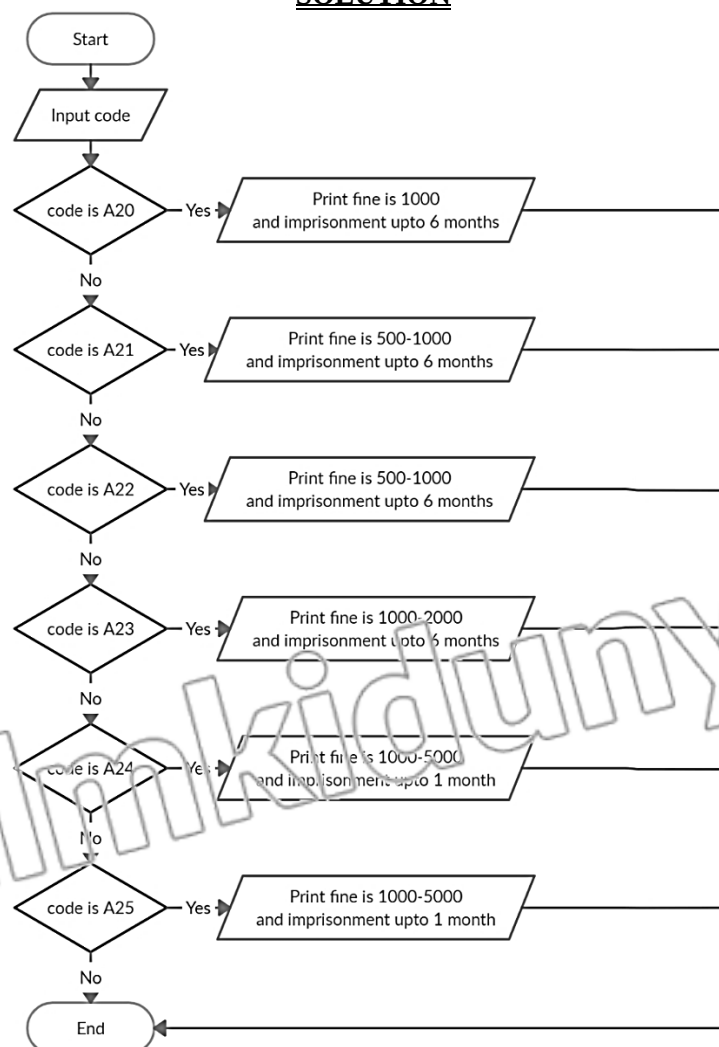
Design a flowchart to calculate fine amount for Pakistan motorway. Fine is imposed according to the following coding scheme. Input a code and display the respective output.

Code	Offence	Penalty (Rs.)	Imprisonment
A20	Driving when disqualified	1000	Upto 6 Months
A21	Obtaining or Applying for a driving licence without disclosing particulars of endorsement	500-1000	Upto 6 Months
A22	Offence relating to construction of vehicle	500-1000	Upto 6 Months
A23	Offence relating to permits	1000-2000	Upto 6 Months
A24	Overloading of goods 15 % in excess of permissible limits.	1000-5000	Upto 1 Month
A25	Overloading of passengers 30 % in excess of permissible limits	1000-5000	Upto 1 Month

For more codes, visit <http://nhmp.gov.pk>

Make the flowchart more comprehensive by adding more codes. Make your algorithm on a chart. Display your chart in your school or community for further awareness on traffic related crimes and their penalties.

Respective teachers can request school administration to arrange a traffic awareness campaign for the community. Students can display their charts as part of the campaign.

SOLUTION

ANSWER KEY**1.1 PROBLEM SOLVING STEPS**

1	D	2	B	3	A	4	C	5	A
6	A	7	C	8	B	9	E	10	A
11	C	12	B	13	D	14	C	15	C

1.2 FLOWCHARTS

1	B	2	A	3	B	4	A	5	A
6	D	7	A	8	B	9	C	10	A
11	B								

1.3 ALGORITHM

1	A	2	B	3	D	4	D	5	A
6	B	7	B	8	D	9	B	10	A
11	C								

1.4 TEST DATA

1	C	2	C	3	D	4	A	5	B
---	---	---	---	---	---	---	---	---	---

1.5 VERIFICATION AND VALIDATION

1	B	2	C
---	---	---	---

1.6 IDENTIFICATION AND CORRECTION OF ERRORS

1	C	2	B
---	---	---	---