Flow of Control

In This Chapter

9.1 Introduction

Generally a program executes its statements from beginning to end. But not many programs execute all their statements in strict order from beginning to end. Programs, depending upon the need, can choose to execute one of the available alternatives or even repeat a set of statements. To perform their manipulative miracles, programs need tools for performing repetitive actions and for making decisions. Python, of course, provides such tools by providing statements to attain so. Such statements are called *program control statements*. This chapter discusses such statements in details. Firstly, selection statement *if* and later iteration statements *for* and *while* are discussed.

This chapter also discusses some jump statements of Python which are *break* and *continue*.

9.2 Types of Statements in Python

Statements are the instructions given to the computer to perform any kind of action, be it *data movements*, and be it *making decisions* or be it *repeating actions*. Statements form the smallest executable unit within a Python program. Python statements can belong to one of the following *three* types :

- Empty Statement
- Simple Statement (Single statement)
- Compound Statement

1. Empty Statement (Null Statement)

The simplest statement is the *empty* statement *i.e.*, a statement which does nothing. In Python an empty statement is **pass** statement. It takes the following form :

```
pass
```

Wherever Python encounters a **pass** statement, Python does nothing and moves to next statement in the flow of control.

NOTE

The **pass** statement of Python is a *do nothing* statement *i.e.*, empty statement or null operation statement.

A **pass** statement is useful in those instances where the syntax of the language requires the presence of a statement but where the logic of the program does not. We will see it in loops and their bodies.

2. Simple Statement

Any single executable statement is a simple statement in Python. For example, following is a simple statement in Python :

```
name = input ( "Your name" )
```

Another example of simple statement is :

```
print (name)      # print function called
```

As you can make out that simple statements are single line statements.

3. Compound Statement

A compound statement represents a group of statements executed as a unit. The compound statements of Python are written in a specific pattern as shown below :

```
<compound statement header> :
    <indented body containing multiple\
    simple and/or compound statements>
```

That is, a compound statement has :

- a **header line** which begins with a keyword and ends with a colon.
- a **body** consisting of one or more Python statements, each indented[1] inside the header line. All statements in the body are at the same level of indentation.

You'll learn about some other compound statements (*if, for, while*) in this chapter.

NOTE

A *compound statement* in Python has a *header* ending with a colon (:) and a *body* containing a sequence of statements at the same level of indentation.

9.3 Statement Flow Control

In a program, statements may be executed sequentially, selectively or iteratively. Every programming language provides constructs to support sequence, selection or iteration.

Let us discuss what is meant by sequence, selection or iteration constructs.

Sequence

The sequence construct means the statements are being executed sequentially. This represents the default flow of statement (*see* Fig. 9.1).

Every Python program begins with the first statement of program. Each statement in turn is executed (sequence construct). When the final statement of program is executed, the program is done. **Sequence** refers to the normal flow of control in a program and is the simplest one.

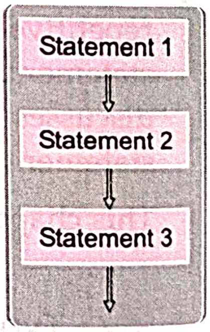

Figure 9.1 The sequence construct.

Selection

The selection construct means the execution of statement(s) depending upon a condition-test. If a condition evaluates to *True*, a course-of-action (a set of statements) is followed otherwise another course-of-action (a different set of statements) is followed. This construct (*selection construct*) is also called *decision construct* because it helps in making decision about which set-of-statements is to be executed.

[1] **Conventionally, Python uses four spaces to move to next level of indentation.**

Adjacent figure (Fig. 9.2) explains selection construct.

You apply decision-making or selection in your real life so many times *e.g.*, if the traffic signal light is **red**, then **stop**; if the traffic signal light is **yellow** then **wait** ; and if the signal light is **green** then **go**.

You can think of many such real life examples of selection/decision-making.

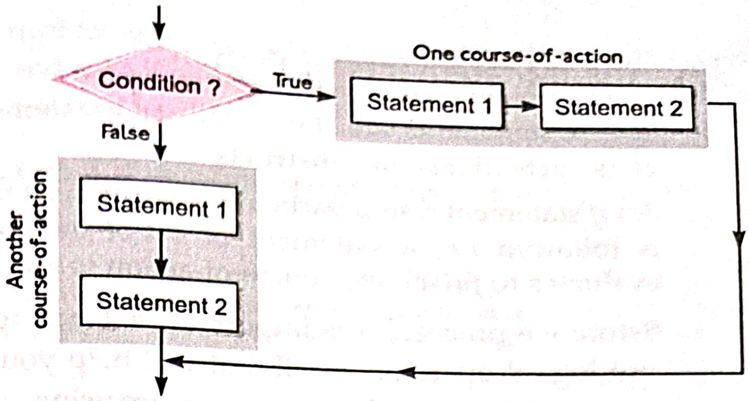

Figure 9.2 The selection construct.

Repetition Iteration (Looping)

The iteration constructs mean *repetition of a set-of-statements* depending upon a *condition-test*. Till the time a condition is *True* (or *False* depending upon the loop), a set-of-statements are repeated again and again. As soon as the condition becomes *False* (or *True*), the repetition stops. The iteration construct is also called *looping construct*.

The adjacent figure (Fig. 9.3) illustrates an iteration construct.

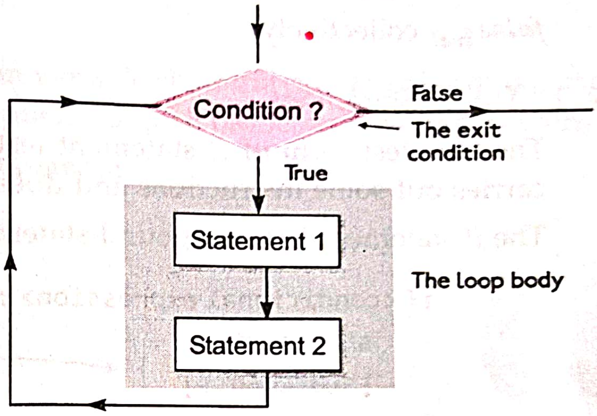

Figure 9.3 The iteration/repetition construct.

The set-of-statements that are repeated again and again is called the *body of the loop*. The condition on which the execution or exit of the loop depends is called *the exit condition* or *test-condition*.

You can find many examples of iteration or looping around you. For instance, you often see your mother cook *chapatis* or *dosas* or *appams* for you.

Let's see, what she does for it :

(*i*) put rolled chapati or dosa batter on flat pan or tawa

(*ii*) turn it 2-3 times (*iii*) once done take it off.

Repeat the adjacent process (steps (*i*), (*ii*), (*iii*)) for next chapati/dosa/appam. This is looping or iteration.

Check Point

9.1

1. What is a statement ? How many types of statements are there in Python ?
2. What is the significance of a pass statement?
3. What is a compound statement ? Give example of a compound statement.
4. What are the three constructs that govern statement flow ?
5. What is the need for selection and looping constructs ?

You can find numerous other examples of repetitive work in your real life *e.g.*, washing clothes ; colouring in colouring book etc. etc.

Every programming language must support these three types of constructs as the sequential program execution (the default mode) is inadequate to the problems we must solve. Python also provides statements that support these constructs. Coming sections discuss these Python statements – ***if*** that supports selection and ***for*** and ***while*** that support iteration. Using these statements you can create programs as per your need.

9.4 The if Statements of Python

The **if** statements are the conditional statements in Python and these implement **selection constructs (decision constructs)**.

An *if* statement tests a particular condition ; if the condition evaluates to ***true***, a course-of-action is followed *i.e.*, a statement or set-of-statements is executed. Otherwise (if the condition evaluates to ***false***), the course-of-action is ignored.

Before we proceed, it is important that you recall what you learnt in Chapter 7 in relational and logical operators as all that will help you form conditionals in this chapter. Also, please note in all forms of *if* statement, we are using *true* to refer to Boolean value ***True as well as truth value true*** $_{tval}$ collectively ; similarly, *false* here will refer to Boolean value ***False and truth value false*** $_{tval}$ collectively.

9.4.1 The if Statement

The simplest form of *if* statement tests a condition and if the condition evaluates to *true*, it carries out some instructions and does nothing in case condition evaluates to *false*.

The *if* statement is a compound statement and its syntax (general form) is as shown below :

```
if <conditional expression> :
    statement
    [statements]
```

*The statements inside an **if** are indented at same level.*

where a statement may consist of a single statement, a compound statement, or just the *pass* statement (in case of empty statement).

Carefully look at the *if statement* ; it is also a *compound statement* having a *header* and a *body* containing indented statements.

For instance, consider the following code fragment :

```
if ch == ' ' :
    spaces += 1
    chars += 1
```

Conditional expression

*The **header** of if statement; notice colon (**:**) at the end*

***Body of if** . Notice that all the statements in the **if-body** are indented at same level*

In an ***if statement***, if the *conditional expression* evaluates to *true*, the statements in the *body-of-if* are executed, otherwise ignored.

The above code will check whether the character variable **ch** stores a space or not ; if it does (*i.e.*, the condition ch== ' ' evaluates to *true*) , the number of spaces are incremented by *1* and number of characters (stored in variable chars) are also incremented by value *1*.

NOTE

Indentation in Python is very important when you are using a compound statement. Make sure to indent all statements in one block at the same level.

To see
if Statement
in action

If, however, variable ch does not store a space *i.e.*, the condition ch==' ' evaluates to *false*, then nothing will happen ; no statement from the *body-of-if* will be executed. Consider another example illustrating the use of *if* statement :

```
ch = input ( "Enter a single character :" )
if ch >= '0' and ch <= '9' :
    print ("You entered a digit.")
```

The above code, after getting input in **ch**, compares its value ; if value of **ch** falls between characters '0' to '9' *i.e.*, the condition evaluates to *true*, and thus it will execute the statements in the ***if-body*** ; that is, it will print a message saying 'You entered a digit.'

Now consider another example that uses two if statements one after the other :

```
ch = input ('Enter a single character :')

if ch == ' ' :
```

*If this condition is **false** then the control will directly reach to following **if** statement, ignoring the body-of this-if statement*

```
    print ("You entered a space")

if ch >='0' and ch <='9' :
    print ("You entered a digit.")
```

The above code example reads a single character in variable **ch**. If the character input is a space, it flashes a message specifying it. If the character input is a digit, it flashes a message specifying it.

The following example also makes use of an ***if*** statement :

```
A = int ( input ( "Enter first integer :" ) )
B = int ( input ( "Enter second integer :" ) )
    if A > 10 and B < 15 :
    C = (A - B) * (A + B)
    print ("The result is", C)
print ("Program over")
```

*This statement is not part of **if** statement as it not indented at the same level as that of **body of if** statements.*

The above program has an ***if*** statement with two statements in its body ; last ***print*** statement is not part of ***if*** statement. Have a look at some more examples of conditional expressions in if statements :

(*a*)
```
if grade == 'A' :                  # comparison with a literal
        print ("You did well")
```

(*b*)
```
if a > b :                         # comparing two variables
        print ("A has more than B has")
```

(*c*)
```
if x :                             # testing truth value of a variable
        print ("x has truth value as true")
        print ("Hence you can see this message.")
```

You have already learnt about truth values and ***truth value testing*** in ***Chapter 7 under section 7.4.3A***. I'll advise you to have a look at section 7.4.3A once again as it will prove very helpful in understanding conditional expressions.

Now consider one more test condition :

```
if not x :                 # not x will return True when x has a truth value as false
    print ("x has truth value as false this time")
```

The value of **not *x*** will be *True* only when *x* is $false_{tval}$ and *False* when *x* is $true_{tval}$.

The above discussed plain if statement will do nothing if the condition evaluates to *false* and moves to the next statement that follows if-statement.

9.4.2 The if – else Statement

This form of *if* statement tests a condition and if the condition evaluates to *true*, it carries out statements indented below **if** and in case condition evaluates to *false*, it carries out statements indented below **else**. The syntax (general form) of the *if-else* statement is as shown below :

```
if <conditional expression> :
        statement
        [statements]
else :
        statement
        [statements]
```

colons after both if and else

The block below if gets executed if the condition evaluates to *true* and the block below else gets executed if the condition evaluates to *false*.

For instance, consider the following code fragment :

```
if a >= 0 :
        print (a, "is zero or a positive number")
else :
        print (a, "is a negative number")
```

For any value more than zero (say 7) of variable *a*, the above code will print a message like :

```
7 is zero or a positive number
```

And for a value less than zero (say –5) of variable *a*, the above code will print a message like :

```
-5 is a negative number
```

Unlike previously discussed plain-if statement, which does nothing when the condition results into *false*, the **if-else** statement performs some action in both cases whether condition is *true* or *false*. Consider one more example :

```
if sales >= 10000 :
        discount = sales * 0.10
else :
        discount = sales * 0.05
```

The above statement calculates *discount* as 10% of *sales amount* if it is 10000 or more otherwise it calculates discount as 5% of *sales amount*.

NOTE

An if-else in comparison to two successive **if** statements has less number of condition-checks *i.e.*, with **if-else**, the condition will be tested once in contrast to two comparisons if the same code is implemented with two successive **ifs**.

Following figure (Fig. 9.4) illustrates *if* and *if-else* constructs of Python.

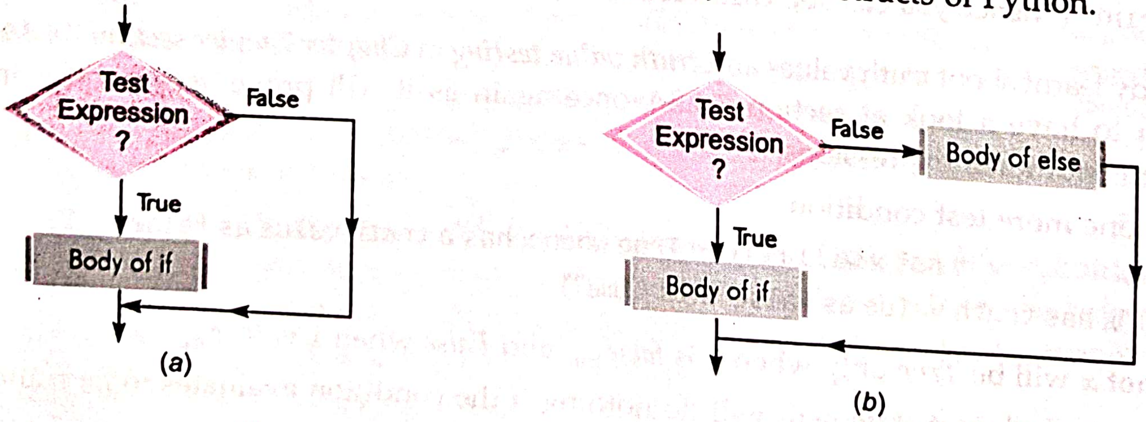

Figure 9.4 (*a*) The **if** statement's operation (*b*) The **if-else** statement's operation.

Let us now apply this knowledge of *if* and *if-else* in form of some programs.

9.1 *Program that takes a number and checks whether the given number is odd or even.*

```
num = int ( input( "Enter an integer :" ))
if num % 2 == 0 :
    print (num, "is EVEN number.")
else :
    print (num, "is ODD number.")
```

The sample run of above code is as shown below.

This Program in action

Scan QR Code

```
Enter an integer : 8
8  is EVEN number.
```

9.2 *Program to accept three integers and print the largest of the three. Make use of only if statement.*

```
x = y = z = 0
x = float (input( "Enter first number :" ) )
y = float (input( "Enter second number :" ) )
z = float (input( "Enter third number :" ) )

max = x
if y > max :
    max = y
if z > max :
    max = z
print ("Largest number is", max)
```

```
Enter first number : 7.235
Enter second number : 6.99
Enter third number : 7.533
Largest number is  7.533
```

9.3 *Program that inputs three numbers and calculates two sums as per this :*

Sum1 as the sum of all input numbers

Sum2 as the sum of non-duplicate numbers; if there are duplicate numbers in the input, ignores them

e.g., Input of numbers 2, 3, 4 will give two sums as 9 and 9

Input of numbers 3,2, 3, will give two sums as 8 and 2 (both 3's ignored for second sum)

Input of numbers 4, 4, 4 will give two sums as 12 and 0 (all 4's ignored for second sum)

Alternative 1

```
sum1 = sum2 = 0
num1 = int(input("Enter number 1 : "))
num2 = int(input("Enter number 2 : "))
num3 = int(input("Enter number 3 : "))

sum1 = num1 + num2 + num3
if num1 != num2 and num1 != num3 :
    sum2 += num1
if num2 != num1 and num2 != num3 :
    sum2 += num2
if num3 != num1 and num3 != num2 :
    sum2 += num3

print("Numbers are", num1, num2, num3)
print("Sum of three given numbers is", sum1)
print("Sum of non-duplicate numbers is", sum2)
```

Alternative 2

```
sum1 = sum2 = 0
num1 = int(input("Enter number 1 : "))
num2 = int(input("Enter number 2 : "))
num3 = int(input("Enter number 3 : "))
sum1 = num1 + num2 + num3

if num1 == num2 :
    if num3 != num1 :
        sum2 += num3
else :
    if num1 == num3 :
        sum2 += num2
    else :
        if num2 == num3 :
            sum2 += num1
        else :
            sum2 += num1 + num2 + num3
print("Numbers are", num1, num2, num3)
print("Sum of three given numbers is", sum1)
print("Sum of non-duplicate numbers is", sum2)
```

Sample run of above program is as shown below :

```
Enter number 1 : 2
Enter number 2 : 3
Enter number 3 : 4
Numbers are 2 3 4
Sum of three given numbers is 9
Sum of non-duplicate numbers is 9
==========================
Enter number 1 : 3
Enter number 2 : 2
Enter number 3 : 3
Numbers are 3 2 3
Sum of three given numbers is 8
Sum of non-duplicate numbers is 2
==========================
Enter number 1 : 4
Enter number 2 : 4
Enter number 3 : 4
Numbers are 4 4 4
Sum of three given numbers is 12
Sum of non-duplicate numbers is 0
```

Program 9.4 *Program to test the divisibility of a number with another number (i.e., if a number is divisible by another number).*

```
number1 = int(input("Enter first number :"))
number2 = int(input("Enter second number :"))
remainder = number1 % number2
if remainder == 0 :
    print(number1,"is divisible by", number2)
else :
    print(number1,"is not divisible by", number2)
```

```
Enter first number : 119
Enter second number : 3
119.0 is not divisible by 3.0
====================
Enter first number : 119
Enter second number : 17
119.0 is divisible by 17.0
====================
Enter first number : 1234.30
Enter second number : 5.5
1234.3 is not divisible by 5.5
```

Program 9.5 *Program to find the multiples of a number (the divisor) out of given five numbers.*

```
print("Enter five numbers below")
num1 = float(input("First number :"))
num2 = float(input("Second number :"))
num3 = float(input("Third number :"))
num4 = float(input("Fourth number :"))
num5 = float(input("Fifth number :"))
divisor = float(input("Enter divisor number :"))
count = 0
print("Multiples of", divisor, "are :")
remainder = num1 % divisor
if remainder == 0 :
    print(num1, sep =" ")
    count += 1
remainder = num2 % divisor
if remainder == 0 :
    print(num2, sep =" ")
    count += 1
remainder = num3 % divisor
if remainder == 0 :
    print(num3, sep =" ")
    count += 1
remainder = num4 % divisor
if remainder == 0 :
    print(num4, sep =" ")
    count += 1
remainder = num5 % divisor
if remainder == 0 :
    print(num5, sep =" ")
    count += 1
print()
print(count, "multiples of", divisor, "found")
```

Sample run of above program is as shown below :

```
Enter five numbers below
First number : 185
Second number : 3450
Third number : 1235
Fourth number : 1100
Fifth number : 905
Enter divisor number : 15

Multiples of 15.0 are :
3450.0
1 multiples of 15.0 found
```

Program 9.6 *Program to display a menu for calculating area of a circle or perimeter of a circle.*

```
radius = float ( input ( "Enter radius of the circle :" ))
print ("1. Calculate Area")
print ("2. Calculate Perimeter")
choice = int (input( "Enter your choice (1 or 2 ) :" ))
if choice == 1 :
    area = 3.14159 * radius * radius
    print ("Area of circle with radius", radius, 'is', area)
else :
    perm = 2 * 3.14159 * radius
    print ("Perimeter of circle with radius", radius, 'is', perm)
```

```
Enter radius of the circle : 2.5
     1. Calculate Area
     2. Calculate Perimeter
Enter your choice (1 or 2 ) : 1
Area of circle with radius  2.5  is 19.6349375
===================== RESTART =========================
Enter radius of the circle : 2.5
     1. Calculate Area
     2. Calculate Perimeter
Enter your choice (1 or 2 ) : 2
Perimeter of circle with radius 2.5 is 15.70795
```

Notice, the test condition of *if* statement can be any relational expression or a logical statement (*i.e.*, a statement that results into either *true* or *false*). The ***if*** statement is a compound statement, hence its both **if** and **else** lines must end in a colon and statements part of it must be indented below it.

9.4.3 The if - elif Statement

Sometimes, you need to check another condition in case the test-condition of *if* evaluates to *false*. That is, you want to check a condition when control reaches **else** part, *i.e.*, condition test in the form of **else if**. To understand this, consider this adjacent example.

```
if runs are more than 100
    then it is a century
else if runs are more than 50
    then it is a fifty
else
    batsman has neither scored a century nor fifty
```

Refer to program 9.3 given earlier, where we have used **if** inside another **if/else**.

To serve conditions as above *i.e.*, in **else if** form (or **if** inside an **else**), Python provides ***if-elif*** and ***if-elif-else*** statements. The general form of these statements is :

```
if <conditional expression> :
    statement
    [statements]
elif <conditional expression> :
    statement
    [statements]
```

and

```
if <conditional expression> :
    statement
    [statements]
elif <conditional expression> :
    statement
    [statements]
else :
    statement
    [statements]
```

NOTE

if, elif and **else** all are block or compound statements.

Now the above mentioned example can be coded in Python as :

```
if runs >= 100 :
    print ("Batsman scored a century")
elif runs >= 50 :
    print ("Batsman scored a fifty")
else :
    print ("Batsman has neither scored a century nor fifty")
```

Python will test this condition in case previous condition (runs >= 100) is false.

This block will be executed when both the if's condition (i.e., runs >=100) and elif condition (i.e., runs>=50) are false.

To see **if-elif Statement** in action

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Let us have a look at some more code examples :

```
if num < 0 :
    print (num, "is a negative number.")
elif num == 0 :
    print (num, "is equal to zero.")
else :
    print (num, "is a positive number.")
```

Can you make out what the above code is doing ? Hey, don't get angry. I was just kidding. I know you know that it is testing a number whether it is negative (< 0), or zero (= 0) or positive (> 0). Consider another code example :

```
if sales >= 30000 :
    discount = sales * 0.18
elif sales >= 20000 :
    discount = sales * 0.15
elif sales >= 10000 :
    discount = sales * 0.10
else :
    discount = sales * 0.05
```

*There can be as many **elif blocks** as you need. Here, the code is having two **elif blocks***

This block will be executed when none of above conditions are true.

Consider following program that uses an if-elif statement.

Program 9.7 *Program that reads two numbers and an arithmetic operator and displays the computed result.*

```
num1 = float ( input( "Enter first number :" ) )
num2 = float ( input( "Enter second number :" ) )
op = input( "Enter operator [ + - * / % ] :" )
result = 0
if op == '+' :
    result = num1 + num2
elif op == '-' :
    result = num1 -  num2
elif op == '*' :
    result = num1 * num2
elif op == '/' :
    result = num1 / num2
elif op == '%' :
    result = num1 % num2
else :
    print ("Invalid operator!!")
print (num1, op, num2 , '=', result)
```

```
Enter first number : 5
Enter second number : 2
Enter operator [ + - * / % ] : *
5.0 * 2.0 = 10.0
============ RESTART ==========
Enter first number : 5
Enter second number : 2
Enter operator [ + - * / % ] : /
5.0 / 2.0 = 2.5
========= RESTART +============
Enter first number : 5
Enter second number : 2
Enter operator [ + - * / % ] : %
5.0 % 2.0 = 1.0
```

Now try writing code of program 9.3 using **if-elif-else** statements.

9.4.4 The nested if Statement

Sometimes above discussed forms of if are not enough. You may need to test additional conditions. For such situations, Python also supports *nested-if form of if.*

A *nested if* is an *if* that has another **if** in its *if*'s body or in *elif*'s body or in its *else*'s body.

The **nested if** can have one of the following forms :

Form 1 (*if inside if's body*)

```
if <conditional expression> :
    if <conditional expression> :
        statement(s)
    else :
        statement(s)
elif <conditional expression> :
    statement
    [statements]
else :
    statement
    [statements]
```

Form 2 (*if inside elif's body*)

```
if <conditional expression> :
    statement
    [statements]
elif <conditional expression> :
    if <conditional expression> :
        statement(s)
    else :
        statement(s)
else :
    statement
    [statements]
```

Form 3 (*if inside else's body*)

```
if <conditional expression> :
    statement
    [statements]
elif <conditional expression> :
    statement
    [statements]
else :
    if <conditional expression> :
        statement(s)
    else :
        statement(s)
```

Form 4 (*if inside if's as well as else's or elif's body, i.e., multiple ifs inside*)

```
if <conditional expression> :
    if <conditional expression> :
        statement(s)
    else :
        statement(s)
elif <conditional expression> :
    if <conditional expression> :
        statement(s)
    else :
        statement(s)
else :
    if <conditional expression> :
        statement(s)
    else :
        statement(s)
```

In a **nested if** statement, either there can be *if* statement(s) in its *body-of-if* or in *its body-of-elif* or in its *body-of-else* or in any two of these or in all of these. Recall that you used **nested-if** unknowingly in program 9.3. Isn't that superb ? ;)

Following example programs illustrate the use of nested ifs.

Program 9.8 *Program that reads three numbers (integers) and prints them in ascending order.*

```
x = int(input( "Enter first number :" ))
y = int(input( "Enter second number :" ))
z = int(input( "Enter third number :" ))
min = mid = max = None

if x < y and x < z :
    if y < z :
        min, mid, max = x, y, z
    else :
        min, mid, max = x, z, y
elif y < x and y < z :
    if x < z :
        min, mid, max = y, x, z
    else :
        min, mid, max = y, z, x
else :
    if x < y :
        min, mid, max = z, x, y
    else:
        min, mid, max = z, y, x
print ("Numbers in ascending order :", min, mid, max)
```

Two sample runs of the program are as given below :

```
Enter first number : 5
Enter second number : 9
Enter third number : 2
Numbers in ascending order : 2 5 9
=========== RESTART ===========
Enter first number : 9
Enter second number : 90
Enter third number : 19
Numbers in ascending order : 1 19 90
```

Let us now have a look at some programs that use different forms of *if* statement.

Program 9.9 *Program to print whether a given character is an uppercase or a lowercase character or a digit or any other character.*

```
ch = input( "Enter a single character :" )
if ch >= 'A' and ch <= 'Z' :
  print ("You entered an Upper case character.")
elif ch >= 'a' and ch <= 'z'  :
  print ("You entered a lower case character.")
elif ch >= '0' and ch <= '9'  :
  print  ("You entered a digit.")
else :
  print ("You entered a special character.")
```

Sample run of the program is as shown below :

```
Enter a character : 5
You entered a digit.
=========== RESTART ===========
Enter a character : a
You entered a lower case character.
=========== RESTART ===========
Enter a character : H
You entered an Upper case character.
=========== RESTART ===========
Enter a character : $
You entered a special character.
```

Program

9.10 *Program to calculate and print roots of a quadratic equation :* $ax^2 + bx + c = 0$ $(a \neq 0)$.

```
import math
print ("For quadratic equation, ax**2 + bx + c = 0, enter coefficients below")
a = int( input ( " Enter a :" ) )
b = int( input ( " Enter b :" ) )
c = int( input ( " Enter c :" ) )
if a == 0 :
     print ("Value of", a, ' should not be zero')
     print ("\n Aborting !!!!!!")
else :
     delta = b * b - 4 * a * c
     if  delta > 0 :
          root1 = ( -b + math.sqrt(delta)) / (2 * a)
          root2 = (-b - math.sqrt(delta)) / (2 * a)
          print ("Roots are REAL and UNEQUAL")
          print ("Root1 =", root1, ", Root2 =", root2)
     elif delta == 0 :
          root1 = -b / (2 * a)
          print ("Roots are REAL and EQUAL")
          print ("Root1 =", root1, ", Root2 =", root1)
     else :
          print ("Roots are COMPLEX and IMAGINARY")
```

NOTE

You can use sqrt( ) function of math package to calculate squareroot of a number. Use it as :

`math.sqrt(<number or expression>)`

To use this function, add first line as **import math** to your program

NOTE

An *if* statement is also known as a conditional.

```
For quadratic equation, ax**2 + bx + c = 0, enter coefficients below
  Enter a : 3
  Enter b : 5
  Enter c : 2
Roots are REAL and UNEQUAL
Root1 =  - 0.666666666667 ,  Root2 =  -1.0
======================== RESTART ===========================
For quadratic equation, ax**2 + bx + c = 0, enter coefficients below
  Enter a : 2
  Enter b : 3
  Enter c : 4
Roots are COMPLEX and IMAGINARY
======================== RESTART ===========================
For quadratic equation, ax**2 + bx + c = 0, enter coefficients below
  Enter a : 2
  Enter b : 4
  Enter c : 2
Roots are REAL and EQUAL
Root1 =  -1 , Root2 =  -1
```

Storing Conditions

Sometimes the conditions being used in code are complex and repetitive. In such cases, to make your program more readable, you can use **named conditions** *i.e.*, you can store conditions in a name and then use that named conditional in the if statements.

For example, to create conditions similar to the ones given below :

- If a deposit is less than ₹2000 and for 2 or more years, the interest rate is 5 percent.
- If a deposit is ₹2000 or more but less than ₹6000 and for 2 or more years, the interest rate is 7 percent.
- If a deposit is more than ₹6000 and is for 1 year or more, the interest is 8 percent.
- On all deposits for 5 years or more, interest is 10 percent compounded annually.

Check Point

9.2

1. What is a selection statement? Which selection statements does Python provide ?
2. How does a conditional expression affect the result of if statement?
3. Correct the following code fragment :

```
if (x = 1)
    k = 100
else
    k = 10
```

4. What will be the output of following code fragment if the input given is (*i*) 7 (*ii*) 5 ?

```
a = input('Enter a number')
if (a == 5) :
    print ("Five" )
else :
    print ("Not Five")
```

5. What will be the output of the following code fragment if the input given is (*i*) 2000 (*ii*) 1900 (*iii*) 1971 ?

```
year = int(input( "Enter 4-digit year"))
if (year % 100 == 0) :
    if (year % 400 == 0):
        print ("LEAP century year")
else :
    print ("Not century year")
```

6. What will be the output of the following code fragment if the input given is (*i*) 2000 (*ii*) 1900 (*iii*) 1991 ?

```
year = int(input( "Enter 4-digit year"))
if (year % 100 == 0) :
    if (year % 400 == 0):
        print ("LEAP century year")
    else :
        print ("Not century year")
```

The traditional way of writing code will be :

```
if deposit < 2000 and time >= 2 :
    rate = 0.05
    :
```

But if you name the conditions separately and use them later in your code, it adds to readability and understandability of your code, *e.g.*,

```
eligible_for_5_percent = deposit < 2000 and time >= 2
eligible_for_7_percent = 2000 <= deposit < 6000 and time >= 2
eligible_for_8_percent = deposit > 6000 and time >= 1
eligible_for_10_percent = time >= 5
```

Now you can use these *named conditionals* in the code as follows :

```
if eligible_for_5_percent :
    rate = 0.05
elif eligible_for_7_percent :
    rate = 0.075
    :
```

TIP

You can use named conditions in *if* statements to enhance readability and reusability of conditions.

riP

DECISION CONSTRUCT *if*

Progress In Python 9.1

This 'Progress in Python' session is aimed at laying strong foundation of decision constructs.

:

>>>❖<<<

9.5 Repetition of Tasks – a Necessity

We mentioned earlier that there are many situations where you need to repeat same set of tasks again and again *e.g.*, the tasks of making chapatis/dosas/appam at home, as mentioned earlier. Now if you have to write pseudocode for this task how would you do that.

Let us first write the task of making dosas/appam from a prepared batter.

1. Heat flat pan/tawa
2. Spread evenly the dosa/appam batter on the heated flat pan.
3. Flip it carefully after some seconds.
4. Flip it again after some seconds.
5. Take it off from pan.
6. To make next dosa/appam go to step 2 again.

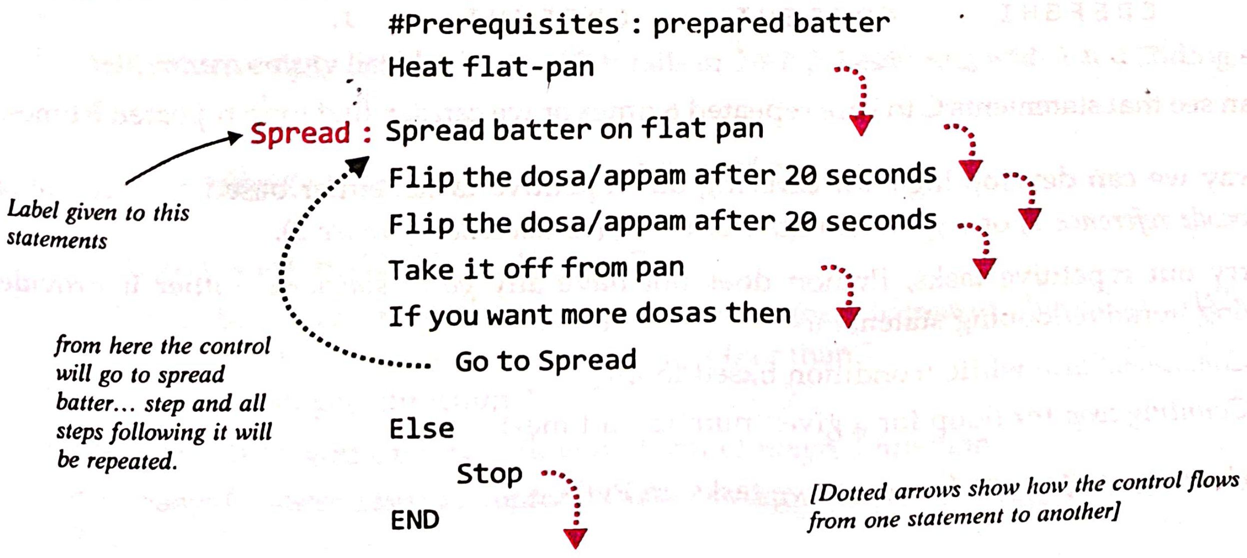
Let us try to write pseudocode for above task of making dosas/appam as many as you want.

```
#Prerequisites : Prepared batter
Heat flat-pan/tawa
Spread batter on flat pan
Flip the dosa/appam after 20 seconds
Flip the dosa/appam after 20 seconds
Take it off from pan
if you want more dosas then
    ????
else
    stop
```

Now what should you write at the place of ????, so that it starts repeating the process again from second step ? Since there is no number associated with steps, how can one tell from where to repeat ?

There is a way out : If there is a **label** that marks the statement from where you want to repeat the task, then we may send the control to that label and then that statement onwards, statements get repeated. That is,

Pseudocode Reference 1



```
         #Prerequisites : prepared batter
         Heat flat-pan
Spread : Spread batter on flat pan
         Flip the dosa/appam after 20 seconds
         Flip the dosa/appam after 20 seconds
         Take it off from pan
         If you want more dosas then
             Go to Spread
         Else
             Stop
         END
```

Label given to this statements

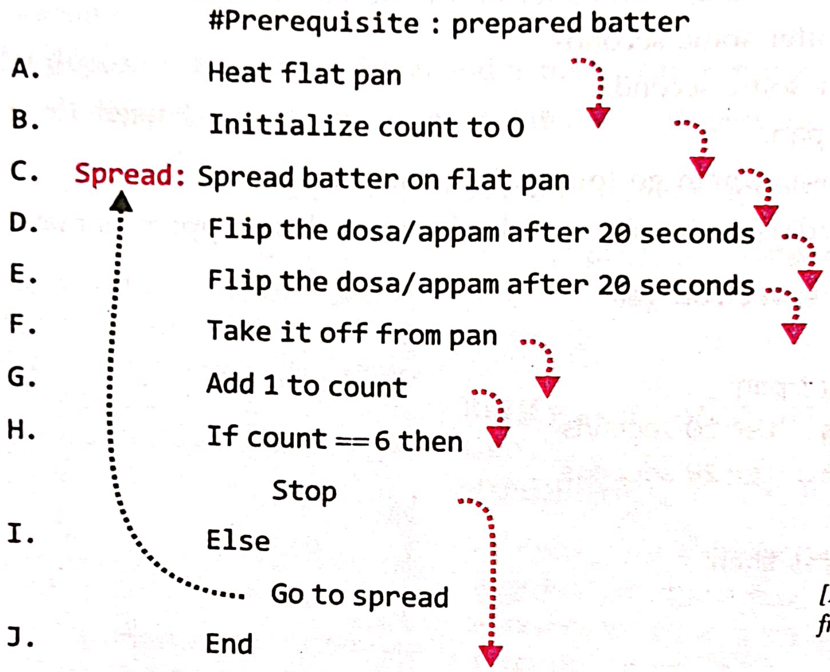
from here the control will go to spread batter... step and all steps following it will be repeated.

[Dotted arrows show how the control flows from one statement to another]

Now the above pseudocode is fit for making as many dosas/appam as you want. But what if you already know that you need only 6 dosas/appam ? In that case above pseudocode will not serve the purpose.

Let us try to write pseudocode for this situation. For this, we need to maintain a count of dosa/appam made.

Pseudocode Reference 2



```
                  #Prerequisite : prepared batter
A.                Heat flat pan
B.                Initialize count to 0
C.   Spread:  Spread batter on flat pan
D.                Flip the dosa/appam after 20 seconds
E.                Flip the dosa/appam after 20 seconds
F.                Take it off from pan
G.                Add 1 to count
H.                If count == 6 then
                      Stop
I.                Else
                      Go to spread
J.                End
```

[Dotted arrows show how the control flows from one statement to another]

If we number the pseudocode statements as A.B.C.... as shown above for our reference, if you notice carefully, the statements are executed as :

$$A \quad B \quad \underbrace{CDEFGHI} \quad \underbrace{CDEFGHI}_{\text{Statements repeated}} \quad \underbrace{CDEFGHI} \quad \underbrace{CDEFGHI} \quad \underbrace{CDEFGHI} \quad \underbrace{CDEFGHI} \quad J.$$

You can see that statements C to I are repeated 6 times or we can say that loop repeated 6 times.

This way we can develop logic for carrying out repetitive tasks, either based on a condition (*pseudocode reference* 1) or a given number of times (*pseudocode reference* 2).

To carry out repetitive tasks, Python does not have any *go to statement* rather it provides following iterative/looping statements :

- *Conditional loop* **while** (condition based loop)
- *Counting loop* **for** (loop for a given number of times).

Let us learn to write code for repetitive tasks, in Python.

9.6 The range( ) Function

Before we start with loops, especially *for loop* of Python, let us discuss the ***range( )*** function of Python, which is used with the Python ***for loop***. The *range ( )* function of Python generates a list which is a special sequence type. A sequence in Python is a succession of values bound together by a single name. Some Python sequence types are : *strings, lists, tuples* etc. (see Fig. 9.5). There are some advance sequence types also but those are beyond the scope of our discussion.

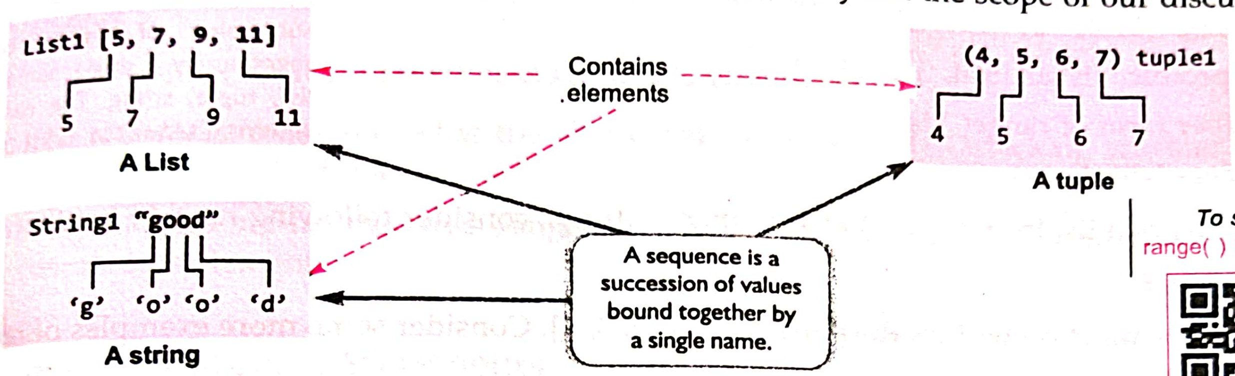


Figure 9.5 Some common sequence types

To see
range( ) Function

Scan
QR Code

Let us see how *range( )* function works. The common use of *range( )* is in the form given below :

```
range( <lower limit>, <upper limit>)    # both limits should be integers
```

The function in the form **range(l, u)** will produce a list having values starting from ***l***, ***l*** **+ 1**, ***l*** **+ 2** ... **(*u* – 1)** (***l*** and ***u*** being integers). Please note that the lower limit is included in the list but upper limit is not included in the list, *e.g.*,

```
range(0,5)
```

the default step-value in values will be +1

will produce list as **[0, 1, 2, 3, 4].**

As these are the numbers in arithmetic progression (a.p.) that begins with lower limit 0 and goes up till *upper limit minus 1 i.e.*, 5 – 1 = 4.

```
range(5,0)
```

default step-value = +1

will return empty list [ ] as no number falls in the a.p. beginning with 5 and ending at 0 (difference *d* or step-value = +1).

```
range(12, 18)
```

default step-value = +1

will give a list as [12, 13, 14, 15, 16, 17].

All the above examples of *range( )* produce numbers increasing by value 1. What if you want to produce a list with numbers having gap other than 1, *e.g.*, you want to produce a list like [2, 4, 6, 8] using range( ) function ?

For such lists, you can use following form of *range( )* function :

```
range( <lower limit>, <upper limit>, <step value>)    #all values should be integers
```

That is, function

```
range(l, u, s)              # l, u and s are integers
```

will produce a list having values as *l, l + s, l + 2s, ... <= u – 1.*

```
range(0, 10, 2)  ◄------  step-value = +2
```

will produce list as [0, 2, 4, 6, 8]

```
range (5, 0, -1) ◄------  step-value = –1
```

will produce list as [5, 4, 3, 2, 1].

Another form of range( ) is :

```
range(<number>)
```

that creates a list from 0 (zero) to <number> – 1, *e.g.*, consider following *range( )* function :

```
range(5)
```

The above function will produce list as [0, 1, 2, 3, 4]. Consider some more examples of *range()* function :

Statement	Values generated
range(10)	0, 1, 2, 3, 4, 5, 6, 7, 8, 9
range(5, 10)	5, 6, 7, 8, 9
range(3, 7)	3, 4, 5, 6
range(5, 15, 3)	5, 8, 11, 14
range(9, 3, –1)	9, 8, 7, 6, 5, 4
range(10, 1, –2)	10, 8, 6, 4, 2

NOTE

A sequence in Python is a succession of values bound together by a single name *e.g.*, list, tuple, string. The range( ) returns a sequence of list type.

Operators in and not in

Let us also take about **in** operator, which is used with *range( )* in for loops.

To check whether a value is contained inside a list you can use **in** operator, *e.g.*,

```
3 in [1,2,3,4]  ◄------  This expression will test if value 3 is
                         contained in the given sequence
```

will return *True* as value 3 is contained in sequence [1, 2, 3, 4].

```
5 in [1,2,3,4]
```

will return *False* as value 5 is not contained in sequence [1, 2, 3, 4]. But

```
5 not in [1,2,3,4]
```

will return *True* as this fact is true that as value 5 is not contained in sequence [1, 2, 3, 4]. The operator **not in** does opposite of **in** operator.

NOTE

The **in** operator tests if a given value is contained in a sequence or not and returns **True** or **False** accordingly.

You can see that **in** and **not** in are the operators that check for membership of a value inside a sequence. Thus, **in** and **not in** are also called **membership operators**. These operators work with all sequence types *i.e., strings, tuples* and *lists* etc. For example, consider following code :

```
'a' in "trade"
```

will return *True* as *'a'* is contained in sequence (string type) "trade".

```
"ash" in "trash"
```

will also return *True* for the same reason.

Now consider the following code that uses the **in** operator :

```
line = input( "Enter a line :" )
string = input( "Enter a string :" )
if string in line :
    print (string, "is part of", line.)
else :
    print (string, "is not contained in", line.)
```

if the given string is a part of line

> **NOTE**
>
> Operators **in** and **not in** are also called **membership operators.**

You can easily make out what the above code is doing – it is checking whether a string is contained in a line or not.

Now that you are familiar with **range( )** function and **in** operator, we can start with Looping (Iteration) statements.

9.7 Iteration/Looping Statements

The iteration statements or repetition statements allow a set of instructions to be performed repeatedly until a certain condition is fulfilled. The iteration statements are also called ***loops*** or ***looping statements.*** Python provides *two* kinds of loops : *for loop* and *while loop* to represent *two* categories of loops, which are :

- *counting loops* — the loops that repeat a certain number of times ; Python's *for loop* is a counting loop (or ***count-controlled loop***).
- *conditional loops* — the loops that repeat until a certain thing happens *i.e.,* they keep repeating as long as some condition is *true* ; Python's *while loop* is conditional loop.

If the condition is test before executing the *loop-body, i.e.,* before entering in the loop, the loop is called **entry-controlled loop** or **pre-condition loop**. And if the condition is tested after executing the *loop-body* at least once, it is called ***exit-controlled loop*** or ***post-condition loop***.

9.7.1 The for Loop

To see **for Loop** in action

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The *for loop* of Python is designed to process the items of any sequence, such as a list or a string, one by one.

The general form of *for loop* is as given below :

```
for <variable> in <sequence> :
    statements_to_repeat
```

This determines how many time the loop will get repeated.

Colon is must here

here the statements to be repeated will be placed (body-of-the-loop)

For example, consider the following loop :

```
for a in [1, 4, 7] :
    print (a)
    print(a * a)
```

*The loop variable **a**. Variable a will be assigned each value of list one by one, i.e., for the first time **a** will be **1**, then **4** and then **7**.*

*This is the **body of the for loop**. All statements in the body of the loop will be executed for each value of loop variable **a**, i.e., firstly for **a =1**; then for **a = 4** and then for **a=7***

A *for loop* in Python is processed as :

- The loop-variable is assigned the first value in the sequence.
- all the statements in the body of *for loop* are executed with assigned value of loop variable (step 2)
- once step 2 is over, the loop-variable is assigned the next value in the sequence and the loop-body is executed (*i.e.*, step 2 repeated) with the new value of loop-variable.
- This continues until all values in the sequences are processed.

NOTE

Each time, when the loop-body is executed, is called an ***iteration***.

That is, the given *for loop* will be processed as follows :

(*i*) firstly, the loop-variable *a* will be assigned first value of list *i.e.*, *1* and the statements in the body of the loop will be executed with this value of *a*. Hence value 1 will be printed with statement **print(a)** and value 1 will again be printed with **print(a*a)**. (*see execution shown on right*)

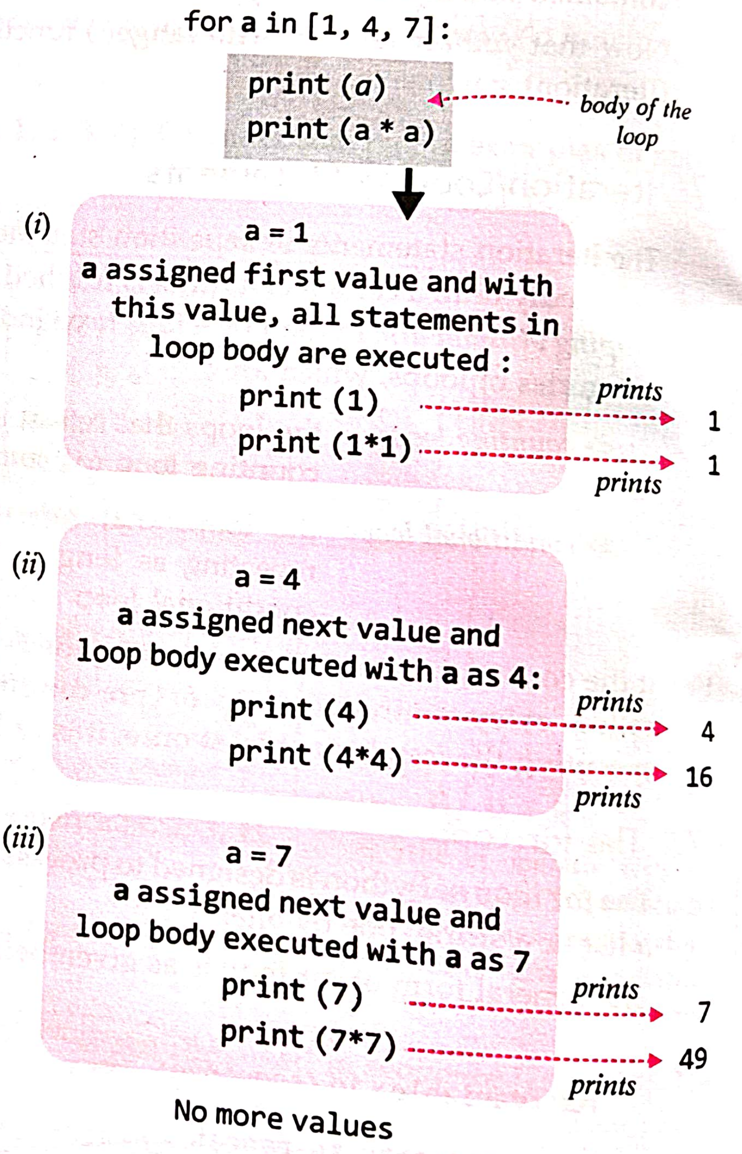
(*ii*) Next, *a* will be assigned next value in the list *i.e.*, *4* and loop-body executed. Thus 4 (as result of **print(a)**) and 16 (as result of **print(a*a)**) are printed.

(*iii*) Next, *a* will be assigned next value in the list *i.e.*, *7* and loop-body executed. Thus 7 (as result of **print(a)**) and 49 (as result of **print(a*a)**) are printed.

(*iv*) All the values in the list are executed, hence loop ends.

Therefore, the output produced by above *for loop* will be :

```
1
1
4
16
7
49
```



```
for a in [1, 4, 7]:
    print (a)
    print (a * a)
```

body of the loop

(*i*) a = 1

a assigned first value and with this value, all statements in loop body are executed :

print (1) prints 1

print (1*1) prints 1

(*ii*) a = 4

a assigned next value and loop body executed with a as 4:

print (4) prints 4

print (4*4) prints 16

(*iii*) a = 7

a assigned next value and loop body executed with a as 7

print (7) prints 7

print (7*7) prints 49

No more values

Consider another *for loop* :

```
        for ch in 'calm' :
                print (ch)
```

The above loop will produce output as :

```
c
a
l
m
```

(variable **ch** given values as 'c', 'a', 'l', 'm' – one at a time from string 'calm'.)

NOTE

(*i*) *for* loop ends when the loop is repeated for the last value of the sequence.

(*ii*) The *for loop* repeats ***n*** number of times, where ***n*** is the length of sequence given in for-loop's header.

Here is another *for loop* that prints the cube of each value in the list :

```
  for v in [1, 2, 3 ] :
        print (v * v * v)
```

The above loop will produce output as :

```
1
8
27
```

The *for loop* works with other sequence types such as *tuples* also, but we'll stick here mostly to *lists* to process a sequence of numbers through *for loops*.

As long as the list contains small number of elements, you can write the *list* in the *for loop* directly as we have done in all above examples. But what if we have to iterate through a very large list such as containing natural numbers between 1 – 100 ? Writing such a big list is neither easy nor good on readability. Then ? Then what ? ☺ Arey, our very own *range( )* function is there to rescue. Why worry? ;) For big number based lists, you can specify *range( )* function to represent a list as in :

```
  for val in range(3, 18) :
        print (val)
```

In the above loop, *range*(3, *18*) will first generate a list [3, 4, 5, ... , 16, 17] with which *for loop* will work. Isn't that easy and simple ? ☺

You need not define loop variable (**val** above) before-hand in a *for loop*. Now consider following code example that uses *range( )* function in a *for loop* to print the table of a number.

Program 9.11 *Program to print table of a number, say 5.*

```
num = 5
for a in range(1, 11) :
      print (num, 'x', a, '=', num * a)
```

The above code will print the output as shown here :

```
5 x 1 = 5
5 x 2 = 10
5 x 3 = 15
5 x 4 = 20
5 x 5 = 25
5 x 6 = 30
5 x 7 = 35
5 x 8 = 40
5 x 9 = 45
5 x 10 = 50
```

NOTE

You need not pre-define loop variable of a *for loop*.

Program 9.12 *Program to print sum of natural numbers between 1 to 7. Print the sum progressively, i.e., after adding each natural number, print sum so far.*

```
sum = 0
for n in range(1, 8) :
    sum += n
    print ("Sum of natural numbers <=", n, "is", sum)
```

The above code will print the output as shown here :

```
Sum of natural numbers <= 1 is 1
Sum of natural numbers <= 2 is 3
Sum of natural numbers <= 3 is 6
Sum of natural numbers <= 4 is 10
Sum of natural numbers <= 5 is 15
Sum of natural numbers <= 6 is 21
Sum of natural numbers <= 7 is 28
```

Program 9.13 *Program to print sum of natural numbers between 1 to 7.*

```
sum = 0
for n in range(1, 8) :
    sum += n
print ("Sum of natural numbers <=", n, 'is', sum)
```

```
Sum of natural numbers <= 7 is 28
```

Carefully look at above program. It again emphasizes that body of the loop is defined through indentation and one more fact and important one too – *the value of loop variable after the **for loop** is over, is the highest value of the list.* Notice, the above loop printed value of ***n*** after ***for loop*** as 7, which is the maximum value of the list generated by *range(1, 8)*.

NOTE

The loop variable contains the highest value of the list after the ***for loop*** is over. Program 9.13 highlights this fact.

9.7.2 The while Loop

A ***while loop*** is a conditional loop that will repeat the instructions within itself as long as a conditional remains *true* (Boolean *True* or truth value *true*$_{tval}$). The general form of Python while loop is :

```
while <logicalexpression> :
    loop-body
```

where the loop-body may contain a *single statement* or *multiple statements* or *an empty statement* (*i.e.*, *pass* statement). The loop iterates while the *logical expression* evaluates to *true*. When the expression becomes *false*, the program control passes to the line after the loop-body.

To understand the working of ***while loop***, consider the following code :

```
a = 5
while a > 0 :
    print ("hello", a)
    a = a – 3
print ("Loop Over!!")
```

*This condition is tested, if it is **true**, the loop-body is executed. After the loop-body's execution, the condition is tested again, loop-body is executed as long as condition is **true**.*

*The loop ends when the condition evaluates to **false***

The above code will print :

```
hello 5
hello 2
Loop Over!!
```

*These two lines are the result of **while loops'** body execution (which executed twice).*

*This line is because of print statement after the **while loop**.*

Let us see how a *while loop* is processed :

Step 1 The *logical/conditional expression in the while loop* (*e.g.*, $a > 0$ above) is evaluated.

Step 2 *Case I* if the result of step 1 is *true* (*True* or *true*$_{tval}$) then all statements in the loop's body are executed, (see section *(i)* & *(ii)* on the right).

Case II if the result of step 1 is *false* (*False* or *false*$_{tval}$) then control moves to the next statement after the body-of the loop *i.e.*, loop ends. (see section *(iii)* on the right).

Step 3 Body-of-the loop gets executed. This step comes only if *Step 2*, *Case I* executed, *i.e.*, the result of *logical expression* was *true*. This step will execute two statements of loop body.

```
while a > 0 :
    print ("hello", a)   ◄········ body of the
    a = a - 3                       loop
```

[a has value 5 before entering into while loop]

(i) while's condition tested with a's current value as 5

```
5 > 0 = True
hence loop's body will get executed
print ("hello", 5) ---------------► hello 5
                             prints
a = 5 - 3 = 2. (a becomes 2 now)
```

(ii) while's condition tested with a's current values 2

```
2 > 0 = True
        loop body will get executed
print ("hello", 2) ---------------► hello 2
                             prints
a = 2 - 3 = -1 (a becomes -1 now)
```

(iii) while's condition tested with a's current value −1

```
-1 > 0 = False
        loop body will not get executed
        control passes to next statement
        after while loop
```

After executing the statements of loop-body again, *Step 1*, *Step 2* and *Step 3* are repeated as long as the condition remains *true*.

The loop will end only when the logical expression evaluates to *false*. (*i.e.*, *Step 2, Case II* is executed.) Consider another example :

NOTE

The variable used in the condition of *while loop* must have some value before entering into *while loop*.

```
n = 1
while n < 5 :
    print ("Square of ", n , 'is', n * n)
    n += 1
print ("Thank You.")   ◄──── This statement is not part of the loop-body
```

The above code will print output as :

```
Square of 1 is 1
Square of 2 is 4
Square of 3 is 9
Square of 4 is 16
Thank You.
```

These lines of output are because of the loop-body execution (loop executed 4 times)

Thus you see that as long as the condition $n < 5$ is *true* above, the *while loop's* body is executed (for values $n = 1$, $n = 2$, $n = 3$, $n = 4$). After exiting from the loop the statement following the *while loop* is executed that prints *Thank You*.

Anatomy of a while Loop (Loop Control Elements)

Every while loop has its elements that control and govern its execution. A **while** loop has fo elements that have different purposes. These elements are as given below :

1. Initialization Expression(s) (Starting). Before entering in a *while* loop, its loop variable must be initialized. The initialization of the loop variable (or control variable) takes place under initialization expression(s). The initialization expression(s) give(s) the loop variable(s) their first value(s). The initialization expression(s) for a *while loop* are outside the *while* loop before it starts.

2. Test Expression (Repeating or Stopping). The test expression is an expression whose truth value decides whether the loop-body will be executed or not. If the test expression evaluates to *true*, the loop-body gets executed, otherwise the loop is terminated.

In a *while* loop, the test-expression is evaluate before entering into a loop.

3. The Body-of-the-Loop (Doing). The statemen that are executed repeatedly (as long as th test-expression is *true*) form the *body of the loop*

In a *while* loop, before every iteration th test-expression is evaluated and if it is *true*, th *body-of-the-loop* is executed; if the test-expressio evaluates to *false*, the loop is terminated.

4. Update Expression(s) (Changing). The updat expressions change the value of loop variable. Th update expression is given as a statement insid the body of *while* loop.

Consider the following code that highlights these elements of a *while* loop :

Initialization expression *: initializes loop variable*

Test expression *: based on this condition, loop iterates i.e., repeats*

```
n = 10
while n > 0 :
    print (n)
    n -= 3
```

Body of the loop *(contains indented statements beneath while)*

Update expression *: changing value of loop variable*

Other important things that you need to know related to *while loop* are :

- In a *while loop*, a loop control variable should be initialized before the loop begins as an uninitialized variable cannot be used in an expression. Consider following code :

```
while p != 3 :
        :
```

*This will result in error if variable **p** has not been created beforehand.*

- The loop variable must be updated inside th *body-of the-while* in a way that after some tim the test-condition becomes *false* otherwise th loop will become an **endless loop** or **infinit loop**. Consider following code :

```
a = 5
while a > 0 :
    print (a)
print ("Thank You")
```

*ENDLESS LOOP! Because the loop-variable **a** remains 5 alway as its value is not updated i the loop-body, hence the co dition*

The above loop is an endless loop as the value of loop-variable *a* is not being updated inside loop body, hence it always remains 5 and the loop-condition *a* > 0 always remains *true*.

To see while Loop in action

Scan QR Code

The corrected form of above loop will be :

```
a = 5
while a > 0 :
    print (a)
    a -= 1
print ("Thank You")
```

*Loop variable **a** being updated inside the loop-body.*

We will talk about infinite loops once again after the *break* statement is discussed.

Since in a *while loop*, the control in the form of condition-check is at the entry of the loop (loop is not entered, if the condition is *false*), it is an example of an **entry-controlled loop** or **pre-condition loop**. An *entry-controlled loop* is a loop that controls the entry in the loop by testing a condition. Python does not offer any *exit-controlled loop*.

NOTE

To cancel the running of an endless loop, you can press CTRL+C keys anytime during its endless repetition to stop it.

Now that you are familiar with *while loop*, let us write some programs that make use of *while loop*.

Program **9.14** *Program to calculate the factorial of a number.*

```
num = int( input ( "Enter a number :" ) )
fact = 1
a = 1
while a <= num :
    fact *= a                          # fact = fact*a
    a += 1                             # a = a + 1
print ("The factorial of" , num, "is" , fact)
```

This program in action

Scan QR Code

Sample runs of above program are given below :

```
Enter a number : 3
The factorial of 3 is 6
======================== RESTART ============================
Enter a number : 4
The factorial of 4 is 24
```

Program **9.15** *Program to calculate and print the sums of even and odd integers of the first n natural numbers.*

```
n = int(input( "Up to which natural number ?" ))
ctr = 1
sum_even = sum_odd = 0
while ctr <= n :
    if ctr % 2 == 0 :                  # number is even
        sum_even += ctr
    else :
        sum_odd += ctr
    ctr += 1                           #increment the counter
print ("The sum of even integers is" , sum_even)
print ("The sum of odd integers is" , sum_odd)
```

The output produced by above code is :

```
Up to which natural number? 25
The sum of even integers is 156
The sum of odd integers is 169
```

9.7.3 Loop else Statement

Both loops of Python (*i.e.*, **for** loop and **while** loop) have an else clause, which is different from *else* of *if-else* statements. The **else of a loop executes only when the loop ends normally** (*i.e.*, only when the loop is ending because the *while* loop's test condition has resulted in *false* or the *for loop* has executed for the last value in sequence.) You'll learn in the next section that if a **break** statement is reached in the loop, *while* loop is terminated pre-maturely even if the test-condition is still *true* or all values of sequence have not been used in a *for* loop.

In order to fully understand the working of *loop-else clause*, it will be useful to know the working of *break* statements. Thus let us first talk about **break** statement and then we'll get back to *loop-else* clause again with examples.

NOTE

The **else clause of a Python loop** executes when the loop terminates normally, **not** when the loop is terminating because of a ***break*** statement.

9.7.4 Jump Statements – break and continue

Python offers two jump statements to be used within loops to jump out of loop-iterations. These are *break* and *continue* statements. Let us see how these statements work.

NOTE

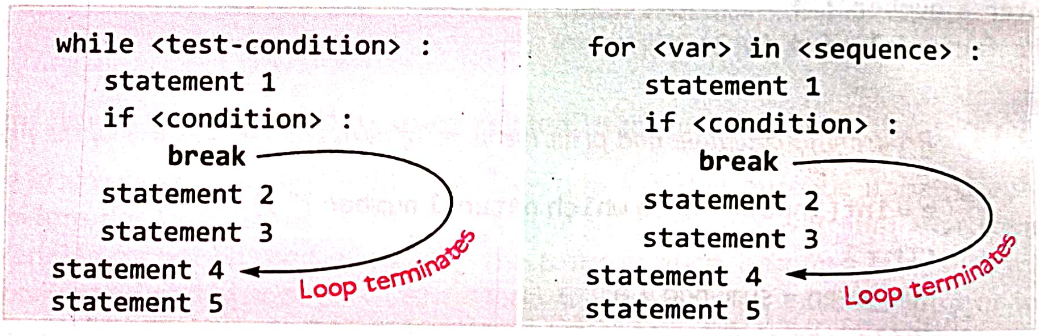
A ***break*** statement skips the rest of the loop and jumps over to the statement following the loop.

9.7.4A The break Statement

The ***break*** statement enables a program to skip over a part of the code. A ***break*** statement terminates the very loop it lies within. Execution resumes at the statement immediately following the body of the terminated statement.

The following figure (Fig. 9.6) explains the working of a break statement :

Statements 4 is the first statement after the loop



```
while <test-condition> :
    statement 1
    if <condition> :
        break
    statement 2
    statement 3
statement 4
statement 5
```

```
for <var> in <sequence> :
    statement 1
    if <condition> :
        break
    statement 2
    statement 3
statement 4
statement 5
```

Figure 9.6 The working of a **break** statement.

The following code fragment gives you an example of a ***break*** statement :

```
a = b = c = 0
for i in range(1, 21) :
    a = int (input ( "Enter number 1 :" ))
    b = int (input ( "Enter number 2 :" ))
    if b == 0 :
        print ("Division by zero error! Aborting!")
        break
    else :
        c = a // b
        print ("Quotient = ", c)
print ("Program over !")
```

The above code fragment intends to divide ten pairs of numbers by inputting two numbers *a* and *b* in each iteration. If the number *b* is zero, the loop is immediately terminated displaying message '**Division by zero error! Aborting!**' otherwise the numbers are repeatedly input and their quotients are displayed.

Sample run of above code is given below :

```
Enter number 1 : 6
Enter number 2 : 2
Quotient =  3
Enter number 1 : 8
Enter number 2 : 3
Quotient =  2
Enter number 1 : 5
Enter number 2 : 0
Division by zero error! Aborting!
Program over !
```

This message is printed just prior to execution of break statement. Notice that the next message is because of the statement outside the loop. That is, after break, next statement to be executed is the statement outside the loop.

NOTE

A loop can end in two ways : (*i*) if the while's condition results in false or for loop executes with last value of the sequence (*NORMAL TERMINATION*). (*ii*) Or if during the loop execution, **break** statement is executed. In this case even if the condition is true or the for has not executed all the values of sequence, the loop will still terminate.

Consider another example of *break* statement in the form of following program.

Program

9.16 *Program to implement 'guess the number' game. Python generates a number randomly in the range[10, 50]. The user is given five chances to guess a number in the range 10 <=number <=50.*

- *If the user's guess matches the number generated, Python displays 'You win' and the loop terminates without completing the five iterations.*
- *If, however, cannot guess the number in five attempts, Python displays 'You lose'.*

To generate a random number in a range, use following function :

```
random.randint(lower limit, upper limit)
```

Make sure to add first line as import ***random***

```
import random
number = random.randint(10,50)
ctr = 0
while ctr < 5 :
    guess = int(input( "Guess a number in range 10..50 :" ))
    if guess == number :
        print ("You win!! :)")

        break
    else :
        ctr += 1
if not ctr < 5 :                    # i.e., whether the loop terminated after 5 iterations
    print ("You lose :( \n The number was", number)
```

This will generate a number randomly, within the range 10-50.

*The moment this statement is reached the loop will terminate without completing all iterations, even if the loop condition **ctr** < **5** is still true.*

Sample run of above program is as shown below :

```
Guess a number in range 10..50 : 31
Guess a number in range 10..50 : 23
Guess a number in range 10..50 : 34
Guess a number in range 10..50 : 40
Guess a number in range 10..50 : 50
You lose :(
The number was 28
===================== RESTART ==========================
Guess a number in range 10..50 : 39
Guess a number in range 10..50 : 46
You win!! :)
```

*At this point the **break** statement executed.*

From the above program, you can make out that if the ***while loop*** is terminated because of a **break** statement, the test-condition of the ***while loop*** will still be ***true*** even outside the loop. Thus, you can check the test-condition outside the loop to determine what caused the loop termination – the **break** statement or the test-condition's result. Recall the last part of above program, *i.e.*,

```
if not ctr < 5 :
    print ("You lose :( \n The number was" , number)
```

If the loop-condition is still true outside the loop that means break caused the loop termination.

Infinite Loops and break Statement

Sometimes, programmers create infinite loops purposely by specifying an expression which always remain *true*, but for such purposely created infinite loops, they incorporate some condition inside the loop-body on which they can break out of the loop using **break** statement.

For instance, consider the following loop example :

```
a = 2
while True :
    print (a)
    a *= 2
    if a > 100 :
        break
```

This will always remain True, hence infinite loop; must be terminated through a break statement

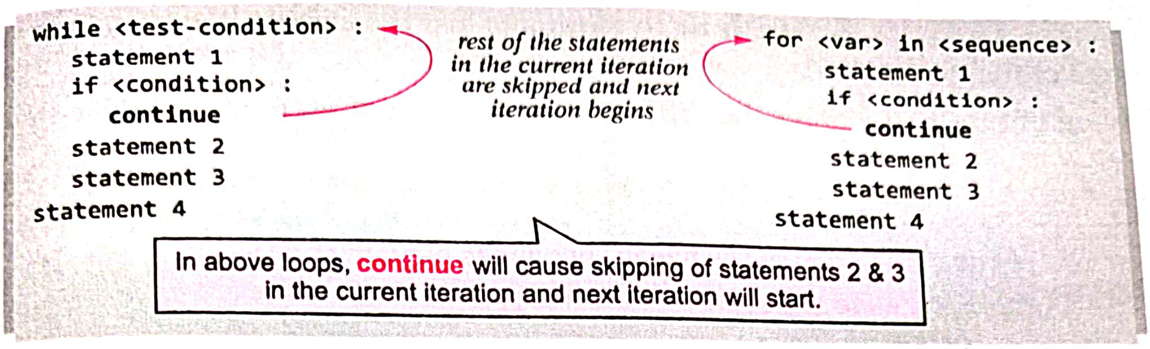
NOTE

For purposely created ***infinite*** (or ***endless***) loops, there must be a provision to reach break statement from within the body of the loop so that loop can be terminated.

9.7.4B The continue Statement

The **continue** statement is another jump statement like the **break** statement as both the statements skip over a part of the code. But the **continue** statement is somewhat different from **break**. Instead of forcing termination, the continue *statement forces the next iteration of the loop to take place*, skipping any code in between.

The following figure (Fig. 9.7) explains the working of **continue** statement :



```
while <test-condition> :
    statement 1
    if <condition> :
        continue
    statement 2
    statement 3
statement 4
```

rest of the statements in the current iteration are skipped and next iteration begins

```
for <var> in <sequence> :
    statement 1
    if <condition> :
        continue
    statement 2
    statement 3
statement 4
```

In above loops, continue will cause skipping of statements 2 & 3 in the current iteration and next iteration will start.

Figure 9.7 The working of a continue statement.

For the *for loop,* **continue** causes the next iteration by updating the loop variable with the next value in sequence ; and for the *while loop,* the program control passes to the conditional test given at the top of the loop.

NOTE

The **continue** statement skips the rest of the loop statements and causes the next iteration of the loop to take place.

```
a = b = c = 0
for i in range(0, 3) :
    print ("Enter 2 numbers" )
    a = int (input( "Number 1 :" ))
    b = int (input( "Number 2 :" ))
    if b == 0 :
        print ("\n The denominator cannot be zero. Enter again !")
        continue
    else :
        c = a//b
        print ("Quotient =", c)
```

Sample run of above code is shown below :

```
Enter 2 numbers
Number 1 : 5
Number 2 : 0

The denominator cannot be zero. Enter again !
Enter 2 numbers
Number 1 : 5
Number 2 : 2
Quotient = 2
Enter 2 numbers
Number 1 : 6
Number 2 : 2
Quotient = 3
```

At this point continue forced next iteration to take place.

Sometimes you need to abandon iteration of a loop prematurely. Both the statements **break** and **continue** can help in that but in different situations : statement **break** to terminate all pending iterations of the loop ; and **continue** to terminate just the current iteration, loop will continue with rest of the iterations.

Following program illustrates the difference in working of *break* and *continue* statements.

9.17 *Program to illustrate the difference between break and continue statements.*

```
print ("The loop with 'break' produces output as :")
for i in range (1,11) :
    if i % 3 == 0 :
        break
    else :
        print (i)

print ("The loop with 'continue' produces output as :")
for i in range (1,11) :
    if i % 3 == 0 :
        continue
    else :
        print (i)
```

The output produced by above program is :

```
The loop with 'break' produces output as :
1
2
```

*because the loop terminated with break when condition **i % 3** became **true** with **i = 3**. (Loop terminated all pending iterations)*

```
The loop with ' continue ' produces output as :
1
2
4
5
7
8
10
```

*only the values divisible by 3 are missing as the loop simply moved to next iteration with continue when condition **i % 3** became **true**.*

(Only the iterations wtih i % 3 == 0 are terminated ; next iterations are performed as it is)

Though, **continue** is one prominent jump statement, however, experts discourage its use whenever possible. Rather, code can be made more comprehensible by the appropriate use of if/else.

9.7.5 Loop else Statement

Now that you know how **break** statement works, we can now talk about **loop-else** clause in details. As mentioned earlier, the *else clause of a Python loop* executes when the loop terminates normally, *i.e.*, when test-condition results into *false* for a ***while loop*** or ***for loop*** has executed for the last value in the sequence ; *not when* the **break** statement terminates the loop.

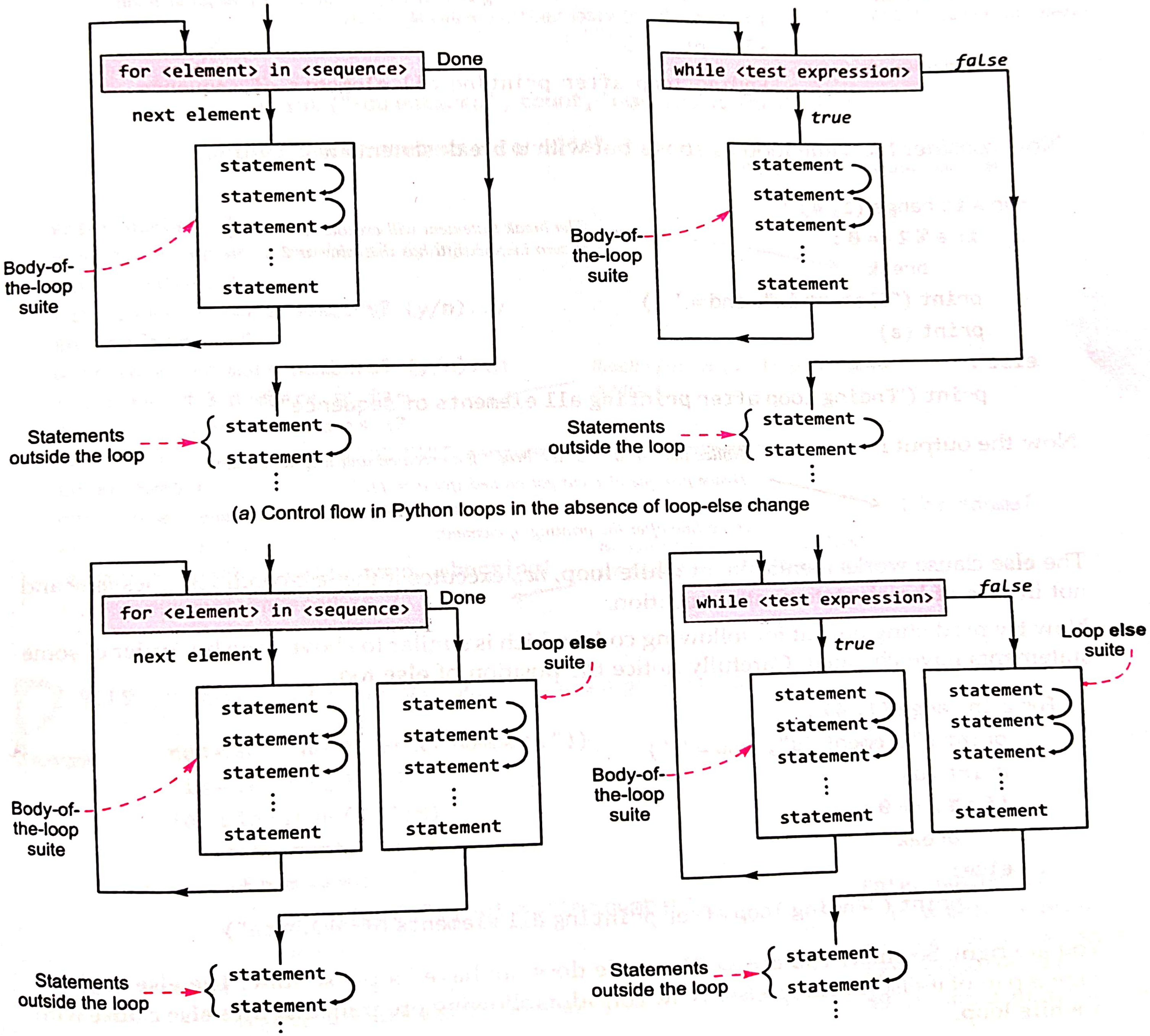
Before we proceed, have a look at the syntax of Python *loops along with else clauses*. Notice that the **else** clause of a loop appears at the same indentation as that of loop keyword **while** or **for**.

Complete syntax of Python loops along with else clause is as given below :

```
for <variable> in <sequence> :
        statement1
        statement2
        :
else :
        statement(s)
```

```
while <test condition> :
        statement1
        statement2
        :
else :
        statement(s)
```

Following figure (Fig. 9.8) illustrates the difference in working of these loops in the absence and presence of loop else clauses.



(a) Control flow in Python loops in the absence of loop-else change

(b) Control flow in Python loops in the presence of loop-else clause.

Figure 9.8 Working of Python Loops with or without else clauses.

Let us understand the working of the Python Loops with or without **else** clause with the help of code examples.

NOTE

The loop-else suite executes only in the case of normal termination of loop.

```
for a in range (1, 4) :
    print ("Element is", end = ' ')
    print (a)
else :
    print ("Ending loop after printing all elements of sequence")
```

The above will give the following output :

*The output produced by for loop. Notice for loop executed for three values of **a** – 1, 2, 3*

```
Element is 1
Element is 2
Element is 3
Ending loop after printing all elements of sequence.
```

*This line is printed because the **else clause of given for loop** executed when the for loop was terminating , normally.*

Now consider the same loop as above but with a **break** statement :

```
for a in range (1, 4) :
    if a % 2 == 0 :
        break
    print ("Element is", end = ' ')
    print (a)
else :
    print ("Ending loop after printing all elements of sequence")
```

*The break statement will execute when **a %2** is zero i.e., when **a** has the value as **2***

Now the output is

```
Element is 1
```

*Notice that for a = 2, the **break** got executed and loop terminated. Hence just one element got printed (for a = 1). As break terminated the loop, the **else clause** also did not execute, so no line after the printing of elements.*

The **else** clause works identically in **while loop**, *i.e.*, executes if the test-condition goes *false* and not in case of **break** statement's execution.

Now try predicting output for following code, which is similar to above code but order of some statements have changed. Carefully notice the position of **else** too.

```
for a in range (1, 4) :
    print ("Element is", end = ' ')
    print (a)
    if a % 2 == 0 :
        break
    else:
        print ("Ending loop after printing all elements of sequence")
```

You are right. So smart you are. ☺ This code does not have loop-else suite. The **else** in above code is part of if-else, not loop-else. Now consider following program that uses **else clause** with a **while loop**.

Program 9.18 *Program to input some numbers repeatedly and print their sum. The program ends when the users say no more to enter (normal termination) or program aborts when the number entered is less than zero.*

```
count = sum = 0
ans = 'y'
while ans == 'y' :
    num = int( input ( "Enter number :" ) )
    if num < 0 :
        print ("Number entered is below zero. Aborting!")
        break
    sum = sum + num
    count = count + 1
    ans = input( "Want to enter more numbers? (y/n).." )
else :
    print ("You entered" , count, "numbers so far.")
print ("Sum of numbers entered is", sum)
```

Body-of-the loop suite

loop-else suite

This statement is outside the loop

```
Enter number: 3
Want to enter more numbers? (y/n)..y
Enter number: 4
Want to enter more numbers? (y/n)..y
Enter number : 5
Want to enter more numbers? (y/n)..n
You entered 3 numbers so far.
Sum of numbers entered is 12
===================== RESTART ==========================
Enter number : 2
Want to enter more numbers? (y/n)..y
Enter number : -3
Number entered is below zero. Aborting!
Sum of numbers entered is 2
```

Result of else clause. Loop terminated normally

No execution of else clause. Loop terminated because of break statement

Program 9.19 *Program to input a number and test if it is a prime number.*

```
num = int(input("Enter number :"))
lim = int(num/2) + 1
for i in range (2, lim) :
    rem = num % i
    if rem == 0 :
        print(num, "is not a prime number")
        break
else:
    print(num, "is a prime number")
```

```
Enter number :7
7 is a prime number
=====================
Enter number :49
49 is not a prime number
```

Sometimes the loop is not entered at all, reason being empty sequence in a *for loop* or test-condition's result as *false* before entering in the while loop. In these cases, the body-of the loop is not executed but loop-else clause will still be executed.

Consider following code examples illustrating the same.

```
while ( 3 > 4) :
    print ("in the loop")
else :
    print ("exiting from while loop")
```

*Body of the loop will not be executed (condition is false) but **else clause** will*

The above code will print the result of execution of while loop's else clause, *i.e.*,

```
exiting from while loop
```

Consider another loop – this time a **for** loop with empty sequence.

```
for a in range(10,1):
    print ("in the loop")
else:
    print ("exiting from for loop")
```

*Body of the loop will not be executed (empty sequence) but **else clause** will*

The above code will print the result of execution of for loop's else clause, *i.e.*,

```
exiting from for loop
```

NOTE

The else clause of Python loops works in the same manner. That is, it gets executed when the loop is terminating normally – after the last element of sequence in **for loop** and when the test-condition becomes *false* in **while loop**.

9.7.6 Nested Loops

A loop may contain another loop in its body. This form of a loop is called **nested loop**. But in a nested loop, the inner loop must terminate before the outer loop. The following is an example of a nested loop, where a **for loop** is nested within another **for loop**.

To see Nested loop in action

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```
for i in range(1, 6) :
    for j in range (1, i ) :
        print ("*" , end = ' ')
    print ()                          # to cause printing from next line.
```

end = ' ' at the end to cause printing at same line

The output produced by above code is :

```
*
* *
* * *
* * * *
```

The inner for loop is executed for each value of *i*. The variable *i* takes values 1, 2, 3 and 4. The inner loop is executed once for *i* = *1* according to sequence in inner loop ***range (1, i)*** (because for *i* as 1, there is just one element 1 in *range (1, 1)* thus *j* iterates for one value, *i.e.*, 1), twice for *i* = *2* (two elements in sequence *range(1, i)*, thrice for *i* = 3 and four times for *i* = 4.

While working with nested loops, you need to understand one thing and that is, the value of outer loop variable will change only after the inner loop is completely finished (or interrupted).

To understand this, consider the following code fragment :

```
for outer in range (5, 10, 4) :
    for inner in range(1, outer, 2) :
        print (outer, inner)
```

The above code will produce the output as :

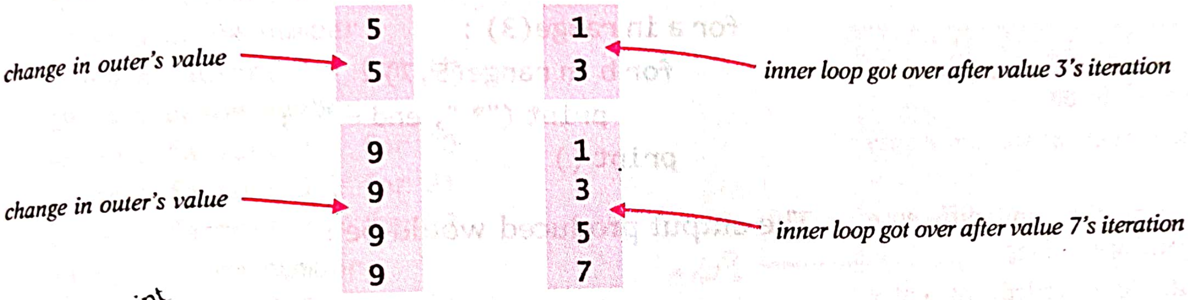
```
5 1
5 3

9 1
9 3
9 5
9 7
```

The output produced when the outer =5

The output produced when the outer = 9

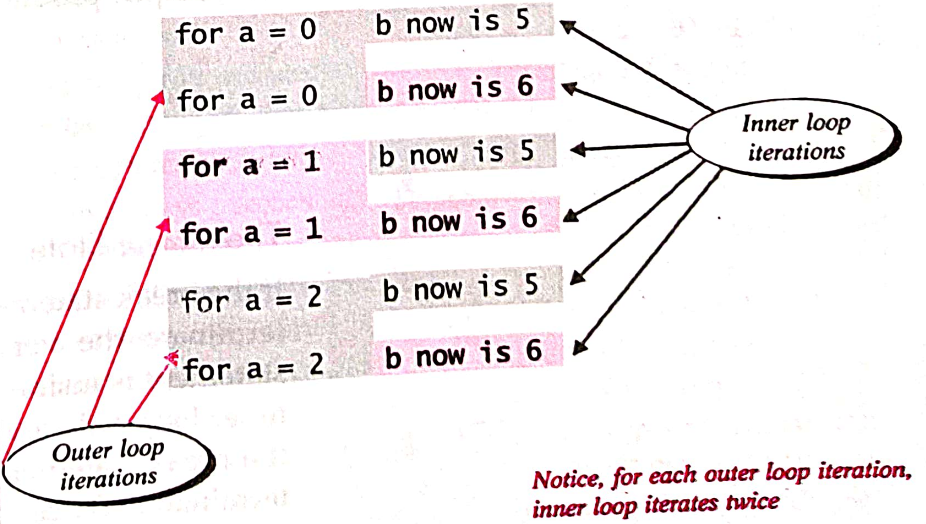
See the explanation below :


change in outer's value
5
5
1
3
inner loop got over after value 3's iteration
change in outer's value
9
9
9
9
1
3
5
7
inner loop got over after value 7's iteration

Let us understand how the control moves in a nested loop with the help of one more example :

```
for a in range(3) :
    for b in range(5,7) :
        print ("for a =", a, "b now is", b)
```

The above nested loop will produce following output :



```
for a = 0    b now is 5
for a = 0    b now is 6
for a = 1    b now is 5
for a = 1    b now is 6
for a = 2    b now is 5
for a = 2    b now is 6
```

Notice, for each outer loop iteration, inner loop iterates twice

Check Point

9.3

1. What are iteration statements ? Name the iteration statements provided by Python.
2. What are the two categories of Python loops ?
3. What is the use of range() function ? What would range(3, 13) return ?
4. What is the output of the following code fragment ?

```
for a in "abcde" :
    print (a, '+', end = ' ')
```

5. What is the output of the following code fragment ?

```
for i in range(0, 10) :
    pass
print (i)
```

6. Why does "Hello" not print even once ?

```
for i in range(10,1) :
    print ("Hello")
```

7. What is the output of following code ?

```
for a in range (2, 7) :
    for b in range(1, a) :
        print ('#', end = ' ')
    print ( )
```

For the outer loop, firstly *a* takes the value as 0 and for *a* = 0, inner loop iterates as it is part of outer for's loop-body.

- for *a* = 0, the inner loop will iterate twice for values *b* = 5 and *b* = 6
- hence the first two lines of output given above are produced for the first iteration of outer loop (*a* = 0 ; which involves two iterations of inner loop)
- when *a* takes the next value in sequence, the inner will again iterate two times with values 5 and 6 for *b*.

Thus we see, that for each iteration of outer loop, inner loop iterates twice for values *b* = 5 and *b* = 6.

Check Point

9.3

8. Write a for loop that displays the even numbers from 51 to 60.
9. Suggest a situation where an empty loop is useful.
10. What is the similarity and difference between for and while loop ?
11. Why is while loop called an entry controlled loop ?
12. If the test-expression of a while loop evaluates to false in the beginning of the loop, even before entering in to the loop :
    (*a*) how many times is the loop executed?
    (*b*) how many times is the loop-else clause executed ?
13. What will be the output of following code:

```
while (6 + 2 > 8) :
    print ("Gotcha!")
else:
    print ("Going out!")
```

14. What is the output produced by following loop ?

```
for a in (2, 7) :
    for b in (1, a) :
        print (b, end = ' ')
        print ()
```

15. What is the significance of break and continue statements?
16. Can a single break statement in an inner loop terminate all the nested loops ?

Consider some more examples and try understanding their functioning based on above lines.

```
for a in range(3) :
    for b in range(5,7) :
        print ("* ", end = ' ')
    print ()
```

The output produced would be :

```
* *
* *
* *
```

Consider another nested loop :

```
for a in range(3) :
    for b in range(5,8) :
        print ("* ", end = ' ')
    print ()
```

notice end = ' ' at the end of print

The output produced would be :

```
* * *
* * *
* * *
```

The break Statement in a Nested Loop

If the break statement appears in a nested loop, then it will terminate the very loop it is in. That is, if the break statement is inside the inner loop then it will terminate the inner loop only and the outer loop will continue as it as. If the break statement is in outer loop, then outer loop gets terminated. Since inner loop is part of outer loop's body it will also not execute just like other statement of outer loop's body.

Following program illustrates this. Notice that **break** will terminate the inner loop only while the outer loop will progress as per its routine.

Program 9.20 *Program that searches for prime numbers from 15 through 25.*

```
for num in range(15,25):
    for i in range(2,num):
        if num % i == 0:                 #to determine factors
            j = num/i
            print ("Found a factor( ", i ," ) for", num)
            break                        # need not continue - factor found
    else:                                # else part of the inner loop
        print (num, "is a prime number")
```

This break will terminate the inner for loop only

```
Found a factor( 3 ) for 15
Found a factor( 2 ) for 16
17 is a prime number
Found a factor( 2 ) for 18
19 is a prime number
Found a factor( 2 ) for 20
Found a factor( 3 ) for 21
Found a factor( 2 ) for 22
23 is a prime number
Found a factor( 2 ) for 24
```

More examples of nested loops and other simple loops you'll find in solved problems given at the end of this chapter.

PYTHON LOOPS

Progress In Python 9.2

This 'Progress in Python' session works on the objective of Python loops practice.

⋮

>>>❖<<<

LET US REVISE

- *Statements are the instructions given to the computer to perform any kind of action.*
- *Python statements can be on one of these types : empty statement, single statement and compound statement.*
- *An empty statement is the statement that does nothing. Python offers* **pass** *statement as empty statement.*
- *Single executable statement forms a simple statement.*
- *A compound statement represents a group of statements executed as a unit.*
- *Every compound statement of Python has a header and an indented body below the header.*
- *Some examples of compound statements are : if statement, while statement etc.*
- *The flow of control in a program can be in three ways : sequentially (the sequence construct), selectively (the selection construct), and iteratively (the iteration construct).*
- *The sequence construct means statements get executed sequentially.*
- *The selection construct means the execution of statement(s) depending upon a condition-test.*
- *The iteration (looping) constructs mean repetition of a set-of-statements depending upon a condition-test.*
- *Python provides one selection statement if in many forms – if..else and if..elif..else.*
- *The if..else statement tests an expression and depending upon its truth value one of the two sets-of-action is executed.*
- *The if-else statement can be nested also i.e., an if statement can have another if statement.*
- *A sequence is a succession of values bound together by a single name. Some Python sequences are strings, lists and tuples.*

- *The range( ) function generates a sequence of list type.*
- *The statements that allow a set of instructions to be performed repeatedly are iteration statements.*
- *Python provides two looping constructs – **for** and **while**. The **for** is a counting loop and **while** is a conditional loop.*
- *The while loop is an entry-controlled loop as it has a control over entry in the loop in the form of test condition.*
- *Loops in Python can have **else** clause too. The **else** clause of a loop is executed in the end of the loop only when loop terminates normally.*
- *The **break** statement can terminate a loop immediately and the control passes over to the statement following the statement containing break.*
- *In nested loops, a **break** terminates the very loop it appears in.*
- *The **continue** statement abandons the current iteration of the loop by skipping over the rest of the statements in the loop-body. It immediately transfers control to the beginning of the next iteration of the loop.*

OBJECTIVE TYPE QUESTIONS OTQs

MULTIPLE CHOICE QUESTIONS

1. In a Python program, a control structure :
   (*a*) directs the order of execution of the statements in the program
   (*b*) dictates what happens before the program starts and after it terminates
   (*c*) defines program-specific data structures
   (*d*) manages the input and output of control characters

2. An empty/null statement in Python is ______ .
   (*a*) go (*b*) pass (*c*) over (*d*) ;

3. The order of statement execution in the form of top to bottom, is known as ______ construct.
   (*a*) selection (*b*) repetition
   (*c*) sequence (*d*) flow

4. The ______ construct allows to choose statements to be executed, depending upon the result of a condition.
   (*a*) selection (*b*) repetition
   (*c*) sequence (*d*) flow

5. The ______ construct repeats a set of statements a specified number of times or as long as a condition is true.
   (*a*) selection (*b*) repetition
   (*c*) sequence (*d*) flow

6. Which of the following statements will make a selection construct ?
   (*a*) if (*b*) if-else (*c*) for (*d*) while

7. Which of the following statements will make a repetition construct ?
   (*a*) if (*b*) if-else (*c*) for (*d*) while

8. In Python, which of the following will create a block in a compound statement ?
   (*a*) colon
   (*b*) statements indented at a lower, same level
   (*c*) indentation in any form (*d*) { }

9. What signifies the end of a statement block or suite in Python ?
   (*a*) A comment (*b*) } (*c*) end
   (*d*) A line that is indented less than the previous line

10. Which one of the following if statements will not execute successfully ?

(*a*)
```
if (1, 2) :
  print('foo')
```

(*b*)
```
if (1, 2)
  print('foo')
```

(*c*)
```
if (1, 2) :
print('foo')
```

(*d*)
```
if (1) :
  print('foo')
```

11. What does the following Python program display ?

```
x = 3
if x == 0:
    print ("Am I here?", end = ' ')
elif x == 3:
    print("Or here?", end = ' ')
else :
    pass
print ("Or over here?")
```

(*a*) Am I here ? (*b*) Or here ?
(*c*) Am I here? Or here ?
(*d*) Or here? Or over here ?
(*e*) Am I here? Or over here ?

12. If the user inputs : 2<ENTER>, what does the following code snippet print ?

```
x = float(input())
if(x == 1):
    print("Yes")
elif (x >= 2):
    print("Maybe")
else:
    print ("No")
```

(*a*) Yes (*b*) No (*c*) Maybe
(*d*) Nothing is printed (*e*) Error

Consider the following code segment for the questions 13 –17 :

```
a = int(input("Enter an integer: "))
b = int(input("Enter an integer: "))
if a <= 0:
    b = b + 1
else:
    a = a + 1
if a > 0 and b > 0:
    print("W")
elif a > 0:
    print("X")
if b > 0:
    print("Y")
else:
    print("Z")
```

13. What letters will be printed if the user enters 0 for a and 0 for b ?

(*a*) Only W (*b*) Only X (*c*) Only Y
(*d*) W and X (*e*) W, X and Y

14. What letters will be printed if the user enters 1 for a and 1 for b ?

(*a*) W and X (*b*) W and Y (*c*) X and Y
(*d*) X and Z (*d*) W, X and Y

15. What letters will be printed if the user enters 1 for a and –1 for b ?

(*a*) W and X (*b*) X and Y (*c*) Y and Z
(*d*) X and Z (*e*) W and Z

16. What letters will be printed if the user enters 1 for a and 0 for b ?

(*a*) W and X (*b*) X and Y (*c*) Y and Z
(*d*) X and Z (*e*) W and Z

17. What letters will be printed if the user enters –1 for a and –1 for b ?

(*a*) Only W (*b*) Only X (*c*) Only Y
(*d*) Only Z (*e*) No letters are printed

18. What values are generated when the function **range(6, 0, –2)** is executed ?

(*a*) [4, 2] (*b*) [4, 2, 0]
(*c*) [6, 4, 2] (*d*) [6, 4, 2, 0]
(*e*) [6, 4, 2, 0, –2]

19. Which of the following is not a valid loop in Python ?

(*a*) for (*b*) while
(*c*) do-while (*d*) if-else

20. Which of the following statement(s) will terminate the whole loop and proceed to the statement following the loop ?

(*a*) pass (*b*) break
(*c*) continue (*d*) goto

21. Which of the following statement(s) will terminate only the current pass of the loop and proceed with the next iteration of the loop ?

(*a*) pass (*b*) break (*c*) continue (*d*) goto

22. Function **range(3)** is equivalent to :

(*a*) range(1, 3) (*b*) range(0, 3)
(*c*) range(0, 3, 1) (*d*) range(1, 3, 0)

23. Function **range(3)** will yield an iteratable sequence like ______ .

(*a*) [0, 1, 2] (*b*) [0, 1, 2, 3]
(*c*) [1, 2, 3] (*d*) [0, 2]

24. Function **range(0, 5, 2)** will yield on iterable sequence like

(*a*) [0, 2, 4] (*b*) [1, 3, 5]
(*c*) [0, 1, 2, 5] (*d*) [0, 5, 2]

25. Function **range(10, 5, –2)** will yield an iterable sequence like

(*a*) [10, 8, 6] (*b*) [9, 7, 5]
(*c*) [6, 8, 10] (*d*) [5, 7, 9]

26. Function **range(10, 5, 2)** will yield an iterable sequence like

(*a*) [ ] (*b*) [10, 8, 6]
(*c*) [2, 5, 8] (*d*) [8, 5, 2]

27. Consider the loop given below :

```
for i in range(-5) :
    print(i)
```

How many times will this loop run ?

(*a*) 5 (*b*) 0

(*c*) infinite (*d*) Error

28. Consider the loop given below :

```
for i in range(10, 5, -3) :
    print(i)
```

How many times will this loop run ?

(*a*) 3 (*b*) 2 (*c*) 1 (*d*) Infinite

29. Consider the loop given below :

```
for i in range(3) :
    pass
```

What will be the final value of i after this loop ?

(*a*) 0 (*b*) 1 (*c*) 2 (*d*) 3

30. Consider the loop given below :

```
for i in range(7, 4, -2) :
    break
```

What will be the final value of **i** after this loop ?

(*a*) 4 (*b*) 5 (*c*) 7 (*d*) –2

31. In **for a in** ______ **:**, the blank can be filled with

(*a*) an iterable sequence

(*b*) a range( ) function

(*c*) a single value (*d*) an expression

32. Which of the following are entry controlled loops ?

(*a*) if (*b*) if-else (*c*) for (*d*) while

33. Consider the loop given below. What will be the final value of *i* after the loop ?

```
for i in range(10) :
    break
```

(*a*) 10 (*b*) 0 (*c*) Error (*d*) 9

34. The **else** statement can be a part of ______ statement in Python.

(*a*) if (*b*) def (*c*) while (*d*) for

35. Which of the following are jump statements ?

(*a*) if (*b*) break (*c*) while (*d*)
continue

36. Consider the following code segment :

```
for i in range(2, 4):
    print(i)
```

What values(s) are printed when it executes ?

(*a*) 2 (*b*) 3 (*c*) 2 and 3

(*d*) 3 and 4 (*e*) 2, 3 and 4

37. When the following code runs, how many times is the line "x = x * 2" executed ?

```
x = 1
while ( x < 20 ):
    x = x * 2
```

(*a*) 2 (*b*) 5 (*c*) 19 (*d*) 4 (*e*) 32

38. What is the output when this code executes ?

```
x = 1
while (x <= 5):
    x + 1
print(x)
```

(*a*) 6 (*b*) 1 (*c*) 4

(*d*) 5 (*e*) no output

39. How many times does the following code execute ?

```
x = 1
while (x <= 5):
    x + 1
print (x)
```

(*a*) 6 (*b*) 1 (*c*) 4

(*d*) 5 (*e*) infinite

40. What is the output produced when this code executes ?

```
i = 1
while (i <= 7):
    i *= 2
print (i)
```

(*a*) 8 (*b*) 16 (*c*) 4

(*d*) 14 (*e*) no output

41. Consider the following loop:

```
j = 10
while j >= 5:
    print("X")
    j = j - 1
```

Which of the following for loops will generate the same output as the loop shown previously ?

(*a*)
```
for j in range(-1, -5, -1):
    print("X")
```

(*b*)
```
for j in range(0, 5):
    print("X")
```

(*c*)
```
for j in range(10, -1, -2):
    print("X")
```

(*d*)
```
for j in range(10, 5):
    print("X")
```

(*e*)
```
for j in range(10, 5, -1):
    print("X")
```

42. What is the output produced when this code executes ?

```
a = 0
for i in range(4,8):
    if i % 2 == 0:
        a = a + i
print(a)
```

(*a*) 4 (*b*) 8

(*c*) 10 (*d*) 18

43. Which of the following code segments contain an example of a nested loop ?

(*a*)
```
for i in range(10):
    print(i)
for j in range(10):
    print(j)
```

(*b*)
```
for i in range(10):
    print(i)
    for j in range(10):
        print(j)
```

(*c*)
```
for i in range(10):
    print(i)
    while i < 20:
        print(i)
        i = i + 1
```

(*d*)
```
for i in range(10):
    print(i)
while i < 20 :
    print(i)
```

FILL IN THE BLANKS

1. The ______ statement forms the selection construct in Python.
2. The ______ statement is a do nothing statement in Python.
3. The______ and ______ statements for the repetition construct in Python.
4. Three constructs that govern the flow of control are ______ , ______ and ______ .
5. In Python, ______ defines a block of statements.
6. An ______ statement has less number of conditional checks than two successive ifs.
7. The ______operator tests if a given value is contained in a sequence or not.
8. The two membership operators are ______ and ______ ______ .
9. An iteration refers to one repetition of a ______ .
10. The ______ loop iterates over a sequence.
11. The ______ loop tests a condition before executing the body-of-the-loop.
12. The ______ clause can occur with an **if** as well as with loops.
13. The ______ block of a loop gets executed when a loop ends normally.
14. The **else** block of a loop will not get executed if a ______ statement has terminated the loop.
15. The ______ statement terminates the execution of the whole loop.
16. The ______ statement terminates only a single iteration of the loop.
17. The **break** and **continue** statements, together are called ______ statements.
18. In a nested loop, a **break** statement inside the inner loop, will terminate the ______ loop only.

TRUE/FALSE QUESTIONS

1. An if-else tests less number of conditions than two successive ifs.
2. A for loop is termed as a determinable loop.
3. The *while loop* is an exit controlled loop.
4. The **range( )** creates an iterable sequence.
5. The *for loop* can also tests a condition before executing the loop-body.
6. Only if statement can have an else clause.
7. A loop can also take an else clause.
8. The **else** clause of a loop gets executed only when a *break* statement terminates it.
9. An loop with an **else** clause executes its **else** clause only when the loop terminates normally.
10. A loop with an **else** clause cannot have a **break** statement.

11. A continue statement can replace a break statement.
12. For a *for loop*, an equivalent while loop can always be written.
13. For a *while loop*, an equivalent for loop can always be written.
14. The range( ) function can only be used in *for loops*.
15. An if-elif-else statement is equivalent to a nested-if statement.

Assertions and Reasons

DIRECTIONS

In the following question, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as :

(*a*) Both A and R are true and R is the correct explanation of A.

(*b*) Both A and R are true but R is not the correct explanation of A.

(*c*) A is true but R is false (or partly true).

(*d*) A is false (or partly true) but R is true.

(*e*) Both A and R are false or not fully true.

1. Assertion. Python's pass statement is an empty statement.

   Reason. An empty statement does nothing.

2. Assertion. The flow of control in a program can occur sequentially, selectively or iteratively

   Reason. The sequence construct means that the statements will get executed sequentially.

3. Assertion. Python statement 'if' represents selection construct.

   Reason. The selection construct means the execution of a set of statements, depending upon the outcome of a condition.

4. Assertion. The for loop is a counting loop that works with sequences of values.

   Reason. The range( ) function generates a sequence of list type.

5. Assertion. Both break and continue are jump statements.

   Reason. Both break and continue can stop the loops and hence can substitute one-another.

6. Assertion. Only while loops can use break statement.

   Reason. Loop while is a conditional loop of Python and stops when its condition results in false.

NOTE : Answers for OTQs are given at the end of the book.

Solved Problems

1. *What is a statement ? What is the significance of an empty statement ?*

   Solution. A statement is an instruction given to the computer to perform any kind of action.

   An empty statement is useful in situations where the code requires a statement but logic does not. To fill these two requirements simultaneously, empty statement is used.

   Python offers **pass** statement as an empty statement.

2. *If you are asked to label the Python loops as determinable or non-determinable, which label would you give to which loop ? Justify your answer.*

   Solution. The 'for loop' can be labelled as ***determinable loop*** as number of its iterations can be determined before-hand as the size of the sequence, it is operating upon.

   The 'while loop' can be labelled as ***non-determinable loop***, as its number of iterations cannot be determined before-hand. Its iterations depend upon the result of a test-condition, which cannot be determined before-hand.

3. *There are two types of else clauses in Python. What are these two types of else clause ?*

Solution. The *two* types of Python else clauses are : (*a*) else in an if statement (*b*) else in a loop statement

The *else* clause of an *if* statement is executed when the condition of the if statement results into *false.*

The *else* clause of a *loop* is executed when the loop is terminating normally *i.e.*, when its test-condition has gone *false* for a *while* loop or when the *for* loop has executed for the last value in sequence.

4. *Use the Python range( ) function to create the following list* : [7, 3, –1, –5].

Solution. `range (7, -6, -4).`

5. *Identify and correct the problem with following code :*

```
    countdown = 10                    # Count from 10 down to 1
    while countdown > 0 :
        print (countdown, end = ' ')
        countdown - 1
    print ("Finally.")
```

Solution. *It is an infinite loop.* The reason being, in the above *while* loop, there is an expression **countdown – 1,** which subtracts 1 from value of **countdown** BUT this statement is not updating the loop variable **countdown,** hence loop variable **countdown** always remains unchanged and hence it is an **infinite loop.**

The solution to above problem will be replacement of **countdown – 1** with following statement in the body of while loop : `countdown = countdown - 1`

Now the while loop's variable will be updated in every iteration and hence loop will be a finite loop.

6. *Following code is meant to be an interactive grade calculation script for an entrance test that converts from a percentage into a letter grade :*

90 and above is A+, 80-90 is A, 60-80 is A–, and everything below is fail.

The program should prompt the user 100 times for grades. Unfortunately, the program was written by a terrible coder (me :/), so there are numerous bugs in the code. Find all the bugs and fix them.

```
    For i : range(1 .. 100)
        grade == float (input( 'What\'s the grade percentage ?" ))
        if grade > 90
            print ("That's an A + !")
        if 80 > grade > 90:
            print (" " "An A is really good!" " ")
        elsif 60 < grade :
            print (You got an A-!)
        else grade < 60 :
            print ("Sorry, you need an A- to qualify!")
```

Solution. The corrected code is given below, with corrections marked in colour.

```
    for i in range (0, 100) :
        grade = float (input( 'What\'s the grade percentage ?" ))
        if grade >= 90 :
            print ("That's an A + ! ")
        if 80 <= grade < 90:
            print ("An A is really good!")        # although triple-quoted string is also OK
        elif 60 <= grade :
            print ("You got an A-!")
        else grade < 60:
            print ("Sorry, you need an A- to qualify!")
```

7. *What is the output of following code ?*

```
if (4 + 5 == 10) :
    print ("TRUE")
else :
    print ("FALSE")
print ("TRUE")
```

Solution.

```
FALSE
TRUE
```

8. *Following code contains an endless loop. Could you find out why ? Suggest a solution.*

```
n = 10
answer = 1
while ( n > 0 ) :
    answer = answer + n ** 2
    n = n + 1
print (answer)
```

Solution. For a while loop to terminate, it is necessary that its condition becomes false at one point. But in the above code, the test-condition of *while* loop will never become *false*, because the condition is *n* > 0 and *n* is always incrementing ; thus *n* will always remain > 0. Hence it will repeat endlessly.

There are *two* possible solutions :

(*i*) change the condition to some reachable limit (as per update expression) *e.g.*,

```
while (n < 100) :
```

(*ii*) change the updation equation of loop variable so that it makes the condition *false* at some point of time, *e.g.*,

```
while (n > 0 ) :
    :
    n = n – 1
```

9. *Consider below given two code fragments. What will be their outputs if the inputs are entered in the given order are (i) 'Jacob' (ii)'12345' (iii) 'END' (iv) 'end' ?*

(*a*)

```
name = " "
while True :
    name = input( "Enter name ('end' to exit):")
    if name == "end" :
        break
    print ("Hello", name)
else :
    print ("Wasn't it fun ?")
```

(*b*)

```
name = " "
while name != "end" :
    name = input( "Enter name ('end' to exit):" )
    if name == "end" :
        pass
    print ("Hello", name)
else :
    print ("Wasn't it fun ?")
```

Solution.

Code (*a*) will print

for input (*i*)

```
Hello Jacob
```

for input (*ii*)

```
Hello 12345
```

for input (*iii*)

```
Hello END
```

for input (*iv*)

```
no output will be printed
```

Code (*b*) will print

for input (*i*)

```
Hello Jacob
```

for input (*ii*)

```
Hello 12345
```

for input (*iii*)

```
Hello END
```

for input (*iv*)

```
Hello end
Wasn't it fun ?
```

10. *Write Python code to add the odd numbers up to (and including) a given value N and print the result.*

Solution.

```
N = int (input ('Enter number'))
sum = 0
i = 1
while i <= N :
    sum = sum + i
    i = i + 2
print (sum)
```

11. *Consider the following Python program :*

```
N = int(input ( "Enter N :" ))
i = 1
```

```
sum = 0
while i < N :
    if i % 2 == 0 :
        sum = sum + i
    i = i + 1
print (sum)
```

(a) What is the output when the input value is 5 ?

(b) What is the output when the input value is 0 ?

Solution. (*a*) 6 (*b*) 0

12. *Consider the following Python program, intended to calculate factorials :*

```
number = int(input ("Enter number"))
n, result = number, 1
while True or n :
    result = result * n
    n = n - 1
factorial = result
print ("factorial of ", number, "is", factorial)
```

(a) What happens when the user enters a value of 5 ?

(b) How would you fix this program ?

Solution. The problem is that the program will repeat infinitely.

The problem lies with the condition of while loop this condition will never go false.

Correct condition will be any of these :

```
while n :
    :
```

or

```
while n > 0 :
:
```

13. *Write a program to input three numbers and display the largest / smallest number.*

Solution.

```
num1 = float(input("Enter 1st number: "))
num2 = float(input("Enter 2nd number: "))
num3 = float(input("Enter 3rd number: "))

if (num1 > num2) and (num1 > num3):
    largest = num1
elif (num2 > num1) and (num2 > num3):
    largest = num2
else:
    largest = num3
print("The largest number is", largest)
```

The output produced by above program will be :

```
Enter 1st number: 45.2
Enter 2nd number: 66
Enter 3rd number: 11.56
The largest number is 66.0
```

14. *Write a program to input a 6 digit number and divide it into three 2 digit numbers.*

Solution.

```
num = int(input("Enter a 6 digit number : "))
if num < 100000 or num > 999999 :
    print("Please enter a 6 digit number")
else:
    n1 = num % 100
    int1 = num //100
    n2 = int1 % 100
    int2 = int1 // 100
    n3 = int2 %100
    print("Three 2-digit numbers are:", n1, n2, n3)
```

```
Enter a 6 digit number : 678923
Three 2-digit numbers are: 23 89 67
```

15. *Write a program to input a number and then print its first and last digit raised to the length of the number (the number of digits in the number is the length of the number).*

Solution.

```
import math
num = int(input("Enter a number : "))
ln = len( str(num)) # length of the number
lst = num % 10
fst = num // math.pow(10, ln-1)
print("Length of given number", num, "is", ln)
print("The first digit is ", fst)
print("The last digit is ", lst)
print("First digit raised to the length :",\
math.pow(fst, ln))
print("Last digit raised to the length :",\
math.pow(lst, ln))
```

```
Enter a number : 326868
Length of given number 326868 is 6
The first digit is  3.0
The last digit is  8
First digit raised to the length : 729.0
Last digit raised to the length : 262144.0
```

16. *Write a program to find lowest and second lowest number from the 10 numbers input.*

Solution.

```
# to find lowest and second lowest integer from 10 integers
small = smaller = 0
for i in range(10):
  n = int(input("Enter number :"))
  if i == 0 :                           # first number read
      small = n
  elif i == 1 :                         # second number read
      if n <= small :
          smaller = n
      else:
          smaller = small
          small = n
  else:                                 # for every integer read 3rd integer onwards
      if n < smaller :
          small = smaller
          smaller = n
      elif n < small :
          small = n
print("The lowest number is : ", smaller)
print("The second lowest number is : ", small)
```

Sample Run

```
The lowest number is : –6
The second lowest number is : –
```

The sample run of above program (from the ten input numbers as : –6, 13, 20, –3, 15, 18, 99, –4, 11, 23) has been given above.

17. *Number Guessing Game – This program generates a random number between 1 and 100 and continuousl asks the user to guess the number, giving hints along the way.*

Solution.

```
import random
secretNum = random.randint(1,100)           #generate a random integer between [1 100]
guessNumString = int(input ("Guess a number between 1 and 100 inclusive:"))
while guessNum != secretNum :
    if guessNum < secretNum :
        print ("Your guess is too low.")
    else:
        print ("Your guess is too high.")
    guessNum = int(input ( "Guess a number between 1 and 100 inclusive:"))
print ("Congratulations! You guessed the number correctly.")
```

18. *Write a Python script to print Fibonacci series' first 20 elements. Some initial elements of a Fibonacci series are :*

`0 1 1 2 3 5 8...`

Solution.

```
first = 0
second = 1
print (first)
print (second)
for a in range(1, 19) :
    third = first + second
    print (third)
    first, second = second, third
```

19. *Write a Python script to read an integer > 1000 and reverse the number.*

Solution.

```
num = int(input( "Enter an integer (>1000) :"))
tnum = num
reverse = 0
while tnum :
    digit = tnum % 10
    #take out int part of division
    tnum = int(tnum/10)
    reverse = reverse * 10 + digit
print ("Reverse of", num , "is", reverse)
```

20. *Write a Python script to generate divisors of a number.*

Solution.

```
num = int(input("Enter an integer :" ))
mid = num /2
print ("The divisors of" num, "are :")
for a in range (2, mid + 1) :
    if num % a == 0 :
        print (a, end = ' ')
else :
    print ("-End-")
```

21. *Input three angles and determine if they form a triangle or not.*

Solution.

```
#check triangle from angles
angle1 = angle2 = angle3 = 0
angle1 = float(input("Enter angle 1 : "))
angle2 = float(input("Enter angle 2 : "))
angle3 = float(input("Enter angle 3 : "))
if (angle1 + angle2 + angle3) == 180 :
    print("Angles form a triangle.")
else:
    print("Angles do not form a triangle.")
```

22. *Write a program to input two integers x and n, compute x^n using a loop.*

Solution.

```
x = int(input("Enter a positive number(x): "))
n = int(input("Enter the power (n): "))
power = 1
for a in range(n):
    power = power*x
print(x,"to the power", n , "is", power)
```

```
Enter a positive number(x): 7
Enter the power (n): 3
7 to the power 3 is 343
```

23. *Write a program to input a number and calculate its double factorial.*

(For an even integer n, the double factorial is the product of all even positive integers less than or equal to n. For an odd integer p, the double factorial is the product of all odd positive integers less than or equal to p.)

Solution.

```
num = int(input("Enter a number : "))
fac = 1
for i in range(num, 0, -2):
    fac *= i
print(num, "!! is :", fac)
```

```
Enter a number : 7
7 !! is : 105
====================
Enter a number : 6
6 !! is : 48
```

24. *Numbers in the form $2^n - 1$ are called Mersenne Numbers, e.g.,*

$$2^1-1=1, 2^2-1=3, 2^3-1=7.$$

Write a Python script that displays first ten Mersenne numbers.

Solution.

```
#program to print mersenne numbers
print("First 10 Mersenne numbers are:")
for a in range(1, 11):
    mersnum = 2 ** a - 1
    print(mersnum, end = " ")
print()
```

```
First 10 Mersenne numbers are :
1 3 7 15 31 63 127 255 511 1023
```

25. *Write Python script to print the following pattern :*

```
1
1 3
1 3 5
1 3 5 7
```

Solution.

```
for a in range(3, 10, 2) :
    for b in range(1, a, 2) :
        print (b, end = ' ')
    print ( )
```

26. *Mersenne numbers that are prime numbers also, are called Mersenne Prime numbers. Make modifications in previous question's Python script so that it also displays 'Prime' next to the Mersenne Prime numbers. Also, this time print 20 Mersenne numbers.*

Solution.

```
# program to print mersenne prime numbers
for a in range(1, 21):
    mersnum = 2 ** a - 1
    mid = int(mersnum / 2) + 1
    for b in range(2, mid):
        if mersnum % b == 0 :
            print(mersnum)
            break
    else:
        print(mersnum, "\tPrime")
```

Sample Run

(With first 10 Mersenne numbers)

```
1          Prime
3          Prime
7          Prime
15
31         Prime
63
127        Prime
255
511
1023
```

27. *Write a program to calculate BMI of a person after inputting its weight in kgs and height in meters and then print the* ***Nutritional Status*** *as per following table :*

Nutritional Status	WHO criteria BMI cut-off
Underweight	< 18.5
Normal	18.5 – 24.9
Overweight	25 – 29.9
Obese	≥ 30

Solution.

```
weight_in_kg = float(input("Enter weight in kg :"))
height_in_meter = float(input("Enter height in meters :"))
bmi = weight_in_kg / ( height_in_meter * height_in_meter)
print("BMI is : ", bmi, end = " ")
if bmi < 18.5 :
    print("... Underweight")
elif bmi < 25 :
    print("... Normal")
elif bmi < 30 :
    print("... Overweight")
else:
    print("... Obese")
```

28. *Write a program to find sum of the series :* $s=1+x+x^2+x^3 \ldots +x^n$ *(Input the values of x and n)*

Solution.

```
x = float (input ( "Enter value of x :" ))
n = int (input( "Enter value of n (for x ** n) :" ))
s = 0
for a in range(n + 1) :
    s += x ** a
print ("Sum of first" , n , "terms :", s)
```

29. *Write a program to input the value of x and n and print the sum of the series :*

$$1-x+x^2-x^3+x^4-......x^n$$

Solution.

```
x = int(input("Enter value of x: "))
n = int(input("Enter the power (n): "))
s = 0
sign = +1
for a in range(n + 1):
    term = (x ** a) * sign
    s += term
    sign *= -1
print("Sum of first", n, "terms :", s)
```

```
Enter value of x: 5
Enter the power (n): 4
Sum of first 4 terms : 521
```

30. *Write a program to input the value of x and n and print the sum of the series :*

$$x+\frac{x^2}{2!}-\frac{x^3}{3!}+\frac{x^4}{4!}-......\frac{x^n}{n!}$$

Solution.

```
x = int(input("Enter value of x: "))
n = int(input("Enter the power (n): "))
s = x          # first term added
sign = +1
for a in range(2, n + 1):
    f = 1
    for i in range(1, a+1) :
        f *= i
    term =  ((x ** a) * sign ) / f
        s += term
    sign *= -1
print("Sum of first", n, "terms :", s)
```

```
Enter value of x: 4
Enter the power (n): 5
Sum of first 5 terms : 3.466666666666667
```

31. *Write a program to check if a given number is a perfect number or not.*

(**Note.** *A perfect number is a positive integer, which is equal to the sum of its divisors.*)

Solution.

```
n = int(input("Enter number: "))
summ = 0
for i in range(1, n):
    if(n % i == 0):
        summ = summ + i
if (summ == n):
    print("The number", n, "is a Perfect number!")
else:
    print("The number", n, " is not a Perfect number!")
```

```
Enter number: 28
The number 28 is a Perfect number!
```

32. *Write a program to check if a given number is an Armstrong number or not.*

(**Note.** *If a 3 digit number is equal to the sum of the cubes of its each digit, then it is an Armstrong Number.*)

Solution.

```
num = int(input("Enter a 3 digit number: "))
summ = 0
temp = num
while (temp > 0):
    digit = temp % 10
    summ += digit ** 3
    temp //= 10
if (num == summ):
    print(num, "is an Armstrong number")
else:
    print(num, "is Not an Armstrong number")
```

```
Enter a 3 digit number: 407
407 is an Armstrong number
```

33. *Write a program to check if a given number is a palindrome number or not.*

Solution. (A palindrome number's reversed number is same as the number.)

```
num = int(input("Enter number:"))
wnum = num  # working number stores num initially
rev = 0
while(wnum > 0):
    dig = wnum % 10
    rev = rev*10 + dig
    wnum = wnum // 10
if(num == rev):
    print("Number", num,"is a palindrome!")
else:
    print("Number", num,"is not a palindrome!")
```

```
Enter number:67826
Number 67826 is not a palindrome!
```

34. *Write a program to print Fibonacci series.*

Solution.

```
t = int(input("How many terms?(enter 2+ value): "))

first = 0
second = 1

print("\nFibonacci series is:")
print(first, ",", second, end =", ")

for i in range(2, t):
    next = first + second
    print(next, end=", ")
    first = second
    second = next
```

```
How many terms?( enter 2+ value): 8
Fibonacci series is:
0 , 1, 1, 2, 3, 5, 8, 13,
```

35. *Write a Python script to input two numbers and print their lcm (Least common multiple) and gcd (greatest common divisor).*

Solution.

```
x = int(input("Enter first number: "))
y = int(input("Enter second number: "))
if x > y:
    smaller = y
else:
    smaller = x
for i in range(1, smaller + 1):
    if((x % i == 0) and (y % i == 0)):
        hcf = i
lcm = (x * y ) / hcf
print("The H.C.F. of", x, "and", y, "is", hcf)
print("The L.C.M. of", x, "and", y, "is", lcm)
```

36. *Write a Python script to calculate sum of following series :*

$s = (1) + (1+2) + (1+2+3) + \ldots + (1+2+3+\ldots+n)$

Solution.

```
sum = 0
n = int ( input ( "How many terms ?" ) )
# added 2 to n because started with 2
for a in range(2, n + 2) :
    term = 0
    for b in range(1, a) :
        term += b
    print ("Term" , (a - 1), ":", term)
    sum += term
print ("Sum of", n, "terms is" , sum)
```

37. *Write a program to design a dice throw.*

Solution.

```
import random
n = int(input ("How many dice throws ? "))
for i in range(1, n+1) :
    print("Throw", i, ":", random.randint(1, 6))
```

```
How many dice throws ? 5
Throw 1 : 5
Throw 2 : 4
Throw 3 : 5
Throw 4 : 3
Throw 5 : 5
```

38. *Write a program to implement a simple calculator for two input numbers. Offer choices through a menu.*

Solution.

```
print("Enter 2 numbers below")
a = int(input("Enter number 1:"))
b = int(input("Enter number 2:"))
ch = 0
while ch < 5 :
    print("Calculator Menu")
    print("1.Add")
    print("2.Substract")
    print("3.Multiply")
    print("4.Divide")
    print("5.Exit")

    # input choice
    ch = int(input("Enter Choice(1-5): "))

    if ch == 1:
        c = a + b
        print("Sum = ",c)
    elif ch == 2:
        c = a - b
        print("Difference = ",c)
    elif  ch == 3:
        c = a * b
        print("Product = ",c)
    elif ch == 4:
        c = a / b
        print("Quotient = ",c)
    elif ch == 5:
        break
    else:
        print("Invalid Choice")
```

34. *Write a program to print Fibonacci series.*

Solution.

```
t = int(input("How many terms?(enter 2+ value): "))

first = 0
second = 1

print("\nFibonacci series is:")
print(first, ",", second, end =", ")

for i in range(2, t):
    next = first + second
    print(next, end=", ")
    first = second
    second = next
```

```
How many terms?( enter 2+ value): 8
Fibonacci series is:
0 , 1, 1, 2, 3, 5, 8, 13,
```

35. *Write a Python script to input two numbers and print their lcm (Least common multiple) and gcd (greatest common divisor).*

Solution.

```
x = int(input("Enter first number: "))
y = int(input("Enter second number: "))
if x > y:
    smaller = y
else:
    smaller = x
for i in range(1, smaller + 1):
    if((x % i == 0) and (y % i == 0)):
        hcf = i
lcm = (x * y ) / hcf
print("The H.C.F. of", x, "and", y, "is", hcf)
print("The L.C.M. of", x, "and", y, "is", lcm)
```

36. *Write a Python script to calculate sum of following series :*

$s = (1)+(1+2)+(1+2+3)+\ldots+(1+2+3+\ldots+n)$

Solution.

```
sum = 0
n = int ( input ( "How many terms ?" ) )
# added 2 to n because started with 2
for a in range(2, n + 2) :
    term = 0
    for b in range(1, a) :
        term += b
    print ("Term" , (a - 1), ":", term)
    sum += term
print ("Sum of", n, "terms is" , sum)
```

37. *Write a program to design a dice throw.*

Solution.

```
import random
n = int(input ("How many dice throws ? "))
for i in range(1, n+1) :
    print("Throw", i, ":", random.randint(1, 6))
```

```
How many dice throws ? 5
Throw 1 : 5
Throw 2 : 4
Throw 3 : 5
Throw 4 : 3
Throw 5 : 5
```

38. *Write a program to implement a simple calculator for two input numbers. Offer choices through a menu.*

Solution.

```
print("Enter 2 numbers below")
a = int(input("Enter number 1:"))
b = int(input("Enter number 2:"))
ch = 0
while ch < 5 :
    print("Calculator Menu")
    print("1.Add")
    print("2.Substract")
    print("3.Multiply")
    print("4.Divide")
    print("5.Exit")

    # input choice
    ch = int(input("Enter Choice(1-5): "))

    if ch == 1:
        c = a + b
        print("Sum = ",c)
    elif ch == 2:
        c = a - b
        print("Difference = ",c)
    elif ch == 3:
        c = a * b
        print("Product = ",c)
    elif ch == 4:
        c = a / b
        print("Quotient = ",c)
    elif ch == 5:
        break
    else:
        print("Invalid Choice")
```

39. *Write a program to print the following using a single loop (no nested loops) :*

```
1
11
111
1111
11111
```

Solution.

```
n = 1
for a in range(5) :
    print (n)
    n = n * 10 + 1
```

40. *Write a program to print a pattern like :*

```
4321
432
43
4
```

Solution.

```
for i in range(4):
    for j in range(4, i, -1):
        print(j, end =" ")
    else:
        print()
```

Guidelines to NCERT Questions [NCERT Chapter 6]

1. *What is the difference between else and elif construct of if statement ?*

   Ans. The **else** clause gets executed when the condition tested with **if** is false.

   The **elif** clause tests another condition when the condition with **if** is false.

2. *What is the purpose of range( ) function ? Given one example.*

   Ans. The **range( )** function generates an iterable sequence using the arguments ***start, stop*** and ***stop*** of **range( )** function. It is very handy and useful for the 'for' loops, which require an iterable sequence for looping.

3. *Differentiate between break and continue statements using examples.*

   Ans. Both the **break** and **continue** statements are jump statements. When the **break** statement gets executed, it terminates its loop completely and the control reaches to the statement immediately following the loop.

   The **continue** statement on the other hand, terminates only the current iteration of the loop by skipping rest of the statements in the body of the loop. The control resumes the next iteration of the loop after the **continue** statement.

4. *What is an infinite loop ? Give one example.*

   Ans. An infinite loop is the one whose terminating condition is either missing or is not reachable. Thus, the body-of-the-loop keeps repeating endlessly in an infinite loop.

5. *Find the output of the following program segments :*

(*i*)
```
a = 110
while a > 100 :
    print(a)
    a -= 2
```

(*ii*)
```
for i in range(20, 30, 2) :
    print(i)
```

(*iii*)
```
country = 'INDIA'
for i in country:
    print(i)
```

(*iv*)
```
i = 0 ; sum = 0
while i < 9 ;
    if i % 4 == 0 :
        sum = sum + i
    i = i + 2
print(sum)
```

(*v*)
```
for x in range(1, 4) :
    for y in range(2, 5):
        if x * y > 10:
            break
        print(x * y)
```

(*vi*)
```
var = 7
while var > 0
    print('Current variable value:', var)
    var = var - 1
    if var == 3:
        break
    else:
        if var == 6:
            var = var - 1
            continue
    print("Good bye!")
```

Ans.

```
(i)  110        (ii)  20        (iii)  I        (iv)  12        (v)  2
     108              22               N                             3
     106              24               D                             4
     104              26               I                             4
     102              28               A                             6
                                                                     8
                                                                     6
                                                                     9
```

(*vi*)
```
Current variable value : 7
Current variable value : 5
Good bye!
Current variable value : 4
```

NCERT Programming Exercises

1. *Write a program that takes the name and age of the user as input and displays a message whether the user is eligible to apply for a driving license or not. (the eligible age is 18 years).*

Ans.

```
name = input("Enter name :")
age = int(input("Enter age :"))
if age >=18:
    print(name, "is eligible for a driving license.")
else:
    print(name, "is not eligible for a driving license.")
```

Sample run :

```
Enter name : Ria
Enter age : 18
Ria is eligible for a driving license.
```

2. *Write a function to print the table of a given number. The number has to be entered by the user.*

Ans.

```
n = int(input("Enter number :"))
for i in range(1, 11):
    print(n, "x", i, "=", (n * i))
```

Sample Run

```
Enter number :3
3 x 1 = 3
3 x 2 = 6
3 x 3 = 9
3 x 4 = 12
3 x 5 = 15
3 x 6 = 18
3 x 7 = 21
3 x 8 = 24
3 x 9 = 27
3 x 10 = 30
```

3. *Write a program that prints minimum and maximum of five numbers entered by the user.*

Ans.

```
n = int(input("Enter a number :"))           # 1st number read
mn, mx = n, n
for i in range(4):                            # next 4 numbers being read
    n = int(input("Enter a number :"))
    if mx < n :
        mx = n
    if mn > n :
        mn = n
print("Maximum of numbers entered :", mx)
print("Minimum of numbers entered :", mn)
```

Sample Run

```
Enter a number :5
Enter a number :3
Enter a number :7
Enter a number :2
Enter a number :1
Maximum of numbers entered : 7
Minimum of numbers entered : 1
```

4. *Write a program to check if the year entered by the user is a leap year or not.*

Ans.

```
yr = int(input("Enter a 4-digit year :"))
if yr % 100 == 0 :  # century year check
    if yr % 400 == 0 :
        leap = True
    else :
        leap = False
elif yr %4 == 0 :
    leap = True
else :
    leap = False
if leap == True :
    print(yr, "is a leap year")
else :
    print(yr, "is not a leap year")
```

Sample Run

```
Enter a 4-digit year :1900
1900 is not a leap year
===========================
Enter a 4-digit year :2000
2000 is a leap year
===========================
Enter a 4-digit year :2016
2016 is a leap year
```

5. *Write a program to generate the sequence : – 5, 10, – 15, 20, – 25, ... upto n, where n is an integer input by the user.*

Ans.

```
n = int(input("Enter limit : "))
sign = -1
for i in range( 5, n, 5):
   term = i * sign
   sign = sign *-1
   print(term, end = " ")
```

Sample Run

```
Enter limit : 38
-5 10 -15 20 -25 30 -35
```

6. *Write a program to find the sum of* $1+1/8+1/27.....1/n^3$, *where n is the number input by the user.*

Ans.

```
n = int(input("Enter limit (n) :"))
ssum = 0
print("1", end = " ")                    # first term printed
ssum += 1                                # first term added
for i in range(2, (n + 1)):              # 2nd term onwards
   icube = (i * i * i)
   term = 1/ icube
   ssum += term
   print("+ 1 /", icube, end = " ")
print("=", ssum)
```

Sample Run

```
Enter limit (n) : 5
1 + 1 / 8 + 1 / 27 + 1 / 64 + 1 / 125 = 1.185662037037037
```

7. *Write a program to find the sum of digits of an integer number, input by the user.*

Ans.

```
num = int(input("Enter number : "))
ssum = 0
nnum = num
while (nnum != 0):
     digit = nnum % 10;
     nnum = nnum // 10
     ssum += digit
print("Sum of digits of number", num, "is :", ssum)
```

Sample Run

```
Enter number : 23903
Sum of digits of number 23903 is : 17
```

8. *Write a function that checks whether an input number is a palindrome or not.*
[Note. A number or a string is called palindrome if it appears same when written in reverse order also. For example, 12321 is a palindrome while 123421 is not a palindrome]

Ans.

```
num = int(input("Enter number : "))
rev = 0
nnum = num
```

```
    while (nnum != 0):
        digit = nnum % 10;
        nnum = nnum // 10
        rev = rev * 10 + digit
    if rev == num :
        print(num, "is a palindrome number.")
    else :
        print(num, "is not a palindrome number.")
```

Sample Run

```
Enter number : 34543
34543 is a palindrome number.
==============================
Enter number : 6787
6787 is not a palindrome number.
```

9. *Write a program to print the following patterns :*

(i)

```
    *
  * * *
* * * * *
  * * *
    *
```

(ii)

```
        1
      2 1 2
    3 2 1 2 3
  4 3 2 1 2 3 4
5 4 3 2 1 2 3 4 5
```

(iii)

```
1 2 3 4 5
  1 2 3 4
    1 2 3
      1 2
        1
```

(iv)

```
    *
  *   *
*       *
  *   *
    *
```

Ans. (i)

```
n = 5                        # number of lines
# upper half
k = round(n/2) * 2           # for initial spaces
for i in range(0 , n, 2):
    for j in range(0, k + 1):
        print(end=" ")
    for j in range(0, i + 1):
        print("* ", end ="")
    k = k - 2
        print()
#lower half
k = 1
for i in range(n-1, 0, -2):
    for j in range(0 , k+2):
        print(end = " ")
    for j in range(0, i-1):
        print("*", end="")
    k = k + 2
    print()
```

Sample Run

```
    *
  * * *
* * * * *
  * * *
    *
```

(ii)

```
n = 5              # number of lines
s  = n * 2 - 1     # for initial spaces
for i in range(1 , n + 1) :
    for j in range(0 , s ) :
        print(end =" ")
    for j in range(i, 0, -1) :
        print(j, end=" ")
    for j in range(2, i + 1) :
        print(j, end =" ")
    s = s – 2
        print()
```

Sample Run

```
        1
      2 1 2
    3 2 1 2 3
  4 3 2 1 2 3 4
5 4 3 2 1 2 3 4 5
```

(iii)

```
n = 5      # number of lines
s  = 0     # for initial spaces
for i in range(n, 0, -1):
   for j in range( 1, s+1 ):
       print(end = " ")
   for j in range(1, i + 1):
       print(j, end = " ")
   s += 2
       print( )
```

Sample Run

```
1 2 3 4 5
  1 2 3 4
    1 2 3
      1 2
        1
```

(iv)

```
n = 3
j = n-1
print(' '*(n)+'*')
for i in range(1, 2*n):
     if i > n:
         print(' '*(i-n)+'*'+' '*(2*j– 1)+'*')
         j -=1
     else:
         print(' '*(n-i) +'*'+' '*(2*i-1) +'*')
if n>1:
     print(' '*n+'*')
```

Sample Run

```
   *
  *  *
 *     *
  *  *
   *
```

10. *Write a program to find the grade of a student when grades are allocated as given in the table below.*

Percentage of Marks	Grade
Above 90%	A
80% to 90%	B
70% to 80%	C
60% to 70%	D
Below 60%	E

Percentage of the marks obtained by the student is input to the program.

Ans.

```
marks = float(input("Enter marks : "))
if marks >= 90 :
    grade = 'A'
elif marks >= 80 :
    grade = 'B'
elif marks >= 70 :
    grade = 'C'
elif marks >= 60 :
    grade = 'D'
else  :
    grade = 1E'
print("For marks", marks, "the Grade is", grade)
```

Sample Run

```
Enter marks : 90
For marks 90.0 the Grade is A
==============================
Enter marks : 80
For marks 80.0 the Grade is B
==============================
Enter marks : 69.9
For marks 69.9 the Grade is D
```

GLOSSARY

Block	A group of consecutive statements having same indentation level.
Body	The block of statements in a compound statement that follows the header.
Empty statement	A statement that appears in the code but does nothing.
Infinite Loop	A loop that never ends. *Endless loop.*
Iteration Statement	Statement that allows a set of instructions to be performed repeatedly.
Jump Statement	Statement that unconditionally transfers program control within a function.
Looping Statement	Iteration statement. Also called a loop.
Nesting	Same program-construct within another of same type of construct.
Nested Loop	A loop that contains another loop inside its body.
Suite	Block.

Assignments

For Solutions for Selected Questions

Scan QR Code

TYPE A : SHORT ANSWER QUESTIONS/CONCEPTUAL QUESTIONS

1. What is the common structure of Python compound statements ?
2. What is the importance of the three programming constructs ?
3. What is empty statement ? What is its need ?
4. Which Python statement can be termed as empty statement ?
5. What is an algorithm ?
6. What is a flowchart ? How is it useful ?
7. Draw flowchart for displaying first 10 odd numbers.
8. What is entry-controlled loop ?
9. What are the four elements of a while loop in Python ?
10. What is the difference between else clause of if-else and else clause of Python loops ?
11. In which cases, the else clause of a loop does not get executed ?
12. What are jump statements ? Name them.
13. How and when are named conditions useful ?
14. What are endless loops ? Why do such loops occur ?
15. How is **break** statement different from **continue** ?

TYPE B : APPLICATION BASED QUESTIONS

1. Rewrite the following code fragment that saves on the number of comparisons :

```
if (a == 0) :
  print ("Zero")
if (a == 1) :
  print ("One")
if (a == 2) :
  print ("Two")
if (a == 3) :
  print ("Three")
```

2. Under what conditions will this code fragment print "water" ?

```
if temp < 32 :
   print ("ice")
elif temp < 212:
   print ("water")
else :
   print ("steam")
```

3. What is the output produced by the following code ?

```
x = 1
if x > 3 :
   if x > 4 :
       print ("A", end = ' ')
   else :
       print ("B", end = ' ')
elif x < 2:
   if (x != 0):
       print ("C", end = ' ')
print ("D")
```

4. What is the error in following code ? Correct the code :

```
weather = 'raining'
if weather = 'sunny' :
   print ("wear sunblock")
elif weather = "snow":
   print ("going skiing")
else :
   print (weather)
```

5. What is the output of the following lines of code ?

```
if int('zero') == 0 :
   print ("zero" )
elif str(0) == 'zero' :
   print (0)
elif str(0) == '0 ' :
   print (str(0))
else:
   print ("none of the above")
```

6. Find the errors in the code given below and correct the code :

```
if n == 0
   print ("zero")
elif : n == 1
   print ("one")
elif
   n == 2:
   print ("two")
else n == 3:
   print ("three")
```

7. What is following code doing ? What would it print for input as 3 ?

```
n = int (input( "Enter an integer:" ))
if n < 1 :
   print ("invalid value")
else :
   for i in range(1, n + 1):
       print (i * i)
```

8. How are following two code fragments different from one another ? Also, predict the output of the following code fragments :

(a)
```
n = int(input( "Enter an integer:" ))
if n > 0 :
    for a in range(1, n + n ) :
        print (a / (n/2))
    else :
        print ("Now quiting")
```

(b)
```
n = int (input( "Enter an integer:"))
if n > 0 :
    for a in range(1, n + n) :
        print (a / (n/2))
else :
    print ("Now quiting")
```

9. Rewrite the following code fragments using for loop :

(a)
```
i = 100
while (i > 0) :
    print (i)
    i -= 3
```

(b)
```
while num > 0 :
print (num % 10)
    num = num/10
```

(c)
```
while num > 0 :
    count += 1
    sum += num
        num -= 2
    if count == 10 :
        print (sum/float(count))
        break
```

10. Rewrite following code fragments using while loops :

(a)
```
min = 0
max = num
if num < 0 :
    min = num
    max = 0 # compute sum of integers
            # from min to max

    for i in range(min, max + 1):
        sum += i
```

(b)
```
for i in range(1, 16) :
    if i % 3 == 0 :
        print (i)
```

(c)
```
for i in range(4) :
    for j in range(5):
        if i + 1 == j or j + i == 4 :
            print ("+", end = ' ')
    else :
        print ("o", end = ' ')
print()
```

11. Predict the output of the following code fragments :

(a)
```
count = 0
while count < 10:
    print ("Hello")
    count += 1
```

(b)
```
x = 10
y = 0
while x > y:
    print (x, y)
    x = x – 1
    y = y + 1
```

(c)
```
keepgoing = True
x = 100
while keepgoing :
    print (x)
    x = x - 10
    if x < 50 :
        keepgoing = False
```

(d)
```
x = 45
while x < 50 :
    print (x)
```

(e)
```
for x in [1,2,3,4,5]:
    print (x)
```

(f)
```
for x in range(5):
    print (x)
```

(g)
```
for p in range(1, 10):
    print (p)
```

(h)
```
for q in range(100, 50, -10):
    print (q)
```

(i)
```
for z in range(-500, 500, 100):
    print (z)
```

(j)
```
for y in range(500, 100, 100):
    print (" * ", y)
```

(k)
```
x = 10
y = 5
for i in range(x-y * 2):
    print (" % ", i)
```

(l)
```
for x in [1, 2, 3]:
    for y in [4, 5, 6]:
        print (x, y)
```

(m)
```
for x in range(3):
    for y in range(4):
        print (x, y, x + y)
```

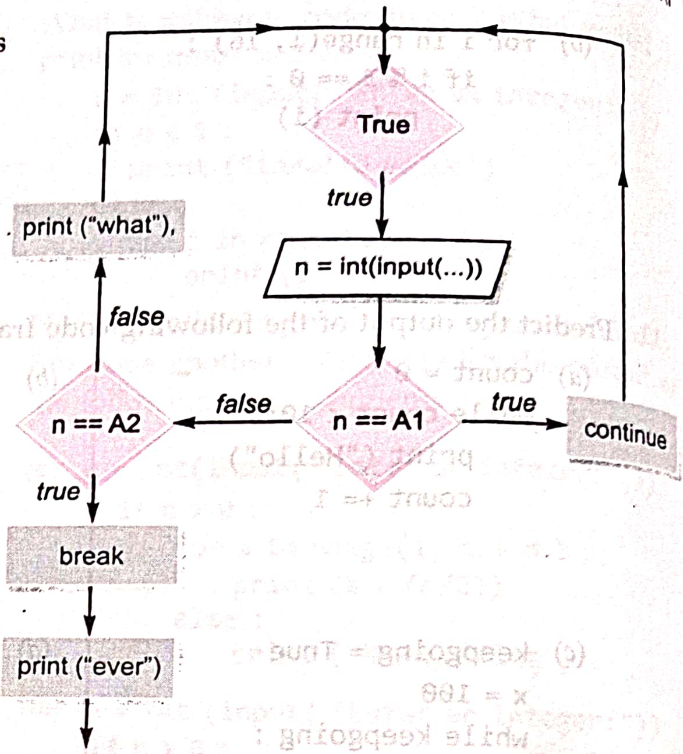
(n)
```
c = 0
for x in range(10):
    for y in range(5):
        c += 1
print (c)
```

12. What is the output of the following code ?

```
for i in range(4):
    for j in range(5):
        if i + 1 == j or j + i == 4:
            print ("+", end = ' ')
        else:
            print ("o", end = ' ')
print()
```

13. In the nested for loop code above (Q. 12), how many times is the condition of the if clause evaluated ?

14. Which of the following Python programs implement the control flow graph shown ?



(*a*)
```
while True :
        n = int(input("Enter an int:"))
        if n == A1 :
            continue
        elif n == A2 :
            break
        else :
            print ("what")
else :
        print ("ever")
```

(*b*)
```
while True :
        n = int(input("Enter an int: "))
        if n == A1 :
            continue
        elif n == A2 :
            break
        else :
            print ("what")
print ("ever")
```

(*c*)
```
while True :
        n = int(input("Enter an int: "))
        if n == A1 :
            continue
        elif n == A2 :
            break
print ("what")
print ("ever")
```

15. Find the error. Consider the following program :

```
a = int(input("Enter a value: "))
while a != 0:
    count = count + 1
    a = int(input("Enter a value: "))
print("You entered", count, "values.")
```

It is supposed to count the number of values entered by the user until the user enters 0 and then display the count (not including the 0). However, when the program is run, it crashes with the following error message after the first input value is read :

```
Enter a value: 14
Traceback (most recent call last):
  File "count.py", line 4, in <module>
    count = count + 1
NameError: name 'count' is not defined
```

What change should be made to this program so that it will run correctly ? Write the modification that is needed into the program above, crossing out any code that should be removed and clearly indicating where any new code should be inserted.

TYPE C : PROGRAMMING PRACTICE/KNOWLEDGE BASED QUESTIONS

1. Write a Python script that asks the user to enter a length in centimetres. If the user enters a negative length, the program should tell the user that the entry is invalid. Otherwise, the program should convert the length to inches and print out the result. There are 2.54 centimetres in an inch.
2. A store charges ₹ 120 per item if you buy less than 10 items. If you buy between 10 and 99 items, the cost is ₹ 100 per item. If you buy 100 or more items, the cost is ₹ 70 per item. Write a program that asks the user how many items they are buying and prints the total cost.
3. Write a program that reads from user – (*i*) an hour between 1 to 12 and (*ii*) number of hours ahead. The program should then print the time after those many hours, *e.g.*,

```
Enter hour between 1-12 : 9
How many hours ahead : 4
Time at that time would be : 1 O'clock
```

4. Write a program that asks the user for two numbers and prints **Close** if the numbers are within .001 of each other and **Not close** otherwise.
5. A year is a leap year if it is divisible by 4, except that years divisible by 100 are not leap years unless they are also divisible by 400. Write a program that asks the user for a year and prints out whether it is a leap year or not.
6. Write a program to input length of three sides of a triangle. Then check if these sides will form a triangle or not. **(Rule is** : a + b > c ; b + c > a ; c + a > b)
7. Write a short program to input a digit and print it in words.
8. Write a short program to check whether square root of a number is prime or not.
9. Write a short program to print first *n* odd numbers in descending order.
10. Write a short program to print the following series :

    (*i*) 1 4 7 10 . . . . . . 40. (*ii*) 1 – 4 7 – 10 . . . . . . – 40
11. Write a short program to find average of list of numbers entered through keyboard.
12. Write a program to input 3 sides of a triangle and print whether it is an equilateral, scalene or isosceles triangle.
13. Write a program to take an integer **a** as an input and check whether it ends with *4* or *8*. If it ends with 4, print **"ends with 4"**, if it ends with 8, print **"ends with 8"**, otherwise print **"ends with neither"**.
14. Write a program to take *N* (*N* > 20) as an input from the user. Print numbers from 11 to *N*. When the number is a multiple of 3, print "Tipsy", when it is a multiple of 7, print "Topsy". When it is a multiple of both, print "TipsyTopsy".
15. Write a short program to find largest number of a list of numbers entered through keyboard.
16. Write a program to input N numbers and then print the second largest number.
17. Given a list of integers, write a program to find those which are palindromes. For example, the number 4321234 is a palindrome as it reads the same from left to right and from right to left.
18. Write a complete Python program to do the following :

    (*i*) read an integer X. (*ii*) determine the number of digits *n* in X.

    (*iii*) form an integer *Y* that has the number of digits *n* at ten's place and the most significant digit of X at one's place. (*iv*) Output Y.

    (For example, if X is equal to 2134, then *Y* should be 42 as there are 4 digits and the most significant number is 2).
19. Write a Python program to print every integer between 1 and *n* divisible by *m*. Also report whether the number that is divisible by *m* is even or odd.
20. Write Python programs to sum the given sequences :

    (*a*) $\frac{2}{9} - \frac{5}{13} + \frac{8}{17}$....... (print 7 terms) (*b*) $1^2 + 3^2 + 5^2 + ... + n^2$ (Input *n*)

21. Write a Python program to sum the sequence : $1+\frac{1}{1!}+\frac{1}{2!}+\frac{1}{3!}+....+\frac{1}{n!}$ (Input n)

22. Write a program to accept the age of n employees and count the number of persons in the following age group : (*i*) 26 – 35 (*ii*) 36 – 45 (*iii*) 46 – 55.

23. Write programs to find the sum of the following series :

(*a*) $x-\frac{x^2}{2!}+\frac{x^3}{3!}-\frac{x^4}{4!}+\frac{x^5}{5!}-\frac{x^6}{6!}$ (Input x) (*b*) $x+\frac{x^2}{2}+\frac{x^3}{3}+.....+\frac{x^n}{n}$ (Input x and n both)

24. Write programs to print the following shapes :

(*a*)
```
  *
 * *
* * *
 * *
  *
```
(*b*)
```
*
* *
* * *
* *
*
```
(*c*)
```
    *
  *   *
*       *
  *   *
    *
```
(*d*)
```
*
* *
*   *
*     *
*   *
* *
*
```

25. Write programs using nested loops to produce the following patterns :

(*a*)
```
A
A B
A B C
A B C D
A B C D E
A B C D E F
```
(*b*)
```
A
B B
C C C
D D D D
E E E E E
```
(*c*)
```
0
2 2
4 4 4
6 6 6 6
8 8 8 8 8
```
(*d*)
```
2
4 4
6 6 6
8 8 8 8
```

26. Write a program using nested loops to produce a rectangle of *'s with 6 rows and 20 *'s per row.

27. Given three numbers *A*, *B* and *C*, write a program to write their values in an ascending order. For example, if *A* = 12, *B* = 10, and *C* = 15, your program should print out :

```
Smallest number = 10
Next higher number = 12
Highest number = 15
```

28. Write a Python script to input temperature. Then ask them what units, Celsius or Fahrenheit, the temperature is in. Your program should convert the temperature to the other unit. The conversions are F = 9/5C + 32 and C = 5/9 (F 32).

29. Ask the user to enter a temperature in Celsius. The program should print a message based on the temperature :

- If the temperature is less than – 273.15, print that the temperature is invalid because it is below absolute zero.
- If it is exactly – 273.15, print that the temperature is absolute 0.
- If the temperature is between – 273.15 and 0, print that the temperature is below freezing.
- If it is 0, print that the temperature is at the freezing point.
- If it is between 0 and 100, print that the temperature is in the normal range.
- If it is 100, print that the temperature is at the boiling point.
- If it is above 100, print that the temperature is above the boiling point.

30. Write a program to display all of the integers from 1 up to and including some integer entered by the user followed by a list of each number's prime factors. Numbers greater than 1 that only have a single prime factor will be marked as prime.

For example, if the user enters 10 then the output of the program should be :

```
Enter the maximum value to display: 10
1 = 1
2 = 2 (prime)
3 = 3 (prime)
4 = 2x2
5 = 5 (prime)
6 = 2x3
7 = 7 (prime)
8 = 2x2x2
9 = 3x3
10 = 2x5
```