
Exercises – Sequential problems

- 1 – What will this program display?

VARIABLES :

number1, number2, number3: Real (Input)

START

 number1 ← 1

 number2 ← 2

 number3 ← 3

 number1 ← number2

 number2 ← number3

 number3 ← number1

 WRITE number1, number2, number3

END

- 2 – In the old system of calculating sales tax in Québec, the taxes on a product were 7% for the GST, and 7.5% for the QST (applied after calculating the GST). Make a program that reads the unit price of a product and the quantity purchased, and that displays the amounts for the GST, the QST, and the total price after taxes.
- 3 – Make a program that calculates an employee's gross salary for a week, given their hourly rate and the number of hours worked.
- 4 – Make a program that reads a temperature in degrees Fahrenheit and converts it into degrees Celsius. The conversion formula is:

$$C = \frac{F - 32}{9} \times 5$$

- 5 – Make a program that displays the volume of a rectangular prism after reading the dimensions of the prism.
- 6 – A dealership selling new vehicles asks you to construct a program that calculates the compensation paid to their salespeople. The base salary for all the salespeople is \$400. For each vehicle sold, the salesperson receives a commission of \$200. Also, the salesperson receives a bonus of 5% of the total amount of all their sales. Make the program for a salesperson.

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- 7 – We want to determine the height of a building of n floors, knowing that the ground floor has a height of 6 meters and that the other floors each have a height of 4 meters.
- 8 – An aircraft pilot wants to know the atmospheric pressure, expressed in atmosphere units (atm), as the weather station only provides pressure data in kilopascal units (kPa). 1 atm is equivalent to 101.325 kPa. Make a program that performs the conversion.
- 9 – In a computer technology course, the following evaluation weights are used:
- Laboratory work counts for 40% of the grade
 - The midterm exam counts for 25%
 - The final exam counts for 35%

Make a program that calculates the final grade of a student, assuming that each of the three grades the user inputs is out of 100.

- 10 – Monique want to have a little program that allows her to evaluate the total amount of her expenses for a month, as well as the amount of money she can allocate for her leisure activities and non-essential spending. The program should read her projections for expenses in the following categories:

Weekly expenses (one time per week; assuming that 1 month = 4 weeks)

- Food expenses and household expenses
- Common expenses

Monthly expenses (one time per month)

- Public transit pass
- Rent
- Total of monthly bills

The program should also read the amount of her paycheques. Monique receives two paycheques per month.

The program should then display her total expenses, her total income, and the difference.

Conditionals

- 11 – Develop an algorithm that determines the greater value out of two numbers provided by the user. Display this value.
- 12 – Write an algorithm that determines the amount to pay as a tip to a server in a restaurant. The tip should be 15% when the bill is at least \$1.
- 13 – A computer store sells diskettes at a price of \$1 each for small orders. The store sells them at a price of 70 cents each for orders of 25+ units. Furthermore, if you are a member of Club Z, the store will give you an extra discount of 2%. Write an algorithm that determines the total price for a purchase.
- 14 – A print shop charges 5 cents per copy for the first 100 copies. For any subsequent copies, they charge 3 cents each. Write an algorithm that determines the price associated with a given number of copies.
- 15 – Write an algorithm that simulates the withdrawal of an amount of money from an ATM. The algorithm should ask for the amount of the current balance and the amount of the withdrawal. If the amount of the withdrawal is greater than the balance, display an error message; otherwise, display the new balance.
- 16 – An electricity bill is calculated by obtaining the number of days for which electricity is supplied and the number of kilowatt hours (kWh) consumed. The client is billed at a rate of \$0.50 per day and \$0.30 per kWh. For a client that has consumed more than 200 kWh, their rate is reduced from \$0.30 to \$0.20 for additional kWh. We want to obtain the total amount for the bill.
- 17 – Write an algorithm that reads an integer and determines whether it is even or odd.
- 18 – Write an algorithm that reads two integers m and n and determines whether m is a multiple of n .
- 19 – Give an algorithm that reads three numbers (a , b , c) and determines whether any one of the numbers is equal to the sum of the other two. If such a number exists, display it; otherwise, display the message “No solution”.

20 – Improve the following algorithm by reducing the number of lines of code:

```
READ a, b, c
IF a < b THEN
    IF c < 5 THEN
        WRITE "Hello"
    ENDIF
ENDIF
```

21 – Correct the error in the following algorithm:

```
IF number > 1 OR number < 3 THEN
    WRITE "The number is between 1 and 3."
ENDIF
```

22 – Correct the error:

```
READ number
IF number < 1 AND number > 5 THEN
    WRITE "The number is outside the limits."
ELSE
    WRITE "The number is inside or equal to the limits."
ENDIF
```

23 – Rewrite the following code using AND and OR.

```
VARIABLES:
number1, number2, number3:    Real (Input)

START
    READ number1, number2, number3
    IF number1 = number2 THEN
        IF number1 = number3 THEN
            WRITE "The three numbers are identical."
        ELSE
            WRITE "Two of the numbers are identical."
        ENDIF
    ELSE
        IF number2 = number3 THEN
            WRITE "Two of the numbers are identical."
```

```
ELSE
    IF number1 = number3 THEN
        WRITE "Two of the numbers are identical."
    ENDIF
ENDIF
ENDIF
END
```

- 24 – In a game, the player tosses two coins. Let's suppose that, if the first and second coin land on heads, the player wins \$10; if the first lands on heads and the second on tails, the player wins \$5; otherwise, the player loses. We want a program that reads the value of the two coins (heads or tails) and determines whether the player has won. If yes, it should display the amount won.
- 25 – Write a program that reads 3 values, determines the greatest one, and displays it.
- 26 – Write a program that reads three values and displays them in ascending order.
- 27 – The Ministère des Finances of Québec is adopting a project aiming to reduce taxes. Develop an algorithm that calculates taxes according to the table provided below. In addition, a 2% reduction of the tax rate is granted if the person is married. Furthermore, a 0.5% reduction is granted for each child. Finally, 8% is subtracted from the tax rate for those who have newly arrived in the province. Determine the amount of tax to be paid as a function of the information provided by the user.

Table of basic tax rates:

Salary	Tax rate
\$0.00 to \$18,000.00	10%
\$18,000.01 to \$32,000.00	20%
\$32,000.01 to \$60,000.00	30%
\$60,000.01 and more	40%

28 – We want to create a program that displays the letter grade for a student, given their grade in percentage, according to the following table:

Grade	Letter
90% – 100%	A
80% – 89%	B
70% – 79%	C
60% – 69%	D
< 60%	F

29 – Write an algorithm that reads two triplets day1, month1, year1, and day2, month2, year2, representing two dates, and that determines whether the first date comes before the second.

30 – Write an algorithm that reads three numbers and determines whether these numbers, considered as the lengths of the three sides of a triangle, would correspond to:

- An equilateral triangle (three equal sides)
- An isosceles triangle (two equal sides)
- A scalene triangle (three different sides)

31 – An automobile insurance company wants to computerize the calculation of renewals for the premiums of its clients. The increase of a client's premium is a function of the number of accidents, according to the table below:

Number of accidents	Increase
0	2%
1 or 2	5%
3	10%
4 and more	30%

You are asked to create a program that calculates the new value of a premium, according to the old premium and the number of accidents.

- 32 – In a competition where scores are given by 6 judges, a competitor's final score is calculated as follows: first the highest and the lowest of the initial scores are eliminated, and then one takes the average of the other 4 scores. You are asked to create a program that reads 6 scores and determines the final score according to this method.
- 33 – Write the algorithm of a program that reads a date (3 integers: day, month, year) and that displays the date of the next day (in numbers). Suppose that the year is not a leap year.
- 34 – Create an algorithm that determines whether a year provided by the user is a leap year. To be a leap year, a year must be divisible by 4 but not divisible by 100; despite this, if it is divisible by 400, it is a leap year after all.
Example: 2000 is a leap year, but 1700, 1800, and 1900 are not.

For loops and while loops

Complete numbers 35 to 48 two times: first with a **for** loop, and then with a **while** loop.

- 35 – Write an algorithm that calculates the sum of all the integers contained (inclusively) between two positive integer limits entered by the user. The program reads the smallest limit first.
Example: the sum of the integers between 5 and 10, inclusively.

- 36 – Create four algorithms, each displaying the corresponding one of the following sequences:

- a) 5 10 15 20 25 30 35 40
- b) 3 5 7 9 11 13 15
- c) 80 70 60 50 40 30 20
- d) 1 2 6 24 120 720

- 37 – Write an algorithm that reads a positive integer (> 0) and determines whether it is a prime number. (Hint: try dividing the number by the numbers coming before it.)
Validate the input.
- 38 – Write an algorithm that displays a table for converting Celsius units into Fahrenheit units. The table should display all of the values from -40 to 40 degrees Celsius, at increments of 5 degrees. The conversion formula is:

$$F = \frac{9}{5} \times C + 32$$

- 39 – Write a program that calculates the average of 1000 grades. The program asks the user for each of the grades.
- 40 – Write a program that reads 1000 numbers and determines the largest and the smallest.

Tracing

- 41 – Construct a trace table for this program, testing with various values for the variables *number1* and *number2*. Explain what the program does.

VARIABLES:

number1: Real (Input)
number2: Integer (Input)
total: Real (Output)
counter: Integer (Internal)

START

```
  READ number1, number2
  total ← 1
  IF number2 ≤ 0 THEN
    WRITE "The second number should be > 0."
  ELSE
    FOR counter = 1 TO number2
      total ← total * number1
    ENDFOR
  ENDIF
  WRITE total
END
```

- 42 – Construct a trace table for this program using *number* = 12. Explain what the program does.

VARIABLES:

number: Integer (Input)
counter: Integer (Internal)


```
START
  READ number
  FOR counter = 1 TO number
    IF number MODULO counter = 0 THEN
      WRITE counter
    ENDIF
  ENDFOR
END
```

43 – Construct a trace table for this program to find out what the program displays.

VARIABLES:

result:	Integer (Internal)
number:	Integer (Internal)
counter:	Integer (Internal)

```
START
  result ← 0
  number ← 1
  FOR counter = 1 TO 5
    number ← number + counter
    result ← result + number
  ENDFOR
  WRITE number, result
END
```

Synthesis

For the following exercises, make an analysis and write pseudocode accordingly.

- 44 – You just won a million dollars! You decide to invest \$500,000 in a term deposit for a period of 5 years. The annual interest rate is 10%, and the interest is added to the principal sum each year (compound interest). How much will your savings be worth in 5 years?
- Make the algorithm with specified number (internal data).
 - Generalize for any amount, any duration, and any interest rate.
- 45 – Write an algorithm that displays the first 100 numbers of the Fibonacci sequence. This sequence begins with the numbers 1, 1, 2, 3, 5, 8, ..., where each new number in the sequence can be found by adding the two previous numbers in the sequence.
- 46 – Write a program that displays all the prime numbers from 1 to 50,000.
- 47 – (*) Write a program that reads the grades for the exams and assignments in a course including 2 exams and 2 assignments. The program should be able to adapt to the conditions of the course. More precisely:
- The program should read the number of students in the course.
 - For each of the four grades, ask the user what the weight of the grade is. In other words, how much is the grade worth as a percentage of the final grade for the course?
 - The program should validate that the total of the four weights given is indeed equal to 100.
 - Then, for each student, the program should read the student's four grades (each out of 100). Verify that the values entered are between 0 and 100. Then calculate the final course grade for each student.
 - The program should display whether the student passes or fails the course. A student passes if they achieve 60 or greater.
 - Finally, the program should display the average of all the students' final course grades.

Supplementary exercises

- 1 – Determine what will be displayed when each of the following lines is executed. Suppose that $x = 2$ and $y = 3$.
 - a) Write x
 - b) Write $x + x$
 - c) Write “ $x =$ ”
 - d) Write “ $x * x$ ”
 - e) Write “ $x * y$ ”, $y + x$
 - f) Write $x * y + y + x$
 - g) Write “ $x * y + y + x$ ”
- 2 – Write a program that asks the user to enter two numbers, and that displays the sum, the product, the difference, and the quotient of these two numbers.
- 3 – Write a program that asks the user to enter two integers, and that displays the larger number, followed by the words “ is greater than ”, followed by the smaller number. However, if the numbers are equal, the program should display “These numbers are equal.”
- 4 – Write a program that receives three integers entered via the keyboard, and that displays the sum, the average, the product, the smallest, and the largest of these numbers.
- 5 – Write a program that reads the radius of a circle, and that displays the diameter, the circumference, and the area of the circle. Use the constant value 3.14159 for π .
- 6 – Drivers are concerned with the mileage of their automobiles. A driver decides to record the number of kilometers traveled and the number of litres of gasoline used, each time they refill their gas tank. Develop a program with the goal of being able to enter the number of kilometers traveled and the number of litres used upon each gas refill. The program should calculate and display the rate of gas consumption (in litres per 100 kilometers) between each gas refill. After having processed all of the information entered, the program should calculate and display the total rate of gas consumption (in litres per 100 kilometers) for all of the gas refills.

Example of the program’s execution:

Enter the number of litres used (-1 to terminate):

48.5

Enter the number of kilometers traveled:

459

The rate of gas consumption in litres per 100 kilometers for this gas refill is 10.566448.

Enter the number of litres used (-1 to terminate):

40.0

Enter the number of kilometers traveled:

320

The rate of gas consumption in litres per 100 kilometers for this gas refill is 12.500000.

Enter the number of litres used (-1 to terminate):

19

Enter the number of kilometers traveled:

192

The rate of gas consumption in litres per 100 kilometers for this gas refill is 9.8958333.

Enter the number of litres used (-1 to terminate):

-1

The total rate of gas consumption in litres per 100 kilometers is 11.071060.

- 7 – A large chemical products company compensates its commercial representatives by commission. The representatives receive \$200 per week plus 9% of their gross sales per week. For example, a representative who sells \$5000 of chemical products in one week receives a salary of \$200 plus 9% of \$5000, for a total of \$650. Develop a program that asks for the gross weekly sales of each representative and that calculates and displays their salary. Process the information of one representative at a time.

Example of the program's execution:

Enter the representative's sales in dollars (-1 to terminate):

5000.00

The representative's salary is \$650.00.

Enter the representative's sales in dollars (-1 to terminate):

6000.00

The representative's salary is \$740.00.

Enter the representative's sales in dollars (-1 to terminate):

7000.00

The representative's salary is \$830.00

Enter the representative's sales in dollars (-1 to terminate):

-1

- 8 – A palindrome is a number, a word, or a sentence that remains identical whether read from left to right or from right to left. For example, each of the following five-digit numbers is a palindrome: 12321, 55555, 45554, 11611. Write a program capable of reading a positive integer (greater than 0) with five digits, and of determining whether

this integer is a palindrome. (Hint: use the modulus and division operators to separate the different digits composing the numbers.)

- 9 – Write a program that converts the input of positive integer greater than 0 that is composed only of the digits 0 and 1 (that is, a “binary” integer) in order to display its decimal equivalent. (Hint: use the modulus and division operators to process the digits of the “binary” number one at a time, from right to left.)
- 10 – Write a program that calculate the square and the cube of the numbers from 0 to 10.
- 11 – Write a program that reads three non-zero integers and that determines and displays whether these integers could form the sides of a right-angled triangle.
- 12 – A company desires to transmit data by telephone, but is concerned about the fact that their telephone lines can be secretly listened in on. All of this data is transmitted in the form of four-digit integers. You are asked to write a program able to encrypt this data, in order to ensure a more secure transmission. Your program should read a four-digit integer and execute the encryption in the following way: replace each of the digits in the integer by ((this digit + 7) modulo 10). Then, exchange the first digit with the third digit, and exchange the second digit with the fourth, and display the encrypted integer. Write a separate program for encrypting the four-digit integer entered, and for decrypting the encrypted integer in order to find the original number.
- 13 – The factorial of a non-negative integer is written with the expression $n!$ (pronounced “ n factorial”), and is defined in the following way:

$$n! = n * (n - 1) * (n - 2) * \dots * 1 \quad (\text{for } n \geq 1)$$

and

$$n! = 1 \quad (\text{for } n = 0)$$

For example, $5! = 5 * 4 * 3 * 2 * 1 = 120$.

Write a program that reads a non-negative integer, and then calculates and displays its factorial.

- 14 – Write a program that calculates and displays the product of all the odd numbers between 1 to 15, inclusively.