



Sheet 1

Problem 1: *Diamond*

Write a program that prints the following diamond shape. You may use output statements that print either a single asterisk or a single blank. Maximize your use of repetition (with nested `for` structures) and minimize the number of output statements.

```

      *
     ***
    *****
   ********
  **********
 *

```

Problem 2: *Factorial*

The factorial of a nonnegative integer n is written $n!$ (pronounced “n factorial”) and is defined as follows:

$$n! = \begin{cases} n \cdot (n - 1) \cdot (n - 2) \cdot \dots \cdot 1 & , n \geq 1 \\ 1 & , n = 0 \end{cases}$$

For example, $5! = 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1$, which is 120.

- Write a program that reads a nonnegative integer and computes and prints its factorial.
- Write a program that estimates the value of the mathematical constant e by using the formula:

$$e = 1 + \frac{1}{1!} + \frac{1}{2!} + \frac{1}{3!} + \dots$$

- Write a program that computes the value of e^x by using the formula:

$$e^x = 1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \dots$$

Problem 3: *Pi*

Calculate the value of π from the infinite series

$$\pi = 4 - \frac{4}{3} + \frac{4}{5} - \frac{4}{7} + \frac{4}{9} - \frac{4}{11} + \dots$$

Print a table that shows the value π approximated by one term of this series, by two terms, by three terms, etc. How many terms of this series do you have to use before you first get 3.14, 3.141, 3.1415, and 3.14159?

Problem 4: *Encryption/Decryption*

A company wants to transmit data over the telephone, but they are concerned that their phones may be tapped. All of their data are transmitted as four-digit integers. They have asked you to write a program that encrypts their data so that it can be transmitted more securely. Your program should read a four-digit integer and encrypt it as follows: Replace each digit by (the sum of that digit plus 7) modulus 10. Then, swap the first digit with the third, swap the second digit with the fourth and print the encrypted integer. Write a separate program that inputs an encrypted four-digit integer and decrypts it to form the original number.