Lab 10/11

Please do not use while, do/while,math functions, if/else, and array in this Lab.

Lab Part

1. Write a program which prompt the user to input a single odd integer "height" and displays a "hourglass" of this height made up of "*" characters on the screen as example. Please use only one nested loop, and at most two for loops inside, but one is better.
   Input will less than 99.

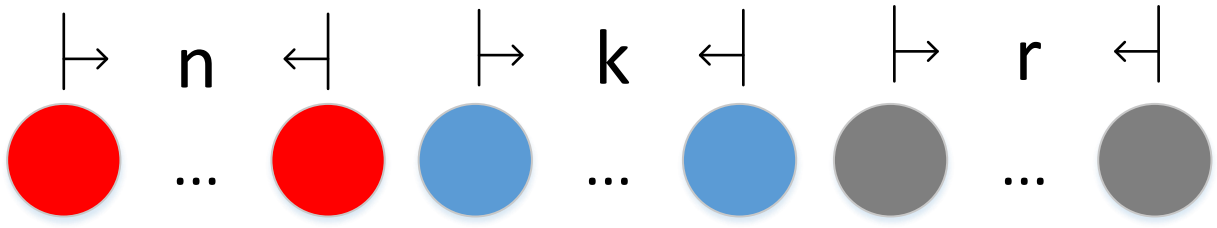
   Hint: using ternary operator

   Input/Output Example:

```
Input: 11

    1  2  3  4  5  6  7  8  9 10 11
 1
 2  *                          *
 3  *  *                    *  *
 4  *  *  *                 *  *  *
 5  *  *  *  *              *  *  *  *
 6  *  *  *  *  *     *     *  *  *  *
 7  *  *  *  *              *  *  *  *
 8  *  *  *                 *  *  *
 9  *  *                    *  *
10  *                          *
11
```

2. Now, there have n red balls, k blue balls and r gray balls. please write a program to calculate all permutations.



Hint:

$$\frac{(n+k+r)!}{n!\,k!\,r!}$$

Input/Output Example:

```
(n,k,r)= 4 3 2
ans=1260
```

3. Write a program which print out the following multiplication table using for loop. You just can use only one loop to finish the content of this table (red frame), please do not use nested loop and if/else.
   Hint: You can try to use ternary operator.

Input/Output Example:

```
Input odd number: 15

      -7  -6  -5  -4  -3  -2  -1   0   1   2   3   4   5   6   7
-------------------------------------------------------------------
 -7|  49  42  35  28  21  14   7   0  -7 -14 -21 -28 -35 -42 -49
 -6|  42  36  30  24  18  12   6   0  -6 -12 -18 -24 -30 -36 -42
 -5|  35  30  25  20  15  10   5   0  -5 -10 -15 -20 -25 -30 -35
 -4|  28  24  20  16  12   8   4   0  -4  -8 -12 -16 -20 -24 -28
 -3|  21  18  15  12   9   6   3   0  -3  -6  -9 -12 -15 -18 -21
 -2|  14  12  10   8   6   4   2   0  -2  -4  -6  -8 -10 -12 -14
 -1|   7   6   5   4   3   2   1   0  -1  -2  -3  -4  -5  -6  -7
  0|   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
  1|  -7  -6  -5  -4  -3  -2  -1   0   1   2   3   4   5   6   7
  2| -14 -12 -10  -8  -6  -4  -2   0   2   4   6   8  10  12  14
  3| -21 -18 -15 -12  -9  -6  -3   0   3   6   9  12  15  18  21
  4| -28 -24 -20 -16 -12  -8  -4   0   4   8  12  16  20  24  28
  5| -35 -30 -25 -20 -15 -10  -5   0   5  10  15  20  25  30  35
  6| -42 -36 -30 -24 -18 -12  -6   0   6  12  18  24  30  36  42
  7| -49 -42 -35 -28 -21 -14  -7   0   7  14  21  28  35  42  49
```

Homework Part

4. Write programs to accumulate and print the following:
   a. where n reads from the keyboard.
   b. Please show the answer accurate to the 12th decimal place if its decimal part is not zero.
   c. This homework is designed for the loop practice.

   Please do not use array or pow function and use only one loop no nested loop.

   (a). $20 + 22 + 24 + \cdots + 2n$
   (b). $1 + \frac{1}{3} + \frac{1}{5} + \ldots + \frac{1}{101}$
   (c). $1 + \frac{1}{2!} + \frac{1}{3!} + \ldots + \frac{1}{n!}$
   (d). $1 - 2 + 3 - 4 + \cdots + (-1)^{n+1} n$
   (e). 1+ (1+2) + (1+2+3) +(1+2+3+4) +…+(1+2+3+…+ n)

Modification:

1) $20 + 22 + 24 + \cdots + 2n$ => $4 + 6 + 8 + \cdots + 2n$
2) $1 + \frac{1}{2!} + \frac{1}{3!} + \ldots + \frac{1}{n!}$ => $1 + \frac{1}{2!} + \frac{1}{4!} + \ldots + \frac{1}{2n!}$, $\frac{1}{0!} = 1$
3) 1+ (1+2) +(1+2+3) +(1+2+3+4) +…+(1+2+3+…+ n) => 1+ (1+3) +(1+3+5) +(1+3+5+7) +…+(1+3+…+ 2n+1)
4) 12th decimal place => 10^{th} decimal place

Input/Output Example:

```
Input n = 4
(a) 18
(b) 2.9476758386
(c) 1.5430803571
(d) -2
(e) 55
```

5. A polynomial $a_n x^n + a_{n-1}x^{n-1} + \cdots + a_0$ can be evaluated(計值)

Method I. In a straightforward way by performing the indicated operations.

Method II. An alternative method is to factor the polynomial according to the following formula, known as HORNER'S Rule:

$$(\ldots(\ ((\ 0 * x + a_n)x + a_{n-1})\ x + a_{n-2})\ x + \cdots + a_1)\ x + a_0$$

(1). Write two programs to evaluate polynomials by these two different methods. (The order of the polynomial is not greater than 5, and the coefficients are read by the keyboard.)

Please use only one loop for method II (nested loop is not allowed)

(2). Print out the number of multiplications and additions are used in each method.

Modification:

1) $a_n x^n + a_{n-1}x^{n-1} + \cdots + a_0 => \frac{1}{\mathrm{n+1}} a_n x^{n+1} + \frac{1}{\mathrm{n}} a_{n-1}x^n + \cdots + a_0 x$

2) $(\ldots(((\ 0 * x + a_n)x + a_{n-1})\ x + a_{n-2})\ x + \cdots + a_1)\ x + a_0$

⇨ $((\ldots(\left(\ 0 * x + \frac{1}{\mathrm{n+1}} a_n\right)x + \frac{1}{\mathrm{n}} a_{n-1})x + \cdots + \frac{1}{2} a_1)\ x + a_0)x$

3) Not greater than 5 => Not greater than 6

4) show the answer accurate to the 8th decimal place

Input/Output Example:

```
-----Method I-----
Please input the order: 3
Please input x: 4
Please input a_3: 3
Please input a_2: 2
Please input a_1: 1
Please input a_0: 0
Answer: 242.66666667, ADD time: 3, MUL time: 10

-----Method II-----
Please input the order: 3
Please input x: 4
Please input a_3: 3
Please input a_2: 2
Please input a_1: 1
Please input a_0: 0
Answer: 242.66666667, ADD time: 4, MUL time: 5
```

6. A common highway patro speed-detection radar unit emits a beam of microwaves at a frequency . The beam is reflected off an approaching car, and the reflected beam is picked up and analyzed by the radar unit. The frequency of the reflected beam is shifted slightly from f_0 to f_1 due to the motion of the car. The relationship between the speed of the car, v, in miles per hour and the two microwave frequencies is

$$v = (6.685 * 10^8) * \frac{f_1 - f_0}{f_1 + f_0}$$

Where the emitted waves have a frequency of $f_0 = 2 * 10^{10}\ s^{-1}$.

(a).Using this formula, write a program to calculate and display the speed corresponding to a received frequency of $5.0012345 \times 10^{12}\ s^{-1}$

(b). Modify the above program to determine the frequency that will be returned by a car traveling at 195 miles per hour.

(c) Please initialize variables as Scientific Notation (C++ Exponential Notation).

Ex:The C++ Exponential Notation of 725.83 is 7.258300E+02.

(d) Use format specifier: double precision %lf and scientific notation %e to print out large numbers and display 13 digits after the decimal point.

Modification:

1) $6.685 * 10^8$ => $6.70616626 * 10^8$
2) $f_0 = 2 * 10^{10}\ s^{-1}$ => $3 * 10^{10}\ s^{-1}$
3) 13 digits => 10th

Input/Output Example:

```
v = 662619185.6978236437
v = 6.6261918570e+08
f1 = 30000017446.6348571777
f1 = 3.0000017447e+10
```