S.A. Computer Olympiad
Second Round 2004

Q1. TriSquare

Prepared by Donald Cook

Description

Triangles and squares are commonplace but these ones are a special type known as TriSquares.

Task

Your task is to write a program that will draw a TriSquare of any size up to 25. The Triangle part shown in the figure has a pointed top and the height is equal to the (width-of-the-base +1) /2. The width gives the size of the Square part of the shape.

A TriSquare of size 7:

```
   @              <- Single point at top
  @ @
 @   @
@@@@@@@           <- Width (size)
@     @
@     @
@     @           <- Height = Width
@     @
@     @
@@@@@@@
```

Constraints

The top is always 1 @ wide. An odd number always describes the size.

Input

Enter an odd number for the size: 9

Output

```
    @
   @ @
  @   @
 @     @
@@@@@@@@@
@       @
@       @
@       @
@       @
@       @
@       @
@       @
@@@@@@@@@
```

Test your program with

a. 5
b. 13

Q2. Elections

Prepared By: Graham Poulter

Description

The elections in the land are over and the results are in. As chief of the electoral commission, it is up to you to take the votes each party got and work out how many of the fixed number of seats in parliament each party is awarded. You decide it would be best to write a program that can work it out fairly as possible.

When one works out the number of seats allocated to each party, some parties often win a fractional part of a seat. Your program should first give each party their rounded-down number of seats. Then it should take the leftover seats and distribute them, starting with the party with the largest fractional seat and working down until no leftover seats remain. To avoid tiebreaks, no two parties will have the same number of votes or same fractional number of seats.

Example:

As an example, if there are 20 seats in parliament and three parties with 240, 315 and 420 votes get 4.92, 6.46 and 8.62 seats respectively, which means the parties get 4, 6 and 8 seats, leaving 2 seats over. Once the leftover seats have been distributed as described, the parties will have 5, 6 and 9 seats respectively.

Input

Number of seats: 20
Number of parties: 3
Votes for party #1: 240
Votes for party #2: 315
Votes for party #3: 420

Output

Seats for party #1: 5
Seats for party #2: 6
Seats for party #3: 9

Test your program with:

a. 83 seats, 7 parties
18824, 6092, 22000, 2253, 83, 600, 1123 votes
b. 400 seats, 4 parties
2527196, 3815596, 410105, 3243589 votes

P.O.Box 13287 Mowbray, 7705
Ph: +27 21 4487864 Fax: +27 21 477 4410

SACO Second Round 2004

Q3. Smartie Ring

Prepared by: Graham Poulter

Credit: Adapted from USACO training problem "Broken Necklace"

Description

In a birthday party lucky dip you find a necklace made of red, green and blue smarties. Here is an example with 16 smarties:

```
    b  g  g
  r          g
r              b
g                b
 r             r
  g          r
    b  b  g
```

For your program we can write this (starting from the top left) as: bgggbbrrgbbgrgrr

Remember that the necklace is a circle, so the smartie after the red one at the end is the blue one at the beginning.

Break the necklace somewhere, say, just after the three green smarties. Now you have two ends, off which you can pull the smarties and eat them. However, there is a very strange rule about these smarties - once you start pulling smarties of one colour off one end, you are not allowed to pull off any other colours from the same end. You're also only allowed to break the necklace once, so you want to choose the place where you can pull off the most smarties in total.

In the example, this best place happens to be just after the three green smarties – there you can pull off the three green smarties from one end, and the two blue from the other end, and have five smarties in total. This is the most you can get using the rules. Your program should print the answer as follows:
bggg*bbrrgbbgrgrr
Where the "*" shows the place at which the necklace was broken. If more than one place can give the same biggest number of smarties, use the one that is furthest to the left. Also, just before the first and just after the last smartie are exactly the same place. If the best break is there put the "*" on the left.

Sample run

Input:

bgggbbrrgbbgrgrr

Output:

bggg*bbrrgbbgrgrr

Test your program with:

a. bgbrrrbrbbbrrgg
b. bbbrgbrbrgrrrgggbbbrggg

Q4. Sweets

Prepared by: Harry Wiggins

Description

N children numbered 1 to N are sitting in a circle; starting at child 1, a sweet is passed; after M passes the child holding the sweet is eliminated. If child x gets eliminated he gives the sweet to child x+1 and leaves the ring. That does not count for a pass, the children in the circle close ranks and the game continues with the child who was sitting after the eliminated child, taking the sweet; the last remaining child gets the sweet. Assume M is constant for each elimination.

Your task is to write a computer program to determine which child will get the sweet.

Sample run:
1234567 (child 1 have sweet before round 1)
456712 (child 4 have sweet before round 2)
71245 (child 7)
4571 (child 4)
145 (child 1)
14 (child 1)
4 (he gets the sweet)

Input:
N = 7
M = 2
Output:
Sweet goes to child 4.

Test your program with:

a. N = 999
   M = 9
b. N = 123456
   M = 789

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Q5. Martian Elections

Prepared by: Carl Hultquist

Description

Martians have taken to watching the coverage of the South African elections. They particularly enjoy the South African elections, as they feel that these are the most free and fair elections that occur on Earth.

Elections in South Africa happen every 5 years. On Mars, elections can only take place in a year whose number is prime, a prime number is a number greater than 1 which is only divisible by 1 and itself (the Martians measure years in the same way as people on Earth do). Furthermore, the Martians do not need to have an election on every prime year: they can choose the prime years that they have elections on. They do this to try and ensure the greatest happiness of the Martian people. Since Martians enjoy the South African elections, they are happiest when the Martian elections are close to the South African elections. However, the longer the Martians wait between successive elections, the unhappier they get.

Your goal is to work out the years that the Martians should hold elections on to ensure the greatest "happiness", and then to print out this total "happiness".

Suppose the Martians were to hold elections in year Y. Their "happiness" with this election is equal to S + L, where S and L are calculated as follows:

1) If Y is the same year as a South African election, then S = 5.
2) If Y is the year after a South African election, then S = 3.
3) If Y is 2 years after a South African election, then S = 1.
4) If Y is 3 years after a South African election, then S = -1.
5) If Y is 4 years after a South African election, then S = -3.

If the previous election was held in year X, then L is equal to -(P^2), where P is the number of prime years between Y and X (that is, P is the number of elections that have been skipped).

The total happiness of the Martians for a set of elections is calculated as the sum of their happiness for each individual election.

Given the most recent year in which the Martians had an election, the most recent year that the South Africans had an election, and the final year in which the Martians must have an election, calculate the best total happiness for the Martians.

Sample run:

Suppose the Martians had their last election in the year 2, and that the South Africans also had their last election in the year 2. The Martians will have their last election in the year 19. The prime numbers between 2 and 19 are: 3, 5, 7, 11, 13 and 17. Having elections in years 3, 7, 13, 17 and 19 ensures the greatest "happiness" for the Martians.
The individual "happiness" amounts for these years are (3 - 0), (5 - 1), (3 - 1), (5 - 0) and (1 - 0), giving a total happiness of 3 + 4 + 2 + 5 + 1 = 15.

Input:

When was the most recent Martian election? 2
When was the most recent South African election? 2
When will the Martians have their last election? 19

Output:

Total happiness is 15

Test your program with:

a.
The most recent Martian election = 31
The most recent South African election = 28
The Martians will have their last election = 83

b.
The most recent Martian election = 2003
The most recent South African election = 2004
The Martians will have their last election = 4999

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