# Chinese remainder theorem

Due: June 1, 2023

**Problem Description**

In mathematics, the Chinese remainder theorem states that if one knows the remainders of the Euclidean division of an integer n by several integers, then one can determine uniquely the remainder of the division of n by the product of these integers, under the condition that the divisors are pairwise coprime (no two divisors share a common factor other than 1).For example, if we know that the remainder of n divided by 3 is 2, the remainder of n divided by 5 is 3, and the remainder of n divided by 7 is 2, then without knowing the value of n, we can determine that the remainder of n divided by 105 (the product of 3, 5, and 7) is 23. Importantly, this tells us that if n is a natural number less than 105, then 23 is the only possible value of n. The earliest known statement of the theorem is by the Chinese mathematician Sun-tzu in the Sun-tzu Suan-ching in the 3rd century CE. The Chinese remainder theorem is widely used for computing with large integers, as it allows replacing a computation for which one knows a bound on the size of the result by several similar computations on small integers. The Chinese remainder theorem (expressed in terms of congruences) is true over every principal ideal domain.

中國剩餘定理，又稱孫子定理或中國餘數定理，是數論中的一個關於一元線性同餘方程組的定理，說明了一元線性同餘方程組有解的準則以及求解方法。該定理在中國古代也被稱為「韓信點兵」、「求一術」（宋 沈括）、「鬼谷算」（宋 周密）、「隔牆算」（宋 周密）、「剪管術」（宋 楊輝）、「秦王暗點兵」、「物不知數」等。最早可見於中國南北朝時期（公元5世紀）的數學著作《孫子算經》卷下第二十六題，叫做「物不知數」問題，原文如下：

**有物不知其數，三三數之剩二，五五數之剩三，七七數之剩二。問物幾何？**

即，一個整數除以三餘二，除以五餘三，除以七餘二，求這個整數。《孫子算經》中首次提到了同餘方程組問題，以及以上具體問題的解法，

**「術曰：三三數之，賸二，置一百四十；五五數之，賸三，置六十三；七七數之，賸二 ，置三十。并之，得二百三十三，以二百一十減之，即得。凡三三數之，賸一，則置七十 五；五五數之，賸一，則置二十一；七七數之，賸一，則置十五。一百六以上，以一百五 減之，即得。」**

因此在中文數學文獻中也會將中國剩餘定理稱為孫子定理。孫子沒正式證明，但後來印度數學家及天文學家阿耶波多給出具體過程，徹底解決了此定理的任何給定實例。最初對「物不知數」問題作出完整系統解答的是宋朝數學家秦九韶，載於1247年《數書九章》卷一、二《大衍類》中，從而使這一問題變為定理。明朝數學家程大位在《算法統宗》中將解法編成易於上口的《孫子歌訣》：

**三人同行七十稀，五樹梅花廿一支，七子團圓正半月，除百零五便得知**

**Write the RISC-V assembly program to obtain the magic numbers and answer for any given feasible inputs (three divisors and three remainders).**

Please make the first line of the printed message be your student ID number.

You should use RISC-V instruction set simulator **RARS** to develop and execute the assembly code. The RARS simulator can be downloaded from <https://www.rose-hulman.edu/class/csse/csse232/Lab1/rars_27a7c1f.jar> .

**Input Format**

When the code is executed on RARS, Just follows the instruction presented on the monitor to provide input data.

**Output Format**

The output format should be exactly the same as the example given below. Certainly, different input will result in different numbers presented on the monitor.

**What Should Be Handed In:**

* **The first line of assembly code should consist of your student ID number**. Every **added** instruction should have a comment to explain what the instruction does. a comment should start with ### at the beginning of the comment. The file name of the assembly code should be **sID.asm** where ID is your student ID number. A valid file name will look like s1111111.asm .
* A clip like the one shown in the example of input and output below. Save the clip as a file called **sID.png**, where ID is your student ID number. A valid file name for an output clip will look like s1111111.png .
* The homework will not be graded if you do not follow the above rules.

**Example of input and output :**

Ex1:

**有物不知其數，三三數之剩二，**

**五五數之剩三，七七數之剩二。**

**問物幾何？**

s1111111

input divisor 1 :3

input divisor 2 :5

input divisor 3 :7

input remainder 1: 2

input remainder 2: 3

input remainder 3: 2

magic numbers are 70,21,15,105

answer=23

**三人同行七十稀**

**五樹梅花廿一支**

**七子團圓正半月**

**除百零五便得知**

**2\*70 + 3\*21 + 2\*15 = 140+63+30 = 233**

**233 % 105 = 23**

Ex2

s1111111

input divisor 1 :3

input divisor 2 :5

input divisor 3 :7

input remainder 1: 0

input remainder 2: 0

input remainder 3: 2

magic numbers are 70,21,15,105

answer=30

Ex3

s1111111

input divisor 1 :2

input divisor 2 :3

input divisor 3 :5

input remainder 1: 0

input remainder 2: 1

input remainder 3: 2

magic numbers are 15,10,6,30

answer=22

Ex4

s1111111

input divisor 1 :3

input divisor 2 :7

input divisor 3 :2

input remainder 1: 1

input remainder 2: 5

input remainder 3: 0

magic numbers are 28,36,21,42

answer=40