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Maplesoft™, a subsidiary of Cybernet Systems Co. Ltd. in Japan, is the leading provider of high-performance software tools for engineering, science, and mathematics. Its product suite reflects the philosophy that given great tools, people can do great things. Learn more about Maplesoft. Let  $f$  be a polynomial with integer coefficients in one or more variables. An algebraic equation of the form  $f(x_1, x_2, \dots, x_n) = 0$ , whose roots are required to be integers, is called a Diophantine equation. The simplest equations are linear Diophantine equations of the form  $a_1x_1 + a_2x_2 + \dots + a_nx_n = m$ , where  $a_1, a_2, \dots, a_n, m \in \mathbb{Z}$ . Linear Diophantine equation

In more detail, we will observe a linear Diophantine equation in two variables,  $ax + by = c$ , where  $a, b, c \in \mathbb{Z}$ . First of all, we will show how to solve a homogeneous linear Diophantine equation  $ax + by = 0$ , by using the following example.

**Example 1.** Find all integer solutions of the following equation:  $2x - 3y = 0$ .

**Solution.** The given equation we write in the form:  $y = \frac{2x}{3}$ . Since  $y$  must be an integer, and how  $2$  and  $3$  are relatively prime numbers, that  $x$  must be a multiple of  $3$ . Therefore,  $x = 3k$ , where  $k \in \mathbb{Z}$ . If we include it in the given equation, we will obtain  $y = 2k$ ,  $k \in \mathbb{Z}$ . Therefore,  $x = 3k$ ,  $y = 2k$ ,  $k \in \mathbb{Z}$  is the set of all solutions of the given equation. We can see that the equation has infinitely many solutions. In general, if we have the equation  $ax + by = 0$ ,  $a^2 + b^2 \neq 0$ , then  $x = -\frac{by}{a}$ , from where it follows  $y = -at$ ,  $t \in \mathbb{Z}$  and  $x = bt$ ,  $t \in \mathbb{Z}$ . Therefore, with  $x = bt$  and  $y = -at$ ,  $t \in \mathbb{Z}$  is given the set of all integer solutions of the equation  $ax + by = 0$ . We can show now how to solve a non-homogeneous linear Diophantine equation in two variables  $ax + by = c$ ,  $c \neq 0$ . The basic idea of solving these equations consists in the fact that we solve its associated homogeneous linear equation  $ax + by = 0$ . Consider the following example.

**Example 2.** Solve the following Diophantine equation:  $7x - 9y = 3$ .

**Solution.** First of all, we will find any integer solution of the given equation. Such a solution surely exists because  $\gcd(7, 9) = 1$  and  $3$  is divisible by  $1$ . One solution of the given equation is  $x_0 = 3$ ,  $y_0 = 2$ . Any concrete solution of the equation is called a particular solution. Therefore,  $x_0 = 3$ ,  $y_0 = 2$  is one particular solution of the given equation, so the following is valid:  $7x_0 - 9y_0 = 3$ . If from the given equation we subtract the previous equality, we will obtain the following:  $7(x - x_0) - 9(y - y_0) = 0$ , and that is a homogeneous linear equation. Its solution is:  $x - x_0 = 9t$ ,  $y - y_0 = 7t$ , that is,  $x = 9t + x_0$ ,  $y = 7t + y_0$ . Substituting  $x_0$  and  $y_0$  to the solution of a homogeneous equation, we obtain all integer solutions of the given equation:  $x = 3 + 9t$ ,  $y = 2 + 7t$ ,  $t \in \mathbb{Z}$ . In general, solution of the non-homogeneous linear Diophantine equation is equal to the integer solution of its associated homogeneous linear equation plus any particular integer solution of the non-homogeneous linear equation, what is given in the form of a theorem. We write:  $x = x_0 + bt$ ,  $y = y_0 - at$ ,  $t \in \mathbb{Z}$ . However, there appears a problem, that is, the question of whether each of the linear Diophantine equation has integer solutions. For example, the equation  $4x + 2y = 13$  has no integer solutions because its left side is an even number, for all  $x, y \in \mathbb{Z}$ , and its right side is an odd number, so, there are no integers  $x$  and  $y$  that satisfy the specified equation. Therefore, we must first determine the requirement with which a linear Diophantine equation has integer solutions. The following theorem gives us a condition of resolvability of Diophantine equations.

**Theorem 1.** The equation  $ax + by = c$ ,  $a^2 + b^2 \neq 0$ ,  $a, b, c \in \mathbb{Z}$  has integer solution if and only if  $\gcd(a, b) \mid c$ . To search for the greatest common measure of two numbers, we use the Euclidean algorithm, and it relies on the divisibility theorem: For  $a \in \mathbb{Z}$  and  $b \in \mathbb{N}$  there exist unique integers  $q$  and  $r$  such that  $a = bq + r$  and  $0 \leq r < b$ . The number  $q$  is called the quotient and  $r$  is called the remainder. The quotient and remainder defined by the theorem above are unique. If the remainder is  $0$ , then  $a = bq$ , therefore, by the definition of divisibility,  $b$  divides  $a$ . Now we are going to write a scheme of the Euclidean algorithm. On the left of the page we will indicate the ordered pairs of numbers to which we will apply the equality from the divisibility theorem:  $(a, b)$ ,  $a = bq_1 + r_1$ ,  $r_1 < b$ ,  $(b, r_1)$ ,  $b = r_1q_2 + r_2$ ,  $r_2 < r_1$ ,  $(r_1, r_2)$ ,  $r_1 = r_2q_3 + r_3$ ,  $r_3 < r_2$ ,  $(r_2, r_3)$ ,  $r_2 = r_3q_4 + r_4$ ,  $r_4 < r_3$ ,  $(r_3, r_4)$ ,  $r_3 = r_4q_5 + r_5$ ,  $r_5 < r_4$ ,  $(r_4, r_5)$ ,  $r_4 = r_5q_6 + r_6$ ,  $r_6 < r_5$ ,  $(r_5, r_6)$ ,  $r_5 = r_6q_7 + r_7$ ,  $r_7 < r_6$ ,  $(r_6, r_7)$ ,  $r_6 = r_7q_8 + r_8$ ,  $r_8 < r_7$ ,  $(r_7, r_8)$ ,  $r_7 = r_8q_9 + r_9$ ,  $r_9 < r_8$ ,  $(r_8, r_9)$ ,  $r_8 = r_9q_{10} + r_{10}$ ,  $r_{10} < r_9$ ,  $(r_9, r_{10})$ ,  $r_9 = r_{10}q_{11} + r_{11}$ ,  $r_{11} < r_{10}$ ,  $(r_{10}, r_{11})$ ,  $r_{10} = r_{11}q_{12} + r_{12}$ ,  $r_{12} < r_{11}$ ,  $(r_{11}, r_{12})$ ,  $r_{11} = r_{12}q_{13} + r_{13}$ ,  $r_{13} < r_{12}$ ,  $(r_{12}, r_{13})$ ,  $r_{12} = r_{13}q_{14} + r_{14}$ ,  $r_{14} < r_{13}$ ,  $(r_{13}, r_{14})$ ,  $r_{13} = r_{14}q_{15} + r_{15}$ ,  $r_{15} < r_{14}$ ,  $(r_{14}, r_{15})$ ,  $r_{14} = r_{15}q_{16} + r_{16}$ ,  $r_{16} < r_{15}$ ,  $(r_{15}, r_{16})$ ,  $r_{15} = r_{16}q_{17} + r_{17}$ ,  $r_{17} < r_{16}$ ,  $(r_{16}, r_{17})$ ,  $r_{16} = r_{17}q_{18} + r_{18}$ ,  $r_{18} < r_{17}$ ,  $(r_{17}, r_{18})$ ,  $r_{17} = r_{18}q_{19} + r_{19}$ ,  $r_{19} < r_{18}$ ,  $(r_{18}, r_{19})$ ,  $r_{18} = r_{19}q_{20} + r_{20}$ ,  $r_{20} < r_{19}$ ,  $(r_{19}, r_{20})$ ,  $r_{19} = r_{20}q_{21} + r_{21}$ ,  $r_{21} < r_{20}$ ,  $(r_{20}, r_{21})$ ,  $r_{20} = r_{21}q_{22} + r_{22}$ ,  $r_{22} < r_{21}$ ,  $(r_{21}, r_{22})$ ,  $r_{21} = r_{22}q_{23} + r_{23}$ ,  $r_{23} < r_{22}$ ,  $(r_{22}, r_{23})$ ,  $r_{22} = r_{23}q_{24} + r_{24}$ ,  $r_{24} < r_{23}$ ,  $(r_{23}, r_{24})$ ,  $r_{23} = r_{24}q_{25} + r_{25}$ ,  $r_{25} < r_{24}$ ,  $(r_{24}, r_{25})$ ,  $r_{24} = r_{25}q_{26} + r_{26}$ ,  $r_{26} < r_{25}$ ,  $(r_{25}, r_{26})$ ,  $r_{25} = r_{26}q_{27} + r_{27}$ ,  $r_{27} < r_{26}$ ,  $(r_{26}, r_{27})$ ,  $r_{26} = r_{27}q_{28} + r_{28}$ ,  $r_{28} < r_{27}$ ,  $(r_{27}, r_{28})$ ,  $r_{27} = r_{28}q_{29} + r_{29}$ ,  $r_{29} < r_{28}$ ,  $(r_{28}, r_{29})$ ,  $r_{28} = r_{29}q_{30} + r_{30}$ ,  $r_{30} < r_{29}$ ,  $(r_{29}, r_{30})$ ,  $r_{29} = r_{30}q_{31} + r_{31}$ ,  $r_{31} < r_{30}$ ,  $(r_{30}, r_{31})$ ,  $r_{30} = r_{31}q_{32} + r_{32}$ ,  $r_{32} < r_{31}$ ,  $(r_{31}, r_{32})$ ,  $r_{31} = r_{32}q_{33} + r_{33}$ ,  $r_{33} < r_{32}$ ,  $(r_{32}, r_{33})$ ,  $r_{32} = r_{33}q_{34} + r_{34}$ ,  $r_{34} < r_{33}$ ,  $(r_{33}, r_{34})$ ,  $r_{33} = r_{34}q_{35} + r_{35}$ ,  $r_{35} < r_{34}$ ,  $(r_{34}, r_{35})$ ,  $r_{34} = r_{35}q_{36} + r_{36}$ ,  $r_{36} < r_{35}$ ,  $(r_{35}, r_{36})$ ,  $r_{35} = r_{36}q_{37} + r_{37}$ ,  $r_{37} < r_{36}$ ,  $(r_{36}, r_{37})$ ,  $r_{36} = r_{37}q_{38} + r_{38}$ ,  $r_{38} < r_{37}$ ,  $(r_{37}, r_{38})$ ,  $r_{37} = r_{38}q_{39} + r_{39}$ ,  $r_{39} < r_{38}$ ,  $(r_{38}, r_{39})$ ,  $r_{38} = r_{39}q_{40} + r_{40}$ ,  $r_{40} < r_{39}$ ,  $(r_{39}, r_{40})$ ,  $r_{39} = r_{40}q_{41} + r_{41}$ ,  $r_{41} < r_{40}$ ,  $(r_{40}, r_{41})$ ,  $r_{40} = r_{41}q_{42} + r_{42}$ ,  $r_{42} < r_{41}$ ,  $(r_{41}, r_{42})$ ,  $r_{41} = r_{42}q_{43} + r_{43}$ ,  $r_{43} < r_{42}$ ,  $(r_{42}, r_{43})$ ,  $r_{42} = r_{43}q_{44} + r_{44}$ ,  $r_{44} < r_{43}$ ,  $(r_{43}, r_{44})$ ,  $r_{43} = r_{44}q_{45} + r_{45}$ ,  $r_{45} < r_{44}$ ,  $(r_{44}, r_{45})$ ,  $r_{44} = r_{45}q_{46} + r_{46}$ ,  $r_{46} < r_{45}$ ,  $(r_{45}, r_{46})$ ,  $r_{45} = r_{46}q_{47} + r_{47}$ ,  $r_{47} < r_{46}$ ,  $(r_{46}, r_{47})$ ,  $r_{46} = r_{47}q_{48} + r_{48}$ ,  $r_{48} < r_{47}$ ,  $(r_{47}, r_{48})$ ,  $r_{47} = r_{48}q_{49} + r_{49}$ ,  $r_{49} < r_{48}$ ,  $(r_{48}, r_{49})$ ,  $r_{48} = r_{49}q_{50} + r_{50}$ ,  $r_{50} < r_{49}$ ,  $(r_{49}, r_{50})$ ,  $r_{49} = r_{50}q_{51} + r_{51}$ ,  $r_{51} < r_{50}$ ,  $(r_{50}, r_{51})$ ,  $r_{50} = r_{51}q_{52} + r_{52}$ ,  $r_{52} < r_{51}$ ,  $(r_{51}, r_{52})$ ,  $r_{51} = r_{52}q_{53} + r_{53}$ ,  $r_{53} < r_{52}$ ,  $(r_{52}, r_{53})$ ,  $r_{52} = r_{53}q_{54} + r_{54}$ ,  $r_{54} < r_{53}$ ,  $(r_{53}, r_{54})$ ,  $r_{53} = r_{54}q_{55} + r_{55}$ ,  $r_{55} < r_{54}$ ,  $(r_{54}, r_{55})$ ,  $r_{54} = r_{55}q_{56} + r_{56}$ ,  $r_{56} < r_{55}$ ,  $(r_{55}, r_{56})$ ,  $r_{55} = r_{56}q_{57} + r_{57}$ ,  $r_{57} < r_{56}$ ,  $(r_{56}, r_{57})$ ,  $r_{56} = r_{57}q_{58} + r_{58}$ ,  $r_{58} < r_{57}$ ,  $(r_{57}, r_{58})$ ,  $r_{57} = r_{58}q_{59} + r_{59}$ ,  $r_{59} < r_{58}$ ,  $(r_{58}, r_{59})$ ,  $r_{58} = r_{59}q_{60} + r_{60}$ ,  $r_{60} < r_{59}$ ,  $(r_{59}, r_{60})$ ,  $r_{59} = r_{60}q_{61} + r_{61}$ ,  $r_{61} < r_{60}$ ,  $(r_{60}, r_{61})$ ,  $r_{60} = r_{61}q_{62} + r_{62}$ ,  $r_{62} < r_{61}$ ,  $(r_{61}, r_{62})$ ,  $r_{61} = r_{62}q_{63} + r_{63}$ ,  $r_{63} < r_{62}$ ,  $(r_{62}, r_{63})$ ,  $r_{62} = r_{63}q_{64} + r_{64}$ ,  $r_{64} < r_{63}$ ,  $(r_{63}, r_{64})$ ,  $r_{63} = r_{64}q_{65} + r_{65}$ ,  $r_{65} < r_{64}$ ,  $(r_{64}, r_{65})$ ,  $r_{64} = r_{65}q_{66} + r_{66}$ ,  $r_{66} < r_{65}$ ,  $(r_{65}, r_{66})$ ,  $r_{65} = r_{66}q_{67} + r_{67}$ ,  $r_{67} < r_{66}$ ,  $(r_{66}, r_{67})$ ,  $r_{66} = r_{67}q_{68} + r_{68}$ ,  $r_{68} < r_{67}$ ,  $(r_{67}, r_{68})$ ,  $r_{67} = r_{68}q_{69} + r_{69}$ ,  $r_{69} < r_{68}$ ,  $(r_{68}, r_{69})$ ,  $r_{68} = r_{69}q_{70} + r_{70}$ ,  $r_{70} < r_{69}$ ,  $(r_{69}, r_{70})$ ,  $r_{69} = r_{70}q_{71} + r_{71}$ ,  $r_{71} < r_{70}$ ,  $(r_{70}, r_{71})$ ,  $r_{70} = r_{71}q_{72} + r_{72}$ ,  $r_{72} < r_{71}$ ,  $(r_{71}, r_{72})$ ,  $r_{71} = r_{72}q_{73} + r_{73}$ ,  $r_{73} < r_{72}$ ,  $(r_{72}, r_{73})$ ,  $r_{72} = r_{73}q_{74} + r_{74}$ ,  $r_{74} < r_{73}$ ,  $(r_{73}, r_{74})$ ,  $r_{73} = r_{74}q_{75} + r_{75}$ ,  $r_{75} < r_{74}$ ,  $(r_{74}, r_{75})$ ,  $r_{74} = r_{75}q_{76} + r_{76}$ ,  $r_{76} < r_{75}$ ,  $(r_{75}, r_{76})$ ,  $r_{75} = r_{76}q_{77} + r_{77}$ ,  $r_{77} < r_{76}$ ,  $(r_{76}, r_{77})$ ,  $r_{76} = r_{77}q_{78} + r_{78}$ ,  $r_{78} < r_{77}$ ,  $(r_{77}, r_{78})$ ,  $r_{77} = r_{78}q_{79} + r_{79}$ ,  $r_{79} < r_{78}$ ,  $(r_{78}, r_{79})$ ,  $r_{78} = r_{79}q_{80} + r_{80}$ ,  $r_{80} < r_{79}$ ,  $(r_{79}, r_{80})$ ,  $r_{79} = r_{80}q_{81} + r_{81}$ ,  $r_{81} < r_{80}$ ,  $(r_{80}, r_{81})$ ,  $r_{80} = r_{81}q_{82} + r_{82}$ ,  $r_{82} < r_{81}$ ,  $(r_{81}, r_{82})$ ,  $r_{81} = r_{82}q_{83} + r_{83}$ ,  $r_{83} < r_{82}$ ,  $(r_{82}, r_{83})$ ,  $r_{82} = r_{83}q_{84} + r_{84}$ ,  $r_{84} < r_{83}$ ,  $(r_{83}, r_{84})$ ,  $r_{83} = r_{84}q_{85} + r_{85}$ ,  $r_{85} < r_{84}$ ,  $(r_{84}, r_{85})$ ,  $r_{84} = r_{85}q_{86} + r_{86}$ ,  $r_{86} < r_{85}$ ,  $(r_{85}, r_{86})$ ,  $r_{85} = r_{86}q_{87} + r_{87}$ ,  $r_{87} < r_{86}$ ,  $(r_{86}, r_{87})$ ,  $r_{86} = r_{87}q_{88} + r_{88}$ ,  $r_{88} < r_{87}$ ,  $(r_{87}, r_{88})$ ,  $r_{87} = r_{88}q_{89} + r_{89}$ ,  $r_{89} < r_{88}$ ,  $(r_{88}, r_{89})$ ,  $r_{88} = r_{89}q_{90} + r_{90}$ ,  $r_{90} < r_{89}$ ,  $(r_{89}, r_{90})$ ,  $r_{89} = r_{90}q_{91} + r_{91}$ ,  $r_{91} < r_{90}$ ,  $(r_{90}, r_{91})$ ,  $r_{90} = r_{91}q_{92} + r_{92}$ ,  $r_{92} < r_{91}$ ,  $(r_{91}, r_{92})$ ,  $r_{91} = r_{92}q_{93} + r_{93}$ ,  $r_{93} < r_{92}$ ,  $(r_{92}, r_{93})$ ,  $r_{92} = r_{93}q_{94} + r_{94}$ ,  $r_{94} < r_{93}$ ,  $(r_{93}, r_{94})$ ,  $r_{93} = r_{94}q_{95} + r_{95}$ ,  $r_{95} < r_{94}$ ,  $(r_{94}, r_{95})$ ,  $r_{94} = r_{95}q_{96} + r_{96}$ ,  $r_{96} < r_{95}$ ,  $(r_{95}, r_{96})$ ,  $r_{95} = r_{96}q_{97} + r_{97}$ ,  $r_{97} < r_{96}$ ,  $(r_{96}, r_{97})$ ,  $r_{96} = r_{97}q_{98} + r_{98}$ ,  $r_{98} < r_{97}$ ,  $(r_{97}, r_{98})$ ,  $r_{97} = r_{98}q_{99} + r_{99}$ ,  $r_{99} < r_{98}$ ,  $(r_{98}, r_{99})$ ,  $r_{98} = r_{99}q_{100} + r_{100}$ ,  $r_{100} < r_{99}$ ,  $(r_{99}, r_{100})$ ,  $r_{99} = r_{100}q_{101} + r_{101}$ ,  $r_{101} < r_{100}$ ,  $(r_{100}, r_{101})$ ,  $r_{100} = r_{101}q_{102} + r_{102}$ ,  $r_{102} < r_{101}$ ,  $(r_{101}, r_{102})$ ,  $r_{101} = r_{102}q_{103} + r_{103}$ ,  $r_{103} < r_{102}$ ,  $(r_{102}, r_{103})$ ,  $r_{102} = r_{103}q_{104} + r_{104}$ ,  $r_{104} < r_{103}$ ,  $(r_{103}, r_{104})$ ,  $r_{103} = r_{104}q_{105} + r_{105}$ ,  $r_{105} < r_{104}$ ,  $(r_{104}, r_{105})$ ,  $r_{104} = r_{105}q_{106} + r_{106}$ ,  $r_{106} < r_{105}$ ,  $(r_{105}, r_{106})$ ,  $r_{105} = r_{106}q_{107} + r_{107}$ ,  $r_{107} < r_{106}$ ,  $(r_{106}, r_{107})$ ,  $r_{106} = r_{107}q_{108} + r_{108}$ ,  $r_{108} < r_{107}$ ,  $(r_{107}, r_{108})$ ,  $r_{107} = r_{108}q_{109} + r_{109}$ ,  $r_{109} < r_{108}$ ,  $(r_{108}, r_{109})$ ,  $r_{108} = r_{109}q_{110} + r_{110}$ ,  $r_{110} < r_{109}$ ,  $(r_{109}, r_{110})$ ,  $r_{109} = r_{110}q_{111} + r_{111}$ ,  $r_{111} < r_{110}$ ,  $(r_{110}, r_{111})$ ,  $r_{110} = r_{111}q_{112} + r_{112}$ ,  $r_{112} < r_{111}$ ,  $(r_{111}, r_{112})$ ,  $r_{111} = r_{112}q_{113} + r_{113}$ ,  $r_{113} < r_{112}$ ,  $(r_{112}, r_{113})$ ,  $r_{112} = r_{113}q_{114} + r_{114}$ ,  $r_{114} < r_{113}$ ,  $(r_{113}, r_{114})$ ,  $r_{113} = r_{114}q_{115} + r_{115}$ ,  $r_{115} < r_{114}$ ,  $(r_{114}, r_{115})$ ,  $r_{114} = r_{115}q_{116} + r_{116}$ ,  $r_{116} < r_{115}$ ,  $(r_{115}, r_{116})$ ,  $r_{115} = r_{116}q_{117} + r_{117}$ ,  $r_{117} < r_{116}$ ,  $(r_{116}, r_{117})$ ,  $r_{116} = r_{117}q_{118} + r_{118}$ ,  $r_{118} < r_{117}$ ,  $(r_{117}, r_{118})$ ,  $r_{117} = r_{118}q_{119} + r_{119}$ ,  $r_{119} < r_{118}$ ,  $(r_{118}, r_{119})$ ,  $r_{118} = r_{119}q_{120} + r_{120}$ ,  $r_{120} < r_{119}$ ,  $(r_{119}, r_{120})$ ,  $r_{119} = r_{120}q_{121} + r_{121}$ ,  $r_{121} < r_{120}$ ,  $(r_{120}, r_{121})$ ,  $r_{120} = r_{121}q_{122} + r_{122}$ ,  $r_{122} < r_{121}$ ,  $(r_{121}, r_{122})$ ,  $r_{121} = r_{122}q_{123} + r_{123}$ ,  $r_{123} < r_{122}$ ,  $(r_{122}, r_{123})$ ,  $r_{122} = r_{123}q_{124} + r_{124}$ ,  $r_{124} < r_{123}$ ,  $(r_{123}, r_{124})$ ,  $r_{123} = r_{124}q_{125} + r_{125}$ ,  $r_{125} < r_{124}$ ,  $(r_{124}, r_{125})$ ,  $r_{124} = r_{125}q_{126} + r_{126}$ ,  $r_{126} < r_{125}$ ,  $(r_{125}, r_{126})$ ,  $r_{125} = r_{126}q_{127} + r_{127}$ ,  $r_{127} < r_{126}$ ,  $(r_{126}, r_{127})$ ,  $r_{126} = r_{127}q_{128} + r_{128}$ ,  $r_{128} < r_{127}$ ,  $(r_{127}, r_{128})$ ,  $r_{127} = r_{128}q_{129} + r_{129}$ ,  $r_{129} < r_{128}$ ,  $(r_{128}, r_{129})$ ,  $r_{128} = r_{129}q_{130} + r_{130}$ ,  $r_{130} < r_{129}$ ,  $(r_{129}, r_{130})$ ,  $r_{129} = r_{130}q_{131} + r_{131}$ ,  $r_{131} < r_{130}$ ,  $(r_{130}, r_{131})$ ,  $r_{130} = r_{131}q_{132} + r_{132}$ ,  $r_{132} < r_{131}$ ,  $(r_{131}, r_{132})$ ,  $r_{131} = r_{132}q_{133} + r_{133}$ ,  $r_{133} < r_{132}$ ,  $(r_{132}, r_{133})$ ,  $r_{132} = r_{133}q_{134} + r_{134}$ ,  $r_{134} < r_{133}$ ,  $(r_{133}, r_{134})$ ,  $r_{133} = r_{134}q_{135} + r_{135}$ ,  $r_{135} < r_{134}$ ,  $(r_{134}, r_{135})$ ,  $r_{134} = r_{135}q_{136} + r_{136}$ ,  $r_{136} < r_{135}$ ,  $(r_{135}, r_{136})$ ,  $r_{135} = r_{136}q_{137} + r_{137}$ ,  $r_{137} < r_{136}$ ,  $(r_{136}, r_{137})$ ,  $r_{136} = r_{137}q_{138} + r_{138}$ ,  $r_{138} < r_{137}$ ,  $(r_{137}, r_{138})$ ,  $r_{137} = r_{138}q_{139} + r_{139}$ ,  $r_{139} < r_{138}$ ,  $(r_{138}, r_{139})$ ,  $r_{138} = r_{139}q_{140} + r_{140}$ ,  $r_{140} < r_{139}$ ,  $(r_{139}, r_{140})$ ,  $r_{139} = r_{140}q_{141} + r_{141}$ ,  $r_{141} < r_{140}$ ,  $(r_{140}, r_{141})$ ,  $r_{140} = r_{141}q_{142} + r_{142}$ ,  $r_{142} < r_{141}$ ,  $(r_{141}, r_{142})$ ,  $r_{141} = r_{142}q_{143} + r_{143}$ ,  $r_{143} < r_{142}$ ,  $(r_{142}, r_{143})$ ,  $r_{142} = r_{143}q_{144} + r_{144}$ ,  $r_{144} < r_{143}$ ,  $(r_{143}, r_{144})$ ,  $r_{143} = r_{144}q_{145} + r_{145}$ ,  $r_{145} < r_{144}$ ,  $(r_{144}, r_{145})$ ,  $r_{144} = r_{145}q_{146} + r_{146}$ ,  $r_{146} < r_{145}$ ,  $(r_{145}, r_{146})$ ,  $r_{145} = r_{146}q_{147} + r_{147}$ ,  $r_{147} < r_{146}$ ,  $(r_{146}, r_{147})$ ,  $r_{146} = r_{147}q_{148} + r_{148}$ ,  $r_{148} < r_{147}$ ,  $(r_{147}, r_{148})$ ,  $r_{147} = r_{148}q_{149} + r_{149}$ ,  $r_{149} < r_{148}$ ,  $(r_{148}, r_{149})$ ,  $r_{148} = r_{149}q_{150} + r_{150}$ ,  $r_{150} < r_{149}$ ,  $(r_{149}, r_{150})$ ,  $r_{149} = r_{150}q_{151} + r_{151}$ ,  $r_{151} < r_{150}$ ,  $(r_{150}, r_{151})$ ,  $r_{150} = r_{151}q_{152} + r_{152}$ ,  $r_{152} < r_{151}$ ,  $(r_{151}, r_{152})$ ,  $r_{151} = r_{152}q_{153} + r_{153}$ ,  $r_{153} < r_{152}$ ,  $(r_{152}, r_{153})$ ,  $r_{152} = r_{153}q_{154} + r_{154}$ ,  $r_{154} < r_{153}$ ,  $(r_{153}, r_{154})$ ,  $r_{153} = r_{154}q_{155} + r_{155}$ ,  $r_{155} < r_{154}$ ,  $(r_{154}, r_{155})$ ,  $r_{154} = r_{155}q_{156} + r_{156}$ ,  $r_{156} < r_{155}$ ,  $(r_{155}, r_{156})$ ,  $r_{155} = r_{156}q_{157} + r_{157}$ ,  $r_{157} < r_{156}$ ,  $(r_{156}, r_{157})$ ,  $r_{156} = r_{157}q_{158} + r_{158}$ ,  $r_{158} < r_{157}$ ,  $(r_{157}, r_{158})$ ,  $r_{157} = r_{158}q_{159} + r_{159}$ ,  $r_{159} < r_{158}$ ,  $(r_{158}, r_{159})$ ,  $r_{158} = r_{159}q_{160} + r_{160}$ ,  $r_{160} < r_{159}$ ,  $(r_{159}, r_{160})$ ,  $r_{159} = r_{160}q_{161} + r_{161}$ ,  $r_{161} < r_{160}$ ,  $(r_{160}, r_{161})$ ,  $r_{160} = r_{161}q_{162} + r_{162}$ ,  $r_{162} < r_{161}$ ,  $(r_{161}, r_{162})$ ,  $r_{161} = r_{162}q_{163} + r_{163}$ ,  $r_{163} < r_{162}$ ,  $(r_{162}, r_{163})$ ,  $r_{162} = r_{163}q_{164} + r_{164}$ ,  $r_{164} < r_{163}$ ,  $(r_{163}, r_{164})$ ,  $r_{163} = r_{164}q_{165} + r_{165}$ ,  $r_{165} < r_{164}$ ,  $(r_{164}, r_{165})$ ,  $r_{164} = r_{165}q_{166} + r_{166}$ ,  $r_{166} < r_{165}$ ,  $(r_{165}, r_{166})$ ,  $r_{165} = r_{166}q_{167} + r_{167}$ ,  $r_{167} < r_{166}$ ,  $(r_{166}, r_{167})$ ,  $r_{166} = r_{167}q_{168} + r_{168}$ ,  $r_{168} < r_{167}$ ,  $(r_{167}, r_{168})$ ,  $r_{167} = r_{168}q_{169} + r_{169}$ ,  $r_{169} < r_{168}$ ,  $(r_{168}, r_{169})$ ,  $r_{168} = r_{169}q_{170} + r_{170}$ ,  $r_{170} < r_{169}$ ,  $(r_{169}, r_{170})$ ,  $r_{169} = r_{170}q_{171} + r_{171}$ ,  $r_{171} < r_{170}$ ,  $(r_{170}, r_{171})$ ,  $r_{170} = r_{171}q_{172} + r_{172}$ ,  $r_{172} < r_{171}$ ,  $(r_{171}, r_{172})$ ,  $r_{171} = r_{172}q_{173} + r_{173}$ ,  $r_{173} < r_{172}$ ,  $(r_{172}, r_{173})$





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