

1 Contest

2 Matma

Contest (1)

sol.cpp

```
#include <bits/stdc++.h>
using namespace std;

#ifdef LOCAL
auto& operator<<(auto&, pair<auto, auto>);
auto operator<<(auto& o, auto x) -> decltype(x.end()), o) {
    o << ' ';
    for (int i = 0; auto y : x) o << ", " + !i++ * 2 << y;
    return o << ' ';
}
auto& operator<<(auto& o, pair<auto, auto> x) {
    return o << ' (' << x.first << ", " << x.second << ') ' ;
}
void __print(auto... x) { ((cerr << ' ' << x), ...) << endl; }
#define debug(x...) cerr << "[" #x "]:", __print(x)
#else
#define debug(...) 2137
#endif

int main() {
    ios_base::sync_with_stdio(0);
    cin.tie(0);
}
```

.vimrc

```
set nu et ts=2 sw=2
filetype indent on
syntax on
colorscheme habamax
hi MatchParen ctermfg=66 ctermbg=234 cterm=underline
nnoremap ; :
nnoremap ; :
inoremap {<cr> {<cr>}<esc>O <bs>
```

Makefile

```
CXXFLAGS=-std=c++20 -Wall -Wextra -Wshadow
sol: sol.cpp
    g++ $(CXXFLAGS) -fsanitize=address,undefined -g -DLOCAL \
        sol.cpp -o sol
fast: sol.cpp
    g++ $(CXXFLAGS) -O2 sol.cpp -o fast
```

test.sh

```
#!/bin/bash
for((i=1;i>0;i++)) do
    echo "$i"
    echo "$i" | ./gen > int
    diff -w <(. /sol < int) <(. /slow < int) || break
done
```

hash.sh

```
#!/bin/bash
cpp -dD -P -fpreprocessed | tr -d '[:space:]' | md5sum |cut -c-6
```

.bashrc

```
alias rm='trash'
alias mv='mv -i'
alias cp='cp -i'
```

Matma (2)

2.1 Arytmetyka modularna

GCD.h

Opis: Rozszerzony algorytm Euklidesa.
Czas: $\mathcal{O}(\log \min(a, b))$

```
ll gcd(ll a, ll b, ll &x, ll &y) {
    if (!b) return x = 1, y = 0, a;
    ll d = gcd(b, a % b, y, x);
    return y -= a / b * x, d;
}
```

CRT.h

Opis: Chińskie twierdzenie o resztach.
Czas: $\mathcal{O}(\log \min(m, n))$

```
ll crt(ll a, ll m, ll b, ll n) {
    if (n > m) swap(a, b), swap(m, n);
    ll x, y, g = gcd(m, n, x, y);
    assert((a - b) % g == 0); // no solution
    x = (b - a) % n * x % n / g * m + a;
    return x < 0 ? x + m * n / g : x;
}
```

ModMul.h

Opis: Mnożenie i potęgowanie dwóch long longów modulo. Jest to wyraźnie szybsze niż zamiana na __int128.

```
using ull = uint64_t;
ull modmul(ull a, ull b, ull M) {
    ll ret = a * b - M * ull(1.L / M * a * b);
    return ret + M * (ret < 0) - M * (ret >= (ll)M);
}
ull modpow(ull b, ull e, ull mod) {
    ull ans = 1;
    for (; e; b = modmul(b, b, mod), e /= 2)
        if (e & 1) ans = modmul(ans, b, mod);
    return ans;
}
```

2.2 Liczby pierwsze

MillerRabin.h

Opis: Test pierwszości Millera-Rabina.

```
bool prime(ull n) {
    if (n < 2 || n % 6 % 4 != 1) return (n | 1) == 3;
    ull A[] = {2, 325, 9375, 28178, 450775, 9780504, 1795265022},
        s = __builtin_ctzll(n - 1), d = n >> s;
    for (ull a : A) {
        ull p = modpow(a % n, d, n), i = s;
        while (p != 1 && p != n - 1 && a % n && i--)
            p = modmul(p, p, n);
        if (p != n - 1 && i != s) return 0;
    }
    return 1;
}
```

PollardRho.h

Opis: Algorytm rho Pollarda.
Czas: $\mathcal{O}(n^{1/4})$

```
ull pollard(ull n) {
    ull x = 0, y = 0, t = 30, prd = 2, i = 1, q;
    auto f = [&](ull x) { return modmul(x, x, n) + i; };
    while (t++ % 40 || __gcd(prd, n) == 1) {
        if (x == y) x = ++i, y = f(x);
        if ((q = modmul(prd, max(x, y) - min(x, y), n))) prd = q;
        x = f(x), y = f(f(y));
    }
    return __gcd(prd, n);
}
void factor(ull n, map<ull, int>& cnt) {
    if (n == 1) return;
    if (prime(n)) { cnt[n]++; return; }
    ull x = pollard(n);
    factor(x, cnt); factor(n / x, cnt);
}
```