Codeforces 837E (2100)

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https://codeforces.com/problemset/problem/837/E
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§1 Solution

§1.1 Explanation

Lemma 1.1
For any two natural numbers a and b,

$$\gcd(a, b) \mid (b - k\gcd(a, b))$$

for any $k \in \mathbb{Z}^+$

However, it is not true that for all k

$$\gcd(b - k\gcd(a, b)) = \gcd(a, b)$$

So we need to compute this extra factor in the gcd of $(b - k\gcd(a, b))$ and a. Or in other words, we need to find the minimum k such that,

$$\gcd\left(\frac{a}{\gcd(a, b)}, \frac{b}{\gcd(a, b)} - k\right) > 1$$

However we know that,

$$\gcd\left(\frac{a}{\gcd(a, b)}, \frac{b}{\gcd(a, b)} - k\right) \mid \frac{a}{\gcd(a, b)}$$

Therefore we could iterate over the divisors of

$$\frac{a}{\gcd(a, b)}$$

and take the minimum k. Iterating over divisors should take $\mathcal{O}(\sqrt{a})$ time and we will do this atmost $\mathcal{O}(\log a)$ times. Therefore, the total time complexity of this algorithm is $\mathcal{O}(\sqrt{a}\log a)$

§1.2 Code

```
void solve() {
    ll a, b;
    std::cin >> a >> b;

```

```
    ll ans = 0;
    while (b > 0) {
        ll d = std::gcd(a, b);

        a /= d;
        b /= d;

        if (a == 1) {
            ans += b;
            break;
        }

        ll best = LLONG_MAX;
        for (ll i = 1; i * i <= a; i++) {
            if (a % i == 0) {
                if (i > 1) {
                    best = std::min(best, b % i);
                }

                if (i * i != a) {
                    best = std::min(best, b % (a / i));
                }
            }
        }

        ans += best;
        b -= best;
    }

    std::cout << ans << '\n';
}
```