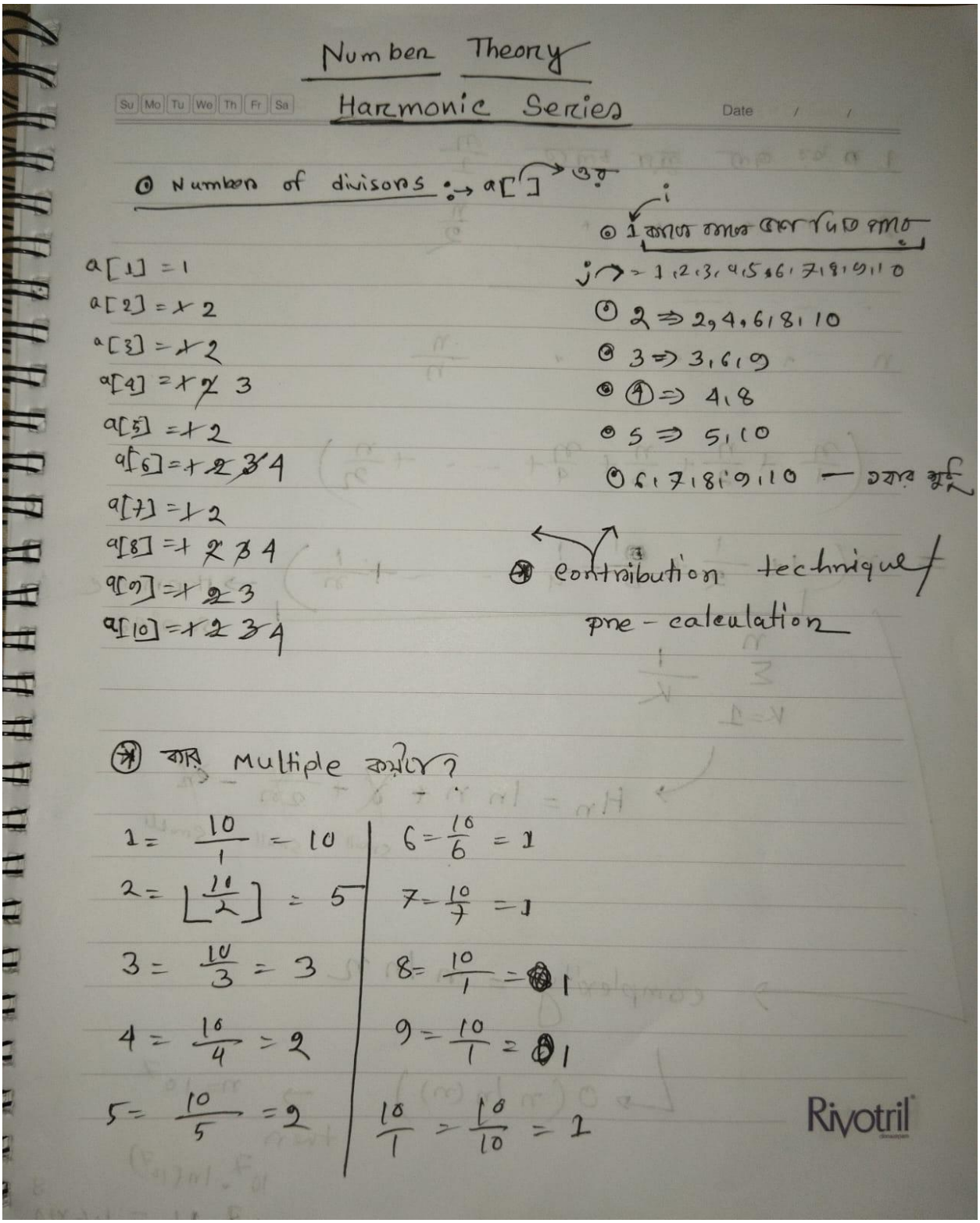
Harmony Series



1 এর জন্য লুপ চলবে $\frac{n}{1}$

2 " " " " $\frac{n}{2}$

n " " " " $\frac{n}{n}$

$$\left(\frac{n}{1} + \frac{n}{2} + \frac{n}{3} + \frac{n}{4} + \cdots + \frac{n}{n}\right)$$

$$= n\left(1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \cdots + \frac{1}{n}\right) \rightarrow \text{Harmonic Series}$$

$$\sum_{K=1}^{n} \frac{1}{K}$$

$$\rightarrow H_n = \ln n + \gamma + \frac{1}{2n} - \cdots$$

(small, small, small)

$\rightarrow$ complexity $= n \ln n$

$\hookrightarrow O(n \ln(n)) \rightarrow n = 10^7$

then

$10^7 \cdot \ln(10^7)$

$= 10^7 \cdot 16 = 1.6 \times 10^8$

```cpp
#include<bits/stdc++.h>
using namespace std;
const int mx = 1e7+123;
int cnt[mx];

int main()
{
   int lim = 10;

   for ( int i = 1; i <= lim; i++ ) {          ///i = 1
      for ( int j = i; j <= lim; j += i ) {    ///j = 1
         cnt[j]++;                          ///cnt[1] = 1
      }
   }

   for(int i=1;i<=lim;i++) cout<<i<<" : "<<cnt[i]<<endl;

   return 0;
}
```

```
1 : 1
2 : 2
3 : 2
4 : 3
5 : 2
6 : 4
7 : 2
8 : 4
9 : 3
10 : 4
```

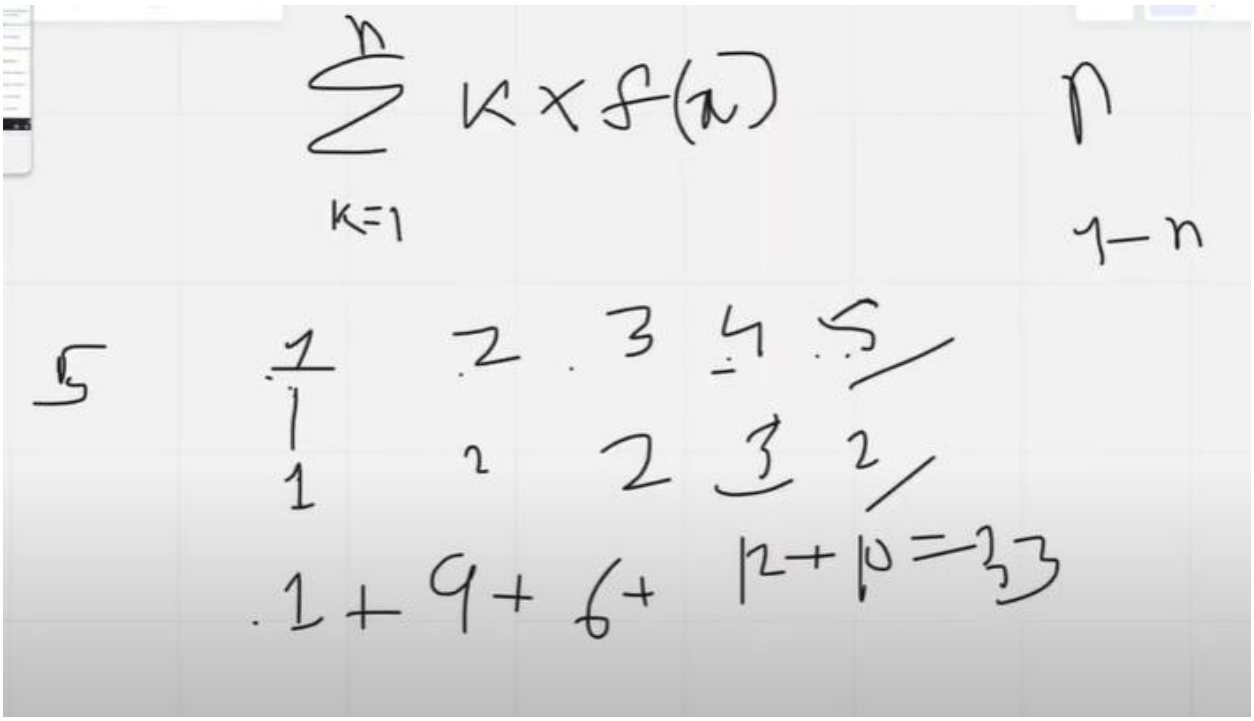
```cpp
#include<bits/stdc++.h>
using namespace std;
const int mx = 1e3+123;
vector<int> d[mx];

int main()
{
   int lim = 10;
   for ( int i = 1; i <= lim; i++ )           ///i = 1
      {
         for ( int j = i; j <= lim; j += i )      ///j = 1
            {
               d[j].push_back(i);                ///cnt[1] = 1
            }
      }
   for(int i=1; i<=lim; i++)
      {
         cout<<i<<" : ";
         for(auto u : d[i]) cout<<u<<" ";
         cout<<endl;
      }

   return 0;
}
```

```
1 : 1
2 : 1 2
3 : 1 3
4 : 1 2 4
5 : 1 5
6 : 1 2 3 6
7 : 1 7
8 : 1 2 4 8
9 : 1 3 9
10 : 1 2 5 10
```

```cpp
#include<bits/stdc++.h>
using namespace std;
const int mx = 1e7+123;
int sum_of_div[mx];
int main()
{
   int lim = 10;

   for ( int i = 1; i <= lim; i++ ) {          ///i = 1
      for ( int j = i; j <= lim; j += i ) {    ///j = 1
            sum_of_div[j] += i;                    ///cnt[1] = 1
      }
   }

   for(int i=1;i<=lim;i++) cout<<i<<" : "<<sum_of_div[i]<<endl;

   return 0;
}
```

```
1 : 1
2 : 3
3 : 4
4 : 7
5 : 6
6 : 12
7 : 8
8 : 15
9 : 13
10 : 18
```

1) https://cses.fi/alon/task/1713
2) https://atcoder.jp/contests/abc172/tasks/abc172_d
3) https://cses.fi/problemset/task/1082



1)

```
///  ***  ---  ||       In the name of ALLAH       |||  ---  ***  ///



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


typedef long long ll;
typedef vector<int> vi;
typedef vector<ll> vl;
typedef vector<vi> vvi;
typedef vector<vl> vvl;
typedef pair<int,int> pii;
typedef pair<double, double> pdd;
typedef pair<ll, ll> pll;
typedef vector<pii> vii;
typedef vector<pll> vll;
typedef double dl;

#define endl '\n'
#define PB push_back
#define F first
#define S second
#define all(a) (a).begin(),(a).end()
#define rall(a) (a).rbegin(),(a).rend()
#define sz(x) (int)x.size()

const double PI = acos(-1);
const double eps = 1e-9;
const int inf = 2000000000;
const ll infLL = 9000000000000000000;
#define MOD 1000000007

#define mem(a,b) memset(a, b, sizeof(a) )
#define sqr(a) ((a) * (a))

#define optimize() ios_base::sync_with_stdio(0);cin.tie(0);cout.tie(0);
#define fraction() cout.unsetf(ios::floatfield); cout.precision(10); cout.setf(ios::fixed,ios::floatfield);
#define file() freopen("input.txt","r",stdin);freopen("output.txt","w",stdout);

#define dbg(args...) do {cerr << #args << " : "; faltu(args); } while(0)
void faltu () {          cerr << endl;}
template < typename T, typename ... hello>void faltu( T arg, const hello &... rest) {cerr << arg << '
';faltu(rest...);}
```

```
ll gcd ( ll a, ll b ) { return __gcd ( a, b ); }
ll lcm ( ll a, ll b ) { return a * ( b / gcd ( a, b ) ); }

const int mx = 1e6+123;
int cnt[mx];

int main()
{
   optimize();

   int lim = 1e6;

   for ( int i = 1; i <= lim; i++ ) {
      for ( int j = i; j <= lim; j += i ) {
         cnt[j]++;
      }
   }

   int n;
   cin >> n;

   while ( n-- ) {
      int x;
      cin >> x;
      cout << cnt[x] << endl;
   }


   return 0;
}
```

2)

```
///  ***  ---  ||       In the name of ALLAH       |||  ---  ***  ///



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


typedef long long ll;
typedef vector<int> vi;
typedef vector<ll> vl;
typedef vector<vi> vvi;
typedef vector<vl> vvl;
typedef pair<int,int> pii;
```

```
typedef pair<double, double> pdd;
typedef pair<ll, ll> pll;
typedef vector<pii> vii;
typedef vector<pll> vll;
typedef double dl;

#define endl '\n'
#define PB push_back
#define F first
#define S second
#define all(a) (a).begin(),(a).end()
#define rall(a) (a).rbegin(),(a).rend()
#define sz(x) (int)x.size()

const double PI = acos(-1);
const double eps = 1e-9;
const int inf = 2000000000;
const ll infLL = 9000000000000000000;
#define MOD 1000000007

#define mem(a,b) memset(a, b, sizeof(a) )
#define sqr(a) ((a) * (a))

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#define file() freopen("input.txt","r",stdin);freopen("output.txt","w",stdout);

#define dbg(args...) do {cerr << #args << " : "; faltu(args); } while(0)
void faltu () {          cerr << endl;}
template < typename T, typename ... hello>void faltu( T arg, const hello &... rest) {cerr << arg << '
';faltu(rest...);}

ll gcd ( ll a, ll b ) { return __gcd ( a, b ); }
ll lcm ( ll a, ll b ) { return a * ( b / gcd ( a, b ) ); }

const int mx = 1e7+123;
int cnt[mx];

int main()
{
   optimize();

   int lim = 1e7;

   for ( int i = 1; i <= lim; i++ ) {
      for ( int j = i; j <= lim; j += i ) {
         cnt[j]++;
      }
```

```
    }

    int n;
    cin >> n;

    ll ans = 0;
    for ( int i = 1; i <= n; i++ ) {
        ans += ( 1LL * i * cnt[i] );
    }

    cout << ans << endl;

    return 0;
}
```