***Valid Pairs***

C371\_Coding\_December2022

**Topic**: Hash Table

**Difficulty Level:** Medium

**Question / Problem Statement**:

Jason was given an array **A** consisting of **N** non-negative integers. Jason was also given 2 integers **P** (a prime number) and **K**.

Jason was required to count the number of pairs (i, j) where, 1≤i<j≤N and satisfying:

(**A**[i]^2+**A**[j]^2+**A**[i]∗**A**[j]) mod **P** = **K**

Write a program to count the number of pairs that satisfy the above condition.

**Note**

**P** is a Prime number.

a mod p=b means that b is the remainder when a is divided by p. In particular, 0≤b<p.

**Function Description**

In the provided code snippet, implement the provided **validPairs(...)** method using the variables to count the number of pairs that satisfy the above condition. You can write your code in the space below the phrase **“WRITE YOUR LOGIC HERE”**.   
  
There will be multiple test cases running so the Input and Output should match exactly as provided.  
The base Output variable **result** is set to a default value of **-404** which can be modified. Additionally, you can add or remove these output variables.

**Input Format**

The first line contains three space-separated integers **N**, **K** and **P** denoting the length of the array, the required remainder/modulo and the prime number respectively.

The second line contains **N** space-separated integers denoting the integer array **A**.

**Sample Input**

4 1 2 –denotes N, K and P.

3 2 1 0 –denotes array A.

**Constraints**

1 <= **N** <= 10^5.

0 <= **K** < **P**.

1 <= **P** <= 10^9.

0 <= **A***i* <= 10^9.

**Output Format**

Output should return the count of the number of pairs that satisfy the above condition.

**Sample Output**

5

**Explanation**

In the first sample, N=4, k=1, p=2, A=[3,2,1,0]. Calculations for each pair (i, j) are shown below:

* (1,2) : A1^2+A2^2+A1∗A2 mod p=(9+4+6) mod 2=1.
* (1,3) : A1^2+A3^2+A1∗A3 mod p=(9+1+3) mod 2=1.
* (1,4) : A1^2+A4^2+A1∗A4 mod p=(9+0+0) mod 2=1.
* (2,3) : A2^2+A3^2+A2∗A3 mod p=(4+1+4) mod 2=1.
* (2,4) : A2^2+A4^2+A2∗A4 mod p=(4+0+0) mod 2=0.
* (3,4) : A3^2+A4^2+A3∗A4 mod p=(1+0+0) mod 2=1.
* Therefore, the number of pairs satisfying the equation are 5.

**Solution Steps**

1. Reduce all elements to modulo P, find unique values and store them in a map with frequency.

2. Now for different values of Ai and Aj(Remember under modulo P), we can multiply both sides by (Ai−Aj). This does not change the answer because gcd(Ai−Aj,P)=1 since P is prime and we have reduced array elements so, 0≤Ai,Aj<P. Once we multiply with this, we obtain : Ai^3−Aj^3=k∗(Ai−Aj) mod P.

Simplifying this, we obtain : Ai^3−k∗Ai = Aj^3−k∗Aj mod P.

3. Count of such pairs can be calculated easily using hashmaps now. Remember not to count pairs satisfying Ai=Aj mod p in this equation. We have already counted those pairs.

**Running Solution in C++**:

#include <bits/stdc++.h>

#define fastio ios::sync\_with\_stdio(0);cin.tie(0);cout.tie(0);

#define int long long int

using namespace std;

int32\_t main() {

fastio;

int n, k, p;

cin >> n >> k >> p;

vector<int> arr(n);

int i;

for(i = 0; i < n; i++)

{

cin >> arr[i];

arr[i] = arr[i]%p;

}

sort(arr.begin(), arr.end());

int ans = 0;

//creating map

vector<pair<int, int>> vec;

for(i = 0; i < n ; i++){

int j = i, cnt = 0;

while(j < n && arr[j] == arr[i])

cnt++, j++;

int x = arr[i];

if((3\*x\*x%p) == k)

ans += cnt\*(cnt - 1)/2;

int y = (((x\*x%p)\*x%p - k\*x%p)%p + p)%p;

vec.push\_back({y, cnt});

i = j - 1;

}

sort(vec.begin(), vec.end());

for(i = 0; i < vec.size() ; i++){

int j = i, lin = 0, sqr = 0;

while(j < vec.size() && vec[i].first == vec[j].first)

lin += vec[j].second, sqr += vec[j].second\*vec[j].second, j++;

ans += (lin\*lin - sqr)/2;

i = j - 1;

}

cout << ans << '\n';

return 0;

}

Input:

8 0 3

9 2 1 8 4 5 9 10

Output:

7

**Test Cases [ Qty: 12 ]**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test Case No** | **Input** | **Output** | **Score** |
| 1 | 4 1 2  3 2 1 0 | 5 | 0 |
| 2 | 8 0 3  9 2 1 8 4 5 9 10 | 7 | 0 |
| 3 | 5 2 13  11 8 6 9 10 | 3 | 1 |
| 4 | 9 1 13  8 9 9 7 10 6 10 8 10 | 6 | 1 |
| 5 | 9 7 11  9 3 3 10 10 9 3 10 20 | 27 | 1 |
| 6 | 32 35 59  34 36 20 36 26 34 30 25 32 35 0 0 26 33 31 38 34 39 29 20 35 25 22 27 32 34 34 24 25 38 26 22 | 35 | 1 |
| 7 | 40 2 5  23 27 3 20 20 20 39 26 20 23 34 28 48 40 37 26 29 44 29 24 36 38 29 39 25 39 38 39 21 28 21 28 32 36 33 27 34 24 35 37 | 205 | 1 |
| 8 | 90 233 251  63 96 71 60 92 94 73 75 57 83 68 98 91 80 79 68 98 69 87 77 76 98 50 96 83 51 58 97 63 56 77 104 90 73 82 79 56 81 58 66 75 54 64 53 64 98 58 65 65 96 51 52 68 50 100 72 64 55 96 84 58 67 67 55 54 95 83 50 71 64 99 59 67 97 72 95 86 104 59 68 99 68 64 65 61 100 99 94 78 88 | 56 | 1 |
| 9 | 944 138911 381301  398102404 68065010 687610227 998895579 369818 369818 369818 523496093 65350424 842037132 773402952 827928995 991507124 987075248 866376453 214132474 749791915 97952125 903724588 933693108 887030650 980540735 996142217 921729041 313935247 363681322 905476834 140818784 369818 923016680 744060102 165609158 328231492 227042934 369818 357657720 935599613 592446495 19573466 806785965 96388179 524999098 656023337 369818 203292555 881836172 119086949 960384178 369818 717451041 311206043 247163317 599874432 928736195 188086174 862389821 762925064 454330834 580470810 986490321 369818 301352314 87366759 958096372 369818 336539695 895181707 854001199 223882015 369818 869506037 853214136 816633701 369818 496448609 931405302 958477673 650395606 474844269 369818 596509236 229286425 369818 404952236 490096309 778635082 369818 955568596 998514278 975254917 508100595 872803447 253310765 348252337 369818 369818 618169505 843562336 369818 164465255 848662985 218294991 137829184 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| 10 | 990 82587 860311  161205247 428696833 29195665 354732548 810451845 471902751 780195549 83956684 628323913 273385707 74457840 162371644 957828724 800143405 204552127 51229626 272109297 463547342 278275368 328581625 518680713 645249530 576302328 92292621 995940898 424504283 551303236 682678486 902950362 321848807 259878585 442552293 331384257 100691212 642324415 884159904 645479479 839025852 282680254 976243739 722369083 250460281 493783384 795494475 950476592 403276626 438994246 802355279 827283176 76803391 906503927 432979165 598049610 606278022 482843855 872060858 591235569 73961125 934674207 664782021 521349095 154529805 708314120 847655803 455438691 360316709 773362233 3951833 44120267 768425275 459636529 964894738 577990709 872980383 593566190 767955971 931164511 42701546 461276801 483880210 430270684 88371134 67497639 879702649 312191487 137048810 995932274 626512404 617924290 492706485 106156757 183006139 319033277 974059630 832812453 181185297 99581046 102301054 590996637 888102944 401684222 600559560 587454443 836263474 186224714 176219873 349122327 529401356 233491035 511326871 748970552 468642977 384991421 97001295 432235406 376650103 572645662 612628066 795931473 456670905 916594507 794239503 903668245 278957877 107792951 372672647 690521102 109188590 336071045 671872194 685268663 86914752 404207666 943635004 663023133 863617852 498996010 303833158 577041150 671578306 762950208 594861594 349539109 987876867 322900834 978986865 995952404 729662337 422128454 778512907 736373394 969919806 616585048 801088934 90799316 373008275 968109027 267018409 254967784 117252071 368725088 453623513 883853005 322605473 506043087 79288859 256017651 723435291 571518479 433842231 220813857 902212045 169279447 185390133 628389897 370790194 993973829 781945781 205477782 945085413 316461594 450761815 256315501 890349536 375696354 33902595 129118401 55210254 99962576 178291110 899342569 547568233 503254840 767479428 746121476 113662720 612081419 872105760 625358569 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| 11 | 5 0 2  16 20 6 9 10 | 6 | 1 |
| 12 | 35 3 17  30 34 27 31 36 39 23 20 26 33 40 32 33 38 20 37 27 24 24 29 33 22 39 38 35 32 29 39 35 23 21 22 39 40 38 | 42 | 1 |

Plagiarism found – No

Clarity of the problem statement - Yes

Clarity of the example in the problem statement - Yes

Clarity of sample test cases - Yes

Clarity of test cases (Dual output) – Yes

Clarity of explanations - Yes

Provided Solution running – Yes

EEOC complaint (using abusive words/Indian Names/) - No

Similar Question in System - No

Difficulty Level – Medium

Question w.r.t Hash Tables concepts- Yes

Final Comment: **Accepted**