Topics that you should know with sieve:

1. Modular exponentiation
2. Greatest Common Divisor (GCD)
3. Extended Euclidean algorithm
4. Modular multiplicative inverse

Tutorial:
https://www.hackerearth.com/practice/math/number-theory/basic-number-theory-1/tutorial/

Problems:

1. https://www.hackerearth.com/practice/math/number-theory/basic-number-theory-1/practice-problems/algorithm/calculate-the-power/
2. https://www.hackerearth.com/practice/math/number-theory/basic-number-theory-1/practice-problems/algorithm/name-count/
3. https://www.hackerearth.com/practice/math/number-theory/basic-number-theory-1/practice-problems/algorithm/beautiful-primes/description/
4. https://www.hackerearth.com/practice/math/number-theory/basic-number-theory-1/practice-problems/algorithm/diedie/

Once you are done with all these topics,you can move on to the next topic.

Sieve of eratosthenes:

While solving problems related to number theory we all come across situation where we need to find prime numbers from **L to R,**number of divisors of given number,factors of given number etc.All of these problem could be solved using one efficient algorithm called seive.It has many variants.

Tutorial:

https://www.geeksforgeeks.org/sieve-of-eratosthenes/
https://www.hackerearth.com/practice/math/number-theory/basic-number-theory-2/tutorial/

Please go through both tutorials carefully before moving on to the problems.

Once you are done with tutorials,you should know how to these things efficiently.

1. Prime numbers in given range **L to R.** (1<=L<=R<= 10^6)
2. Count number of divisors of given number
3. Prime factorization of given number in O(logn)

Problem: Find all prime numbers between **L to R.** (1<=L<=R<= 10^{12}) (R-L<= 10^{6})

How would you solve this???
As you have seen,Simple Sieve has limitation that it requires space of O(n). So for bigger numbers,we cannot always create array on size n. Here comes the new approach to find number of primes between **L to R** called segmented sieve.

We will find all numbers between 1 to 10^{6} . We will store them in array say **primes.**Now we will iterate through all members of **primes** and multiples of **p[i] between given range(L to R)** will be marked as non-prime.Unmarked numbers between **L to R** will be our prime numbers.

NOTE: Why considering primes between 1 to 10^{6} is enough ?
(Think yourself.Answer is given at the end of document.)

Tutorial for Segmented Seive:
https://www.geeksforgeeks.org/segmented-sieve/

Problems on sieve:

Since these problems are very time sensitive… Use FAST i/o to avoid TLE.

Easy

1. https://www.hackerearth.com/practice/math/number-theory/basic-number-theory-1/practice-problems/algorithm/can-you-guess/
2. https://www.hackerearth.com/practice/math/number-theory/basic-number-theory-1/practice-problems/algorithm/hell-1/
3. https://www.hackerearth.com/practice/math/number-theory/basic-number-theory-1/practice-problems/algorithm/archery-1/
4. https://www.hackerearth.com/practice/math/number-theory/basic-number-theory-2/practice-problems/algorithm/sum-of-primes-7/
5. https://www.hackerearth.com/practice/math/number-theory/basic-number-theory-2/practice-problems/algorithm/ashu-and-prime-factors-4/

Medium:

1. https://www.hackerearth.com/practice/math/number-theory/basic-number-theory-1/practice-problems/algorithm/gotta-beat-em-all/

2. https://www.hackerearth.com/practice/math/number-theory/basic-number-theory-2/practice-problems/algorithm/nearest-prime-a828361b/

3. https://www.hackerearth.com/ja/practice/math/number-theory/basic-number-theory-2/practice-problems/algorithm/holi-and-division-function-1dfc3294/

Hard:

1. https://www.hackerearth.com/practice/math/number-theory/basic-number-theory-1/practice-problems/algorithm/kala-set/

2. https://www.hackerearth.com/practice/math/number-theory/basic-number-theory-2/practice-problems/algorithm/mike-and-gcd-issues/

Answer:

1. Suppose prime number x is between 10^6 to 10^12. Then multiples of this prime number till 10^12 will contain at least one prime which is in range 1 to 10^6.hence primes till 10^6 will be enough.

This can be also proved using fact that if two prime numbers greater than 10^6 say x1,x2 construct a number y,then y will definitely exceed range of 10^12.

If you want to learn about prime factorization or want to do some easy math questions check this doc ,

https://docs.google.com/document/d/1fl2xLi8afbcv4w525DeCZW4Y0hw5gK8AIRdYK0itdf4/edit?usp=sharing