The IPv4 address is 32 bits long and it is written in the form of dotted decimal notation.

IP address in binary format: 11000000.00000001.00000001.00000020

In dotted decimal notation   192   .   1   .   1   .   2

In the following table,

   The first line represents the Prefix.

   The second line represents the place value of the bit in binary format.

   The third line is the MASK

   The fourth line is the value of the bit in dotted decimal notation.

The first 8 bits of the IP address is not shown.

2nd number   3rd number   4th number

/9	/10	/11	/12	/13	/14	/15	/16	/17	/18	/19	/20	/21	/22	/23	/24	/25	/26	/27	/28	/29	/30	/31	/32
8388608	4194304	2097152	1048576	524288	262144	131072	65536	32768	16384	8192	4096	2048	1024	512	256	128	64	32	16	8	4	2	1
128	192	224	240	248	252	254	255	128	192	224	240	248	252	254	255	128	192	224	240	248	252	254	255
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1

The subnet mask determines the number of bits used to identify the network address and the remainder bits gives us the size of the subnet (the number of addresses in the subnet)

The subnet mask can be written as a prefix or in the traditional format. Example: /23 = 255.255.254.0

Every IP address class has a default mask: class A - /8 = 255.0.0.0, class B - /16 = 255.255.0.0, class C - /24 = 255.255.255.0

In subnetting, we are making the mask longer than the default for the IP class. This way we can create sub-networks that allows for the efficient use of the address space. We create subnets that closely match the required number of addresses needed for each sub-network. To do this we need to identify the correct mask that gives us just enough addresses to satisfy the requirements. To do this we can use the table above to identify the correct mask.

Example:

  The requirement is 500 users for the subnet. To do this, start counting the bits on the second line (place value of the bit in binary format) from right to left. Because we count from right to left, we write down the numbers in the same sequence. You are building the mask from right to left. If you counted to 8 and you did not find the correct value, write down a zero and place a period in front of it. Continue the bit count until you reach the correct bit position. If you counted to 8 again and you still did not find the correct value, write down a zero again and place a period in front of it. Continue the count until you find the first bit location that is equal or larger than the requirement. You just found the end of the mask. The bit that satisfies the requirement will be the last bit in the mask. The number on the third line (mask) will be the end of the mask. Write this number down in front of the zero(s) if you have any and pad the remaining numbers with "255" until you have 4 numbers. You must end up with four numbers.

2nd number								3rd number								4th number							
/9	/10	/11	/12	/13	/14	/15	/16	/17	/18	/19	/20	/21	/22	/23	/24	/25	/26	/27	/28	/29	/30	/31	/32
8388608	4194304	2097152	1048576	524288	262144	131072	65536	32768	16384	8192	4096	2048	1024	**512**	256	128	64	32	16	8	4	2	1
128	192	224	240	248	252	254	255	128	192	224	240	248	252	254	255	128	192	224	240	248	252	254	255
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1

^

254.0   now pad it with "255" until you have 4 numbers --- 255.255.254.0

The correct mask is 255.255.254.0.

This mask cannot be shorter than the default mask for the IP address class. If it is, you are not subnetting.

The mask gives us the subnet size, but we need to write the size in decimal notation. To identify how we write the subnet size in decimal notation we will use the last non-zero number in the mask.

Mask: 255.255.254.0 -- the last none-zero number in the mask is 254, subtract it from 256.

256 – 254 = 2 now write the zeros contained in the mask after your number (if there is any). In this case, there is one so we end up with 2.0

256
255.255.254.0
2.0   -- this is the number that we need to quickly generate the sub-network addresses

If we have a class B IP address the first two numbers are given (X.X.0.0 represent any class B address), so we work with the last two numbers (host portion of the address space).

X.X.0.0 /16 is the starting IP address. To create subnets which are able to support 500 users each, we do following. We start from subnet zero and add 2.0 to the sub-network address to create the next sub-network address. We can continue this until we reach the mask in the host portion of the address in our count.

Create a table:

Network address	Mask	Host range	Broadcast address
X.X.0.0 (subnet zero)	255.255.254.0	X.X.0.1 – X.X.1.254	X.X.1.255
X.X.2.0	255.255.254.0	X.X.2.1 – X.X.3.254	X.X.3.255
X.X.4.0	255.255.254.0	X.X.4.1 – X.X.5.254	X.X.5.255
X.X.6.0	255.255.254.0	X.X.6.1 – X.X.7.254	X.X.6 255

|

Continue until you reach the host portion of the mask

|

| X.X.254.0 | 255.255.254.0 | X.X.254.1 -- X.X.255.254 | X.X.255.255 |

This method will work for all classes of IP addresses!

On the CCNA exam, you might be asked to answer the following questions about a given IP address. Example: 172.10.17.5 255.255.240.0

How many bits are allocated to hosts?

Convert the mask to prefix format: 255.255.240.0 = /20

Because there are 32 bits in an IP address, 32 minus the prefix equals the number of host bits. 32 – 20 = 12

12 bits are allocated to hosts

How many bits are used for subnetting?

Convert the mask to prefix format: 255.255.240.0 = /20

The difference between the default mask for the IP address class and the current mask gives the number of bits used for subnetting.

In this case 172 is a class B address and /16 is the default prefix so 20 – 16 = 4

4 bits are used for subnetting

What is the number of hosts on the network?

The question is; are they looking for the total number of available addresses or just the usable addresses. (Be careful as you read the question)

32 – current prefix = host bits. 2^host bits = total number of addresses (2^{12} = 4096

Total number of addresses -2 = usable hosts (we cannot use the network and broadcast address) 4096 – 2 = 4094

How many subnets are created?

The difference between the default mask for the IP address class and the current mask gives the number of bits used for subnetting.

In this case 172 is a class B address and /16 is the default prefix so 20 – 16 = 4

2^4 = 16

16 subnets were created

What is the network address of the host?

To get the network address of the host we need to perform the AND operation between the IP address and the mask.

We know that if we AND something with 255 then the value remains the same.

We also know, if we AND something with 0 then the value turns into 0. So, the only number that we need to work with that is not zero or 255.

```
          172. 10. 17.5
AND     255.255.240.0
Result   172. 10. ?.0
```

In this case, it is the third number in the mask and we need to AND 240 with 17. We must convert the two values to binary.

        17 = 00010001
AND   240 = 11110000
            00010000 convert it back to decimal = 16

The third number in the IP address is 16. So, the host belongs to the 172.10.16.0 network.

What is the broadcast address of the host or network?

We need to know the network address of the host. (See the previous question.)

We also need to know the size of the subnet; and how it is written in dotted decimal notation. (See above)

            256
        255.255.240.0
            16.0 - size of the subnet in decimal notation

Add this number to the network address of the host.
        172.10.16.0 n e t w o r k address of the host
            16.0 size of the subnet
        172.10.32.0 this is the next subnet – the broadcast address is one less than this value (minus 1)

The answer is 172.16.31.255