

IP Address Classes

Class A	1 – 127	(Network 127 is rese	rved fo	r loopback and internal testing)
		Leading bit pattern	0	00000000.00000000.00000000.00000000000
Class B	128 – 191	Leading bit pattern	10	1000000.00000000.0000000.0000000000000
Class C	192 – 223	Leading bit pattern	110	11000000.00000000.00000000.00000000000
Class D	224 – 239	(Reserved for multication	ast)	
Class E	240 – 255	(Reserved for experi	mental,	used for research)

Private Address Space

Class A	10.0.0.0 to 10.255.255.255
Class B	172.16.0.0 to 172.31.255.255
Class C	192.168.0.0 to 192.168.255.255

Default Subnet Masks

Class A	255.0.0.0
Class B	255.255.0.0
Class C	255.255.255.0

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Workbooks included in the series:

IP Addressing and Subnetting Workbooks
ACLs - Access Lists Workbooks
VLSM Variable-Length Subnet Mask IWorkbooks

Binary To Decimal Conversion

128	64	32	16	8	4	2	1	Answers	Scratch Area
1	0	0	1	0	0	1	0	146	128 64 16 32
0	1	1	1	0	1	1	1	119	$\begin{array}{ccc} \frac{2}{146} & 16 \\ & 4 \end{array}$
1	1	1	1	1	1	1	1		- 2 - 1
1	1	0	0	0	1	0	1		119
1	1	1	1	0	1	1	0		-
0	0	0	1	0	0	1	1		-
1	0	0	0	0	0	0	1		-
0	0	1	1	0	0	0	1		-
0	1	1	1	1	0	0	0		-
1	1	1	1	0	0	0	0		_
0	0	1	1	1	0	1	1		_
0	0	0	0	0	1	1	1		-
						0001	11011		_
						1010)1010		
						0110)1111		
						1111	1000		-
						0010	00000		-
						0101	10101		
						0011	1110		
							00011		
)1101		
						11000000			-
									-

Decimal To Binary Conversion Use all 8 bits for each problem

128	64	32	16	8	4	2	1 =	255	Scratch Area
1	1	1	0	1	1	1	0	238	238 34 -128 -32
0	0	1	0	0	0	1	0	34	-128 110 -32 -64 -2
								123	40 0
								50	<u>-32</u> 14
								255	<u>-8</u> 6
								200	<u>-4</u> 2
								10	6 -4 2 -2 0
								138	
								1	
								13	
								250	
								107	
								224	
								114	
								192	
								172	
								100	
								119	
								57	
								98	
								179	
								2	

Address Class Identification

Address	Class
10.250.1.1	_A_
150.10.15.0	B
192.14.2.0	C
148.17.9.1	B
193.42.1.1	C
126.8.156.0	A
220.200.23.1	C
230.230.45.58	_D
177.100.18.4	B
119.18.45.0	_A
249.240.80.78	E
199.155.77.56	_C
117.89.56.45	Α
215.45.45.0	_C
199.200.15.0	
95.0.21.90	A
33.0.0.0	
158.98.80.0	_B

219.21.56.0

Network & Host Identification

Circle the network portion of these addresses:

(177.100.)8.4

(119.18.45.0

209.240.80.78

199.155.77.56

117.89.56.45

215.45.45.0

192.200.15.0

95.0.21.90

33.0.0.0

158.98.80.0

217.21.56.0

10.250.1.1

150.10.15.0

192.14.2.0

148.17.9.1

193.42.1.1

126.8.156.0

220.200.23.1

Circle the host portion of these addresses:

10.15.123.50

171.2.199.31

198.125.87.177

223.250.200.222

17.45.222.45

126.201.54.231

191.41.35.112

155.25.169.227

192.15.155.2

123.102.45.254

148.17.9.155

100.25.1.1

195.0.21.98

25.250.135.46

171.102,77.77

55.250.5.5

218.155.230.14

10.250.1.1

Network Addresses

Using the IP address and subnet mask shown write out the network address:

188.10.18.2 255.255.0.0	188 . 10 . 0 . 0
10.10.48.80 255.255.255.0	10.10.48.0
192.149.24.191 255.255.255.0	192.149.24.0
150.203.23.19 255.255.0.0	150.203.0.0
10.10.10.10 255.0.0.0	10.0.0.0
186.13.23.110 255.255.255.0	186.13.23.0
223.69.230.250 255.255.0.0	223.69.0.0
200.120.135.15 255.255.255.0	200.120.135.0
27.125.200.151 255.0.0.0	27.0.0.0
199.20.150.35 255.255.255.0	199.20.150.0
191.55.165.135 255.255.255.0	191.55.165.0
28.212.250.254 255.255.0.0	28.212.0.0

Host Addresses

Using the IP address and subnet mask shown write out the host address:

188.10.18.2 255.255.0.0	0.0.18.2
10.10.48.80 255.255.255.0	0.0.0.80
222.49.49.11 255.255.255.0	0.0.0.11
128.23.230.19 255.255.0.0	0.0.230.19
10.10.10.10 255.0.0.0	0.10.10.10
200.113.123.11 255.255.255.0	0.0.0.11
223.169.23.20 255.255.0.0	0.0.23.20
203.20.35.215 255.255.255.0	0.0.0.215
117.15.2.51 255.0.0.0	0.15.2.51
199.120.15.135 255.255.255.0	0.0.0.135
191.55.165.135 255.255.255.0	0.0.0.135
48.21.25.54 255.255.0.0	0.0.25.54

Default Subnet Masks

Write the correct default subnet mask for each of the following addresses:

177.100.18.4	255 . 255 . 0 . 0
119.18.45.0	255 . 0 . 0 . 0
191.249.234.191	
191.249.234.191	255 255 255 0
223.23.223.109	<u> </u>
10.10.250.1	255 . 0 . 0 . 0
126.123.23.1	255 . 0 . 0 . 0
223.69.230.250	255 . 255 . 255 . 0
192.12.35.105	
77.251.200.51	255 . 0 . 0 . 0
189.210.50.1	255 . 255 . 0 . 0
88.45.65.35	255 . 0 . 0 . 0
128.212.250.254	
193.100.77.83	255 . 255 . 255 . 0
125.125.250.1	
1.1.10.50	
220.90.130.45	255 . 255 . 255 . 0 ———————————————————————————————————
134.125.34.9	255 . 255 . 0 . 0
95.250.91.99	

ANDING With

Default subnet masks

Every IP address must be accompanied by a subnet mask. By now you should be able to look at an IP address and tell what class it is. Unfortunately your computer doesn't think that way. For your computer to determine the network and subnet portion of an IP address it must "AND" the IP address with the subnet mask.

Default Subnet Masks:

Class A 255.0.0.0 Class B 255.255.0.0 Class C 255.255.255.0

ANDING Equations:

1 AND 1 = 1 1 AND 0 = 0 0 AND 1 = 0

0 AND 0 = 0

Sample:

What you see...

IP Address: 192 . 100 . 10 . 33

What you can figure out in your head...

Address Class: C

Network Portion: <u>192.100.10</u>.33 Host Portion: 192.100.10.<u>33</u>

In order for you computer to get the same information it must AND the IP address with the subnet mask in binary.

Maturante

	Network Hos	ST .
IP Address:	11000000.01100100.00001010	1 0 0 0 0 1 (192 . 100 . 10 . 33)
Default Subnet Mask:	11111111.01111111.1111111.00	0000000 (255.255.255.0)
AND:	[1 1 0 0 0 0 0 0 . 0 1 1 0 0 1 0 0 . 0 0 0 0	0 0 0 0 0 0 (192 . 100 . 10 . 0)

ANDING with the default subnet mask allows your computer to figure out the network portion of the add

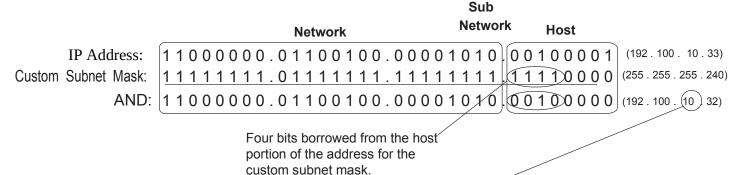
ANDING With

Custom subnet masks

When you take a single network such as 192.100.10.0 and divide it into five smaller networks (192.100.10.16, 192.100.10.32, 192.100.10.48, 192.100.10.64, 192.100.10.80) the outside world still sees the network as 192.100.10.0, but the internal computers and routers see five smaller subnetworks. Each independent of the other. This can only be accomplished by using a custom subnet mask. A custom subnet mask borrows bits from the host portion of the address to create a subnetwork address between the network and host portions of an IP address. In this example each range has 14 usable addresses in it. The computer must still AND the IP address against the custom subnet mask to see what the network portion is and which subnetwork it belongs to.

IP Address: 192 . 100 . 10 . 0 Custom Subnet Mask: 255.255.255.240

```
Address Ranges:
                    192.10.10.0 to 192.100.10.15
                    192.100.10.16 to 192.100.10.31
                    192.100.10.32 to 192.100.10.47
                                                     (Range in the sample below)
                    192.100.10.48 to 192.100.10.63
                    192.100.10.64 to 192.100.10.79
                    192.100.10.80 to 192.100.10.95
                    192.100.10.96 to 192.100.10.111
                    192.100.10.112 to 192.100.10.127
                    192.100.10.128 to 192.100.10.143
                    192.100.10.144 to 192.100.10.159
                    192.100.10.160 to 192.100.10.175
                    192.100.10.176 to 192.100.10.191
                    192.100.10.192 to 192.100.10.207
                    192.100.10.208 to 192.100.10.223
                    192.100.10.224 to 192.100.10.239
                    192.100.10.240 to 192.100.10.255
```



The ANDING process of the four borrowed bits shows which range of IP addresses this particular address will fall into.

In the next set of problems you will determine the necessary information to determine the correct subnet mask for a variety of IP addresses.

How to determine the number of subnets and the number of hosts per subnet

Two formulas can provide this basic information:

Number of subnets = 2^s (Second subnet formula: Number of subnets = $2^s - 2$)

Number of hosts per subnet = 2^h - 2

Both formulas calculate the number of hosts or subnets based on the number of binary bits **used**. For example if you borrow three bits from the host portion of the address use the *number of subnets* formula to determine the total number of subnets gained by borrowing the three bits. This would be 2° or $2 \times 2 \times 2 = 8$ subnets

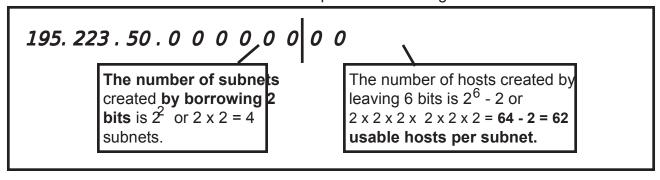
To **determine the number of hosts per subnet** you would take the number of binary bits used in the host portion and apply this to the *number of hosts per subnet* formula If five bits are in the

host portion of the address this would be 2 or 2 x 2 x 2 x 2 x 2 x 2 = 32 hosts.

When dealing with the number of hosts per subnet you have to subtract two addresses from the range. The first address in every range is the subnet number. The last address in every

range is the broadcast address. These two addresses cannot be assigned to any device in the network which is why you have to subtract two addresses to find the number of usable addresses in each range.

For example if two bits are borrowed for the network portion of the address you can easily determine the number of subnets and hosts per subnets using the two formulas.



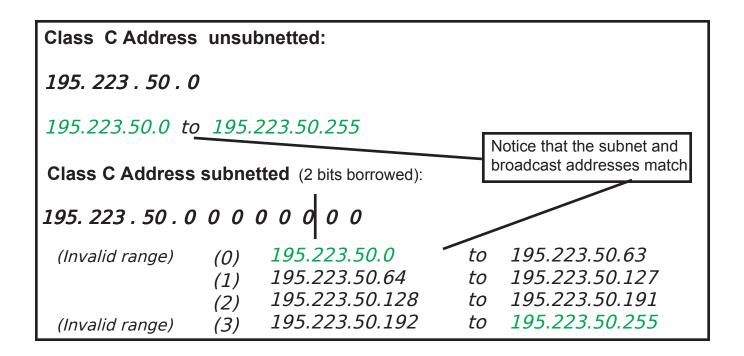
What about that second subnet formula:

Number of subnets = 2^{s} - 2

In some instances the first and last subnet range of addresses are reserved. This is similar to the first and last host addresses in each range of addresses.

The first range of addresses is the **zero subnet**. The subnet number for the **zero subnet** is also the subnet number for the classful subnet address.

The last range of addresses is the **broadcast subnet**. The broadcast address for the last subnet in *the broadcast subnet* is the same as the classful broadcast address.



The primary reason the zero and broadcast subnets were not used had to do primarily with the broadcast addresses. If you send a broadcast to 195.223.255 are you sending it to all 255 addresses in the classful C address or just the 62 usable addresses in the broadcast range?

The **CCNA** and **CCENT** certification exams may have questions which will require you to determine which formula to use, and whehter or not you can use the first and last subnets. Use the chart below to help decide.

When to use which formula to determine the number of subnets			
Use the 2 ^s - 2 formula and don't use the zero and broadcast ranges if	Use the 2 ^s formula and use the zero and broadcast ranges if		
Classful routing is used	Classless routing or VLSM is used		
RIP version 1 is used	RIP version 2, EIGRP, or OSPF is used		
The <i>no ip subnet zero</i> command is configured on your router	The <i>ip subnet zero</i> command is configured on your router (default setting)		
	No other clues are given		

Bottom line for the CCNA exams; if a question does not give you any clues as to whether or not to allow these two subnets, assume you can use them.

This workbook has you use the number of subnets = 2 formula.

Problem 1

Number of needed subnets 14
Number of needed usable hosts 14
Network Address 192.10.10.0

Address class _____C

Default subnet mask ______255 . 255 . 0

Custom subnet mask ______255 . 255 . 255 . 240

Total number of subnets ______16

Total number of host addresses _______16

Number of bits borrowed ______4

Show your work for Problem 1 in the space below.

Number of Subnets - 2 4 8 16 32 64 128 256 128 64 32 16 8 4 2 - Number of Hosts 192.10.10.0 . 0 0 0 0 0 0 0 0

Add the binary value numbers to the left of the line to create the custom subnet mask. $\begin{array}{c}
128 \\
64 \\
32 \\
\underline{+16} \\
240
\end{array}$

Observe the total number of hosts.

-2
Subtract 2 for the number of usable hosts.

Problem 2

Number of needed subnets 1000

Number of needed usable hosts 60

Network Address 165.100.0.0

Address class _____B

Default subnet mask ______255 . 0 . 0

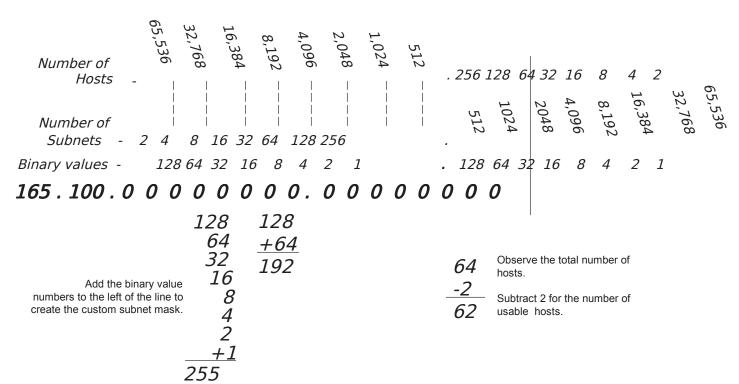
Custom subnet mask ______255 . 255 . 255 . 192

Total number of host addresses ______64

Number of usable addresses 62

Number of bits borrowed 10

Show your work for Problem 2 in the space below.



Problem 3

Network Address 148.75.0.0 /26

/26 indicates the total number of bits used for the network and subnetwork portion of the address. All bits remaining belong to the host portion of the address.

Address class ______B

Default subnet mask _____255 . 255 . 0 . 0

Custom subnet mask _____255 . 255 . 255 . 192

Total number of host addresses ______64

Number of usable addresses _______62

Number of bits borrowed 10

Show your work for Problem 3 in the space below.

Problem 4

Number of needed subnets 6
Number of needed usable hosts 30
Network Address 210.100.56.0

Address class	
Default subnet mask	
Custom subnet mask	
Total number of subnets	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed	

Show your work for Problem 4 in the space below.

Number of Subnets - 2 4 8 16 32 16 8 4 2 - Hosts

128 64 32 16 8 4 2 1 - Binary values

210 . 100 . 56 . 0 0 0 0 0 0 0 0

Problem 5

Number of needed subnets 6
Number of needed usable hosts 30
Network Address 195.85.8.0

Address class	
Default subnet mask	
Custom subnet mask	
Total number of subnets	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed	

Show your work for Problem 5 in the space below.

Number of Subnets - 2 4 8 16 32 64 32 16 8 4 2 - Hosts

195 . 85 . 8 . 0 0 0 0 0 0 0 0 0

Number of Subnets - 2 4 8 16 32 64 128 256

128 64 32 16 8 4 2 1 - Binary values

0

Problem 6

Number of needed subnets 126
Number of needed usable hosts 131,070
Network Address 118.0.0.0

Address class _____

Default subnet mask _____

Custom subnet mask _____

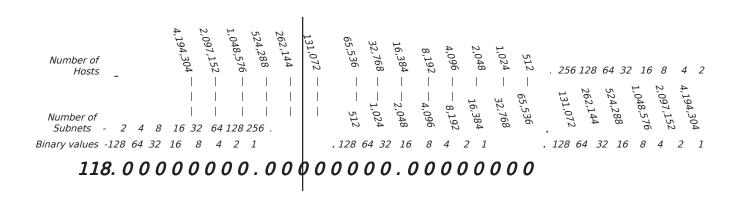
Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 6 in the space below.



Problem 7

Number of needed subnets 2000
Number of needed usable hosts 15
Network Address 178.100.0.0

Address class ______

Default subnet mask ______

Custom subnet mask ______

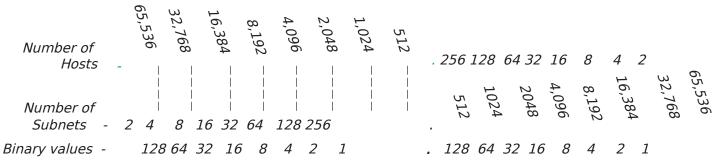
Total number of subnets ______

Total number of host addresses ______

Number of usable addresses ______

Number of bits borrowed ______

Show your work for Problem 7 in the space below.



178.100.0000000000000000000

Problem 8

Number of needed subnets 3
Number of needed usable hosts 45
Network Address 200.175.14.0

Address class C

Default subnet mask 255.255.255.0

Custom subnet mask 255.255.255.192

Total number of subnets _____

Total number of host addresses ______

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 8 in the space below.

Problem 9

Number of needed subnets 60
Number of needed usable hosts 1,000
Network Address 128.77.0.0

Address class	
Default subnet mask	
Custom subnet mask	
Total number of subnets	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed	

Show your work for Problem 9 in the space below.

Problem 10

Number of needed usable hosts 60
Network Address 198.100.10.0

Address class	
Default subnet mask	
Custom subnet mask	
Total number of subnets	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed	

Show your work for Problem 10 in the space below.

Problem 11

Number of needed subnets **250**Network Address **101.0.0.0**

Address class	
Default subnet mask	
Custom subnet mask	
Total number of subnets	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed	

Show your work for Problem 11 in the space below.

Problem 12

Number of needed subnets 5
Network Address 218.35.50.0

Address class	
Default subnet mask	
Custom subnet mask	
Total number of subnets	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed	

Show your work for Problem 12 in the space below.

Problem 13

Number of needed usable hosts 25
Network Address 218.35.50.0

Default subnet mask Custom subnet mask
Custom subnet mask
Total number of subnets
Total number of host addresses
Number of usable addresses
Number of bits borrowed

Show your work for Problem 13 in the space below.

Problem 14

Number of needed subnets 10
Network Address 172.59.0.0

Address class _	
Default subnet mask _	
Custom subnet mask _	
Total number of subnets _	
Total number of host addresses _	
Number of usable addresses _	
Number of bits borrowed _	

Show your work for Problem 14 in the space below.

Problem 15

Number of needed usable hosts 50
Network Address 172.59.0.0

Address class	
Default subnet mask	
Custom subnet mask	
Total number of subnets .	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed	

Show your work for Problem 15 in the space below.

Problem 16

Number of needed usable hosts 29
Network Address 23.0.0.0

Address class	
Default subnet mask	
Custom subnet mask	
Total number of subnets	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed	

Show your work for Problem 16 in the space below.

Subnetting

Problem 1

Number of needed subnets 14
Number of needed usable hosts 14
Network Address 192.10.10.0

What is the 4th subnet range? 192.10.10.48 to 192.10.10.63

What is the subnet number

What is the subnet broadcast address for

the 13th subnet? 192 . 10 . 10 . 207

What are the assignable addresses for the 9th

subnet? <u>192.10.10.129 to 192.10.10.142</u>

Show your work for Problem 1 in the space below.

			256	5 128 6	4 32	16	8 4	2	_	Hosts	Num	nber (of		
	Number o Subnets		2				4 128	256	5						
	54577615		_	. 64 3.		8	4 2			Binary va	alues				
102 1	10.10.	0					7 2	_	_	Silially VC	inacs				
192. 1	10.10.	0 0		0 0	0 0										
		(0)	0	0	0	0	192	2.10	<i>0.1</i>	0.0		to	192.10	0.10.1	5
		(1)	0	0	0	1	192	2.10	<i>9.1</i>	0.16		to	192.10	0.10.3	1
		(2)	0	0	1	0	192	2.10	<i>0.1</i>	0.32		to	192.10	0.10.4	7
		(3)	0	0	1	1	192	2.10	<i>0.1</i>	0.48		to	192.10	0.10.6	3
		(4)	0	1	0	0	192	2.10	<i>0.1</i>	0.64		to	192.10	_	_
		(5)	0	1	0	1	192	2.10	<i>9.1</i>	0.80		to	192.10	0.10.9	5
		(6)	0	1	1	0				0.96		to			
		(7)	0	1	1	1				0.112		to			
		(8)	1	0	0	0	_			0.128		to			
		(9)	1	0	0	1	192	2.10	<i>9.1</i>	0.144		to	192.10	0.10.1	59
		(10)	1	0	1	0				0.160		to	192.10		
		(11)	1	0	1	1	192	2.10	<i>9.1</i>	0.176		to	192.10	0.10.1	91
		(12)	1	1	0	0	192	2.10	<i>9.1</i>	0.192		to	192.10	0.10.2	07
		(13)	1	1	0	1	192	2.10	<i>9.1</i>	0.208		to	192.10	0.10.2	23
		(14)	1	1	1	0	192	2.10	<i>0.1</i>	0.224		to	192.10	0.10.2	39
		(15)	1	1	1	1	192	2.10	0.1	0.240		to	192.10	0.10.2	55
			28 64												
			<i>32</i>							16				16	
			52 -16							-2				-2	
	Custom sub m	onet $\frac{\pi}{24}$		<u>'</u>			Usabl	e subr	nets	<u>-2</u> 14			Usable ho	osts $\frac{-2}{14}$	_

The binary value of the last bit borrowed is the range. In this problem the range is 16.

The first address in each subnet range is the subnet number.

The last address in each subnet range is the subnet broadcast address.

Subnetting

Problem 2

Number of needed subnets 1000

Number of needed usable hosts 60

Network Address 165.100.0.0

What is the 15th subnet range? <u>165.100.3.128 to 165.100.3.191</u>

What is the subnet number

for the 6th subnet? ___165 . 100 . 1 . 64

What is the subnet broadcast address for

the 6th subnet? <u>165 . 100 . 1 . 127</u>

What are the assignable addresses for the 9th

subnet? 165.100.2.1 to 165.100.0.62

Show your work for Problem 2 in the space below.

	165.100.0.63 165.100.0.127 165.100.0.191 165.100.0.255	165.100.1.63 165.100.1.127 165.100.1.191 165.100.1.255	165.100.0.63 165.100.0.127 165.100.0.191 165.100.0.255	165.100.3.63 165.100.3.127 165.100.3.191 165.100.3.255	to	5,100,255,191 5,100,255,255
65,536	to to to	<i>5</i>	<i>5 5 5 5</i>	to to to	Down to	165 165
32,768 7 16,384 8 8,192 91 4,096 28 2048 2048 2048	165.100.0.0 165.100.0.64 165.100.0.128 165.100.0.192	165.100.1.0 165.100.1.64 165.100.1.128 165.100.1.192	165.100.2.0 165.100.2.64 165.100.2.128 165.100.2.192	165.100.3.0 165.100.3.64 165.100.3.128 165.100.3.192	Do	165.100.255.128 to 165.100.255.192 to
0 1024	100	7070	7070	7070		0
0 0 0 0	1	00	00	7 7 0		7
512	•		0000			. 1
1,024			$\Pi\Pi\Pi\Pi$	7777		T
2,048 95	(0) (1) (2) (3)	(4)	(8) (9) (10) (11)	(12) (13) (14) (15)		1
128 2	128	25 16 8 8 4	7 + 1 5			. <i>1</i>
8,192 49 8 0	I	8 7	255			7 7
16 90	64	02 128 4 + 64	192 ed is 64.	is the		7
H (r)		nosts bZ Custom 128 et mask ± 64	oorrowe ange is :t range	t range		7
Number of Hosts	Usable	Custom subnet mask.	The binary value of the last bit borrowed is the range. In this problem the range is 64. The first address in each subnet range is the subnet number.	The last address in each subnet range is the subnet broadcast address.		(1022) (1023)

Subnetting

Problem 3

Number of needed subnets 2
Network Address 195.223.50.0

Address class	
Default subnet mask	
Custom subnet mask	
Total number of subnets	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed	
What is the 3rd	
What is the subnet number for the 2nd subnet?	
What is the subnet broadcast address for the 1st subnet?	
What are the assignable addresses for the 3rd subnet?	

Show your work for Problem 3 in the space below.

Number of Subnets - 256 128 64 32 16 8 4 2 - Hosts

Number of Subnets - 2 4 8 16 32 64 128 256

128 64 32 16 8 4 2 1 - Binary values

195. 223 . 50 . 0 0 0 0 0 0 0 0

Subnetting

Problem 4

Number of needed subnets **750**Network Address **190.35.0.0**

Address clas	S
Default subnet masl	<
Custom subnet mask	<
Total number of subnet	S
Total number of host addresses	3
Number of usable addresses	
Number of bits borrowed	l
What is the 15th subnet range?	
What is the subnet number for the 13th subnet?	
What is the subnet broadcast address for the 10th subnet?	
What are the assignable addresses for the 6th subnet?	

Show your work for Problem 4 in the space below.

Problem 5

Number of needed usable hosts 6
Network Address 126.0.0.0

Address clas	3
Default subnet mask	
Custom subnet mask	.
Total number of subnets	3
Total number of host addresses	·
Number of usable addresses	
Number of bits borrowed	
What is the 2nd subnet range?	
What is the subnet number for the 5th subnet?	
What is the subnet broadcast address for the 7th subnet?	
What are the assignable addresses for the 10th subnet?	

Show your work for Problem 5 in the space below.

Problem 6

Number of needed subnets 10
Network Address 192.70.10.0

Addre	ss class	
Default subn	net mask	
Custom subn	et mask	
Total number of	subnets	
Total number of host ad	dresses	
Number of usable add	dresses	
Number of bits be	orrowed	
What is the 9th subnet range? _		
What is the subnet number for the 4th subnet?		-
What is the subnet broadcast address for the 12th subnet?		-
What are the assignable addresses for the 10th subnet?		

Show your work for Problem 6 in the space below.

Problem 7

Network Address 10.0.0.0 /16

Address class	
Default subnet mask	
Custom subnet mask	
Total number of subnets	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed	
What is the 11th subnet range?	
What is the subnet number for the 6th subnet?	
What is the subnet broadcast address for the 2nd subnet?	
What are the assignable addresses for the 9th subnet?	

Show your work for Problem 7 in the space below.

Problem 8

Number of needed subnets 5
Network Address 172.50.0.0

Address class	8
Default subnet mask	<u> </u>
Custom subnet mask	·
Total number of subnets	S
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed	
What is the 4th subnet range?	·
What is the subnet number for the 5th subnet?	
What is the subnet broadcast address for the 6th subnet?	
What are the assignable addresses for the 3rd subnet?	

Show your work for Problem 8 in the space below.

Problem 9

Number of needed usable hosts 28
Network Address 172.50.0.0

Addre	ss class	
Default subr	net mask	
Custom subr	net mask	
Total number of	subnets	
Total number of host ad	dresses	
Number of usable ad	dresses	
Number of bits b	orrowed	
What is the 2nd subnet range?		
What is the subnet number for the 10th subnet?		
What is the subnet broadcast address for the 4th subnet?		
What are the assignable addresses for the 6th subnet?		

Show your work for Problem 9 in the space below.

Problem 10

Number of needed subnets 45
Network Address 220.100.100.0

Address c	lass
Default subnet m	ask
Custom subnet m	ask
Total number of subr	nets
Total number of host addres	ses
Number of usable address	ses
Number of bits borrov	ved
What is the 5th subnet range?	
What is the subnet number for the 4th subnet?	
What is the subnet broadcast address for the 13th subnet?	
What are the assignable addresses for the 12th subnet?	

Show your work for Problem 10 in the space below.

Problem 11

Number of needed usable hosts 8,000 Network Address 135.70.0.0

Address clas	S
Default subnet mas	(
Custom subnet masl	<
Total number of subnets	S
Total number of host addresses	.
Number of usable addresses	
Number of bits borrowed	
What is the 6th subnet range?	
What is the subnet number for the 7th subnet?	
What is the subnet broadcast address for the 3rd subnet?	
What are the assignable addresses for the 5th subnet?	

Show your work for Problem 11 in the space below.

Problem 12

Number of needed usable hosts 45 Network Address 198.125.50.0

Address class	8
Default subnet mask	·
Custom subnet mask	
Total number of subnets	·
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed	
What is the 2nd subnet range?	
What is the subnet number for the 2nd subnet?	
What is the subnet broadcast address for the 4th subnet?	
What are the assignable addresses for the 3rd subnet?	

Show your work for Problem 12 in the space below.

Problem 13

Network Address 165.200.0.0 /26

Address class	
Default subnet mask	
Custom subnet mask	
Total number of subnets	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed	
What is the 10th subnet range?	
What is the subnet number for the 11th subnet?	
What is the subnet broadcast address for the 1023rd subnet?	
What are the assignable addresses for the 1022nd subnet?	

Show your work for Problem 13 in the space below.

Problem 14

Number of needed usable hosts 16
Network Address 200.10.10.0

Address class	·
Default subnet mask	
Custom subnet mask	
Total number of subnets	
Total number of host addresses	
Number of usable addresses	
Number of bits borrowed	
What is the 7th subnet range?	
What is the subnet number	
	
What is the subnet broadcast address for the 4th subnet?	
What are the assignable addresses for the 6th subnet?	

Show your work for Problem 14 in the space below.

Problem 15

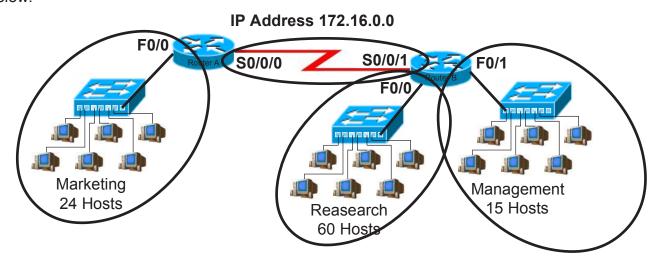
Network Address 93.0.0.0 \19

Address clas	ss
Default subnet mas	k
Custom subnet mas	k
Total number of subnet	S
Total number of host addresses	S
Number of usable addresses	S
Number of bits borrowed	d
What is the 15th subnet range?	
What is the subnet number for the 9th subnet?	
What is the subnet broadcast address for the 7th subnet?	
What are the assignable addresses for the 12th subnet?	

Show your work for Problem 15 in the space below.

Practical Subnetting 1

Based on the information in the graphic shown, design a network addressing scheme that will supply the <u>minimum number of subnets</u>, and allow enough extra subnets and hosts for 100% growth in both areas. Circle each subnet on the graphic and answer the questions below.



Address class			В	
Custom subnet mask			255.255.224.0	_
Minimum number of subnets needed		4		
Extra subnets required for 100% growth (Round up to the next whole number)	+	4	_	
Total number of subnets needed	=	8		
Number of host addresses in the largest subnet group		60		
Number of addresses needed for 100% growth in the largest subnet (Round up to the next whole number)	+	60		
Total number of address needed for the largest subnet	=	120		

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

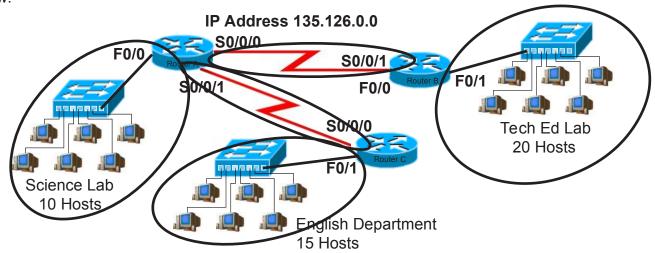
IP address range for Research	<i>172.16.0.0 to 172.31.255</i>
IP address range for Marketing	172.16.32.0 to 172.63.255
IP address range for Management	172.16.64.0 to 172.95.255
IP address range for Router A to Router B serial connection	172.16.96.0 to 172.127.255

Show your work for Practical Subnetting 1 in the space below.

65,536 32,768 7 16,384 8 8,192 9 4,096 1024 512 512 512	to 172.16.31.255 to 172.16.63.255 to 172.16.95.255 to 172.16.127.255 to 172.16.191.255 to 172.16.223.255 to 172.16.255.255 to 172.16.255.255
1,024 2,048 2,048 3,049	172.16.0.0 172.16.32.0 172.16.64.0 172.16.96.0 172.16.128.0 172.16.192.0 172.16.224.0
Number of Hosts - 128 64 32 16 Number of Subnets - 2 4 8 16 32 Binary values - 128 64 32 16	(0) 0 (1) 1 (2) 1 0 (3) 1 1 0 (4) 1 0 0 (5) 1 0 1 (6) 1 1 0 (7) 1 1 1
·	4 4 4 60 80 60

Practical Subnetting 2

Based on the information in the graphic shown, design a network addressing scheme that will supply the <u>minimum number of hosts per subnet</u>, and allow enough extra subnets and hosts for 30% growth in all areas. Circle each subnet on the graphic and answer the questions below.



Custom subnet mask 255.255.254

Minimum number of subnets needed 5

Extra subnets required for 30% growth (Round up to the next whole number) + 2

Total number of subnets needed = 7

Number of addresses needed for 30% growth in the largest subnet (Round up to the next whole number) + 6

Total number of address needed for the largest subnet = 26

Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

IP address range for English <u>135.126.0.32 to 135.126.0.63</u>

IP address range for Science 135.126.0.64 to 135.126.0.95

IP address range for Router A to Router B serial connection 135.126.0.96 to 135.126.0.127

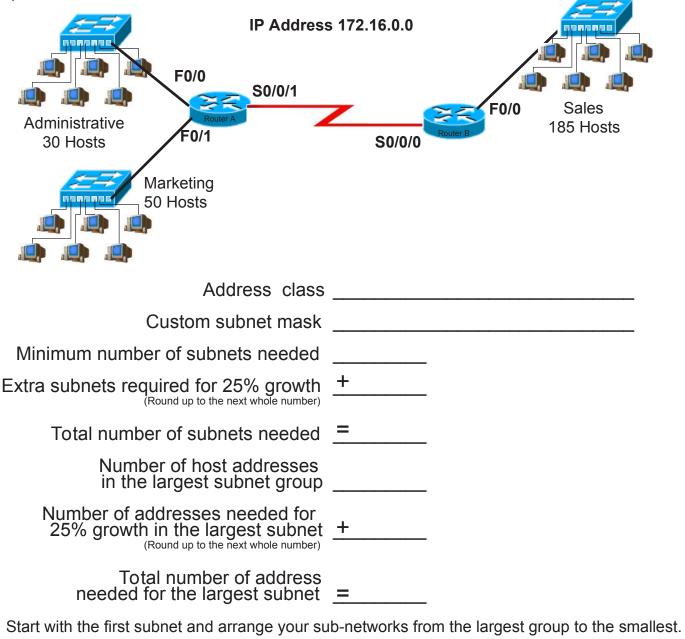
IP address range for Router A to Router B serial connection 135.126.0.128 to 135.126.0.159

Show your work for Problem 2 in the space below.

	135.126.0.31 135.126.0.63 135.126.0.95 135.126.0.127 135.126.0.159 135.126.0.253 135.126.0.253 135.126.1.31 135.126.1.31 135.126.1.127 135.126.1.159 135.126.1.159 135.126.1.123 135.126.1.223
65, ⁵³⁶	22222222222222
32,768 \(\text{7} \) \(\text{7} \) \(\text{16,384} \) \(\text{8} \) \(\text{8,192} \) \(\text{9} \) \(\text{4,096} \) \(\text{8} \)	135.126.0.0 135.126.0.32 135.126.0.64 135.126.0.128 135.126.0.160 135.126.0.192 135.126.0.192 135.126.1.32 135.126.1.32 135.126.1.28 135.126.1.128 135.126.1.128 135.126.1.128
64 32 8402 32 16	0101010101010
87 102 ⁴ 89 0	11001100110011
95 7 512 871	11110001111
512	
1,024	(0) (2) (2) (3) (4) (11) (11) (12) (13) (14)
2.048 4 8 4 72 4 0 0 0 0	
16,50	
32,768 8 15 8 0 0 0 0	
2 0	5 X.3 1.5 8 8 6
Number of Hosts - Number of Subnets - Binary values - 135. 126.0	(Round up to 2)

Practical Subnetting 3

Based on the information in the graphic shown, design a classfull network addressing scheme that will supply the **minimum number of hosts per subnet**, and allow enough extra subnets and hosts for 25% growth in all areas. Circle each subnet on the graphic and answer the questions below.



 IP address range for Sales
 IP address range for Marketing
IP address range for Administrative
IP address range for Router A to Router B serial connection

Show your work for Problem 3 in the space below.

Practical Subnetting 4

Based on the information in the graphic shown, design a network addressing scheme that will supply the <u>minimum number of subnets</u>, and allow enough extra subnets and hosts for 70% growth in all areas. Circle each subnet on the graphic and answer the questions below.

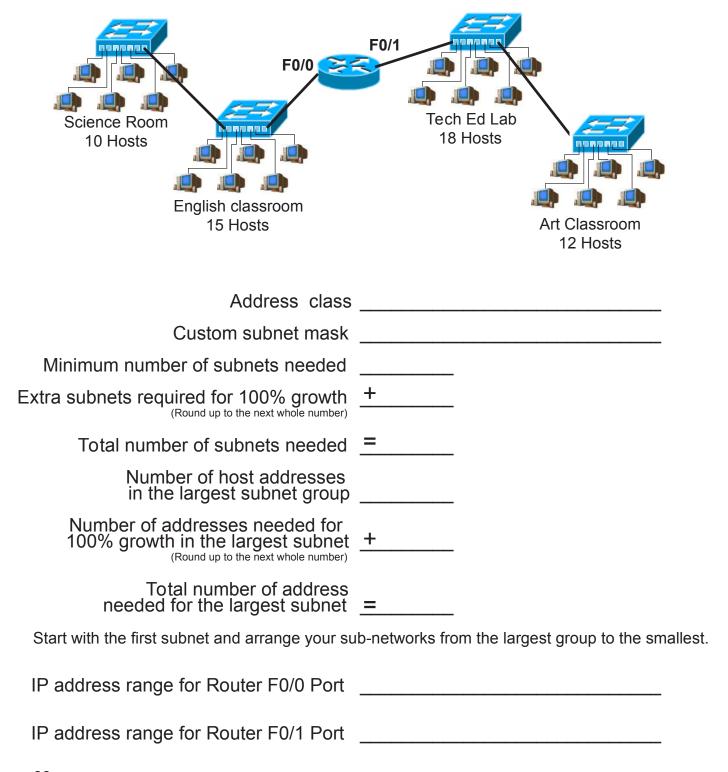
IP Address 135.126.0.0		
F0/0 S0/0/0 Router A S0/0/1	S0/0/1 F0/0	
Dallas 150 Hosts	F0/1 Router C F0/0 New York	
	ashington D.C. 325 Hosts 0 Hosts	
Address class		
Custom subnet mask		
Minimum number of subnets needed		
Extra subnets required for 70% growth (Round up to the next whole number)	+	
Total number of subnets needed	<u>=</u>	
Number of host addresses in the largest subnet group		
Number of addresses needed for 70% growth in the largest subnet (Round up to the next whole number)	+	
Total number of address needed for the largest subnet	<u>=</u>	
Start with the first subnet and arrange your su	b-networks from the largest group to the smallest	
IP address range for New York		
IP address range for Washington D. C.		
IP address range for Dallas		
IP address range for Router A to Router B serial connection		
IP address range for Router A to Router C serial connection		

Show your work for Problem 4 in the space below.

Practical Subnetting 5

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of hosts per subnet**, and allow enough extra subnets and hosts for 100% growth in all areas. Circle each subnet on the graphic and answer the questions below.

IP Address 210.15.10.0



Show your work for Problem 5 in the space below.

Practical Subnetting 6

Based on the information in the graphic shown, design a network addressing scheme that will supply the <u>minimum number of subnets</u>, and allow enough extra subnets and hosts for 20% growth in all areas. Circle each subnet on the graphic and answer the questions below.

S0/0/0	ss 10.0.0.0
F0/0 S0/0/1 S0/0/0 Art & Drama 75 Hosts	S0/0/1 S0/0/0 Router B Building 320 Hosts F0/1 Administration 35 Hosts
Address class	
Custom subnet mask	
Minimum number of subnets needed	
Extra subnets required for 20% growth (Round up to the next whole number)	+
Total number of subnets needed	=
Start with the first subnet and arrange your su	b-networks from the largest group to the smallest.
IP address range for Technology	
IP address range for Science	
IP address range for Arts & Drama	
IP Address range Administration	
IP address range for Router A to Router B serial connection	
IP address range for Router A to Router C serial connection	
IP address range for Router B to Router C serial connection	

Show your work for Problem 6 in the space below.

Practical Subnetting 7

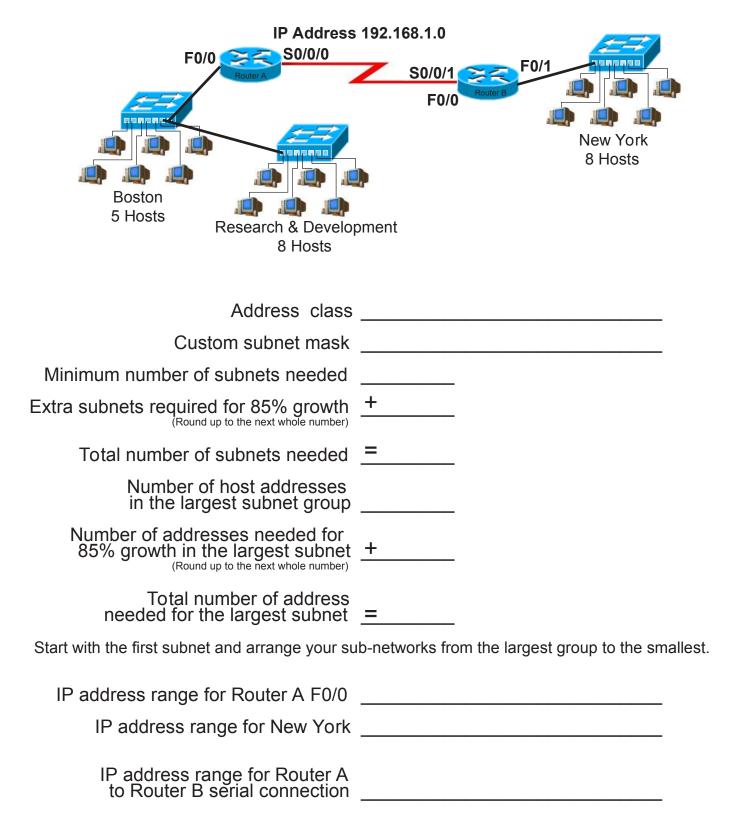
Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of hosts per subne**t, and allow enough extra subnets and hosts for 125% growth in all areas. Circle each subnet on the graphic and answer the questions below.

IP Address 177.135.0.0 S0/0/0	S0/0/0 F0/0
F0/0 Administration Marketing 33 Hosts Sales 75 Hosts 255 Hosts	Research Deployment 135 Hosts 63 Hosts
Address class	
Custom subnet mask	
Minimum number of subnets needed	-
Extra subnets required for 125% growth (Round up to the next whole number)	-
Total number of subnets needed =	_
Number of host addresses in the largest subnet group	_
Number of addresses needed for 125% growth in the largest subnet (Round up to the next whole number)	_
Total number of address needed for the largest subnet =	_
Start with the first subnet and arrange your sub-networks fr	om the largest group to the smallest.
IP address range for Router A Port F0/0	
IP address range for Research	
IP address range for Deployment	
IP address range for Router A to Router B serial connection	

Show your work for Problem 7 in the space below.

Practical Subnetting 8

Based on the information in the graphic shown, design a network addressing scheme that will supply the <u>minimum number subnets</u>, and allow enough extra subnets and hosts for 85% growth in all areas. Circle each subnet on the graphic and answer the questions below.



Show your work for Problem 8 in the space below.

Practical Subnetting 9

Based on the information in the graphic shown, design a network addressing scheme that will supply the minimum number of hosts per subnet, and allow enough extra subnets and hosts for 15% growth in all areas. Circle each subnet on the graphic and answer the questions

	IP Address 1	48.55.0.0	
	S0/0/0 S0/0/1	S0/0/1 F0/0	F0/1
F0/0		\$0/0/0	Dallas 1500 Hosts
	S0/0/0	S0/0/1	
Ft. Worth 2300 Hosts	Address class _		
	ıstom subnet mask _		
Minimum number	of subnets needed _		
Extra subnets require (Rou	red for 15% growth dind up to the next whole number)	-	
Total number	of subnets needed _=		
	of host addresses rgest subnet group _		
15% arowth in	resses needed for the largest subnet dup to the next whole number)	-	
	number of address the largest subnet <u>=</u>	=	
Start with the first subr	et and arrange your sub-	networks from the	largest group to the smallest
IP address i	range for Ft. Worth _		
IP addre	ss range for Dallas _		· · · · · · · · · · · · · · · · · · ·
IP address to Router	range for Router A _ B serial connection		
IP address to Router (range for Router A _ C serial connection		
IP address to Router I	range for Router C _ D serial connection _		

Show your work for Problem 9 in the space below.

Practical Subnetting 10

Based on the information in the graphic shown, design a network addressing scheme that will supply the <u>minimum number of subnets</u>, and allow enough extra subnets and hosts for 110% growth in all areas. Circle each subnet on the graphic and answer the questions below.

IP Ac	Idress 172.16.0.0
Sales 115 Hosts	Marketing 56 Hosts
F0/0 Router A S0/0/	S0/0/1
Management 25 Hosts	F0/1 Research 35 Hosts
Address	class
Custom subnet n	nask
Minimum number of subnets nee	ded
Extra subnets required for 110% gro	owth +
Total number of subnets nee	eded <u>=</u>
Number of host addres in the largest subnet g	
Number of addresses needed 110% growth in the largest su (Round up to the next whole n	bnet +
Total number of add needed for the largest sul	ress onet <u>=</u>
Start with the first subnet and arrange y	our sub-networks from the largest group to the smallest.
IP address range for Sales/Manage	mnt
IP address range for Marke	eting
IP address range for Resea	arch
IP address range for Rout	er A

Show your work for Problem 10 in the space below.

Valid and Non-Valid IP Addresses

Using the material in this workbook identify which of the addresses below are correct and usable. If they are not usable addresses explain why.

IP Address: 0.230.190.192 Subnet Mask: 255.0.0.0 Reference Page Inside Front Cover	The network ID cannot be 0.
IP Address: 192.10.10.1 Subnet Mask: 255.255.255.0 Reference Pages 28-29	<u>OK</u>
IP Address: 245.150.190.10 Subnet Mask: 255.255.255.0 Reference Page Inside Front Cover	
IP Address: 135.70.191.255 Subnet Mask: 255.255.254.0 Reference Pages 48-49	
IP Address: 127.100.100.10 Subnet Mask: 255.0.0.0 Reference Pages Inside Front Cover	
IP Address: 93.0.128.1 Subnet Mask: 255.255.224.0 Reference Pages 56-57	
IP Address: 200.10.10.128 Subnet Mask: 255.255.255.224 Reference Pages 54-55	
IP Address: 165.100.255.189 Subnet Mask: 255.255.255.192	
IP Address: 190.35.0.10 Subnet Mask: 255.255.255.192 Reference Pages 34-35	
IP Address: 218.35.50.195 Subnet Mask: 255.255.0.0 Reference Page Inside Front Cover	
IP Address: 200.10.10.175 /22 Reference Pages 54-55 and/or Inside Front Cover	
IP Address: 135.70.255.255 Subnet Mask: 255.255.224.0	

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IP Address Breakdown

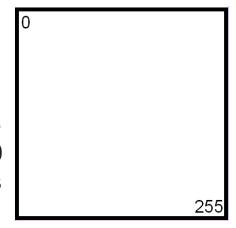
8 8-8-6 255.50. 255.255.00 25 225.255.00 275.255.50.240 255.255.250.240 255.255.255.240 255.255.255.240 255.255.255.240 255.255.255.255.250.240 255.255.255.255.255.255.255.255.255.255	/24	/25	/26	/27	/28	/29	/30
256 Hosts 128 Hosts 0-15 0-17 0-16 0-7 4-7 4-7 8-15 128-15 128-15 128-15 128-15 128-15 128-15 128-15 128-15 0-63 0-7 4-7 4-7 8-15 128-15 128-191 108-31 108-31 108-31 24-41 44-47 44-47 44-47 44-47 24-21 24-225 24-239 224-239 224-239 224-239 224-239 224-231 224-255 224-239 224-231 224-255		8+8+8+1	8+8+8+2				
0-15							
0-15	200 110010	120110010	3111000	02 110010	10110010		0-3
0-63 0-63 16-31 16-23 16-23 16-23 20-23 24-31 24-31 28-31 32-39 32-39 32-39 32-39 32-39 32-39 32-39 40-47 44-47					0-15	0-7	
0-63 16-31 24-31 24-31 28-31 32-39 36-39 36-39 36-39 40-47 44-47 44-47 44-47 44-47 44-47 48-63 64-79 64-79 64-79 64-79 64-79 64-79 64-79 64-127 88-95 80-95 88-96 98-91 98-111 104-111 104-110 104-107 104-111 104-1107 112-115 112-127 120-123 120-127 120-123 120-127 121-121 112-119 112-115 112-144-159 128-143 128-143 128-143 128-191 128-191 128-255 128-255 192-255 192-255 192-255 208-223 208-215 218-219 218-219 224-239 224-231 228-231 232-239 242-247 244-247 244-247						8-15	
0-63 16-31 24-31 24-31 24-31 24-31 24-31 32-39 33-39 33-39 33-39 40-47 40-47 40-43 40-47 40-43 40-47 40-47 40-47 40-47 40-47 40-47 40-43 40-47 40-47 40-43 40-47 40-47 40-47 40-43 40-47 40-47 40-43 40-47 40-47 40-47 40-43 40-47 40-47 40-43 40-47 40-47 40-43 40-47 40-47 40-43 40-47 40-47 40-47 40-43 40-47 40-47 40-43 40-47 40-47 40-47 40-47 40-43 40-47 40-47 40-47 40-47 40-47 40-47 40-43 40-47 40-47 40-47 40-47 40-47 40-47 40-47 40-43 40-47 40-48 40-48 40-48 40-48 40-48 40-48 40-48 40-						16-23	
0-63 24-31 28-31 32-39 33-36 39 33-39 33-39 33-39 33-39 33-39 33-39 33-39 33-39 33-39 33-39 40-47 44-47 44-47 44-47 44-47 44-47 44-47 44-47 44-47 44-47 44-47 44-47 64-67 68-59 60-63 6					16-31		
0-127 10-111 10-111 10-111 112-112 112-112 112-112 112-112 112-113 112-112 112-113 112			0.62			24-31	28-31
0-127 0-128 0-128 0-128 0-128 0-129 0-			0-63			32-39	
0-127 48-63 48-55 48-55 48-55 52-55 56-63 56-69 64-71 64-71 64-71 64-79 72-79 72-79 72-75 72-79 72					32-47	_	
0-127 48-63						40-47	44-47
0-127 64-79 64-71 64-67 64-71 64-67 64-79 72-79 72-75 76-79 76-79 80-95 80-87 84-87 98-95 92-95 99-103 100-103 104-111 104-107 104-111 104-107 112-127 112-115 112-127 120-123 120-127 120-123 120-127 120-123 128-131 136-143 136-139 136-143 136-139 144-159 152-155 152-159 152-155 152-159 152-155 160-175 161-167 161-167 168-175 172-175 176-191 176-183 176-179 176-191 176-183 176-179 176-191 176-183 176-179 176-191 176-183 176-179 176-191 176-183 176-179 176-191 176-183 176-179 176-191 176-183 176-179 176-191 176-183 176-179 176-191 176-183 176-179 176-191 176-183 176-179 176-191 176-183 176-179 176-192 176-179 176-193 176-179 176-194 176-179 176-195 176-179 176-197 176-179 176-183 176-179 176-184 176-179 176-185 176-179 176-180 176-179 176-181 176-179 176-182 176-179 176-183 176-179 176-184 176-179 176-185 176-179 176-180 176-179 176-181 176-179 176-182 176-179 176-183 176-179 176-183 176-179 176-184 176-179 176-185 176-179 176-180 176-179 176-181 176-179 176-182 176-179 176-183 176-179 176-184 176-179 176-185 176-179 176-185 176-179 176-185 176-179 176-187 176-179 176-188 176-179 176-189 176-179 176-189 176-179 176-180 176-179 176-181 176-179 176-182 176-179 176-183 176-179 176-183 176-179 176-184 176-179 176-185 176-179 176-185 176-179 176-185 176-179 176-185 176-179 176-185 176-179 176-185 176-179 176-185 176-179 176-185 176-179 176-185 176-179 176-185 176-179 176-185 176-179 176-185 176-179 176-185 176-179 176-185 176-179 176-185 176-179 176-185 176-179 176-185 176-17						48-55	
0-127 64-79					48-63		
0-255 64-79		0-127				56-63	60-63
0-255 128-191 128-255 192-255 192-255 192-255 192-255 192-255 192-255 192-255 192-255 192-255 192-255 192-239		0-127				64-71	
80-95 80-87 84-87 84-87 88-95 92-95 88-91 96-111 96-103 96-99 96-103 100-103 104-111 108-111 112-127 120-127 120-123 120-127 120-123 120-127 120-123 128-143 136-143 136-139 136-143 140-143 144-159 152-155 156-159 152-159 156-159 160-175 168-167 164-167 168-175 172-176 168-175 172-176 176-191 184-191 188-191 128-255 192-255 192-207 200-203 200-207 200-203 2					64-79	70.70	
80-95 88-97 88-87 88-97 88-97 89-98 92-95						72-79	
128-191 128-255 128-						80-87	
128-191 128-191 128-255 64-127 96-111 96-103 96-99 100-103 100-103 100-103 100-103 100-103 100-103 100-103 112-119 112-119 112-119 112-119 112-119 112-119 112-127 120-127 120-123 128-131 128-135 128-131 136-143 136-139 144-151 144-159 144-151 144-151 144-151 144-151 168-171 168-175 168-175 172-176 168-175 176-191 176-191 176-183 180-183					80-95	99.05	88-91
128-191 128-191 128-255 128-255 128-255 128-255 128-255 128-255 128-255 128-255 128-255 128-255 128-255 128-255 128-255 128-255 128-255 128-255 128-255 128-27 128-27 128-28 128			64-127			00-95	
128-191 112-127 112-119 112-119 112-115 112-119 112-115 112-127 120-127 120-127 120-127 121-135 128-135 128-135 136-143 136-133 136-143 140-143 144-159 144-151 144-151 144-151 144-151 144-151 160-175 160-175 160-175 168-175 176-183 180-183 184-191 184-191 188-191 184-191 188-191 192-207 192-199 196-199 200-207 200-203 200-207 200-207 200-203 200-207 200-203 200-207 200-203 200-207 200-203 200-207 200-203 200-207 200-203 200-207 200-203 200						96-103	
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112-127						104-111	
0-255 120-127						112-119	
128-143 128-135 128-135 132-135 136-143 140-143 140-143 144-159 1144-151 144-151 144-151 152-159 152-155 152-159 152-155 160-175 168-175 176-191 176-191 128-255 192-207 192-195 192-207 200-203 200-203 200-203 200-203 200-203 204-207 200-203 216-223 216-223 228-231 228-231 232-239 232-235 232-239 232-235 232-239 232-235					112-127	120-127	120-123
128-143	0-255					120-121	
128-191 128-191 128-191 128-191 128-191 128-255 128-255 128-255 128-255 128-255 128-255 128-255 128-255 136-143 136-139 144-151 144-147 144-151 144-151 144-151 152-159 156-159 156-159 160-163 16-167 160-163 16-167 168-175 172-175 172-175 172-175 176-191 176-191 176-183 180-183 180-183 184-191 188-191 188-191 192-207 192-199 192-199 192-195 192-195 200-207 200-203 200-203 200-207 200-203 200-203 200-207 200-203 200-203 200-207 200-203 200					128-143	128-135	132-135
128-191 128-191 128-191 144-159 144-151 144-151 148-151 152-159 152-159 152-159 152-159 152-159 152-159 160-163 16-167 168-175 168-175 176-191 176-191 176-191 176-191 176-193 184-191 188-191 188-191 192-207 192-199 192-199 192-199 192-199 192-199 200-207 200-203 204-207 204-207 208-211 208-215 216-223 216-223 224-227 224-227 224-239 224-239 224-239 224-239 224-239 224-239 224-239 224-247 240-243 240-247 240-243 240-247 240-243						136-143	136-139
128-191 128-191 128-191 128-191 128-191 144-159 152-159 152-155 155-159 156-159 168-163 160-167 168-167 168-167 168-175 172-175 172-175 176-191 176-191 176-191 176-191 192-207 192-199 192-195 192-199 192-195 192-190 200-207 200-203 204-207 200-203 204-207 200-203 204-207 208-215 216-223 216-223 224-231 228-231 232-239 232-239 232-239 232-239 240-247 244-247 244-247 244-247 244-247						100 140	
128-191 128-191 160-175 160-167 161-167 168-171 172-175 176-183 180-183 184-191 184-191 184-191 184-191 184-191 192-207 192-199 192-195 200-207 200-203 200-207 200-203 200-207 200-207 200-207 200-207 200-207 200-203 200-207 201-207 202-203 216-223 216-223 216-223 224-231 224-231 224-235 224-239 232-236 232-239 232-235 240-247 240-243 240-247 240-243					144 150	144-151	
128-191 160-175 160-163 160-163 164-167 168-175 172-175 176-183 180-183 180-183 180-183 184-191 188-191 192-207 192-199 192-195 192-199 192-195 200-207 200-203 200-207 204-207 208-211 208-223 216-223 224-231 224-231 224-231 224-231 232-239 232-235 240-247 240-247 240-247 240-247 240-247					144-139	152-159	
160-175			128-191				
128-255 128					160-175	16-167	
176-191 176-183 176-179 180-183 180-183 184-191 184-191 182-195 192-207 192-199 196-199 200-207 200-203 204-207 204-207 208-215 216-223 216-223 220-223 224-231 228-231 232-235 236-239 240-247 244-247 244-247 248-251 248-251						168-175	
176-191 176-191 176-191 184-191 184-187 184-191 188-191 192-195 192-199 192-199 200-207 200-203 200-207 200-203 204-207 208-215 216-223 216-219 224-231 224-231 224-235 232-235 236-239 240-247 244-247 244-247 244-247							
128-255 192-207 192-199 192-199 192-199 192-199 200-207 200-203 204-207 208-215 216-223 216-223 224-231 222-231 232-239 232-235 232-235 240-247 240-243 240-247 248-251					176-191	176-183	180-183
192-207 192-199 192-199 192-195 196-199 200-207 200-207 204-207 208-215 216-223 216-223 224-239 224-231 224-239 224-231 232-239 232-235 232-239 240-247 240-243 240-243 240-247 244-247						184-191	
192-207 192-207 200-207 200-203 204-207 208-215 208-215 216-219 216-223 216-219 224-227 224-239 224-231 232-235 232-235 232-235 240-247 240-243 240-247 248-251		128-255				100 100	
200-207					192-207	192-199	196-199
208-223 208-215 212-215 216-219 216-223 220-223 220-223 220-223 224-227 224-239 232-235 236-239 236-239 240-247 244-247 244-247 248-251						200-207	200-203
208-223 212-215 216-223 216-219 220-223 220-223 224-227 224-231 228-231 228-231 232-239 236-239 240-247 240-243 240-247 240-243 240-247 248-251						200 045	208-211
192-255 216-223 220-223 224-231 224-239 224-239 224-239 232-235 232-239 232-239 232-239 240-247 240-243 240-247 244-247					208-223	208-215	212-215
224-239 224-231 224-227 228-231 228-231 232-235 236-239 236-239 240-247 244-247 244-247 248-255 248-251						216-223	
224-239 232-235 232-239 232-239 236-239 240-247 240-247 244-247 248-251			192-255			224 224	224-227
232-239 236-239 236-239 240-247 240-243 240-255 248-251					224-239	224-231	228-231
240-243 240-255 240-255 240-255 240-247 244-247 248-251						232-239	
240-255 249-255 248-251						240 247	240-243
248-251					240-255	240-241	
1 737-7367 1						248-255	248-251 252-255

Visualizing Subnets Using The Box Method

The box method is the simplest way to visualize the breakdown of subnets and addresses into smaller sizes.

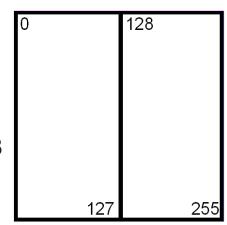
Start with a square. The whole square is a single subnet comprised of 256 addresses.

/24 255.255.255.0 256 Hosts 1 Subnet



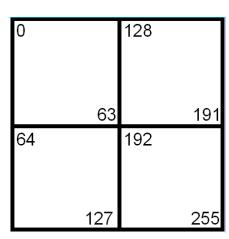
Split the box in half and you get two subnets with 128 addresses,

/25 255.255.255.128 128 Hosts 2 Subnets



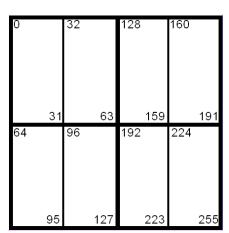
Divide the box into quarters and you get four subnets with 64 addresses,

/26 255.255.255.192 64 Hosts 4 Subnets



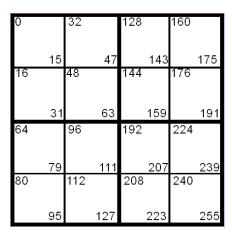
Split each individual square and you get eight subnets with 32 addresses,

/27 255.255.255.224 32 Hosts 8 Subnets



Split the boxes in half again and you get sixteen subnets with sixteen addresses,

/28 255.255.255.240 16 Hosts 16 Subnets



The next split gives you thirty two subnets with eight addresses,

/29 255.255.255.248 8 Hosts 32 Subnets

0	8		32	40	128	136	160	168
7		15	39	47	135	143		175
16	24		48	56	144	152	176	184
23	:	31	55	63	151	159	183	191
64	72		96	104	192	200	224	232
71		79	103	111	199	207	321	239
80	88		112	120	208	216	240	248
87	!	95	119	127	215	223	247	255

The last split gives sixty four subnets with four addresses each,

/30 255.255.255.252 4 Hosts 64 Subnets

0		8		32	40	128	136	160	168
	3		11	35	43	131	139	163	171
4		12		36	44	132	140	164	172
	7		15	39	47	135	143	167	175
16		24		48	56	144	152	176	184
	19		27	51	59	147	155	179	187
20		28		52	60	148	156	180	188
	23		31	55	63	151	159	183	191
64		72		96	104	192	200	224	232
	67		75	99	107	195	203	227	235
68		76		100	108	196	204	228	236
	71		79	103	111	199	207	321	239
80		88		112	120	208	216	240	248
	83		91	115	123	211	219	243	251
84		92		116	124	212	220	244	252
	87		95	119	127	215	223	247	255

Class A Addressing Guide							
	# of Bits	Subnet	Total # of	Total # of	Usable # of		
CIDR	Borrowed	Mask	Subnets	Hosts	Hosts		
/8	0	255.0.0.0	1	16,777,216	16,777,214		
/9	1	255.128.0.0	2	8,388,608	8,388,606		
/10	2	255.192.0.0	4	4,194,304	4,194,302		
/11	3	255.224.0.0	8	2,097,152	2,097,150		
/12	4	255.240.0.0	16	1,048,576	1,048,574		
/13	5	255.248.0.0	32	524,288	524,286		
/14	6	255.252.0.0	64	262,144	262,142		
/15	7	255.254.0.0	128	131,072	131,070		
/16	8	255.255.0.0	256	65,536	65,534		
/17	9	255.255.128.0	512	32,768	32,766		
/18	10	255.255.192.0	1,024	16,384	16,382		
/19	11	255.255.224.0	2,048	8,192	8,190		
/20	12	255.255.240.0	4,096	4,096	4,094		
/21	13	255.255.248.0	8,192	2,048	2,046		
/22	14	255.255.252.0	16,384	1,024	1,022		
/23	15	255.255.254.0	32,768	512	510		
/24	16	255.255.255.0	65,536	256	254		
/25	17	255.255.255.128	131,072	128	126		
/26	18	255.255.255.192	262,144	64	62		
/27	19	255.255.255.224	524,288	32	30		
/28	20	255.255.255.240	1,048,576	16	14		
/29	21	255.255.255.248	2,097,152	8	6		
/30	22	255.255.255.252	4,194,304	4	2		

Class B Addressing Guide								
	# of Bits Subnet Total # of Total # of Usable # of							
CIDR	Borrowed	Mask	Subnets	Hosts	Hosts			
/16	0	255.255.0.0	1	65,536	65,534			
/17	1	255.255.128.0	2	32,768	32,766			
/18	2	255.255.192.0	4	16,384	16,382			
/19	3	255.255.224.0	8	8,192	8,190			
/20	4	255.255.240.0	16	4,096	4,094			
/21	5	255.255.248.0	32	2,048	2,046			
/22	6	255.255.252.0	64	1,024	1,022			
/23	7	255.255.254.0	128	512	510			
/24	8	255.255.255.0	256	256	254			
/25	9	255.255.255.128	512	128	126			
/26	10	255.255.255.192	1,024	64	62			
/27	11	255.255.255.224	2,048	32	30			
/28	12	255.255.255.240	4,096	16	14			
/29	13	255.255.255.248	8,192	8	6			
/30	14	255.255.255.252	16,384	4	2			

Class C Addressing Guide								
CIDR	# of Bits Borrowed	Subnet Mask	Total # of Subnets	Total # of Hosts	Usable # of Hosts			
/24	0	255.255.255.0	1	256	254			
/25	1	255.255.255.128	2	128	126			
/26	2	255.255.255.192	4	64	62			
/27	3	255.255.255.224	8	32	30			
/28	4	255.255.255.240	16	16	14			
/29	5	255.255.255.248	32	8	6			
/30	6	255.255.255.252	64	4	2			