IPv4 Addressing and Subnetting

Workbook

Version 2.1

11111110

10010101

00011011

10000110

11010011

Student Name:

IPv4 Address Classes

Class A	1 – 127	Leading bit pattern	0	00000000.00000000.00000000.00000000 Network . Host . Host . Host
Class B	128 – 191	Leading bit pattern	10	10000000.00000000.00000000.00000000 Network . Network . Host . Host
Class C	192 – 223	Leading bit pattern	110	11000000.00000000.00000000.00000000 Network . Network . Network . Host
Class D	224 – 239	(Reserved for multicast)		
Class E	240 – 255	(Reserved for experimental, used for research)		

Speciality Address Ranges

Loopback -	Only the single 127.0.0.1 address is used, addresses 127.0.0.0 to 127.255.255.255 are reserved. Any address within this block will loop back to the local host.
Link-Local Addresses -	IPv4 addresses in the address block 169.254.0.0 to 169.254.255.255 (169.254.0.0/16) are designated as link-local addresses.
TEST-NET Addresses -	The address block 192.0.2.0 to 192.0.2.255 (192.0.2.0/24) is set aside for teaching and learning purposes.
Experimental Addresses -	The addresses in the block 240.0.0.0 to 255.255.255.254 are listed as reserved for future use (RFC 3330).

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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Binary To Decimal Conversion

128	64	32	16	8	4	2	1	Answers
1	0	0	1	0	0	1	0	146
0	1	1	1	0	1	1	1	119
1	1	1	1	1	1	1	1	
1	1	0	0	0	1	0	1	
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	

Scratch Area

128
16
2
146

64
32
16
4
2
1
119

00011011	
10101010	
01101111	
11111000	
00100000	
01010101	
00111110	
00000011	
11101101	
11000000	

Decimal To Binary Conversion

Use all 8 bits for each problem

128	64	32	16	8	4	2	1	=	255
1	1	1	0	1	1	1	0		238
0	0	1	0	0	0	1	0		34
									123
									50
									255
									200
									10
									138
									1
									13
									250
									107
									224
									114
									192
									172
									100
									119
									57
									98
									179
									2

Scratch Area

238
-128
110
-64
46
-32
14
-8
6
-4
2
-2
0

34
-32
2
-2
0

Address Class Identification

Address	Class
10.250.1.1	A
150.10.15.0	B
192.14.2.0	_____
148.17.9.1	_____
193.42.1.1	_____
126.8.156.0	_____
220.200.23.1	_____
230.230.45.58	_____
177.100.18.4	_____
119.18.45.0	_____
249.240.80.78	_____
199.155.77.56	_____
117.89.56.45	_____
215.45.45.0	_____
199.200.15.0	_____
95.0.21.90	_____
33.0.0.0	_____
158.98.80.0	_____
219.21.56.0	_____

Network & Host Identification

Circle the network portion of these addresses:

177.100.18.4

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 — _____

150.203.23.19
255.255.0.0 — _____

10.10.10.10
255.0.0.0 — _____

186.13.23.110
255.255.255.0 — _____

223.69.230.250
255.255.0.0 — _____

200.120.135.15
255.255.255.0 — _____

27.125.200.151
255.0.0.0 — _____

199.20.150.35
255.255.255.0 — _____

191.55.165.135
255.255.255.0 — _____

28.212.250.254
255.255.0.0 — _____

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 _____

128.23.230.19
255.255.0.0 _____

10.10.10.10
255.0.0.0 _____

200.113.123.11
255.255.255.0 _____

223.169.23.20
255.255.0.0 _____

203.20.35.215
255.255.255.0 _____

117.15.2.51
255.0.0.0 _____

199.120.15.135
255.255.255.0 _____

191.55.165.135
255.255.255.0 _____

48.21.25.54
255.255.0.0 _____

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	
223.23.223.109	
10.10.250.1	
126.123.23.1	
223.69.230.250	
192.12.35.105	
77.251.200.51	
189.210.50.1	
88.45.65.35	
128.212.250.254	
193.100.77.83	
125.125.250.1	
1.1.10.50	
220.90.130.45	
134.125.34.9	
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:	**192 . 100 . 10** . 33
Host Portion:	192 . 100 . 10 . **33**

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

	Network	Host	
IP Address:	1 1 0 0 0 0 0 0 . 0 1 1 0 0 1 0 0 . 0 0 0 0 1 0 1 0	. 0 0 1 0 0 0 0 1	(192 . 100 . 10 . 33)
Default Subnet Mask:	1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1	. 0 0 0 0 0 0 0 0	(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 1 0 1 0	. 0 0 0 0 0 0 0 0	(192 . 100 . 10 . 0)

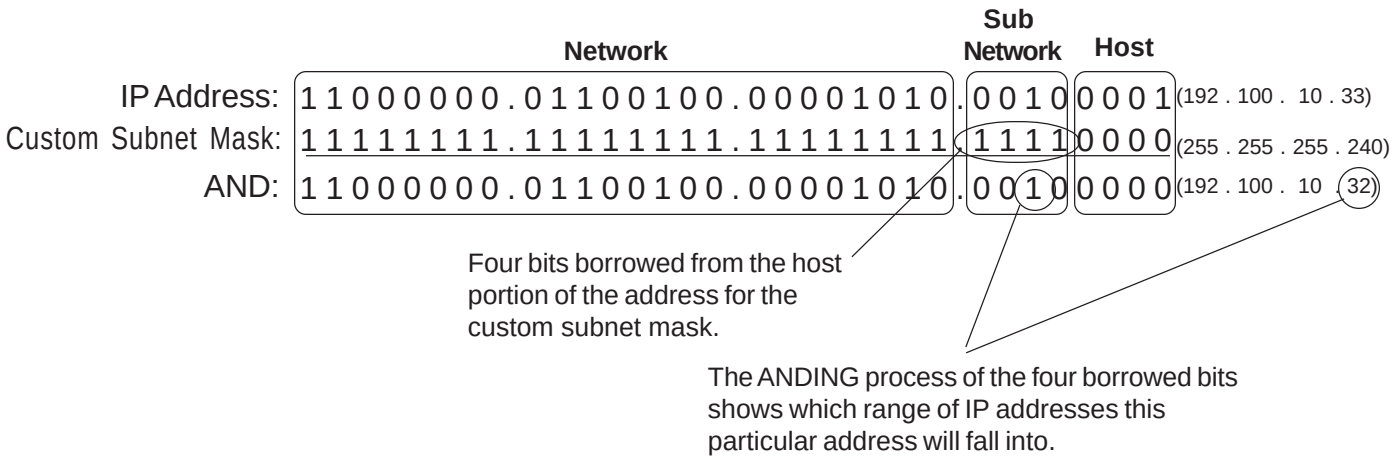
ANDING with the default subnet mask allows your computer to figure out the network portion of the address.

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



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

The formula that can provide this basic information:

Number of subnets = 2^s

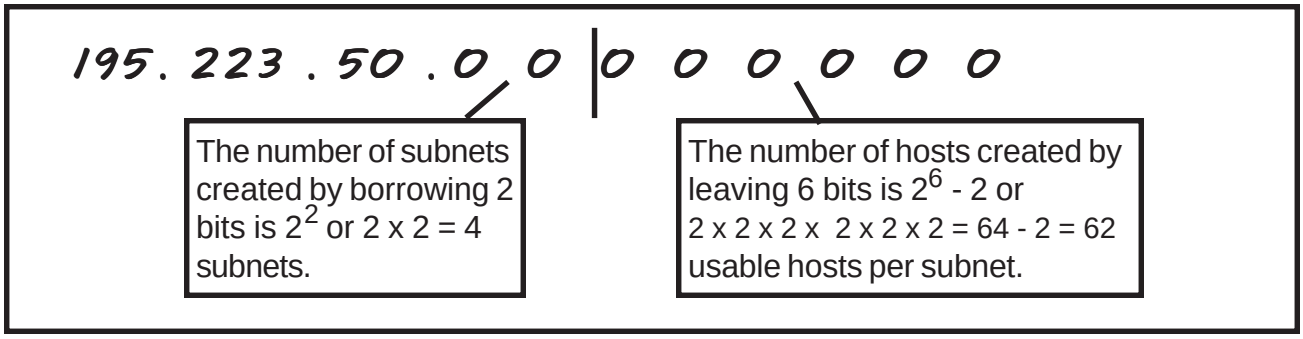
Number of usable hosts per subnet = 2^h - 2

This formula calculates 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 2^3 or 2 x 2 x 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 2^5 or 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 formula.



Custom Subnet Problems

Custom Subnet Masks

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 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 240

Total number of subnets 16

Total number of host addresses 16

Number of usable addresses 14

Number of bits borrowed 4

Show your work for Problem 1 in the space below.

	256	128	64	32	16	8	4	2	– Number of Hosts
Number of Subnets –	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1	– Binary values
192 . 10 . 10 .	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.

128
64
32
+16
240

16 Observe the total number of hosts.
−2 Subtract 2 for the number of usable hosts.
14

Custom Subnet Masks

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 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 1,024

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.

Number of Hosts –	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	.	256	128	64	32	16	8	4	2	
Number of Subnets –	2	4	8	16	32	64	128	256	.	512	1024	2048	4,096	8,192	16,384	32,768	65,536	
Binary values –	128	64	32	16	8	4	2	1	.	128	64	32	16	8	4	2	1	
165 . 100 .	0	0	0	0	0	0	0	0	.	0	0	0	0	0	0	0	0	

128 128
64 +64
32 192
16
8
4
2
+1
255

Add the binary value numbers to the left of the line to create the custom subnet mask.

64 Observe the total number of hosts.
−2 Subtract 2 for the number of usable hosts.
62

Custom Subnet Masks

Problem 3

/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.

Network Address **148.75.0.0 /26**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 1,024

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.

	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	. 256	128	64	32	16	8	4	2
Number of Hosts	–															
Number of Subnets	–	2	4	8	16	32	64	128	256.	512	1024	2048	4,096	8,192	16,384	32,768	65,536
Binary values	–	128	64	32	16	8	4	2	1 .	128	64	32	16	8	4	2	1
148 . 75 .	0	0	0	0	0	0	0	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.

128
64
32
16
8
4
2
+1
255

128
+64
192

64 Observe the total number of hosts.
−2 Subtract 2 for the number of usable hosts.
62

1024
−2
1,022

Subtract 2 for the total number of subnets to get the usable number of subnets.

Custom Subnet Masks

Problem 4

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 <u>Problem 5</u> in the space below.

		256	128	64	32	16	8	4	2	- Number of Hosts
Number of Subnets	-	2	4	8	16	32	64	128	256	
		128	64	32	16	8	4	2	1	- Binary values
195 . 85 . 8 .		0	0	0	0	0	0	0	0	

Custom Subnet Masks

Problem 5

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 <u>Problem 4</u> in the space below.

		256	128	64	32	16	8	4	2	– Number of Hosts
Number of Subnets	–	2	4	8	16	32	64	128	256	
		128	64	32	16	8	4	2	1	– Binary values
210 . 100 . 56 .		0	0	0	0	0	0	0	0	

Custom Subnet Masks

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 _____

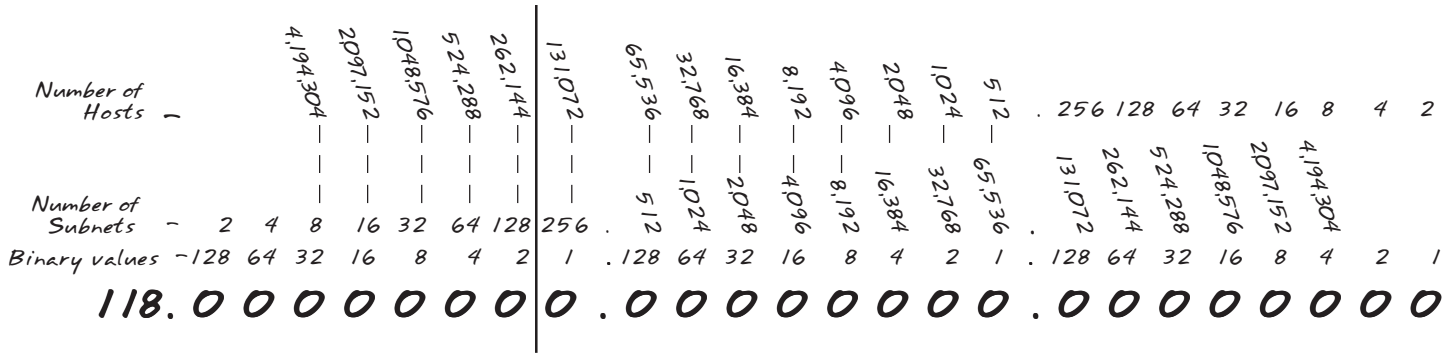
Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 6 in the space below.



Custom Subnet Masks

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 _____

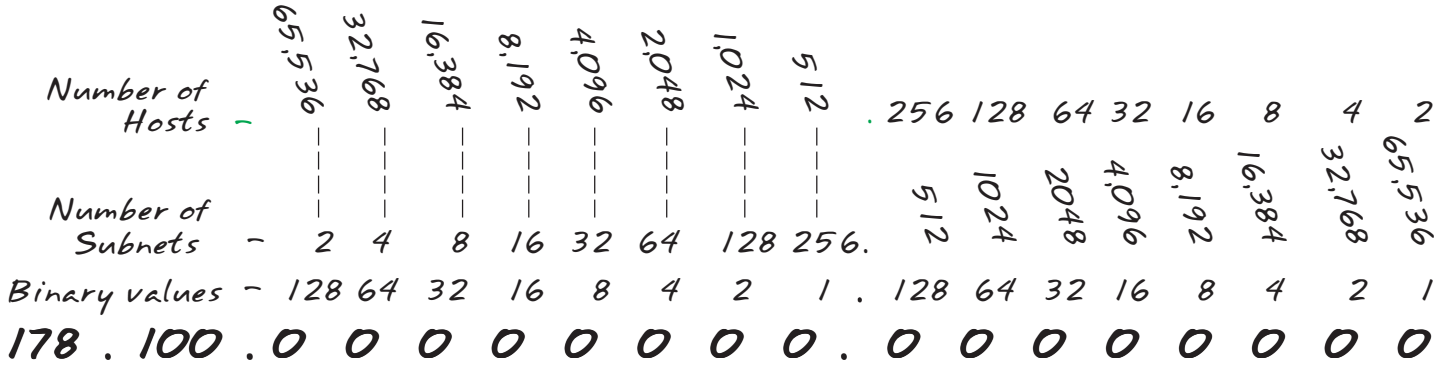
Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 7 in the space below.



Custom Subnet Masks

Problem 8

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

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 8 in the space below.

Custom Subnet Masks

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.

Custom Subnet Masks

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.

Custom Subnet Masks

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.

Custom Subnet Masks

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.

Custom Subnet Masks

Problem 13

Number of needed usable hosts **25**

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 13 in the space below.

Custom Subnet Masks

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.

Custom Subnet Masks

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.

Custom Subnet Masks

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**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 240

Total number of subnets 16

Total number of host addresses 16

Number of usable addresses 14

Number of bits borrowed 4

What is the 4th subnet range? 192.10.10.48 to 192.10.10.63

What is the subnet number for the 8th subnet? 192 . 10 . 10 . 112

What is the subnet broadcast address for the 13th subnet? 192 . 10 . 10 . 207

What are the assignable addresses for the 9th subnet? 192.10.10.129 to 192.10.10.142

Show your work for Problem 1 in the space below.

Number of Subnets		256	128	64	32	16	8	4	2	–	Number of Hosts
	–	2	4	8	16	32	64	128	256		
		128	64	32	16	8	4	2	1	–	Binary values
192.10.10.0		0	0	0	0	0	0	0	0		
(1)		0	0	0	0	192.10.10.0		to			192.10.10.15
(2)		0	0	0	1	192.10.10.16		to			192.10.10.31
(3)		0	0	1	0	192.10.10.32		to			192.10.10.47
(4)		0	0	1	1	192.10.10.48		to			192.10.10.63
(5)		0	1	0	0	192.10.10.64		to			192.10.10.79
(6)		0	1	0	1	192.10.10.80		to			192.10.10.95
(7)		0	1	1	0	192.10.10.96		to			192.10.10.111
(8)		0	1	1	1	192.10.10.112		to			192.10.10.127
(9)		1	0	0	0	192.10.10.128		to			192.10.10.143
(10)		1	0	0	1	192.10.10.144		to			192.10.10.159
(11)		1	0	1	0	192.10.10.160		to			192.10.10.175
(12)		1	0	1	1	192.10.10.176		to			192.10.10.191
(13)		1	1	0	0	192.10.10.192		to			192.10.10.207
(14)		1	1	0	1	192.10.10.208		to			192.10.10.223
(15)		1	1	1	0	192.10.10.224		to			192.10.10.239
(16)		1	1	1	1	192.10.10.240		to			192.10.10.255

Custom subnet mask

128
64
32
+16
240

Usable subnets

16
−2
14

Usable hosts

16
−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**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 1,024

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 10

What is the 15th subnet range? 165.100.3.128 to 165.100.3.191

What is the subnet number for the 6th subnet? 165 . 100 . 1 . 64

What is the subnet broadcast address for the 6th subnet? 165 . 100 . 1 . 127

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.

Number of Hosts	–	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	. 256	128	64	32	16	8	4	2
Number of Subnets	–	2	4	8	16	32	64	128	256.	512	1024	2048	4,096	8,192	16,384	32,768	65,536
Binary values	–	128	64	32	16	8	4	2	1 .	128	64	32	16	8	4	2	1
165 . 100 .		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0** .	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Usable hosts: 64 − 2 = 62

Custom subnet mask: 128 + 64 = 192

128 / 64 / 32 / 16 / 8 / 4 / 2 / +1 = 255

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.

(1)											0	165.100.0.0	to	165.100.0.63
(2)											1	165.100.0.64	to	165.100.0.127
(3)										1	0	165.100.0.128	to	165.100.0.191
(4)										1	1	165.100.0.192	to	165.100.0.255
(5)									1 .	0	0	165.100.1.0	to	165.100.1.63
(6)									1 .	0	1	165.100.1.64	to	165.100.1.127
(7)									1 .	1	0	165.100.1.128	to	165.100.1.191
(8)									1 .	1	1	165.100.1.192	to	165.100.1.255
(9)								1	0 .	0	0	165.100.2.0	to	165.100.2.63
(10)								1	0 .	0	1	165.100.2.64	to	165.100.2.127
(11)								1	0 .	1	0	165.100.2.128	to	165.100.2.191
(12)								1	0 .	1	1	165.100.2.192	to	165.100.2.255
(13)														
(14)								1	1 .	0	0	165.100.3.0	to	165.100.3.63
(15)								1	1 .	0	1	165.100.3.64	to	165.100.3.127
(16)								1	1 .	1	0	165.100.3.128	to	165.100.3.191
								1	1 .	1	1	165.100.3.192	to	165.100.3.255

Down to

(1023)	1	1	1	1	1	1	1	1 .	1	0	165.100.255.128	to	165.100.255.191
(1024)	1	1	1	1	1	1	1	1 .	1	1	165.100.255.192	to	165.100.255.255

Subnetting

Problem 3

Hint: It is possible to borrow one bit to create two subnets.

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 2nd subnet range? _____

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 1st subnet? _____

Show your work for <u>Problem 3</u> in the space below.

		256	128	64	32	16	8	4	2	- Number of 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	0	

Subnetting

Problem 4

Number of needed subnets **750**

Network Address **190.35.0.0**

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 _____

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.

Subnetting

Problem 5

Number of needed usable hosts **6**

Network Address **126.0.0.0**

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 _____

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.

Subnetting

Problem 6

Number of needed subnets **10**

Network Address **192.70.10.0**

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 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.

Subnetting

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.

Subnetting

Problem 8

Number of needed subnets **5**

Network Address **172.50.0.0**

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 _____

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.

Subnetting

Problem 9

Number of needed usable hosts **28**

Network Address **172.50.0.0**

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 _____

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.

Subnetting

Problem 10

Number of needed subnets **45**

Network Address **220.100.100.0**

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 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.

Subnetting

Problem 11

Number of needed usable hosts **8,000**
Network Address **135.70.0.0**

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 _____

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.

Subnetting

Problem 12

Number of needed usable hosts **45**

Network Address **198.125.50.0**

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 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.

Subnetting

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.

Subnetting

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 for the 5th 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 14 in the space below.

Subnetting

Problem 15

Network Address **93.0.0.0 \19**

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 15th subnet range? _____

What is the subnet number for the 9th subnet? _____

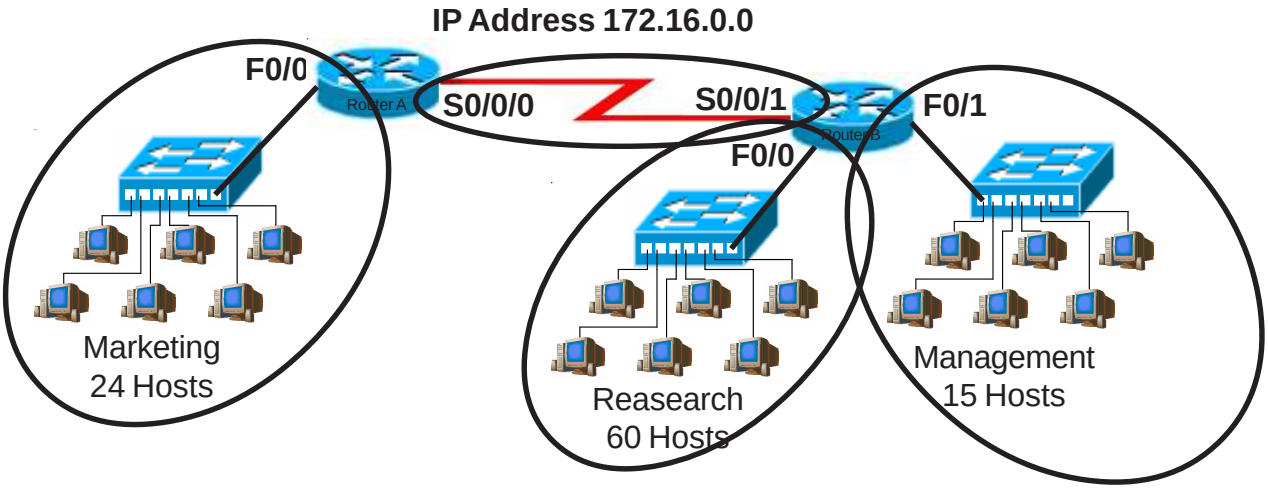
What is the subnet broadcast address for the 7th subnet? _____

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 **minimum number of subnets**, 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	B
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	172.16.0.0 to 172.31.255
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.

Number of Hosts – 65,536 32,768 16,384 8,192 4,096 2,048 1,024 512 . 256 128 64 32 16 8 4 2

Number of Subnets – 2 4 8 16 32 64 128 256 . 512 1024 2048 4,096 8,192 16,384 32,768 65,536

Binary values – 128 64 32 16 8 4 2 1 . 128 64 32 16 8 4 2 1

172 . 16 . 0 0 0 0 0 0 0 0 . 0 0 0 0 0 0 0 0

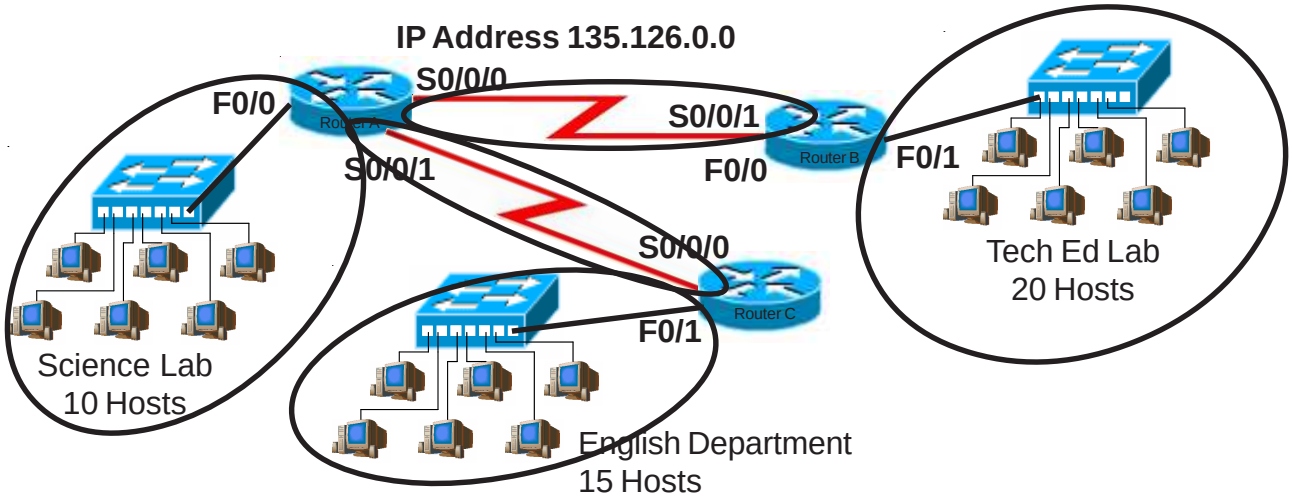
(1)			0	172.16.0.0	to	172.16.31.255
(2)			1	172.16.32.0	to	172.16.63.255
(3)		1	0	172.16.64.0	to	172.16.95.255
(4)		1	1	172.16.96.0	to	172.16.127.255
(5)	1	0	0	172.16.128.0	to	172.16.159.255
(6)	1	0	1	172.16.160.0	to	172.16.191.255
(7)	1	1	0	172.16.192.0	to	172.16.223.255
(8)	1	1	1	172.16.224.0	to	172.16.255.255

4
×1.0
4

60
×1.0
60

Practical Subnetting 2

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 30% growth in all areas. Circle each subnet on the graphic and answer the questions below.



Address class	B
Custom subnet mask	255.255.255.224
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 host addresses in the largest subnet group	20
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 Tech Ed	135.126.0.0 to 135.126.0.31
IP address range for English	135.126.0.32 to 135.126.0.63
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.

Number of Hosts –	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	. 256	128	64	32	16	8	4	2	
Number of Subnets –	2	4	8	16	32	64	128	256.	512	1024	2048	4,096	8,192	16,384	32,768	65,536	
Binary values –	128	64	32	16	8	4	2	1 .	128	64	32	16	8	4	2	1	
135. 126 .	0	0	0	0	0	0	0	0 .	0	0	0	0	0	0	0	0	

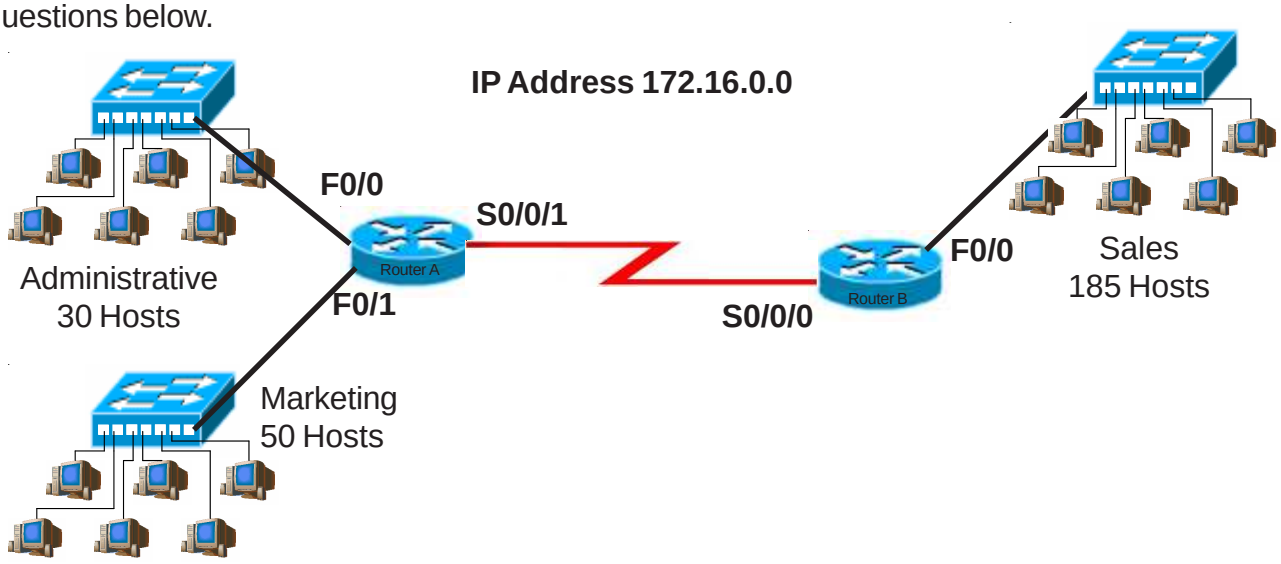
5
x.3
1.5
(Round up to 2)

20
x.3
6

	1	.	128	64	32			
(1)		.			0	135.126.0.0	to	135.126.0.31
(2)					1	135.126.0.32	to	135.126.0.63
(3)				1	0	135.126.0.64	to	135.126.0.95
(4)				1	1	135.126.0.96	to	135.126.0.127
(5)			1	0	0	135.126.0.128	to	135.126.0.159
(6)			1	0	1	135.126.0.160	to	135.126.0.191
(7)			1	1	0	135.126.0.192	to	135.126.0.223
(8)			1	1	1	135.126.0.224	to	135.126.0.255
(9)	1	.	0	0	0	135.126.1.0	to	135.126.1.31
(10)	1	.	0	0	1	135.126.1.32	to	135.126.1.63
(11)	1	.	0	1	0	135.126.1.64	to	135.126.1.95
(12)	1	.	0	1	1	135.126.1.96	to	135.126.1.127
(13)	1	.	1	0	0	135.126.1.128	to	135.126.1.159
(14)	1	.	1	0	1	135.126.1.160	to	135.126.1.191
(15)	1	.	1	1	0	135.126.1.192	to	135.126.1.223
(16)	1	.	1	1	1	135.1261.224	to	135.126.1.255

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.



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

Extra subnets required for 25% 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 25% 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 from the largest group to the smallest.

IP address range for Sales _____

IP address range for Marketing _____

IP address range for Administrative _____

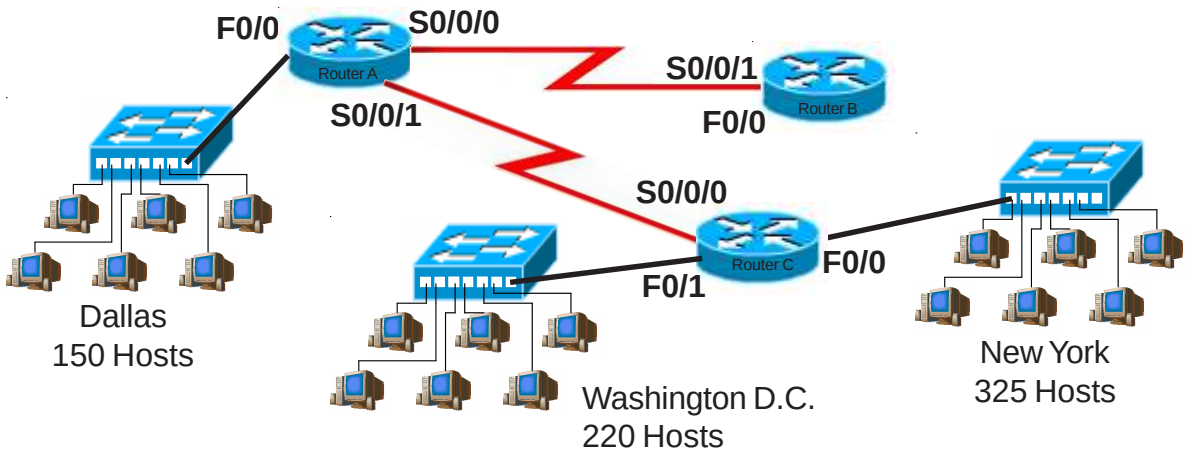
IP address range for Router A to Router B serial connection _____

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 **minimum number of subnets**, 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



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 = _____

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 = _____

Start with the first subnet and arrange your sub-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 _____

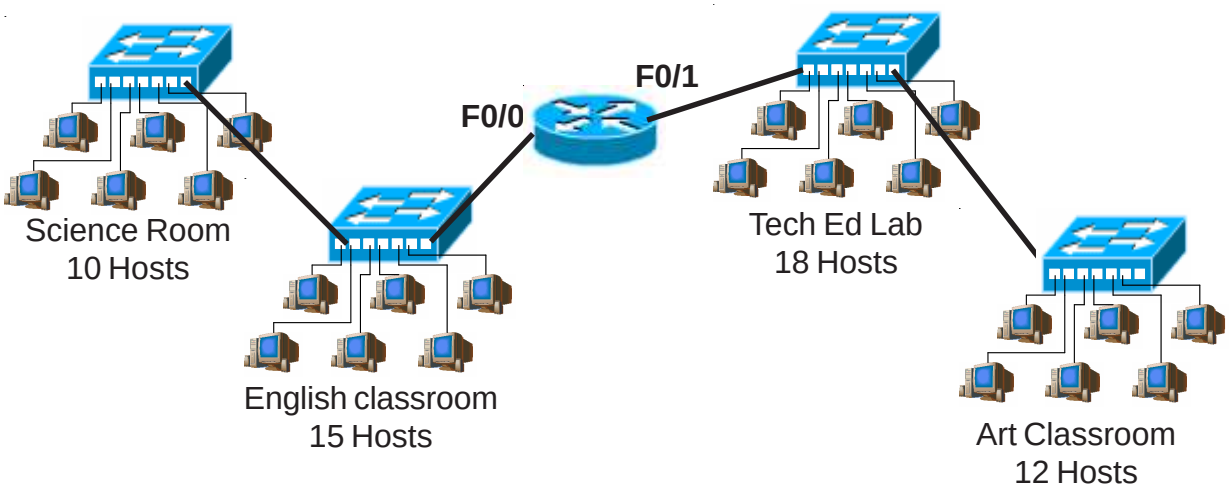
IP address range for Router A to Router C serial connection _____

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



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

Extra subnets required for 100% 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 100% 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 from the largest group to the smallest.

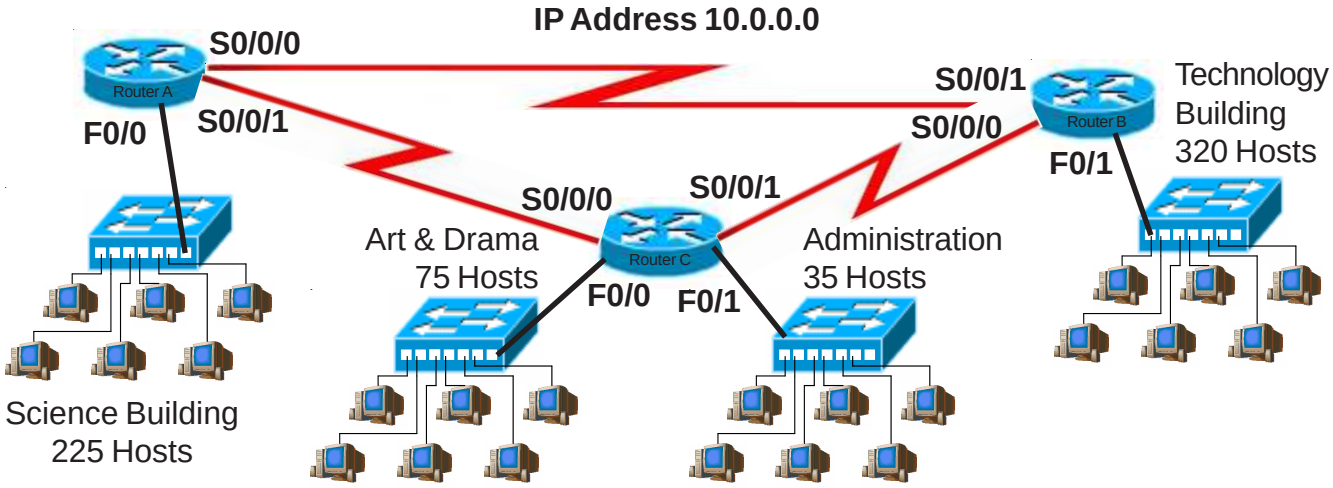
IP address range for Router F0/0 Port _____

IP address range for Router F0/1 Port _____

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 **minimum number of subnets**, and allow enough extra subnets and hosts for 20% growth in all areas. Circle each subnet on the graphic and answer the questions below.



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 sub-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 _____

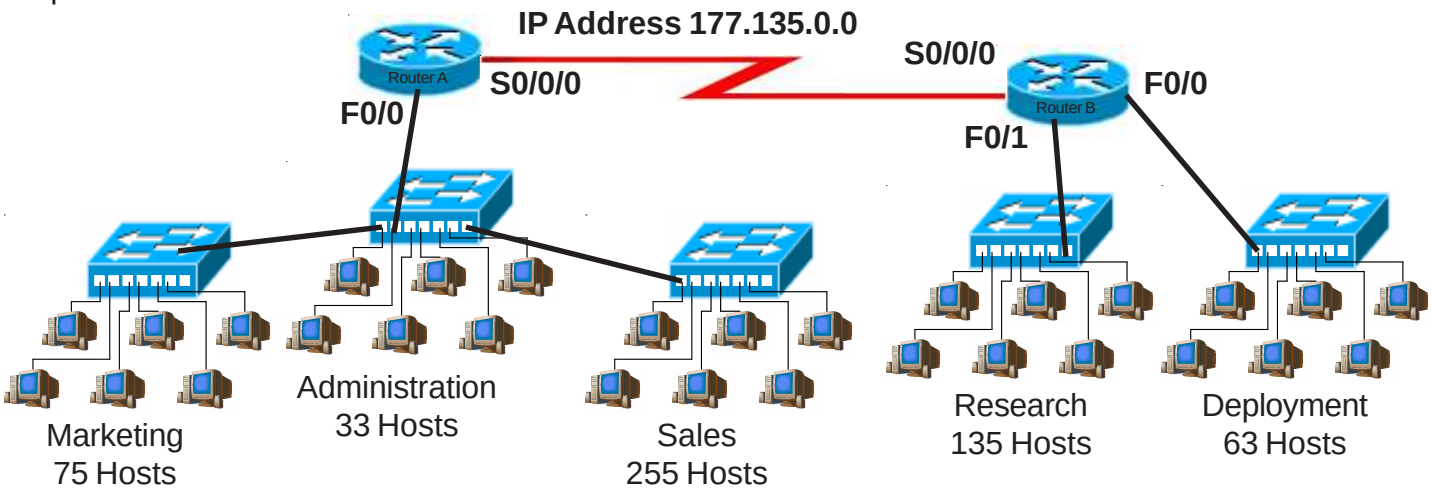
IP address range for Router A to Router C serial connection _____

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 subnet**, and allow enough extra subnets and hosts for 125% growth in all areas. Circle each subnet on the graphic and answer the questions below.



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 from the largest group to the smallest.

IP address range for Router A Port F0/0 _____

IP address range for Research _____

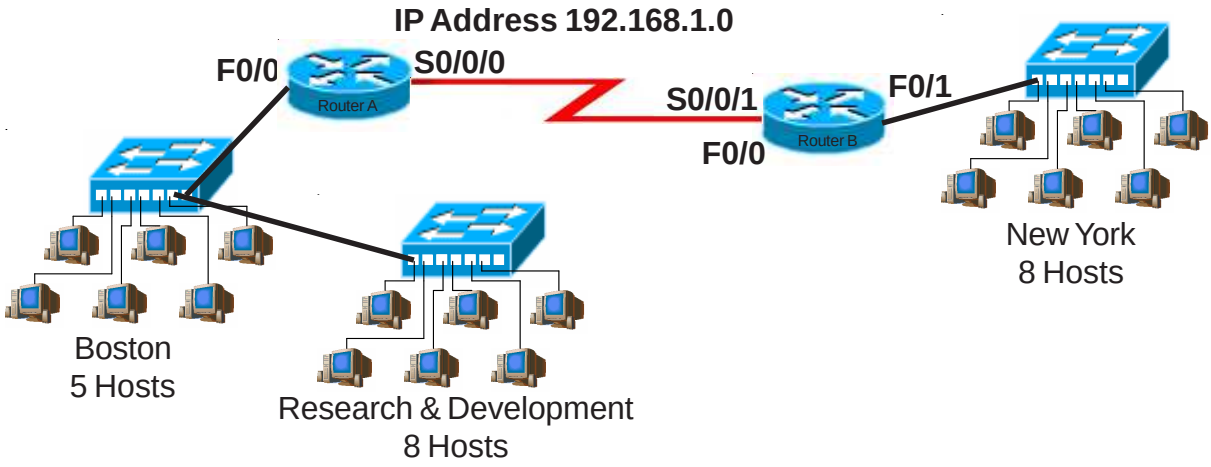
IP address range for Deployment _____

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 **minimum number subnets**, and allow enough extra subnets and hosts for 85% growth in all areas. Circle each subnet on the graphic and answer the questions below.



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

Extra subnets required for 85% 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 85% 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 from the largest group to the smallest.

IP address range for Router A F0/0 _____

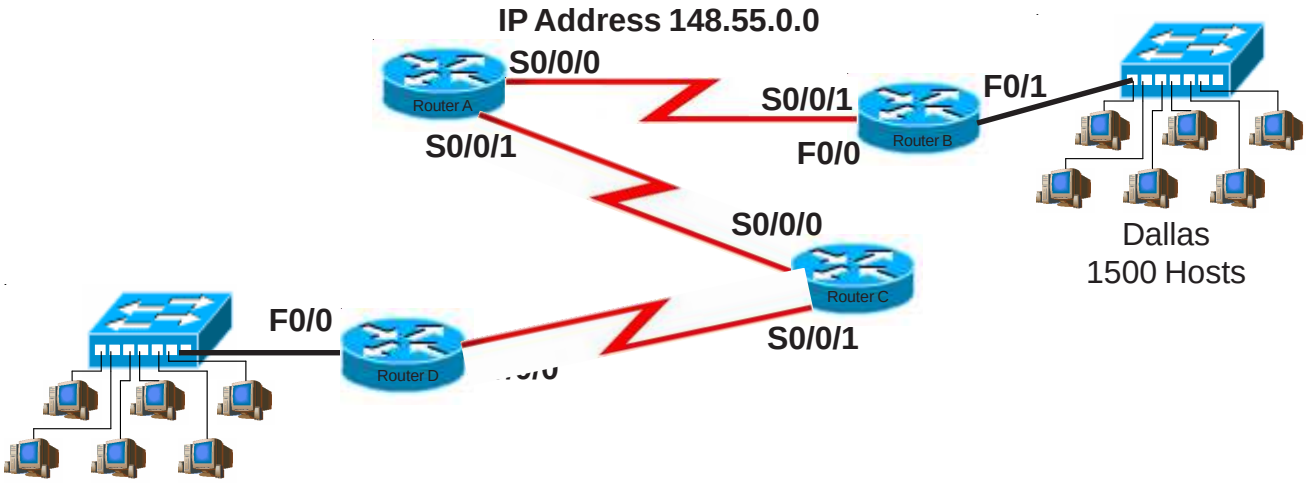
IP address range for New York _____

IP address range for Router A to Router B serial connection _____

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 below.



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

Extra subnets required for 15% 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 15% 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 from the largest group to the smallest.

IP address range for Ft. Worth _____

IP address range for Dallas _____

IP address range for Router A to Router B serial connection _____

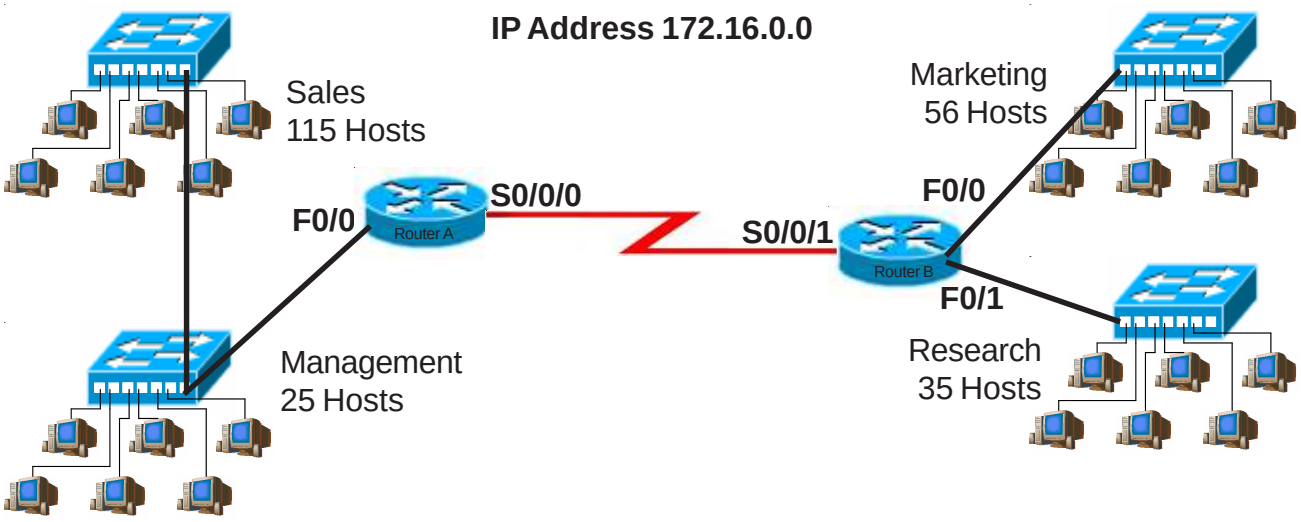
IP address range for Router A to Router C serial connection _____

IP address range for Router C to Router 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 **minimum number of subnets**, and allow enough extra subnets and hosts for 110% growth in all areas. Circle each subnet on the graphic and answer the questions below.



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

Extra subnets required for 110% 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 110% 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 from the largest group to the smallest.

IP address range for Sales/Managemnt _____

IP address range for Marketing _____

IP address range for Research _____

IP address range for Router A to Router B serial connection _____

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

OK

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
Reference Pages 30-31

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
Reference Pages 48-49

Reference Charts and Support Materials

Class A Addresses
VLSM Chart 8-15 Bits (2nd octet)

/8 255.0.0.0 16,777,216 Hosts	/9 255.128.0.0 8,388,608 Hosts	/10 255.192.0.0 4,194,304 Hosts	/11 255.224.0.0 2,097,152 Hosts	/12 255.240.0.0 1,048,576 Hosts	/13 255.248.0.0 524,288 Hosts	/14 255.252.0.0 262,144 Hosts	/15 255.254.0.0 131,072 Hosts
0 - 255	0-127	0-63	0-31	0-15	0-7	0-3	0-1
						4-7	2-3
					8-15	8-11	4-5
						12-15	6-7
				16-31	16-23	16-19	8-9
						20-23	10-11
					24-31	24-27	12-13
						28-31	14-15
			32-63	32-47	32-39	32-35	16-17
						36-39	18-19
					40-47	40-43	20-21
						44-47	22-23
				48-63	48-55	48-51	24-25
						52-55	26-27
					56-63	56-59	28-29
						60-63	30-31
		64-127	64-95	64-79	64-71	64-67	32-33
						68-71	34-35
					72-79	72-75	36-37
						76-79	38-39
				80-95	80-87	80-83	40-41
						84-87	42-43
					88-95	88-91	44-45
						92-95	46-47
			96-127	96-111	96-103	96-99	48-49
						100-103	50-51
					104-111	104-107	52-53
						108-111	54-55
				112-127	112-119	112-115	56-57
						116-119	58-59
					120-127	120-123	60-61
						124-127	62-63
	128-255	128-191	128-159	128-143	128-135	128-131	64-65
						132-135	66-67
					136-143	136-139	68-69
						140-143	70-71
			144-159	144-151	144-147	72-73
						148-151	74-75
				152-159	152-155	76-77
						156-159	78-79
			160-191	160-175	160-167	80-81
						164-167	82-83
				168-175	168-171	84-85
						172-175	86-87
				176-191	176-183	176-179	88-89
						180-183	90-91
					184-191	184-187	92-93
						188-191	94-95
		192-255	192-223	192-207	192-199	192-195	96-97
						196-199	98-99
					200-207	200-203	100-101
						204-207	102-103
				208-223	208-215	208-211	104-105
						212-215	106-107
					216-223	216-219	108-109
						220-223	110-111
			224-255	224-239	224-231	224-227	112-113
						228-231	114-115
					232-239	232-235	116-117
						236-239	118-119
				240-255	240-247	240-243	120-121
						244-247	122-123
					248-255	248-251	124-125
						252-255	126-127

Class B Addresses
VLSM Chart 16-23 Bits (3rd octet)

/16 255.255.0.0 65,536 Hosts	/17 255.255.128.0 32,768 Hosts	/18 255.255.192.0 16,384 Hosts	/19 255.255.224.0 8,192 Hosts	/20 255.255.240.0 4,096 Hosts	/21 255.255.248.0 2,048 Hosts	/22 255.255.252.0 1,024 Hosts	/23 255.255.254.0 512 Hosts
0 - 255	0-127	0-63	0-31	0-15	0-7	0-3	0-1
							2-3
					8-15	8-11	4-5
						12-15	6-7
				16-31	16-23	16-19	8-9
						20-23	10-11
					24-31	24-27	12-13
						28-31	14-15
			32-63	32-47	32-39	32-35	16-17
						36-39	18-19
					40-47	40-43	20-21
						44-47	22-23
				48-63	48-55	48-51	24-25
						52-55	26-27
					56-63	56-59	28-29
						60-63	30-31
		64-127	64-95	64-79	64-71	64-67	32-33
						68-71	34-35
					72-79	72-75	36-37
						76-79	38-39
				80-95	80-87	80-83	40-41
						84-87	42-43
					88-95	88-91	44-45
						92-95	46-47
			96-127	96-111	96-103	96-99	48-49
						100-103	50-51
					104-111	104-107	52-53
						108-111	54-55
				112-127	112-119	112-115	56-57
						116-119	58-59
					120-127	120-123	60-61
						124-127	62-63
	128-255	128-191	128-159	128-143	128-135	128-131	64-65
						132-135	66-67
					136-143	136-139	68-69
						140-143	70-71
				144-159	144-151	144-147	72-73
						148-151	74-75
				152-159	152-155	76-77
						156-159	78-79
			160-191	160-175	160-167	80-81
						164-167	82-83
				168-175	168-171	84-85
						172-175	86-87
				176-191	176-183	176-179	88-89
						180-183	90-91
					184-191	184-187	92-93
						188-191	94-95
		192-255	192-223	192-207	192-199	192-195	96-97
						196-199	98-99
					200-207	200-203	100-101
						204-207	102-103
				208-223	208-215	208-211	104-105
						212-215	106-107
					216-223	216-219	108-109
						220-223	110-111
			224-255	224-239	224-231	224-227	112-113
						228-231	114-115
					232-239	232-235	116-117
						236-239	118-119
				240-255	240-247	240-243	120-121
						244-247	122-123
					248-255	248-251	124-125
						252-255	126-127

Class C Addresses
VLSM Chart 24-30 Bits (4th octet)

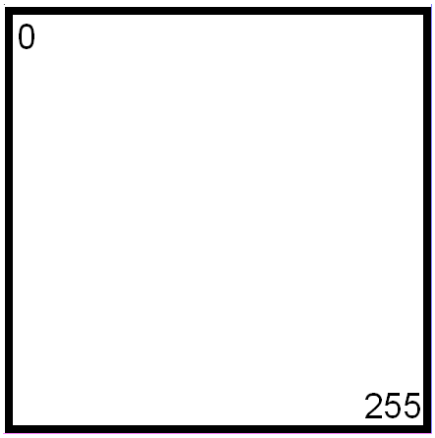
/24 255.255.255.0 256 Hosts	/25 255.255.255.128 128 Hosts	/26 255.255.255.192 64 Hosts	/27 255.255.255.224 32 Hosts	/28 255.255.255.240 16 Hosts	/29 255.255.255.248 8 Hosts	/30 255.255.255.252 4 Hosts
0 - 255	0-127	0-63	0-31	0-15	0-7	0-1
						2-3
					8-15	4-5
						6-7
				16-31	16-23	8-9
						10-11
					24-31	12-13
						14-15
			32-63	32-47	32-39	16-17
						18-19
					40-47	20-21
						22-23
				48-63	48-55	24-25
						26-27
					56-63	28-29
						30-31
		64-127	64-95	64-79	64-71	32-33
						34-35
					72-79	36-37
						38-39
				80-95	80-87	40-41
						42-43
					88-95	44-45
						46-47
			96-127	96-111	96-103	48-49
						50-51
					104-111	52-53
						54-55
				112-127	112-119	56-57
						58-59
					120-127	60-61
						62-63
	128-255	128-191	128-159	128-143	128-135	64-65
						66-67
					136-143	68-69
						70-71
				144-159	144-151	72-73
						74-75
				152-159	152-159	76-77
						78-79
			160-191	160-175	160-167	80-81
						82-83
				168-175	168-175	84-85
						86-87
				176-191	176-183	88-89
						90-91
					184-191	92-93
						94-95
		192-255	192-223	192-207	192-199	96-97
						98-99
					200-207	100-101
						102-103
				208-223	208-215	104-105
						106-107
					216-223	108-109
						110-111
			224-255	224-239	224-231	112-113
						114-115
					232-239	116-117
						118-119
				240-255	240-247	120-121
						122-123
					248-255	124-125
						126-127

Visualizing Subnets Using The Box Method

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

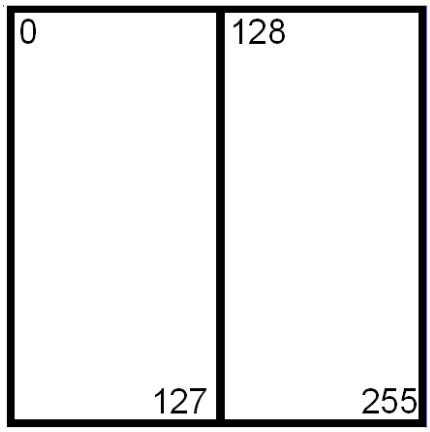
Start with a square. The whole square is a single subnet comprised of 256 addresses.

/24
255.255.255.0
256 Hosts
1 Subnet



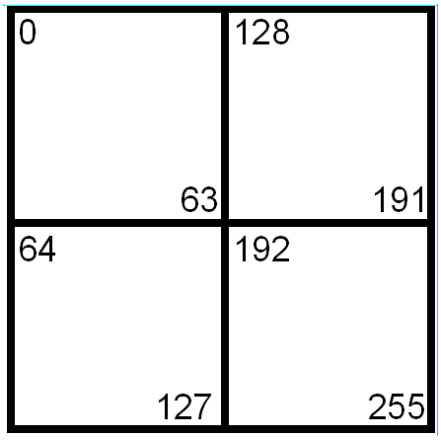
Split the box in half and you get two subnets with 128 addresses,

/25
255.255.255.128
128 Hosts
2 Subnets



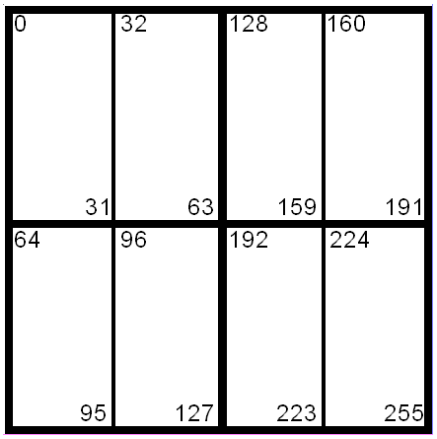
Divide the box into quarters and you get four subnets with 64 addresses,

/26
255.255.255.192
64 Hosts
4 Subnets



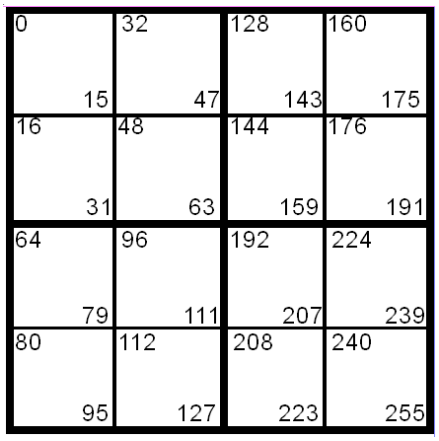
Split each individual square and you get eight subnets with 32 addresses,

/27
255.255.255.224
32 Hosts
8 Subnets



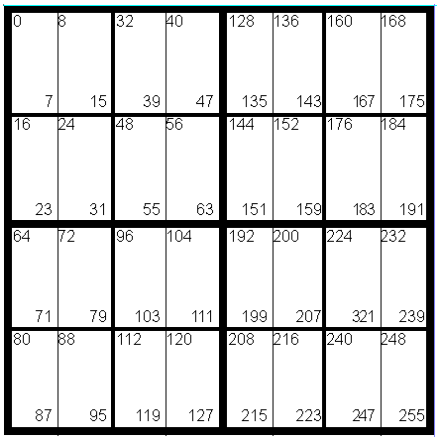
Split the boxes in half again and you get sixteen subnets with sixteen addresses,

/28
255.255.255.240
16 Hosts
16 Subnets



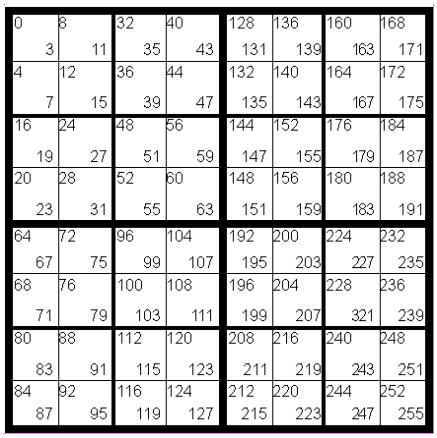
The next split gives you thirty two subnets with eight addresses,

/29
255.255.255.248
8 Hosts
32 Subnets



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

/30
255.255.255.252
4 Hosts
64 Subnets

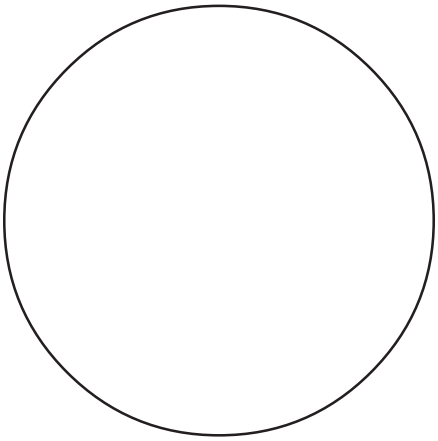


Visualizing Subnets Using The Circle Method

The circle method is another method used to visualize the breakdown of subnets and addresses into smaller sizes. By shading or coloring in the different sections of the circle you can easily break up your subnets without overlapping your addresses. You adjust each subnet to the correct size needed.

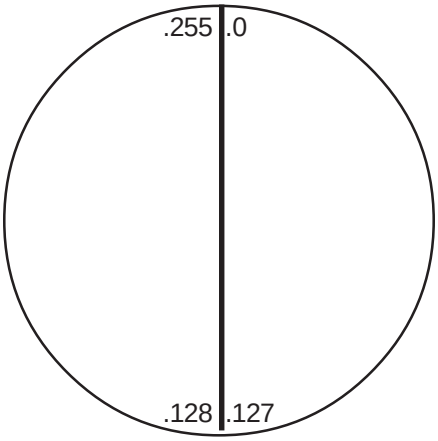
Start with a circle. The whole circle is a single subnet comprised of 256 addresses.

/24
255.255.255.0
256 Hosts
1 Subnet



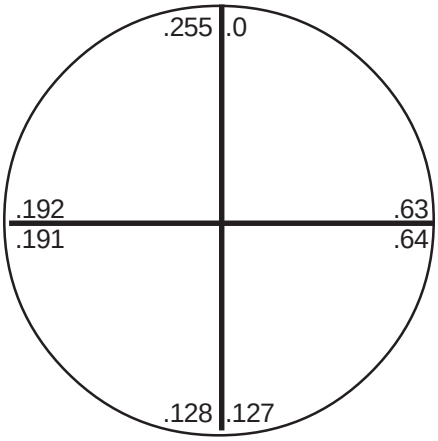
Split the circle in half and you get two subnets with 128 addresses.

/25
255.255.255.128
128 Hosts
2 Subnets

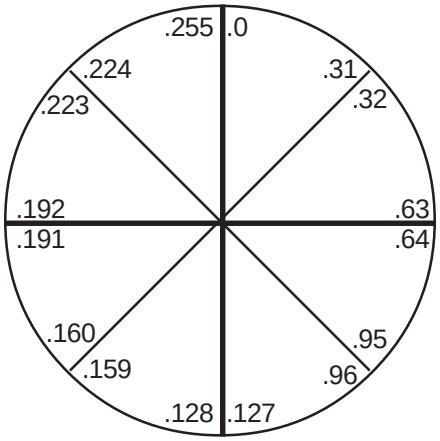


Divide the circle into quarters and you get four subnets with 64 addresses.

/26
255.255.255.192
64 Hosts
4 Subnets

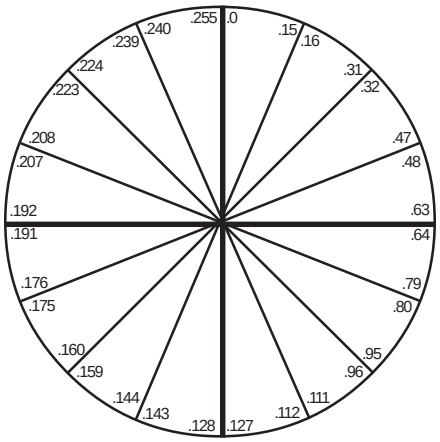


Split each quarter and you get eight subnets with 32 addresses.



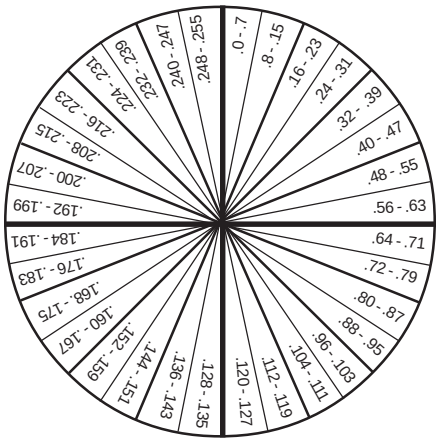
/27
255.255.255.224
32 Hosts
8 Subnets

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



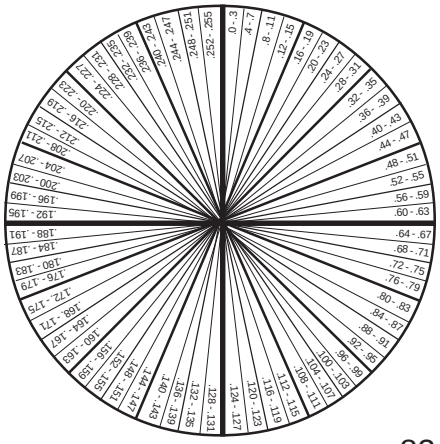
/28
255.255.255.240
16 Hosts
16 Subnets

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



/29
255.255.255.248
8 Hosts
32 Subnets

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



/30
255.255.255.252
4 Hosts
64 Subnets

Class A Addresses

VLSM Chart 8-15 Bits (2nd octet)

/8 255.0.0.0 16,777,216 Hosts	/9 255.128.0.0 8,388.608 Hosts	/10 255.192.0.0 4,194,304 Hosts	/11 255.224.0.0 2,097,152 Hosts	/12 255.240.0.0 1,048,576 Hosts	/13 255.248.0.0 524,288 Hosts	/14 255.252.0.0 262,144 Hosts	/15 255.254.0.0 131,072 Hosts
0 - 255	0-127	0-63	0-31	0-15	0-7	0-3	0 - 1 2 - 3
						4-7	4 - 5 6 - 7
					8-15	8-11	8 - 9 10 - 11
						12-15	12 - 13 14 - 15
				16-31	16-23	16-19	16 - 17 18 - 19
						20-23	20 - 21 22 - 23
					24-31	24-27	24 - 25 26 - 27
						28-31	28 - 29 30 - 31
			32-63	32-47	32-39	32-35	32 - 33 34 - 35
						36-39	36 - 37 38 - 39
					40-47	40-43	40 - 41 42 - 43
						44-47	44 - 45 46 - 47
				48-63	48-55	48-51	48 - 49 50 - 51
						52-55	52 - 53 54 - 55
					56-63	56-59	56 - 57 58 - 59
						60-63	60 - 61 62 - 63
		64-127	64-95	64-79	64-71	64-67	64 - 65 66 - 67
						68-71	68 - 69 70 - 71
					72-79	72-75	72 - 73 74 - 75
						76-79	76 - 77 78 - 79
				80-95	80-87	80-83	80 - 81 82 - 83
						84-87	84 - 85 86 - 87
					88-95	88-91	88 - 89 90 - 91
						92-95	92 - 93 94 - 95
			96-127	96-111	96-103	96-99	96 - 97 98 - 99
						100-103	100 - 101 102 - 103
					104-111	104-107	104 - 105 106 - 107
						108-111	108 - 109 110 - 111
				112-127	112-119	112-115	112 - 113 114 - 115
						116-119	116 - 117 118 - 119
					120-127	120-123	120 - 121 122 - 123
						124-127	124 - 125 126 - 127
	128-255	128-191	128-159	128-143	128-135	128-131	128 - 129 130 - 131
						132-135	132 - 133 134 - 135
					136-143	136-139	136 - 137 138 - 139
						140-143	140 - 141 142 - 143
				144-159	144-151	144-147	144 - 145 146 - 147
						148-151	148 - 149 150 - 151
					152-159	152-155	152 - 153 154 - 155
						156-159	156 - 157 158 - 159
			160-191	160-175	160-167	160-163	160 - 161 162 - 163
						164-167	164 - 165 166 - 167
					168-175	168-171	168 - 169 170 - 171
						172-175	172 - 173 174 - 175
				176-191	176-183	176-179	176 - 177 178 - 179
						180-183	180 - 181 182 - 183
					184-191	184-187	184 - 185 186 - 187
						188-191	188 - 189 190 - 191
		192-255	192-223	192-207	192-199	192-195	192 - 193 194 - 195
						196-199	196 - 197 198 - 199
					200-207	200-203	200 - 201 202 - 203
						204-207	204 - 205 206 - 207
				208-223	208-215	208-211	208 - 209 210 - 211
						212-215	212 - 213 214 - 215
					216-223	216-219	216 - 217 218 - 219
						220-223	220 - 221 222 - 223
			224-255	224-239	224-231	224-227	224 - 225 226 - 227
						228-231	228 - 229 230 - 231
					232-239	232-235	232 - 233 234 - 235
						236-239	236 - 237 238 - 239
				240-255	240-247	240-243	240 - 241 242 - 243
						244-247	244 - 245 246 - 247
					248-255	248-251	248 - 249 250 - 251
						252-255	252 - 253 254 - 255

Class B Addresses

VLSM Chart 16-23 Bits (3rd octet)

/16 255.255.0.0 65,536 Hosts	/17 255.255.128.0 32,768 Hosts	/18 255.255.192.0 16,384 Hosts	/19 255.255.224.0 8,192 Hosts	/20 255.255.240.0 4,096 Hosts	/21 255.255.248.0 2,048 Hosts	/22 255.255.252.0 1,024 Hosts	/23 255.255.254.0 512 Hosts
0 - 255	0-127	0-63	0-31	0-15	0-7	0-3	0 - 1
							2 - 3
						4-7	4 - 5
							6 - 7
					8-15	8-11	8 - 9
							10 - 11
						12-15	12 - 13
							14 - 15
				16-31	16-23	16-19	16 - 17
							18 - 19
						20-23	20 - 21
							22 - 23
					24-31	24-27	24 - 25
							26 - 27
						28-31	28 - 29
							30 - 31
			32-63	32-47	32-39	32-35	32 - 33
							34 - 35
						36-39	36 - 37
							38 - 39
					40-47	40-43	40 - 41
							42 - 43
						44-47	44 - 45
							46 - 47
				48-63	48-55	48-51	48 - 49
							50 - 51
						52-55	52 - 53
							54 - 55
					56-63	56-59	56 - 57
							58 - 59
						60-63	60 - 61
							62 - 63
		64-127	64-95	64-79	64-71	64-67	64 - 65
							66 - 67
						68-71	68 - 69
							70 - 71
					72-79	72-75	72 - 73
							74 - 75
						76-79	76 - 77
							78 - 79
				80-95	80-87	80-83	80 - 81
							82 - 83
						84-87	84 - 85
							86 - 87
					88-95	88-91	88 - 89
							90 - 91
						92-95	92 - 93
							94 - 95
			96-127	96-111	96-103	96-99	96 - 97
							98 - 99
						100-103	100 - 101
							102 - 103
					104-111	104-107	104 - 105
							106 - 107
						108-111	108 - 109
							110 - 111
				112-127	112-119	112-115	112 - 113
							114 - 115
						116-119	116 - 117
							118 - 119
					120-127	120-123	120 - 121
							122 - 123
						124-127	124 - 125
							126 - 127
	128-255	128-191	128-159	128-143	128-135	128-131	128 - 129
							130 - 131
						132-135	132 - 133
							134 - 135
					136-143	136-139	136 - 137
							138 - 139
						140-143	140 - 141
							142 - 143
				144-159	144-151	144-147	144 - 145
							146 - 147
						148-151	148 - 149
							150 - 151
					152-159	152-155	152 - 153
							154 - 155
						156-159	156 - 157
							158 - 159
			160-191	160-175	160-167	160-163	160 - 161
							162 - 163
						164-167	164 - 165
							166 - 167
					168-175	168-171	168 - 169
							170 - 171
						172-175	172 - 173
							174 - 175
				176-191	176-183	176-179	176 - 177
							178 - 179
						180-183	180 - 181
							182 - 183
					184-191	184-187	184 - 185
							186 - 187
						188-191	188 - 189
							190 - 191
		192-255	192-223	192-207	192-199	192-195	192 - 193
							194 - 195
						196-199	196 - 197
							198 - 199
					200-207	200-203	200 - 201
							202 - 203
						204-207	204 - 205
							206 - 207
				208-223	208-215	208-211	208 - 209
							210 - 211
						212-215	212 - 213
							214 - 215
					216-223	216-219	216 - 217
							218 - 219
						220-223	220 - 221
							222 - 223
			224-255	224-239	224-231	224-227	224 - 225
							226 - 227
						228-231	228 - 229
							230 - 231
					232-239	232-235	232 - 233
							234 - 235
						236-239	236 - 237
							238 - 239
				240-255	240-247	240-243	240 - 241
							242 - 243
						244-247	244 - 245
							246 - 247
					248-255	248-251	248 - 249
							250 - 251
						252-255	252 - 253
							254 - 255

Class C Addresses

VLSM Chart 24-30 Bits (4th octet)

/24 255.255.255.0 256 Hosts	/25 255.255.255.128 128 Hosts	/26 255.255.255.192 64 Hosts	/27 255.255.255.224 32 Hosts	/28 255.255.255.240 16 Hosts	/29 255.255.255.248 8 Hosts	/30 255.255.255.252 4 Hosts
0 - 255	0-127	0-63	0-31	0-15	0-7	0-3
						4-7
					8-15	8-11
						12-15
				16-31	16-23	16-19
						20-23
					24-31	24-27
						28-31
			32-63	32-47	32-39	32-35
						36-39
					40-47	40-43
						44-47
				48-63	48-55	48-51
						52-55
					56-63	56-59
						60-63
		64-127	64-95	64-79	64-71	64-67
						68-71
					72-79	72-75
						76-79
				80-95	80-87	80-83
						84-87
					88-95	88-91
						92-95
			96-127	96-111	96-103	96-99
						100-103
					104-111	104-107
						108-111
				112-127	112-119	112-115
						116-119
					120-127	120-123
						124-127
	128-255	128-191	128-159	128-143	128-135	128-131
						132-135
					136-143	136-139
						140-143
				144-159	144-151	144-147
						148-151
					152-159	152-155
						156-159
			160-191	160-175	160-167	160-163
						164-167
					168-175	168-171
						172-175
				176-191	176-183	176-179
						180-183
					184-191	184-187
						188-191
		192-255	192-223	192-207	192-199	192-195
						196-199
					200-207	200-203
						204-207
				208-223	208-215	208-211
						212-215
					216-223	216-219
						220-223
			224-255	224-239	224-231	224-227
						228-231
					232-239	232-235
						236-239
				240-255	240-247	240-243
						244-247
					248-255	248-251
						252-255

Class A Addressing Guide

CIDR	# of Bits Borrowed	Subnet Mask	Total # of Subnets	Total # of Hosts	Usable # of 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

CIDR	# of Bits Borrowed	Subnet Mask	Total # of Subnets	Total # of Hosts	Usable # of 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