

**IP Addressing
and
Subnetting**
Workbook
Version 1.5

11111110

10010101

00011011

10000110

11010011

Student Name:

IP Address Classes

Class A	1 – 127	(Network 127 is reserved for loopback and internal testing)	
	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)	

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 16 32
0	1	1	1	0	1	1	1	119	2 146 4
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		
								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	Scratch Area	
1	1	1	0	1	1	1	0	238	238	34
									-128	-32
0	0	1	0	0	0	1	0	34	110	2
									-64	-2
								123	46	0
									-32	
								50	14	
									-8	
								255	6	
									-4	
								200	2	
									-2	
								10	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	<u>A</u>
150.10.15.0	<u>B</u>
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

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 your 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 . 0 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)

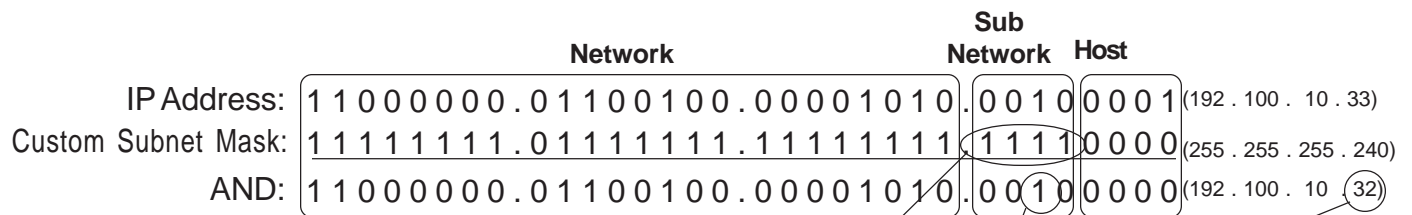
ANDING with the default subnet mask allows your computer to figure out the network portion of the address.

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



Four bits borrowed from the host portion of the address for the custom subnet mask.

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 = $2^s - 2$**)

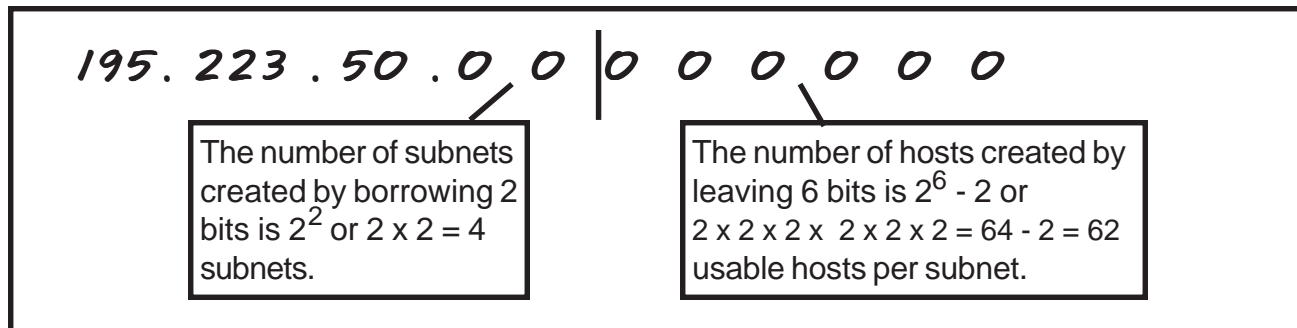
Number of hosts per subnet = $2^h - 2$

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 2^3 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 2^5 or $2 \times 2 \times 2 \times 2 \times 2 = 32$ 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.

Class C Address unsubnetted:

195. 223 . 50 . 0

195.223.50.0 to 195.223.50.255

Notice that the subnet and broadcast addresses match.

Class C Address subnetted (2 bits borrowed):

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

- (Invalid range) (0) 195.223.50.0 to 195.223.50.63
- (1) 195.223.50.64 to 195.223.50.127
- (2) 195.223.50.128 to 195.223.50.191
- (Invalid range) (3) 195.223.50.192 to 195.223.50.255

The primary reason the 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 whether 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 no ip subnet zero command is configured on your router	The ip subnet zero 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^s formula.

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	1	-	<i>Number of Hosts</i>
<i>Number of Subnets</i>	-	2	4	8	16	32	64	128	256		
	128	64	32	16	8	4	2	1	-	<i>Binary values</i>	
192 . 10 . 10 . 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	
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.

	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	4096	8192	16384	32768	65536
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
			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 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.

	256	128	64	32	16	8	4	2	1	-	<i>Number of Hosts</i>
<i>Number of Subnets</i>	-	2	4	8	16	32	64	128	256		
	128	64	32	16	8	4	2	1	-		<i>Binary values</i>
210 . 100 . 56 .	0	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 **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.

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

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.

		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	4096	8192	16384	32768	65536
Binary values	-	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
		178	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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.

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

$$\begin{array}{r}
 128 \\
 64 \\
 32 \\
 +16 \\
 \hline
 \text{Custom subnet mask } 240
 \end{array}$$

$$\begin{array}{r}
 16 \\
 -2 \\
 \hline
 \text{Usable subnets } 14
 \end{array}$$

$$\begin{array}{r}
 16 \\
 -2 \\
 \hline
 \text{Usable hosts } 14
 \end{array}$$

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*

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
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 3rd
subnet? _____

Show your work for Problem 3 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
<hr/>										
195.	223	.	50	.	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? _____

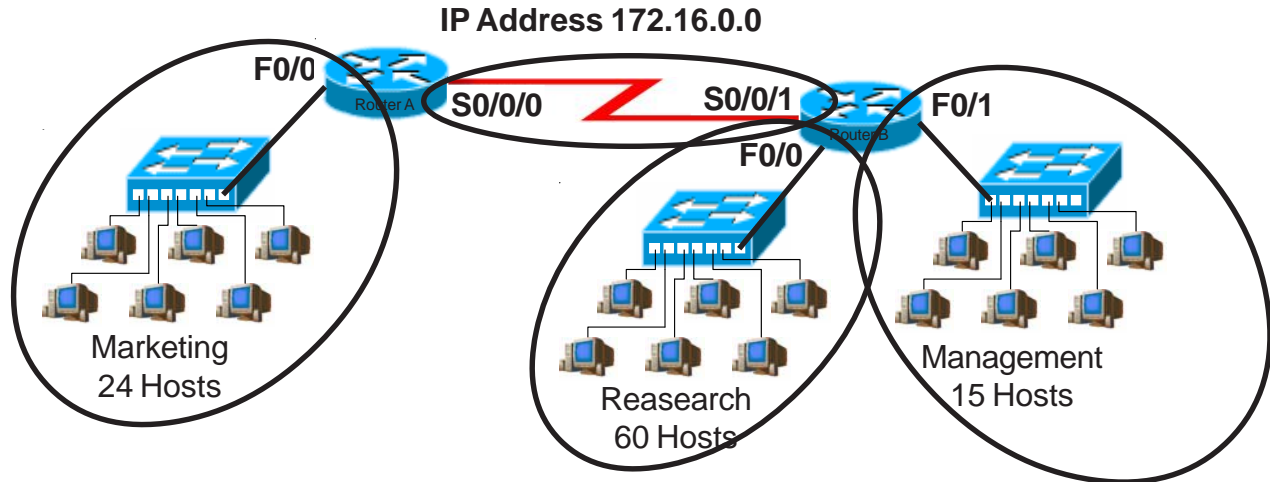
What is the subnet
broadcast address for
the 7th subnet? _____

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.



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

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

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

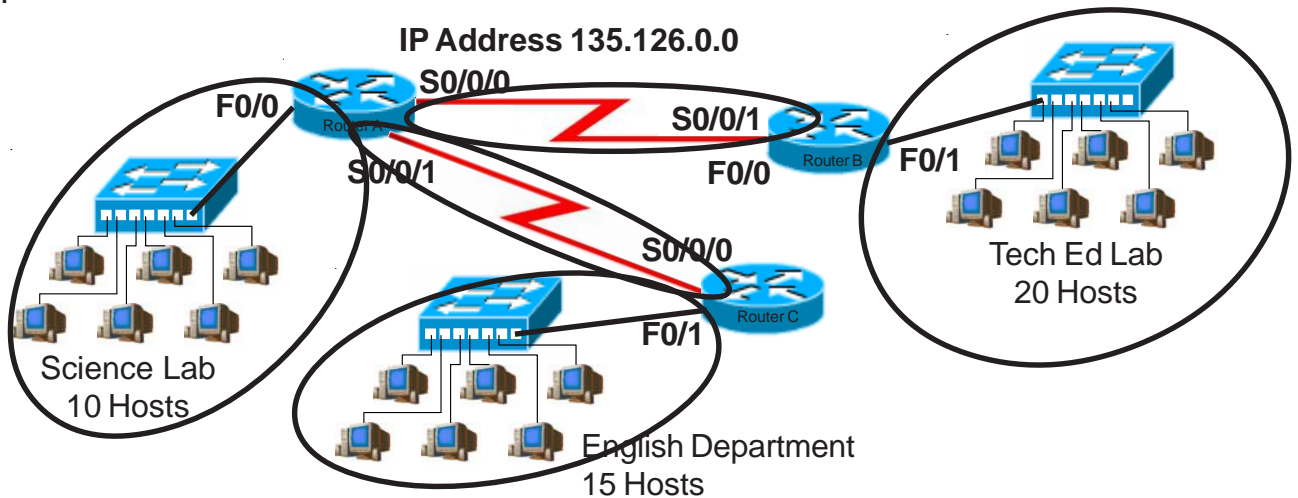
<p>Number of Hosts -</p> <p>Number of Subnets -</p> <p>Binary values -</p>	<p>128 64 32 16 8 4 2</p> <p>128 64 32 16 8 4 2</p> <p>128 64 32 16 8 4 2</p>	<p>172.16.0.0</p>	<p>0</p>
<p>65,536</p> <p>32,768</p> <p>16,384</p> <p>8,192</p> <p>4,096</p> <p>2,048</p> <p>1,024</p> <p>512</p>	<p>2</p> <p>4</p> <p>8</p> <p>16</p> <p>32</p> <p>64</p> <p>128</p> <p>256</p>	<p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p>	<p>(0)</p> <p>(1)</p> <p>(2)</p> <p>(3)</p> <p>(4)</p> <p>(5)</p> <p>(6)</p> <p>(7)</p>
<p>172.16.0.0</p>	<p>172.16.0.0</p>	<p>172.16.0.0</p>	<p>0</p>
<p>172.16.32.0</p>	<p>172.16.32.0</p>	<p>172.16.32.0</p>	<p>1</p>
<p>172.16.64.0</p>	<p>172.16.64.0</p>	<p>172.16.64.0</p>	<p>0</p>
<p>172.16.96.0</p>	<p>172.16.96.0</p>	<p>172.16.96.0</p>	<p>1</p>
<p>172.16.128.0</p>	<p>172.16.128.0</p>	<p>172.16.128.0</p>	<p>0</p>
<p>172.16.160.0</p>	<p>172.16.160.0</p>	<p>172.16.160.0</p>	<p>1</p>
<p>172.16.192.0</p>	<p>172.16.192.0</p>	<p>172.16.192.0</p>	<p>0</p>
<p>172.16.224.0</p>	<p>172.16.224.0</p>	<p>172.16.224.0</p>	<p>1</p>
<p>172.16.255.255</p>	<p>172.16.255.255</p>	<p>172.16.255.255</p>	<p>1</p>

$$\begin{array}{r} 4 \\ \times 1.0 \\ \hline 4 \end{array}$$

$$\begin{array}{r} 60 \\ \times 1.0 \\ \hline 60 \end{array}$$

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 + 2
(Round up to the next whole number)

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 + 6
(Round up to the next whole number)

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

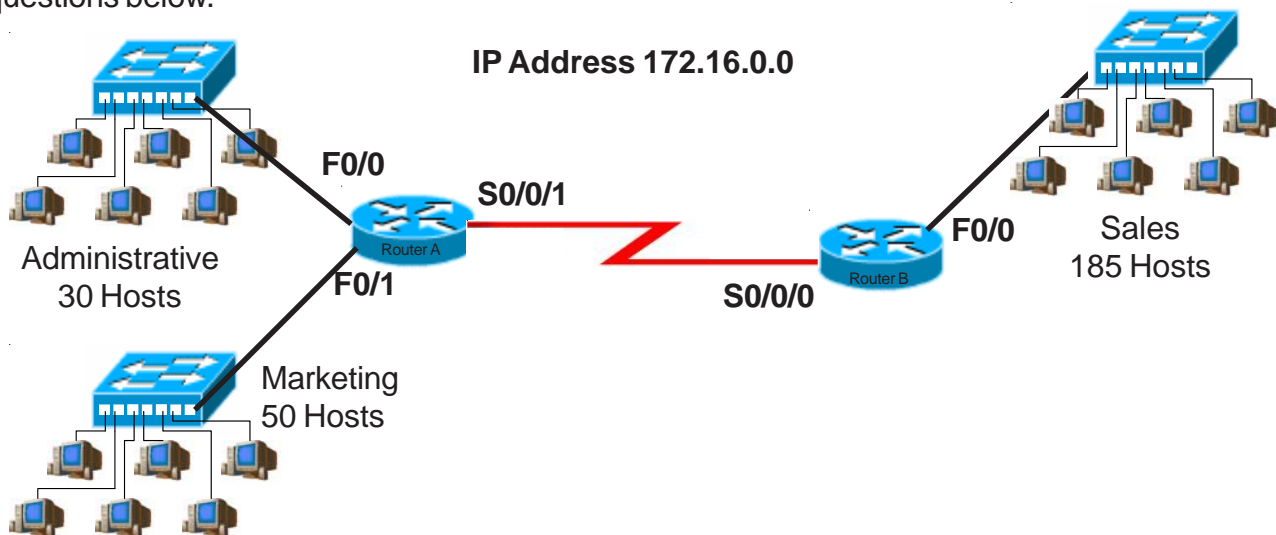
IP address range for Science 135.126.0.64 to 135.126.0.95

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 C serial connection 135.126.0.128 to 135.126.0.159

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 _____

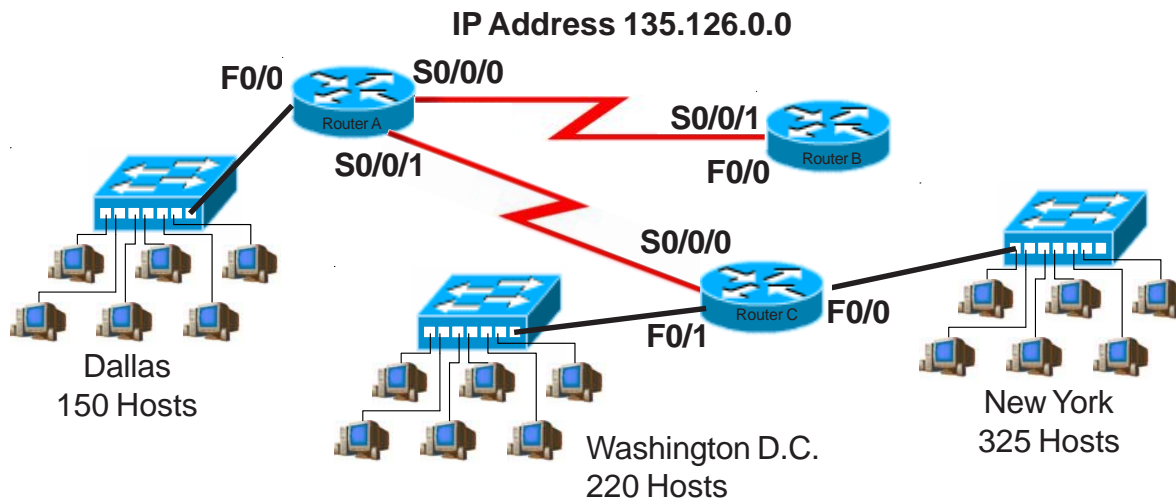
IP address range for Administrative _____

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. 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 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 _____

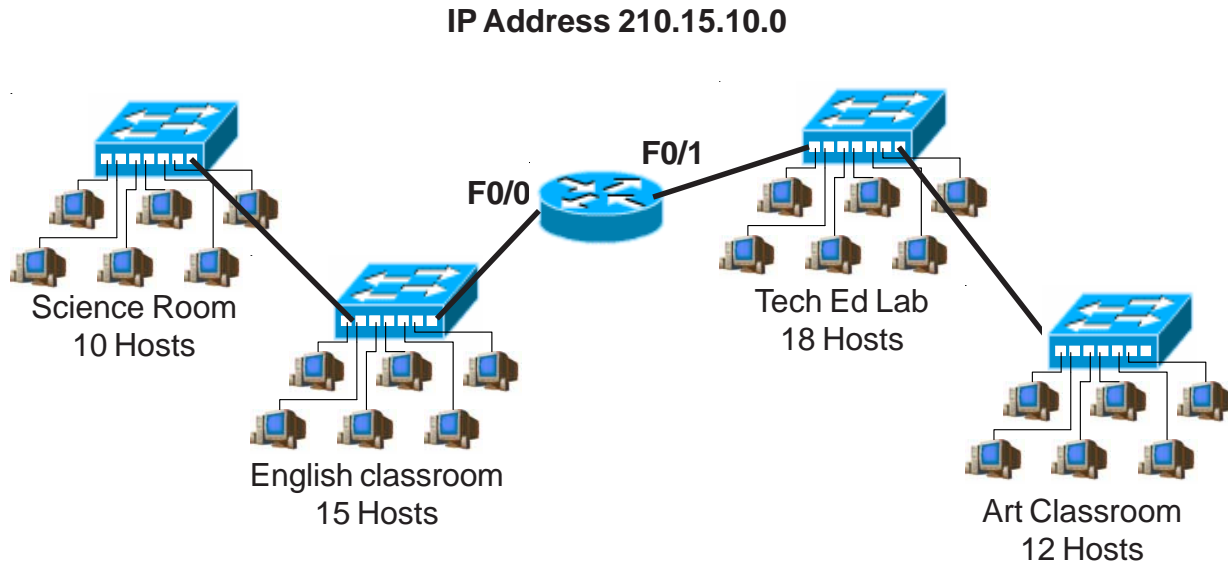
IP address range for Router A to Router B serial connection _____

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.



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.

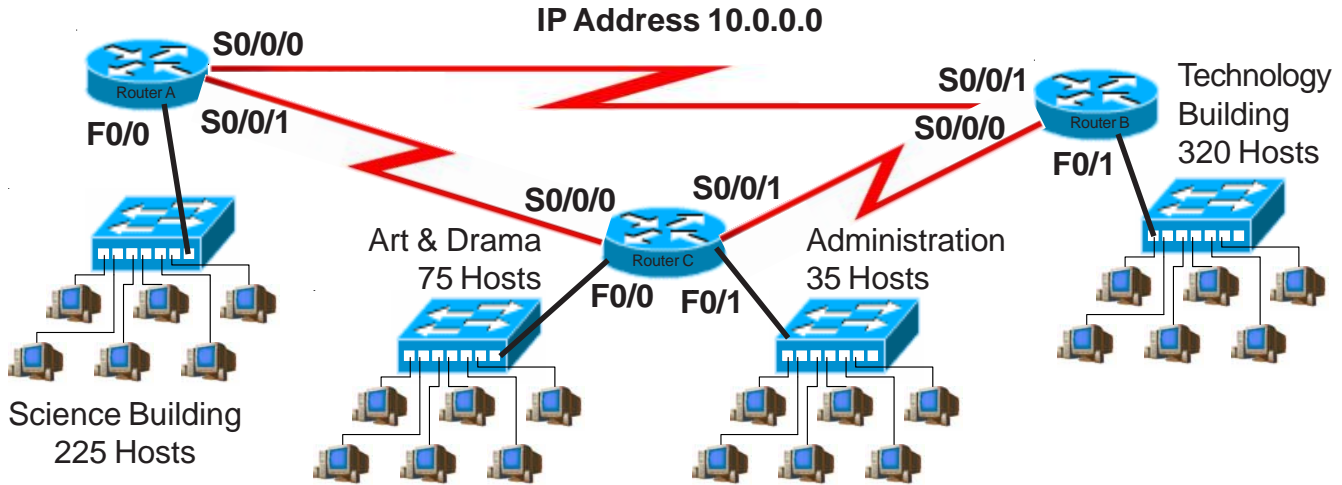
IP address range for Router F0/0 Port _____

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. 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 _____

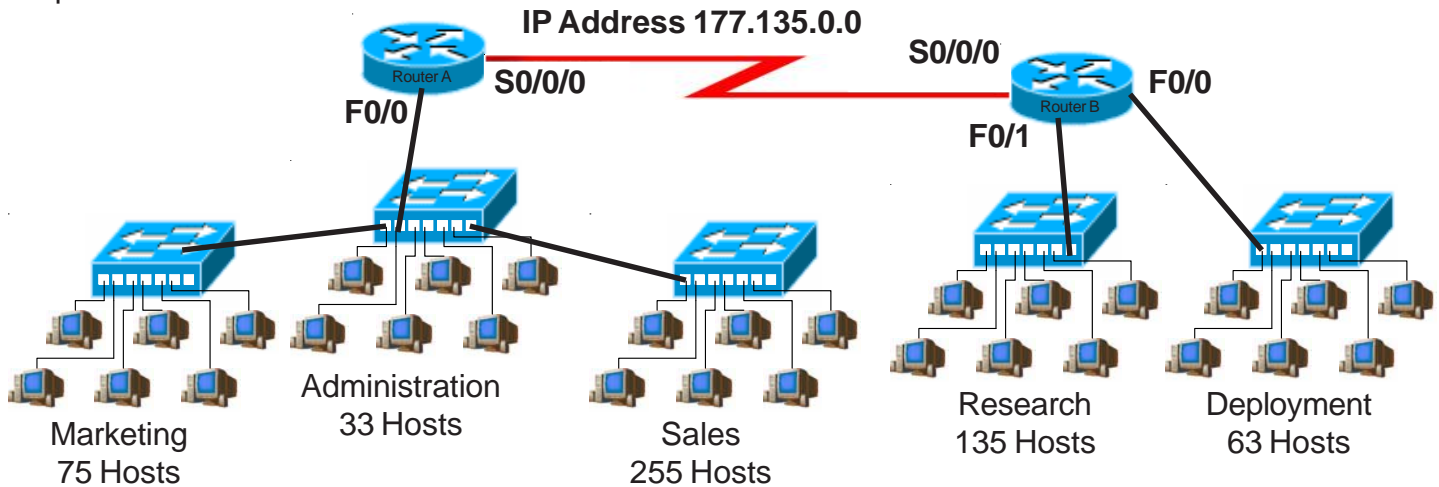
IP address range for Router A
to Router C serial connection _____

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 _____

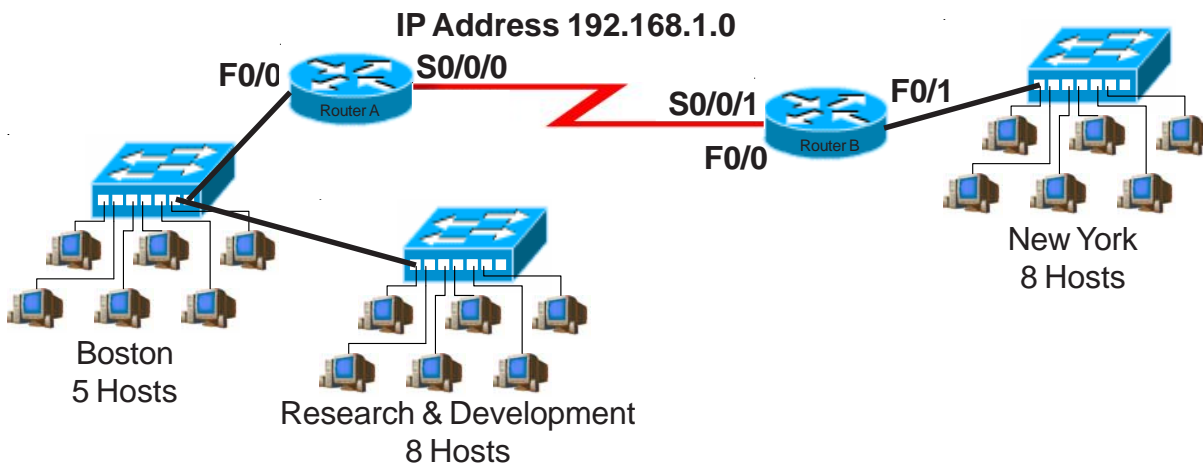
IP address range for Deployment _____

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. 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 _____

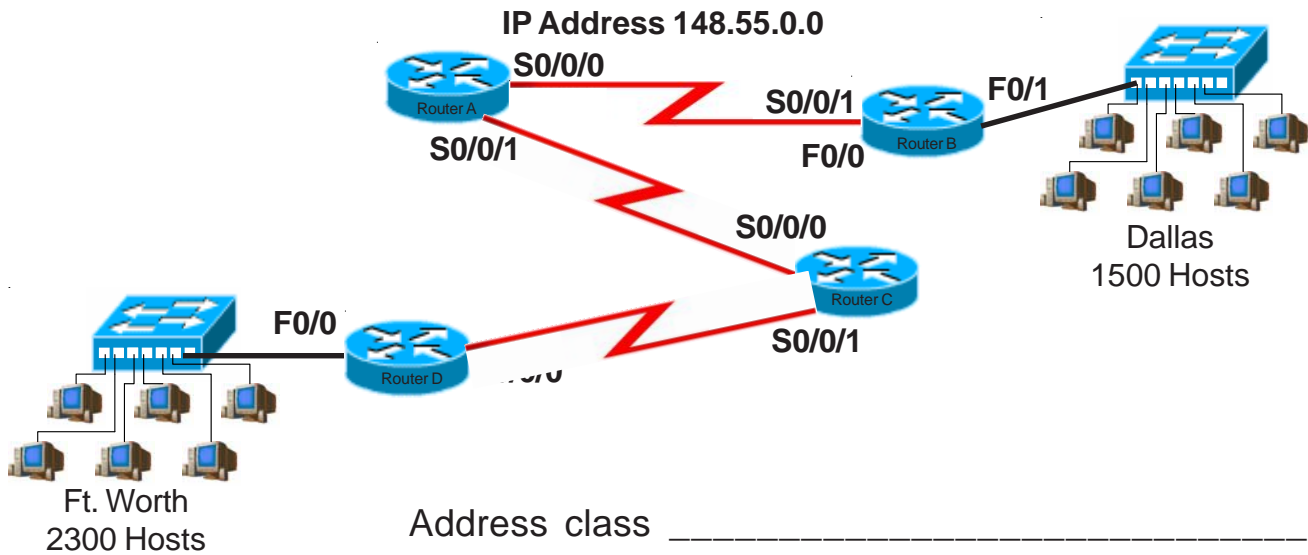
IP address range for New York _____

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 _____

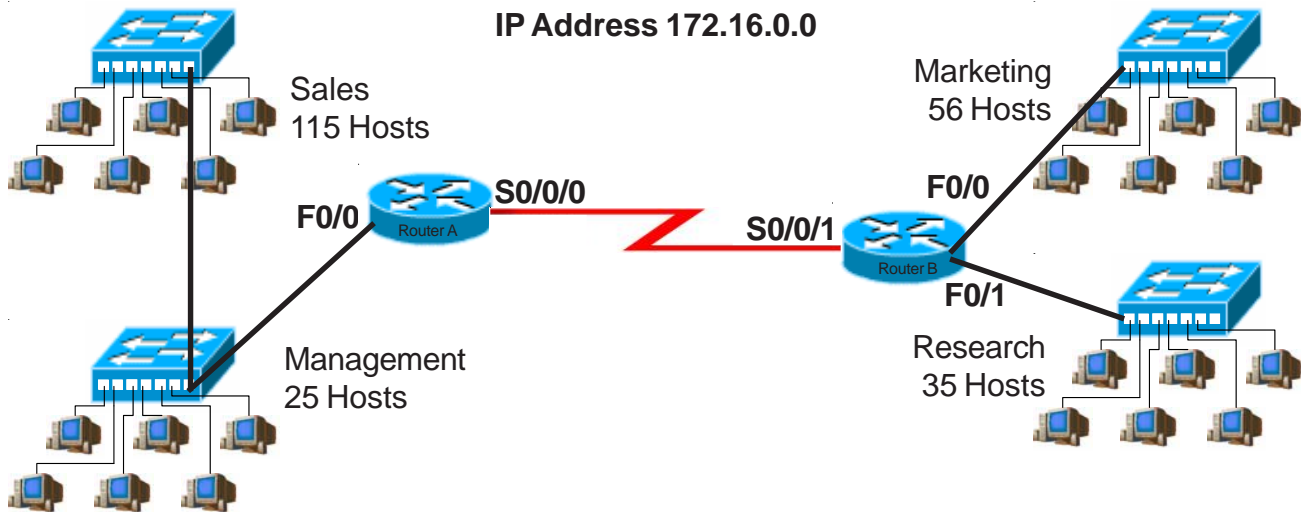
IP address range for Router A to Router C serial connection _____

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/Management _____

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

IP Address Breakdown

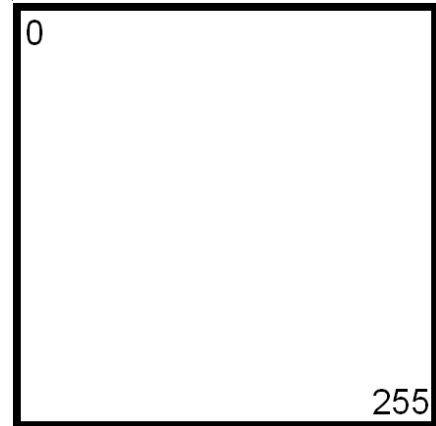
/24	/25	/26	/27	/28	/29	/30
8+8+8	8+8+8+1	8+8+8+2	8+8+8+3	8+8+8+4	8+8+8+5	8+8+8+6
255.255.255.0	255.255.255.128	255.255.255.192	255.255.255.224	255.255.255.240	255.255.255.248	255.255.255.252
256 Hosts	128 Hosts	64 Hosts	32 Hosts	16 Hosts	8 Hosts	4 Hosts
0-255	0-127	0-63		0-15	0-7	0-3
						4-7
					8-15	8-11
						12-15
				16-31	16-23	16-19
						20-23
					24-31	24-27
						28-31
		32-47	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	64-79	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		
	96-111	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	128-143	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		
	160-175	16-167	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	192-207	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			
224-239	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				

Visualizing Subnets Using The Box Method

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

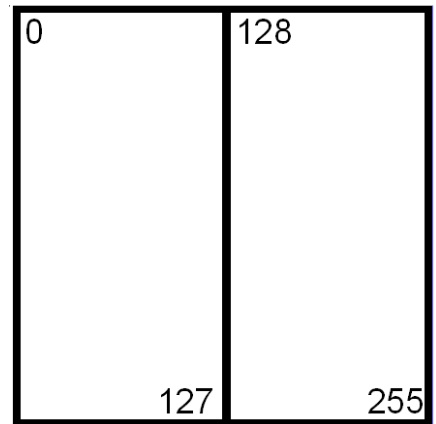
Start with a square. The whole square is a single subnet comprised of 256 addresses.

/24
255.255.255.0
256 Hosts
1 Subnet



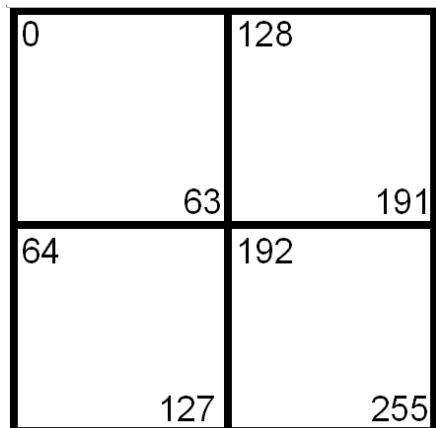
Split the box in half and you get two subnets with 128 addresses,

/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

0	32	128	160
31	63	159	191
64	96	192	224
95	127	223	255

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

/28
255.255.255.240
16 Hosts
16 Subnets

0	32	128	160
15	47	143	175
16	48	144	176
31	63	159	191
64	96	192	224
79	111	207	239
80	112	208	240
95	127	223	255

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	167	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

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

