

IP Addressing and Subnetting

Workbook
Version 2.0

Instructor's Edition

11010011

00011011

10010101

10000110

11111110

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

Produced by: Robb Jones
jonesr@careertech.net and/or Robert.Jones@fcps.org
Frederick County Career & Technology Center
Cisco Networking Academy
Frederick County Public Schools
Frederick, Maryland, USA

Special Thanks to Melvin Baker and Jim Dorsch
for taking the time to check this workbook for errors,
and to everyone who has sent in suggestions to improve the series.

Workbooks included in the series:

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

Instructors (and anyone else for that matter) please do not post the Instructors version on public websites. When you do this you are giving everyone else worldwide the answers. Yes, students look for answers this way. It also discourages others; myself included, from posting high quality materials.

Binary To Decimal Conversion

128	64	32	16	8	4	2	1	Answers	Scratch Area	
1	0	0	1	0	0	1	0	<u>146</u>	128	64
0	1	1	1	0	1	1	1	<u>119</u>	16	32
1	1	1	1	1	1	1	1	<u>255</u>	2	16
1	1	0	0	0	1	0	1	<u>197</u>	146	4
1	1	1	1	0	1	1	0	<u>246</u>		2
0	0	0	1	0	0	1	1	<u>19</u>		1
1	0	0	0	0	0	0	1	<u>129</u>		119
0	0	1	1	0	0	0	1	<u>49</u>		
0	1	1	1	1	0	0	0	<u>120</u>		
1	1	1	1	0	0	0	0	<u>240</u>		
0	0	1	1	1	0	1	1	<u>59</u>		
0	0	0	0	0	1	1	1	<u>7</u>		
							00011011	<u>27</u>		
							10101010	<u>170</u>		
							01101111	<u>111</u>		
							11111000	<u>248</u>		
							00100000	<u>32</u>		
							01010101	<u>85</u>		
							00111110	<u>62</u>		
							00000011	<u>3</u>		
							11101101	<u>237</u>		
							11000000	<u>192</u>		

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
0	0	1	0	0	0	1	0	34	-128	-32
0	1	1	1	1	0	1	1	123	110	2
0	0	1	1	0	0	1	0	50	-64	-2
1	1	1	1	1	1	1	1	255	46	0
1	1	0	0	1	0	0	0	200	-32	
0	0	0	0	1	0	1	0	10	14	
1	0	0	0	1	0	1	0	138	-8	
0	0	0	0	0	0	0	1	1	6	
0	0	0	0	1	1	0	1	13	-4	
1	1	1	1	1	0	1	0	250	2	
0	1	1	0	1	0	1	1	107	-2	
1	1	1	0	0	0	0	0	224	0	
0	1	1	1	0	0	1	0	114		
1	1	0	0	0	0	0	0	192		
1	0	1	0	1	1	0	0	172		
0	1	1	0	0	1	0	0	100		
0	1	1	1	0	1	1	1	119		
0	0	1	1	1	0	0	1	57		
0	1	1	0	0	0	1	0	98		
1	0	1	1	0	0	1	1	179		
0	0	0	0	0	0	1	0	2		

Address Class Identification

Address	Class
10.250.1.1	<u>A</u>
150.10.15.0	<u>B</u>
192.14.2.0	<u>C</u>
148.17.9.1	<u>B</u>
193.42.1.1	<u>C</u>
126.8.156.0	<u>A</u>
220.200.23.1	<u>C</u>
230.230.45.58	<u>D</u>
177.100.18.4	<u>B</u>
119.18.45.0	<u>A</u>
249.240.80.78	<u>E</u>
199.155.77.56	<u>C</u>
117.89.56.45	<u>A</u>
215.45.45.0	<u>C</u>
199.200.15.0	<u>C</u>
95.0.21.90	<u>A</u>
33.0.0.0	<u>A</u>
158.98.80.0	<u>B</u>
219.21.56.0	<u>C</u>

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	<u>188 . 10 . 0 . 0</u>
10.10.48.80 255.255.255.0	<u>10 . 10 . 48 . 0</u>
192.149.24.191 255.255.255.0	<u>192 . 149 . 24 . 0</u>
150.203.23.19 255.255.0.0	<u>150 . 203 . 0 . 0</u>
10.10.10.10 255.0.0.0	<u>10 . 0 . 0 . 0</u>
186.13.23.110 255.255.255.0	<u>186 . 13 . 23 . 0</u>
223.69.230.250 255.255.0.0	<u>223 . 69 . 0 . 0</u>
200.120.135.15 255.255.255.0	<u>200 . 120 . 135 . 0</u>
27.125.200.151 255.0.0.0	<u>27 . 0 . 0 . 0</u>
199.20.150.35 255.255.255.0	<u>199 . 20 . 150 . 0</u>
191.55.165.135 255.255.255.0	<u>191 . 55 . 165 . 0</u>
28.212.250.254 255.255.0.0	<u>28 . 212 . 0 . 0</u>

Host Addresses

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

188.10.18.2 255.255.0.0	<i>0 . 0 . 18 . 2</i>
10.10.48.80 255.255.255.0	<i>0 . 0 . 0 . 80</i>
222.49.49.11 255.255.255.0	<i>0 . 0 . 0 . 11</i>
128.23.230.19 255.255.0.0	<i>0 . 0 . 230 . 19</i>
10.10.10.10 255.0.0.0	<i>0 . 10 . 10 . 10</i>
200.113.123.11 255.255.255.0	<i>0 . 0 . 0 . 11</i>
223.169.23.20 255.255.0.0	<i>0 . 0 . 23 . 20</i>
203.20.35.215 255.255.255.0	<i>0 . 0 . 0 . 215</i>
117.15.2.51 255.0.0.0	<i>0 . 15 . 2 . 51</i>
199.120.15.135 255.255.255.0	<i>0 . 0 . 0 . 135</i>
191.55.165.135 255.255.255.0	<i>0 . 0 . 0 . 135</i>
48.21.25.54 255.255.0.0	<i>0 . 0 . 25 . 54</i>

Default Subnet Masks

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

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

ANDING With Default subnet masks

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

Default Subnet Masks:

Class A	255.0.0.0
Class B	255.255.0.0
Class C	255.255.255.0

ANDING Equations:

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

Sample:

What you see...

IP Address: 192 . 100 . 10 . 33

What you can figure out in your head...

Address Class:	C
Network Portion:	<u>192 . 100 . 10</u> . 33
Host Portion:	192 . 100 . 10 . <u>33</u>

In order for 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)

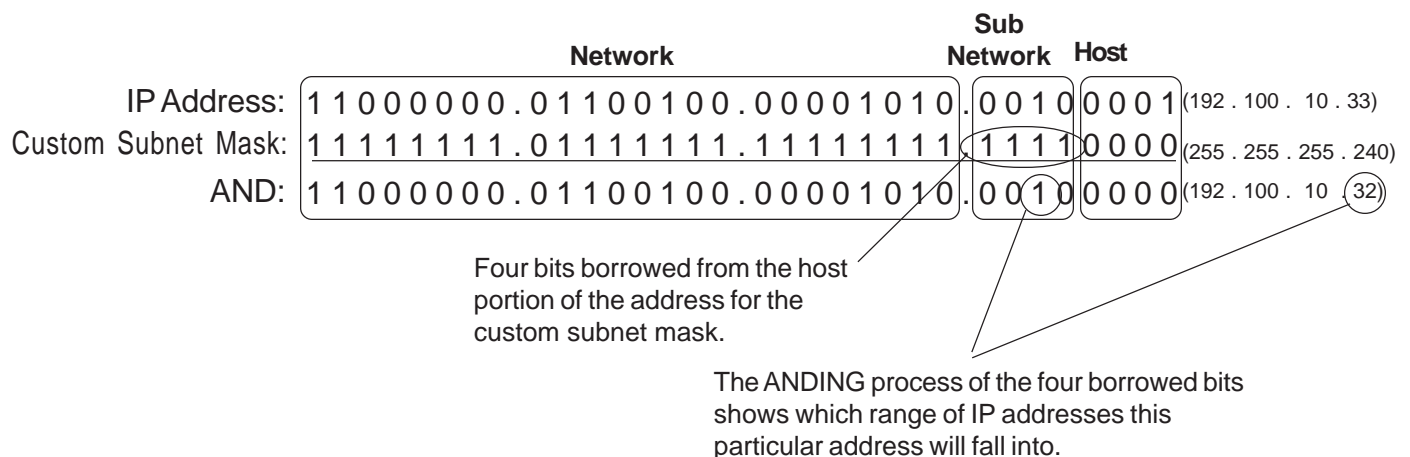
ANDING with the default subnet mask allows your computer to figure out the network portion of the address.

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



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.

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

The number of subnets created by borrowing 2 bits is 2^2 or $2 \times 2 = 4$ subnets.

The number of hosts created by leaving 6 bits is $2^6 - 2$ or $2 \times 2 \times 2 \times 2 \times 2 \times 2 = 64 - 2 = 62$ usable hosts per subnet.

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

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

Notice that the subnet and broadcast addresses match.

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 <u>don't use</u> the zero and broadcast ranges if...	Use the 2^S formula and <u>use</u> 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	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		

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

	128
	64
	32
	+16
	<hr/>
	240

16	Observe the total number of hosts.
-2	
<hr/>	
14	Subtract 2 for the number of usable hosts.

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	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

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

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

Observe the total number of hosts.

Subtract 2 for the number of usable hosts.

64
-2
62

Custom Subnet Masks

Problem 3

Network Address **148.75.0.0 /26**

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

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of 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	4096	8192	16384	32768
Binary values	-	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2
		148	75	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	128
64	+64
32	192
16	
8	
4	
2	
+1	
<u>255</u>	

64	Observe the total number of hosts.
-2	
<u>62</u>	Subtract 2 for the number of usable hosts.

1024	
-2	
<u>1,022</u>	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 C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 8

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 3

Show your work for Problem 5 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
195 . 85 . 8 .	0	0	0	0	0	0	0	0	0	

128	32	8
64	-2	-2
+32	30	6
224		

Custom Subnet Masks

Problem 5

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

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 8

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 3

Show your work for Problem 4 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	0		
		128									
		64	8			32					
		+32	-2			-2					
		224	6			30					

Custom Subnet Masks

Problem 7

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

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 2,048

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 11

Show your work for Problem 7 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	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	0	0	0

128		
64		
32		
16		
8		
4	2,048	32
2	-2	-2
+1	2,046	30
<hr/> 255		

Custom Subnet Masks

Problem 8

Number of needed subnets **3**

Number of needed usable hosts **45**

Network Address **200.175.14.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 4

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 2

Show your work for Problem 8 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
200 . 175 . 14 .	0	0	0	0	0	0	0	0		

128	4	64
+64	-2	-2
<hr/> 240	<hr/> 2	<hr/> 62

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 B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 252 . 0

Total number of subnets 64

Total number of host addresses 1,024

Number of usable addresses 1,022

Number of bits borrowed 6

Show your work for Problem 9 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
Binary values	-	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2
		128	77	0	0	0	0	0	0	0	0	0	0	0	0	0

128		
64		
32		
16		
8	64	1,024
+4	-2	-2
<hr/> 252	<hr/> 62	<hr/> 1,022

Custom Subnet Masks

Problem 10

Number of needed usable hosts **60**

Network Address **198.100.10.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 4

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 2

Show your work for Problem 10 in the space below.

	256	128	64	32	16	8	4	2	1	Number of Hosts
Number of Subnets	-	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1	-	Binary values
198 . 100 . 10 .	0	0	0	0	0	0	0	0	0	

128	64	4
+64	-2	-2
192	62	2

Custom Subnet Masks

Problem 11

Number of needed subnets **250**

Network Address 101.0.0.0

Address class A

Default subnet mask 255 . 0 . 0 . 0

Custom subnet mask 255 . 255 . 0 . 0

Total number of subnets 256

Total number of host addresses 65,536

Number of usable addresses 65,534

Number of bits borrowed 8

Show your work for Problem 11 in the space below.

Number of Hosts	1	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536	131072	262144	524288	1048576	2097152	4194304	8388608	16777216	33554432	67108864	134217728	268435456	536870912	1073741824	2147483648	4294967296	8589934592	17179869184	34359738368	68719476736	137438953472	274877906944	549755813888	1099511627776	2199023255552	4398046511104	8796093022208	17592186044416	35184372088832	70368744177664	140737488355328	281474976710656	562949953421312	1125899906842624	2251799813685248	4503599627370496	9007199254740992	18014398509481984	36028797018963968	72057594037927936	144115188075855872	288230376151711744	576460752303423488	1152921504606846976	2305843009213693952	4611686018427387904	9223372036854775808	18446744073709551616	36893488147419103232	73786976294838206464	147573952589676412928	295147905179352825856	590295810358705651712	1180591620717411303424	2361183241434822606848	4722366482869645213696	9444732965739290427392	18889465931478580854784	37778931862957161709568	75557863725914323419136	151115727451828646838272	302231454903657293676544	604462909807314587353088	1208925819614629174706176	2417851639229258349412352	4835703278458516698824704	9671406556917033397649408	19342813113834066795298816	38685626227668133590597632	77371252455336267181195264	154742504910672534362390528	309485009821345068724781056	618970019642690137449562112	1237940039285380274899124224	2475880078570760549798248448	4951760157141521099596496896	9903520314283042199192993792	19807040628566084398385987584	39614081257132168796771975168	79228162514264337593543950336	158456325028528675187087900672	316912650057057350374175801344	633825300114114700748351602688	1267650600228229401496703205376	2535301200456458802993406410752	5070602400912917605986812821504	10141204801825835211973625643008	20282409603651670423947251286016	40564819207303340847894502572032	81129638414606681695789005144064	162259276829213363391578010288128	324518553658426726783156020576256	649037107316853453566312041152512	1298074214633706907132624082305024	2596148429267413814265248164610048	5192296858534827628530496329220096	10384593717069655257060992658440192	20769187434139310514121985316880384	41538374868278621028243970633760768	83076749736557242056487941267521536	166153499473114484112975882535043072	332306998946228968225951765070086144	664613997892457936451903530140172288	1329227995784915872903807060280344576	2658455991569831745807614120560689152	5316911983139663491615228241121378304	10633823966279326983230456482242756608	21267647932558653966460912964485513216	42535295865117307932921825928971026432	85070591730234615865843651857942052864	17014118346046923173168730371588410528	34028236692093846346337460743176821056	68056473384187692692674921486353642112	136112946768375385385349842972707284224	272225893536750770770699685945414568448	544451787073501541541399371890829136896	1088903574147003083082798743781658273792	2177807148294006166165597487563316547584	4355614296588012332331194975126633095168	8711228593176024664662389950253266190336	17422457186352049329324779900506532380672	34844914372704098658649559801013064761344	69689828745408197317299119602026129522688	139379657490816394634598239204052259045376	278759314981632789269196478408104518090752	557518629963265578538392956816209036181504	1115037259926531157076785913632418072363008	2230074519853062314153571827264836144726016	4460
--------------------	---	---	---	---	----	----	----	-----	-----	-----	------	------	------	------	-------	-------	-------	--------	--------	--------	---------	---------	---------	---------	----------	----------	----------	-----------	-----------	-----------	------------	------------	------------	------------	-------------	-------------	-------------	--------------	--------------	--------------	---------------	---------------	---------------	---------------	----------------	----------------	----------------	-----------------	-----------------	-----------------	------------------	------------------	------------------	------------------	-------------------	-------------------	-------------------	--------------------	--------------------	--------------------	---------------------	---------------------	---------------------	---------------------	----------------------	----------------------	----------------------	-----------------------	-----------------------	-----------------------	------------------------	------------------------	------------------------	------------------------	-------------------------	-------------------------	-------------------------	--------------------------	--------------------------	--------------------------	---------------------------	---------------------------	---------------------------	---------------------------	----------------------------	----------------------------	----------------------------	-----------------------------	-----------------------------	-----------------------------	------------------------------	------------------------------	------------------------------	------------------------------	-------------------------------	-------------------------------	-------------------------------	--------------------------------	--------------------------------	--------------------------------	---------------------------------	---------------------------------	---------------------------------	----------------------------------	----------------------------------	----------------------------------	----------------------------------	-----------------------------------	-----------------------------------	-----------------------------------	------------------------------------	------------------------------------	------------------------------------	-------------------------------------	-------------------------------------	-------------------------------------	-------------------------------------	--------------------------------------	--------------------------------------	--------------------------------------	---------------------------------------	---------------------------------------	---------------------------------------	--	--	--	--	--	--	--	---	---	---	--	--	--	--	---	---	---	--	--	--	---	---	------

Custom Subnet Masks

Problem 12

Number of needed subnets **5**

Network Address **218.35.50.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 8

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 3

Show your work for Problem 12 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
218 . 35 . 50 .	0	0	0	0	0	0	0	0		

128		
64	64	4
+32	-2	-2
224	62	2

Custom Subnet Masks

Problem 13

Number of needed usable hosts **25**

Network Address **218.35.50.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 8

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 3

Show your work for Problem 13 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
218 . 35 . 50 .	0	0	0	0	0	0	0	0		

128		
64	8	32
+32	-2	-2
224	6	30

Custom Subnet Masks

Problem 14

Number of needed subnets **10**

Network Address **172.59.0.0**

Address class **B**

Default subnet mask **255 . 255 . 0 . 0**

Custom subnet mask **255 . 255 . 240 . 0**

Total number of subnets **16**

Total number of host addresses **4,096**

Number of usable addresses **4,094**

Number of bits borrowed **4**

Show your work for Problem 14 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	4096	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	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0

$$\begin{array}{r}
 128 \\
 64 \\
 32 \\
 +16 \\
 \hline
 240
 \end{array}
 \qquad
 \begin{array}{r}
 16 \\
 -2 \\
 \hline
 14
 \end{array}
 \qquad
 \begin{array}{r}
 4,096 \\
 -2 \\
 \hline
 4,094
 \end{array}$$

Custom Subnet Masks

Problem 15

Number of needed usable hosts **50**

Network Address **172.59.0.0**

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 15** in the space below.

	128	64	32	16	8	4	2	1		128	64	32	16	8	4	2	1
Number of Hosts	-																
Number of Subnets	-	2	4	8	16	32	64	128	256		512	1024	2048	4096	8192	16384	32768
Binary values	-	128	64	32	16	8	4	2	1		128	64	32	16	8	4	2
	172	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

128			
64			
32			
16			
8			
4			
2	128	64	1,024
+1	+64	-2	-2
255	192	62	1,022

Custom Subnet Masks

Problem 16

Number of needed usable hosts **29**

Network Address **23.0.0.0**

Address class **A**

Default subnet mask **255 . 0 . 0 . 0**

Custom subnet mask **255 . 255 . 255 . 224**

Total number of subnets **524,288**

Total number of host addresses **32**

Number of usable addresses **30**

Number of bits borrowed **19**

Show your work for Problem 16 in the space below.

Number of Hosts	1	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536	131072	262144	524288	1048576	2097152	4194304	8388608	16777216	33554432	67108864	134217728	268435456	536870912	1073741824	2147483648	4294967296	8589934592	17179869184	34359738368	68719476736	137438953472	274877906944	549755813888	1099511627776	2199023255552	4398046511104	8796093022208	17592186044416	35184372088832	70368744177664	140737488355328	281474976710656	562949953421312	1125899906842624	2251799813685248	4503599627370496	9007199254740992	18014398509481984	36028797018963968	72057594037927936	144115188075855872	288230376151711744	576460752303423488	1152921504606846976	2305843009213693952	4611686018427387904	9223372036854775808	18446744073709551616	36893488147419103232	73786976294838206464	147573952589676412928	295147905179352825856	590295810358705651712	1180591620717411303424	2361183241434822606848	4722366482869645213696	9444732965739290427392	18889465931478580854784	37778931862957161709568	75557863725914323419136	151115727451828646838272	302231454903657293676544	604462909807314587353088	1208925819614629174706176	2417851639229258349412352	4835703278458516698824704	9671406556917033397649408	19342813113834066795298816	38685626227668133590597632	77371252455336267181195264	154742504910672534362390528	309485009821345068724781056	618970019642690137449562112	1237940039285380274899124224	2475880078570760549798248448	4951760157141521099596496896	9903520314283042199192993792	19807040628566084398385987584	39614081257132168796771975168	79228162514264337593543950336	158456325028528675187087900672	316912650057057350374175801344	633825300114114700748351602688	1267650600228229401496703205376	2535301200456458802993406410752	5070602400912917605986812821504	10141204801825835211973625643008	20282409603651670423947251286016	40564819207303340847894502572032	81129638414606681695789005144064	162259276829213363391578010288128	324518553658426726783156020576256	649037107316853453566312041152512	1298074214633706907132624082305024	2596148429267413814265248164610048	5192296858534827628530496329220096	10384593717069655257060992658440192	20769187434139310514121985316880384	41538374868278621028243970633760768	83076749736557242056487941267521536	166153499473114484112975882535043072	332306998946228968225951765070086144	664613997892457936451903530140172288	1329227995784915872903807060280344576	2658455991569831745807614120560689152	5316911983139663491615228241121378304	10633823966279326983230456482242756608	21267647932558653966460912964485513216	42535295865117307932921825928971026432	85070591730234615865843651857942052864	170141183460469231731687303715884105728	340282366920938463463374607431768211456	680564733841876926926749214863536422912	1361129467683753853853498429727072845824	2722258935367507707706996859454145691536	5444517870735015415413993718908291383072	10889035741470030830827987437816582766144	21778071482940061661655974875633165532288	43556142965880123323311949751266331064576	87112285931760246646623899502532662129152	174224571863520493293247799005065324258304	348449143727040986586495598010130648516608	696898287454081973172991196020261297033216	1393796574908163946345982392040522594066432	2787593149816327892691964784081045188132864	5575186299632655785383929568162090376265728	11150372599265311570767859136324180752531456	22300745198530623141535718272648361505062912	44601490397061246283071436545296723010125824	89202980794122492566142873090593446020251648	178405961588244985132285746181186892040503296	356811923176489970264571492362373784081006592	713623846352979940529142984724747568162013184	1427247692705959881058285969449495136324026368	2854495385411919762116571938898990272648052736	5708990770823839524233143877797980545296105472	11417981541647679048466287755595961090592210944	22835963083295358096932575511191922181184421888	45671926166590716193865151022383844362368843776	91343852333181432387730302044767688724737687552	182687704666362864775460604089535377449475375104	365375409332725729550921208179070754898950750208	730750818665451459101842416358141509797901500416	1461501637330902918203684832716283019595803000832	2923003274661805836407369665432566039191606001664	5846006549323611672814739330865132078383212003328	11692013098647223345629478661730264156766424006656	23384026197294446691258957323460528313532848013312	46768052394588893382517914646921056627065696026624	93536104789177786765035829293842113254131392053248	187072209578355573530071658587684226508262784106496	374144419156711147060143317175368453016525568212992	748288838313422294120286634350736906033051136425984	1496577676626844588240573268701473812066102272851968	2993155353253689176481146537402947624132204545703936	5986310706507378352962293074805895248264409091407872	11972621413014756705924586149611790496528818182815744	23945242826029513411849172299223580993057636365631488	47890485652059026823698344598447161986115272731262976	95780971304118053647396689196894323972230545462525952	191561942608236107294793378393788647944461090925051904	383123885216472214589586756787577295888922181850103808	766247770432944429179173513575154591777844363700207616	1532495540865888858358347027150309183555688727400415232	3064991081731777716716694054300618367111377454800830464	6129982163463555433433388108601236734222754909601660928	1225996432692711086686677621720247346844550981920332176	2451992865385422173373355243440494693689101963840664352	4903985730770844346746710486880989387378203927681328704	9807971461541688693493420973761978774756407855362657408	19615942923083377386986841947523957549512815710725314816	3923188584616675477397368389504791509902563142145062912	7846377169233350954794736779009583019805126284290125824	15692754338466701909589473558019166039610252568580251648	31385508676933403819178947116038332079220505137160503296	62771017353866807638357894232076664158441010274321006592	125542034707733615276715788464153328316882020548642013184	251084069415467230553431576928306656633764041097284026368	502168138830934461106863153856613313267528082194568052736	1004336277661868922213726307713226626535056164389136105472	2008672555323737844427452615426453253070112328778272210944	4017345110647475688854905230852906506140224657556544421888	8034690221294951377709810461705813012280449315113088843776	1606938044258990275541962092341162602456089863022617768752	3213876088517980551083924184682325204912179726045235537504	6427752177035961102167848369364650409824359452090471075008	12855504354071922204335696738729300819648718904180942150016	25711008708143844408671393477458601639297437808361884300032	51422017416287688817342786954917203278594875616723768600064	102844034832575377634685573909834406557189751233447537200128	205688069665150755269371147819668813114379502466895074400256	411376139330301510538742295639337626228759004933790148800512	822752278660603021077484591278675252457518009867580297601024	1645504557321206042154969182557350504915036019735160595202048	3291009114642412084309938365114701009830072039470321190404096	6582018229284824168619876730229402019660144078940642380808192	13164036458569648337239753460458804039320288157881247761616384	26328072917139296674479506920917608078640576315762495523232768	52656145834278593348959013841835216157281152631524991046465536	105312291668557186697918027683670432314562305263049982092931072	210624583337114373395836055367340864629124610526099964185862144	421249166674228746791672110734681729258249221052199928371724288	842498333348457493583344221469363458516498442104399856743448576	1684996666696914987166688442938726917032996884208799713486897152	3369993333393829974333376885877453834065993768417599426973794304	6739986666787659948666753771754907668131987536835198853947588608	13479973333575319897333507543509815336263975073670397707895177216	26959946667150639794667015087019630672527950147340795415790354432	53919893334301279589334030174039261345055900294681590831580708864	107839786668602559178668060348078522690111800589363181663161417728	215679573337205118357336120696157045380223601178726363326322835456	431359146674410236714672241392314090760447202357452726652645670912	862718293348820473429344482784628181520894404714905453305291341824	1725436586697640946858688965569256363041788809429810906610582683648	3450873173395281893717377931138512726083577618859621813221165367296	6901746346790563787434755862277025452167155237719243626442330734592	13803492693581127574869511724554050904334310475438487252884661471184	27606985387162255149739023449108101808668620950876974505769322942368	55213970774324510299478046898216203617337241901753949011538645884736	110427941548649020598956093796432407234674483803507898023077291769472	220855883097298041197912187592864814469348967607015796046154583538944	441711766194596082395824375185729628938697935214031592092309167077888	883423532389192164791648750371459257877395870428063184184618334155776	1766847064778384329583297500742918515754791740856126368369236668311552	3533694129556768659166595001485837031509583481712252736738473336623104	7067388259113537318333190002971674063019166963424505473476946673246208	14134776518227074636666380005943348126038333926849010946953893346492416	28269553036454149273332760011886696252076667853698021893907786692984832	56539106072908298546665520023773392504153335707396043787815573385969664	113078212145816597093331040047546785008306671414792087575631146771939328	226156424291633194186662080095093570016613342829584175151262293543878656	452312848583266388373324160190187140033226685659168350302524587087757312	904625697166532776746648320380374280066453371318336700605049174175514624	1809251394333065553493296640760748560132906742636673401210098348351029248	3618502788666131106986593281521497120265813485273346802420196696702058496	7237005577332262213973186563042994240531626970546693604840393393404116992	14474011154664524427946373126085988481063253941093387209680786786808233984	28948022309329048855892746252171976962126507882186774419361573573616467968	57896044618658097711785492504343953924253015764373548838723147147232935936	115792089237316195423570985008687907848506031528747097677446294294465871872	231584178474632390847141970017375815697012063057494195354892588588931743744	463168356949264781694283940034751631394024126114988390709785177177867487488	926336713898529563388567880069503262788048252229976781419570354355734974976	1852673427797059126777135760139006525576096504459953562839140708711469949952	3705346855594118253554271520278013051152193008919907125678281417422939899904	7410693711188236507108543040556026102304386017839814251356562834845879799808	14821387422376473014217086081112052204608772035679628502713125669691759599616	29642774844752946028434172
-----------------	---	---	---	---	----	----	----	-----	-----	-----	------	------	------	------	-------	-------	-------	--------	--------	--------	---------	---------	---------	---------	----------	----------	----------	-----------	-----------	-----------	------------	------------	------------	------------	-------------	-------------	-------------	--------------	--------------	--------------	---------------	---------------	---------------	---------------	----------------	----------------	----------------	-----------------	-----------------	-----------------	------------------	------------------	------------------	------------------	-------------------	-------------------	-------------------	--------------------	--------------------	--------------------	---------------------	---------------------	---------------------	---------------------	----------------------	----------------------	----------------------	-----------------------	-----------------------	-----------------------	------------------------	------------------------	------------------------	------------------------	-------------------------	-------------------------	-------------------------	--------------------------	--------------------------	--------------------------	---------------------------	---------------------------	---------------------------	---------------------------	----------------------------	----------------------------	----------------------------	-----------------------------	-----------------------------	-----------------------------	------------------------------	------------------------------	------------------------------	------------------------------	-------------------------------	-------------------------------	-------------------------------	--------------------------------	--------------------------------	--------------------------------	---------------------------------	---------------------------------	---------------------------------	----------------------------------	----------------------------------	----------------------------------	----------------------------------	-----------------------------------	-----------------------------------	-----------------------------------	------------------------------------	------------------------------------	------------------------------------	-------------------------------------	-------------------------------------	-------------------------------------	-------------------------------------	--------------------------------------	--------------------------------------	--------------------------------------	---------------------------------------	---------------------------------------	---------------------------------------	--	--	--	--	---	---	---	--	--	--	---	---	---	---	--	--	--	---	---	---	--	--	--	--	---	---	---	--	--	--	---	---	---	---	--	--	--	---	---	---	--	--	--	--	---	---	---	--	--	--	---	---	---	---	--	--	--	---	---	---	---	---	---	---	--	---	---	--	--	--	---	---	---	--	--	--	--	--	--	--	---	---	---	--	--	--	--	---	---	---	--	--	--	---	---	---	---	--	--	--	---	---	---	--	--	--	--	---	---	---	--	--	--	---	---	---	---	--	--	--	---	---	---	--	--	--	--	---	---	---	--	--	--	---	---	---	---	--	--	--	---	----------------------------

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

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

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

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

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

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	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 0 0									0	0	0	0	0	0	0	0

Usable hosts	64	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2
	-2															
	62															

Custom subnet mask	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
	+64															
	192															
	+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)	165.100.0.0	to	165.100.0.63
(2)	165.100.0.64	to	165.100.0.127
(3)	165.100.0.128	to	165.100.0.191
(4)	165.100.0.192	to	165.100.0.255
(5)	165.100.1.0	to	165.100.1.63
(6)	165.100.1.64	to	165.100.1.127
(7)	165.100.1.128	to	165.100.1.191
(8)	165.100.1.192	to	165.100.1.255
(9)	165.100.2.0	to	165.100.2.63
(10)	165.100.2.64	to	165.100.2.127
(11)	165.100.2.128	to	165.100.2.191
(12)	165.100.2.192	to	165.100.2.255
(13)	165.100.3.0	to	165.100.3.63
(14)	165.100.3.64	to	165.100.3.127
(15)	165.100.3.128	to	165.100.3.191
(16)	165.100.3.192	to	165.100.3.255

Down to

(1023)	165.100.255.128	to	165.100.255.191
(1024)	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 **C**

Default subnet mask **255 . 255 . 255 . 0**

Custom subnet mask **255 . 255 . 255 . 128**

Total number of subnets **2**

Total number of host addresses **128**

Number of usable addresses **126**

Number of bits borrowed **1**

What is the 2nd subnet range? **195.223.50.128 - 195.223.50.255**

What is the subnet number for the 2nd subnet? **195.223.50.128**

What is the subnet broadcast address for the 1st subnet? **195.223.50.127**

What are the assignable addresses for the 1st subnet? **195.223.50.1 - 195.223.50.126**

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
195. 223 . 50 . 0			0	0	0	0	0	0	0	0	
(1)		0	195.223.50.0 to 195.223.50.127								
(2)		1	195.223.50.128 to 195.223.50.255								

Subnetting

Problem 4

Number of needed subnets **750**

Network Address **190.35.0.0**

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? 190.35.3.128 to 190.35.3.191

What is the subnet number for the 13th subnet? 190.35.3.0

What is the subnet broadcast address for the 10th subnet? 190.35.2.127

What are the assignable addresses for the 6th subnet? 190.35.1.65 to 190.35.1.126

Show your work for Problem 4 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	4096	8192	16384	32768	65536
Binary values -	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
190.35.0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	128	64	32	16	8	4	2	1	0	0	0	0	0	0	0	0
(2)	64	32	16	8	4	2	1	0	1	0	0	0	0	0	0	0
(3)	32	16	8	4	2	1	0	0	1	1	0	0	0	0	0	0
(4)	16	8	4	2	1	0	0	0	1	1	1	0	0	0	0	0
(5)	8	4	2	1	0	0	0	0	1	1	1	1	0	0	0	0
(6)	4	2	1	0	0	0	0	0	1	1	1	1	1	0	0	0
(7)	2	1	0	0	0	0	0	0	1	1	1	1	1	1	0	0
(8)	1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
(9)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
(10)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
(11)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
(12)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
(13)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
(14)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
(15)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
(16)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
190.35.0.63	190	35	0	63	to											
190.35.0.127	190	35	0	127	to											
190.35.0.191	190	35	0	191	to											
190.35.0.255	190	35	0	255	to											
190.35.1.63	190	35	1	63	to											
190.35.1.127	190	35	1	127	to											
190.35.1.191	190	35	1	191	to											
190.35.1.255	190	35	1	255	to											
190.35.2.63	190	35	2	63	to											
190.35.2.127	190	35	2	127	to											
190.35.2.191	190	35	2	191	to											
190.35.2.255	190	35	2	255	to											
190.35.3.63	190	35	3	63	to											
190.35.3.127	190	35	3	127	to											
190.35.3.191	190	35	3	191	to											
190.35.3.255	190	35	3	255	to											

Subnetting

Problem 5

Number of needed usable hosts **6**

Network Address **126.0.0.0**

Address class A

Default subnet mask 255 . 0 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 248

Total number of subnets 2,097,152

Total number of host addresses 8

Number of usable addresses 6

Number of bits borrowed 21

What is the 2nd subnet range? 126.0.0.8 to 126.0.0.15

What is the subnet number for the 5th subnet? 126.0.0.32

What is the subnet broadcast address for the 7th subnet? 126.0.0.55

What are the assignable addresses for the 10th subnet? 126.0.0.73 to 126.0.0.78

Show your work for **Problem 5** in the space below.

[illegible]

Subnetting

Problem 6

Number of needed subnets **10**

Network Address **192.70.10.0**

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 9th subnet range? 192.70.10.128 to 192.70.10.143

What is the subnet number for the 4th subnet? 192.70.10.48

What is the subnet broadcast address for the 12th subnet? 192.70.10.191

What are the assignable addresses for the 10th subnet? 192.70.10.145 to 192.70.10.158

Show your work for Problem 6 in the space below.

		256 128 64 32				16 8 4 2 -				Number of	
Number of										Hosts	
Subnets		-	2	4	8	16	32	64	128	256	
		128	64	32	16	8	4	2	1	- Binary values	
192	. 70 . 10 .	0	0	0	0	0	0	0	0		
(1)					0	192.70.10.0					to 192.70.10.15
(2)					1	192.70.10.16					to 192.70.10.31
(3)				1	0	192.70.10.32					to 192.70.10.47
(4)				1	1	192.70.10.48					to 192.70.10.63
(5)			1	0	0	192.70.10.64					to 192.70.10.79
(6)			1	0	1	192.70.10.80					to 192.70.10.95
(7)			1	1	0	192.70.10.96					to 192.70.10.111
(8)			1	1	1	192.70.10.112					to 192.70.10.127
(9)	1	0	0	0	0	192.70.10.128					to 192.70.10.143
(10)	1	0	0	0	1	192.70.10.144					to 192.70.10.159
(11)	1	0	1	0	0	192.70.10.160					to 192.70.10.175
(12)	1	0	1	1	0	192.70.10.176					to 192.70.10.191
(13)	1	1	0	0	0	192.70.10.192					to 192.70.10.207
(14)	1	1	0	1	0	192.70.10.208					to 192.70.10.223
(15)	1	1	1	0	0	192.70.10.224					to 192.70.10.239
(16)	1	1	1	1	0	192.70.10.240					to 192.70.10.255

$$\begin{array}{r}
 128 \\
 +64 \\
 \hline
 240
 \end{array}
 \qquad
 \begin{array}{r}
 16 \\
 -2 \\
 \hline
 14
 \end{array}$$

Subnetting

Problem 7

Network Address **10.0.0.0 /16**

Address class A

Default subnet mask 255 . 0 . 0 . 0

Custom subnet mask 255 . 255 . 0 . 0

Total number of subnets 256

Total number of host addresses 65,536

Number of usable addresses 65,534

Number of bits borrowed 8

What is the 11th subnet range? 10.10.0.0 to 10.10.255.255

What is the subnet number for the 6th subnet? 10.5.0.0

What is the subnet broadcast address for the 2nd subnet? 10.1.255.255

What are the assignable addresses for the 9th subnet? 10.8.0.1 to 10.8.255.254

Show your work for Problem 7 in the space below.

[illegible]

Subnetting

Problem 8

Number of needed subnets **5**

Network Address **172.50.0.0**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 224 . 0

Total number of subnets 8

Total number of host addresses 8,192

Number of usable addresses 8,190

Number of bits borrowed 3

What is the 4th subnet range? 172.50.96.0 to 172.50.127.255

What is the subnet number for the 5th subnet? 172.50.128.0

What is the subnet broadcast address for the 6th subnet? 172.50.191.255

What are the assignable addresses for the 3rd subnet? 172.50.64.1 to 172.50.95.254

Show your work for Problem 8 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	1,024	2,048	4,096	8,192	16,384	32,768	65,536
Binary values -	128	64	32	16	8	4	2	1	1	128	64	32	16	8	4	2
	172	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	0	172	50	0	0	0	0	0	to	172	50	0	31	255		
(2)	1	172	50	0	32	0	0	0	to	172	50	0	63	255		
(3)	1	172	50	0	64	0	0	0	to	172	50	0	95	255		
(4)	1	172	50	0	96	0	0	0	to	172	50	0	127	255		
(5)	1	172	50	0	128	0	0	0	to	172	50	0	159	255		
(6)	1	172	50	0	160	0	0	0	to	172	50	0	191	255		
(7)	1	172	50	0	192	0	0	0	to	172	50	0	223	255		
(8)	1	172	50	0	224	0	0	0	to	172	50	0	255	255		

128

64

+32

224

8,192

-2

8,190

Subnetting

Problem 9

Number of needed usable hosts **28**

Network Address **172.50.0.0**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 2,048

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 11

What is the 2nd subnet range? 172.50.0.32 to 172.50.0.63

What is the subnet number for the 10th subnet? 172.50.1.32

What is the subnet broadcast address for the 4th subnet? 172.50.0.127

What are the assignable addresses for the 6th subnet? 172.50.0.161 to 172.50.0.190

Show your work for Problem 9 in the space below.

[illegible]

Subnetting

Problem 10

Number of needed subnets **45**

Network Address **220.100.100.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 252

Total number of subnets 64

Total number of host addresses 4

Number of usable addresses 2

Number of bits borrowed 6

What is the 5th subnet range? 220.100.100.16 to 220.100.100.19

What is the subnet number for the 4th subnet? 220.100.100.12

What is the subnet broadcast address for the 13th subnet? 220.100.100.51

What are the assignable addresses for the 12th subnet? 220.100.100.45 to 220.100.100.46

Show your work for Problem 10 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	
220 . 100 . 100 .		0	0	0	0	0	0	0	0		
128	(1)						0	220.100.100.0	to	220.100.100.3	
64	(2)						1	220.100.100.4	to	220.100.100.7	
32	(3)					1	0	220.100.100.8	to	220.100.100.11	
16	(4)					1	1	220.100.100.12	to	220.100.100.15	
8	(5)				1	0	0	220.100.100.16	to	220.100.100.19	
+4	(6)			1	0	0	1	220.100.100.20	to	220.100.100.23	
252	(7)			1	1	0	0	220.100.100.24	to	220.100.100.27	
	(8)			1	1	1	1	220.100.100.28	to	220.100.100.31	
	(9)	1	0	0	0	0	0	220.100.100.32	to	220.100.100.35	
	(10)	1	0	0	0	0	1	220.100.100.36	to	220.100.100.39	
	(11)	1	0	0	1	0	0	220.100.100.40	to	220.100.100.43	
	(12)	1	0	0	1	1	1	220.100.100.44	to	220.100.100.47	
	(13)	1	1	0	0	0	0	220.100.100.48	to	220.100.100.51	
	(14)	1	1	0	1	0	1	220.100.100.52	to	220.100.100.55	
	(15)	1	1	1	1	0	0	220.100.100.56	to	220.100.100.59	
	(16)	1	1	1	1	1	1	220.100.100.60	to	220.100.100.63	

Subnetting

Problem 11

Number of needed usable hosts **8,000**

Network Address **135.70.0.0**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 224 . 0

Total number of subnets 8

Total number of host addresses 8,192

Number of usable addresses 8,190

Number of bits borrowed 3

What is the 6th subnet range? 135.70.160.0 to 135.70.191.255

What is the subnet number for the 7th subnet? 135.70.192.0

What is the subnet broadcast address for the 3rd subnet? 135.70.95.255

What are the assignable addresses for the 5th subnet? 135.70.128.1 to 135.70.159.254

Show your work for **Problem 11** in the space below.

[illegible]

Subnetting

Problem 12

Number of needed usable hosts **45**

Network Address **198.125.50.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 4

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 2

What is the 2nd subnet range? 198.125.50.64 to 198.125.50.127

What is the subnet number for the 2nd subnet? 198.125.50.64

What is the subnet broadcast address for the 4th subnet? 198.125.50.255

What are the assignable addresses for the 3rd subnet? 198.125.50.129 to 198.125.50.190

Show your work for Problem 12 in the space below.

												Number of		
				256	128	64	32	16	8	4	2	1	Hosts	
Number of Subnets				-	2	4	8	16	32	64	128	256		
				128	64	32	16	8	4	2	1	-	Binary values	
198 . 125 . 50 .				0	0	0	0	0	0	0	0			
(1)				0	198.125.50.0							to	198.125.50.63	
(2)				1	198.125.50.64							to	198.125.50.127	
(3)				1	0	198.125.50.128							to	198.125.50.191
(4)				1	1	198.125.50.192							to	198.125.50.255

$$\begin{array}{r} 128 \\ +64 \\ \hline 192 \end{array}$$

$$\begin{array}{r} 64 \\ -2 \\ \hline 62 \end{array}$$

Subnetting

Problem 13

Network Address **165.200.0.0 /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

What is the 10th subnet range? 165.200.2.64 to 165.200.2.127

What is the subnet number for the 11th subnet? 165.200.2.128

What is the subnet broadcast address for the 1023rd subnet? 165.200.255.191

What are the assignable addresses for the 1022nd subnet? 165.200.255.65 to 165.200.255.126

Show your work for Problem 13 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	4096	8192	16384	32768	65536
Binary values -	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
165 . 200 . 0 0 0 0 0 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
128	(1)															to 165.200.0.0
64	(2)															to 165.200.0.64
32	(3)															to 165.200.0.128
16	(4)															to 165.200.0.192
8	(5)															to 165.200.0.255
4	(6)															to 165.200.1.63
2	(7)															to 165.200.1.127
+1	(8)															to 165.200.1.191
252	(9)															to 165.200.1.255
	(10)															to 165.200.2.63
	(11)															to 165.200.2.127
	(12)															to 165.200.2.191
64	(13)															to 165.200.2.255
-2	(14)															to 165.200.3.63
62	(15)															to 165.200.3.127
	(16)															to 165.200.3.191
																to 165.200.3.255
(1021)	1	1	1	1	1	1	1	1	1	0	1	165.200.255.64	to 165.200.255.127			
(1022)	1	1	1	1	1	1	1	1	1	1	0	165.200.155.128	to 165.200.255.191			
(1023)	1	1	1	1	1	1	1	1	1	1	1	165.200.255.192	to 165.200.255.255			

Subnetting

Problem 14

Number of needed usable hosts **16**

Network Address **200.10.10.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 8

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 3

What is the 7th subnet range? 200.10.10.192 to 200.10.10.223

What is the subnet number for the 5th subnet? 200.10.10.128

What is the subnet broadcast address for the 4th subnet? 200.10.10.127

What are the assignable addresses for the 6th subnet? 200.10.10.161 to 200.10.10.190

Show your work for Problem 14 in the space below.

												Number of	
Number of Subnets			256	128	64	32	16	8	4	2	-	Hosts	
			-	2	4	8	16	32	64	128	256		
			128	64	32	16	8	4	2	1	-	Binary values	
200 . 10 . 10 . 0 0 0						0	0	0	0	0			
(1)					0	200.10.10.0					to	200.10.10.31	
(2)					1	200.10.10.32					to	200.10.10.63	
(3)				1	0	200.10.10.64					to	200.10.10.95	
(4)				1	1	200.10.10.96					to	200.10.10.127	
(5)			1	0	0	200.10.10.128					to	200.10.10.159	
(6)			1	0	1	200.10.10.160					to	200.10.10.191	
(7)			1	1	0	200.10.10.192					to	200.10.10.223	
(8)			1	1	1	200.10.10.224					to	200.10.10.255	

$$\begin{array}{r}
 128 \\
 64 \\
 +32 \\
 \hline
 224
 \end{array}
 \qquad
 \begin{array}{r}
 32 \\
 -2 \\
 \hline
 30
 \end{array}$$

Subnetting

Problem 15

Network Address **93.0.0.0 /19**

Address class A

Default subnet mask 255 . 0 . 0 . 0

Custom subnet mask 255 . 255 . 224 . 0

Total number of subnets 2,048

Total number of host addresses 8,192

Number of usable addresses 8,190

Number of bits borrowed 11

What is the 15th subnet range? 93.1.192.0 to 93.1.223.255

What is the subnet number for the 9th subnet? 93.1.0.0

What is the subnet broadcast address for the 7th subnet? 93.0.223.255

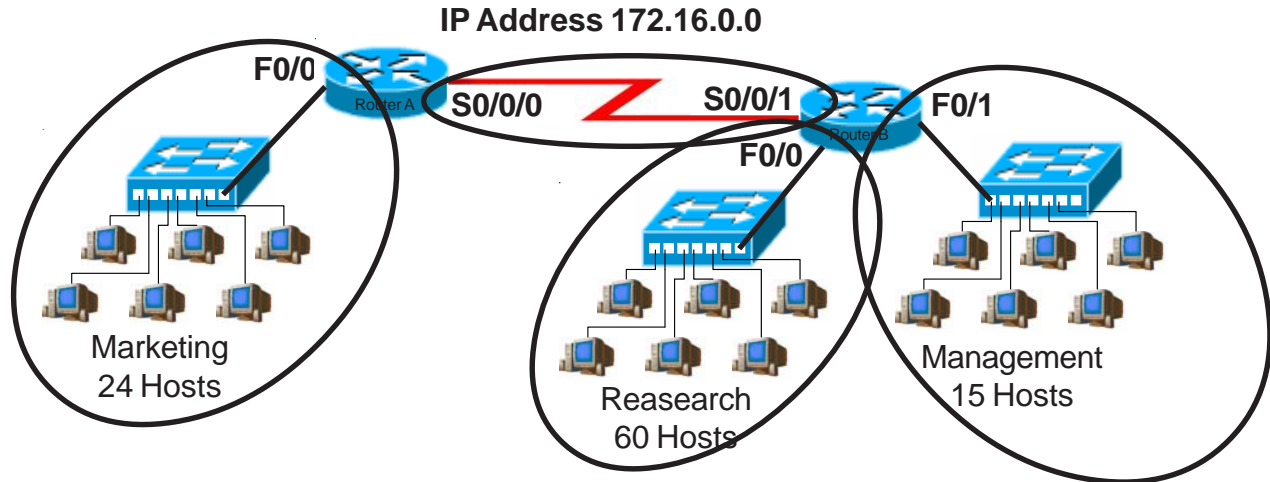
What are the assignable addresses for the 12th subnet? 93.1.96.1 to 93.1.127.254

Show your work for **Problem 15** in the space below.

Number of Hosts	1	2	4	8	16	32	64	128	256	512	1,024	2,048	4,096	8,192	16,384	32,768	65,536	131,072	262,144	524,288	1,048,576	2,097,152	4,194,304	8,388,608	16,777,216	33,554,432	67,108,864	134,217,728	268,435,456	536,870,912	1,073,741,824	2,147,483,648	4,294,967,296	8,589,934,592	17,179,869,184	34,359,738,368	68,719,476,736	137,438,953,472	274,877,906,944	549,755,813,888	1,099,511,627,776	2,199,023,255,552	4,398,046,511,104	8,796,093,022,208	17,592,186,044,416	35,184,372,088,832	70,368,744,177,664	140,737,488,355,328	281,474,976,710,656	562,949,953,421,312	1,125,899,906,842,624	2,251,799,813,685,248	4,503,599,627,370,496	9,007,199,254,740,992	18,014,398,509,481,984	36,028,797,018,963,968	72,057,594,037,927,936	144,115,188,075,855,872	288,230,376,151,711,744	576,460,752,303,423,488	1,152,921,504,606,846,976	2,305,843,009,213,693,952	4,611,686,018,427,387,904	9,223,372,036,854,775,808	18,446,744,073,709,551,616	36,893,488,147,419,103,232	73,786,976,294,838,206,464	147,573,952,589,676,412,928	295,147,905,179,352,825,856	590,295,810,358,705,651,712	1,180,591,620,717,411,303,424	2,361,183,241,434,822,606,848	4,722,366,482,869,645,213,696	9,444,732,965,739,290,427,392	18,889,465,931,478,580,844,784	37,778,931,862,957,161,689,568	75,557,863,725,914,323,379,136	151,115,727,451,828,646,758,272	302,231,454,903,657,293,516,544	604,462,909,807,314,587,033,088	1,208,925,819,614,629,174,066,176	2,417,851,639,229,258,348,132,352	4,835,703,278,458,516,696,264,704	9,671,406,556,917,033,392,529,408	19,342,813,113,834,066,785,058,816	38,685,626,227,668,133,570,117,632	77,371,252,455,336,267,141,235,264	154,742,504,910,672,534,282,470,528	309,485,009,821,345,068,564,941,056	618,970,019,642,690,137,129,082,112	1,237,940,039,285,380,274,258,164,224	2,475,880,078,570,760,548,516,328,448	4,951,760,157,141,521,097,033,656,896	9,903,520,314,283,042,194,067,313,792	19,807,040,628,566,084,388,134,627,584	39,614,081,257,132,168,776,269,255,168	79,228,162,514,264,337,552,538,510,336	158,456,325,028,528,675,105,107,072	316,912,650,057,057,350,210,214,144	633,825,300,114,114,700,420,428,288	1,267,650,600,228,229,400,840,856,576	2,535,301,200,456,458,801,681,713,152	5,070,602,400,912,917,603,363,426,304	10,141,204,801,825,835,206,726,852,608	20,282,409,603,651,670,413,453,705,216	40,564,819,207,303,340,826,907,410,432	81,129,638,414,606,681,653,814,820,864	162,259,276,829,213,363,307,629,641,728	324,518,553,658,426,726,615,259,283,456	649,037,107,316,853,453,230,518,566,912	1,298,074,214,633,706,906,461,037,133,824	2,596,148,429,267,413,812,922,074,267,648	5,192,296,858,534,827,625,845,844,535,296	10,384,593,717,069,655,251,691,689,070,592	20,769,187,434,139,310,503,383,378,141,184	41,538,374,868,278,621,006,766,756,282,368	83,076,749,736,557,242,013,533,512,564,736	166,153,499,473,114,484,027,067,025,129,472	332,306,998,946,228,968,054,134,050,258,944	664,613,997,892,457,936,108,268,100,517,888	1,329,227,995,784,915,872,216,536,216,035,776	2,658,455,991,569,831,744,433,072,432,071,552	5,316,911,983,139,663,488,866,144,864,143,104	10,633,823,966,279,326,977,732,289,728,286,208	21,267,647,932,558,653,955,464,579,456,572,416	42,535,295,865,117,307,910,929,138,913,144,832	85,070,591,730,234,615,821,858,277,827,289,664	170,141,183,460,469,231,643,715,755,654,579,328	340,282,366,920,938,463,287,431,511,309,158,656	680,564,733,841,876,926,574,863,022,618,317,312	1,361,129,467,683,753,853,149,726,125,636,634,624	2,722,258,935,367,507,706,298,452,251,273,269,248	5,444,517,870,735,015,412,596,904,904,546,538,496	
--------------------	---	---	---	---	----	----	----	-----	-----	-----	-------	-------	-------	-------	--------	--------	--------	---------	---------	---------	-----------	-----------	-----------	-----------	------------	------------	------------	-------------	-------------	-------------	---------------	---------------	---------------	---------------	----------------	----------------	----------------	-----------------	-----------------	-----------------	-------------------	-------------------	-------------------	-------------------	--------------------	--------------------	--------------------	---------------------	---------------------	---------------------	-----------------------	-----------------------	-----------------------	-----------------------	------------------------	------------------------	------------------------	-------------------------	-------------------------	-------------------------	---------------------------	---------------------------	---------------------------	---------------------------	----------------------------	----------------------------	----------------------------	-----------------------------	-----------------------------	-----------------------------	-------------------------------	-------------------------------	-------------------------------	-------------------------------	--------------------------------	--------------------------------	--------------------------------	---------------------------------	---------------------------------	---------------------------------	-----------------------------------	-----------------------------------	-----------------------------------	-----------------------------------	------------------------------------	------------------------------------	------------------------------------	-------------------------------------	-------------------------------------	-------------------------------------	---------------------------------------	---------------------------------------	---------------------------------------	---------------------------------------	--	--	--	-------------------------------------	-------------------------------------	-------------------------------------	---------------------------------------	---------------------------------------	---------------------------------------	--	--	--	--	---	---	---	---	---	---	--	--	--	--	---	---	---	---	---	---	--	--	--	--	---	---	---	---	---	---	--

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

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

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

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

[illegible]

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

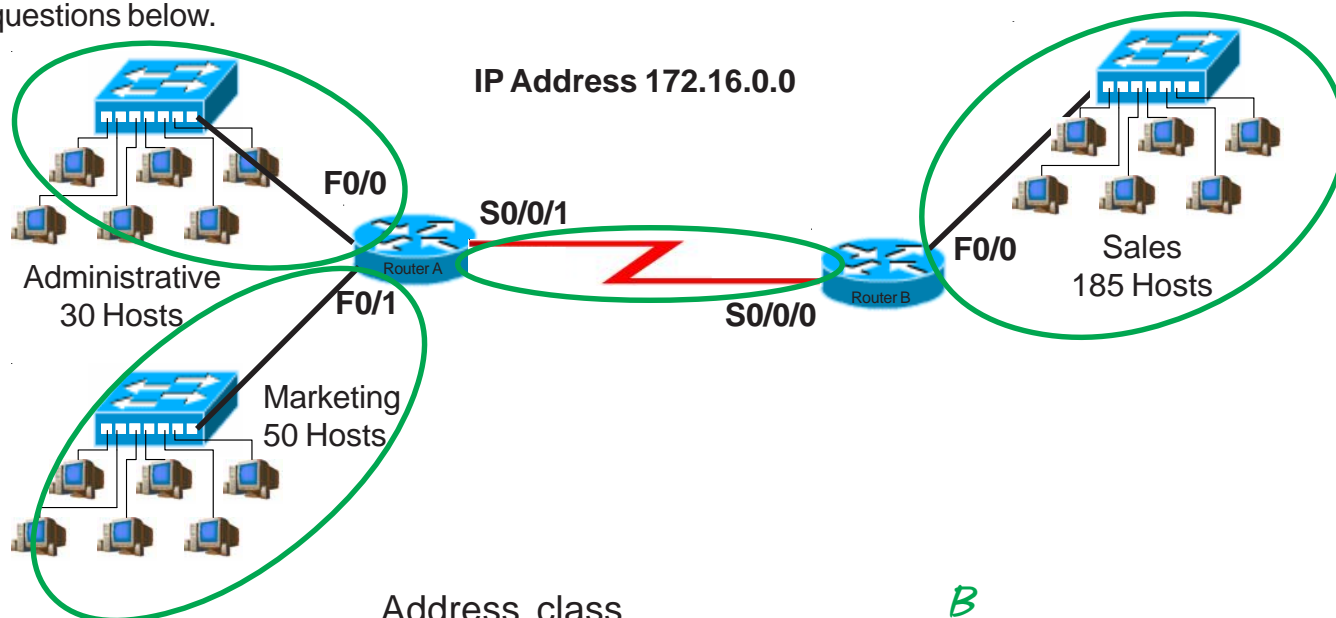
IP address range for Router A to Router B serial connection 135.126.0.128 to 135.126.0.159

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	1,024	2,048	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	0	0
(1)	.															
(2)																
(3)																
(4)																
(5)																
(6)																
(7)																
(8)																
(9)																
(10)																
(11)																
(12)																
(13)																
(14)																
(15)																
(16)																
5																
x.3																
1.5																
(Round up to 2)																
20																
x.3																
6																
135.126.0.31	to															
135.126.0.63	to															
135.126.0.95	to															
135.126.0.127	to															
135.126.0.159	to															
135.126.0.191	to															
135.126.0.223	to															
135.126.0.255	to															
135.126.1.31	to															
135.126.1.63	to															
135.126.1.95	to															
135.126.1.127	to															
135.126.1.159	to															
135.126.1.191	to															
135.126.1.223	to															
135.126.1.255	to															

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 B

Custom subnet mask 255.255.255.0

Minimum number of subnets needed 4

Extra subnets required for 25% growth + 1
(Round up to the next whole number)

Total number of subnets needed = 5

Number of host addresses in the largest subnet group 185

Number of addresses needed for 25% growth in the largest subnet + 47
(Round up to the next whole number)

Total number of address needed for the largest subnet = 232

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

IP address range for Sales 172.16.0.0 to 172.16.0.255

IP address range for Marketing 172.16.1.0 to 172.16.1.255

IP address range for Administrative 172.16.2.0 to 172.16.2.255

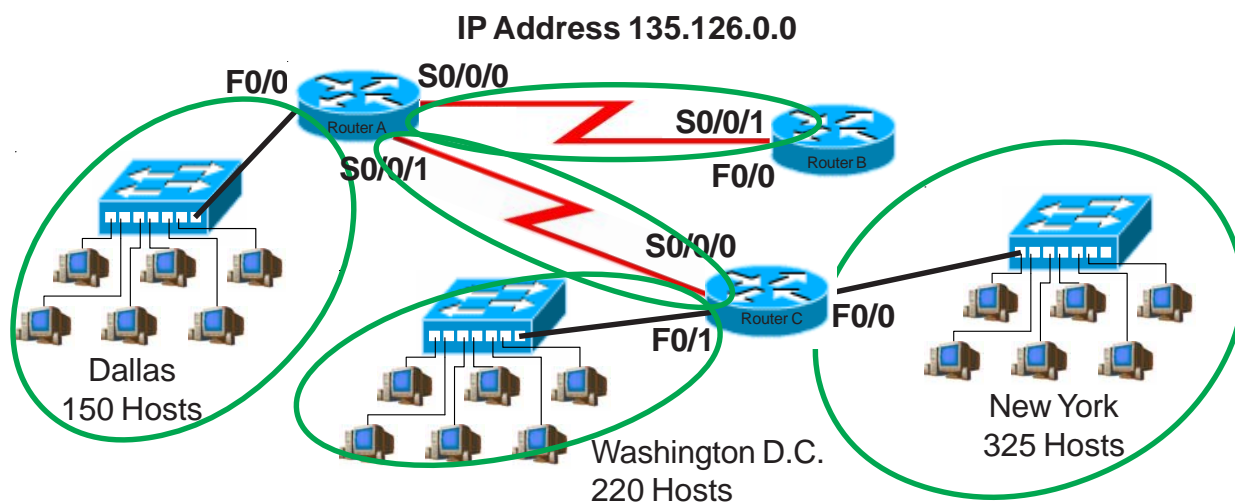
IP address range for Router A to Router B serial connection 172.16.3.0 to 172.16.3.255

Show your work for Problem 3 in the space below.

[illegible]

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 _____

B

Custom subnet mask _____

255.255.240.0

Minimum number of subnets needed _____

5

Extra subnets required for 70% growth
(Round up to the next whole number)

+ 4

Total number of subnets needed _____

= 9

Number of host addresses
in the largest subnet group _____

325

Number of addresses needed for
70% growth in the largest subnet
(Round up to the next whole number)

+ 228

Total number of address
needed for the largest subnet _____

= 553

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

IP address range for New York *135.126.0.0 to 135.126.15.255*

IP address range for Washington D. C. *135.126.16.0 to 135.126.31.255*

IP address range for Dallas *135.126.32.0 to 135.126.47.255*

IP address range for Router A
to Router B serial connection *135.126.48.0 to 135.126.63.255*

IP address range for Router A
to Router C serial connection *135.126.64.0 to 135.126.79.255*

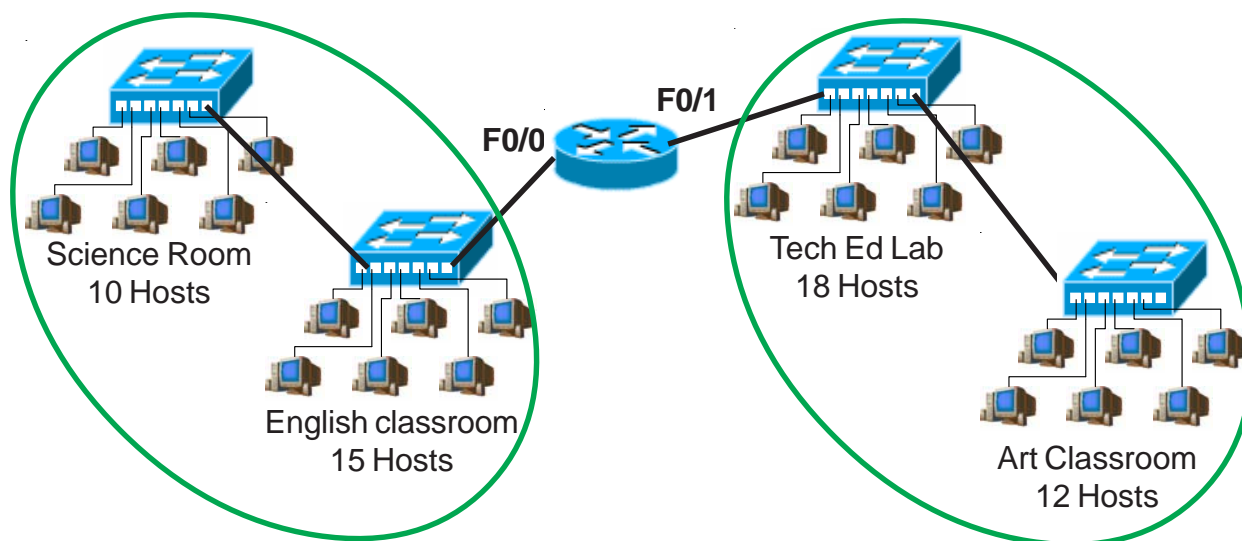
Show your work for Problem 4 in the space below.

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	1,024	2,048	4,096	8,192	16,384	32,768	65,536
Binary values -	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	0	0
(1)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
(2)	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(3)	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
(4)	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(5)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(6)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(7)	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(8)	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
(9)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(10)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(11)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(12)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(13)	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(14)	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(15)	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
(16)	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
135.126.0.0	135.126.0.0	135.126.16.0	135.126.32.0	135.126.48.0	135.126.64.0	135.126.80.0	135.126.96.0	135.126.112.0	135.126.128.0	135.126.144.0	135.126.160.0	135.126.176.0	135.126.192.0	135.126.208.0	135.126.224.0	135.126.240.0
to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to
135.126.15.255	135.126.31.255	135.126.47.255	135.126.63.255	135.126.79.255	135.126.95.255	135.126.111.255	135.126.127.255	135.126.143.255	135.126.159.255	135.126.175.255	135.126.191.255	135.126.207.255	135.126.223.255	135.126.239.255	135.126.255.255	135.126.255.255

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	<u>C</u>
Custom subnet mask	<u>255.255.255.192</u>
Minimum number of subnets needed	<u>2</u>
Extra subnets required for 100% growth (Round up to the next whole number)	<u>+ 2</u>
Total number of subnets needed	<u>= 4</u>
Number of host addresses in the largest subnet group	<u>30</u>
Number of addresses needed for 100% growth in the largest subnet (Round up to the next whole number)	<u>+ 30</u>
Total number of address needed for the largest subnet	<u>= 60</u>

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 210.15.10.0 to 210.15.10.63

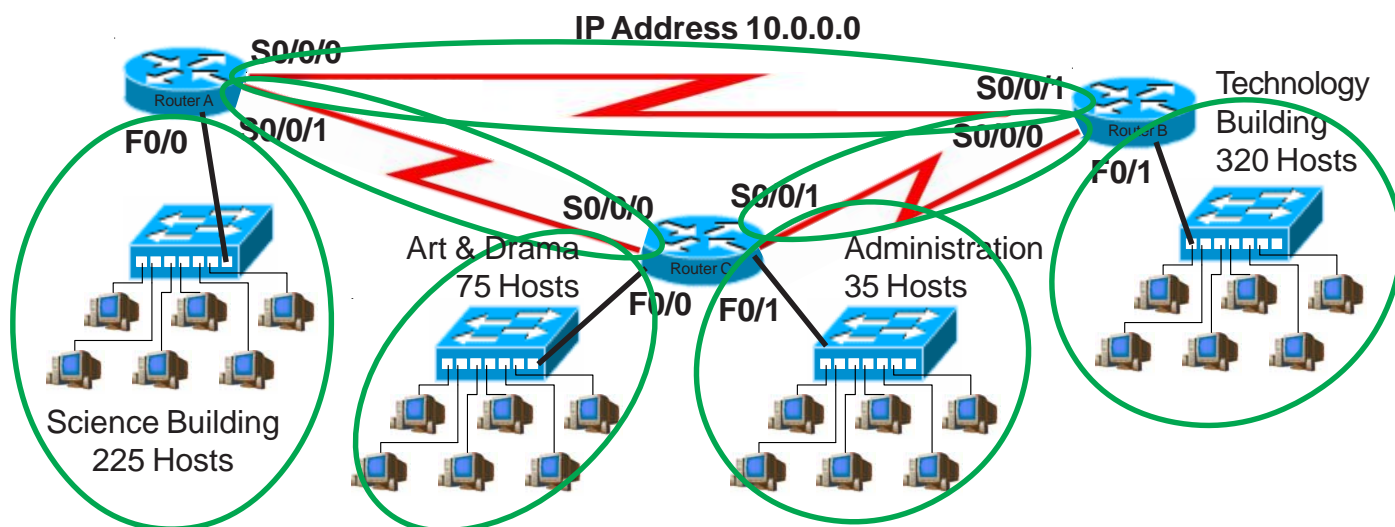
IP address range for Router F0/1 Port 210.15.10.64 to 210.15.10.127

Show your work for Problem 5 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. 15 . 10 . 0 0 0 0 0 0 0 0											
(1)	0	210.15.10.0				to		210.15.10.63			
(2)	1	210.15.10.64				to		210.15.10.127			
(3)	1 0	210.15.10.128				to		210.15.10.191			
(4)	1 1	210.15.10.192				to		210.15.10.255			

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	<u>A</u>
Custom subnet mask	<u>255.240.0.0</u>
Minimum number of subnets needed	<u>7</u>
Extra subnets required for 20% growth (Round up to the next whole number)	<u>+ 2</u>
Total number of subnets needed	<u>= 9</u>

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

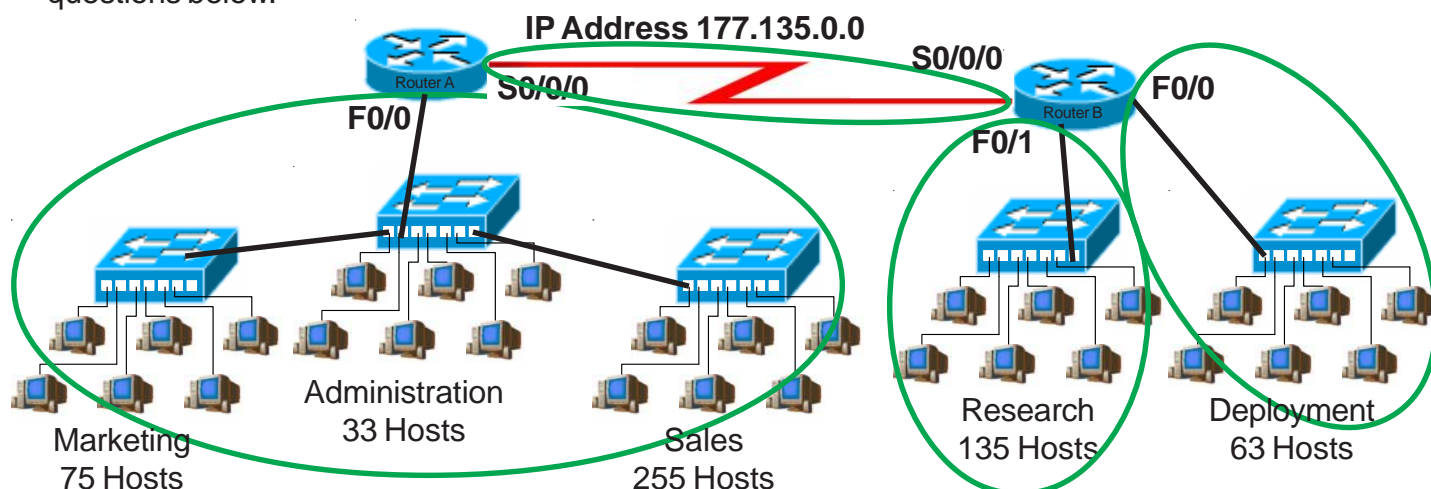
IP address range for Technology	<u>10.0.0.0 to 10.15.255.255</u>
IP address range for Science	<u>10.16.0.0 to 10.31.255.255</u>
IP address range for Arts & Drama	<u>10.32.0.0 to 10.47.255.255</u>
IP Address range Administration	<u>10.48.0.0 to 10.63.255.255</u>
IP address range for Router A to Router B serial connection	<u>10.64.0.0 to 10.79.255.255</u>
IP address range for Router A to Router C serial connection	<u>10.80.0.0 to 10.95.255.255</u>
IP address range for Router B to Router C serial connection	<u>10.96.0.0 to 10.111.255.255</u>

Show your work for Problem 6 in the space below.

[illegible]

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

B

Custom subnet mask

255.255.252.0

Minimum number of subnets needed

4

Extra subnets required for 125% growth
(Round up to the next whole number)

+ 5

Total number of subnets needed

= 9

Number of host addresses
in the largest subnet group

363

Number of addresses needed for
125% growth in the largest subnet
(Round up to the next whole number)

+ 454

Total number of address
needed for the largest subnet

= 817

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

177.135.0.0 to 177.135.3.255

IP address range for Research

177.135.4.0 to 177.135.7.255

IP address range for Deployment

177.135.8.0 to 177.135.11.255

IP address range for Router A
to Router B serial connection

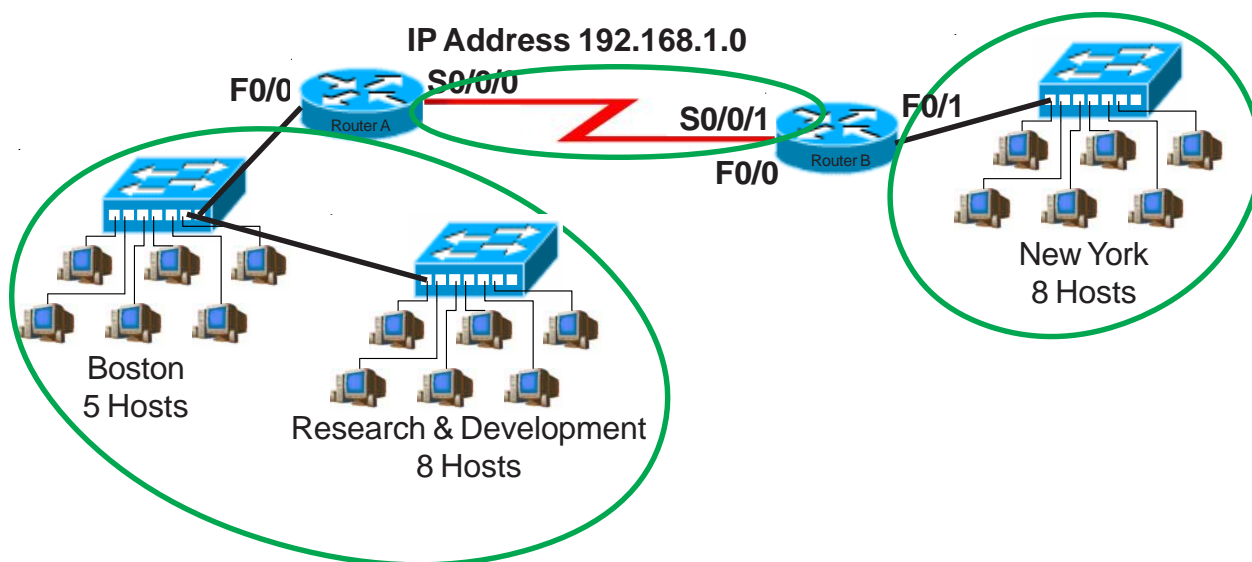
177.135.12.0 to 177.135.15.255

Show your work for Problem 7 in the space below.

Number of Hosts	2	4	8	16	32	64	128	256	512	1,024
Number of Subnets	2	4	8	16	32	64	128	256	512	1,024
Binary values	128	64	32	16	8	4	2	1	1	2
177.135	0	0	0	0	0	0	0	0	0	0
(1)	177.135.0.0	to	177.135.0.0							
(2)	177.135.4.0	to	177.135.4.0							
(3)	177.135.8.0	to	177.135.8.0							
(4)	177.135.12.0	to	177.135.12.0							
(5)	177.135.16.0	to	177.135.16.0							
(6)	177.135.20.0	to	177.135.20.0							
(7)	177.135.24.0	to	177.135.24.0							
(8)	177.135.28.0	to	177.135.28.0							
(9)	177.135.32.0	to	177.135.32.0							
(10)	177.135.36.0	to	177.135.36.0							
(11)	177.135.40.0	to	177.135.40.0							
(12)	177.135.44.0	to	177.135.44.0							
(13)	177.135.48.0	to	177.135.48.0							
(14)	177.135.52.0	to	177.135.52.0							
(15)	177.135.56.0	to	177.135.56.0							
(16)	177.135.60.0	to	177.135.60.0							

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 _____

C

Custom subnet mask _____

255.255.255.224

Minimum number of subnets needed _____

3

Extra subnets required for 85% growth
(Round up to the next whole number)

+ 3

Total number of subnets needed _____

= 6

Number of host addresses
in the largest subnet group _____

13

Number of addresses needed for
85% growth in the largest subnet
(Round up to the next whole number)

+ 12

Total number of address
needed for the largest subnet _____

= 25

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 _____

192.168.1.0 to 192.168.1.31

IP address range for New York _____

192.168.1.32 to 192.168.1.63

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

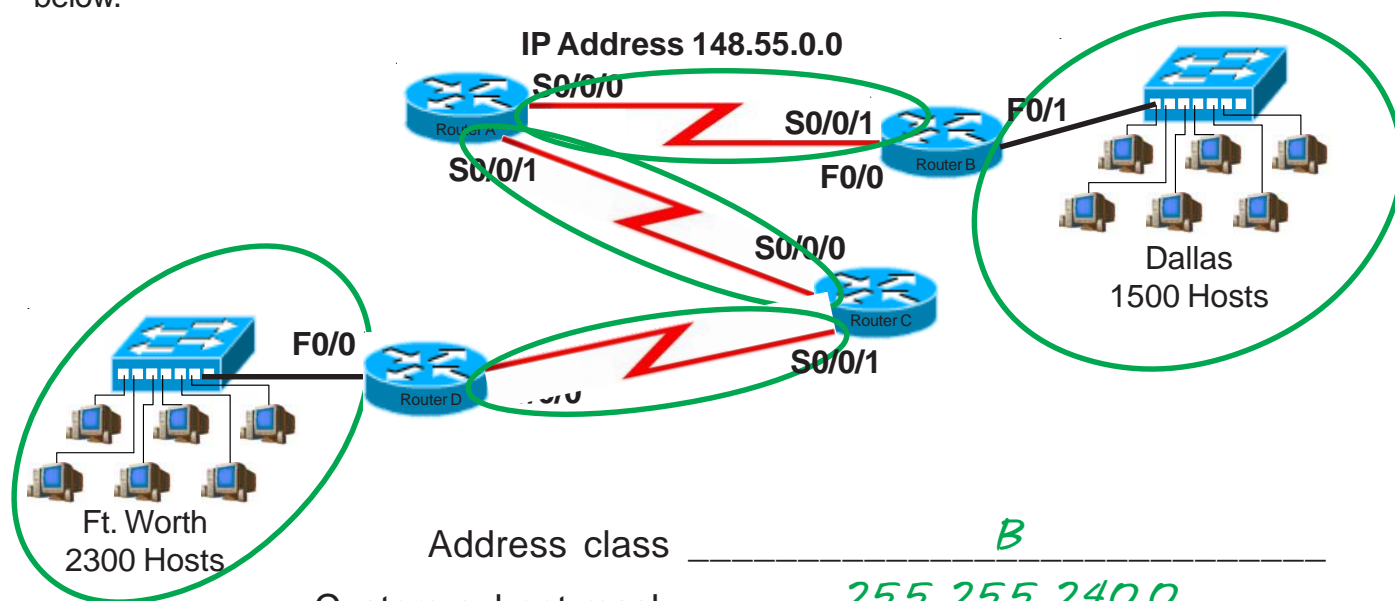
192.168.1.64 to 192.168.1.95

Show your work for Problem 8 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
192.168.1.0 0 0 0 0 0										
(1)			0							192.168.1.0 to 192.168.1.31
(2)			1							192.168.1.32 to 192.168.1.63
(3)		1	0							192.168.1.64 to 192.168.1.95
(4)		1	1							192.168.1.96 to 192.168.1.127
(5)	1	0	0							192.168.1.128 to 192.168.1.159
(6)	1	0	1							192.168.1.160 to 192.168.1.191
(7)	1	1	0							192.168.1.192 to 192.168.1.223
(8)	1	1	1							192.168.1.224 to 192.168.1.255

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	<u>B</u>
Custom subnet mask	<u>255.255.240.0</u>
Minimum number of subnets needed	<u>5</u>
Extra subnets required for 15% growth (Round up to the next whole number)	<u>+ 1</u>
Total number of subnets needed	<u>= 6</u>
Number of host addresses in the largest subnet group	<u>2300</u>
Number of addresses needed for 15% growth in the largest subnet (Round up to the next whole number)	<u>+ 345</u>
Total number of address needed for the largest subnet	<u>= 2645</u>

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

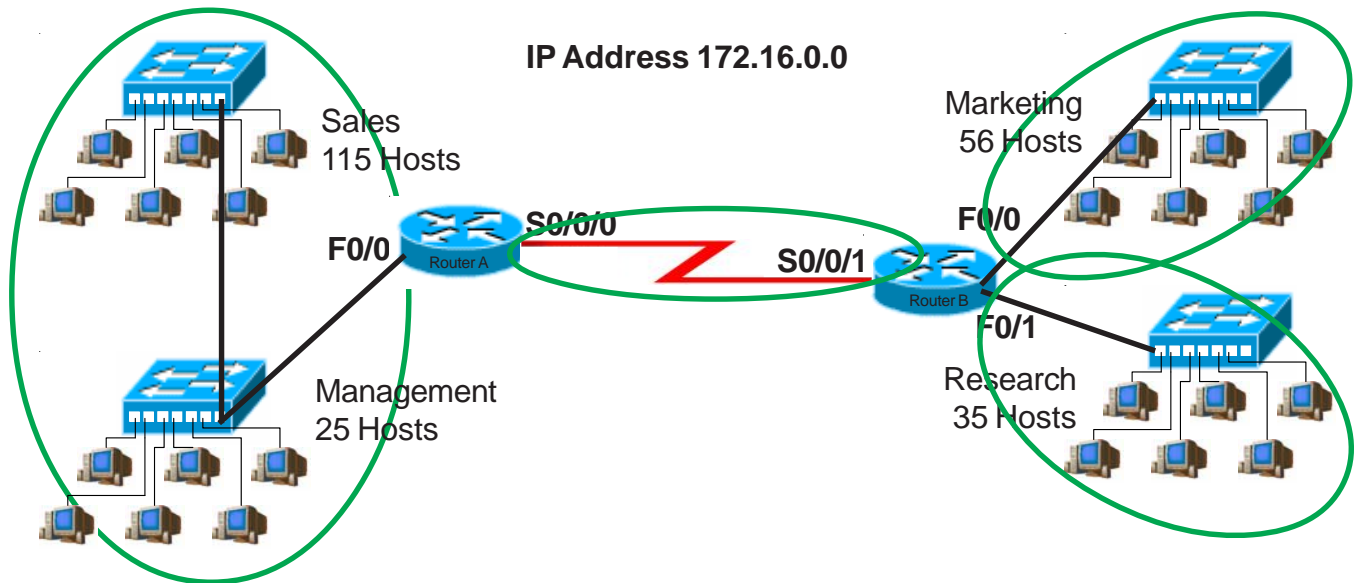
IP address range for Ft. Worth	<u>148.55.0.0 to 148.55.15.255</u>
IP address range for Dallas	<u>148.55.16.0 to 148.55.31.255</u>
IP address range for Router A to Router B serial connection	<u>148.55.32.0 to 148.55.47.255</u>
IP address range for Router A to Router C serial connection	<u>148.55.48.0 to 148.55.63.255</u>
IP address range for Router C to Router D serial connection	<u>148.55.64.0 to 148.55.79.255</u>

Show your work for Problem 9 in the space below.

Number of Hosts -	2	4	8	16	32	64	128	256	512	1,024	2,048	4,096	8,192	16,384	32,768	65,536
Number of Subnets -	1	2	4	8	16	32	64	128	256	512	1,024	2,048	4,096	8,192	16,384	32,768
Binary values -	128	64	32	16	8	4	2	1								
148.55.0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.															
(2)																
(3)																
(4)																
(5)																
(6)																
(7)																
(8)																
(9)																
(10)																
(11)																
(12)																
(13)																
(14)																
(15)																
(16)																

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	<u>B</u>
Custom subnet mask	<u>255.255.255.240</u>
Minimum number of subnets needed	<u>4</u>
Extra subnets required for 110% growth (Round up to the next whole number)	<u>+ 5</u>
Total number of subnets needed	<u>= 9</u>
Number of host addresses in the largest subnet group	<u>140</u>
Number of addresses needed for 110% growth in the largest subnet (Round up to the next whole number)	<u>+ 154</u>
Total number of address needed for the largest subnet	<u>= 294</u>

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

IP address range for Sales/Management	<u>172.16.0.0 to 172.16.15.255</u>
IP address range for Marketing	<u>172.16.16.0 to 172.16.31.255</u>
IP address range for Research	<u>172.16.32.0 to 172.16.47.255</u>
IP address range for Router A to Router B serial connection	<u>172.16.48.0 to 172.16.63.255</u>

Show your work for Problem 10 in the space below.

Number of Hosts -	8,192	16,384	32,768	65,536	256	512	1,024	2,048	4,096	8,192	16,384	32,768	65,536
Number of Subnets -	16	8	4	2	1	1	2	4	8	16	32	64	128
Binary values -	128	64	32	16	8	4	2	1	256	512	1,024	2,048	4,096
172.16.0.0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	0								172.16.0.0	to	172.16.15.255		
(2)	1								172.16.16.0	to	172.16.31.255		
(3)		1							172.16.32.0	to	172.16.47.255		
(4)		1	1						172.16.48.0	to	172.16.63.255		
(5)		1	0	0					172.16.64.0	to	172.16.79.255		
(6)		1	0	1					172.16.80.0	to	172.16.95.255		
(7)		1	1	0					172.16.96.0	to	172.16.111.255		
(8)		1	1	1					172.16.112.0	to	172.16.127.255		
(9)	1	0	0	0					172.16.128.0	to	172.16.143.255		
(10)	1	0	0	1					172.16.144.0	to	172.16.159.255		
(11)	1	0	1	0					172.16.160.0	to	172.16.175.255		
(12)	1	0	1	1					172.16.176.0	to	172.16.191.255		
(13)	1	1	0	0					172.16.192.0	to	172.16.207.255		
(14)	1	1	1	0					172.16.208.0	to	172.16.223.255		
(15)	1	1	1	1					172.16.224.0	to	172.16.239.255		
(16)	1	1	1	1					172.16.240.0	to	172.16.255.255		

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

245 is reserved for experimental use.

IP Address: 135.70.191.255

Subnet Mask: 255.255.254.0

Reference Pages 48-49

This is the broadcast address for this range.

IP Address: 127.100.100.10

Subnet Mask: 255.0.0.0

Reference Pages Inside Front Cover

127 is reserved for loopback testing.

IP Address: 93.0.128.1

Subnet Mask: 255.255.224.0

Reference Pages 56-57

OK

IP Address: 200.10.10.128

Subnet Mask: 255.255.255.224

Reference Pages 54-55

This is the subnet address for the 3rd usable range of 200.10.10.0

IP Address: 165.100.255.189

Subnet Mask: 255.255.255.192

Reference Pages 30-31

OK

IP Address: 190.35.0.10

Subnet Mask: 255.255.255.192

Reference Pages 34-35

This address is taken from the first range for this subnet which is invalid.

IP Address: 218.35.50.195

Subnet Mask: 255.255.0.0

Reference Page Inside Front Cover

This has a class B subnet mask.

IP Address: 200.10.10.175 /22

Reference Pages 54-55 and/or Inside Front Cover

A class C address must use a minimum of 24 bits.

IP Address: 135.70.255.255

Subnet Mask: 255.255.224.0

Reference Pages 48-49

This is a broadcast address.

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

Visualizing Subnets Using The Box Method

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

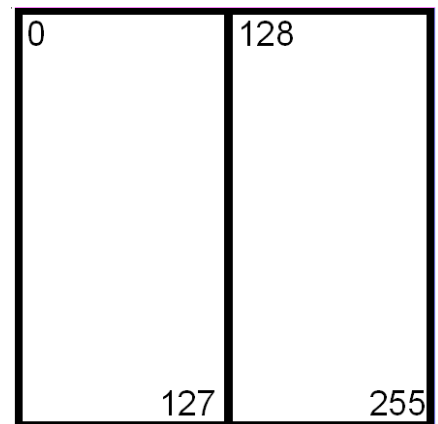
Start with a square. The whole square is a single subnet comprised of 256 addresses.

/24
255.255.255.0
256 Hosts
1 Subnet



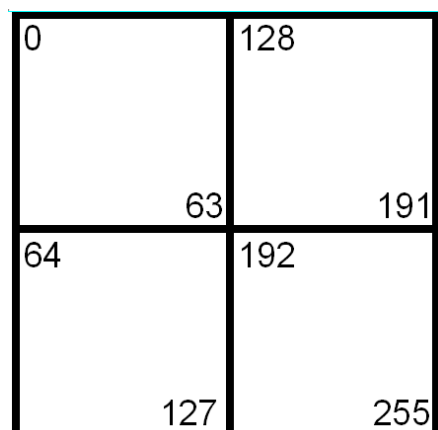
Split the box in half and you get two subnets with 128 addresses,

/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

