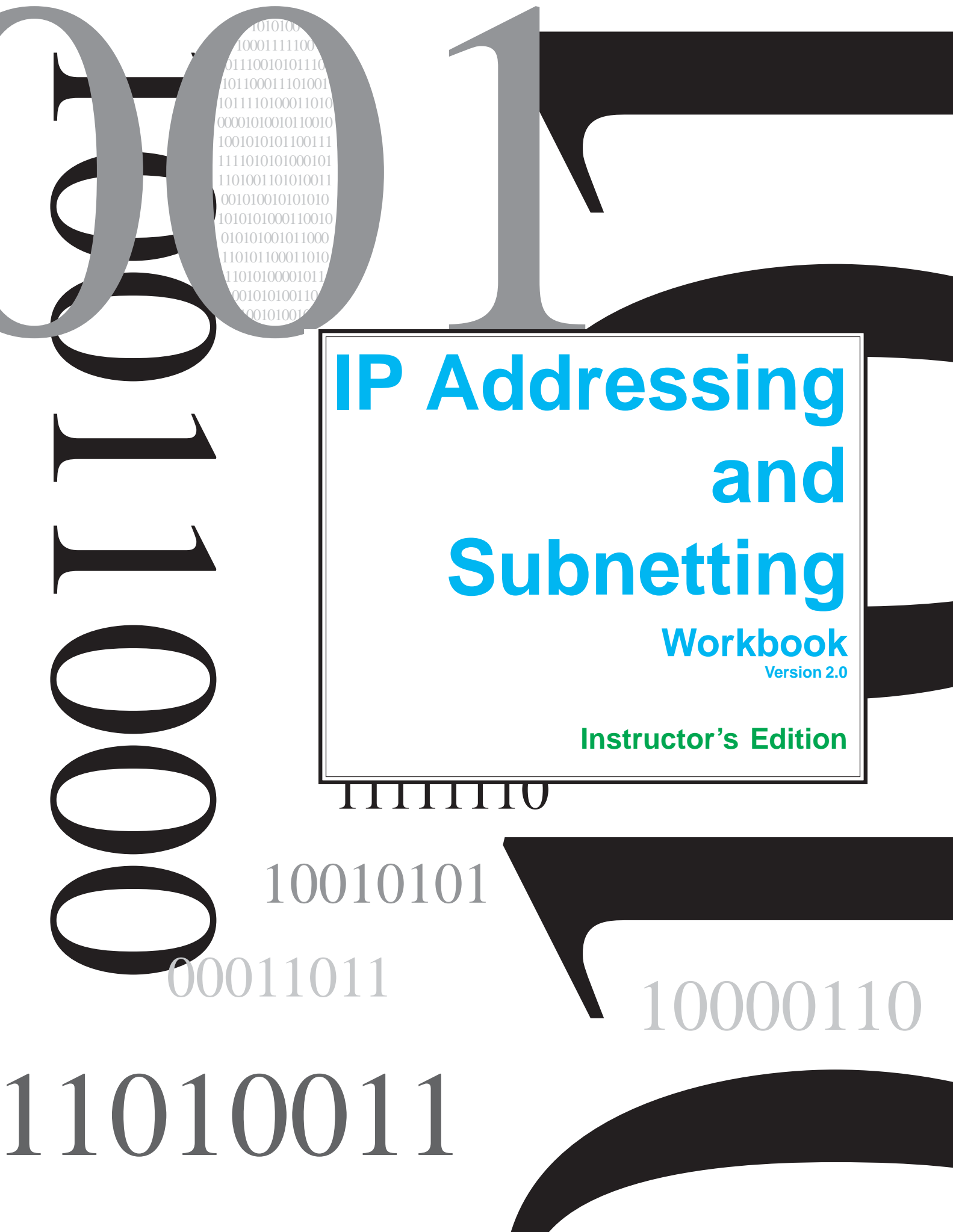


IP Addressing and Subnetting

Workbook
Version 2.0

Instructor's Edition



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

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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 pirmarily with the broadcast addresses. If you send a broadcast to 195.223.255 are you sending it to all 255 addresses in the classful C address or just the 62 usable addresses in the broadcast range?

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

When to use which formula to determine the number of subnets	
Use the $2^S - 2$ formula and <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	
255	

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

1024	
-2	
1,022	Subtract 2 for the total number of subnets to get the usable number of subnets.

Custom Subnet Masks

Problem 4

Number of needed subnets **6**

Number of needed usable hosts **30**

Network Address **195.85.8.0**

Address class 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		

128	32	8
64	-2	-2
+32		
<u>224</u>	<u>30</u>	<u>6</u>

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 6

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

Address class **A**

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

Custom subnet mask **255 . 254 . 0 . 0**

Total number of subnets **128**

Total number of host addresses **131,072**

Number of usable addresses **131,070**

Number of bits borrowed **7**

Show your work for **Problem 6** 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	272225893536750770770699685945414569152	544451787073501541541399371890829138304	1088903574147003083082798743781658276608	2177807148294006166165597487563316553216	4355614296588012332331194975126633106432	8711228593176024664662389950253266212864	17422457186352049329324779900506532425728	34844914372704098658649559801013064851456	69689828745408197317299119602026129702912	139379657490816394634598239204052259405824	278759314981632789269196478408104518811648	557518629963265578538392956816209037623296	1115037259926531157076785913632418075246592	2230074519853062314153571827264836150493184	4460149039706124628307143654529672300986368	8920298079412249256614287309059344601972736	17840596158824498513228574618118689203945472	35681192317648997026457149236237378407890848	71362384635297994052914298472474756815781696	142724769270595988105828596944949513631563392	285449538541191976211657193889899027263126784	570899077082383952423314387779798054526253568	1141798154164767904846628775559596109052507136	2283596308329535809693257551119192218105014272	4567192616659071619386515102238384436210028544	9134385233318143238773030204476768872420057088	18268770466636286477546060408953537744840114176	36537540933272572955092120817907075489680228352	73075081866545145910184241635814150979360456704	146150163733090291820368483271628301958720913408	292300327466180583640736966543256603917441826816	584600654932361167281473933086513207834883653632	1169201309864722334562947866173026415669767307264	2338402619729444669125895732346052831339534614528	4676805239458889338251791464692105662679069229056	9353610478917778676503582929384211325358138458112	18707220957835557353007165858768422650716276916224	37414441915671114706014331717536845301432553832448	74828883831342229412028663435073690602865107664896	149657767662684458824057326870147381205730215329792	299315535325368917648114653740294762411460430659584	598631070650737835296229307480589524822920861319168	1197262141301475670592458614961179049645841722638336	2394524282602951341184917229922358099291683445276672	4789048565205902682369834459844716198583366890553344	9578097130411805364739668919689432397166733781106688	19156194260823610729479337839378864794333467562213376	38312388521647221458958675678757729588666935124426752	76624777043294442917917351357515459177333870248853504	153249554086588885835834702715030918354667740497707008	306499108173177771671669405430061836709335480995414016	612998216346355543343338810860123673418670961990828032	1225996432692711086686677621720247346837341923981665664	2451992865385422173373355243440494693674683847963331328	4903985730770844346746710486880989387349367695926662656	9807971461541688693493420973761978774698735391853325312	19615942923083377386986841947523957549397470783706650624	39231885846166754773973683895047915098794941567413301248	78463771692333509547947367790095830197589883134826602496	156927543384667019095894735580191660395179766269653204992	313855086769334038191789471160383320790359532539306409984	627710173538668076383578942320766641580719065078612819968	1255420347077336152767157884641533283161438130157225639936	2510840694154672305534315769283066566322876260314451279872	5021681388309344611068631538566133132645752520628902559744	10043362776618689222137263077132266265291505041257805119488	20086725553237378444274526154264532530583010082515610238976	40173451106474756888549052308529065061166020165031220477952	80346902212949513777098104617058130122332040330062440955904	160693804425899027554196209234116260244664080660124881911808	321387608851798055108392418468232520489328161320249763837616	642775217703596110216784836936465040978656322640499527675232	1285550435407192220433569673872930081957312645280999055350464	2571100870814384440867139347745860163914625290561998110700928	5142201741628768881734278695491720327829250581123996221401856	10284403483257537763468557390983440655658501162247992442803712	20568806966515075526937114781966881311317002324495984885607424	41137613933030151053874229563933762622634004648991969771214848	82275227866060302107748459127867525245268009297983939542429696	164550455732120604215496918255735050490536018595967879084859392	329100911464241208430993836511470100981072037191935758169718784	658201822928482416861987673022940201962144074383871516339437568	1316403645856964833723975346045880403924288148767743032678875136	2632807291713929667447950692091760807848576297535486065357750272	5265614583427859334895901384183521615697152595070972130715500544	10531229166855718669791802768367043231394305190141944261431001088	21062458333711437339583605536734086462788610380283888522862002176	42124916667422874679167211073468172925577220760567777045724004352	84249833334845749358334422146936345851154441521135554091448008704	168499666669691498716668844293872691702308883042271108182896017408	336999333339382997433337688587745383404617766084542216365792034816	673998666678765994866675377175490766809235532169084432731584069632	1347997333357531989733350754350981533618471064338168865463168138656	2695994666715063979466701508701963067236942128676337730926336277312	5391989333430127958933403017403926134473884257352675461852672554624	10783978666860255917866806034807852268947768514705350923705345109248	21567957333720511835733612069615704537895537029410701847410690218496	43135914667441023671467224139231409075791074058821403694821380436992	86271829334882047342934448278462818151582148117642807389642760873984	172543658669764094685868896556925636303164296235285614779285521747968	345087317339528189371737793113851272606328592470571229558571043495936	690174634679056378743475586227702545212657184941142459117142086991872	1380349269358112757486951172455405090425314369882284918234284173983744	2760698538716225514973902344910810180850628739764569836468568347967488	5521397077432451029947804689821620361701257479529139672937136695934976	1104279415486490205989560937964324072340251495905827934587427339186992	2208558830972980411979121875928648144680502991811655869174854678373984	4417117661945960823958243751857296289361005983623311738349709356747968	8834235323891921647916487503714592578722011967246623476699418713495936	17668470647783843295832975007429185157444023934493246953398837426991872	35336941295567686591665950014858370314888047868986493906797674853983744	70673882591135373183331900029716740629776095737972987813595349707967488	141347765182270746366663800059433481259552191475945975627190699415934976	282695530364541492733327600118866962519104382951891951254381398831869952	565391060729082985466655200237733925038208765903783902508762797663739904	1130782121458165970933310400475467850076417531807567805017525595327479808	2261564242916331941866620800950935700152835063615135610035051190654959616	4523128485832663883733241601901871400305670127230271220070102381309919232	9046256971665327767466483203803742800611340254460542440140204762619838464	18092513943330655534932966407607485601222680508921084880280409525239676928	36185027886661311069865932815214971202445361017842169760560819050479353856	72370055773322622139731865630429942404890722035684339521121638100958707712	144740111546645244279463731260559884809781444071368679042243276201917415424	289480223093290488558927462521119769619562888142737358084486552403834830848	578960446186580977117854925042239539239125776285474716168973104807669661696	1157920892373161954235709850084479078478251552570949432337946209615339323392	2315841784746323908471419700168958156956503105141898864675892419230678646784	4631683569492647816942839400337916313913006210283797729351784838461357293568	9263367138985295633885678800675832627826012420567595458703569676922714587136	18526734277970591267771357601351665255652024841135190917407139353845429174272	37053468555941182535542715202703330511304049682270381834814278707690858348544	74106937111882365071085430405406661022608099364540763669628557415381716697088	1482138742237647301421708608108133220452161987290815273392
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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	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
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
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		

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	170141183460469231731687303715884105216	340282366920938463463374607431768210432	680564733841876926926749214863536420864	1361129467683753853853498429727072841728	2722258935367507707706996859454145683456	5444517870735015415413993718908291366912	10889035741470030830827987437816582733824	21778071482940061661655974875633165467648	43556142965880123323311949751266330935296	87112285931760246646623899502532661870592	174224571863520493293247799005065323541184	348449143727040986586495598010130647082368	696898287454081973172991196020261294164736	1393796574908163946345982392040522588329472	2787593149816327892691964784081045176658944	5575186299632655785383929568162090353317888	11150372599265311570767859136324180706635776	223007451985306231415357182726483614
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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
<u>224</u>	<u>62</u>	<u>2</u>

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.

[illegible]

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	272225893536750770770699685945414569152	544451787073501541541399371890829138304	1088903574147003083082798743781658276608	2177807148294006166165597487563316553216	4355614296588012332331194975126633106432	8711228593176024664662389950253266212864	17422457186352049329324779900506532425728	34844914372704098658649559801013064851456	69689828745408197317299119602026129702912	139379657490816394634598239204052259405824	278759314981632789269196478408104518811648	557518629963265578538392956816209037623296	1115037259926531157076785913632418075246592	2230074519853062314153571827264836150493184	4460149039706124628307143654529672300986368	8920298079412249256614287309059344601972736	17840596158824498513228574618118689203945472	35681192317648997026457149236237378407890848	71362384635297994052914298472474756815781696	142724769270595988105828596944949513631563392	285449538541191976211657193889899027263126784	570899077082383952423314387779798054526253568	1141798154164767904846628775559596109052507136	2283596308329535809693257551119192218105014272	4567192616659071619386515102238384436210028544	9134385233318143238773030204476768872420057088	18268770466636286477546060408953537744840114176	36537540933272572955092120817907075489680228352	73075081866545145910184241635814150979360456704	146150163733090291820368483271628301958720913408	292300327466180583640736966543256603917441826816	584600654932361167281473933086513207834883653632	1169201309864722334562947866173026415669767307264	2338402619729444669125895732346052831339534614528	4676805239458889338251791464692105662679069229056	9353610478917778676503582929384211325358138458112	18707220957835557353007165858768422650716276916224	37414441915671114706014331717536845301432553832448	74828883831342229412028663435073690602865107664896	149657767662684458824057326870147381205730215329792	299315535325368917648114653740294762411460430659584	598631070650737835296229307480589524822920861319168	1197262141301475670592458614961179049645841722638336	2394524282602951341184917229922358099291683445276672	4789048565205902682369834459844716198583366890553344	9578097130411805364739668919689432397166733781106688	19156194260823610729479337839378864794333467562213376	38312388521647221458958675678757729588666935124426752	76624777043294442917917351357515459177333870248853504	153249554086588885835834702715030918354667740497707008	306499108173177771671669405430061836709335480995414016	612998216346355543343338810860123673418670961990828032	1225996432692711086686677621720247346837341923981665664	2451992865385422173373355243440494693674683847963331328	4903985730770844346746710486880989387349367695926662656	9807971461541688693493420973761978774698735391853325312	19615942923083377386986841947523957549397470783706650624	39231885846166754773973683895047915098794941567413301248	78463771692333509547947367790095830197589883134826602496	156927543384667019095894735580191660395179766269653204992	31385508676933403819178947116038332079035953253930640992	62771017353866807638357894232076664158071906507861281984	125542034707733615276715788464153328316143813015722563968	251084069415467230553431576928306656632287626031445127936	502168138830934461106863153856613313264575252062890255872	1004336277661868922213726307713226626529150504125780511744	2008672555323737844427452615426453253058301008251561023488	4017345110647475688854905230852906506116602016503122046976	8034690221294951377709810461705813012233204033006244093952	1606938044258990275541962092341162602446640806601248818784	3213876088517980551083924184682325204893281613202497637568	6427752177035961102167848369364650409786563226404995275136	1285550435407192220433569673872930081957312645280990550272	2571100870814384440867139347745860163914625290561981100544	5142201741628768881734278695491720327829250581123962201088	1028440348325753776346855739098344065565850116224792402176	2056880696651507552693711478196688131131700232449584804352	4113761393303015105387422956393376262263400464899169608704	8227522786606030210774845912786752524526800929798339217408	16455045573212060421549691825573505049053601859596678434816	32910091146424120843099383651147010098107203719193356869632	65820182292848241686198767302294020196214407438386713739264	131640364585696483372397534604588040392428814876773427478528	263280729171392966744795069209176080784857629753546854957056	526561458342785933489590138418352161569715259507093709914112	1053122916685571866979180276836704323139430519014187419828224	2106245833371143733958360553673408646278861038028374839656448	4212491666742287467916721107346817292557722076056749679312896	8424983333484574935833442214693634585115444152113499358625792	16849966666969149871666884429387269170230888304226998717251584	33699933333938299743333768858774538340461776608453997434503168	67399866667876599486667537717549076680923553216907994869006336	134799733335753198973335075435098153361847106433815989738012672	269599466671506397946670150870196306723694212867631979476025344	539198933343012795893340301740392613447388425735263958952050688	1078397866686025591786680603480785226894776851470527917904101376	2156795733372051183573361206961570453789553702941055835808202752	4313591466744102367146722413923140907579107405882111671616405504	8627182933488204734293444827846281815158214811764223343232811008	17254365866976409468586889655692563630316429623528446686465622016	34508731733952818937173779311385127260632859247056893372931244032	69017463467905637874347558622770254521265718494113786745862488064	138034926935811275748695117245540509042531436988227573491724976128	276069853871622551497390234491081018085062873976455146983479952256	552139707743245102994780468982162036170125747952910293966959904512	1104279415486490205989560937964324072340251495905820587933919809024	2208558830972980411979121875928648144680502991811641175867839618048	4417117661945960823958243751857296289361005983623282351735679236096	8834235323891921647916487503714592578722011967246564703471358472192	17668470647783843295832975007429185157444023934493129406942716944384	35336941295567686591665950014858370314888047868986258813885433888768	70673882591135373183331900029716740629776095737972517627770867777536	141347765182270746366663800059433481259552191475945035255541735555072	282695530364541492733327600118866962519104382951890070511083471110144	565391060729082985466655200237733925038208765903780141022166942220288	1130782121458165970933310400475467850076417531807560282044333884440576	2261564242916331941866620800950935700152835063615120564088667768881152	4523128485832663883733241601901871400305670127230241128177335537762304	9046256971665327767466483203803742800611340254460482256354671075524608	18092513943330655534932966407607485601222680508920964512709342151049216	36185027886661311069865932815214971202445361017841929025418684302098432	72370055773322622139731865630429942404890722035683858050837368604196864	144740111546645244279463731260859884809781444071367716101674737208393728	289480223093290488558927462521719769619562888142735432203349474416787456	578960446186580977117854925043439539239125776285470864406698948833574912	1157920892373161954235709850086879078478251552570941728813397897667149824	2315841784746323908471419700173758156956503105141883457626795795334299648	4631683569492647816942839400347516313913006210283766915253591590668599296	9263367138985295633885678800695032627826012420567533830507183181337198592	18526734277970591267771357601390065255652024841135067661014366362675397184	37053468555941182535542715202780130511304049682270135322028732725350794368	74106937111882365071085430405560261022608099364540270644057465450701588736	148213874223764730142170860811120522045216198729080541288114930901403177472	296427748447529460284341721622241044090432397458161082576229861802806354944	592855496895058920568683443244482088180864794916322165152459723605612709888	1185710993790117841137366886488964
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Subnetting

Problem 1

Number of needed subnets **14**

Number of needed usable hosts **14**

Network Address **192.10.10.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 240

Total number of subnets 16

Total number of host addresses 16

Number of usable addresses 14

Number of bits borrowed 4

What is the 4th subnet range? 192.10.10.48 to 192.10.10.63

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

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

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

Show your work for Problem 1 in the space below.

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

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

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

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

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	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
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	0	0	0	0	0	0	0
(4)	16	8	4	2	1	0	0	0	1	0	0	0	0	0	0	0
(5)	8	4	2	1	0	0	0	0	1	0	0	0	0	0	0	0
(6)	4	2	1	0	0	0	0	0	1	0	0	0	0	0	0	0
(7)	2	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
(8)	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
(9)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
(10)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
(11)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
(12)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
(13)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
(14)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
(15)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
(16)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
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.

Number of Hosts		Number of Subnets																							
		Binary values																							
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1		
128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1</										

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.

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	70	10	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	192.70.10.128	to	192.70.10.143		
(10)	1	0	0	1	192.70.10.144	to	192.70.10.159		
(11)	1	0	1	0	192.70.10.160	to	192.70.10.175		
(12)	1	0	1	1	192.70.10.176	to	192.70.10.191		
(13)	1	1	0	0	192.70.10.192	to	192.70.10.207		
(14)	1	1	0	1	192.70.10.208	to	192.70.10.223		
(15)	1	1	1	0	192.70.10.224	to	192.70.10.239		
(16)	1	1	1	1	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	1	1	1	1	1	1	1
	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	0	0	0	0	0	0	0	0
(2)	1	172	50	0	32	0	0	0	0	0	0	0	0	0	0	0
(3)	1	172	50	0	64	0	0	0	0	0	0	0	0	0	0	0
(4)	1	172	50	0	96	0	0	0	0	0	0	0	0	0	0	0
(5)	1	172	50	0	128	0	0	0	0	0	0	0	0	0	0	0
(6)	1	172	50	0	160	0	0	0	0	0	0	0	0	0	0	0
(7)	1	172	50	0	192	0	0	0	0	0	0	0	0	0	0	0
(8)	1	172	50	0	224	0	0	0	0	0	0	0	0	0	0	0

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				Number of Hosts			
256	128	64	32	16	8	4	2
-	2	4	8	16	32	64	128
128	64	32	16	8	4	2	1
220 . 100 . 100 .	0	0	0	0	0	0	0
Binary values							
(1)	0					220.100.100.0	to 220.100.100.3
(2)	1					220.100.100.4	to 220.100.100.7
(3)		1				220.100.100.8	to 220.100.100.11
(4)		1				220.100.100.12	to 220.100.100.15
(5)		1	0	0		220.100.100.16	to 220.100.100.19
(6)		1	0	1		220.100.100.20	to 220.100.100.23
(7)		1	1	0		220.100.100.24	to 220.100.100.27
(8)		1	1	1		220.100.100.28	to 220.100.100.31
(9)	1	0	0	0		220.100.100.32	to 220.100.100.35
(10)	1	0	0	1		220.100.100.36	to 220.100.100.39
(11)	1	0	1	0		220.100.100.40	to 220.100.100.43
(12)	1	0	1	1		220.100.100.44	to 220.100.100.47
(13)	1	1	0	0		220.100.100.48	to 220.100.100.51
(14)	1	1	0	1		220.100.100.52	to 220.100.100.55
(15)	1	1	1	0		220.100.100.56	to 220.100.100.59
(16)	1	1	1	1		220.100.100.60	to 220.100.100.63

128
64
32
16
8
+4
252

4
-2
2

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 165.200.0.63
64	(2)															to 165.200.0.127
32	(3)															to 165.200.0.191
16	(4)															to 165.200.0.255
8	(5)															to 165.200.1.63
4	(6)															to 165.200.1.127
2	(7)															to 165.200.1.191
+1	(8)															to 165.200.1.255
252	(9)															to 165.200.2.63
	(10)															to 165.200.2.127
	(11)															to 165.200.2.191
	(12)															to 165.200.2.255
64	(13)															to 165.200.3.63
-2	(14)															to 165.200.3.127
62	(15)															to 165.200.3.191
	(16)															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 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	
<u>200 . 10 . 10 . 0 0 0</u>											
(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

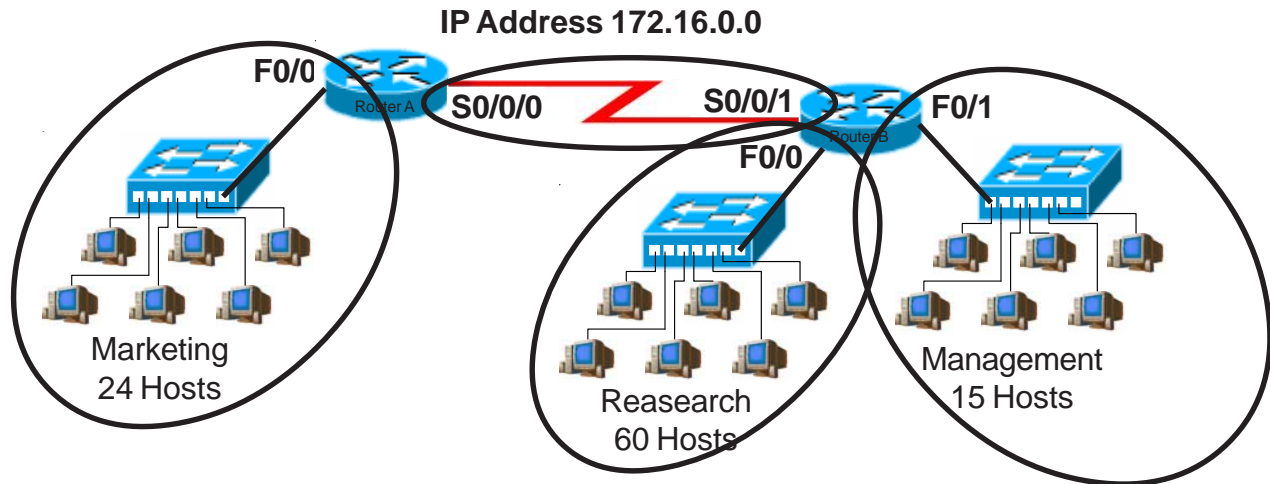
What are the assignable addresses for the 12th subnet? 93.1.96.1 to 93.1.127.254

Show your work for Problem 15 in the space below.

Number of Hosts	Number of Subnets	Binary values	Subnet	Hosts
128	2	128	128	128
64	4	64	64	64
32	8	32	32	32
16	16	16	16	16
8	32	8	8	8
4	64	4	4	4
2	128	2	2	2
+1				
255				
128				
64				
+32				
224				
8,192				
-2				
8,190				

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

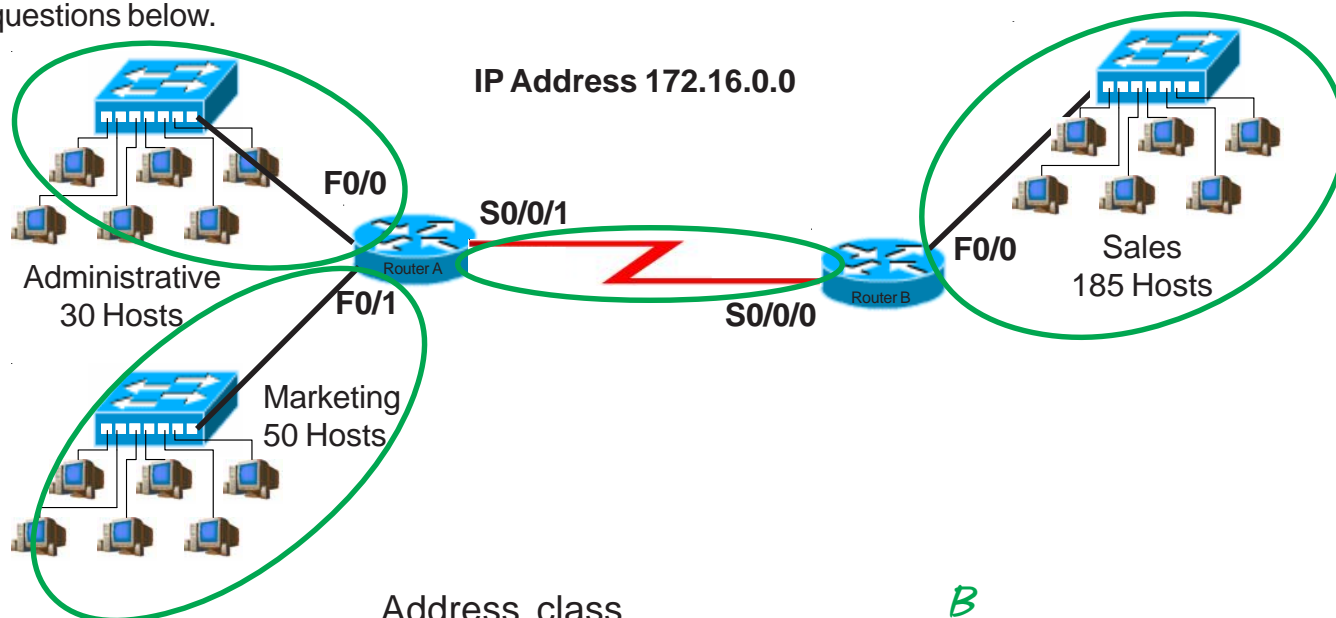
IP address range for Router A to Router B serial connection 135.126.0.128 to 135.126.0.159

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

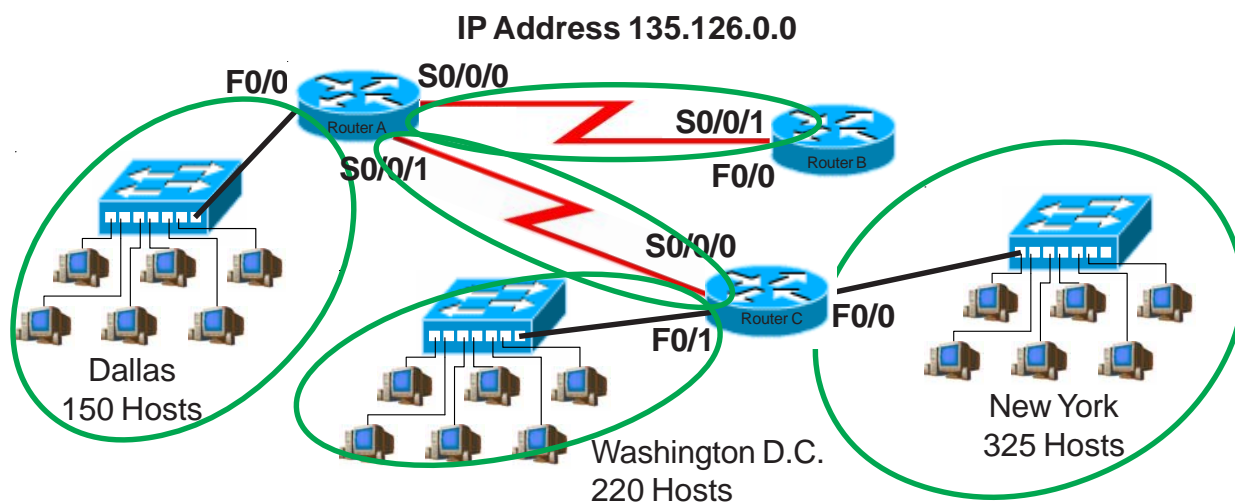
IP address range for Router A to Router B serial connection 172.16.3.0 to 172.16.3.255

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*

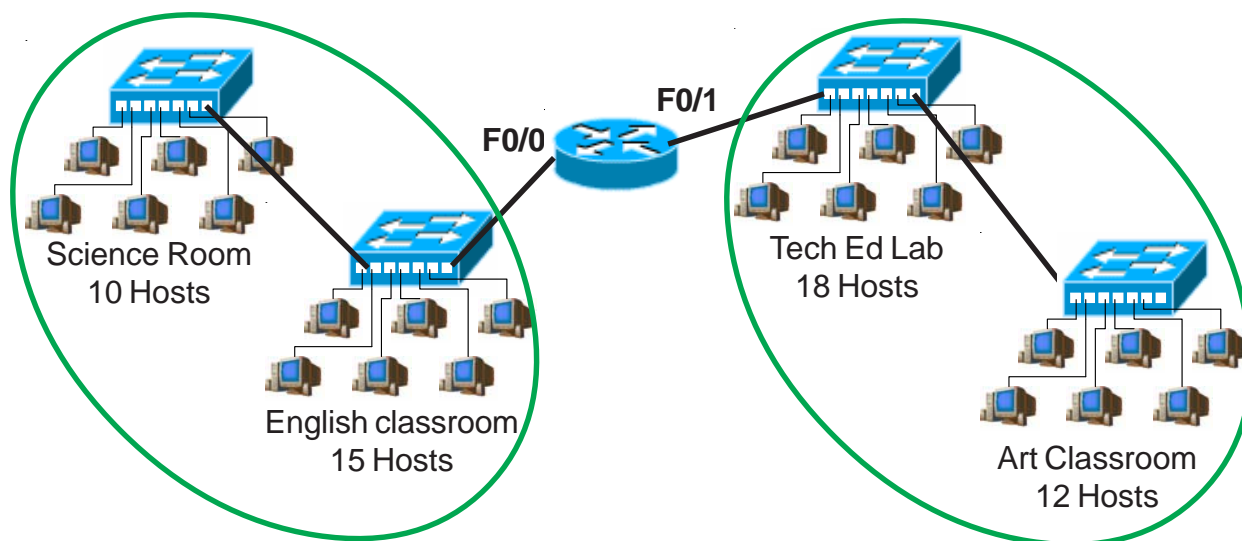
Show your work for Problem 4 in the space below.

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

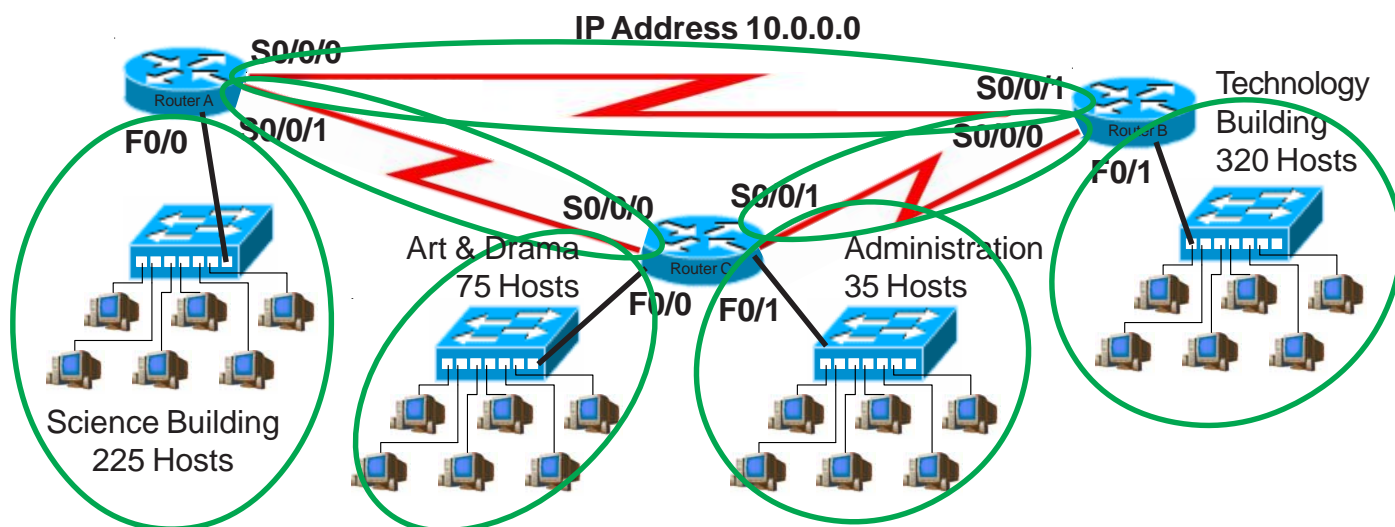
IP address range for Router F0/1 Port 210.15.10.64 to 210.15.10.127

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.

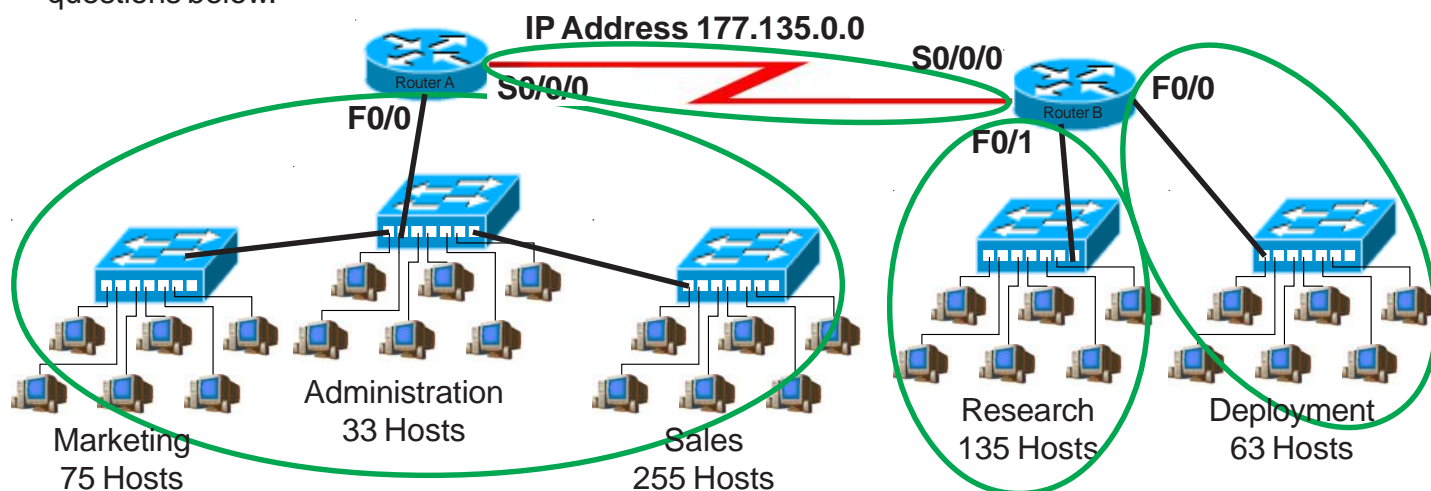
IP address range for Technology	<u>10.0.0.0 to 10.15.255.255</u>
IP address range for Science	<u>10.16.0.0 to 10.31.255.255</u>
IP address range for Arts & Drama	<u>10.32.0.0 to 10.47.255.255</u>
IP Address range Administration	<u>10.48.0.0 to 10.63.255.255</u>
IP address range for Router A to Router 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

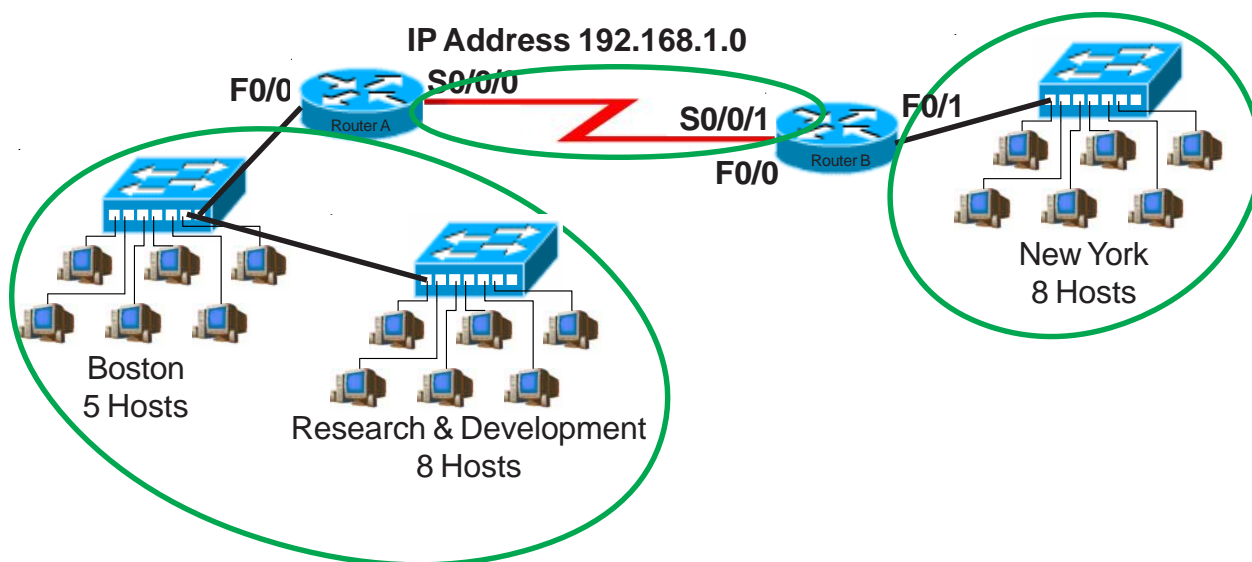
177.135.12.0 to 177.135.15.255

Show your work for Problem 7 in the space below.

Number of Hosts -	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
177.135 .	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	.									177.135.0.0	to	177.135.0.0	177.135.0.0	177.135.0.0	177.135.0.0	177.135.0.0
(2)										177.135.4.0	to	177.135.4.0	177.135.4.0	177.135.4.0	177.135.4.0	177.135.4.0
(3)										177.135.8.0	to	177.135.8.0	177.135.8.0	177.135.8.0	177.135.8.0	177.135.8.0
(4)										177.135.12.0	to	177.135.12.0	177.135.12.0	177.135.12.0	177.135.12.0	177.135.12.0
(5)										177.135.16.0	to	177.135.16.0	177.135.16.0	177.135.16.0	177.135.16.0	177.135.16.0
(6)										177.135.20.0	to	177.135.20.0	177.135.20.0	177.135.20.0	177.135.20.0	177.135.20.0
(7)										177.135.24.0	to	177.135.24.0	177.135.24.0	177.135.24.0	177.135.24.0	177.135.24.0
(8)										177.135.28.0	to	177.135.28.0	177.135.28.0	177.135.28.0	177.135.28.0	177.135.28.0
(9)										177.135.32.0	to	177.135.32.0	177.135.32.0	177.135.32.0	177.135.32.0	177.135.32.0
(10)										177.135.36.0	to	177.135.36.0	177.135.36.0	177.135.36.0	177.135.36.0	177.135.36.0
(11)										177.135.40.0	to	177.135.40.0	177.135.40.0	177.135.40.0	177.135.40.0	177.135.40.0
(12)										177.135.44.0	to	177.135.44.0	177.135.44.0	177.135.44.0	177.135.44.0	177.135.44.0
(13)										177.135.48.0	to	177.135.48.0	177.135.48.0	177.135.48.0	177.135.48.0	177.135.48.0
(14)										177.135.52.0	to	177.135.52.0	177.135.52.0	177.135.52.0	177.135.52.0	177.135.52.0
(15)										177.135.56.0	to	177.135.56.0	177.135.56.0	177.135.56.0	177.135.56.0	177.135.56.0
(16)										177.135.60.0	to	177.135.60.0	177.135.60.0	177.135.60.0	177.135.60.0	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 _____

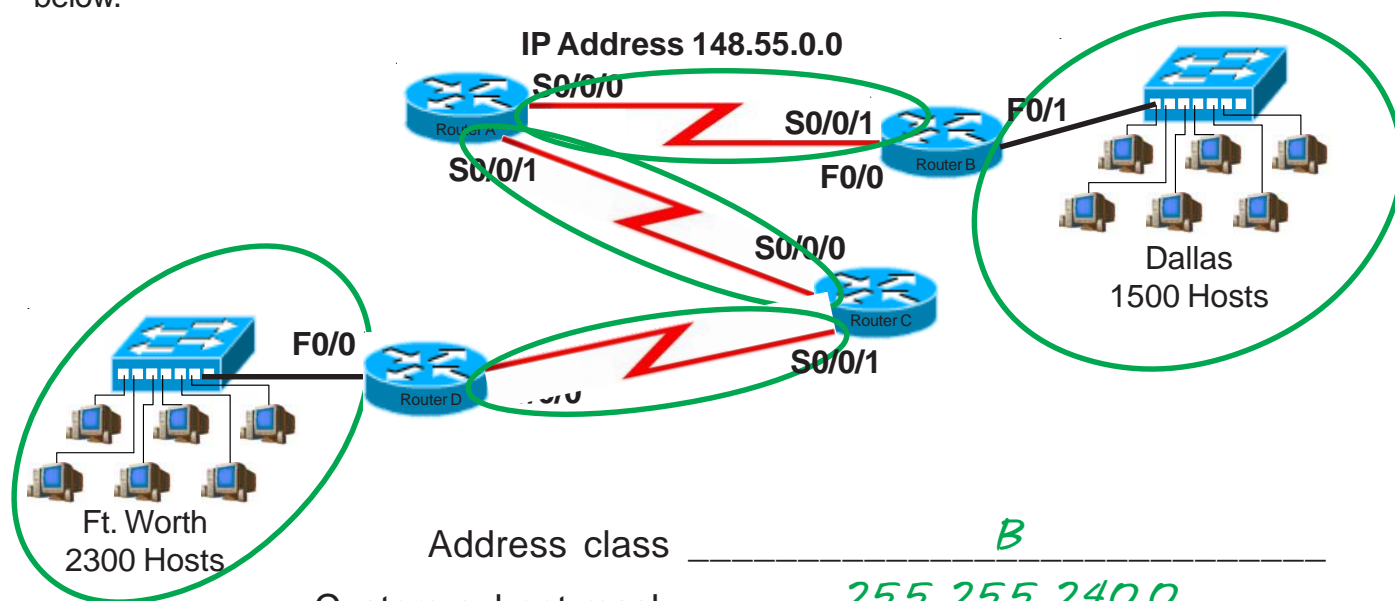
192.168.1.64 to 192.168.1.95

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

B

Custom subnet mask

255.255.240.0

Minimum number of subnets needed

5

Extra subnets required for 15% growth
(Round up to the next whole number)

+ 1

Total number of subnets needed

= 6

Number of host addresses
in the largest subnet group

2300

Number of addresses needed for
15% growth in the largest subnet
(Round up to the next whole number)

+ 345

Total number of address
needed for the largest subnet

= 2645

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

IP address range for Ft. Worth

148.55.0.0 to 148.55.15.255

IP address range for Dallas

148.55.16.0 to 148.55.31.255

IP address range for Router A
to Router B serial connection

148.55.32.0 to 148.55.47.255

IP address range for Router A
to Router C serial connection

148.55.48.0 to 148.55.63.255

IP address range for Router C
to Router D serial connection

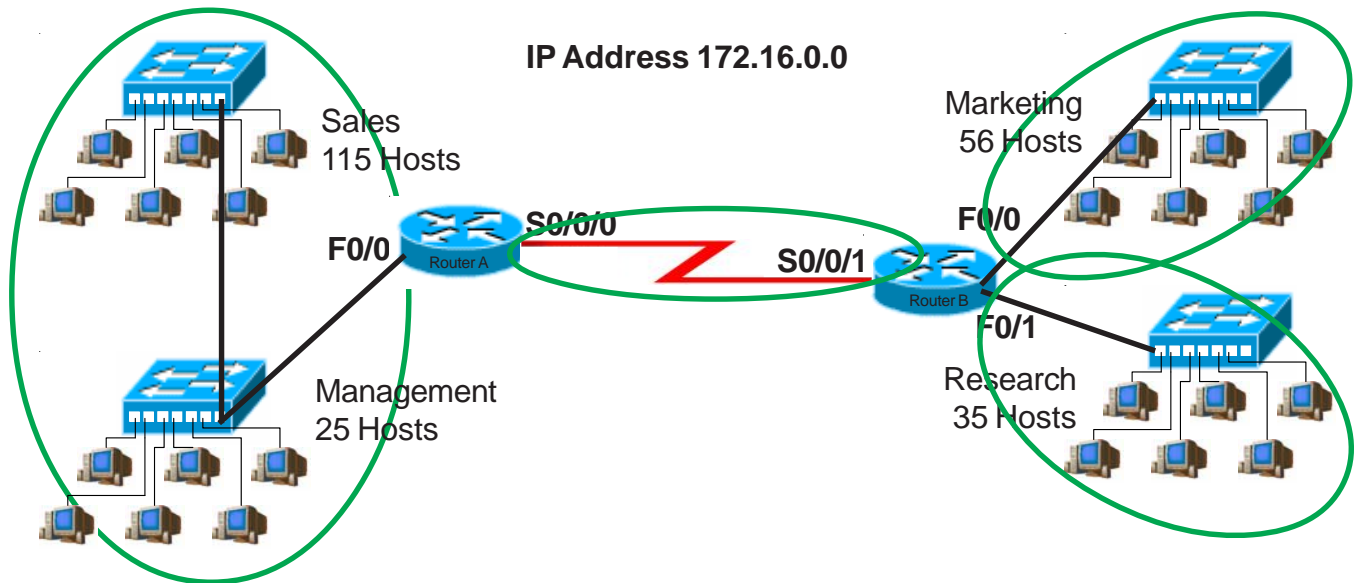
148.55.64.0 to 148.55.79.255

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/Managemnt	<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	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0	0.0.0.0
(1)	0								172.16.0.0	to	172.16.15.255		
(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	0	1					172.16.208.0	to	172.16.223.255		
(15)	1	1	1	0					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	0-15	0-7	0-3
						4-7
				16-31	8-15	8-11
						12-15
			32-47	16-31	16-23	16-19
						20-23
				48-63	24-31	24-27
						28-31
		64-127	64-79	32-47	32-39	32-35
						36-39
				40-47	40-47	40-43
						44-47
			80-95	48-63	48-55	48-51
						52-55
				56-63	56-63	56-59
						60-63
			96-111	64-79	64-71	64-67
						68-71
				80-95	72-79	72-75
						76-79
			112-127	80-87	80-87	80-83
						84-87
				88-95	88-95	88-91
						92-95
			128-143	96-103	96-103	96-99
						100-103
				104-111	104-111	104-107
						108-111
			144-159	112-119	112-119	112-115
						116-119
				120-127	120-127	120-123
						124-127
	128-255	128-191	128-143	128-135	128-135	128-131
						132-135
				136-143	136-143	136-139
						140-143
			144-159	144-151	144-151	144-147
						148-151
				152-159	152-159	152-155
						156-159
		192-255	160-175	16-167	16-167	160-163
						164-167
				168-175	168-175	168-171
						172-175
			176-191	176-183	176-183	176-179
						180-183
				184-191	184-191	184-187
						188-191
			192-207	192-199	192-199	192-195
						196-199
				200-207	200-207	200-203
						204-207
			208-223	208-215	208-215	208-211
						212-215
				216-223	216-223	216-219
						220-223
			224-239	224-231	224-231	224-227
						228-231
				232-239	232-239	232-235
						236-239
			240-255			240-247	240-247	240-243
						244-247
				248-255	248-255	248-251
						252-255

Visualizing Subnets Using The Box Method

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

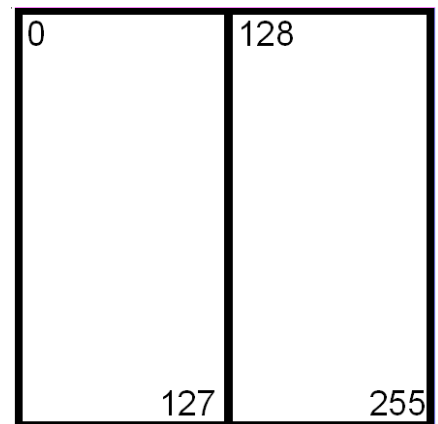
Start with a square. The whole square is a single subnet comprised of 256 addresses.

/24
255.255.255.0
256 Hosts
1 Subnet



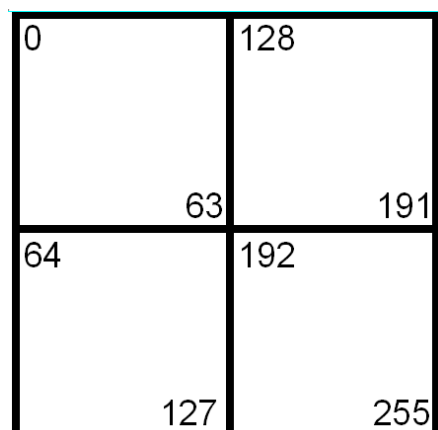
Split the box in half and you get two subnets with 128 addresses,

/25
255.255.255.128
128 Hosts
2 Subnets



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

/26
255.255.255.192
64 Hosts
4 Subnets



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

/27
255.255.255.224
32 Hosts
8 Subnets

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

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

/28
255.255.255.240
16 Hosts
16 Subnets

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

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

/29
255.255.255.248
8 Hosts
32 Subnets

0	8	32	40	128	136	160	168
7	15	39	47	135	143	167	175
16	24	48	56	144	152	176	184
23	31	55	63	151	159	183	191
64	72	96	104	192	200	224	232
71	79	103	111	199	207	321	239
80	88	112	120	208	216	240	248
87	95	119	127	215	223	247	255

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

/30
255.255.255.252
4 Hosts
64 Subnets

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

Class A Addressing Guide

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

Class B Addressing Guide

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

Class C Addressing Guide

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

