

IP Addressing and Subnetting Workbook

Version 2.0

11111110

10010101

00011011

10000110

11010011

Student Name:

Lee Kai Yang

IP Address Classes

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

Private Address Space

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

Default Subnet Masks

Class A	255.0.0.0
Class B	255.255.0.0
Class C	255.255.255.0

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

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

Workbooks included in the series:

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

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	0	1	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>B</u>
249.240.80.78	<u>E</u>
199.155.77.56	<u>C</u>
117.89.56.45	<u>B</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

158.98.30.0

217.21.56.0

10.250.1.1

150.10.5.0

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

171.102.77.7

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	0 . 0 . 18 . 2
10.10.48.80 255.255.255.0	0 . 0 . 0 . 80
222.49.49.11 255.255.255.0	0 0 0 8
128.23.230.19 255.255.0.0	0 0 230 19
10.10.10.10 255.0.0.0	0 . 10 10 10
200.113.123.11 255.255.255.0	0 0 0 11
223.169.23.20 255.255.0.0	0 0 23 20
203.20.35.215 255.255.255.0	0 0 . 0 215
117.15.2.51 255.0.0.0	0 15 2 51
199.120.15.135 255.255.255.0	0 0 0 135
191.55.165.135 255.255.255.0	0 0 0 135
48.21.25.54 255.255.0.0	0 0 25 . 54

Default Subnet Masks

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

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

ANDING With Default subnet masks

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

Default Subnet Masks:

Class A	255.0.0.0
Class B	255.255.0.0
Class C	255.255.255.0

ANDING Equations:

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

Sample:

What you see...

IP Address: 192 . 100 . 10 . 33

What you can figure out in your head...

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

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

	Network	Host	
IP Address:	1 1 0 0 0 0 0 0 . 0 1 1 0 0 1 0 0 . 0 0 0 0 1 0 1 0	0 0 1 0 0 0 0 1	(192 . 100 . 10 . 33)
Default Subnet Mask:	1 1 1 1 1 1 1 1 . 0 1 1 1 1 1 1 1 . 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0	(255 . 255 . 255 . 0)
AND:	1 1 0 0 0 0 0 0 . 0 1 1 0 0 1 0 0 . 0 0 0 0 1 0 1 0	0 0 0 0 0 0 0 0	(192 . 100 . 10 . 0)

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

ANDING With Custom subnet masks

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

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

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



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

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

Two formulas can provide this basic information:

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

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

Both formulas calculate the number of hosts or subnets based on the number of binary bits used. For example if you borrow three bits from the host portion of the address use the *number of subnets* formula to determine the total number of subnets gained by borrowing the three bits. This would be 2^3 or $2 \times 2 \times 2 = 8$ subnets

To determine the number of hosts per subnet you would take the number of binary bits used in the host portion and apply this to the *number of hosts per subnet* formula. If five bits are in the host portion of the address this would be 2^5 or $2 \times 2 \times 2 \times 2 \times 2 = 32$ hosts.

When dealing with the *number of hosts per subnet* you have to subtract two addresses from the range. The first address in every range is the subnet number. The last address in every range is the broadcast address. These two addresses cannot be assigned to any device in the network which is why you have to subtract two addresses to find the number of usable addresses in each range.

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

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

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

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

What about that second subnet formula:

Number of subnets = $2^s - 2$

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

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

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

Class C Address unsubnetted:

195. 223 . 50 . 0

195.223.50.0 to 195.223.50.255

Class C Address subnetted (2 bits borrowed):

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

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

Notice that the subnet and broadcast addresses match.

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

The **CCNA** and **CCENT** certification exams may have questions which will require you to determine which formula to use, and 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.

[illegible]

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

	128
	64
	32
	+16
	<hr/>
	240

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

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 2^6

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	-----
16	192
8	
4	
2	
+1	
255	

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

N 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 1,024 2¹⁰

Total number of host addresses 64 2⁶

Number of usable addresses 62 2⁶ - 2

Number of bits borrowed 10 26 - 16

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.

$$\begin{array}{r}
 128 \\
 64 \\
 32 \\
 16 \\
 8 \\
 4 \\
 2 \\
 +1 \\
 \hline
 255
 \end{array}$$

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

$$\begin{array}{r}
 1024 \\
 -2 \\
 \hline
 1,022
 \end{array}$$

Observe the total number of hosts.

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

Subtract 2 for the number of usable hosts.

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

Custom subnet mask

Total number of subnets

Total number of host addresses

Number of usable addresses

Number of bits borrowed

Show your work for Problem 5 in the space below.

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

Custom Subnet Masks

Problem 5

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

Address class **C**

Default subnet mask **255.255.255.0**

Custom subnet mask **255.255.255.124**

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.

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

11111111. 11111111 00000000 00000000 00000000
 N 14 Custom Subnet Masks 14

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

Custom subnet mask

Total number of subnets

Total number of host addresses

Number of usable addresses

Number of bits borrowed

Show your work for Problem 6 in the space below.

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	321387608851798055108392418468232520489328161320249763833616	642775217703596110216784836936465040978656322640499527667232	1285550435407192220433569673872930081957312645280999055334464	2571100870814384440867139347745860163914625290561998110668928	5142201741628768881734278695491720327829250581123996221337856	10284403483257537763468557390983440655658501162247992442675712	20568806966515075526937114781966881311317002324495984885351424	41137613933030151053874229563933762622634004648991969770702848	82275227866060302107748459127867525245268009297983939541405696	164550455732120604215496918255735050490536018595967879082811392	329100911464241208430993836511470100981072037191935758165622784	658201822928482416861987673022940201962144074383871516331245568	1316403645856964833723975346045880403924288148767743032662491136	2632807291713929667447950692091760807848576297535486065324982272	5265614583427859334895901384183521615697152595070972130649964544	10531229166855718669791802768367043231394305190141944261299929088	21062458333711437339583605536734086462788610380283888522599858176	42124916667422874679167211073468172925577220760567777045199716352	84249833334845749358334422146936345851154441521135554090399432704	168499666669691498716668844293872691702308883042271108180798865408	336999333339382997433337688587745383404617766084542216361597730816	673998666678765994866675377175490766809235532169084432723195461632	1347997333357531989733350754350981533618471064338168865446390923264	2695994666715063979466701508701963067236942128676337730892781846528	5391989333430127958933403017403926134473884257352675461785563693056	10783978666860255917866806034807852268947768514705350923571127386112	21567957333720511835733612069615704537895537029410701847142254772224	43135914667441023671467224139231409075791074058821403694284509544448	86271829334882047342934448278462818151582148117642807388569019088896	172543658669764094685868896556925636303164296235285614777138038177792	345087317339528189371737793113851272606328592470571229554276076355584	690174634679056378743475586227702545212657184941142459108552152711168	1380349269358112757486951172455405090425314369882284918217104305422336	2760698538716225514973902344910810180850628739764569836434208610844672	5521397077432451029947804689821620361701257479529139672868417221689344	11042794154864902059895609379643240723402514959058279345736834443378688	22085588309729804119791218759286481446805029918116558691473668886757376	44171176619459608239582437518572962893610059836233117382947337773514752	88342353238919216479164875037145925787220119672466234765894675547029504	176684706477838432958329750074291851574440239344932469531789351094059008	353369412955676865916659500148583703148880478689864939063578702188118016	706738825911353731833319000297167406297760957379729878127157404376236032	1413477651822707463666638000594334812595521914759459756254314808752472064	2826955303645414927333276001188669625191043829518919512508629617504944128	5653910607290829854666552002377339250382087659037839025017259235009888256	11307821214581659709333104004754678500764175318075678050034518470019776512	22615642429163319418666208009509357001528350636151356100069036940039553024	45231284858326638837332416019018714003056701272302712200138073880079106048	90462569716653277674664832038037428006113402544605424400276147760158212096	180925139433306555349329664076074856012226805089210848800552295520316424192	361850278866613110698659328152149712024453610178421697601104591040632848384	723700557733226221397318656304299424048907220356843395202209182081265696768	1447401115466452442794637312608598848097814440713686790404418364162531393536	2894802230932904885589274625217197696195628881427373580808836728325062787072	5789604461865809771178549250434395392391257762854747161617673456650125574144	11579208923731619542357098500868790784782515525709494323235346913300251148288	23158417847463239084714197001737581569565031051418988646470693826600502296576	46316835694926478169428394003475163139130062102837977292941387653201004593152	92633671389852956338856788006950326278260124205675954585882775306402009186304	185267342779705912677713576013900652556520248411351909171765550612804018372608	370534685559411825355427152027801305113040496822703818343531101225608036745216	741069371118823650710854304055602610226080993645407636687062202451216073490432	1482138742237647301421708608111205220452161987290815273374124404902432146980864
-----------------	---	---	---	---	----	----	----	-----	-----	-----	------	------	------	------	-------	-------	-------	--------	--------	--------	---------	---------	---------	---------	----------	----------	----------	-----------	-----------	-----------	------------	------------	------------	------------	-------------	-------------	-------------	--------------	--------------	--------------	---------------	---------------	---------------	---------------	----------------	----------------	----------------	-----------------	-----------------	-----------------	------------------	------------------	------------------	------------------	-------------------	-------------------	-------------------	--------------------	--------------------	--------------------	---------------------	---------------------	---------------------	---------------------	----------------------	----------------------	----------------------	-----------------------	-----------------------	-----------------------	------------------------	------------------------	------------------------	------------------------	-------------------------	-------------------------	-------------------------	--------------------------	--------------------------	--------------------------	---------------------------	---------------------------	---------------------------	---------------------------	----------------------------	----------------------------	----------------------------	-----------------------------	-----------------------------	-----------------------------	------------------------------	------------------------------	------------------------------	------------------------------	-------------------------------	-------------------------------	-------------------------------	--------------------------------	--------------------------------	--------------------------------	---------------------------------	---------------------------------	---------------------------------	----------------------------------	----------------------------------	----------------------------------	----------------------------------	-----------------------------------	-----------------------------------	-----------------------------------	------------------------------------	------------------------------------	------------------------------------	-------------------------------------	-------------------------------------	-------------------------------------	-------------------------------------	--------------------------------------	--------------------------------------	--------------------------------------	---------------------------------------	---------------------------------------	---------------------------------------	--	--	--	--	---	---	---	--	---	---	--	--	--	--	---	---	---	--	--	--	---	---	---	---	--	--	--	---	---	---	--	--	--	--	---	---	---	--	--	--	---	---	---	---	--	--	--	---	---	---	--	--	--	--	---	---	---	--	--	--	---	---	---	---	--	--	--	---	---	---	--	--	--	---	---	---	---	--	--	--	---	---	---	--	--	--	--	---	---	---	--	--	--	---	---	---	---	--	--	--	---	---	---	--	--	--	--	---	---	---	--	--	--	---	---	---	---	--	--	--	---	---	---	--	--	--	--	---	---	---	--	--	--	---	---	---	---	--	--	--	---



Custom Subnet Masks

Problem 7

Number of needed subnets **2000** 2^4
 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
 Total number of subnets 4096
 Total number of host addresses 16
 Number of usable addresses 14
 Number of bits borrowed 12

Show your work for Problem 7 in the space below.

Number of Hosts	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536
Binary values	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
178 . 100 . 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0



Problem 8

Number of needed subnets **3** 2^6
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**
Total number of subnets **1024**
Total number of host addresses **64**
Number of usable addresses **62**
Number of bits borrowed **10**

Show your work for **Problem 8** in the space below.

1111 1111 . 1111 1111 | 1111 1111 00 0000 0000
 N N 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 **1024**
 Number of usable addresses **1022**
 Number of bits borrowed **6**

Show your work for **Problem 9** in the space below.



Problem 10

Number of needed usable hosts **60**

Network Address **198.100.10.0**

Address class 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.

Custom Subnet Masks

Problem 11

Number of needed subnets **250**²⁸
 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 **65536**

Number of usable addresses **65534**

Number of bits borrowed **8**

Show your work for Problem 11 in the space below.

N N

23

23

23



255.255 255 0

255.255 255 224



32

> 0



Show your work for Problem 12 in the space below.

Custom Subnet Masks

Problem 13

Number of needed usable hosts 25

Network Address 218.35.50.0

Address class 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.

Custom Subnet Masks

Problem 14

Number of needed subnets 10 2^4
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 4096
Number of usable addresses 4094
Number of bits borrowed 4

Show your work for Problem 14 in the space below.

Custom Subnet Masks

Problem 15

Number of needed usable hosts 50

Network Address 172.59.0.0

Address class C

Default subnet mask

Custom subnet mask

Total number of subnets

Total number of host addresses

Number of usable addresses

Number of bits borrowed

2^6
255.255.255.0
255.255.255.192
4
32
50
2

Show your work for Problem 15 in the space below.

Custom Subnet Masks

Problem 16

Number of needed usable hosts 29 ^{2⁵}

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.

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				
					16	8	4	2	Hosts
Number of	256	128	64	32	32	64	128	256	
Subnets	-	2	4	8	16	8	4	2	1 - Binary values
192.10.10.0	0	0	0	0	0	0	0	0	
(1)	0	0	0	0	0	192.10.10.0	to	192.10.10.15	
(2)	0	0	0	0	1	192.10.10.16	to	192.10.10.31	
(3)	0	0	0	1	0	192.10.10.32	to	192.10.10.47	
(4)	0	0	0	1	1	192.10.10.48	to	192.10.10.63	
(5)	0	1	0	0	0	192.10.10.64	to	192.10.10.79	
(6)	0	1	0	0	1	192.10.10.80	to	192.10.10.95	
(7)	0	1	0	1	0	192.10.10.96	to	192.10.10.111	
(8)	0	1	0	1	1	192.10.10.112	to	192.10.10.127	
(9)	1	0	0	0	0	192.10.10.128	to	192.10.10.143	
(10)	1	0	0	0	1	192.10.10.144	to	192.10.10.159	
(11)	1	0	0	1	0	192.10.10.160	to	192.10.10.175	
(12)	1	0	0	1	1	192.10.10.176	to	192.10.10.191	
(13)	1	1	0	0	0	192.10.10.192	to	192.10.10.207	
(14)	1	1	0	0	1	192.10.10.208	to	192.10.10.223	
(15)	1	1	0	1	0	192.10.10.224	to	192.10.10.239	
(16)	1	1	1	0	0	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	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
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	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
Custom subnet mask	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
	192	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255	255
<p>The binary value of the last bit borrowed is the range. In this problem the range is 64.</p> <p>The first address in each subnet range is the subnet number.</p> <p>The last address in each subnet range is the subnet broadcast address.</p>																
(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) 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 (1024) 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 165.100.255.128 to 165.100.255.191
 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? 192.223.50.129 - 192.223.50.254

What is the subnet number for the 2nd subnet? 192.223.50.128

What is the subnet broadcast address for the 1st subnet? 192.223.50.0

What are the assignable addresses for the 1st subnet? 192.223.50.1 - 192.223.50.126

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		

Subnetting $2^{10} = 1024$

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 **1024**

Total number of host addresses **64**

Number of usable addresses **62**

Number of bits borrowed **10**

What is the 15th subnet range? **192.35.3 129 - 192.35.3 190**

What is the subnet number for the 13th subnet? **192 35 3 0**

What is the subnet broadcast address for the 10th subnet? **192 35 3 127**

What are the assignable addresses for the 6th subnet? **192.35.3 65 - 192.35.3 126**

Show your work for Problem 4 in the space below.

Subnetting

Problem 5

Number of needed usable hosts 6

Network Address 126.0.0.0

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 2nd
subnet range?

What is the subnet number
for the 5th subnet?

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

What are the assignable
addresses for the 10th
subnet?

Show your work for Problem 5 in the space below.

Subnetting

Problem 6

Number of needed subnets **10**

2^4

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 - 192 70 10 142

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 - 192 70 10 158

Show your work for Problem 6 in the space below.

Subnetting

Problem 7

Network Address **10.0.0.0 /16**

Address class A

Default subnet mask 255 0 0 0

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 11th
subnet range? _____

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

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

What are the assignable
addresses for the 9th
subnet? _____

Show your work for Problem 7 in the space below.

Subnetting

Problem 8

Number of needed subnets **5**

Network Address **172.50.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 4th
subnet range? _____

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

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

What are the assignable
addresses for the 3rd
subnet? _____

Show your work for Problem 8 in the space below.

Subnetting

Problem 9

Number of needed usable hosts **28**

Network Address **172.50.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 2nd
subnet range? _____

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

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

What are the assignable
addresses for the 6th
subnet? _____

Show your work for Problem 9 in the space below.

Subnetting

Problem 10

Number of needed subnets **45**

Network Address **220.100.100.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 5th
subnet range? _____

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

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

What are the assignable
addresses for the 12th
subnet? _____

Show your work for Problem 10 in the space below.

Subnetting

Problem 11

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

Network Address **135.70.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 6th
subnet range? _____

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

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

What are the assignable
addresses for the 5th
subnet? _____

Show your work for Problem 11 in the space below.

Subnetting

Problem 12

Number of needed usable hosts **45**

Network Address **198.125.50.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 2nd
subnet range? _____

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

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

What are the assignable
addresses for the 3rd
subnet? _____

Show your work for Problem 12 in the space below.

Subnetting

Problem 13

Network Address **165.200.0.0 /26**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 10th
subnet range? _____

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

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

What are the assignable
addresses for the 1022nd
subnet? _____

Show your work for Problem 13 in the space below.

Subnetting

Problem 14

Number of needed usable hosts **16**

Network Address **200.10.10.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 7th
subnet range? _____

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

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

What are the assignable
addresses for the 6th
subnet? _____

Show your work for Problem 14 in the space below.

Subnetting

Problem 15

Network Address **93.0.0.0** \19

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 15th
subnet range? _____

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

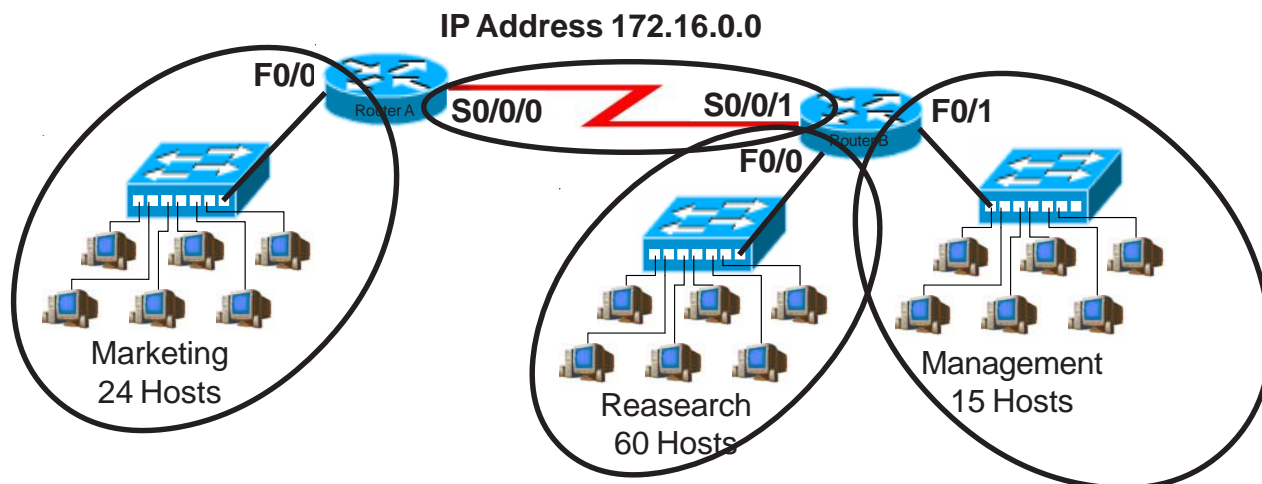
What is the subnet
broadcast address for
the 7th subnet? _____

What are the assignable
addresses for the 12th
subnet? _____

Show your work for Problem 15 in the space below.

Practical Subnetting 1

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



Address class	<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.

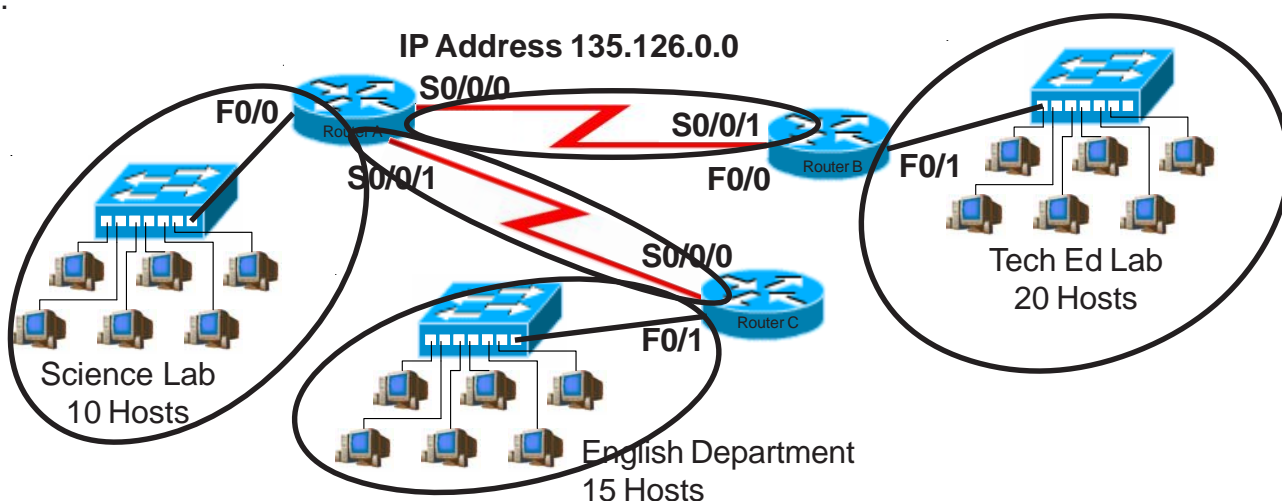
IP address range for Research	<u>172.16.0.0 to 172.31.255</u>
IP address range for Marketing	<u>172.16.32.0 to 172.63.255</u>
IP address range for Management	<u>172.16.64.0 to 172.95.255</u>
IP address range for Router A to Router B serial connection	<u>172.16.96.0 to 172.127.255</u>

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

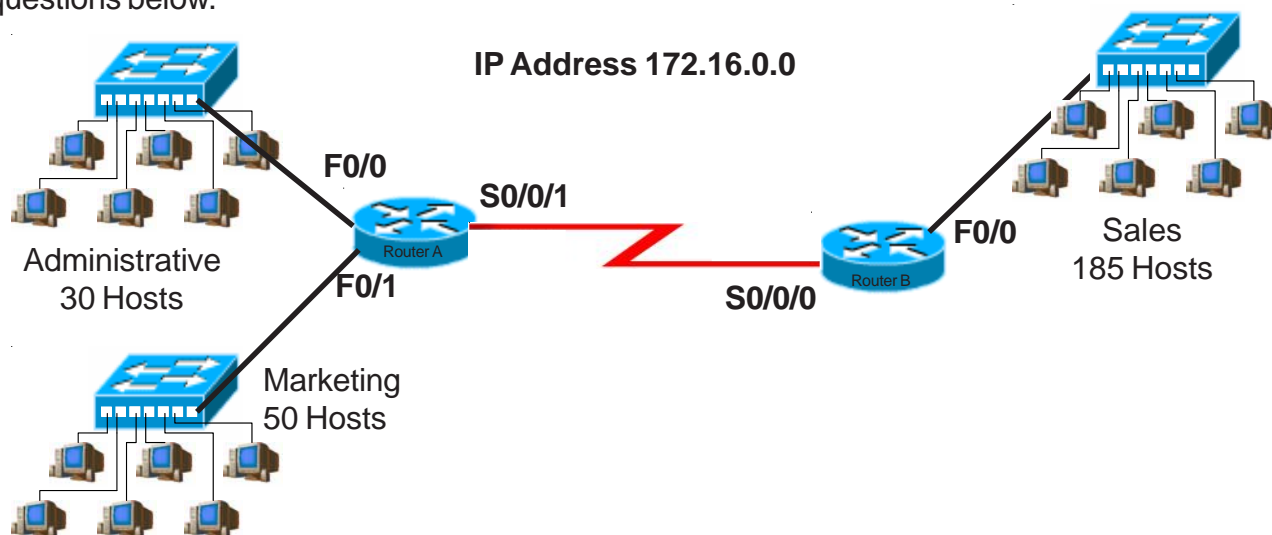
IP address range for Router A to Router C serial connection 135.126.0.128 to 135.126.0.159

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	135.126.0.0	to	135.126.0.32	to	135.126.0.64	to	135.126.0.96	to	135.126.0.128	to	135.126.0.160	to	135.126.0.192	to	135.126.0.224	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 _____

Custom subnet mask _____

Minimum number of subnets needed _____

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

Total number of subnets needed **=** _____

Number of host addresses
in the largest subnet group _____

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

Total number of address
needed for the largest subnet **=** _____

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

IP address range for Sales _____

IP address range for Marketing _____

IP address range for Administrative _____

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

Show your work for Problem 3 in the space below.

Practical Subnetting 4

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



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

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

Total number of subnets needed **=** _____

Number of host addresses
in the largest subnet group _____

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

Total number of address
needed for the largest subnet **=** _____

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

IP address range for New York _____

IP address range for Washington D. C. _____

IP address range for Dallas _____

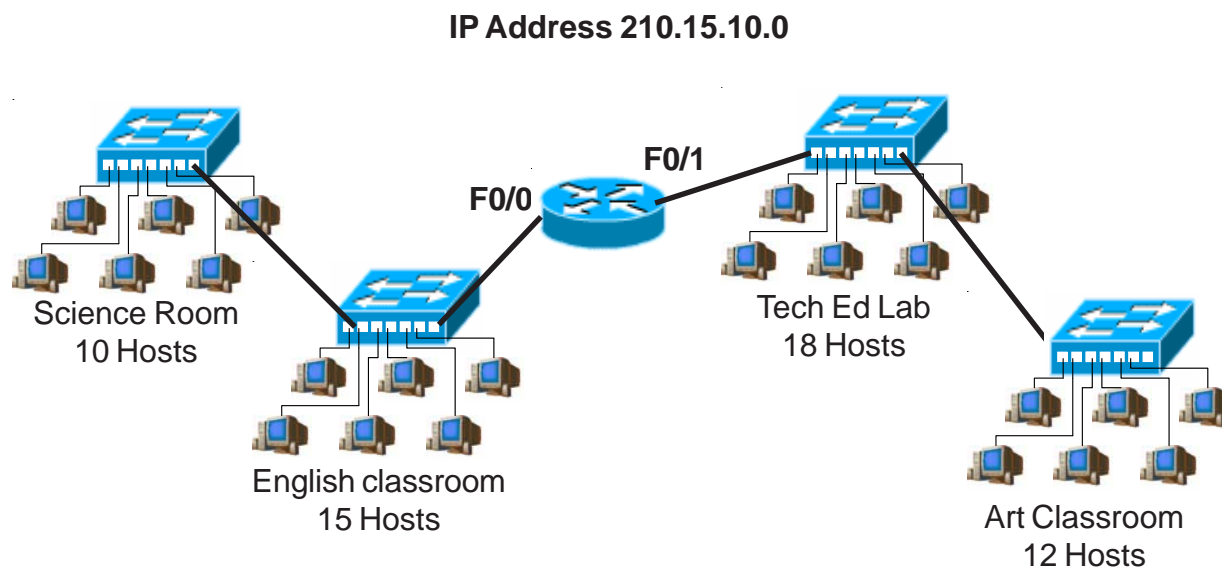
IP address range for Router A
to Router B serial connection _____

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

Show your work for Problem 4 in the space below.

Practical Subnetting 5

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



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

Extra subnets required for 100% growth **+** _____
(Round up to the next whole number)

Total number of subnets needed **=** _____

Number of host addresses
in the largest subnet group _____

Number of addresses needed for
100% growth in the largest subnet **+** _____
(Round up to the next whole number)

Total number of address
needed for the largest subnet **=** _____

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

IP address range for Router F0/0 Port _____

IP address range for Router F0/1 Port _____

Show your work for Problem 5 in the space below.

Practical Subnetting 6

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



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

Extra subnets required for 20% growth **+** _____
(Round up to the next whole number)

Total number of subnets needed **=** _____

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

IP address range for Technology _____

IP address range for Science _____

IP address range for Arts & Drama _____

IP Address range Administration _____

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

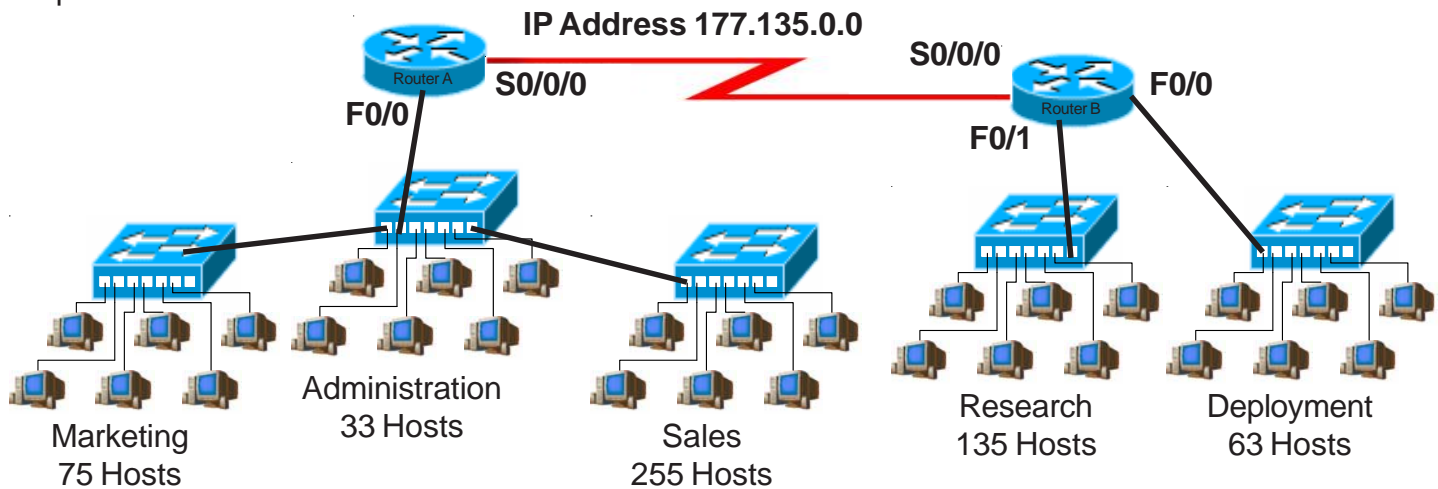
IP address range for Router A
to Router C serial connection _____

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

Show your work for Problem 6 in the space below.

Practical Subnetting 7

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



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

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

Total number of subnets needed = _____

Number of host addresses
in the largest subnet group _____

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

Total number of address
needed for the largest subnet = _____

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

IP address range for Router A Port F0/0 _____

IP address range for Research _____

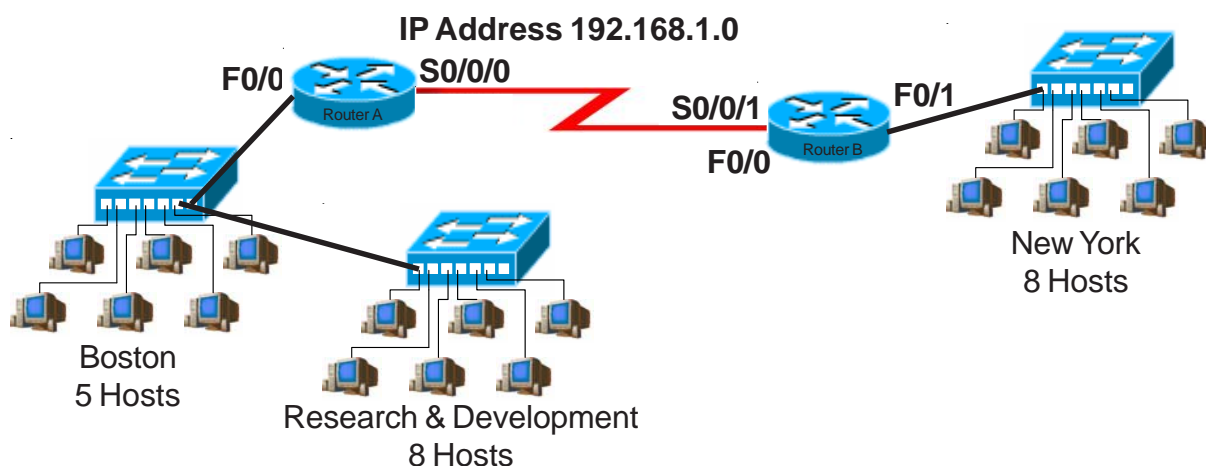
IP address range for Deployment _____

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

Show your work for Problem 7 in the space below.

Practical Subnetting 8

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



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

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

Total number of subnets needed $=$ _____

Number of host addresses
in the largest subnet group _____

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

Total number of address
needed for the largest subnet $=$ _____

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

IP address range for Router A F0/0 _____

IP address range for New York _____

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

Show your work for Problem 8 in the space below.

Practical Subnetting 9

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



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

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

Total number of subnets needed = _____

Number of host addresses in the largest subnet group _____

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

Total number of address needed for the largest subnet = _____

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

IP address range for Ft. Worth _____

IP address range for Dallas _____

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

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

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

Show your work for Problem 9 in the space below.

Practical Subnetting 10

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



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

Extra subnets required for 110% growth **+** _____
(Round up to the next whole number)

Total number of subnets needed **=** _____

Number of host addresses
in the largest subnet group _____

Number of addresses needed for
110% growth in the largest subnet **+** _____
(Round up to the next whole number)

Total number of address
needed for the largest subnet **=** _____

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

IP address range for Sales/Managemnt _____

IP address range for Marketing _____

IP address range for Research _____

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

Show your work for Problem 10 in the space below.

Valid and Non-Valid IP Addresses

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

IP Address: 0.230.190.192

Subnet Mask: 255.0.0.0

Reference Page Inside Front Cover

The network ID cannot be 0.

IP Address: 192.10.10.1

Subnet Mask: 255.255.255.0

Reference Pages 28-29

OK

IP Address: 245.150.190.10

Subnet Mask: 255.255.255.0

Reference Page Inside Front Cover

IP Address: 135.70.191.255

Subnet Mask: 255.255.254.0

Reference Pages 48-49

IP Address: 127.100.100.10

Subnet Mask: 255.0.0.0

Reference Pages Inside Front Cover

IP Address: 93.0.128.1

Subnet Mask: 255.255.224.0

Reference Pages 56-57

IP Address: 200.10.10.128

Subnet Mask: 255.255.255.224

Reference Pages 54-55

IP Address: 165.100.255.189

Subnet Mask: 255.255.255.192

Reference Pages 30-31

IP Address: 190.35.0.10

Subnet Mask: 255.255.255.192

Reference Pages 34-35

IP Address: 218.35.50.195

Subnet Mask: 255.255.0.0

Reference Page Inside Front Cover

IP Address: 200.10.10.175 /22

Reference Pages 54-55 and/or Inside Front Cover

IP Address: 135.70.255.255

Subnet Mask: 255.255.224.0

Reference Pages 48-49

IP Address Breakdown

/24	/25	/26	/27	/28	/29	/30	
8+8+8 255.255.255.0 256 Hosts	8+8+8+1 255.255.255.128 128 Hosts	8+8+8+2 255.255.255.192 64 Hosts	8+8+8+3 255.255.255.224 32 Hosts	8+8+8+4 255.255.255.240 16 Hosts	8+8+8+5 255.255.255.248 8 Hosts	8+8+8+6 255.255.255.252 4 Hosts	
0-255	0-127	0-63		0-15	0-7	0-3 4-7	
					8-15	8-11 12-15	
				16-31	16-23	16-19 20-23	
					24-31	24-27 28-31	
			32-47	32-39	32-35 36-39		
				40-47	40-43 44-47		
				48-63	48-55	48-51 52-55	
					56-63	56-59 60-63	
		64-127		64-79	64-71	64-67 68-71	
					72-79	72-75 76-79	
				80-95	80-87	80-83 84-87	
					88-95	88-91 92-95	
			96-111	96-103	96-99 100-103		
				104-111	104-107 108-111		
				112-127	112-119	112-115 116-119	
					120-127	120-123 124-127	
		128-255	128-191		128-143	128-135	128-131 132-135
						136-143	136-139 140-143
					144-159	144-151	144-147 148-151
						152-159	152-155 156-159
	160-175			16-167	160-163 164-167		
				168-175	168-171 172-175		
				176-191	176-183	176-179 180-183	
					184-191	184-187 188-191	
	192-255				192-207	192-199	192-195 196-199
						200-207	200-203 204-207
					208-223	208-215	208-211 212-215
						216-223	216-219 220-223
			224-239	224-231	224-227 228-231		
				232-239	232-235 236-239		
				240-255	240-247	240-243 244-247	
					248-255	248-251 252-255	

Visualizing Subnets Using The Box Method

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

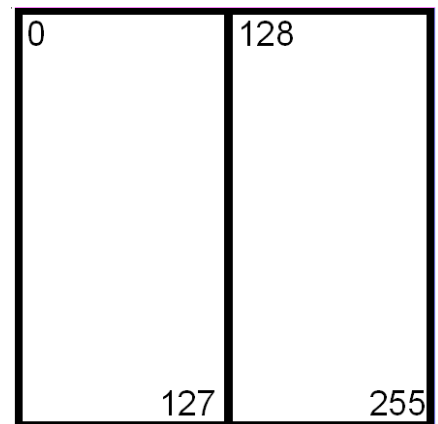
Start with a square. The whole square is a single subnet comprised of 256 addresses.

/24
255.255.255.0
256 Hosts
1 Subnet



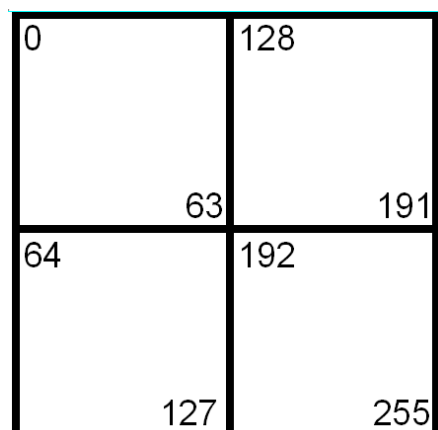
Split the box in half and you get two subnets with 128 addresses,

/25
255.255.255.128
128 Hosts
2 Subnets



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

/26
255.255.255.192
64 Hosts
4 Subnets



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

/27
255.255.255.224
32 Hosts
8 Subnets

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

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

/28
255.255.255.240
16 Hosts
16 Subnets

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

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

/29
255.255.255.248
8 Hosts
32 Subnets

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

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

/30
255.255.255.252
4 Hosts
64 Subnets

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

Class A Addressing Guide

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

Class B Addressing Guide

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

Class C Addressing Guide

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

