

# IP Addressing and Subnetting

Workbook  
Version 2.0

Instructor's Edition

111111110

10010101

00011011

10000110

11010011

## IP Address Classes

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

## Private Address Space

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

## Default Subnet Masks

Class A	255.0.0.0
Class B	255.255.0.0
Class C	255.255.255.0

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

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

### Workbooks included in the series:

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

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

# Binary To Decimal Conversion

128	64	32	16	8	4	2	1	Answers	Scratch Area
1	0	0	1	0	0	1	0	<u>146</u>	128 16 32
0	1	1	1	0	1	1	1	<u>119</u>	2 146 16 4
1	1	1	1	1	1	1	1	<u>255</u>	2 1
1	1	0	0	0	1	0	1	<u>197</u>	119
1	1	1	1	0	1	1	0	<u>246</u>	
0	0	0	1	0	0	1	1	<u>19</u>	
1	0	0	0	0	0	0	1	<u>129</u>	
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
									-128	-32
0	0	1	0	0	0	1	0	34	110	2
									-64	-2
0	1	1	1	1	0	1	1	123	46	0
									-32	
0	0	1	1	0	0	1	0	50	14	
									-8	
1	1	1	1	1	1	1	1	255	6	
									-4	
1	1	0	0	1	0	0	0	200	2	
									-2	
0	0	0	0	1	0	1	0	10	0	
1	0	0	0	1	0	1	0	138		
0	0	0	0	0	0	0	1	1		
0	0	0	0	1	1	0	1	13		
1	1	1	1	1	0	1	0	250		
0	1	1	0	1	0	1	1	107		
1	1	1	0	0	0	0	0	224		
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

---

*188 . 10 . 0 . 0*

10.10.48.80  
255.255.255.0

---

*10 . 10 . 48 . 0*

192.149.24.191  
255.255.255.0

---

*192 . 149 . 24 . 0*

150.203.23.19  
255.255.0.0

---

*150 . 203 . 0 . 0*

10.10.10.10  
255.0.0.0

---

*10 . 0 . 0 . 0*

186.13.23.110  
255.255.255.0

---

*186 . 13 . 23 . 0*

223.69.230.250  
255.255.0.0

---

*223 . 69 . 0 . 0*

200.120.135.15  
255.255.255.0

---

*200 . 120 . 135 . 0*

27.125.200.151  
255.0.0.0

---

*27 . 0 . 0 . 0*

199.20.150.35  
255.255.255.0

---

*199 . 20 . 150 . 0*

191.55.165.135  
255.255.255.0

---

*191 . 55 . 165 . 0*

28.212.250.254  
255.255.0.0

---

*28 . 212 . 0 . 0*

## Host Addresses

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

188.10.18.2  
255.255.0.0

---

*0 . 0 . 18 . 2*

10.10.48.80  
255.255.255.0

---

*0 . 0 . 0 . 80*

222.49.49.11  
255.255.255.0

---

*0 . 0 . 0 . 11*

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	<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:            192 . 100 . 10 . 33  
 Host Portion:                192 . 100 . 10 . 33

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

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

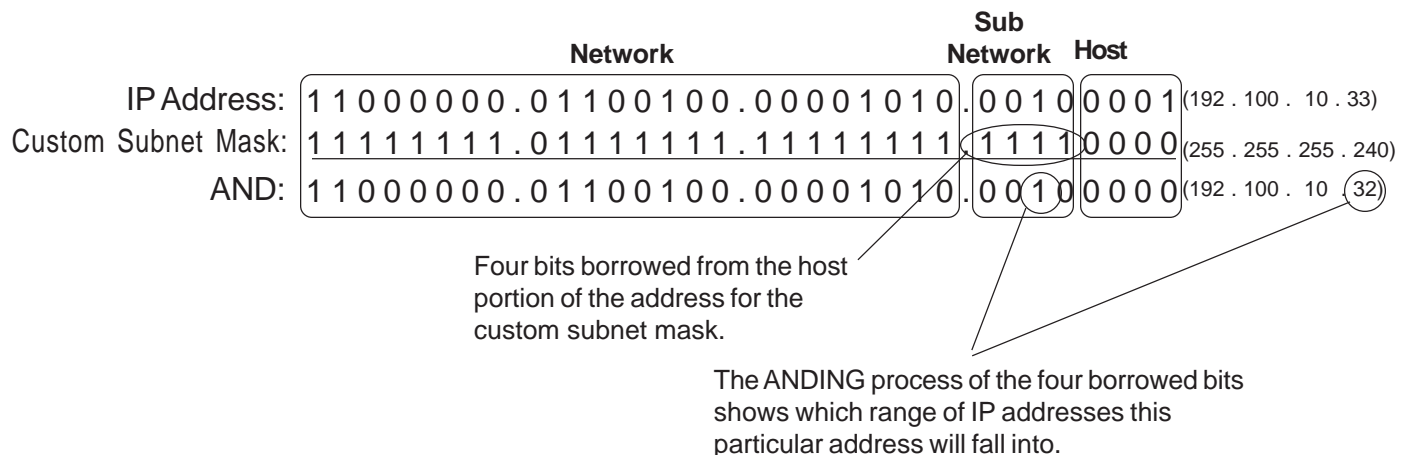
ANDING with the default subnet mask allows your computer to figure out the network portion of the address.

## ANDING With Custom subnet masks

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

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

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



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.

195.223.50.00 | 000000

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

Notice that the subnet and broadcast addresses match.

**Class C Address subnetted** (2 bits borrowed):

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

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

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

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

When to use which formula to determine the number of subnets	
Use the $2^s - 2$ formula and <b>don't use</b> the zero and broadcast ranges if...	Use the $2^s$ formula and <b>use</b> 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 <b>no ip subnet zero</b> command is configured on your router	The <b>ip subnet zero</b> 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.

<i>Number of</i>	256	128	64	32	16	8	4	2	-	<i>Number of</i>
<i>Subnets</i>	-	2	4	8	32	64	128	256		<i>Hosts</i>
		128	64	32	8	4	2	1	-	<i>Binary values</i>
<b>192 . 10 . 10 . 0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>		

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

128
64
32
+16
240

16	Observe the total number of hosts.
-2	
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.

	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Hosts -																
Number of Subnets -	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536
Binary values -	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
<b>165 . 100 . 0 0 0 0 0 0 0 0 0 . 0 0</b>																
		128		128												
		64		+64												
		32		192												
		16														
		8														
		4														
		2														
		+1														
		<u>255</u>														

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

**64** Observe the total number of hosts.

**-2** Subtract 2 for the number of usable hosts.

**62**

# Custom Subnet Masks

## Problem 3

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.

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
		148	75	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.

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

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

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

64 Observe the total number of hosts.  
 $\frac{-2}{62}$  Subtract 2 for the number of usable hosts.



# 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.

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

128	32	8
64	-2	-2
+32	30	6
<u>224</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	-	<i>Number of Hosts</i>
<i>Number of Subnets</i>	-	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1	-	<i>Binary values</i>
<b>210 . 100 . 56 .</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	
	128									
	64				8	32				
	+32	-2			-2					
	224	6			30					



# Custom Subnet Masks

## Problem 7

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

Address class     **B**    

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

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

Total number of subnets     **2,048**    

Total number of host addresses     **32**    

Number of usable addresses     **30**    

Number of bits borrowed     **11**    

**Show your work for Problem 7 in the space below.**

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

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
<b>200 . 175 . 14 .</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	

128	4	64
+64	-2	-2
240	2	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	65536
Binary values	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
	128	77	0	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/>	<hr/>	<hr/>
252	62	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	-	<i>Number of Hosts</i>
<i>Number of Subnets</i>	-	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1	-	<i>Binary values</i>
<b>198 . 100 . 10 .</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	

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	131072 262144 524288 1048576 2097152 4194304	65536 32768 16384 8192 4096 2048 1024 512	256 128 64 32 16 8 4 2	131072 262144 524288 1048576 2097152 4194304	128 64 32 16 8 4 2 1
Number of Subnets	2 4 8 16 32 64 128 256	128 64 32 16 8 4 2 1			
Binary values	101.00000000	.00000000	.00000000	.00000000	.00000000

128		
64		
32		
16		
8		
4		
2	256	65,536
+1	-2	-2
255	254	65,534



# 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	-	<i>Number of Hosts</i>
<i>Number of Subnets</i>	-	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1	-	<i>Binary values</i>
<b>218 . 35 . 50 .</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	

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

## Custom Subnet Masks

### Problem 13

Number of needed usable hosts **25**

Network Address **218.35.50.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 8

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 3

Show your work for Problem 13 in the space below.

	256	128	64	32	16	8	4	2	-	Number of Hosts
Number of Subnets	-	2	4	8	16	32	64	128	256	
		128	64	32	16	8	4	2	1	- Binary values
<b>218 . 35 . 50 .</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	

128		
64	8	32
<u>+32</u>	<u>-2</u>	<u>-2</u>
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

128		
64		
32	16	4,096
+16	-2	-2
240	14	4,094

# 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.

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
		172	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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

# Custom Subnet Masks

## Problem 16

Number of needed usable hosts **29**

Network Address **23.0.0.0**

Address class    A   

Default subnet mask    255 . 0 . 0 . 0   

Custom subnet mask    255 . 255 . 255 . 224   

Total number of subnets    524,288   

Total number of host addresses    32   

Number of usable addresses    30   

Number of bits borrowed    19   

**Show your work for Problem 16 in the space below.**

	4,194,304	2097,152	1048,576	524,288	262,144	131,072	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2			
Number of Hosts	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Number of Subnets	-	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536	131072	262144	524288	1048576	2097152	4194304		
Binary values	-	128	64	32	16	8	4	2	1	.128	.064	.032	.016	.008	.004	.002	.001	.128	.064	.032	.16	.08	.04	.02	.01
		23	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	

128		
64	32	524,288
+32	-2	-2
224	30	524,286

# Subnetting

## Problem 1

Number of needed subnets **14**

Number of needed usable hosts **14**

Network Address **192.10.10.0**

Address class     C    

Default subnet mask     255 . 255 . 255 . 0    

Custom subnet mask     255 . 255 . 255 . 240    

Total number of subnets           16          

Total number of host addresses           16          

Number of usable addresses           14          

Number of bits borrowed           4          

What is the 4th subnet range?     192.10.10.48 to 192.10.10.63    

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

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

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

Show your work for Problem 1 in the space below.

	256	128	64	32	16	8	4	2	-	Number of Hosts
Number of Subnets	-	2	4	8	16	32	64	128	256	
	128	64	32	16	8	4	2	1	-	Binary values
<b>192.10.10.0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
(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	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536
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	1	1	1	1	1	1	1	1
<b>165.100.0.0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(2)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(3)	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(4)	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
(5)	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
(6)	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0
(7)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
(8)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
(9)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
(10)	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
(11)	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
(12)	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0
(13)	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0
(14)	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
(15)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
(16)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Usable hosts:  $64 - 2 = 62$

Custom subnet mask:  $128 + 64 = 192$

$192 + 1 = 193$

$193 - 1 = 192$

$192 + 63 = 255$

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.

Down to

(1023) 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  
 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? 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.

<p>Number of Hosts -</p> <p>Number of Subnets -</p> <p>Binary values -</p> <p><b>190.35.0.0</b></p>	<p>65,536</p> <p>32,768</p> <p>16,384</p> <p>8,192</p> <p>4,096</p> <p>2,048</p> <p>1,024</p> <p>512</p> <p>256</p> <p>128</p> <p>64</p> <p>32</p> <p>16</p> <p>8</p> <p>4</p> <p>2</p> <p>1</p>	<p>190.35.0.0</p> <p>190.35.0.64</p> <p>190.35.0.128</p> <p>190.35.0.192</p> <p>190.35.1.0</p> <p>190.35.1.64</p> <p>190.35.1.128</p> <p>190.35.1.192</p> <p>190.35.2.0</p> <p>190.35.2.64</p> <p>190.35.2.128</p> <p>190.35.2.192</p> <p>190.35.3.0</p> <p>190.35.3.64</p> <p>190.35.3.128</p> <p>190.35.3.192</p>
<p>65,536</p> <p>32,768</p> <p>16,384</p> <p>8,192</p> <p>4,096</p> <p>2,048</p> <p>1,024</p> <p>512</p> <p>256</p> <p>128</p> <p>64</p> <p>32</p> <p>16</p> <p>8</p> <p>4</p> <p>2</p> <p>1</p>	<p>190.35.0.63</p> <p>190.35.0.127</p> <p>190.35.0.191</p> <p>190.35.0.255</p> <p>190.35.1.63</p> <p>190.35.1.127</p> <p>190.35.1.191</p> <p>190.35.1.255</p> <p>190.35.2.63</p> <p>190.35.2.127</p> <p>190.35.2.191</p> <p>190.35.2.255</p> <p>190.35.3.63</p> <p>190.35.3.127</p> <p>190.35.3.191</p> <p>190.35.3.255</p>	<p>(1)</p> <p>(2)</p> <p>(3)</p> <p>(4)</p> <p>(5)</p> <p>(6)</p> <p>(7)</p> <p>(8)</p> <p>(9)</p> <p>(10)</p> <p>(11)</p> <p>(12)</p> <p>(13)</p> <p>(14)</p> <p>(15)</p> <p>(16)</p>
<p>128</p> <p>64</p> <p>32</p> <p>16</p> <p>8</p> <p>4</p> <p>2</p> <p>+1</p> <hr style="border: 0; border-top: 1px solid black; margin: 0;"/> <p>252</p>	<p>64</p> <p>-2</p> <hr style="border: 0; border-top: 1px solid black; margin: 0;"/> <p>62</p>	<p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p>

# 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



# 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	256	128	64	32	16	8	4	2	-	Number of Hosts
	2	4	8	16	32	64	128	256		
192 . 70 . 10 .	0	0	0	0	0	0	0	0	0	Binary values
(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



# 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 -	16,384	8	16	32	64	128	256	512	1,024	2,048	4,096	8,192	16,384	32,768	65,536
Number of Subnets -	32,768	4	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	0	0	0	0	0	0	0
	172	50	0	0	0	0	0	0	0	0	0	0	0	0	0
(1)	0	172.50.0.0	to	172.50.31.255											
(2)	1	172.50.32.0	to	172.50.63.255											
(3)	1	172.50.64.0	to	172.50.95.255											
(4)	1	172.50.96.0	to	172.50.127.255											
(5)	1	172.50.128.0	to	172.50.159.255											
(6)	1	172.50.160.0	to	172.50.191.255											
(7)	1	172.50.192.0	to	172.50.223.255											
(8)	1	172.50.224.0	to	172.50.255.255											

$$\begin{array}{r} 128 \\ 64 \\ +32 \\ \hline 224 \end{array}$$

$$\begin{array}{r} 8,192 \\ -2 \\ \hline 8,190 \end{array}$$

# 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.

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 -	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	0	0	0	0	0	0	0	0	0
	172	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

128	(1)	0	172.50.0.0	to	172.50.0.31
64	(2)	1	172.50.0.32	to	172.50.0.63
32	(3)	1 0	172.50.0.64	to	172.50.0.95
16	(4)	1 1	172.50.0.96	to	172.50.0.127
8	(5)	1 0 0	172.50.0.128	to	172.50.0.159
4	(6)	1 0 1	172.50.0.160	to	172.50.0.191
2	(7)	1 1 0	172.50.0.192	to	172.50.0.223
+1	(8)	1 1 1	172.50.0.224	to	172.50.0.255
252	(9)	0 0 0	172.50.1.0	to	172.50.1.31
	(10)	0 0 1	172.50.1.32	to	172.50.1.63
	(11)	0 1 0	172.50.1.64	to	172.50.1.95
	(12)	0 1 1	172.50.1.96	to	172.50.1.127
	(13)	1 0 0	172.50.1.128	to	172.50.1.159
	(14)	1 0 1	172.50.1.160	to	172.50.1.191
	(15)	1 1 0	172.50.1.192	to	172.50.1.223
	(16)	1 1 1	172.50.1.224	to	172.50.1.255

128	
64	
32	
16	
8	128
4	64
2	+32
+1	224
252	

32	
-2	
30	

# Subnetting

## Problem 10

Number of needed subnets **45**

Network Address **220.100.100.0**

Address class     C    

Default subnet mask     255 . 255 . 255 . 0    

Custom subnet mask     255 . 255 . 255 . 252    

Total number of subnets     64    

Total number of host addresses     4    

Number of usable addresses     2    

Number of bits borrowed     6    

What is the 5th subnet range?     220.100.100.16 to 220.100.100.19    

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

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

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



Show your work for Problem 10 in the space below.

Number of Subnets		256 128 64 32 16 8				4 2 - Hosts				Number of Hosts	
-		2	4	8	16	32	64	128	256		
220 . 100 . 100 . 0		0	0	0	0	0	0	0	0	Binary values	
128	(1)	0						220.100.100.0	to	220.100.100.3	
64	(2)	1						220.100.100.4	to	220.100.100.7	
32	(3)		1					220.100.100.8	to	220.100.100.11	
16	(4)		1	1				220.100.100.12	to	220.100.100.15	
8	(5)		1	0	0			220.100.100.16	to	220.100.100.19	
+4	(6)		1	0	1			220.100.100.20	to	220.100.100.23	
<u>252</u>	(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)		0	0	0	0		220.100.100.32	to	220.100.100.35	
	(10)		0	0	1			220.100.100.36	to	220.100.100.39	
	(11)		0	1	0			220.100.100.40	to	220.100.100.43	
	(12)		0	1	1			220.100.100.44	to	220.100.100.47	
	(13)		1	0	0			220.100.100.48	to	220.100.100.51	
	(14)		1	0	1			220.100.100.52	to	220.100.100.55	
	(15)		1	1	0			220.100.100.56	to	220.100.100.59	
	(16)		1	1	1			220.100.100.60	to	220.100.100.63	

# Subnetting

## Problem 11

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

Network Address **135.70.0.0**

Address class     *B*    

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

Custom subnet mask     *255 . 255 . 224 . 0*    

Total number of subnets     *8*    

Total number of host addresses     *8,192*    

Number of usable addresses     *8,190*    

Number of bits borrowed     *3*    

What is the 6th subnet range?     *135.70.160.0 to 135.70.191.255*    

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

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

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

Show your work for Problem 11 in the space below.

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	0	0	0	0	0	0	0	0	0
	135	.70	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
(1)	0																135.70.0.0
(2)	1																135.70.32.0
(3)	0	1															135.70.64.0
(4)	0	0	1														135.70.96.0
(5)	1	0	0														135.70.128.0
(6)	0	1	0														135.70.160.0
(7)	0	0	1														135.70.192.0
(8)	1	1	1														135.70.224.0

128  
64  
+32  
224

8,192  
-2  
8,190

# 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.

	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
198 . 125 . 50 . 0	0	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



# 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
<b>200 . 10 . 10 . 0 0 0</b>					<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
	(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	

$$\begin{array}{r}
 128 \\
 64 \\
 +32 \\
 \hline
 224
 \end{array}$$

$$\begin{array}{r}
 32 \\
 -2 \\
 \hline
 30
 \end{array}$$

# 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

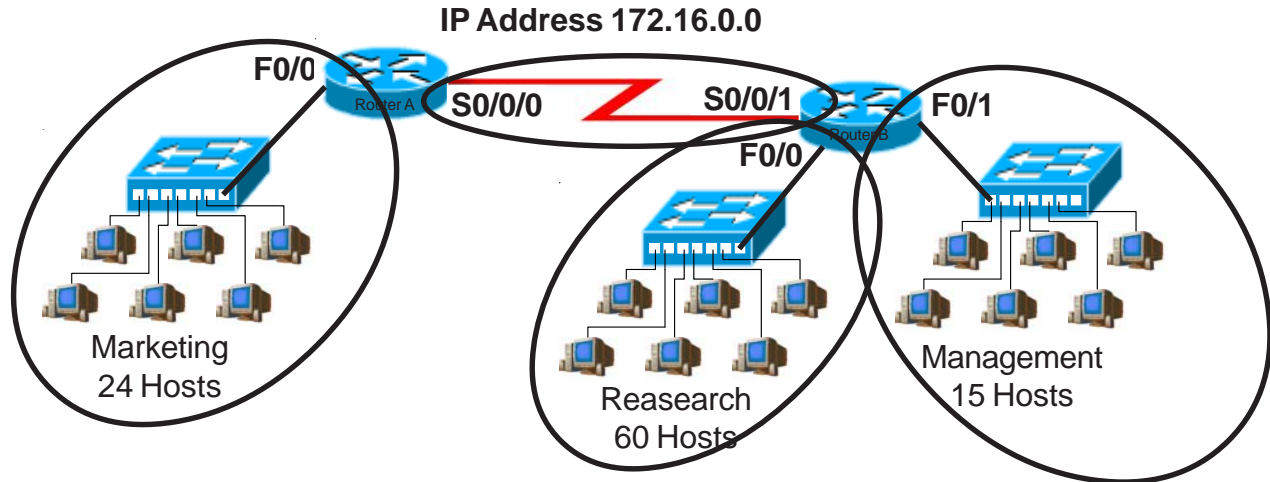
What is the subnet broadcast address for the 7th subnet? 93.0.223.255

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



# Practical Subnetting 1

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



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

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

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

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

Number of Hosts -  
 2  
 4  
 8  
 16  
 32  
 64  
 128  
 256  
 512  
 1024  
 2048  
 4096  
 8192  
 16384  
 32768  
 65536

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

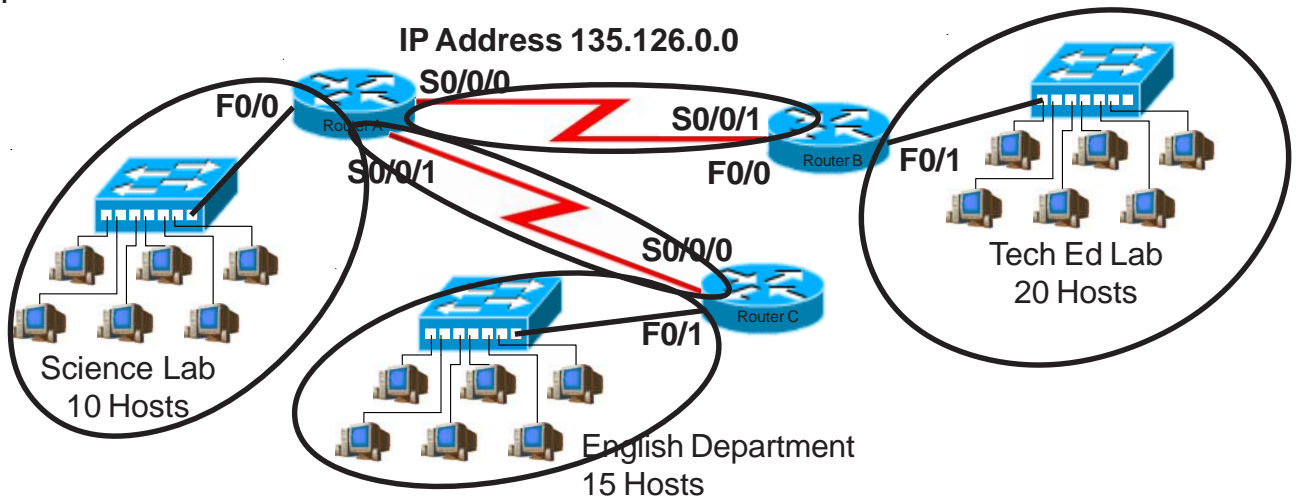
(1)	0	172.16.0.0	to	172.16.31.255
(2)	1	172.16.32.0	to	172.16.63.255
(3)	1	172.16.64.0	to	172.16.95.255
(4)	1	172.16.96.0	to	172.16.127.255
(5)	1	172.16.128.0	to	172.16.159.255
(6)	1	172.16.160.0	to	172.16.191.255
(7)	1	172.16.192.0	to	172.16.223.255
(8)	1	172.16.224.0	to	172.16.255.255

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

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

## Practical Subnetting 2

Based on the information in the graphic shown, design a network addressing scheme that will supply the **minimum number of hosts per subnet**, and allow enough extra subnets and hosts for 30% growth in all areas. Circle each subnet on the graphic and answer the questions below.



Address class B

Custom subnet mask 255.255.255.224

Minimum number of subnets needed 5

Extra subnets required for 30% growth + 2  
(Round up to the next whole number)

Total number of subnets needed = 7

Number of host addresses in the largest subnet group 20

Number of addresses needed for 30% growth in the largest subnet + 6  
(Round up to the next whole number)

Total number of address needed for the largest subnet = 26

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

IP address range for Tech Ed 135.126.0.0 to 135.126.0.31

IP address range for English 135.126.0.32 to 135.126.0.63

IP address range for Science 135.126.0.64 to 135.126.0.95

IP address range for Router A to Router B serial connection 135.126.0.96 to 135.126.0.127

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

Show your work for Problem 2 in the space below.

<p>Number of Hosts -</p> <p>Number of Subnets -</p> <p>Binary values -</p> <p><b>135.126.0.0</b></p>	<p>2</p> <p>4</p> <p>8</p> <p>16</p> <p>32</p> <p>64</p> <p>128</p> <p>256</p> <p>512</p> <p>1024</p> <p>2048</p> <p>4096</p> <p>8192</p> <p>16384</p> <p>32768</p> <p>65536</p>	<p>1</p> <p>2</p> <p>4</p> <p>8</p> <p>16</p> <p>32</p> <p>64</p> <p>128</p> <p>256</p> <p>512</p> <p>1024</p> <p>2048</p> <p>4096</p> <p>8192</p> <p>16384</p> <p>32768</p> <p>65536</p>
<p>Number of Hosts -</p> <p>Number of Subnets -</p> <p>Binary values -</p> <p><b>135.126.0.0</b></p>	<p>2</p> <p>4</p> <p>8</p> <p>16</p> <p>32</p> <p>64</p> <p>128</p> <p>256</p> <p>512</p> <p>1024</p> <p>2048</p> <p>4096</p> <p>8192</p> <p>16384</p> <p>32768</p> <p>65536</p>	<p>1</p> <p>2</p> <p>4</p> <p>8</p> <p>16</p> <p>32</p> <p>64</p> <p>128</p> <p>256</p> <p>512</p> <p>1024</p> <p>2048</p> <p>4096</p> <p>8192</p> <p>16384</p> <p>32768</p> <p>65536</p>

	$\begin{array}{r} 5 \\ \times 3 \\ \hline 15 \end{array}$ <p>(Round up to 2)</p>				
	$\begin{array}{r} 20 \\ \times 3 \\ \hline 6 \end{array}$				

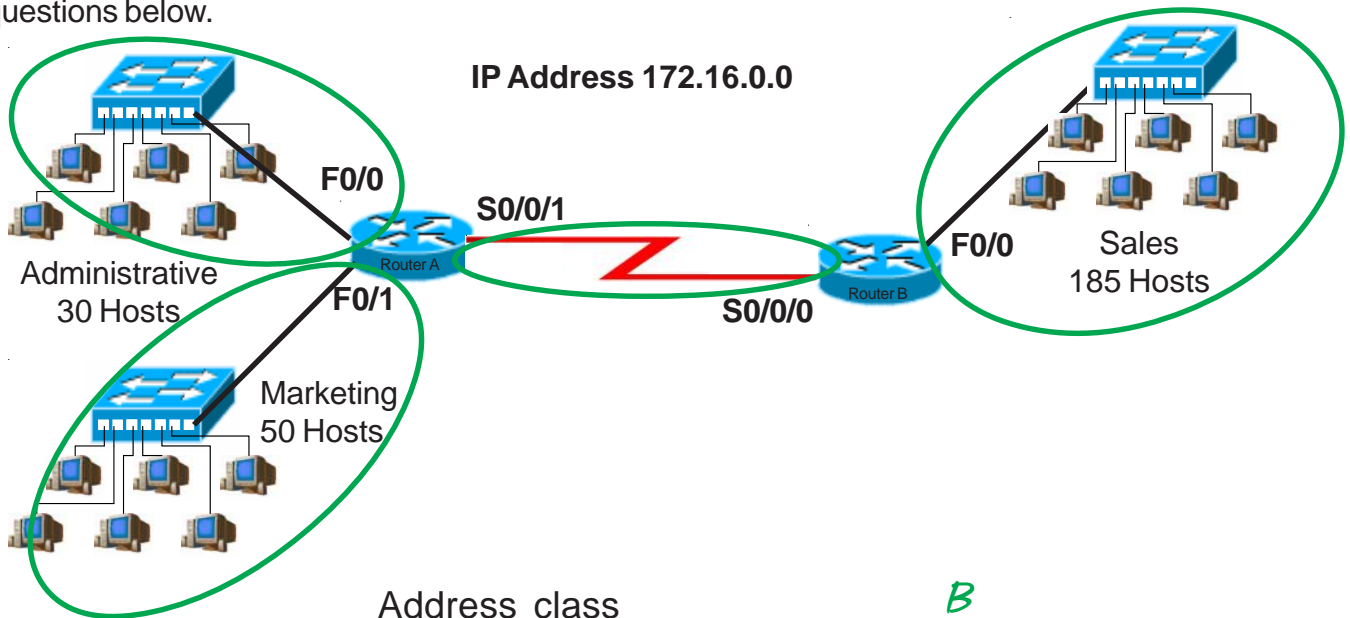
	<p>(1)</p> <p>(2)</p> <p>(3)</p> <p>(4)</p> <p>(5)</p> <p>(6)</p> <p>(7)</p> <p>(8)</p> <p>(9)</p> <p>(10)</p> <p>(11)</p> <p>(12)</p> <p>(13)</p> <p>(14)</p> <p>(15)</p> <p>(16)</p>	<p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p>	<p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p>	<p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p> <p>0</p> <p>1</p>	<p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p>
--	--	---	---	---	---

	<p>135.126.0.0</p> <p>135.126.0.32</p> <p>135.126.0.64</p> <p>135.126.0.96</p> <p>135.126.0.128</p> <p>135.126.0.160</p> <p>135.126.0.192</p> <p>135.126.0.224</p> <p>135.126.1.0</p> <p>135.126.1.32</p> <p>135.126.1.64</p> <p>135.126.1.96</p> <p>135.126.1.128</p> <p>135.126.1.160</p> <p>135.126.1.192</p> <p>135.126.1.224</p>	<p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p> <p>to</p>
--	---	---

# 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.

<p>Number of Hosts -</p> <p>Number of Subnets -</p> <p>Binary values -</p>	<p>512 ----- 128 256</p> <p>1,024 ----- 128 256</p> <p>2,048 ----- 64 64 64</p> <p>4,096 ----- 32 8 4 4 4 4</p> <p>8,192 ----- 16 16 8 4 2 1</p> <p>16,384 ----- 8 8 4 2 1</p> <p>32,768 ----- 4 4 2 1</p> <p>65,536 ----- 2 2 1</p>	<p>256 128 64 32 16 8 4 2</p> <p>16,384</p> <p>8,192</p> <p>4,096</p> <p>2,048</p> <p>1,024</p> <p>512</p>	<p>172.16.0.0</p> <p>172.16.1.0</p> <p>172.16.2.0</p> <p>172.16.3.0</p> <p>172.16.4.0</p> <p>172.16.5.0</p> <p>172.16.6.0</p> <p>172.16.7.0</p> <p>172.16.8.0</p> <p>172.16.9.0</p> <p>172.16.10.0</p> <p>172.16.11.0</p> <p>172.16.12.0</p> <p>172.16.13.0</p> <p>172.16.14.0</p> <p>172.16.15.0</p>
	<p>0</p> <p>1</p> <p>1 0</p> <p>1 1</p> <p>1 0 0</p> <p>1 0 1</p> <p>1 1 0</p> <p>1 1 1</p> <p>0 0 0</p> <p>0 0 1</p> <p>0 1 0</p> <p>0 1 1</p> <p>1 0 0</p> <p>1 1 0</p> <p>1 1 1</p>	<p>0 0 0 0 0 0 0 0</p> <p>0 0 0 0 0 0 0 0</p> <p>0 0 0 0 0 0 0 0</p> <p>0 0 0 0 0 0 0 0</p> <p>0 0 0 0 0 0 0 0</p> <p>0 0 0 0 0 0 0 0</p> <p>0 0 0 0 0 0 0 0</p> <p>0 0 0 0 0 0 0 0</p> <p>0 0 0 0 0 0 0 0</p> <p>0 0 0 0 0 0 0 0</p> <p>0 0 0 0 0 0 0 0</p> <p>0 0 0 0 0 0 0 0</p> <p>0 0 0 0 0 0 0 0</p> <p>0 0 0 0 0 0 0 0</p> <p>0 0 0 0 0 0 0 0</p> <p>0 0 0 0 0 0 0 0</p> <p>0 0 0 0 0 0 0 0</p>	<p>(1) 172.16.0.255</p> <p>(2) 172.16.1.255</p> <p>(3) 172.16.2.255</p> <p>(4) 172.16.3.255</p> <p>(5) 172.16.4.255</p> <p>(6) 172.16.5.255</p> <p>(7) 172.16.6.255</p> <p>(8) 172.16.7.255</p> <p>(9) 172.16.8.255</p> <p>(10) 172.16.9.255</p> <p>(11) 172.16.10.255</p> <p>(12) 172.16.11.255</p> <p>(13) 172.16.12.255</p> <p>(14) 172.16.13.255</p> <p>(15) 172.16.14.255</p> <p>(16) 172.16.15.255</p>

4

x.25

---

1

225

x.25

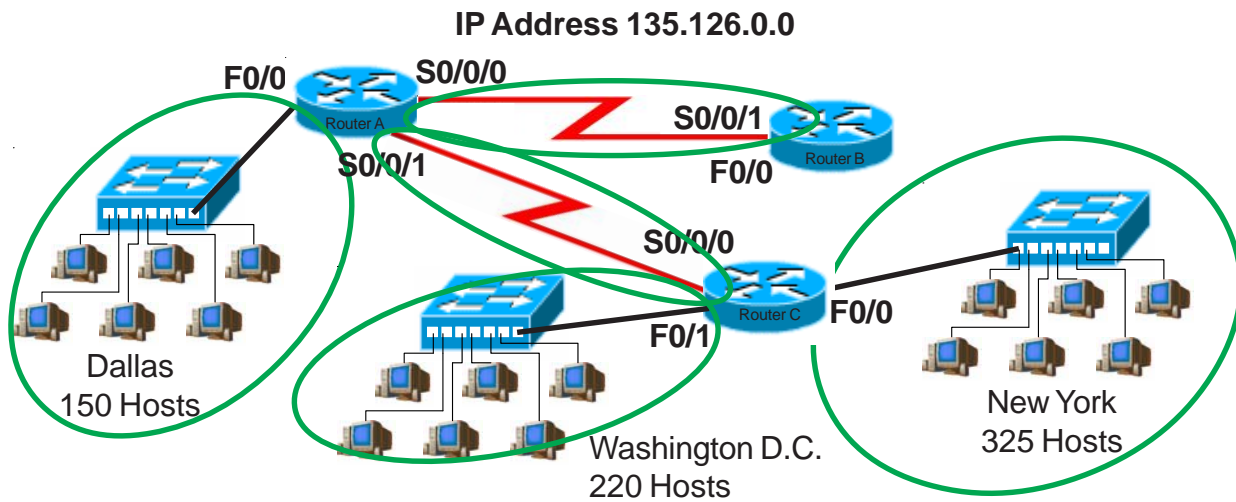
---

56.25

(Round up to 57)

# 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 + 4  
(Round up to the next whole number)

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 + 228  
(Round up to the next whole number)

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

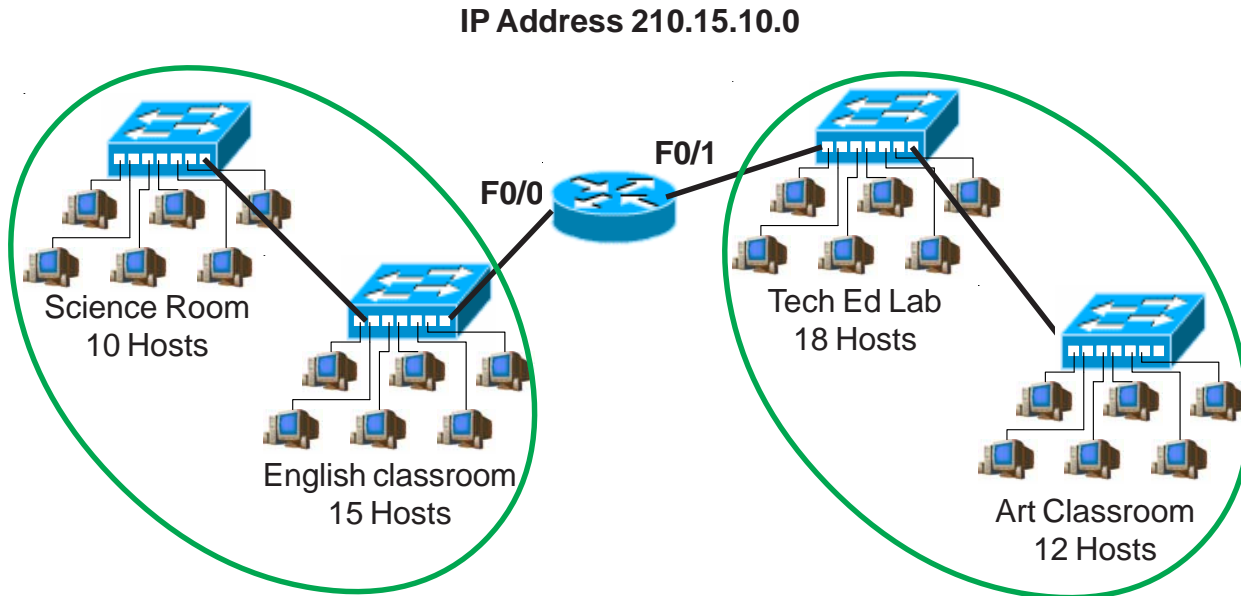
IP address range for Router A to Router C serial connection 135.126.64.0 to 135.126.79.255

Show your work for Problem 4 in the space below.

Number of Hosts -	256	128	64	32	16	8	4	2
	512	1,024	2,048	4,096	8,192	16,384	32,768	65,536
Number of Subnets -	32	64	128	256				
Binary values -	8	4	2	1				
	135.126.0.0	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)	135.126.0.0	to	135.126.15.255					
(2)	135.126.16.0	to	135.126.31.255					
(3)	135.126.32.0	to	135.126.47.255					
(4)	135.126.48.0	to	135.126.63.255					
(5)	135.126.64.0	to	135.126.79.255					
(6)	135.126.80.0	to	135.126.95.255					
(7)	135.126.96.0	to	135.126.111.255					
(8)	135.126.112.0	to	135.126.127.255					
(9)	135.126.128.0	to	135.126.143.255					
(10)	135.126.144.0	to	135.126.159.255					
(11)	135.126.160.0	to	135.126.175.255					
(12)	135.126.176.0	to	135.126.191.255					
(13)	135.126.192.0	to	135.126.207.255					
(14)	135.126.208.0	to	135.126.223.255					
(15)	135.126.224.0	to	135.126.239.255					
(16)	135.126.240.0	to	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.



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 <small>(Round up to the next whole number)</small>	<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 <small>(Round up to the next whole number)</small>	<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

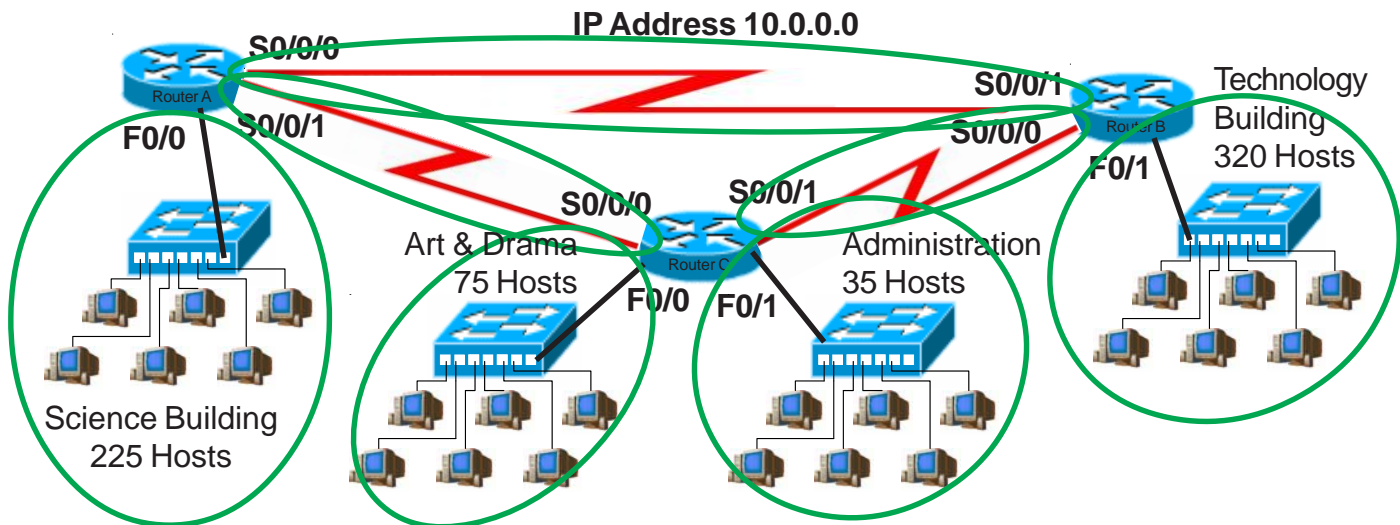
IP address range for Router F0/1 Port 210.15.10.64 to 210.15.10.127

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
<span style="font-size: 1.2em; font-weight: bold;">210.15.10.00000000</span>										
(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.

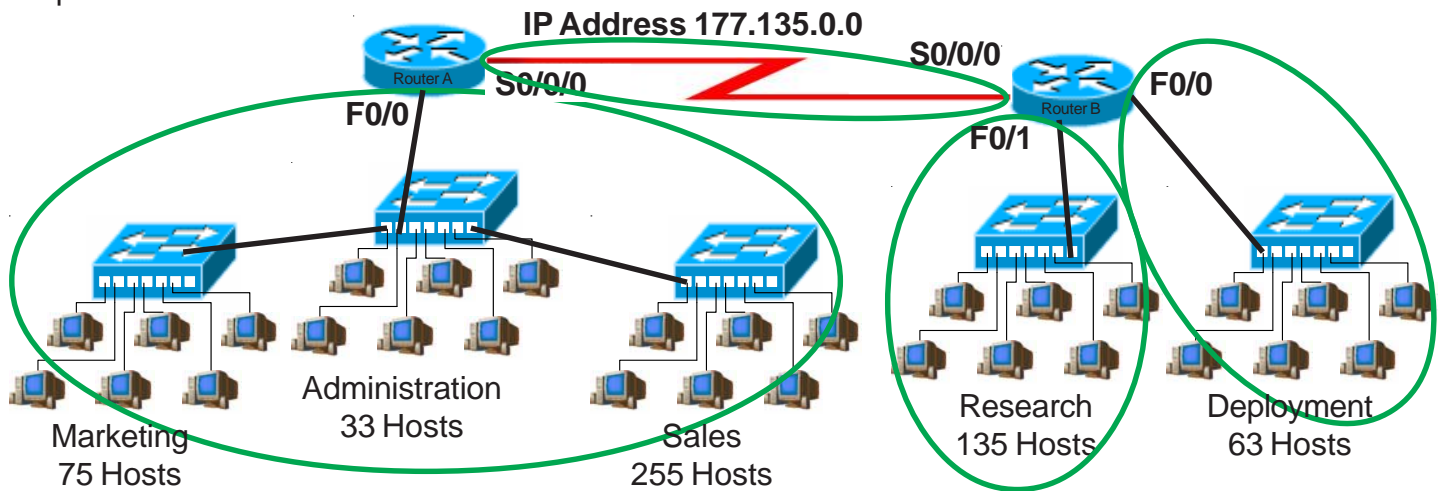
IP address range for Technology	<u>10.0.0.0 to 10.15.255.255</u>
IP address range for Science	<u>10.16.0.0 to 10.31.255.255</u>
IP address range for Arts & Drama	<u>10.32.0.0 to 10.47.255.255</u>
IP Address range Administration	<u>10.48.0.0 to 10.63.255.255</u>
IP address range for Router A to Router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

Number of Hosts	Number of Subnets	Binary values	Subnet 1	Subnet 2	Subnet 3	Subnet 4	Subnet 5	Subnet 6	Subnet 7	Subnet 8	Subnet 9	Subnet 10	Subnet 11	Subnet 12	Subnet 13	Subnet 14	Subnet 15	Subnet 16
4,194,304	2	128 64 32 16 8 4 2	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
2,097,152	4	64 32 16 8 4 2	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
1,048,576	8	32 16 8 4 2 1	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
524,288	16	16 8 4 2 1	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
262,144	32	8 4 2 1	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
131,072	64	4 2 1	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
65,536	128	2 1	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
32,768	256	1	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
16,384	512		10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
8,192	1,024		10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
4,096	2,048		10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
2,048	4,096		10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
1,024	8,192		10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
512	16,384		10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
256	32,768		10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
128	65,536		10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
64	131,072		10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
32	262,144		10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
16	524,288		10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
8	1,048,576		10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
4	2,097,152		10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
2	4,194,304		10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0
1	8,388,608		10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0	10.0.0.0

# 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	<u>B</u>
Custom subnet mask	<u>255.255.252.0</u>
Minimum number of subnets needed	<u>4</u>
Extra subnets required for 125% growth <small>(Round up to the next whole number)</small>	<u>+ 5</u>
Total number of subnets needed	<u>= 9</u>
Number of host addresses in the largest subnet group	<u>363</u>
Number of addresses needed for 125% growth in the largest subnet <small>(Round up to the next whole number)</small>	<u>+ 454</u>
Total number of address needed for the largest subnet	<u>= 817</u>

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	<u>177.135.0.0 to 177.135.3.255</u>
IP address range for Research	<u>177.135.4.0 to 177.135.7.255</u>
IP address range for Deployment	<u>177.135.8.0 to 177.135.11.255</u>
IP address range for Router A to Router B serial connection	<u>177.135.12.0 to 177.135.15.255</u>

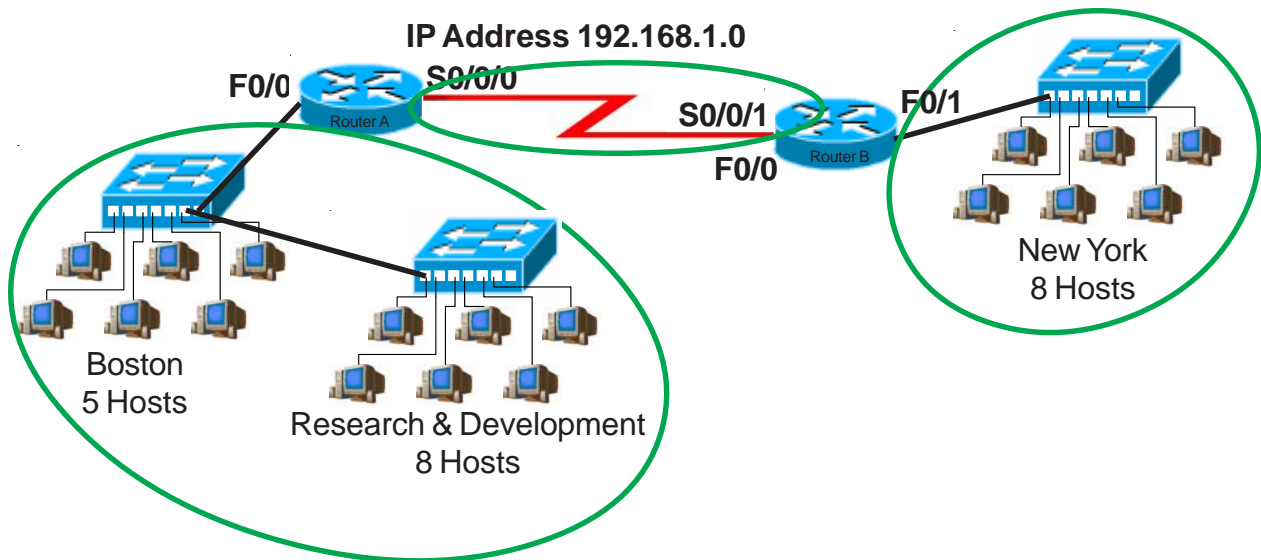


Show your work for Problem 7 in the space below.

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

## Practical Subnetting 8

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



Address class	<u>C</u>
Custom subnet mask	<u>255.255.255.224</u>
Minimum number of subnets needed	<u>3</u>
Extra subnets required for 85% growth (Round up to the next whole number)	<u>+ 3</u>
Total number of subnets needed	<u>= 6</u>
Number of host addresses in the largest subnet group	<u>13</u>
Number of addresses needed for 85% growth in the largest subnet (Round up to the next whole number)	<u>+ 12</u>
Total number of address needed for the largest subnet	<u>= 25</u>

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

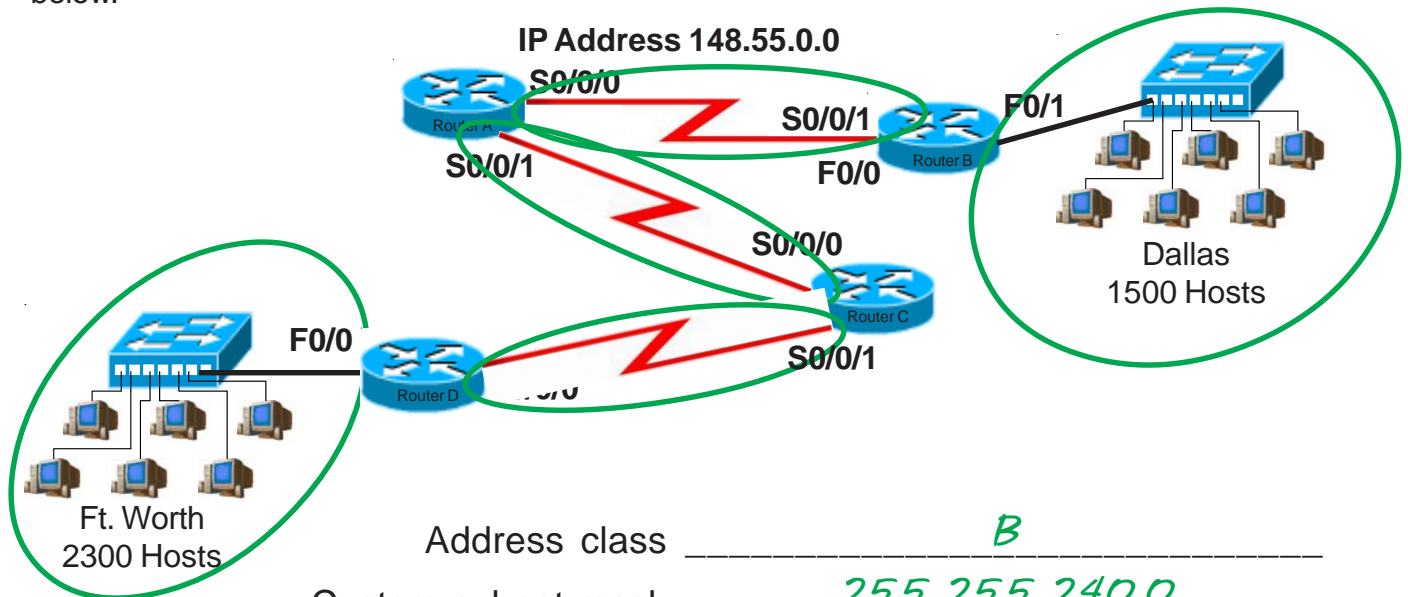
IP address range for Router A F0/0	<u>192.168.1.0 to 192.168.1.31</u>
IP address range for New York	<u>192.168.1.32 to 192.168.1.63</u>
IP address range for Router A to Router B serial connection	<u>192.168.1.64 to 192.168.1.95</u>

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
192.168.1.0	0	0	0	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 + 1  
(Round up to the next whole number)

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 + 345  
(Round up to the next whole number)

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

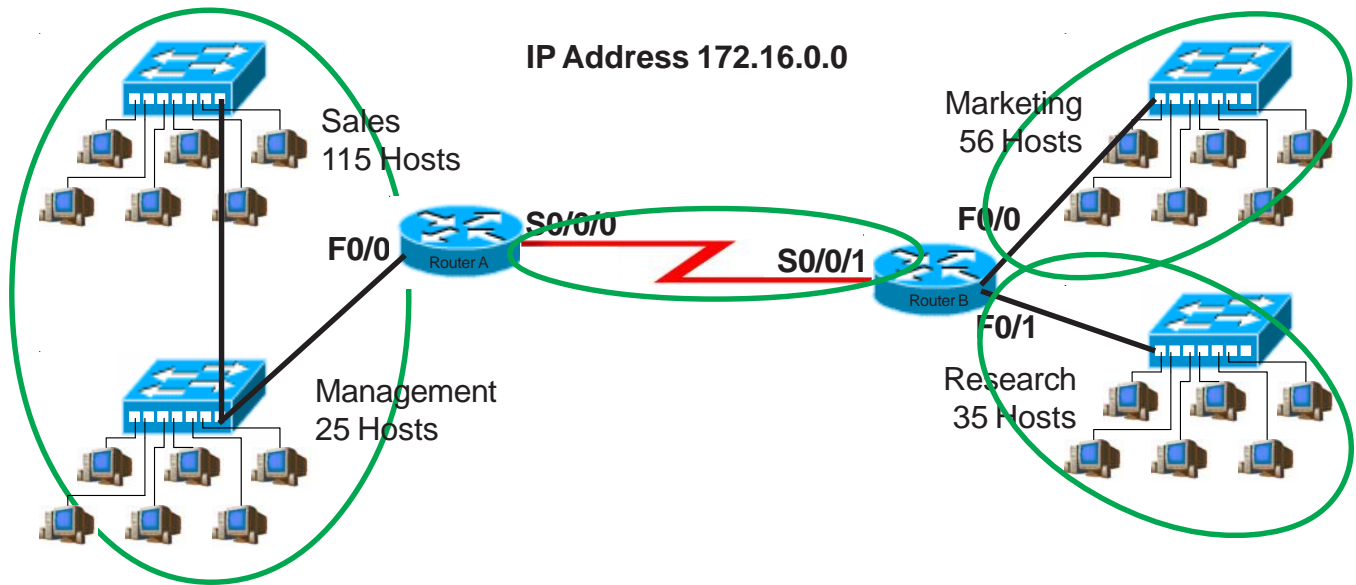
IP address range for Router C to Router D serial connection 148.55.64.0 to 148.55.79.255

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	0	0	0	0	0	0	0	0	0
<b>148.55.0.0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
(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 <small>(Round up to the next whole number)</small>	<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 <small>(Round up to the next whole number)</small>	<u>+ 154</u>
Total number of address needed for the largest subnet	<u>= 294</u>

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

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

Show your work for Problem 10 in the space below.

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

## 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

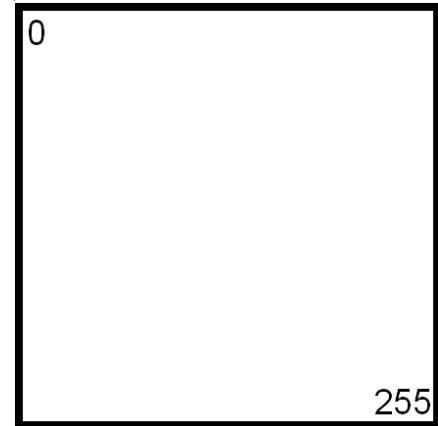
<b>/24</b>	<b>/25</b>	<b>/26</b>	<b>/27</b>	<b>/28</b>	<b>/29</b>	<b>/30</b>
8+8+8 255.255.255.0 256 Hosts	8+8+8+1 255.255.255.128 128 Hosts	8+8+8+2 255.255.255.192 64 Hosts	8+8+8+3 255.255.255.224 32 Hosts	8+8+8+4 255.255.255.240 16 Hosts	8+8+8+5 255.255.255.248 8 Hosts	8+8+8+6 255.255.255.252 4 Hosts
0-255	0-127	0-63		0-15	0-7	0-3 4-7
				16-31	8-15	8-11 12-15
					16-23 24-31	16-19 20-23 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
		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.

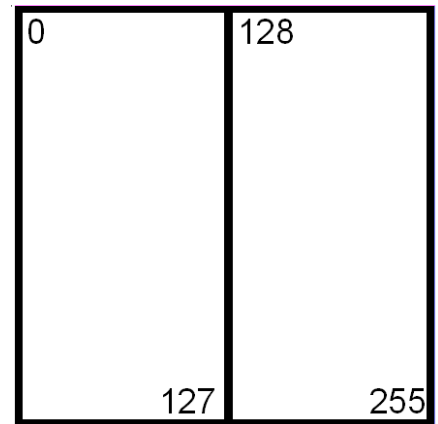
Start with a square. The whole square is a single subnet comprised of 256 addresses.

*/24*  
255.255.255.0  
256 Hosts  
1 Subnet



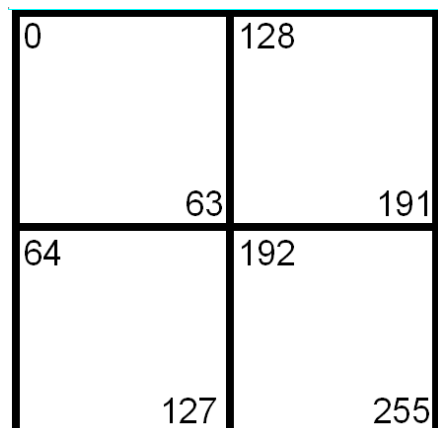
Split the box in half and you get two subnets with 128 addresses,

*/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

