The background of the page features a large, stylized representation of binary code. It consists of several thick, black, horizontal bars of varying lengths that overlap each other. In the upper left area, there is a white oval containing a grid of binary digits (0s and 1s).

# IP Addressing and Subnetting

**Workbook**  
Version 2.0

11111110

10010101

00011011

11010011

10000110

Student Name:

## IP Address Classes

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

## Private Address Space

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

## Default Subnet Masks

Class A	255.0.0.0
Class B	255.255.0.0
Class C	255.255.255.0

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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>	<u>128</u> <u>16</u> <u>32</u> <u>2</u> <u>146</u> <u>4</u> <u>2</u> <u>1</u>
0	1	1	1	0	1	1	1	<u>119</u>	<u>64</u> <u>32</u> <u>16</u> <u>4</u>
1	1	1	1	1	1	1	1	<u>255</u>	<u>2</u>
1	1	0	0	0	1	0	1	<u>197</u>	<u>119</u>
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.

**Use all 8 bits for each problem**

128	64	32	16	8	4	2	1	=	255	Scratch Area
/	/	/	0	/	/	/	0	238	238 -128 110 -64 46 -32 14 -8 6 -4 2 -2 0	34 -32 2 -2 0
0	0	/	0	0	0	/	0	34		
0	1	1	1	1	0	1	1	123		
0	0	1	1	0	0	1	0	50		
1	1	1	1	1	1	1	1	255		
1	1	0	0	1	0	0	0	200		
0	0	0	0	1	0	1	0	10		
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	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	0	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

0.0.011

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

191.249.234.191 255.255.0.0

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

189.210.50.1 255.255.0.0

88.45.65.35 255.0.0.0

128.212.250.254 255.255.0.0

193.100.77.83 255.255.255.0

125.125.250.1 255.0.0.0

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:

$$\begin{aligned}1 \text{ AND } 1 &= 1 \\1 \text{ AND } 0 &= 0 \\0 \text{ AND } 1 &= 0 \\0 \text{ AND } 0 &= 0\end{aligned}$$

### 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)

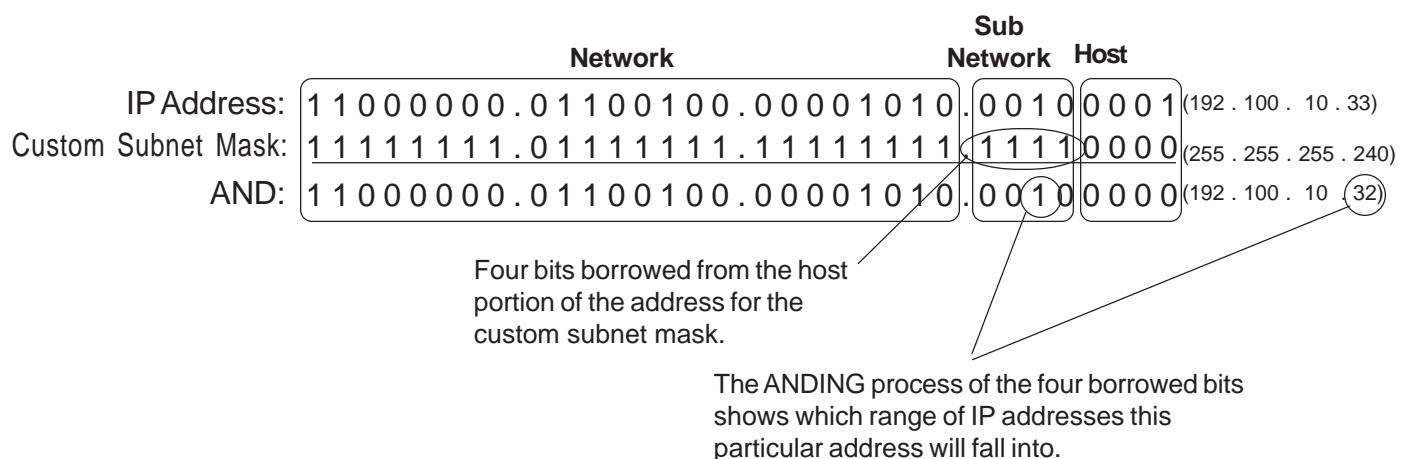
ANDING with the default subnet mask allows your computer to figure out the network portion of the address.

## 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:

$$\text{Number of subnets} = 2^s \quad (\text{Second subnet formula: Number of subnets} = 2^s - 2)$$

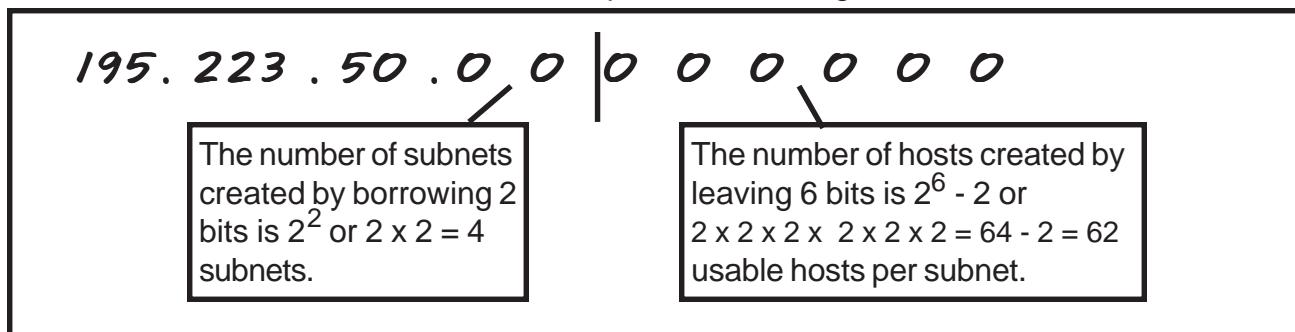
$$\text{Number of hosts per subnet} = 2^h - 2$$

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

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

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

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



**What about that second subnet formula:**

$$\text{Number of subnets} = 2^s - 2$$

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

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

When to use which formula to determine the number of subnets	
Use the $2^s - 2$ formula and <u>don't use</u> the zero and broadcast ranges if...	Use the $2^s$ formula and <u>use</u> the zero and broadcast ranges if...
Classful routing is used	Classless routing or VLSM is used
RIP version 1 is used	RIP version 2, EIGRP, or OSPF is used
The <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.

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>192 . 10 . 10 . 0</b>	<b>0</b>									

$$\begin{array}{r} 128 \\ 64 \\ 32 \\ +16 \\ \hline 240 \end{array}$$

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

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

Observe the total number of hosts.  
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.

## 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 \_\_\_\_\_

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.

# Custom Subnet Masks

## Problem 4

Number of needed subnets **6**

Number of needed usable hosts **30**

Network Address **195.85.8.0**

Address class **C**

Default subnet mask **255.255.255.0**

Custom subnet mask **255.255.255.224**

Total number of subnets **8**

Total number of host addresses **32**

Number of usable addresses **30**

Number of bits borrowed **3**

Show your work for Problem 5 in the space below.

Number of Subnets	256	128	64	32    16    8    4    2    -    Number of Hosts	16	32	64	128	256	Binary values
	-	2	4		16	32	64	128	256	
	128	64	32		16	8	4	2	1	
<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>	

# 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.

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

# Custom Subnet Masks

## Problem 6

Number of needed subnets **126**

Number of needed usable hosts **131,070**

Network Address **118.0.0**

## Address class A \_\_\_\_\_

Default subnet mask 255.0.0.0

Custom subnet mask 255.254.0.0

Total number of subnets 128

Total number of host addresses 131072

Number of usable addresses 131070

Number of bits borrowed 7

Show your work for Problem 6 in the space below.

# 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 **2048**

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	1
Number of Subnets	-	2	4	8	16	32	64	128	256.	512	1024	2048	4096	8192	16384	32768	65536	1
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

# 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.**

## 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.**

## 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.

## 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 **65536** \_\_\_\_\_

Number of usable addresses **65534** \_\_\_\_\_

Number of bits borrowed **8** \_\_\_\_\_

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

## Custom Subnet Masks

### Problem 12

Number of needed subnets **5**

Network Address **218.35.50.0**

Address class **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.

## Custom Subnet Masks

### **Problem 13**

Number of needed usable hosts **25**

Network Address **218.35.50.0**

Address class **C**

**255.255.255.0**

Default subnet mask \_\_\_\_\_

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**

Network Address **172.59.0.0**

Address class **B**

Default subnet mask **255.255.0.0**

**255.255.240.0**

Custom subnet mask \_\_\_\_\_

**16**

Total number of subnets \_\_\_\_\_

**4096**

Total number of host addresses \_\_\_\_\_

**4094**

Number of usable addresses \_\_\_\_\_

**4**

Number of bits borrowed \_\_\_\_\_

Show your work for Problem 14 in the space below.

## Custom Subnet Masks

### **Problem 15**

Number of needed usable hosts **50**

Network Address **172.59.0.0**

Address class **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**  
**62**

Number of usable addresses \_\_\_\_\_

Number of bits borrowed **10**

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

## Custom Subnet Masks

## Problem 16

## Number of needed usable hosts **29**

# Network Address **23.0.0.0**

Address class A

Default subnet mask \_\_\_\_\_

255.255.255.224

Custom subnet mask \_\_\_\_\_

Total number of subnets \_\_\_\_\_

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

128										
64										
32										
+16										
Custom subnet mask	240									

Usable subnets										
16										
-2										
14										

Usable hosts										
16										
-2										
14										

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.

# Subnetting

## Problem 3

Number of needed subnets **2**

Network Address **195.223.50.0**

Hint: It is possible to borrow one bit to create two subnets.

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? **195.223.50.128 - 195.223.50.191**

What is the subnet number for the 2nd subnet? **195.223.50.64**

What is the subnet broadcast address for the 1st subnet? **195.223.50.63**

What are the assignable addresses for the 1st subnet? **195.223.50.129 - 195.223.50.190**

Show your work for Problem 3 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. 223 . 50 . 0      0 0 0 0 0 0 0 0

# 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 **1024**

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 - 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? **190.35.1.165 - 190.35.1.126**

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 **A**

Default subnet mask **255.0.0.0**

Custom subnet mask **255.255.255.248**

Total number of subnets **2097152**

Total number of host addresses **8**

Number of usable addresses **61**

Number of bits borrowed **21**

What is the 2nd subnet range? **126.0.08 - 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 - 126.0.0.78**

Show your work for Problem 5 in the space below.

# Subnetting

## Problem 6

Number of needed subnets **10**

Network Address **192.70.10.0**

Address class 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 - 192.70.10.143

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 - 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 **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** \_\_\_\_\_

What is the 11th  
subnet range? **10.10.0.0 - 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 - 10.8.255.254** \_\_\_\_\_

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 \_\_\_\_\_ **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 \_\_\_\_\_ **8192** \_\_\_\_\_

Number of usable addresses \_\_\_\_\_ **8190** \_\_\_\_\_

Number of bits borrowed \_\_\_\_\_ **3** \_\_\_\_\_

What is the 4th  
subnet range? \_\_\_\_\_ **172.50.96.0 - 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? \_\_\_\_\_ **172.50.192.255** \_\_\_\_\_

What are the assignable  
addresses for the 3rd  
subnet? \_\_\_\_\_ **172.50.84.1 - 172.50.95.254** \_\_\_\_\_

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 **B**

Default subnet mask **255.255.0.0**

Custom subnet mask **255.255.255.224**

Total number of subnets **2048**

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 - 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 - 172.50.0.190**

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 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 - 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 - 220.100.100.46

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 **B**

**255.255.0.0**

Default subnet mask \_\_\_\_\_

**255.255.224.0**

Custom subnet mask \_\_\_\_\_

Total number of subnets **8**

Total number of host addresses **8192**

Number of usable addresses **8190**

Number of bits borrowed **3**

What is the 6th  
subnet range? **135.70.160.0 - 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 - 135.70.159.254**

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 C

255.255.255.0

Default subnet mask \_\_\_\_\_

255.255.255.192

Custom subnet mask \_\_\_\_\_

Total number of subnets 4

64

Total number of host addresses \_\_\_\_\_

62

Number of usable addresses \_\_\_\_\_

2

Number of bits borrowed \_\_\_\_\_

What is the 2nd  
subnet range? 198.125.50.64 - 98.125.50.127

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 - 198.125.50.190

Show your work for Problem 12 in the space below.

# 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 **1024**

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 - 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 - 165.200.255.126**

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 **C**

Default subnet mask **255.255.255.0**

Custom subnet mask **255.255.255.224**

Total number of subnets **8**

**32**

Total number of host addresses \_\_\_\_\_

Number of usable addresses **30**

**3**

Number of bits borrowed \_\_\_\_\_

What is the 7th subnet range? **200.10.10.192 - 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 - 200.10.10.190**

Show your work for Problem 14 in the space below.

# 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 **2048** \_\_\_\_\_

Total number of host addresses **8192** \_\_\_\_\_

Number of usable addresses **8190** \_\_\_\_\_

Number of bits borrowed **11** \_\_\_\_\_

What is the 15th  
subnet range? **93.1.192.0 - 93.1.223.255** \_\_\_\_\_

What is the subnet  
number  
for the 9th subnet? **93.1.0.0** \_\_\_\_\_

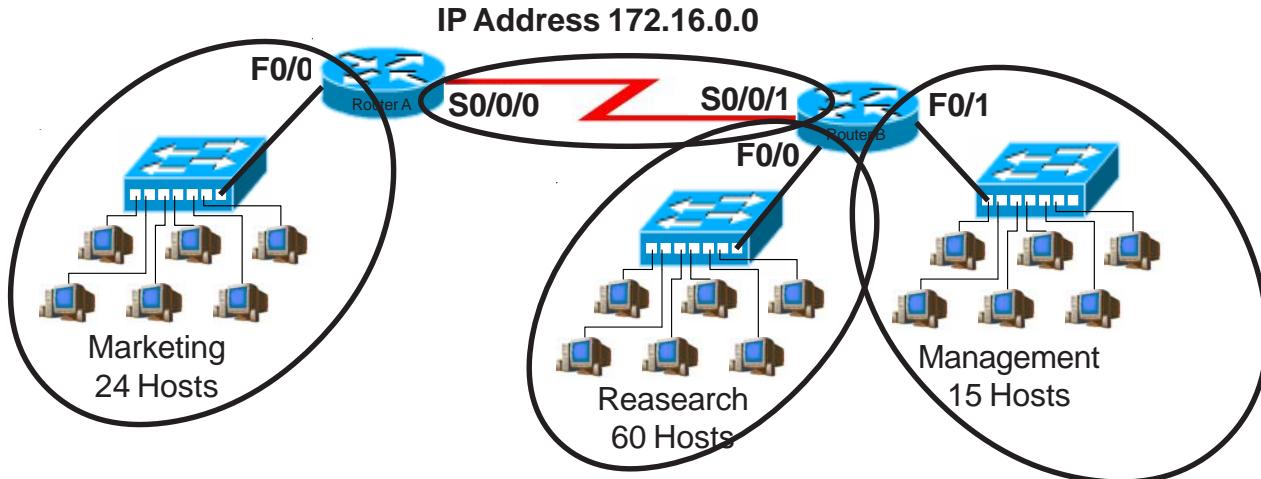
What is the subnet  
broadcast address for  
the 7th subnet? **93.0.223.255** \_\_\_\_\_

What are the assignable  
addresses for the 12th  
subnet? **93.1.96.1 - 93.1.127.254** \_\_\_\_\_

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 \_\_\_\_\_

*B*

Custom subnet mask \_\_\_\_\_

*255.255.224.0*

Minimum number of subnets needed \_\_\_\_\_

*4*

Extra subnets required for 100% growth  
(Round up to the next whole number) \_\_\_\_\_

*+ 4*

Total number of subnets needed \_\_\_\_\_

*= 8*

Number of host addresses  
in the largest subnet group \_\_\_\_\_

*60*

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

*+ 60*

Total number of address  
needed for the largest subnet \_\_\_\_\_

*= 120*

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

IP address range for Research \_\_\_\_\_

*172.16.0.0 to 172.31.255*

IP address range for Marketing \_\_\_\_\_

*172.16.32.0 to 172.63.255*

IP address range for Management \_\_\_\_\_

*172.16.64.0 to 172.95.255*

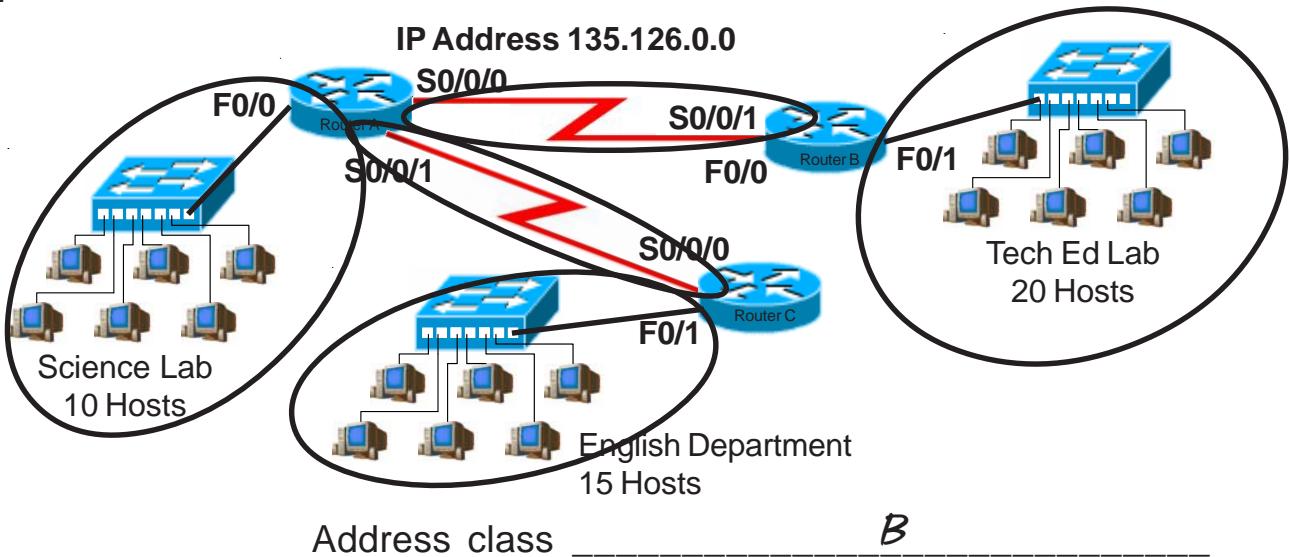
IP address range for Router A  
to Router B serial connection \_\_\_\_\_

*172.16.96.0 to 172.127.255*

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

## 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  
(Round up to the next whole number) + 2

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  
(Round up to the next whole number) + 6

Total number of address  
needed for the largest subnet = 26

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

IP address range for Tech Ed 135.126.0.0 to 135.126.0.31

IP address range for English 135.126.0.32 to 135.126.0.63

IP address range for Science 135.126.0.64 to 135.126.0.95

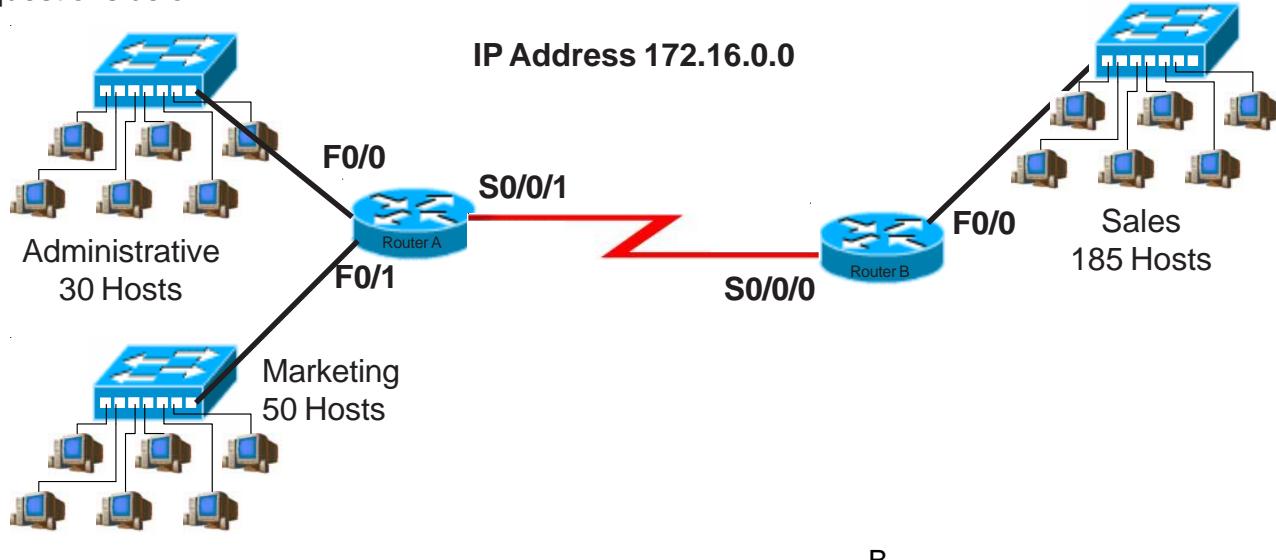
IP address range for Router A  
to Router B serial connection 135.126.0.96 to 135.126.0.127

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

Show your work for **Problem 2** in the space below.

## 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 - 172.16.0.255

IP address range for Marketing \_\_\_\_\_ 172.16.1.0 - 172.16.1.255

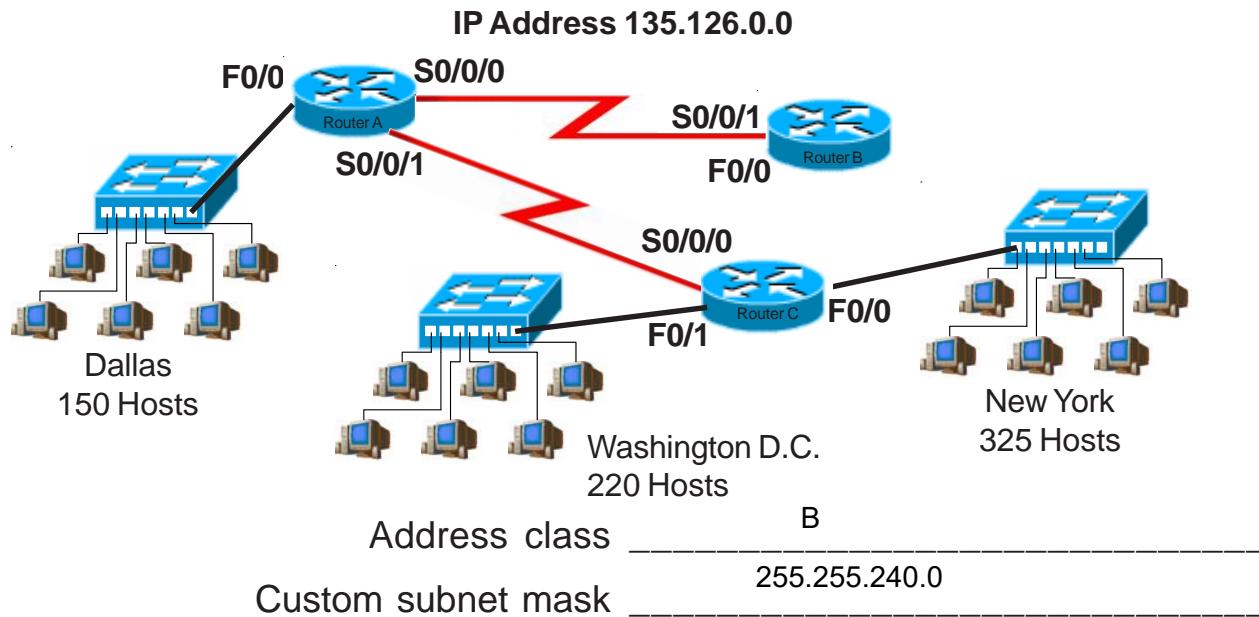
IP address range for Administrative \_\_\_\_\_ 172.16.2.0 - 172.16.2.255

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

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.



Minimum number of subnets needed \_\_\_\_\_ 5

Extra subnets required for 70% growth  
(Round up to the next whole number) \_\_\_\_\_ + 4

Total number of subnets needed = \_\_\_\_\_ 9

Number of host addresses  
in the largest subnet group \_\_\_\_\_ 325

Number of addresses needed for  
70% growth in the largest subnet  
(Round up to the next whole number) \_\_\_\_\_ + 228

Total number of address  
needed for the largest subnet = \_\_\_\_\_ 553

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

IP address range for New York \_\_\_\_\_ 135.126.0.0 - 135.126.15.255

IP address range for Washington D. C. \_\_\_\_\_ 135.126.16.0 - 135.126.31.255

IP address range for Dallas \_\_\_\_\_ 135.126.32.0 - 135.126.47.255

IP address range for Router A  
to Router B serial connection \_\_\_\_\_ 135.126.48.0 - 135.126.63.255

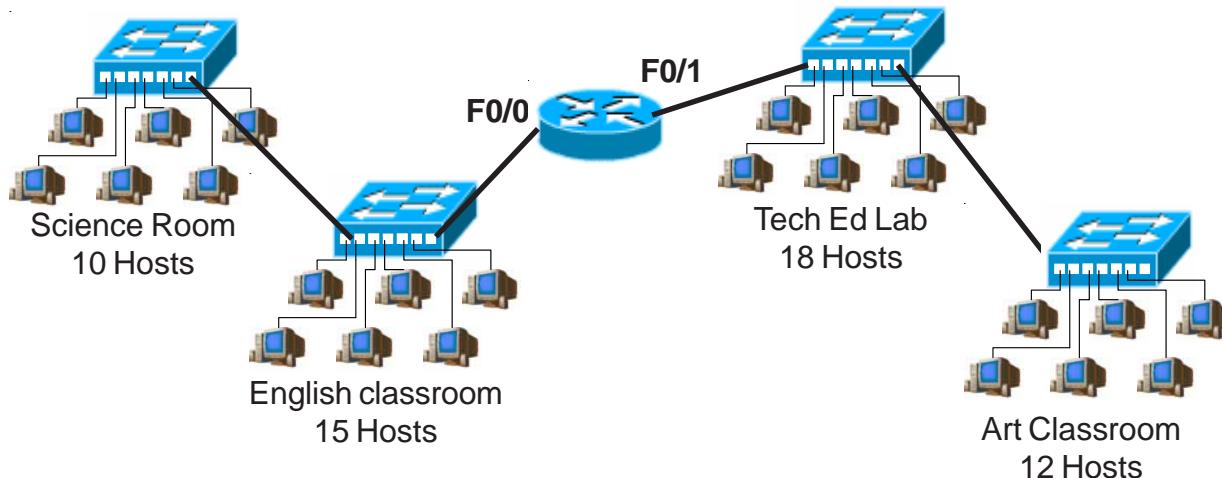
IP address range for Router A  
to Router C serial connection \_\_\_\_\_ 135.126.64.0 - 135.126.79.255

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.

IP Address 210.15.10.0



Address class \_\_\_\_\_ C

Custom subnet mask \_\_\_\_\_ 255.255.255.192

Minimum number of subnets needed \_\_\_\_\_ 2

Extra subnets required for 100% growth  
(Round up to the next whole number) \_\_\_\_\_ + 2

Total number of subnets needed \_\_\_\_\_ = 4

Number of host addresses  
in the largest subnet group \_\_\_\_\_ 30

Number of addresses needed for  
100% growth in the largest subnet  
(Round up to the next whole number) \_\_\_\_\_ + 30

Total number of address  
needed for the largest subnet \_\_\_\_\_ = 60

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

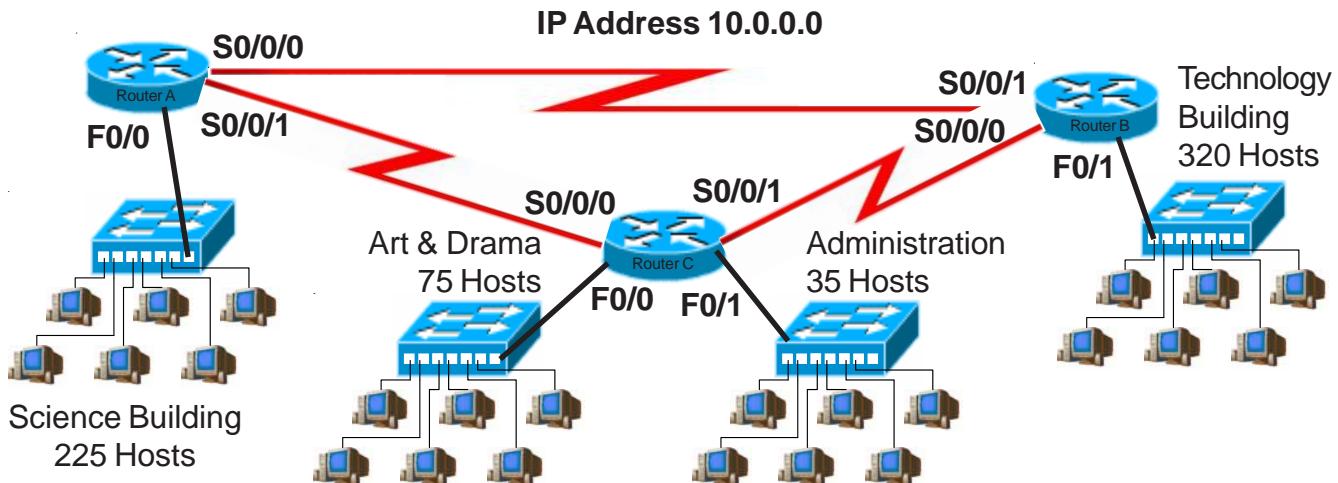
IP address range for Router F0/0 Port \_\_\_\_\_ 210.15.10.0 - 210.15.10.63

IP address range for Router F0/1 Port \_\_\_\_\_ 210.15.10.64 - 210.15.10.127

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 A

Custom subnet mask 255.240.0.0

Minimum number of subnets needed 7

Extra subnets required for 20% growth  
(Round up to the next whole number) + 2

Total number of subnets needed = 9

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

IP address range for Technology 10.0.0.0 - 10.15.255.255

IP address range for Science 10.16.0.0 - 10.31.255.255

IP address range for Arts & Drama 10.32.0.0 - 10.47.255.255

IP Address range Administration 10.48.0.0 - 10.63.255.255

IP address range for Router A to Router B serial connection 10.64.0.0 - 10.79.255.255

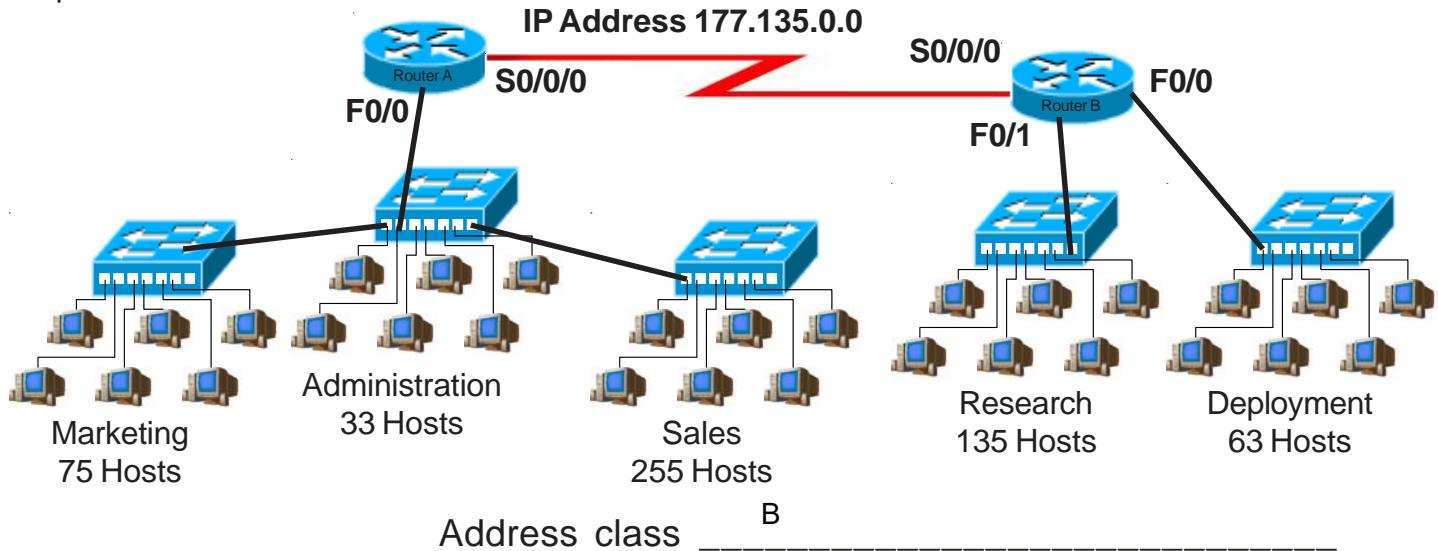
IP address range for Router A to Router C serial connection 10.80.0.0 - 10.95.255.255

IP address range for Router B to Router C serial connection 10.96.0.0 - 10.111.255.255

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 B

Custom subnet mask 255.255.252.0

Minimum number of subnets needed 4

Extra subnets required for 125% growth  
(Round up to the next whole number) + 5

Total number of subnets needed = 9

Number of host addresses in the largest subnet group 363

Number of addresses needed for 125% growth in the largest subnet  
(Round up to the next whole number) + 454

Total number of address needed for the largest subnet = 817

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

IP address range for Router A Port F0/0 177.135.0.0 - 177.135.3.255

IP address range for Research 177.135.4.0 - 177.135.7.255

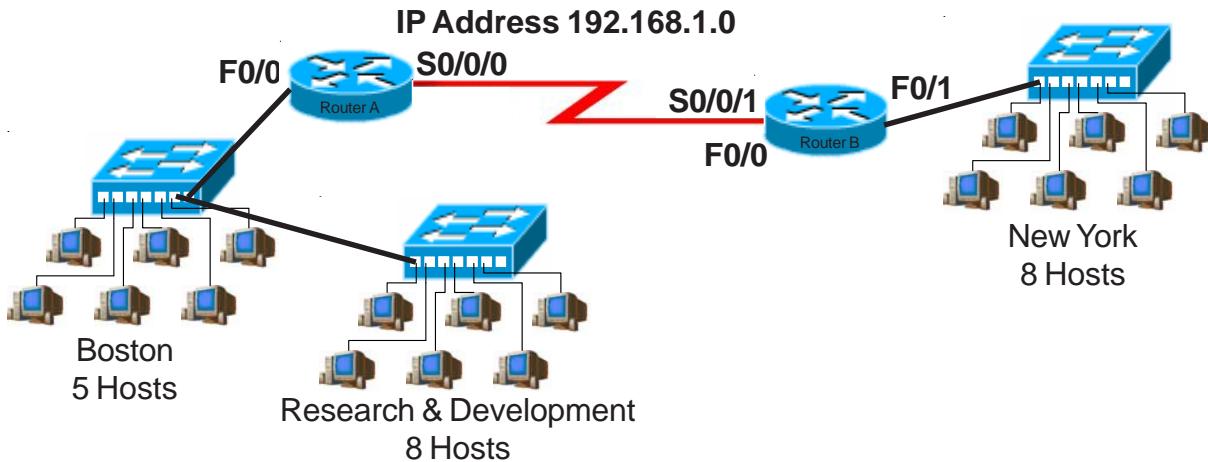
IP address range for Deployment 177.135.8.0 - 177.135.11.255

IP address range for Router A to Router B serial connection 177.135.12.0 - 177.135.15.255

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.



Address class \_\_\_\_\_ C

Custom subnet mask \_\_\_\_\_ 255.255.255.224

Minimum number of subnets needed \_\_\_\_\_ 3

Extra subnets required for 85% growth  
(Round up to the next whole number) \_\_\_\_\_ + 3

Total number of subnets needed = \_\_\_\_\_ 6

Number of host addresses  
in the largest subnet group \_\_\_\_\_ 13

Number of addresses needed for  
85% growth in the largest subnet  
(Round up to the next whole number) \_\_\_\_\_ + 12

Total number of address  
needed for the largest subnet = \_\_\_\_\_ 25

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

IP address range for Router A F0/0 \_\_\_\_\_ 192.168.1.0 - 192.168.1.31

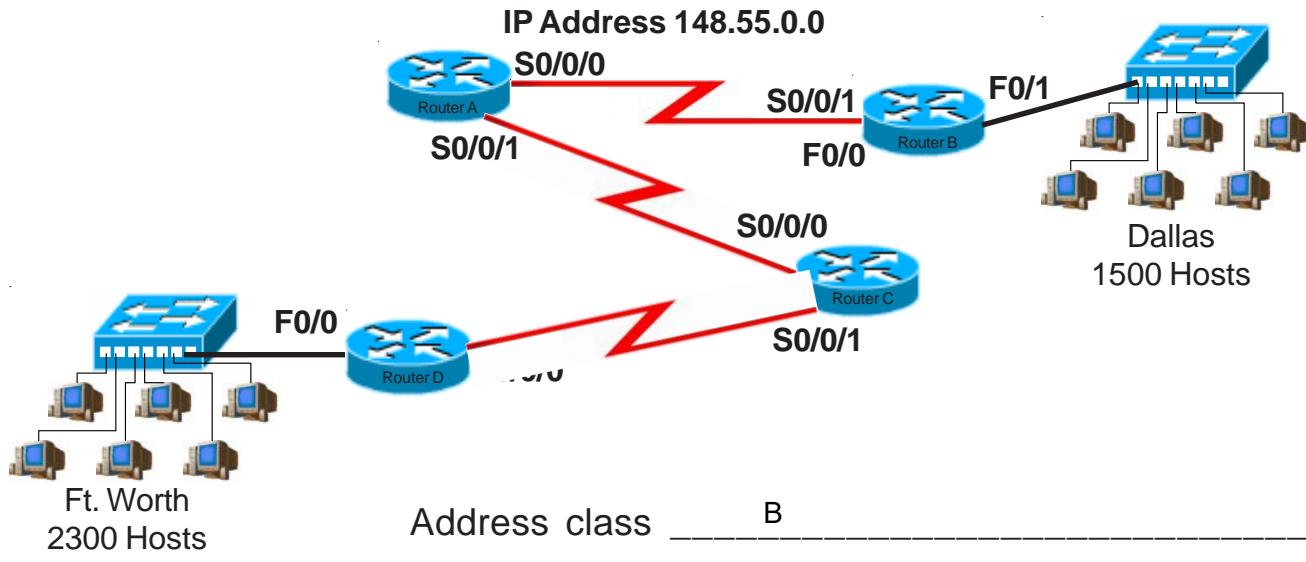
IP address range for New York \_\_\_\_\_ 192.168.1.32 - 192.168.1.63

IP address range for Router A  
to Router B serial connection \_\_\_\_\_ 192.168.1.64 - 192.168.1.95

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

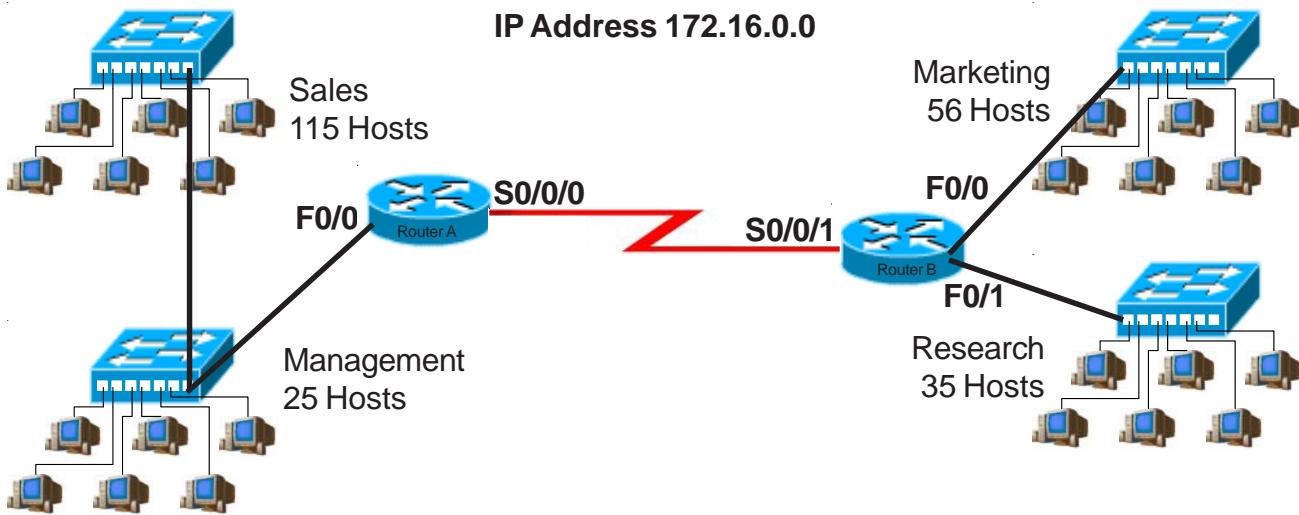
Start with the first subnet and arrange your sub-networks from the largest group to the smallest.

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

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.



B  
Address class \_\_\_\_\_

Custom subnet mask \_\_\_\_\_ 255.255.255.240

Minimum number of subnets needed \_\_\_\_\_ 4

Extra subnets required for 110% growth + 5  
(Round up to the next whole number)

Total number of subnets needed = 9

Number of host addresses in the largest subnet group \_\_\_\_\_ 140

Number of addresses needed for 110% growth in the largest subnet + 154  
(Round up to the next whole number)

Total number of address needed for the largest subnet = 394

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

IP address range for Sales/Management \_\_\_\_\_ 172.16.0.0 - 172.16.15.255

IP address range for Marketing \_\_\_\_\_ 172.16.16.0 - 172.16.31.255

IP address range for Research \_\_\_\_\_ 172.16.32.0 - 172.16.47.255

IP address range for Router A to Router B serial connection \_\_\_\_\_ 172.16.48.0 - 172.16.63.255

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*

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

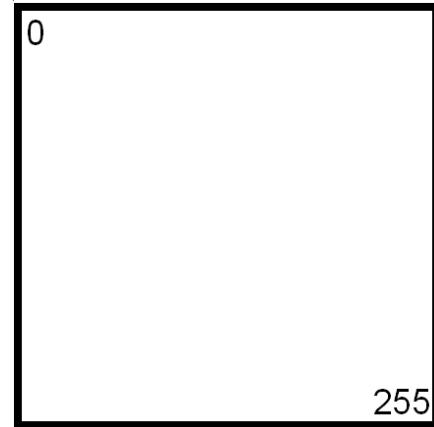
<b>/24</b> 8+8+8 255.255.255.0 256 Hosts	<b>/25</b> 8+8+8+1 255.255.255.128 128 Hosts	<b>/26</b> 8+8+8+2 255.255.255.192 64 Hosts	<b>/27</b> 8+8+8+3 255.255.255.224 32 Hosts	<b>/28</b> 8+8+8+4 255.255.255.240 16 Hosts	<b>/29</b> 8+8+8+5 255.255.255.248 8 Hosts	<b>/30</b> 8+8+8+6 255.255.255.252 4 Hosts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

# Visualizing Subnets Using The Box Method

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

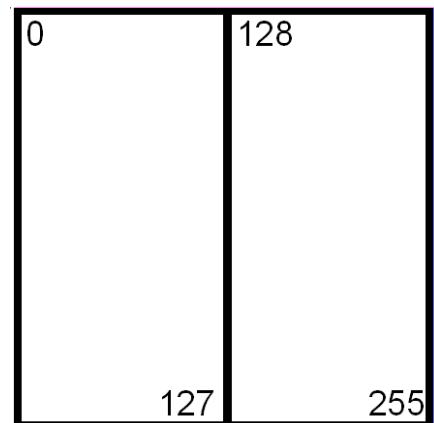
Start with a square. The whole square is a single subnet comprised of 256 addresses.

/24  
255.255.255.0  
256 Hosts  
1 Subnet



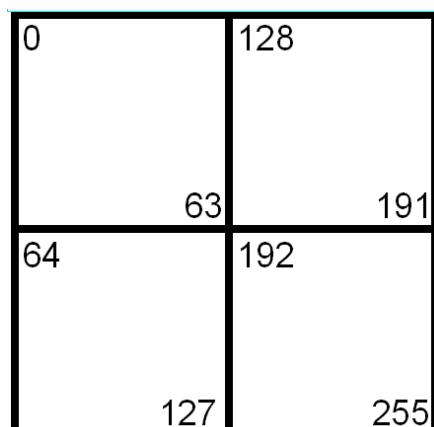
Split the box in half and you get two subnets with 128 addresses,

/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	339
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	339
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

<b>CIDR</b>	<b># of Bits Borrowed</b>	<b>Subnet Mask</b>	<b>Total # of Subnets</b>	<b>Total # of Hosts</b>	<b>Usable # of Hosts</b>
/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

<b>CIDR</b>	<b># of Bits Borrowed</b>	<b>Subnet Mask</b>	<b>Total # of Subnets</b>	<b>Total # of Hosts</b>	<b>Usable # of Hosts</b>
/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

<b>CIDR</b>	<b># of Bits Borrowed</b>	<b>Subnet Mask</b>	<b>Total # of Subnets</b>	<b>Total # of Hosts</b>	<b>Usable # of Hosts</b>
/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

