

IP Addressing and Subnetting

Workbook
Version 1.4

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

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Workbooks included in the series:
IP Addressing and Subnetting Workbook Instructors Edition
IP Addressing and Subnetting IP Workbook
Access Lists Instructors Edition
Access Lists
VLSM Variable-Length Subnet Mask Instructors Edition
VLSM Variable-Length Subnet Mask

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.

Inside Cover

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>	$\begin{array}{r} 128 \\ 16 \\ 2 \\ \hline 146 \end{array}$
0	1	1	1	0	1	1	1	<u>119</u>	$\begin{array}{r} 32 \\ 16 \\ 4 \\ \hline 52 \end{array}$
1	1	1	1	1	1	1	1	<u>255</u>	$\begin{array}{r} 2 \\ 1 \\ \hline 3 \end{array}$
1	1	0	0	0	1	0	1	<u>197</u>	$\begin{array}{r} 119 \\ \hline \end{array}$
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 -128 <hr/> 110 -64 <hr/> 46 -32 <hr/> 14 -8 <hr/> 6 -4 <hr/> 2 -2 <hr/> 0
0	0	1	0	0	0	1	0	34	34 -32 <hr/> 2 -2 <hr/> 0
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	1	0	114	
1	1	0	0	0	0	0	0	192	
1	0	1	0	1	1	0	0	172	
0	1	1	0	0	1	0	0	100	
0	1	1	1	0	1	1	1	119	
0	0	1	1	1	0	0	1	57	
0	1	1	0	0	0	1	0	98	
1	0	1	1	0	0	1	1	179	
0	0	0	0	0	0	1	0	2	

Address Class Identification

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

Network & Host Identification

Circle the network portion of these addresses:

177.100.18.4

119.18.45.0

209.240.80.78

199.155.77.56

117.89.56.45

215.45.45.0

192.200.15.0

95.0.21.90

33.0.0.0

158.98.80.0

217.21.56.0

10.250.1.1

150.10.15.0

192.14.2.0

148.17.9.1

193.42.1.1

126.8.156.0

220.200.23.1

Circle the host portion of these addresses:

10.15.123.50

171.2.199.31

198.125.87.177

223.250.200.222

17.45.222.45

126.201.54.231

191.41.35.112

155.25.169.227

192.15.155.2

123.102.45.254

148.17.9.155

100.25.1.1

195.0.21.98

25.250.135.46

171.102.77.77

55.250.5.5

218.155.230.14

10.250.1.1

Network Addresses

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

188.10.18.2 255.255.0.0	<u>188 . 10 . 0 . 0</u>
10.10.48.80 255.255.255.0	<u>10 . 10 . 48 . 0</u>
192.149.24.191 255.255.255.0	<u>192 . 149 . 24 . 0</u>
150.203.23.19 255.255.0.0	<u>150 . 203 . 0 . 0</u>
10.10.10.10 255.0.0.0	<u>10 . 0 . 0 . 0</u>
186.13.23.110 255.255.255.0	<u>186 . 13 . 23 . 0</u>
223.69.230.250 255.255.0.0	<u>223 . 69 . 0 . 0</u>
200.120.135.15 255.255.255.0	<u>200 . 120 . 135 . 0</u>
27.125.200.151 255.0.0.0	<u>27 . 0 . 0 . 0</u>
199.20.150.35 255.255.255.0	<u>199 . 20 . 150 . 0</u>
191.55.165.135 255.255.255.0	<u>191 . 55 . 165 . 0</u>
28.212.250.254 255.255.0.0	<u>28 . 212 . 0 . 0</u>

Host Addresses

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

188.10.18.2
255.255.0.0

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)

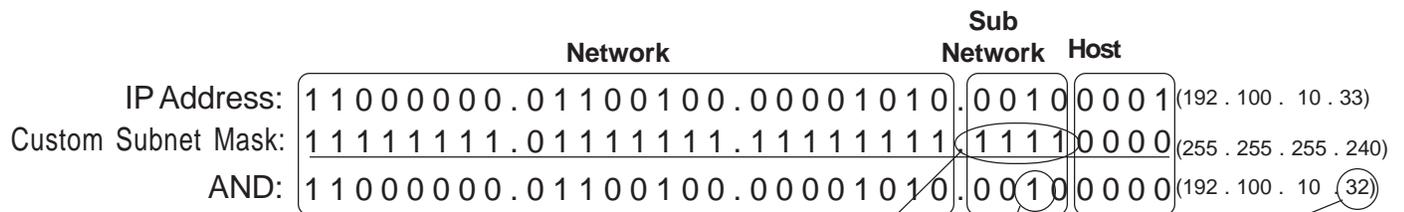
ANDING with the default subnet mask allows your computer to figure out the network portion of the address.

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 (Invalid Range)
 192.100.10.16 to 192.100.10.31 (1st Usable Range)
 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 (Invalid Range)



Four bits borrowed from the host portion of the address for the custom subnet mask.

The ANDING process of the four borrowed bits shows which range of IP addresses this particular address will fall into.

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

Custom Subnet Masks

Problem 1

Number of needed usable 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

Number of usable subnets 14

Total number of host addresses 16

Number of usable addresses 14

Number of bits borrowed 4

Show your work for Problem 1 in the space below.

	256	128	64	32	16	8	4	2	1	-	<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>	
192 . 10 . 10 . 0	0										

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.

16	Subtract 2 for the total number of subnets to get the usable number of subnets.
-2	
14	

Custom Subnet Masks

Problem 2

Number of needed usable 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**

Number of usable subnets **1,022**

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		
165 . 100 . 0 0 0 0 0 0 0 0 . 0 0	0																	

<p>Add the binary value numbers to the left of the line to create the custom subnet mask.</p> $ \begin{array}{r} 128 \\ 64 \\ 32 \\ 16 \\ 8 \\ 4 \\ 2 \\ +1 \\ \hline 255 \end{array} $	$ \begin{array}{r} 128 \\ 128 \\ +64 \\ \hline 192 \end{array} $ $ \begin{array}{r} 1024 \\ -2 \\ \hline 1,022 \end{array} $	<p>64 Observe the total number of hosts.</p> <p>-2 Subtract 2 for the number of usable hosts.</p> <p>64 Observe the total number of hosts.</p> <p>-2 Subtract 2 for the total number of subnets to get the usable number of subnets.</p>
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Custom Subnet Masks

Problem 3

/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.

Network Address **148.75.0.0 /26**

Address class **B**

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

Custom subnet mask **255 . 255 . 255 . 192**

Total number of subnets **1,024**

Number of usable subnets **1,022**

Total number of host addresses **64**

Number of usable addresses **62**

Number of bits borrowed **10**

Show your work for Problem 3 in the space below.

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

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 usable 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

Number of usable subnets 6

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>
210 . 100 . 56 . 0 0 0	0	0	0	0	0	0	0	0	0	
	128									
	64	8		32						
	+32	-2		-2						
	224	6		30						

Custom Subnet Masks

Problem 5

Number of needed usable 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

Number of usable subnets 6

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

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

Custom Subnet Masks

Problem 7

Number of needed usable 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**

Number of usable subnets **2,046**

Total number of host addresses **32**

Number of usable addresses **30**

Number of bits borrowed **11**

Show your work for Problem 7 in the space below.

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

128
64
32
16
8
4
2
+1

255

2,048
-2

2,046

32
-2

30

Custom Subnet Masks

Problem 8

Number of needed usable subnets **1**
 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

Number of usable subnets 2

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	-	<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>
200 . 175 . 14 . 0	0									

128	4	64
+64	-2	-2
<hr style="width: 50%; margin: 0;"/>	<hr style="width: 50%; margin: 0;"/>	<hr style="width: 50%; margin: 0;"/>
240	2	62

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

Number of usable subnets 2

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

128	64	4
+64	-2	-2
<hr style="width: 100%;"/>	<hr style="width: 100%;"/>	<hr style="width: 100%;"/>
192	62	2

Custom Subnet Masks

Problem 12

Number of needed usable 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

Number of usable subnets 6

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>
218 . 35 . 50 .	0									

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

Custom Subnet Masks

Problem 13

Number of needed usable hosts **25**

Network Address **218.35.50.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 224

Total number of subnets 8

Number of usable subnets 6

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 3

Show your work for Problem 13 in the space below.

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

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

Custom Subnet Masks

Problem 14

Number of needed usable 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

Number of usable subnets 14

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 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

Number of usable subnets 524,286

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 19

Show your work for Problem 16 in the space below.

Number of Hosts	1	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536	131072	262144	524288	1048576	2097152	4194304	8388608	16777216	33554432	67108864	134217728	268435456	536870912	1073741824	2147483648	4294967296	8589934592	17179869184	34359738368	68719476736	137438953472	274877906944	549755813888	1099511627776	2199023255552	4398046511104	8796093022208	17592186044416	35184372088832	70368744177664	140737488355328	281474976710656	562949953421312	1125899906842624	2251799813685248	4503599627370496	9007199254740992	18014398509481984	36028797018963968	72057594037927936	144115188075855872	288230376151711744	576460752303423488	1152921504606846976	2305843009213693952	4611686018427387904	9223372036854775808	18446744073709551616	36893488147419103232	73786976294838206464	147573952589676412928	295147905179352825856	590295810358705651712	1180591620717411303424	2361183241434822606848	4722366482869645213696	9444732965739290427392	18889465931478580854784	37778931862957161709568	75557863725914323419136	151115727451828646838272	302231454903657293676544	604462909807314587353088	1208925819614629174706176	2417851639229258349412352	4835703278458516698824704	9671406556917033397649408	19342813113834066795298816	38685626227668133590597632	77371252455336267181195264	154742504910672534362390528	309485009821345068724781056	618970019642690137449562112	1237940039285380274899124224	2475880078570760549798248448	4951760157141521099596496896	9903520314283042199192993792	19807040628566084398385987584	39614081257132168796771975168	79228162514264337593543950336	158456325028528675187087900672	316912650057057350374175801344	633825300114114700748351602688	1267650600228229401496703205376	2535301200456458802993406410752	5070602400912917605986812821504	10141204801825835211973625643008	20282409603651670423947251286016	40564819207303340847894502572032	81129638414606681695789005144064	162259276829213363391578010288128	324518553658426726783156020576256	649037107316853453566312041152512	1298074214633706907132624082305024	2596148429267413814265248164610048	5192296858534827628530496329220096	10384593717069655257060992658440192	20769187434139310514121985316880384	41538374868278621028243970633760768	83076749736557242056487941267521536	166153499473114484112975882535042672	332306998946228968225951761070085344	664613997892457936451903522140170688	132922799578491587290380704428341376	265845599156983174580761408856682752	531691198313966349161522817713365504	106338239662793269832304563542671008	2126764793255865396646091270853420032	4253529586511730793292182541706840064	8507059173023461586584365083413680128	17014118346046923173168730166827360256	34028236692093846346337460333654720512	68056473384187692692674920667309441024	136112946768375385385349841334618882048	27222589353675077077069968266923764096	54445178707350154154139936533847528192	108890357414700308308279873067695056384	217780714829400616616559746135390112768	435561429658801233233119492270780225536	871122859317602466466238984541560451072	17422457186352049329324779690831209024	348449143727040986586495593816624180448	696898287454081973172991187633248360896	1393796574908163946345982355266496721792	2787593149816327892691964710532934435384	5575186299632655785383929421065868870688	1115037259926531157076785884213173773776	2230074519853062314153571768426347547552	4460149039706124628307143536852750951104	892029807941224925661428707370550180224	1784059615882449851322857414741100360448	3568119231764899702645714829482200720896	7136238463529799405291429658964401441792	1427247692705959881058285931792880283584	2854495385411919762116571863585760567168	5708990770823839524233143727171521134336	1141798154164767904846628745434304266872	2283596308329535809693257490868608533744	456719261665907161938651498173721706688	913438523331814323877302996347443413376	1826877046663628647754605992694886826752	36537540933272572955092119853897734528	73075081866545145910184239707795469056	146150163733090291820368479415590938112	292300327466180583640736958831181872224	584600654932361167281473917662363744448	1169201309864722334562947835324727488896	2338402619729444669125895670649454977792	4676805239458889338251791341298909955536	9353610478917778676503582682597819911104	18707220957835557353007165365195639822208	3741444191567111470601433073039127844416	7482888383134222941202866146078255688832	14965776766268445882405732292156511377664	2993155353253689176481146458431302275328	598631070650737835296229291686260450656	1197262141301475670592458583372520901312	2394524282602951341184917166745041802624	4789048565205902682369834333490083605248	957809713041180536473966866698016720896	1915619426082361072947933733396034417792	3831238852164722145895867466792068835384	766247770432944429179173493358413770768	153249554086588885835834698671682755136	30649910817317777167166939734336510272	61299821634635554334333879468673020544	122599643269271108668667748937346040888	24519928653854221733733549787469208176	490398573077084434674670995749384153536	980797146154168869349341991498768307072	1961594292288337738698683982997536614144	39231885845766754773973679659950732288	78463771691533509547947359319901465576	1569275433830670190958947186398029311532	313855086766134038191789437279605862264	62771017353226807638357887455921172448	125542034706453615276715774911842344896	25108406941290723055343154982368468992	50216813882581446110686309964736937984	100433627765162892221372619929473875776	200867255530325784442745239858947751552	40173451106065156888549047971789550304	80346902212130313777098095943579100608	160693804424260675544196191887158201216	321387608848521351088392383774316402432	642775217697042702176784767548632804672	1285550435394085404353569535097265609144	2571100870788170808707139070194531218288	5142201741576341617414278140389062436576	1028440348315268323482855628077812473152	205688069663053664696571125615562494624	411376139326107329393142251231124989248	822752278652214658786284502462249978496	164550455730442931757256900492449956992	329100911460885863514513800984899113984	658201822921771727029027601969798227968	1316403645843543454058055203939596455936	2632807291687086908116110407879192911872	526561458337417381623222081575838583544	105312291667435476324644416315167706888	210624583334870952649288832630335413776	421249166669741905298577665260670827552	842498333339483810597155330521341651104	1684996666678967621194310661042823302208	336999333335793524238862132208564604416	67399866667158704847772426441712088832	13479973333431740969554485288342177664	26959946666863481939108970576684355328	539198933337269638782179411533697106656	1078397866674539277564358823067384213312	2156795733349078555128717660134768426624	4313591466698157110257435320269536853248	862718293339631422051487064053907366688	1725436586679262844102974128107814733376	3450873173358525688205948256215629466752	690174634671705137641189651243125933344	138034926934341027528237930248625186688	276069853868682055056475860497251373776	552139707737364110112951709994502747552	1104279415474728220225903419989005491104	220855883094945644045180683997801082208	44171176618989128809036136799560216544	88342353237978257618072273599120433088	176684706475956515236144547198240865776	353369412951913030472289094396481731552	706738825903826060944578188792963463104	1413477651807652121889156377585927226208	2826955303615304243778312755171854452416	56539106072306084875566255103430888928	11307821214461216975113251020686177776	22615642428922433950226502041372355532	45231284857844867900453004082744711064	9046256971568973580090600816548142208	18092513943137947160181201633096284416	36185027886275894320362403266192568832	72370055772551788640724806532385137664	144740111545103577281449613064770713328	28948022309020715456289922612954142656	57896044618041430912579845225908285312	11579208923608286182515969045181657024	23158417847216572365031938090363114048	46316835694433144730063876180726228096	92633671388866289460127752361452456192	185267342777732578920255504722904912384	370534685555465157840511009445809824672	7410693711109303156810220188916177344448	1482138742221860631362044037783234688896	296427748444372126272408875556647377792	592855496888744252544817751113295555536	1185710993777488505089635502226591111104	237142198755497701017927100445318222208	474284397510995402035854200890634444416	94856879502199080407170840178126888832	189713759004398160814341680356253777664	379427518008796321628683360712507555328	758855036017592643257366721425015110656	151771007203518528611473344285003021312	303542014407037057222946688570006042224	607084028814074114445893371140012084448	1214168057628148228891786742280024168896	2428336115256296457783573484560048377792	4856672230512592915567146969120096755584	971334446102518583113431393824019311104	194266889220503716622686277764803862208	38853377844100743324537255552807724416	77706755688201486649074511105615448832	15541351137640297329814902221123089664	31082702275280594659629804442246179328	62165404550561189319259608884492354656	124330809101122378638519217768984709112	248661618202244757277038435537969418224	497323236404489514554076871075938836448	994646472808979029108153742151877672896	1989292945617958058216275244303755355712	397858589123591611643255048860751071104	795717178247183223286510097721502142208	1591434356494366446573020195443004244416	3182868712988732893146040390886008488832	6365737425977465786292080781772016977664	127314748519549315725841615635440339552	2546294970390986314516832126708806711104	509258994078197262903366425341761342208	1018517988156394525806732850683522684448	2037035976312789051613465601367045288896	4074071952625578103226931202734090577792	8148143905251156206453862405468181555536	16296287810502312412907724810936323111104	3259257562100462482581544962187264622208	6518515124200924965163089924374532444416	13037030244401849930326179848749064888832	2607406048880369986065235969749812977664	5214812097760739972130471939499625755328	10429624195521479944260943878992515110656	20859248391042959888521887757985030221312	41718496782085919777043775515970060442224	83436993564171839554087550231940120844448	16687398712834367910817510046388024168896	33
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Subnetting

Problem 1

Number of needed usable 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

Number of usable subnets 14

Total number of host addresses 16

Number of usable addresses 14

Number of bits borrowed 4

What is the 3rd usable subnet range? 192.10.10.48 to 192.10.10.63

What is the subnet number for the 7th usable subnet? 192 . 10 . 10 . 112

What is the subnet broadcast address for the 12th usable subnet? 192 . 10 . 10 . 207

What are the assignable addresses for the 8th usable subnet? 192.10.10.129 to 192.10.10.142

Subnetting

Problem 2

Number of needed usable 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*

Number of usable subnets *1,022*

Total number of host addresses *64*

Number of usable addresses *62*

Number of bits borrowed *10*

What is the 14th usable subnet range? *165.100.3.128 to 165.100.3.191*

What is the subnet number for the 5th usable subnet? *165 . 100 . 1 . 64*

What is the subnet broadcast address for the 5th usable subnet? *165 . 100 . 1 . 127*

What are the assignable addresses for the 8th usable subnet? *165.100.2.1 to 165.100.0.62*

Subnetting

Problem 3

Number of needed usable subnets **1**

Network Address **195.223.50.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 4

Number of usable subnets 2

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 2

What is the 2nd usable subnet range? 195.223.50.128 - 195.223.50.191

What is the subnet number for the 1st usable subnet? 195.223.50.64

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

What are the assignable addresses for the 2nd usable subnet? 195.223.50.129 - 195.223.50.190

Show your work for Problem 3 in the space below.

	256	128	64	32	16	8	4	2	1	Number of Hosts												
Number of Subnets	2	4	8	16	32	64	128	256														
	128	64	32	16	8	4	2	1		Binary values												
195.223.50.0 0 0 0 0 0 0 0 0																						
(Invalid range) (0)	0		195.223.50.0 to 195.223.50.63																			
(1)	1		195.223.50.64 to 195.223.50.127																			
(2)	1	0	195.223.50.128 to 195.223.50.191																			
(Invalid range) (3)	1	1	195.223.50.192 to 195.223.50.255																			
<table border="0"> <tr> <td>128</td> <td>4</td> <td>64</td> </tr> <tr> <td>+64</td> <td>-2</td> <td>-2</td> </tr> <tr> <td><hr/></td> <td><hr/></td> <td><hr/></td> </tr> <tr> <td>192</td> <td>2</td> <td>62</td> </tr> </table>											128	4	64	+64	-2	-2	<hr/>	<hr/>	<hr/>	192	2	62
128	4	64																				
+64	-2	-2																				
<hr/>	<hr/>	<hr/>																				
192	2	62																				

Subnetting

Problem 4

Number of needed usable 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*

Number of usable subnets *1,022*

Total number of host addresses *64*

Number of usable addresses *62*

Number of bits borrowed *10*

What is the 14th usable subnet range? *190.35.3.128 to 190.35.3.191*

What is the subnet number for the 12th usable subnet? *190.35.3.0*

What is the subnet broadcast address for the 9th usable subnet? *190.35.2.127*

What are the assignable addresses for the 5th usable subnet? *190.35.1.65 to 190.35.1.126*

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

Number of usable subnets 2,097,150

Total number of host addresses 8

Number of usable addresses 6

Number of bits borrowed 21

What is the 1st usable subnet range? 126.0.0.8 to 126.0.0.15

What is the subnet number for the 4th usable subnet? 126.0.0.32

What is the subnet broadcast address for the 6th usable subnet? 126.0.0.55

What are the assignable addresses for the 9th usable subnet? 126.0.0.73 to 126.0.0.78

Subnetting

Problem 6

Number of needed usable 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

Number of usable subnets 14

Total number of host addresses 16

Number of usable addresses 14

Number of bits borrowed 4

What is the 8th usable subnet range? 192.70.10.128 to 192.70.10.143

What is the subnet number for the 3rd usable subnet? 192.70.10.48

What is the subnet broadcast address for the 11th usable subnet? 192.70.10.191

What are the assignable addresses for the 9th usable subnet? 192.70.10.145 to 192.70.10.158

Show your work for Problem 6 in the space below.

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

128	16	16
+64	-2	-2
<hr style="width: 50%; margin: 0 auto;"/>	<hr style="width: 50%; margin: 0 auto;"/>	<hr style="width: 50%; margin: 0 auto;"/>
240	14	14

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

Number of usable subnets 254

Total number of host addresses 65,536

Number of usable addresses 65,534

Number of bits borrowed 8

What is the 10th usable subnet range? 10.10.0.0 to 10.10.255.255

What is the subnet number for the 5th usable subnet? 10.5.0.0

What is the subnet broadcast address for the 1st usable subnet? 10.1.255.255

What are the assignable addresses for the 8th usable subnet? 10.8.0.1 to 10.8.255.254

Show your work for Problem 7 in the space below.

<p>Number of Hosts -</p> <p>Number of Subnets -</p> <p>Binary values -</p>	<p>2 4 8 16 32 64 128 256</p> <p>2 4 8 16 32 64 128 256</p>	<p>131,072 - - -</p> <p>262,144 - - -</p> <p>524,288 - - -</p> <p>1,048,576 - - -</p> <p>2,097,152 - - -</p> <p>4,194,304 - - -</p>	<p>128 64 32 16 8 4 2 1</p> <p>10.0.0.0</p>	<p>0</p> <p>(Invalid range) (0)</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>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="width: 50%; margin-left: 0;"/> <p>256</p> <p>-2</p> <hr style="width: 50%; margin-left: 0;"/> <p>254</p> <p>255</p>	<p>256 128 64 32 16 8 4 2</p> <p>4,194,304</p> <p>2,097,152</p> <p>1,048,576</p> <p>524,288</p> <p>262,144</p> <p>131,072</p>	<p>512</p> <p>1,024</p> <p>2,048</p> <p>4,096</p> <p>8,192</p> <p>16,384</p> <p>32,768</p> <p>65,536</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>128 64 32 16 8 4 2 1</p> <p>10.0.0.0</p>	<p>0</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>10.0.0.0</p> <p>10.1.0.0</p> <p>10.2.0.0</p> <p>10.3.0.0</p> <p>10.4.0.0</p> <p>10.5.0.0</p> <p>10.6.0.0</p> <p>10.7.0.0</p> <p>10.8.0.0</p> <p>10.9.0.0</p> <p>10.10.0.0</p> <p>10.11.0.0</p> <p>10.12.0.0</p> <p>10.13.0.0</p> <p>10.14.0.0</p> <p>10.15.0.0</p>	<p>to</p>	<p>10.0.255.255</p> <p>10.1.255.255</p> <p>10.2.255.255</p> <p>10.3.255.255</p> <p>10.4.255.255</p> <p>10.5.255.255</p> <p>10.6.255.255</p> <p>10.7.255.255</p> <p>10.8.255.255</p> <p>10.9.255.255</p> <p>10.10.255.255</p> <p>10.11.255.255</p> <p>10.12.255.255</p> <p>10.13.255.255</p> <p>10.14.255.255</p> <p>10.15.255.255</p>
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Subnetting

Problem 8

Number of needed usable subnets 4

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

Number of usable subnets 6

Total number of host addresses 8,192

Number of usable addresses 8,190

Number of bits borrowed 3

What is the 3rd usable subnet range? 172.50.96.0 to 172.50.127.255

What is the subnet number for the 4th usable subnet? 172.50.128.0

What is the subnet broadcast address for the 5th usable subnet? 172.50.191.255

What are the assignable addresses for the 2nd usable subnet? 172.50.64.1 to 172.50.95.254

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*

Number of usable subnets *2,046*

Total number of host addresses *32*

Number of usable addresses *30*

Number of bits borrowed *11*

What is the 1st usable subnet range? *172.50.0.32 to 172.50.0.63*

What is the subnet number for the 9th usable subnet? *172.50.1.32*

What is the subnet broadcast address for the 3rd usable subnet? *172.50.0.127*

What are the assignable addresses for the 5th usable 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
	(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(Invalid range)
	128	64	32	16	8	4	2	+1	252	1,024	-2	1,022	64	-2	62		
	128	64	32	16	8	4	2	+1	252	1,024	-2	1,022	64	-2	62		
	172.50.0.31	172.50.0.63	172.50.0.95	172.50.0.127	172.50.0.159	172.50.0.191	172.50.0.223	172.50.0.255	172.50.1.31	172.50.1.63	172.50.1.95	172.50.1.127	172.50.1.159	172.50.1.191	172.50.1.223	172.50.1.255	
	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to	to

Subnetting

Problem 10

Number of needed usable 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*

Number of usable subnets *62*

Total number of host addresses *4*

Number of usable addresses *2*

Number of bits borrowed *6*

What is the 4th usable subnet range? *220.100.100.16 to 220.100.100.19*

What is the subnet number for the 3rd usable subnet? *220.100.100.12*

What is the subnet broadcast address for the 12th usable subnet? *220.100.100.51*

What are the assignable addresses for the 11th usable subnet? *220.100.100.45 to 220.100.100.46*

Show your work for Problem 10 in the space below.

		Number of Subnets				Number of Hosts							
		256	128	64	32	16	8	4	2	2	1	Binary values	
		-	2	4	8	16	32	64	128	256	0	0	0
220.100.100.0		0	0	0	0	0	0	0	0	0	0	0	0
<i>(Invalid range)</i>		(0)				0				220.100.100.0	to	220.100.100.3	
128		(1)				1				220.100.100.4	to	220.100.100.7	
64		(2)			1	0	1			220.100.100.8	to	220.100.100.11	
32		(3)			1	1				220.100.100.12	to	220.100.100.15	
16		(4)			1	0	0			220.100.100.16	to	220.100.100.19	
8		(5)			1	0	1			220.100.100.20	to	220.100.100.23	
+4		(6)			1	1	0			220.100.100.24	to	220.100.100.27	
<u>252</u>		(7)			1	1	1			220.100.100.28	to	220.100.100.31	
		(8)	1		0	0	0			220.100.100.32	to	220.100.100.35	
		(9)	1		0	0	1			220.100.100.36	to	220.100.100.39	
		(10)	1		0	1	0			220.100.100.40	to	220.100.100.43	
		(11)	1		0	1	1			220.100.100.44	to	220.100.100.47	
		(12)	1		1	0	0			220.100.100.48	to	220.100.100.51	
		(13)	1		1	0	1			220.100.100.52	to	220.100.100.55	
		(14)	1		1	1	0			220.100.100.56	to	220.100.100.59	
		(15)	1		1	1	1			220.100.100.60	to	220.100.100.63	
64													
-2													
<u>62</u>													
4													
-2													
<u>2</u>													

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*

Number of usable subnets *6*

Total number of host addresses *8,192*

Number of usable addresses *8,190*

Number of bits borrowed *3*

What is the 5th usable subnet range? *135.70.160.0 to 135.70.191.255*

What is the subnet number for the 6th usable subnet? *135.70.192.0*

What is the subnet broadcast address for the 2nd usable subnet? *135.70.95.255*

What are the assignable addresses for the 4th usable subnet? *135.70.128.1 to 135.70.159.254*

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*

Number of usable subnets *2*

Total number of host addresses *64*

Number of usable addresses *62*

Number of bits borrowed *2*

What is the 1st usable subnet range? *198.125.50.64 to 198.125.50.127*

What is the subnet number for the 1st usable subnet? *198.125.50.64*

What is the subnet broadcast address for the 2nd usable subnet? *198.125.50.191*

What are the assignable addresses for the 2nd usable 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	1	-	Number of Hosts
Number of Subnets	-	2	4	8	16	32	64	128	256		
		128	64	32	16	8	4	2	1	-	Binary values
198 . 125 . 50 . 0 0	0 0	0	0	0	0	0	0	0	0		
(Invalid range) (0)	0	0	198.125.50.0					to		198.125.50.63	
(1)	1	1	198.125.50.64					to		198.125.50.127	
(2)	1	0	198.125.50.128					to		198.125.50.191	
(Invalid range) (3)	1	1	198.125.50.192					to		198.125.50.255	

128	4	64
+64	-2	-2
<hr style="width: 100%; border: 0; border-top: 1px solid black; margin: 0;"/>	<hr style="width: 100%; border: 0; border-top: 1px solid black; margin: 0;"/>	<hr style="width: 100%; border: 0; border-top: 1px solid black; margin: 0;"/>
192	2	62

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

Number of usable subnets 1,022

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 10

What is the 9th usable subnet range? 165.200.2.64 to 165.200.2.127

What is the subnet number for the 10th usable subnet? 165.200.2.128

What is the subnet broadcast address for the 1022nd usable subnet? 165.200.255.191

What are the assignable addresses for the 1021st usable 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

Number of usable subnets 6

Total number of host addresses 32

Number of usable addresses 30

Number of bits borrowed 3

What is the 6th usable subnet range? 200.10.10.192 to 200.10.10.223

What is the subnet number for the 4th usable subnet? 200.10.10.128

What is the subnet broadcast address for the 3rd usable subnet? 200.10.10.127

What are the assignable addresses for the 5th usable subnet? 200.10.10.161 to 200.10.10.190

Show your work for Problem 14 in the space below.

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

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

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

Number of usable subnets 2,046

Total number of host addresses 8,192

Number of usable addresses 8,190

Number of bits borrowed 11

What is the 14th usable subnet range? 93.1.192.0 to 93.1.223.255

What is the subnet number for the 8th usable subnet? 93.1.0.0

What is the subnet broadcast address for the 6th usable subnet? 93.0.223.255

What are the assignable addresses for the 11th usable subnet? 93.1.96.1 to 93.1.127.254

Show your work for Problem 15 in the space below.

<p>Number of Hosts -</p> <p>Number of Subnets -</p> <p>Binary values -</p>	<p>2 4 8 16 32 64 128 256</p> <p>2 4 8 16 32 64 128 256</p>	<p>4,194,304</p> <p>2097,152</p> <p>1048,576</p> <p>524,288</p> <p>262,144</p> <p>131,072</p>	<p>16,384</p> <p>32,768</p> <p>65,536</p> <p>131,072</p> <p>262,144</p> <p>524,288</p> <p>1048,576</p> <p>2097,152</p> <p>4,194,304</p>	<p>256 128 64 32 16 8 4 2</p> <p>512</p> <p>1024</p> <p>2048</p> <p>4096</p> <p>8192</p>	<p>16 8 4 2 1</p> <p>128 64 32 16 8 4 2 1</p>	<p>93.00000000</p> <hr/> <p>(Invalid range)</p> <p>(0)</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>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>1 0 0 0</p> <p>1 0 0 1</p> <p>1 0 1 0</p> <p>1 0 1 1</p> <p>1 1 0 0</p> <p>1 1 0 1</p> <p>1 1 1 0</p> <p>1 1 1 1</p>	<p>93.0.0.0</p> <p>93.0.32.0</p> <p>93.0.64.0</p> <p>93.0.96.0</p> <p>93.0.128.0</p> <p>93.0.160.0</p> <p>93.0.192.0</p> <p>93.0.224.0</p> <p>93.1.0.0</p> <p>93.1.32.0</p> <p>93.1.64.0</p> <p>93.1.96.0</p> <p>93.1.128.0</p> <p>93.1.160.0</p> <p>93.1.192.0</p>	<p>to</p>	<p>93.0.31.255</p> <p>93.0.63.255</p> <p>93.0.95.255</p> <p>93.0.127.255</p> <p>93.0.159.255</p> <p>93.0.191.255</p> <p>93.0.223.255</p> <p>93.0.255.255</p> <p>93.1.31.255</p> <p>93.1.63.255</p> <p>93.1.95.255</p> <p>93.1.127.255</p> <p>93.1.159.255</p> <p>93.1.191.255</p> <p>93.1.223.255</p>
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$\begin{array}{r} 128 \\ 64 \\ 32 \\ 16 \\ 8 \\ 4 \\ 2 \\ +1 \\ \hline 255 \end{array}$	$\begin{array}{r} 128 \\ 64 \\ +32 \\ \hline 224 \end{array}$	$\begin{array}{r} 2,048 \\ -2 \\ \hline 2,046 \end{array}$	$\begin{array}{r} 8,192 \\ -2 \\ \hline 8,190 \end{array}$
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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 26-27

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 46-47

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 54-55

OK

IP Address: 200.10.10.128

Subnet Mask: 255.255.255.224

Reference Pages 52-53

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 28-29

OK

IP Address: 190.35.0.10

Subnet Mask: 255.255.255.192

Reference Pages 32-33

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 52-53 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 46-47

This is a broadcast address.

IP Address Breakdown

/24	/25	/26	/27	/28	/29	/30		
255.255.255.0 256 Hosts	255.255.255.128 128 Hosts	255.255.255.192 64 Hosts	255.255.255.224 32 Hosts	255.255.255.240 16 Hosts	255.255.255.248 8 Hosts	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 40-47	32-35 36-39 40-43 44-47		
					48-63	48-55 56-63	48-51 52-55 56-59 60-63	
				64-127		64-79	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
		112-127	112-119 120-127		112-115 116-119 120-123 124-127			
			128-255		128-191	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
				192-255	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.

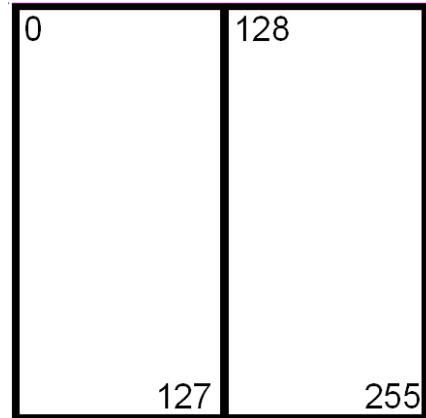
Start with a square. The whole square is a single subnet comprised of 256 addresses.

/24
255.255.255.0
256 Hosts
1 Subnet



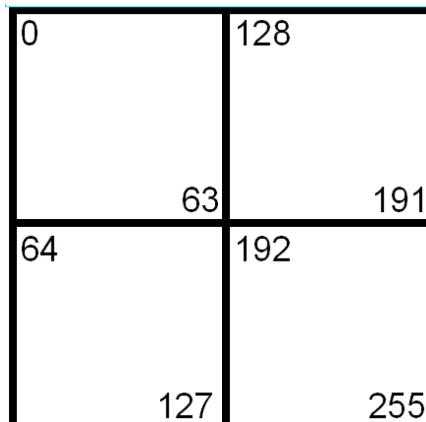
Split the box in half and you get two subnets with 128 addresses,

/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	231	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	231	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

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

Class B Addressing Guide

# of Bits Borrowed	Subnet Mask	Total # of Subnets	Usable # of Subnets	Total # of Hosts	Usable # of Hosts
2	255.255.192.0	4	2	16,384	16,382
3	255.255.224.0	8	6	8,192	8,190
4	255.255.240.0	16	14	4,096	4,094
5	255.255.248.0	32	30	2,048	2,046
6	255.255.252.0	64	62	1,024	1,022
7	255.255.254.0	128	126	512	510
8	255.255.255.0	256	254	256	254
9	255.255.255.128	512	510	128	126
10	255.255.255.192	1,024	1,022	64	62
11	255.255.255.224	2,048	2,046	32	30
12	255.255.255.240	4,096	4,094	16	14
13	255.255.255.248	8,192	8,190	8	6
14	255.255.255.252	16,384	16,382	4	2

Class C Addressing Guide

# of Bits Borrowed	Subnet Mask	Total # of Subnets	Usable # of Subnets	Total # of Hosts	Usable # of Hosts
2	255.255.255.192	4	2	64	62
3	255.255.255.224	8	6	32	30
4	255.255.255.240	16	14	16	14
5	255.255.255.248	32	30	8	6
6	255.255.255.252	64	62	4	2

