

IP Addressing and Subnetting

Workbook
Version 1.5

11111110

10010101

00011011

10000110

11010011

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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Workbooks included in the series:

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

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>	<i>128</i>	<i>64</i>
0	1	1	1	0	1	1	1	<u>119</u>	<i>16</i>	<i>32</i>
1	1	1	1	1	1	1	1		<i>2</i>	<i>16</i>
1	1	0	0	0	1	0	1		<i>146</i>	<i>4</i>
1	1	1	1	0	1	1	0			<i>2</i>
1	1	1	1	0	1	1	0			<i>1</i>
0	0	0	1	0	0	1	1			<u>119</u>
1	0	0	0	0	0	0	1			
0	0	1	1	0	0	0	1			
0	1	1	1	1	0	0	0			
1	1	1	1	0	0	0	0			
0	0	1	1	1	0	1	1			
0	0	0	0	0	1	1	1			
								00011011		
								10101010		
								01101111		
								11111000		
								00100000		
								01010101		
								00111110		
								00000011		
								11101101		
								11000000		

Decimal To Binary Conversion

Use all 8 bits for each problem

128	64	32	16	8	4	2	1	=	255	Scratch Area	
1	1	1	0	1	1	1	0		238	238	34
										-128	-32
0	0	1	0	0	0	1	0		34	110	2
										-64	-2
									123	46	0
										-32	
									50	14	
										-8	
									255	6	
										-4	
									200	2	
										-2	
									10	0	
									138		
									1		
									13		
									250		
									107		
									224		
									114		
									192		
									172		
									100		
									119		
									57		
									98		
									179		
									2		

Address Class Identification

Address	Class
10.250.1.1	<u> <i>A</i> </u>
150.10.15.0	<u> <i>B</i> </u>
192.14.2.0	<u> </u>
148.17.9.1	<u> </u>
193.42.1.1	<u> </u>
126.8.156.0	<u> </u>
220.200.23.1	<u> </u>
230.230.45.58	<u> </u>
177.100.18.4	<u> </u>
119.18.45.0	<u> </u>
249.240.80.78	<u> </u>
199.155.77.56	<u> </u>
117.89.56.45	<u> </u>
215.45.45.0	<u> </u>
199.200.15.0	<u> </u>
95.0.21.90	<u> </u>
33.0.0.0	<u> </u>
158.98.80.0	<u> </u>
219.21.56.0	<u> </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 *188 . 10 . 0 . 0*
255.255.0.0 _____

10.10.48.80 *10 . 10 . 48 . 0*
255.255.255.0 _____

192.149.24.191
255.255.255.0 _____

150.203.23.19
255.255.0.0 _____

10.10.10.10
255.0.0.0 _____

186.13.23.110
255.255.255.0 _____

223.69.230.250
255.255.0.0 _____

200.120.135.15
255.255.255.0 _____

27.125.200.151
255.0.0.0 _____

199.20.150.35
255.255.255.0 _____

191.55.165.135
255.255.255.0 _____

28.212.250.254
255.255.0.0 _____

Host Addresses

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

188.10.18.2 *0 . 0 . 18 . 2*
255.255.0.0 _____

10.10.48.80 *0 . 0 . 0 . 80*
255.255.255.0 _____

222.49.49.11 _____
255.255.255.0

128.23.230.19 _____
255.255.0.0

10.10.10.10 _____
255.0.0.0

200.113.123.11 _____
255.255.255.0

223.169.23.20 _____
255.255.0.0

203.20.35.215 _____
255.255.255.0

117.15.2.51 _____
255.0.0.0

199.120.15.135 _____
255.255.255.0

191.55.165.135 _____
255.255.255.0

48.21.25.54 _____
255.255.0.0

Default Subnet Masks

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

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

ANDING With Default subnet masks

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

Default Subnet Masks:

Class A	255.0.0.0
Class B	255.255.0.0
Class C	255.255.255.0

ANDING Equations:

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

Sample:

What you see...

IP Address: 192 . 100 . 10 . 33

What you can figure out in your head...

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

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

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

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

ANDING With Custom subnet masks

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

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

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



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

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

Two formulas can provide this basic information:

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

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

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

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

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

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

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

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

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

What about that second subnet formula:

Number of subnets = $2^s - 2$

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

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

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

Class C Address unsubnetted:

195. 223 . 50 . 0

195.223.50.0 to 195.223.50.255

Class C Address subnetted (2 bits borrowed):

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

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

Notice that the subnet and broadcast addresses match.

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

The **CCNA** and **CCENT** certification exams may have questions which will require you to determine which formula to use, and 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 no ip subnet zero command is configured on your router	The ip subnet zero command is configured on your router (default setting)
	No other clues are given

Bottom line for the CCNA exams; if a question does not give you any clues as to whether or not to allow these two subnets, assume you can use them.

This workbook has you use the number of subnets = 2^S formula.

Custom Subnet Masks

Problem 1

Number of needed subnets **14**
 Number of needed usable hosts **14**
 Network Address **192.10.10.0**

Address class C

Default subnet mask 255 . 255 . 255 . 0

Custom subnet mask 255 . 255 . 255 . 240

Total number of subnets 16

Total number of host addresses 16

Number of usable addresses 14

Number of bits borrowed 4

Show your work for Problem 1 in the space below.

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

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

128
64
32
+16
<hr/> 240

16	Observe the total number of hosts.
-2	
<hr/> 14	Subtract 2 for the number of usable hosts.

Custom Subnet Masks

Problem 2

Number of needed subnets **1000**

Number of needed usable hosts **60**

Network Address **165.100.0.0**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 1,024

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 10

Show your work for Problem 2 in the space below.

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

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

128	128
64	+64
32	192
16	
8	
4	
2	
+1	
255	

Observe the total number of hosts.

Subtract 2 for the number of usable hosts.

64
-2
62

Custom Subnet Masks

Problem 3

Network Address **148.75.0.0 /26**

/26 indicates the total number of bits used for the network and subnetwork portion of the address. All bits remaining belong to the host portion of the address.

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 1,024

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 10

Show your work for Problem 3 in the space below.

	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Hosts	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Number of Subnets	-	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768
Binary values	-	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2
		148	75	0	0	0	0	0	0	0	0	0	0	0	0	0

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

128	128
64	+64
32	192
16	
8	
4	
2	
+1	
<u>255</u>	

64	Observe the total number of hosts.
-2	
<u>62</u>	Subtract 2 for the number of usable hosts.

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

Custom Subnet Masks

Problem 4

Number of needed subnets **6**

Number of needed usable hosts **30**

Network Address **210.100.56.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 4 in the space below.

		Number of Subnets					Number of Hosts						
		256	128	64	32	16	8	4	2	-			
	-	2	4	8	16	32	64	128	256				
		128	64	32	16	8	4	2	1	-	Binary values		
210	.	100	.	56	.	0	0	0	0	0	0		

Custom Subnet Masks

Problem 5

Number of needed subnets 6

Number of needed usable hosts **30**

Network Address **195.85.8.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 5 in the space below.

[illegible]

Custom Subnet Masks

Problem 6

Number of needed subnets **126**

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

Network Address 118.0.0.0

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 6 in the space below.

Number of Hosts	1	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536	131072	262144	524288	1048576	2097152	4194304	8388608	16777216	33554432	67108864	134217728	268435456	536870912	1073741824	2147483648	4294967296	8589934592	17179869184	34359738368	68719476736	137438953472	274877906944	549755813888	1099511627776	2199023255552	4398046511104	8796093022208	17592186044416	35184372088832	70368744177664	140737488355328	281474976710656	562949953421312	1125899906842624	2251799813685248	4503599627370496	9007199254740992	18014398509481984	36028797018963968	72057594037927936	144115188075855872	288230376151711744	576460752303423488	1152921504606846976	2305843009213693952	4611686018427387904	9223372036854775808	18446744073709551616	36893488147419103232	73786976294838206464	147573952589676412928	295147905179352825856	590295810358705651712	1180591620717411303424	2361183241434822606848	4722366482869645213696	9444732965739290427392	18889465931478580854784	37778931862957161709568	75557863725914323419136	151115727451828646838272	302231454903657293676544	604462909807314587353088	1208925819614629174706176	2417851639229258349412352	4835703278458516698824704	9671406556917033397649408	19342813113834066795298816	38685626227668133590597632	77371252455336267181195264	154742504910672534362390528	309485009821345068724781056	618970019642690137449562112	1237940039285380274899124224	2475880078570760549798248448	4951760157141521099596496896	9903520314283042199192993792	19807040628566084398385987584	39614081257132168796771975168	79228162514264337593543950336	158456325028528675187087900672	316912650057057350374175801344	633825300114114700748351602688	1267650600228229401496703205376	2535301200456458802993406410752	5070602400912917605986812821504	10141204801825835211973625643008	20282409603651670423947251286016	40564819207303340847894502572032	81129638414606681695789005144064	162259276829213363391578010288128	324518553658426726783156020576256	649037107316853453566312041152512	1298074214633706907132624082305024	2596148429267413814265248164610048	5192296858534827628530496329220096	10384593717069655257060992658440192	20769187434139310514121985316880384	41538374868278621028243970633760768	83076749736557242056487941267521536	166153499473114484112975882535043072	332306998946228968225951765070086144	664613997892457936451903530140172288	1329227995784915872903807060280344576	2658455991569831745807614120560689152	5316911983139663491615228241121378304	10633823966279326983230456482242756608	21267647932558653966460912964485513216	42535295865117307932921825928971026432	85070591730234615865843651857942052864	170141183460469231731687303715884105216	340282366920938463463374607431768210432	680564733841876926926749214863536420864	1361129467683753853853498429727072841728	272225893536750770770699685945414568352	544451787073501541541399371890829136704	1088903574147003083082798743781658273408	2177807148294006166165597487563316546816	4355614296588012332331194975126633093632	8711228593176024664662389950253266187264	17422457186352049329324779900506532354512	34844914372704098658649559801013064709024	69689828745408197317299119602026129418048	13937965749081639463459823920405225883616	27875931498163278926919647840810451767232	55751862996326557853839295681620903534464	111503725992653115707678591363241807068928	223007451985306231415357182726483614137856	44601
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Custom Subnet Masks

Problem 7

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

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 7 in the space below.

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

Custom Subnet Masks

Problem 8

Number of needed subnets **3**

Number of needed usable hosts **45**

Network Address **200.175.14.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

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 _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 9 in the space below.

Custom Subnet Masks

Problem 10

Number of needed usable hosts **60**

Network Address **198.100.10.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

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 _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 11 in the space below.

Custom Subnet Masks

Problem 12

Number of needed subnets **5**

Network Address **218.35.50.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

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 _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 13 in the space below.

Custom Subnet Masks

Problem 14

Number of needed subnets **10**

Network Address **172.59.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

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 _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

Show your work for Problem 15 in the space below.

Custom Subnet Masks

Problem 16

Number of needed usable hosts **29**

Network Address **23.0.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

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 ~					Number of Hosts				
256	128	64	32	16	8	4	2	1	Binary values
2	4	8	16	32	64	128	256		
128	64	32	16	8	4	2	1		
192	10	10	0	0	0	0	0	0	
(0)	0	0	0	0	192.10.10.0	to	192.10.10.15		
(1)	0	0	0	1	192.10.10.16	to	192.10.10.31		
(2)	0	0	1	0	192.10.10.32	to	192.10.10.47		
(3)	0	0	1	1	192.10.10.48	to	192.10.10.63		
(4)	0	1	0	0	192.10.10.64	to	192.10.10.79		
(5)	0	1	0	1	192.10.10.80	to	192.10.10.95		
(6)	0	1	1	0	192.10.10.96	to	192.10.10.111		
(7)	0	1	1	1	192.10.10.112	to	192.10.10.127		
(8)	1	0	0	0	192.10.10.128	to	192.10.10.143		
(9)	1	0	0	1	192.10.10.144	to	192.10.10.159		
(10)	1	0	1	0	192.10.10.160	to	192.10.10.175		
(11)	1	0	1	1	192.10.10.176	to	192.10.10.191		
(12)	1	1	0	0	192.10.10.192	to	192.10.10.207		
(13)	1	1	0	1	192.10.10.208	to	192.10.10.223		
(14)	1	1	1	0	192.10.10.224	to	192.10.10.239		
(15)	1	1	1	1	192.10.10.240	to	192.10.10.255		

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

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

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

The binary value of the last bit borrowed is the range. In this problem the range is 16.

The first address in each subnet range is the subnet number.

The last address in each subnet range is the subnet broadcast address.

Subnetting

Problem 2

Number of needed subnets **1000**

Number of needed usable hosts **60**

Network Address **165.100.0.0**

Address class B

Default subnet mask 255 . 255 . 0 . 0

Custom subnet mask 255 . 255 . 255 . 192

Total number of subnets 1,024

Total number of host addresses 64

Number of usable addresses 62

Number of bits borrowed 10

What is the 15th
subnet range? 165.100.3.128 to 165.100.3.191

What is the subnet number
for the 6th subnet? 165 . 100 . 1 . 64

What is the subnet
broadcast address for
the 6th subnet? 165 . 100 . 1 . 127

What are the assignable
addresses for the 9th
subnet? 165.100.2.1 to 165.100.0.62

Show your work for Problem 2 in the space below.

Number of Hosts -	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets -	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384	32768	65536
Binary values -	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
165 . 100 . 0 . 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Usable hosts	64	128	256	512	1024	2048	4096	8192	16384	32768	65536	131072	262144	524288	1048576	2097152
Custom subnet mask	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
192 . 168 . 1 . 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
255 . 255 . 255 . 0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
The binary value of the last bit borrowed is the range. In this problem the range is 64.	(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
The first address in each subnet range is the subnet number.	165.100.0.0	165.100.0.64	165.100.0.128	165.100.0.192	165.100.0.255	165.100.1.0	165.100.1.63	165.100.1.127	165.100.1.191	165.100.1.255	165.100.2.0	165.100.2.63	165.100.2.127	165.100.2.191	165.100.2.255	165.100.3.0
The last address in each subnet range is the subnet broadcast address.	165.100.0.63	165.100.0.127	165.100.0.191	165.100.0.255	165.100.1.63	165.100.1.127	165.100.1.191	165.100.1.255	165.100.2.63	165.100.2.127	165.100.2.191	165.100.2.255	165.100.3.63	165.100.3.127	165.100.3.191	165.100.3.255
	Down to															
(1022)	1	1	1	1	1	1	1	1	1	0	165.100.255.128	to	165.100.255.191			
(1023)	1	1	1	1	1	1	1	1	1	1	165.100.255.192	to	165.100.255.255			

Subnetting

Problem 3

Number of needed subnets **2**

Network Address **195.223.50.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 3rd
subnet range? _____

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

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

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

Show your work for Problem 3 in the space below.

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

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

Subnetting

Problem 4

Number of needed subnets **750**

Network Address **190.35.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 15th
subnet range? _____

What is the subnet number
for the 13th subnet?

What is the subnet
broadcast address for
the 10th subnet?

What are the assignable
addresses for the 6th
subnet?

Show your work for Problem 4 in the space below.

Subnetting

Problem 5

Number of needed usable hosts **6**

Network Address **126.0.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 2nd
subnet range? _____

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

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

What are the assignable
addresses for the 10th
subnet? _____

Show your work for Problem 5 in the space below.

Subnetting

Problem 6

Number of needed subnets **10**

Network Address **192.70.10.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 9th
subnet range? _____

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

What is the subnet
broadcast address for
the 12th subnet? _____

What are the assignable
addresses for the 10th
subnet? _____

Show your work for Problem 6 in the space below.

Subnetting

Problem 7

Network Address **10.0.0.0 /16**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 11th
subnet range? _____

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

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

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

Show your work for Problem 7 in the space below.

Subnetting

Problem 8

Number of needed subnets **5**

Network Address **172.50.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 4th
subnet range? _____

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

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

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

Show your work for Problem 8 in the space below.

Subnetting

Problem 9

Number of needed usable hosts **28**

Network Address **172.50.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 2nd
subnet range? _____

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

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

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

Show your work for Problem 9 in the space below.

Subnetting

Problem 10

Number of needed subnets **45**

Network Address **220.100.100.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 5th
subnet range? _____

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

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

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

Show your work for Problem 10 in the space below.

Subnetting

Problem 11

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

Network Address **135.70.0.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 6th
subnet range? _____

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

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

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

Show your work for Problem 11 in the space below.

Subnetting

Problem 12

Number of needed usable hosts **45**

Network Address **198.125.50.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 2nd
subnet range? _____

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

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

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

Show your work for Problem 12 in the space below.

Subnetting

Problem 13

Network Address **165.200.0.0 /26**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 10th
subnet range? _____

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

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

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

Show your work for Problem 13 in the space below.

Subnetting

Problem 14

Number of needed usable hosts **16**

Network Address **200.10.10.0**

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 7th
subnet range? _____

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

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

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

Show your work for Problem 14 in the space below.

Subnetting

Problem 15

Network Address **93.0.0.0** \19

Address class _____

Default subnet mask _____

Custom subnet mask _____

Total number of subnets _____

Total number of host addresses _____

Number of usable addresses _____

Number of bits borrowed _____

What is the 15th
subnet range? _____

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

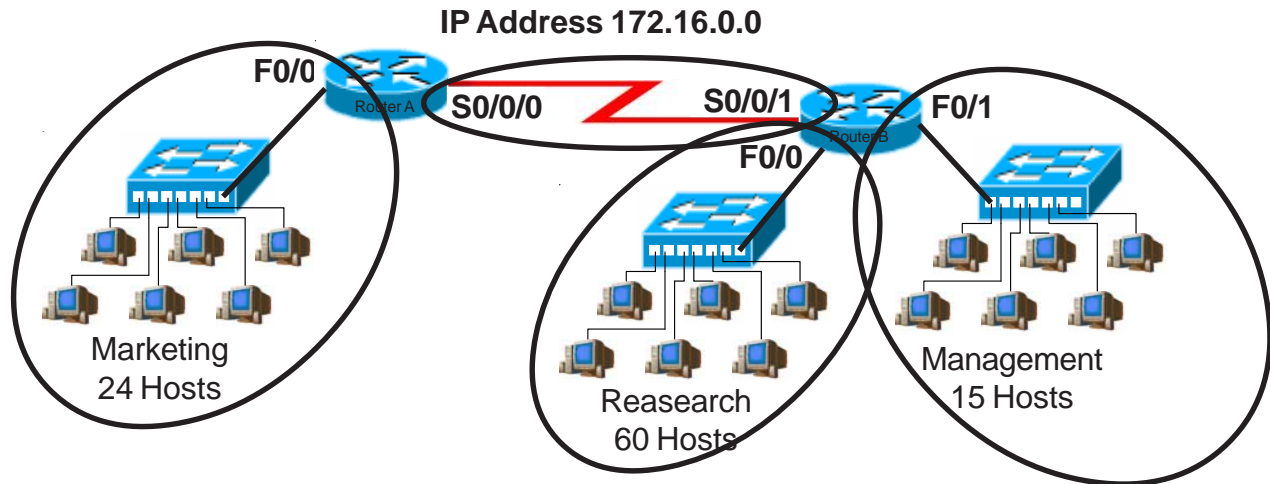
What is the subnet
broadcast address for
the 7th subnet? _____

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

Show your work for Problem 15 in the space below.

Practical Subnetting 1

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



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

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

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

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

Number of Hosts -	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets -	2	4	8	16	32	64	128	256	512	1,024	2,048	4,096	8,192	16,384	32,768	65,536
Binary values -	128	64	32	16	8	4	2	1	256	128	64	32	16	8	4	2
172 . 16 . 0 0 0 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(0)	0															
(1)		1														
(2)			1	0												
(3)				1	1											
(4)					1	0	0									
(5)						1	0	1								
(6)							1	1	0							
(7)								1	1	1						

Practical Subnetting 2

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



Address class B

Custom subnet mask 255.255.255.224

Minimum number of subnets needed 5

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

Total number of subnets needed = 7

Number of host addresses in the largest subnet group 20

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

Total number of address needed for the largest subnet = 26

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

IP address range for Tech Ed 135.126.0.0 to 135.126.0.31

IP address range for English 135.126.0.32 to 135.126.0.63

IP address range for Science 135.126.0.64 to 135.126.0.95

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

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

Show your work for Problem 2 in the space below.

Number of Hosts -	65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256	128	64	32	16	8	4	2
Number of Subnets -	2	4	8	16	32	64	128	256	512	1,024	2,048	4,096	8,192	16,384	32,768	65,536
Binary values -	128	64	32	16	8	4	2	1	128	64	32	16	8	4	2	1
135.126.0.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(0)	0															to
(1)	1															to
(2)		1														to
(3)		1														to
(4)			1													to
(5)			1													to
(6)			1													to
(7)			1													to
(8)			0													to
(9)			0													to
(10)			0													to
(11)			0													to
(12)			1													to
(13)			1													to
(14)			1													to
(15)			1													to

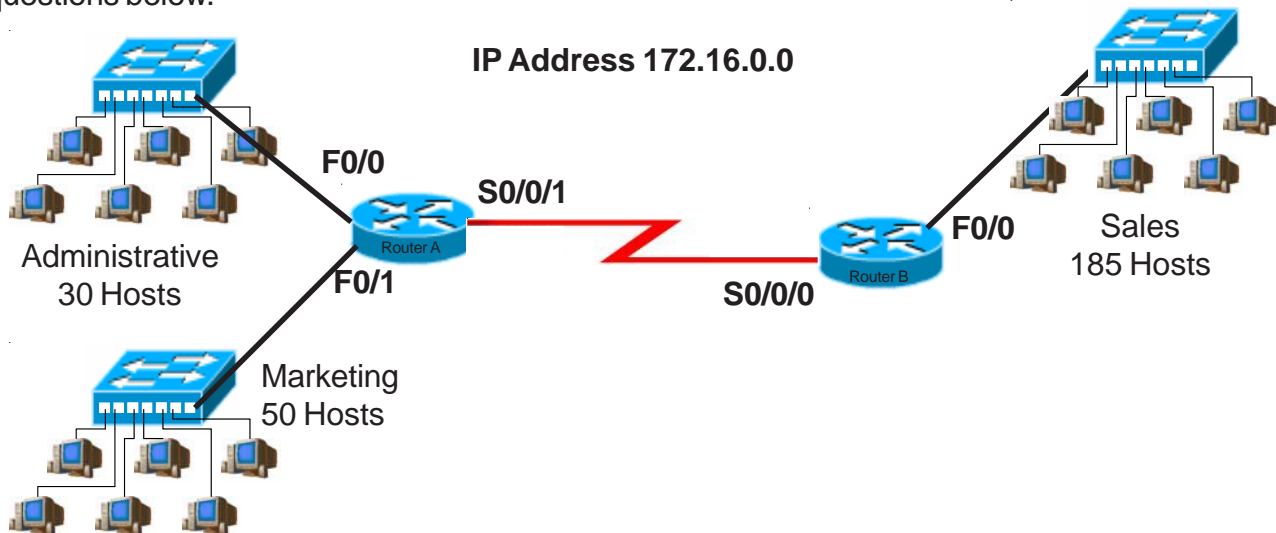
$$\begin{array}{r} 5 \\ \times 3 \\ \hline 15 \end{array}$$

(Round up to 2)

$$\begin{array}{r} 20 \\ \times 3 \\ \hline 60 \end{array}$$

Practical Subnetting 3

Based on the information in the graphic shown, design a classfull network addressing scheme that will supply the **minimum number of hosts per subnet**, and allow enough extra subnets and hosts for 25% growth in all areas. Circle each subnet on the graphic and answer the questions below.



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

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

Total number of subnets needed **=** _____

Number of host addresses
in the largest subnet group _____

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

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

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

IP address range for Sales _____

IP address range for Marketing _____

IP address range for Administrative _____

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

Show your work for Problem 3 in the space below.

Practical Subnetting 4

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



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

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

Total number of subnets needed **=** _____

Number of host addresses
in the largest subnet group _____

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

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

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

IP address range for New York _____

IP address range for Washington D. C. _____

IP address range for Dallas _____

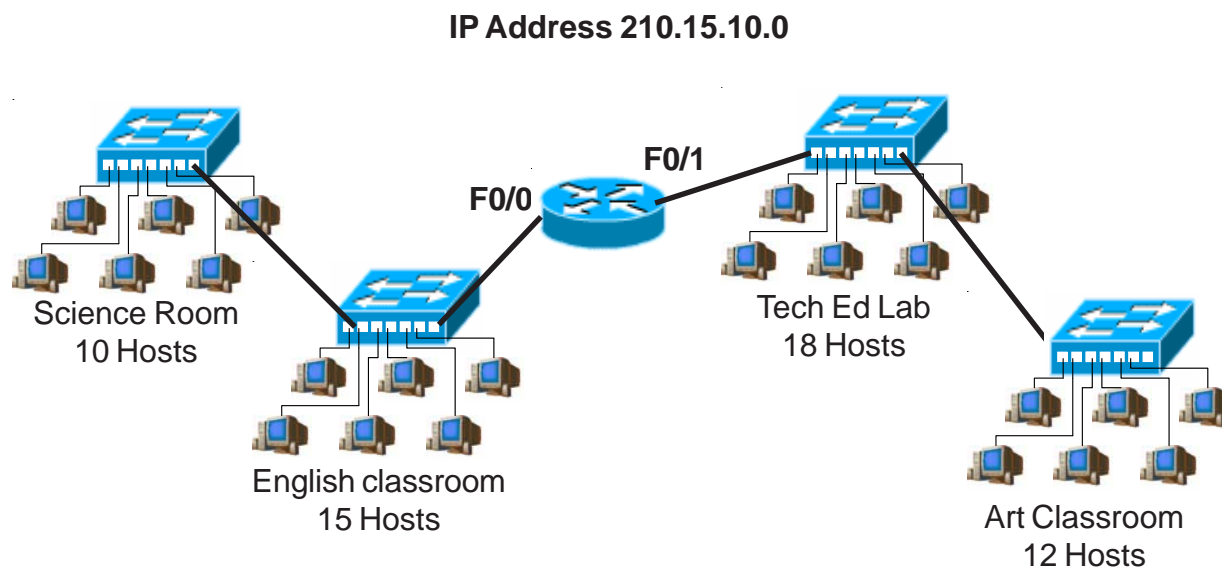
IP address range for Router A
to Router B serial connection _____

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

Show your work for Problem 4 in the space below.

Practical Subnetting 5

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



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

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

Total number of subnets needed **=** _____

Number of host addresses
in the largest subnet group _____

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

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

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

IP address range for Router F0/0 Port _____

IP address range for Router F0/1 Port _____

Show your work for Problem 5 in the space below.

Practical Subnetting 6

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



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

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

Total number of subnets needed **=** _____

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

IP address range for Technology _____

IP address range for Science _____

IP address range for Arts & Drama _____

IP Address range Administration _____

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

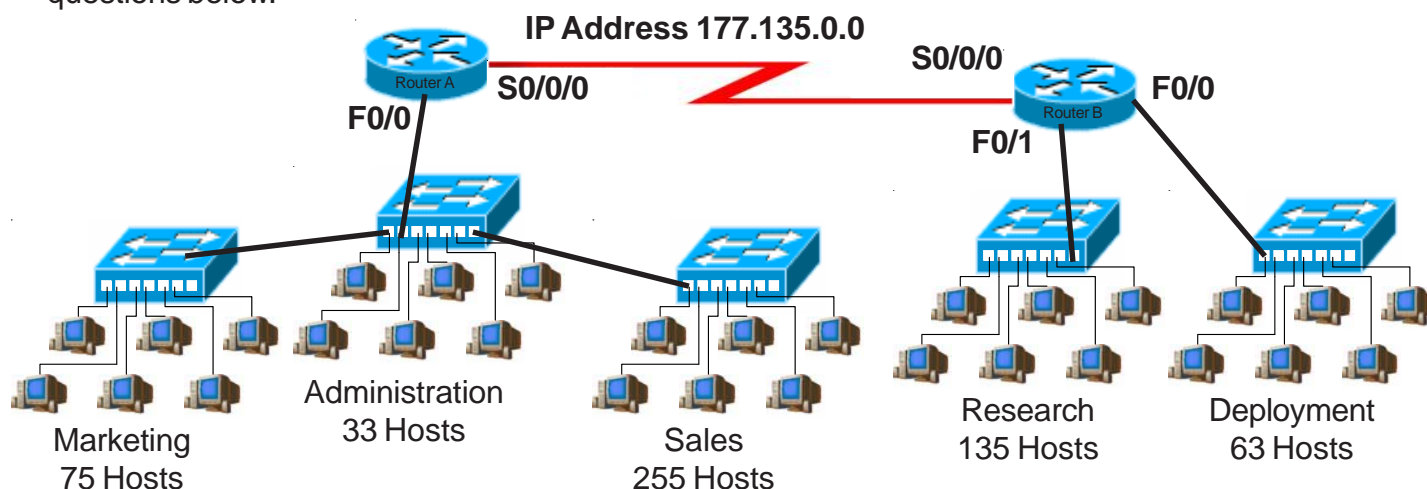
IP address range for Router A
to Router C serial connection _____

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

Show your work for Problem 6 in the space below.

Practical Subnetting 7

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



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

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

Total number of subnets needed **=** _____

Number of host addresses
in the largest subnet group _____

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

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

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

IP address range for Router A Port F0/0 _____

IP address range for Research _____

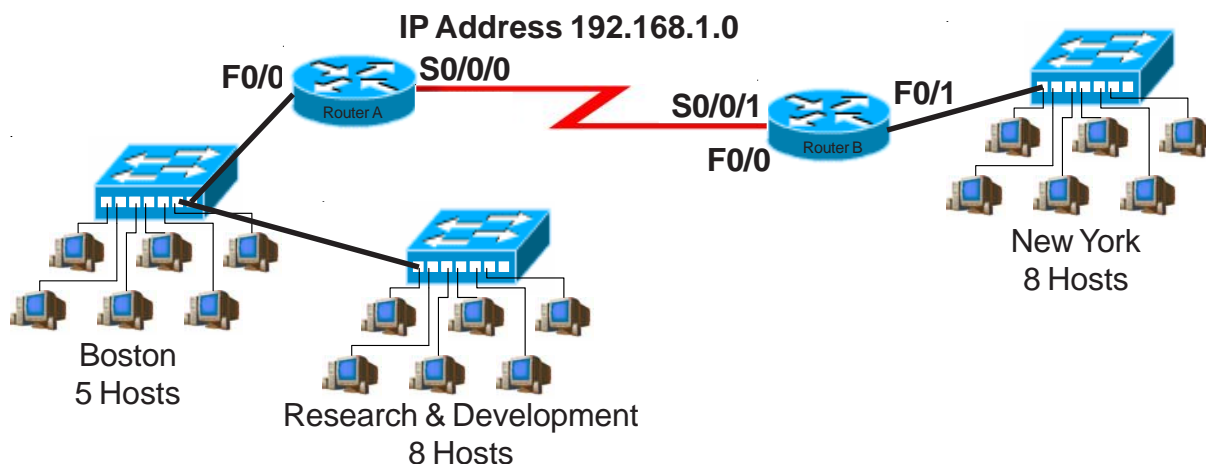
IP address range for Deployment _____

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

Show your work for Problem 7 in the space below.

Practical Subnetting 8

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



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

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

Total number of subnets needed $=$ _____

Number of host addresses
in the largest subnet group _____

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

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

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

IP address range for Router A F0/0 _____

IP address range for New York _____

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

Show your work for Problem 8 in the space below.

Practical Subnetting 9

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



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

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

Total number of subnets needed = _____

Number of host addresses
in the largest subnet group _____

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

Total number of address
needed for the largest subnet = _____

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

IP address range for Ft. Worth _____

IP address range for Dallas _____

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

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

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

Show your work for Problem 9 in the space below.

Practical Subnetting 10

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



Address class _____

Custom subnet mask _____

Minimum number of subnets needed _____

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

Total number of subnets needed **=** _____

Number of host addresses
in the largest subnet group _____

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

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

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

IP address range for Sales/Management _____

IP address range for Marketing _____

IP address range for Research _____

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

Show your work for Problem 10 in the space below.

Valid and Non-Valid IP Addresses

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

IP Address: 0.230.190.192

Subnet Mask: 255.0.0.0

Reference Page Inside Front Cover

The network ID cannot be 0.

IP Address: 192.10.10.1

Subnet Mask: 255.255.255.0

Reference Pages 28-29

OK

IP Address: 245.150.190.10

Subnet Mask: 255.255.255.0

Reference Page Inside Front Cover

IP Address: 135.70.191.255

Subnet Mask: 255.255.254.0

Reference Pages 48-49

IP Address: 127.100.100.10

Subnet Mask: 255.0.0.0

Reference Pages Inside Front Cover

IP Address: 93.0.128.1

Subnet Mask: 255.255.224.0

Reference Pages 56-57

IP Address: 200.10.10.128

Subnet Mask: 255.255.255.224

Reference Pages 54-55

IP Address: 165.100.255.189

Subnet Mask: 255.255.255.192

Reference Pages 30-31

IP Address: 190.35.0.10

Subnet Mask: 255.255.255.192

Reference Pages 34-35

IP Address: 218.35.50.195

Subnet Mask: 255.255.0.0

Reference Page Inside Front Cover

IP Address: 200.10.10.175 /22

Reference Pages 54-55 and/or Inside Front Cover

IP Address: 135.70.255.255

Subnet Mask: 255.255.224.0

Reference Pages 48-49

IP Address Breakdown

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

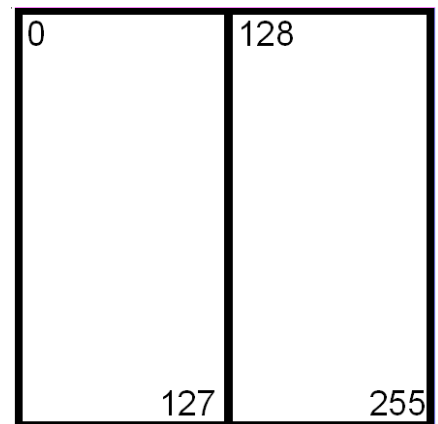
Start with a square. The whole square is a single subnet comprised of 256 addresses.

/24
255.255.255.0
256 Hosts
1 Subnet



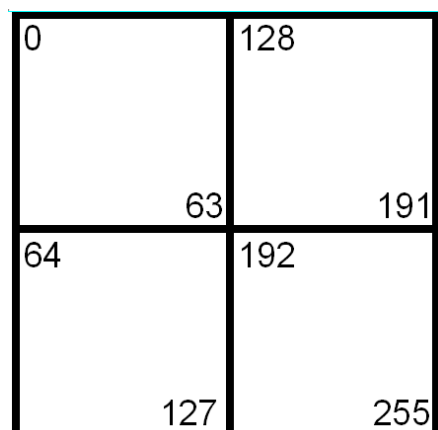
Split the box in half and you get two subnets with 128 addresses,

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

Class A Addressing Guide

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

Class B Addressing Guide

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

Class C Addressing Guide

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

